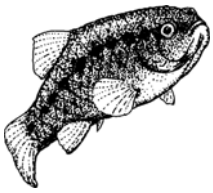

Desert Fishes Council

Consejo de los Peces del Desierto

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

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Oral Presentation Abstracts (in alphabetical order)

Indications of continued Lake Mead razorback sucker recruitment and management progression

Albrecht, Brandon [1], Holden, Paul [1], Kegerries, Ron [1]. (1-BIO-WEST, Inc., Fisheries Section).

An ongoing razorback sucker (*Xyrauchen texanus*) research project on Lake Mead, Arizona and Nevada, has been funded by the Southern Nevada Water Authority and the U.S. Bureau of Reclamation for 13 years. This study continues to document the presence of actual, wild razorback sucker recruitment in the form of young, sexually immature individuals. Continued recruitment denotes that the Lake Mead razorback sucker population is an anomaly in terms of razorback sucker persistence throughout the Colorado River drainage, despite similar non-native fish composition and densities as other locations. Fin ray aging data and back-calculation techniques have indicated that recruitment of razorback sucker on Lake Mead has occurred nearly every year. Furthermore, data collected indicate that high lake elevations - those typically associated with maximum amounts of inundated terrestrial vegetation- appear to be responsible for pulses in recruitment. However, beginning with the 2007 spawning period, we captured large numbers of juvenile/subadult and adult razorback suckers that, based on back-calculation techniques, were spawned under low and declining lake elevations. In fact, the largest number of recruits observed to date coincides with 2005, a low-water year, which alone produced 29 recruits thus far. We believe that cover - both vegetative and in the form of turbidity - provides protection and food resources for larval and juvenile razorback sucker, thereby enabling them to avoid predation by nonnative sportfish present in the system. As monitoring efforts continue, we expect to capture individuals spawned during 2007, 2008, 2009, and beyond. Continued monitoring efforts on Lake Mead should help ascertain if recruitment events continue, and to help understand more fully how to enable this unique trend in other locations. This year a Lake Mead Razorback Sucker Work Group consisting of various state and federal agencies was formalized. In addition, a management plan was developed to present goals, tools, and infrastructure currently available for the conservation of Lake Mead razorback sucker. It is our hope that this management plan will facilitate adaptive management, help in further understanding this unique population, and benefit other researchers focused on razorback sucker recovery efforts.

Desert fishes research and management in Texas during 2009

Allan, Nathan [1], Garrett, Gary [2], Edwards, Robert [3]. (1-U.S. Fish and Wildlife Service, Austin, Texas, 2-Texas Parks and Wildlife Department, Ingram, Texas, 3-University of Texas - Pan American, Edinburg, Texas).

A new ci&enega has been created on Balmorhea State Park to replace an old refuge canal for Comanche Springs pupfish, *Cyprinodon elegans*, Pecos gambusia, *Gambusia nobilis*, and endemic invertebrates. The new ci&enega will provide a more stable habitat for the aquatic species community. An intense monitoring study of the system is underway that includes analyzing energy dynamics. A habitat restoration project was completed in Salt Creek, Texas, to restore the natural hydrology to a stream side marsh that provides habitat for the Pecos pupfish, *Cyprinodon pecosensis*. The construction project used funds from the World Wildlife Fund and the U.S. Fish and Wildlife Service and intense coordination with private landowners was provided by the Natural Resources Conservation Service. More than 400,000 Rio Grande silvery minnows, *Hybognathus amarus*, were released into the Big Bend region of the Rio Grande in December 2008 and additional fish were stocked in October 2009. This represents the first time the fish has been in Texas in some 50 years. Monitoring began in the spring of 2009 and immediately several individuals were collected. Additional stocking and regular monitoring are planned to continue for at least the next four years. A new research project has begun to evaluate the relationship of streamflow rates and available habitat for the threatened Devils River minnow, *Dionda diaboli*. Study efforts will focus on Pinto Creek, where the species habitat is limited by seasonal intermittent flows and the streams are threatened by plans for large-scale groundwater withdrawal and exportation.

Hydrologic and aquatic habitat restoration at Fairbanks and Soda Springs, Ash Meadows National Wildlife Refuge to improve habitat quality for the Ash Meadows pupfish, *Cyprinodon nevadensis mionectes*, Ash Meadows speckled dace, *Rhinichthys osculus nevadensis*, and thermal endemic invertebrate species

Andress, Robert J. [1], McKelvey, Sharon [2], Baldino, Cristi R. [2], Weissenfluh, Darrick [2], Scoppettone, Gayton G. [3]. (1-Otis Bay Ecological Consultants, 2-United States Fish and Wildlife Service, 3-United States Geological Survey).

Fairbanks and Soda springs are critical components in the hydrologic restoration of the Upper Carson Slough. These springs are the first to discharge into the Upper Carson Slough. Presently, the Fairbanks and Soda Spring stream channels are contained in irrigation ditches and the once extensive wetland that was supported by these springs is desiccated. Restoration of Fairbanks and Soda springs will be the first step in restoring the Upper Carson Slough to a semblance of its historic condition. Approximately 2 miles of spring outflow channel will be restored at Fairbanks Spring. Approximately 0.5 miles of spring outflow channel will be restored at Soda springs. The restoration of

Fairbanks and Soda springs will result in the recovery of 150+ acres of emergent marsh and wetland habitat and will restore habitat for the Ash Meadows pupfish *Cyprinodon nevadensis mionectes* and the Ash Meadows speckled dace *Rhinichthys osculus nevadensis* as well as thermal endemic invertebrate species. *R. osculus nevadensis* is presently limited to two populations in the southern half of Ash Meadows. Habitat alteration has prevented the reintroduction *R. osculus nevadensis* into most of its historic habitat. The proposed restoration actions will allow the repatriation of *R. osculus nevadensis* at Fairbanks Spring and will safeguard against extinction.

Hydrologic and aquatic habitat restoration at Ash Meadows National Wildlife Refuge: A refuge-wide restoration plan

Andress, Robert J. [1], McKelvey, Sharon [2], Baldino, Cristi R. [2], Weissenfluh, Darrick [2], Scoppettone, Gayton G. [3]. (1-Otis Bay Ecological Consultants, 2-United States Fish and Wildlife Service, 3-United States Geological Survey).

A refuge-wide hydrologic and aquatic habitat restoration plan is presently being prepared for Ash Meadows National Wildlife Refuge. Prior to refuge establishment spring outflow channels were diverted for agricultural use and the associated stream channel and wetland habitat was lost due to the development of fields for agricultural production. The construction of dams, levees, roads, and other hydrologic barriers resulted in the impairment of ecosystem function and process. Habitat alteration resulted in the extirpation of the Ash Meadows speckled dace *Rhinichthys osculus nevadensis* from the Upper Carson Slough (located in the northern portion of Ash Meadows). The loss of connectivity between individual springs throughout the refuge resulted in the isolation of previously connected populations of the Ash Meadows pupfish *Cyprinodon nevadensis mionectes*. The primary restoration actions include returning spring outflow channels to their historic location, stream channel construction, wetland restoration, and removing hydrologic modifications including ditches and water storage impoundments.

Exercise conditioning of pond-reared razorback suckers (*Xyrauchen texanus*) decreases rate of downstream movement upon release into a stream environment.

Avery, Luke A. [1], Ward, David [2], Marks, Jane C. [1]. (1-Northern Arisona University, Biology, 2-Arizona Game and Fish Department, Research Branch).

This study was conducted to determine if exercise conditioning could decrease downstream movement of pond-reared razorback suckers, *Xyrauchen texanus* , upon release into a stream environment. The razorback sucker is a Southwestern fish species that is federally listed as endangered. Despite efforts at recovery, populations continue to decline. The current recovery technique is augmentation stocking using fish that have been reared in off-channel habitats. Once the fish reach 300-500mm TL they are released into stream habitats where large downstream movement has been observed (Mueller et. al, 2003, N. Amer. J. of Fish. Sci. 23:270-275). We conducted an experiment to determine if this downstream movement could be reduced. Two groups of PIT (Passive Integrated Transponder) tagged razorback suckers, one that had been exercise conditioned and one that had not, were released into Fossil Creek, AZ. Prior to release, a subsample from each treatment group was tested for their ability to maintain a position in the water column using a flow-tube with variable water velocities. This test was conducted to determine if the exercise treatment was having an effect that may not have been detected in the field. Razorback suckers that had been exercise conditioned were able to maintain a position in the water column longer and at higher water velocities than non-exercised fish. The intended method of field data collection via a PIT antenna and remote communication station failed, though useful remote communications technology was developed. The released razorback suckers were heavily preyed upon by river otters (*Lutra canadensis*). The implanted PIT tags were frequently ingested along with the fish and passed by the otters and retained in their scat. Recovery of these PIT tags enabled distributional analysis. Razorback suckers that had been exercise conditioned moved downstream at a slower rate than the non-exercised razorbacks.

Celebrating Ash Meadows National Wildlife Refuge: 25 years along the road to recovery

Baldino, Cristi R. [1], McKelvey, Sharon D. [1], Weissenfluh, Darrick S. [1], Taylor, Kathie A. [2]. (1-U.S. Fish and Wildlife Service, 2-Argenta Ecological Consultants).

After decades of anthropogenic landscape alteration and exploitation of the resources, Ash Meadows became the birthplace of the movement to save desert fishes. In 1976, the Supreme Court made a precedent-setting decision in Cappaert v. United States, which recognized Federal reserved water rights and protected the habitat of the Devils Hole pupfish, *Cyprinodon diabolis*. However, it was another eight years before Ash Meadows National Wildlife Refuge was established. Often overshadowed by its most famous resident, the Refuge protects at least 26 other endemic species, 12 of which are Federally-listed. Ash Meadows also provides habitat for over 100 species of plants and animals that are sensitive, state protected, or priority species. The Recovery Plan for Endangered and Threatened Species of Ash Meadows (US Fish and Wildlife Service, 1990) lists habitat alteration and exotic species as the major threats to the listed species. The primary objective of the Refuge is to recover the listed species and their habitats through an ecosystem-based approach focusing on habitat restoration and the removal of threats. But the road to recovery has not been smooth. Confronting the challenges of more than 80 nonnative species, altered hydrology, and the loss of vital wetland ecosystem functions has been complicated by the lack of staff and funding, land ownership, and jurisdictional issues. In addtion, the multitude of listed species, designated critical habitat, and archeological sites require necessary but time-consuming consultation. Restoration of springs and historic stream flows, identified as a key element in the recovery of Ash Meadows species, began just over 10 years ago. Thanks to proactive management and recent access to additional funding sources, major advances toward ecosystem recovery have been made in the last few years. Although the permanent, base-funded Refuge staff still consists of only three positions, successful funding proposals have resulted in millions of dollars for projects and several term positions. In the last two years, Ash Meadows has contracted for 30 different baseline inventories and studies which will provide the information needed for planning and measuring the success of restoration efforts. Several restoration projects have already been completed or are in the initial stages of progress. The Refuge is moving forward on two major projects: the restoration of Carson Slough beginning with Fairbanks and Soda spring outflows, and restoration planning for the Crystal Spring hydro-basin. Unfortunately, our largest funding source for restoration is diminishing at a time when the need for healthy wetlands, which are more resilient to the effects of climate change, is more critical than ever. We will report on some of our recent successess and on the latest developments regarding land status, private property within the Refuge, visitor improvements, and the future of Crystal Reservoir.

Biblical Zoogeography: Fishes of Jordan River and Sea of Galilee

Behnke, Robert [1]. (1-Emeritus, Colorado State University).

My understanding of the fishes of the Jordan River basin is peripheral and indirect. Thirty five years ago I was advisor for a graduate thesis on the freshwater fishes of Iran and subsequently, as advisor for thesis on the fishes of Saudi Arabia. The fishes of the Jordan basin were considered as potentially zoogeographically informative in regards to ancestors and routes of invasion. The Jordan River flows mainly below sea level. Although highly fluctuating in elevation through time, the "standard" surface elevation of the Sea of Galilee (old testament name is Lake Kinneret, also Lake Tiberias) is given as 686 ft. below sea level and the terminus of the Jordan River at the Dead Sea is given as 1296 ft. below sea level. The Jordan valley is the remnant of a great rift that extended through the present Red Sea and into eastern Africa. During the Pliocene, when the southern end of the Red Sea was closed to the Indian Ocean, the Red Sea was a freshwater lake providing a route for African fishes to invade the Jordan River. Groups of Jordan basin endemic *Barbus* and cichlids are of African origin. The Sea of Galilee, historically, has been a highly productive fishery, significant in the early history of Jews and Christians. The most abundant species, commonly known as "sardine", is a planktivore cyprinid. It was named as a monotypic genus, *Mirogrex* (miracle fish), of uncertain origin and ancestry. Many years ago, Brian Coad visited and examined collections of Arabian fishes then at Colorado State University. He found a peculiar specimen collected from a permanent water area in the wadi Hadiyah, a large drainage on the NW coast of Saudi Arabia. Its diagnostic traits are intermediate

between *Acanthobrama* and *Mirogrex*. In 1983, Coad, Behnke, and Al Kahem published a description of *Acanthobrama hadiyahensis*. The "sardine" of the Sea of Galilee is highly specialized to fill a pelagic niche and is derived from *Acanthobrama* via an ancient connection with the Euphrates basin. I believe *A. hadiyahensis* is the only known example of a southward movement of fish from the Jordan basin into the present Red Sea.

Bonita Creek native fish restoration

Blasius, Heidi [1], Carter, Codey [2], Clarkson, Robert [3], Knowles, Glen [4], Richardson, Mary [2], Timmons, Ross [2], Ward, David . (1-Bureau of Land Management, 2-Arizona Game and Fish Department, 3-Bureau of Reclamation, 4-U.S. Fish and Wildlife Service, 5-U.S. Fish and Wildlife Service, 6-Arizona Game and Fish Department, 7-Arizona Game and Fish Department).

Native fishes historically found in the Gila River basin have suffered significant declines in abundance and distribution due to nonnative fishes and habitat loss and degradation. To reverse this trend, nonnative fishes must be segregated from native fishes and the habitat protected to prevent future reinvasions. Bonita Creek, Graham County, AZ, is considered a high priority for native fish recovery in the Gila River basin due to its assemblage of five native fishes (Gila chub, *Gila intermedia*, longfin dace, *Agosia chrysogaster*, speckled dace, *Rhinichthys osculus*, Sonora sucker, *Catostomus insignis*, and desert sucker, *Pantosteus clarki*) uncontaminated by nonnative fishes and other nonnative aquatic organisms in upper reaches of the stream, habitats appropriate for introduction of additional federally-listed fishes native to the Gila River basin, and its potential to be protected against impacts/invasions of nonnative fishes by constructing a fish barrier and chemically removing the nonnatives. For native fish recovery, a fish barrier was constructed across Bonita Creek by the Bureau of Reclamation in 2008. The barrier is a 160-foot wide concrete-reinforced arched structure with a four-foot tall crest, and is protected against stream scouring with sunken keys and rip-rap emplaced downstream of the apron. To remove nonnative fish species, Bonita Creek was chemically renovated. Renovation included and required beaver pond breaching, native fish salvage, chemical application of the piscicide rotenone (CFT Legumine), and repatriation of the salvaged natives. To facilitate the project, approximately 46 beaver ponds were temporarily breached to lower the pools and to establish greater flow, which was necessary to effectively disperse the piscicide through the stream. Prior to chemical treatment, native fish and Sonora mud turtles were salvaged using a combination of electrofishing, seines, hoop nets, and minnow traps. Captured native fishes were held in flow-through holding tanks. To determine the amount of rotenone necessary, stream discharge and volume were calculated using direct measurements and a fluorescent dye. Rotenone was applied using constant-flow drip stations while roving crews treated shallow backwaters and poorly-mixed shorelines with backpack sprayers. Approximately 2.6 miles of stream was chemically treated twice. To verify a complete kill after the piscicide treatment, hoop nets and minnow traps were set in pool and run habitats and the entire creek was electrofished. No fish were found alive. Sentinel native fish were placed into live cars for two days to ensure the stream had detoxified before the salvaged fish and turtles were repatriated back to the stream near the general vicinity from where they were captured. Federally-listed loach minnow, *Tiaroga cobitis*, spikedace, *Meda fulgida*, desert pupfish, *Cyprinodon macularius*, and Gila topminnow, *Poeciliopsis occidentalis* were also introduced following detoxification. The project was a collaborative effort among Arizona Game and Fish Department, Bureau of Land Management, Bureau of Reclamation, U.S. Fish and Wildlife Service, City of Safford, Arizona State University, University of Arizona, and public volunteers.

Potential impacts of sex-biased dispersal in fragmented desert streams

Boersma, Kate S. [1], Lytle, David A. [1]. (1-Oregon State University, Department of Zoology).

Sex-biased dispersal, unequal dispersal between the sexes, is common in birds and mammals, but relatively unstudied in the rest of the animal kingdom. Sex-biased dispersal may be fundamentally important in predicting species survival in a meta-population context, where relatively few individuals disperse successfully but account for all of the gene flow between habitat patches. Fragmented desert streams provide an ideal context in which to examine sex-biased dispersal because aquatic inhabitants display a wide range of dispersal capacity, from fish that require perennial water to aquatic insects with a terrestrial adult stage. Giant water bugs, *Abedus herberti*, are intermediate dispersers between these extremes because they are flightless but breathe air, allowing them a limited capacity to travel over land before desiccating. Field observations suggest that males may be the dispersing sex, but laboratory experiments demonstrate that all reproductive stages are capable of movement away from unfavorable habitats. This lab study indicates that the likelihood of dispersal varies by sex and reproductive condition, with males brooding eggs as the least likely to disperse and non-brooding adults as the most likely. Combining field and laboratory data, we present evidence both for and against the existence of sex-biased dispersal in *A. herberti* and discuss the potential ecological and evolutionary consequences of uneven dispersal tendency in fragmented systems.

Desert water bugs on the move: the effects of distance from potential source populations on colonization of novel habitats

Bogan T, Michael [1], Boersma S, Kate [1]. (1-Oregon State University, Department of Zoology).

Streams in arid western North America are experiencing extreme droughts and increased anthropogenic water withdrawals. As a result, many streams are transitioning from perennial to ephemeral flow. Understanding dispersal and colonization potential of aquatic organisms is essential in order to predict changes in local community structure as a result of this increased aridity. We examined aquatic invertebrate colonization dynamics over a 6-week period at one perennial and one ephemeral stream, using replicate mesocosms placed at three distances from the stream corridor: 5m, 75m, and 250m. Over 50 species of aquatic invertebrates colonized the mesocosms during the study period. Contrary to our predictions, we found that distance from the stream channel affected colonist species richness at the ephemeral site, but not at the perennial site. At both sites, rainfall was strongly associated with large pulses in colonization, though many new colonists left the mesocosms within a week of the rainfall event. We identified at least five types of colonizers: (1) widespread opportunistic, (2) range-restricted opportunistic, (3) cue-limited opportunistic, (4) widespread haphazard, and (5) infrequent. These results suggest that overland dispersal of aquatic invertebrates is frequent in arid-land streams, but that species exhibit greatly varying abilities and strategies for colonization. Additionally, despite the lack of surface water, ephemeral stream channels may be important dispersal corridors for aquatic invertebrates. Given the wide variety of species-specific colonization potential demonstrated in our experiment, we expect that increased spatial and temporal rarity of perennial habitat will greatly alter community structure in arid-land streams.

Biological and water quality monitoring of native fish sanctuaries in the lower Colorado River Basin, 2005-2009

Carpenter, Jeanette [1]. (1-U.S. Geological Survey).

The conservation plan for native fishes of the lower Colorado River (Minckley et al. (2003: Bioscience 53:219-234) recommends development of isolated, secure, off-channel habitats to be used in the recovery of native fish populations. We designed a monitoring plan to evaluate conditions of potential or current sanctuaries for razorback sucker (*Xyrauchen texanus*) and bonytail (*Gila elegans*). The goal of the monitoring protocol was to provide managers with information that will enhance success of established and future native fish sanctuaries. From 2005 to 2009, we monitored 13 sites. Biological data included mapping and identification of submerged vegetation; density and composition of zooplankton; presence of nonnative fish; and population structure, condition, and reproductive success of native fish. Physiochemical parameters included bathymetric mapping, chlorophyll, nutrients, temperature, pH, dissolved oxygen, conductivity, major ions, and trace elements (e.g., selenium). By September 2009, 11 sites had razorback sucker, bonytail or both: Cibola High Levee Pond, Davis Cove, Emerald Canyon Golf Course (3 ponds), Mohave Community College Pond, Needles Golf Course (2 ponds), Office Cove, Parker Dam Pond, and Three Fingers Lake. Two sites have no native fish: Bulkhead Cove and Palm Lake. In the sites with native fish, we found nonnative fish in 5 ponds: the Needles Golf Course ponds had *Gambusia affinis* and *Lepomis cyanellus*); two of the Emerald ponds had *G. affinis*), and Three Fingers has a suite of non-native species. We documented successful spawning and recruitment of bonytail at the two Needles ponds, at one Emerald Canyon Pond,

and Parker Dam Pond, and both bonytail and razorback sucker at Davis Cove. Growth rates varied among sites. In late May, 2009, partial fish kills occurred at one Needles pond and one Emerald Canyon pond; the probable cause was low dissolved oxygen levels. The range of physiochemical and biological parameters varied considerably among sites that currently support growing or stable populations of native fish. We compared our data with a biological suitability model developed by Bio-West, Inc. in 2007; suitability scores from their model corresponded well with the variable success of our sites in providing native fish habitat.

Using stand-alone videography and water quality sensing to assess relationships between environmental conditions and reproductive behavior in Devils Hole pupfish

Chaudoin, Ambre L. [1], Feuerbacher, Olin G. [1], Bonar, Scott A. [1], Barett, Paul [2]. (1-USGS Arizona Cooperative Fish and Wildlife Research Unit, 2-US Fish and Wildlife Service).

The endangered Devils Hole pupfish, *Cyprinodon diabolis*, is a small, silvery-blue killifish confined to a single hot spring within Death Valley National Park, California/Nevada. This hot spring, Devils Hole, is connected to an aquifer that extends widely across the region. In the past three years, population counts have reached record lows, which has spurred interest in renewed recovery efforts and research. Spawning behavior may be an important factor in regulating population dynamics, particularly in species such as *C. diabolis* that occupy areas with extreme conditions and may thus have specific behavioral and physiological adaptations. However, much is yet unknown about pupfish reproductive behavior and factors that influence spawning within Devils Hole. This information is critically important for designing captive breeding programs for pupfish, and for helping to identify factors contributing to the population decline. Here we describe how current video surveillance technologies and water quality monitoring equipment has been deployed in a remote location to observe pupfish spawning behavior and measure water quality parameters. A surveillance system consisting of three video cameras provides continuous monitoring and recording of pupfish activities on a shallow spawning shelf within Devils Hole. Meters deployed across the shelf simultaneously record dissolved oxygen, temperature, and pH. These stand-alone datalogging systems are being used to capture pupfish spawning behavior and associated conditions over a time-continuum in the field, as uninfluenced by human interaction. These data provide tools for investigating temporal, spatial, and behavioral aspects of spawning activity as related to ambient environmental conditions. The stand-alone systems may be adaptable for use in other remote and/or sensitive habitats where in-person monitoring methods may be suboptimal or impractical.

Genetic characterization and conservation status of pupfish in River Springs, California

Chen, Yongjiu [1], Parmenter, Steve [2], Pezold, Frank [1]. (1-Texas A & M University--Corpus Christi, Life Sciences Department, 2-California Department of Fish and Game).

Pupfish (*Cyprinodon* spp) are a group of short-lived species found in discrete aquatic systems across the southwest desert of North America. These fishes possess extraordinary tolerance of environmental variables including pH, salinity, temperature, and parasite community. An unidentified pupfish population occurs at River Springs in eastern California, presumably derived from Salt Creek pupfish (*C.salinus salinus*) and Amargosa River pupfish (*C.nevadensis amargosae*), introduced by RR Miller in 1940. River Springs and each of the habitats occupied by the two putative ancestral species differ in elevation, temperature, salinity and biotic factors. We investigated the contribution of each ancestral population to the extant River Springs fish using DNA sequence variation in a mitochondrial (cytochrome b) and a nuclear (S7 ribosomal protein intron 1) gene. Pupfish in River Springs share a high sequence similarity with Amargosa River pupfish, and differ from Salt Creek pupfish by diagnostic single nucleotide polymorphisms (SNPs) in both mitochondrial and nuclear genes. The River Springs pupfish population may be eliminated as part of a restoration project. Robust specimen collections from River Springs are being curated by the Los Angeles County Museum of Natural History for their potential future scientific value.

Desert Fishes of Iran

Coad, Brian W. [1], Esmaeili, Hamid R. [2]. (1-Canadian Museum of Nature, Ottawa, 2-Shiraz University, Iran).

The freshwater fishes of Iran comprise about 160 native species in 25 families. New species are still being described, especially in the smaller-sized taxa such as Balitoridae, Cyprinidae and Cyprinodontidae. Climatically, over 80% of Iran is classed as arid or semi-arid. The fauna is derived principally from the Palaearctic with some species showing Oriental and African relationships. There is also a strong endemic element of West Asian species. The family Cyprinidae dominates with 75 species (47% of the total), followed by the Balitoridae with 18 (11%). Desert fishes are a subset of this fauna having anatomical structures favouring desert life such as scraping mouth parts. The fishes are found in streams, springs and in qanats. Ponds and lakes are rare. The qanat is an artificial irrigation system forming a major refuge for fishes. The fauna is distinctive by major basins, but not by individual springs, with two major exceptions, in a cave and a hot spring. Conservation is a major concern as climate change reduces water stored as snow, the qanat refuge is lost to modern techniques, competition from exotics spreads, and demands on water increase with a doubling of the human population over the last 30 years.

Stocking of Gila topminnow, *Poeciliopsis o. occidentalis*, in Arizona's Gila River Basin, an Arizona Game and Fish Department Central Arizona Fund Transfer Program update

Crowder, Clayton D. [1], Timmons, Ross [1]. (1-Arizona Game and Fish Department).

Gila topminnow, Poeciliopsis o. occidentalis, a small, live bearing fish native to the Gila River basin in southwestern New Mexico and central Arizona, was federally listed as endangered within the United States in 1967. In Arizona, the topminnow is genetically represented by 8 meta-populations (lineages) at 14 historic localities. During the late 1970s through 1980s (a wet period), these lineages were stocked into as many suitable habitats as possible (a shotgun approach). As a result, the Gila topminnow has been stocked in more locations than any native fish in the southwest. However, due to impermanence of water, flooding, and invasion by nonnative fish, most of the reintroductions failed. In an effort to improve the success of topminnow reestablishments and recovery, emphasis moved to the protection of natural and reestablished populations in conjunction with a quality-driven approach of reintroduction to higher quality areas. In adoption of quality-driven reestablishment, the Arizona Game and Fish Department's Central Arizona Project Fund Transfer Program (CAP Program) and its partners have successfully stocked and reestablished topminnow in 16 locations throughout the Gila River basin since May 2007. Partnering with county, state and federal landowners, the CAP Program stocked topminnow in locations that would enhance topminnow recovery by replicating the remaining natural populations in natural and human altered habitats. Each of these populations must persist for 10 years in order to contribute towards overall recovery. The successful establishment of these locations was largely due to initial site selection and evaluation.

Opportunities for establishing native fish conservation areas in the Upper Colorado River Basin

Dauwalter, Daniel C. [1], Sanderson, John [2], Williams, Jack E. [3], Sedell, James R. [4]. (1-Trout Unlimited, Boise, Idaho, 2-The Nature Conservancy, Ft. Collins, Colorado, 3-Trout Unlimited, Medford, Oregon, 4-National Fish and Wildlife Foundation, Portland, Oregon).

Fishes native to the Upper Colorado River Basin are in decline. Although the Colorado River cutthroat trout *Oncorhynchus clarkii pleuriticus* has been the focus of many conservation efforts, recent efforts have also been directed towards three declining native warmwater species – the flannelmouth sucker *Catostomus latipinnis*, the bluehead sucker *Catostomus discobolus*, and the roundtail chub *Gila robusta*. Native fish conservation areas are watersheds that are managed primarily for native fish and

aquatic ecosystem conservation, and the National Fish and Wildlife Foundation has adopted this concept as a new 10-year Keystone Initiative for the Upper Colorado River Basin. A network of conservation watersheds will be identified where future conservation actions will benefit both Colorado River cutthroat trout and the three declining native warmwater stream fishes. This network will then serve as a strategic funding framework over the duration of the Initiative. We illustrate how the network of watersheds will be identified using the Upper Green River as an example, and how Muddy Creek in south-central Wyoming currently represents a model system for the Initiative. By focusing at the scale of watersheds, conservation and restoration activities in network of watersheds will facilitate interconnected populations of native cold- and warmwater fishes and increase their likelihood of persistence across the Upper Colorado River Basin.

Colorado pikeminnow habitat availability, use, and selection in the San Juan River, New Mexico and Utah.

de la Hoz, Ernesto A [1], Holden, Paul [1]. (1-BIO-WEST, Inc).

Native to the Colorado River basin, Colorado pikeminnow (*Ptychocheilus lucius*) is an endangered fish that occurs in the San Juan River, New Mexico and Utah. As with many other native fish in the American southwest, the distribution and abundance of this large piscivorous cyprinid has declined as a result of anthropogenic changes to its physical and biological environment. As part of recovery efforts in the San Juan River, over 2 million age-0 and age-1 Colorado pikeminnow were stocked from 2002 to 2008. However, these age-0 and age-1 fish are no longer found during fish-monitoring surveys after about four and two overwintering periods, respectively. The factor(s) precluding recruitment of these fish into the adult population are unknown. In this study we assess habitat availability and use by young Colorado pikeminnow and other native and non-native species and determine whether or not there is evidence of selection for particular habitat types. From 2007 to 2009 we conducted biannual fish and habitat surveys along three 1-mile reaches along the San Juan River. Results suggest that young Colorado pikeminnow select for specific habitat types; fish with total length (TL) less than 100 mm appear to select for low-water velocity habitats with fine substrates including embayment, pool, and backwaters. Colorado pikeminnow in this size class appear to select against riffles, cobble shoals, and slackwaters. Consistent with previous research documenting shifts in diet composition by young Colorado pikeminnow, we find that Colorado pikeminnow with TL over 100 mm appear to select for cobble shoal habitat that is characterized by relatively higher water velocities and large substrate. Pikeminnow in this larger size class also appear to select against run habitat. Our assessment of habitat availability indicate that while young Colorado pikeminnow use habitats that are prevalent along the reaches sampled (e.g., run habitat), habitat types that appear to be selected for by young Colorado pikeminnow are rare. While it would be necessary to sample more reaches over the course of more years to verify findings of habitat selection, this study provides more insight into specific low-velocity habitat types that are important for Colorado pikeminnow. Information about habitat use, selection, and availability could be used to strategically prioritize areas for improvement of habitat quality.

Catostomus in México: Phylogenetic Investigations

Dillman, Casey B. [1], Pilsits, Adria [1], Mayden, Richard L. [1]. (1-Saint Louis University, Department of Biology).

The genus *Catostomus* is comprised of 25 described species. Eight of these species are known to occur in México, three of which are endemic. Since the description of *C. cahita* and *C. leopoldi* in 1986, representatives of *Catostomus* in México have received limited attention. Recent collection efforts in the Sierra Madre Occidental and surrounding areas of México have resulted in numerous samples of *Catostomus*. This sampling has also provided key observations that additional, and undescribed, morphological variation exists throughout the area. To add additional data to the morphological observations, a molecular phylogenetic investigation was undertaken. Three mitochondrial loci were used in this study, primarily because of homology issues in the nuclear DNA of tetraploid species. Results indicate that the genus *Catostomus* is not monophyletic, and species from México do not form a monophyletic group. Additionally, the inter-relationships within species, i.e. lineages, are complex. These results indicate a unique history for the fauna, one that has likely involved numerous cases of stream capture, as well as establish the need for future work inclusive of additional populations and use of independent nuclear loci.

Gila River Basin Native Fishes Conservation Program

Duncan, Doug [1]. (1-US Fish & Wildlife Service).

The CAP Gila River Basin Native Fishes Conservation Program (CAP Program) was established to conserve native fishes and manage against nonnative fishes in response to several ESA biological opinions between the Bureau of Reclamation and the U.S. Fish and Wildlife Service on CAP water transfers to the Gila River basin. Populations of some Gila River native fish species are extremely rare in the wild and appear on the verge of extirpation. A high priority of the CAP Program to conserve and recover native fishes of the Gila River basin is to replicate remaining populations of federally listed species into suitable, protected streams and repatriate populations of listed and other native fishes into streams. The CAP Program provides monies to undertake and support conservation actions for five priority fishes, and other native fishes in the Gila River basin by implementing recovery plans. In addition, the program provides monies to control and eradicate non-native fishes and other non-indigenous aquatic organisms. Thus the Program is also directed toward actions against non-native aquatic biota where they interfere with recovery of native forms. Fund transfers from Reclamation to the Service began in 1997. Though most funding is funneled through the Service, Reclamation does retain some funds. About $5.5 million has been allocated so far; and Reclamation will transfer about $10.5 million to the Service the next 20 years. One half the funding is identified for native fish recovery actions, and one half for non-native aquatic biota control actions. Expenditure of these funds is jointly agreed upon by Reclamation and the Service in consultation with AGFD and NMDGF through a formal process. Multiple conservation and recovery projects benefitting native fish in the Gila basin have been funded so far. In addition, barriers and management against nonnative species have also been funded and completed.

Mechanical removal of nonnative fishes as a management tool for the recovery of Colorado pikeminnow, *Ptychocheilus lucius*, and razorback sucker, *Xyrauchen texanus*, in the San Juan River – New Mexico, Colorado and Utah.

Duran, Bobby R. [1], Davis, Jason E. [1], Furr, Weston [1], Teller Sr., Ernest [1]. (1-U.S. Fish and Wildlife Service, New Mexico Fish and Wildlife Conservation Office).

The San Juan River, New Mexico, Colorado and Utah, is home to two federally endangered fishes, Colorado pikeminnow, *Ptychocheilus lucius*, and razorback sucker, *Xyrauchen texanus*. It is widely accepted that altered flow regimes, habitat degradation and fragmentation, and the introduction and establishment of nonnative fishes contributed to the decline of these fishes. The San Juan River Basin Recovery Implementation Program's (SJRIP) Long Range Plan has identified nonnative fish control as a management element for recovery efforts. Beginning in 2001, intensive mechanical removal via raft mounted electrofishing was initiated in discrete river reaches. Efforts focused on the removal of all nonnative fishes with emphasis on channel catfish, *Ictalurus punctatus*, and common carp, *Cyprinus carpio*. In 2008, a total of 16,968 channel catfish and 1,173 common carp were removed from river miles (RM) 166.6 - 52.9 in 769.63 hours of electrofishing. The lowest channel catfish catch rates (fish/hour of electrofishing; CPUE) since the initiation of intensive nonnative fish removal were observed in each of the two upper sections (PNM Weir to Hogback Diversion, RM 166.6 – 159.0; Hogback Diversion to Shiprock Bridge, RM 158.6 – 147.8). Channel catfish catch rates from PNM Weir to Hogback Diversion in 2008 were similar to CPUE in 2007 but were significantly (p

Identifying sources of error in adult surveys of Devils Hole p upfish *Cyprinodon diabolis*

Dzul, Maria [1], Quist, Mike [1], Dinsmore, Stephen [1]. (1-Iowa State University).

The Devils Hole pupfish, *Cyprinodon diabolis*, is an endangered fish that is endemic to Devils Hole, Nye County, NV. Adult surveys for Devils Hole pupfish began in 1972 and continue to present day. Adult surveys estimate population size from SCUBA diver visual assessments because Devils Hole pupfish cannot be handled. Variability associated with adult surveys makes it difficult for managers to differentiate population trends from sampling error. We tested the effects of four potential sources of error (fish movement, time of day, observer, and diver order) on Devils Hole pupfish counts in July 2009 by implementing a set of twelve experimental dives in Devils Hole. The dive route was divided into four levels designated by depth boundaries. Fish abundance estimates were recorded at each level. The experimental dive design included four days of dives with three dives per day. Dives were conducted in morning, midday, and afternoon to test the effect of time of day. On two days of dives, a mesh block net was placed as a barrier between habitats to test the effect of fish movement on population estimates. To test the effects of observer and diver order, divers switched orders during the course of the dive. Pupfish counts were analyzed using a split-split plot ANOVA, with level added as an additional factor to account for differences in pupfish densities at different depths of Devils Hole. Our results indicate that there was no effect ($P > 0.05$) of observer and diver order. However, we found strong effects of fish movement ($P < 0.01$) and time of day ($P < 0.01$) by level, which indicates that (1) density was greater at shallower depths on dives conducted with a block net compared to dives without a block net, and (2) density was greater at shallower depths during morning and midday dives than during afternoon dives. Our results suggest that fish may swim away from divers during the course of the dive, thus implying that historic Devils Hole pupfish surveys may underestimate abundance. The interpretation of these results highlights the advantages and disadvantages of using a block net on subsequent adult surveys of Devils Hole pupfish.

Application of prophylactic disease treatments in laboratory rearing of hybrid Devils Hole pupfish

Feuerbacher, Olin G [1], Bonar, Scott A [1], Barrett, Paul J [2]. (1-USGS Arizona Cooperative Fish and Wildlife Research Unit, 2-U.S. Fish and Wildlife Service).

Laboratory cultivation of Devils Hole pupfish, *Cyprinodon diabolis*, has proved to be problematic for many years. Although various attempts have been made, long term maintenance and cultivation of this species over multiple generations has thus far been unsuccessful under laboratory conditions. Several strategies are being employed to elucidate the mechanisms behind these difficulties, utilizing hybrid Devils Hole pupfish, *C. diabolis x C. nevadensis mionectesas* as a model. Work is underway to culture these hybrids in biotic and abiotic conditions similar to those found in Devils Hole to determine the reproductive and developmental challenges of living in such harsh conditions. Microbiological and histological analyses are being performed to understand potential pathogens that may affect the physiology of *C. diabolis*, as well as to design strategies that maximize hatch success. Because many of the bottlenecks previously identified in the captive breeding of Devils Hole pupfish have been during larval rearing, particular effort has been placed on maximizing larval survival. Several prophylactic antimicrobial therapies have been compared as they relate to egg hatch rate, larval survival, and long term clearance of targeted pathogens. Treatments of moderate and broad-spectrum antimicrobials were successful in improving hatch rates and larval survival. Mycobacterium-targeted therapies have demonstrated potential for creating specific-pathogen-free lines. These lines could allow for investigation of the intricacies of larval developmental physiology and functional genomics without the confounding effects of chronic disease burdens.

Microsatellite loci reveal bottlenecks and genetic drift in Owens pupfish (*Cyprinodon radiosus*) populations

Finger, Mandi [1], Parmenter, Steve [2], May, Bernie [1]. (1-University of California Davis, 2-California Department of Game and Fish).

The once abundant Owens pupfish (*Cyprinodon radiosus*) was believed extinct by 1948, yet persisted in a single pool isolated from non-native fish predators. Rescued from extinction in 1969, 800 survivors and their progeny have been maintained in a variety of impermanent refuges. At the time of sampling there were four disjunct reproducing populations. A declining fifth population had nearly disappeared, with only 3 fish captured. Analysis of microsatellite DNA from four populations reveals a history of population bottlenecks, low allelic richness, low pairwise-Fst values, low effective population sizes, and private alleles in each of the populations. In order to protect the Owens pupfish from extinction the establishment of more refuge populations is recommended.

Nonnative removal and food web interactions in the Gila River, New Mexico

Gido B, Keith [1], Propst L, David [2], Paroz, Yvette [2], Pilger J, Tyler [1]. (1-Kansas State University, Divison of Biology, 2-New Mexico Department of Game and Fish, Conservation Services Division).

Although stream flows in the upper Gila River basin in New Mexico have remained relatively unaltered by human activities, many populations of native fish are unstable and appear to persist only through connectivity with source populations that exist elsewhere in the stream network. The source of this instability appears to be an interaction between long-term climatic fluctuations and negative interactions with nonnative fishes. Beginning in 2006, efforts began to remove nonnative fishes from a 4.8 km reach of the Gila River using intensive backpack electrofishing and seining multiple times each year. Removal efforts were coordinated with efforts to evaluate temporal variation in food web structure through the use of stable isotope and diet analysis. Changes in fish assemblages and food web structure in the removal reach were contrasted with one or two reference sections using a before-after-control-impact (BACI) design. Preliminary data show that proportion abundance of nonnative fishes in the removal reach has decreased from a high of 19% in 2007 to 6% in 2009. However, there was a high degree of interannual variation in flows that confounded our ability to evaluate the efficacy of the nonnative removal and potential changes in food web structure. It is likely that tracking these management actions over long time periods is necessary to evaluate the response of the native fish community in highly dynamic systems. Moreover, the success of these actions is particularly important in systems like the upper Gila River, which provides refugia for several critically imperiled species.

Upper Colorado Basin Area Report

Hedrick, Trina [1], Wilson, Krissy [1], Cavalli, Pete [2], Martin, Lori [3]. (1-Utah Division of Wildlife Resources, 2-Wyoming Game and Fish, 3-Colorado Division of Wildlife).

Activities continue in an effort to improve the status of many of the native fishes of the Upper Colorado River Basin. These activities are guided principally by three programs: the Upper Colorado River Endangered Fish Recovery 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 roundtail chub (*Gila robusta*), bluehead sucker (*Catostomus discobolus*), and flannelmouth sucker (*C. latipinnis*). The Recovery Program (this program works specifically towards recovery of the Colorado pikeminnow (*Ptychocheilus lucius*), bonytail (*Gila elegans*), razorback sucker (*Xyrauchen texanus*), and humpback chub (*G. cypha*)), uses the protection of instream flow, habitat restoration, nonnative fish control, propagation, life history monitoring, and information and education to bring benefits to the four "big river fishes." Examples of recent efforts include continued research into the use of floodplain habitats by razorback sucker, increased effort towards removal of problematic nonnative species, and the continuation of long-term status assessments. Renovation of rainbow trout streams and reintroduction of the Colorado River cutthroat trout continues in Colorado, Utah, and Wyoming. Additional locations continue to be targeted for barrier placement and cutthroat reintroduction. Research into the movement and life history needs of the roundtail chub, bluehead sucker, and flannelmouth sucker continues in many locations in the upper basin. Fish passage continues to be a problem for these species; however, a few locations (the Duchesne River and the San Rafael River in Utah) have been the target of recent proposals to improve fish passage into potential spawning habitat above migration barriers.

A history of the restoration of Fossil Creek

Hedwall, Shaula [1]. (1-U.S. Fish and Wildlife Service).

Fossil Creek is a tributary to the Verde River in central Arizona. In 1999, after nearly a century of diverting Fossil Creek's flow for hydropower, Arizona Public Service committed to decommissioning two powerplants and restoring flows to the stream channel. Prior to flow restoration, biologists recognized the opportunity to restore the stream's native fish community. Fossil Creek remains a last stronghold for native fish in the Gila River drainage, yet invasion of exotic species has prevented recruitment in native aquatic vertebrates, including ranid frogs. In a collaborative effort between state and federal agencies, including two national forests, universities; and many volunteers, native fishes were salvaged from over 10 stream miles which included designated wilderness. Piscicides were applied to the stream and native fishes were repatriated after exotic fishes were eliminated. A barrier was constructed to prevent future upstream migrations while simultaneously preserving wilderness values. Monitoring results have indicated that native fish increased fifty fold where flow was restored and exotic fish were removed. During planning efforts for Fossil Creek, biologists also included stocking listed-fish species that historically were found in the drainage. Two years after salvaged fish were returned to the stream, five listed species have been stocked. The philosophical outcome of this project was a renewed sense of what can be accomplished when agency mandates to protect native species are supported and conflicting politics are set aside. It also instilled hope and generated excitement for other fish restoration projects in the Southwest that were once considered unachievable because of logistical or political constraints.

Update on the Cuatrociénegas Research Station

Hendrickson, Dean A. [1]. (1-Texas Natural Science Center, University of Texas at Austin).

Since the DFC meeting in Cuatrociénegas in November of 2008, where a report on the Research Station (Centro de Investigación Científica de Cuatrociénegas – CICC) was provided by Cristina Vélez, former manager of the station, the CICC has continued to operate. The station, local community and DFC all benefitted from the 2008 meeting. The event injected an estimated $40,000 US dollars into the local economy (= 20 average annual salaries), generated $11,786 dollars for DFC's coffers, and indirect costs contributed by WWF for CICC's role in organizing the meeting in general and its Mexican trout symposium added about $1,900 dollars to the CICC operating account. Since then, as agreed during the business meeting in 2008, DFC has continued to support the CICC, however, income from room rental continues to increase and thus DFC's contribution continues to decrease. In the time following the 2008 meeting to October 15, 2009, DFC paid for about 41% of the total CICC operating cost while DESUVALLE A.C., our local non-profit partner, contributed about 27%. Since the DFC meeting in November 2008, CICC income covered the remaining 32% of the operating expenses. This despite the fact that the CICC has by far the lowest accommodation rates of any other available option in town, and in some cases lowered rates even more last spring for some Mexican research groups severely impacted by devaluation of the Mexican peso (CICC room rates are in dollars). CICC income since the 2008 DFC meeting (to October 15, 2009) has come from stays by 88 people for periods ranging from 1 – 30 days and totaling 368 person days, or on average 1.26 persons/day. Some groups overlapped, but the station was occupied by at least one person about 35% of the time. Mexican researchers comprised the vast majority in this period, coming from 6 Mexican universities (3 divisions of UNAM, 4 other Mexico City universities, and one regional university class field trip visit). Other visitors were from two US universities (University of Texas at Austin (UT) and University of New Orleans (UNO)), and two Mexican government agencies (National Institute of Ecology and National Institute of Archaeology and History). Eight occupants did not specify affiliations (students and 2 ecotourists). Though not all visitors provided descriptions, research conducted by those using the station included work on fishes, snails, other aquatic invertebrates, as well as botanical, archeological, and hydrogeological surveys. The partnership with DESUVALLE A.C. has long been critical to the CICC and remains more important than ever, particularly following the unfortunate loss of the Peace Corps volunteers as explained at last year's meeting. Desuvalle's contribution to the CICC continues to increase as it staff have largely filled the shoes of the departed volunteers, thus allowing the CICC to remain open. DESUVALLE also this year began to pick up more of the CICC's direct costs, such as the full salary of the housekeeper, which we formerly split with them. Alma Zertuche, the manager of DESUVALLE's office, estimates that about 20% of her full-time position is now dedicated exclusively to the CICC, and about 10% of the four primary DESUVALLE full-time staff's time goes to CICC maintenance, cleaning/laundry, minor repairs, and helping guests. The CICC continues to help users coordinate their research and required permits with the Reserve office, provides landowner contacts to all researchers, and generally facilitates visits in all ways possible. The CICC/Cuatrociénegas website (http://desertfishes.org/cuatroc/estacion/CICCC.php) is being remodeled and re-organized into a much-improved and more attractive system. This new site has been developed with extensive support from both the College of Natural Sciences (CNS) and Jackson School of Geosciences (JSG) at University of Texas at Austin (UT) and will be hosted within the UT Research website. Among many other improvements, the online bibliography of literature will most likely surpass 1,000 citations when the new site is finished sometime early next year, with pdfs available for about 1/3 of those. Support for the website came in response to results of a small grant from the UT Institute of Latin American Studies to publicize UT-based research in Cuatrociénegas and the sustainability issues confronting the area. UT CNS provided videographers, photographers and science reporters for a site visit and subsequent production of a multimedia UT web feature story (http://www.utexas.edu/features/2009/02/23/cuatrocienegas/) that ran for one week in February 2009. Feature stories also appeared in hard copy in the UT Alumni magazine and the CNS's quarterly newsletter magazine. In September 2009 the CICC applied for non-profit status in México. It is anticipated that the application will soon be approved and, if so, in January 2010 we will file the final paperwork naming the initial advisory board. The founding board will consist initially of Mexican citizens only, however, once official, the board may invite foreign members with appropriate (FM3) visas to join. Dean Hendrickson plans to offer to continue his unpaid position as Director if the board desires, and the board may invite an independent DFC representative or consultant. Last summer when the owner inquired regarding CICC's interest in exercising the option to buy that is in the lease, CICC arranged for a lawyer to research the owner's deed and appraise the building. The appraisal was exactly the owner's original asking price when we signed the lease 3 years earlier ($1 million pesos = $76,623 dollars), however, the owner told the lawyer he was now seeking $1.5 million pesos. Funds are not in place to purchase the facility at any price at this time, however, we will continue seeking donors, especially once incorporated as an NGO. Hopefully the owner will renew the CICC's lease for the facility in January when it expires without a huge increase in the rent (currently $536 dollars/month).

Northeast México Area Report, with a focus on Cuatrociénegas

Hendrickson, Dean A. [1]. (1-Texas Natural Science Center, University of Texas at Austin).

Northeastern México remains very poorly surveyed for fishes, but some small, isolated recent collecting efforts and explorations have produced interesting new discoveries of presumably natural populations of native fishes that had been previously overlooked. A small population of *Etheostoma segrex*, the Río Salado darter, reported a few years ago at DFC by this author and collaborators to be on the verge of extinction, was found in summer 2009 downstream of the area recently surveyed by Hendrickson et al. This is promising for the species, though the available habitat is very small, with dense *Arundo* above and below, and is completely disconnected from the small upstream population by mill diversions and associated barriers. A single specimen of *Prietella phreatophila* from a previously unknown locality was provided by Lourdes Lozano et al. a few years ago, and recent discovery of a promising, previously unknown area of karst with extremely high density of large and deep (100 m?) sinkholes (31 discovered by a small party in a single day of exploration) looks likely to expand the range of this species as much as 100 km west of what was previously documented. Plans are in motion to put large groups of speleologists in the region (N and W of Kickapoo springs) in the near future to thoroughly explore the area. In Cuatrociénegas, Poza La Becerra remains closed by PROFEPA for lack of an Environmental Impact Analysis, illegal change of soil use, and lack of a management plan for the extensive tourism that formerly occurred there. Since closure of the site in May 2008, the tourism group that formerly ran the balneario (water-based recreation site) relinquished control back to the original owners, who are left with a substantial fine and a requirement to provide an environmental impact statement and management plan before anyone can re-enter the property. Though the state governor has agreed to pay the fine for them, the owners are said to be reluctant to invest in an impact study and plan until they are assured they will be able to reopen in any way that could be profitable. Nobody has set foot on the property since it was closed, except for those controlling water extraction for irrigation. That activity has been unaffected and is not contested. The entire spring discharge of 500-600 liters/sec continues to be continually diverted into the canal except for occasional brief (2-3 day) periods for canal repairs and maintenance. Tourism-based income in the local community has dropped precipitously as a result of the closure of this formerly popular recreation site, and there is much talk in the local community now of development of new types of

tourism that have no dependence on water or the pozas. Laguna Churince dried again this fall, and sinkholes that divert water from the Río Churince that feeds it have proliferated. The large ejido property that includes Laguna and Poza Churince, Poza Intermedia and Poza Bonita, as well as essentially all of the southwestern part of the valley exclusive of Poza La Becerra (privately owned) and the gypsum dunes (owned by DESUVALLE A.C.), was purchased this year by a private individual (or possibly consortium) from Sonora. Their plans for the property have not been stated, though there is speculation that the buyer is associated with Mexican billionaire Carlos Slim, whose foundation recently donated $100 million U.S. dollars to WWF México for conservation in several focal areas, including the Chihuahuan Desert. Regional newspapers reported in late summer that CONAGUA (National Commission for Water) has broken ground on the first of several projects that will put water from canals that transport water from Cuatrociénegas springs to agriculture outside of the valley into pipelines. The first project is Canal Santa Tecla, in the southeastern corner of the Reserve. Whether agreements have been reached to limit water going into the pipeline and retain some water in natural systems in the CC valley remains unclear, and nobody I have asked, including the Reserve Director and the local manager of the adjacent property owned by conservation group Pronatura Noreste, has seen any on-the-ground construction activity. Similar work on both Canal de La Becerra and Canal Saca Salada are to follow. To the north of Cuatrociénegas, in the Calaveras/Ocampo valley, though not yet officially announced (as far as is known to the author), the National Commission for Water (CNA) has indicated that they have determined that recharge of that valley's aquifer that once naturally fed the now-dry Río el Cañon that once flowed through the town of Cuatrociénegas, is equal to the current extraction by agricultural pumping in that valley. CNA will thus apparently propose an extraction limit equal to current extraction rates. However, previous studies documented that the water table there had dropped precipitously in response to pumping, indicating that extraction exceeded recharge some years ago. Despite the dropping water table, agriculture has continued to expand and diversify in the Calaveras valley. To the south, in Valle El Hundido, an earlier-declared CNA water extraction limit still applies. Persistent Internet investment community blog reports about the imminent opening of a copper mine just outside the southern limit of the Cuatrociénegas reserve remain mysterious. Though within the political limits of the municipality, nobody in the municipal office or any local residents with whom I have inquired, has any knowledge of it. Over the past two years the Reserve has fenced several large areas with aquatic habitats (Los Gatos, Los Hundidos, Churince system) to exclude livestock. Reserve management has generally shifted over the past year to focus on work with local communities, helping them find new income opportunities and more sustainable lifestyles (solar ovens, raised bed gardening with drip irrigation, etc.). Essentially the entire reserve staff except the Reserve Director, sub-director and two clerical assistants now live and work 4 days/week in the outlying ejidos. The National Institute of Ecology (INE) recently published on its website (http://www.ine.gob.mx/emc-cuatrocienegas) all data from their array of 15 poza water level and temperature data loggers scattered widely around the Cuatrociénegas valley. These have logged data hourly since installation in late 2006 and early 2007. Graphs of monthly averages presented on the website generally demonstrate that all pozas (ranging from spring pools through rivers to sumps) vary in both level and temperature, but to different degrees with trends in some clearly independent of those seen in others. Generalities are hard to extract from the simple graphic presentations provided on the website, due to their varied time frames, cryptic missing data, the relatively short overall time frame of a bit more than three years, and sometimes human manipulations of water levels and discharges, but many systems demonstrate the expected January peaks and summer lows. Especially in the southwestern and central parts of the valley it appears that most pozas have experienced slight declines in water levels over the monitored period. The water level of one poza on the far western edge of the valley (Anteojo) is unique in being indicated to have risen steadily a total of about 15 cm over the monitoring period (however, 6 months of data are missing from the middle of the 28 month period) and this poza has a history of human manipulations. Data continue to be collected from these loggers and merit more careful and continued analyses. Unfortunately, data errors and some omissions were found in the raw online files but INE has promised to correct them, and indicate that they plan to continue adding new data periodically as they become available. They are to be congratulated for making these valuable data publicly available.

Reciprocal predation promotes co-existence of native and non-native fishes: A Case study from the Mojave Desert.

Henkanaththegedara, Sujan M. [1], Fisher, Justin D. [1], Stockwell, Craig A. [1]. (1-Department of Biological Sciences, North Dakota State University, PO Box 6050, Fargo ND 58108-6050.).

Ecological interactions between non-native and native species have been of long-standing interest to evolutionary ecologists and conservation biologists. In many cases, non-native species prey upon native biota, however this observation is based on limited experimental data. We conducted controlled mesocosm experiments to assess the effects of invasive western mosquitofish *Gambusia affinis* on endangered Mohave tui chub *Siphateles bicolor mohavensis* reproduction and recruitment. We exposed 30 mesocosms to three treatments 1) Mohave tui chub only, 2) mosquitofish only and 3) Mohave tui chub and mosquitofish. The number of tui chub larvae produced in the mesocosms with mosquitofish (5.40 +/-3.44) was significantly lower than larval production in the control mesocosms (33.80 +/-7.58) (N=10; t=3.41; P>0.05). Conversely, Mohave tui chub had a significant negative impact on mosquitofish recruitment (N=10; t=2.95; P>0.05). Furthermore, adult mosquitofish had exceptionally low survival (24 +/- 5.3 %) in the presence of tui chubs compared to mosquitofish maintained in allopatry (98 +/- 0.82%) (N=10; t=13.90; P>0.001). Mosquitofish were experimentally shown to impact and suppress fish populations by consuming eggs and newly developed larvae. By contrast, predation by Mohave tui chub targets adult moquitofish, and thus may limit mosquitofish population growth which may in turn facilitate co-existence of these two species. Overall, these results suggest a reciprocal predation between two species which may explain the long term co-existence of both species in Lake Tuendae and China Lake habitats.

The Devils Hole Pupfish, another canary in the global climate change coal mine ?

Hillyard, Stanley [1], van Breukelen, Frank [2]. (1-UNLV, School of Dental Medicine, 2-UNLV, Division of Biological Sciences).

The Devils Hole pupfish, Cyprinodon diabolis, is only found in a single pool in western Nevada, one of the most restricted habitats for any known vertebrate species. The main pool has a stable temperature of 33-34° C but breeding occurs on a shallow ledge where temperatures fluctuate annually. In the summer, direct sunlight allows for food production but produces temperatures that may exceed 39° C on some parts of the ledge. The pool is shaded in the winter and cool air temperatures may lower water temperatures on the ledge to 28-30° C. However, food production is much reduced. Reproduction primarily occurs during a narrow window of time, approximately February- May, when cool temperatures prevail and primary production produces food and oxygen. The C. diabolis population has steadily declined from a maximum of over 500 in 1995 to as low as 38 in 2006 for reasons that remain speculative. Analysis of nutrient inputs to Devils Hole, has led to the hypothesis that population size is energy limited. We have quantified metabolic energy requirements of hybrid fish (Cyprinodon diabolis x C. nevadensis mionectes) in larval, juvenile and adult stages. When these numbers are extrapolated to population size the number of fish that can be supported by allochthonous and autochthonous production is near the minimal size measured in 2006. Our results strongly indicate that supplemental feeding is required for recovery of the population, at least until productivity can be restored to that of the mid 1990s. Our experiments also indicate that oxygen delivery is limited at temperatures routinely encountered in Devils Hole due to the combination of increased metabolic rate and low oxygen solubility. Therefore, these fish are sensitive indicators for the effects of increasing temperatures that might result from global climate change.

Stress response of bonytail, roundtail chub, and razorback sucker to handling and confinement

Hunt, Teresa [1], Ward, David [2], Gibb, Alice C. [3]. (1-Arizona Game and Fish, Research Branch and Northern Arizona University, 2-Arizona Game and Fish, Research Branch, 3-Northern Arizona University).

We measure plasma cortisol levels for bonytail (*Gila elegans*), roundtail chub (*Gila robusta*), and razorback suckers (*Xyrauchen texanus*) to determine physiological stress responses before and after exposure to capture and handling. We captured fish held in 1.8 m circular tanks and extracted blood with in an average of 13:55 minutes. Each fish was then confined in a covered bucket for 1 hour after which blood was again extracted. Plasma cortisol concentrations were analyzed to determine cortisol levels before and after confinement. These experiments were conducted with all three species of fish held in 1.8 m, circular tanks; as well as razorback suckers captured from a 0.25 hectare hatchery grow-out pond. Bonytail, roundtail chub and razorback suckers have baseline cortisol levels that exceed values reported for most other fish species

tested under similar conditions. Roundtail chub exhibited the highest levels of baseline cortisol (207.8 ± 36.4 ng/mL) which was over twice as high as the cortisol levels for bonytail (89.2 ± 34.6) and razorback suckers (102.9 ± 38.7). Razorback suckers held in a pond environment exhibited much lower cortisol levels then razorback suckers held in circular tanks. This indicates there is likely some degree of chronic stress associated with fish in 1.8 m circular fiberglass tanks. Chronic stress may lead to increased illness and reduced reproductive capability.

Designing a naturalized rearing system for Gila trout *Oncorhynchus gilae* recovery

James, Angela P. [1], Brooks, James E. [1]. (1-U. S. Fish and Wildlife Service).

The Gila trout *Oncorhynchus gilae* is native to New Mexico and Arizona and is listed as a threatened species. The U.S. Fish and Wildlife Service was tasked with recovering this species by protecting four distinct genetic lineages. A captive rearing program is currently in place, but high mortality rates for incoming wild fish reduced hatchery numbers and threatened unique genetic stocks. We conducted a literature review to develop a naturalized rearing system for the purposes of acclimating wild Gila trout to captive propagation environments while minimizing mortality. We modified a fully functioning recirculation system to enhance habitat complexity consisting of cover, tank color, substrate, light, and underwater cameras to monitor fish behavior. Physical structures were placed in the system to mimic the structural complexity of a natural stream system; these structures were cinder block, artificial plants, aquamats, and polyvinyl chloride (pvc) pipe structures. To mimic cryptic coloration we painted tanks a brown/bronze color and added natural colored substrate (gravel and cobble) to the recirculation system. A true-light lighting system was set-up with timers to mimic natural day-night cycles to improve growth conditions and maintain a natural diel-cycle. To complement the tanks appearance, additional methods such as maintaining near wild densities, varied natural feed diet, and polyculture (rearing multiple species) were utilized. We collected aquatic invertebrates and introduced them into the system to provide a natural food base for the incoming wild fish. Immediately after constructing the system, it was determined the ability to actively conduct fish observations had been diminished and an underwater camera system was used to monitor fish behavior. The naturalized rearing system successfully held aquatic invertebrates (*Ephemeroptera sp.* , *Plecoptera sp.* , and *Diptera sp.*) for three months with larvae of all three orders emerging to adults. In addition, 15 Sonora suckers *Catostomus insignis* (Average TL = 101.5mm) and 15 Desert suckers *Catostomus clarkii* (Average TL = 75.1mm) were introduced to the system. The suckers were observed feeding and using the various habitat structures with the underwater camera system. The natural rearing system is expected to be a beneficial tool in acclimating wild Gila trout to captivity because of the encouraging results of the invertebrates and suckers.

An assessment of long-term monitoring efforts for razorback sucker in Lake Mohave, Arizona and Nevada.

Kesner, Brian R. [1], Karam, Abraham P [1], Pacey, Carol A. [1], Marsh, Paul C. [1]. (1-Marsh & Associates LLC).

The razorback sucker *Xyrauchen texanus* population in Lake Mohave has been monitored for more than 30 years, and augmented by stocking for nearly 20. During this time the population has declined from more than 100,000 individuals to fewer than 2,000. A lack of recruitment has resulted in a near complete loss of the wild population, while augmentation stockings have been decimated by striped bass predation. Sonic telemetry, multi-site mark-recapture analysis, and frequency analysis of mark-recapture data were used to verify results and assess bias. Six month post-stocking survivorship of razorback sucker assessed from sonic telemetry was highly variable, ranging from 6.8 to 66.7% for fish 38 cm total length (TL) and from 36 to 80% for fish 50 cm TL and larger, but within estimates from previous mark-recapture analyses. A multi-site mark-recapture analysis of "at large " repatriated razorback sucker found significant short-term site fidelity indicating non-random assortment within Lake Mohave. However, survival estimates from the multi-site model did not significantly differ from estimates from single site models previously reported and ranged from 70 to 92% among sites. In addition, capture frequencies were not negatively correlated with the number of previous captures, indicating that handling did not impact survivorship. Thus, routine monitoring efforts as currently implemented provide accurate estimates of population abundance and survival for razorback sucker in Lake Mohave without significantly impacting their health, but precision is low due to highly variable size specific post-stocking survivorship.

Reproductive phenology of fishes of the middle Rio Grande, New Mexico.

Krabbenhoft, Trevor J. [1], Platania, Steven P. [2], Turner, Thomas T. [1]. (1-University of New Mexico, Department of Biology and Museum of Southwestern Biology, 2-American Southwest Ichthyological Researchers, LLC).

Fish species often exhibit differences in reproductive timing within a community. In arid-land river systems, where resource availability is temporally variable, differences in timing can differentially affect reproductive success among species. Consequently, reproductive timing can be an important determinant of adult fish community composition. In this study, we ask two questions related to reproductive timing: (1) Is phenology consistent across years? (2)To what extent do environmental conditions (photoperiod, temperature, discharge) correlate with reproduction across species? We collected larval fishes over three years (2007-2009) in the middle Rio Grande, New Mexico, to determine species-specific spawning periodicity and address these questions. Spawning periodicity data were compared with environmental variables to test whether species differed in the suite of environmental conditions under which spawning occurs. We find that, while rank order of spawning is generally similar across years, the absolute timing of spawning varies in relation to interannual-variation in environmental conditions. These data have important implications for determining likely responses of fishes to environmental disturbance (e.g., global climate change). Knowledge of how fishes time reproduction may assist restoration efforts in fish communities in altered and regulated rivers.

New approaches for analyzing the proteome and stress response mechanisms of euryhaline desert fishes

Kültz, Dietmar [1]. (1-Dept. Anim Sci., UC Davis).

Most fish species are limited in their distribution to either the marine or freshwater habitats because they cannot tolerate large salinity fluctuations. Their mechanisms of osmoregulation and transepithelial ion transport are optimized such that they only work efficiently in either the ocean or freshwater. However, a number of fish species are capable of tolerating extremely wide salinity fluctuations. Interestingly, most of these fish species also have increased tolerance towards many other types of environmental stress, including heat stress and hypoxia. Among those fish species are many desert fishes that frequently face severe changes in salinity as a result of evaporation and droughts. We have studied the underlying molecular mechanisms of environmental (in particular salinity) stress tolerance in tilapia (Oreochromis mossambicus), which occur in California's Salton Sea. To study environmental implications and the evolutionary conservation of such environmental stress tolerance mechanisms we are poised to apply a new proteomics approach for revealing such mechanisms in desert pupfish (Cyprinodon macularius) and Salt creek pupfish (C. salinus). This presentation provides a brief overview of my laboratory's proteomics approaches, which utilize sophisticated protein fractionation technologies followed by mass spectrometry using the identification of proteins involved in osmotic stress signaling in tilapia as an example. An outline of our plan for applying this technology to the study of environmental stress tolerance mechanisms in pupfish is discussed.

Genetic diversity of mountain suckers, *Catostomus* (Pantosteus) *platyrhyncus*

Laitinen, Nina J. [1], Shiozawa, Dennis K. [1], Unmack, Peter J. [1], Belk, Mark C. [1]. (1-Brigham Young University, Department of Biology).

Mitochondrial DNA, cytochrome b and ATPase, examined from mountain suckers, *Catostomus platyrhyncus*; bluehead suckers, *C. discobulus*; and desert suckers, *C. clarkii* indicate that the subgenus Pantosteus is more genetically diverse than previously assumed. Mountain suckers in the northern Bonneville Basin were genetically very distinct from mountain suckers in the southern region of the basin. Furthermore, mountain suckers from the Lahontan Basin of Nevada were basal to Bonneville Basin

mountain suckers, bluehead suckers, and desert suckers, suggesting that the subgenus is polyphyletic. Bluehead suckers were most closely related to the desert sucker and formed two distinct clades, one in the upper Snake River/ Bonneville Basin and the other in the Colorado River Basin. By examining mountain sucker and bluehead sucker DNA from the Colorado River, Bonneville, Lahontan and Upper Snake River basins as well as desert sucker from the lower Colorado, I also hope to gain insight into the phylogeographic history of the mountain suckers. Given the strong separation of mountain suckers in the Bonneville Basin, morphological characters are also being examined to help elucidate taxonomic boundaries between the two clades.

Translocation of endangered humpback chub, (*Gila cypha*), into Shinumo Creek, Grand Canyon National Park

Leibfried, William [1], Healy, Brian [2], Omana, Emily [3], Stevens, Lawrence [3], Trammell, Melissa [4]. (1-W. Leibfried Environmental Services, 2-Grand Canyon National Park, 3-Grand Canyon Wildlands Council, 4-National Park Service).

In June 2009, three hundred endangered humpback chub, *Gila cypha,* originally captured in the Little Colorado River were translocated into Shinumo Creek, a tributary of the Colorado River in Grand Canyon National Park. The purpose of this project was to successfully translocate HBC into Shinumo Creek, to monitor the success of that effort and to learn how the fish respond to the treatment, and to learn about how to conduct similar efforts in the future. The primary goals of this project were to: 1) collect, remove parasites from, transport, and translocate 300 young-of-year HBC into Shinumo Creek; 2) monitor the survivorship, growth, movement, and fate of translocated HBC; 3) control non-native fish species; and 4) collect information for the purposes of planning future HBC translocations Prior to translocation, non-native rainbow trout were removed by electrofishing. After translocation only passive techniques were used for non-native removal. As of September 2009, over 1,000 rainbow trout had been removed from Shinumo Creek. Monitoring trips using snorkeling, mini hoop-nets, minnow traps and seines, were conducted during July and September 2009 to determine the abundance, distribution, and growth of these humpback chub within Shimuno Creek. A total of 108 individual translocated chub were captured in July and 116 were captured during September. Two humpback chub had ascended several small waterfalls upstream of their original translocation sites by September. Including both monitoring events, fifteen chub were recaptured below the waterfall in Shinumo Creek. Average total length of all humpback chub increased from 127.7 mm at translocation to 129.5 mm in July and 147.5 mm in September, while growth of individual fish averaged 21.7 mm (n = 47) between July and September. No translocated chub were found during mainstem seining efforts in backwaters between Shinumo Creek and Diamond Creek.

Off-channel habitats to conserve endangered native fish of the lower Colorado River basin

Ley, Guillermo [1], Fell, Michael [1], Kesner, Brian [1], Marsh, Paul [1], McIntosh, Lori [1]. (1-Marsh & Associates).

Persistent decline of native "big river" fishes in the lower Colorado River, despite almost three decades of reintroduction efforts prompted researchers and managers to reconsider conservation measures. Among plans already being implemented is the development of numerous off-channel habitats that are intended to be devoid of non-native fish and provide adequate physicochemical conditions for native fish. A complex of six ponds at Imperial National Wildlife Refuge known as Imperial Ponds is compared to designs described in literature by leading experts of the lower Colorado River basin. Substantial design comprises were made, in part due to unanticipated difficulties encountered during construction. Among these, pumped river water and ground water were used instead of a natural flow-through system, and a wire wedge Z-alloy micromesh screen system was installed to prevent invasion of non-native fish. Due to high groundwater seepage the ponds are difficult to drain. Non-native fish contamination has occurred in all six ponds, and groundwater intrusions that provide fish refugia have made fish removal problematic during renovation. These and other post-construction issues create challenges for engineers and managers alike, but progress is being made toward a workable system where native fish conservation can move forward.

Laboratory replication of Devils Hole algal and zooplankton communities

Mapula, Justin [1], Feuerbacher, Olin [1], Bonar, Scott [1], Wilson, Kevin [2]. (1-USGS, Arizona Cooperative Fish and Wildlife Research Unit , 2-National Park Service).

The Devils Hole Pupfish, *Cyprinidon diabolis*, is a relic of the last ice age; stranded as receding glacial lakes moved across a drying and warming landscape. Recent, dramatic declines in the Devils Hole Pupfish population have raised concerns over the future of the species. As there are no remaining refugia for pure-strain pupfish outside of Devils Hole, the possibility of extinction has become quite real. Previous lack of success for rearing fish in laboratory settings coupled with low egg viability further complicate recovery efforts. Census divers and scientists associated with the Devils Hole program have reported sighting larval pupfish on the stone shelf, as well as adult fish throughout the upper reaches of the water column. However, there are few reports of middle-age class fish, and with numbers of adults that are significantly lower than previous years, it seems that many larval fish are simply not surviving to the adult age class. Through these gradual changes, marked differences have been observed in the natural algal and invertebrate communities. In hope of aiding recovery efforts, we have begun cultures of algae and zooplankton species native to Devils Hole, which will be stocked into a 3000-gallon mesocosm designed to provide maximum control over both biotic and abiotic features. The design of this system will simulate a natural ecosystem while allowing for growth of plankton and larval fish. It also allows for microscale monitoring and control over community dynamics to simulate Devils Hole over different seasons and different decades and is applicable to simulation of other ecological models.

Inferred connectivity among Ash Meadows pupfish (*Cyprinodon nevadensis mionectes*): Populations based on mtDNA and microsatellites

Martin, Andrew [1]. (1-University of Colorado, Dept of Ecology and Evolutionary Biology).

The Ash Meadows pupfish (*Cyprinodon nevadensis mionectes*) is distributed across a number of springs and their outflow channels throughout the Ash Meadows wildlife refuge. Historically, all of the spring systems were probably connected, allowing gene flow among all spring pools and throughout the outflow channels. However, most of the springs and their outflows have been modified in some way over the last one or two centuries. Modifications that have influenced hydrological connectivity include roads, channelization of outflows, impoundments, and flumes at the spring sources. Here I use two different molecular markers with different temporal resolution of long and short term processes to infer the effects of modifications of hydrological flow on the distribution of variation. Notable results include evidence that 1) flumes isolate springs pools and may accelerate genetic drift and the development of inbreeding, 2) impoundments may account for much of the differentiation between the Northern and Southern springs. One implication of the results is that if flumes are maintained at the spring pools, it may be necessary to facilitate upstream movement of fish to maintain the integrity and vitality of spring pool populations.

Biodiversity and evolution of trout species in Mexico (Salmonidae: *Onchorhynchus*)

Mayden, Richard [1], Dillman, Casey [1], Santo Camarillo, Anna Belia de los [1], Espinosa-Pérez, Héctor [2], García De León, Francisco [3], Kuhajda, Bernard [4], Tomelleri, Joseph [5], Propst, David [6]. (1-Department of Biology, 3507 Laclede Ave., Saint Louis University, St. Louis, Missouri 63103 USA, 2-Instituto de Biología, Universidad Nacional Autónoma de México, México, D.F., México, 3-Centro de Investigaciones Biológicas del Noroeste, S.C. Mar Bermejo 195, Col. Playa Palo Santa Rita, C.P. 23090, P.O. Box 128. La Paz,

México, 4-Department of Biological Sciences, Scientific Collections, Box 870345, The University of Alabama, Tuscaloosa, Alabama 35487-0345 USA, 5-Cimarron Trading, 8436 Meadow Lane, Leawood, Kansas 66206 USA, 6-Conservation Services Division, New Mexico Department of Game and Fish, P.O. Box 25112, Santa Fe, New Mexico 87504 USA).
Resident freshwater trout of genus *Oncorhynchus* (Protacanthopterygii: Salmonidae) form a significant component of biodiversity in streams, rivers and lakes of western North America. While trout from the western United States and Canada have received extensive systematic and population genetic investigation, the full range of diversity from native trout endemic to the Sierra Madre Occidental (SMO) of northern Mexico has arguably received less study. Only recently has this native diversity receiving in depth investigation from the binational group Truchas Mexicanas for proposing systematic relationships and understanding population history. In this study we present the first phylogenetic hypothesis for this native fauna based on mtDNA sequence data from two loci. We place the recovered lineages in a geographic context and use these hypotheses for understanding the native diversity. Stocking of non-native *Oncorhynchus* threatens the native fauna through hybridization in some regions. A consortium of biologists from Mexico and the USA are diligently working to advise governmental agencies to enable information-based management of the native trout.

Impoundment subsidies to fish modify the riverine food webs of central Mexico

Mercado-Silva, Norman [1], Helmus, Matthre R. [2], Vander Zanden, Jake [3]. (1-Arizona Cooperative Fish and Wildlife Unit, School of Natural Resources, University of Arizona, 2-Chinese Academy of Sciences, Xishuangbanna Tropical Botanic Garden, 3-Center for Limnology, University of Wisconsin-Madison).
Native riverine fish communities in Mexico's central plateau have been impacted by river regulation with no minimum-flow requirements. We explored the effects of impoundment on riverine food webs by (1) performing a regional food web survey of large-dam tailwater sites; and (2) monitoring multiple sites on the Río Laja (Lerma system, Guanajuato), which is impounded by a large, hypolimnetic-release dam. We found fish diets from tailwater sites with high discharge replete with exported reservoir zooplankton; while diets at sites with little or no discharge were less full and had a wider diet breadth. In support of these spatial data, we found that the proportion of zooplankton in fish diets increases with dam discharge in the Rio Laja, and that fish carbon stable isotope signatures typical in reservoirs, become enriched with increasing distance downstream from the dam. These data suggest that impoundments provide a significant amount of food for downstream fish communities, which initiates a trophic cascade among fish, macroinvertebrates and periphyton. Thus, impoundments subsidize fishes with zooplankton prey and cause cascading food-web impacts on other riverine species.

Las comunidades de peces de los ríos del centro de Mé:xico han sido afectadas por la presencia de presas sin la implementación de flujos ecológicos mí:nimos. Exploramos el efecto de los embalses sobre las cadenas tróficas de río llevando a cabo 1) un estudio regional en sitios ubicados inmediatamente bajo las cortinas de diversas presas, y 2) un estudio longitudinal en muúltiples sitios en el Rí:o Laja (Cuenca del Lerma, Guanajuato) cuyo flujo es truncado por un gran emblase de vaciado hipolimné:tico. Encontramos que en sitios ubicados por debajo de la cortina de presas con altos flujos de agua, las dietas de los peces estuvieron repletas de zooplankton, mientras que en sitios con poco flujo de agua, las dietas fueron mas diversas y de menor volú:men. En el Laja, encontramos que la proporció:n de zooplankton en las dietas aumenta con la descarga de agua, y que las señales de isótopos estables de carbono típicas de las presas, se enriquecen entre más alejado está el sitio de la presa. Estos datos sugieren que las presas proveén una importante cantidad de alimento a las comunidades de peces en sitios río abajo de las presas, lo que da inicio a una cascada trófica entre los peces, los macroinvertebrados y el perifiton. De esta manera, las presas dan subsidios de zooplankton a los peces e ocasionan alteraciones a las cadenas tróficas de otras especies de rí:o.

The effect of introduced western mosquitofish (*Gambusia affinis*) on ecosystem function in a desert spring

Merkley, Steven S. [1], Rader, Russell R. [1]. (1-Brigham Young University, Department of Biology).
Western mosquitofish (*Gambusia affinis*) can be harmful to native fish species because they have physiological, ecological, and behavioral traits that allow them to rapidly reproduce in a wide range of habitats. Previous research in our lab has shown how multiple negative interactions can lead to a decline in least chub (*Iotichythys plegethontis*), a native cyprinid in the desert springs of western Utah (Mills et al., 2004, Oecologia 141-713-721). Predation on juvenile least chub, similar body size, and competition for space and resources are all factors that have led to the decline of least chub and the proliferation of western mosquitofish in desert springs. We are additionally interested in understanding what impact *G. affinis* may have on the overall functioning of this spring ecosystem. The objective of this study is to determine the effects of mosquitofish on food webs and ecosystem function in spring ecosystems. We will test the hypothesis that mosquitofish will interrupt the flow of energy from lower (emergent aquatic insects and primary production) to higher trophic levels, and cause a reduction in food available for numerous species that depend on emerging insects (birds, bats, dragonflies, lizards, etc.). Specifically, we expect treatments with invasive mosquitofish to have a direct negative effect on insect emergence and an indirect positive effect on primary production by reducing grazer abundances. Mesocosm experiments will be performed at Fish Springs National Wildlife Refuge, Utah, to determine effects of western mosquitofish on ecosystem function. Ecosystem function will be measured by two response variables: aquatic insect emergence and primary production.

Morphological variation in "Yaqui sucker, *Catostomus bernardini*, and Rio Grande sucker, *Catostomus plebeius*" (Family Catostomidae)

Neun, Heather R. [1]. (1-Saint Louis University, Department of Biology).
Remote and often inaccessible areas present the opportunity for discovery of patterns of geographic variation in species and prospective new species. The "Yaqui Sucker, *Catostomus bernardini*, and the Rio Grande Sucker, *Catostomus plebeius*," occur naturally in some of the most remote areas of North America in rivers and streams of the Sierra Madre Occidental. In this investigation geographic variation was examined across river drainages in *Catostomus bernardini* (5 drainages) and *Catostomus plebeius* (5 drainages) from northwestern Mexico and southwestern United States for body, head, lip, and fin shape using a morphometric approach. A series of 44 truss landmark measurements were completed for 251 *C. bernardini* and 184 *C. plebeius* from throughout their ranges. All individuals were sexed to account for potential sexual dimorphism and eliminate this variance from shape variation. Shape differences and variation was examined using sheared Principle Components Analysis (PCA) for each species and sex. As demonstrated in many previous studies sheared PCA eliminates size from axes beyond the first to better estimate shape variation in and across populations. Results of these analyses will be discussed.

Repatriation of native fishes to Fossil Creek: An update of efforts from 2007 to 2009

Orabutt Jr., David E. [1], Robinson, Anthony [1], Carter, Codey [1]. (1-Arizona Game and Fish Department).
Fossil Creek is a warm-water perennial tributary stream to the Verde River located in the Gila River Basin of Arizona. For approximately 100 years (early 1900's to 2004), a majority of the stream water was diverted for hydropower generation. In 2004, a concrete fish barrier was constructed in the lower reaches of Fossil Creek and the nonnative fish removed through chemical renovation. Native fish already present were salvaged and restocked following the treatment. Full flows were restored to Fossil Creek in late 2004. A native fishes repatriation plan was developed by an ad-hoc work group. Six native fish species were proposed for repatriation into Fossil Creek in the

near future: loach minnow, *Tiaroga cobitis*, longfin dace, *Agosia chrysogaster*, Gila topminnow, *Poeciliopsis occidentalis*, spikedace, *Meda fulgida*, razorback sucker, *Xyrauchen texanus*, and desert pupfish, *Cyprinodon macularius*. Loach minnow, longfin dace, Gila topminnow, spikedace and razorback sucker were stocked into Fossil Creek from 2007 to 2009 with mixed results. Loach minnow have persisted in apparent low abundance, and longfin dace have persisted though no evidence of reproduction of these species has been detected. Spikedace and razorback sucker were not detected during monitoring one year or two years after the stocking, and likely have not survived or have emigrated from the repatriated reach. Gila topminnow were stocked multiple times and during recent monitoring were detected in the vicinity of four of the seven stocking locations, and had reproduced in at least two locations. We will continue to evaluate, refine, and implement repatriation efforts based on monitoring results.

Habitat restoration and long-term conservation of Ash Meadows naucorids

Parker, Michael S [1], Weissenfluh, Darrick S [2], Goodchild, Shawn [3], Baldino, Cristi R. [2], Simons, Lee [3], Lundblad, Carl [2], Cunningham, Phillip [3]. (1-Southern Oregon University, 2-U.S. Fish & Wildlife Service, Ash Meadows NWR, 3-U.S. Fish& Wildlife Service, Southern Nevada Field Office).

Conservation of thermal endemic invertebrates within spring systems of the Ash Meadows National Wildlife Refuge will require active management to insure the long-term persistence of suitable habitat conditions. We have monitored population responses of two endemic creeping water bugs, the Ash Meadows and relict naucorids (*Ambrysus amargosus* and *A. relictus*), to changes in habitat conditions brought about by active management and long-term succession within restored and unmanipulated channels. Within the Point-of-Rocks system, *A. amargosus* populations increase in response to habitat manipulations that provide more diverse substrate particle size distributions and reduce negative impacts of encroaching terrestrial vegetation. In February 2009, water diverted to the Devils Hole pupfish refuge was returned to the main spring channel at Point-of-Rocks, nearly doubling the discharge and extending suitable habitat for thermal endemic invertebrates within the natural channel. Naucorids recovered from the refuge outflow were introduced into a restored spring channel in which Naucorids had been extirpated. Additional reintroductions from robust populations in restored channels are proposed to reestablish naucorids throughout more of their historic range. Reintroduction of *A. amargosus* into the restored Kings Pool outflow in 1998 resulted in a rapid population increase followed by a gradual decline and ultimate loss of the species from the system in 2002. Large shifts in community structure, including invasion of the restored system by cattails and exotic crayfish, reduction of primary production due to channel shading by natural succession of terrestrial vegetation, and increase in diversity and abundance of predatory invertebrates and fish are likely contributed to the loss of this reintroduced population. Lessons learned from past these past manipulations are informing future restoration, reintroductions, and long-term management of these dynamic spring systems.

Desert Fish Conservation in California during 2009

Parmenter, Steve [1], Keeney, Sharon [1], Hughson, Debra [2]. (1-California Department of Fish and Game).

Effects of nonnative species on food web structure and variability in the Gila River drainage, New Mexico

Pilger, Tyler J. [1], Gido, Keith B. [2], Propst, David L. [3]. (1-University of New Mexico, Department of Biology, 2-Kansas State University, Division of Biology, 3-New Mexico Department of Game and Fish).

The upper Gila River basin in southwest New Mexico, USA is one of the few unimpounded drainage basins remaining in North America and provides a stronghold for a unique and largely endemic fish fauna. However, coincident with introduction of nonnative predators, such as smallmouth bass, *Micropterus dolomieu* and yellow bullhead, *Ameiurus natalis*, distributions of native fishes have severely declined. We used diet and stable isotopes to elucidate trophic relationships and evaluate potential effects of nonnative piscivores in the upper Gila River basin during June-July, 2007 and 2008. Native large-bodied fishes were mainly algivore/detritivores and native small-bodied fishes were primarily insectivores. Small-bodied nonnative fishes fed on detritus and aquatic invertebrates. Nonnative predators preyed on small-bodied fishes and predacious aquatic invertebrates and had higher relative trophic positions than all native fishes. In addition, we calculated measures of food web structure, such as food-chain length and mean trophic position to evaluate variability in food web structure at two spatial scales, macrohabitat and reach scales. Food web structure was more variable among than within reaches and was significantly associated with fish species richness across macrohabitats but was weakly associated with abiotic reach-scale factors. Variation in food web structure was concordant with variation in fish community composition and suggested that factors that influence the distribution of fishes also influence food web structure.

Testing the thermal tolerance of various life stages of fish using the critical thermal method

Recsetar, Matthew [1], Zeigler, Matthew [2], Bonar, Scott A. [1], Ward, David [3], Caldwell, Colleen [2]. (1-USGS Arizona Cooperative Fish and Wildlife Research Unit, 2-USGS New Mexico Cooperative Fish and Wildlife Research Unit, 3-Arizona Game and Fish Department).

Increased stream temperatures resulting from global climate change and urbanization will have important implications for fishes worldwide. While there is information on the effects of elevated water temperatures on individual species, there is little information available comparing the susceptibility of different life stages within the same fish species to high temperatures. In our preliminary test, we examined differences in upper temperature tolerances among rainbow trout (*Oncorhynchus mykiss*) fry (I), fingerling (II), yearling (III) and sub-adult (IV) using critical thermal (CT) tests. Although we found small variations were witnessed, we found little evidence of overwhelming differences in the CTMax of fish at different life stages. In addition to rainbow trout we also tested Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis*), large mouth bass (*Micropterus salmoides*), and tilapia at different life stages. This information will be valuable to identify if life stage is an important consideration when estimating temperature tolerance in fish.

Role of the individual in the conservation of desert fishes

Reid, Stewart B. [1]. (1-Western Fishes).

The conservation of desert fishes has a broad administrative and regulatory framework. Yet this structure, by its very nature, is often driven by adminstrative, rather than biological, priorities. In actual practice, many of the conservation actions that most benefit a species are only made possible through the dedicated work of individual biologists or other champions of the species. The role of these individuals may be direct (e.g. on the ground projects), indirect (e.g. outreach, information or funding), or even administrative (e.g. keeping the adminstrative process focused on the species needs and priorities). However we do it, if we are to ensure the survival of desert fishes, it is crucial that we each as biologists examine our priorities and stay focused on the fish.

Native fish conservation, and management in the upper/middle Rio Grande basin, Pecos River, Canadian River, Tularosa and Guzman basins, New Mexico during 2009

Remshardt, W. Jason [1], Davenport, Stephen R. [1], Propst, David L. [2], Carman, Stephanie M. [2], Dudley, Robert K. [3], Platania, Steven P. [3]. (1-U.S. Fish and Wildlife Service, New Mexico Fish and Wildlife Conservation Office, 2-New Mexico Department of Game and Fish, Conservation Services Division, 3-American Southwest Ichthyological Research Foundation).

Native fish conservation in New Mexico is accomplished through long term monitoring of protected species, captive propagation, stream restoration, and interagency water management. Long term monitoring programs track abundance of many rare native desert fishes including Rio Grande silvery minnow (Hybognathus amarus) in the Rio Grande, New Mexico, Pecos bluntnose shiner (Notropis simus pecosensis), gray redhorse (Moxostoma congestum), and blue sucker (Cycleptus elongatus) in the Pecos River, Arkansas River shiner (Notropis girardi) in the Canadian River, White Sands pupfish (Cyprinidon tularosa) in the Tularosa Basin and Chihuahua chub (Gila nigrescens) in the Guzman Basin. In 2009, an amendment and supplement to the draft revised Recovery Plan for Rio Grande silvery minnow was submitted for public comment. This included revised recovery goals and a population viability analysis. After final review, these will be incorporated into a final revised Recovery Plan. Since 2006, population estimates have been used as an additional resource to standard monitoring for management. Results from the most recent population estimation (fall 2008) were made available in 2009. The total population estimate for all reaches combined (N = 2,283,790) had a standard error [SE] of 740,860.73. The overall proportion of each age-class exhibited a similar pattern among the three reaches (i.e., populations were highest in the Isleta and Angostura reaches and lowest in the San Acacia Reach) and was not significantly different than the estimate from 2007. For the majority of 2009, Rio Grande silvery minnow appear to have had another good year for spawning, which should translate into increased numbers of reproductively capable females available to spawn in the spring of 2010. Population monitoring for Pecos bluntnose shiner has been conducted since 1992. Surveys continued in 2009 and catch rates increased compared to 2008. White Sands Pupfish monitoring has been conducted at least annually since 1995. In 2008, monitoring protocol was updated to better address conservation goals and sampling objectives. Additionally, genetic maintenance of the Lost River population, a replicate of the native Salt Creek ESU was instituted. Investigations are underway to replicate the Malpais Spring population. As usual, fish are present, reproducing, recruiting, and populations look good. Limited monitoring and studies of the status of Pecos River suckers including blue sucker, gray redhorse, and smallmouth buffalo continued in 2009. Both blue sucker and smallmouth buffalo continue to be absent from the mainstem of the Pecos River. Gray redhorse, which was uplisted from state threatened to endangered in 2009, is still found in one locality in the mainstem Pecos. The state recovery plan for these species will be drafted in 2010. Golden algae kills continued through the lower Pecos River in New Mexico. Fish kill reports were down compared to previous years but toxic water (bioassays) was detected at various monitoring locations. Efforts are underway to renew the multi-agency conservation agreement and establish a monitoring protocol for Pecos pupfish. Chihuahua chub from Dexter were stocked in Mimbres River near town of San Lorenzo, New Mexico. Monitoring of two permanent sites was conducted in 2009, and chubs were present at both sites. A new population was found in the upper Mimbres River, unsure if it is relict or from chubs that have moved upstream from stocking efforts.

Spikedace (*Meda fulgida*) and loach minnow(*Rhinichthys cobitis*) conservation in Arizona during 2007-2008

Robinson, Anthony [1]. (1-Arizona Game and Fish Department).

Arizona Game and Fish Department, in collaboration with government agencies and nongovernmental organizations, implemented a two-part conservation strategy for spikedace, *Meda fulgida*, and loach minnow, *Rhinichthys cobitis*, during 2007-2009: propagation and reintroductions. We began bringing spikedace and loach minnow from all remaining populations in need of replication into Bubbling Ponds Hatchery Research Facility. The hatchery serves as a refuge for populations, and fish are propagated and then stocked into selected streams in the Gila River Basin. To date, we have acquired spikedace from Aravaipa Creek in Arizona and the upper Gila River and West Fork Gila River in New Mexico, and have acquired loach minnow from the Blue River and Aravaipa Creek in Arizona, and West Fork Gila River in New Mexico. During 2007 through 2009, we surveyed but found no loach minnow in the North Fork East Fork Black River and Eagle Creek, and surveyed but found no spikedace in the Verde River or Eagle Creek. We will make additional attempts to collect fish from these streams in future years. Also during 2007 through 2009 we repatriated spikedace and loach minnow into four streams: Redfield Canyon, Hot Springs Canyon, Fossil Creek, and Bonita Creek. These mark the first reintroductions of spikedace and loach minnow since 1970; both species were stocked into Sonoita Creek during 1968 and 7-Springs Wash during 1970, but were extirpated. All reintroductions will be monitored for several years to determine if species establish populations.

Temperature and apparent habitat partitioning between a rare springsnail (*Pyrgulopsis trivialis*) and a common snail (*Physa gyrina*)

Rogowski, David L. [1]. (1-Texas Tech University).

The Three Forks Springsnail (*Pyrgulopsis trivialis*) is a listed Federal candidate species that occupies two spring systems near Alpine, Arizona. The springsnail occurs in limited areas within small spring seeps. Previous research suggested that the springsnail and a physid snail partition habitat within these small spring fed streams based primarily on water depth, pH and temperature. Springsnails only occupied stream areas where temperature were lower (13-15° C), whereas the physid snail occupied sections that were considerably warmer (> 15° C). Temperature data loggers were placed at a variety of sites within the spring systems to continuously record temperature. Additionally, laboratory experiments using a temperature gradient apparatus were conducted to determine snail temperature preference. Preliminary results reveal that there is no significant difference in temperature preference between the two snail species. Both species prefer temperatures that were generally warmer (~21° C) than what was available in their native habitat.

Status of Warner suckers in the Warner Basin, Oregon

Scheerer, Paul [1], Jacobs, Steve [1]. (1-Oregon Department of Fish and Wildlife, Native Fish Investigations Project).

The Warner sucker, *Catostomus warnerensis*, is endemic to the Warner Valley, an endorheic subbasin of the Great Basin in southeastern Oregon and northwestern Nevada. This species was historically abundant and its historical range includes three permanent lakes, several ephemeral lakes, and three major tributary drainages. Warner sucker abundance and distribution has declined over the past century and it was federally listed as threatened in 1985 due to habitat fragmentation and threats posed by the proliferation of piscivorous non-native game fishes. In 2006 and 2008, we conducted investigations in Hart and Crump Lakes to quantify the abundance of Warner suckers, to search for evidence of recent recruitment, to estimate sucker abundance relative to nonnative fish abundance, and to track movements during the spawning season. We found the Warner sucker populations in Crump and Hart Lakes were severely depressed. The 2006 and 2008 abundance estimates for suckers in the lakes were some of the lowest on record. In addition, we found little evidence of recent recruitment of suckers to the lake populations. Sucker size distributions were dominated by large, older aged fish and the average sucker length has increased steadily since the lakes were recolonized following their desiccation in 1992. We also found that the proportion of nonnative fish in the catch has increased during this time period. Radio tracking of tagged fish documented losses of spawning fish in irrigation canals. In 2007, we conducted distributional surveys and obtained population estimates of suckers in the Warner basin tributaries. We found the distribution of stream suckers to be patchy with a few distinct areas of relatively high abundance. In 2009, we obtained a mark-recapture estimate and PIT tagged large numbers of suckers in the tributary stream where suckers were found to be most abundant in 2007.

Oregon \ Northern California Area Report, November 2008-2009

Scheerer, Paul [1], Leal, Jimmy [2], Mauer, Alan [3], Reid, Stewart [4], Markle, Doug [5], Richardson, Shannon [1], Perkins, Ray [1], Plemons, Samuel [6]. (1-Oregon Department of Fish and Wildlife, 2-Bureau of Land Management, 3-US Fish and Wildlife Service, 4-Western Fishes, 5-Oregon State University, 6-California Department of Fish and Game).

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) conducted distribution surveys and obtained population estimates for Interior redband trout, *Oncorhynchus mykiss*, at 223 locations in six subbasins in SE Oregon, 2) obtained stream population estimates, operated a downstream migrant screw trap, and radio tracked spawning migrations for Warner suckers, Catostomus warnerensis, in the Warner subbasin, 3) obtained a population estimate for Borax Lake chub, Gila boraxobius, in the Alvord subbasin, 4) obtained a population estimate for Foskett Spring speckled dace, Rhinichthys osculus ssp., in the Warner subbasin, and 5) conducted a chemical treatment of the last 22 mile section of upper McDermitt Creek (Quinn subbasin) to remove non-native rainbow trout, brook trout, Salvelinus fontinalis, and brown trout, Salmo trutta from Lahontan cutthroat trout, Oncorhynchus clarki henshawi, habitat (a total of 42 miles was treated from 2007 through 2009). In October, Oregon Department of Fish and Wildlife and Nevada Department of Wildlife began re-introducing Lahontan cutthroat trout into the McDermitt Creek drainage in Sage, Line Canyon, and Corral Canyon creeks in Nevada and in upper Indian Creek in Oregon. The Bureau of Land Management, Oregon Department of Fish and Wildlife, and U.S. Fish and Wildlife Service completed a restoration project to expand habitat for Foskett Spring speckled dace at Dace Spring. Specked dace will be introduced into the new habitat from Foskett Spring in 2010. Stewart Reid, Western Fishes, continued to monitor populations of Modoc sucker, Catostomus microps, and suppress nonnative fishes from Modoc sucker habitats in the Goose Lake subbasin. Stewart assisted the USFWS in completing a Five-Year Status Review of the Modoc Sucker which recognized the presence of the Goose Lake population in Oregon and recommended downlisting the species from endangered to threatened. Drs. Doug Markle, Oregon State University, and Stewart Reid synthesized available taxonomic data and photo-documented listed or list-able Oregon desert fishes for a book-in-progress focusing on freshwater fishes of Oregon. The California Department of Fish and Game's Heritage and Wild Trout Program conducted fish surveys for Inland redband trout and nonnative trout at more than 80 locations in Modoc and Lassen counties. Tissue samples from redband trout were also collected for genetic analysis.

Thermal tolerances of the desert pupfish, *Cyprinodon macularius*: A case For rapid evolution

Schoenherr, Allan A. [1]. (1-Division of Natural Sciences, Fullerton Colege).

Tolerances among pupfishes for environmental extremes are legendary. *Cyprinodon macularius* is no exception. Published data for critical thermal maxima and minima of fish acclimated to field conditions showed a range of extremes from 7°C to 44.6°C. Bob Feldmeth (now deceased) and I asked the question, "How long do pupfish populations have to be isolated in order to change their inherited thermal tolerances?" We tested fish from three populations by acclimating them to 29°C in the laboratory. By raising and lowering their temperatures 1°C per 2 minutes we determined Ctmax and Ctmin for these populations. Fish from constant-temperature Oasis Spring (28°C) were tested twice. Results showed a Ctmax of 42.7°C and 42.6°C and a Ctmin of 5.3°C and 6.3°C. We also tested fish from native habitat at variable-temperature Salt Creek and found a Ctmax of 41.9°C and Ctmin of 4.6°C. For comparison, a population of fish transferred from Salt Creek to variable-temperature habitat at Thousand Palms also were tested and showed values similar to the parental population with a Ctmax of 42.4°C and a Ctmin of 4.4°C. The latter temperature is the lowest ever recorded for the species. The Oasis Spring population originally transferred from native habitat was isolated for 13 years. During that time their Ctmax remained the same, but it appears that they lost a bit of their tolerance for cold water, clearly a rapid case of change. Other cases of changes in thermal tolerances for pupfishes have been recorded for populations that have been separated for thousands to millions of years. However, the question still remains, "Are thermal tolerances inherited or is this a case of inherited plasticity?"

Interactive advantage of Ash Meadows pupfish over sailfin molly and implications for Ash Meadows Spring system rehabilitation

Scoppettone, G. Gary [1], Rissler, Peter H. [1]. (1-United States Geological Survey, Biological Research Discipline, Western Fisheries Research Center, Reno Field Station).

Habitat use and interactions of Ash Meadows pupfish (*Cyprinodon nevadensis minonectes*) and sailfin molly (*Poecilia latipinna*) were studied to generate information useful for reducing non-native sailfin molly in spring-pool habitat in the Mojave Desert's largest oasis, Ash Meadows, Nevada. *In situ* studies indicated that pupfish reduced sailfin molly reproductive output when species density was equal, but when molly density was greater, pupfish reproductive output was reduced. We concluded that conditions promoting a larger pupfish population would cause molly to decline in number. Pupfish were observed to outnumber molly in spring-pools with little emergent vegetation and an outflow channel dominated by pupfish. Rehabilitation of an Ash Meadows spring system such that these environmental conditions were met resulted in a spring-pool that had been dominated by sailfin molly before rehabilitation to one dominated by pupfish with an increase in pupfish population size after rehabilitation.

California golden trout, *Oncorhynchus mykiss aquabonita*: A management update

Sims, Lisa [1]. (1-Inyo National Forest).

California Department of Fish and Game and the US Forest Service has been implementing the California Golden Trout, *Oncorhynchus mykiss aguabonita*, Conservation Strategy since 2004. Here I present some of the results from management of their habitat including vegetation monitoring, geomorphological monitoring and photo points to display dome of the dramatic vegetation responses within their habitat. Included will be a discussion on Climate Change related to the current occupied habitat of O. mykiss aquabonita and challanges to implementing the strategy to secure habitat with current and further predicted drying of their habitat.

Progress on conservation measures for humpback chub and razorback sucker in the Colorado River below Glen Canyon Dam

Speas, David W. [1]. (1-U.S. Bureau of Reclamation, Upper Colorado Regional Office).

In accordance with biological opinions on the operation of Glen Canyon Dam issued in 2007 and 2008, Reclamation is providing financial and technical support to participants of the Glen Canyon Dam Adaptive Management Program (GCDAMP)and other agencies to implement a suite of conservation measures designed to improve knowledge and reduce adverse effects of dam operations on humpback chub *Gila cypha* and razorback sucker *Xyrauchen texanus* in the Colorado River in Grand Canyon and the Lake Mead inflow area. Since February 2008, significant progress has been made on most of the conservation measures, particularly 1) successful translocation of humpback chub from the Little Colorado River upstream to a previously unoccupied reach and to another Grand Canyon tributary, Shinumo Creek; 2) establishment and maintenance of a humpback chub refuge at Dexter National Fish Hatchery; 3) evaluation of razorback sucker habitat suitability for potential repatriation efforts in the Lower Grand Canyon and Lake Mead inflow areas; 4) a study to relate river flow variables to ecological attributes of nearshore habitats and use of such habitats by early life stage native and nonnative fish species; 5) continued support of the GCDAMP to conduct nonnative fish control efforts, evaluation of the 2008 high flow experiment, a comprehensive humpback chub conservation plan, and other research and monitoring activities to evaluate effects of federal dam operations; and 6) support for Little Colorado River watershed planning, a genetic biocontrol symposium, and other studies. Interagency coordination and execution of these conservation measures has

proven to be rewarding but extraordinarily challenging. Challenges include a wide range of permitting requirements, adherence to various state and federal environmental regulatory guidelines, logistics and communication, labor and financial requirements, public relations, and many other coordination tasks. Nevertheless, implementation of these measures thus far appears to be a significant chapter in the cooperative conservation of native fish in Grand Canyon by state, federal, tribal and private entities.

2009 Area report for the Lower Colorado River Basin

Sponholtz, Pamela [1], Sorensen, Jeff , Voeltz, Jeremy , Avery, Luke , Healy, Brian , Albrecht, Brandon , Paroz, Yvette , Knowles, Glen . (1-U.S. Fish and Wildlife Service, 2-Arizona Game and Fish Department, 3-U.S. Fish and Wildlife Service, 4-Arizona Game and Fish Department, 5-National Park Service, Grand Canyon National Park, 6-Biowest, 7-New Mexico Department of Game and Fish, 8-U.S. Fish and Wildlife Service).

In 2009, conservation of native fishes within the Lower Colorado River Basin was marked by continued efforts to recovery Apache trout (*Oncorhynchus apache*) in the White Mountains, large-scale stream restoration projects such as Bonita Creek and a hopeful upswing in one of the six remnant populations of humpback chub (*Gila cypha*) in Grand Canyon. Restoration projects completed in Fossil Creek entered the next phase of renovation and actively stocked six species of listed fishes as well as opened an historic native fishery highlighting roundtail (*Gila robusta*) and headwater chub (*Gila nigra*). A new spawning ground for razorback sucker (*Xyrauchen texanus* near Needles, CA continued to flourish and bonytail chub (*Gila elegans*) were documented in the Bill Williams River on the Bill Williams National Wildlife Refuge.

Can Collaboration Achieve What Regulation Hasn't? Redrock Canyon Redux — A Case Study

Stefferud, Sally E. [1], Stefferud, Jerome A. [2]. (1-Retired, U.S. Fish and Wildlife Service, Phoenix, AZ, 2-Retired, U.S. Forest Service, Phoenix, AZ).

In 2001 we spoke to Desert Fishes Council, asking the question "Can conservation be achieved through section 7 (ESA)?" using endangered Gila topminnow, *Poeciliopsis occidentalis*, in Redrock Canyon in southern Arizona as a case study. Our conclusion was a resounding "no." Despite conditions conducive to effective use of the section 7 regulatory mechanism and over 15 years of efforts, progress toward recovery had been slow and limited. In addition, there were indications that some forward progress was not lasting. Since that time, the changing national political scene and internal policies of the responsible agencies shifted efforts for Redrock Canyon and its fish away from regulation toward a more collaborative approach. But the intervening eight years have also seen the crash of the population of Gila topminnow in Redrock Canyon; they are now extremely rare. Adverse effects from nonnative species, most notably western mosquitofish, *Gambusia affinis*, in concert with severe drought, are the major factors, exacerbated by past and present land and water uses. Although solutions and funding are available, little effort has been made to deal with those problems due to roadblocks from a variety of sources, including State and Federal agencies, local grazing interests, and other stakeholders. Needed actions have been rejected, significantly scaled back, and/or substantially delayed. Some gains resulting from previous regulatory work have been reversed or are being considered for reversal. Eight years of collaborative effort does not appear to have been successful in moving recovery of Gila topminnow in Redrock Canyon in a forward direction, nor in stemming the catastrophic decline of this or other native species. In fact, it has not yet been successful in overcoming the territoriality and conflicting interests of some parties or in achieving buy-in to a course of action from a majority of the parties. In 2001, we argued that much of the failure in recovery was not due to the regulatory process itself, but rather to failures in understanding and commitment by the entities charged with conserving the natural resources of Redrock Canyon. The past eight years indicate that the same applies to collaborative efforts. Under either mechanism, a lack of historic vision as to what the ecosystem once was and the extent to which it could be restored, is the all-to-frequent justification for inaction by the responsible individuals and agencies. Apathy or opposition on the part of responsible agencies is a major impediment to recovery efforts, exacerbated by opposition from livestock grazing interests, bureacratic ineptitude, and limited resources. This case study suggests that the regulatory or collaborative mechanism used is much less important than a strong commitment by the responsible agencies to actually achieve recovery – a commitment of political will, biological understanding, and necessary resources.

Macroinvertebrates of Ash Meadows National Wildlife Refuge, Nevada

Stevens, Lawrence E. [1], Andress, Robert J. [2]. (1-Museum of Northern Arizona, 2-Otis Bay Ecological Consultants).

Aquatic and terrestrial macroinvertebrates are important sources of food for desert fishes; however, levels of macroinvertebrate biodiversity are known for relatively few landscapes in western North America. Here we report results of research on the invertebrate diversity of Ash Meadows National Wildlife Refuge (AMNWR) in southern Nevada. AMNWR supports at least 28 endemic plant and animal species, including 10 species of plants, 9 hydrobiid snails, 2 naucorid waterbugs, at least one (and possibly three) beetles, 5 fish, and one mammal, and other undescribed endemic species likely exist there. This is the highest concentration of endemic species known to us from a single synoptic valley in the United States. However, prior to the present study, most non-endemic aquatic and terrestrial macroinvertebrate taxa at Ash Meadows had not been inventoried, and their diversity had received little attention. High concentrations of endemic species also have been reported from other constant, harsh aquatic habitats, such as Montezuma Well (central Arizona) and Cuatro Ciénegas (Coahuila, Mexico), but levels of non-endemic macroinvertebrate diversity have not been explored in detail at those locations. The Nevada Test Site, northeast of Ash Meadows, has a relatively robust desert terrestrial macroinvertebrate fauna, but little springs habitat and few endemic species. The overall invertebrate fauna in AMNWR appears to be depauperate and is dominated by generalist taxa. Odonata collections revealed 31 species, a moderately high level of diversity for a relatively small, semi-isolated southern Nevada valley; however, all of the taxa detected were widely distributed. In contrast to aerially-dispersing species, terrestrial and fossorial taxa tended to be low in species richness: we detected only 13 species of ground beetles (Carabidae), 15 species of darkling beetles (Tenebrionidae), and only a single landsnail species. Spider collections from 2004-2005 also revealed a depauperate fauna, with at least 82 species in 61genera and 26 families, dominanted by Salticidae, but with an overall landscape-based species density of only 0.96 species/km2. The depauperate condition of AMNWR is surprising, given the high proportion of endemic species there, but is consistent with that of other low elevation desert and playa habitats in North America. We observed a strong negative relationship between non-native crayfish and native aquatic macroinvertebrate abundance, which underscores the importance of direct management and intervention of non-native species, as well as the need for a consistent monitoring program for endemic aquatic invertebrates.

Where are the good groceries? Food web dynamics in the Warm Springs region, Moapa, NV

StSaviour, Adam B. [1], Gregory, Stanley V. [1], Mesa, Matt [1], Scoppettone, Gary G. [1]. (1-Oregon State University/ USGS, 2-Oregon State University, 3-USGS, 4-USGS).

The headwaters of the Muddy River, known as the Warm Springs area, is home to a host of endemic vertebrate and invertebrate species. A tremendous effort is underway to conserve these species, especially Moapa dace, Moapa coriacea. M. coriacea is an endangered thermophilic minnow that primarily feeds on drift (Scoppettone et al. 1992, Great Basin Naturalist 52, no. 3: 216-225). To provide insight on food availability, drift was quantified at 20 sites throughout the thermally suitable habitat in the Warm Springs area. Stable isotope analyses were also conducted on the organisms from these sites to understand nutrient cycling and specific food resources for M. coriacea. Finally, a drift manipulation experiment was conducted to investigate if M. coriacea are rigid in their drift feeding strategy or if they can exhibit plasticity in a changing environment. Observations were recorded for 30 individual M. coriacea at five different treatment levels of drift. Observed trends indicate the highest diversity and abundance of drifting macroinvertebrates within close proximity to the head spring pools where temperatures are warmest and where the largest numbers of Moapa dace are found. Results are not yet available for stable isotope analysis, but I hypothesize that M. coriacea will exhibit an isotopic signature consistent with consumption of herbivorous macroinvertebrates that are most likely to actively drift. Smaller individual M. coriacea feed more frequently than larger individuals but are less successful, meaning that they reject a greater proportion of the food items that they take. Intraspecific competition occurs when drift is reduced to the lowest levels, but interspecific

competition was not observed between M. coriacea and White River Springfish, Crenichthys baileyi. The implications of this study are to help us better understand how anthropogenic activities affecting the environment might affect Moapa dace, and how to steer habitat restoration efforts in a way that promote a productive food web for Moapa dace.

Inferring dispersal of aquatic invertebrates from genetic variation: A comparative study of an amphipod, Talitridae *Hyalella azteca*, and mayfly, Baetidae *Callibaetis americanus*, in Great Basin springs

Stutz, Heather L. [1], Shiozawa, Dennis K. [1]. (1-Brigham Young University, Department of Biology).

Dispersal studies often ignore the relevant impact of historical events. Whether dispersal is active or passive, dispersal accompanied by gene flow shapes the population genetics and evolutionary divergence of species. Indirect methods which use genetic markers have the ability to assess effective dispersal—that which resulted in gene flow. Two spring invertebrates with differing dispersal abilities were evaluated for genetic variation. The amphipod, *Hyalella azteca*, and mayfly, *Callibaetis americanus*, were collected from 4-5 springs in each of six basins in the Great Basin of western North America. No dispersal or genetic studies of *C. americanus* have been conducted to date. However, several studies focusing on mtDNA diversity of *H. azteca* have revealed a tremendous degree of cryptic diversity in the desert springs of the Great Basin. My objective was to test if aquatic insects that do not have the same restraints as obligate aquatic invertebrates show similar phylogeographic patterns and genetic uniqueness. I hypothesized the amphipods would be genetically differentiated populations amongst springs, and the mayflies would be more genetically homogeneous amongst springs. Nested clade phylogeographical analysis (NCPA), FST values, AMOVA, and Mantel tests were used to examine geographical associations. I also used traditional phylogenetic approaches including maximum parsimony (MP) and likelihood (ML) analyses using cytochrome c oxidase subunit I (COI), 28S, and 16S as genetic markers. The mitochondrial COI sequence divergences in *C. americanus* were higher than *H. azteca* COI divergences within springs but lower among springs. FST values were very high in *H. azteca* reaching near fixation for certain alleles. *C. americanus* FST values were lower suggesting greater gene flow and, consequently, greater dispersal rates. Even though Mantel tests did not detect significant isolation by distance when evaluating all haplotypes together, nested clade analysis was able to examine smaller networks of related haplotypes and detect significant isolation by distance. Whereas the genetic structure in *C. americanus* was dominated by restricted gene flow with isolation by distance, *H. azteca* was characterized more by gradual range expansion followed by fragmentation. Mayflies likely showed more gene flow than amphipods because of their flight capabilities, but movement was still restricted by long distances between isolated springs.

Cutt through the bull trout, a mitochondrial DNA phylogeny of *Oncorhynchus clarkii*, Cutthroat Trout

Unmack, Peter J. [1], Shiozawa, Dennis K. [1]. (1-Brigham Young University, Department of Biology).

Approximately 14 subspecies of *Oncorhynchus clarkii*, Cutthroat Trout are recognized from western North America. Most populations are seriously threatened or endangered mostly due to introgression, predation and competition from introduced trouts as well as general habitat degradation. Many of these impacts occurred so early that the original distributions of some subspecies are incompletely known. Much genetic work has been conducted on different subspecies mostly aimed at determining levels of introgression. Here we present data from four protein coding mitochondrial genes in a combined analysis to investigate broader phylogenetic patterns across the range of the species. Three main groupings were found, a basal cluster consisting of *O. c. clarkii*, Coastal Cutthroat Trout, *O. c. henshawi*, Lahontan Cutthroat Trout and *O. c. lewisi*, Westslope Cutthroat Trout. The last two groups are sister lineages, with one consisting of *O. c. bouvieri*, Yellowstone Cutthroat Trout and *O. c. sp.*, Bear River Cutthroat Trout. The last lineage consists of *O. c. pleuriticus*, Colorado River Cutthroat Trout, *O. c. stomias*, Greenback Cutthroat Trout, *O. c. virginalis*, Rio Grande Cutthroat Trout and *O. c. utah*, Bonneville Cutthroat Trout. We found moderate to strong resolution between the three lineages, but mostly poor resolution within each lineage. Aspects of the biogeographic history of the group will be discussed and compared with previous hypotheses.

Effects of wildland fire on lowland leopard frogs and their habitat in southeastern Arizona

Wallace, J. Eric [1], Swann, Don E. [2]. (1-University of Arizona, School of Natural Resources, 2-Saguaro National Park).

The lowland leopard frog (*Rana yavapaiensis*) is declining over much of its range in southeastern Arizona, including Saguaro National Park and the nearby Santa Catalina District of the Coronado National Forest. One factor implicated in the decline of frog populations is increased stream sedimentation following large, severe wildland fires. We investigated the impact of wildland fire on frogs and their aquatic habitat in watersheds burned by two major fires in 2003 and in unburned control areas. We surveyed frogs and habitat in both burned and unburned canyons prior to fires and twice after fires. Fires affected frog habitat dramatically and in different ways. Frog abundance and breeding success decreased in watersheds where large areas burned, yet frogs persisted in most canyons, at least over the short-term. Fire and sedimentation are natural processes that may impact leopard frogs and other aquatic species more now than historically due to changes in fire regimes. Consequently, we recommend greater integration of studies of fire effects with long-term monitoring of watershed processes and aquatic species.

Laboratory evaluations of stocking strategies for Gila topminnow (*Poeciliopsis occidentalis occidentalis*) and desert pupfish *Cyprinodon macularius*)

Ward, David [1], Robinson, Anthony [1]. (1-Arizona Game and Fish Department, Research Branch).

Gila topminnow (*Poeciliopsis occidentalis occidentalis*) and desert pupfish (*Cyprinodon macularius*) inhabit similar environments and are often stocked into the same waters as part of conservation programs. Success of these stocking efforts varies widely. We conducted laboratory tests in 10, 2.4-m diameter recirculating tanks to evaluate differences in topminnow and pupfish numbers over a 2-month period using the following stocking strategies: 1) stock only pupfish, 2) stock only topminnow, 3) stock pupfish first, and then stock topminnow one month later, 4) stock topminnow first, and then stock pupfish one month later 5) stock both topminnow and pupfish simultaneously. Pupfish appear to do best when stocked alone and had an average increase in numbers of 11%, whereas when topminnow were stocked first, pupfish showed an average decrease in numbers of 27%. Pupfish stocked concurrently with topminnow had an average decrease of 7%. Topminnow recruitment appears low when pupfish are stocked first and showed an average increase of only 157% compared to increases over 1200%, when topminnow were either stocked first or concurrently with pupfish. Although these two species commonly co-exist stocking them simultaneously during reintroduction efforts may not be the best strategy for establishing these species.

Acclimation of razorback sucker, *Xyrauchen texanus*, in a manipulated flood plain wetland on the middle Green River, Utah

Webber, Aaron [1]. (1-US Fish and Wildlife Service).

The razorback sucker,*Xyrauchen texanus*, is an endangered fish endemic to the Colorado River Basin. As part of recovery efforts, razorbacks were taken in to hatcheries to be produced and stocked back into the rivers. These hatchery fish may lack the behavioral skills necessary to survive well in the wild. We thought that if we stocked larval razorbacks into the natural environment where they would grow up in the wild, these fish would acquire the skills necessary to survive in the wild and survive better than the razorbacks that grow up in a hatchery. We chose Baeser Bend (a wetland on the middle Green River, UT) as a wetland we could manipulate to use as an acclimation site for razorback suckers. Baeser was reset during the winter of 2007-2008 to eliminate any other fish species. In May 2008, 43,400 larval razorbacks from the Ouray National Fish Hatchery were stocked into the wetland. In April 2009, an estimated 3,500 survived (8%). In October 2008, 24,000 more razorbacks that were raised in an

earthen pond at the hatchery and averaged 93 mm were stocked in Baeser. In April 2009, we estimated that cohort at 12,000. In June 2009, an additional 110,000 larval razorbacks were stocked. All of the razorbacks from the 2008 stockings should be between 250-400 mm by October 2009, when we plan to PIT tag them and release them into the Green River. Before abstract submission, 330 razorbacks were tagged and released from Baeser Bend to the Green River. We plan on continuing to use Baeser Bend as an acclimation site, and ultimately we plan to deploy pit tag readers on a known razorback spawning bar near Baeser Bend to determine if the razorbacks from Baeser Bend will contribute to the spawning razorback population.

Aquatic invasive species within Ash Meadows National Wildlife Refuge since 2008: Updates, challenges, and goals

Weissenfluh, Darrick S. [1], Baldino, Cristi R. [1], Mckelvey, Sharon D. [1], Andress, Robert J. [2], Scoppettonne, G. Gary [3], Hobbs, Brian [4]. (1-United States Fish and Wildlife Service, 2-Otis Bay Ecological Consultants, 3-United States Geological Survey, 4-Nevada Department of Wildlife).

Ash Meadows National Wwildlife Refuge (Refuge) has a long history of aquatic invasive species (AIS) introductions, most of which occurred before Refuge establishment in 1984. At the beginning of 2008, there were 77 known populations of AIS occurring within Refuge boundaries. Currently, there are 70 known populations, which are comprised of the following 7 AIS: red swamp crayfish, *Procambarus clarkii*, western mosquitofish, *Gambusia affinis*, sailfin molly, *Poecilia latipinna*, largemouth bass, *Micropterus salmoides*, green sunfish, *Lepomis cyanellus*, bullfrog, *Lithobates catesbeiana*, and red-rimmed melania, *Melanoides tuberculatus*. Additionally, koi, *Cyprinus carpio*, and common goldfish, *Carassius auratus auratus*, have been detected in Refuge waters since 2006, though they have not established reproducing populations. Over the past two years, AIS eradications have been a primary focus of restoration activities. In 2008, rotenone was used to eradicate convict cichlids, *Amatitlania nigrofasciata*, from the Fairbanks System and western mosquitofish from the Fairbanks and Soda Spring systems. Rotenone was also used to eradicate black bullhead, *Ameiurus melas*, and a population of western mosquitofish from Davis Spring. Additionally, populations of red swamp crayfish and western mosquitofish were eradicated from School Springs by desiccation. An unsuccessful attempt was also made to eradicate largemouth bass and green sunfish from Crystal Reservoir, Horseshoe Reservoir, and Lower Crystal Marsh by desiccation. Though the Refuge has had success eradicating several populations of AIS, many challenges continue to materialize. A few challenges include expanding AIS populations, data gaps in AIS survival abilities specific to the Mojave Desert, uninformed pet owners, and reduced restoration funding. Despite these challenges, AIS eradications are a primary goal of ongoing restoration activities within the Refuge. Despite early setbacks associated with desiccation, the 2009-2010 goals include the eradication of 4 AIS populations: 1 population of western mosquitofish and red swamp crayfish from each of the North and South Indian springs. If this is achieved, only one spring system (South Scruggs) within the Warm Springs Complex will contain AIS; except red rimmed melania which have persisted despite eradication attempts. This is an important task to support recovery of the endangered Warm Springs pupfish, *Cyprinodon nevadensis pectoralis*.

Distribution and habitat selection of endemic fish and invertebrate species within a desert spring refuge

Weissenfluh, Darrick S. [1], Wilde, Gene R. [1], Baldino, Cristi R. [2]. (1-Texas Tech University, 2-U.S. Fish and Wildlife Service).

The Warm Springs Complex (WSC) is one of four management units within Ash Meadows National Wildlife Refuge (AMNWR). It contains five low-discharge warm spring systems with individual flows ranging from 0.000113 to 0.000198 cubic meters per second (cms) and spring-source water temperatures ranging from 280 to 340C. School Springs refuge is one component of the WSC. This spring has undergone dramatic anthropogenic transformation since 1969, when the Bureau of Land Management (BLM) increased pool habitat in an effort to preserve the endemic, federally-listed (1970) Warm Springs pupfish, *Cyprinodon nevadensis pectoralis*. In 1983, four additional concrete ponds were constructed at School Springs to further increase water volume available to Warm Springs pupfish. During the summer of 2008, AMNWR completed rehabilitation of the School Springs refuge: the large concrete ponds were removed and a "naturalized" channel consisting of pools, runs, and riffles was created. There were three primary goals of the restoration: (1) eradicate three aquatic invasive species; (2) improve suitable habitat for the endangered Warm Springs pupfish and three endemic invertebrates which only occupy springs in the WSC; and (3) test hypotheses concerning endemic fish and invertebrate habitat selection and distribution inherent in the design of the refuge. Preliminary monitoring results indicate: (1) most Warm Springs pupfish (>80%) occupy pool habitat, but they may be distributed throughout the system from spring orifice to wash despite extreme diel temperature fluctuations (~15^{o}C) in parts of the stream and (2) endemic invertebrates are narrowly distributed and are restricted to specific habitats, with the exception of the Warm Springs naucorid, *Ambrysus relictus*, which has been observed utilizing the entire stream channel.

Development and assessment of population dynamics models for Ash Meadows fishes

Wilde, Gene R. [1]. (1-Texas Tech University).

Mark and recapture estimates of population sizes of several Ash Meadows fishes have made since 1989. I used estimates made during 1989-2004, which were made annually to biennially, to parameterize population dynamics models for three species of Ash Meadows endangered fishes, including seven populations of Ash Meadows Amargosa pupfish, *Cyprinodon nevadensis mionectes*, two populations of Warm Springs pupfish, *Cyprinodon nevadensis pectoralis*, and one population of Ash Meadows speckled dace, *Rhinichthys osculus nevadensis*. Population dynamics models were based on a modification of the age-structured Leslie matrix population model and assumed a birth-pulse population with post-breeding census. In this instance, the Leslie matrix model was modified so that fecundity was modeled as a function of a fitted constant multiplied by the adult-juvenile ratio from the previous year. The models accurately predicted population dynamics of most species and populations studied. The correspondence between predicted and estimated population sizes was closest between 1989 and 2000, when adult-juvenile ratio ratios were measured annually. In general, the greatest discrepancy between predicted and estimated population sizes occurred around 2000, when estimated population sizes began to decline in several springs. Thus, the models may provide early warning of the need for management intervention.

Bonneville Basin Area Report

Wilson, Krissy W. [1]. (1-Utah Division Wildlife Resources).

I present a brief summary of activities for this year associated with native aquatic species in the Bonneville Basin. The June Sucker, *Chasmistes liorus*, Recovery Program continues to be very active. Approximately 50,000 (200 mm TL) June sucker were reintroduced into Utah Lake as part of recovery efforts. June sucker are propagated from brood stock held at Utah Division of Wildlife Resources hatchery facility at the Fisheries Experiment Station (FES), Logan, Utah. Thirty-three thousand were reared at FES and the remaining 17,000 were reared in grow out ponds. Record numbers of June sucker are returning to the Utah Lake tributaries to spawn. Least chub, *Iotichthys phlegethontis*, has been petitioned to list and is undergoing a 12-month status review. Refuge populations are exhibiting stable population trends and successful recruitment. Utah, Wyoming, Nevada, and Idaho State and Federal agencies form the rangewide team for the northern leatherside chub, *Lepidomeda copei*. The Northern Leatherside Chub Conservation Agreement and Strategy was finalized during the past year. The northern leatherside was also petitioned to list this year and is undergoing a 12-month status review. The southern leatherside chub, *Lepidomeda aliciae* team is finalizing the Southern Leatherside Chub Conservation Agreement and Strategy supported by signatory agencies solely in Utah and will be finalized during 2009.

Conceptual influence model guides research, monitoring, and management of the Devils Hole pupfish *Cyprinodon diabolis*

Wilson, Kevin [1], Bower, Michael [1], Gaines, D. Bailey [1]. (1-National Park Service, Death Valley National Park).

From the 1970's through the early 1990's, the size of the single wild population of Devils Hole pupfish, *Cyprinodon diabolis*, correlated with water level at Devils Hole. More recently, a population decline starting in the mid-1990's was not correlated with water level, requiring a whole new set of hypotheses to be developed to guide recovery efforts of this highly endangered fish. A conceptual stage-specific influence model is proposed to organize these hypotheses and document scientific progress. Results of ongoing monitoring and research are applied to this model. Additional research and monitoring efforts that are being planned to address model uncertainties will be described.

Wait until dark: influence of turbidity on the foraging ecology of trout in the Colorado River, Grand Canyon

Yard, Michael D. [1], Coggins Jr., Lewis G. [1], Baxter, Colden V. [2]. (1-U.S. Geological Survey, Grand Canyon Monitoring and Research Center, 2-Idaho State University, Department of Biological Sciences, Stream Ecology Center).

Nonnative fish interactions (competition and predation) are considered one of the major factors responsible for the decline of native fishes of the Colorado River. Glen Canyon Adaptive Management Program implemented a large multi-year experiment in Grand Canyon, designed to suppress nonnative fishes, particularly rainbow trout (*Onchorhynchus mykiss*) and brown trout (*Salmo trutta*) near the confluence of the Little Colorado River (LCR). The LCR confluence is an area of strong overlap between nonnative trout and native fishes, especially the humpback chub (*Gila cypha*, endangered species). Thus, the overlap among fish communities at this location and the application of a large-scale removal effort provided the context for determining trout foraging ecology, including piscivory on native fishes. We also evaluated how turbidity affects prey availability, detection, and utilization, including the degree of piscivory of these nonnative salmonids, by examining incidence of predation upstream and downstream of the LCR, a major source of turbidity. Over 20,000 nonnative fishes, of which 98% were salmonids, were removed from a 14 km segment of the Colorado River surrounding the confluence of the Little Colorado River (LCR). Rainbow trout diets were comprised of three general prey types: aquatic invertebrates (85.6%), terrestrial invertebrates (12.6%), and vertebrates (1.8%, aquatic and terrestrial origin). Although brown trout diet also consisted of the same prey types, the proportional use of aquatic invertebrates (73.0%), terrestrial invertebrates (8.7%), and vertebrates (18.3%) was significantly different from rainbow trout. Incidence of piscivory for brown trout was higher (8-46%) than for rainbow trout (0.5-3%); nonetheless, rainbow trout exert a larger cumulative predation effect than other less abundant but more piscivorous species. In modeling daily piscivory estimates, rainbow and brown trout cumulatively consumed nearly 30,000 fish during the first two years of the suppression study (699 days) (rainbow trout 16,157; and brown trout 13,205). On average trout consumed 85% more native than nonnative fish even though native fish were 30% less abundant. Turbidity may mediate piscivory directly by reducing prey detection, yet its influence is uncertain as our results suggest since rainbow and brown trout showed greater piscivory in reaches with higher turbidity. This may suggest a shift in foraging strategy under turbid conditions from drift-feeding to active foraging, and also in response to increases in prey availability due to dispersal of young fish from the LCR.

Poster Presentation Abstracts (in alphabetical order)

Aquatic invertebrate ecology in the Rio Grande, New Mexico: A comprehensive undergraduate training program

Bishara K, Raphaelita [1], Love A, Corey [1], Johnson L, Erica [1], Burdett S, Ayesha [1], Turner F, Thomas [1]. (1-University of New Mexico, Museum of Southwestern Biology).

Relatively little is known about invertebrate communities and food web dynamics of arid land rivers. Over the last five years, we have focused on building an undergraduate student-centered research program in the Rio Grande that aims to increase the knowledge base and to train the next generation of scientists that will tackle pressing environmental problems in the southwestern US and elsewhere. Our approach involves comprehensive training in invertebrate and fish identification, field and experimental methods, and stable isotope biogeochemistry applied to a complex and dynamic river ecosystem. To date, we have identified approximately 160 invertebrate taxa and we are now assembling a digital reference collection to assist researchers in future work. Mesocosm studies that mimic drying conditions in the Rio Grande show dramatic impacts of larval fish on invertebrate communities when they are confined to drying pools. Finally, direct comparison of mesocosm and field data suggest that local effects, such as the presence of leaf litter, can dramatically alter invertebrate community composition. Through this program, undergraduate student researchers develop a vested interest in all projects from inception to execution, and thereby garner experience that will help shape their future careers.

Patterns of genetic diversity in *Notropis girardi* in the Canadian River and Pecos River, New Mexico.

Diver, Tracy A. [1], Osborne, Megan J. [1], Turner, Thomas F. [1]. (1-University of New Mexico Department of Biology).

The Pecos River in New Mexico hosts a diverse community of pelagic spawning cyprinids. Relatively high alpha diversity results from the presence of an intact native fish fauna coupled with non-native species that have been introduced from other rivers. Using the protein-encoding mtND4 gene, we first assessed genetic diversity of six species within this community. There was no evidence of introgression between species, and, contrary to expectations of genetic theory, mtDNA diversity (as measured by è) was higher for recently introduced species *Notropis girardi* and, *Hybognathus placitus* compared to native *Macrhybopsis aestivalis* and *Notropis jemezanus* and endemic species *Notropis simus pecosensis*. Non-native species were presumably introduced into the system by bait bucket release (Bestgen et. al. 1989), and high levels of genetic diversity of non-native populations may result from multiple introductions from genetically divergent sources. In this study, samples from the introduced Pecos River population of *N. girardi* were compared to samples collected in the native range in the Canadian River, NM. Nucleotide sequence data from the mtND4 were compared among groups to determine whether the Canadian River, NM is the likely source population of the introduced population. Future work will focus on genetic assessment of other potential source populations via analysis of mtDNA and nuclear-encoded microsatellite DNA markers.

Monitoring Devils Hole pupfish *Cyprinodon diabolis* larvae: improving survey design at multiple scales

Dzul, Maria [1], Quist, Mike [1], Dinsmore, Steve [1]. (1-Iowa State University).

Devils Hole pupfish *Cyprinodon diabolis* is one of the most endangered vertebrates in North America. The entire population occurs in Devils Hole, a ~20m2 underwater limestone cavern in southwestern Nevada. Since the early 2000s, the threat of extinction has loomed over the Devils Hole pupfish population due to observed declines in adult abundance. In 2005, larval surveys were initiated to better understand patterns in larval abundance and factors influencing recruitment. There are multiple levels in

the current sampling design structure: surveys (2 samples per month), events (3 samples per survey), and plots (9 samples per event). The goal of this study was to determine how changing the sample size at each level (survey, event, and plot) affects the ability of scientists to detect a defined change in abundance at some level of statistical power. Using a linear mixed model, variance components were estimated for all three sampling levels (i.e., survey, event, and plot). Next, sample sizes across all levels were allowed to vary, as to represent different combinations of surveys, events, and plots. Variance of the mean was recalculated and used to calculate statistical power. Increasing sample size at the level of survey had the greatest influence on statistical power, followed by plot and event. However, since surveys are more difficult to implement, the optimal sampling design results from increasing the number of plots per event. Higher statistical power will improve the ability to detect trends in pupfish recruitment.

High-resolution temperature monitoring in Devils Hole

Hausner, Mark B. [1], Tyler, Scott W. [2], Wilson, Kevin P. [3], Bower, Michael R. [3]. (1-University of Nevada Reno Graduate Program of Hydrologic Sciences, Reno, NV., 2-University of Nevada Reno Department of Geological Sciences and Engineering, Reno, NV., 3-Death Valley National Park, Pahrump, NV.).

Devils Hole is a window into the carbonate groundwater that is located in the Amargosa Valley of southwestern Nevada, and is the sole habitat for the endangered Devils Hole pupfish, *Cyprinodon diabolis*. Temperatures within Devils Hole are at the upper physiological threshold for aquatic organisms, consistently at 33.5°C. However, temperatures on the small (2.6 x 6.1 m) shallow shelf can be higher during summer months (approaching 37.0°C) and lower (approaching 26.0°C) during winter. Higher summer temperatures have a negative impact on pupfish life history and productivity of lower trophic levels such as macroinvertebrates and algae. A fiber-optic distributed temperature sensor (DTS) was used to continuously measure temperatures over 3-5 days during different times of the year. Vertical temperature profiles and spatially scattered temperatures on the shallow shelf are presented, and future planned DTS deployments are described. The collected temperature data will form the basis for a hydrodynamic model of the thermal regime of Devils Hole. This computational fluid dynamic model will consider geothermal heating and conduction, latent heat flux, sensible heat flux, short-wave and long-wave radiation, as well as thermally driven convection, and is intended to examine both seasonal and long-term changes in the thermal regime of Devils Hole.

A nonlethal aging technique for threatened, endangered and sensitive fishes

Rogers, Ron J. [1], Albrecht, Brandon [1]. (1-BIO-WEST Inc.).

Morphological structures can be used to determine a fish's age. Typical structures used for fish-aging investigations include scales, otoliths, spines, opercular bones, vertebrae, branchiostegal bones and fin rays. We have found that many of these structures are either unreliable for aging native sucker populations, or require the fish to be sacrificed. Pectoral fin rays offer a nonlethal, reliable alternative to ageing native fishes. Since 1999 BIO-WEST, Inc., has developed, refined, utilized, and benefited from employing a nonlethal aging technique to understand the recruitment patterns of a wild, self-sustaining population of razorback sucker,*Xyrauchen texanus*, in Lake Mead, Arizona and Nevada. Most recently, BIO-WEST, Inc., has expanded the use of this technique to successfully age flannelmouth sucker, *Catostomus latipinnis*, captured from the Lower Colorado River. This aging technique has demonstrated that reliable, nonlethal aging of native sucker is possible. Furthermore, this technique can provide valuable ecological insight to a variety of threatened, endangered, or sensitive fish species. This information can be useful to formulate management actions that can contribute to species recovery.

Phylogenetic relationships of species of *Gila* in Mexico and related Western genera (Cypriniformes: Cyprinidae)

Schonhuth, Susana I. [1], Perdices, Anabel [2], Lozano-Vilano, Lourdes [3], Garcia de Leon, Francisco [4], Espinosa, Hector [5], Harris, Phillip M. [6], Mayden, Richard L. [1]. (1-Saint Louis University, Biology Department, MO, USA, 2-Museo Nacional de Ciencias Naturales, Departamento Biodiversidad y Biologia Evolutiva, Spain, 3-Universidad Autonoma de Nuevo Leon, Facultad de CC Biologicas, Mexico, 4-Centro de Investigaciones Biologicas del Noroeste, Mexico, 5-Universidad Nacional Autonoma de Mexico, Instituto de Biologia, Mexico, 6-Universidad de Alabama, Department of Biological Sciences, USA).

The genus *Gila*, or chubs, is widespread in aquatic habitats of western North America from northern USA to central Mexico. The number of species in the genus remains unclear (Fishbase: up to 23 spp.) and is a topic of debate, but they range from 11 to 62 cm SL. Most of the taxonomy of this group is based on morphology, the genus includes several different forms that inhabit a variety of habitats. Systematic of these cyprinids have a chaotic systematic history, and even closely related species have been placed in different genera by early workers. The relationships of the genus relative to other North American cyprinids has been studied using morphological (Uyeno, 1961, Univ. Michigan Ph.D., pp: 174; Coburn and Cavender, 1992, Standford Univ. Press, pp: 328-373) and molecular data (Simons and Mayden, 1998, Mol. Phyl. Evol 9(2): 308-329). Uyeno's study proposed to combine *Siphateles* and *Snyderichthys* with *Gila*, and unite *Clinostomus* with *Richardsonius*; later studies did not followed these proposed combinations and placed the genus *Gila* within a Western Clade. We present a molecular phylogeny, using one mitochondrial and three nuclear genes, for 12 different genera from the Western Clade (mainly species of *Gila*, *Ptychocheilus*, *Agosia*, *Algansea* and *Siphateles*), with a focus on the genus *Gila* in Mexico. Phylogenetic analyses recover a well-supported clade that included most of the species currently included in the genus *Gila* analyzed here plus seven other Western genera. While relationships among the taxa within this clade are not fully resolved, our results indicate some Western genera are not monophyletic groups.

El género *Gila*, o carpas, se encuentra ampliamente distribuido en el oeste de Norte América, desde el norte de EEUU hasta México central. El numero de especies incluidas en el género es incierto (Fishbase: hasta 23 spp.) y es un asunto de debate, midiendo de 11 a 62 cm de longitud estandar. La mayor parte de la taxonomía del grupo esta basada en morfología, a pesar de que el género actualmente incluye formas muy diferentes que viven en hábitats muy variados. La sistemática de estos ciprínidos ha tenido una historia caótica, e incluso especies muy relacionadas han sido incluidas en géneros diferentes en los primeros trabajos. Las relaciones filogenéticas del género respecto a otros ciprínidos de Norte América ha sido estudiada utilizando caracteres morfológicos (Uyeno, 1961, Univ. Michigan Ph.D., pp: 174; Coburn and Cavender, 1992, Standford Univ. Press, pp: 328-373) y datos moleculares (Simons and Mayden, 1998, Mol. Phyl. Evol 9(2): 308-329). En el trabajo de Uyeno se propuso combinar *Siphateles* y *Snyderichthys* con *Gila*, así como unir en género *Clinostomus* con *Richardsonius*; estudios posteriores no han seguido estas combinaciones y situaron el género *Gila* dentro de un Western Clade. Aquí presentamos una filogenia molecular utilizando un gen mitocondrial y tres genes nucleares para 12 géneros diferentes incluidos en el Western Clade (principalmente para especies de los géneros *Gila*, *Ptychocheilus*, *Agosia*, *Algansea* y *Siphateles*), enfocando el trabajo en el género *Gila* en México. Los análisis filogenéticos recuperaron un clado bien soportado que incluye la mayor parte de las especies actualmente incluidas en el género *Gila* que se analizan aquí, además de otros siete géneros del Western Clade. A pesar de que las relaciones entre taxa dentro de este clado no son plenamente resueltas, nuestros resultados indican que algunos de los géneros del oeste no son grupos monofiléticos.

Complete mitochondrial genome sequentiation of native catfishes genus *Ictalurus*in Northwest Mexico: Phylogenetics implications/Secuenciación del genoma mitocondrial de los bagres nativos endémicos del género *Ictalurus* (Pisces: Ictaluridae) en el Noroeste de México y sus implicaciones filogenéticas

Varela-Romero, Alejandro [1], Grijalva-Chon, José M. [1], Gutiérrez-Millán, Luis E. [1], Yepiz-Plascencia, Gloria [2]. (1-Department of Science and Technology Research, University of Sonora, 2-Aquatic Molecular Biology Laboratory, CIAD).

Catfishes of the genus *Ictalurus* are native freshwater fishes that occur in the northwest Mexico. Several species of the genus were included in the Norma Oficial Mexicana. Recently, Mexico has been referred as the speciation center of the genus in America. However, more than six new *Ictalurus* species, related to the nominal species, has been detected but not formally described. Phylogenetics of the genus was based on morphological characters of nominal species to define the "*punctatus*and *furcatus*" clades, and on the mitochondrial genes *cytb*and control region of scare species to support the clades of the morphological analysis. This phylogenetic approach is not enough conclusive for the rest o the nominal and potential new species of the genus. Actual and potential threats by stocking and culture of the exotic channel catfish increase the risk and the necessity of to know and protect the genomics of these endemics. The complete mitochondrial genome is regional resource at risk of extinction. The knowledge of these native genomes is basic information to understand the Mexican native catfish species evolution, and represents a contribution to the knowledge of the genomics of species conservation and economic use in the local development. This project was designed to obtain the complete nucleotides sequence of the mitochondrial DNA of the natives Yaqui catfish, *Ictalurus pricei* and the Sinaloan catfish, *Ictalurus* sp, endemics to the Northwest Mexico, and to contribute to the knowledge of their origin speciation, and evolution. For the sequentiation of these genomes, we were using the long distance and primer walking technique, tested with success for the sequentiation of complete genomes. At this moment, we have the 20% of three haplotypes of Yaqui catfish (Bavispe & Tutuaca river sub basin, and Fuerte river basin) as a result of the assembling of the *cytb*, CR, *12SrRNA* genes, and the phenylalanine, threonine y proline tRNAs. The project is also including field trips to collect catfish specimens in the Pacific drainages of the Sierra Madre Occidental.

Los bagres nativos del género *Ictalurus* son peces dulceacuícolas que habitan en el Noroeste de México y varias de sus especies se encuentran enlistados en la Norma Oficial Mexicana. México ha sido mencionado recientemente como el centro de especiación del género *Ictalurus* en América, a pesar de que no haberse descrito científica y formalmente hasta el momento más de seis especies que ya han sido reconocidas como formas cercanas a especies existentes ya descritas. La filogenia inicial sobre el género está basada en especies nominales y rasgos morfológicos definiendo los clados "*punctatus* y *furcatus*" y la filogenia molecular basada en los genes mitocondriales *cytb* y la región control de pocas especies, corrobora la hipótesis de los clados morfológicos pero aún no es contundente ni extensiva a todas las especies nominales y las formas aún no descritas. Las amenazas registradas y las potenciales por la utilización de bagres congéneres exóticos (*Ictalurus punctatus*) como sujeto de cultivo y siembras en la acuicultura extensiva en aguas continentales Mexicanas, acelera la necesidad de conocer la genómica de estos importantes representantes del germoplasma nacional. El genoma completo de los bagres nativos, es un recurso regional en riesgo de extinción. El conocimiento de los genomas mitocondriales de especies nativas es información básica para entender la evolución de las especies de bagres nativos mexicanos, además representa una contribución a la genómica de especies de interés para la conservación y económico para el desarrollo regional. Así, este proyecto pretende obtener la secuencia nucleotídica completa del genoma mitocondrial de los bagres Yaqui, *Ictalurus pricei* y de Sinaloa, *Ictalurus* sp, nativos y endémicos al Noroeste de México para contribuir al conocimiento del origen y las relaciones filogenéticas y de especiación. Para la secuenciación del los genomas mitocondriales completos se utiliza la estrategia "long distance" y "primer walking", usada con éxito para la caracterización de genomas completos de otros organismos. Hasta el momento se cuenta con el 20% de tres haplotipos geográficos (Bavíspe, Tutuaca, Fuerte) del bagre Yaqui y del exótico bagre azul con el enzamblaje de los genes *cytb*, CR, *12SrRNA* y los tRNAs de fenilalanina, treonina y prolina. El proyecto también contempla la recolecta de ejemplares de bagres nativos en la vertiente Pacífico de la Sierra Madre Occidental.

New artificial streams for spawning spikedace (*Meda fulgida*) at Bubbling Ponds Research Facility

Ward, David L. [1]. (1-Arizona Game and Fish Department, Research Branch).

Construction of 5 new artificial streams for spawning spikedace (*Meda fulgida*) were completed in April of 2009 at Bubbling Ponds Fish Hatchery, AZ. These new artificial streams are fiberglass raceways made from recycled military surplus shipping containers. Each stream measure 4.7 m long, 1.1 m wide and 0.7 m deep and is set up to mimic a natural stream environment. As larval fish swim-up they are automatically separated from adult fish and moved to the sump by the flowing water. Each stream receives 4 L/min of fresh water at 20° C from an artesian well and has two recirculation pumps that generate either base flow (227 L/min), or simulated flood flows, (984 L/min) to induce spawning. When both pumps are in operation water velocities approach 1 m/sec allowing sediments to remain suspended and simulate high turbidity flood events. Each raceway functions independently allowing distinct populations of fish to be maintained without mixing. These new streams are a valuable resource for spawning and maintaining genetically distinct populations of endangered stream fishes for reintroduction purposes.