11/20/2003 9:00:00 AM - Lower Colorado River Area Report - This reports on a variety of conservation and recovery activities for fish and other aquatic fauna of the lower Colorado River basin during the period October 2002 to October 2003. Species for which activities are reported include Apache trout *Oncorhynchus apache*, Gila trout *Oncorhynchus gilae*, spikedace *Meda fulgida*, loach minnow *Tiaroga cobitis*, Little Colorado spinedace *Lepidomeda vittata*, speckled dace *Rhinichthys osculus*, humpback chub *Gila cypha*, bonytail *Gila elegans*, Gila chub *Gila intermedia*, roundtail chub *Gila robusta*, razorback sucker *Xyrauchen texanus*, bluehead sucker *Catostomus latipinnis*, Gila topminnow *Poeciliopsis occidentalis*, and others.

11/20/2003 9:15:00 AM - Native fish research and management in the upper/middle Rio Grande Basin, 2003 - Native fishes conservation activities in the upper/middle Rio Grande Basin during 2003 were focused on research and management needs relative to dwindling surface water supplies. Low precipiation levels in the upper/middle Rio Grande Basin since 2001 and maintenance of high water use levels have combined to increase the likelihood of river channel drying. Instream reservoirs on the upper Pecos River and middle Rio Grande were at all time lows for storage. Leasing of stored water was accomplished for both attempted maintenance of surface flow and for sustained diversion and consumptive use.

Status and conservation efforts for the Rio Grande silvery minnow *Hybognathus amarus* are detailed here. The declining status of the species continued in 2003. Diminished surface flow and river channel intermittency remained the primary threat to species persistence. Rio Grande silvery minnow have occurred primarily downstream of the Albuquerque area, based upon recent collections (< 30 years). This reach suffers frequent flow intermittency, which serve to minimize survival of post-spawn adults and eliminate young-of-year and juvenile life stage habitats. Active conservation efforts for this species have centered around short-term and non-flow actions. These actions included continuation of captive propagation efforts, augmentation of existing populations, and rescue/salvage/transplant from drying downstream reaches to upstream reaches of continuous flow. In addition, habitat restoration projects have been implemented to diversify the active river channel. Assurance of continuous surface, considered to be the most important conservation activity by most biologists, has not been accomplished. Recent genetics work indicated that captive propagation stocks had lower genetic diversity and fewer alleles at all loci studied than those individuals sampled from the wild. Captive propagation efforts have improved, with additional facilities constructed and survival of propagated fish increased above pervious low levels. Augmentation monitoring indicated that stocked fish survived and in the Albuquerque reach, now outnumber remaining wild fish. Salvage and transplant activities continued, with initiation of studies to determine survival of handled fish. Genetic monitoring of propagated and wild Rio Grande silvery minnow indicated continued loss of genetic variability in propagated fish.

The Rio Grande Silvery Minnow Recovery Team has undertaken the task of revising and updating the Recovery Plan. Formerly, primary recovery strategies centered on protection and stabilization of the existing population in the middle Rio Grande of New Mexico and range expansion through introductions of propagated fish. Review and revision of the Recovery Plan has thus far entailed focus on recovery strategies and updating of Part I (biology, status, distribution, conservation to date) of the Recovery Plan. The recommended recovery strategy, as proposed by the Recovery Team, now emphasizes extinction prevention as paramount.

11/20/2003 9:30:00 AM - Bonneville Basin Area Report - This paper will present a brief summary of activities associated with native aquatic species in the Bonneville Basin this year. An additional population of least chub (*Iotichthys phlegethontis*) was identified this year in Clear Lake in Millard County, Utah on property owned by the Utah Division of Wildlife Resources. Other populations of least chub continue to compete with mosquitofish (*Gambusia affinis*). Control of some of the mosquitofish populations in sympatry with least chub is being attempted. A hatchery population of least chub has been established. The June sucker (*Chasmistes liorus*) Recovery Program continues to be very active. Many suckers were captured in the spawning run up the Provo River this year, but those meeting the morphologic criteria of June sucker were fewer than the previous year. The artificial propagation program for this species is expanding. The status and biology of leatherside chub (*Gila copei*) was discussed in a multi-agency and university meeting in July 2003. Participants agreed to continue to track the status of the species throughout its range in Utah, Idaho, and Wyoming, and to share available knowledge. The workshop participants sampled an apparently viable population in very limited habitat in the Dry Fork of the Smiths Fork River in Wyoming. The Utah Division of Wildlife Resources was directed to update the state sensitive species list. Currently listed and conservation species were automatically included, but a species of concern list required development of formal justifications for each species, many of whom occur in the Bonneville Basin. Twenty of the mollusk species

proposed as state species of concern are found in limited aquatic habitats in the Bonneville Basin. This document is now available for public review and comment, and may be approved as early as the 18 December 2003 Utah Wildlife Board meeting in Salt Lake City. A full-time real estate specialist was hired by the Utah Department of Natural Resources this year to pursue habitat protection for native species. The most pressing task this individual has pursued is the purchase of conservation easements to benefit the Columbia spotted frog (*Rana luteiventris*) in the San Pete River drainage. The Bonneville cutthroat trout (*Oncorhynchus clarki utah*) program is preparing to re-write the tri-state Conservation Agreement. The Utah State University Natural History Museum is preparing curricula for elementary and high schoolteachers regarding the native fish species of Utah.

11/20/2003 9:45:00 AM - Texas Area Report: Desert Fishes research and management in Texas during 2003 - Conservation activities are summarized for desert fishes and their habitats in the Chihuahuan Desert of west Texas. Comanche Springs pupfish (*Cyprinodon elegans*) and Pecos gambusia (*Gambusia nobilis*) are surviving at Phantom Lake Spring, although natural outflow has been nonexistent for more than 3 years. The small spring habitat is only maintained by pumping water from inside Phantom Cave to the surface. The refugium populations of both fishes at the San Solomon Ciénega in Balmorhea State Park appear robust and stable in this artificially-created wetlands habitat. An interagency agreement with the local irrigation district is near conclusion to fulfill commitments made in 1993 as part of the Ciénega project.

Genetic monitoring of the Pecos pupfish (*C. pecosensis*) in Salt Creek, the only natural pure population of the species in Texas, has revealed unique alleles in the most upstream portion of the creek. One of the two C. pecosensis refugia populations, established in 2000 on private lands was compromised in 2002 due to an accidental introduction of irrigation waters containing the nonnative sheepshead minnow (*C. variegatus*).

Devils River minnow (*Dionda diaboli*) populations were found to be relatively stable and in abundance at various localities throughout their range, based on multi-year monitoring studies in the Devils River, San Felipe Creek, and Pinto Creek. The implementation of the 1998 Devils River Minnow Conservation Agreement has resulted in two local management plans for the protection of San Felipe Creek by the City of Del Rio and the local golf course. Each plan is designed to protect the natural resources, while providing recreation along the creek. The Nature Conservancy has purchased 87,000 acres in the Devils River watershed, touted as the largest-ever private land conservation deal in Texas. The Draft Devils River Minnow Recovery Plan is near completion.

The Rio Grande in Big Bend National Park ceased flowing for the first time in recorded history. Studies are underway to evaluate the potential of this reach of the river as a reintroduction site for the endangered Rio Grande silvery minnow (*Hybognathus amarus*). Recent conservation efforts for the Big Bend gambusia (*G. gaigei*) include post-fire restoration (revegetation of native grasses and rebuilding a boardwalk), construction of a nutria-proof fence, and plans for habitat improvement by berm reconstruction and developing an alternate water supply for human consumption.

A genetic assessment to better understand the relationship of the channel (*Ictalurus punctatus*) and headwater catfish (*I. lupus*) in west Texas and southeastern New Mexico has preliminary results available.

Recent fish surveys of Independence Creek have been completed documenting changes in the community structure over the last 50 years.

Preliminary data from an ongoing study of the genetic status of the only population of Clear Creek gambusia (*G. heterochir*) has affirmed that fish upstream of an artificial dam maintain purity.

11/20/2003 10:00:00 AM - 2003 advances in the study and conservation of native fishes in Northwest Mexico - As a result of the project Conservation status of freshwater fishes of PROY-NOM-ECOL-059-2000 in Northwester Mexico, Sonora and Baja California, the status of 21 species were reviewed. The status analysis was based on Biotica 4.0 and the application of MEER methodology. This support a change in the number of species listed by category. We now recognize five extirpated species from national territory, six endangered species, seven threatened species, and two under special protection. One species were delisted under this methodology. The application by experts of this methodology to the rest of the Mexican native species not listed by the actual Norma Oficial Mexicana, surely will increase the current official list. This project was funded by CONABIO. The Distribution, Habitat, and Conservation Status of the Desert Pupfish (*Cyprinodon macularius*) in the Lower Colorado River Basin, Mexico, has been recently published in Reviews in Fish Biology and Fisheries, 12(2):2002.

The research project "ecological and distributional evaluation of exotic fishes in the oases of the San Ignacio and La Purísima drainages, Baja California Sur, and their impacts on the endemic killifish *Fundulus lima* is in process. New localities of distribution of F. lima are reported (3 in San Ignacio drainage and 2 in La Purísima drainage) as well as the presence of four exotic species (*Tilapia* cf. *zilli*, *Cyprinus carpio*, *Poecilia reticulata* and *Xiphophorus helleri*), with high dominance of *T.* cf. *zill*. This project is funded by the SEMARNAT-CONACyT and UABC. An annotated distributional checklist of the freshwater fishes of the State of Baja California Sur, has been recently published in Reviews in Fish Biology and Fisheries, 12(2): 2002.

The project AA005 The Native Fish Collection of Sonora is in progress and was funded by CONABIO. The DICTUS hold the collection, which include almost all the native, and exotics fishes of Sonora. The collection was arranged following Eschmeyer (1998) classification and maintains 1000 records with 35,000 specimens. Collections records came from 1960 to date, and the specimens were keeping in glass gars in ethanol 70%. The collection keep the 64 species native and exotic freshwater fishes of Sonora, which represents the 8.9% of the national native fish species, the 19.5% of genera, 33.3% of families and 38.8% of orders to national level. The 53.48% of Sonoran native fishes were protected by the NOM-059-2001. This project pretends the computerization of the native fish collection of Sonora, and to build a display and develop a permanent actualization of the information using the nodus of REMIB located at DICTUS.

11/20/2003 10:15:00 AM - Upper Colorado River basin Area Report - Upper Colorado River Basin - Instream Flow: The report entitled Flow Recommendations to Benefit Endangered Fishes in the Colorado and Gunnison Rivers was approved by the Upper Basin Recovery Program Biology Committee. The Bureau of Reclamation has begun modeling operations of the Aspinall Unit to try to meet these flow recommendations, for which it will prepare an EIS. The Service and Reclamation will initiate discussions in September 2003 to develop an approach for addressing ESA compliance for Aspinall reoperations, as well as other Gunnison Basin projects. The Flaming Gorge EIS Interdisciplinary Team is preparing a draft EIS on the operation of the Flaming Gorge Dam pursuant FWS requests for endangered fish flow needs. The comment period will end December 2003. A Notice of Availability for a draft Management Plan for Endangered Fishes in the Yampa River Basin (Plan) was published in the Federal Register on July 30, 2003. Comments will be accepted through August 31, after which the Plan and EA will be finalized. Design and permitting for Elkhead Reservoir enlargement are on schedule, and the Colorado River Water Conservation District (River District) plans to award a construction contract next January. The Biology Committee tentatively approved a report entitled Flow Recommendations for the Duchesne River pending incorporation and final review of technical comments submitted by the Committee. The Recovery Program contracted Argonne National Laboratory (Argonne) to develop a strategic plan to prioritize and direct future habitat research and monitoring activities to direct future research toward meeting the recovery goals of the fishes. The draft plan was sent out for Upper Basin Recovery Program Biology Committee and peer review on April 14, and peer review comments were provided to the Biology Committee on June 13 and will be finalized this fall. The Upper Basin Recovery Program Director's staff is preparing recommendations for studies beginning in FY 04 to address the primary research needs identified in the Argonne report.

Habitat Restoration: Three Colorado pikeminnow, one stocked bonytail and over 5,000 native fish ascended the fish ladder at the Redlands Diversion Dam on the Gunnison River in 2003. As of mid-August 2003, the ladder has been used by 53,000 native fishes (versus 7,600 nonnative fishes), including 57 Colorado pikeminnow, and six previously-stocked razorback suckers. Construction of passage structures at Government Highline Dam and Price Stubb Dam on the Colorado River is scheduled for this coming winter the winter of 2004 and 2005, respectively. The Upper Basin Recovery Program is developing a subbasin and site-specific floodplain management plans to provide clear objectives, costs, and measures of success. Drafts of these plans will be available by fall 2003. A floodplain easement of 451 acres on the Thunder Ranch, located 6 miles downstream from the Green River razorback spawning bar, was recently acquired to restore endangered fishes nursery habitat. Research using the 'reset' approach to floodplain management indicated water manipulation in floodplains may hold promise in increasing survival of early life stages of bonytail and razorback sucker.

Nonnative Fishes: Nonnative fish reduction efforts continued to lower the number of northern pike and channel catfish on the Yampa, Duchesne, and Green rivers. Next year smallmouth bass is planned for removal along with catfish and northern pike in both the Green subbasin and upper Colorado River. In late November or early December, biologists will meet to discuss their research findings from 2003 nonnative fish management activities. At that time, the Recovery Program will determine what future directions these projects will take.

Propagation Activities: Species, numbers, and sizes of fish already stocked or expected to be stocked during 2003 to meet the integrated stocking plan.

Species River Section Number Time (Hatchery) Size (inches)

Bonytail Green (Middle) ~12,000 Fall (Mumma)

~2,700 Summer–Fall (Wahweap) > 8

Green (Lower) ~5,300 Summer–Fall (Wahweap) > 8

Colorado (Colorado) 885 Spring (Mumma)

~12,000 Fall (Mumma) > 8

Colorado (Utah) ~2,700 Summer–Fall (Wahweap) > 8

Razorback sucker Green (Middle) 7,830 Spring (Ouray)

~1,900 Summer–Fall (Ouray) ~ 12

Green (Lower) ~4,900 Fall (Ouray)

~4,900 Summer–Fall (Grand Junction) > 12

Colorado (Colorado) ~9,900 Summer–Fall (Grand Junction) > 12

Colorado pikeminnow Colorado (Colorado) ~2,250 Summer–Fall (Grand Junction) > 6

Research, Monitoring, and Data Management: Mark-recapture population estimates are underway to determine progress toward achieving the recovery goals. This past spring was the last in a 4-year sampling effort to obtain population estimates for Colorado pikeminnow in the middle Green River and an expanded 3-year sampling effort for Colorado pikeminnow in the lower Green River. A draft report on these annual population estimates is due in March 2004. A 3-year sampling effort for annual Colorado pikeminnow and humpback chub population estimates in the Colorado River were initiated this past spring.

San Juan River Basin: The fish ladder constructed on San Juan River near Farmington (P&M Weir) was completed and allowed several Colorado Pikeminnow to pass upstream. Stocking of razorback sucker continued through this year (7,177 adult fish stocked since 1994) and the Colorado pikeminnow stocking plan was initiated in 2003 with 200,000 age-0 fish stocked. Over 800 razorback sucker larvae were collected in the San Juan River and represent the offspring of stocked fish. At least two age 1+ razorback sucker were also collected in the San Juan River. Channel catfish reduction efforts continued through 2003.

11/20/2003 10:30:00 AM - National and Northeast Mexico Area Report - There is little news to report this year. Research is continuing at UANL Lab. Ictiología, applying Indexes of Biological Integrity in the Rio Conchos, Chihuahua, and sending reports on exotics to ASIH, AFS, DFC, and SIMAC. Two papers appeared on exotics, one on *Colossoma* X *Piaractus* hybrid near Monterrey, and the formal report of *Hemichromis* in Cuatro Ciénegas. Recent exploration has given materials for reporting 4 more species and a number of new locality records for a number of species. They will be sent for publication soon. Most importantly, they include at least 2 more Loricariidae from Río Balsas, Río Grijalva, and Río Usumacinta. Other recent papers appeared and they refer to the Chihuahuan Desert pupfish, included in the recent issue from the Chihuahuan Symposium from last meeting. Popular articles include a general overview of the Chihuahuan Desert, a local report on fishes of Metropolitan Monterrey, and a general comment on Mexican fishes. Collecting in Chihuahua has revealed that the rivers and creeks are at an all-time low water and several endemic species are very scarce. However, on the good side, we located an excellent spot for the very spotty endemic and listed species *Etheostoma australe* in Chihuahua.

11/20/2003 10:45:00 AM - 2003 Oregon Area Report - This presentation briefly summarizes the fish conservation efforts conducted or underway in 2002-2003 in the Oregon Area (includes State of Oregon and Upper Pit River Drainage of California). The activities reported on were conducted by the U.S. Fish and Wildlife Service (FWS), the Bureau of Land Management (BLM), the Oregon Chapter of the Nature Conservancy (TNC), the Oregon Department of Fish and Wildlife (ODFW), the U.S. Bureau of Reclamation, and other agencies or organizations. The species discussed may include, but are not limited to: Lost River sucker, *Deltistes luxatus*; shortnose sucker, *Chasmistes brevirostris*; Warner sucker, *Catostomus warnerensis*; Warner Valley redband trout, *Oncorhynchus mykiss ssp.*; Modoc sucker, *Catotstomus microps*; Jenny Creek sucker (isolated population of *Catostomus rimiculus*); Lahontan cutthroat trout, *Oncorhynchus*

clarki henshawi; Borax Lake chub, *Gila boraxobius*; Cowhead lake tui chub; the Goose Lake Fishes; Bull trout, *Salvelinus confluentus*; four lamprey species recently petitioned for listing under the Federal Endangered Species Act (Pacific lamprey, *Lampetra tridentata*; river lamprey, *Lampetra ayresi*; western brook lamprey, *Lampetra richardsoni*; and Kern brook lamprey, *Lampetra hubbsi*), as well as mention of a Klamath / Pit River / Goose Lake Basin lamprey genetics study currently underway.

11/20/2003 11:00:00 AM - California Area Report - Desert pupfish (*Cyprinodon macularius*) - In January a pond in Anza Borrego State Park was vandalized by addition of an unknown quantity of motor oil. Approximately 700 desert pupfish were salvaged, with 11 known dead. The contaminated water, sediment and vegetation were removed from the pond. The concrete bottom of the pond was repaired and fish were re-stocked.

The 2002 Tamarisk control project on Salt Creek developed significant re-sprouting that will require additional control efforts.

Owens pupfish (*Cyprinodon radiosus*)

All 5 populations of pupfish (Marvin's Marsh, off channel ponds at BLM Spring, Warm Spring, Mule Spring, and Well 368) continue to thrive.

A dense population of large pupfish in Mule Spring is implicated in near demise of the tui chub in the pond. Cattail biomass (root mat) has diminished the pond volume by approximately 40% after 13 years. Maintenance of the pond plumbing system may not be possible without draining the pond, due to cattail encroachment.

BLM Spring channel above the low head fish barrier is free of largemouth bass. The fish barrier has prevented the upstream movement of bass for more than one year. (See Parmenter et al., this volume). Reintroduction of Owens Valley native fishes will occur before the end of 2003.

Shoshone pupfish (*Cyprinodon nevadensis Shoshone*)

Cattails were removed from the artificial pond in which Shoshone pupfish are contained in May. Re-growth over the summer season came to about 25%.

Owens tui chub (*Siphateles bicolor snyderi*)

Completion of a genetic study (see Chen et al., and Madoz et al.; this volume) confirm the identity and presence of Owens tui chub from AB Spring and CD Spring at Hot Creek State Fish Hatchery, the Owens River Gorge, White Mountain Research Station, Little Hot Creek, and Sotcher Lake.

Toikona tui chub (*Siphateles bicolor* ssp)

Chubs at Mule Spring, and Cabin Bar Ranch in Owens Valley appear to be a separate endemic form (See Chen et al., this volume). The previously robust population in Mule Spring may be near extirpation. Since early July, 2003 no chubs have been observed in the pond. A single adult chub was trapped in late August, 2003. A salvage plan was developed by Fish and Game and is being implemented in cooperation with BLM, the University of California White Mountain Research Station, and Los Angeles Department of Water and Power.

Mohave chub (*Siphateles bicolor mohavensis*)

The National Park Service sponsored a productive two-day workshop at Zzyzx to revisit the 1988 recovery plan, and outline a cooperative agreement/management plan called for in the recovery plan and Mojave National Preserve General Management Plan.

Mohave chub continue to inhabit Lake Tuendae and "M-C Spring" at Zzyzx in Mojave National Preserve, Lark Seep system on China Lake Naval Air Weapons Station, and two artificial ponds at Camp Cady State Wildlife area.

Lake Tuendae has experienced a perennial phytoplankton bloom and loss of most of its Saratoga Springs pupfish population since 2001. Concomitant changes preceding the bloom including increased mean depth by dredging, and establishment of *Gambusia affinis* and Asian tapeworm, defy simple explanations for the bloom. Tui chubs persist in unknown numbers, but are inferred by length distribution to have spawned in 2002 and 2003.

Monitoring at China Lake used new tagging and trapping strategies to increase precision of population estimates. A program of mechanical harvest is proposed to control cattails in the main drainage ditches where chus live.

Piute cutthroat trout (*Oncorhynchus clarki seleniris*)

A planned rotenone treatment of six miles of Silver King Creek to restore Piute trout to their native reach downstream of Llewellyn Falls was cancelled due to a last-minute lawsuit by the Center for Biological Diversity.

Lahontan cutthroat trout (*Oncorhnchus clarki henshawi*)

LCT monitoring results will be reported following September surveys. Of concern: beaver manipulations of streams; fire damage; and drought impacts.

Black toad (*Bufo exsul*)

A small mark recapture survey was conducted on the black toad at Corral Springs, showing good numbers of adults for the site. A Western toad and tadpoles were observed in Deep Springs Valley, posing a potential threat to the black toad population genetic integrity.

11/20/2003 11:15:00 AM - 2003 Nevada Area Report - Management and monitoring activities which occurred during 2003 are summarized for a majority of the desert fishes and other sensitive aquatic organisms of Nevada. In Nye county, Devils Hole pupfish (*Cyprinodon diabolis*) numbers increased with 294 individuals counted during September. One refugium population was lost, while two others remained stable. Ash Meadows Amargosa pupfish(*C. nevadensis mionectes*) were stable to increasing. Ongoing restoration continued to favor this species, although largemouth bass (*Micropterus salmoides*) introduction in Big Springs adversely affected this population. Warm Springs pupfish (*C. n. pectoralis*) likely declined, although no surveys were conducted. Crayfish (*Procambarus clarkii*) and mosquitofish (*Gambusia affinis*), as well as vegetation encroachment, are increasing threats. Ash Meadows speckled dace (*Rhinichthys osculus nevadensis*) data had not yet been analyzed for Bradford Springs at Ash Meadow National Wildlife Refuge. Largemouth bass at Big Springs, as well as a wildfire, likely caused a decline in this population. Bass removal efforts were implemented. Oasis Valley speckled dace (*R. osculus* spp) appeared to be stable. The mark-recapture estimate at Torrance Ranch was 703. This species appeared to be common throughout the watered portions of Amargosa River in Nye County. Pahrump poolfish (*Empetrichthys latos*) were stable in Clark County, with an estimated population of 17,775. The newly constructed Corn Creek refugium was stocked with poolfish and they are currently reproducing. The population at Shoshone ponds refugium in White Pine County has shown a decline. Moapa dace (*Moapa coriacea*) remained stable in the upper Muddy River and tributaries at 907 individuals. Blue tilapia (*Oreochromis aurea*) eradication projects are ongoing. Habitat degradation and water cooling posed problems for this dace. Moapa White River springfish (*Crenichthys baileyi moapae*) have greatly increased due to restoration activities to 11,800 individuals. Habitat for the Muddy River population of Virgin River chub (*Gila seminuda*), as well as the Moapa speckled dace (*R. osculus moapae*), has been enhanced by tamarisk (*Tamarix ramosissima*) removal. These fishes have had a positive year of recruitment, and are stable to increasing in numbers. Efforts to utilize ponds at the Reid-Gardner Nevada Power generation plant for refugia are ongoing. In Lincoln county, very few Pahranagat roundtail chub (*Gila robusta jordani*) were seen in the wild in 2001, and were likely extirpated by 2003. Agencies have been unable to survey for this species due to denied access. Pahranagat roundtail chub were spawned at Dexter National Fish Hatchery and Technology Center and it is anticipated that these fish will be used to stock a refugium at Key-Pittman Wildlife Management Area in 2004. The federally-managed portion of Ash Springs was visually surveyed and White River springfish (*C. b. baileyi*) appeared to be common and stable. Hiko White River springfish (*C. b. grandis*) were stable in Hiko Springs with 1,190 individuals estimated. Surveys in Crystal Springs were ongoing. Non-native fish, primarily convict cichlid (*Cichlasoma nigrofasciatum*), shortfin molly (*Poecilia mexicana*), and mosquitofish (*G. affinis*), appeared to be the greatest threat to this species. Fish in Condor Canyon, including the Big Springs spinedace (*Lepidomeda mollispinis pratensis*), Meadow Valley Wash desert sucker (*Catostomus clarki ssp*), and Meadow Valley Wash speckled dace (*R. osculus* ssp), had declined in Condor Canyon due to a storm event. Estimates were not precise due to habitat conditions affecting the depletion technique. Limited surveys occurred in Meadow Valley wash due to rain events. A fire near Carp, Lincoln County, reduced a population of these fish to very low numbers. White River spinedace (*Lepidomeda albivallus*) were stable to increasing in numbers at the Flagg Springs outflow, with 1,528 individuals. Speckled dace (*R. osculus* ssp) and desert suckers (*C. clarki* ssp) in the White River Valley were abundant. Visual estimates of the Moormon White River springfish (*C. b. thermophilus*) and the Preston White River springfish (*C. b. albivallus*) suggested that

they were common and stable. Largemouth bass were being removed from the Hot Creek diversion to protect the Hot Creek population of springfish, and restorations are underway to benefit the fish near Preston, White Pine County. A refugium population of Virgin River spinedace (*Lepidomeda mollispinis mollispinis*) in upper Beaver Dam Wash was extirpated, presumably by drought conditions or rainbow trout (*Oncorhynchus mykiss*). Railroad Valley Tui Chub (*Gila bicolor* ssp) had increased to 34,700 in Twin Springs Slough, which was the only public land sampled. There was likely more tui chub on private property that remained unsurveyed. Railroad Valley springfish (*C. nevadae*) remained stable, with an estimate of 5,000. Red-bellied tilapia (*Oreochromis zillii*) still occured on the Duckwater Indian Reservation, but renovations were being planned with the Tribe to remove this threat. A new population of this springfish was also discovered. The relict leopard frog (*Rana onca*) had been stable since 2002, although the overall population had decreased over past decade. Captive propagation and introductions have been ongoing, and amplexus has been documented in captivity. The most recent surveys for spotted frog (*R. luteiventris*) have shown a drastic decline, but a wide distribution. This decline has likely been caused by the drought. A conservation agreement for this species was signed in September, 2003. The Amargosa toad (*Bufo nelsoni*) was estimated at 1,774 adults, which suggested a stable population. Vegetation encroachment and bullfrogs pose an increasing threat. Bullfrog (*R.catesbiana*) removal activities occurred during the late summer, resulting in removal of several hundred bullfrogs. Stomach analysis of these frogs confirmed that Amargoa toad are consumed by bullfrogs. Several projects have occurred that benefit invertebrates. Informal surveys for the Ash Meadows naucorid (*Ambrysus amargosus*) suggested a population decline, due to cattail encroachment on naucorid habitat. Ongoing restoration activities including vegetation management will alleviate this threat. The springheads at Corn Creek Springs in Clark County were restored, resulting in a rebound of the Corn Creek pyrgulopsis (*Pyrgulopsis fausta*), which was formerly at very low numbers.

11/20/2003 11:30:00 AM - Devils Hole, cradle of the Desert Fishes Council - It is an ecological truism that organisms do not exist in isolation, but are relevant only as components of, and in reference to, their environments. It follows, then, that to understand the Devils Hole pupfish we also have to understand the Devils Hole environment. What follows is an overview of the aspects of the Devils Hole physical environment that most strongly impact its suitability as Devils Hole pupfish habitat. A 110-160-km-wide swath of brittle Paleozoic carbonate rocks, which extends south from east-central Nevada through the Spring Mountains, hosts an extensive network of interconnected subterranean fissures opened by extensional tectonism active in the Great Basin since the Miocene. The fissure network conducts snowmelt and rain water primarily from the well-watered upper elevations of the Spring Mountains to the arid circumjacent basin-floor discharge areas. The high-elevation recharge area assures that valley-floor springs flow even during arid climates (as at present), although the amount of flow and discharge-area water-level elevations appear to vary with both climate and tectonics. Devils Hole formed, apparently about 60,00 years ago, when ceiling collapse of a small part of one of the fissures opened a skylight to the water table adjacent the Ash Meadows oasis. Once Devils Hole had opened to the land surface, the 32-33-degree-C waters of the previously subterranean segment of the aquifer were available for colonization by a photosynthetically based aquatic community. Since colonization, the extent and health of the aquatic community in the narrow 17-m-deep fissure has been largely dependent on (1) the height of the water table, which determines both the amount of semi-horizontal subaquatic surface area that intercepts sunlight, and the intensity and duration of the sunlight intercepted, and (2) the configuration of the Hole as it evolves by continued spreading, wall collapse, and swallowing of breakdown blocks. Since about 750,000 years ago, the water table in the vicinity of Devils Hole has fallen roughly 26 m, but more importantly, available evidence indicates that in the 60,000 years since Devils Hole is thought to have opened, the water table has always been 7-17 m below ground surface, hence there is no obvious way for obligately aquatic organisms like the Devils Hole pupfish to have colonized the pool. From 60,000-15,000 years ago, water table was 5-9 m higher than at present, presumably increasing the amount of shallow substrate, the duration and intensity of solar radiation on that substrate, and likely the suitability of Devils Hole as an aquatic habitat, compared to today. In the last 15,000 years, the water table dropped precipitously to present levels, probably as a result of the change from glacial to interglacial climates. At present water levels, the shallow shelf, which is the upper surface of a breakdown block wedged just below water surface at the SW end of the pool, includes essentially all the sub-horizontal, shallowly submerged substrate in Devils Hole. The shallow shelf is thought to be critical to pupfish survival because it is the only place they are known to spawn and is location of a disproportionately large part of the primary productivity in Devils Hole. To the extent that the shallow shelf is critical to pupfish, their survival may be tenuous for several reasons: (1) Surfaces etched by photosynthetic endolithic borers on the now-shaded fissure wall adjacent to the breakdown block indicate that the block fell to its present position after Devils Hole opened to the sky, i.e., relatively recently in geological time. The block presumably will fall deeper the next time the fissure spreads, or new blocks could fall on the shallow shelf, covering and/or

shading it. (2) When it opened, Devils Hole captured a small ephemeral channel on Devils Hole Ridge. During its approximately annual flows in response to thunderstorms, the channel flushes up to a cubic meter of sediment into Devils Hole, much of which is deposited on the shelf, flushing off algal mats, smothering the surface, and reducing water depth. The tendency for sediment to accumulate on the shelf is apparently counteracted by seismic water table bounces that set off mini-tsunamis that flush material off the shelf. (3) Groundwater pumping in the late 1960s and early 1970s lowered the water table to a level where most of the shelf was exposed. Had it been allowed to continue, pumping may well have exposed the whole shelf surface. And (4) at an unknown time in the past, the water table in Devils Hole dipped to about a meter below present -- low enough to completely expose the shallow shelf.

In sum, the present configuration of Devils Hole is a snapshot of a naturally dynamic environment where continuing change will pose continuing challenges and opportunities for its aquatic inhabitants. Their responses to these challenges and opportunities will, as in the past, continue to determine the species composition and population density of all components of this unique aquatic community.

11/20/2003 2:00:00 PM - Devil's Hole: this magical place - Several tens of thousands of years ago the ceiling over Devil's Hole collapsed, opening it to sunlight, rain, wind, dust, surface inflow, and colonization by aquatic organisms. Owls, bats, chuckwallas, and honey bees find refuge in its fissured walls, drink its waters, and, along with the wind, carry in organic materials from the surrounding desert to help feed the flatworms, ostracods, beetles, snails and pupfish that live in isolated splendor in its tepid waters. By far the most well-known inhabitant, the Devil's Hole pupfish Cyprinodon diabolis, interacting with the dynamic processes creating this unique environment, has managed to survive here for millennia, living on the edge of its ability to survive and reproduce under the physiological pressures of high temperature and low oxygen. Each winter, when the limited sunlight stimulates precious little photosynthesis, food limitations dependably reduce population size to fewer than 200 individuals. Spawning substrate is created, maintained, or withheld by floods and earthquakes, and the size and suitability of this little corner of the world is ultimately determined by the tectonic stretching of the Earth's crust and the vagaries of climate. Pupfish ancestors apparently began their odyssey in the Tethys Sea, rode the Atlantic coast of the North American plate as the Tethys opened, ascended the Rio Grande into what is now NW Mexico, flashed over into the Colorado River drainage and into Death Valley/Amargosa some 2-3 million years ago apparently to be stopped less than a kilometer from Devil's Hole by a patch of dry ground. Somehow, it made the leap into the safe haven of Devil's Hole, only to be confronted, thousands of years later, by the threat of extinction due to a falling water table caused by groundwater pumping in support of agriculture. Instead of disappearing into the obscurity of extinction, it became a poster child for the conservation movement in the arid southwest and the focus of a battle between developers and conservationists that led to a Supreme Court decision affirming the pupfish's prior rights to enough water for survival, helped build support for passage of the visionary U.S. environmental legislation of the 1970s, stimulated creation of the Ash Meadows National Wildlife Refuge, assisted in the transformation of Death Valley into a National Park, and was a primary force behind formation of the Desert Fishes Council. So today the pupfish lives on, apparently more precariously balanced on the edge than ever in an environment that has fascinated humans for over 9000 years, continues to produce a wealth of scientific information, and leaves us wondering why we can't understand and manage the system predictably enough to guarantee survival of pupfish in this, the smallest, simplest, environment in the world supporting the entire population of a vertebrate species.

11/20/2003 2:30:00 PM - Morphometric analysis of scales of the Owens River basin *Gila bicolor* populations - In 1973 Robert Rush Miller described the Owens tui chub, *Gila bicolor snyderi* Miller 1973, as endemic of the Owens River Basin, differing from other subspecies of *G. bicolor* (Girard 1856) by meristic and morphometric features of the scales (easily and harmlessly removable in vivo) and some cranial bones. As of 2003, this subspecies is endangered due to introgressive hybridization with the Lahontan tui chub, *G. b. obesa* (Girard). Adequate conservation strategies require prior identification of pure populations of *G. b snyderi*. We sampled scales from the front body of 201 individuals from 17 localities of the Owens River and other nearby basins. Populations of *G. b. snyderi*, *G. b. obesa*, *G. b. obesa* x *G. b. snyderi* and *G. b. pectinifer* were expected. Scale lengthening, relative position of the focus, number of radii and radii proportion in the lateral fields were measured. The observed morphometric variability (within subspecies, within populations, and even within individuals) was too high to obtain good discrimination between populations on each separate parameter. However, when analyzed jointly the variables showed a distribution trend of the expected subspecies along the lines set forth by Miller (1973).

11/20/2003 2:45:00 PM - Introgressive hybridization and genetic differentiation of endangered Owens tui chub populations - The Owens tui chub (Siphateles bicolor snyderi) was common in a variety of habitats of the Owens River basin of eastern California in the early 20th century. As a result of species introductions and habitat degradation, Owens tui chubs have become introgressed with introduced Lahontan tui chubs or extirpated throughout most of their range. Remaining populations are only found in nine isolated habitats. These survivors are considered "endangered" under both the state and federal endangered species acts. This study employs six microsatellite DNA loci to assess the degree of genetic difference within and among populations of Owens and Lahontan tui chubs and their hybrids. It reveals four distinct groupings of tui chubs: Owens, Lahontan, hybrid Owens X Lahontan, and Cabin Bar. Surprisingly, Cabin Bar tui chubs are more differentiated from other Owens tui chubs than are Lahontan tui chubs, coupled with a significantly lower level of genetic variability. Cabin Bar tui chubs represent a distinct ESU and could merit designation as a separate subspecies. We suggest that they be given the common name "toikona tui chubs" to distinguish them from Owens tui chubs. In addition, this report confirms the presumed hybridization of tui chubs in the Owens River, its tributaries, and Mono Lake tributaries. Management practices should strive to prevent gene flow between populations belonging to separate ESUs. Habitats of Owens and toikona tui chubs should be protected, enhanced, and expanded.

11/20/2003 3:00:00 PM - Rodeo-Chediski fire reduces nonative fish population in the Salt River - In June-July 2002 the Rodeo-Chediski fire burned 467,000 acres of the White Mountain Apache Indian Reservation, Apache-Sitgreaves National Forest, and Tonto National Forest; the largest fire in Arizona history. Over 290,000 acres burned in the Salt River Basin. Rains after the fire washed ash and fire-related compounds into streams and rivers. A few dead fish were noted in Tonto Creek, the Salt River, and several streams on the White Mountain Apache Reservation during the first runoff in July. We conducted three sampling trips down the Salt River in winter and spring of 2003 to determine if runoff after the fire had impacted the predominantly nonnative fish population in the river. The first trip, in February, was a disaster; we flipped the electroshocking boat an hour into the trip, and were never able to get the generator started again. The second trip, in May, we shocked a 4 km stretch between Horseshoe Bend and Highway 288 and captured a single red shiner; 4 red shiner were also captured via seining. The final trip was conducted in June, and we shocked 26.7 of the 52 km from Gleason Flat to Highway 288, plus set gill nets and trot lines. Over the five-day period, only 35 flathead catfish (Pylodictis olivaris) and 3 common carp (Cyprinus carpio) were collected by electrofishing. One carp was collected in an overnight gill net set. No fish were collected in gill nets set in cooperation with the electrofishing boat, nor were any fish collected by the trotline. Our evidence indicates the runoff from the fire suppressed the fish populations (mostly nonnative species) in the river.

11/20/2003 3:15:00 PM - Genetic re-evaluation of population structure in the White Sands pupfish, with the use of microsatellite markers - Genetic evaluations of population structure in many desert fish species has been hampered by a lack of variable markers. We applied 12 microsatellite markers to examine population structure in the White Sands pupfish (*Cyprinodon tularosa*), a New Mexico Threatened species. These markers show moderate levels of polymorphism (2-6 alleles per locus). We found significant divergence between the two native populations (Theta = 0.52 - 0.83, 95% CI). Of considerable interest was an exceptionally high frequency of private alleles (78%). This suggests that the two native populations have experienced considerable levels of genetic drift and/or mutation since their presumptive isolation at the end of the Pleistocene. These markers will be most useful for monitoring genetic status of refuge populations.

11/20/2003 3:30:00 PM - A physically-based approach to characterizing snowmelt hydrographs - Features and variability of snowmelt hydrographs change in response to hydroclimatic driving forces and basin conditions, including land and water use. Since streamflow hydrographs integrate variations in precipitation input and storage and transfer processes within a catchement, inferences may be made about catchement-scale processes in snowmelt basins from the slope, magnitude, and timing of the hydrograph, and characteristics of variations in flow, and how they vary with hydroclimatic or basin conditions. An approach is presented that couples physically-based techniques with statistical methods to characterize diel and seasonal hydrographs of snowmelt river systems. The procedure is applied to streamflow timeseries from three different snowmelt rivers in the Colorado River system, for unregulated and regulated streamflow conditions, and over a range of hydroclimatic conditions. Differences in hydrograph characteristics reflect the effects on snowmelt storage and transfer processes through the basin that accompany changes in hydroclimatic conditions, or result from upstream storage and river regulation. Because hydrologic variation structures physical templates of aquatic systems, knowledge and understanding

of how changes in land and water use affect characteristic trends in hydrograph patterns and variability associated with historic hydrologic variation have application in river restoration and reconciling differences between natural resource and societal demands for water.

11/20/2003 3:45:00 PM - A small fish in a large landscape: Evolution of *Rhinichthys osculus* in the American West - We mapped 114 restriction sites in the mitochondrial (mt) DNA genome of the Speckled Dace (*Rhinichthys osculus*), a small cyprinid fish broadly distributed in western North America. These data were used to derive a molecular phylogeny for the species that was contrasted against the hydrographic evolution of the region. Although haplotypic variation was extensive among our 59 sampled populations and 104 individuals, their fidelity to current drainage basins was a hallmark of the study. Two large clades, representing the Colorado and Snake rivers, were prominent in our results. The Colorado River clade was divided into four cohesive and well-defined sub-basins that arose in profound isolation as an apparent response to regional aridity and tectonism. The Lower, and Little Colorado River sub-basins are sister to one another, and (with the Upper Colorado River), form a large clade of higher-elevation populations that reflect post-glacial re-colonization from refugia in the Middle Colorado River. The latter sub-basin is sister to the Los Angeles Basin, and thus supports the hypothesis of an ancient connection between the two. A haplotype from the Northern Bonneville was sister to the entire Colorado River clade. The Snake River clade revealed a strongly supported Lahontan group that did not share haplotypes with surrounding basins. It contained instead scattered sites from former Pluvial Lake Lahontan, as well as from eastern California. It was, in turn, sister to the Owens River, while *R. falcatus* was sister to this larger clade. The hypothesis of a southerly, "fishhook"-configured tributary associated with a westward-draining Pliocene Snake River was manifested by the relationship of this Lahontan clade to upper Snake and northern Bonneville localities. The Klamath/Pit and Columbia rivers were sisters and their basal relationship to all the above, and this supported the hypothesis of a pre-Pliocene western passage of the Snake River. Our data also supported at least three separate ichthyofaunal invasions of California, as well as a Bonneville Basin fragmented by a north-south connection between southeastern Idaho and the Colorado River. The dual western and southern movements of *R. osculus* from southern Idaho suggested a northern origin for the species, possibly associated with Tertiary Lake Idaho.

11/20/2003 4:00:00 PM - Drought in an evolutionary context: Molecular variability in flannelmouth sucker (*Catostomus latipinnis*) in the Colorado River basin - Fishes can often rebound numerically and distributionally from short-term (i.e., seasonal) drought, yet their capacity to recover from decades of drought is less apparent. Circa 7,500 y. BP, an exceedingly warm and dry period swept the intermontane west of North America, concomitant with an abrupt extinction of 35+ North American mammal species. Were larger fishes in mainstem rivers of the Colorado River Basin also impacted by this drought? The basin encompasses seven states and drains 600,000 km2. Its endemic mainstem fish community is ancient (i.e., Miocene) but depauperate (two families, five genera, eight species). Four are listed as federally endangered, two are "candidates" for such listing, and two are of unknown status. We evaluated one widely distributed candidate species (flannelmouth sucker, *Catostomus latipinnis*) for basin-wide genetic and geographic structure at three fast-evolving mitochondrial (mt)DNA genes [ND2 (589 bp); ATPase8/6 (642 bp)]. We hypothesized that a concomitant signature would be present in the mtDNA of this species if indeed it had been seriously bottlenecked by post-Pleistocene drought. Approximately 352 individuals were sequenced from 24 populations (4--40 individuals/population; m = 14.7). Only 49 unique haplotypes were found, 53% of which represented single individuals. Haplotype diversity was high (0.905 ± 0.007) whereas nucleotide diversity was low (0.002 ± 0.000). A significant and positive geographic cline ($P < 0.001$) in nucleotide diversity was observed as sampling locations progressed upstream from southwest to northeast. These results divided the Colorado River basin into three reaches: lower (six populations and 83 individuals from Virgin River and lower Grand Canyon); upper (seven populations and 83 individuals from Yampa and upper Green rivers), and middle (11 populations and 186 individuals from mid--Grand Canyon through lower Green and upper Colorado rivers). AMOVA revealed 81.5% of genetic variation was within populations, 16% among-populations-within-reaches, and 2.5% among reaches. Only the last was significant, thus demonstrating reaches differed from one another. Haplotype distribution suggested populations in the upper Colorado River are expanding. The lack of genetic variation and recent coalescence of lineages in *C. latipinnis* are unusual given its fossil history, our broad geographic sampling, the rapid rate of mtDNA evolution, and the number (and evolutionary rate) of the genes examined. The most parsimonious explanation for these data is a rapid expansion following a recent period of low effective population size at end-of-Pleistocene. We suggest the intense drought at end-of-Pleistocene severely impacted not only large mammals but also larger fishes in Western North American rivers. These perspectives have important

implications for management of endangered and threatened species in this region, particularly those defined from a molecular standpoint as management units.

11/20/2003 4:15:00 PM - Control of jewelfish (*Hemichromis guttatus* Gunther, 1862) in Poza Churince, Cuatro Ciénegas, Coahuila, México - Since 1999 we have been conducting a program to eradicate the exotic fish Hemichromis guttatus (Jewelfish) from Poza Churince in Cuatro Ciénegas, México. This area is very well known for its endemic fishes and other aquatic organisms. The jewelfish was found for the first time in 1996, but the eradication program did not start until 1999 when we detected damage to populations of Cichlasoma minckleyi, the basin's endemic cichlid, as well as to other species. In four years we captured more than 47,000 specimens. Recently we visited Poza Churince and found that the jewelfish population had increased while other species, such as Cyprinella xanthicara disappeared from the area. It is necessary to keep the constant eradication effort, and for the Government of Mexico, the head of protected area, and the non-governmental organizations increase support for control of this Afican fish. They need to know the effect of this species in this biogeographic area, and the risk of loss pf ecological equilibrium in this important ecosystem.

11/20/2003 4:30:00 PM - Current status of Sandia Pluvial Lake, Aramberri, Nuevo León, México - In the recent past, pluvial lake Sandia in Aramberri, N. L., México had several springs that harbored four endemic species of Cyprinodon: ceciliae, inmemoriam, veronicae and longidorsalis, as well as some crustaceans and mollusks. All are now extinct in nature since all habitats are totally dry, and recent subterranean fires have made recuperation of the springs impossible. The area presents a large-scale ecological problem for the government. The fish extinctions were only the first step in general area degradation, and now the forest is in risk of disappearing since the trees are drying, the soil is burning, and soil and air temperatures are increasing, and subterranean water levels are dropping. Agricultural is in trouble since water extraction has decreased. A diversity of studies by geologists and biologists, with support from government, universities, non-profits, etc. to find a solution to this great environmental impact that is not simply biological but also socioeconomic.

11/20/2003 4:45:00 PM - Population genetics of the genus *Gila* in the Bill Williams and Gila River drainages, Arizona - Three species of chub (*Gila robusta*, *G. intermedia*, and *G. nigra*) occur in fragmented localities throughout the lower Colorado River basin. Given the geologic history of the region and mosaic distribution of this species group, the robusta complex provides an excellent opportunity to evaluate relative historical influences governing the distribution of genetic variation and phylogenetic relationships of fishes in the American southwest. Previous genetic surveys of allozymic variation did not reveal patterns consistent with morphology or concordant with geography. This study describes variation in mtDNA sequences from subunit 2 of the NADH dehydrogenase gene. Variable alleles identified by single-stranded conformational polymorphism (SSCP) analysis were subsequently sequenced and analyzed by phylogenetic and population genetic methods. To date, preliminary population genetic data concur with past studies. Samples of *G. robusta* possess more alleles of more equivalent frequency distribution of alleles within their respective populations than either *G. intermedia* or *G. nigra*. Further, phylogenetic relations of geographic populations will be discussed.

11/20/2003 8:30:00 PM - A Brief History of the Desert Fishes Council - It was 34 years ago this month, November 18-19, 1969, that the fledgling Desert Fishes Council held its first meeting, as with this year in Death Valley. About 40 very concerned individuals, all sharing a common fear for the well being of the Devils Hole pupfish (*Cyprinodon diabolis*, Owens pupfish (*Cyprinodon radiosus*), Pahrump poolfish *Empetrichthys latos*) and other, similarly endangered taxa and their habitats, met together to devise a rough plan for their protection and preservation. Among those in attendance were Carl and Laura Hubbs, W.L. Minckley, Bob and Fran Miller, Jim Deacon, and others around whom the Council was formed and continues to flourish. At this meeting the first rough recovery plans were devised, later to become an integral part of the Endangered Species Act, yet four years in the future. The evolution of the Council is discussed, highlights of the intervening 34 years are presented, and inevitable challenges of the future are presented as we consider: "Where do we go from here?"

11/20/2003 9:00:00 PM - W. L. Minckley: scholar, mentor, friend - On June 22, 2001, the Desert Fishes Council lost one of its most influential founding members, a man who helped shape the organization, and whose career exemplified the kinds of accomplishments the Council attempts to promote. While pursuing a research program focused on the deserts of northern Mexico and Southwestern U. S., W. L. Minckley managed to inform and shape the fields of Conservation Biology, Aquatic Ecology, and Ecological

and Systematic Ichthyology. His research, along with his efforts to interpret the significance of his discoveries to resource managers, politicians, influential local citizens, and anyone else who would listen, often produced a re-evaluation and redirection of resource management practices. To an especially notable extent in Cuatro Cienegas, and the Rio Yaqui/San Pedro basins of northern Mexico and southern Arizona, Mink's efforts have influenced the economic future and the cultural and social values of the local population.

Mink's first paper was published in 1956 while he was still an undergraduate at Kansas State University. Since then he has been an author and/or editor of three books and well over 200 journal articles and book chapters, many of them with colleagues, or with his 22 Ph.D. students and/or his 39 masters students. Colleagues and students alike were enriched by his insights and abilities to see connections across many fields, one indication of which is the fact that five species (a snail, a scorpion, a water-penny beetle, a fly, and a cichlid fish) have been assigned the specific name minckleyi in recognition of his influence and contributions.

While in graduate school at the University of Kansas, Mink embarked on a field expedition to Cuatro Cienegas, recognized the area as a hotspot of biodiversity, and for the next 40 years focused attention of colleagues, students, conservationists, local citizens, and influential decision makers on the area, while producing and/or stimulating a remarkable body of scientific literature. He was instrumental in having the area designated a Natural Protected Area by the Mexican government and helping local citizens understand the economic, cultural and social value of sustainable management practices for the area. In recognition of Mink's influence, the city of Cuatro Cienegas has erected a monument to his memory at a nearby desert spring, and is using small models of their endemic tortoise Terrapene coahuila and an endemic fish Cichlasoma minckleyi when presenting awards to people who have made exceptional contributions to the life of the community.

In southern Arizona and northern Mexico, Mink's work led to creation of the San Bernardino National Wildlife Refuge, the San Pedro Riparian Conservation Area, a Nature Conservancy preserve on Aravaipa Creek, influenced a shift toward more sustainable practices on thousands of acres of private ranch land, and influenced management toward recovery of several endangered fish species. Mink saw connections and interrelationships in nature, and helped those of us fortunate enough to work with him see them too, especially when engaged in frequent, legendary conversations around the campfire.

11/20/2003 9:30:00 PM - James E. Deacon: scholar and advocate for desert fishes – No abstract available

11/21/2003 8:30:00 AM - Genetic diversity in native and introduced Mexican trout species - Though biologists have been aware of the existence of Mexican trout for over a century, little devoted taxonomic attention has been given to these native *Onchorhynchus*. Recent concerted collecting efforts by Mexican and US ichthyologists have revealed significant morphological diversity, in addition to the well-known Mexican golden trout (*Onchorhynchus chrysogaster*), of other native trout populations from the Ríos Yaqui and Casas Grandes in the north to the Ríos Presidio and San Lorenzo in the south. These populations are now threatened due to water shortages, habitat destruction, and competition from or hybridization with escaped hatchery fish. The current study is an initial effort to assess the genetic diversity of these native trout populations and species, as well as examining potential genetic interactions between the native and hatchery fish. We analyzed data from 11 microsatellite loci to examine genetic structure and diversity within these populations. All populations of Mexican trout analyzed show very high allelic diversity. Allelic differences between native *Onchorhynchus "mykiss"* populations and *O. chrysogaster* is indicative of separate evolutionary status for at least three major groupings. Further study of these populations holds strong potential for resolving many questions about the zoogeographic history of the region, as well as for identifying undescribed diversity in these enigmatic salmonids.

11/21/2003 8:30:00 AM - Evidence of a hormonal basis for behavioral variation among Death Valley pupfishes - Pupfish populations in the Death Valley region show considerable variation in reproductive and agonistic behaviors. The social behaviors of pupfish, however, are responsive to the immediate ecological conditions that populations are experiencing. This plasticity suggests that population differences in behavior might be partially explained as a physiological response of individuals to the unique environments they inhabit. As a first step toward exploring the proximate basis of this population variation, we are studying how the hormone arginine vasotocin (AVT) affects behavior in Amargosa pupfish (*Cyprinodon nevadensis*). AVT and its mammalian homologue, arginine vasopressin, are known to play key roles in osmoregulation and stress physiology. Yet these hormones also act on the nervous system to modulate behavior, and recent evidence has implicated them to underlie species differences in social

behavior. We used immunocytochemistry to examine AVT expression in the brain of two Death Valley populations: 1) the Amargosa River population of *C. n. amargosae*, and 2) Big Spring occupied by the *C. n. mionectes* subspecies. We found that AVT-immunoreactive neurons were significantly larger in cell soma area in males and females from the Amargosa River population than in same sex pupfish from Big Spring. Although it is unclear whether larger neurons in Amargosa River pupfish indicate increased secretion of AVT or an inhibition of secretion, the difference suggests that the ecological conditions of these habitats have brought about changes in AVT pathways in the brain. To understand how AVT affects pupfish behavior, we intraperitoneally administered AVT to male Amargosa River pupfish both in mixed-sexed groups in the laboratory and in freely-behaving fish in the wild. Under both conditions, AVT reduced aggression while having no effects on courtship or feeding. Combined, results from these studies suggest that changes to AVT physiology may in part mediate differences in aggression between these populations.

11/21/2003 8:30:00 AM - Overlap in the seasonal diel habitat utilization of least chub (*Iotichthys phlegethontis*) and mosquitofish (*Gambusia affinis*) - Least chub (Iotichthys phlegethontis) were once widely distributed in the Bonneville Basin but are currently limited to a few spring pools in the west desert and central region of Utah. Predation and competition from introduced mosquitofish (Gambusia affinis) pose one of the greatest threats to remaining least chub populations. Better understanding of spatio-temporal habitat requirements of least chub and how habitat utilization is influenced by the presence of Gambusia is necessary to improve protection and management of remaining least chub populations. In the 2003 field season, we measured least chub habitat utilization in the presence and absence of Gambusia at three springs (two inhabited by both least chub and Gambusia and one inhabited by least chub without Gambusia) to determine overlap in the seasonal and diel habitat requirements of adult and young-of-the-year (YOY) least chub and Gambusia. Minnow traps were equally distributed in spring-head, channel and marsh habitats and retrieved the following morning. Water depth, temperature, oxygen concentrations, distance to inflow and outflow, and presence of submersed macrophytes and metaphyton were correlated with the number of YOY and adult least chub and mosquitofish. Preliminary analyses indicate that least chub utilized deeper cooler habitats in the presence of Gambusia, compared to springs without Gambusia. Gambusia preferred warmer shallow habitats during early spring and late fall. These results suggest that deep spring complexes with cooler temperatures may slow Gambusia growth and development giving early spawned YOY least chub time to reach a size refuge before predation and competition increase with increasing mosquitofish densities.

11/21/2003 8:30:00 AM - The effects of gender, predation risk and sexual selection on depth choice in the mosquitofish, *Gambusia affinis* - Habitat use by fishes often varies spatially and temporally, and may have fitness consequences depending on the habitat that is chosen. Depth selection is an extremely important habitat choice in the life histories of fishes, and may be influenced by variables such as predation risk, gender and gender interactions. In this experiment, the role of predation risk, gender and sexual selection on depth choice (quantified by depth and distance from shore) in the mosquito fish, *Gambusia affinis* will be investigated. An experimental apparatus with a depth gradient will be used, such that a fish of 10-50 mm Standard Length can choose a depth ranging from 0-42 cm and a distance from shore ranging from 0-125 cm. A two factor ANOVA will be performed to analyze the interactions between predation risk, gender, gender interactions and depth choice. Also, regressions will be performed to determine whether size affects depth distribution, and if so, an ANCOVA analysis will be used to test if the size-depth distribution for females differs from the size-depth distribution of males. This experiment will illuminate important life history traits of the mosquito fish, a poeciliid species that has been widely introduced for the biological control of mosquitoes and may have negative impacts on native amphibian populations.

11/21/2003 8:30:00 AM - Spawning by loach minnow in the laboratory - Loach minnow, *Tiaroga cobitis*, were collected by seine (n = 77) from Aravaipa Creek, Arizona, during September 2002. Adult fish were captured at the east end of Aravaipa Canyon, transported by vehicle to Bubbling Ponds Hatchery near Cornville, Arizona, and held indoors in recirculating fiberglass tanks at an April photoperiod and an ambient room temperature of 21 C. Fish were fed *ad libitum* twice each day with a combination of freeze-dried bloodworms and Tetramin® flake diet. Spawning activity began in October 2002, and multiple spawning events occurred during each month for the ensuing 12 months. A single spawning event (also described by David and Wirtanen, 2001) consists of a male and female loach minnow aligning laterally, followed by a shuttering movement, during which eggs (roughly 1-3) are expelled and fertilized. Typically, multiple spawning events occur over several hours, as clusters of 1-50 eggs are usually found upon inspection of spawning cobbles. Spawning usually takes place on the down-current or lateral sides of cobbles, and male

female loach minnow retrieve displaced eggs as they drift downstream following spawning events, and deposit them in one or two clusters underneath the cobble. Both male and female loach minnow guard eggs, but male loach minnow are both more aggressive and more often found guarding eggs in the laboratory. Video of spawning behavior was recorded during May 2003.

11/21/2003 8:30:00 AM - Desert Fishes Council 2002 species status tracking tables - To facilitate the dissemination and gathering of current information on the status of desert aquatic species at risk, Desert Fishes Council Area Coordinators have developed Species Status Tracking Tables, organized by geographic area, for the period of November 2001 to November 2002. The 10 geographic areas for which annual oral reports are regularly presented at Desert Fishes Council meetings are Oregon and Upper Pit River Drainage of California, California, Nevada, Bonneville Basin, Upper Colorado River, Lower Colorado River, Upper/Middle Rio Grande and Pecos Rivers, Texas, Northwestern Mexico, and Northeastern Mexico. This year, for 8 of the 10 geographic areas, information is presented on species status, specific threats, previous year's conservation activities, and sources of status and other information. Following each table is space for meeting participants to provide comments and additional data. Area Coordinators hope that the tracking tables will provide a forum for exchange of detailed information that normally can not be accommodated within the time limits of the oral Area Report session. In the future, Species Status Tracking Tables will serve to summarize annual changes in species status for all North American desert aquatic species at risk and identify data gaps and research needs.

11/21/2003 8:30:00 AM - Status and distribution of fishes in selected areas of the Cuatro Ciénegas Valley, Coahuila, México - The Ichthyology Laboratory of the Facultad de Ciencias Biológicas, Universidad Autónoma de Nuevo León, has been carrying out studies on fishes and their habitats in 10 springs in the Cuatro Ciénegas Valley, Coahuila. Samples were collected monthly for 1 year resulting in 447 specimens representing seven families (Characidae, Cyprinidae, Cyprinodontidae, Fundulidae, Poeciliidae, Centrarchidae and Cichlidae), 10 genera and 10 species (two exotic). Six species are endemic to the valley and four native. Zoogeographically four families are nearctic and three neotropical. Ecologically two families are primary and five secondary. The species most widely distributed were Astyanax mexicanus and Gambusia marshi. The physicochemical water quality of the springs examined displayed a wide range of anions represented by sulfates. Dominant cations in order of dominance were Calcium and Magnesium. A Canonical Discriminant Analysis of water quality demonstrates that Las Argollas, Orozco, Churince and Juan Santos are saline and El Anteojo, Poza Grande, Los Tulares, El Robalo, Huizachal and Tía Tecla are freshwater. Aquatic plants productivity includes Nymphaea and Chara.

11/21/2003 8:30:00 AM - Effects of drought on least chub (*Ioticthys plegethontis*) - Many fishes have evolved to persevere in harsh desert environments. Recently, our western states have experienced a severe drought with the most extreme conditions occurring in Utah. The least chub (Iotichthys phlegethontis), endemic to Utah and a conservation species, may be particularly vulnerable to the drought due to its gradual decline in the past half-century. The primary causes of the decline have been attributed to the loss of habitat through water impoundments and to the persistence of predatory nonnative species. Least chub and its habitat have been monitored for nearly ten years in the west desert of Utah. Least chub occurrence and body size were compared to average spring volume measurements to investigate the potential adverse effects of the drought. The presence of nonnative species and a variety of abiotic factors were also examined. During the five-year drought, least chub numbers fluctuated but were not correlated to water levels in the springs. Least chub body size was inversely correlated to water volume which may be explained by low recruitment.

11/21/2003 8:30:00 AM - Complex interactions between native and invasive fish: size dependent effects of predation and competition - Invasive species can potentially have a dramatic effect on native species populations. These effects can be complex and involve a combination of multiple interactions. Body size is often an important component of both predatory and competitive interactions between native and invasive species. Body size establishes a framework for the possible direct and indirect effects of predatory and competitive interactions. We present a framework of possible effects based on the body size of the interacting species. We illustrate the possible effects of interactions between two similar sized species using a case study of native least chub (*Iotichthys phlegethontis*) and introduced western mosquitofish (*Gambusia affinis*). Both competition and predation play a role in the interaction of these two species because they are similar in size. Studies on interactions between native and invasive species need to account for body size and include different size classes to fully understand the potential effects of invasive species.

11/21/2003 8:30:00 AM - Effects of flooding on abundance of native and nonnative fishes downstream from a small impoundment - Flooding can benefit native fishes in southwestern streams by disproportionately displacing nonnative fishes. We examined how the presence of an upstream impoundment affected this relationship in lower Sonoita Creek, Arizona. Nonnative species not found in the reservoir decreased in abundance in lower Sonoita Creek after flooding. Catch and relative abundance of some nonnative species found in both the reservoir and the creek increased in lower Sonoita Creek following flooding. Movement of nonnative fishes out of the reservoir via the spillway during periods of high water probably contributes to the persistence and abundance of these species downstream. Preventing nonnative fishes from escaping reservoirs and release of flushing flows would aid in conservation of native fishes downstream.

11/21/2003 8:30:00 AM - Factors associated with the presence and abundance of non-native fish species across the western United States - Understanding the role of exotic species in an ecosystem is based on both the distribution and the impact of the species. We used EPA (Environmental Protection Agency) EMAP (Environmental Monitoring and Assesment Program) data from over 500 sites across 12 western states to evaluate environmental, anthropogentic, and biological factors that were related to the distribution and relative abundance of introduced fishes in the American West. First, we evaluated which biotic and abiotic variables were associated with the presence and relative abundance of specific species at sites across their range. We then investigated the relationship between human land-use and disturbance, and the presence and relative abundance of introduced fishes. Though the scope of the study encompasses a region larger than the desert southwest, the results will be important to evaluate where new species might invade, the potential effects of introduced fishes in western streams, and strategies to manage existing populations of introduced fishes.

11/21/2003 8:30:00 AM - Santa Ana sucker distribution, biology and interactions with exotic fishes in the middle Santa Ana River, Southern California - For about six years increasingly intensive sampling and study of the federally threatened Santa Ana sucker, Catostomus santaanae, has established several details of its existence in the middle Santa Ana River. The upstream 9 km of this area with higher gradient, rocky and gravelly, substrate, and artificially fluctuating flow supports populations of this sucker and of the cyprinid, the arroyo chub, Gila orcutti, a California Species of Special Concern. The stream adapted sucker and chub are maintaining themselves in artificially fluctuating flows that probably limit most of the oviparous exotic fishes. Two exotic fishes, the live-bearing mosquitofish and mouth-brooding tilapia can survive in this upstream area. The next river reach down to Prado Dam (27 km) with lower gradient, predominantly shifting sand substrate, increased turbidity, and dampened fluctuation in flow, lacks arroyo chubs. Juvenile suckers occur in small numbers in spring, summer and fall, after the spring spawning season upstream, and adult suckers are rare. In one spring (2003) exceptionally large numbers of larval and juvenile suckers occurred in this downstream area. Exotics like mosquitofish, sunfishes, largemouth bass, carp, and bullhead catfishes are common. The lowermost reach below Prado Dam (19 km) with higher flows, greater turbidity, and a mixture of substrates, has only a few adult suckers and no arroyo chubs. Exotic fishes are more common, including various ictalurid catfishes. Sucker reproduction is lacking downstream or usually not successful. During the El Nino spring of 1998 juvenile suckers were common below Prado Dam indicating possible reproduction at that time. Channel catfishes were rare. In later years channel catfishes greatly increased in numbers and both adult and small suckers were very rare. For three years in the upper 9 km multiple pass depletion and snorkel surveys give a preliminary indication that the total sucker population may be about one per meter of stream, thus at most about 9,000 may occur here including all life stages in mid-summer after the YOY are up to 40-80 mm SL.

11/21/2003 8:30:00 AM - Molecular systematics of the Southwestern darter group (*Etheostoma*: subgenus *Oligocephalus*) - The Southwestern darter species group is a distinctive assemblage of six named species in the subgenus *Oligocephalus* (genus *Etheostoma*) that are distributed across the Rio Grande (and associated endorheic basins) and adjacent Gulf of Mexico drainages in New Mexico, Texas and Mexico. All but two species were described in the 1800s and several taxonomic revisions were produced in the early 1980s. None of the species have been included in published phylogenetic hypotheses and relationships within and placement of this group are unknown. A previous hypothesis (Lang, DFC 2002) was based on incomplete taxon sampling; samples of the rare *E. Segrex* and *E. pottsi* had not yet been obtained. Recent collections have allowed us to include these species, as well as finer scale population analyses of other species. The dataset includes 2187 base pairs from the mitochondrial genome including the complete ND2 and cytochrome *b* genes. The ingroup includes members of the remaining species groups

within *Oligocephalus* and representatives of all remaining genera and subgenera within Etheostomatinae. The outgroup consists of *Zander vitreous* and *Perca flavescens*. Equally weighted parsimony analysis recovered a monophyletic Southwestern darter clade inclusive of a clade corresponding to the *E. Grahami* species group proposed by Norris (1997). The Southwestern darter group is within a reduced subgenus *Oligocephalus*, but relationships are not resolved enough to hypothesize a sister clade. All species for which multiple populations are sampled were recovered as monophyletic except *E. Grahami*. Populations of this species in the Rio Grande and Pecos in TX are more closely related to *E. Lugoi* and *E. segrex* than to populations referred to *E. grahami* in the Rio San Juan drainage of eastern Mexico. This hypothesis must be considered tentative due to unsampled populations in central and eastern Mexico. In addition, there is a high degree of phylogenetic structure within the currently recognized *E. Lepidum* that may be concordant with previously reported morphological variation. Further sampling of *E. australe*, *E. grahami*, and *E. pottsi* is required for a complete resolution of both species boundaries and relationships within this clade.

11/21/2003 8:30:00 AM - Freshwater mollusks of the Western United States: where are we today, and where are we going? - The western states contain at least six endemic mussel species, and many endemic snail species. Records of western freshwater mollusks date from the mid-1800s, but there is a dearth of current information on the distribution and abundance of western freshwater mollusks, in part because a comprehensive survey throughout their distributional ranges has not been done. There is also confusion regarding the taxonomic status of western species, and the exact number of valid species that occur in the region is not clear. Although several western states recognize that mollusk populations are declining, conservation and recovery efforts are hampered by the lack of basic information on western mollusk genetics, zoogeography, systematics and host fish. In addition, the conservation status for most western mollusks is unknown. The objectives of our work were to produce a database of all western freshwater mollusk species and their historical distributions, produce a synonymy of western freshwater mollusks that includes all previously described western species, compile a georeferenced distributional database for all western mollusk mussels, and to conduct additional field surveys, host fish analyses, and genetic work. Data on historical occurrences, habitat, life history and other information on western mollusks were entered into a relational database. Distributional data were georeferenced, and special attention was given to nomenclature issues in order to determine whether some of the previously described western species deserve species-level status. To date, approximately 1,000 records of unionid mussels and 1,400 records of freshwater gastropods have been compiled from over 180 publications and museum records. These data were augmented by current field studies conducted in five western states. We also conducted an intensive genetic survey of western mussel populations to describe patterns of phylogeny and gene flow. The results of our studies raise intriguing questions about taxonomy, reproduction, gene flow, and host fish requirements in western mollusk species.

11/21/2003 8:30:00 AM - A long-term ecosystem monitoring protocol for Devils Hole, Nevada - The federally endangered Devils Hole pupfish (Cyprinodon diabolis) resides in a detached unit of Death Valley National Park in Nye County, Nevada. A number of investigations since the late 1960s have studied various aspects of the ecology of the species. Until the present time, however, no attempt has been undertaken to develop a comprehensive monitoring strategy that assesses temporal changes in the "vital signs" of the dominant ecological processes and keystone species that affect the number of Devils Hole pupfish. In 2002, a three tiered monitoring protocol was developed to track a number of these vital signs. Each tier provides for different intensities of monitoring based on funding levels that might be available. Tier 1 is the most expensive and comprehensive monitoring protocol, while tier 3 represents the absolute minimum program for monitoring factors that might affect pupfish numbers.

The abiotic variables that would be quantified in a tier 1 program include: substrate composition, water level, water temperature, solar energy levels, physico-chemical constituents (e.g., dissolved oxygen, pH, etc.), nutrients (total nitrogen and phosphorus), effects related to earthquakes and flash floods, and various parameters measured by a weather station. The biotic variables that should be documented in a tier 1 program include mass and composition of algae, invertebrates, allochthonous carbon input, flatworm (Dugesia sp.) densities and distribution, and microbiological analyses involving total coliform and fecal coliform. The estimated cost for purchasing equipment and implementing the tier 1 protocol in year 1 is $46,750 and the annual cost in subsequent years after equipment is purchased would decline to $27,750. The abiotic parameters that would be monitored under the tier 3 protocol include: substrate composition, water level, water temperature, pH, percent oxygen saturation, and specific conductance, and earthquake, flash flood, and weather station parameters. The biotic variables assessed in the tier 3 protocol include: seasonal photodocumentation of filamentous algae, summer and winter allochthonous input, and flatworm densities

and distribution. Implementation of the tier 3 protocol would cost $36,400 in year 1 and decline to $17,400 in subsequent years.

Monitoring of critical habitats is frequently overlooked as an important tool in the conservation of natural resources. Resource managers should collect comprehensive, long-term, ecological data sets when fish communities are healthy in order to identify factors that may be responsible for declines in fish numbers at a later date.

11/21/2003 8:30:00 AM - Determining the ecological integrity of isolated desert wetlands in the Bonneville basin - Isolated desert wetlands in the Great Basin are some of the most unique, but least protected wetlands in the United States. Many of these wetlands occur within the Bonneville Basin where species of fish, (e.g. least chub, *Iotichthys phlegethontis*), amphibians (e.g. Columbia spotted frog, *Rana luteioventris*), and mollusks (e.g. California floater, *Anadonta californiensis*) have maintained relict or endemic populations since Ancient Lake Bonneville receded more than 10,000 years ago. Significant loss and degradation of these wetlands has provided impetus for resource agencies to develop conservation and management plans to protect these vital ecosystems, however, one hurdle facing management agencies is the lack of information for determining which wetlands should be protected and restored based on their ecological condition. Several community components (e.g. macrophytes, macroinvertebrates) are valuable assessment tools because they rapidly respond to pulsed disturbances and continuous pressures exerted by human activities. Although basic bioassessment procedures have already been developed for a variety of aquatic habitats, their application to desert wetlands required new data. This study was implemented to develop bioassessment procedures to assist in making biologically defendable decisions regarding protection, acquisition, restoration, and mitigation specific to these wetlands. During the 2001 and 2002 field seasons, biological and physical data were collected at over 240 sites within 15 areas throughout the Bonneville Basin. Sites representing minimally impacted conditions were used to establish assessment reference criteria. The remaining sites represented varying intensities of impacted wetlands, specifically focusing on the effects of livestock use and the introduction of mosquito fish, *Gambusia affinis*. Impacted sites were used to test the validity of the bioassessment procedures. This study provides information on 1) What criteria define desert wetland reference conditions, 2) Which taxa or combination of taxa might be the best indicators of degradation in these desert wetlands, and 3) a process for detecting the condition of a Bonneville Basin desert wetlands using reference criteria.

11/21/2003 8:30:00 AM - Metapopulation processes or infinite dispersal? Habitat patch occupancy by toads (*Bufo punctatus*) in a naturally fragmented desert landscape - Amphibians are often thought to have a metapopulation structure, which may render them vulnerable to habitat fragmentation. The red-spotted toad (*Bufo punctatus*) in the southwestern USA and Mexico commonly inhabits wetlands that have become much smaller and fewer since the late Pleistocene. This study tests two predictions based on metapopulation theory --- the incidence of habitat patch occupancy is directly related to patch size and inversely related to patch isolation --- and a third, potentially competing hypothesis that patch occupancy is influenced by local environmental conditions. In a 20,000 km^2 area of the eastern Mojave Desert, 128 potential habitat patches (primarily springs) were identified and surveyed for local environmental characteristics and presence/absence of *B. punctatus*. Patch isolation metrics were based on nearest-neighbor distances, calculated both as Euclidian distance and distance via connecting drainage channels. *B. punctatus* was found at 73% of the sites, including all of the 15 historic (pre-1970) sites. Based on stepwise multiple logistic regression, the incidence of patch occupancy increased significantly with patch size, and was also significantly related to elevation, latitude, and four metrics that were associated with rocky terrain, periodic scouring water flows, and ephemeral water. In contrast, incidence of patch occupancy was not significantly related to patch isolation. These findings are consistent with a "patchy population" model, rather than the classical equilibrium metapopulation model, implying frequent dispersal among patches and virtually no local extinctions. Implicated dispersal distances of many kilometers are large for an amphibian.

11/21/2003 8:30:00 AM - Impact of predation by nonnative fishes on native fishes in the Verde River, Arizona - Predation by nonnative fishes may be contributing to the decline of native fishes in the southwest. We conducted field investigations from March 2002 through January 2003 to estimate the impact of predation by nonnative fishes on native fishes in the Verde River, Arizona. We used estimated densities and consumption rates to estimate the relative impact of predation on native fishes by largemouth bass *Micropterus salmoides*, smallmouth bass *M. dolomieui*, channel catfish *Ictalurus punctatus*, flathead catfish *Pylodictis olivaris* , yellow bullhead *Ameriurus natalis*, and rainbow trout *Oncorhynchus mykiss*. Estimated

loss of native fishes to predation by nonnative fishes was greatest in the spring and summer, and varied substantially by predator species, size class, environment type and section of river. Overall, age 2+ largemouth bass had the highest predation impact on native fishes in pools and runs, with an estimated 145.58 mg of native prey fish eaten/ 100m2 of river/ day (SE = 35.98) and 59.68 mg of native prey fish eaten/ 100m2/ day (SE = 16.08), respectively. To maximize the protection of native fishes while maintaining an economically valuable sport fishery, the localized removal of largemouth bass should be considered.

11/21/2003 8:30:00 AM - Restoration of BLM Spring, a desert spring overrun by largemouth bass and emergent vegetation - BLM Spring is one of three limnocrene springs in "Fish Slough Area of Critical Environmental Concern" at the north end of Owens Valley, California. Beginning in 1969, efforts were made to manage the spring for Owens pupfish, *Cyprinodon radiosus*. Gravel percolation dams were built to prevent upstream access by largemouth bass, and exotic fishes were eliminated using rotenone. During this period spring discharge declined to 1.3 cfs and giant bulrush *Scirpus acutus* established dense stands in pooled water extending from the dam to the head springs. In 1988 a largemouth bass population had established upstream of the barrier and was eliminated using rotenone. In 1996 largemouth bass were again rediscovered above the barriers. An integrated restoration approach was devised to restore 750 m2 of spring channel. We designed and tested a low-head (15 cm) baffled fish barrier, eradicated encroaching vegetation by repetitive harvest, and eliminated bass by electrofishing and speargun. Tagged fish studies and observation shows the barrier excludes bass and is not subject to debris plugging. Maintenance of the barrier and emergent plant community is minimal, and *Scirpus* has not recolonized. The project was more cost effective and engendered less controversy than a traditional rotenone project.

11/21/2003 8:30:00 AM - Two regimes of exposure to the pesticide Lindane: Differential effects on the Mosquitofish, *Gambusia affinis* - In this study, I compared the effects of short term, high-dose exposures and long term, low-dose exposure to Lindane, an agricultural pesticide used on seed crops. Though production and regulation of the use of Lindane has come under tighter regulation since the beginning of this study, it is still a commonly used pesticide. Mosquitofish were used in this study because their viviparous nature allowed me to investigate the effect of Lindane exposure on females and the subsequent number of live births. In addition, mosquitofish are widely present in Gulf of Mexico drainages. Thus, disruption of the mosquitofish population, given their low place in the food chain, could have far-reaching effects. All fish used in the study were collected from the Pecos River, near Fort Sumner, New Mexico. Fish were weighed, measured and exposed to Lindane via two different regimens: a long term (30 day) exposure at low-dose concentrations (0.1 and 0.01 parts per billion or ppb) and short term (7 day) exposure at high Lindane concentrations (96, 192 and 384 ppb). The low concentration levels were chosen because they are below the 0.2 ppb Maximum Concentration Level for drinking water as reported by the Environmental Protection Agency. The low concentrations also reflect levels of surface water contamination that have been found in the United States. The high-dose concentrations have been shown to elicit production of an inducible molecular chaperone, heat shock protein 70 (Hsp70) which serves as an indicator of the amount of molecular stress an organism has experienced. After exposure, three fish from each trial group were sacrificed and tissue samples taken. Remaining fish were kept in isolation tanks so that the number of offspring delivered by each female could be documented. The amount of Lindane absorbed is being assessed from the lipid and muscle tissue samples collected. Other tissue samples (heart, gill, liver, ovary) will be analyzed for the production of Hsp70. Data already collected shows that there is substantial temporal variation in mosquitofish reproductive effort during the breeding season. Data also indicates that when subjected to long term low-dose Lindane exposure, smaller fish are more likely than larger fish to perish. Both 0.1 and 0.01 ppb concentrations show trends of reduction in the number of gravid females. Lindane exposure at the highest concentration, 384 ppb, proved fatal in all but one instance. An unexpected finding of this research has been that the number of live births showed reductions in both the control and exposure groups, likely due to the handling. These results may prove to be important for future investigations that utilize mosquitofish. After completing analysis of the amount of Lindane absorbed and the amount of Hsp70 produced, I hope to add support to these initial findings, and to our understanding of the impact of high and low dose Lindane exposure.

11/21/2003 8:30:00 AM - Field application of the 'floodplain reset' approach to enhance survival of bonytail and razorback sucker in the middle Green River, Utah - A major bottleneck in establishing self-sustaining populations of bonytail and razorback sucker in the Green River is survival of larval life stages in the presence of nonnative fishes in offchannel floodplains. Because floodplains that are valuable as nursery habitat for endangered fishes typically overwinter fish, large numbers of residual nonnative fishes of all life stages are present in the spring and represent predatory obstacle to

survival of bonytail and razorback sucker. In an effort to reduce predator pressure, the use of resetting, or draining floodplains prior to stocking was evaluated as a method of enhancing larval and juvenile bonytail and razorback sucker in the presence of nonnative fishes.

Bonytail larvae, and larval and juvenile razorback sucker were stocked into floodplains of the middle Green River between 2 May and 16 June 2003. Bonytail larvae were stocked at a rate of 1,430 larvae/ha into the three largest floodplains and adult bonytail were stocked all five floodplains. Razorback sucker were stocked in all five floodplains between 4 and 16 June at a rate of 1,945 fish/ha. All floodplains were connected to the Green River by high flows between 21 May and 5 June 2003. Nonnative fish accessed all study floodplains and reproduced. Fyke net collections in June indicated that most fish accessing the floodplains were adult individuals. Zooplankton numbers peaked in all floodplains shortly after inundation and declined dramatically shortly afterward. Fish collections between 22-30 July indicated juvenile razorback sucker and bonytail juveniles were present in five and four of the floodplains, respectively. Bonytail reproduction was observed in three of the five floodplains. Catch rates were highest in the largest floodplains and those with the greatest quantity of submergent vegetation.

11/21/2003 8:30:00 AM - Analysis of PIT tag data from bluehead suckers (*Catostomus discobolus*) in the Little Colorado River in Grand Canyon, 1991-2003 - Over 6,600 bluehead suckers (*Catostomus discobolus*) were tagged with Passive Integrated Transponders (PIT) in the Colorado and Little Colorado Rivers (LCR) from 1991 to 2003. Only 603 of these fish have been recaptured with only 309 fish at large for more than 60 days. Recaptures came almost exclusively from the LCR (574 of 603). Maximum time at large was 5.3 years. This fish was initially tagged at 250 mm total length (TL) indicating a life span of at least 8 years. Bluehead suckers move throughout the entire lower 12 km of the LCR and as far as 65 km upstream and 30 km downstream in the mainstem Colorado River. Small hoopnets set from March to May were used to analyze catch per unit effort trends (CPUE) for bluehead suckers in the LCR. Length frequency histograms indicate age-0 bluehead suckers often reach 80 – 90 mm TL by May of the first year. No significant changes in CPUE or size structure of adult bluehead suckers (>190 mm TL) are evident from 1991 to present, but CPUE of age-0 bluehead suckers appears to be inversely correlated with LCR spring discharge.

11/21/2003 8:30:00 AM - Recent trends in June sucker spawning and larval drift - We investigated June sucker *Chasmistes liorus* spawning activity in the lower Provo River (a tributary to Utah Lake, Utah) during 1997 – 2002. June sucker usually spawned prior to peak flows. Water temperature at the onset of spawning varied less [coefficient of variation (CV) = 17; mean = 11.7^{o} C) than did discharge (CV = 89; mean = 7.6 m^3/s), indicating that June sucker spawned over a wide range of flows but a relatively narrow thermal range during the study period. Drift of larval suckers ranged from 0.0006 to 0.0282 larvae/m^3 and increased 30-fold from 2000 through 2002. We attribute this increase mainly to increased spawner abundance over that time period, although correlation analyses suggest that increased riverine spawning habitat caused by declining lake elevations may have played a secondary role. The lack of other correlations between hydrologic and thermal variables and June sucker larval density suggests that river discharge, temperature and spawning habitat (as predicted by previous instream flow models) may exert negligible influence on spawning success when spawner density is at historically low levels. We recommend continued collection and analyses of larval drift data as part of the flow recommendation development process for recovery of June sucker.

11/21/2003 8:30:00 AM - Suppression of populations and reproduction in a nonnative fish: sensitivity of various life history stages of red shiners to environmental manipulation - Nonnative fishes may contribute to declines of native fishes in the southwest United States and elsewhere. Strategies to recover native species often include removal of nonnative species, but complete removal is unrealistic, especially where nonnatives have established reproducing populations. An alternative approach would expose both types of species to conditions that selectively suppress survival or reproductive success of nonnative species. We seek environmentally realistic (e.g., non-extreme) conditions that suppress survival of early life history stages (eggs, larvae) of red shiners (Cyprinidae: Cyprinella lutrensis). Early life history stages of fish exhibit relatively narrow environmental tolerance ranges as compared to adult stages. We assess survival of eggs, larvae and young-of-the-year subjected to combinations of physicochemical variables (temperature, salinity, turbidity, water velocity, etc.) in laboratory tests. Combinations of such variables often result in increased susceptibility due to the synergistic effects of multiple stressors. Data suggest red shiner eggs and larvae may have lower temperature tolerances than some native desert fishes. Data also suggest that simulated flood events in the laboratory may result in differential displacement of native and nonnative fishes

in desert streams. Our goal is to develop recommendations for timing and type of environmental manipulations that would suppress shiner populations or their reproductive success, thereby reducing the negative effects of this introduced species on native species. A more expansive goal is to demonstrate the efficacy of this approach to the recovery of threatened native species.

11/21/2003 8:30:00 AM - Investigations into the early life histories of razorback sucker and bonytail in Cibola High Levee Pond - After 50 years, bonytail and razorback sucker are once again producing young in the Lower Colorado River Basin! Cibola High Levee Pond (CHLP) was initially developed as a grow-out pond for two endangered fish: bonytail (*Gila elegans*) and razorback suckers (*Xyrauchen texanus*). From 1993-1996, thousands of bonytail and razorbacks were stocked in the pond to be later relocated in the mainstem. Since 1998, several year classes have been produced and the pond supports a self-sustaining native fish community. The fact that these fish, which many consider to be riverine, would produce young in an isolated pond is unprecedented.

Population estimates based on >4,000 net hours of sampling effort indicate bonytail dominate the community numerically, making up 89% of the population. However razorbacks constitute 67% of the pond's biomass. Only a handful of non-native fish have been seen since 2001. Telemetry observations show adult bonytail are strictly nocturnal, hiding in specific cavities deep inside the levee during the day. Bonytail appear to have had more successful recruitment recently. Although razorbacks successfully recruited in 1999, YOY have been absent since 2001. Underwater videography revealed interesting fish behavior, such as razorbacks exposing the reflective lining of their eyes, causing a "flashing" in a distinctive manner. Tank tests to determine whether YOY of non-natives pose a predation risk to larval razorback suckers were initiated this year. Seven common non-natives were aggressive predators, although predation rates varied.

Sream flow is not necessary for successful recruitment of bonytail and razorbacks. The ability of these fish to successfully spawn in non-flowing habitats strongly suggests that oxbow communities were essential to their survival strategy. CHLP provides the opportunity to study the early life history of these unique fish in a controlled, semi-natural setting, in addition to providing the fish a refuge for survival.

11/21/2003 8:30:00 AM - Adaptive morphological divergence of a pupfish species in as little as three decades - Previous work has shown that White Sands pupfish (*Cyprinodon tularosa*) have undergone significant morphological divergence in a potential refuge population. This population was introduced to a brackish spring environment from a saline river environment approximately three decades before this study. The level of morphological divergence was as great as historic divergence in native populations isolated in similar contrasting environments since the Pleistocene. In the current study, we quantitatively examine three possible evolutionary explanations (genetic drift, natural selection, or phenotypic plasticity) as possible mechanisms for morphological variation among White Sands pupfish populations. Our results illustrate that adaptive morphological divergence may arise rapidly in pupfishes. Therefore, translocations of populations as a conservation tool may likewise require further consideration.

11/21/2003 9:30:00 AM - Symposium Introduction - This symposium is a salute to Wendell L. Minckley and James E. Deacon, two of the founding members of the Desert Fishes Council. Presentations from former students or colleagues of Minckley and Deacon largely reflect current research or management activities dedicated to the preservation of desert fishes. It is designed to remind DFC members why the Council was founded and emphasize why our original responsibility must not change. The growing challenges to a future for desert aquatic ecosystems and species therein (**not just fishes**) must be met with good science and dedication. We have voices, something the organisms we want to protect lack, and our voices need to be heard loudly!

11/21/2003 10:00:00 AM - Temporal variation in Saratoga Springs pupfish demography and habitat use as illustrated by long term studies between 1966 - 1995 - Almost 40 years ago the National Park Service funded Jim Deacon to conduct an ecological study of Saratoga Springs in Death Valley, which included work with the Saratoga Springs pupfish (*Cyprinodon nevadensis nevadensis*). It was the first ecological examination of pupfish in the region, and one of the first ecological studies on the genus Cyprinodon. During 1994 and 1995 the National Park Service funded a similar study. Comparing data from these allows a temporal assessment of demographic trends over almost four decades.

Fish abundance and demography in the spring pool were similar during the two studies, with Deacon abundance estimates ranging between a minimum 761 to a maximum of 3833, and Sada estimates from 686 to 2993. Length-frequency distributions were also similar, and it appears that the population remains in good condition.

Fish abundance in the marsh exceeded that in the spring pool by as much as 2 orders of magnitude, and length-frequency distributions differed between the two habitats. The spring pool population was always dominated by adults, whereas juvenile fish dominated the marsh population. Length-weight regressions also showed the body condition of spring pool fish exceeded marsh fish. Spring pool habitat, and habitat preference by fish, exhibited little temporal variation. Fish in the marsh occupied a diversity of habitats, and characteristics of their preferred habitat varied seasonally. Marsh fish also buried in the substrate during cool months.

The physical condition of Saratoga Springs has changed little over the past 40 years, and the pupfish population appears secure. This is demonstrated because of quantitative data collected by Deacon during early studies.

11/21/2003 10:15:00 AM - Environmental determinants of demographic characteristics of Saratoga Springs pupfish - The Saratoga Springs system is located at the southern end of Death Valley National Monument, California. The only species of fish found at this location is the Saratoga Springs pupfish, Cyprinodon nevadensis nevadensis. Saratoga Springs consists of a relatively constant temperature main spring pool that flows into a marsh contained by a ridge of sand dunes.

Reproductive activity in the spring pool reaches a peak during the spring of the year, tapers off during the summer, and is virtually nonexistent during fall and winter. This produces an annual population cycle with a low of about 800 fish in March and a high of about 2700 fish in September. During most of the year fish activity reaches a peak slightly after sunup and just before sundown. Cycles of reproduction and daily activity (including feeding) in the main spring pool therefore tend to be loosely governed by an apparent photoperiodic response. Smaller fish (juveniles) tend to prefer shallower water with some cover, while larger fish (adults) tend to prefer deeper water with some cover, except during the reproductive season when adults tend to shift to more open water near the bottom.

In the shallow marsh, reproduction and feeding are much more strictly controlled by annual and daily temperature variation. Fish are largely inactive from late November to late January at water temperatures of < 7-10º C. During summer peak activity is concentrated at temperatures of 31-35º C, and fish seek cooler waters or bury in bottom mud increasingly as temperatures rise above 35-38º C. Reproduction occurs at temperatures of about 28-35º C, reproductive behavior and reproductive colors fade at 35-38º C, and fish seek cooler, more shaded waters or bury into the cooler bottom mud at temperatures of 42-44º C.

The research reported herein was sponsored by the National Park Service to investigate the biology of native fishes in Death Valley National Monument through funding to my undergraduate and M.S. mentor, James E. Deacon of University of Nevada, Las Vegas (then known as Nevada Southern University). His influence and friendship, like those same qualities of W.L. Minckley, my major professor during my Ph.D. years, still guide my professional career and sometimes haunts me about past studies that never got published, something shared by most students of almost any graduate mentor. This presentation is a step to complete a task I took on many decades ago. The information remains timely, and it might now be difficult to obtain necessary approvals to conduct this kind of field research at this location we were able to do in those earlier years.

11/21/2003 10:30:00 AM - Jim Deacon and Devils Hole - Jim Deacon has the longest continuous association with Devils Hole and Devils Hole pupfish *Cyprinodon diabolis* than any other individual, and has perhaps been the biggest influence in the survival of this species. Jim established regular scuba counts for Devils Hole in 1972, a method of counting that continues to this day. He provided expert testimony for the government during the litigation over water rights at Devils Hole that resulted in a landmark Supreme Court Decision, Cappaert v. United States, 426 U.S. 128 (1976). Jim's research and that of his graduate students have contributed greatly to our understanding of this simple and yet complex system. Information gained from his aquarium rearing experiment will be used as we work with an aquarium to develop a captive propagating population. A larval fish survey is being undertaken to determine the optimal substrate composition and temperature for the larval fish, a previous survey suggested the innermost portion of the spawning shelf was the most productive for larvae. A review of Devils Hole pupfish refugia design and functionality has begun. A systems dynamic model of Devils Hole is being developed and a bioenergetics study is reaching conclusion. The current recovery team relies greatly on Jim Deacon's knowledge as we once again struggle to understand this species and the reasons for the current low population.

11/21/2003 10:45:00 AM - Index of Biological Integrity, Historical Version, of the lower Río Nazas, Coahuila, México: 2002 - The Río Nazas in arid north central México is an interior drainage subject to dewatering since the early 20th century, and with wide fluctuations of runoff. It drains 76,000 km2

and has a large dam in the middle reaches that controls the river and provides for 100% water consumption for agricultural and urban uses. Its 14 known fish species are of the Río Grande/Río Bravo origin, with the same or closely related derived species occupying the Nazas. Ten species are endemic to the basin complex, 7 have been listed in NOM 059-2001 and 8 are introduced invasives. This highly endemic fish fauna is a matter of concern. An Index of Biological Integrity, historical version, based on tables provided by R.R. Miller, was applied at 10 localities to the known fish community changes and to a survey of the lower basin below El Palmito reservoir. The IBIh was 50-57 in the northern tributary, 39-61 in the southern one, and 0-57-37-22-0 from the junction of those to the lowest locality. The results were very low integrity, especially as related to reservoirs and in the lower reaches where human activities consume all available water. The main causes of eradication and extinction affecting this interesting fish fauna are habitat disruption, pollution, dewatering and invasive species (except at one locality), factors that drastically alter native fish communities. I am grateful to the late W.L. Minckley and to J.E. Deacon for their valuable advice in my research efforts over many years. Their insight on conservation and preservation of desert fishes and habitats has been and remains a valuable asset.

11/21/2003 11:00:00 AM - Big, wet 'scribbles' gone dry, and other stories of changing Cuatro Ciénegas habitats: the W.L. Minckley legacy lives, but the battle never ends - The contribution of Dr. W. L. Minckley to knowledge of the highly endemic biota of Cuatro Ciénegas is well known. As his knowledge of this remarkable valley grew during the 1960's –1990s, so did his concern regarding its conservation. He left a legacy of data and insights that has proven invaluable to more recent researchers, and he sparked considerable local environmental awareness and concern. Minck was clearly one of very few who knew the basin and its aquatic habitats well, and though he freely shared his knowledge with others, much of his wealth of familiarity with the basin was lost with his death. Our continuing work in the basin leads us to conclude that Minckley's familiarity with the basin was truly exceptional. Our earlier discussions with him and, more recently, comparisons of conditions we see today with his publications, photos and field notes, clearly indicate that the wetlands of Cuatro Ciénegas are disappearing perhaps far faster than most realize. The rapidity of changes is even more frightening since we have come to realize how very few people alive today are more than very incompletely aware of how much water this valley had as recently as 10-20 years ago, let alone 50 and more years ago. This lack of general awareness and quickly eroding perception of historic conditions poses a critical impediment to conservation efforts. Most local residents and tourists are familiar with only a very tiny sub-sample of the basin's extensive wetland habitats - the few, already heavily impacted public bathing areas. Most measure declining water availability more by what they see in town and read in newspapers than by what's actually happening in the natural wetlands. Better documentation of the recent ecological history of Cuatrociénegas, and firm documentation of the geographic extent and water budget of former and extant wetlands is necessary for both research and effective management. In hopes of providing all stakeholders in the valley a better understanding of the true magnitude of the recent losses of natural aquatic habitats, we are building on Minckley's legacy by collecting photographs of Cuatro Ciénegas aquatic habitats that date from the 1920s. As possible we have returned to photograph the same views. For this presentation we focus on one major river system, the Río Garabatal (garabal means scribble in Spanish), since this remarkable, formerly high-discharge (1,200 liters / second in the 1960s), travertine-depositing system has been nearly completely dried over the last few decades and the local populace is mostly ignorant even of its former existence. We also document the demise of formerly important shallow marshlands that once edged the valley. Extinction threats to endemic vertebrates, most notably the polymorphic cichlid (Herichthys minckley) and other fishes, as well as the Coahuilan box turtle (Terrapene coahuila), are graphically documented. The photos also suggest that some alternative management strategies not before seriously discussed might be advantageously applied. Such aquatic habitat mapping and photography, complemented by taxa-specific distributional data and ecological studies addressing impacts of habitat fragmentation and shrinkage, will help managers make informed decisions. We hope that our comparative "then and now" photography will more effectively convey information about the true magnitude and extent of aquatic habitat losses suffered to date and spur more detailed, quantitative analyses, particularly of regional and valley floor hydrology. A better understanding of historic conditions and the inter-relationships of biology, hydrology and the human socioeconomic setting will aid managers and local residents as they consider difficult decisions and sacrifices as the debate over continued regional development and conservation of aquatic habitats continues to escalate.

11/21/2003 11:15:00 AM - Hybridization between *Cyprinodon bifasciatus* and *C. atrorus*: history, patterns, and dynamics - Our investigations into natural hybridization between the endemic pupfishes of Cuatro Ciénegas, *Cyprinodon bifasciatus* and *C. atrorus*, would not have been possible without the numerous contributions of W.L. Minckley. His extensive interest in these species spanned six decades

and involved critical investigations into their ecology, behavior, and hybridization, as well as efforts to ensure their preservation. Minck's direct involvement in the initiation and development of this project were invaluable, and we dedicate this presentation to his memory.

Our research has focused on understanding the history, patterns, and dynamics of hybridization between *Cyprinodon bifasciatus* and *C. atrorus*. To ascertain the historical context and modern extent of hybridization between these species, we conducted a basin-level population genetic analysis of mitochondrial (Cyt b) and nuclear gene (CK-A, RAG-1 and TPI-B) sequence variation within and among populations of *C. bifasciatus* and *C. atrorus*. Based on findings from this study, we then focused on two regions of hybridization to assess the spatio-temporal relationships between environmental and genetic variation across the physicochemical gradient that separates these species. Next, reciprocal transplant experiments were conducted to determine whether environmental tolerance differences between *C. bifasciatus* and *C. atrorus* could help explain observed associations between genetic and environmental variation in the hybrid zones. Results from our studies indicate that hybridization between these species is probably very old and involves complete replacement of *C. bifasciatus* mitochondrial genome by that of *C. atrorus*. However, nuclear gene introgression appears limited to regions of contemporary hybridization. Results from our reciprocal transplant experiments provide strong evidence that *C. bifasciatus* has a significantly narrower tolerance of environmental variation than does *C. atrorus*, which may in part explain the limited introgression of *C. bifasciatus* genes into *C. atrorus* populations. We will discuss the significance and limitations of our findings, and as well as plans for future research.

11/21/2003 11:30:00 AM - New species of *Gambusia* from Texas - In his lifetime, W. L. Minckley described four species of *Gambusia* from northeastern Mexico. One of these, *G. krumholzi* was described in 1963 from the Río Nava, Coahuila, México. Forty years later and 100 km away, we have discovered a closely related congener of *G. krumholzi*. Both species are members of the *Gambusia nobilis* species group, and like other members of the group, they have a limited distribution and are of conservation concern. The new species is known only from the type locality, San Felipe Creek, Val Verde Co., Texas within the city of Del Rio and occurs sympatrically with *G. speciosa*.

11/21/2003 11:45:00 AM - W.L. Minckley and the razorback sucker of the lower Colorado River - Even before coming west in 1963, W.L. Minckley (WL) had developed a strong affection for and interest in the big river fishes of the Colorado, especially razorback sucker *Xyrauchen texanus*. This is apparent among species accounts in his 1973 book "Fishes of Arizona," which reflect the depth of his early insights. Intensive study at Lake Mohave began in 1974 and major results appeared in his 1983 status paper with a prediction of extirpation, and a subsequent paper in 1989 dealt generally with the species in the lower river. The Lake Mohave population was the largest anywhere, numbering perhaps more than 100,000, but chronic recruitment failure doomed the stock, decline was evident by the early 1990s, and fewer than 2,500 wild adults now remain. As population collapse loomed, a group of biologists later to formalize as the Lake Mohave Native Fish Work Group, including WL, convened and determined to conserve the stock without resorting to hatchery-based propagation. Lakeside and other conferences led to a series of trial and error experiments in backwaters, development of larval capture and handling protocols, perfection of rearing and grow-out, continuing population status monitoring, and a pro-active repatriation program that places naturally produced fish back into the lake. Mark-recapture methods estimate survivorship of wild and repatriate populations, and data analysis results are applied to develop management strategies and recommendations. Since 1991 more than 60,000 fish have been repatriated and overall survival through 2001 was approximately 5%. Predation on stocked fish was identified as a primary mortality factor, and survival has increased significantly as minimum release size has been increased. The program goal of establishing a population of 50,000 repatriated fish is still some years in the future, but there is no biological impediment to its attainment. Biologists and managers then can focus their effort on establishing self-sustaining populations. Not surprisingly, WL had some ideas about that, too, as offered in his 2003 paper in BioScience.

11/21/2003 2:00:00 PM - Genetic monitoring and repatriation of razorback sucker (*Xyrauchen texanus*) in Lake Mohave - W. L. Minckley was keenly interested in conservation of large, long-lived species of the Colorado River, with special emphasis on the razorback sucker (*Xyrauchen texanus*). Most populations of this Colorado River endemic have dwindled and disappeared, and only a handful remain. Minckley and others focused considerable effort on the declining wild population in Lake Mohave, Arizona and Nevada, a population comprised of old adults and characterized by recruitment failure due to predation on larvae by introduced fishes. In an attempt to prevent its extirpation, Minckley and others developed a repatriation program designed to generate recruitment. Efforts to conserve the species in Lake Mohave have

focused over the past decade-plus on collection of wild larvae, rearing in protected sites to sufficient size to escape predation, and repatriation to the lake. Attempts to insure transmission of genetic variation from adults to repatriates were accommodated by sampling larvae throughout the spawning period from multiple locations. To assess the validity of this approach, single-stranded conformational polymorphism in mitochondrial DNA (mtDNA) was used as a tool for monitoring transmission of genetic variation. Initial analyses of larval samples yielded genetic variability estimates that were comparable to those observed in the adult population. Spatial and temporal variation in allele frequencies was observed, but no consistent pattern was discernable within the time period sampled. Analysis of repatriated individuals that have grown to adulthood and joined the spawning population is required to assess transmission of variation into the new adult population.

11/21/2003 2:15:00 PM - A comparison of four techniques for aging Colorado pikeminnow - Ages of Colorado pikeminnow *Ptychocheilus lucius* were estimated by counting presumed annuli in scales, vertebral centra, whole otoliths, and thin otolith sections. The "best" structure for aging was considered to be the one that produced the most precise estimates of age and growth. Counts obtained from vertebrae were the most precise estimator of age, and the ranges of ages obtained were highly correlated with fish total length. Ages obtained from sectioned otoliths were ranked second in precision and strongly correlated with vertebral ages. Ages read from scales underestimated vertebral ages, and ages estimated from whole otoliths were most variable and least related to total length. Ages estimated from vertebrae and sectioned otoliths were strongly correlated and produced equivalent average ages. In contrast, there was little correlation between vertebral ages and those determined from whole otoliths or scales. Ages estimated using all four structures from the same indiviudals also revealed similar ages estimated with vertebrae and sectioned otoliths. Our findings indicate that vertebral centra are just as useful for aging Colorado pikeminnow as sectioned otoliths, however otoliths are more difficult to extract, and require more time and expense to age. The use of vertebrae or other hard structures for aging and determining growth patterns could aid in conservation of this endangered species.

11/21/2003 2:30:00 PM - Conservation history of Leon Springs pupfish - In December of 1965, W.L. Minckley and W.E. Barber collected pupfish at a previously unknown site north of Fort Stockton, Pecos County, Texas. The result was the rediscovery of *Cyprinodon bovinus*, Leon Springs pupfish, at Diamond Y Spring and its marshy watercourse. The species had been presumed extinct for several decades due to the alteration, and eventual total failure, of Leon Springs for irrigation farming. This rediscovery set in motion four decades of intense conservation actions, as the endangered *C. bovinus* faces severe threats from habitat loss and hybridization with an introduced congener. The history of efforts for this species offers a summary of the limited conservation tools available in an on-going, uphill struggle to preserve native biota. Conservation measures have included population and genetic monitoring, a captive refugium, habitat protection, hybrid population elimination and pure strain reestablishment (twice), and land purchases, stewardship and management.

11/21/2003 2:45:00 PM - Rarity, fragmentation, and the scale-dependence of extinction risk in desert fishes - Theoretical efforts and small-scale experiments have given rise to the widespread belief that the fewer occurrences a species has or the more fragmented its distribution is, the more vulnerable that species should be to extinction. Lacking, however, are large-scale studies exploring the connection between these aspects of spatial rarity and local extinction risk across many species. We present a landscape-level, biogeographic test of this widely assumed linkage. Using a unique dataset detailing the occurrence patterns of native freshwater fishes of the Sonoran Desert (compiled by W.L. Minckley), we obtained several measures of spatial rarity for each of 25 species. Some of these rarity measures were scale-dependent, and one, the "scale-area slope" was independent of spatial scale. This slope statistic, which characterized the degree to which species' ranges were historically fragmented, proved a consistently strong predictor of extinction risk, and reached a maximum of predictability at intermediate scales. At the 100km scale, historic range fragmentation explained over 90% of the among-species variance in realized extinction risk, and desert fish species with the most fragmented historic distributions were more than nine times more likely to be currently absent from a given stream reach than were species with the most continuous distributions. In contrast, the number of reaches occupied (as defined on a series of hierarchical scales) was a significant predictor of extinction risk only if fragmentation had not already been accounted for and decreased in importance as scale increased. These findings have three major implications. First, they underscore what a strong link exists between spatial distribution and vulnerability to extinction. Second, they clarify that the link exists even at the landscape-level and across an entire biogeographic fauna. Last, they demonstrate how

extinction risk can be a scale-dependent phenomenon that is affected by aspects of species' distributions operating at both finer and coarser scales.

11/21/2003 3:00:00 PM - Nonnative fishes in the southwestern USA versus northwestern Mexico: time-lagged invasions as a predictor in desert fish communities - W.L. Minckley began efforts to create a comprehensive database on southwestern fishes in 1994 to allow accurate and quantitative investigations into various aspects of native and nonnative fishes. Unfortunately, Minckley passed away before the first paper stemming directly from the database was published, but his legacy via this database continues to grow and be expanded upon. Minckley was intensely interested in the Pacific Coast rivers of northern Mexico, especially their biogeography and conservation, hence the reason for their inclusion into the database. This presentation stems directly from Minckley, who in 1991, first put forth the hypothesis we are testing today. Here we quantify the historical development of nonnative fish assemblages of two North American desert drainages, one with many nonnative fishes (Gila Basin, principally southwestern USA), and one with few (Yaqui Basin, principally northwestern Mexico). Each river is similar in size, physiography, and ecology, but because of differences in the timing of regional development, Minckley hypothesized the richness and geographic spread of nonnative fishes in the Yaqui are time-lagged relative to the Gila, and that a slow, but steady increase of nonnative fish occurrence is underway in the Yaqui, similar to what has occurred in the Gila. We found increases in regional richness of persistent nonnative species over time have been roughly linear in both basins. Meanwhile, previously established species have continued to spread, such that the cumulative number of reach records for nonnative species has increased roughly exponentially in both systems. For all comparisons, a time lag of 40-50 years exists between the Gila and Yaqui. The majority of nonnative fishes are piscivores, and many have high levels of parental care, a life history trait affording considerable advantages over native fishes. These results predict the presently abundant fauna of the Yaqui may become increasingly imperiled, with a future similar to the Gila, where most native fishes are either extirpated, threatened, or substantially reduced in range and nonnative fishes dominate most fish communities. We recommend immediate actions to identify and protect high priority portions of the Yaqui from further nonnative fish invasions before further degradation occurs.

11/21/2003 3:15:00 PM - Non-native invasion: fathead minnow introduction and spread in West Turkey Creek, Arizona - West Turkey Creek is an ephemeral stream on the west slope of the Chiricahua Mountains in southeastern Arizona. The upper 2/3 of West Turkey is encompassed by the El Coronado Ranch (1,900 acres private land/ 13,300 acres leased Forest Service allotments). Two species of native Rio Yaqui fish can be found in West Turkey Creek, the federally endangered Yaqui chub (Gila purpurea) and the Yaqui form of the longfin dace (Agosia sp.). Dr. W.L. Minckley had always been concerned with Rio Yaqui fishes, so when the opportunity arose in 1996 to advise the owners of El Coronado Ranch in both Arizona and Mexico he took it. Fathead minnow (Pimephales promelas) were first discovered by ASU in late fall 1997 in two locations; Forest Service land above the El Coronado and in one ranch pond. Within a year fathead minnow had spread throughout West Turkey Creek and into seven ranch ponds via diversion systems on the El Coronado Ranch. Summer surveys showed fathead minnow outnumbered native fish 100:1. No Young-of-the-year Yaqui chub or longfin dace were captured during the surveys. Its ability to outcompete the Yaqui chub and dominate the system both impressed and alarmed Minck. This led him to initiate and gather support for a complete renovation of West Turkey Creek.

11/21/2003 3:30:00 PM - W.L. Minckley and the Aravaipa Creek fish barriers: History and legacy - W.L. Minckley adopted the study of Aravaipa Creek and its native fish assemblage as one of his first research interests upon arriving to Arizona in 1963, and over the course of the next 35+ years of study there, he developed one of the longest continuous fish databases in the southwest. During the mid-1980s, Minckley realized that threats of nonnative fish invasions into Aravaipa Creek were increasing, and recommended to the Fish and Wildlife Service and others that emplacement of a low-head fish barrier(s) on the lower creek was warranted. He and the Desert Fishes Recovery Team struggled through the late 1980s to implement his fish barrier vision, but it wasn't until an early 1990s Section 7 Endangered Species Act consultation on the Central Arizona Project produced the means to fund their construction. The Bureau of Reclamation worked closely with Minckley and others over nearly the next full decade to define the design and function of the structures, which were finally built in April 2001, shortly before his death. Minckley never saw the completed barriers, and he disagreed with aspects of the their final design. However, his basic concept of paired structures capable of withstanding 100-year floods was realized. A plaque dedicating the barriers in Minckley's name was installed on the lower barrier following his death, acknowledging his enormous contributions to native fish conservation in Aravaipa Creek and throughout the American

Southwest. This history and the complexities of design and construction of the barriers are illustrated and reviewed here in detail.

11/21/2003 3:45:00 PM - Wildfire in the Southwestern U.S.A.: Effects on rare, native fishes and their habitats - Skinny Rinne first met Minckley in an icthyology class at Arizona State University in 1966. With manure on his shoes and grease on his hands, a young Nebraska farmboy began his journey. From field zoology in summer 1967, through graduate school at Arizona Sate, to finally working for one of "those agencies", I, as many gathered here today, never have departed the influence of W. L. and Jim Deacon in our professional careeers. These two individuals have contributed to so many lives and careers while just doing what they did as graduate students on rivers in Kansas -- biology. They have and continue to 'hand the torch' to run the race for their clients, native southwestern fishes and their habitats. Let us hope we are up to the task. Always ahead of their times, in the late 1960s after a wildfire on Mt. Ord, Minck was quick to suggest a need to study the effects of postfire runoff on plankton in Roosevelt Lake. That brings me to the rest of this presentation -- over 30 years later -- the effects of wildfire on native southwestern fishes. Until recently, the effects of wildfire on aquatic ecosystems in the southwestern USA have been given little attention. In the early 1990s, wildfire impacts on fishes and their habitats increased concern for this management issue. In summer 2002, wildfires burned over 5 million acres in the western USA. Several large wildfires occurred in the Southwest and provided opportunity to delineate the effects on a dozen native fishes--several threatened and endangered species. Information was gathered on three fires in 2002 and two in 2003. In one stream, all fishes were lost in the fire-impacted reaches of stream. In the other two streams, a 70% reduction in total fish numbers was recorded. In 2002, differential responses by species also were recorded in one stream. Based on data collected in summer 2002-03, that from a fire in 1990 and historic data, immediate, post-fire stream water quantity and quality and both short and long-term alteration of habitat are primary determinants of impacts on fishes. Recent study and historic information indicate that listed species of fishes could especially be affected by post wildfire impacts in southwestern stream ecosystems. The impact of fire on native fishes is a rapidly emerging management concern in the Southwest.

11/21/2003 4:00:00 PM - Fighting the Battle Against Extinction: W.L. Minckley and the Desert Fishes Recovery Team - In addition to outstanding research achievements, W.L. Minckley was distinguished by his willingness to become embroiled in the tedious and often contentious process of managing and conserving native fish in the American southwest. He persisted in doing so, contrary to characteristic academic reluctance to participate in management, and despite agency reluctance to incorporate such participation. One of his most outstanding roles in management was as leader of the Desert Fishes Recovery Team, from its inception in 1985 to his death in 2001. The Team's formal charged was to provide guidance to the U.S. Fish and Wildlife Service on native fish in portions of Arizona and New Mexico. Under Minckley's leadership, the Team became an open discussion of native fish conservation issues, expanding on the formal charge. It filled a need for a forum where information could be shared and biological issues discussed outside of inhibiting and mind-numbing bureaucratic rules and roles. Although few Team recommendations to the Service received official response or action, members and other participants used the sound information and professional support gleaned at Team meetings to shoehorn into management many Team ideas and recommendations that were officially ignored. The Team completed recovery plans for eight fish species and a revised a ninth. Team recommendations resulted in proposed listing for one fish species, although similar recommendations for other species were disregarded. The Team pushed for on-the-ground actions and was instrumental in getting barriers to nonnative fish invasion placed on Aravaipa Creek. Team recommendations failed to induce some actions, such as renovation and native fish restoration at Bog Hole Tank, which was a reiterated 16-year-long recommendation. The Team produced guidance stepping-down recovery plan recommendations to the Blue River basin and was beginning other basin-specific plans. But, the Team's resistance to pressure to restrain discussions and recommendations for political and bureaucratic reasons engendered disapproval and opposition in some places. Minckley's biological credentials and reputation and his role as leader, participant, mentor, and repository of vast amounts of knowledge, allowed the Team to weather the storm and continue striving for a biologically-based approach and recommendations oriented to needs of fish, not agencies. With the loss of Minckley's influence, the Team came rapidly under increasing attack and shortly after his death the Team was disbanded by the Fish and Wildlife Service, in conjunction with Arizona Game and Fish Department. As the Service's liaison to the Team from 1988 to 2002, I had the opportunity to participate in this group and play a role in inserting Team ideas and efforts into management programs. I would like to express my thanks Minckley's efforts in the Desert Fishes Recovery Team, and offer my hope that his leadership and unwavering dedication will continue to inspire us all to a greater role in southwestern fish conservation.

11/21/2003 4:15:00 PM - Everyone on earth wants my opinion: A letter by Dr. W.L. Minckley - Partnership, collaboration, and group effort by scientists, sportsmen and laymen are how native desert fishes will survive the existence of biological pollution in the Colorado River basin. Dr. W.L. Minckley supported this concept throughout his career as his curriculum vitae reads like a "Who's Who" in conservation biology while his public record stands by itself and second to few. In one correspondence, Dr. Minckley responded to a member of the Sierra Club Legal Defense Fund regarding the U.S. Fish and Wildlife Service's draft procedures to guide stocking of non-native fishes in the upper Colorado River basin. Dated January 17, 1994, this four-page letter presents Dr. Minckley's steadfast resolve and commitment to desert fish conservation, as well as his opinionated views on governmental agencies and their continued efforts to stock non-native fishes. In this letter, Dr. Minckley took issue with the exclusion of salmonids, the lack of proposed defensive plans against certain escape, and the precedence the proposed procedures would create for the lower Colorado River basin and other watersheds. This letter, and others like it, should be maintained and referred to as permanent testimony given on behalf of creatures great yet mostly small, from a man who dedicated his life to their preservation.

11/21/2003 4:30:00 PM - Out of the ashes, rises a Phoenix - W.L. Minckley and J.E Deacon described in scientific detail, the loss of the native fish community of the lower Colorado River. Through their joint efforts, they provided us not only an understanding, but an appreciation of the uniqueness and resiliency of its fishes. In little more than a century, the physical and biological features they described have been destroyed by society. When Minckley surveyed the river in the mid-1970s, its native fish fauna was gone. Recently something which borders on the miraculous happened. A native fish species is now thriving and expanding in the tailwaters of Davis Dam. A single stocking of 611 flannelmouth suckers in 1976 has resulted in a thriving and expanding population near Bullhead City, Arizona. Its recent success raises some interesting questions pertaining to recovery and native fish management.

11/21/2003 4:45:00 PM - Recovery of endangered desert fishes: A realistic expectation or merely a lofty goal? - The Endangered Species Act of 1973 (ESA) has many goals, including the recovery of listed species and the conservation of ecosystems that harbor endangered and threatened species. However, the number of species that have been recovered is a small percentage (<1%) of those listed. In the 30-years since the ESA was signed into law, only 33 taxa have been delisted. Of these, 14 have been recovered, 12 were removed from the list because of taxonomic revision or other new information that found the original listing to be in error, and 7 were delisted because of extinction. Only two desert fishes, the Tecopa pupfish (Cyprinodon nevadensis calidae) and Amistad gambusia (Gambusia amistadensis), have been delisted, both because of extinction. In this paper we examine the likelihood of recovery of desert fishes in the future to determine whether recovery is a realistic expectation for such species or functions merely as an aspirational goal that is unlikely to be achieved. A related and important concern is how success of the ESA is measured. We argue that for desert fishes, recovery should not be considered the only appropriate measure of success. Instead, management efforts undertaken pursuant to the Endangered Species Act that preclude extinction and result in improving population trends should be recognized as indicators of endangered species management success.

11/21/2003 5:00:00 PM - DFC BUSINESS MEETING / DFC JUNTA DE NEGOCIOS -

11/21/2003 5:15:00 PM - PROPOSED RESOLUTION - Relative to the conservation of native fishes in Arizona - WHEREAS Arizona's aquatic ecosystems have been dammed, ditched, drained, diverted, degraded and intentionally and unintentionally contaminated by biologically invasive fishes; and

WHEREAS more than half of Arizona's fishes are federally listed while the rest have substantially declined; and

WHEREAS one fish in the state has become extinct; and

WHEREAS in the past the Arizona Game and Fish Commission has been dominated by interests with little regard for native fish species; and

WHEREAS it has become the Department's policy to manage for "no net loss" of fishing opportunity thereby inhibiting the Department from taking action using the most basic tool at hand; the replacement of sport fish with listed and imperilled native fish in rivers and streams that still have adequate habitat; and

WHEREAS it is AGFD's policy to require approval from livestock permittees for any listed fish stockings on state and federal lands resulting in failure of some recovery projects despite their merit: and

WHEREAS it is the stated mission of the Arizona Game and Fish Department "to conserve, enhance, and restore Arizona's diverse wildlife resources and habitats through aggressive protection and management programs, and to provide wildlife resources and safe watercraft and off-highway vehicle recreation for the enjoyment, appreciation, and use by present and future generations;" now therefore be it

RESOLVED that the Desert Fishes Council (an international organization numbering in excess of 500 university and agency research scientists and resource specialists, private conservationists, and other individuals concerned with the long-term integrity of North America's desert ecosystems) assembled at its thirty-fifth

Annual Symposium on November XX, 2003 in Death Valley National Park, Furnace Creek, California, urges the Governor of Arizona to create a balanced Arizona Game and Fish Commission with representation from individuals with a strong conservation ethic and record of advocacy for native fish conservation. Be it further

RESOLVED that the Desert Fishes Council urges the Governor of Arizona to work with the Arizona Game and Fish Commission to revise certain Departmental policies that inhibit progress toward recovery of Arizona's native fishes. Be it further

RESOLVED that the Desert Fishes Council urges the Governor of Arizona to assist the Arizona Game and Fish Commission and Department in fulfilling its stated mission including the conservation, enhancement and restoration of native fishes in Arizona and the aquatic ecosystems in which they depend.

11/22/2003 8:45:00 AM - Green sunfish impacts on Gila chub, a natural experiment thanks to a waterfall - Gila chub (*Gila intermedia*) is a medium sized minnow restricted to an irregular patchwork of isolated populations in the Gila River drainage. They are typically isolated by dry or unsuitable habitat and/or downstream presence of either roundtail chub (*G. robusta*) or headwater chub (*G. nigra*). Their occurrence in smaller tributary streams has allowed them to avoid most of the effects of major hydrologic alterations so common in southwestern streams, such as dams and diversions, although minor alterations remain problematic in some populations. They have also somewhat avoided impacts from exotic fishes, as they are often isolated from other habitats by dry reaches or waterfalls. Despite their isolation, at least one population, Monkey Spring has been lost due to the introduction of largemouth bass (*Micropterus salmoides*). Green sunfish (*Lepomis cyanellus*) has also been implicated in their demise as populations of Gila chub have declined as green sunfish became more abundant. Recent rehabilitation efforts have narrowly saved two populations from impending extirpation due to green sunfish (Sabino Canyon, O'Donnell Creek). Natural waterfalls have also apparently saved several populations (Turkey Creek, Sycamore Creek, and Silver Creek). At these sites, Gila chub are usually abundant above the waterfalls in the absence of green sunfish, but are rare below when green sunfish are common. We set out to investigate this pattern by sampling fish populations above and below the waterfall on Silver Creek (Agua Fria drainage). We found only Gila chub above the waterfall, where they were abundant, with ~160 captured from four short seine hauls. Below the waterfall, green sunfish were the most abundant, and, despite significantly more sampling effort with a seine and electroshocker, Gila chub were considerably less abundant with only 23 individuals captured versus over 200 green sunfish. More striking however was the distribution of size classes. Above the falls, over half the population were less than 70 mm; this entire size class was missing below the falls, suggesting recruitment is either very low or nonexistent. This difference we attribute to the presence of green sunfish. We are planning additional work to further test this hypothesis, although on the basis of our initial results, it appears clear these two species cannot successfully coexist when green sunfish are abundant. Any populations of Gila chub that also have an abundance of green sunfish must be renovated or else Gila chub will eventually be extirpated as green sunfish invade further upstream.

11/22/2003 9:00:00 AM - Population estimates for humpback chub (*Gila cypha*) and roundtail chub (*Gila robusta*) in Westwater Canyon, Colorado River, Utah, 1998-2002 - Within the upper Colorado River basin, one of the most robust populations of the federally endangered humpback chub (*Gila cypha*) is found in Westwater Canyon. The fish community in Westwater has been monitored since 1986 through examination of catch rate trends. Mark-recapture population estimates for adult humpback chub and roundtail chub (*Gila robusta*) were initially completed in 1998 through 2000. Recovery goals were revised in 2002, requiring that a mark-recapture adult population estimate be completed in three of every five years. A new round of estimates begins fall 2003 and preliminary results will provide comparisons. Results from 1998–2000 indicated a decline in the adult humpback chub population: 4,744 in 1998; 2,215 in 1999; and 2,201 in 2000. This declining trend was not statistically significant, but may be of concern. Analysis of catch per unit effort (CPUE) data from this project and historic interagency standardized monitoring indicated an ongoing declining trend in mean CPUE for humpback chub which was significant. Population estimates were also completed in 1998–2000 for adult roundtail chub in Westwater Canyon: 5,005 in 1998;

4,234 in 1999; and 4,971 in 2000 indicating a stable population. Historical mean CPUE for roundtail chub indicated a slight declining trend, but it was not statistically significant. Analysis of recaptures indicated both species exhibited movement between Black Rocks and Westwater Canyon. This movement may be frequent enough to consider Black Rocks and Westwater Canyon a single population for humpback chub and roundtail chub. The results of this project will provide valuable information for conducting future population estimates of chub in the upper Colorado River basin in addition to providing three point estimates that will be used to aid in determining if humpback chub have met the recovery goals.

11/22/2003 9:15:00 AM - Brown trout removal in Bright Angel Creek, Grand Canyon National Park: A potential recovery effort for native fishes - In Bright Angel Creek in Grand Canyon National Park, the fish community has been altered towards non-native salmonids, to the detriment of its native fishes. The National Park Service is charged with preserving and protecting the natural resources within Grand Canyon. Active, hands-on management of resources is at times required to achieve this goal. Construction and operation of a temporary weir in Bright Angel Creek will provide the opportunity to determine if removal of brown trout (Salmo trutta) will benefit native fish survival in Bright Angel Creek. In the mainstem Colorado River, maximum brown trout numbers occurred near the confluence of Bright Angel Creek (Speas 2001). Bright Angel Creek is thought to be the primary spawning location for brown trout in the Grand Canyon, although mainstem spawning may also occur. Removal of spawning brown trout from Bright Angel Creek may reduce the numbers of brown trout in the mainstem as well, thus potentially benefiting the endangered humpback chub and other native fish in the mainstem. A temporary fish weir was installed in Bright Angel Creek and operated continuously from November 18, 2002 to January 21, 2003. Spawning brown trout were collected in the weir and removed from the creek. Removal of brown trout and annual monitoring to document the fish community response will be conducted for four years.

11/22/2003 9:30:00 AM - Population estimate for humpback chub (*Gila cypha*) (2001-2003) and long term trend data for *Gila* spp. (1989-2003) in Desolation and Gray canyons on the Green River, Utah - Six extant wild populations of humpback chub (*Gila cypha*) are known to exist in the Colorado River Basin, one of them resides in Desolation and Gray canyons of the Green River in Utah. The humpback chub was listed under the Endangered Species Act in 1973. The Desolation/Gray population is considered a potential "core population" in which the population is an independent self-sustaining population sufficiently large enough to maintain genetic and demographic viability. Recovery goals for the humpback chub were finalized in 2002 and require that eventual downlisting and subsequent delisting will in part be determined by point estimates of population size. Population estimates are scheduled to be conducted three out of every five years. The period between 2001 and 2003 was the first round of estimates to be conducted for the Desolation/Gray canyon population under the current protocol. Humpback chub population estimate sampling was conducted in the summer of 2001 and 2002, and the fall of 2003. Low river discharge in 2002 forced cancellation of the last pass. In fall 2003, sampling was conducted during low water conditions. Twelve individual sites were sampled throughout the two canyons. Four of these sites were long term trend sites that had been monitored at least once a year since 1989. Main channel habitats were sampled with trammel nets, boat mounted electrofishers, hoop nets and minnow traps. Point estimates are generated for each of the three years that sampling is conducted using mark/recapture data. Data collected since 1989 is also analyzed to determine long term catch rate trends of *Gila* spp. Catch rates of all *Gila* spp. remained variable among the four long term trend sites in Desolation/Gray canyons since annual sampling began in 1989. What appeared to be a downward trend from 1989 through 1996, rebounded somewhat in 1997. Catch rates between 1998 and 2002 remained relatively consistent and considerably higher than 1992-1996 period, but not as high as that observed in 1989. Fall sampling in 2003 will provide the third point estimate and add to the continuing trend data for *Gila* spp. in these two canyons.

11/22/2003 9:45:00 AM - Genetic effects of hatchery propagation in the endangered Rio Grande silvery minnow (*Hybognathus amarus*) - The Rio Grande silvery minnow, *Hybognathus amarus*, is a federally endangered cyprinid that is now confined to the middle Rio Grande, New Mexico, in a fraction of its former range. The precipitous decline of the remaining wild population and lack of recruitment in the summer of 2000 prompted the collection and placement of eggs and wild Rio Grande silvery minnow in propagation facilities. The aim of this study was to assess the genetic effects of hatchery propagation in the Rio Grande silvery minnow using 10 microsatellite loci and partial mitochondrial ND4 sequences. Three hatchery stocks (2001, 2002 and 2003) and the wild source population (collected in 2001-2002 and 2002-2003) were considered. Principal findings were; (i) captively-spawned and reared Rio Grande silvery minnow had depleted levels of allelic diversity but similar levels of heterozygosity to the wild population, and (ii) fish raised from wild caught eggs maintained similar levels of allelic diversity but had higher

inbreeding coefficients than the wild source stock. With the repatriation of over 500,000 Rio Grande silvery minnow to the Rio Grande the genetic effects of propagation are likely to impact the remaining wild population, particularly as numbers in the wild continue to decline.

11/22/2003 10:00:00 AM - Augmentation and monitoring of Rio Grande silvery minnow - The first year of experimental augmentation and monitoring for Rio Grande silvery minnow (*Hybognathus amarus*) was completed in May 2003. Between June 2002 and April 2003, 126,966 Rio Grande silvery minnow were batch marked with a Visible Implant Elastomer (VIE) tag and released in the Rio Grande near Albuquerque, New Mexico. In post-release monitoring, including 15 trips and 2,660 seine hauls, a total of 196 Rio Grande silvery minnow have been collected. Of these, 73 (37.2%) had a VIE mark. Rio Grande silvery minnow represented 1.2% of all fish collected, were collected in 3.2% of all seine hauls, and were collected at a density of 0.37 individuals/100m^2. Marked individuals have been collected within 4 km of the release site up to 6 months after release, collected in spawning condition, and have been collected with unmarked individuals. This information provides evidence to the acclimation of released Rio Grande silvery minnow. With upcoming releases and continued monitoring, more information on the persistence and contribution of augmented populations of Rio Grande silvery minnow will be collected. This information could provide guidance for repatriation efforts within the historic range.

11/22/2003 10:15:00 AM - Apache trout protection evaluation study: Apache trout habitat use - This study investigated if Apache trout (*Oncorhynchus apache*) habitat use changed as a function of time since streams were fenced to exclude livestock. We measured used and available Apache trout habitat in seven White Mountain streams in east-central Arizona, that were fenced 0-13 years ago. Apache trout used simliar habitat on all White Mountain streams surveyed, using a deeper, wider, and less current velocity habitat than the randomly chosen available sites. Cover at used sites was composed of more boulders and less in-stream vegetation than random sites. So far, we have not detected any effect of time since fencing on habitat use of Apache trout.

11/22/2003 10:30:00 AM - Diet and consumption rates of native fishes by nonnative fishes in the Verde River, Arizona - Predation by nonnative fishes is thought to contribute to the decline of native fishes in southwestern rivers. We conducted field investigations from March 2002 through January 2003 on the Verde River, Arizona to estimate the impact of predation by of nonnative fishes on the abundance and distribution of native fishes. We identified the percentage of fish, including native fish, in the diet of nonnative fishes and used Wisconsin bioenergetics model to estimate consumption rates of fish by nonnative fishes. Largemouth bass Micropterus salmoides had the highest percentage of fish and native fish in their diet and the highest consumption rates of fish, including native fish. Rainbow trout Oncorhynchus mykiss had the second highest consumption rate of fish. The daily ration of prey fish for smallmouth bass M. dolomieui, channel catfish Ictalurus punctatus, flathead catfish Pylodictis olivaris, rainbow trout, and yellow bullhead Ameiurus natalis was less than half of that for largemouth bass and rainbow trout. Predation on fish, including native fish was highest during the spring and summer, which overlaps with spawning of native fishes. We also primarily found predation on native fishes occurring below Bartlett Dam, which coincides with the highest density of native fishes. Data on consumption rates of native fishes suggests that the abundance and distribution of native fishes in the Verde River might be increased if focusing future management efforts reduce the abundance of all age classes of largemouth bass and rainbow trout during the spring and summer seasons across the Verde River. Continued research is needed to test the effect of removing the primary piscivores from the Verde River on the abundance and distribution of native fishes.

11/22/2003 10:45:00 AM - Lethal thermal maxima of native and non-native fishes in the San Pedro River, Arizona - As the human population of the southwestern United States continues to grow, greater pressure is put on local stream systems. Water withdrawals and riparian vegetation destruction are suspected to cause increasing water temperatures in Southwestern rivers. These changes in water temperature may have contributed to the decline of native fish species, as fish are more likely to be exposed to their upper thermal limit. Temperature affects all biochemical, physiological, and life history activities of fishes. The San Pedro River in Arizona was once home to 13 native fishes, but only 2 remain today. We examined the lethal thermal maxima of the San Pedro River fish assemblage to evaluate the relationship among higher water temperatures and the survival of native fishes, and to test whether non-native fish have an advantage over native desert fishes at high water temperatures. The species tested included native and non-native fish currently found within the San Pedro River. In addition, we tested two fish species that were historically found in the river and are currently listed as Threatened under the U.S. Endangered Species Act: *Tiaroga cobitis* and *Meda fulgida*. These two species have critical habitat designated on the San Pedro River. We also

report preliminary results from a chronic lethal temperature experiment performed on *T. cobitis* and *M. fulgida*. The two methods differ in temperature change rates and test endpoints and therefore measure different aspects of the effects of thermal stress. The effects of elevated water temperatures on Southwestern fish communities have implications for groundwater pumping and riparian management activities.

11/22/2003 11:00:00 AM - Native fish status and distribution in Soldier Meadows, Nevada with emphasis on the desert dace - Desert dace (*Eremichthys acros*) is a threatened species endemic to thermal springs and streams in Mud and Soldier Meadows, Humboldt County, Nevada. Its habitat lies within the recently designated Black Rock/High Rock National Conservation Area. There is little current status information on desert dace and other native fishes of Mud and Soldier Meadows. In this study we systematically surveyed Mud and Soldier Meadows seasonally. Since the latest survey in the mid 1990's, we found one population of desert dace extirpated due to an invasion of green sunfish (*Lepomis cyanellus*) and goldfish (*Carassius auratus*), but two additional populations were located. Other natives found were tui chub (*Gila bicolor*, Tahoe sucker (*Catostomas tahoensis*, and speckled dace(*Rhinichthys osculus*. Green sunfish have greatly expanded their range from Mud Meadows Reservoir into Mud Meadows; having already invaded two systems, they threaten to invade others. An aggressive effort is needed to control and or extirpate the green sunfish population.

11/22/2003 11:15:00 AM - Is the California state fish in trouble? - Endemic to Golden Trout Creek and the upper south fork Kern River, and transplanted into streams and lakes throughout the southern Sierra Nevada Mountains, California golden trout (Oncorhynchus mykiss aguabonita), were once believed to be widespread. Threats of hybridization, predation, interspecific competition, and habitat degradation are now known to be pushing California's state fish near the brink of extinction. As a result, the California golden trout was petitioned for federal listing as endangered in 2000. Restoration efforts, begun in 1969, focused on the construction of barriers, habitat improvement, and the removal of introduced brown trout in populations in the upper south fork Kern River watershed. When allozyme analysis of golden trout was conducted in 1995, it was discovered that the majority of the populations originating from hatchery golden trout stock had become hybridized with rainbow trout. DNA analysis in 1999 and 2003 revealed low levels of rainbow trout introgression in most of the endemic populations as well. With the new genetic information, plans for restoration had to undergo major revisions, and a new Conservation Assessment and Strategy was drafted in 2003. The current management focus is on identifying and protecting any remaining pure populations, identifying potential locations for the establishment of refugia, and habitat monitoring, particularly in two cattle grazing allotments that are being rested for 10-years.

11/22/2003 11:30:00 AM - Microhabitat use and spatial distribution of larval and juvenile fishes in the Middle Rio Grande, New Mexico - The spatial distribution and microhabitat preferences of larval and juvenile fishes in the Middle Rio Grande, New Mexico were studied during the spring, summer and autumn of 2003. Fishes were captured using quatrefoil light traps and a larval seine. Physicochemical variables including depth, current velocity, temperature, dissolved oxygen, substrate type and the amount of in-stream cover were measured at sampling locations. Preliminary results suggest that current velocity is the primary factor determining distribution of fishes in this system during early life stages. Specifically, the presence of slow-flow refugia in backwaters or abandoned side channels is associated with increased abundance and diversity of juveniles and larvae. Other variables such as temperature appear important, and are likely related to speed of flow. The Middle Rio Grande region suffered severe drought conditions in 2003, and flow at the study site ceased completely during much of the summer. The effects of these conditions on recruitment among species in this reach are also examined.

11/22/2003 11:45:00 AM - Age structure and variation in year class strength of the roundtail chub, *Gila robusta* (Cyprinidae), in the Yampa River Canyon, Colorado - The Gila robusta complex includes three large, morphologically variable cyprinid species native to the Colorado River drainage. All three members of this complex, *G. cypha*, *G. elegans*, and *G. robusta*, occur (or occurred) in the Yampa River Canyon. Both *G. elegans* and *G. cypha* are federally listed as endangered, with the former likely extirpated from the Yampa River; only *G. robusta* is still unlisted federally and relatively common. Beginning in 1998, we have obtained otolith data on 121 fish (1998-28; 1999-26; 2001-37; 2002-30). Presumed maximum age is 23 years (2 fish), with fish 2 to 10 years comprising 92% of the samples. The frequency distribution of presumed ages suggests considerable variation among years. Hence, our objective in this study was to test the hypothesis that year class strength was related to river flow characteristics. Given that year class representation in a sample is a function of initial year class strength and subsequent annual mortality, we represented year class strength as the residual after regressing age frequency against hatching

year for years 1982 to 1997. Eight years showed strong negative residuals and seven showed strong positive residuals. Discharge data available from USGS were incomplete before 1983 and after 1993, hence year class residuals were tested against discharge data from 1983 to 1993. Residuals were not significantly correlated with annual mean discharge, discharge by season, or September low flow. Use of nonlinear models also failed to show a relationship between discharge and positive or negative residuals. Consequently, the analysis does not support the hypothesis that year class strength is affected by river discharge. Although desert fishes have undergone strong selection for tolerating wide variations in flow so that this result might not be unanticipated, other factors may weaken the analysis. These include problems with the accuracy of age determination and problems with the assumptions involved in using residuals as a measure of year class strength.

11/22/2003 2:00:00 PM - Cui-ui, an overlooked prey for Pyramid Lake's nesting colony of American white pelican - Cui-ui (*Chasmistes cujus*) is endemic to Pyramid Lake, Nevada, which is also known for harboring one of the largest nesting colonies of American white pelican (*Pelecanus erythrorhynchos*) on its largest island (Anaho Island). The two species come into close proximity in late winter and early spring at the mouth of the Truckee River. Mature cui-ui migrate there and await the high turbid flows that are their environmental cue to initiate their spawning migration up the lower Truckee River. Simultaneously, American white pelicans congregate near the mouth of the Truckee and await migrating fish to prey upon. Because it was believed that most were too large for these birds, cui-ui had previously been dismissed as an important American white pelican food item. Having observed white pelicans taking cui-ui at the mouth of the Truckee in spawning season, we decided to investigate American white pelican predation on these fish. Since 1988 we have estimated the number of adult cui-ui in the prespawning aggregation through mark (anchor tags) and recapture, and used the tags recovered from Anaho Island to estimate number and size of cui-ui taken to the nesting colony. We have found that American white pelicans feed on all sizes of cui-ui and that they took tens of thousands to the nesting colony over several years. We are continuing to refine our estimates of adult cui-ui taken to Anaho Island. We are also studying the effect of the pelican on cui-ui population dynamics. Preliminary results indicate that heavy pelican predation reduces cui-ui density sufficiently to accelerate growth rate and to cause early maturation. Cui-ui has been an overlooked American white pelican forage resource because of its seasonality and its occasional lack of availability due to insufficient flow for a spawning migration in some years. This study adds insight into the reciprocal importance of cui-ui and American white pelicans for one another's population dynamics, and suggests that preservation of a large and healthy cui-ui population is of paramount importance to a healthy Anaho Island nesting colony of American white pelicans.

11/22/2003 2:15:00 PM - Systematic investigations of the warm-water fish assemblage in San Pedro River, 1990-2003 - Fourteen years of monitoring disclosed no changes in species diversity, and few in relative abundance of the fish assemblage or aquatic habitats in the San Pedro Riparian National Conservation Area (SPRNCA), Arizona. The Congress established the SPRNCA in 1988 to conserve, protect, and enhance the desert riparian ecosystem along 40 miles of the upper San Pedro River. After establishment, the U. S. Bureau of Land Management closed the area to livestock grazing, and substantially reduced vehicular access and other uses. Several monitoring efforts were established to track potential changes in flora and fauna. We sampled the fish assemblage with electrofishing gear and evaluated aquatic habitat and riparian conditions at four sites in the SPRNCA annually in the spring during 1990 to 2003. During this period, we detected no change in species diversity. The once rich native fauna was represented only by longfin dace *Agosia chrysogaster* and desert sucker *Catostomus (Pantosteus) clarki*, which comprised 52% and 25% of the total catch (n = 5,347 individuals), respectively. Nonnative species in our catch were western mosquitofish *Gambusia affinis* (9%), fathead minnow *Pimephales promelas* (6%), green sunfish *Lepomis cyanellus* and black bullhead *Ameiurus melas* (4% each), and largemouth bass *Micropterus salmoides* and common carp *Cyprinus carpio* (<1% each). Although there were annual differences in total numbers and relative abundance in the assemblage, only desert sucker exhibited a long-term downward trend in abundance. Long-term trends of all other species were static. During the sampling period, floods were unremarkable but drought flows were the lowest on record, and significantly affected total abundance of fish the following year. A dramatic response in herbaceous and woody riparian vegetation occurred after grazing was removed, but aquatic habitats did not change qualitatively or quantitatively. The sequence and pattern of riffle-run-pool complexes remained the same through the study period, as did channel widths, depths of pools, and embeddedness of substrate materials. This corroborates observations in other streams that changes in aquatic habitat generally lag substantially behind changes in vegetation.

11/22/2003 2:30:00 PM - A comparison of genetic effective population size between the Rio Grande silvery minnow (*Hybognathus amarus*) and the plains minnow (*Hybognathus placitus*) - Previous findings suggest that the federally endangered Rio Grande silvery minnow (Hybognathus amarus) has experienced an enormous decrease in genetic effective population size (Ne) (e.g., long-term Ne≈106, present Ne≈100). The reason for this decrease is presumably due in part to intermittent water flow and impediment of *H. amarus* by diversion dams. *H. amarus* produces semi-buoyant eggs, which passively drift downstream, and historically, the new year class was uninhibited to colonize upstream habitat. However, due to stream intermittency and construction of numerous diversion dams along the Rio Grande, the movement of *H. amarus* (i.e., eggs, larvae, and adults) can be impeded. We hypothesize that these waterway obstructions, in conjunction with stream intermittency, are contributing to the decline in Ne of *H. amarus*. To provide *H. placitus* (n≈360) from the Pecos River (similar in habitat and flow regime to the Rio Grande but unobstructed by diversion dams along study site) and compare it to that of *H. amarus*. Estimates of Ne are based on the temporal method using four microsatellite loci and a fragment of mitochondrial encoded ND4 gene. In contrast to nuclear estimates of Ne (ca. 100) for *H. amarus*, Ne values (>51,000) for *H. placitus* suggest sizes that are significantly greater (i.e., the CI values do not overlap). The life history and habitats of these species are similar; as such our findings indicate that the reduction of Ne in *H. amarus* is associated with the impediment of up and down stream movement by diversion dams.

11/22/2003 2:45:00 PM - Evaluation of growth and survival of larval razorback suckers (*Xyrauchen texanus*) in a floodplain depression inhabited by nonnative fish in the Green River, Utah - As part of ongoing efforts to recover the endangered razorback sucker (*Xyrauchen texanus*), hatchery produced larval razorback suckers were experimentally stocked into a floodplain depression along the Green River, Utah. This study was designed to evaluate if larval razorback suckers could survive in a floodplain depression that was also inhabited with nonnative fish and eventually reenter the river. Earlier efforts to demonstrate survival of stocked larval razorback suckers in Green River floodplain depressions containing abundant nonnative fish were unsuccessful. The very large number of nonnative predators was likely the reason for no observed survival of the stocked larval razorback suckers. Floodplains that dry up during drought years and then flood during wet years have much lower densities of nonnative fish for the first year. The fish populations in these depressions are reset to zero during these dry cycles. This study was designed to evaluate if large numbers of razorback sucker larvae that entered a "reset" floodplain depression could overwhelm nonnative fish predation, survive, grow and reenter the river during future spring floods. This situation was experimentally created by pumping water from the river into a dry floodplain and introducing larval razorback suckers and nonnative fish into partitioned portions of the floodplain depression. Survival of many razorback sucker larvae was detected, reaching lengths of up to 115mm by mid-summer. Continued monitoring of this floodplain during future spring floods will determine when these razorback suckers enter the river. This study continued during 2003 in a different floodplain with a goal of obtaining an estimate of the density of larval razorback sucker necessary to survive predation in a "reset" floodplain. This was done by evaluating survival and growth of larval razorback suckers stocked into experimental enclosures at several lower densities.

11/22/2003 3:00:00 PM - Striving for success: Colorado pikeminnow stocking efforts in the San Juan River - In the late 1980s and early 1990s, Colorado pikeminnow (*Ptychochelius lucius*) were found to be present and reproducing in the San Juan River. A seven-year research effort found that natural reproduction was limited and recruitment was thought to be almost nonexistent. This prompted the San Juan Recovery Implementation Program (SJRIP) to attempt to supplement the natural population through stocking. Larval, young-of-year (YOY), and adult Colorado pikeminnow have all been stocked in the San Juan River since 1996. Most of these stockings have taken place downstream of Shiprock, NM (RM 148). While a few fish seem to have survived from most of these stockings, the YOY stockings from 1996-1998 appeared to have the best success rate. Therefore, in 2002 the SJRIP stocked 200,000 YOY pikeminnow in the San Juan River. An important goal for the SJRIP is to establish pikeminnow above Shiprock, NM (RM 148). In an effort to move toward this goal approximately half of the pikeminnow stocked in 2002 were stocked further up in the system (near Farmington, NM [RM 180.2]) than the 1996-1998 stockings. We collected information on the retention and habitat use of the 2002 stocked fish, and compared that to past stockings. We used this information to evaluate the success of the 2002 stocking, and to provide recommendations for future research needs and for improving augmentation protocols to increase retention.

11/22/2003 3:15:00 PM - Effects of two exotics on experimental populations of White Sands pupfish - The potential impact of introduced species on rare taxa is of particular concern to conservation

biologists. We evaluate the impacts of western mosquitofish (*Gambusia affinis*) and virile crayfish (*Orconectes virilis*) on experimental populations of a threatened species, the White Sands pupfish (*Cyprinodon tularosa*). Forty experimental pupfish populations were exposed to one of four treatments; a) 1 crayfish, b) 4 crayfish, c) 5 adult mosquitofish and d) control. Pupfish population size and biomass was monitored over the duration of one breeding season. A repeated measure multiple analysis of covariance revealed a significant effect of treatments on response variables (population size and biomass) ($p < 0.0001$). Mosquitofish had a significant effect on population size and biomass ($p = 0.0330$). The effect of one crayfish was not significant ($p = 0.0683$), however 4 crayfish had a significant effect ($p < 0.0001$) on population size. We use these data along with information on environmental tolerances of crayfish and mosquitofish to evaluate risks for specific pupfish populations.

11/22/2003 3:30:00 PM - Could exercise conditioning increase the success of repatriation programs for Colorado River fishes? - Rare native fishes are often propagated at hatcheries and reared in ponds or fiberglass tanks for later stocking into streams with depleted populations. Fish unaccustomed to moving water may experience increased stress, downstream displacement, or high predation mortality when released into lotic environments. We compared the swimming performance of captive fish held in non-moving water, captive fish exercised in flowing water, and wild fish captured from a stream, to evaluate the effects of exercise conditioning and holding environment on swimming performance. Swimming performance of flannelmouth sucker (*Catostomus latipinnis*), bonytail chub (*Gila elegans*), razorback sucker (*Xyrauchen texanus*), and spikedace (*Meda fulgida*) held in non-moving water increased by 10, 18, 24, and 60% respectively after exercise conditioning in flowing water (0.1 – 1 m/s) for as little as 10 days. Exercising fish reared in non-moving water may improve swimming performance and increase success of stocking programs for stream-dwelling fishes.

11/22/2003 3:45:00 PM - CANCELLATION -

11/22/2003 4:00:00 PM - Evolution of MHC class I and class II gene loci among closely related trout species in the American southwest - Trouts and salmon, genus *Oncorhynchus*, make up an important component of cold water fisheries in many parts of the world. Consequently, genes involved with adaptive immunity, like the major histocompatibility complex (MHC), are among the best characterized of teleost (bony) fishes. What is lacking is an understanding of how these genes evolve at the population level. Our aim in this study was to understand patterns of evolution at MHC loci by comparing genetic diversity at four loci (two microsatellites linked to MHC class I; MHC class II $\beta 1$; and MHC class I $\alpha 1$) across three closely-related species of inland trout; (i) rainbow trout, *Oncorhynchus mykiss*, obtained from a number of hatcheries in the southwestern US, (ii) Gila trout, *Oncorhynchus gilae* and (iii) Apache trout, *Oncorhynchus apache* . Phylogenetic analysis indicated that these three species shared very few MHC class II alleles, despite very recent common ancestry. Moreover, microsatellites linked to MHC class I showed nearly fixed differences between native species and the introduced rainbow trout. We suggest that comparative study of native inland trouts may offer insight into the role of population genetic processes like selection, drift, migration, and hybridization for maintaining genetic variation at MHC.

11/22/2003 4:15:00 PM - The role of reservoir fluctuations and cover on the recruitment of razorback sucker in Lake Mead - 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 Bureau of Reclamation for the past 7 years. Two primary populations at Echo Bay and Las Vegas Bay were followed during the first 6 years of the study and a third potential population was investigated recently at the Colorado River inflow area. A major emphasis of this research has been to examine the age of the Echo Bay and Las Vegas Bay populations and then use this information to identify patterns of recruitment. Ages calculated nonlethally for 40 individual razorback sucker (6 to 35 years of age) indicated that these were young populations that potentially recruited under specific reservoir conditions. An additional 24 razorback sucker were aged during the 2002-2003 study year, including eight sub-adult fish from Las Vegas Bay that were aged at 4 and 5 years. Comparing the years all aged razorback sucker were spawned with historical Lake Mead water elevations provides some evidence that a combination of small, annual lake-level fluctuations and larger, multi-year changes in lake elevation may influence razorback sucker recruitment. The long-term lake-level changes may promote growth of terrestrial vegetation that may provide increased protective cover for larval and juvenile razorback sucker, resulting in the limited recruitment documented in Lake Mead. The fact that the recently aged sub-adult fish were apparently spawned in 1998 and 1999, at a time when large amounts of protective cover were inundated at Las Vegas Bay, generally supports this theory. During the last 3 years terrestrial vegetation has grown between the full pool elevation and the littoral

zone as the lake's elevation has steadily declined to levels not encountered since the early 1970s. If a future management goal is to establish additional populations of razorback sucker in Lake Mead through juvenile fish introduction, a knowledge of the amount and types of vegetation that may be inundated at specific areas as lake levels increase would be desirable. Comparing these areas with Las Vegas Bay and Echo Bay may provide additional information on their potential for sustaining razorback sucker populations and the role of cover in the recruitment of razorback sucker in the lake. To this end, we assessed the amount and types of terrestrial vegetation at Echo Bay, Las Vegas Bay/Wash and eight other coves and river/wash inflow areas of Lake Mead. The two known population areas, Las Vegas Bay/Wash and Echo Bay, both contained substantial amounts of woody terrestrial vegetation that could be used as cover by young razorback sucker. These two areas, however, contained much less woody vegetative cover than the Muddy River, Virgin River, and Colorado River inflow areas. The three river inflow areas represent the best potential habitat for establishing additional razorback sucker populations in the lake through the supplemental introduction of juvenile fish.

11/22/2003 4:30:00 PM - Status of the Gila topminnow and desert pupfish in Arizona: A five-year summary (1998-2003) - The Arizona Game and Fish Department (AGFD) conducts management activities for the Gila topminnow, *Poeciliopsis occidentalis*, and desert pupfish, *Cyprinodon macularius*, as a project funded jointly by AGFD, the U.S. Fish and Wildlife Service, and other funding sources. This presentation provides background on management of these endangered species, information collected during the past five years of this project, and a summary of the status of populations of both species.

11/22/2003 4:45:00 PM - Gila topminnow and desert pupfish management in Arizona: RIP stands for Recovery Implementation Plan, not rest in peace - Management activities involving translocations or reestablishment of Gila topminnow, *Poeciliopsis occidentalis*, and desert pupfish, *Cyprinodon macularius*, began in 1936 when topminnows were stocked into Arivaca Creek. Since then, more than 200 reestablishment efforts or natural dispersals have occurred. However, since the widespread reestablishment project that occurred during early 1980s, only a handful of reestablishment projects for the two species have occurred, due in part to a lack of a programmatic plan necessary to address and outline all of the steps required to implement large-scale recovery actions. Here we will summarize the development of a Gila topminnow and desert pupfish Recovery Implementation Plan, including objectives to protect and restore habitat, identify suitable habitat, reestablish or augment populations, manage genetic variation of the species, monitor populations and habitats, and provide information and education.