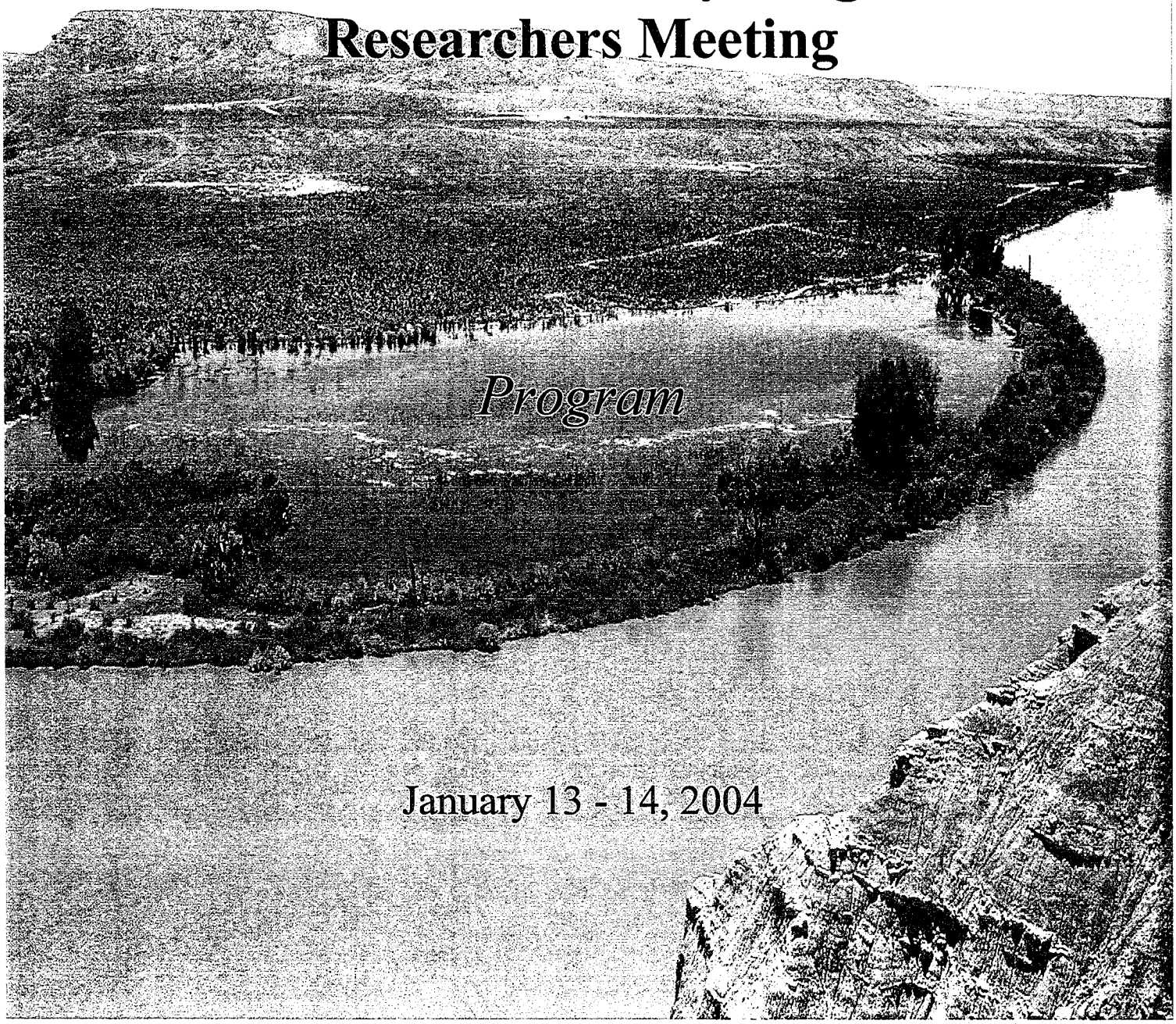
2004 Recovery Implementation Program

9691

Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin

25th Annual Recovery Program Researchers Meeting



Program

January 13 - 14, 2004

Moab Valley Inn
Moab, Utah

Upper Colorado River Endangered Fish Recovery Program

25th Annual Recovery Program Researchers' Meeting

January 13-14, 2004

Moab Valley Inn
Moab, Utah

Schedule

8:00 Registration begins

Tuesday, January 13, 2004

9:00 Introduction and Welcome. BRUNSON, R.

Instream Flow

9:10 **Instream flow recommendations using a meso-habitat approach for native fish populations in the Yampa and Colorado Rivers.** ANDERSON, R. and G. B. Stewart *15 min w/ 5 for questions*

Nonnative Fish Control

9:30 **Northern Pike Control in the Middle Green River.** WILLIAMS, B. and R. Brunson
15 min w/ 5 for questions

9:50 **Dynamics of Northern Pike Spawning and Nursery Habitat in the Yampa River, Colorado.** HILL, C. and E. Bergersen
15 min w/ 5 for questions

10:10 **Nonnative Fish Studies in the Yampa River.** HAWKINS, J., C. Walford and T. Sorensen
15 min w/ 5 for questions

10:30 **Examining Predation Demand by Nonnative Piscivores and its Utility in Evaluating and Prescribing Nonnative Fish Control Strategies.** MARTINEZ, P., B. Johnson, J. Hawkins and K. Bestgen
20 min w/ 5 for questions

10:55 **Elemental and Stable Isotope Markers of Non-native Fish Provenance in the Upper Colorado River Basin.** WHITLEDGE, G. W., B. M. Johnson, P. J. Martinez and A. M. Martinez
25 min w/ 5 for questions

11:25 **Predator Removal and Control in the Colorado River Mainstem: What Have We Learned?** MUELLER, G.
15 min w/ 5 for questions

11:45 **Suppression of Populations and Reproduction in a Nonnative Fish: Sensitivity of Various Life History Stages of Red Shiners to Environmental Manipulation.** HILWIG, K. D. and W. L. Montgomery
15 min w/ 5 for questions

12:05 - 1:30 ***Lunch*** (on your own)

1:30 **Predation on early life stages of razorback sucker in laboratory trials.** CARPENTER, J. and G. Mueller
15 min w/ 5 for questions

1:50 **Evaluation of mechanical removal of large bodied non-native fishes in the San Juan River, New Mexico – Colorado – Utah, 1998-2003.** DAVIS, J. E.
15 min w/ 5 for questions

Instream Flow

2:10 **Gunnison River / Aspinall Unit Temperature Study – Phase II** CUTLER, A. and J. M. Boyer *25 min w/ 5 for questions*

Research and Monitoring

2:40 **Translocation of humpback chub (*Gila cypha*) above Chute Falls, Little Colorado River.** SPONHOLTZ, P. J., D. M. Stone and K. Hilwig
15 min w/ 5 for questions

3:00 **Effects of repeated handling on bonytail chub - preliminary results.** HILWIG, K. D. and P. J. Sponholtz
15 min w/ 5 for questions

3:20 – 3:40 ***Break (refreshments provided)***

Propagation and Genetics

3:40 **What's Really Happening to Our Stocked Fish? Experiences from the San Juan River.** HOLDEN, P., M. Golden and K. Dahle, M. Ulibarri, and D. Hampton *25 min w/ 5 for questions*

4:10 **Could Exercise Conditioning Increase the Success of Repatriation Efforts for Colorado River Fishes?** WARD, D. L. and K. D. Hilwig
15 min w/ 5 for questions

4:30 **Lake Mohave Razorback Sucker Program Update.** BURKE, T.
15 min w/ 5 for questions

4:50 **A genetic evaluation of hybridization among indigenous and non-native Yampa River suckers (Catostomidae).** DOUGLAS, M. R. and M. E. Douglas
15 min w/ 5 for questions

5:10 **A small fish in a large landscape: Phylogeography of *Rhinichthys osculus*, the Speckled Dace.** DOUGLAS, M. E., D. D. Oakey and M. R. Douglas
15 min w/ 5 for questions

5:30 ***Adjourn***

6:00 -? **Evening Social and "Outstanding Researcher" Award** presented by last year's recipient, Doug Osmundson. (refreshments provided)

Wednesday, January 14, 2004

Habitat

8:00 **The Use of Topographic Models to Predict the Effect of Stage Changes on Physical Backwater Characteristics.** HAYSE, J., K. LaGory, B. Cantwell, S. Railsback and A. Deschais
15 min w/ 5 for questions

8:20 **Recommended Priorities for Geomorphology Research in Endangered Fish Habitats of the Upper Colorado River Basin.** HAYSE, J., K. LaGory and D. Tomasko
15 min w/ 5 for questions

8:40 **Cibola High Levee Pond: Annual Report 2003.** MUELLER, G., J. Carpenter and P. Marsh *15 min w/ 5 for questions*

9:00 **Yes, Razorback Sucker Can Recruit Naturally in the Wild!** WELKER, T. L., P. B. Holden, K. Dahle and J. E. Heinrich
15 min w/ 5 for questions

9:20 **Flow-through connection at the Above Brennan and Bonanza Bridge Bottomlands.** CAREY, P. E.
15 min w/ 5 for questions

9:40 **A Generalized Interactive Model To Predict Floodplain Habitat Area Needed To Recover The Endangered Razorback Sucker In The Upper Colorado River Basin.** VALDEZ, R. A. and P. Nelson
15 min w/ 5 for questions

10:00 **Floodplain Management Plans for the Upper Colorado River Basin to Assist Recovery of the Razorback Sucker** VALDEZ, R. A. and P. Nelson *15 min w/ 5 for questions*

10:20 **Survival of Larval Razorback Sucker *(Xyrauchen texanus)* in Floodplain Depressions Inhabited by Nonnative Fish in the Middle Green River, Utah.** BRUNSON, R. and K. Christopherson
15 min w/ 5 for questions

10:40 **Field application of the 'floodplain reset' approach to enhance survival of bonytail and razorback sucker in the middle Green River, Utah.** MODDE, T.
15 min w/ 5 for questions

11:00 **An Overview of Utah's Recovery Efforts for Razorback Sucker.** CHRISTOPHERSON, K.
15 min w/ 5 for questions

***11:20 – 12:30 Lunch** (on your own)*

12:30 Floodplain Panel Discussion

Moderator: Tom Chart – Bureau of Reclamation

Panel participants:
Dan Alonso – Ouray National Wildlife Refuge
Kevin Christopherson – Utah Division of Wildlife Resources
Chuck McAda – USFWS – Grand Junciton
Tim Modde – USFWS – CRFP Vernal
Rich Valdez - R.A. Valdez & Associates, Inc.
Pat Nelson – USFWS – Denver

12:30 – 1:00 Panelist viewpoints, issues and concerns
30 minutes

1:00 – 1:30 Collective panelist response to questions
30 minutes

1:30 – 2:00 Questions from the Audience

2:00 ***Adjourn***

Posters - *available for viewing at the back of the room.*

Channel Catfish Control in the Lower Yampa River. FULLER, M.

Identification of Desert and Sonora Sucker Larvae and Early Juveniles. SNYDER, D. E., K. R. Bestgen, S. C. Seal and L. Bjork

Demonstration – *available during the afternoon break on Tuesday.*

Computer-interactive Keys for the Larvae and Early Juveniles of Selected Southwestern Catostomids (Hands-on Experimentation). SNYDER, D. E.

PIT tag scanner demonstration (FS2001F-ISO; multiple frequencies,"tennis racket" style scanner). BRADWISCH, Q.

ABSTRACTS

Instream Flow

Instream flow recommendations using a meso-habitat approach for native fish populations in the Yampa and Colorado Rivers.

Anderson, Rick[1], and Gregory B. Stewart[2]

[1] Colorado Division of Wildlife, Grand Junction, CO [2] Oregon State University, Corvallis, OR

Establishment of instream flows are generally considered to be a valuable tool for maintaining declining or threatened native fish populations. In 1999 the DOW began a research project to make biologically justified instream flow recommendations. Anderson and Stewart (2003) designed a Meso-Habitat approach similar in concept to PHABSIM in that it included a hydraulic model to simulate flow conditions and a species habitat suitability index used to predict habitat availability. Channel topography was surveyed with RTK GPS at six study sites on three rivers. A 2-D flow model was used to simulate depths and velocities for each site. A large part of the study was to develop meso-habitat criteria for two native fish, the flannelmouth and bluehead suckers. This was accomplished by examining the relationship between their abundance within sub-reaches of each study site. The physical attributes of each sub-reach were correlated against fish abundance. The output of the Meso-Habitat methodology was four meso-habitat types for each species that quantified unusable, unsuitable, marginal and optimal habitat availability for a range of flows. Channel geomorphology was found to be similar for the Yampa River and 15-Mile Reach of Colorado River. Flows that optimized habitat were also similar and in the range of 900 to 1,200 cfs. However because of differences in historic water availability the minimum base flow recommendation for the Yampa River was 200 cfs and it was 600 cfs for the 15-Mile Reach.

Gunnison River / Aspinall Unit Temperature Study – Phase II

Cutler, Amy[1], and Jean Marie Boyer[2]

[1] Bureau of Reclamation; [2]Hydrosphere Consultants

A reservoir temperature model, CE-QUAL-W2, and a river temperature model, QUAL-2K, are used to analyze reservoir operational scenarios to determine the range of release temperatures possible from Crystal Reservoir and temperature-related effects on the Gunnison River downstream for the purpose of enhancing the survivability endangered native fish species, the Colorado pikeminnow. Historic reservoir release temperatures are compared to modeled release temperatures resulting from the proposed "Flow Recommendations", and from two hypothetical selective withdrawal structures at the

dam. A fifth scenario re-analyzes historic hydrology but begins with current drought-related low reservoir elevations to determine the effect of extremely low elevations on release temperatures (without selective withdrawal). Model results determine the temperature regimes which are possible throughout a given set of years, the effectiveness of incorporating selective withdrawal structures at the dam, and the effect of selective withdrawals on the reservoir's long term heat budget. The optimal range of temperature and releases needed to meet the temperature targets downstream at Delta identified in Osmundson's 1999 report are determined. This study indicates that it is possible to meet downstream temperature targets through incorporation of a multiple-level selective withdrawal structure. The effect of selective temperature releases on the heat budget of the reservoir is minor and of short duration, being dominated by other hydrologic and meteorological factors.

Nonnative Fish Control

Review of Middle Green River Northern Pike Control

Williams, Ben and Ron Brunson

Utah Division of Wildlife Resources, Vernal, Utah

Effort to control Northern pike *(Esox lucius)* in the Middle Green River was initiated in 2001 and continued through 2003. The purpose of this effort is to develop an effective control program and reduce the density of adults such that predatory and competitive impacts on growth, recruitment, and survival of endangered and other native fishes are minimized. Northern pike were removed from known concentration areas of the middle Green River, including the mouth of Brush Creek, Cliff Creek, Stewart Lake Drain, Ashley Creek, Sportsman Drain and the mouth of the Duchesne River. Other habitats sampled were large, relatively deep backwaters and shoreline areas. Sampling gear used included fyke nets, trammel nets and electrofishing. Trammel nets were used in conjunction with electrofishing as a productive sample method. A total of 248 northern pike were removed from the middle Green River in 2001, 42 in 2002, and 22 in 2003. Catch rates have decreased from 0.56 northern pike/net-night in 2001 to 0.03 northern pike/net-night in 2003, and 1.24 northern pike/electrofishing-hour in 2001 to 0.22 northern pike/electrofishing-hour in 2003. Four Northern pike were captured with razorback suckers in their stomachs during 2003 sampling. Mechanical removal has been shown to be an effective northern pike control method in the middle Green river.

Dynamics of Northern Pike Spawning and Nursery Habitat in the Yampa River, Colorado

Hill, Chris, and Eric Bergersen

Colorado Cooperative Fish and Wildlife Research Unit, Colorado State University, Fort Collins, CO 80523

Northern pike in the Yampa River are a major concern to fish managers in Colorado because of their potential threat to native fish and especially those listed as threatened or endangered species. Management of northern pike has been identified as a key step in the recovery efforts for the endangered fish of the region. One possible approach for managing northern pike is to limit their access to backwater spawning habitat and thereby reduce recruitment success. We evaluated the effectiveness of barriers as a possible management option for reducing recruitment. We evaluated different barrier materials, designs, and installation times as well as the likelihood of installing barriers on a large scale between Steamboat Springs and Craig, Colorado. Determining the effectiveness of barriers required that we document northern pike spawning times, the abundance and quality of spawning and nursery habitat, the possible effects of variable spring runoff on spawning and nursery habitat, and the success of recruitment. Collections of spawning adult pike in backwaters and water temperatures indicate that the primary spawning period takes place in the first two weeks of April. Potential backwater spawning habitat appears to be abundant in the Yampa River, but what we considered high quality backwaters are limited. Because pike spawn before the spring runoff begins the availability of spawning habitat appears to be consistent from year to year, but spring runoff can adversely affect nursery habitat if the backwater connects to the main channel. Relatively few young of the year northern pike were found in backwaters while limited sampling of off channel ponds indicate that these areas appear to be a more significant source for young of the year recruitment. Fall installation of barriers is not effective because of damage from ice during the winter. Spring installation is feasible but is limited to a very narrow window of time and is labor intensive. The reluctance of some land owners to allow barriers to be installed in backwaters on private property and the overall low recruitment found in backwaters suggest that the time and money spent on installation may not be worthwhile. Off channel ponds along the Yampa River are an important source of recruitment and should be the focus of future management. Escapement of adult pike from Catamount Reservoir into the Yampa River is a management concern that also needs to be addressed.

Nonnative fish studies in the Yampa River

Hawkins, John, Cameron Walford, and Tasha Sorensen

Larval Fish Laboratory, Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO

In the Yampa River, nonnative piscivorous, channel catfish (*Ictalurus punctatus*), northern pike (*Esox lucius*), and smallmouth bass (*Micropterus dolomieu*) pose a threat to native and endangered fishes. Channel catfish have occurred in the Yampa River for 75–100 years, northern pike have occupied the river for 25 years, and smallmouth bass have occupied the river in significant numbers only in the last 10 years. Northern pike were stocked into the tributary Elkhead Reservoir in the late 1970s and colonized the Yampa River almost immediately. Smallmouth bass were extremely rare in the Yampa River until 1992 when a rapid draw down at Elkhead Reservoir introduced large numbers into the river. Catfish and smallmouth bass are now abundant downstream of Craig, Colorado and northern pike occur throughout the river. Northern pike also occur upstream in the mainstem Stagecoach Reservoir, where they were illegally stocked. Range of those three species overlaps designated critical habitat for federally listed Colorado pikeminnow (*Ptychocheilus lucius*), razorback sucker (*Xyrauchen texanus*), humpback chub (*Gila cypha*), and bonytail (*Gila elegans*) in the Yampa River. Management actions to reduce abundance of nonnative piscivorous fish may be necessary to recover the endangered fishes. A key piece of information required for effective management is the effort required to remove a given proportion of the targeted nonnative population.

In 2003, we designed several studies to evaluate effectiveness of removal of northern pike, smallmouth bass, and channel catfish in the Yampa River. In our 75-mile study reach within critical habitat northern pike and channel catfish were captured, tagged, and released on three sample occasions. No channel catfish were removed and northern pike were removed only in an 8-mile treatment reach. Smallmouth bass were captured, tagged, and released on five sample occasions in a 12-mile study reach and were removed only in a 6-mile treatment site of that reach. We describe movement, density, length-frequency, population abundance, and capture probabilities for northern pike, channel catfish, and smallmouth bass. These results will be useful to design effective control strategies for nonnative fish predators in the Yampa River.

Examining Predation Demand by Nonnative Piscivores and its Utility in Evaluating and Prescribing Nonnative Fish Control Strategies

Martinez, Patrick[1], Brett Johnson[2], and John Hawkins & Kevin Bestgen[3]

[1] *Colorado Division of Wildlife, Grand Junction, CO;* [2] *Dept. of Fish & Wildlife Bio, Colorado State University, Fort Collins, CO;* .[3] *Larval Fish Laboratory, Colorado State University, Fort Collins, CO*

Bioenergetics provides a framework to quantify the biomass of prey consumed by fishes based on their thermal experience, growth rate, body condition and the availability of their prey. Using data on seasonal diet composition, it becomes possible to estimate predation by the type of prey consumed, e.g., invertebrate vs. fish. By calculating the amount of food consumed by a fish in each size class (trophic stanza), and scaling these per capita estimates of prey consumption up to the entire population with abundance data, it becomes possible to estimate of overall demand for fish prey by piscivores. Population level estimates of piscivore consumption of various prey clarifies which species or size class of piscivores may be exerting the greatest predation demand in a fish community. Because the predation impact on native fishes by nonnative piscivores is of increasing concern within Critical Habitat for endangered fishes in the Upper Colorado River Basin, bioenergetics analysis has the potential to identify which species or size-class of nonnative piscivores exert the greatest predation threat to native fishes. The level of refinement attainable by applying the bioenergetics framework is reliant upon the quality of the data available. Examination of piscivore diet by season is necessary to detect predation on native vs. nonnative species. Projection of predation demand by piscivores at the population or river reach level is reliant on sound estimates of piscivore abundance. Further, these estimates of abundance should be unbiased in their representation of size classes in the population. By meeting these sampling standards accurate estimates of the amount of fish prey consumed by piscivores are possible. This information would allow managers to identify the most problematic species and target the most predaceous size classes to optimize the ecological and economic efficiency of efforts to remove or control nonnative piscivores. Further, these estimates can be used to determine how many nonnative piscivores need to be removed to protect and restore native fishes and facilitate recovery of endangered ones. An example is presented for nonnative channel catfish, northern pike and smallmouth bass in the Yampa River using available data and identifying data needs and model limitations that must be addressed by additional research to optimize the utility of this technique.

Elemental and stable isotope markers of non-native fish provenance in the Upper Colorado River basin

Whitledge, Gregory W.[1], Brett M. Johnson[1], Patrick J. Martinez[2], and Anita M. Martinez[2]

[1] *Dept. of Fishery & Wildlife Biology, Colorado State University, Ft. Collins, CO;*
[2] *Colorado Division of Wildlife, Grand Junction, CO.*

Non-native centrarchids are present throughout much of the Upper Colorado River basin and can adversely affect recovery of threatened and endangered native fishes through predation or competition within critical habitats. Identification of sources of centrarchids to critical riverine habitats is crucial if centrarchid control efforts are to proceed in an efficient and effective manner. We are employing stable isotope and elemental analyses of fish otoliths to determine origins and reconstruct movements of centrarchids in and upstream of the Grand Valley reach of the Colorado River. Otoliths are metabolically inert structures whose elemental and stable isotopic compositions reflect those of the

fish's environment. Chronological information from otoliths coupled with analysis of otolith chemical makeup enables identification of chemically distinct environments occupied over the lifetime of a fish. Spatial distributions of selenium concentrations and naturally-occurring stable isotope signatures of carbon, nitrogen, hydrogen, and strontium within the Colorado River and adjacent floodplain ponds, tributaries, and irrigation ditches indicate that these elements have good potential to serve as natural markers of non-native fish origins and movements.

Predator Removal and Control in the Colorado River Mainstem: What have we learned?

Mueller, Gordon

USGS, Denver, CO

Predator removal programs have gained popularity, especially in the Colorado River Basin. Non-native fish control features have benefited the recovery of several native salmon and spring fish; however, these successes have been limited to headwater streams and small, isolated ponds or springs. Never-the-less, these same approaches are being applied to mainstem species on the belief that removing non-native predators will benefit natives. Unfortunately, after 10 years, the expenditure of >$4 million (USA) and the removal of >1.5 million fish, we have yet to see any positive response from native communities. This failure is primarily due to the severity of the problem coupled with institutional issues and constraints. Predation is actually getting worst in some areas. This leads to the obvious question; is predator removal or control in the mainstem feasible? If not, recovery for some species may not be practical in the conventional sense. This review examines what's been attempted, what has worked, and what has not in the Colorado River mainstem and provides recommendations.

Suppression of populations and reproduction in a nonnative fish: sensitivity of various life history stages of red shiners to environmental manipulation.

Hilwig, Kara D., Graduate Student, and Dr. W. Linn Montgomery

Department of Biological Sciences, Northern Arizona University, Flagstaff, AZ

Nonnative fishes may contribute to declines of native fishes in the southwest United States and elsewhere. Strategies to recover native species often include removal of nonnative species, but complete removal is unrealistic, especially where nonnatives have established reproducing populations. An alternative approach would expose both types of species to conditions that selectively suppress survival or reproductive success of nonnative species. We seek environmentally realistic (e.g., non-extreme) conditions that suppress survival of early life history stages (eggs, larvae) of red shiners (Cyprinidae: *Cyprinella lutrensis*). We assess survival of eggs and larvae subjected to physicochemical variables (temperature and salinity) in laboratory tests. Data indicate red shiner eggs and

larvae have reduced survivorship at temperatures greater than 34 °C, however, shiner eggs and larvae were able to withstand conductivities up to 19,750 µS/cm (12.8 ppt salinity). Data also indicate that simulated flood events in the laboratory result in greater displacement of red shiners as compared to spikedace. We develop recommendations for timing and type of environmental manipulations that would suppress shiner populations or their reproductive success, thereby reducing the negative effects of this introduced species on native species. Our goal is to demonstrate the efficacy of this approach to the recovery of threatened native species.

Predation on early life stages of razorback sucker in laboratory trials

Carpenter, Jeanette, and Gordon Mueller

U.S. Geological Survey, Fort Collins Science Center

Few biologists question the impact of introduced predators on endangered fishes of the Colorado River. Substantial effort is being expended to remove large fish predators. However, abundance of smaller non-natives may be increasing as large predators decline. In laboratory experiments we examined predation of larval razorback suckers by small non-natives now common in the Colorado River: young bluegill, rainbow trout, largemouth bass, yellow bullhead, and channel catfish, as well as red shiners and bullfrog tadpoles. We also tested predation by young bonytail, and bullfrog tadpole predation on razorback eggs. All species tested preyed on razorbacks. Tadpoles consumed 100% of available razorback eggs. Larval predation was >85% in tanks with trout, red shiner, bullhead, and bonytail. In mixed-prey trials, we used larval razorbacks with similar-sized fathead minnows. Channel catfish, largemouth bass, and bluegill showed no preference for prey size or prey species. Our results show a clear negative impact by small non-natives on razorback young. Furthermore, small predators are more numerous and less vulnerable to mechanical removal than their larger cohorts. Small non-natives may pose a more significant predatory threat to young razorbacks than larger predators.

Evaluation of mechanical removal of large bodied non-native fishes in the San Juan River, New Mexico – Colorado – Utah, 1998-2003.

Davis, J.E.,

United States Fish and Wildlife Service, New Mexico Fishery Resources Office, Albuquerque, NM

Control of large bodied non-native fishes in the San Juan River, New Mexico – Colorado - Utah is considered integral to recovery efforts for the federally protected Colorado pikeminnow *Ptychocheilus lucius* and razorback sucker *Xyrauchen texanus*. Mechanical removal of channel catfish *Ictalurus punctatus* and common carp *Cyprinus carpio* by electrofishing in the San Juan River began in 1995 but was not formally instituted as a long-term management tool until 1998. Riverwide, annual numbers of channel catfish removed have increased with each successive year of sampling since 1998. Mean total

length of channel catfish significantly ($p < 0.05$) decreased and fewer large channel catfish were collected. Few changes in distribution, abundance, and size class of common carp were observed. Additional removal efforts were concentrated on a discrete eight mile reach of the San Juan River between two water diversion structures. These intensified efforts have led to seasonal declines in both channel catfish and common carp abundance and significant declines in mean size class of channel catfish. Significant reductions in distribution and abundance of large bodied non-native fishes in the San Juan River by mechanical removal may reduce negative interactions with native fishes and assist in the recovery of both the Colorado pikeminnow and razorback sucker.

Research and Monitoring

Translocation of humpback chub (*Gila cypha*) above Chute Falls, Little Colorado River

Sponholtz, Pamela J.[1], Dennis M. Stone [1], and Kara Hilwig[2]

[1] *USFWS, AZFRO-Flagstaff;* [2] *Northern Arizona University.*

In summer 2003, the Arizona Fishery Resources Office, along with personnel from the Arizona Game and Fish Department, released 283 humpback chub (HBC) into the Little Colorado River (LCR), above Chute Falls, near river kilometer 16.2. HBC were captured via baited hoop nets and seining near the confluence of the Colorado River. All translocated fish were implanted with a yellow elastomer tag near the dorsal fin insertion on the left side to identify them from downstream populations. This action was part of the December 6, 2002, Biological Opinion on the proposed experimental releases from Glen Canyon Dam and removal of nonnative fish. As a conservation measure for this project, the U.S. Bureau of Reclamation, Grand Canyon Monitoring and Research Center, and the National Park Service agreed to relocate approximately 300, 50-100 mm HBC to upstream areas of the LCR in an attempt to increase survivorship of HBC. It is hoped that this translocation will increase HBC recruitment to adulthood by allowing them an opportunity to exploit the abundant food resources, warmer water temperatures, and reduced competition/predation by fewer large-bodied fishes associated with this area. During post-translocation monitoring efforts in October 2003, we captured (42) HBC during three days using baited hoopnets from river kilometer 14.5 to 16.8. Of the 42 HBC captured, 9 individuals had no elastomer tag. However, significant fading of the elastomer tag occurred in nearly all HBC captured that retained the tag. One of the larger individuals (143mm) was found 0.5 km upstream of the release site and had no visible tag. This suggests either upstream movement by HBC from below Chute Falls or significant growth and subsequent loss of the elastomer tag. In addition, the largest marked individual was 134mm, which indicates that this fish experienced at least 34mm of growth between the release date, August 1, and the monitoring date of November 1 (92 days). All HBC captured were implanted with a 134.2Khz PIT tag and released back into

the LCR. Hoop net captures were dominated by speckled dace (94% of the total catch) in addition to nonnative carp, fathead minnows, plains killifish, black bullhead and YOY channel catfish. In spring 2004, monitoring will continue above Chute Falls to determine retention following spring runoff events.

Effects of repeated handling on bonytail chub - preliminary results

Hilwig, Kara[1], Pamela J. Sponholtz[1], David Ward[2], and Craig Paukert[3]

[1]USFWS, Arizona Fishery Resources Office; [2]Arizona Game and Fish Department; [3]Kansas State University Cooperative Research Unit.

Humpback chub are sampled in the Little Colorado River in Grand Canyon each year during the spring and fall to obtain population estimates. Repeated capture and handling of fish during monitoring or research activities may cause stress leading to reduced growth and/or condition and eventual mortality. We used bonytail chub as a surrogate species to assess the effects of repeated handling on growth, condition, and mortality of humpback chub. We simulated handling procedures currently used for humpback chub in the Little Colorado River. Using a 0.10-acre pond divided in half with a net into control and experimental sides, we placed 160 PIT tagged bonytail chub into each side. Fish were sampled with hoop nets with two sampling trips in the fall and will be sampled again in spring 2004. We measured fish length and weight and recorded the time required to complete all steps for processing individual fish during two 3-day sampling events. Preliminary results from fall sampling indicate handled fish did not gain as much weight as non-handled fish however no differences in fork length were observed. Fish were handled for a mean total time of 4.21 minutes that included removing fish from nets, length and weight measurements, visual inspection, scanning and insertion of PIT tags and release back into the pond (includes time in bucket). Although handling fish is essential in understanding population dynamics, researchers should seek to understand the effects of handling on fish and try to minimize any harmful sampling practices.

Propagation and Genetics

What's Really Happening to Our Stocked Fish? Experiences from the San Juan River

Holden, Paul[1], Mike Golden[1], Kirk Dahle,[1] Manuel Ulibarri[2], and Dave Hampton[2]

[1] BIO-WEST, Inc. Logan, Utah; [2]Dexter National Fish Hatchery and Technology Center, Dexter, New Mexico

Approximately 175,000 yoy Colorado pikeminnow were stocked in the San Juan River in New Mexico in early November 2003. About 20,000 of these fish were marked with a calcein mark and held in net pens and netted-off backwaters to study the effect of acclimating the fish prior to release. Approximately 24 hours after stocking, a major mortality event occurred with the fish being held and over the next 48-72 hours 70-80 percent of the fish were lost. Autopsies conducted by Dexter personnel showed that internal organs of the dead fish had hemorrhaged, suggesting the fish could not osmotically adjust to changes in water quality between Dexter water and the San Juan River. It was also hypothesized that the accumulated stress of removal from the rearing ponds, transportation to the San Juan River, and stocking added to the severity of mortality. Dexter had maintained 2,000 of the yoy year class stocked in the river and experiments were designed and implemented in late November to attempt to determine the cause of the mortality and protocols to avoid the mortality in the future. The first set of experiments were conducted at Dexter and used water hauled from the San Juan River. These experiments tested stressed and unstressed fish. No mortalities occurred in these tests. A second set of experiments were conducted in the San Juan River in net pens in a backwater where mortality occurred in early November. This experiment tested various tempering times and attempted to recreate the mortality event. Again, few mortalities occurred. The two sets of experiments suggested that water quality differences by themselves were not the cause of the mortality event, but the combination of accumulated handling stress and water quality differences could not be adequately tested this year. We hypothesize that the accumulated stress of handling from the rearing ponds to stocking, along with a major water quality change, were the causes of the mortality seen in early November 2003.

Could Exercise Conditioning Increase the Success of Repatriation Efforts for Colorado River Fishes?

Ward, David L.[1], and Kara D. Hilwig[2]

[1]Arizona Game and Fish Department, Research Branch, Phoenix, AZ; [2]Northern Arizona University, Department of Biological Science, Flagstaff, AZ

Rare native fish are often reared at hatcheries in ponds or tanks for later stocking into streams with depleted populations. Fish reared in standing water may experience increased stress, downstream displacement, or high predation mortality when released into lotic environments. We compared the swimming performance of captive fish held in standing water, captive fish exercised in flowing water, and wild fish captured from a stream, to evaluate the effects of exercise conditioning and holding environment on swimming performance. Swimming performance of flannelmouth sucker *Catostomus latipinnis*, bonytail chub *Gila elegans*, razorback sucker *Xyrauchen texanus*, and spikedace *Meda fulgida* held in standing water increased by 10, 15, 26, and 40% respectively after exercise conditioning in flowing water (10 – 100 cm/s) for as little as 10 d. Exercising fish reared in standing water may improve swimming performance and increase survival.

Lake Mohave Razorback Sucker Program Update

Tom Burke

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During the late 1980's over 90% of the wild, adult razorback sucker population left in the world, roughly 63,000 fish, resided in Lake Mohave. Despite annual spawning along the lake's shoreline, natural recruitment of new fish into the population was almost nonexistent due to predation from non-native fishes. Razorback suckers live about 40-45 years, and Lake Mohave was formed in the early 1950's. These fish were slowly dying of old age. Without help, this population was expected to die off around the turn of the century. The Native Fish Work Group began working in 1991 to replace this stock with its own offspring. The NFWG is a team of fishery biologists representing Arizona Game and Fish, Nevada Division of Wildlife, National Park Service, Arizona State University, Southern Nevada Water Authority, Fish and Wildlife Service and Bureau of Reclamation. The team collects young fry from the early spring spawning and transfers them to a local hatchery where they are raised to approximately 4 inches. The young fish are then moved to lakeside ponds or other hatcheries for further rearing. When the fish reach 12 inches in length, they are tagged and released into the main body of the reservoir. The Native Fish Work Group's goal is to build up the spawning population to 50,000 adult fish. To date, over 75,000 juvenile fish have been repatriated to the lake, and an additional 120,000 are at some stage of rearing to target release size. An overview of program methods are presented along with results to date.

A genetic evaluation of hybridization among indigenous and non-native Yampa River suckers (Catostomidae).

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Numerous factors contribute to the decline of indigenous fishes in western North America. While habitat alteration is a major concern for indigenous fish communities, impromptu introduction of alien species is probably a more serious threat to their long-term survival. Impacts of the latter are less immediate, and often go unnoticed by the general public. Introgression of alien genes gradually erodes the genetic integrity of native species, and irreversibly alters the local genetic adaptation that has evolved over millions of years. As a result, indigenous genes become replaced and the endemic fauna is effectively eliminated. We applied a molecular genetic approach to define the extent and magnitude of hybridization between the introduced White Sucker (*Catostomus commersoni*) and endemic suckers of the Colorado River Basin, the Flannelmouth Sucker (*C. latipinnis*) and the Bluehead Sucker (*C. discobolus*). These three hybridize in a 50-mile reach of river between Lily Park and Craig. Species-specific nuclear markers were developed to assess the status (i.e., pure or hybrid) of over 500 specimens. Results demonstrated that morphological and genotypic identifications were congruent with over 95% of the individuals.

A small fish in a large landscape: Phylogeography of *Rhinichthys osculus*, the Speckled Dace.

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We mapped 114 restriction sites in the mitochondrial (mt) DNA genome of the Speckled Dace (*Rhinichthys osculus*), a small cyprinid fish broadly distributed in western North America. These data were used to derive a molecular phylogeny for the species that was contrasted against the hydrographic evolution of the region. Although haplotypic variation was extensive among our 59 sampled populations and 104 individuals, their fidelity to current drainage basins was a hallmark of the study. Two large clades, representing the Colorado and Snake rivers, were prominent in our results. The Colorado River clade was divided into four cohesive and well-defined sub-basins that arose in profound isolation as an apparent response to regional aridity and tectonism. The Lower, and Little Colorado River sub-basins are sister to one another, and (with the Upper Colorado River), form a large clade of higher-elevation populations that reflect post-glacial re-colonization from refugia in the Middle Colorado River. The latter sub-basin is sister to the Los Angeles Basin, and thus supports the hypothesis of an ancient connection between the two. A haplotype from the Northern Bonneville was sister to the entire

Colorado River clade. The Snake River clade revealed a strongly supported Lahontan group that did not share haplotypes with surrounding basins. It contained instead scattered sites from former Pluvial Lake Lahontan, as well as from eastern California. It was, in turn, sister to the Owens River, while *R. falcatus* was sister to this larger clade. The hypothesis of a southerly, "fishhook"-configured tributary associated with a westward-draining Pliocene Snake River was manifested by the relationship of this Lahontan clade to upper Snake and northern Bonneville localities. The Klamath/Pit and Columbia rivers were sisters and their basal relationship to all the above, and this supported the hypothesis of a pre-Pliocene western passage of the Snake River. Our data also supported at least three separate ichthyofaunal invasions of California, as well as a Bonneville Basin fragmented by a north-south connection between southeastern Idaho and the Colorado River. The dual western and southern movements of *R. osculus* from southern Idaho suggested a northern origin for the species, possibly associated with Tertiary Lake Idaho.

Habitat

The Use of Topographic Models to Predict the Effect of Stage Changes on Physical Backwater Characteristics

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To protect backwater habitats used by Colorado pikeminnow (*Ptychocheilus lucius*) juveniles, flow recommendations for the Green River call for limiting within-day stage changes to 0.1 m or less at the Jensen gage during the baseflow period. We developed topographic models for six representative backwaters in the Ouray reach of the Green River to evaluate the effects of stage changes on their physical characteristics. Standard surveying techniques were used to obtain detailed topographic information for backwaters from 19 to 21 August 2003. Stage data in the study area were collected using a temporary stage recorder. Using topographic data, contour maps and GIS models for each backwater area were developed to predict the area, volume, and depths for each backwater as a function of main channel water stage. Maximum depth of backwaters ranged from 0.5 m to 2.4 m (mean maximum depth = 1.2 m, SD = 0.7), surface area ranged from 220 m^2 to 1744 m^2 (mean surface area = 779 m^2, SD = 582.7), and volume ranged from 59.5 m^3 to 853.7 m^3 (mean volume = 349.4 m^3, SD = 399.4) at the time that topographic data were collected. For the study backwaters, a 0.1 m decrease in stage would result, on average, in an 11% decrease in maximum depth, a 19% decrease in surface area, and a 30% decrease in backwater volume. This information is useful for evaluating relationships between main channel flow conditions and physical conditions in

backwaters and may provide a better understanding of how flow and stage affect backwater habitat quality and use by young pikeminnow.

Recommended Priorities for Geomorphology Research in Endangered Fish Habitats of the Upper Colorado River Basin

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We developed and implemented an approach to prioritize river reaches and habitats for geomorphic research in the Upper Colorado River Basin. Recommended priorities are being used by the Recovery Program as it develops a comprehensive research and monitoring program for endangered fish habitats. A scoring system was used to represent the relative importance of (1) existing (or potential) reach use for species and life stages; (2) habitat use for species and life stages; (3) habitat occurrence within planform type; and (4) dependencies among habitat characteristics and hydrologic and geomorphic parameters. Scores also were assigned to life stages and species on the basis of sensitivity to environmental variability and population status, respectively. Two workshops involving Upper Basin researchers were held in December 2002 and February 2003 to gather input and assign scores to attributes. A linked-matrix approach was used to combine scores and develop overall (all species combined) and species-specific priorities based on these attributes. Overall priority habitats identified included (1) connected backwaters and side channels in the middle and lower Green River and lower portions of the upper Colorado River; (2) flooded bottomlands in the middle Green, Colorado (near the confluence with the Gunnison), and lower Gunnison Rivers; and (3) spawning bar complexes in the middle Green, Colorado, and Gunnison Rivers.

Cibola High Levee Pond: Annual Report 2003

Mueller, Gordon[1], Jeanette Carpenter[1], Paul Marsh[2], Chuck Minckley[3]

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Bonytail and razorback sucker have once again spawned and produced young at Cibola High Levee Pond (CHLP), Arizona-California. Underwater videography during spawning showed both species fed aggressively on their own eggs. Videos also recorded concentrations (average 0.89 to 3.66 animals/m^2) of bullfrog (*Rana catesbeiana*) tadpoles and red swamp crayfish (*Procambarus clarkii*) which in subsequent tank tests illustrated they both fed on razorback eggs and larvae.

Telemetry studies revealed that adult bonytail were strictly nocturnal, having a fidelity to specific bank cavities during daylight hours. All life stages exhibited schooling behavior. Predator/prey tank experiments revealed that most nonnative young fed on razorback larvae and fry. Literature suggests that at current densities, tadpoles have the potential to consume nearly a million fish larvae per day. Crayfish were also an effective predator of

sucker fry. Small (< 6cm) sunfish, rainbow trout (5 and 18 cm), red shiner (<7 cm), largemouth bass (<8 cm), yellow bullhead (<14 cm), channel catfish (<13 cm) and bonytail (<8 cm) were all aggressive predators of 10-50 mm razorback sucker.

Yes, Razorback Sucker Can Recruit Naturally in the Wild!

Tim L. Welker[1], Paul B. Holden[1], Kirk Dahle[1], and Jim E. Heinrich[2]

[1] *BIO-WEST, Inc.;* [2]*Nevada Division of Wildlife*

We have studied the ecology and life history characteristics of the Lake Mead razorback sucker (*Xyrauchen texanus*) population for the past 7 years. A major emphasis of this research has been to examine the age structure of this population to determine its age relative to existing wild populations of razorback sucker and to identify patterns of recruitment. Ages calculated nonlethally for 57 wild razorback sucker during this study indicate that the Lake Mead population is relatively young with a current average age of approximately 16 years. Additionally, the capture of one 5-year-old and seven 4-year-old subadult fish in 2003 shows that natural recruitment has occurred recently in the lake.

A comparison of the years all aged razorback sucker were spawned with historical Lake Mead water elevations provides some evidence that a combination of small, annual lake-level fluctuations and larger, multi-year changes in lake elevation may influence razorback sucker recruitment. The long-term lake-level changes may promote growth of terrestrial vegetation that, when inundated by the lake, provides increased protective cover for larval and juvenile razorback sucker, resulting in the limited recruitment documented in Lake Mead. The fact that the recently aged sub-adult fish were apparently spawned in 1997 and 1998, at a time when large amounts of protective cover were inundated, generally supports this theory.

Flow-through connection at the Above Brennan and Bonanza Bridge Bottomlands

Carey, Jason

Tetra Tech

In April of 2000 Above Brennan and Bonanza Bridge Bottomlands were reconfigured to connect to the Green River with a flow-through condition. Previously the bottomlands were configured with a notch at the downstream end that only provided a backwater condition in the bottomland during connection with the river. The flow-through configuration was created by constructing notches at the upstream ends of the bottomlands. The gradient of the river now causes flows to pass through the bottomland and exit through the notches at the downstream of the bottomlands.

The flow-through condition has potential to capture magnitudes greater numbers of drifting larvae in the bottomland than a backwater condition. However, the potential

geomorphologic response of the bottomland to a flow-through condition is uncertain. Runoff of 2003 presented the first significant flow-through connection for these bottomlands since the reconfiguration. Hydrographic survey crews from Tetra Tech performed monitoring surveys in July of 2003. Analyses of the data showed that the bottomlands experienced localized scour and deposition without indications of aggradation or degradation trends. These findings suggest that the flow-through condition may help to maintain the bottomlands and refresh the bed of the bottomland without negatively impacting the long-term function of the bottomlands. However, data is limited and monitoring is expected to continue with future connectivity to better understand the geomorphic response of these habitats.

A Generalized Interactive Model To Predict Floodplain Habitat Area Needed To Recover The Endangered Razorback Sucker In The Upper Colorado River Basin

Valdez, Richard A.[1] and Pat Nelson[2]

[1]R.A. Valdez & Associates, Inc.; [2]USFWS, Upper Colorado River Endangered Fish Recovery Program

Floodplain Model was developed for the Recovery Program to estimate the amount of floodplain habitat necessary to recover the razorback sucker (*Xyrauchen texanus*) and to support recovered self-sustaining populations. This mathematical model was developed on an Excel platform and is user interactive. It consists of 31 numbered steps, including 17 user-specified input variables and 48 automated output variables. Input variables include initial population size, sex ratio, average total length (TL) of females, percent hatching success, percent larval emergence, survival of larvae during drift, entrainment rate of larvae in floodplains at various river miles, time spent in floodplains, monthly survival in floodplains, annual survival in the mainstem, and fish density. Automated output variables include number of females based on initial number of adults and sex ratio, average female fish weight, number of eggs produced, number of larvae emerging, number of larvae entrained, and number of fish surviving in floodplains. Output variables also include computations of total acres and hectares of floodplains necessary to support specified densities of fish, number of fish recruiting to maturity at 400 mm TL, and recruitment rate as a percentage of the initial adult population. The model estimates that 2,032 acres of floodplain depressions are necessary as nursery and rearing habitat to support a self-sustaining population of 5,800 adult razorback sucker with average annual recruitment of 30% (i.e., 1,740 adults; Recovery Goals target).

Floodplain Management Plans for the Upper Colorado River Basin to Assist Recovery of the Razorback Sucker

Richard A. Valdez, Richard A.[1] and Pat Nelson[2]

[1]R.A. Valdez & Associates, Inc.; [2]USFWS, Upper Colorado River Endangered Fish Recovery Program

The Recovery Program is developing Flooplain Management Plans (Plans) for the Upper Colorado River Basin to provide restoration and management strategies for existing floodplain sites that have been acquired and/or are managed by the Recovery Program for the benefit of the endangered razorback sucker (*Xyrauchen texanus*). The goal of these Plans is to provide adequate floodplain habitats for all life stages of razorback sucker, particularly to serve as nursery areas for larvae and juveniles, for establishment and maintenance of a self-sustaining population, consistent with Species Recovery Goals. The objectives of this Plan are to: (1) inventory floodplain habitats; (2) identify and acquire available floodplain easements; (3) restore and manage available floodplains to benefit razorback sucker and bonytail; and (4) evaluate the effectiveness of restoration. It is hypothesized from scientific studies and hatchery culture that two other endangered fish species, bonytail (*Gila elegans*) and Colorado pikeminnow (*Ptychocheilus lucius*), will also benefit from a greater availability of floodplain habitat. Separate Floodplain Management Plans are being developed for the Green River Subbasin and the Upper Colorado River Subbasin. These Plans will be implemented in three phases with the first phase including prior program actions and achievements, and the last two corresponding to the recovery schedules of the razorback sucker and bonytail. Recovery of these species is estimated to span 22 years, including the first 14 years to establish self-sustaining populations, and the subsequent 8 years for recovery monitoring.

Survival of larval razorback suckers *(Xyrauchen texanus)* in a floodplain depression inhabited by nonnative fish in the Green River, Utah.

Brunson, Ron and Kevin Christopherson

Utah Division of Wildlife Resources, Vernal, Utah

As part of ongoing efforts to recover the endangered razorback sucker *(Xyrauchen texanus)* hatchery produced larval razorback suckers were experimentally stocked into a natural floodplain depression along the Green River, Utah. This study was designed to evaluate if larval razorback suckers could survive in a natural floodplain depression that was also inhabited with nonnative fish and eventually reenter the river. Earlier efforts of stocking larval razorback suckers into Green River floodplain depressions containing abundant nonnative fish were unsuccessful. The very large number of nonnative predators was likely the reason for no observed survival of the stocked larval razorback suckers. Floodplains that dry up during drought years and then flood during wet years

have much lower densities of nonnative fish for the first year. The fish populations in these depressions are reset to zero during these dry cycles. This study was designed to evaluate if large numbers of razorback sucker larvae that entered a "reset" floodplain depression could overwhelm nonnative fish predation, survive, grow and reenter the river during future spring floods. This situation was experimentally created by pumping water from the river into a dry floodplain and introducing larval razorback suckers and nonnative fish into partitioned portions of the floodplain depression. Survival of many razorback sucker larvae was detected, reaching lengths of up to 115mm by mid-summer. Continued monitoring of this floodplain during future spring floods will determine when these razorback suckers enter the river. To continue building on the successes of these studies, we evaluated survival at lower stocking densities to identify the lower stocking threshold needed to enable detection of surviving larvae. This evaluation took place in a "reset" floodplain that connected with the river during spring high flows and was re-invaded by nonnative fishes. Twelve 1/8-acre experimental enclosures were constructed at the Baeser floodplain site. Larval razorback sucker were stocked into the enclosures at six densities ranging from 36,000 to 800 larvae/acre. Survival of razorback sucker was detected in the lowest and the highest density enclosures. However, survival among all enclosures was quite variable. The highest survival (11%) was observed in the highest density (36,000 larvae/acre) enclosure. On average, the four enclosures with the lowest density of stocked razorback sucker had the lowest estimated survival rate, indicating that survival of larval razorback sucker in the presence of nonnative predators is density dependent.

Field application of the 'floodplain reset' approach to enhance survival of bonytail and razorback sucker in the middle Green River, Utah.

Modde, Tim

U.S. Fish and Wildlife Service, Vernal, UT

Floodplains provide nursery habitat for endangered fishes but also support residual nonnatives that prevent survival of native fishes. In an effort to reduce predator pressure, the use of resetting, or draining floodplains, prior to stocking was evaluated as a method of enhancing larval bonytail and razorback sucker survival.

Bonytail and razorback sucker were stocked into Green River floodplains in June 2003. Bonytail larvae were stocked at a rate of 1,430 larvae/ha into the three largest floodplains and adult bonytail were stocked all five floodplains. Razorback sucker were stocked in all five floodplains between 4 and 16 June at a rate of 1,945 fish/ha. All floodplains were connected to the Green River by high flows between 21 May and 5 June 2003. Nonnative fish accessed all study floodplains and reproduced. At the conclusion of the study, nonnative fishes dominated fish numbers and biomass. However, the minimum number of bonytail estimated in floodplains during July ranged between 0 and 112/ha. Bonytail reproduction was observed in three of the five floodplains. Razorback sucker surviving through the end of July was much lower, ranging between 1.3 and 5.6 fish/ha.

Catch rates were correlated to both floodplain size and quantity of submergent vegetation.

Posters

Channel Catfish Control in the Lower Yampa River

Fuller, Mark H.

U.S. Fish and Wildlife Service, Vernal, UT

Since 1998 mechanical removal strategies to reduce subadult and adult channel catfish abundance in the lower Yampa River have been successful. In 1998 methodologies were tested and in 1999 electrofishing and volunteer assisted angling resulted in significant population reductions in several test reaches (57.4 -81.5%). In 2000, the Vernal Field Office made recommendations to expand the control effort and emphasize reduction of channel catfish abundance in the entire Yampa Canyon for 2001 -2003. Study recommendations from the 1998-99 study included removal strategies based on catfish behavior and flow regimes to increase capture effectiveness. Electrofishing on flows between 3000 and 1000 cfs provided the highest catch rates and effectively sampled shallow higher velocity environments (runs and riffles), and volunteer assisted angling provided the most fish per trip when flows were too low to navigate electrofishing rafts in the canyon. Angling effectively sampled the deeper slower velocity habitat (pools) in late summer during lower water levels and when catfish movement between habitats was minimal.

The majority of catfish collected in the canyon have been between 200 and 400 mm total length and data show a steady decrease in average length over the years. Juvenile catfish (<150 mm) are absent from the canyon. Fyke netting, shoreline electrofishing and seining during other studies have failed to detect yoy channel catfish in the canyon . Thus, recruitment (catfish between three and four years of age) of catfish into the canyon consists of catfish mostly > 150mm TL.

Channel catfish growth is slow in the lower Yampa River. Growth data (Tyus and Nikirk 1990) indicates that the most common sized catfish collected from the study area (200 - 400 mm) ranged between five to fourteen years of age. Channel catfish mature between 250 mm and 400 mm (Carlander 1969). Because growth rates are slow, and densities of larger catfish are fairly low (Modde and Fuller 2000), it appears that we are removing much of the mature catfish population in the canyon.

Though nonnative channel catfish (*Ictalurus punctatus*) have been recognized as the principal predator and competitor affecting humpback chub populations in the lower Yampa River, a highly prolific and migratory population of smallmouth bass may raise the bar of demise in Yampa Canyon. Anderson (2002) and Fuller (2003) reported that smallmouth bass in the Yampa and Green Rivers have been increasing since 2001. It is

thought that an increase in smallmouth bass abundance will severely worsen the adverse effects that nonnatives already have on the lower Yampa's distressed native fauna. Concern for susceptible humpback and Colorado pikeminnow to smallmouth bass predation mounted at the RIP's nonnative fish control workshop in 2003 and smallmouth bass were recognized to pose the greatest threat to endangered and native fishes in the lower Yampa River. Therefore, the Vernal Field Office proposed an incidental take of channel catfish and a primary focus of control on smallmouth in Yampa Canyon.

Identification of Desert and Sonora Sucker Larvae and Early Juveniles.

Snyder, Darrel E., Kevin R. Bestgen, Sean. C. Seal, and C. Lynn Bjork (illustrator).

Larval Fish Laboratory, Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO

Desert sucker (*Catostomus clarki*, subgenus *Pantosteus*) and Sonora sucker (*Catostomus insignis*, subgeneus *Catostomus*) are common native fishes of the Gila River Basin in southern Arizona and southwestern New Mexico. Appearance and development are very similar to that of bluehead sucker (*C. discobolus*) and flannelmouth sucker (*C. latipinnis*), respectively, in upstream portions of the Colorado River Basin. Hatching at 8-10 mm SL, completing yolk absorption by 12-14 mm SL and becoming juveniles by 23-24 mm SL, desert sucker are generally 1-2 mm smaller than Sonora sucker at comparable states of development. However, gut loop formation proceeds much more rapidly in desert sucker with prominent cross-wise folds developing by or shortly after transition to the metalarval phase whereas in Sonora sucker such folds don't appear until well after transition to the juvenile period. Desert sucker protolarvae and flexion mesolarvae are characterized by broadly and evenly scattered melanophore pigmentation over the dorsal surface, gradually extending onto lateral surfaces of the body, and a highly variable but usually very extensive line or band of melanophores on the ventral midline between heart and vent. In contrast, dorsal surface pigmentation in Sonora sucker is limited to a line or band of grouped, obliquely aligned, melanophores parallel to each side of the midline, and ventral midline pigmentation is usually absent or sparse. Desert sucker metalarvae and juveniles have 8-12 principal dorsal-fin rays, distinct notches separating upper and lower lips at the corners of the mouth, broadly connected lower-lip lobes, a well-folded gut, and a dark peritoneum. Sonora sucker metalarvae and early juveniles have 10-12 principal dorsal-fin rays, lips continuous at the corners of the mouth, deeply divided lower-lip lobes, a simple s-shaped gut until well after transition to the juvenile period, and little if any ventro-lateral to ventral peritoneal pigmentation.

Demonstration

Computer-interactive Keys for the Larvae and Early Juveniles of Selected Southwestern Catostomids (Hands-on Experimentation).

Snyder, Darrel E.

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Computer-interactive keys for the larvae and early juveniles of selected southwestern catostomids (suckers) are provided for hands-on experimentation. One covers the Catostomidae of the Upper Colorado River Basin (*Catostomus ardens*, *C. catostomus*, *C. commersoni*, *C. discobolus*, *C. latipinnis*, *C. platyrhynchus*, and *Xyrauchen texanus*). The other key covers most of the subfamily Catostominae of the Gila River Basin (*C. Clarki*, *C. insignis*, *C. latipinnis*, *X. texanus*). Computer-interactive keys are more flexible and user-friendly tools for specimen identification than printed dichotomous or polychotomus keys. Among other features, users of such keys can limit consideration to only likely candidate species, have available characters listed in best (most diagnostic) order for remaining taxa, and select from that list in any desired sequence, bypassing characters that are unfamiliar, difficult to assess, or based on structures that are damaged or missing. Depending on the similarity of taxa included, such keys may be easier to prepare and are almost always much easier to correct, modify, or expand than more traditional printed keys. Most computer-interactive keys consist of a descriptive dataset and a commercial, share-ware, or free-ware program for its interrogation (see web site below for a list of such programs). The datasets for the keys presented were prepared in DELTA format (DEscriptive Language for Taxonomy–Dallwitz 1980; Dallwitz, et al. 1993 onwards) and transformed for use by Intkey (Dallwitz et al. 1993 onwards, 1995 onwards), a widely used program available free over the internet (http://biodiversity.uno.edu/delta/).