Fisheries Abstracts

Oral Presentation

Listed Alphabetically by Presenter

Repatriation planning for Rio Grande Cutthroat Trout in streams affected by the Las Conchas Fire

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Catastrophic wildfire can be a threat to native fishes, but also a tool in the restoration toolbox. In New Mexico, The Las Conchas Fire of 2011 eradicated non-native fishes in 7 streams, opening up new habitats in which to reintroduce populations of the native Rio Grande Cutthroat Trout (RGCT). Using the "Three Rs" framework for species conservation (resiliency, redundancy, and representation), we determined that these small, newly available streams should be used to replicate existing RGCT populations elsewhere within their historic range. Two approaches were used to decide which aboriginal RGCT populations would be replicated. One approach is to replicate populations that are large and have high genetic diversity. The other is to replicate populations that are at risk of extirpation such as those sympatric with competing non-native fishes. Since there are positive and negative aspects of each of these, 7 source populations were selected along the spectrum between the two approaches. As catastrophic fire, non-native invasions, and habitat loss continue to threaten native fishes throughout the Western U.S., deciding how to incorporate redundancy in repatriation planning will be needed to prevent the loss of individual populations and ensure the long-term persistence of RGCT and other species of conservation concern.

Factors affecting angler satisfaction and catch rates in Arizona streams

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The Arizona Game and Fish Department's stream trout stocking program costs approximately $2.2 million annually and recreational sport fishing in Arizona provides $1.47 billion in economic benefits. Stream trout anglers contribute to a large proportion of the total fishing license sales in Arizona and 69% of active anglers in 2013 reported that they preferred fishing for trout. Given the large economic impact of this program it is important to understand the factors (e.g., catch rates) that influence stream trout angler satisfaction and catch rates (e.g., number of trout stocked, days post stocking) to improve and maintain the efficiency of Arizona's stream trout stocking program. Our objectives were to evaluate factors affecting angler satisfaction and catch rates in Arizona streams. Creel surveys were conducted on six Arizona streams during the summers of 2013-2016. Multinomial logistic regression was used to model angler satisfaction. Hurdle models were used to model angler catch rates. In total, creel surveys were conducted on 487 days, resulting in 4,984 angler interviews. Interviewed anglers fished for 8,319 hours, and caught 4,311 Rainbow Trout *Oncorhynchus mykiss* and 5,347 Apache Trout *Oncorhynchus apache*. Results from multinomial logistic regression suggest catch rate, age, and terminal tackle were the most important factors influencing angler satisfaction. Hurdles models suggest that days post stocking, the number of trout stocked per km, and the terminal tackle type were the most important factors

influencing angler catch rates. Results suggest that managers might consider stocking closer to weekends to improve catch rates and angler satisfaction.

Movement of stocked Rainbow and Apache Trout in Arizona streams

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Arizona Game and Fish Department's stream trout stocking program costs approximately $2.2 million annually and recreational sport fishing in Arizona provides $1.47 billion in economic benefits. Stream trout anglers contribute to a large proportion of the total fishing license sales in Arizona and 69% of active anglers in 2013 reported that they preferred fishing for trout. Despite the economic importance, little is known about the fate and movements of hatchery trout released in Arizona streams. Our objectives were to determine the fate and movement of hatchery trout released in Arizona streams. A total of 490 VHF radio tags were implanted in Rainbow Trout *Oncorhynchus mykiss* and Apache Trout *Oncorhynchus apache* and released in three Arizona streams during the summers of 2014-2016. Radio tagged fish were tracked for ten days immediately following release, and once per week every six weeks thereafter. In general, radio tagged fish did not move far from where they were released (< 1-2 km). The percentage of trout left in the stream after one week varied from 20 to 59%. Harvest of trout by anglers varied from 20 to 25%. Nonhuman predation of trout varied from 6 to 25%. Persistence of trout in Arizona streams was higher than expected (20-59%) and return to creel rates were similar to others reported in the literature. Results suggest managers might consider stocking sites close to areas of high angler use.

Fish are friends, not food? Angler attitudes at Lees Ferry

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There is widespread anecdotal evidence that catch and release angling has become more prevalent in many recreational fisheries, but there have been few empirical studies documenting shifts in angler behavior. We used a 40 year creel dataset from the Rainbow Trout fishery in the Colorado River at Lees Ferry, Arizona, to examine changes in harvest rates over time. We observed two distinct changes in harvest rates. Before 1990, mean harvest per angler was 1.08 fish (SD, 1.13), or 52% (SD, 39%) of their catch. From 1990 - 1993, we observed lower numbers of fish being harvested (mean, 0.32; SD, 0.86; mean 12%; SD, 24% of catch). From 1994 – 1997 there was a further reduction in numbers of fish harvested. Between 1997 and the present, anglers have harvested only 0.15 (SD, 0.63) fish per angler, or 3% (SD, 15%) of their catch, releasing 97% (SD, 14%) of fish caught. Concurrent with changes in harvest, we observed changes in fishing gear used by anglers. Fly fishing became more common than bait and spin fishing as regulations and social factors changed; during the last five years 52% to 68% of anglers at Lees Ferry have been fly fishing. Some management strategies that are effective in heavily harvested fisheries are not effective in primarily catch and release fisheries, so knowledge about harvest rates can inform management decisions. Additionally, information about harvest rates can be used to explain decisions to the public when social concerns are as high profile as biological concerns.

Genetic Distinctness of a Population of Rio Grande Chub in the Rio Mora, NM

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The Rio Grande Chub (*Gila pandora)* is presently listed as a species of least concern however, its range has been steadily declining. Formerly, the fish was widespread throughout the upper Rio Grande and Pecos watersheds and now only exists in the Pecos and Canadian River drainages, the latter an area where it was possibly introduced. Within the Rio Mora, a tributary of the Canadian River, we worked to determine if a population of Rio Grande Chub found there are genetically distinct from those in the Pecos and Rio Grande watershed. We did microsatellite analysis from Rio Grande Chub fin clip samples collected in the Rio Mora Wildlife Refuge, NM. This aids determination of how and when the species arrived in that area and if that population warrants special protection. We compared the Rio Mora DNA samples with samples from 18 other locations previously collected. Data from 7 microsatellite loci were analyzed to assess genetic diversity, Hardy-Weinberg, allelic richness, and population structure analysis between the 19 tested populations. Our data showed that samples from the Mora River were closely related to those collected from the Pecos River.

Conservation and recovery of the Gila topminnow in the United States

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Originally listed in 1967, the Gila Topminnow (*Poeciliopsis occidentalis*) occurs in the Gila River basin in New Mexico, Arizona, and Sonora, and in other river basins in Sonora. Once the commonest fish in the Gila basin, it was reduced to two or three known populations when listed. The species has been released to hundreds of wild and captive sites since listing, with an active recovery program over the last decade. A revised recovery plan has been in draft form for more than 20 years. The basic action called for in the plan is for Topminnow from the known Management Units to be reestablished. Reestablished populations must be broadly distributed within historical range. The plan mirrors the Desert Pupfish Recovery Plan, using three tiers to classify populations. Tier 1 is naturally occurring populations that must be protected, and if lost, reestablished if possible. Tier 2 is reestablished stable and secure populations at wild natural, or enhanced natural sites, within historical range of the species, and have survived at least five years. Lastly, Tier 3 includes reestablished sites that have not survived five years, or may require extensive human intervention. Captive sites can count as Tier 3, which I believe is contrary to the stated intent of the Endangered Species Act, which states that recovery should be in the wild. Captive sites counting towards recovery and other criteria in the recovery plan have been reduced over time. I will discuss the history of draft plan revisions and the near future.

Abundance and growth of age 0 humpback chub in the Little Colorado River, AZ

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Age 0 fish are difficult to sample, and consequently little is known about the mechanisms that affect survival and growth of age 0 desert fishes. This presentation describes a mark-recapture study of age 0 humpback chub *Gila cypha*, initiated by U.S. Geological Survey biologists in 2013. Biologists marked

age 0 humpback chub with visual implant elastomer (VIE) tags during July sampling trips to the Little Colorado River (LCR), a tributary to the Colorado River that is the primary spawning location for humpback chub in the lower Colorado River below Glen Canyon Dam. Mark-recapture information was used to evaluate spatiotemporal differences in total length and abundance of age 0 humpback chub. Results indicate that size of age 0 humpback chub differed in 2013 and 2014, and that abundance of these juvenile chub varies spatially within the LCR. Continuing to monitor age 0 humpback chub will help provide insight as to which environmental and biological factors influence recruitment of this endangered species.

Developing a useful stocking evaluation method for winter trout waters in southeast New Mexico utilizing remote camera technology

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Stocking catchable size Rainbow Trout (> 8") plays an integral role in sport fisheries management of winter trout waters in southeast New Mexico. We implemented a study to determine if current stocking strategies provide maximum benefit to the angling public while ensuring the most efficient use of hatchery stock. Our objectives were to estimate angler use, harvest rates, catch rates, level of angler satisfaction, and develop an effective creel survey protocol. Roving creel surveys were designed to interview anglers during randomly selected days and times during the winter trout season at six southeast area lakes. Trail cameras stationed at two lakes were used simultaneous with creel surveys to monitor angler use at hourly intervals. This study is ongoing throughout the 2017-18 winter trout season with the intention of reducing or eliminating creel surveys in the future while continuing to utilize trail cameras to estimate angler use. Stocking strategies would then be modified throughout the remaining southeast area winter trout waters based on angler use and the mean harvest and catch rates estimated during the study. While preliminary results indicate more intensive creel surveys may be necessary to increase confidence in catch rate, harvest rate, and angler satisfaction estimates, thus far, angler use data analyzed using creel surveys compared to the trail cameras was not significantly different.

More-bigger: the challenges of managing put and take Rainbow Trout fisheries in New Mexico

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The New Mexico Department of Game and Fish has developed and implemented a number of fisheries management strategies. Many of these strategies have been in effect for decades – often perpetuated by tradition and angler expectations fostered through historic stocking practices. Catchable-sized trout stocking has evolved as a strategy of maintaining a viable fishery in environmentally perturbed areas. Early stocking schedules were developed through assessing hatchery and transportation capabilities serving as foundation on which current schedules are based. In the 1980's and 1990's we began to assess schedules in a predictive fashion to try and optimize efficiency of the system. We have revised this view since the mid-2000's to assess angler use and satisfaction in modifying stocking schedules. Additionally we have taken steps to understand availability of stocked fish to the angler and how that might affect the success of a stocking program. Current stocking recommendations are made with consideration of our management goals as set out in our 2016 Statewide Fisheries Management Plan.

Mechanical suppression of nonnative trout leads to increases in abundance of native fishes in Bright Angel Creek, Grand Canyon

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Nonnative species introductions and habitat modifications due to the construction of Glen Canyon Dam upstream have caused the decline of native fishes in Grand Canyon National Park. Nonnative salmonids that prey on or compete with native fish, including the Brown Trout (*Salmo trutta*) and Rainbow Trout (*Oncorhynchus mykiss*), are particularly threatening because they thrive in cooler waters in the Colorado River tailwater below the dam. Despite these threats, the largest remaining population of endangered Humpback Chub remains centered on the Little Colorado River inflow in Grand Canyon. Trout control, via electrofishing, has been a focus of conservation measures for Humpback Chub (*Gila cypha*) in U.S. Fish and Wildlife Biological Opinions on the U. S. Bureau of Reclamation's (USBR) operation of the dam, but past efforts mainly targeted the Little Colorado River inflow reach. Beginning in 2012, the National Park Service, with funding provided by the USBR, implemented an annual experimental trout control project in Bright Angel Creek, which was the primary source of brown trout spawning in Grand Canyon, to attempt to enhance the native fish community in the creek and reduce predation upon Humpback Chub throughout the Colorado River. Through 2017, mechanical removal efforts over 16 kilometers of Bright Angel Creek, combined with the operation of a weir near the mouth to trap brown trout on spawning migrations into the creek, has resulted in a decline in trout abundance of >65%, and increases in recruitment, abundance, and distribution of native species.

The trials and errors of quantitative gene expression work with a novel fish model organism

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Field studies are essential for assessing location-specific research questions and examining current environmental risks. However these studies are often limited by the availability and presence of model organisms within a specific research site. Working with a novel model organism poses challenges for laboratory analyses, including genetic work. My project aims to evaluate the effects of current polychlorinated biphenyl (PCB) exposure on stress, immune, and cancer-related genes in ninespine stickleback (*Pungitius pungitius*) from St. Lawrence Island, Alaska. The improper storage and remediation of the Northeast Cape formerly used defense (FUD) site continues to contribute PCBs to the local environment and poses a threat to the health of local wildlife. Ninespine stickleback are native to St. Lawrence Island and easily collected from the field, however its genome is not publically available. In

order to quantitatively analyze gene expression in ninespine stickleback, we developed a method for primer design using genomic comparison analyses and draft genomic alignments in Linux. We also developed procedures to optimize and standardize qPCR conditions for ninespine stickleback. This research outlines the trials and errors of assessing gene expression in a novel fish model andsuggests optimization methods for this type of work.

Evaluating relationships between fish populations and flow regime in Arizona streams

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Conserving the natural flow regime of streams is critical to safeguarding the diversity of native fish species throughout river systems. To understand the relationship between fish species and flow regime, scientists have used stream flow statistics based on USGS gage stations to characterize streams and compared these statistics to the relative abundance of species in these streams. In Arizona's streams, fish populations and flow can vary significantly throughout a single river, and these statistics may not represent the diversity of flows and fish populations found throughout each stream. The USGS program StreamStats uses regional regression models to create flow-related statistics for a precise location in a stream based on drainage area. Our research uses these statistics and relative abundance of fish species at precise locations to examine relationships between StreamStats statistics and fish populations within four Arizona streams. StreamStats statistics analyzed included peak 2-year flow, peak 10-year flow, and peak 100-year flow. We also use flow statistics from USGS gage stations. This information can provide critical information to managers on how flow dynamics interact with different fish species in arid-land rivers. Future research will expand upon these analyses to include historical data.

Classification Success of Species within the *Gila robusta* Complex Using Morphometric and Meristic Characters - A Reexamination

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Three cyprinids often referred to as the *Gila robusta* complex, *G. robusta*, *G. nigra*, and *G. intermedia*, are morphologically similar and genetically indistinguishable at the currently recognized species level. Current taxonomy is based on morphometric and meristic differences detailed in a classification key; however, the ability of the key to reliably distinguish the species has recently come into question. Chubs were collected in Arizona and two methods were used to predict species' identification using the key: 1) correct assignment to species using cluster analysis and multinomial logistic regression; and 2) observer identification success by species. Cluster analysis and multinomial logistic regression correctly assigned 62% and 74% of fish, respectively, to the assumed species designation. Identification success using both methods was most successful for *G. robusta* (82% cluster; 82% regression), followed by *G. intermedia* (53% cluster; 80% regression), and *G. nigra* (49% cluster; 58% regression). Overall observer identification success was 54%, led by *G. intermedia* (68%), followed by *G. robusta* (63%), and *G. nigra*

(33%). The high level of misidentification appears to be due to overlap in morphometric and meristic characters among assumed species groups. Although the three species are currently considered allopatric, sympatry was found in 88%, 76%, and 100% of locations in the cluster analysis, regression analysis, and observer analysis, respectively. These results indicate that the morphometric and meristic characters in the key do not consistently distinguish the three putative chub species. Because independent genetic analyses also fail to support the delineation of the three species, we consider *G. robusta* as a single polymorphic species a viable hypothesis.

Blue River Native Fish Restoration Project

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The Blue River Native Fish Restoration Project is a multi-agency effort focused on protecting and restoring the native fish assemblage within the Blue River drainage in eastern Arizona. The project was initially focused on the lower 19 km of the Blue River, from Fritz Ranch to its confluence with the San Francisco, and consisted of three main components: construction of a fish barrier (completed in 2012), mechanical removal of nonnative piscivorous fishes, and repatriation and monitoring of federally listed warm-water fishes. Between 2009-2017, Arizona Game and Fish Department staff conducted 7 nonnative piscivorous fish removal efforts (Flathead Catfish, Channel Catfish, Common Carp, and Green Sunfish), 6 native fish stockings (2 Spikedace, 2 Loach Minnow, and 2 Roundtail Chub), and 6 post-stocking monitoring efforts in the lower Blue River. As of 2017, large-bodied piscivorous fish have not been detected in the lower Blue River for four years and Green Sunfish have not been detected for one year. Spikedace and Roundtail Chub have also established self-sustaining populations, and Loach Minnow abundance appears to be increasing following the 2011 Wallow Fire. Due to these successes in the lower Blue River, restoration efforts have expanded upstream to include the middle Blue River between The Box and McKittrick Creek. Roundtail Chub and Spikedace were stocked into the middle Blue River in 2016 and 2017, respectively, in efforts to expand the range of these species in the river. Roundtail Chub monitoring efforts in 2017 detected 57 Roundtail Chub in the middle Blue River; however, additional monitoring efforts are needed to determine if this population is establishing.

A review of research behind using native fish as baitfish

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Anglers using non-native species as live bait represent a significant risk of introducing aquatic nuisance species across the state. Examples abound of situations where live bait has escaped or been introduced and subsequently caused damage to fish communities. Requiring the use of native species as bait can mitigate this damage. Research is in progress to determine viable methods of propagation, collection, and use of Longfin dace (*Agosia chrysogaster*) and Sonora sucker (*Catostomus insignis*) as live bait. Spawning techniques, feed types, effective capture methods, fecundity, and rigging mortality are aspects currently being researched. This research will contribute to planning for commercial production of native baitfish in the future.

Stream-Specific and Generalized Habitat Suitability Criteria for Three Native Desert Fishes

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Endemic fishes of the arid southwestern United States have rapidly declined due to anthropogenic stressors. Identifying the habitat conditions needed by these species is critical for their successful management. Habitat suitability criteria are commonly used to conserve species of interest. Therefore, developing habitat suitability criteria for native fish species across multiple rivers permits better understanding of how different environments are occupied under various circumstances. We developed stream-specific and generalized criteria for Longfin Dace *Agosia chrysogaster*, Speckled Dace *Rhinichthys osculus*, and Desert Sucker *Pantosteus clarki*, across four central Arizona streams. Over 1,200 sites were sampled using pre-positioned electrofishing devices during the 2017 summer low-flow period to identify relationships among fish presence and habitat variables (depth, velocity, and substrate class). Optimal (central 50% of range used) and suitable (central 95% of range used) ranges within each habitat variable were calculated for each stream, based on the occurrence of each species. In general, Longfin Dace occupied depths of 9.00 – 54.75 cm (14.25 – 27.25 cm) velocities of 0.00 – 0.63 m/sec (0.11 – 0.31 m/sec), and substrate (modified Wentworth scale) of 0.5 – 4.3 (2.1 – 3.3). Speckled Dace occupied depths of 8.25 – 74.00 cm (17.00 – 34.25 cm) velocities of 0.00 – 0.74 m/sec (0.16 – 0.43 m/sec), and substrate of 0.0 – 4.5 (2.2 – 3.6). Desert Sucker occupied depths of 9.00 – 45.00 cm (15.25 – 25.00 cm) velocities of 0.09 – 0.72 m/sec (0.21 – 0.44 m/sec), and substrate of 1.0 – 4.6 (2.5 – 3.7). Generalized habitat suitability criteria for all three species were significantly (P<0.05) transferable with the exception of substrate class.

Through the fish's eye: Comparison of densiometer and inexpensive hemispherical photography to assess streamside canopy

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The spherical densiometer is a common field tool that measures the overstory density, commonly known as canopy cover, of forested areas. This tool has been used in several fish habitat studies, stream surveys, and sampling protocols when assessing coverage of riparian vegetation over streams. Although densiometers are very effective they cannot visually document an ever-changing canopy. Hemispherical photography is another tool that has been developed to evaluate the forest canopy. Photographs are taken in an upward direction using a wide-angle lens and post processed with image-analyzing software. However, hemispherical photography systems are typically expensive (~$2,000-$8,000), time consuming, and highly susceptible to damage when used in aquatic environments. The purpose of this study was to develop an inexpensive, fast, and rugged hemispherical photography system that can be used in aquatic ecosystems without fear of damage of equipment. We obtained paired densiometer readings and hemispherical photographs using GoPro Hero 4 action camera at sites in the Verde River in central Arizona. We post-processed the photos using two different image editing software programs. The inexpensive hemispherical photography method we developed provided cover measurements which were correlated (r = 0.8546, P < 0.05) with densitometer measurements, but could also provide a visual record of the overstory (different plant species, and amounts). Hemispherical photography, with further

development, will be a useful addition or alternative to densitometer measurements for measuring stream canopy

Are Captured Fish in Minnow Traps Safe from Electrofishing?

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Electrofishing and minnow trapping may occur in the same area at the same time. If fish have been caught in a trap, will they be exposed to nearby electroshock? Minnow traps made of bare-metal mesh are Faraday cages, but those made of plastic-coated metal are not. A Faraday cage prevents an electrical field inside the cage in the same way that the interior of a closed car is protected from water in a car wash. To test the theory, I selected two minnow traps of similar size, the Gee trap made of bare galvanized steel mesh, therefore a Faraday cage, and the Eagle Claw trap constructed of plastic-coated metal. In a 100-L cooler, I applied 120-V AC to two parallel metal plates about 60 cm apart to create a homogenous electric field with a voltage gradient of 2 V/cm. The voltage gradient inside the Eagle Claw trap was 2 V/cm, the same as that in the empty cooler. Voltage gradient inside the Gee trap was zero. Another test using Rainbow Trout *Onchorhynchus mykiss* fingerlings (11-13 cm) in the two traps confirmed the initial electrical test results: fish in the Eagle Claw trap were immobilized at 0.8 V/cm, but those in the Gee trap were not immobilized at a maximum 1.7 V/cm when the test was concluded. Electrofishing should not occur near plastic-coated minnow traps that may contain fish.

Application of beaver dam analogs to restore riparian and stream habitats in occupied critical habitat for the New Mexico meadow jumping mouse, Jemez Mountains, New Mexico

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Human activities including the extirpation of beaver (*Castor canadensis*) have often led to extensive channel incision, a rapid downcutting of the stream bed that disconnects the stream from its floodplain. This incision is common in meadow streams such as the Rio Cebolla on the Santa Fe National Forest and many other areas in the Southwest. Channel incision leads to a lowered water table and decreased baseflows, increased water temperatures, and reduced habitat complexity leading to loss of riparian plant biomass and diversity and reduced riparian and aquatic species diversity. We applied the relatively new technique of beaver dam analogs (BDAs) to mimic the effects of natural beaver dams with the goal of accelerating the incision recovery process, allowing for improved regeneration of woody riparian species that would set the stage for beaver recolonization and improved habitat conditions. BDAs were built by pounding wooded fence posts into the stream channel and adjacent floodplain, weaving willow branches between the posts, and allowing natural sediment and debris to seal the dams. I will present design and permitting considerations, initial results of the construction of eight BDAs in the fall of 2017, and geomorphic and biotic monitoring to inform future application of this restoration method along with evaluating the effectiveness of treatments in achieving project goals.

Nonnative fish in the Colorado River, Grand Canyon

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The unregulated Colorado River once contained a large variety of endemic fishes. Since dams have been constructed and the Colorado River regulated many of those endemic species have become extirpated or functionally extinct. While alteration of habitat, flow and temperature, have contributed to the decline of our native fish species, introduced fishes are perhaps the greatest threat to our native fishes. Within the Colorado River in the Grand Canyon area – Glen Canyon Dam to Lake Mead, nonnative fish species and numbers have changed over time as well as in distribution. Before Glen Canyon Dam was constructed Channel Catfish and Carp once dominated this reach; now trout dominate the fish community the first 60 miles of river below the dam, and native fish including Flannelmouth Sucker and Speckled Dace are the most common species below the Little Colorado River inflow. The largest source of nonnatives is from Lake Powell and Lake Mead. Currently approximately 17 nonnative fishes are found in this reach of the Colorado River, and distributed throughout the system in various densities. We detect low numbers of Red Shiner, Fathead Minnows, Gizzard Shad and other fishes, but generally not in quantities to be concerned about (e.g. competition, predation). Periodically we detect relatively large numbers of Rainbow Trout, Brown Trout, and Green Sunfish, that have led to management actions. Nonnative fish will continue to pose a threat to native fishes; however data should inform management on the severity of that threat and what an appropriate response should be if any.

Brown Trout telemetry at Lees Ferry and Grand Canyon, Arizona

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Brown Trout (*Salmo trutta*) were introduced into tributaries of the Colorado River in the newly established Grand Canyon National Park in the 1920's and 30's, and established a self-sustaining population, which has expanded beyond just tributaries into the main channel following the closure of Glen Canyon Dam. Recognizing the elevated predation threat from Brown Trout on endangered Humpback Chub (*Gila cypha*) within Grand Canyon, the National Park Service has recently undertaken a mechanical removal program targeting a source population of Brown Trout at Bright Angel Creek. While Brown Trout have declined in both Bright Angel Creek and the adjacent mainstem reaches in response to sustained removal, Brown Trout captures and spawning behavior have increased in the Colorado River between Glen Canyon Dam and Lees Ferry since 2014. This is a concern for both Humpback Chub populations downstream and the tailwater Rainbow Trout (*Oncorhynchus mykiss*) fishery at Lees Ferry. In an effort to identify seasonal movements and habitat use, and potentially guide future control efforts, we have begun a three-year telemetry study of Brown Trout, with a target of 40 individuals captured at Lees Ferry and surgically implanted with dual acoustic / radio tags. Active telemetry passes using a towable hydrophone are complemented by passive tracking with a network of submersible ultrasonic receivers (SURs) deployed at Lees Ferry and throughout Marble and Grand Canyons. Preliminary results

have identified seasonal use of deep, electrofishing invulnerable eddy habitats outside of the spawning season, along with detectable downstream migration into Marble Canyon.

Turbidity as a tool for management of Rainbow Trout in the Colorado River downstream of Lees Ferry

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Rainbow Trout (*Onchoryhnchus mykiss*) in the Colorado River in Glen and Grand Canyon downstream of the Paria River experience frequent prolonged periods of high turbidity, yet their impact on trout within the Canyon is not well understood. Rainbow Trout within the first 60 river miles (97 km), of the Colorado River below Glen Canyon Dam are managed as a sport fishery, while 60 miles downstream in reaches adjacent to, and downstream of the Little Colorado River, Rainbow Trout are considered detrimental to endemic species. We hypothesize that Lees Ferry Rainbow Trout will experience decreases in condition when exposed to prolonged periods of turbidity. In a laboratory setting, we exposed Lees Ferry Rainbow Trout to daily feedings in clear and turbid (100 FNU) water at 16 C for 30 days. To compliment laboratory results, we also evaluated Rainbow Trout condition of fish captured within Grand Canyon during field studies with respect to turbidity events. Preliminary results indicate significant decreases in fish condition when Rainbow Trout experience prolonged high turbidity (over 100 FNU) both within Grand Canyon and in our laboratory studies. Small (102mm mean TL) Rainbow Trout and large (353 mm mean TL) Rainbow Trout display differing abilities to withstand turbidity events in relation to fish condition. This study indicates turbidity may be useful as a management tool within Grand Canyon in areas downstream of the confluence with the Paria River to favor native fishes and disadvantage Rainbow Trout.

Get to Know Your Slimy Neighbors - Desert Snails in Arizona

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Arizona is home to hundreds of gastropods—over 200 species of native snails and slugs, and one native freshwater mussel. Three of those snail species are listed as threatened or endangered under the Endangered Species Act. There are also over 20 nonnative snails and freshwater mussels and clams that have become established in wild habitats and waterways within the State. This presentation describes several species of ambersnails, talussnails, and springsnails throughout Arizona that the AZ Game and Fish Department and its conservation partners monitor, research, and manage. Threats to native mollusks, information needs, and conservation efforts will also be discussed.

The Effect of Predator Recognition Conditioning Frequency on Survival of Hatchery-reared Bonytail and Razorback Sucker

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Bonytail *Gila elegans* and Razorback sucker *Xyrauchen texanus* are two endangered fishes endemic to the Colorado River Basin. Population declines of both species are attributed to the introduction of non-native fish species and alteration to flow. Each year hatchery-reared Bonytail and Razorback Sucker are reintroduced back into the wild. However post-stocking survival is often poor as offspring are naïve to predation. Previous experiments have demonstrated that conditioning hatchery-reared Razorback Sucker and Bonytail to avoid predation increases survival in 24 hour trials. The objective of this project is to evaluate the efficacy of increasing the number of conditioning events to further increase post-stocking survival. To condition Bonytail and Razorback Sucker (prey) to recognize predators, a hindered predator (Largemouth Bass *Micropterus salmoides*) was added to a tank of prey species for a 5 minute period. Each predator was previously injected in the jaw muscles with botulinum toxin to prevent fish capture but still allow capture of pellet feed. When the predator is added, an alarm pheromone (Shreckstoff's substance) extracted from the skin of Bonytail and Razorback Suckers is also introduced within the tank thus allowing the naïve fish to associate the alarm pheromone with the predator In this experiment, prey fishes were conditioned zero (control), one, or three times. Preliminary results indicate that three conditionings result in the highest survival among treatments.

Are non-native piscivores gape-limited when feeding on hatchery-reared native fish?

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Populations of Roundtail Chub (*Gila robusta*), a native cyprinid from the Southwestern Unites States, have recently diminished in the Colorado River Basin. In the Verde River (Arizona), Roundtail Chub populations have declined, while non-native fish populations, such as Smallmouth Bass (*Micropterus dolomieu*), have increased. As one effort toward population recovery, Roundtail Chub are cultured in hatcheries and then released into the Verde. However, predators may target recently-released fish, thereby reducing the effectiveness of stocking programs. We conducted laboratory trials to determine if Smallmouth Bass consume chub based on predator gape size and body depth of potential prey. Trials were initially conducted with 12 prey fish and four predators; a second set of trials was conducted using two prey fish and one predator. In the lab, Smallmouth Bass consumed chub that were as large as 64% of gape, with a mean of 39.6% gape. In a field experiment where 2,177 pit-tagged Roundtail Chub were released into the Verde (December 2016), we used electrofishing-surveys 48 hours after release to evaluate predation on stocked fish. In the field, Smallmouth Bass consumed prey that did not exceed 71.0% of gape, with a mean of 52.4% gape. A logistic regression model suggests that, when prey body-depth exceeds 75% of predator gape, the probability of survival exceeds 95%. Based on these findings, we suggest that the size of both hatchery-reared fish and existing predators at stocking locations should be considered before native fish are released into the wild to reduce predator-related mortality.

Evaluating spikedace and loach minnow habitat in Arizona streams

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Spikedace (*Meda fulgida*) and loach minnow (*Tiaroga cobitis*) are among the rarest of native fish species that remain in streams of the southwestern United States. Once widespread within the Gila watershed,

both species are now known to occur in only a handful of streams in Arizona and New Mexico. They were listed as Endangered in 2012. In Arizona, loach minnow and spikedace repatriation has been attempted in several streams with varying degrees of success. Although the general habitat preferences of these species are known, managers lack quantitative biotic and abiotic habitat data to help guide future repatriation efforts in selected streams. In an effort to address this need, we surveyed streams by measuring a suite of biotic and abiotic habitat variables hypothesized to limit spikedace and loach minnow populations. Preliminary survey data (10 of approximately 20 total sites) were collected in autumn of 2016 and 2017. In both inhabited and potential repatriation streams lacking these species, we measured geomorphic, hydrological, macroinvertebrate, fish assemblage, and stream productivity variables. We related these habitat variables to the abundance and composition of fish assemblages. Future fieldwork will expand habitat surveys to an additional ~10 sites and may include collecting behavioral and stable isotope data to better understand how native and non-native species compete for space and resources. Together, these data will help prioritize new stream reaches for successful spikedace and loach minnow repatriations.

Conservation of an imperiled mussel through repatriation of historic habitat and cooperative agreements

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The Texas hornshell mussel (*Popenaias popeii)*, is a freshwater bivalve native to the lower Pecos River, and Rio Grande drainages, as well as several river systems in Mexico. The species was proposed for listing as endangered under the US Endangered Species Act in August 2017. The New Mexico Department of Game and Fish has been actively pursuing conservation of the population of Texas hornshell in the Black River, near Carlsbad, NM since 1996. This presentation will describe the status of Texas hornshell mussel as well as recent conservation actions including the development of Candidate Conservation Agreements and restoration of mussel populations to historic habitat through streamside inoculations of host fish and adult mussel translocations.

Using Social Psychology Principles in Education Videos to Acquaint the Public with Cryptic Desert Fishes

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Desert fishes are cryptic, and infrequently seen by the public. Apathy of the public toward these fishes and their ecosystems hinders their conservation. Fortunately, advanced technological means to acquaint the public with these species is becoming increasingly common. High-definition underwater and aerial footage are now possible with current low-cost, advanced technology. We are creating low-cost, educational videography presentations featuring the unique and often rare desert fishes of Nevada and Death Valley. In

conjunction with this high-definition, we are testing the inclusion of various widely recognized social psychology principles to maximize presentation effectiveness. Low cost technology, especially when combined with the use of easy to include psychological principles, may provide spectacular visual results and could potentially serve as an effective tool to acquaint the public with rare desert fishes.

Gila Trout Recovery: Progress in the Five Years Since the Whitewater-Baldy Fire

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The 2012 Whitewater-Baldy Fire burned through a large portion of the current range of Gila trout and eliminated six of the 18 Gila trout populations that existed at the time of the fire. The following year the Silver Fire eliminated two more. In the years since the fire management agencies have been successful in re-establishing Gila trout in three of those streams as well as three additional streams, constructed a fish barrier in Willow Creek, initiated a new hatchery rearing program, conducted the first successful field spawn of Gila trout, increased angling opportunities for this rare species, and begun a restoration project in Whitewater Creek. Due to these efforts, the status of Gila trout has rebounded to nearly what it was prior to the fire.

An identification crisis: It's a Razorback… it's a Flannelmouth… No, it's a hybrid!

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Razorback Sucker and Flannelmouth Sucker are endemic to the Colorado River basin and hybridize naturally. A study that evaluated early life stage viability of Razorbacks, Flannelmouths, and their hybrids could not detect a difference in hatch success or larval survival, which suggests that hybridization is likely to continue between the two species. The Razorback Sucker is listed as endangered and recovery goals include maintaining self-sustaining populations in the Upper and Lower Colorado River basins. Razorback Suckers do spawn naturally, but recruitment is limited. In order to accurately monitor recruitment of the endangered Razorback Sucker, an accurate method of identification is needed to differentiate young Razorback Suckers from Flannelmouth Sucker and hybrids. It is extremely difficult to differentiate between Razorbacks, Flannelmouths, and their hybrids smaller than 137mm total length by using shape alone. To inform field biologists on how to identify young suckers, we investigated the feasibility of three other methods for identification: lip morphologies, meristic counts, and weight-length ratios. Lip structures of hybrids are intermediate to Razorback and Flannelmouth suckers, but the differences in lip structures are too difficult to see in small fish to be used as a reliable method of field identification. Meristic counts of dorsal and anal fin rays are too variable to stand alone for accurate differentiation between the three fish types. Preliminary data shows that weight-length ratios are the most reliable and feasible method of field identification investigated in this study.

Predicting persistence of Rio Grande Cutthroat Trout populations in an uncertain future

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Rio Grande Cutthroat Trout *Oncorhynchus clarkii virginalis* (RGCT) are the southernmost subspecies of Cutthroat Trout and subject to many threats including invasions of nonnative fish and parasites, small population size, and stressors associated with a changing climate. We developed a Bayesian Network (BN) model to predict how these stressors will likely influence the current and future persistence for the 121 remaining RGCT Conservation Populations. The BN uses information from a range-wide database as well as site specific data on habitat use and quality, population size, and proximity of nonnative species coupled with future stream temperature and summer baseflow projections to predict future persistence of RGCT Conservation Populations at two time horizons; short-term (2040s) and long-term (2080s). Results indicate that without human intervention, the average probability of population persistence will be halved by 2080, with only 13 RGCT populations predicted to have a >75% chance of persisting till then. The 72 populations threatened by nonnative fishes (invaded or lacking a complete barrier) faired much worse than others, with 47 likely extirpated by 2080 and the remainder averaging only 10% chance of persistence. The BN model, informed by site-specific data for each population, indicates that Cutthroat Trout at the southern limit of the species are in greater jeopardy than their sister subspecies to the north.

Distribution and Habitat Association of Rio Grande Silvery Minnow Larvae in the Middle Rio Grande

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Spring flows in the Middle Rio Grande were unusually high during 2017, allowing activation of much of the restored and unrestored floodplain along the river. This scenario, only comparable with few recent years, presented a unique opportunity to gather data on the spatiotemporal distribution of larval Rio Grande Silvery Minnow (*Hybognathus amarus*) in both restored floodplain habitat in the Angostura Reach and longitudinally in the three reaches (i.e., Angostura, Isleta, and San Acacia) of the Middle Rio Grande. During May and June 2017, we conducted a study to evaluate the distribution of larvae in association with several habitat variables, including water temperature, depth, canopy cover, instream cover, and water velocity. Sampling consisted of standardized swiping (1-meter swipe) of a fine mesh dip net at randomly selected points in each of four restored floodplain habitat locations and at 10 random sampling locations in each of the three reaches of the Middle Rio Grande. A total of 526 larval Rio Grande Silvery Minnow were captured in restored floodplain habitat, and a total of 2139 were captured from the three reaches along the wetted margin of the river. Data from this study provides valuable information on the effectiveness of each restored floodplain habitat on providing key habitat variables during ontogeny. Likewise, this study evaluated whether these same habitat variables contribute to the distribution of larvae along the wetted margin of the river, where no restoration was present. This data can guide future restoration projects in order to maximize available habitat for this species.