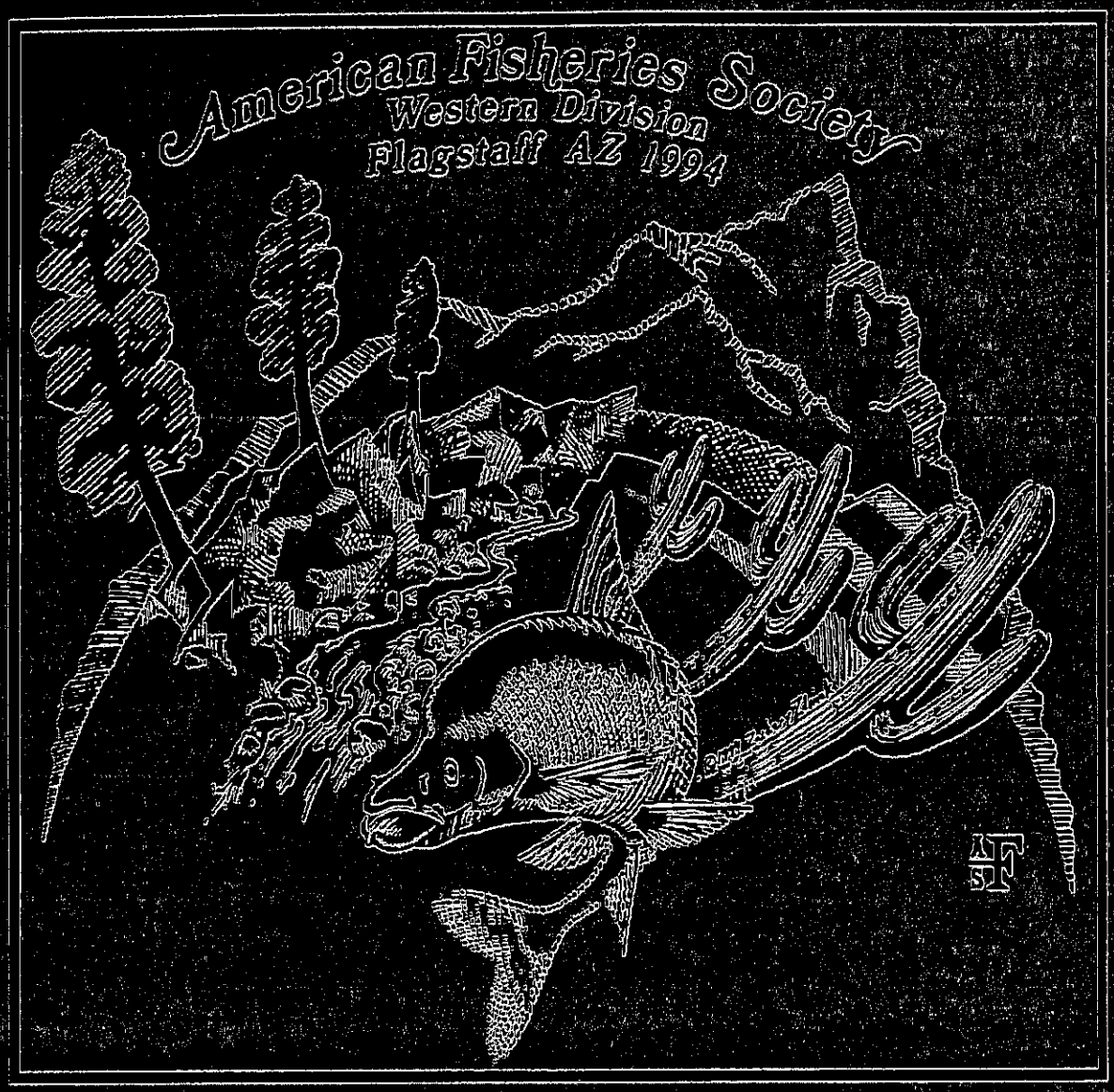

1994 ANNUAL MEETING
PROGRAM AND ABSTRACTS
NORTHERN ARIZONA UNIVERSITY
JUNE 19-23, FLAGSTAFF, ARIZONA

NORTHERN ARIZONA UNIVERSITY

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The meeting organizers cordially thank Northern Arizona University for their generous assistance in printing the program booklet

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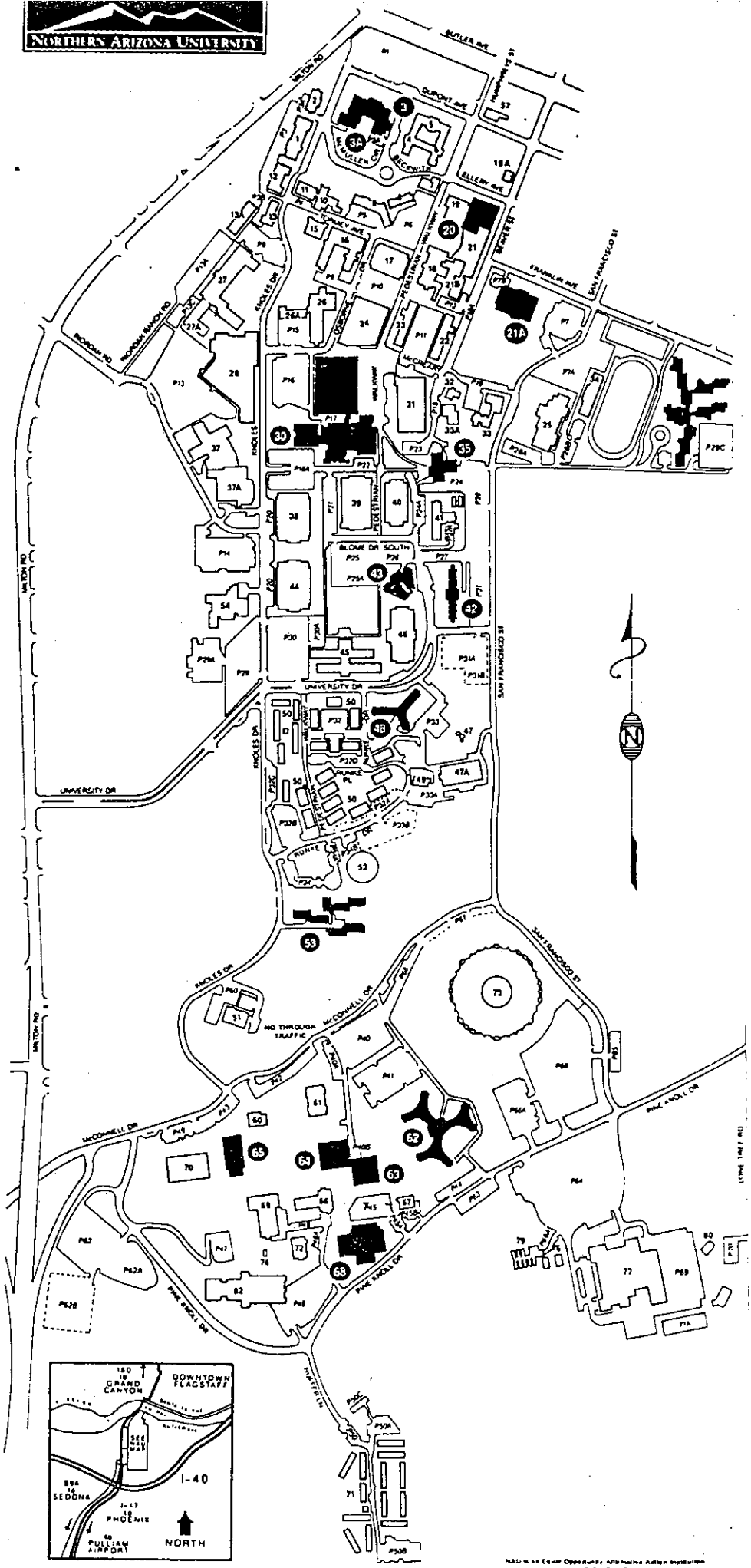

1994 Annual Meeting, Western Division American Fisheries Society

PROGRAM OVERVIEW

SUNDAY JUNE 19 Afternoon

16:00-21:00 **REGISTRATION AND WELCOMING AT STUDENT UNION ATRIUM**
(Mountain View Hall check-in for those residing on campus)

MONDAY JUNE 20

7:30-17:30 **REGISTRATION CONTINUES AT NAU FIELD HOUSE**

CLINE LIBRARY AUDITORIUM SCHEDULE

8:00-8:15 **WELCOMING REMARKS**
Randy Bailey, President, Western Division
Dr. Henry Hooper, NAU Vice President of Academic Affairs

8:15-8:45 **KEYNOTE ADDRESS**
Dr. David Cottingham
Counselor to Assistant Secretary for Water and Science, US Dept. of Interior
"How does policy interface with ecosystem management?"

8:45-9:00 **"ADVANTAGES OF THE ECOSYSTEM APPROACH IN RESOURCE PROBLEM SOLVING"**
Dr. Michael Dombeck, Acting Director
Bureau of Land Management, Washington, D.C.

9:00-9:15 **"ECOSYSTEM MANAGEMENT: A STATE FISHERY MANAGER'S PERSPECTIVES ON ITS LIMITATIONS (HOW CAN YOU ADDRESS A WHOLE ECOSYSTEM WHEN YOU CAN'T PROPERLY MANAGE A SINGLE SPECIES?)"**
Dr. Dana Schmidt
Alaska Department of Fish and Game

9:15-9:45 BREAK

9:45-12:30 **INTERGOVERNMENTAL PANEL ON ECOSYSTEM MANAGEMENT**
Featured speakers will represent various government agencies from the U.S., Canada, and Mexico. Each will present a synopsis (up to 15 minutes) of their perspectives on ecosystem management including current applications and future plans on how the "EM" approach should be implemented. The speakers include:
William Doubleday, Assistant Deputy Minister of Science, Department of Fisheries and Oceans, Ottawa, Canada
Larry Hancock, Regional Director, Bureau of Reclamation, Boulder City, CO
Chris Wood/Allen Thomas, Bureau of Land Management, Washington, D.C.
James Sedell, Research Ecologist, U.S. Forest Service, Corvallis, OR
Lynn Starnes, Deputy Regional Director, U.S. Fish and Wildlife Service, Albuquerque, NM
Rey Stendell, Director, Midcontinent Ecological Science Center, National Biological Survey, Fort Collins, CO
Salvador Contreras Balderas, Universidad Autonomade Neuvo Leon (emeritus), Monterey, Mexico

– Concerned about sensitive species that are not yet endangered.
– Concerned about exotics.

1800 people in NBS (Came from Interior agencies)
75% from USFWS

* They are science based, non-advocacy for management.

MONDAY JUNE 20

12:30-17:30 **TRADE SHOW AT NAU FIELD HOUSE**

13:30-17:30 **POINT-COUNTERPOINT DEBATE SERIES** (Cline Library)
"Conservation Genetics and Fish Stocking Policies"
Moderator: Jim Martin, Oregon Department of Fisheries and Wildlife
Speakers will include Marty Jennings, Dave Philipp, Gary Carmichael, and Bruce Schmidt

18:00-22:00 **SOUTHWESTERN BUFFET AND SOCIAL** (North Dining Hall)

TUESDAY JUNE 21

8:00-17:00 **REGISTRATION AND TRADE SHOW AT NAU FIELD HOUSE**

8:00-11:30 **FISHERIES ACTION NETWORK DEVELOPMENT AND IMPLEMENTATION COMMITTEE MEETING** (Oak Creek Room, University Union)
Chair, Dale Burkett

8:00-12:00 **SESSION 1,** Southwestern Aquatic Ecosystems and Native Fishes (Cline Library)

8:00-12:00 **SESSION 2,** Ecosystem Management in Regulated Rivers (Havasupai & Oak Creek Room, University Union)

12:00-14:00 **BUSINESS MEETING AND AWARDS LUNCHEON** (North Dining Hall)

14:20-17:00 **SPECIAL WORKSHOP - USE OF SOCIOECONOMICS IN FISHERIES APPLICATIONS** (Havasupai Room, University Union)
Moderator: Lisa Tripp, Southwick & Associates
Speakers: Drs. Peter Fricke and Leroy Hushak, AFS Socioeconomics Section

14:20-17:00 **SESSION 3,** Ecosystems Management and Urban Streams & Lakes (Cline Library)

18:00-22:00 **TRADE SHOW SOCIAL AND RAFFLE** in NAU Field house

WEDNESDAY JUNE 22

8:00-12:10 **SESSION 4,** Large River Ecosystems: The Rio Grande, Colorado, New Mexico, and Mexico (Cline Library)

8:00-10:50 **SESSION 5,** Surveys and Techniques (Havasupai Room, University Union)

11:00-12:00 **SPECIAL MEETING ON CULTURAL DIVERSITY IN THE WESTERN DIVISION** (Havasupai Room, University Union) Moderator: Judy Gordon, AK Chapter

13:20-17:10 **SESSION 6,** Large River Ecosystems: Colorado River, Glen Canyon, Arizona (Cline Library)

13:20-16:50 **SESSION 7,** Western Riverine and Reservoir Ecosystems (Havasupai Room)

THURSDAY JUNE 23

8:00-11:50 **SESSION 8,** Biology and Management of Western Salmonids (Cline Library)

8:00-12:00 **TRADE SHOW**

12:00-13:00 **LUNCHEON, LOCAL ARRANGEMENTS AND BUDGET PERSONNEL** (location TBA)

Got his PhD in 1982 and it took him three years to get over it.

Stock transfer: Moving different stock of a species into an area that contains another stock.

Session 1-8

Titles of papers and speakers

TUESDAY JUNE 21 Morning

CONCURRENT SESSION I: SOUTHWESTERN AQUATIC ECOSYSTEMS AND NATIVE FISHES

SESSION CHAIR: W.L. Minckley
SESSION BUILDING: Cline Library

8:00-8:20 **EFFECTS OF PERTURBATION OF THE VIRGIN RIVER, AZ-NV-UT, ON GENETICS OF NATIVE FISHES**
Ross Timmons (student) [pg.42]

8:20-8:40 **INTER- AND INTRASPECIFIC RELATIONSHIPS OF THE FLANNELMOUTH SUCKER (*CATOSTOMUS LATIPINNIS*) BASED ON mtDNA**
Angela Hutchinson (student) [pg.28]

8:40-9:00 **QUANTIFICATION OF SEXUAL DIMORPHISM IN RAZORBACK SUCKER (*XYRAUCHEN TEXANUS*)**
Christopher Reimus (student) [pg.37]

9:00-9:20 **MOVEMENTS AND HABITAT SELECTION OF REINTRODUCED RAZORBACK SUCKERS (*XYRAUCHEN TEXANUS*) AND COLORADO SQUAWFISH (*PTYCHOCHEILUS LUCIUS*) IN THE VERDE RIVER, ARIZONA**
Robert Clarkson, Edward Creef, and Debra McGuinn-Robbins [pg.20]

9:20-9:40 **PATTERNS OF GENETIC VARIATION IN THREE CYPRINID FISHES NATIVE TO THE SOUTHWESTERN UNITED STATES**
C.A. Tibbets (student) and T.E. Dowling [pg.42]

9:40-10:10 BREAK

10:10-10:30 **GENETIC VARIATION WITHIN AND AMONG POPULATIONS OF THE LITTLE COLORADO SPINEDACE**
C.A. Tibbets (student), A.C. Weibel, and T.E. Dowling [pg.41]

10:30-10:50 **VARIANCE IN FISH POPULATIONS OF ARAVAIPA CREEK, ARIZONA, AND ITS IMPLICATIONS IN MANAGEMENT DECISIONS**
Anthony Velasco (student) [pg.43]

10:50-11:10 **BIOTIC AND ABIOTIC FACTORS INFLUENCING THE USE OF BACKWATERS AND ASSOCIATED MAINCHANNEL BEACHFACES BY JUVENILE NATIVE FISHES IN THE COLORADO RIVER, GRAND CANYON, ARIZONA**
Timothy Hoffnagle, William Persons, Glenn Doster, and Martin Tuegel [pg.27]

11:10-11:30 **EFFECTS OF INORGANICS FROM IRRIGATION DRAINWATER ON THE ENDANGERED RAZORBACK SUCKER AND BONYTAIL IN THE MIDDLE GREEN RIVER**
S.J. Hamilton and K.J. Buhl [pg.26]

11:30-11:50 **EFFECTS OF GREEN SUNFISH ON THE DISTRIBUTION AND ABUNDANCE OF GILA CHUB IN SABINO CREEK, ARIZONA**
Robert Dudley (student) and William Matter [pg.23]

TUESDAY JUNE 21 Morning

CONCURRENT SESSION II: ECOSYSTEM MANAGEMENT IN REGULATED RIVERS

SESSION CHAIR: William Trush
SESSION BUILDING: University Union--Havasupai Room

8:00-8:20 **OPENING COMMENTS: ECOLOGICAL HEALTH OF RIVERS BELOW DAMS**
William Trush

8:20-8:40 **PRESERVING BIOLOGICAL HABITAT BELOW DAMS: A GEOMORPHIC IMPERATIVE**
Frank Ligon

8:40-9:00 **COTTONWOODS AND DAMS: CAN THEY COEXIST?**
Mike Merigliano

9:00-9:20 **THE ILLUSION OF GEOMORPHIC STABILITY: IMPLICATIONS FOR RESEARCH AND MONITORING OF RIPARIAN HABITAT**
Brian Cluer

9:20-9:40 **FLOWS REQUIRED TO MAINTAIN COTTONWOOD COMMUNITIES ON THE UPPER MISSOURI RIVER**
Greg Auble and Mike Scott

9:40-10:10 BREAK

10:10-10:30 **MAINTAINING DYNAMICS OF STEEP BEDROCK RIVERS: IMPLICATIONS FOR CHANNEL MORPHOLOGY AND BIOLOGICAL COMMUNITIES**
Scott McBane and Wes Smith

NO ABSTRACTS AVAILABLE ON PAPERS ABOVE

10:30-10:50 **VERIFYING PREDICTIONS OF FISH POPULATION AND PRODUCTION CHANGES IN REGULATED COLD WATER STREAMS**
Samuel Williamson and R. Barry Nehring [pg.46]

10:30-12:00 **PANEL DISCUSSION**

TUESDAY JUNE 21 Afternoon

CONCURRENT SESSION III: ECOSYSTEM MANAGEMENT AND URBAN STREAMS & LAKES

SESSION CHAIR: Mike Ward
SESSION BUILDING: Cline Library

14:20-14:40 **URBANIZATION EFFECTS ON STREAM HABITAT AND FISHES AND OPTIONS FOR RESTORATION AND PROTECTION IN KING COUNTY, WASHINGTON, USA**
Gino Lucchetti and Robert Fuerstenberg [pg.30]

14:40-15:00 **BIOLOGICAL ASSESSMENT AND PRELIMINARY DESIGN FOR RESTORATION OF A REACH OF FANNO CREEK, TUALATIN BASIN, OREGON**
Michael Bonoff, Paul Tappel, and Kevin Malone [pg.17]

15:00-15:20 **BACK FROM OBLIVION: THE CASE OF JOLLY GIANT CREEK**
George Allen, Ph.D. [pg.14]

15:20-15:50 BREAK

15:50-16:10 **ARIZONA'S URBAN FISHING PROGRAM - LAKE MANAGEMENT CHALLENGES AND OPPORTUNITIES**
Eric Swanson [pg.40]

16:10-16:30 **URBAN CREEK RESTORATION PROJECTS IN THE EAST SAN FRANCISCO BAY**
Dennis O'Connor, A.L. Riley, and Reggie Archie [pg.35]

WEDNESDAY JUNE 22 Morning

CONCURRENT SESSION IV: LARGE RIVER ECOSYSTEMS: THE RIO GRANDE, COLORADO, NEW MEXICO, AND MEXICO

SESSION CHAIR: David Propst
SESSION BUILDING: Cline Library

8:00-8:20	**AN OVERVIEW OF THE FISHES AND HISTORY OF THE RIO GRANDE BASIN** Steven Platania [pg.36]
8:20-8:40	**NATIVE FISH FAUNA OF THE RIO GRANDE IN COLORADO: CHANGES AND CAUSES** Thomas Nesler and David Langlois [pg.34]
8:40-9:00	**RIO GRANDE CUTTHROAT TROUT: DECLINE AND RECOVERY OF A NATIVE SALMONID** David Cowley, Ph.D., Michael Hatch, and Bill Stumpff [pg.21]
9:00-9:20	**FISHES OF STENOTHERMAL HABITATS OF THE RIO GRANDE BASIN** Clark Hubbs [pg.27]
9:20-9:40	**DISTRIBUTION PATTERNS OF RIO GRANDE FISHES** Steven Platania [pg.35]
9:40-10:10	BREAK
10:10-10:30	**CHANGES IN THE NATIVE FISH FAUNA OF THE MIDDLE PECOS RIVER, NEW MEXICO** James Brooks and Nathan Allan [pg.17]
10:30-10:50	**NON-NATIVE FISHES AND THEIR IMPACTS UPON NATIVE FISH COMMUNITIES; THE PECOS RIVER AS A CASE STUDY** D.L. Propst and A.L. Hobbes [pg.37]
10:50-11:10	**THE HISTORY AND FUTURE OF FISHES IN THE DEVILS RIVER AND SAN FELIPE CREEK** Gary Garrett [pg.24]
11:10-11:30	**FISHES OF THE LOWER RIO GRANDE (RÍO BRAVO DEL NORTE), TEXAS AND MÉXICO** Robert Edwards [pg.23]
11:30-11:50	**FISHES OF THE MEXICAN TRIBUTARIES OF RIO GRANDE** Salvador Contreras-B., M.L. Lozano-V., and M.E. García-R. [pg.21]
11:50-12:10	**COMPLEXITY OF AQUATIC ECOSYSTEM MANAGEMENT ILLUSTRATED BY DECLINE OF RIO GRANDE SILVERY MINNOW, *HYBOGNATHUS AMARUS*** Kevin Bestgen (student) and Steven Platania [pg.15]

WEDNESDAY JUNE 22 Morning

CONCURRENT SESSION V: SURVEYS AND TECHNIQUES

SESSION CHAIR: Jim Cooper
SESSION BUILDING: University Union--Havasupai Room

8:00-8:20 **CAPTURE AND REARING WILD RAZORBACK SUCKER LARVAE TO MAINTAIN GENETIC DIVERSITY AT LAKE MOHAVE**
Thomas Burke [pg.18]

8:20-8:40 **A SYSTEM FOR ESTIMATING ENTRAINMENT OF ORGANISMS INTO WATER DIVERSIONS**
Richard Grost and Linda Prendergast [pg.25]

8:40-9:00 **HEAVY METAL CONTAMINATION OF AQUATIC FOOD CHAIN ORGANISMS IN THE UPPER SACRAMENTO RIVER**
Michael Saiki, Daniel Castleberry, and Barbara Martin [pg.38]

9:00-9:20 **EVALUATION OF FIELD ELECTROFISHING-INDUCED SPINAL INJURIES IN LARGEMOUTH BASS *(MICROPTEROUS SALMOIDES)* IN MITTRY LAKE**
Cliff Schleusner (student) and O. Eugene Maughan [pg.39]

9:20-9:40 **ELECTROFISHING: THE USE OF INDUCED EPILEPSIES TO CAPTURE FISH**
Norman Sharber [pg.40]

9:40-10:10 BREAK

10:10-10:30 **"THE ARIZONA ANGLER:" A REVIEW OF TRENDS FROM THE 1986, 1989 AND 1992 STATEWIDE ANGLER SURVEYS**
Todd Pringle [pg.36]

10:30-10:50 **HABITAT UTILIZATION BY FISHES OF THE SAN BERNARDINO NATIONAL WILDLIFE REFUGE**
Ronnie Maes (student) and O. Eugene Maughan [pg.31]

WEDNESDAY JUNE 22 Afternoon

CONCURRENT SESSION VI: LARGE RIVER ECOSYSTEMS: COLORADO RIVER, GLEN CANYON, ARIZONA

SESSION CHAIR: Dave Wegner
SESSION BUILDING: Cline Library

13:20-13:40 **THE NATIVE FISH COMMUNITY IN THE GRAND CANYON: A FOREGONE LOSS OR A RECOVERABLE FISHERY**
Dave Wegner [pg.45]

13:40-14:00 **LIMNOLOGY AND LOWER TROPHIC LEVELS OF THE COLORADO RIVER: FROM LAKE POWELL THROUGH THE GRAND CANYON**
Michael Yard, Larry Stevens, Dean Blinn, Joe Shannon [pg.47]

14:00-14:20 **HISTORICAL PERSPECTIVES OF THE DEVELOPMENT OF THE NATIVE FISH ASSEMBLAGES IN THE COLORADO RIVER WITH SPECIAL EMPHASIS ON THE GRAND CANYON**
Charles Minckley [pg.33]

14:20-14:40 **RECOMMENDATIONS FOR OPERATION OF GLEN CANYON DAM AS A TOOL FOR MANAGEMENT OF NATIVE FISHES**
Dennis Kubly, Rob Clarkson, Owen Gorman, Paul Marsh, Rich Valdez [pg.29]

14:40-15:00 **LIFE HISTORY AND ECOLOGY OF NATIVE FISHES IN THE COLORADO RIVER, GRAND CANYON, ARIZONA**
Anthony Wasowicz, Rich Valdez, William Masslich, William Liebfried, Brian Cowdell [pg.44]

15:00-15:30 BREAK

15:30-15:50 **TRANSPORT AND FATE OF EARLY LIFE STAGES OF NATIVE FISHES IN GRAND CANYON, ARIZONA**
Rob Clarkson, Tim Hoffnagle, Tony Robinson [pg.20]

15:50-16:10 **POPULATION ESTIMATES AND POPULATION MOVEMENTS OF *GILA CYPHA*, AN ENDANGERED CYPRINID FISH IN THE GRAND CANYON REGION OF ARIZONA**
Michael Douglas and Paul Marsh [pg.22]

16:10-16:30 **HABITAT USE BY NATIVE FISHES IN THE LITTLE COLORADO RIVER AND OTHER TRIBUTARIES OF THE COLORADO RIVER IN THE GRAND CANYON**
Owen Gorman and Stuart Leon [pg.24]

16:30-16:50 **NON-NATIVE FISH INTERACTIONS IN THE COLORADO RIVER, GRAND CANYON: WHAT WILL THE FUTURE HOLD?**
William Liebfried and Ben Zimmerman [pg.29]

16:50-17:00 **THE FUTURE OF NATIVE FISH IN GRAND CANYON**
Rich Valdez [pg.43]

WEDNESDAY JUNE 22 Afternoon

CONCURRENT SESSION VII: WESTERN RIVERINE AND RESERVOIR ECOSYSTEMS

SESSION CHAIR: Tom Burke
SESSION BUILDING: University Union--Havasupai Room

13:20-13:40 **ROLE OF BASIN-WIDE FISH MOVEMENT IN POPULATION RESPONSE TO HABITAT ENHANCEMENT**
Charles Gowan (student) and Kurt Fausch [pg.25]

13:40-14:00 **FISH COMMUNITIES AND AQUATIC HABITAT OF THE PURGATOIRE RIVER AND ITS TRIBUTARIES IN SOUTHEASTERN COLORADO: ANALYSIS OF CHANGES OVER A DECADE**
Samuel Lohr (student) and Kurt Fausch [pg.30]

14:00-14:20 **URBAN LAND USE EFFECTS ON SALMONID HABITAT--A BASIN-WIDE PERSPECTIVE**
Elizabeth Ablow, John Knutzen, Bruce Stoker, and Clayton Antieau [pg.13]

14:20-14:40 **FISHERY RESPONSES TO SEDIMENT SLUICING IN THE WIND RIVER ON THE WIND RIVER INDIAN RESERVATION, WYOMING**
Lee Bergstedt (student) and Eric Bergersen [pg.14]

14:40-15:00 **LOWER COLORADO RIVER BASIN NATIVE FISH MANAGEMENT PLAN WITH EMPHASIS ON "BIG-RIVER FISHES", A U.S. FISH AND WILDLIFE PERSPECTIVE**
Charles Minckley [pg.32]

15:00-15:30 BREAK

15:30-15:50 **THE REOPERATION OF NAVAJO DAM, AN "ECOSYSTEM APPROACH" TO FISHERIES AND WATER MANAGEMENT IN THE SAN JUAN RIVER**
Lief Ahlm [pg.13]

15:50-16:10 **RELATIONSHIPS AMONG PISCIVOROUS SPORTFISH, PREY AND ANGLER EFFORT AT TWO SOUTHWESTERN WARM-WATER RESERVOIRS**
Debra Salmela (student) and Richard Cole [pg.39]

16:10-16:30 **NATURAL ORGANIC LOADING AND ABUNDANCE OF HERBIVOROUS FISH AT TWO SOUTHWESTERN RESERVOIRS**
Mark Herzog (student) and Richard Cole [pg.26]

16:30-16:50 **A PILOT PROGRAM TO IMPLEMENT ECOSYSTEM MANAGEMENT BY THE BUREAU OF LAND MANAGEMENT IN IDAHO WITH EMPHASIS ON WATERSHEDS AND AQUATIC RESOURCES**
Allan Thomas [pg.41]

THURSDAY JUNE 23 Morning

CONCURRENT SESSION VIII: BIOLOGY AND MANAGEMENT OF WESTERN SALMONIDS
SESSION CHAIR: Jerry Stefferud
SESSION BUILDING: Cline Library

8:00-8:20 **CATCH RATES AND RETURN OF APACHE TROUT IN STREAMS OF THE FORT APACHE INDIAN RESERVATION, ARIZONA**
Derald DeClay and Kelly Meyer [pg.22]

8:20-8:40 **APACHE TROUT MANAGEMENT: NEW APPROACHES USING GENETICS, HABITAT IMPROVEMENT, REGULATIONS, AND FISH CULTURE**
Gary Carmichael, James Hanson, James Novy, Kelly Meyer, Donald Morizot [pg.19]

8:40-9:00 **APACHE TROUT MANAGEMENT: THE ROLE OF FINE SEDIMENT IN STREAMS**
John Rinne [pg.38]

9:00-9:20 **THE EFFECTS OF LIVESTOCK GRAZING ON GOLDEN TROUT *ONCORHYNCHUS MYKISS AGUABONITA* AND THEIR NATIVE HABITAT ON THE GOLDEN TROUT WILDERNESS, CALIFORNIA**
Roland Knapp and Kathleen Matthews [pg.28]

9:20-9:40 **APACHE TROUT AS A SPORTS FISH ON THE FORT APACHE INDIAN RESERVATION, ARIZONA**
Kelly Meyer, Daniel Parker, Stuart Leon, James Hanson, and Robert David [pg.32]

9:40-10:10 BREAK

10:10-10:30 **DIEL MOVEMENT AND HABITAT USE OF GOLDEN TROUT, *ONCORHYNCHUS MYKISS AGUABONITA*, IN NATIVE STREAMS OF THE GOLDEN TROUT WILDERNESS, INYO NATIONAL FOREST**
Kathleen Matthews [pg.31]

10:30-10:50 **DIEL AND SEASONAL MOVEMENT AND HABITAT USE BY COLORADO RIVER CUTTHROAT TROUT**
Michael Young [pg.48]

10:50-11:10 **A GENETIC EXAMINATION OF HYBRIDIZATION BETWEEN COLORADO RIVER CUTTHROAT TROUT AND RAINBOW TROUT IN THREE HIGH ALTITUDE STREAMS IN THE UINTA MOUNTAINS**
Catherine Bischoff (student) [pg.16]

11:10-11:30 **ROLE OF SALMON CARCASSES IN MAINTAINING STREAM PRODUCTIVITY: RESULTS OF A TEST FOR DIRECT CONSUMPTION OF CARCASSES BY JUVENILE COHO SALMON, STEELHEAD AND CUTTHROAT TROUT**
Peter Bisson, Robert Bilby, and Brian Fransen [pg.16]

11:30-11:50 **ROLE OF COHO SALMON CARCASSES IN MAINTAINING STREAM PRODUCTIVITY: EVIDENCE FROM NITROGEN AND CARBON STABLE ISOTOPE ANALYSIS**
Robert Bilby, Brian Fransen, and Peter Bisson [pg.15]

ALPHABETIC LISTING OF

ABSTRACTS BY AUTHOR

URBAN LAND USE EFFECTS ON SALMONID HABITAT – A BASIN-WIDE PERSPECTIVE

Elizabeth A. Ablow, John A. Knutzen, Bruce A. Stoker, Clayton J. Antieau

Enserch Environmental
10900 NE 8th St.
Bellevue, WA 98004

ABSTRACT

Extensive urban development occurring in the Pacific Northwest is directly impacting freshwater habitat and thus the productivity and success of the freshwater life stages of salmonids. May Creek, a tributary to Lake Washington, has been impacted by timber harvest, truck farming, gravel mining, livestock grazing and urbanization which has directly altered its ability to support salmonid production. Historically, chinook, coho, sockeye salmon and steelhead trout utilized the May Creek basin. A Basin Plan is being developed that evaluates past, current, and future watershed problems and identifies actions to improve fisheries habitat. An interdisciplinary approach has been applied to evaluate how development has degraded fish habitat. A fish habitat inventory utilizing Global Positioning (GPS), rainfall-runoff modeling, hydraulic modeling, water quality modeling, wetland inventory and Geographic Information Systems (GIS) were used to develop a comprehensive picture of the basin and identify trends in salmonid habitat degradation. Development in the basin has increased water runoff, sediment erosion, and mass wasting. This combined with significant loss of large woody debris supply, loss of riparian vegetation, and dredging of channels has directly impacted aquatic habitat conditions. As a result, habitat diversity in the stream has been reduced. Recommendations are currently being developed for stream habitat and basin management improvements. Restoration of functional riparian buffer zones will be a high priority for habitat improvements.

THE REOPERATION OF NAVAJO DAM, AN "ECOSYSTEM APPROACH" TO FISHERIES AND WATER MANAGEMENT IN THE SAN JUAN RIVER

Lief Ahlm

New Mexico Department of Game and Fish
P.O. Box 6355
Navajo Dam, NM 87419

ABSTRACT

The San Juan River was impounded by Navajo Dam in 1962, permanently altering the river's hydrograph. This alteration has been linked to the decline of the endangered Colorado squawfish and Razorback sucker in the river. It is also responsible for the creation of one of the most popular tailwater trout fisheries in the west as well as one of the largest reservoir sport fisheries in New Mexico. In 1991, Section 7 consultation over additional water development in the San Juan basin called for the reoperation of the dam to mimic a natural hydrograph. Prior to 1992, dam operation was typified by moderate fall-winter releases and low spring flows directed at maximizing storage while preventing spilling. Since 1992, reoperation has resulted in high spring releases during runoff provided for by fall and winter storage. Recent studies indicate that the reoperation of the dam may prove to be beneficial for the tailwater and lake sport fisheries as well as for the endangered fishes for which it was directed.

BACK FROM OBLIVION: THE CASE OF JOLLY GIANT CREEK

George H. Allen, Ph.D.

Professor Emeritus Fisheries
Fisheries-Aquaculture Consultant to City of Arcata

ABSTRACT

This paper describes the progress and constraints to the reestablishment of self-sustaining populations of anadromous salmonids in a virtually destroyed small urban drainage located entirely within the city limits of Arcata, Humboldt County, northern coastal California. Dams, diversions, logging, industrialization, lumber mills, university development, highway construction, and urban growth has forced most of the creek into ditches, channels, and underground culverts by the early 1950's. Use of the estuary of the creek as a point-of-capture of returning adult coho salmon, chinook, salmon, and steelhead trout from smolts reared in an experimental wastewater-seawater pond located at the city's sewage treatment plant began focusing public attention on the stream. Land acquisition by the city along the creek allowed development of fish trapping and artificial spawning beds. Subsequently three major development projects favorable to salmonids that have been recently completed will be described. Non-point urban pollution during smolt out-migration is probably the limiting factor to self-sustaining runs and is currently one of the major concerns of the city's water quality management program.

FISHERY RESPONSES TO SEDIMENT SLUICING IN THE WIND RIVER ON THE WIND RIVER INDIAN RESERVATION, WYOMING

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ABSTRACT

A two-year study was conducted in the Wind River on the Wind River Indian Reservation, Wyoming to determine the effects of sediment sluicing operations at a lowhead diversion dam on the fishery resources. Sluicing resulted in dramatic increases in suspended solid pulses that could be followed 90 km downstream. Increased salmonid movement below the dam was attributed to the sluicing operations. A necropsy-based assessment of fish health showed significant signs of stress in mountain whitefish (*Prosopium williamsoni*) downstream of the dam. Salmonid condition indices were always lower in the sluiced area than upstream of the dam. Omnivorous feeders, generalist spawners, and tolerant species increased significantly below the dam indicating habitat degradation.

COMPLEXITY OF AQUATIC ECOSYSTEM MANAGEMENT ILLUSTRATED BY DECLINE OF RIO GRANDE SILVERY MINNOW, *HYBOGNATHUS AMARUS*

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ABSTRACT

The poorly known conservation status and biology of Rio Grande fishes is illustrated by endemic Rio Grande silvery minnow, *Hybognathus amarus*. Although Rio Grande *Hybognathus* was regarded as distinct from widespread congeners as early as 1971, official recognition was not until the late 1980's. Systematic revisions prompted reevaluation of *H. amarus* distribution. Prior to 1960, *H. amarus* was widespread throughout the Rio Grande Basin, but is presently restricted to the Rio Grande in central New Mexico, occurring in < 10% of its original range. Dams have dissected rivers and changed discharge and temperature regimes. Channelization and non-native plant species altered stream geomorphology. Introduction of congeneric plains minnow, *Hybognathus placitus*, into the Pecos River, New Mexico before 1964 resulted in hybridization, competition, and extirpation of *H. amarus* there. Conservation strategies for *H. amarus* may require an ecosystem perspective because of connectedness of life history traits with broad scale habitat features. For example, plains stream fishes such as *H. amarus* may require highly fluctuating flows and contiguous riverine habitat in order to successfully reproduce. Implementation of ecosystem-level conservation strategies may be ineffective until cryptic species are recognized and the distribution and biology of Rio Grande fish assemblages are better elucidated.

ROLE OF COHO SALMON CARCASSES IN MAINTAINING STREAM PRODUCTIVITY: EVIDENCE FROM NITROGEN AND CARBON STABLE ISOTOPE ANALYSIS

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ABSTRACT

Nitrogen and carbon (N and C) contained in the eggs and carcasses of Pacific salmon returning to spawn display an isotope ratio distinct from terrestrial sources in forested watersheds. Thus, the proportion of N and C in organisms living in streams contributed by spawning salmon can be estimated by determining the isotope ratios of their tissues. We compared C and N isotopic ratios among small tributaries of the Snoqualmie River in western Washington, with and without anadromous fishes. Samples of coho salmon carcasses and eggs, epilithic organic matter, terrestrial vegetation, invertebrates, and fish were collected seasonally. We found that more than 35% of the N and C in juvenile coho salmon and steelhead originated from spawning fish. The proportion of spawner N and C in cutthroat trout increased with age of the fish, ranging from 20% to 35%. Invertebrates also displayed high levels of marine-derived N and C, with grazers exhibiting values over 30% and shedders, collector/gatherers, and predators containing from 18% to 30% spawner-derived N and C. The proportions of marine N and marine C were very similar for the organisms we analyzed, indicating carcass material is incorporated into the trophic system of the stream in an organic form. Direct feeding on eggs and carcasses and uptake of organic molecules released during decomposition by the streambed substrate are the two primary pathways by which spawner N and C are introduced into the streams's trophic system. Growth rates of juvenile coho salmon doubled followed arrival of adult salmon in the anadromous system we examined. No increase in growth rate of cutthroat trout was observed in those systems inaccessible to salmon.

A GENETIC EXAMINATION OF HYBRIDIZATION BETWEEN COLORADO RIVER CUTTHROAT TROUT AND RAINBOW TROUT IN THREE HIGH ALTITUDE STREAMS IN THE UINTA MOUNTAINS

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ABSTRACT

I examined the extent of non-native salmonid hybridization in three streams in the Uinta Mountains of north eastern Utah. Protein electrophoresis was used to 1) identify diagnostic loci between native Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*) and introduced rainbow trout (*Oncorhynchus mykiss*), 2) examine the extent of hybridization between Colorado River cutthroat trout and rainbow trout in three high altitude streams and 3) identify genetically pure populations of Colorado River cutthroat trout.

I identified marker loci between pure hatchery populations of Colorado River cutthroat trout and rainbow trout. Individual and population hybrid indices were developed for each stream and sampling point within a stream. I found a significantly higher proportion of individuals with rainbow trout alleles in the lower reaches of study streams than in the upper reaches. Pure populations of Colorado River cutthroat trout were identified.

ROLE OF SALMON CARCASSES IN MAINTAINING STREAM PRODUCTIVITY: RESULTS OF A TEST FOR DIRECT CONSUMPTION OF CARCASSES BY JUVENILE COHO SALMON, STEELHEAD AND CUTTHROAT TROUT

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ABSTRACT

To test the hypothesis that juvenile salmonids feed on the remains of spawned-out salmon during a time of year when food is scarce, we experimentally added chum salmon carcasses to portions of an experimental channel adjacent to Big Beef Creek, a small stream in western Washington. The channel was partitioned into three sections: (1) a control, which contained no carcasses and was not exposed to any dissolved or particulate matter originating from carcasses, (2) a section into which 16 carcasses were placed – 4 in riffles and 12 in pools, and (3) a section without carcasses but exposed to carcass leachate, located immediately downstream from the section containing carcasses. Juvenile coho salmon, steelhead, and cutthroat trout, as well as several non-salmonid species, were stocked in each section at approximately equal densities. Salmon carcasses in pools rapidly developed a thick coating of fungus within a week of placement while those in riffles did not; however, carcasses in riffles decomposed more rapidly than those in pools. Bi-weekly stomach samples from salmonids in the carcass treatment section revealed only small amounts of carcass material. Apparently the fungus inhibited carcass consumption in pools, and water in the riffles of the experimental channel was too shallow for feeding. Rapid disappearance of juvenile salmonids from stream sections without carcasses may have been related to avian predation. Far more fish survived the 44-day experiment in the section with carcasses, suggesting that the carcasses themselves may have served as cover from predators in what was an otherwise highly simplified environment. We speculate that salmon carcasses provide a direct food resource to fish only when edible tissue is exposed (as might occur on a partially scavenged carcass), but opportunities for direct feeding are quickly lost as the caracas becomes covered with fungus.

BIOLOGICAL ASSESSMENT AND PRELIMINARY DESIGN FOR RESTORATION OF A REACH OF FANNO CREEK, TUALATIN BASIN, OREGON

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ABSTRACT

A biological assessment was conducted and conceptual plans for water quality and fish habitat enhancement were developed for Fanno Creek, an urban stream in western Multnomah County. The project reach is heavily developed, and within the City limits of Portland, OR. As a Tualatin River tributary, the City of Portland is required to meet total maximum daily loads for phosphorous reduction in Fanno Creek. The primary objective of the project was to develop conceptual design for water quality improvement, bank stabilization, and revegetation of riparian areas. The biological assessment utilized the U.S. EPA Rapid Bioassessment Protocols to assess habitat quality of the creek, in comparison to a reference stream of known higher quality. A variety of physical characteristics of the creek were measured to provide a habitat quality score, in comparison to the reference stream. Fisheries and macroinvertebrate surveys were also conducted.

CHANGES IN THE NATIVE FISH FAUNA OF THE MIDDLE PECOS RIVER, NEW MEXICO

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ABSTRACT

The ecosystem of the middle Pecos River in New Mexico has undergone drastic, man-induced changes over the past century. Water impoundments for agricultural uses and flood control, irrigation diversions, the complete intrusion of non-native salt cedar (*Tamarix pentandra*), and stream channel incision have resulted in the severe degradation of aquatic habitats. Periodic dewatering, deficient water quality, and erratic, nonnatural flow regimes are indicators of the present conditions on the Pecos River. An analysis of historic fish collections from the 1920's to the present reveals numerous associated changes in the native fish fauna. One native species (*Hybognathus amarus*) has been replaced by a nonnative form (*H. placitus*), apparently more adaptable to altered conditions. Also, the abundance and distribution of the federally threatened Pecos bluntnose shiner (*Notropis simus pecosensis*) has declined significantly since collections from the 1920's and 1930's. Current research efforts involve correlating variable release scenarios from Sumner Dam (and resulting habitat conditions) to specific responses in abundance, distribution, and habitat use by *N. simus* populations, as well as the entire fish community. These data will assist in developing water management strategies designed to accommodate consumptive downstream uses, while ensuring suitable habitat conditions for the native fish community.

CAPTURE AND REARING WILD RAZORBACK SUCKER LARVAE TO MAINTAIN GENETIC DIVERSITY AT LAKE MOHAVE

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ABSTRACT

Over the last decade, the population of razorback suckers (*Xyrauchen texanus*) in Lake Mohave has declined from an estimated 60,000 in 1987 to 47,000 in 1991 to 25,000 today. While the adults spawn and produce larvae, there is no effective recruitment into adulthood. The Native Fish Work Group is working to replace the present population in both quantity and quality, including the tremendous genetic diversity inherent in the extant stock. Work conducted by the NFWG since 1991 has shown that larval razorbacks can be reared to young adults, returned to the lake, and be recaptured at known spawning grounds. During the late winter and early spring 1994, over 10,000 wild razorback sucker larvae were captured from the lake, reared for three weeks in aquariums and transferred to lakeside rearing ponds for grow out. The program is expected to yield 5000 young adults for reintroduction into the lake each year.

APACHE TROUT MANAGEMENT: NEW APPROACHES USING GENETICS, HABITAT IMPROVEMENT, REGULATIONS, AND FISH CULTURE

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ABSTRACT

The Apache trout historically was an important food and sport fish in Arizona. Through introductions of other trouts and habitat loss and degradation the Apache trout became imperiled, was recognized as such in the 1950's by the White Mountain Apache Tribe, and was listed under the Endangered Species Act of 1973. Hybridization of Apache trout with rainbow trout and cutthroat trout has been proven using isozyme locus polymorphisms in aggregate as diagnostics for taxon discrimination. Predation and competition with brown trout and brook trout have been identified as range limiting factors for Apache trout populations. Habitat deterioration due to land use practices and related activities have reduced the amount of habitat that is suitable for Apache trout on part of their range. Previous restoration efforts on Apache trout have had limited success for a number of reasons but have offered insights to allow present and future efforts to have increased chances of success. We are developing a new and revised "recovery plan" that includes new data and should increase Apache trout populations to levels that remove risks of further depletion and extinction as well as provide viable fisheries for anglers. Fisheries management techniques selected evince the technical and complex nature of the recovery effort needed to increase the probability of success. Genetic analyses of various trouts play a central role in Apache trout management and new data are presented. Ecological surveys of the watersheds in the White Mountains were and will be required to determine specific habitat management efforts such as barrier installation, and stream renovation. Hatchery reared Apache trout also play a key role, as do land use regulations. We recommend different levels of habitat and fish use that range from no intentional human use or impact to stocking of exotic fishes and Apache trout in altered habitats. No single management tool is adequate to address the problems faced by Apache trout fisheries biologists.

MOVEMENTS AND HABITAT SELECTION OF REINTRODUCED RAZORBACK SUCKERS (*XYRAUCHEN TEXANUS*) AND COLORADO SQUAWFISH (*PTYCHOCHEILUS LUCIUS*) IN THE VERDE RIVER, ARIZONA

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ABSTRACT

Fifteen sub-adult Colorado squawfish (*Ptychocheilus lucius*) and 24 adult and sub-adult razorback suckers (*Xyrauchen texanus*) were implanted with radiotransmitters and released into the upper Verde River, Arizona, as part of an ongoing reintroduction program for these endangered species in the Gila River Basin. Weekly aerial telemetry flights and ground telemetry surveys were used to collect information on movements and habitat use. Habitat availability was estimated within habitat types and reach-wide to evaluate different scales of habitat selection. Reach-wide, both species used slower current velocities, greater depths, and finer substrates in proportions significantly greater than their availability would suggest. Utilization patterns of microhabitats within habitat types were similar to those in reach-wide comparisons. Squawfish moved a mean absolute distance of 166 m/day, with a net overall upstream movement of 20 m/day. There was a greater tendency for razorbacks to move downstream following stocking (net downstream movement of 60 m/day), and razorbacks moved greater absolute distances per day (204 m) than squawfish. Hourly ground telemetry locations over 24 or 48-hr periods indicated that both species moved significantly greater distances during nighttime hours. The success of reintroductions of adult-sized Colorado squawfish and razorback suckers into the Verde River was equivocal.

TRANSPORT AND FATE OF EARLY LIFE STAGES NATIVE FISHES IN GRAND CANYON, ARIZONA

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ABSTRACT

The Little Colorado River (LCR) and other tributaries are the major sites of reproduction and rearing in Grand Canyon by humpback chub, *Gila cypha*, speckled dace, *Rhinichthys osculus*, bluehead sucker, *Catostomus discobolus*, and flannelmouth sucker, *Catostomus latipinnis*. Successful reproduction in the mainstem Colorado River is largely precluded by year-round low water temperatures. Based on studies in the LCR, native species drift into the mainstem as larvae, and some are transported there by flood events. Fishes that do not succumb to the cold coma upon entering the mainstem inhabit eddy return channel backwaters and other slow velocity nearshore habitats downstream from tributary sites of reproduction. Laboratory temperatures tolerance experiments on humpback chub demonstrated significant growth depression at 10 C (Colorado River temperature) compared to 20 C (LCR temperature). Daily fluctuations in river stage subject fish to drastic changes in current velocity and water temperature by dewatering or submerging backwaters. Weak-swimming larval and post larval fishes accrue additional physiological costs when they are forced to move to other habitats under fluctuating flow conditions. Early life stage fishes that enter the Colorado River from tributaries are expected to experience elevated mortality from a suite of effects related to reduced temperature and instability of habitats. We recommend minimization of daily flow fluctuations in the mainstem and evaluation of water temperature modification to benefit native fishes.

FISHES OF THE MEXICAN TRIBUTARIES OF RIO GRANDE

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ABSTRACT

The Rio Grande Basin, senso stricto, contains at least 131 forms of native continental fishes. The Mexican tributaries, are inhabited by 93 of them, distributed as Río Conchos (38), small basins (20), Río Salado (36 + 2), Cuatro Ciénegas (18), Río Alamo (22), and Río San Juan (46). Endemisms are present, basin wide 1, Río Conchos 15, small basins 3, Río Salado 6 + 2, Cuatro Ciénegas 8, Río Alamo 1, and Río San Juan 4. Endemics are usually punctual (13, single locality; 21, other) and inhabit small springs related to the main streams. Of special interest is the valley of Cuatro Ciénegas, where endemism is high in aquatic biota. Some species are difficult to categorize, given that they nay be both, native and introduced, in different parts of the basins, or be spontaneous invaders of non native areas as a result of impacts favorable to their way of life. Introduced species known are 8, 3, 7, 2, 5, 19, respectively. There are at least 5 undescribed species.

RIO GRANDE CUTTHROAT TROUT: DECLINE AND RECOVERY OF A NATIVE SALMONID

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ABSTRACT

Rio Grande cutthroat trout (RGC) are native to the Rio Grande, Pecos and Canadian River drainages. The present confinement of RGC to small, isolated headwater streams is primarily the result of habitat degradation and adverse interactions with nonnative salmonids. As RGC became confined to isolated streams, population size decreased and substantial within-population genetic variation was lost. A program has been initiated to produce a genetically-heterogeneous broodstock of RGC for augmenting restoration efforts. Goals for annual hatchery propagation include 100,000 fingerlings for wilderness lakes and 25,000 for streams. Broodstock founders will come from genetically pure populations. Gametes will be taken initially from wild fish. Crossbreeding of fish derived from different wild populations will be carried out so that by the 8th year, broodstock replacements will carry genes from 6 wild populations. The breeding program limits the rate of loss of genetic variation to 0.25% per generation in both the hatchery broodstock *and* the wild populations from which broodstock founders are taken.

The breeding program for RGC is one part of an integrated management approach. This program seeks to improve the status of RGC by restoring genetic variation to presumed historic conditions, expanding its distribution, and improving the general biotic integrity of its habitat.

CATCH RATES AND RETURN OF APACHE TROUT IN STREAMS OF THE FORT APACHE INDIAN RESERVATION, ARIZONA

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ABSTRACT

Native Apache trout *Oncorhynchus apache* were stocked in streams on the Fort Apache Reservation. Three areas were stocked with a total of 80,000 eight inch trout from May through August of 1993. Catch rates were 0.80 fish per hour (SE= .084) throughout the summer. Catch rates were higher later in the summer, although not significantly. Catch rates by month were: May (0.56 trout per hour), June (0.79 trout per hour), July (0.94 trout per hour), and August (0.79 trout per hour. Estimated return rate of Apache trout was variable by section (12-30%) and closely related to the amount of angling effort. We also stocked rainbow trout (mean size 400 gms) with Apaches (mean size 100 gms) on July 22 1993, to determine differences in return rates. Rainbow trout returned to the creel higher (48%) than Apache trout (2%) in the first week. After the first week, return rates were similar for rainbows (0.06 fish per hour) and Apache trout (0.03 trout per hour). Apache trout were stocked at small sizes (5 to the pound) and anglers released 34% of trout caught. After examining the results of this study we concluded that stream stocking was an attractive management practice because anglers had high catch rates in summer (catch rates in lakes drop during the summer). Management changes were made to stop stocking trout in streams with poor returns, increase the size of trout stocked and to publicize stream fishing in late summer so anglers would fish streams instead of lakes.

POPULATION ESTIMATES AND POPULATION MOVEMENTS OF *GILA CYPHA* AN ENDANGERED CYPRINID FISH IN THE GRAND CANYON REGION OF ARIZONA

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ABSTRACT

The humpback chub (*Gila cypha*) is restricted to tight, canyon-bound reaches of the Colorado River and its tributaries. This fish reaches greatest abundance in the lower basin of the Colorado, where it reproduces in the Little Colorado River, a tributary of the Colorado River in the northern Grand Canyon. This study was undertaken to define the nature and extent of the chub's movements within the Little Colorado River and to test the hypothesis that duration of stay by the humpback chub within that river is restricted to the reproductive period. During 1991 and 1992, population estimates were derived on a monthly basis from adult *Gila cypha* PIT-tagged within the Little Colorado River. These data indicate an extensive upriver migration by adult chub in early spring. A post-reproduction movement back to the mainstream Colorado River also occurs but is slow and protracted. Similarly, there is strong evidence for localized stasis by adult chub in the Little Colorado River, particularly in summer and autumn. These fish overwinter within the Little Colorado River, then exhibit considerable local movement in spring during the reproductive period. Movement by *Gila cypha* in the Little Colorado River thus appears to be an amalgam of two processes: Upriver spring migration coupled with localized movements by overwintering adults.

EFFECTS OF GREEN SUNFISH ON THE DISTRIBUTION AND ABUNDANCE OF GILA CHUB IN SABINO CREEK, ARIZONA

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ABSTRACT

We are assessing the effects of introduced green sunfish (*Lepomis cyanellus*) on the distribution and abundance of Gila chub (*Gila intermedia*) in Sabino Creek. All size classes of chub were abundant in upstream areas without green sunfish. Small chub (< 50 mm TL) often were absent and larger chub were infrequent in downstream areas containing sunfish. Our underwater observation of microhabitat use in winter revealed that both species were relatively inactive and remained close to or fully concealed in cover provided primarily by interstitial spaces between cobble and boulders. Sunfish and chub rarely occurred together in the same interstitial space. Sunfish appear to be negatively affecting the distribution and abundance of Gila chub, but the mechanism of interaction is unclear. We will conduct predation experiments in instream enclosures and stomach analyses of sunfish to determine the vulnerability of different sized chub to predation by sunfish. We will also remove sunfish from select downstream areas where only larger chub are now present to determine whether YOY chub will be produced and/or persist in these areas.

FISHES OF THE LOWER RIO GRANDE (RÍO BRAVO DEL NORTE), TEXAS AND MÉXICO

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ABSTRACT

Collections of fishes from the lower Rio Grande from over the past 140+ years have indicated two indigenous faunal assemblages. One fauna is upstream, composed of mostly freshwater species, and the other is a downstream assemblage composed of a mixture of the more abundant upstream elements and more estuarine species. Collections in the past decade indicate that major alterations in these fish communities have occurred. The upstream fauna has lost many of its characteristic freshwater components; native freshwater species have been replaced by non-native and estuarine forms. The downstream fauna has many fewer freshwater species with replacement by estuarine and marine species. These faunal changes appear to be correlated with decreasing stream flows, the proliferation of exotic species, and degraded water quality. Recent legislation (NAFTA) and increased cooperation between the U.S. and Mexico, notwithstanding, is expected to do little in the short-term future to reverse these trends.

THE HISTORY AND FUTURE OF FISHES IN THE DEVILS RIVER AND SAN FELIPE CREEK

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ABSTRACT

The Devils River may be Texas' most pristine river and San Felipe Creek originates at one of the largest springs in the state, yet both are indicative of the water problems facing Texas. Approximately one third of the fishes reported from the Devils River are introduced, one native species is already extirpated and six others are federal Category 2. San Felipe Creek is encompassed by a large, metropolitan area, but supports three Category 2 species. Although most of the impact issues are primarily concerned with water quality and quantity, we also must deal with the inherent problems of human access and use. To some, it may seem that precluding human use would be the easiest way to manage ecosystems, however people seldom support things they can not use. Conversely, access allows an opportunity for education and appreciation. Our challenge is to allow and encourage recreational uses that do not jeopardize habitat quality or stability. This area is being closely studied as part of a larger, Section 6 project to determine the status of 10 species of the Chihuahuan Desert region. We seek to determine conservation needs of these species, but also the overall status of the various fish communities and the biological integrity of these systems. What we learn from these studies should provide guidance to federal and state management of these critically important ecosystems.

HABITAT USE BY NATIVE FISHES IN THE LITTLE COLORADO RIVER AND OTHER TRIBUTARIES OF THE COLORADO RIVER IN THE GRAND CANYON

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ABSTRACT

The primary objective of our study was to determine habitat use by the endangered humpback chub (*Gila cypha*) and other native fishes in the Little Colorado River (LCR) in the vicinity of the Grand Canyon. During the day, adult humpback chubs, flannelmouth suckers (*Catostomus latipinnis*), and bluehead suckers (*Catostomus discobolus*) used habitats > 1 m depth with moderate to high cover and substantial vertical structure. At night, these fishes used a wider array of habitat types. In contrast, young-of-year (YOY) fishes and speckled dace (*Rhinichthys osculus*) used more open, shallow habitats and were most active during daylight hours. Adult fishes showed a high degree of habitat segregation. Results of the LCR study will be used as a model to evaluate the potential for habitat in other Grand Canyon tributaries to support additional reproducing populations of humpback chub.

ROLE OF BASIN-WIDE FISH MOVEMENT IN POPULATION RESPONSE TO HABITAT ENHANCEMENT

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ABSTRACT

Results of an 8-yr evaluation of habitat enhancement using log structures to create pools in six Colorado mountain streams showed that resident brook trout (*Salvelinus fontinalis)* and brown trout (*Salmo trutta)* populations increased rapidly and dramatically in 250-m treatment sections versus adjacent controls. However, analysis of recaptures of individually marked trout and direct trapping to measure dispersal indicated that structures increased adult trout populations primarily by influencing fish movement, rather than by increasing growth or *in situ* overwinter survival as reported by others. Research and management of resident stream salmonids has been guided by a paradigm of restricted movement, which states that most fish are relatively sedentary. However, reanalysis of past movement studies revealed that most investigators focused only on recaptured fish found in the reach of origin, a critical design flaw that causes a consistent bias against detecting movement. Operating under the restricted movement paradigm has important implications for the validity of measuring fish production, developing models that predict standing stocks from habitat, and long-term studies of population and community dynamics in defined reaches. Substantial movement also potentially affects the outcome of habitat restoration, special angling regulations, and introduction of hatchery fish, and calls for a watershed management approach.

A SYSTEM FOR ESTIMATING ENTRAINMENT OF ORGANISMS INTO WATER DIVERSIONS

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ABSTRACT

As a component of relicensing for a PacifiCorp hydroelectric project on the North Umpqua River, OR, a series of custom nets was designed to sample diverted flow for estimating the number of fish entrained annually. Once adjusted for site-specific constraints, the nets successfully sampled 100% of the flow through 5 canals and 85% of the flow through 2 submerged penstock intakes. Canals and penstock intakes ranged from 3 to 7 m wide and had maximum flows of 5 to 46 m3/s (170 to 1,600 cfs), velocities of 30 to 270 cm/s (1 to 9 fps) and varying amounts of algae and debris. Diversion sites included large and small storage reservoirs, small in-stream impoundments, and project tailraces. Watersheds ranged from a flashy mountain stream to a stable spring-fed river, and contained brook trout (Salvelinus fontinalis), brown trout (Salmo trutta), and rainbow trout (Oncorhynchus mykiss). Estimated annual entrainment of trout ranged from about 100 to 10,000 fish, mostly juveniles. Other organisms captured included tui chubs (Gila bicolor), crayfish, and amphibians. Entrainment was highly variable among sites, seasons, and time of day; and was related to lunar phases and reservoir drawdowns. Our description of net design, installation, troubleshooting, and operation will assist others investigating fish movement into stream and reservoir diversions.

EFFECTS OF INORGANICS FROM IRRIGATION DRAINWATER ON THE ENDANGERED RAZORBACK SUCKER AND BONYTAIL IN THE MIDDLE GREEN RIVER

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ABSTRACT

The Department of the Interior (DOI) irrigation drainwater investigation of the middle Green River of Utah reported that concentrations of inorganics were sufficiently elevated to be potentially harmful to fish and wildlife. We conducted two 90-day chronic toxicity studies with two endangered fish, one with razorback sucker and the other with bonytail, to determine the effects of exposure to an inorganic mixture (arsenic, boron, copper, molybdenum, uranium, vanadium, selenate, selenite, and zinc) simulating the environmental ratio and concentrations reported in the DOI study for the mouth of Ashley Creek-Stewart Lake outflow on the Green River. Swimup larvae were exposed in a reconstituted water simulating the middle Green River. The mixture was tested at 1X, 2X, 4X, 8X, and 16X where X was the average expected environmental concentration. Razorback suckers had reduced survival after 40 days exposure to the inorganic mixture at 16X and after 60 days at 8X; whereas growth was reduced after 30 days at 8X and after 60 days at 4X. Bonytail had reduced survival after 20 days exposure at 16X, whereas growth was reduced after 60 days at 8X. These studies show that at environmentally realistic concentrations, the inorganic mixture simulating Ashley Creek-Stewart Lake outfall adversely affects larval endangered fish.

NATURAL ORGANIC LOADING AND ABUNDANCE OF HERBIVOROUS FISH AT TWO SOUTHWESTERN RESERVOIRS

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ABSTRACT

Gizzard shad, common carp, and river carpsucker are mostly herbivorous fish found in many warm-water reservoirs where they contribute importantly to sport fish forage. Relationships between herbivorous fish abundance and an estimate of natural reservoir organic loading (primary production plus watershed sources) were examined over an 11-year period at two southwestern warm-water reservoirs located on the Rio Grande and Pecos River in New Mexico. Fish were sampled with research gill nets over a 3-4 day period in summer of each year. The allochthonous organic loading was estimated from lake inflow and tributary concentration of organic matter. Primary production was estimated from a modeled relationship with phosphorus, light transmission, temperature, and lake storage ratio. Herbivorous fish biomass was positively correlated with lake organic loading in years preceding the year when netted fish biomass was measured. The correlation appears to be a consequence mostly of growth and differential reproductive success with greater success in high loading years. Predator biomass contributed positively and weakly to explaining variation in herbivore biomass. Other factors played lesser roles. We concluded that watershed sources of nutrient and organic matter drove forage fish dynamics more so than variation in water level and storage ratio.

BIOTIC AND ABIOTIC FACTORS INFLUENCING THE USE OF BACKWATERS AND ASSOCIATED MAINCHANNEL BEACHFACES BY JUVENILE NATIVE FISHES IN THE COLORADO RIVER, GRAND CANYON, ARIZONA

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ABSTRACT

The use of backwaters and their associated mainchannel beachface habitats by juvenile (larval and young-of-year) native fishes (bluehead sucker {*Catostomus discobolus*}, flannelmouth sucker {*Catostomus latipinnis*}, humpback chub {*Gila cypha*} and speckled dace {*Rhinichthys osculus*}) in the Colorado River, Grand Canyon, was studied over the past three years. Backwaters are important rearing areas for juvenile native fishes in the Colorado River and are also inhabited by exotic species (esp. rainbow trout {*Oncorhynchus mykiss*} and fathead minnow {*Pimephales promelas*}) that may compete with or prey on native species. Abiotic factors (dissolved oxygen, temperature, turbidity, conductivity, pH, velocity, depth and ambient light) were measured at all sites. Biotic factors (densities of benthic invertebrates and plankton) and sediments were measured at five sites, four times per year. The relationship between abiotic and biotic variables and catch-per-unit-effort (CPUE = number of fish / m^2 seined) was examined for native and common exotic species in backwaters and their associated mainchannel beachface habitats. Backwaters were warmer, had less current velocity, turbidity and dissolved oxygen, and finer sediments than the adjacent mainchannel beachface habitat. Preliminary results showed that CPUE for juvenile native fishes was higher in backwaters than mainstem beachfaces. Within each habitat, preliminary analyses did not show a significant relationship between CPUE and abiotic factors.

FISHES OF STENOTHERMAL HABITATS OF THE RIO GRANDE BASIN

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ABSTRACT

Aquatic habitats vary widely in many environmental parameters. Waters emerging from aquifers (= springs) tend to have minimal temperature variations (= stenothermal) especially if the water has been in the aquifer for more than one year. Most spring outflows are within 0.1 o C of the average annual temperature for that area. Although the aquifer may also add other factors: heat, dissolved solids, low dissolved oxygen, high clarity, I will focus on thermal stability. Stenothermal springs tend to be separated from other such springs by discharge streams--these discharge streams tend to approach ambient air temperatures especially with low spring discharge and distance from source. Any organism in stenothermal spring waters will tend to adapt to the stenothermal conditions and be at a competitive disadvantage (i.e. become endangered) with close relatives downstream in more eurythermal streams. Several fishes tend to occupy stenothermal habitats: pupfish (*Cyprinodon*), mosquitofish (*Gambusia*), springfish (*Crenichthys*), Devil's river minnow (*Dionda diaboli*), Proserpine shiner (*Cyprinella proserpina*), and foutain darters (*Etheostoma fonticola*). Case studies from the Rio Grande basin (3 *Cyprinodon*, 3 *Gambusia*, *Dionda diaboli*, and *Cyprinella proserpina*) will be presented.

INTER- AND INTRASPECIFIC RELATIONSHIPS OF THE FLANNELMOUTH SUCKER (*CATOSTOMUS LATIPINNIS*) BASED ON mtDNA

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ABSTRACT

Morphological divergence within *C. latipinnis* has resulted in speculation as to the specific status of some of its forms. Fifteen restriction enzymes with 6-base recognition sequences were used to analyze variation among five populations from the Colorado River basin, including two populations of the putative Little Colorado River sucker (*Catostomus* sp.). Three other species were analyzed as geographically nearest relative (*C. insignis*) and outgroups (*C. ardens, C. commersoni*) to *Catostomus* sp. Restriction maps were constructed to establish homologous sites among populations analyzed. Data suggest little genetic differentiation among *C. latipinnis* populations. MtDNA of *Catostomus* sp. does not differ significantly from that of *C. latipinnis*.

THE EFFECTS OF LIVESTOCK GRAZING ON GOLDEN TROUT *ONCORHYNCHUS MYKISS AGUABONITA* AND THEIR NATIVE HABITAT ON THE GOLDEN TROUT WILDERNESS, CALIFORNIA

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ABSTRACT

The purpose of our study was to quantify channel morphology, fish habitat quality, and native golden trout population structure in stream reaches inside and outside of four livestock exclosures in the Golden Trout Wilderness, Inyo National Forest. Stream morphology and habitat quality parameters included channel and stream width, bankfull height, bank overhang, water depth and velocity, water temperature, substrate size, and density of riparian vegetation. Density and biomass of golden trout populations were quantified using standard multiple-pass depletion electrofishing. Stream morphology and habitat quality were generally markedly different inside and outside of cattle exclosures, and changes inside exclosures were consistent with those expected under recovery from livestock grazing. Stream reaches inside exclosures generally were narrower and deeper, and had greater bank overhangs and riparian vegetation densities than reaches outside of exclosures. Density and biomass of golden trout were higher inside than outside of exclosures, but these differences were not statistically significant. The statistical power of our analyses to detect differences was weakened by large spatial variation in fish density and biomass within each stream reach. We conclude that streams in the Golden Trout Wilderness are being degraded by current levels of livestock grazing. In addition, to better understand the nature of the impacts on fish populations, much greater emphasis must be placed on developing rigorous sampling and statistical methods that maximize the possibility of detecting these impacts.

RECOMMENDATIONS FOR OPERATION OF GLEN CANYON DAM AS A TOOL FOR MANAGEMENT OF NATIVE FISHES

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ABSTRACT

Closure of Glen Canyon Dam in 1963 and subsequent operation of the facility altered flows, water temperatures, and sediment transport dynamics in the downstream Colorado River. These changes resulted in severe impacts to the native big-river fishes in Grand Canyon and exacerbated existing effects of introduced fishes. We contend that the preservation of remnant native species and the success of any attempts to restore the predam ichthyofauna depend on a return to environmental conditions approximating those present in the evolutionary history of this community. A protracted period, measured in generations of these long-lived fishes, likely will be necessary for the restoration process. Under existing water temperature and sediment regimes, we recommend modifications of dam releases that (1) minimize daily flow fluctuations, (2) adjust seasonal hydrology to parallel the natural predam patterns, and (3) deliver controlled floods to help maintain a favorable balance between native and introduced fishes. Modifying the dam to effect seasonal increases in water temperature and adopting a mechanism for sediment augmentation could provide further advantages to native fishes, while allowing more flexibility in operations. Increased flexibility in operations and successful implementation of adaptive management are necessary to use the dam as a truly effective tool to manage native fishes and the other natural, recreational, and economic resources identified as benefactors of this multiple-use structure.

NON-NATIVE FISH INTERACTIONS IN THE COLORADO RIVER, GRAND CANYON: WHAT WILL THE FUTURE HOLD?

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ABSTRACT

Non-native fish interactions are an important component in the management in native fishes in the Southwest today. This paper will discuss the specific issues related to non-native fish interactions in the Colorado River in Grand Canyon. Before Glen Canyon Dam was constructed a suite of warmwater fishes, dominated by channel catfish and carp likely competed with and preyed upon native fishes. After Glen Canyon Dam closed the warmwater non-natives were replaced by stocked cold-water forms, dominated by rainbow trout (*Onchoryhnchus mykiss*). Both the native and warm water exotics were negatively affected by the hypolimnetic releases from Glen Canyon dam. Recent research indicates predation on the humpback chub (*Gila cypha*) in the Colorado River by brown trout (*Salmo trutta*). Fewer native fish were also preyed upon by channel catfish (*Ictalurus punctatus*) and rainbow trout. Striped bass (*Morone saxatilis*) were observed making seasonal migrations from Lake Mead into western Grand Canyon during periods of warmer river temperatures.

The impact of present non-native fish management, with specific reference to the trout fishery and potential implications for future native and non-native fish management, such as temperature modifications, flooding with habitat stabilization will be discussed.

FISH COMMUNITIES AND AQUATIC HABITAT OF THE PURGATOIRE RIVER AND ITS TRIBUTARIES IN SOUTHEASTERN COLORADO: ANALYSIS OF CHANGES OVER A DECADE

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ABSTRACT

Data on the fish communities and aquatic habitat of the Purgatoire River and its tributaries have been collected at the U.S. Army Pinon Canyon Maneuver Site, Colorado, to assess the effects of mechanized infantry training and flow regime on aquatic resources. Aquatic surveys were conducted during three periods, which included pretraining (1983-1984), recent post-training (1987-1989), and current post-training (1993-1994) intervals. The fish community of the Purgatoire River was depauperate, and consisted of 11 native species widely distributed in the Great Plains region. Two to three species (red shiner, flathead chub, and longnose dace) consistently comprised over 90% of the individuals captured at 12 survey sites. Common carp was collected at two sites in fall 1993 and was the first instance that an exotic species was collected in the study area. Persistence of the fish community, based on species presence/absence at 12 river sites sampled during fall 1983, 1987, and 1993, was low due to the sporadic occurrence of rare species; however, fish community persistence was high for the entire study reach. The most dramatic change in species composition since 1983 has been an abrupt decline in the abundance of red shiner at all river sites. Species distribution relative to flow regime and habitat in tributaries will be discussed.

URBANIZATION EFFECTS ON STREAM HABITAT AND FISHES AND OPTIONS FOR RESTORATION AND PROTECTION IN KING COUNTY, WASHINGTON, USA

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ABSTRACT

Urbanization results in dramatic modifications in watershed hydrology, riparian conditions, water quality, and structural complexity and stability of stream channels. Streams once characterized by hydraulically complex pool and riffle mosaics become dominated by extended riffle habitats and water quality is changed at both the chronic and acute scales. Habitat characteristics may ultimately be shifted beyond the adaptive capabilities of some fishes to favor those that are adapted to the relatively small, simple hydraulic patches and flashy hydrologic extremes that result in streams affected by urbanization. Cutthroat trout and sculpins dominate small urbanizing streams of western King County, replacing coho and steelhead as the historically dominant species. Options for protection and restoration are being evaluated through a basin planning process and are directed at protecting or restoring the balance between hydrologic and hydraulic forces which originally created the environment for coho production. A gradient of conditions, ranging from intact healthy systems to those which are severely degraded with little or no hope of biologically meaningful recovery, is being considered in allocating limited funds for restoration.

HABITAT UTILIZATION BY FISHES OF THE SAN BERNARDINO NATIONAL WILDLIFE REFUGE

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ABSTRACT

The San Bernardino National Wildlife Refuge was purchased as a refuge for the endangered fishes of the Rio Yaqui drainage in Mexico and the United States. Little information exists on the habitat requirements of the Rio Yaqui species. We are studying microhabitat utilization of Yaqui chub (*Gila purpurea*), Yaqui topminnow (*Poeciliopsis occidentalis sonoriensis*), and beautiful shiner (*Cyprinella formosa*) in three ponds and one stream (Leslie Creek) on the refuge. Snorkeling was used to determine depth, substrate, and velocity (in the stream) of areas used by each species. Yaqui topminnow tended to occupy the upper portion of the water column in ponds, but have not been observed in the stream. Beautiful shiner tended to occupy mid-depths in the water column of ponds, but do not occur in the stream. In the ponds, Yaqui chub tend to occupy the bottom portion of the water column, usually just above or within submerged aquatic vegetation. In the stream they tend to occupy the mid to lower portions of the water column in pools with little or no velocity. No preference for substrate has been detected for any of the species.

DIEL MOVEMENT AND HABITAT USE OF GOLDEN TROUT, *ONCORHYNCHUS MYKISS AGUABONITA*, IN NATIVE STREAMS OF THE GOLDEN TROUT WILDERNESS, INYO NATIONAL FOREST

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ABSTRACT

Golden trout, the California state fish, have long been recognized for their unique beauty and restricted distribution in the southern high Sierra. However, little is known about their behavior or habitat requirements. In the 1960s, there was concern about the viability of golden trout because of introduced non-native fishes and their native habitat was overgrazed and degraded; non-native fishes were eradicated. Little work, however, has been directed towards understanding golden trout behavior or habitat requirements in areas being restored. In this study, we radio tagged 23 golden trout to determine their diel habitat use and movement behavior in the Ramshaw meadows on the upper South Fork of the Kern River. Ramshaw meadows is one area where golden trout were re-established after the eradication of non-native fish and cattle exclosures were also constructed. In our tracking study from September 9-19, 1993, golden trout were active both day and night. They were most frequently observed in pools with either sedge *Carex spp.* or undercut banks. Most golden trout remained stationary although several long distance movements (> 100 m) were initiated at about 2200 hrs and ended when the fish returned to their original location at daylight. This research is the first radio tracking study of golden trout in their native habitat and the results will be used to assess restoration efforts and critical habitat requirements.

APACHE TROUT AS A SPORTS FISH ON THE FORT APACHE INDIAN RESERVATION, ARIZONA

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ABSTRACT

Recently, there have been a lot of initiatives to bring back native trout and use them as sports fish. A review of recent fisheries management on Fort Apache Reservation is useful in looking at the effects of a native trout policy. Native Apache trout *Oncoryhynchus apache* were stocked on Fort Apache Reservation in a wholesale manner as both subcatchable, catchable, and trophy fish in Summer of 1991. Results of this management were mixed. Apache trout were successful in meeting fisheries management objectives in streams, as 8 inch subcatchables in lakes, and as a trophy fish. Apache trout did not meet objectives as 3 inch subcatchables, 8 inch subcatchables when stocked at high densities in lakes, or 8 inch catchables in lakes. Advantages of using native trout were: anglers had a high interest in trophy fishing, and fish survived well in streams and some lakes. Disadvantages of using native trout were: high mortality at small sizes, poor catch rates in lakes, poor growth in lakes, and unavailability of desired trout sizes. Our results suggest that using native trout has benefits but may not meet all fisheries management objectives. We recommend that fisheries managers use a conservative approach (with adequate monitoring) when implementing native trout in a sports fishery.

HISTORICAL PERSPECTIVE OF THE DEVELOPMENT OF THE NATIVE FISH ASSEMBLAGES IN THE COLORADO RIVER WITH SPECIAL EMPHASIS ON THE GRAND CANYON

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ABSTRACT

Distribution of the native fishes of Grand Canyon is presented and discussed from a historical and current perspective. A basic scenario of how and where the fish lived in the habitat will be presented. Reasons for the decline throughout the basin and Grand Canyon are presented and ways to enhance current populations or reestablish and manage endangered and extirpated species in the Grand Canyon are presented.

LOWER COLORADO RIVER BASIN NATIVE FISH MANAGEMENT PLAN WITH EMPHASIS ON "BIG-RIVER FISHES", A SERVICE PERSPECTIVE

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ABSTRACT

No comprehensive management plan exists for threatened and endangered fishes in the lower Colorado River basin. Plans currently under implementation for "big-river" species in the upper basin USFWS Region VI, do no satisfy lower basin needs due to major differences in conditions and circumstances. Because of this absence of attention, endangered status of the taxa, their regional extirpation or small population sizes, and continuing threats to their existence in the lower basin, USFWS Region II has determined that such a plan is necessary. The following presentation discusses the draft plan currently under development by USFWS Region II for "big river" fishes and presents the rationale for its development. It also provides current research pertaining to how the initial steps in such a management plan can be implemented in the lower Colorado River Basin.

TECHNICAL DEMONSTRATION OF THE MULTIFAN APPROACH TO INFER THE AGE AND GROWTH STRUCTURE OF A TAILWATER RAINBOW (*ONCORHYNCHUS MYKISS*) FISHERY FROM LENGTH-FREQUENCY DATA: GLEN CANYON DAM (LAKE POWELL), COLORADO RIVER, LEE'S FERRY

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ABSTRACT

Of the potential problems that face fisheries investigators, perhaps the most serious is an inability to assign correct age-classes to the cohorts that comprise a fishery. These inabilities may stem from experimental flaws or may represent true biological phenomenon. For example, previous attempts to age tailwater rainbow trout (*Oncorhynchus mykiss*) from Lee's Ferry with otoliths and scales apparently proved unsuccessful, possibly due to the release of hypolimnial water from Lake Powell which remains relatively constant (8.4 to 10.4 °C). From April 1984 to September 1993, length-frequency samples were collected by electrofishing for >21,000 rainbow trout from Lee's Ferry, Colorado River. To gain insight on the age and growth structure of this tailwater fishery, the temporal length-frequency data was subjected to analysis by the MULTIFAN approach. MULTIFAN is a non-linear approach that can describe length-frequency data with a robust maximum likelihood procedure. For rainbow trout in Lee's Ferry, I modeled from five to 11 different age classes each with varying combinations of Brody's growth coefficient (K in von Bertalanffy's equation) and with or without length dependent standard deviations. The model suggests rainbow trout in Lee's Ferry exhibit slow growth and contain a mixture of perhaps 5+ age classes. Estimates of the Brody growth coefficient ranged from K=0.468 to K=0.160 and the estimated asymptotic lengths ranged from L_∞=670 to L_∞=860. In summary, it appears that the MULTIFAN model for rainbow trout in Lee's Ferry produced biologically reasonable results.

NATIVE FISH FAUNA OF THE RIO GRANDE IN COLORADO: CHANGES AND CAUSES

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ABSTRACT

Fishes in the Rio Grande River in Colorado were described as early as the end of the 18th century, and by the end of the 19th century were already impacted by early settlers through dewatering, irrigation, siltation, and fish culture activities. Similar to many major rivers, the headwaters of the Rio Grande form a rapid transition zone from coldwater lakes and streams to the desert-like floodplain of the San Luis Valley near the Colorado-New Mexico border. As part of its geologic past, the north end of the valley was formed into a closed basin, and the river's fish community is affected by geothermal artesian wells and springs, playa lakes, ephemeral streams, oxbows and wetland marshes, as well as man-made reservoirs, farm ponds, and irrigation canals. Only 10 fish species are native, while 29 species have been introduced. Another 13 species known to be native to the lower Rio Grande have not been observed in the upper river. Three other species documented as likely inhabitants of the Rio Grande in historic times were extirpated long before the 20th century. One species, the Rio Grande sucker, is State-listed as endangered. Three other species are listed as special concern. Due to the geothermal waters in the basin, an abundance of exotic tropical fishes and cichlids survive and spread through escapement from commercial aquaculture and the aquarium pet industry. Similar to all western states, water is a limited and valuable commodity whose development will take precedence at the expense of wildlife resource values. Comprehensive conservation planning in concert with agricultural and water development interests is necessary to meet wildlife resource management goals. The threat of federal intervention through endangered species listing should compel a cooperative program of resource use planning among competing interests.

URBAN CREEK RESTORATION PROJECTS IN THE EAST SAN FRANCISCO BAY AND CRUW

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ABSTRACT

Since 1987, urban creek restoration projects have been installed in the East San Francisco bay in the cities of Oakland, Berkeley, Richmond and Pinole. These projects located represent a wide range of urban stream restoration technologies including innovative flood control project designs, soil bioengineering, unusual gabion bank stabilization techniques, crib wall design, riparian revegetation, wetland restoration and stream channel recreation. Local citizen participation in the design, implementation and fund raising, monitoring and maintenance of these projects is responsible for the continued success of these projects. Other groups have assisted the implementation of these restoration projects including the Urban Creeks Council of California, the California Department of Water Resources' Stream Restoration Grant Program and the local Youth Conservation Corps (YCC). The Coalition to Restore Urban Waterways (CRUW) has been formed to promote successful urban stream restoration projects at a national level. This national network of diverse grassroots groups works with local communities to address the unique values, opportunities, and issues of urban waterways. The CRUW recognizes that urban waterways form an important link between the environment, the economy, recreation, and neighborhood identity. The Coalition provides its partners with information sharing; technical assistance; promotion of economic opportunities; assistance with funding; a forum for collaboration; and opportunities for environmental education, community awareness, and environmental stewardship.

DISTRIBUTION PATTERNS OF RIO GRANDE FISHES

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ABSTRACT

Hydrologic regimes and physical habitat barriers in the Rio Grande basin produced conditions that support unique ichthyofaunal communities. At least 125 species of fishes have been reported from the Rio Grande and its principal tributaries, the Pecos and Devils rivers and the Rio Conchos. Distributional patterns of mainstem Rio Grande fishes suggest that there are currently at least seven distinct ichthyofaunal reaches, many of which are bounded by large mainstem impoundments. Severe disruptions of the uppermost warmwater fish community, located in New Mexico's Middle Rio Grande, have led to the extirpation of seven species where there were previously at least 18. Similarly, shifts in fish communities between Elephant Butte Reservoir and the mouth of the Rio Conchos (Presidio) reflect channelization and dewatering. The most species-rich portions of the Rio Grande are between Big Bend and Falcon Reservoir, where at least 40 native species are found. Several species that are common in the Big Bend reach (Presidio to Amistad Reservoir) are rare or absent between Amistad and Falcon Reservoirs. The ichthyofaunal communities in the lowermost section (Falcon Dam to Boca Chica), formerly comprised primarily of indigenous freshwater species, are now dominated by estuarine and marine species.

AN OVERVIEW OF THE FISHES AND HISTORY OF THE RIO GRANDE BASIN

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ABSTRACT

The Rio Grande is the fifth longest river in North America, flowing 3,036 km from its headwaters in Colorado's San Juan Mountains to Boca Chica at the Gulf of Mexico. Along its course the Rio Grande drains over 637,000 km^2 of the Chihuahuan Desert. Tributaries in the basin are widely-spaced, and flow in many reaches can be non-existent for long periods of time. Principal tributaries to the lower Rio Grande are the Rio Conchos (Mexico), Pecos River (United States), Devils River (United States), Rio Salado (Mexico), and Rio San Juan (Mexico).

The first scientific collection of fishes from the Rio Grande was made in 1851 by John H. Clark, a naturalist assigned to the United States and Mexican Boundary Commission. Subsequent government surveys in the late 1800s yielded additional fish collections throughout the basin. These works, along with publications in the late-1800s and early-1900s by S.F. Baird, E.D. Cope, B.W. Evermann, C. Girard, W.C. Kendall, S.E. Meek, A.J. Woolman, H.C. Yarrow, comprise the historic data on the Rio Grande's ichthyofaunal communities.

"THE ARIZONA ANGLER:" A REVIEW OF TRENDS FROM THE 1986, 1989 AND 1992 STATEWIDE ANGLER SURVEYS

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ABSTRACT

The Fisheries Branch of the Arizona Game and Fish Department (AGFD) conducted Statewide Angler Surveys in 1986, 1989 and 1992 for the purpose of gathering baseline data and to develop Strategic Plans. These surveys are an ongoing Responsive Management effort by the AGFD to better understand the angling public and to detect any changes or trends in this user group.

Estimated angler user days have fluctuated slightly from 7.0 million in 1986 to 7.2 million in 1989 with the average of 7.1 million in 1992. Large inland reservoirs, such as Roosevelt lake, are used by anglers the most followed by small mountain lakes. The Colorado river reservoirs are the third most popular water type used by anglers. The mean number of days fished has increased since 1986 from 17.5 to 22.8 in 1992 while the Departments fishing license sales have declined. This reflects the loss of the 'occasional' angler. The most preferred fish species is rainbow trout (38%), followed by, in descending order, largemouth bass, channel catfish and striped bass.

The 'typical' Arizona angler has aged since 1986 from a 36 year old male to a 39 year old indicating a loss of younger anglers. Females constitute 24% of the angling population, with a median age of 36 in 1986 and 40 in 1992.

NON-NATIVE FISHES AND THEIR IMPACTS UPON NATIVE FISH COMMUNITIES; THE PECOS RIVER AS A CASE STUDY

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ABSTRACT

The Pecos River system in New Mexico historically supported about 37 fish species, the richest and most diverse ichthyofauna of the five major drainages in the state. Currently, 34 native fish species persist but the range and abundance of most have declined since the 1930's. Within the same timeframe, at least 26 non-native fish species were introduced and established. Introductions were to develop or enhance sports fisheries, to provide additional forage species, to control aquatic vegetation, or as baitfish (accidental and intentional). Changes in fish communities, whether measured as declines in abundance of individual species, disruption of "natural" community or population dynamics, trophic or ecological shifts, or elimination of individual elements have resulted from an array of anthropogenic modifications of the river system. For most changes for which human-induced disruption is at least partially responsible, apportionment of the relative importance of habitat modification versus interaction with non-native fish species is difficult. In some situations the issue is how much effect habitat modification had in altering conditions to the benefit of non-native forms and the detriment of native forms. Data are sufficient in several situations to characterize the impacts of non-natives on native fish communities and in others reasonable conjectures can be made about the role of non-natives. The decline of at least five native species (*Oncorhynchus clarki virginalis, Hybognathus amarus, Ictalurus lupus*, and *Cyprinodon pecosensis*) is partially attributable to establishment of non-native species. Hybridization as a causative factor is usually readily apparent (e.g., native trout and introduced *Oncorhynchus mykiss*), but in some instances may be less so (e.g., native *Hybognathus amarus* and introduced *H. placitus*). If the interaction is via predation or competition, the evidence is typically less obvious and certainly less quantifiable. Demonstrating competition (particularly from field studies) is tentative at best and must be considered within the context of modified habitats. Among introduced fishes of the Pecos River, three non-piscivorous species (*Hybognathus placitus, Notropis girardi*, and *Phenacobius mirabilis*) have caused or may contribute to the decline of congeners and ecological equivalents. The modes of potential interaction vary among species and demonstration of competition derives from circumstantial evidence and similarity of life history strategies. Several speculative, but congruent with available data, scenarios are proposed to explain changes in the native ichthyofauna of the Pecos River.

QUANTIFICATION OF SEXUAL DIMORPHISM IN RAZORBACK SUCKER (*XYRAUCHEN TEXANUS*)

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ABSTRACT

Catostomid fishes commonly exhibit marked sexual dimorphism in size and shape of fins and other body parts, coloration, and pattern or density of nuptial tubercles. Razorback suckers are unique among catostomids in having a large, pronounced predorsal keel, shich is sometimes considered a dimorphic character most strongly developed in breeding males. I measured various morphometric features on a sizeable sample to determine ontogenetic and sexual variance in this structure, and quantified in addition a number of other features already known to differ markedly between adult males and females.

APACHE TROUT MANAGEMENT: THE ROLE OF SUBSTRATE FINE SEDIMENT

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ABSTRACT

Fine sediment and fishes were sampled during 1993 on Centerfire and Boggy Creeks, Apache Sitgreaves National Forest, Arizona. Analyses of preliminary data indicate both substantial amounts and linear patterns of fine sediments (< 2 mm) in both streams. Numbers and biomass of the native Apache trout *Oncorhynchus apache* and speckled dace *Rhinichthys osculus* vary linearly and suggest inverse and direct relations, respectively, to sediment levels. Laboratory raceway experiments examining fine sediment effects on Apache trout egg development and fry emergence were conducted. Preliminary results suggest that significant reduction in fry emergence results as percentage fines increase.

HEAVY METAL CONTAMINATION OF AQUATIC FOOD CHAIN ORGANISMS IN THE UPPER SACRAMENTO RIVER

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ABSTRACT

This study was designed to determine if aquatic food chains in the Upper Sacramento River near Redding, California, have been contaminated by heavy metals. The metals enter the river in acidic runoff from an EPA Superfund Site (Iron Mountain Mine). During July-September 1990, we sampled water, sediment, detritus, aquatic plants, benthic invertebrates, and fishes from the Sacramento River and from reference sites on nearby tributary streams that received no acid-mine drainage. Compared to reference sites, the Sacramento River sites contained elevated concentrations of copper ($\leq$200 μg/g dry weight in midge larvae), cadmium ($\leq$23 μg/g dry weight in mayfly nymphs), and zinc ($\leq$1,700 μg/g dry weight in mayfly nymphs). None of the metals showed evidence of biomagnification (a progressive increase in concentration from one trophic level to the next higher level). Judging from published information on toxic concentrations of metals in fish diets, salmonids (specifically, rainbow trout) should not experience metal toxicity even if they foraged exclusively on invertebrates from the Sacramento River. However, other fishes (e.g., common carp, channel catfish) might exhibit reduced growth, feed conversion, or other sublethal effects from copper or zinc toxicity if they consumed detritus, plants, and invertebrates from the river.

RELATIONSHIPS AMONG PISCIVOROUS SPORTFISH, PREY AND ANGLER EFFORT AT TWO SOUTHWESTERN WARM-WATER RESERVOIRS

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ABSTRACT

Relationships among prey, piscivores, and angler effort and harvest were examined in a 10-year record of fish abundance and angler effort at Sumner and Caballo reservoirs in New Mexico. Fish relative biomass was randomly sampled each year by fishing research gill nets during summer months under similar lake conditions each year of study. Angler use and harvest were estimated through a statewide mail survey. The piscivorous sportfish in both lakes were white bass, walleye, largemouth bass, spotted bass (in Sumner) and large white crappie. Gizzard shad was the prominent forage fish, which also included carp, warm-water suckers, and small centrarchids, catfish, white bass and walleye. Piscivore biomass and prey biomass were positively correlated. Fishing pressure (angler days/hectare) and harvest were negatively correlated with piscivore sportfish biomass. Multiple-regression analysis indicated that both forage availability and angler effects explained over half of the variation in piscivore biomass while water level fluctuation, storage ratio, and other possible causal factors played less important roles, perhaps partly because of compensatory fingerling stocking. Results suggest that water-level management may not be as significant as factors controlling forage abundance, including watershed runoff of nutrient and organic matter.

EVALUATION OF FIELD ELECTROFISHING-INDUCED SPINAL INJURIES IN LARGEMOUTH BASS (*MICROPTEROUS SALMOIDES*) IN MITTRY LAKE

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ABSTRACT

Little information is available on the effects of electrofishing on the health of warm water fish. We captured largemouth bass from Mittry Lake (about 29 km north of Yuma Arizona) by electrofishing and examined them for incidence of spinal injury. A Coffelt electrofishing boat was used with a modified Mark-22 control unit. The output for fish collection was 60 Hz, DC square-wave, with a 2-msec pulse-width. The anode was a stainless steel, 38-in Wisconsin Ring with 10 droppers. Fish were frozen, x-rayed, then partially thawed and necropsied. Spinal injury was evaluated using the ranking criteria developed by Reynolds (1992). X-rays were scored (0-3) from no spinal damage/ compression of vertebrae/ misalignment and compression/ to fracture or separation of vertebrae. Necropsies were scored (0-3) from no hemorrhage apparent/ mild hemorrhage (separate from spine)/moderate hemorrhage (width of two vertebrae)/ to severe hemorrhage (> width of two vertebrae). Preliminary data have shown no indication of spinal injury.

ELECTROFISHING: THE USE OF INDUCED EPILEPSIES TO CAPTURE FISH

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ABSTRACT

Electric fields induce epileptic events in animals from amoebae to humans. Three generalized types of seizures are recognized in vertebrates: 1) automatisms, 2) petit mal, and 3) grand mal. The symptoms of these seizures are 1) automatic patterns of movements that are species specific; 2) sleep, muscle flaccidity, and apnea and; 3) sleep, tonic-clonic contractions, tetany, and apnea. These epilepsies occur progressively as the intensity of the shock (chemical, light, electric, e.g.) increases. Compression fractures of vertebrae are seen in 40% to 50% per cent of the animals and humans that have incurred a petit mal or grand mal seizure. Spinal injuries occur during myoclonic jerks (brief simultaneous contractions of paired myotomes on either side of the spinal column). These symptoms appear to equate with activities and trauma of fish seen while electrofishing: automatisms = electrotaxis; petit mal = narcosis; grand mal = tetany; myoclonic jerks = contractions of the white muscles along the fish's spine. Current research confirms that 40% to 75% of rainbow trout suffer compression fractures of the spine when they are captured by electrofishing. An understanding of this paradigm has contributed to the design of electrofishing equipment that has reduced the incidence of injury in rainbow trout from about 50% to 8%.

ARIZONA'S URBAN FISHING PROGRAM - LAKE MANAGEMENT CHALLENGES AND OPPORTUNITIES

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ABSTRACT

The Arizona Game and Fish Department Urban Fishing Program has grown over the past 12 years to include 12 urban lakes and partnerships with six cities. Over 500,000 angler days are provided annually on these 112 total surface acres. Every-other week stockings of catchable rainbow trout (November to March) and channel catfish (April to October) provide local recreational opportunity to meet high angler demand. Recent groundwater management legislation in Arizona, coupled with municipal efforts towards water reuse, is affecting water supplies to urban lakes. These water supply changes require management actions to resolve problems associated with reduced inflows and increased use of reclaimed water. Aquatic habitat manipulation and enhancement activities must balance between objectives for fishery, parks and recreation, and public safety management. Simultaneous to these emerging issues and constraints on urban lakes are an increasing public awareness and sensitivity to aquatic ecosystem restoration with associated funding opportunities for fishery and wildlife resource enhancements.

A PILOT PROGRAM TO IMPLEMENT ECOSYSTEM MANAGEMENT BY THE BUREAU OF LAND MANAGEMENT IN IDAHO WITH EMPHASIS ON WATERSHEDS AND AQUATIC RESOURCES

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ABSTRACT

The Bureau of Land Management (BLM) in Idaho has defined Ecosystem Management as "A State of Mind and a Style of Management." In February 1993, we began a proactive approach to focus our goals and objectives on the concept of Ecosystem Management. All Idaho BLM employees are involved. Fifteen teams examined specific processes and made suggestions. Proposed improvements include (1) a streamlined Budget Implementation Team, (2) an Ecoregion Core Team to support management activities, (3) an Ecosystem Sciences Team to provide technical support, (4) Conversion of present boundaries to four "ecosystems", (5) development of trained, interdiscipline teams, and (6) establish procedures to monitor activities and measure improvements.

The four top priorities facing Idaho BLM are all related to watersheds and aquatic resources. These priorities are (1) PACFISH, (2) management of sensitive ecosystems, (3) Snake River water rights adjudication, and (4) riparian management. The recovery of the endangered Snake River sockeye salmon and the threatened fall and spring/summer chinook salmon and the removal of threats to candidate species, such as bull trout and redband trout, are major efforts in our management activities. Ecosystems are designed along watershed drainages boundaries. We propose establishing ecoregional boundaries rather than within states. We would seek to manage BLM resources in the Columbia River Drainage.

GENETIC VARIATION WITHIN AND AMONG POPULATIONS OF THE LITTLE COLORADO SPINEDACE

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ABSTRACT

The Little Colorado spinedace, *Lepidomeda vitatta*, is a cyprinid fish historically found throughout the Little Colorado River drainage in Arizona. This species has declined in recent years and is currently found only in three regions (Chevelon and East Clear crocks, and the upper Little Colorado River). Patterns of genetic variations within and among remaining populations will provide information essential to the successful management of this species.

Results from mitochondrial DNA and allozyme surveys indicate considerable population structure, with most variation found among samples. The distribution of variation suggests that there are three distinct populations within the Little Colorado River drainage, and all of these populations should be maintained to conserve genetic variation in this species.

PATTERNS OF GENETIC VARIATION IN THREE CYPRINID FISHES NATIVE TO THE SOUTHWESTERN UNITED STATES

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ABSTRACT

Patterns of genetic variation were examined in three species of cyprinid fishes native to the lower Colorado River drainage. These species occupied similar historical ranges, and presumably have been affected by similar geological and climatic events. Due to recent anthropogenic affects, ranges of all three species have been fragmented due to habitat alteration, although two of them (*Meda fulgida* and *Tiaroga cobitis*) have been affected more severely than the third (*Agosia chrysogaster*). Pattern of variation within and among populations of these species should be similar, but may be affected by intrinsic differences such as dispersal capabilities, habitat specificity, and/or reproductive characteristics. Results from mitochondrial DNA and allozyme surveys show variation within *M. fulgida* and *T. cobitis* follows drainage patterns, suggesting little gene flow among rivers. Levels of divergence from both data sets indicate populations within rivers are unique, and represent evolutionarily independent lineages. In contrast, mitochondrial DNA and allozyme data for *A. chrysogaster* suggest the presence of one large, panmictic population within the upper Gila River drainage.

EFFECTS OF PERTURBATION OF THE VIRGIN RIVER, AZ-NV-UT, ON GENETICS OF NATIVE FISHES

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ABSTRACT

Accidental poisoning of a substantial reach of the Virgin River, AZ-NV-UT in 1988 drastically reduced populations of both native and non-native fishes. Analyses of allozymes of three native species indicate substantial and coincidental alteration in allele frequencies. The present report tracks the dynamics of genetic change as populations reestablished following the event.

THE FUTURE OF NATIVE FISHES IN GRAND CANYON

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ABSTRACT

Five of eight Colorado River native fish species remain in Grand Canyon following more than a century of land-use malpractice, dams and diversions, chemical pollutants, and introduction of large numbers of non-native species. Endangered humpback chub (*Gila cypha*) remain as one of only six reproducing populations in existence, while endangered razorback sucker (*Catostomus latipinnis*), bluehead sucker (*C. discobolus*), and speckled dace (*Rhinichthys osculus*) are low in numbers in the mainstem Colorado River, with reproduction and higher numbers in warm tributaries. Colorado squawfish (*Ptychocheilus lucius*), roundtail chub (*G. robusta*), and bonytail (*G. elegans*) have been extirpated from this region of the Colorado River Basin.

The future of native fishes in Grand Canyon is not favorable for restoring the pre-1850 fish assemblage. Anthropogenic changes are too extensive and pervasive to permit recovery of the former ecosystem and associated biological, chemical, and physical linkages, and therefore concomitant reinstatement of the native ichthyofauna. Recognition of new environmental dynamics and equilibria is vital to understanding possible and accomplishable levels of species recovery. The recovery is dependent on identifying and alleviating limiting factors imposed by construction and operation of Glen Canyon Dam, hydrographic and chemical changes in tributaries, and invasion of large numbers of native fishes. A Native Fishes Recovery Plan is recommended, with specific objectives, detailed management actions, and target timelines. Long-term monitoring, core research, and adaptive management are essential to provide a continuing perspective of species demography, population trajectories, and efficacy of management actions. These elements, and the recovery plan must consider the entire ichthyofauna of the Grand Canyon ecosystem, and strive to achieve a balanced native/non-native fish assemblage, concomitant with a new set of environmental equilibria created by past and ongoing anthropogenic actions.

VARIANCE IN FISH POPULATIONS OF ARAVAIPA CREEK, ARIZONA, AND ITS IMPLICATIONS IN MANAGEMENT DECISIONS

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ABSTRACT

Trends of decline and extirpation in Southwestern fish populations has over time catalyzed field studies resulting in management decisions. Yet, populations continue to decline, indicating either the misinterpretation or incorrect interpretation of field data or a pattern of ineffectual agency decisions. Field data often represent short-term studies. Analyses of fish population fluctuations in Aravaipa Creek were conducted using short-term and long-term datasets. Variance is described in respect to location, time, and species composition, followed by a discussion of the need to consider population variance in management applications

LIFE HISTORY AND ECOLOGY OF NATIVE FISHES IN THE COLORADO RIVER, GRAND CANYON, ARIZONA

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ABSTRACT

Four of eight fish species native to the Colorado River in the Grand Canyon remain as small, fragmented populations or aggregations in the 300-mile reach from Glen Canyon Dam to Pearce Ferry, including humpback chub (*Gila cypha*), flannelmouth sucker (*Catostomus latipinnis*), bluehead sucker (*C. discobolus*), and speckled dace (*Rhinichthys osculus*). Cold hypolimnetic dam releases limit reproduction by these warmwater species primarily to warm tributaries. Of approximately 28,200 fishes captured by BIO/WEST as part of the Glen Canyon Environmental Studies (GCES), from October 1990 through November 1993, 41 percent were natives, and 59 percent were non-natives, consisting of 12 introduced species. Non-native rainbow trout (*Onchorhynchus mykiss*) were the most common species (39% of total number), while humpback chub (22%) and flannelmouth sucker (10%) were second and third most abundant. Endangered razorback sucker (*Xyrauchen texanus*) were not captured. The endangered humpback chub occurred as a self-sustaining population in the lower 14 km of the Little Colorado River (LCR) and a 30-km reach of the mainstem Colorado River around the LCR inflow. Eleven other aggregations of pre-adults and adults were identified in association with warm tributary inflows, tepid springs, or suitable habitat. Small mainstem numbers of flannelmouth and bluehead suckers, particularly young, indicated low reproductive success and a population dominated by adults, dependent on warm tributaries for spawning and nursery habitat. Adults were found primarily near tributary inflows, with decreasing abundance longitudinally downstream. Speckled dace were common throughout, with aggregation in tributary inflows and tepid springs.

Adult humpback chub occupied primarily large eddy complexes (85% captures and 80% radiocontacts), which formed only 20 percent of available mainstem habitat, while the majority of subadults were found along talus and vegetated shorelines and in eddy return channels, indicating a transition in habitat use from shoreline to offshore habitats at 175-200 mm TL, or 2-3 years of age. Adults showed a high fidelity for specific river reaches: 69 radiotagged adults moved an average of 1.5 km from first to last contact over an average of 93 days, with the majority of movement during spawning migration to the LCR (February-May) and from the LCR after spawning (June-July). Prolonged turbidity from floods in the LCR limited mainstem abundance and condition of rainbow trout below the confluence and probably served as cover for native fishes during feeding and against predation. Flannelmouth and bluehead suckers were caught sympatrically with adult humpback chub in swift habitats (i.e., eddy interfaces, runs, riffles) and near tributary inputs, while speckled dace were associated with juveniles along sheltered shorelines and tributary inflows. Adult humpback chub after primarily simuliids (62% by volume), *Gammaruss lacustris* (24%), midges (13%), and annelid worms, terrestrial insects, and algae (1%), in approximate proportion to drift material. Non-native fishers represent a serious through to native fishers in Grand Canyon, with documented predation by brown trout (*Salmo trutta*), channel catfish (*Ictalurus punctatus*), and rainbow trout. Diet overlap between humpback chub and non-natives also indicates completion.

THE NATIVE FISH COMMUNITY IN THE GRAND CANYON A FOREGONE LOSS OR A RECOVERABLE FISHERY? AN OVERVIEW

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ABSTRACT

The native fish of the Colorado River through Grand Canyon National Park are in peril. The future of the native fish is being debated between legions of technical experts, decision makers and lawyers representing the Federal agencies, the Colorado River Basin states, power interests, environmentalists, resource managers, and development groups from throughout the West. Today the native fish in the Colorado River are at a crossroads and our activities over the next ten years will be critical to their long-term survival. Without scientific input, the ability to understand the ecosystem and develop a technically sound recovery strategy will not be possible.

This presentation provides the background information that defines the present state of the native fish community relationships and the background information essential to placing the present situation into context. The geomorphology and hydrology of the pre- and post-human impact on the river system and specifically the Grand Canyon will be defined. From this, the relationship of the basin constraints and their impact on the aquatic habitats and functional activities of the native fish community will be explored. With the pre-dam ecosystem as a background, the fragmentation and destruction of the aquatic habitats caused by the development of the Colorado River will be discussed. The anthropogenic impacts associated with the development of the Colorado River basin provides the basis for interpretation of the results from the Glen Canyon Environmental Studies native fish research program in the Grand Canyon.

Prior to human intervention, Colorado River basin supported a unique fish assemblage that developed specific characteristics and morphology to match river system dynamics. The future of the native fish species are now intrinsically linked to the activities of man and his management of the river system. It is imperative that we understand the past in order to put into context the future options and probability of sustaining this native fish community assemblage for the future.

VERIFYING PREDICTIONS OF FISH POPULATION AND PRODUCTION CHANGES IN REGULATED COLD WATER STREAMS

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ABSTRACT

We are in the process of predicting and verifying typical stream physical habitat and fish population conditions in weekly time steps for use in improved annual flow scheduling and long-term reservoir management planning. We have completed construction and calibration of an early life-stage fish population and production model for the Trinity River based on assumptions related to physical habitat, water temperature, and seasonal factors. The available population data for the Trinity River was recognized by our river system experts to be deficient for even a moderate level of confidence in quantitative predictions and also that further work in another river basin would be needed to elucidate other life stages. The Trinity River of northern California and Gunnison River of western Colorado have different salmonid species and life stages present, but one model (with appropriate input data for each river) appears to be able to account for those dissimilarities. To fit the Gunnison River, we have added life stages through adult, intraspecific habitat competition among adults, an interspecific overall habitat capacity, and principal mortality events to the model developed for the Trinity River.

In the Black Canyon and Gunnison Gorge of the Gunnison River, river flow regulation for the rainbow and brown trout fishery is currently done largely through flow rules (i.e., minimizing negative effects through minimum flows and release ramping rate rules). Lake level regulation (for Blue Mesa Reservoir) for the trout and kokanee fishery is done through water level change rules (i.e., minimizing negative effects through lake drawdown rules). River flow regulation for downstream endangered species such as Colorado River squawfish is done through water budgets (i.e., maximizing instantaneous peak flows at a desired spawning area). Flow management practices for these three capabilities for flow scheduling. Using thirteen years of adult population and two years of young-of-year production estimates for the rainbow and brown trout in the Gunnison Gorge, we have: designed and improved young-of-year population data collection efforts; probed and tested hypotheses that physical habitat significantly influences movement, growth, and mortality of salmonid fishes; and judged relative severity of limiting factors during each life stage.

LIMNOLOGY AND LOWER TROPHIC LEVELS OF THE COLORADO RIVER FROM LAKE POWELL THROUGH THE GRAND CANYON

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ABSTRACT

Hypolimnetic (unithermally cold), clear release from Glen Canyon Dam affects the distribution of lower trophic levels in the downstream Colorado River in lower Glen Canyon and through the Grand Canyon. Prior to flow regulation the Colorado River was flood-prone, turbid and seasonally warm. Impoundment 1) replaced seasonal flooding with daily "tidal" fluctuations associated with hydroelectric power production, 2) reduced the mean and variance of water temperature, and 3) reduced total sediment transport and scoured fine sediments, thereby increasing water clarity and the availability of hard-bottom substrata. Except for changes associated with hypolimnial release and tributary-derived sediment input, post-dam water quality changes little with seasonally and with distance through the regulated Colorado River.

The clearwater reach downstream from Glen Canyon Dam is dominated by *Cladophora glomerata* which provides structural (but not nutritional) support for associated epiphytic algae and grazing macroinvertebrates (Oliochaeta, *Physella* sp., Chironomidae and *Gammarus lacustris*). In contrast, the lower turbid reaches are strongly dominated by a rock-coating *Oscillatoria* spp and filter-feeding *Simuliium arcticum* (buffalo gnat) assemblage. This system is essentially devoid of Ephemeroptera, Odonata, Hemiptera, Plecoptera, Coleoptera and Trichoptera, taxa that are typically abundant in tributaries and in other southwestern rivers.

Standing biomass (SM) of benthic algae and invertebrates is distributed in a stairstep fashion through this river system. An abrupt decrease in SM occurs at the Paria River, the first significant sediment-contributing tributary confluence 26 km downstream from the dam, and smaller decreases occur downstream. Benthos distribution is correlated with the probabilities of turbid inflow from tributaries and therefore with the availability of photosynthetically active radiation (PAR). In contrast, total drift is cumulative, with substantial inputs from tributaries. Benthic SM is associated with hard-bottom substrata whereas little SM is associated with soft-bottom sediments.

Data on the benthic ecology of the less-regulated upper Colorado and Green rivers indicates that Glen Canyon Dam has strongly altered the Colorado River. Flow regulation has created a unique set of environmental parameters to which the benthos is still adjusting. Management of the benthos, and therefore its fisheries food base, should consider the role of interactions between velocity, temperature and PAR availability.

DIEL AND SEASONAL MOVEMENT AND HABITAT USE BY COLORADO RIVER CUTTHROAT TROUT

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ABSTRACT

Previous studies have suggested that cutthroat trout in small streams are relatively sedentary, and that habitat use is affected by cover. I evaluated these assertions by monitoring the positions of adult Colorado River cutthroat trout in 1992 and 1993 by using radiotelemetry. Immediately after spawning, cutthroat trout moved up to 2 km, and the patterns of movement were unpredictable. In summer, adult trout moved an average of 65 m in each 24-hr cycle. Mean home range was 21 m during the 24 hours, and was about half the length of the summer home range. The lengths of the 24-hr and summer home ranges were highly correlated ($r=0.88$). Feeding activity of these fish peaked at mid-day, and reached a nadir two hours after midnight. Habitats created by woody debris were used more often than expected by chance alone. However, positions of Colorado River cutthroat trout were not related to the distance to cover or stream banks. Movement, behavior, and habitat use probably reflect the feeding strategy of cutthroat trout in these small streams.