SAN JUAN RIVER BASIN RECOVERY IMPLEMENTATION PROGRAM

FISCAL YEAR 2005 ANNUAL BUDGET and WORK PLAN

Approved: December 23, 2004

Page	Title	Agency	Program	Other Direct	Total	Funding[1]
Monitoring Proposals						
1	Adult/Juvenile Fish Community Monitoring	FWS, GJ	$ 100,947		$ 100,947	B
5	YOY/Small Bodied Fish Monitoring	NMDGF	$ 72,645		$ 72,645	B
10	Larval Colorado Pikeminnow Survey	UNM, NMDGF	$ 63,089		$ 63,089	B
15	Larval Razorback Sucker Survey	UNM, NMDGF	$ 58,489		$ 58,489	B
22	Specimen Curation/Identification	UNM	$ 23,575		$ 23,575	B
26	Long Term Monitoring - Channel Morphology	KB	$ 203,599		$ 203,599	B
31	Habitat Mapping	KB/ERI	$ 100,507		$ 100,507	B
33	Water Temperature Monitoring	KB	$ 9,713		$ 9,713	B
34	Update and Maintenance of GIS Database	UNM/KB	$ 40,411		$ 40,411	B
38	Additional funding request to complete the Standardized Monitoring Integration Report	MEC/ERI	$ 14,680		$ 14,680	B
Subtotals			**$687,655.00**		**$687,655.00**	
Peer Review Proposal						
40	Peer Review	BIOWEST	$ 23,000[2]		$ 23,000[2]	B
Subtotals			**$ 0**		**$ 0**	

[1]Funding

B – Base funding; C – Capital funding

[2] Peer review proposal funding is a carry over from previous fiscal year allocation.

Page	Title	Agency	Program	Other Direct	Total	Funding[1]
Research Proposals						
43	Population Model Maintenance	MEC/ERI	$ 30,404		$ 30,404	B
45	Trophic Relationships Among Colorado Pikeminnow and Its Prey in the San Juan River	NMDG&F KSU	$ 51,000		$ 51,000	B
57	Assessment of Colorado Pikeminnow Augmentation	BIOWEST, NMDG&F UNM	$172,706	$ 14,200	$ 172,706	B C
68	Development of Stocking Protocols for Colorado Pikeminnow	BIOWEST FWS	$ 5,250		$ 5,250	B
72	Characterization of Razorback Spawning Bar	KB/ERI	$56,768		$56,768	B
Subtotals			**$316,128.00**	**$ 14,200**	**$316,128.00**	
Recovery Proposals						
75	Nonnative Species Monitoring and Control in the Upper Colorado	FWS, Abq	$ 136,062		$ 136,062	B
80	Nonnative Species Control -Lower San Juan	UDWR and others	$ 147,649		$ 147,649	B
85	Razorback Sucker Augmentation and Monitoring	FWS, G.J.	$ 135,219		$ 135,219	B
90	Colorado Pikeminnow Fingerling Production	FWS/DNF HTC	$ 73,059		$ 73,059	B
93	Stocking of Fingerling Colorado Pikeminnow	FWS, G.J.	$ 16,230		$ 16,230	B
96	Razorback Sucker Pond Limnological Monitoring	ERI/BIA	$ 55,212		$ 55,212	B
Subtotals			**$563,431.00**		**$563,431.00**	

[1]Funding

B – Base funding; C – Capital funding

Page	Title	Agency	Program	Other Direct	Total	Funding[1]
Hydrology Committee						
98	Maintenance & Operation of Model	BR	$ 199,206		$ 199,206	B
Subtotals			**$ 199,206**		**$ 199,206**	
Program Coordination and Management						
102	Program Coordination & Program Assistant	FWS, Abq	$ 163,245		$ 163,245	B
104	Program Management	BR	$ 84,960		$ 84,949	B
Subtotals			**$248,205.00**		**$248,194.00**	
Capital Projects and Management						
105	Capital Improvement Program Management	BR	$ 58,100	$ 58,100	0	C
107	Operation of PNM Fish Passage/NAPI Ponds Management Training	Navajo Nation	$ 114,386	0	$ 114,386	B
	PIT Tags[3]	FWS, G.J.	$ 40,000	$ 40,000	0	C
Subtotals			$212,486.00	$98,100.00	$114,386.00	

[1]Funding

B – Base funding; C – Capital funding

[3] PIT tags are capital expenses related to Adult/Juvenile Fish Community Monitoring project.

Table of Contents

FY 2005 Project Proposals

Proposals and Principal Investigators

Adult/Juvenile Fish Community Monitoring

Principal Investigators: Dale Ryden and Chuck McAda, U.S. Fish and Wildlife Service, Grand Junction.

YOY/Small Bodied Fish Monitoring

Principal Investigators: David L. Propst and Amber L. Kingsbury, New Mexico Department of Game and Fish.

San Juan River Larval Colorado Pikeminnow Survey

Principal Investigators: Michael A. Farrington, W. Howard Brandenburg and Sara Gottlieb University of New Mexico; David L. Propst New Mexico Department of Game and Fish.

San Juan River Larval Razorback Sucker

Principal Investigators: W. Howard Brandenburg and Sara J. Gottlieb, University of New Mexico; David L. Propst New Mexico Department of Game and Fish.

San Juan River Specimen Curation

Principal Investigators: Alexandra M. Snyder and Thomas F. Turner, University of New Mexico.

Long Term Monitoring – Channel Morphology

Principal Investigator: Ron Bliesner, Keller-Bliesner Engineering.

Habitat Mapping

Principal Investigators: Ron Bliesner, Keller-Bliesner Engineering; Vince Lamarra, Ecosystems Research Institute.

Water Temperature Monitoring

Principal Investigator: Ron Bliesner, Keller-Bliesner Engineering.

Update and Maintenance of San Juan River Basin Recovery Implementation Program GIS Database and Development of a Web-Based Interactive Interface

Principal Investigators: Sara J. Gottlieb and Alexandra M. Snyder, University of New Mexico.

Additional funding request to complete the Standardized Monitoring Integration Report

Principal Investigator: Bill Miller, Miller Ecological Consultants, Inc..

Peer Review for 2004

Principal Investigator: Paul B. Holden BIO-WEST, Inc., Jicarilla-Apache Nation.

San Juan River Population Model Maintenance

Principal Investigators: Bill Miller, Miller Ecological Consultants; Vince Lamarra, Ecosystems Research Institute.

Trophic Relationships Among Colorado Pikeminnow and Its Prey in the San Juan River

Principal Investigators: Keith B. Gido, Kansas State University; David L. Propst, New Mexico Department of Game and Fish.

Assessment of Colorado Pikeminnow Augmentation in the San Juan River

Principal Investigators: Paul B. Holden and Michael Golden, BIO-WEST, Inc.; David L. Propst

New Mexico Department of Game and Fish; W. Howard Brandenburg and Michael A. Farrington, University of New Mexico; Julie Jackson, Utah Division of Wildlife Resources.

Development of Stocking Protocols for Colorado Pikeminnow in the San Juan River

Principal Investigators: Paul B. Holden and Michael Golden, BIO-WEST, Inc.; Manuel E. Ulibarri, U.S. Fish and Wildlife Service.

Characterization of Razorback Spawning Bar

Principal Investigators: Vince Lamarra Ecosystems Research Institute.

Non-native Species Monitoring and Control in the Upper Colorado Basin

Principal Investigators: Jason Davis, Stephanie Coleman and Jim Brooks, U.S. Fish and Wildlife Service.

Non-native Species Control in the Lower San Juan River

Principal Investigators: Julie A. Jackson and J. Michael Hudson, Utah Division of Wildlife Resources.

Razorback Sucker Augmentation and Monitoring

Principal Investigators: Dale Ryden and Chuck McAda, U.S. Fish and Wildlife Service.

Colorado Pikeminnow Fingerling Production

Principal Investigator: Roger L. Hamman and Mauel E. Ulibarri , U.S. Fish and Wildlife Service.

Stocking of Fingerling Colorado Pikeminnow

Principal Investigator: Dale Ryden and Chuck McAda, U.S. Fish and Wildlife Service.

Razorback Sucker Augmentation Ponds Limnological Study

Principal Investigators: Vince Lamarra Ecosystems Research Institute; Ernie Teller, Bureau of Indian Affairs.

Maintenance and Operation of the San Juan River Basin Hydrology Model

Principal Investigator: Pat Page, U.S. Bureau of Reclamation.

Program Coordinator and Program Assistant

Principal Investigator: David L. Campbell, U.S. Fish and Wildlife Service.

Program Management (Base Funding)

Principal Investigator: Tom Chart and Pat Page, U.S. Bureau of Reclamation.

Capital Improvement Program Management

Principal Investigator: Brent Uilenberg , U.S. Bureau of Reclamation.

Operation of Public Service Company of New Mexico Fish - Passage Structure/NAPI Ponds

Principal Investigator: Jeff Cole, Navajo Nation.

Adult/Juvenile Fish Community Monitoring
Fiscal Year 2005 Project Proposal
14 December 2004

Principal Investigators: Dale Ryden and Chuck McAda
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Background:

Studies performed before 1991 documented a native San Juan River fish fauna of eight species, including Colorado pikeminnow (previously known as Colorado squawfish), razorback sucker, and roundtail chub and provided baseline information on distribution and abundance of native and introduced fish species in the San Juan River. Main channel fish community monitoring studies (known as "adult monitoring") performed from 1991 to 2003 has greatly refined our understanding of the San Juan River fish community and provided data on specific habitat usage by rare fish species. Adult monitoring proved to be a highly effective tool for monitoring populations of stocked razorback sucker and Colorado pikeminnow. Information gathered during adult monitoring also aided in the selection of specific sites for detailed hydrologic measurements and larval drift sampling. Integration of adult monitoring data with data from Colorado pikeminnow macrohabitat studies, razorback sucker experimental stocking studies, tributary and secondary channel studies, fish health studies, contaminants studies, habitat mapping studies, and non-native species interaction studies, helped provide data to make flow recommendations for reoperation of Navajo Reservoir.

As stated above, intensive electrofishing surveys conducted from 1991 to 2003 greatly expanded our knowledge on the distribution and abundance of the San Juan River fish community, especially the endangered fish species. As of October 2003, nineteen wild Colorado pikeminnow (two juveniles and 17 adults) have been collected and PIT-tagged; 13 of the 19 Colorado pikeminnow were radio-tagged. In addition, 45 adult and over 300 juvenile stocked Colorado pikeminnow have been recaptured (95 of these fish were captured on the October 1998 adult monitoring trip). Thirty-seven roundtail chub were collected, 26 of which were PIT-tagged. No wild razorback sucker were collected, however 137 recapture events (including multiple recaptures of individual fish) have occurred with stocked razorback sucker during adult monitoring trips. The 2004 adult monitoring trip is scheduled for late September through early October 2004.

The need for a long-term, standardized monitoring program, such as the adult monitoring study, is addressed in objective 5.7.1, a Milestone in the San Juan River Long Range Plan. Additionally, future monitoring will help determine fish community response to reoperation flows from Navajo Dam (objective 5.2.10), as well as monitoring both wild and augmented populations of Colorado pikeminnow and razorback sucker (objective 5.3.9).

Adult monitoring will continue with one trip in fall 2005, to measure fish community response to reoperation flows from Navajo Dam, monitor populations of stocked Colorado pikeminnow and razorback sucker, and assess the impacts of management actions (e.g., nonnative fish removal efforts) on native fish species. In support of objective #3 below, nonnative fish removal will continue to be done on adult monitoring trips. The study design for adult monitoring is based upon the criteria for

long-term monitoring of the San Juan River main channel fish community. These criteria were accepted as final by the San Juan River Biology Committee on 31 March 2000.

Description of Study Area:
The study area for adult monitoring extends from river mile (RM) 180.0 (Animas River confluence) in Farmington, New Mexico, downstream to RM 2.9 (Clay Hills Landing) just above Lake Powell in Utah. The entire reach of river from RM 180.0 to RM 2.9 will be sampled in the fall of every year (sampling to begin in the second to third week of September).

Objectives:

1.) Monitor the San Juan River's main channel fish community, specifically the large-bodied fish species, to identify shifts in fish community structure, species abundance and distribution, and length/weight frequencies that are occurring corresponding to management actions that are being implemented by the San Juan River Recovery Implementation Program. These include (but may not be limited to) the following:

a) reoperation of water releases from Navajo Reservoir
b) mechanical removal of nonnative fishes
c) modification or removal of instream water diversion structures
d) augmentation efforts for both federally-listed endangered fish species -– Colorado pikeminnow and razorback sucker

2.) Monitor population trends (e.g., distribution and abundance, habitat use, spawning and staging areas, growth rates, recruitment) of the rare San Juan River fish species -– Colorado pikeminnow, razorback sucker, and roundtail chub (both wild and stocked fish).

3.) Remove nonnative fish species which prey upon and compete with native fish species in the San Juan River.

Methods:
Objectives 1-3: One adult monitoring trip will take place in fall 2005. This trip will sample from the Animas River confluence in New Mexico (RM 180.0) to Clay Hills Landing in Utah (RM 2.9). Electrofishing will be the primary sampling technique, although seining and trammel netting may also be employed.

Two oar-powered rafts, with one netter each, will electrofish in a continuous downstream fashion, with one raft on each shoreline. No outboard motors will be used. Sampling crews will consist of approximately 8-9 people (4 for electrofishing, 2 for baggage rafts, and 2-3 for other research elements that are being done simultaneously with our sampling). Electrofishing will sample two out of every three miles (approximately 120 total sampled miles). All fish collected will be enumerated by species and life stage every sampled mile. Every fifth sampled mile (known as a "designated mile" or DM), all fish collected will be weighed and measured. All native fish collected will be returned alive to the river. All nonnative fish collected will be removed from the river. All nonnative predatory fishes (i.e. - walleye, striped bass, largemouth bass, smallmouth bass) collected will be weighed, measured, and have stomach contents taken, before being removed from the river. Tag numbers, total length, and weight will be recorded on all recaptured, FLOY- tagged fish (both native and nonnative), as well as any rare fish collected. Colorado pikeminnow, razorback sucker, and roundtail chub greater than 200 mm TL will be implanted with PIT (Passive Integrated Transponder) tags. Notes will be kept on any parasites and/or abnormalities observed on collected fishes.

Electrofishing will follow the methods set forth above and in the long-term monitoring plan. Seining and trammel netting may be done where suitable habitat is available at the sampling crews' discretion.

The Service will have the lead for adult monitoring trips and other cooperating agencies will provide personnel and equipment as needed. Costs for cooperating agencies are included in this budget.

Products:
An interim progress report for adult monitoring data collected during 2005 is scheduled to be available by 31 March 2006. The "draft final" of this interim progress report which incorporates comments received, is scheduled to be completed by 1 June 2006. DBASE files containing information on total catch and length/weight data gathered on adult monitoring trips will be submitted to the University of New Mexico's Museum of Southwestern Biology (Division of Fishes) for inclusion on the San Juan River Recovery Implementation Program integrated database CD-ROM and web page by 31 March 2006.

Major equipment purchases for FY-2005:
The Coffelt VVP and Honda generator we are currently using have been in continuous service since 1992. We are requesting funds to replace these units with a combination Smith-Root GPP 5.0 electrofisher and a new Honda generator (made by Smith-Root specifically to run with the GPP 5.0) in FY-2005. This would also serve to standardize the electrofishing equipment on this raft with all the other electrofishing rafts being used by other agencies.

YOY/Small Bodied Fish Monitoring
Fiscal Year 2005 Project Proposal

Principal Investigators: David L. Propst and Yvette Paroz
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Background:

As set forth in Section 5.7 of the San Juan River Basin Recovery Implementation Program (SJRIP) Long-Range Plan, a long-term monitoring program "to identify changes in the endangered and other native species populations, status, distributions and habitat conditions" was to be developed by the SJRIP Biology Committee. The ichthyofaunal monitoring portion of the San Juan River Monitoring Plan and Protocols (Propst, et al., 2000) was divided into four primary areas, larval fish (drift sampling), larval fish (seining), young-of-year/small bodied, and subadult and adult/large-bodied fishes. The portion of the San Juan River to be monitored extends from the confluence of the Animas and San Juan rivers (Farmington) to Lake Powell (Clay Hills Crossing). The purposes of small-bodied fish monitoring are to document occurrence and mesohabitat of young-of year Colorado pikeminnow, razorback sucker, and roundtail chub; characterize the fish assemblages of primary channel shoreline and near-shoreline mesohabitats, secondary channels, and backwaters; and document and assess changes in the abundance of common native and nonnative small-bodied fishes (including age 0 flannelmouth sucker, bluehead sucker, common carp, and channel catfish). The following work proposal for 2005 is to conduct the young-of-year/small-bodied fishes monitoring effort per protocols set forth in the San Juan River Monitoring Plan and Protocols (SJRMPP). Beginning in 2003, specimens collected from each mesohabitat were preserved separately, data were recorded in database by mesohabitat, and annual reporting included summary of species occurrences by mesohabitat. During 2004 autumn monitoring, sampling of primary channel near-shore riffle and run mesohabitats was accomplished, on a trial basis, by enclosing a 30 m^2 area and using a backpack electrofisher to drive fishes into a bag seine. This sampling was done at two sample sites in each geomorphic reach.

In addition to accomplishing work (field, laboratory, data analyses, and report writing) specific to the young-of-year/small-bodied fish monitoring effort, NMGF personnel participate in telemetry studies, native-nonnative interactions studies (upper and lower San Juan), Colorado pikeminnow augmentation evaluation, and larval fish sampling of the San Juan River Basin Recovery Implementation Program. This work and budgeting for NMGF participation in these activities is included with Scopes of Work for each activity and submitted by Principal Investigator(s) for each.

Study Area:

The study area for YOY/small bodied fish monitoring extends from river mile RM 180.0 (Animas River confluence) in Farmington, New Mexico, downstream to RM 2.9 (Clay Hills Crossing), just above Lake Powell in Utah.

Collections:

Specimens collected will be inspected to determine if any rare fishes (Colorado pikeminnow, roundtail chub, and razorback sucker) are present in a sample or collection. All identifiable rare fish and all large-bodied native fishes (i.e., flannelmouth and bluehead suckers)>150 mm TL will be released. Specimens

from each sampled mesohabitat will be preserved separately. All other specimens will be preserved in 10% formalin and returned to the New Mexico Department of Game and Fish Laboratory for identification, enumeration, and measurement (total length). After processing, all specimens will be accessioned to the UNM Museum of Southwestern Biology, Fish Section.

Objectives:

The objectives of this portion of the San Juan River monitoring effort are to document occurrence and habitat use in primary channel shoreline and near-shoreline mesohabitats, secondary channels, and backwaters by age 0 Colorado pikeminnow, razorback sucker, and roundtail chub; occurrence and habitat use by other native and nonnative fishes is sampled habitats, to obtain data that will aid in the evaluation of the responses (e.g., reproduction, recruitment, and growth) of native and nonnative fishes to different flow regimes and other management actions (e.g., impediment modification); to track trends in species populations (e.g., abundance and relative condition); and to characterize patterns of mesohabitat use by common native and nonnative small bodied fishes (including age 0 flannelmouth sucker, bluehead sucker, common carp, and channel catfish). The data will also be available to all researchers and may be used in conjunction with data obtained in other studies to evaluate future management activities.

Methods:

The study reach (Farmington to Clay Hills Crossing) includes geomorphic reaches 6 through 1, with Reach 1 being the most downstream. Previously, as stated in SJRMPP, sampling occurred every third mile within the study reach. Because of the addition of enclosure sampling of near-shoreline primary channel mesohabitats and additional time and resources required, primary channel sampling will occur every fifth mile. To the extent possible, all secondary channels will continue to be sampled. Secondary channels are defined as channels having less than 25% of the volume of flow at the time of sampling and are at least 200 m in length. Inflow at the top of a channel is not necessary for it to be classified as a secondary channel. Young-of-year/small-bodies fish monitoring will occur in conjunction with the large-bodied fish monitoring effort. Fieldwork will be accomplished in autumn (late-September through mid-October) and involves one foray through each of three macro-reaches (Farmington-Shiprock, Shiprock-Four Corners, and Four Corners-Clay Hills Crossing).

In addition to structured primary channel sampling, all backwaters and embayments (>25 m^2) associated with the primary channel within each fifth-mile will be sampled. Large backwaters (ca. 250 m^2) outside designated sample-miles will be sampled, if possible.

Sample sites within secondary channels will be a sufficient distance from the inflow to and outflow from the secondary channel to minimize primary channel faunal and physiochemical influences. Secondary channel sample sites will be at least 100 and not more than 200 m in length. Each mesohabitats (e.g., pool, riffle, riffle-eddy, and shoal) within the site will be sampled in approximate proportion to its availability within the site; typically, at least five mesohabitat types will be sampled in each secondary channel with inflow. Mesohabitat of secondary channels lacking inflow is typically only pool. Each mesohabitat will be sampled separately with 3.2 x. 1.6 m (4 mm mesh) drag seines. Each secondary channel sampling effort will be a minimum of 5 seine hauls. The number of seine hauls, area (m^2) of seined portion of each mesohabitat, and types of mesohabitats sampled will be recorded on standard field forms. Specimens collected in each mesohabitat will be inspected to determine if any rare fishes (Colorado pikeminnow, roundtail chub, and razorback sucker) are present in the seine. If a rare fish is captured, it will be identified, total length (±1.0 mm) and mass (±1.0g) determined, and released. Any rare fish >150 mm TL will be scanned to determine presence of a PIT tag. If none is present, the specimen will be implanted with a PIT tag having a unique alphanumeric code. All pertinent data (i.e., total and standard lengths, mass, PIT tag code, mesohabitat, water depth,

substrate, and cover) on rare fish captured will be recorded. All large-bodied native fishes (i.e., flannelmouth and bluehead suckers) will be weighted, measured, and released. All other specimens will be preserved separately by mesohabitat in 10% formalin and returned to the New Mexico Department of Game and Fish Laboratory for identification, enumeration, and measurement (total length). Field collection number, habitat number, and river mile will be recorded on a water-proof label and placed in each specimen container. Location of site (UTM) will be determined with a GPS unit. Identification of all retained rare fishes will be confirmed by personnel of the Museum of Southwestern Biology. Preserved specimens will be accessioned to the New Mexico Department of Game and Fish Collection of Fishes or the University of New Mexico Museum of Southwestern Biology.

Within each fifth-mile, shoreline habitats of the primary channel will be sampled. At each designated mile, all mesohabitats (e.g., riffle, debris pool, and shoal) along 200 m (near center of mile) of shoreline will be sampled. All mesohabitats present will be sampled in approximate proportion to their availability within the site. Regardless of the number of mesohabitats present at a primary channel site, at least 5 seine hauls will be made with a drag seine (3.2 x 1.6 m, 4mm mesh). The shoreline (river right or left) sampled will be dependent upon accessibility of the shoreline. Where more than one shoreline is accessible (and can be seined efficiently), that with greater diversity/complexity will be sampled. Alternatively, primary channel island shorelines may be sampled. In addition to shoreline mesohabitats, a near-shore riffle, near-shore run, and near-shore shoal (if present) will be sampled by enclosing on three sides about 30 m^2. One 30 ft seine (1/4 in mesh) will be placed parallel to shore and held in place with tee posts. The shoreline will serve as parallel "fence" to staked seine, if feasible. If not, a second seine will be staked to provide parallel fence. A 20 ft bag seine (¼ in panel mesh and 1/8 in bag mesh) will be placed across downstream opening. A backpack shocker will be used to stun and drive fish into bag seine. One electrofishing pass will be made within each enclosure. Fish captured in each enclosure will be identified, enumerated, and measured (except nonnatives $\leq$ 100 mm TL, which will be preserved). Location (UTM) will be determined with a GPS unit. Specimen and habitat data will be obtained and recorded as required for secondary channel sampling. All retained specimens from primary channel sampling will be preserved separately from the adjacent secondary channel collection. All retained specimens will be accessioned to the New Mexico Department of Game and Fish Collection of Fishes or the University of New Mexico Museum of Southwestern Biology.

Backwaters and embayments (>25 m^2) not located within structured primary channel sampling sites, but within each designated mile, also will be sampled. During periods of low flow, secondary channel mouths frequently function as backwaters or embayments. In this monitoring effort, secondary channel mouths without surface inflow from upstream will be treated as backwater/embayment habitat. The maximum number of backwaters or embayments sampled will be one per mile. Two seine hauls will be made in each backwater or embayment sampled. All specimens collected, except rare fishes, will be retained and returned to the laboratory for identification and enumeration. All rare fish will be measured and released; those >150 mm will be PIT tagged. Data collection and recording of relevant information (including GPS determined location) will be the same as for secondary and primary channels.

Ambient temperature and water quality data (water temperature, dissolved oxygen, conductivity, and salinity) will be measured in each sampled secondary channel, at primary channel sites, and in backwaters/embayments. Secondary channel water quality data will be obtained a sufficient distance from the inflow to the secondary channel to minimize primary channel influences. All water quality data for each sample will be recorded on standard field forms.

Products:

Data collected during the 2005 monitoring effort will be summarized by geomorphic reaches. Minimally, the annual report will report density per species (number/m^2) per geomorphic reach (primary

and secondary channels and backwaters) and rare fishes and the mesohabitats in which each was found. A comparison of off-shore enclosure versus shoreline mesohabitat sampling catch (species and catch-per-unit effort) and a preliminary evaluation of each method will be presented. Community-comparison metrics, such as the Shannon-Wiener Index and Morisita's Index of Diversity, will be used for longitudinal and annual comparisons. River discharge data (Shiprock gage) will be used to assess the effect of discharge volume on species density estimates. All data obtained during 2005 monitoring activities will be electronically recorded in a format to be determined by the SJRIP Biology Committee. The annual report (including electronic database) will be submitted to the SJRIP Biology Committed by 31 March 2006.

Literature Cited:

Propst, D.L., S. P. Platania, D.W. Ryden, and R. Bliesner. 2000. San Juan River Monitoring Plan and Protocols. San Juan Basin Recovery Implementation Program. U.S. Fish and Wildlife Service, Albuquerque, NM.

San Juan River Larval Colorado Pikeminnow Survey
Fiscal Year 2005 Project Proposal

Principal Investigators: Michael A. Farrington, W. Howard Brandenburg, and Sara J. Gottlieb
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Background:

Beginning in spring 1995, personnel from the Division of Fishes, Museum of Southwestern Biology (MSB), at the University of New Mexico assumed responsibility for the San Juan River larval fish passive drift-netting study. This project, formerly conducted by the Utah Division of Wildlife Resources, continued with only minor changes in sampling protocol. Data collected from this research activity provided several discrete types of information on the fishes of the San Juan River. Data that can be obtained on the endangered fishes of the river include determining approximate spawning period, identifying approximate location of spawning sites, and assessing effects of annual hydrology (and temperature) on their reproductive activities. Similar data could also be obtained for other members of the ichthyofaunal community and contrasted with previously drift-net sampling to assess the effects of that year's flow regime on fish reproduction. Samples collected during this research program were and will continue to be processed and curated by Fish Division personnel at the University of New Mexico.

Between 1993-2001, a total of six larval Colorado pikeminnow have been collected. The two YOY Colorado pikeminnow collected in 1993 (at Mexican Hat) were the same length (9.2 mm TL; MSB 18098, 18099) and were taken on consecutive days in late July (26-27). From these two individuals, we determined the date of spawning to be about 8-9 July 1995.

Two larval Colorado pikeminnow were taken at Mexican Hat during the 1995 larval fish passive drift-netting study. The first specimen, 9.5 mm TL mesolarvae (MSB 26187) was taken between 2114-2310 hours on 2 August 1995. The next morning (3 August 1995) between 0531-0800 hours, a second Colorado pikeminnow, 9.0 mm TL mesolarvae (MSB 26191) was collected. The similar size and developmental stage of these two individuals, in combination with the fact that the two fish were collected within 12 hours of each other, strongly suggest that they were cohorts from a spawning event. From these two individuals, a spawning date (between 15-17 July) was determined.

A single YOY Colorado pikeminnow was collected in 1996. That specimen was an 8.6 mm TL yolked-mesolarvae taken on 2 August 1996 in a drift net at the Mixer sampling locality (RM 128.0). The 1996 back-calculated spawning date for Colorado pikeminnow (18 July 1996) was similar to that predicted in

1995 despite considerable difference in spring peak discharge (1995 - 12,100 cfs; 1996 - 3,450 cfs) and total annual discharge. The 1997-2000 drift netting samples did not yield any Colorado pikeminnow.

A single larval Colorado pikeminnow was collected in 2001 at the Mixer sampling locality (RM 128.0). The specimen was collected on 1 August 2001, and was a 8.5mm TL yolked mesolarvae. From this specimen a spawning date (between 17-18) July was determined.

Table 1. Summary of larval and YOY Colorado pikeminnow collected in the San Juan River during larval drift-netting (1993-2001) and back-calculated dates of spawning.

Field Number	MSB Number	Catalog Number	specimen.	Total Length	Date Collected	Date Spawned	River Mile	Sample Method
MH72693-2	18098	1	9.2	26 Jul 93	08 Jul 93	53.0	drift netting	
MH72793-2	18099	1	9.2	27 Jul 93	09 Jul 93	53.0	drift netting	
JPS95-205	26187	1	9.2	02 Aug 95	15 Jul 95	53.0	drift netting	
JPS95-207	26191	1	9.0	03 Aug 95	17 Jul 95	53.0	drift netting	
WHB96-037	29717	1	8.6	02 Aug 96	18 Jul 96	128.0	drift netting	
FC01-054	50194	1	8.5	01 Aug 01	18 Jul 01	128.0	drift netting	
TOTAL			**6**					

The specimen collected in 2001 represents the first non-stocked larval Colorado pikeminnow collected in the drift since August 1996. In 2001, less than 1,000 specimens were collected during a year replete with intense summer rainstorm events. These flushing flows transported considerable detritus into the river and overwhelmed drift collecting gear with debris. This excessive amount of debris required over a year of processing before fish could be separated from all samples and identified. The sampling conducted in 1999 occurred during an extremely low flow year, which was reflected in the collection of a very limited number of drifting larval fish (only 84 at Four Corners and 79 at Mexican Hat). Conversely, 2000 was a Amore normal@ flow year resulting in the collection of over 2,100 specimens (1,370 at Four Corners and 768 at Mexican Hat).

The limited number of wild adult San Juan River Colorado pikeminnow (versus stocked individuals) is reflective in the extremely low catch rate of larval Colorado pikeminnow. However, numerous adult and sub-adult pikeminnow have been stocked into the San Juan River over the last seven years in an effort to augment the diminished population. The Colorado pikeminnow augmentation plan calls for continued stocking efforts in the San Juan River over the next 10 years. The Biology Research Team expects, as was documented with stocked razorback sucker, that reproduction among stock pikeminnow will occur and can be documented through the sampling of larval fish. There are no means to differentiate between native versus stocked larval Colorado pikeminnow.

As the number of adult (reproductively mature) Colorado pikeminnow in the San Juan River increases (due to both stocking and recruitment), so does the probability of elevated levels of spawning by this species. The San Juan River Biology Committee charged us with exploring the possibility of expanding the sampling effort for larval Colorado pikeminnow in fiscal year 2003. One means of accomplishing

this task was to include an additional sampling site in (increasing from two-to-three sites). Another suggestion for FY 2003 Colorado pikeminnow studies was to perform targeted sampling for Colorado pikeminnow similar to that being performed for larval razorback sucker. Collections targeting larval Colorado pikeminnow could be accomplished either by expanding the duration of the current larval razorback sucker survey (April-June) or through development of a discrete (new) project.

These and other items were considered and evaluated during the February 2002 San Juan Biology Committee meeting. The team recommended the immediate expansion of the larval razorback sucker survey (April-June) to encompass the months of June, July, and August with seining efforts to target sampling for Colorado pikeminnow. This change in sampling protocol required deviation from the FY 2002 Scope of Work was initiated July 2002 (using FY 2002 funds).

Approval for this change in sampling was acquired at the 19-21 February 2002 San Juan Biology Committee meeting in Farmington, New Mexico. This new sampling protocol resulted in the collection of over 95,000 specimens for the Colorado pikeminnow larval survey in 2002, and over 70,000 specimens in 2003. Unfortunately, no larval Colorado pikeminnow were collected in 2002 or 2003.

The objectives of this specific monitoring effort are identified in the aforementioned document (1a, 3a, 3b) and listed below.

Study Area:
The principal sampling area for this study will be the San Juan River between Cudei Diversion Dam (RM 141.5) and the Clay Hills boat landing (RM 2.9) just above Lake Powell Utah. This study will include acquiring collections in reaches of the San Juan River under the jurisdiction of the National Park Service.

Objectives:

1.) Determine the relative annual reproductive success of Colorado pikeminnow

2.) Provide annual summaries of monitoring results

3.) Provide detailed analysis of data collected to determine progress towards endangered species recovery in three years and thence every five years

4.) Provide comparative analysis of the reproductive success of the San Juan River fishes

5.) Attempt to validate presumed spawning period of Colorado pikeminnow

Methods:
Sampling for Colorado pikeminnow larvae will be conducted in the San Juan River between Cudei (Rm 141.5) and Clay Hills (RM 2.9) from early July through mid-September using sampling techniques that will provide sufficient numbers of individual fish necessary to meet study objectives. Access to the river will be gained through the use of inflatable rafts. Sampling efforts for larval fish will be concentrated in low velocity habitats. Samples in those habitats will be collected with small mesh seines.

Meso-habitat type, length, maximum and minimum depths, water clarity, water quality, and substrate will be recorded for each sampling locality. Digital photos as well as GPS coordinates will also be taken at each of the sampling localities. For each sampling locality, river mile will be determined to the nearest tenth of a mile using the San Juan River Basin Recovery Implementation Program 2003 Standardized Map Set. For seine samples, the length and number of hauls made will be recorded. Catch per unit effort for seine samples will be recorded as the number of fish per 100 m^2.

Catch rate date will be compared across and within site by species. In addition, catch rate between and within site will be compared temporally. Specimens will be distinguished and compared by residence status (native versus non-native) and catch rate over-laid with the annual hydrograph.

Products:

A draft report for the 2005 larval Colorado pikeminnow sampling activities (combined with 2005 larval razorback sucker sampling activities) will be prepared and distributed by 31 March 2006 to the San Juan River Biology Committee for review. Upon receipt of written comments, that report will be finalization and disseminated to members of the San Juan River Biology Committee by 1 June 2006. Fish collected from those studies will be curated in the Division of Fishes, Museum of Southwestern Biology (MSB), Department of Biology, at the University of New Mexico. Original field notes will be retained in the Division of Fishes and collection information will be electronically stored in a permanent MSB database program where the geo-referenced collection information will be maintained in a consistent database and GIS format. These data and any maps generated from them will be available to the San Juan River Biology Committee via hard-copy reports and electronically. Electronic copies of the field and collection data will be transferred to the San Juan River database manager following the successful protocol previously employed.

San Juan River Larval Razorback Sucker Survey
Fiscal Year 2005 Project Proposal

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Background:
In 1994, the first series of razorback sucker (n=672) were stocked in the San Juan River between Bluff, Utah and Hogback, New Mexico. Mean length and mass of those individuals, at the time of stocking, was about 400 mm TL and 710 g, respectively. In 1995, 13 of the recaptured razorback sucker were tuberculate males and six of those individuals were ripe. Four recaptured 1995-razorback sucker were determined to be female but, unlike the males, none were sexually mature. In their 1995 report of activities, Ryden and Pfeifer (1996) suggested that the majority of the experimentally stocked San Juan River razorback sucker reached sexual maturity in 1995-96 and that spawning of these individuals might begin in the next two years.

The UNM-NMGF larval fish drift study, whose primary focus was determining spawning period, identifying approximate location of spawning sites, and assessing effects of annual hydrology (and temperature) on Colorado pikeminnow reproductive activities, provided similar information for other members of the ichthyofaunal community. At the November 1996 San Juan River Biology Committee integration meeting, it was suggested that a portion of the larval fish drift study be expanded to allow for documentation of razorback sucker spawning. However, because reproduction by razorback sucker (March-May) occurred considerably earlier than Colorado pikeminnow (June-July), separate investigations of spawning periodicity and magnitude were necessary for each species.

The most significant potential difference identified between the two studies, besides temporal differences in spawning, was that we were attempting to provide the first documentation of reproduction by individuals (razorback sucker) whose spawning potential had not been determined. Sampling for larval razorback sucker was being conducted with no assurance that the stocked population of adult razorback sucker would spawn in this system. Conversely, we knew from previous studies that Colorado pikeminnow reproduction had and was still occurring in the San Juan River and, because of this certainty, our larval fish sampling efforts for this minnow could be different than those for razorback sucker.

Numerous Upper Colorado River basin researchers had reported light-traps as one of the best means of collecting larval razorback sucker, we too elected to use that sampling procedure during the first year

(calendar year 1997) of sampling. The only previous San Juan River fish investigation that employed light-traps was in 1994-1995 (conducted by the National Park Service) near the San Juan River-Lake Powell confluence. The 1994 sampling effort produced an extremely large number of larval fish (ca. 25,000) from a modest number of samples (n=20), of which over 99% were red shiner. Similar sampling in 1995 yielded 25,455 specimens in 47 light-traps samples and as in 1994, red shiner numerically dominated the catch. No Colorado pikeminnow or razorback sucker were taken in the 1994-1995 light-trap sampling efforts.

During the 1997 razorback sucker larval fish survey, light traps were set nightly in low-velocity habitats between Aneth and Mexican Hat from late March through mid-June 1997. The traps were distributed at dusk and retrieved about four hours later. Fish taken in those samples were preserved in the field. Sampling success during the 1997 razorback sucker larval fish study was quite poor. While there were over 200 light-trap sets, those sampling efforts produced only 297 fish. Of those, about 200 (66%) were larval suckers (either flannelmouth sucker or bluehead sucker). Larval razorback sucker were not present in the 1997 sampling survey. While there were probably several factors to account for the poor light trap catch rate, a principal factor was the limited access to suitable habitats. Light traps are most effective when set in habitats with little or no water velocity. During our driving survey of riverine habitats in the region (March 1997), we identified numerous locations that appeared to be suitable sites for light trap sampling.

However, we found that high flow in the San Juan River eliminated virtually all previously identified low velocity habitats. Further driving reconnaissance failed to yield additional locations to set light traps. Being tied to specific collecting sites was not the most efficient means of collecting large numbers of individuals.

In 1998 we modified our sampling technique to allow for the sampling of a greater portion of the San Juan River and the collection of a significantly larger number of larval fish over a wider reach of the river. We conducted sampling forays (n=6) at approximately bi-weekly intervals from 17 April (first trip - no larval suckers) to 6 June 1998 between the Four Corners drift-net station (RM 128) and Bluff (RM 80) and used both active and passive sampling techniques to collect larval fish. The primary sampling method was a fine mesh larval seine (in 1998, we collected more larval sucker in a single seine sample than in all of the 1997 light trap samples). Passive sampling techniques were both drift-netting and the use of light-traps. Drift-nets were set periodically to determine if larval sucker comprised a significant portion of the drift community while light-traps were set adjacent to campsites if appropriate aquatic mesohabitats could be located. An inflatable raft was used to traverse this river reach and allowed investigators the opportunity to sample habitats that were either not formerly accessible or observable under the constraints of the previous sampling protocol.

The 1998 sampling protocol resulted in 183 collections and 13,000 specimens between river miles 68.7 and 126.1. The majority of these individuals (n=9,960) were larval catostomids. This 43-fold increase in number of specimens, as compared with 1997, provided substantially better resolution of spawning periodicity of the sucker community.

In addition, the 1998 samples produced enough individuals for investigators to determine, with a high degree of confidence, if razorback sucker reproduction occurred in the San Juan River during that period. None of the aforementioned information was obtainable from 1997 light-trap samples. In 1998, two larval razorback sucker were collected. These specimens provide verification of spawning by the re-established population.

In 1999, the study area was expanded to include the San Juan River from near Four Corners (River Mile 128) to near Clay Hills (River Mile 4.9). The scope of work for that year included at least one

collecting effort between Sand Island and Clay Hills. A total of 174 fish collections were made in 1999 producing over 20,000 fishes. Over 37% of these individuals were sucker larvae (n=7,635). Seven larval razorback sucker were collected in 1999 between 4 May and 14 June. The seven larvae (razorback) were taken in backwaters or low velocity habitats located between river miles 96.2 and 11.5. Almost half (n=3) of these individuals were in the new-downstream reach first sampled in 1999.

There was no substantive change in the sampling protocol or methodology for this project in 2000. A total of 210 collections were made between 4 April and 23 June 2000. These collections yielded 11,316 specimens of which 7,587 (67%) were larval sucker. There was a marked increase in the number of larval razorback sucker taken in 2000 as compared with 1999 and 1998. Identifications of individuals revealed 129 larval razorback sucker in 24 separate collections. Individuals were collected in low velocity habitats between river miles 124.8 and 8.1. The lowest-most sampling location that yielded larval razorback sucker (RM 8.1) produced over 85 individuals in a single sample (26 May 2000). Conversely, the uppermost collection of larval razorback sucker was less than four river miles downstream of the upper boundary of the study area on 1 June 2000.

In 2001 the study area was expanded once more to include an additional 14 miles upstream, to Cudei NM. There was a substantial increase in the number of fish collected in 2001. A total of 206 collections were made between 10 April 2001 and 14 June 2001 yielding 95,628 specimens. The majority of these fishes were represented by non-native larval cyprinids accounting for 94% of the total number of fish collected in 2001. Catostomids comprised only 8.4% of the total catch. There was a decline in the overall catch of larval razorback in 2001 (n=50). The decreased number in 2001 compared with 2000 (n=129) is within the normal boundaries of sample variation that would be experienced in annual fish collections of such a magnitude. Razorback sucker were collected at 15 sites, two of which produced more than 10 individuals, and for the first time since 1999, larval razorback (n=2) were collected in light-traps.

The results in 2002 produced informative and interesting data. A total of 152 fish collections were made between river mile 141.6 and 2.8 from 15 April 2002- 29 June 2002. A total of 813 larval and juvenile razorback sucker was collected during 2002, the largest number taken to date. Twenty collections contained >10 individual razorback sucker and five samples contained >50 individuals. In 2002 razorback sucker exhibited a more uniform longitudinal distribution compared to previous years. The most upstream larval razorback sucker collection was RM 134.5 (Reach 5) while the most downstream site of collection was Clay Hills, Utah (RM 2.8). Reaches 3 and 4 produced the greatest number of razorback sucker (n=312 and n=320 respectively). Much larger juveniles were collected in 2002 than in previous years. The largest juvenile razorback sucker collected was 54.4 mm TL as compared to 28.8 mm TL for the largest specimen collected prior to 2002. Juvenile razorback sucker comprised 15.9% of all razorback sucker collected in 2002 and were taken throughout the study area.

Due to the continued documentation and increased numbers of razorback sucker larvae collected over the previous years, the study design was altered in 2003. Rather than breaking the river up into upper and lower reaches as was done in previous years, the entire study area was sampled each trip and data analyzed along the predesignated San Juan River Reaches. This change facilitated integration of the larval surveys with that of the other monitoring activities (i.e., small bodied fish, adult monitoring, habitat, etc). The 2003 larval razorback sucker survey produced a total of 208 fish collections and a total effort of 7,329.5 m^2 in which 41,181 specimens were collected. Catostomids comprised 15.2% (n= 6275) of the total fish catch. For the sixth consecutive year razorback sucker reproduction was documented on the San Juan River in 2003. Although there was a 41.9% decrease in larval razorback sucker collected in 2003 (n= 472) compared with 2002 (n= 813), there were 60.2% more individuals collected in 2003 than 1998 through 2001 combined. The distribution of razorback sucker in 2003 was

reduced from previous years to reaches 3, 2, and 1, with reaches 3 and 1 producing the greatest numbers of individuals (42.4% and 40.2%, respectively).

The results of this investigation continues to provide unequivocal documentation of reproduction in the San Juan River by members of a razorback sucker cohort that had been stocked as part of the San Juan River Basin Recovery Implementation Program. Excluding 2001, there has been a logarithmic increase in the number of individuals collected and there is no reason to assume that this trend will not continue in 2003 and FY2004. The sampling process has proven an extremely effective means of monitoring this ontogenetic stage of razorback sucker.

This work is being conducted as required by the San Juan River Basin Recovery Implementation Program Monitoring Plan and Protocol dated 31 March 2000. The objectives of this specific monitoring effort are identified in the aforementioned document (1a, 3a, 3b) and listed below.

Study Area:
The principal sampling area for this study will be the San Juan River between Cudei (near RM 141.5) and the Clay Hills boat landing (ca. RM 2.9) just above Lake Powell in Utah. A spring 2000 collection of larval razorback sucker at RM 124.8 indicated the need to expand the upstream boundary of the study area (formerly RM 128). Beginning in 2001, sampling included an additional 14 river miles of the San Juan River (the reach between Cudei and RM 128). As in all post 1999 sampling efforts, the study will include making collections in reaches of the San Juan River under the jurisdiction of the National Park Service.

Objectives:

1.) Determine the spawning periodicity of catostomids between mid-April and early June and examine potential correlation with temperature and discharge.

2.) Attempt to validate presumed spawning period of San Juan River catostomids using data from the razorback sucker and Colorado pikeminnow larval fish studies.

3.) Determine if reproduction by razorback sucker occurred in the San Juan River (upstream of Mexican Hat, UT)

4.) Provide comparative analysis of the reproductive effort of catostomids.

5.) Determine the relative annual reproductive success of razorback sucker (1a).

6.) Provide annual summaries of monitoring results (3a).

7.) Provide detailed analysis of data collected to determine progress towards endangered species recovery in three years and thence every five years (3b).

Methods:
Sampling for razorback sucker larvae will be conducted in the San Juan River between Cudei (RM 141.5) and Clay Hills (RM 2.9) from early April through early June using sampling techniques that will provide sufficient number of individual fish necessary to meet study objectives. GPS readings and digital photos, and water quality (dissolved oxygen, conductivity, temperature, and salinity) will be taken at each sampling locality, and researchers will record UTM coordinates and zone corresponding with each field number as agreed upon at the May, 2001 meeting of the San Juan River Biological Committee. Access to the river shall be acquired through the use of an inflatable raft. The tentative sampling schedule will be once a month and encompass the entire study area (Cudei to Clay Hills).

As previous San Juan River investigations have clearly demonstrated, larval fish most frequently occur and are most abundant in low velocity habitats (i.e., backwaters, isolated pools, and secondary channels), sampling efforts will be concentrated in these mesohabitats. Small mesh seines (1 m x 1 m x 0.8 mm) will be the primary means of collecting larval fish from low-velocity habitats. Meso-habitat type, length, maximum depth, and substrate will be recorded for each sample. For seine samples, the length of each seine haul will be determined in addition to the number of seine hauls per site.

In prior years, a number of samples were taken utilizing light-traps when suitable sampling sites coincided with the evenings' campsite. This method was determined to provide no additional information that the seining method alone could not provide, and furthermore complicated data analysis. At a 4-6 May, 2004 Biology Committee meeting, it was agreed that this method would no longer be employed during larval razorback sucker sampling.

All retained specimens will be placed in plastic bags containing a solution of 5% buffered formalin and a tag inscribed with unique alpha-numeric code that will also be recorded on the field data sheet. River Mile, standardized for the San Juan River Basin Recovery Implementation Program, will be the primary descriptor used to designate the location of sampling sites. Global Positioning System (GPS) readings (the principal numeric descriptor) will be taken at each sampling locality as stipulated at the May, 2001 meeting of the San Juan River Biological Committee. Universal Transverse Mercator (UTM) coordinates and zone will be determined with a Garmin Navigation Geographic Positioning System Instrument for each sampling locality and recorded on a field data sheet whose unique alpha-numeric code matches that of the tag in the retained sample.

Preserved collections will be returned to the laboratory where they will be sorted, specimens identified to species, enumerated, measured (minimum and maximum size [mm SL] for each species at each site), transferred to 70% ethyl alcohol, and catalogued in the Division of Fishes of the Museum of Southwestern Biology (MSB) at the University of New Mexico (UNM). Specimens whose species-specific identity is dubious or merit additional verification will be forwarded to Darrel E. Snyder (Larval Fish Laboratory, Colorado State University) for review.

Catch per unit effort (CPUE), for each seine sample, will be determined as the number of fish per 100 m^2 of water sampled. The annual 2004 razorback sucker survey report will present, in summarized tabular form, fish catch rate (per species) for the entire study period as well by river reach. In addition, catch rate between and within reaches will be compared temporally. Detailed collection information (i.e., catch methodology, species composition of the sample, mesohabitat description, physical-chemical habitat characteristics, length and developmental stage of razorback sucker specimens) will be provided for samples that contain larval razorback sucker. Community-comparison metrics, such as the Shannon-Wiener Index and Morisita's Index of Diversity, will be used for longitudinal and annual comparisons. Specimens will be distinguished and compared by residence status (native versus non-native) and catch rate over-laid with the annual hydrograph. Mean daily discharge data during the study period will be obtained from U.S. Geological Survey Gauge at Four Corners (#09371010), Colorado. The river discharge data will be used to assess the effect of discharge volume on species density estimates.

For reporting purposes, pre-2003 larval razorback sucker data were separated into upper and lower reaches with the former including collections between RM 141.5 and Bluff and the latter containing collections from Bluff downstream to Clay Hills Crossing (RM 2.9). A new protocol for reporting on annual monitoring activities was agreed to by the San Juan River Basin Biology Committee and initiated beginning with 2002 reports. One component of the new reporting was that data were to be analyzed along the predesignated San Juan River Reaches. This change in reporting did not work well for the larval San Juan River razorback sucker survey project as that investigation was not conducted in the same format as the other monitoring activities (i.e., small bodied fish, adult monitoring, habitat, etc).

In those other, well established monitoring programs, sampling of the entire river was done during a single uninterrupted effort which allowed for meaningful between-reach comparisons. Conversely, the larval San Juan River razorback sucker survey project does not attempt to sample the entire study area under a single, continuous sample event. Instead, the river was divided into functional reaches (upper and lower) based solely on the distance that could be sampled in five to seven days and points of access. The period between sampling events of the upper and lower reaches of the San Juan River (under this study) were often one to two weeks. This sampling protocol allowed for a more efficient sampling of the San Juan River, especially given that the larval San Juan River razorback sucker survey project was still functioning primarily as a "search and capture" versus "monitoring" project.

Products:

A draft report for the 2005 larval razorback sucker sampling activities (combined with 2005 larval Colorado pikeminnow sampling activities) will be prepared and distributed to the San Juan River Biology Committee for review by 31 March 2006. Upon receipt of written comments, that report will be finalized and disseminated to members of the San Juan River Biology Committee by 1 June 2006. Fish collected from this study will be curated in the Division of Fishes, Museum of Southwestern Biology (MSB), Department of Biology, at the University of New Mexico. Original field notes will be retained in the Division of Fishes and collection information will be electronically stored in a permanent MSB database program where the geo-referenced collection information will be maintained in a consistent database and GIS format. These data and any maps generated from them will be available to the San Juan River Biology Committee via hard-copy reports and electronically. Electronic copies of the field and collection data will be transferred to the San Juan River database manager.

San Juan River Specimen Curation
Fiscal Year 2005 Project Proposal

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Background:
Personnel from the Division of Fishes, Museum of Southwestern Biology (MSB), at the University of New Mexico are responsible for two inter-related programs on the San Juan River. The Fish Division is the repository for specimens collected and retained by researchers. Fish taken under these programs are initially sorted by the principal investigator, held until they have submitted their yearly-progress report, and then received by MSB personnel. The collection is accessioned, specimens transferred from formalin to alcohol, identifications verified, individuals enumerated, length ranges recorded (largest and smallest specimen in a collection), collection data verified and transferred to wet labels, and incorporated into a database. It is standard policy at all major Natural History museums (i.e., Smithsonian Institution, Carnegie Museum, University of Michigan Museum of Zoology) that, prior to incorporation into the collection, all specimens be examined by qualified personnel (in that particular field of study) in an effort to verify the original identification and collection information. This system provides a final check (safeguard mechanism) to minimize the likelihood of misidentification of San Juan River fish species with particular attention on Colorado pikeminnow and razorback sucker. Any changes in species identifications that are detected are noted and returned to the principal investigator along with the entire data set (listing of collection locality, collectors, date, original field number, species, number of specimens, length ranges, and museum catalog number).

In addition to performing duties associated with collections curation, we are also responsible for complete processing (sorting, identifying, counting, curating, and reporting) of selected San Juan River collections (Colorado pikeminnow larval fish sampling and razorback sucker larval fish sampling). The samples generated by the aforementioned studies resulted in the collection of over 20,000 larval fish during 1999, 15,000 during 2000, and 96,000 during 2001. In 1999 and 2001, we processed almost 200,000 larval and juvenile fishes collected by the New Mexico Department of Game and Fish and Utah Division of Wildlife Resources. As in the past, deviations in the identifications of those samples have been noted and forwarded to the principal investigators.

The number of fish processed by the MSB Division of Fishes under the San Juan River Basin Recovery Program can fluctuate greatly between years. One reason for the vacillation in number of specimens is because the samples sent to MSB by non-MSB researchers are not processed until almost one year following their collection. This lag between time of collection and MSB processing is necessary as individual researchers must perform the preliminary sort and require the specimens for preparation of their reports. Other factors such as annual variability of sampling conditions and initiation of new or completion of old projects has resulted in marked changes in the number of samples and specimens (As occurred between 2001 and 2002 when drift sampling for larval Colorado pikeminnow was eliminated in favor of seine sampling).

Discussion of this issue with the San Juan River Biology Committee resulted in the recommendation that the annual budget for the San Juan River Specimen Curation and Larval Fish Identification reflect an "average" year of sample processing. Almost all MSB-San Juan River Basin archived samples are the result of collections made under the San Juan River Basin Recovery Implementation Program Monitoring Plan and Protocol. The Biology Committee recognized that some years would require more effort from MSB than budgeted while other years might not require the same high level of activity. A relatively stable budget allowed for uninterrupted processing of samples and was sufficient to allow the processing of backlogged samples generated during years of exceptionally high fish capture. To date, over 1,000,000 specimens (along with associated locality and ecological data) have been curated into the MSB Division of Fish Collection and are available to researchers.

The $6,800 decrease in the 2005 budget (from that projected in 2004) reflects absorption of some costs by MSB, elimination of costs that could be shared with other SJRBRIP funded work, and a general decline in the amount of material being retained under current sampling activities.

Study Area:
This project does not involve the collection of specimens but instead the processing and curation of samples gathered by the different research components of the San Juan River Research program. The collective sampling area for other researchers will be the San Juan River between the outfall of Navajo Reservoir and the Clay Hills boat landing (RM 2.9) just above Lake Powell in Utah.

Objectives:

1.) Provide a permanent repository for San Juan River fish collections, field notes, and associated data

2.) Verify species identifications, enumerate specimens, and report to principal investigators

3.) Maintain a GIS reference database for current material

4.) Assist principal investigators with secondary collection sorting and identifications as time and resources permit

Methods:
The primary task to be completed under this project is the processing and curation of fish specimens generated by research projects executed under the auspices of the San Juan River Basin Recovery Implementation Program. Samples are transferred to the Division of Fishes, by the principal investigator of a project, once that individual has completed their work and prepared the necessary reports. (This usually infers a lag-time of one year between collection of specimens and transference to the Division of Fishes). Collections are matched with the appropriate data-sheet, transferred from formalin to alcohol, stored in museum quality jars, re-identified, counted, measured (range), labeled, and catalogued into the permanent MSB Fish Division collection and placed on the shelves in the light and temperature controlled collection room. All data associated with the specimens are entered into the database of the Division of Fishes and subsequently copied to the San Juan River database.

In addition to the aforementioned responsibilities, the Division of Fishes is available and has frequently assisted principal investigators by taking on the added responsibility of processing (a limited number) of their unsorted collections (without requesting additional funding). Specimens are sorted, identified, counted, measured, catalogued, and data submitted to the principal investigator for inclusion in reports. In cases where the amount of backlogged material in the possession of the principal investigator was beyond our capabilities, supplemental funds have been sought so that additional personnel can be hired (under the supervision of the permanent staff) to process the excess material.

Products:
A draft report of the 2005 San Juan River specimen curation and larval fish identification sampling activities will be prepared and distributed by 31 March 2006 to the San Juan River Biology Committee for review. Upon receipt of written comments, that report will be finalized and disseminated to members of the San Juan River Biology Committee by 1 June 2006. Fish collected from this study will be curated in the Division of Fishes, Museum of Southwestern Biology (MSB), Department of Biology, at the University of New Mexico. Original field notes will be retained in the Division of Fishes and collection information will be electronically stored in a permanent MSB database program. Electronic copies of the field and collection data will be transferred to the San Juan River database manager following the successful protocol previously employed.

Long Term Monitoring - Channel Morphology
Detailed Reach Monitoring, Modeling and Habitat Mapping
Fiscal Year 2005 Project Proposal
July 1, 2004

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Study Area:
The study area consists of the San Juan River and its flood plain from RM 180 (Farmington, NM) to RM 3 (Clay Hills Crossing).

Collections:
There are no collections associated with this study.

Background:
From 1998 through 2004, long-term monitoring of channel morphology continued semi-annual (pre- and post-runoff) measurement of channel cross-sections first established in 1992. As a result of the 2003 analysis of channel response, the Biology Committee and Peer Review Panel recommended going to a 5-year measurement interval for these cross-sections, with the next survey in 2009, using the protocol outlined in the Long Term Monitoring Program.

From 1998 through 2003, cobble bars identified as having characteristics suitable for Colorado pikeminnow monitoring where surveyed for bar change and open interstitial space. It was theorized that these bars may deteriorate with time and other bars replace them. By 2003, open interstitial space on the bars had diminished to the point that a survey of the river to identify potential replacement bars was recommended for 2004. At the recommendation of the Biology Committee and Peer Review Panel, the task is being eliminated until an evaluation of the 2004 survey is available. Therefore, this task was removed for 2005.

During the data integration process, it became evident that backwater habitat types have been reduced in number and surface area since 1995. Surface areas have decreased from 130,000 square meters to less than 25,000 square meters river wide. Several hypotheses have been proposed as a possible causes including channel simplification, secondary channel abandonment, or lack of high runoff flows. In addition, the channel morphology monitoring program (specifically the across stream transects) indicate a slightly narrower, deeper channel, which could lead to channel simplification as a potential mechanism. However, review of a limited data set from the 1960's appeared to support the lack of high flows as a probable cause.

The data integration analysis also indicated that complex channel reaches (those with high habitat diversity, islands, multi-threaded channels and complex channel margins) correlate to native fish abundance. Further, capture of yoy endangered fish also tends to be correlated with channel complexity. Finally, backwater and low velocity habitats are more likely to occur in these reaches. In order to better understand the mechanism or process for creation and maintenance of these complex reaches and to understand the processes resulting in the loss or creation of backwater habitat important for the rare fish in the San Juan River, the objectives of this study have been modified to include selection and detailed monitoring of two complex reaches.

Objectives:

1.) River Cross-Section Monitoring. Determine long term change in river cross sections at key locations and the relationship of this change to antecedent hydrology.

2.) Detailed Reach Selection. Identify 2 complex river reaches that have been important for endangered fish, exhibit channel and habitat complexity, include backwater habitat area, are representative of other complex reaches and are accessible for efficient survey.

3.) Channel Morphology Monitoring of Detailed Reaches. Annually survey multiple cross sections in each detailed reach at sufficient density to allow two-dimensional modeling of the hydrologic processes involved in forming and maintaining the reach.

4.) Map Habitat in the Detailed Reaches. Map Habitat in the detailed reaches annually at a level of detail adequate to represent yoy fish sampling.

5.) Identify Habitat Use of YOY Endangered Fish and Correlate to Detailed Mapping. Map sampled habitat during YOY fish surveys in these reaches to identify characteristics and scale of habitats important to these life stages. Utilize this information to refine scale of mapping in the detailed reach and allow better interpretation of the larger scale mapping of the entire river.

6.) Develop One-Dimensional Steady State Model of Detailed Reaches. Based on the survey data collected under Objective 3, select a modeling platform and develop a onedimensional model steady state model of each detailed reach.

7.) Analyze Response of Channel Morphology and Habitat to Hydrology. The data collected will be used to better define the relationships between hydrology and habitat, both with stage and in response to antecedent conditions.

Methods:

1.) River Geometry Monitoring. The 14 cross-sections identified in 1999 as part of the long term monitoring plan will be surveyed post-runoff every 5 years (next survey in 2009) for

2.) Analysis of long-term change and compared to previous surveys to determine trends.

3.) Analysis of the change in cross-section geometry and substrate in relation to hydrographic conditions will be completed to monitor response of the system to flow recommendations. (No activity in 2005)

4.) Detailed Reach Selection. Two representative sites will be selected from reaches 3,4,5, or 6, with priority on reaches 3 and 5. The sites will need to have all of the following characteristics: Island complexes; main stem and secondary associated backwaters at low flows; slackwater and riffle habitats; a history of razorback and pike minnow captures; a length that captures a repeating pattern of run-riffle

sequence and contains at least 1 island, but typically between 1/4 and ½ mile in length to make surveying manageable; and be accessible for efficient survey. The selection process will involve the use of existing data (rare fish captures and habitat mapping) as well as field verification. We intend to pre-select 12 locations throughout the river which meet our criteria. These sites will be field inspected with two sites being selected for detailed investigation and monitoring. Upon final selection, rectified color aerial photographs will be produced and base maps prepared for mapping at a scale of 1 inch equal 50 ft. Present videography mapping is at a scale of about 1 inch equal 200 ft. The higher quality base map will allow mapping of smaller habitats.

5.) Channel Morphology Monitoring of Detailed Reaches. Each detailed reach will be surveyed at cross-section intervals sufficient to represent the channel topography to the bank-full water line(approximately 100 - 200 ft intervals, on average) utilizing a total station or sub-centimeter accuracy GPS system. Survey points will be at approximate 20 ft intervals, at major elevation changes at each cross-section and at waters edge. Survey will continue to bank-full elevation. Characterization of substrate (cobble/gravel or fines) will be made at the time of survey. If fine sediment is encountered, elevations will be taken at the top and bottom of the sediment by working the rod down to solid substrate. Water depth will also be measured at each data point when below water. First year task includes installation of bench marks and establishment of cross-sections. The cross-sections will be plotted and a three-dimensional surface of the channel developed. Change between surveys will be calculated by intersecting the surface generated for the previous survey with that for the current survey.

6.) Map Habitat in the Detailed Reaches. Habitat will be mapped on base aerial photos with a scale of 1 inch equal 50 ft. In 2005, one mapping will be completed in the fall during the time the entire river is mapped. The detailed reaches will be mapped at the standard mapping resolution as a part of the regular habitat mapping and at the higher detail. In 2006, two mappings will be completed, one on the descending limb during typical Colorado Pike minnow drift and one in the fall during the standard monitoring trip.

7.) Identify Habitat Use of YOY Endangered Fish and Correlate to Detailed mapping. There are a number of fish monitoring programs that will collect fish within these detailed sections that will be investigated in this study. As these areas are sampled, habitat mapping crews will interface to document habitats where rare and native fish are captured. Establishing this direct link between habitat use, habitat availability, and potential temporal changes in habitats combined with the causative reasons for habitat changes will strengthen the flow recommendations and further the recovery of the rare fishes in the San Juan River.

8.) Develop Two-Dimensional Steady State Model of Detailed Reaches. To better understand the hydraulic properties of these complex reaches, a two-dimensional steady state model will be configured. River 2-D, a two-dimensional depth-averaged, finite element hydrodynamic model, is intended as the platform, although others will be explored prior to model development. The survey data collected under Objective 3 will be used to configure the model and the water surface elevations will be used for calibration. Once developed, the model can be used to predict stage at different flows and the influence on key habitats. As subsequent survey data are available, the change in water profile can be predicted as a result of the change in channel form. Velocities predicted from the model can be used to determine shear stress and sediment transport through these detailed reaches to compare with the empirical data on channel change.

9.) Analyze Response of Channel Morphology and Habitat to Hydrology. Utilizing the results of the model and habitat mapping, response of the channel form and habitat to

spring runoff can be analyzed and response at a range of flows predicted. Multiple years of data will be needed to calibrate response calculations and fully interpret the data. In 2005, only the basic modeled response based on one set of calibration data will be possible. Change analysis will begin in 2006.

Habitat Mapping
Fiscal Year 2005 Project Proposal

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and

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Study Area:
The study area consists of the San Juan River from RM 180 (Farmington, NM) to RM 3 (Clay Hills Crossing).

Collections:
There are no collections associated with this study.

Background:
Habitat mapping completed during the period 1992 - 1997 has been used to develop flow/habitat relationships used in the flow recommendation process. Monitoring from 1998 through 2003 has documented a loss of backwater habitat during this drought period. Examination of backwater abundance in Reach 5 using 1961 aerial photography indicates that backwater abundance may be cyclic, in response to long-term hydrologic cycles. To verify and refine habitat-flow relationships and examine long term trends, habitat mapping will be continued on an annual basis during the low flow period in the fall per the long range plan. In addition, it is proposed that the remainder of the 1961 aerial photography be processed to verify the preliminary conclusions of cyclic availability of backwater habitat.

Objectives:

1.) Main River Habitat Mapping. Map San Juan River habitat from RM 180 to RM 0 during September-October. This objective is a continuation of the 2000 work as described in the long term monitoring program.

2.) Digitize and process data utilizing GIS. Habitat mapping data will be digitized and entered into the ArcCAD system.

3.) Analyze long-term trends in backwater type habitat using historic aerial photography. Analyze 1961 aerial photography to determine backwater and channel area, comparing the results to the 1992-2004 data set and long-term hydrology to examine trends related to hydrology. (Objective identified in 2003 synthesis report).

Methods:
1.) Habitat mapping (San Juan River). One flight to collect digital aerial photography or videography will be completed for the San Juan River from RM 180 to RM 0 and printed at an approximate scale of 200 ft/inch. Thirty-eight categories of aquatic habitat will be

mapped in the field utilizing the digital imagery as a base map. The flights and mapping will be completed as soon after runoff as flows reach 1,000 cfs or less and weather will allow. Field mapping will be completed at flows between 500 and 1,000 cfs if possible.

2.) Digitize and process data utilizing GIS. Upon completion of each habitat mapping program (Objectives 1 and 2), the field maps will be rectified and digitized into ArcCAD.

3.) Analyze long-term trends in backwater type habitat using historic aerial photogrpahy. Aerial photography of the San Juan River for Reaches 3-6 from 1961 will be scanned and registered to USGS quadrangle base. The water's edge and backwater category (backwaters and embayments) perimeters will be digitized in Autocad and compared to habitat mapping from 1992 through 2004. The data will be analyzed against long-term hydrology to describe relationships between wet and dry cycles and abundance of backwater area.

Products:
An annual report and GIS coverages for inclusion in the GIS database will be produced under this task. The annual report and coverages will be for the 2004 mapping. Reporting for the 2005 mapping will be in the 2006 budget. A GIS coverage of the 1961 mapping will be produced and results of the analysis included in the annual report. The draft progress report and data submittal to the database are due 31 March 2006. Final report is due 1 June 2006.

Water Temperature Monitoring
Fiscal Year 2005 Project Proposal

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Study Area:
Temperature recorders are installed from RM 224 (Navajo Dam) to RM 92.5 (Montezuma Creek Bridge).

Collections:
None.

Background:
Water temperature recorders were installed in 1992. This work element is a continuation of the original work, with station servicing and data extraction.

Objective:
Collect Water Temperature Data at 7 locations

Methods:
Collect Water Temperature Data at 7 locations. Temperature recorders are located at Navajo Dam, Archuleta, Farmington, Shiprock, Four Corners and Montezuma Creek and on the Animas River at Farmington. These recorders will be serviced twice and the data extracted and plotted for the annual report.

Products:
An annual report and data files for inclusion in the GIS database will be produced under this task. The draft progress report and data submittal to the database are due 31 March 2006. Final report is due 1 June 2006.

Update and Maintenance of San Juan River Basin Recovery Implementation Program GIS Database and Development of a Web-Based Interactive Interface
Fiscal Year 2005 Project Proposal

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Background:

San Juan River research efforts that preceded the establishment of the San Juan River Basin Recovery Implementation Program (SJRBRIP), in combination with those that have subsequently resulted from that program, form the basis of the suite of decisions already made and those to be made regarding biologic and hydrologic issues. An immense amount of information has been gathered through the San Juan River research activities that have been conducted over the last 15 years. Most of this information has been synthesized and made available in the form of reports or publications. For example, in 2003 and 2004 researchers consolidated and analyzed data from their individual long-term research projects and presented it as an integrated report of five years of research (1999-2003). Likewise, the flow recommendation report released in 1999 represented a synthesis between biological, hydrological, and habitat research activates.

Preparation of the aforementioned integration report was made difficult due to the absence of an updated, standardized, and easily accessible SJRBRIP database. An updated SJRBRIP database has not been distributed to the researchers since 1998, the last time Keller-Bliesner Engineering, LLC (previously the organization responsible for maintaining the database until the end of 2002, when the project was transferred to UNM) produced and distributed a CD containing the database.

During the second half of 2003 (funds for the SJRBRIP GIS/Database project were received by UNM in June 2003) and first half of 2004, the major development (programming and data formatting) of the SJRBRIP GIS/Database has been accomplished. Development of a user-friendly, web-based interface will decrease the time between distribution of updated versions of the database (data will be updated on a continuing basis as it is received from the researchers) and enable researchers to access their own and other researchers' data for use in their analyses and reports. A prototype of the new interface will be presented to the Biology Committee and researchers during a meeting in summer of 2004. At that time, feedback and suggestions for changes to the database will be taken and implemented. Finally, decisions regarding authorization of access to the web-based interface will be discussed in 2004 by the Biology Committee and will be finalized under consultation with the SJRBRIP Coordination Committee.
By the end of 2004, a working version of the SJRBRIP GIS/Database containing all data from 1998 through 2003 (and possibly some older data as time permits) will be "live" and available to Biology Committee members and researchers (and others at various levels pending the outcome of access discussions). In 2005, the project will move into a maintenance phase, in which the majority of work will involve integrating data submitted by individual researchers, supporting database users, and upgrading hardware and software as necessary.

The purpose of this proposal, initiated in 2003, is to fund this effort with the goal of developing a user-friendly web-based interface to SJRBRIP's GIS Database. Another important objective of this proposal

is to provide for the generation of distribution maps that result from user-initiated queries. In addition, continuation of funds to cover the cost of maintenance and distribution of the database are requested.

Study Area:
This project will initially encompass the San Juan River Basin downstream of Navajo Reservoir but should ultimately be expanded to include the entire San Juan River Basin.

Objectives: (continued from FY2003, with completion projected for out years):

1.) Maintain and incorporate researchers' comments into the web-based interface to the San Juan River Recovery Implementation Program's GIS Database.

2.) Maintain, perform Quality Control, annually update, and distribute current San Juan River Recovery Implementation Program GIS researcher database using appropriate format.

3.) Establish electronic archives of the aforementioned database at the ultimate repository for this information (U.S. Fish and Wildlife Service Region 2 Office, Albuquerque, New Mexico).

4.) Generate for distribution and maintain a standardized set of hard-copy aerial photos with river mile, 10^{th} of mile, and appropriate landmarks connoted.

Methods:
1.) Maintain a web-based interface to the GIS Database.
In 2004, a web page interface is being developed which authorized researchers can use to access and analyze the data geographically. The interface will provide the ability to create custom multiple-parameter queries within the researchers' datasets and result in generation of maps and data reports that can be used in analysis as well as reporting activities. A prototype of the interface will be provided to the researchers in 2004 and their comments solicited. These comments will be incorporated, as appropriate, in future versions of the interface.

2.) Update and Maintain GIS Database.
In 2003, the existing GIS Database, which has been maintained by Keller-Bliesner since its inception, was transferred to UNM/USFWS. The database format is being modified (under consultation and coordination with Keller-Bliesner) to better integrate with the data program being prepared for GIS interface application. Starting in 2003, UNM has assumed responsibility for tracking and acquisition of annual datasets to be submitted by 31 March of each year by individual researchers. New data will be incorporated with the existing San Juan River Recovery Implementation Program's GIS Database. Existing data will be checked for Quality Control and updated as necessary.

3.) Coordinate Database Updates and Maintenance with FWS-Region 2. The close proximity of UNM to the U.S. Fish and Wildlife Service's - Region 2 Albuquerque Office provides for

extensive coordination of updates, maintenance, and development of the database. The UNM staff will consult and coordinate closely with appropriate staff (including the San Juan River Program Coordinator and San Juan River Program Assistant) in the FWS-Region 2 office in all aspects of the work. This effort will result in the collaborative production of the database and web-based interface.

4.) Contact and coordinate with appropriate personnel in the Upper Colorado River Basin and Glen Canyon Environmental Studies offices to investigate the feasibility of linkage of the proposed San Juan River Recovery Implementation Database with other regional fish databases.

5.) Generate and Maintain standardized and customized maps. Appropriate base layers, including Digital Orthophoto Quarter Quadrangles (DOQQs) will be obtained and additional layers, including 10^{th} of mile designations will be generated in order to provide researchers with a standardized set of hard copy aerial photo maps for use in the field. These standardized maps will allow for seamless integration of field data with the GIS database. In addition, at researchers' request, customized maps will be generated for use in reports and presentations.

Products:

The database and associated documentation will be disseminated via a password-protected project web page. Standardized hard copy aerial photo maps with river mile and 10^{th} of mile designations will be generated and distributed to the researchers in paper and electronic (CD) format. The database and interface will reside with Region 2 (Albuquerque) of the U.S. Fish and Wildlife Service, the designated repository for the data, and on a UNM server. A draft report that describes the results and progress of the FY 2005 efforts will be distributed by 31 March 2006. Upon receipt of written comments, that report will be finalized and disseminated to members of the San Juan River Biology Committee by 1 June 2006.

Additional funding request to complete the
Standardized Monitoring Integration Report
Fiscal Year 2005 Project Proposal
Revised September 27, 2004

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Study Area:
The study area for this task is for the San Juan below Navajo Dam.

Background:
The long-term monitoring program calls for production of a data integration and synthesis report covering the monitoring data from 1998-2001 in conjunction with data used to prepare the research period final report and the flow recommendation report. This task covers all aspects of monitoring completed under the San Juan River Basin Recovery Implementation Program (SJRIP). All principle investigators responsible for data collection and reporting over this period of time will be included in this data integration process. 2002 was to be the first integration of the standardized monitoring program for the San Juan River Implementation Program. The integration of data and report preparation was delayed in 2002 and continued into 2003 and 2004. The original scope of work consisted of integration of three years of data. With the delays and continued monitoring, the Biology Committee and researchers have now included five years of data from the Standardized monitoring program (1998-2003). This has required additional meetings, review and integration which were not anticipated in the original scope of work. In addition, the latest review comments from the Biology Committee and researchers will require substantial changes to the draft integration report, which goes beyond the original scope of work.
The objective of the original proposal in 2002 was to facilitate the synthesis and integration process and also be the technical editor for the report that summarizes and synthesizes the three year monitoring. Since the task has required additional time and effort, we are requesting additional funding to complete the integration of five years of monitoring.

Objective:

1.) Integrate 1998 - 2003 monitoring data to evaluate the effectiveness of each monitoring protocol and its ability to determine response to hydrology and influence on recovery of the endangered species (by MEC with assistance if needed from each investigator).

2.) Integrate individual study results to identify interactions and assess progress toward recovery.

3.) Evaluate and update flow recommendations based on new findings.

4.) Evaluate and update Standardized Monitoring and Long Range Plan, if needed.

Methods:
1.) Integration of findings of all studies. Lead by MEC with group data exchange as needed

to explore relationships between study findings.

2.) Evaluate and update flow recommendations based on new findings. Based on response of the geomorphology, habitat and fish community to flows since implementation of the flow recommendations, the foundation of the flow recommendations will be evaluated. If the new data suggest modification to the recommendations, they will be proposed.

3.) Evaluate and update Standardized Monitoring and Long Range Plan. Both the Standardized Monitoring Program and Long Range Plan will be reviewed and updated, as needed, based on the integrated findings.

4.) Preparation of additional draft(s) and final integration/synthesis report for the Standardized monitoring program. MEC will function as the author/editor for the standardized monitoring report, the focus of this effort will be to complete the revisions of the draft report as requested by the Biology Committee, Researchers and Peer review panel.

Schedule:
The schedule for preparation of the report is as follows:
Item/Task Start Date End Date
Draft Final Report Preparation October 1 October 30
Comment period for draft Final Report October 30 November 30
Final Report Preparation December 1 December 22
Distribution of Final Report December 22

Products:
The integration report of the standardized monitoring plan will include the following: 1) a revised draft report for the Biology Committee and Peer Review panel; 2) a draft final report to be submitted to the Biology Committee, Peer Review Panel and Coordination Committee; and, 3) a final report on the integration and synthesis of the first five years of the standardized monitoring program. All draft reports will be submitted via email or on CD as Adobe PDF format. The final report will be in Adobe PDF format for direct posting to the web site.

Peer Review for 2005
Fiscal Year 2005 Project Proposal

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Background:
A Peer Review Panel was established in 1997 to assist the SJRIP with reports and plans for future studies. The four members of the panel participated in meetings in 1997 where the flow recommendations were discussed, and continued involvement in the flow recommendation report process by commenting on the pre-draft report and attending a Biology Committee meeting to discuss the pre-draft report in 1998. They also met with the Biology Committee in 1999 to discuss the draft flow recommendation report that the Biology Committee sent to the Coordination Committee for review. In addition, in 1999 the Peer Review Panel reviewed the draft Monitoring Plan, and initial drafts of the final research reports.

In 2000 and 2001, the Peer Review Panel reviewed and commented on the final research reports, the long term monitoring plan, and the Program Evaluation Report.

In 2002, the Peer Review Panel was changed somewhat. Drs. Ron Ryel and David Galat were retained from the existing panel and two new members were added. Dr. John Pitlick from the University of Colorado was selected as the geomorphologist and Dr. Stephen Ross from the University of Southern Mississippi was selected as the fishery ecologist after a lengthy selection process. During 2003 the Peer Review Panel participated in subcommittee and Biology Committee meetings related to integration of 1999-2002 monitoring data, as well as attending Biology Committee meetings related to the Work Plan. Dr. Galat resigned from the panel and the Biology Committee selected Dr. Wayne Hubert, U.S. Geological Survey, University of Wyoming, to fill that position as a river aquatic ecologist for the Panel. Dr. Hubert resigned in late 2003 and Dr. Mel Warren was selected to replace him on the panel. During 2004 the Peer Review panel remained involved in the integration effort with Dr. Ryel taking a larger role in conducting statistical analyses of fishery data. The committee also became involved in reviewing scopes of work for new projects that were solicited by the Bureau of Reclamation.

This proposal provides for funding for the Peer Review Panel activities during 2005. It is anticipated that the Panel will meet with the Biology Committee at two meetings during the year, the February, 2005 summary meeting and another meeting typically in May to discuss Scopes of Work for 2006. If any new scopes of work are identified, the Panel may again be asked to assist in the review and ranking of the proposals that are submitted.

Goal:
The goal of peer review is to provide additional scientific oversight over San Juan River Recovery Implementation Program technical studies and reporting. The Peer Review Panel will work with the Biology Committee to produce scientific credible documents and will assist the Biology Committee in maintaining a highly scientific direction to the Program.

Methods:
The Peer Review Panel will meet with the Biology Committee in 2005 two times to review monitoring and research progress and to discuss scopes of work for2006. They will provide verbal input during the

meetings and provide written reviews of the progress of the Program. Their reviews will be provided to the Biology Committee through Dr. Paul Holden in letter form, or on the Biology Committee list server, and through discussions at the Biology Committee meetings. Biology Committee researchers may call Peer Review Panel members to ask for advice, and Peer Review Panel members may call Biology Committee researchers if they have questions concerning Program activities. All correspondence between the Biology Committee and the Peer Review Panel will be coordinated through Dr. Paul Holden.

Products:
Peer review participation at 2 Biology Committee meeting, letter or verbal reports from each peer reviewer.

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San Juan River Population Model Maintenance
Population Model Runs
Fiscal Year 2005 Project Proposal

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Principle Investigator: Vince Lamarra
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Background:

A modeling effort to construct a conceptual framework for the fish community and endangered fishes in the San Juan River began in 1998. This effort relates to Sections 5.1; 5.1.1; 5.1.2; 5.1.3.; 5.1.4 of the Long Range Plan. These models have helped direct a focused field effort with the intent of using key site specific data to determine the carrying capacity of Colorado pikeminnow and razorback sucker in the river. A mechanistic population model has been constructed from the original conceptual model.

The San Juan River population model includes bioenergetics, population, and trophic components. Data for fish populations by age class and habitats as well as other trophic components are required as model parameters. The population model was demonstrated to the Biology Committee, Researchers and Peer Review Panel in May 2004. The Committee requested that a scope of work be developed to continue model maintenance and conduct model runs during FY 2005. The intent of the FY2005 program is to refine the structural and functional components of the mechanistic model, distribute an updated run-time version of the model to the Biology Committee members and make additional model runs with updated input data from the monitoring in the San Juan River.

Objectives:

1.) Maintain Stella model software for the San Juan population model, which includes updating the model parameters with new information from the monitoring program.

2.) Update the user interface and run-time version of the model to distribute to the Biology Committee.

3.) Make model additional model runs that incorporate the information from the monitoring data to evaluate SJRIP Program objectives.

Methods:

The model will be updated with current data on species distributions and abundance from population estimates and the standardized monitoring program. Model simulations will be made to evaluate the change in population dynamics as a result of stocking Colorado pikeminnow and razorback sucker. Model simulations will be conducted for a maximum of 10 different simulations.

Schedule:
Model maintenance will be concurrent with model simulations. Model maintenance will consist of updating the model with new model parameters based on new information and updating the model software as needed. Model maintenance will begin with the notice that funding has been secured and continues through September 30, 2005.

Products:
A brief report will be prepared that documents the model maintenance and model runs.
Summary tables of model simulations will be produced for each model run. A summary of model maintenance activities will be completed and submitted to the standardized data base. A user manual will be distributed with the run-time version of the software.

Trophic Relationships among Colorado Pikeminnow (Ptychocheilus Lucius) And it's Prey in the San Juan River (Scope of Work for FY 2005)

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Activities for FY 2005: The scope of work (SOW) and budget for FY 2005 are within this study plan for the entire study. Work to be accomplished during FY 2005 corresponds to Year 3 of the Study Plan. In FY 2005, we will conduct experiments that address Objectives 3 and 4, listed on page 6. The total budget of $51,000 for FY 2005 is detailed on page 19 and 20.

Background:

An essential element of restoration or recovery of an endangered species, such as Colorado pikeminnow (*Ptychocheilus lucius*), is a thorough understanding of the relative importance of factors that have contributed to its decline. Various studies (e.g., Holden and Wick 1992, U.S. Fish and Wildlife Service 1990, Platania et al. 1991) have demonstrated that altered flow regimes, habitat modifications, range fragmentation, and establishment of numerous nonnative fish species have contributed to the imperiled status of Colorado pikeminnow. To enhance survival of the species, efforts have been made to remove or ameliorate factors identified as causing its decline. In addition, augmentation of extant populations by stocking hatchery-reared fishes has been undertaken in the San Juan River. All efforts to improve the status of Colorado pikeminnow by increasing its abundance implicitly assume there is an adequate prey base. However, considering the dramatic changes to the prey assemblages in this system, there is no clear evidence that adequate prey is available.

In the San Juan River, the historical prey base of Colorado pikeminnow was composed mainly of soft-rayed cyprinids and catostomids; other fishes such as mottled sculpin (*Cottus bairdi*) and cutthroat trout *(Oncorhynchus clarki*) occurred mainly in habitats upstream of those occupied by Colorado pikeminnow. Based upon their current distribution throughout warmwater reaches of the San Juan River and their high abundance (Gido et al. 1997, Gido and Propst 1999, Propst and Hobbes 2000), speckled dace (*Rhinichthys osculus*), flannelmouth sucker (*Catostomus latipinnis*), and bluehead sucker (*Catostomus discobolus*) were likely important prey for Colorado pikeminnow. Although currently rare in the San Juan River, roundtail chub (*Gila robusta*) and razorback sucker (*Xyrauchen texanus*) were more common historically (Tyus et al. 1982) and thus potential prey of Colorado pikeminnow. In the past 100 years, over 20 nonnative fishes have become established in the San Juan River; some are common and generally distributed, but others are rare (Bestgen 2000). Common and widespread

nonnative fishes include red shiner (*Cyprinella lutrensis*), common carp (*Cyprinus carpio*), fathead minnow (*Pimephales promelas*), and channel catfish (*Ictalurus punctatus*). Although other ictalurids (e.g., *Ameiuus* spp.), in addition to channel catfish, and centrarchids are established in the San Juan River, none are common (Propst and Hobbes 2000, Ryden 2000).

Colorado pikeminnow begin to consume fish at an early age and small size (Vanicek and Kramer 1969). As an individual increases in size, its potential prey likewise increases in size. To some extent, prey availability is mediated by the habitat occupied by different life stages of Colorado pikeminnow. Young (<1 yr) and small (<100 mm TL) individuals that primarily inhabit low-velocity habitats, such as backwaters, prey largely upon syntopic species such as larvae or young of large-bodied species (e.g., roundtail chub and flannelmouth sucker). As Colorado pikeminnow grow, and move from low-velocity into main channel habitats, the size range and variety of prey likely increase, typical of piscivorous fishes (Gerking 1994). At this point, an individual's gape dimensions and where it forages are major factors limiting prey size and variety. In primary channel habitats typically occupied by adult Colorado pikeminnow, its primary prey species historically were speckled dace and sub-adults and adults of roundtail chub, flannelmouth sucker, bluehead sucker, and razorback sucker. Although speckled dace, flannelmouth sucker, and bluehead sucker are currently common in the San Juan River, historical data are insufficient to determine whether abundance of any, or all, have declined, increased, or remained constant. Roundtail chub and razorback sucker, however, are now less common than historically (Tyus et al. 1982, Platania et al. 1991).

Three factors probably were major determinants of prey consumed by Colorado pikeminnow: habitat occupied, gape dimensions, and prey encountered. To the extent that habitat of a potential prey species differed from that typically occupied by Colorado pikeminnow, the less likely it was to be preyed upon. For example, because speckled dace occurred mainly in riffles and adult Colorado pikeminnow typically occupied deeper and less turbulent habitats, dace were not likely primary prey items of pikeminnow. For sub-adult Colorado pikeminnow, however, speckled dace may have been an important prey species. In addition, the small-bodied speckled dace (adult size <120 mm TL) are presumably more energetically costly than larger prey species because of the large number necessary to maintain basal metabolic demands. Moreover, prey items of Colorado pikeminnow may be dependent on its hunting tactics. If it is an ambush predator, habitat occupied largely determined what it would most likely encounter and therefore consume. Alternatively, if it stalks or actively hunts prey and moves among habitats, diversity of prey likely increased.

Introduction and establishment of nonnative fish species, both caused the decline of native fish species (via competitive interactions or predation by nonnatives) and the addition of potential prey items for native predators. Whereas these nonnative fishes may serve as prey for Colorado pikeminnow, they may be better adapted to escape predation

than native prey species because they evolved in eastern systems with higher densities of predators. Thus, it is unclear what effect the establishment of nonnative species and decline of native prey species had or will have on populations of Colorado pikeminnow. Has the introduction of nonnative species increased, decreased, or had no effect on the forage base? Or, as assemblage structure and composition changed, has Colorado pikeminnow foraging success declined, increased, or remained the same? *A key question is whether changes in prey base affected viability of Colorado pikeminnow in the San Juan River and if these changes are likely to impair success of augmentation efforts?*

We propose a series of field experiments, using recently developed stable isotope tracer technology, to evaluate relative use of native and nonnative prey species by Colorado pikeminnow. This study will quantify the dietary importance of commonly occurring species (e.g., native flannelmouth sucker, bluehead sucker, and speckled dace and nonnative common carp, red shiner, fathead minnow, and

channel catfish) under controlled and existing "natural" conditions. In addition, roundtail chub will be used in experiments to determine if Colorado pikeminnow preferably forage on this species, which was once abundant in the San Juan River. Finally, our results will complement existing bioenergetics models (Lamarra and Miller) by quantifying relative importance and caloric content of different tropic levels.

Recent developments in mass spectrometry have enabled the use of naturally occurring stable isotopes of nitrogen (^{15}N) and carbon (^{13}C) to determine trophic position and trace pathways to determine ultimate energy sources. Ratios of $^{15}N/^{14}N$ are typically low in naturally occurring elements. Stable isotopes of nitrogen (^{15}N) are particularly helpful in evaluating trophic position of organisms because individuals that feed high in the food web (i.e., predators) tend to be enriched with heavy ^{15}N, which accumulates during protein synthesis at a faster rate than the lighter ^{14}N isotope. Stable isotopes also provide information on the source(s) of energy. For example, Cherel et al. (2000) were able to establish the breeding origins of seabirds by analyzing stable isotope signatures in feathers. McCarthy and Waldron (2000) were able to differentiate freshwater-resident and sea-run migratory brown trout based on changes in stable isotopes of N and C in their tissues. Martinez et al. (2001) characterized the isotope ratios of fishes in the

Colorado River basin and suggested that isotopes may be helpful in determining if off-channel ponds were the source of nonnative fishes. Thus, naturally occurring stable isotope ratios can be used to determine the origin of energy assimilated by organisms, which compliments traditional food habits studies that only give a snap-shot of food items consumed at a particular moment. In addition, components of natural systems can be enriched with ^{15}N and then those molecules can be followed through the system to quantify energy transfer (e.g., Dodds et al. 2000). We propose to use this technology combined with a series of field experiments to evaluate the relative contribution of potential prey, including roundtail chub, to Colorado pikeminnow in the San Juan River.

Below, we describe a series of field and laboratory studies and experiments to examine the relative importance of common native and nonnative fishes in the diet of Colorado pikeminnow. The first phase of the proposed study will be to identify caloric content and signatures of stable isotopes of N and C at all trophic levels in the San Juan River (organic sediments through "top" predator) in each geomorphic reach of the river (Farmington to Lake Powell). The next phase of the study will quantify differences in prey behavior among native and nonnative species and vulnerability of these species to consumption by Colorado pikeminnow using a combination of artificial streams and field experiments. We also will use ^{15}N tracers during these experiments to positively identify native prey species of Colorado pikeminnow.

Objectives:

The overarching goal of this study is to *assess the capability of current San Juan River prey base for maintenance of viable Colorado pikeminnow populations*. Specific objectives/goals of the study are:

Characterize prey base of Colorado pikeminnow and linkages with lower tropic levels by determining stable isotope signatures ($\delta^{15}N$ and $\delta^{13}C$) of the biotic assemblages in the San Juan River for six geomorphic reaches of the river (Farmington to Lake Powell).

Work in conjunction with Lamarra and Miller to incorporate prey suitability, trophic relationships, and caloric content of lower trophic groups into bioenergetics models. Quantify caloric content for different trophic levels in the San Juan River by reach to parameterize bioenergetics models for Colorado pikeminnow.

Determine if Colorado pikeminnow use nonnative prey as efficiently as native prey by conducting foraging experiments in artificial streams located at the Konza Prairie Biological Station (KPBS), Kansas and in field enclosures in secondary channels of the San Juan River.

Quantify the use of specific prey items by Colorado pikeminnow by using $\delta^{15}N$ labeled roundtail chub or other fish species in field enclosure experiments.

STUDY DESIGN

Stable isotope signatures and caloric content—To establish baseline data on carbon and nitrogen isotope signatures of the fish assemblage in the San Juan River, we will collect and analyze samples from fishes and potential prey items from the six geomorphic reaches of the San Juan River from Farmington to Lake Powell beginning in 2003. In addition, we will analyze these samples for caloric content. Both the stable isotope analysis and the caloric data will help quantify the feeding relationship and energy requirements of Colorado pikeminnow and its prey. This aspect of the study will complement the bioenergetics modeling of Lamara and Miller and thus, we will work to coordinate our sampling and analysis to accommodate those models.

Collections of fish tissue will be made in conjunction with ongoing monitoring programs to facilitate capture of fishes. Small-bodied fishes will be collected whole, whereas tissue plugs or fin clips will be taken from large-bodied native and nonnative fishes. This information will allow us to characterize trophic position of each species in the assemblage and possibly determine specific prey items of native (Colorado pikeminnow) and nonnative (channel catfish) predators. These data also will provide essential information on naturally occurring levels of these isotopes to compare with the experiments described below.

Tissue samples from fishes and other organisms from lower trophic levels will be frozen in the field and brought to the laboratory, thawed, dried at 50°C for 48hr and ground to a powder with a mortar and pestle. Ground samples will be analyzed in the Stable Isotope Mass Spectrometry Laboratory (SIMSL) in the Division of Biology at Kansas State University (KSU) using a ThermoFinnigan Delta Plus mass spectrometer. Stable isotope ratios will be calculated in the standard notation:

$$\delta^{15}N = [{}^{15}N/{}^{14}N_{sample}/{}^{15}N/{}^{14}N_{standard}) - 1 \times 1000$$

$$\delta^{13}C = [{}^{13}C/{}^{12}C_{sample}/{}^{13}C/{}^{12}C_{standard}) - 1 \times 1000$$

Values will be expressed on a per mil (‰) basis. Because carbonates are known to bias isotope ratios of carbon, a separate aliquot will be taken from each sample, acidified to remove carbonates and then analyzed for carbon isotope ratios as described above. A pilot study, in which samples from the San Juan River community were taken in October 2001 demonstrated our ability to process samples necessary to complete the proposed experiments using the facilities at KSU. Although we did not

collected samples from adult native fishes, preliminary results suggest a high degree of overlap in

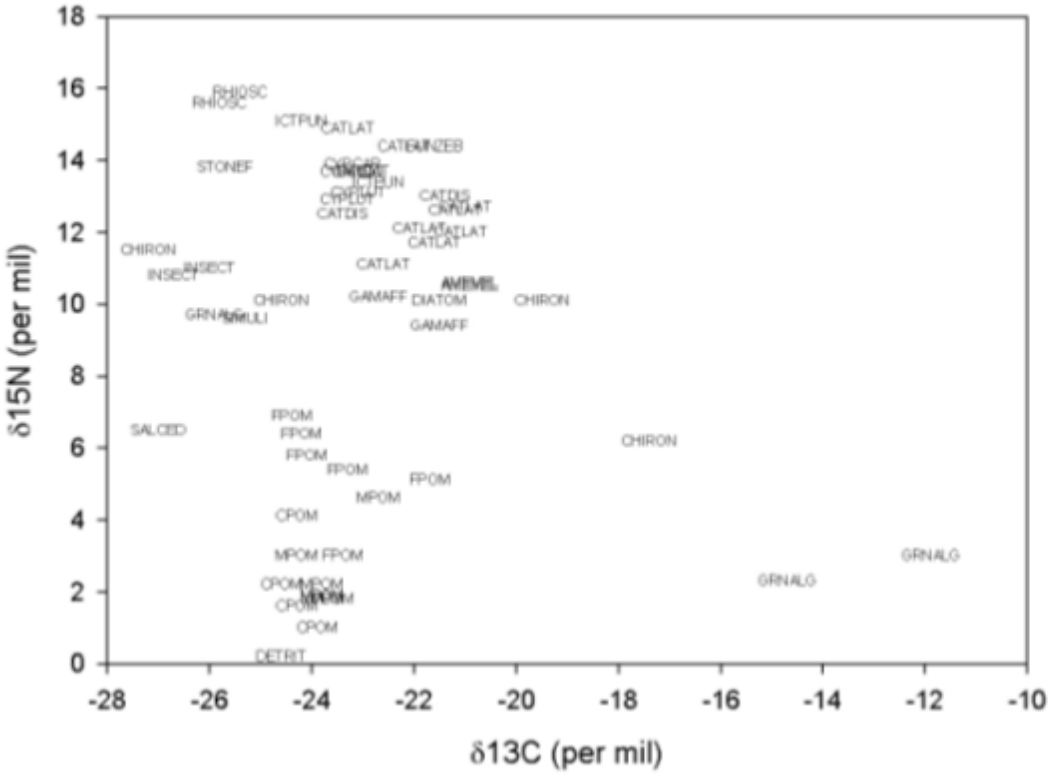

Figure 1. Stable isotope signatures for various components of the aquatic community in the San Juan River between RM 120 and RM 90. Abbreviations are as follows: Labels for fishes include the first three letters for the genus plus the first three letters of the specific epithet; FPOM, MPOM, and CPOM = fine, medium, and coarse particulate organic matter, respectively; CHIRON = chironomid; STONEFL = Stoneflies; GRNALG = green algae; SIMULI = Simulids; DETRIT = Detritus; SALCED = Salt Cedar; INSECT = various insects.

energy acquisition between juvenile natives and adult nonnative fishes (Figure 1). In addition, spatial variation in $\delta^{13}C$ signatures between backwaters (Green algae and chironomids) and main-channel habitats suggest a high potential to determine the relative importance of different habitats on consumer species.

Caloric content of fish, invertebrate, and plant material will allow us to evaluate the potential quality of different resources bases for Colorado pikeminnow. Measurements will be made with a Parr semi-microbomb calorimeter. For fishes, only muscle tissue from the dorsal region will be used. All samples will be homogenized as described as above and pressed into a pellet for combustion in the calorimeter.

ARTIFICIAL STREAM EXPERIMENTS

A combination of artificial streams and field enclosures will be used to quantify the importance of native and nonnative fishes as prey by Colorado pikeminnow. Artificial streams are located at the KPBS in Kansas and have been designed to match the stream

units that have been successfully used in previous experiments at the University of Oklahoma (Gido et al. 1999, Gido and Matthews 2001, Matthews et al. 2001). Each stream will be configured to have two pools connected by a riffle (Figure 2) and mimic natural pool and riffle habitats. These systems should

provide sufficient structural heterogeneity to provide cover for experimental fishes. Substrate will be a mixture of cobble, gravel, sand, and silt to match conditions in the San Juan River (i.e., predominately sand and cobble substrate). This experiment will examine changes in behavior of the various prey fishes when in the presence of a caged Colorado pikeminnow. In addition, we will release the pikeminnow and determine its foraging efficiency on the different prey species. Our working hypothesis is that nonnative species will alter their behavior more than native species in the presence of Colorado pikeminnow and also be less vulnerable to predation than the native species.

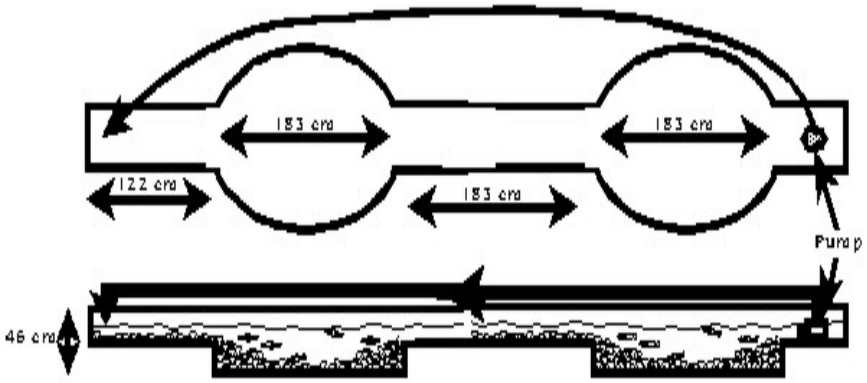

Figure 1. Configuration of artificial stream to be used to test prey response to and foraging efficiency of Colorado pikeminnow.

Prey behavior trials –In this experiment we will monitor the behavior of three native species (speckled dace, flannelmouth sucker, and roundtail chub) and two nonnative species (red shiner and fathead minnow) before and after the introduction of a caged pikeminnow into the streams. Five replicate trials will be run for each species using different fishes. The prey fish will be stocked at moderate densities (sensu Gido and Propst 1999) in the streams, 24 hr before the introduction of the pikeminnow, to allow them time to "adjust" to the system. After this period, habitat use of each individual will be characterized. Next, one caged pikeminnow will be placed into a randomly selected pool. Habitat use of the prey species will be measured one hour after the introduction of the pikeminnow. Habitat use measurements will include location in the water column (surface, bottom, etc.), mesohabitat (pool or riffle), proximity to caged predator, and activity rates (e.g., feeding, swimming, resting).

Predation efficiency - Additional experiments will be conducted to determine the relative predation efficiency of pikeminnow on the various prey species. Stream configuration, stocking densities, and acclimation period will be the same as above. However, in these trials, the pikeminnow will be released and allowed to forage on the various prey species. The pikeminnow will be removed after 24 hours and all fish will be seined from the streams to determine the number consumed by the pikeminnow. Pikeminnow will be starved for 48 hr prior to the foraging efficiency experiment.

For all experiments, the fishes will be kept at a holding facility at Kansas State University and facilities will be modified to preclude accidental escape of San Juan fishes in the Kansas River system. For this experiment and those described below, all the appropriate permits necessary to work with endangered species and the transfer of nonindigenous fishes will be obtained beforehand.

Field experiment

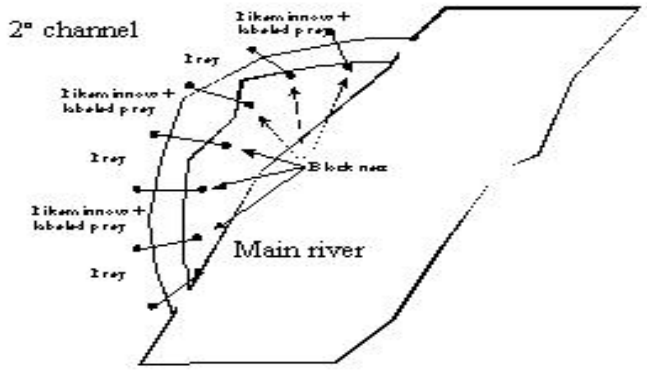

Figure 2. Design of field enclosure experiments to be conducted in San Juan River secondary channels.

Results from the experimental stream studies will be complimented with field enclosure experiments to evaluate our ability to scale our results up to natural systems. Field enclosures will allow us to recapture Colorado pikeminnow, prey species, and nonnative predators at the end of the experiment. For these experiments, 10 mm-mesh plastic netting will be used to block six ca.100-m reaches in a secondary channel of the San Juan River. Previous studies (e.g., Gido et al. 1997, Gido and Propst 1999) found that 100m reaches of San Juan River secondary channels contained a diverse array of habitats including pools, riffles, eddies and backwaters. Thus, these reaches should adequately represent major habitats available to pikeminnow and their prey. Reaches will be selected to have similar physical habitat features (e.g., depth, flow and large woody debris). Each reach will be sufficiently long (100 m) so that fishes behave normally and predation rates by Colorado pikeminnow will not be artificially high. After block nets (constructed of wire mesh and secured to the substrate with rebar) are in place, each reach will be sampled with three or more passes of a seine and DC-pulsed backpack electrofisher to quantify species present in the experimental reaches. All captured fish will be identified, counted, and released back into the reach from which they were captured. Muscle plugs will be taken from 30 to 50 individuals of each species for isotope characterization. If there are major differences in assemblage structure among enclosed reaches, we will remove or add fish to facilitate comparisons among reaches. After fish are sampled, three of the six reaches will be stocked with 5 sub-adult pikeminnow (200 to 350 mm TL). Prior to stocking, these individuals will be marked with a PIT tag and a tissue plug will be taken for isotope analysis. By monitoring changes in abundance of all species relative to enclosures without Colorado pikeminnow, we will be able to quantify changes in mortality rates of nonnative prey species as well. Captive-reared and nitrogen –labeled roundtail chub will be placed in one exclosure during each trial.

We will attempt to run the experiment twice a year for two years to account for temporal variation in abiotic and biotic conditions. The length of each experimental run will be approximately two weeks, assuming this will be adequate time to uptake sufficient ^{15}N for detection, as determined from laboratory experiments (see below). A field crew consisting of at least two individuals will be on site during each experiment to monitor field conditions and clean debris and maintain block nets. At the end of the experiment, a combination of seining and DC-pulsed backpack electrofishing will be used to capture all stocked fishes from each reach. A sample of dorsal muscle tissue will be taken from each pikeminnow,

frozen and returned to the laboratory for analysis. Channel catfish and any other predators captured during this study will be sacrificed for tissue samples and analysis of stomach contents. All other fishes captured will be identified, measured, and released, with the exception of labeled prey species, which will be preserved in 10% formalin and returned to the laboratory to characterize growth during the experiment.

During Year 1 of this study, we will construct block nets on one secondary channel to evaluate the feasibility of the field experiments. If we are able to contain fishes for two weeks, we will proceed with the experiments the following year.

Field trials will be conducted from cessation of spring runoff (late June-early July) through early autumn (late September) during summer 2004 and 2005. The two field experiments will be conducted within a six week period; the second experiment will occur two weeks after completion of first experiment. Information and insights gained during the first run will be considered in making changes to the experimental design in subsequent trials.

Probability of success will depend on the frequency of flood events that may destroy or damage exclosures. An evaluation of historic flows from the USGS gauging station at the Four Corners Bridge indicates we have a very high likelihood of success. We selected a likely starting date of 1 July and examined previous discharge records between 1978 and 2000 to determine how many years there would have been a significant flow event during a two week period after 1 July. In three of the 23 years examined, the flow in the river doubled in the two weeks following 1 July, suggesting a 13% chance that our experiment would be ruined. However, if we attempt these experiments during two years, or twice each year, the chances of a flood of sufficient magnitude to destroy or damage exclosures drops to 1.7 % or less. Moreover, we will closely monitor weather forecasts to increase our chances of success.

Laboratory study to evaluate use of $\delta^{15}N$ as a tracer
In conjunction with the artificial stream and field experiments, we will evaluate the feasibility of using ^{15}N labeled prey items to confirm consumption of particular prey

species by a predator. This will allow us to separate losses of prey items to natural mortality from those consumed by pikeminnow. Brine shrimp cultures will be reared at KSU and their tissue will be ^{15}N enriched by feeding them algae grown in ^{15}N labeled ammonium chloride. The ^{15}N labeled shrimp will be stockpiled in a freezer and used to enrich the tissues of captive native San Juan fishes (roundtail chub, speckled dace, and flannelmouth sucker). To evaluate the uptake efficiency and tissue enrichment of the ^{15}N in the prey, tissue samples from five individuals of each species will be taken one, two, and three weeks after the initiation of a ^{15}N enriched brine shrimp diet and analyzed for ^{15}N using procedures described above. To further evaluate the ability of the ^{15}N label in minnows and suckers to be transferred to a predator, we will feed the ^{15}N enriched fish to pikeminnow at a rate of one individual per day for one, two, and three week

periods and measure ^{15}N accumulation in pikeminnow muscle tissue from five individuals after different feeding durations. We will use the results from this study to adjust the amount of time necessary to feed prey fishes a ^{15}N labeled diet and the number of ^{15}N labeled prey fishes that are necessary for the pikeminnow to consume to detect their consumption in the field. In addition, this will allow us to assess our ability to use ^{15}N concentration in pikeminnow tissue to quantify the biomass of prey consumed. That is, individuals that consume a greater quantity of enriched prey should have higher concentrations of ^{15}N in their tissue.

DATA ANALYSIS

Differences in isotope signatures among geomorphic reaches will first be assessed using biplots of $\delta^{15}N$ and $\delta^{13}C$ signatures. Significant differences among reaches for each species will be assessed using Analysis of Variance (ANOVA) with post hoc corrections for multiple comparisons. ANOVA also will be used to evaluate difference in prey behavior and prey mortality rates in the presence or absence of Colorado pikeminnow in artificial stream and field experiments. Because the field experiments will be repeated over time (i.e., two years), year of experiment will be included as a blocking variable. Finally, paired t-tests will be used to evaluate differences in $\delta^{15}N$ in Colorado pikeminnow tissue before and after field experiments stocked with enriched native fishes. This will allow us to confirm the consumption of different prey species under natural conditions.

SIGNIFICANCE OF PROPOSED RESEARCH

Recovery of endangered species often depends on maintaining important linkages of imperiled species with other components of the ecosystem. Hydrology and fish assemblage structure has been drastically altered in the San Juan River. Thus, recovery efforts to increase populations of Colorado pikeminnow may depend on restoring both a natural hydrology and other native species populations, such as roundtail chub. The

proposed research will quantify the use of both native and nonnative prey species in the diet of Colorado pikeminnow. In addition, we will generate energy density information that can be used to refine bioenergetics models that estimate carrying capacity of the system. This information will strongly influence management decisions to either supplement native prey species or eradicate nonnative species. Moreover, by examining the consumption of prey items by nonnative predators (e.g., channel catfish), we can evaluate the potential competitive interactions among these fishes. This proposed study, if conducted, will provide information necessary to achieve SJRRIP Long Range Plan Objectives 4.4, 5.3.6, and 5.4.3. The use of manipulative field experiments will build upon existing correlative data (e.g., monitoring programs and carrying-capacity modeling efforts) to characterize the interactions of Colorado pikeminnow with native and nonnative fishes in the San Juan River, and to provide information that enables implementation of adaptive management strategies to recover Colorado pikeminnow in the San Juan River.

SCHEDULE

The first year of the proposed research will focus on collecting tissue samples for isotope signatures and caloric content. This information will help define the trophic interaction of Colorado pikeminnow and its prey resources. In addition, we will conduct several pilot experiments to assess the feasibility of the proposed field experiments. Thus, at the end of the first year, we will evaluate the likelihood that forthcoming experiments will be successful. If it is determined, based on pilot projects, that the experiments have a low probability of success we will either modify the proposed activities accordingly, or terminate the experiments and spend a second year finalizing a written report of the first year's results.

TIMELINE

June 2003 – May 2004: Collect samples from six geomorphic reaches of the San Juan River to characterize stable isotope signatures and caloric content of fishes and resource bases to evaluate sources of energy. Conduct pilot laboratory experiments at KSU, capture and rear fish to be ^{15}N enriched, select study secondary channel.

Conduct pilot experiments to evaluate and refine the feasibility of using blocked sections of secondary channels as replicates for field experiments.

Jul. 2004 – Sep. 2004: Conduct first year of field experiments (two trials).

Oct. 2004 – Nov. 2004 Conduct prey behavior and predator consumption experiments in artificial streams.
Nov. 2004 – July 2005: Laboratory and data analyses
Jul. 2005 – Sept 2005: Conduct second year of field experiments (two trials).
Oct. 2005 – Nov. 2005: Conduct second year of prey behavior and predator consumption experiments in artificial stream.
Nov. 2005 – Dec. 2006: Complete data analysis and synthesis. Draft and complete project completion report.

Facilities and Equipment available at Kansas State University
Artificial Stream system located at Konza Prairie Biological Station (12 riffle/pool units are currently in place and another 12 units are expected to be running by December 2002)
Wet lab (1100 ft^2) with fiberglass holding tanks and carbon filter water conditioning system
ThermoFinnigan Delta Plus mass spectrometer
Parr semi-microbomb calorimeter w/2 bombs
Large capacity drying oven
Ohaus digital analytical balance
Compound and dissecting microscopes

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Assessment of Colorado Pikeminnow Augmentation in the San Juan River
Scope of work for FY 2005

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Background:
In 1996 and again in 1997, approximately 100,000 young-of-year (YOY) Colorado pikeminnow were stocked in the San Juan River to characterize growth and retention in the river and quantify and characterize nursery habitat used by stocked fish (Trammel and Archer 2000). This experiment showed that habitat for young Colorado pikeminnow was available and reasonably common in the San Juan River, that YOY survived for at least 2 years, grew up to 250 mm TL, and that a large proportion remained in the river, rather than dispersing to Lake Powell. Differences in survival and retention observed between sampling trips and years were attributed to storm events and flow patterns. Storm events and runoff events tended to reduce

survival and move the fish downstream. Fish in the lower river tended to be more susceptible to flow-induced changes in retention than fish in the upper river.

Based on the success of this experimental study, the SJRIP stocked 100,000 pikeminnow above the Fruitland Diversion in Farmington, NM, and another 100,000 at the Shiprock bridge in Shiprock, NM, on October 24, 2002. The SJRIP also funded BIO-WEST, the New Mexico Department of Game and Fish, and the University of New Mexico to follow the progress of the stocked pikeminnow seasonally through 2002-2003. The overall goal of the study was to characterize retention of stocked Colorado pikeminnow and what, if any, changes should be made to the augmentation program to increase retention. In addition, an important objective of the current augmentation program is to establish Colorado pikeminnow in the area above Shiprock, especially the area above the PNM Weir. The adult Colorado pikeminnow recovery goals (USFWS 2002) were based on the assumption that Colorado pikeminnow could be expanded into this area to utilize the abundant available forage (native suckers and dace). Therefore, determining whether the area upstream of PNM weir could retain stocked pikeminnow was an important objective of the pikeminnow monitoring project in 2002-2003.

Results of the December 2002 and March 2003 samplings showed that retention above the Hogback Diversion appears to have been poor, and few if any pikeminnow appear to have moved upstream from the Farmington stocking site. Only 12 pikeminnow were collected in approximately 14 miles of sampling between the Farmington stocking site and the Hogback Diversion in December 2002. By the March 2003 sampling, only 1 pikeminnow was found in 9 miles of river sampled between the Farmington stocking site and the Hogback Diversion. Below the Hogback Diversion retention seems to have been better. In December 2002, 111 pikeminnow were captured in 29 miles of river sampled between the Shiprock Bridge and Sand Island. In March 2003, 96 pikeminnow were collected in the 29 miles sampled between the Shiprock Bridge and Sand Island. All of these catches are lower than similar sampling after the 1996 and 1997 experimental stockings by the Utah Division of Wildlife Resources (UDWR), even though more pikeminnow (4 times more in this area) were stocked in 2002.

In early November 2003 nearly another 200,000 YOY pikeminnow were stocking in the upper San Juan River. A number of experiments were conducted by stocking the fish into low velocity habitats in two 5 mile river reaches (Dale Ryden, USFWS, personal communication), and holding fish in two other five mile reaches for almost a week prior to release. Monitoring in December 2003 found relatively few of these fish, but more than was found in December 2002. Monitoring in March also found more fish in 2004 than 2003 but catch rates were similar (Golden 2004). Hence, retention of the stocked Colorado pikeminnow may have been slightly higher from the 2003 stocking than the 2002 stocking, but still not as high as seen in 1996-97.

Stocking Colorado pikeminnow into the San Juan River is expected to continue annually (Ryden 2003) with the intent of developing an adult population capable of sustaining itself in the river and meeting the recovery goals of 800/1,000 adult Colorado pikeminnow (USFWS 2002). At least 300,000 YOY pikeminnow are scheduled for stocking in October or November 2004. Some of the 2004 fish will be stocked over several miles of river at each stocking area, rather than in only two locations (Dale Ryden, USFWS, personal communication).

In this scope of work, we propose continuing the YOY Colorado pikeminnow monitoring that was initiated in 2002. This includes monitoring fish that will be stocked in 2004 and any pikeminnow remaining in the study area from the 2002 and 2003 stockings. This monitoring will help to more clearly understand factors affecting pikeminnow growth and retention in the San Juan River. We proposed some changes to study reaches, by deleting the two upper

stations where no stocked fish have been found yet, and adding portions of the river now uncovered by a lowering Lake Powell.

The study will also continue to help refine augmentation protocols. Due to the low retention from the 2002 stocking, studies related to acclimating the fish to the river environment and providing cover (brush piles) for the stocked fish were experimented with in 2004. The fish used in acclimation study were marked with a calcein dye that was not readable in field conditions. Hence, it could not be determined if more fish retained from those held in the experiment. In addition, nearly 75 % of the fish used in the study exhibited a delayed mortality. A separate scope of work has been prepared to examine the causes of the mortality. The brush pile experiments in 2003 also did not produce viable results. One day after the brush piles were placed in the river, flows from Navajo Dam were reduced and the brush piles were generally left out of the water. These studies are proposed to be reinitiated for 2005 with adequate controls for marking fish and maintaining the brush piles in usable habitat.

The 2003, 2004, and 2005 data will provide a baseline to compare against future years. Continued sampling will allow the SJRIP to judge the success of new stocking protocols, habitat restoration efforts which may be implemented in the future, and different flow conditions between years, at improving the retention of stocked YOY pikeminnow. This information can be used to make management decisions regarding future augmentation efforts.

Study Area:

The study area will be enlarged from the area studied in 2004 and will encompass the San Juan River from the Lake Powell water elevation (approximately RM-25) to the mouth of the Animas River (RM185). Nine stations from Farmington to Clay Hills and one river reach from Clay Hills to the Lake Powell water line will be utilized to represent the study area rather than the 11 stations used in 2004, two in Geormorphic Reach 6 near Farmington, two in Reaches 2 and 3, and one each in Reaches 1, 4, and 5. Within geomorphic reaches 1-6 the study stations will remain the same as the 2004 stations to allow for retention comparisons between years. The two stations above Farmington will be dropped, and a new river reach below Clay Hills will be added. Table 1 provides the stations to be sampled, along with their river mile boundaries.

Table 1. Stations to be sampled for the 2003-2004 Colorado pikeminnow monitoring.

Station	River miles
Fruitland Diversion to Hatch Trading Post	170-179.4
APS Weir to Hogback Diversion	160-164.7
Shiprock Bridge to Cudei	143-148.9
Drift station to Four Corners Bridge	120.2-128.5
Aneth	97.3-105.2
Bluff	77.5-84.0
Below Mexican Hat	40-45
Johns Canyon	20.0-25.0
Grand Gulch	8.0-13.0
Clay Hills to Lake Powell	3.0-(-25?)

Specific experiments to improve retention will occur in the Fruitland Diversion to Hatch station (RM 170-179), the APS Weir to Hogback Diversion Station (RM 160-165), and the Shiprock to Cudei station (RM 143-149).

Objectives:
The objectives of the study are listed below.

1.) Characterize growth and retention of 2004 stocked YOY Colorado pikeminnow during the first year after stocking in the San Juan River.

2.) Identify factors such as river flow, storm events, and canal locations, with emphasis on the area above the PNM Weir, that are related to high or low retention of stocked YOY Colorado pikeminnow during the first year after stocking.

3.) Characterize growth and retention of age 1 stocked YOY Colorado pikeminnow from the 2002 and 2003 stocking during their second and third years in the river, respectively.

4.) Compare growth and retention between 2002-2004 stocked fish and relate to changes in stocking protocol, river conditions, habitat improvements, and habitat availability.

5.) Compare growth and retention of the 2002-2004 stocked fish with historical stockings, and relate to changes in stocking protocol, river conditions, habitat improvements, and habitat availability.

6.) Experiment with augmentation protocols for Colorado pikeminnow to improve retention, especially in the upper river.

Methods:
Protocol Experiments - BIO-WEST proposes to continue experiments of the benefits of site acclimation and increased cover (brush piles) in 2004-2005. In addition, experiments of stocking fish earlier, at a warmer river temperature, will be conducted.

Conducting multiple stocking protocol studies at the same time can be complicated unless fish in the different experiments can be marked or different study areas are used. In 2003-2004 we experimented with a calcein marker that Dexter National Fish Hatchery is studying. Our results found the calcein mark to be very difficult to read in the field and, hence, have decided not to use calcein in 2005. An elastomer dye mark will be used that is injected under the skin of the fish in various colors and locations to separate different experiments. The dye mark is clearly visible with the naked eye. BIO-WEST has used the elastomer dye tag on native fish in other basins with great success, and Dexter used it in 2003 on several other endangered fish with great success. The disadvantage of the elastomer is the time and cost associated with marking the fish. Dexter estimates a crew of 7-10 individuals can mark 20,000 pikeminnow in 2-3 days, whereas the calcein mark takes 1-2 people a few hours. The advantages of the elastomer include ease of positive identification in the field and the availability of multiple colors and/or locations on the fish to mark different experiments, All fish used in the acclimation and earlier stocking experiments proposed in this SOW will be elastomer marked to differentiate them from the bulk of the YOY pikeminnow to be stocked by the USFWS. The USFWS is proposing to use the same stocking protocol initiated in 2003 by stocking pikeminnow over two 10-12 mile reaches of the San Juan River in October 2004. The YOY pikeminnow will be stocked

directly into low velocity habitats throughout the river from the confluence of the Animas (RM 181.5) to the Hatch Trading Post (RM 170), and also from the Hogback Diversion (RM 159) to the Shiprock Bridge (RM 148.9) (D. Ryden, USFWS, personal communication). A GPS location will be taken at each area where pikeminnow are released.

Acclimation studies will occur in the Fruitland Diversion to Hatch Trading Post and the APS Weir to Hogback Diversion stations. The USFWS will be stocking fish in all available low velocity habitats from the mouth of the Animas River to Hatch Trading Post, so some overlap will occur between our acclimation study and their stocking. The habitat available in each reach of river at any given time is largely a function of prevailing flow conditions. Therefore, BIO- WEST will perform a reconnaissance trip through both stations the week of the stocking to identify appropriate backwater and side channel habitat available for acclimation studies in October 2004. During the reconnaissance trip, BIO-WEST will identify 5-10 low velocity habitats suitable for acclimation in each station. A GPS location will be taken for all acclimation study sites. Block nets with < 2 mm mesh will be used to enclose the low velocity habitat to prevent the escape of introduced pikeminnow and the entrance of other fish. Block nets will be set in place several days prior to stocking to determine any obvious problems with the maintenance of the acclimation study sites.

BIO-WEST personnel will receive a subset of approximately 20,000 fish from Dexter National Fish Hatchery. These fish will be marked with an elastomer dye mark. The dye will allow identification of those fish that were site-acclimated during the 2004-2005 YOY Colorado pikeminnow monitoring. BIO-WEST will place approximately 1,000 of these marked pikeminnow into each selected acclimation habitat in each of the two study stations. Block nets will be monitored every day for 7 days after the stocking, at which point block nets will be removed. Monitoring of the block nets will involve visiting each acclimation study site at least once daily over the 7-day period.

The December 2002 monitoring data indicated that the presence of cover, in the form of debris piles, may be important in retention of stocked pikeminnow in colder winter months. BIO-WEST proposes to add debris piles to low velocity habitats throughout the Shiprock to Cudei monitoring station prior to the October 2004 stocking. In combination with the reconnaissance trips to identify acclimation study sites, BIO-WEST personnel will also float the Shiprock to Cudei study station the week of the October 2004 stocking. Branches will be removed from the abundant nonnative tree, Russian olive (*Elaeagnus angustifolia*), and placed into appropriate pikeminnow nursery habitats. Care will be taken to remove only a few branches from individual trees, to avoid any visual denudation of the stream bank and damage to the riparian zone. Branches that have already fallen will be used when possible. A GPS location will be taken at all habitats where debris is added.

Early Stocking Experiment - In 1996 and 1997 YOY Colorado pikeminnow were stocked in the San Juan River, but stocking times were different between the two years. In 1996 the fish were stocked in early November, in 1997 they were stocked on August 15. Fish stocked in 1996 showed little growth until the following spring, whereas the 1997 stocked fish grew during the fall after stocking. Some of the 1997 fish were found over 8 miles upstream of the stocking site, indicating they had moved upriver that distance. No fish in 1996, or in the recent 2002 and 2003 stockings, have been found upriver from the stocking sites. The growth and movement of young pikeminnow stocked earlier in the year when river temperatures are warmer suggested they may have become more acclimated to their new river environment. Warmer river temperatures may have contributed to this behavior since most fish tend to become fairly inactive as water temperature declines.

We propose to stock a group of 20,000 YOY Colorado pikeminnow with an elastomer dye mark (different than for the acclimation experiments) to test the hypothesis that earlier stocking will lead to increased retention in the river, and to increased retention in the upper river. The fish will be stocked in low velocity habitats in the Animas River to Hatch Trading Post reach of the San Juan River in late August, 2005. BIO-WEST personnel would coordinate with Dexter National Fish Hatchery for the fish tagging and will conduct the actual stocking.

Data Analysis:

Data collected during the 2004-2005 YOY Colorado pikeminnow monitoring will be used to judge the success of each of the above methods in increasing the retention of stocked pikeminnow. All pikeminnow captured during monitoring will be scanned for the presence of the elastomer dye. A comparison of pikeminnow CPE between 2002-2003, 2003-2004, and 2004-2005 in the Fruitland to Hatch and APS Weir to Hogback stations will provide information on whether site acclimation studies increased the retention of fish in these stations. Examining all fish captured during the monitoring for dye marks should provide information on how far site- acclimated fish drifted from their stocking site, whether site acclimated fish had better retention than non-acclimated fish, and if stocking earlier increased retention. Comparing CPE of pikeminnow between 2002-2003, 2003-2004, and 2004-2005 in the Shiprock to Cudei station should give an indication of whether brush piles increased retention in that station. The CPE of pikeminnow in the Shiprock to Cudei station will also be compared to downstream stations that will not receive debris pile manipulations. Pikeminnow CPE will be compared between 2002- 2003, 2003-2004, and 2004-2005 in the Fruitland Diversion station to provide information on whether stocking fish into individual habitats increased retention. Finally, comparing the overall pikeminnow CPE between 2002-2003, 2003-2004, and 2004-2005 should indicate whether the suite of protocols implemented during the 2004 stocking had an impact on the retention of pikeminnow throughout the river.

Fish data will be transformed to more closely approximate the normal distribution. The statistical program SYSTAT will be used to make the comparisons noted above. Where appropriate, we plan to use parametric tests, such as Analysis of Variance and t-tests, to compare catch per effort between years and stations.

The early stocking, acclimation, and brush pile studies are proposed to run for another 3 years since different techniques may work better under different flow/habitat/temperature conditions.

Monitoring - Three sampling trips will be made between the 2004 YOY pikeminnow stocking and September 2005. The first trip will be 2 to 4 weeks following stocking, most likely in late October or early November 2004. The second will be post-winter, but pre-runoff, most likely in March 2005. The third trip will be post-runoff, most likely in July or August, 2005. Trips will be scheduled to avoid periods of changing flow conditions.

During each trip, each of the 9 sampling stations will be sampled for one day. Access to the stations will be made with a raft. The river reach below Clay Hills will be sampled as one long station since we are not sure at this time what type of habitat occurs in this reach. Within each station or reach, as many backwaters, shoals, and other low-velocity habitats available for young Colorado pikeminnow (Trammel and Archer 2000) will be sampled as is practicable in a day. Random sampling between stations will occur in Reaches 1 and 2 and below Clay Hills as the entire area below Mexican Hat will be floated. Sampling will be conducted using a 4 m x 2 m x 3 mm, 3 m x 2 m x 3 mm or a 9 m x 2 m x 6 mm double-weighted seine during the fall 2004 and spring 2005 sample. Shock and block electrofishing will be used in conjunction with seining in the summer 2005 sample. This will involve using a 30 foot seine to block the lower

end of a habitat and working two backpack electrofishers downstream to the seine. This technique is being experimented with during the July 2004 monitoring trip and may be refined at that time. Electrofishing is being instituted because sampling in June 2003 found that the stocked pikeminnow had grown large enough to avoid the seine, whereas crews using raft-mounted electrofishing throughout the summer of 2003 had success in capturing the larger stocked pikeminnow.

Information collected at each seining/electrofishing location will include: river mile location, GPS location (UTM), habitat type, seine type, water temperature, area sampled (length and width), average depth, maximum depth, and substrate type. All fish collected, except for small larvae, will be identified to species and counted. A minimum of 50 randomly selected individuals of each species will be measured at each station except for Colorado pikeminnow, which will all be measured. This will provide information on the general size and age of the fishes that are collected at each station and during each sampling trip. Native fishes will be returned to the habitat alive, and nonnative fishes will be retained. A separate data sheet will be used for each seine location. Multiple seine hauls/electrofishing runs may be made in large (>100 m^2) habitats. The emphasis will be to take as many samples as possible rather than to gather detailed information on each fish captured.

A PIT tag reader will be taken on monitoring trips. All pikeminnow over 150 mm TL captured during monitoring will be scanned for PIT tags and tagged if they do not already have a PIT tag.

It is anticipated that data on stocked Colorado pikeminnow will also be obtained during the annual April-June razorback sucker larval fish and July-September larval Colorado pikeminnow surveys currently being conducted under the SJRIP, as was the case in 2003. Additionally, the fall standardized sampling (Propst et al. 2000), adult monitoring (Ryden 2004), and nonnative removal studies (Davis and Coleman 2004, Jackson 2003) should provide some information on pikeminnow retention during various other times of the year. Since University of New Mexico (UNM) personnel responsible for the two aforementioned larval fish studies, the New Mexico Department of Game and Fish (NMGF) personnel responsible for the fall small-bodied fish standardized sampling, and the Utah Division of Wildlife Resources personnel responsible for the nonnative monitoring study are the co-principal investigators on this proposal, we expect seamless integration of data between the respective projects.

Data analysis will include an evaluation of changes during the course of the year in YOY Colorado pikeminnow catch rate, size, and location in the river. Information from the razorback sucker spring-summer sampling, as well as the September-October standardized monitoring, will be included in the analysis to provide a complete first year picture of the fate of the stocked fish. As the fish grow, information from the large-bodied fish electrofishing surveys will also be added. Changes in YOY Colorado pikeminnow catch rates will be compared with factors such as flow, river location, presence of canals, and other factors that may influence growth or retention. The results from the first year of the study will be compared with the second year of the study to determine changes in retention and identify potential causes for those changes. Information from earlier pikeminnow stocking efforts and follow-up sampling will be reviewed and compared where appropriate to the 2002, 2003, and 2004 information. YOY pikeminnow habitat use will be examined with chi-square analysis. Potential changes to the augmentation program will be suggested based on the results of the study, especially if growth or retention are not within the range of expected results as noted in the Augmentation Plan (Ryden 2003).

Collection information will be compared with physical information such as river flow, storm event timing, and habitat availability that will be obtained from the physical monitoring

activities of the SJRIP (Keller-Bliesner Engineering data). This physical information will be compared to the catch information to determine possible reasons for changes in retention between years and between sampling periods. In addition, if habitat improvements are implemented in 2004, the effect of those actions will be evaluated by comparing catch rates between 2002-2003 sampling, 2003-2004 sampling, and 2004-2005 sampling at appropriate stations.

BIO-WEST personnel will have the lead role in the study. Mr. Michael Golden will be the team leader. Personnel from NMGF and UNM will assist with field collection efforts and provide equipment as necessary for the upper eight stations. Personnel and rafts from UDWR will be used to access the lower three stations and the reach below Clay Hills. A standard field crew of four people is anticipated for all trips.

The study is planned for a minimum of 3 more years to allow for an evaluation of the various factors that may be impacting YOY Colorado pikeminnow retention.

Products:

Letter-type trip reports summarizing what was found will be prepared following each trip. These short reports will be sent to the Biology Committee via the listserver once data have been preliminarily analyzed.

BIO-WEST personnel will also attend the annual researchers' meeting in February 2004 and provide a Microsoft Powerpoint presentation of the results of the project.

The annual draft report for 2004-2005 will be prepared and distributed to the SJRIP Biology Committee on or before March 31, 2006. Upon receipt of comments, a final report will be prepared on or before June 1, 2006, and provided to the SJRIP for distribution. All data will be presented in a Microsoft Access database and provided to the SJRIP for inclusion in the standardized database by March 31, 2006.

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Development of Stocking Protocols for Colorado Pikeminnow
In the San Juan Basin River Recovery Implementation Program
Scope of work for FY 2005

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Background:

Augmentation of Colorado pikeminnow is a major portion of the recovery strategy for this species in the San Juan River where the wild population is extremely small. The general augmentation strategy is to stock 200,000 to 300,000 young-of-the-year (yoy) pikeminnow in the fall of each year for a number of years, or until certain population goals are met (Ryden 2003). The first stocking occurred in 2002 when approximately 200,000 yoy were stocked by the U.S. Fish and Wildlife Service (USFWS), half at Farmington (RM 180.1) and half at Shiprock (RM 147.9) NM. The fish were reared at Dexter National Fish Hatchery and Technology Center (Dexter) who has had the lead in culturing and propagating Colorado pikeminnow since 1981. BIO-WEST conducted monitoring studies of the stocked fish in 2002 and 2003 to determine overall retention in the river and location of retained fish.

In fall 2003 stocking was conducted on November 6 when the USFWS stocked most of the available fish (175,000 were available in 2003) into low velocity habitats along 20 miles of river; 10 miles near Farmington and about 10 miles between the Hogback Diversion and Shiprock. In addition, BIO-WEST was funded to utilize 20,000 of the total available yoy to study stocking protocols, primarily acclimation of the fish prior to release to the open river. The 20,000 fish for BIO-WEST were marked with calcein, a non-lethal fluorochrome compound that chemically binds with calcium, three days prior to stocking the fish into net pens and netted off backwaters in two areas, above Farmington reach and the APS Weir to Hogback Diversion reach. Fish were delivered to the river on November 6 in three trucks from Dexter and stocking was initiated in late morning. BIO-WEST monitored their pens and backwaters during the next 7 days.

Monitoring of the young fish for the first 24 hours after stocking showed that they were healthy and doing very well with very few mortalities, (less than 10 observed out of 20,000 fish handled).
At about 24 hours post stocking, large numbers of fish started showing signs of stress (swimming near the surface erratically and developing a red blush on ventral portion of the fish) and died. About 70 to 80 percent of the fish died during the following 48 hours, after which the remaining live fish appeared to

have recovered from the traumatic event and were released on November 12. On November 8 during the mortality period, BIO-WEST crews seined near the APS Weir and caught 6 non-marked pikeminnow that had been stocked by the USFWS near Farmington. Two of those 6 fish showed stress signs similar to the fish being held in the pens and backwaters. At the time the fish were dying (November 9), Paul Holden of BIO-WEST contacted Dr. Ron Goede, a retired Utah Division of Wildlife Resources fish health expert to determine cause and effect for the catastrophic loss. Dr. Goede suggested that accumulated stress and large changes in water hardness and conductivity (salinity) may be an issue. He had noted similar delayed mortality taking cutthroat trout from very hard to very soft water in the past.

Discussions with Manuel Ulibarri began on November 10 and dead fish were sent overnight to Dexter. Autopsies of some of the dead fish were made by Manuel on November 11 and hemorrhaging of the internal organs was noted as the likely cause of death. Based on Manuel's past experience, and information from the literature, as well as a comparison of Dexter and San Juan River water (Table 1), it was generally concluded that taking the fish from Dexter with very hard and saline water, to the San Juan River with low hardness and salinity, was the likely reason for the death of most of the stocked fish. Dexter staff believe the delayed mortality was caused by the fishes internal organs not being able to osmotically adjust to the drastic change in water quality. Dexter harvest protocols consist of a several day cycle that begins with draining one acre rearing ponds over a 48 hour period. During harvest, approximately 50gpm fresh water flow is added to the harvest basin where fish are collected and transported in oxygenated tanks and a 0.5% saline solution to the fish culture building for enumeration and marking. The 2 day harvest time frame and fresh water provides the fish sufficient time to acclimate to well water quality that they will be in for the next few days. Over the next two days debris and unwanted invertebrates are removed from the culture tanks, and the fish are netted, weighed, marked and enumerated. Following this process the fish are placed in a 0.5% saline solution to alleviate the handling stress and allowed to rest prior to shipping. The fish are then netted, and loaded into oxygenated, insulated fiberglass tanks and hauled in a 0.5% saline solution at densities of approximately 100 to150 fish (2#) per gallon of water. It is possible that fish mortalities were incurred due to the extreme difference in water quality of the receiving water, compounded by the several days long harvest, handling, marking and shipping scenario. Since the stocking protocols used on November 6 were essentially the same ones used since 1996 when yoy Colorado pikeminnow were first stocked in the San Juan River (tempering for temperature at the river lasted approximately a half hour), it is likely that similar large mortality events happened at all previous stockings.

Table 1. Water quality comparison of Dexter National Fish Hatchery and Technology Center wells and the San Juan River near Farmington, NM.

Constituent	Dexter	San Juan River
Hardness	1700-2200 mg/l	180 mg/l
TDS	3950-4800 mg/l	240 mg/l
Alkalinity	188-245 mg/l	110 mg/l
Conductance	3420-5500 umhos/cm	390 umhos/cm

Dexter and BIO-WEST received funding from the SJRIP in November 2003 and conducted experiments with approximately 2,000 yoy pikeminnow that had been retained at Dexter. In November 2003, Dexter attempted to recreate some of the handling stress and the calcein marking, and hauled San Juan River water to the hatchery to test changes in water quality, but no fish died in their experiments. BIO-WEST conducted tempering experiments in the San Juan River in December 2003 with 1,000 fish transported

to the river from Dexter. Again, no mortality was seen. These studies suggested that water quality differences between Dexter and the river were not sufficient to cause the mortality seen in November and that the calcein mark also was not responsible for the mortality. It was concluded that the lack of accumulated stress, which was the primary factor that could not be recreated in these experiments, was likely the missing component in this mortality mystery. Our hypothesis is that accumulated handling stress and a dramatic change in water quality worked synergistically to create the mortality seen in 2003.

Study Area:
The study will be conducted at Dexter and in the San Juan River in the area from the Fruitland Diversion to the Hogback Diversion (RM 179.4-165.0).

Objectives:

1.) Determine if the 2003 mortality event can be duplicated.

2.) Determine if new handling protocols reduce or eliminate the mortality.

3.) Determine if longer tempering at the river will reduce mortality.

Methods:
During 2003, Dexter personnel harvested yoy pikeminnow from nursery ponds, readied them for transport in the hatchery building, and transported them via truck to the San Juan River in a period of 3-4 days. We believe that having several very stressful events occur during such a short period of time, along with relatively short tempering at the river (30-45 minutes), and the change in water quality, all acted together to cause the delayed mortality. Dexter plans to expand the handling period for the fish to be stocked in October or November 2004 to 10-14 days. This scenairo should allow the fish to recovery for several days between stress events.

This experiment will compare fish handled with the new 2004 protocol, to those handled using the 2003 protocols. To do this, Dexter will leave approximately 10,000 YOY pikeminnow in one of the nursery ponds when the bulk of the fish are removed approximately 3 weeks before the anticipated stocking date. Approximately 3 days prior to the stocking date, the 10,000 fish will be removed from the pond, half will be calcein

dipped and half will remain unmarked. They will be transported in separate small live boxes with the other fish to the San Juan River. Hence, the bulk of the fish to be stocked by the USFWS will have been handled over a 2-3 week period before stocking whereas the 10,000 fish for this study will be handled for a 3-4 day period before stocking, similar to 2003. In addition, about 20,000 of the main group of fish to be stocked will be marked with an elastomer injectable dye for acclimation experiments by BIO-WEST (separate scope of work).
Once the fish reach the San Juan River, the bulk of the fish will be taken by the USFWS and stocked in the Farmington and Shiprock areas, with many of those fish being placed in low velocity habitats in two 5-10 mile reaches of river. BIO-WEST will take the 20,000 elastomer tagged fish and place them in backwaters and net pens to repeat the acclimation experiment where the mortality was experienced in 2003. The 10,000 fish for the experiment proposed in this scope of work will be taken by BIO-WEST personnel to a backwater where tempering experiments will be conducted.

BIO-WEST will have placed 10 net pens (2 m x 2 m) in the backwater on the previous day. The fish will be placed into three experimental lots. One lot of 2,000 calcein dipped and 2,000 non- calcein dipped fish will be stocked in 4 pens at a rate of 1,000 fish/pen to simulate the 2003 stocking protocol. Another lot of 2,000 dipped and non-dipped fish will be acclimated with river water for 3 hours prior to

stocking in 4 pens, and the final lot of 1,000 dipped and non-dipped fish will be acclimated for 6 hours prior to stocking in 2 pens. Acclimation will involve changing the conductivity of the water in which the fish are being held from the level of the transport water (essentially that of Dexter) to within 10 % of the conductivity of the water in the backwater during the specified time period. This will be accomplished by replacing water in the coolers holding the fish (initially all Dexter water) with backwater water at specified times and amounts. The pens will be checked daily for 5-7 days and the number of mortalities per day in each pen recorded. Any fish remaining alive after the experiments are completed will be stocked into the river.

This experiment will compare the fish being held with the new 2004 protocols in the BIO-WEST acclimation experiments (separate scope of work) with the fish using the 2003 protocols. In addition, tempering for longer periods of time under the 2003 protocols will also be tested.

Products:

A report detailing the methods used and results of the study will be prepared and presented at the February 2005 Biology Committee meeting. A final report will be submitted by March 31, 2005.

Literature Cited:

Ryden, D. W. 2003. Augmentation plan for Colorado pikeminnow for the San Juan River. U.S. Fish and Wildlife Service, Grand Junction, CO.

Characterization of Razorback Spawning Bar
Fiscal Year 2005 Project Proposal

(second year of 2-year study. Original funding diverted to integration)

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Study Area:
The study area consists of the San Juan River in the Vicinity of Aneth, UT, or other identified Razorback Spawning locations.

Collections:
Interstitial and course substrate samples for grain size analysis.

Background:
Razorback sucker monitoring has identified aggregations of ripe males and females in a primary location in the river near Aneth, UT in 2002 and 2003 during typical spawning time. While actual spawning has not been observed, the conditions are right for spawning to occur and larval razorback suckers have been found in the larval drift studies downstream of this site. A second site at RM 152.2 was identified with a running ripe female in 2004. Since little is known about suitable spawning habitat for razorback sucker in the San Juan River, characterizing this site at or near the time of fish observation could aid in the understanding of the nature of the spawning site.

Objectives:

1.) Identify and characterize typical characteristics of a suspected razorback spawning site. (2004, verify 2005)

2.) Characterize habitat in the vicinity of the suspected spawning site. (2004, verify 2005)

3.) Identify other potential sites with similar characteristics (2005)

4.) Coordinate with the razorback sucker monitoring program to analyze findings.

Methods:
1.) Characterize spawning bar characteristics. As soon as the razorback sucker monitoring program identifies the presence of ripe fish at a location, a crew will be mobilized to the site to characterize the bar. (Up to three locations will be surveyed.) Topographic surveys will be completed for each of the sites identified utilizing total station or gps survey equipment and survey control bench marks established at each site.

At the same time, the structure of the bar will be assessed by completing point counts of

the surface bed material (n=200 per sample or more) at each bar. Particles will be selected by the point count method over the full extent of the bar within the survey boundary. Size is determined by placing the rocks through a square hole in an aluminum plate, cut to represent an equivalent screen size from 1 cm through 10 cm at 1 cm increments, then 2 cm increments through 20 cm. Those larger than 20 cm are recorded as greater than 20 cm. Interstitial material smaller than 1 cm is not recorded.

Depth of open interstitial space (depth to embeddedness) will be measured on a 5 or 10-ft grid over the extend of the bar. Measurement will be made by working a hand between rocks until the fingers touch the sand embedded depth. The depth of penetration below the average top of cobble immediately adjacent to the sample point will be measured and recorded as the depth of open interstitial space.

Bar morphology will be determined by producing three-dimensional plots of the surveyed surface. Characteristics of the bar will be compared to other bars characterized during the 7-year research period.

The size distribution of cobble at each bar is computed and the D16, D50 and D84 sizes reported and compared to previous years. Depth of open interstitial space will be computed as actual depth and multiples of mean cobble diameter. Gross water quality parameters (temperature, DO, Ph, Conductivity) will be collected at the site and from local tributaries.

2.) Map habitat in the vicinity. Utilizing existing aerial photography taken near the flowrate at sampling as a base map, detailed habitat mapping will be completed to the long-term monitoring protocol for one mile up and downstream of the site. The information will be digitized and the data summarized.

3.) Identify other potential sites. Based on the characteristics identified at the suspected spawning sites, including vicinity habitat mapping, a review of mapped habitat will be completed and similar sites identified. A field investigation will be completed to characterize those identified as being similar utilizing the protocol in Task 1. This activity will be completed in the second year of the study based on preliminary data review in year one. The budget shown assumes complete surveys on 5 additional sites. If more sites are identified, the budget will be adjusted accordingly.

4.) Coordination with razorback sucker monitoring team. Data analysis will be coordinated with the razorback sucker monitoring team to compare habitat and substrate data with observed fish position. As disturbance of the fish at spawning time should be minimized, no field work will be completed without the approval of the Biology Committee and the razorback sucker monitoring team.

Products:
A summary report will be prepared covering the findings and comparing them to literature results, including unpublished observation data in the upper Colorado River Basin. A draft monitoring plan will also be prepared to track changes at this site and identify other potential sites. Draft report and data submitted to the database by March 31, 2006. Final report June 30, 2006.

Non-native Species Monitoring and Control in the *Upper* San Juan River
FY 2005 Workplan Proposal

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Background:

From 1991 to 1997, non-native species studies on the San Juan River focused on the identification of impacts to native fishes. Research characterized non-native species distribution and abundance in main channel habitats, seasonal movements of both channel catfish *Ictalurus punctatus* and common carp *Cyprinus carpio*, food habits of non-native predators, overlap of resource use between native and non-native fish species, and the relation of these findings to differing flow regimes. Channel catfish were the most abundant large bodied non-native fish in main channel collections (Ryden, 2000). Data showed channel catfish occupied a variety of main channel habitats, exhibited localized movement, and fish > 450 millimeters total length (TL) preyed upon native fishes (Brooks et al., 2000).

Beginning in 1999, emphasis on removal of channel catfish and common carp was placed on a portion of Reach 6, PNM Weir to Hogback Diversion (River Mile [RM] 166.6 to 159.0) and was designed to address efficacy of mechanical removal and minimization of the reproductive effort in the upper portion of these species ranges. This sub-reach was selected based on studies conducted from 1991 to 1997 indicating low numbers of both channel catfish and common carp above PNM Weir and channel catfish collected within this reach were almost exclusively large adult fish, > 300 mm (Ryden, 2000).

Intensive non-native removal completed its third consecutive year in 2003. Removal efforts have focused on the PNM Weir to Hogback Diversion reach but in 2003 were expanded to include the Hogback to Shiprock reach. This downstream expansion in effort was a result of frequently low catch rates (CPUE), < 5.0 channel catfish/hour of electrofishing, from PNM to Hogback during removal trips and an associated high abundance, > 40.0 channel catfish/hour of electrofishing downstream of Hogback Diversion.

Channel catfish CPUE throughout intensive removal reaches has varied greatly from 2001-2003 and between reaches. Mark/recapture data suggest that these flucuations in CPUE are a result of channel catfish emigration from areas adjacent to intensive removal reaches. Although an overall reduction in CPUE has not been observed since 2001, a significant increase in juvenile fish and associated decrease in adult fish has been observed (Davis and Coleman, 2004). Juvenile catfish comprised < 1% of the total catch in 1999 and > 40% in 2003. Fish > 500 mm comprised 39.6% of the catch in 1999 and only 3.1% in 2003.

A shift to smaller sized channel catfish is important to the control of this species due to attainment of sexual maturity and increased reproductive potential of larger sizes. Helms (1975) found that length was positively correlated with fecundity. In this study, 1 of 10 channel catfish were sexually mature at 330 mm TL, producing about 4,500 eggs compared to 5 of 10 at 380 mm TL, producing over 41,000 eggs. These shifts to smaller individuals coupled with declines in seasonal abundance throughout this reach may have long term effects to the channel catfish populations in adjacent downstream reaches.

In addition, common carp CPUE from PNM Weir to Hogback Diversion has significantly decreased between 2001-2003. No apparent decrease in size class distribution of common carp has been noticed with the majority of the catch consisting of individuals > 400 mm TL.

Supplementing intensive removal trips are the opportunistic removal of non-native fish during juvenile/adult fish monitoring trips (RM's 147.9 – 0.00). Monitoring trips in 2002 and 2003 have shown riverwide declines in CPUE for both channel catfish and common carp (Ryden, 2004). Although these trends cannot be attributed exclusively to removal efforts, the observed declines in CPUE of non-native fish is encouraging. Declining shifts in channel catfish size structure, most notably in Reaches 4-2 (RM 131.0 – 17.0), may be effecting overall recruitment in the San Juan River.

Since 2002, elevation at Lake Powell has been decreasing resulting in the formation of a waterfall near Piute Farms, RM -0.50 (Jackson, 2004). It has been hypothesized that the lack of lacustrine fish in electrofishing collections the past several years are a result of the formation of this waterfall. In addition to preventing upstream movement by striped bass *Morone saxatilis* and walleye *Sander vitreus*, the presence of a waterfall may also limit movement by both channel catfish and common carp from Lake Powell to the river.

For the past several years the Utah Division of Wildlife Resources have focused non-native removal efforts in the lower San Juan River (RM 52.7 – 0.00) while U.S. Fish and Wildlife Service efforts have focused on 17 river miles in the upper portions of critical habitat for both Colorado pikeminnow *Ptychocheilus lucius* and razorback sucker *Xyrauchen texanus*. Current conditions including declining trends in riverwide CPUE for both species, a shift to smaller less fecund individuals, and the presence of a waterfall preventing upstream movement of non-native fish provide researchers with a unique opportunity to expand removal efforts. If removal efforts continue, while a high percentage of the population are small less fecund individuals, a continued decrease in overall abundance can be expected. Expansion of removal to areas where exploitation occurs only once or twice a year (RM's 147.9 – 52.7) may be critical in accomplishing significant riverwide declines in distribution and abundance of these two non-native fish.

Proposed expansion of removal efforts will include sampling trips to be conducted from Shiprock to Montezuma Creek, Utah (RM 147.9 – 93.6). The addition of this stretch will add 54.3 river miles of removal to the 69.7 river miles where intensive removal currently takes place.

Given the popularity of channel catfish as a sport fish and the concerns expressed by the public regarding disposal of removed fish, a program to transplant removed fish to isolated fishing impoundments within the Basin was initiated in 1998 and continues through the present. Channel catfish are transported by the New Mexico Department of Game and Fish or the Navajo Nation to closed impoundments. This effort is strongly supported by the State of New Mexico and the local public and expansion of the program is highly recommended.

The USFWS has a long standing working relationship with Native American tribes in assisting in various fisheries related issues including non-native recreational fishing programs on tribal lands. The Service has long provided recreational game fish to tribal partners throughout the Southwest with emphasis on rainbow trout, *Oncorhyncus mykiss*, and channel catfish. Many hatchery programs which supplied these fish for tribal use have suffered cutbacks or complete closures causing many tribal programs to suffer. The Southwest Tribal Fisheries Commission (SWTFC) was formed to restore and enhance tribal sport fishery resources and may provide additional support for distribution of removed channel catfish.

Objectives:

1.) Continue data collection and mechanical removal of large bodied non-native fish during main channel and rare fish monitoring efforts.

2.) Evaluate distribution and abundance patterns of non-native species to determine effects of mechanical removal.

3.) Expand intensive removal efforts downstream to Montezuma Creek, Utah (RM 93.6) while still maintaining sufficient effort to maintain current accomplishments within upstream sub-reaches.

4.) Continue and expand transplantation of channel catfish to closed impoundments isolated from the San Juan River with the assistance of New Mexico Department of Game and Fish, Navajo Nation Fish and Wildlife Service and the SWTFC.

5.) Characterize the seasonal distribution and abundance of striped bass upstream of Shiprock, NM during removal efforts and continue to document the predative impacts via stomach content analysis.

Methods:

Mechanical removal will continue during the fall main channel monitoring efforts. During these sampling efforts, all non-native species collected will be sacrificed and data recorded for species identification and enumeration, ontogenetic stage (young-of-year, sub-adult, adult) at non-designated miles, and standard and total lengths and weight at designated miles. Data will be summarized by geomorphic reach and sampling will occur two out of every three river miles. Data for recaptured channel catfish and common carp tagged during all studies will be recorded in the field and integrated into existing databases for movement and abundance. Catch per unit effort (CPUE) will be calculated as number of fish collected per hour electrofishing time and be calculated for the total collection and for each species. Analyses will include comparison of 1998-2003 data summaries.

Initial sampling efforts, minimum of one trip, will be conducted from PNM Weir to Hogback Diversion to monitor and evaluate prior year's effort and to remove fish that remain or have moved upstream of Hogback Diversion. If catch rates remain low (< 5.0 catfish/hour of electrofishing) during initial sampling, removal efforts will shift to the adjacent downstream reach. After high spring/summer flows, sampling efforts again will be shifted to the PNM Weir to Hogback Diversion reach to address any upstream emigration that occurred.

Removal from PNM Weir to Shiprock will be conducted by two electrofishing rafts. Captured channel catfish will be measured (nearest 1 mm) for standard and total lengths, weighed (nearest 1 g), and, if not sacrificed for study purposes, transported by hatchery truck to isolated recreational angling impoundments. All other nonnative species sampled during these efforts will be sacrificed and appropriate data recorded for location, length/weight, and, for lacustrine predators, stomach contents. Total and individual daily catch rates will be calculated to evaluate efforts of short-term suppression efforts to locally deplete non-native species numbers.

In addition, a minimum of three removal trips will be conducted from Shiprock to Montezuma Creek, Utah. These trips will follow similar protocol to removal efforts conducted by UDWR in the lower portion of the San Juan River. Two shocking rafts will sample the entire reach with a support raft following to collect fish not captured by the electrofishing rafts. Fish collected by the support raft will be included in the calculation of total CPUE. Fish will be processed, weighed and measured, every three river miles.

If rare species are collected, sampling will be immediately halted and the fish will be weighed, measured, checked for the presence of a radio transmitter or PIT tag and will be released within the general area of collection. Notes on the condition of the fish and location of collection (RM) will be recorded. In addition catch rate data on native fish collected within intensive removal reaches including flannelmouth sucker, *Catostomus latipinnis*, and bluehead sucker, *Catostomus discobolus*, during fall adult monitoring and spring razorback sucker trips will be analyzed to determine any effects non-native removal has had on distribution and abundance of these species.

Summary of proposed intensive removal trips (FY 2005):

PNM to Hogback- minimum of one trip
Hogback to Shiprock- 3-6 trips

Shiprock to
Montezuma Creek- 3-5 trips

Total # of trips- 10 trips in FY 2005

Deliverables:

An electronic data file will be provided for inclusion in the centralized database by 31 March 2006. A draft summary report detailing findings will be submitted to the San Juan River Implementation Program, Biology Committee, by 31 March 2006. Revisions will be completed and a final annual report will be submitted by 1 June 2006.

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Brooks, J.E., M.J. Buntjer, and J.R. Smith. 2000. Non-native species interactions: Management implications to aid in recovery of the Colorado pikeminnow *Ptychocheilus lucius* and razorback sucker *Xyrauchen texanus* in the San Juan River, CO-NM-UT. San Juan River Recovery Implementation Program, U.S. Fish and Wildlife Service, Albuquerque, NM.

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Non-native Species Control in the *Lower* San Juan River
Fiscal Year 2005 Project Proposal

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Background:

The lower San Juan River is particularly important in the recovery of the Colorado pikeminnow (*Ptychocheilus lucius*) and razorback sucker (*Xyrauchen texanus*) since it contains typical nursery habitat similar to what is present on the Green and Colorado rivers. Within the past five years, collections of endangered fish have been increasing in this section of river. The largest collection of razorback sucker larvae in 2002 was from Reach 2 (RM 21.2; Brandenburg et al. 2003) and the largest single collection of razorback sucker larvae in 2003 came from a backwater in Reach 1 at RM 8.1 (Brandenburg et al. 2004). Additionally, adult razorback sucker were found congregating around Slickhorn Rapid (RM 17.7) in the spring of 2002, during this study, and were apparently using this area for spawning. Collections of adult Colorado pikeminnow in the San Juan River have been extremely rare. No wild adults have been collected since 2000 (Ryden 2003). From 2002 to 2004, Colorado pikeminnow adults and subadults, presumably from the 1996-1997 stocking efforts, have been found using the lower canyon (Reach 2 and 1) of the San Juan River in the spring and summer. In 2003 and 2004, young-of-year Colorado pikeminnow stocked in the fall of the previous year near Farmington, NM, were also found using the lower portions of the San Juan River (Golden et al. 2004).

Nonnative species are also prevalent in the lower San Juan River. Channel catfish (*Ictalurus punctatus*) and common carp (*Cyprinus carpio*) remain the most abundant fish species collected during fall monitoring in Reaches 2 and 1(Ryden 2003). Native and endangered fish are directly threatened by predation from adult channel catfish (Marsh and Brooks 1989, Brooks et al. 2000), while competing for food and space with juvenile channel catfish. Additionally, Colorado pikeminnow have been found choking on channel catfish (Ryden and Smith 2002) and common carp tend to feed on larval fish and eggs (Cooper 1987). In spring 2004, a 690 mm channel catfish, collected during this project, had a recently stocked 325 mm razorback sucker in its stomach (personal observation). Since 1995, many nonnative species including striped bass (*Morone saxatilis*) and walleye (*Sander vitreus*) have been able to move into the San Juan River from Lake Powell, where they are considered sportfish. From 1988 to 1995, a waterfall at approximately RM 0 acted as a barrier between the San Juan River and Lake Powell, preventing species in Lake Powell from moving up the San Juan River. During 1995, lake levels rose to full pool (3700 ft above sea level) and inundated the waterfall allowing for the upstream movement of many nonnative species from Lake Powell. When lake levels receded in the winter of 1996, the waterfall did not reappear. Striped bass, walleye and threadfin shad (*Dorosoma petenense*), not previously documented in the San Juan River before waterfall inundation, were collected during large bodied fish sampling (Ryden 2001). Since then, striped bass and walleye have been collected periodically until 2000 when large numbers were collected near Farmington, NM (approximately 166 river miles upstream of Lake Powell). Many native suckers were found inside the stomachs of these striped bass (unpublished data from San Juan River database). The San Juan River Recovery Implementation Program (SJRIP) determined in 2001 that control of striped bass and other nonnative species in the lower river was warranted. Utah Division of Wildlife Resources began nonnative fish control with the goal of removing striped bass and other nonnative species in the lower San Juan River,

while documenting river and lake conditions that may be correlated to striped bass movement out of Lake Powell. This information would then determine when removal actions would be most effective. Lake Powell temperature was found to be correlated with increased catch rates of striped bass during 2002. In 2003, no striped bass or walleye were observed in the river, and a new waterfall had appeared approximately one mile downstream of the previous waterfall. This new waterfall is approximately 10 feet high and 50 feet across at river flows of approximately 600 cfs. It is suspected that this was the reason no striped bass or walleye had been collected in 2003.

The presence of the waterfall, which acts as a barrier to upstream movement of channel catfish, may provide the opportunity to more significantly impact removal of this species in the lower San Juan River. Removal of channel catfish and common carp will assist in similar efforts conducted further upstream by U.S. Fish and Wildlife-New Mexico Fishery Resources, and aid in the suppression of negative impacts caused by nonnative fish on the endangered and native fish community.

This work plan proposes the continuation of nonnative control in the lower San Juan River from Mexican Hat to Clay Hills, with the addition of sampling just below the new waterfall. Since it is likely that striped bass are unable to navigate the waterfall, sampling below the waterfall will determine their presence or absence. If they are there, we can continue to document the riverine and lacustrine conditions related to their movement. This study will serve to determine the most effective time for removal actions, so that more intensive and specific removal efforts may be employed in the future when Lake Powell is once again influencing the lower San Juan River. In addition, conducting work below the waterfall will provide information on endangered fish that may be present and unable to move upstream. Continued removal efforts in the lower river above the waterfall will aid in current efforts by U.S. Fish and Wildlife Service conducted further upstream, and hopefully suppress any negative impacts to the endangered and native fish community by nonnative fish.

Description of Study Area:

The study area for this project includes the San Juan River from Mexican Hat (RM 53) to Clay Hills (RM 2.9), Utah. Additionally, this project will continue to sample downstream of Clay Hills to the confluence with Lake Powell. The river from Mexican Hat to RM 16 is part of Geomorphic Reach 2 and is primarily bedrock confined and dominated by riffle-type habitat. River mile 16 down to Clay Hills contains Geomorphic Reach 1 where the river is canyon bound with an active alluvial bed. Habitats within this section are heavily influenced by the shifting thalweg, changing river flow, and reservoir elevations. Additionally, this section of river has been identified as important nursery habitat for native and endangered fish species.

Objectives:

1.) Continue mechanical removal efforts of large bodied nonnative species in the lower portion of the San Juan River from Mexican Hat to Clay Hills and sample just below the new waterfall.

2.) Generate a population estimate of channel catfish by mark-recapture data from Mexican Hat to Clay Hills.

3.) Characterize abundance of endangered fish in the San Juan River just below the waterfall.

4.) Characterize abundance of lacustrine predators moving out of Lake Powell into the San Juan River upstream to the new waterfall.

5.) Relate striped bass movement from Lake Powell into the San Juan River to lake and river conditions (including temperature, flows and turbidity).

Methods/Approach:
Mechanical removal of nonnative species will be conducted from Mexican Hat to Clay Hills, Utah. Sampling effort will be conducted via two raft mounted electrofishing boats. The entire study area will be electrofished in a downstream fashion with one boat on each shoreline. Each boat will have one netter and one rower. A third boat will follow behind to pick up nonnative fish missed by the electrofishing boats. These fish will not be included in catch rate calculations, so that comparisons can be made between trips and years. Nine five-day trips with 6 people are anticipated, and timing of sampling will be dependent on 2004 data. Bimonthly trips will be conducted, which will likely translate into every other week sampling from March through August. Data from the adult fall monitoring conducted by U.S. Fish and Wildlife Service- Grand Junction in October will be incorporated into data analysis. In an average water year, this schedule would allow for sampling a variety of habitat conditions, including variable flows, temperatures, and turbidity. In addition, a variety of sampling methods will be used below the waterfall, including hoop and trammel netting, hook and line, and electrofishing, if possible. Five sampling events will take place at the waterfall, most likely between April and August.

All nonnative fish collected will be identified, enumerated, measured to the nearest mm for total and standard length, weighed to the nearest gram, and removed from the river. Gender and reproductive status of lacustrine species will be determined and approximate location of capture by river mile recorded. Stomach contents of lacustrine species will be examined. Contents needing microscopic identification will be preserved. Any threatened and/or endangered fish encountered will be collected, identified, enumerated, measured to the nearest mm for total and standard length, weighed to the nearest gram, and scanned for a PIT tag. If a PIT tag is not present, one will be inserted. General condition of the fish will be recorded in addition to any parasites or abnormalities. All threatened and endangered fish collected will be returned to the river at the location in which they were caught. River mile and GPS coordinates will be recorded at the location in which threatened and endangered fish are collected. Catch rates for all fish will be calculated as number of fish caught per hour. Other native fish will not be netted.

Channel catfish collected during the first trip of the year will receive a floy tag and be returned to the river. Channel catfish collected on subsequent trips will be removed from the river. A Lincoln-Peterson population estimate will be generated for channel catfish captured during the first pass and recaptured in the second pass. Captures of channel catfish during subsequent trips will allow us to monitor ratios of marked to unmarked fish and use these ratios to calculate a rough population estimate thereafter. Ratios of marked fish to unmarked fish will help determine if assumptions of a closed population are being met.

General water quality parameters will be recorded including temperature, conductivity, salinity and dissolved oxygen. Daily river discharge, temperature and turbidity will be compared to catch rates for striped bass to determine the relationship between river conditions and movement of these fish upstream.

Costs for other cooperating agencies that may provide personnel and equipment as needed are included in this budget.

Products/Schedule:
A draft report for the Nonnative Species Control in the Lower San Juan River activities will be prepared and distributed to the San Juan River Biology Committee for review by 31 March 2005. Historical information on nonnative fish species use of the lower San Juan River will be included to the extent it is available. Upon receipt of written comments, that report will be finalized and forwarded to members of the San Juan River Biology Committee 1 June 2005. Electronic copies of the field and collection data

will be transferred to the San Juan River database manager following the successful protocol previously employed.

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Razorback Sucker Augmentation and Monitoring
Fiscal Year 2005 Project Proposal
15 July 2004

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Background:
Razorback sucker is a federally-listed endangered fish native to the San Juan River. At present this species is rare in the San Juan River. In order to gain information on habitat use, possible spawning areas, and survival and growth rates of hatchery-reared razorback sucker in the wild, it was necessary to experimentally stock a small number of fish. Experimental stocking of razorback sucker into the San Juan River began in 1994, as outlined in An Experimental Stocking Plan For Razorback Sucker In The San Juan River. Between 1994 and 1996, a total of 940 razorback sucker were stocked into the San Juan River by personnel from the U.S. Fish and Wildlife Service's (Service) Colorado River Fishery Project (CRFP) office in Grand Junction, Colorado. All fish were PIT-tagged before release into the wild. Based on the success of this experimental stocking study the decision was made to implement a full-scale augmentation program for razorback sucker in the San Juan River. Information obtained during the evaluation of stocked razorback sucker will help address objectives 5.1 through 5.5 in the San Juan River Long Range Plan.

In August 1997, a Five-Year Augmentation Plan for Razorback Sucker in the San Juan River was finalized. The five-year augmentation plan, recommended the stocking of 73,482 razorback sucker into the San Juan River between 1997 and 2001. Stocking of razorback sucker from various sources into the San Juan River began in early September 1997. However, between 3 September 1997 and 1 November 2001 a total of only 5,896 razorback sucker were stocked into the San Juan River. If razorback sucker stocked as part of the experimental stocking plan (1994-1997) are included, 6,836 razorback sucker have been stocked into the San Juan River since 1994. The 5,896 razorback sucker stocked as part of the five-year augmentation effort represents a shortfall of 67,586 fish when compared to numbers recommended in the five-year augmentation.

The inability to achieve San Juan River razorback sucker augmentation goals has been due to a suite of circumstances all of which ultimately result in a lack of fish. However, the main problem is that rearing facilities outside of the San Juan River Basin lack the capabilities to hold and rear razorback sucker for the San Juan River Recovery Implementation Program (SJRIP). To alleviate this problem, the SJRIP undertook efforts to obtain or build grow-out ponds within the San Juan River basin that would afford a measure of self-sufficiency (for holding/rearing fish) to the San Juan River razorback sucker augmentation program. Beginning in 1997, a series of grow-out ponds were established on NAPI lands southwest of Farmington, New Mexico.

Presently there are about 25 surface acres of grow-out ponds (i.e., nine individual ponds) being used to rear razorback sucker. The San Juan River Biology Committee is currently pursuing the acquisition and/or construction of additional pond acreage.
In spring 2004, the 6-Pack grow-out ponds, Hidden Pond, and East Avocet Pond were all stocked with age-0 razorback sucker obtained from the Service's 24-Road hatchery. These razorback sucker were

excess fish that were being culled from the UCRB razorback sucker broodstock lots. In subsequent years, larval razorback sucker from various sources (i.e., Dexter NFH, 24-Road hatchery, Willow Beach NFH, or other appropriate sources) will be used to stock ponds, as they become available.

Because of the large shortfall in numbers of stocked fish during the 1997-2001 augmentation effort, the San Juan River Biology Committee adopted an addendum to the 1997 stocking plan (finalized in February 2003) that extends the intensive stocking period for razorback sucker for an additional eight-year period, beginning in 2004 and continuing through 2011. This addendum calls for stocking a minimum of 11,400 age-2 razorback sucker per year, with the goal of establishing an adult population of 5,800 adult razorback sucker in the San Juan River.

Razorback sucker stocked into the grow-out ponds in spring 2004 (as well as holdover fish from previous years' harvest efforts) will be harvested throughout 2005 (and outyears) for this eight-year augmentation effort.

In 2005 (the second year of stocking to occur under the new razorback sucker augmentation plan addendum; 2004-2011) the grow-out ponds currently in use will be sampled multiple times and fish $\geq$ 300 mm TL will be selectively removed, PIT-tagged, and stocked into the San Juan River. This selective removal of larger fish from grow-out ponds will allow for accelerated growth of smaller razorback sucker remaining in the grow-out ponds.

Because of the large increase in numbers of fish that need to be handled since the 6-Pack ponds came online in 2002 (this tripled the number of ponds to be harvested), it has become necessary to employ increased numbers of fyke-nets and multiple sampling efforts to adequately harvest fish in the grow-out ponds. Because of this, harvest efforts have increased roughly four-fold over previous years.

Description of Study Area:

Razorback sucker will be reared in ponds southwest of Farmington, New Mexico for two full growing seasons (to TL $\geq$ 300 mm), at which time they will be harvested, PIT-tagged, and stocked into the San Juan River at RM 158.6, just downstream of the Hogback Diversion (between Farmington and Shiprock, New Mexico).

The study area for monitoring razorback sucker stocked into the San Juan River extends from RM 158.6 downstream to RM 2.9 (Clay Hills boat landing) just upstream of Lake Powell in Utah.

Objectives:

1.) Obtain, rear, harvest, and stock razorback sucker to fulfill tasks and objectives outlined in the current version of the razorback sucker augmentation plan addendum (*2003 final*)

2.) Monitor stocked razorback sucker in the wild for various parameters, including:
   a) Spawning season habitat use and movement patterns
   b) Survival and growth rates
   c) Determine whether hatchery-reared razorback sucker will recruit into the adult population and successfully spawn in the wild

3.) Remove nonnative fish species which prey upon and compete with native fish species in the San Juan River.

Methods:
USFWS personnel will coordinate the obtaining of larval razorback sucker from appropriate sources during March and April 2005. CRFP personnel will determine when it is appropriate to transfer larval razorback sucker from holding facilities to grow-out ponds (presumably late May to early June). This transfer and disposition of larvae will be determined and coordinated by CRFP personnel.

CRFP personnel will coordinate obtaining any excess larval or juvenile razorback sucker that may become available from UCRB recovery efforts (e.g., those from the 24-Road hatchery). CRFP personnel will transport these fish and stock them in the appropriate grow-out pond.

Razorback sucker will be reared for two full growing seasons before stocking. Management of ponds, including maintenance of water level, fertilization, and monitoring of pond water quality, invertebrate, and plant communities will be performed by personnel from Ecosystems Research Institute and BIA-NIIP (under a separate workplan). Once a pond management plan has been developed, it is assumed that long-term management of the grow-out ponds will become the responsibility of a locally-based, on-the-ground pond manager.

Starting in 2005, the process of rearing razorback sucker will enter a two-step process. In the first step larval razorback sucker will be reared at an intensively-managed facility to maximize growth of these fish in the first year. Whether this intensively-managed facility will be newly-constructed "nursery ponds" or an existing hatchery facility has yet to be determined. It is anticipated that intensively-managed age-0 fish will be fed an artificial diet and precautions will be taken to eliminate, or at least minimize, threats from avian and aquatic predators (e.g., tiger salamanders), which can take a very heavy toll on larval fish.

In the fall of their first growing season (or early in the spring of their second growing season), these fish will be harvested, transported to, and stocked into the existing grow-out ponds near Farmington, NM. They will spend their second growing season in these more passively-managed, grow-out ponds before being harvested, PIT-tagged, and stocked into the San Juan River. This approach should allow fish being stocked into existing grow-out ponds to avoid predation by aquatic predators (specifically tiger salamanders) due to their larger size and increased mobility.

Harvest of grow-out ponds will occur for four to five weeks during the year.
Ponds will be harvested using fyke nets (6-8 per pond), working a maximum of three grow-out ponds at any one time. During harvest, razorback sucker $\geq$ 300 mm TL will be harvested from ponds, PIT-tagged, and stocked into the San Juan River just downstream of

Hogback Diversion (RM 158.6). Razorback sucker < 300 mm TL will be returned to grow-out ponds. However, the first 50 fish from each group, harvested from each pond will be weighed and measured. This will allow for the tracking of fish growth in the ponds.

To monitor fish that have been stocked into the river, CRFP personnel (along with personnel from cooperating agencies) will monitor stocked fish on two electrofishing/netting trips in 2005. One trip will sample RM 158.6-76.4, followed shortly thereafter (or possibly concurrently) by a second trip that will sample RM 52.9-2.9. These two sampling trips will occur on the ascending limb of the hydrograph, from late April to late May. Electrofishing along with selective seining and trammel netting will be used to determine dispersal, and survival of stocked fish. The fall 2005 main channel fish community monitoring trip will act as the second "riverwide" pass to monitor stocked razorback sucker. Survival rates can then be determined using mark-recapture models (e.g., Program CAPTURE, MARK, Petersen, Schnabel). Electrofishing and handling of rare fish species will follow the protocols found in the sub-adult and adult large-bodied fish community monitoring workplan, except that only

data on rare fish species collected (i.e., razorback sucker, Colorado pikeminnow, and roundtail chub) will be recorded. When rare fish species are collected, PIT tag number, length, weight, reproductive status (if evident), and information about health abnormalities (if any) will be recorded.

Electrofishing recapture efforts will be aimed at gaining data on age, growth, and sexual status as well as trying to identify groups of razorback sucker that are aggregating to spawn. If spawning aggregations of razorback sucker are identified, crews from other research elements monitoring razorback sucker larval drift (i.e., Steven Platania) and habitat quality and quantity (i.e., Ron Bliesner and Vince Lamarra) will be notified.

In support of objective 3, mechanical removal of nonnative fish species will continue to take place on all razorback sucker monitoring trips.

The Service (CRFP) will have the lead for the razorback sucker monitoring with the Service's New Mexico Fishery Resources Office (NMFRO) providing field personnel and equipment for monitoring trips. Other cooperating agencies may provide personnel and equipment for these trips as needed.

Products:
An interim progress report for razorback sucker monitoring trips conducted in 2005 will be completed by 31 March 2006. A "draft final" incorporating all comments received will be completed by 1 June 2006. DBASE files containing information on total catch and length/weight data gathered for rare fish species will be submitted to the University of New Mexico's Museum of Southwestern Biology (Division of Fishes) for inclusion on the SJRIP integrated database CD-ROM and web page by 31 March 2006.

Qualifications of Personnel Included in the Budget:
Principal Biologist -- Dale Ryden
Holds a BS degree has 15 years experience performing fisheries research/management in the Colorado River Basin has been performing fisheries research/management in the San Juan River Basin for the last 14 years

Field Biologists -- Staff biologists from USFWS-CRFP
all hold at least a BS degree depending upon the individual, they have from 1-5 years experience performing fisheries research/management in the Colorado River Basin

Project Leader -- Chuck McAda holds an MS degree has 25 years experience performing fisheries research/management in the Colorado River Basin is the current chairman of the San Juan River Recovery Implementation Program's Biology Committee

Colorado Pikeminnow Fingerling Production
San Juan River FY-2005

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Background:

Once very common throughout the Colorado River Basin, Colorado pikeminnow have declined from historic levels and are now found primarily in the Upper basin of the Colorado River. Various factors have contributed to the decline of the specie including alteration of natural stream flows and temperature regimes, loss of habitat and habitat fragmentation as a result of water development and the introduction of nonnative fish species.

Colorado Pikeminnow are native to the San Juan River. Its historic distribution included the entire mainstem San Juan River up to Rosa, New Mexico, located approximately 25 miles upstream from present day Navajo Dam. Currently the species is considered extremely rare and the small population is estimated at less then 20 adults. This small group of fish has persisted in the San Juan River since the closure of Navajo Dam in 1962. Recent studies being conducted by the San Juan Recovery Implementation Program (SJRIP) indicate that the Colorado pikeminnow is reproducing and recruiting in the river to at least a limited degree, however the low numbers collected do not satisfy recovery goal requirements for the specie. The Recovery criteria calls for a target of 1,000 subadults fish established by the end of a five year down listing period, and 800 adults maintained during the 7 year delisting period. The Upper Colorado River Endangered Fish Recovery Program has recommended that the wild population be increased by augmenting with hatchery produced fish.

Dexter NFH & TC has been the leader in propagating and culturing Colorado pikeminnow (Ptychocheilus lucius) since 1981. The facility maintains several captive stocks as genetic reserves and has successfully produced fish for the Upper and Lower Colorado River Basin programs and the SJ RIP. The major emphasis has been on the reproductive biology, broodstock development and culturing fry, fingerlings and adults. This work plan proposes to continue the production of 300,000 fingerlings (50 mm TL) annually for reintroduction in the San Juan River. Funding is also requested to provide proper care of broodstock necessary to successfully carry out this study for future years and aide in restoration of the species.

Stocking will require coordination with New Mexico FRO, CRFP-Grand Junction, New Mexico Department of Game and Fish, Colorado Division of Wildlife and Utah Department of Wildlife Resources.

Objectives:

1.) Produce 300,000 fingerlings (50 mm TL) for stocking in the San Juan River in 2005.

2) Continue data collection on induced spawning of Colorado pikeminnow under controlled conditions.

3) Evaluate distributions methods of transporting 300,000 Colorado pikeminnow fingerlings from Dexter to the San Juan River.

4) Maintain 500+ Colorado pikeminnow broodstock for recovery efforts.

Methods:

Broodstock will consist of 500+ (F1) adults. These fish are 1974, 1981 and 1991 year-class progeny from wild adults collected from the Yampa, Green and Colorado Rivers, respectively.. A maximum of 40 paired matings (1 female X 1 male) will be spawned during 2005. Given the past history of hormonal induced ovulation, 30 females (75%) should produce viable eggs during a given year. All members of the broodstock are PIT tagged and records of spawning pairs will be maintained at Dexter.

Ovulation will be induced with intraperitoneal injections of common carp pituitary (CCP) at the rate of 4 mg/kg of body weight. When eggs can be expelled using slight pressure, a female will be stripped and milt added from one male. Each individual egg lot will be enumerated and kept separate in Heath trays until hatching occurs, about 96 hours after fertilization.

When eggs begin hatching, larvae will be transferred to hatchery tanks and held until swim-up occurs, five to seven days. Fry will be enumerated and stocked into three earthen ponds ranging from .33 to .35 ha. Fry will be cultured in earthen ponds for 120 days and fingerlings (50 mm TL) will then be available for stocking in the San Juan River during November, 2005. All fish will be marked with VIE and/or Calcein prior to stocking.

Stocking of Fingerling Colorado Pikeminnow and Reporting of 2004 Results
Fiscal Year 2005 Project Proposal 15 July 2004

Principal Investigator: Dale Ryden and Chuck McAda
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Background:
Colorado pikeminnow is a federally-listed endangered fish native to the San Juan River. The capture of low numbers of Colorado pikeminnow of all life stages over the past ten years has confirmed that a small, but reproducing population of Colorado pikeminnow still exists in the San Juan. In 1996, experimental stocking of Colorado pikeminnow into the San Juan River was undertaken by the Utah Division of Wildlife Resources (UDWR). The purpose of this effort was to evaluate dispersal and retention of stocked juvenile Colorado pikeminnow as well as determining the availability, use, and selection of habitats critical to early life stage Colorado pikeminnow. Between 1996 and 2000, approximately 832,000 larval and age-0 Colorado pikeminnow were stocked into the San Juan River by the UDWR. In addition, 197 adult Colorado pikeminnow have been stocked into the San Juan River, 49 in 1997 and 148 in 2001. To date, several hundred stocked juvenile and adult Colorado pikeminnow have been recaptured during either seining or electrofishing efforts. A handful of the individuals stocked in 1996 have been documented as having recruited into the San Juan River adult Colorado pikeminnow population. Based on data collected from these experimentally stocked fish, it is apparent that stocked, hatchery-reared, juvenile Colorado pikeminnow can survive in the San Juan River and can provide a viable method of supplementing the numbers and expanding the range of the wild San Juan River Colorado pikeminnow population.

The need for artificial propagation and augmentation of this species in the San Juan River is apparent for several reasons. Augmentation of Colorado pikeminnow would increase population numbers, provide more individuals for research purposes, add genetic diversity to the existing gene pool, and provide a riverine refugia population that would, hopefully, remain stable until further research can identify factors limiting successful recruitment of this species in the San Juan River. The San Juan River Long Range Plan identifies the need to assess the feasibility of, and then implement the augmentation of Colorado pikeminnow. In January 2003, ***An Augmentation Plan For Colorado Pikeminnow In The San Juan River*** was finalized. This augmentation plan provides the necessary guidance for augmentation efforts as well as directly fulfilling objective 5.3.8.2 of the San Juan River Long Range Plan.

The first stocking of Colorado pikeminnow under the direction of this augmentation plan took place on 24 October 2002 (plan was still in draft form), when 210,418 age-0 Colorado pikeminnow were stocked into the San Juan River, half each at RM 180.2 and RM 158.6. The second stocking of 176,933 age-0 Colorado pikeminnow occurred on 6 November 2003, with fish being stocked into numerous low velocity habitats between RM 188.4 and RM 148.5. The Colorado pikeminnow augmentation plan calls for a minimum of 300,000 age-0 Colorado pikeminnow to be stocked at roughly the same stocking locations for the next six years (i.e., through 2009). In December 2002, a study was begun (under a separate workplan) to intensively monitor newly-stocked age-0 Colorado pikeminnow at several stations, throughout the river on three occasions during the year.

Objectives:

1.) Coordinate with Dexter National Fish Hatchery to procure and stock fish according to guidelines set forth in ***An Augmentation Plan For Colorado Pikeminnow In The San Juan River***.

2.) Provide a report that gathers information from various sources on fingerling production, numbers of fish stocked, subsequent recaptures during various sampling efforts (other than the intensive monitoring effort), and makes recommendations (if necessary) for modifying methods being employed for Colorado pikeminnow augmentation efforts.

Methods:

Objective 1: Young Colorado pikeminnow will be reared in grow-out ponds (under a separate workplan) at Dexter National Fish Hatchery (NFH) until late October or early November, at which time they will be harvested and stocked into the San Juan River in river sections specified in the augmentation plan (i.e., between Fruitland diversion and PNM weir; between Hogback diversion and Shiprock bridge). Once young Colorado pikeminnow are transported to the San Juan River, CRFP crews (two crews of two people each and two people to run shuttles) will load them into live wells and transport them downstream via boat, stocking them in several appropriate low-velocity locations in the two target sections of river. Fish will be stocked in roughly equal numbers in each of the two river reaches. This will allow young Colorado pikeminnow to be introduced into many appropriate low velocity habitats and avoid their grouping up in large numbers and thus becoming more susceptible to predation (e.g., by channel catfish) or catastrophic loss due to other factors.

Objective 2: After stocking, CRFP personnel will collect information on stocked fish from Dexter NFH (numbers produced, size at stocking, locations stocked at) and on recaptures during subsequent monitoring and sampling efforts by various agencies (other than the intensive Colorado pikeminnow monitoring effort). This data will be examined to help determine if augmentation efforts are successful. Success will be determined by examining post-stocking dispersal patterns, analyzing age and growth data, and using mark-recapture population estimators (e.g., Program MARK) to determine survivorship, with the end goal of determining if progress is being made towards reaching target numbers set forth in the Colorado pikeminnow augmentation plan. Results obtained will be used to make recommendations for modifying (if necessary) methods being employed for augmentation efforts in future years.

Products:

An interim progress report detailing the field activities performed in 2005 will be produced by 30 March 2006. A "draft final" of this report, incorporating all comments received will be completed by 1 June 2006. DBASE files containing information on stocked and recaptured Colorado pikeminnow will be submitted to the University of New Mexico's Museum of Southwestern Biology (Division of Fishes) for inclusion on the San Juan River Recovery Implementation Program integrated database CD-ROM and web page by 31 March 2006.

Qualifications of Personnel Included in the Budget:

Principal Biologist -- Dale Ryden holds a BS degree has 15 years experience performing fisheries research/management in the Colorado River Basin has been performing fisheries research/management in the San Juan River Basin for the last 14 years

Field Biologists: Staff biologists from USFWS-CRFP
all hold at least a BS degree depending upon the individual, they have from 1-5 years experience performing fisheries research/management in the Colorado River Basin

Project Leader -- Chuck McAda holds an MS degree has 25 years experience performing fisheries research/management in the Colorado River Basin is the current chairman of the San Juan River Recovery Implementation Program's Biology Committee

Razorback Sucker Augmentation Ponds Limnological Monitoring

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and

Principle Investigator: Ron Bliesner
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Study Area:
The study area for this project involves the razorback sucker augmentation ponds recently built on the Navajo Indian Irrigation Project.

Background:
This work plan represents a continuation of the monitoring program established as part of the two year limnological investigation of the razorback sucker augmentation ponds located on the Navajo Indian Irrigation Project. The Navajo Nation has requested that the long-term operations and maintenance be undertaken by the Navajo Fish and Game staff. This work plan is a bridge towards that goal. The major objective of this work is to continue to collect limnological data on the ponds (given that two ponds have been retooled and now have no data) and institute a training and support program for its implementation by Navajo Nation.

Objectives:

1.) Continue monitoring the 9 ponds located on the NAPI project site 2.) Undertake a training and support program for the long-term operations and maintenance of the razorback augmentation ponds 3.) Implement the Pond Management Plan (pond fertilization, weed control, ETC)

Methods:
1. Implement a long term water quality and hydrologic monitoring program. During the first year of this investigation, a systematic set of biological and chemical samples were collected to better define the factors which are limiting the growth rates of razorback suckers in the grow-out ponds located on the NAPI facility. In year two, data were collected only quarterly. The results of these investigations are being incorporated into the draft plan, which will be reviewed by the San Juan RIP Biology Committee. In general, the plan will require a moderate level of monitoring especially following pond fertilization. Secondary problems may occur if over-fertilization affects the dissolved oxygen levels. Parameters will include quarterly water quality grab samples (ortho-P; total-P; NH3; NO2-NO3; heavy metals; Field parameters such as pH, Dissolved Oxygen and temperature will also be measured. Water chemistries will include nitrogen, phosphorous, pH, and TDS.

2.) Implement a long term biological monitoring program Investigations of the literature and site specific data indicated the the density of zooplankton are critical for the first years growth of razorbacks. Having a high survival rate during the first year is critical in meeting our target stocking rates. It is anticipated that a long-term water quality and biological monitoring program will be needed to track the results of the ongoing management of the ponds. This program will include both the growth

rates of the target fish as well as limnological parameters including phytoplankton biomass (Chl a); and invertebrates (zooplankton and benthic) biomass.

3.) *Undertake a training and support program for the long-term operations andmaintenance of the razorback augmentation ponds* This task will train Navajo Nation staff to fully implement the Final Grow-out Pond Management Plan. This training will include instructions on appropriate field methodologies, QA/QC procedure, water supply operation and maintenance training, reporting requirements and periodic facilities inspections.

Products:
Annual reports will be produced as part of this ongoing management program. This report will include the summation of the analytical water quality data as well as the biological parameters including the growth rates of the target species. Comparisons will be made to previous year's results. The draft annual report will be submitted by March 31, 2006 with final report due June 1, 2006.

Maintenance and Operation of the San Juan River Basin Hydrology Model
San Juan River Basin Recovery Implementation Program - Hydrology Committee
Fiscal Year 2005 Project Proposal

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Revised September 15, 2004, to reflect SJRIP Coordination Committee directive to reduce overall FY05 budget (Note: Revisions made to "Costs" section only).

Background:
The model will be made available to generate and analyze runs associated with Section 7 Consultations and/or special requests from the Biology or Coordination Committees related to the flow recommendations or other hydrological aspects of the Program. In order for the model to be available for such requests, the model and data must be maintained to adjust configurations, correct for errors, and evolve the data set forward through time. The FY2005 request includes funds to provide technical transfer from the model developer to the model users and maintainers.

The Third Generation San Juan Basin Hydrology Model (SJBHM) was completed in FY2004. However, as noted below, the Hydrology Committee has been requested to investigate alternative flow recommendations. The scope of work includes upgrading of the model to support anticipated revision flow recommendations. The Bureau of Reclamation has the primary responsibility for model O&M. Keller-Bliesner Engineering will assist Reclamation in testing and implementation of flow recommendation alternatives. The scope of work includes funds to do a complete updating of data in FY2005.

In the 2004 Biology Committee Standardized Monitoring Program Integration Report, they recommended evaluating changes in the flow recommendation to examine ways of increasing frequency of high flow years and suggested some things to look at with the model to test the efficacy of these changes in preparation for supporting changes in the flow recommendations as a part of adaptive management. Following is an excerpt of their request to the Hydrology Committee:

During the Biology Committee conference call of (7-13-04), the Biology Committee authorized the request for modeling to support potential changes in the flow recommendations. Specifically, the changes will be to investigate increased frequency of 8,000 and 10,000 cfs conditions at the expense of 5,000 cfs criteria. This will place an emphasis on more concentrated release hydrographs, better matching of the Animas Peak and a focus on fewer small releases in favor of increased frequency of large releases. An entire change in the priorities in the decision tree will be necessary, supported by model results. Based on this background, model results examining the following will be needed:

1. Reduce ascending and descending limbs of release hydrographs to the minimum time allowed by ramping criteria (5-6 days presently)

2. Avoid the early spring low level release in wet years (nose water) in favor of extended peak release (this may exacerbate the spill problem, requiring some rules to prevent spills).

3. Examine effectiveness of matching the Animas Peak

4. If matching the Animas Peak accomplishes the above goals, then examine better forecast routines to achieve an improved match

5. Examine the decision tree release hydrographs, removing the smaller releases and focusing on the larger releases.

6. Summarize results and coordinate with the Biology Committee on results.

Study Area:
San Juan River Basin

Tasks:
1.) Test the third Generation SJBHM to examine the impacts of changes recommended for examination by the Biology Committee referenced above. Reclamation would implement rule changes and Keller-Bliesner would assist Reclamation in analyzing the model runs, summarizing results, and examining impacts to the flow recommendations. Prepare report to the Biology Committee on testing of changes in operating rules with summary of test results and recommendations for implementation. This task would include Reclamation revising the existing SJBHM documentation to reflect changes made in operating criteria with Keller-Bliesner reviewing the changes. This task could also include other modeling activities to evaluate the Flow Recommendations as agreed to by Hydrology Committee, so long as it was within the budget for FY05.

2.) Maintain data to evolve the data set forward through time.

3.) Maintain the model to update and test data and to adjust model configuration, methodologies, or assumptions.

4.) Maintain software associated with data and model.

5.) Generate and analyze model runs associated with Section 7 consultations or special requests from the Biology and/or Coordination Committees. Assumes that three consultations in FY04 will be requested, requiring five model runs/consultation. It also assumes that the Coordinating Committee will request two special runs in FY04. A consultation run will usually require a model reconfiguration and the implementation of operating criteria. Each consultation request will require approximately eleven staff days; each special run will require five staff days.

6.) Program management and coordination.

7.) Provide technology transference to Reclamation's Western Colorado Area Office staff in the details of maintaining the data and models, and in operating the models.

Products:
Hydrological analysis of water development scenarios or other scenarios as requested by stakeholders or Program committees.

Costs:
FY2005 costs are shown in the following table. They include a $20,000 contingency fund to cover unanticipated costs associated with implementation of the revised flow recommendations. The contingency fund would be used only on an "as-needed" basis, and only after Hydrology Committee approval.

Backup Information for Scope of Work Objectives:

1.) Data maintenance is to evolve the data set forward through time and make other adjustments to the data.

2.) Model maintenance is to adjust the model configuration or operating criteria to correct for errors or other changes.

3.) Software maintenance is for updating and maintaining data management interfaces and other software associated with the data and models.

4.) Program support is to make and analyze all model runs that are associated with Section 7 Consultations or to make special runs for the Coordinating Committee. The above computation assumes that 3 consultations per year will occur, requiring 5 model runs/consultation. It also assumes that the Coordinating Committee will request 2 special runs/year. A consultation run will usually require a model reconfiguration and operating criteria implementation and testing. Special runs may also require some setup time. The cost estimate assumes that a consultation run will require 3 days of setup time, 1 day to run and analyze each run, and 3 days to report the results. Therefore, each consultation run will take approximately 11 days. It is assumed that special runs will require 2 days of setup time, 1 day to run and analyze, and 1 day to report results.

5.) Technical transfer is to provide transfer of technology necessary to operate and maintain the data and model.

6.) Task 1 (Model testing for flow recommendation change) would be completed in FY2005.

Program Coordinator and Program Assistant
Fiscal Year 2005 Project Proposal

U.S. Fish and Wildlife Service
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Background:

The San Juan River Recovery Implementation Program (Program) is designed to simultaneously address endangered fish species recovery and development of water resources within the Basin. The Program includes representatives from not only Federal agencies, but also the States of Colorado and New Mexico, the Jicarilla Apache Nation, the Southern Ute Indian Tribe, the Ute Mountain Ute Tribe, the Navajo Nation and the water development interests, most of which have legal mandated responsibilities to the endangered fish and/or the water resources.

The Service is responsible for directing and coordinating the overall Program. As stated in the Program Document, the Service will appoint a Program Coordinator who will be responsible for overall Program coordination and a Program Assistant to dissemination of information about Program activities.

Tasks:

1. Coordinate the activities of the Biology, Hydrology and Coordination Committees.

2. See that approved recovery activities are implemented.

3. Disseminate information to involved state, federal, and tribal agencies.

4. Coordinate activities with the Upper Basin Recovery Implementation Program.

5. Coordinate and disseminate information on Program activities to the public through brochures, newsletters and/or the website.

6. Forward plans and recommendation to the Coordination Committee for review and approval.

7. Annual Work Plan:

   A. Work with the Biology and Hydrology Committees to identify and expedite individual projects that are needed to accomplish the long range plan for each of the recovery elements.

   B. Draft an annual work plan consisting of high priority individual projects, formulated within the available funding.

   C. Forward the work plan to the Coordination Committee for review and approval.

8. Maintain records showing distribution and expenditures of all annual and capital funds expended under the work plan by each funding source.

9. Maintain a list of interested parties and provide those parties with the meeting dates, times, locations, and agendas for Program meetings.

10. Provide draft and final summaries of meetings to committee members.

11. Report to the Coordination Committee at each meeting the status of Program activities and research projects, and accomplishment of milestones; report any problems with maintaining schedules and provide recommendations for solving those problems; implement the recommendations of the Coordination Committee to resolve scheduling problems.

12. Provide support materials for annual funding efforts with the U.S. Congress and state legislatures.

Program Management -Base Funding Fiscal Year 2005 Project Proposal

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801-524-3835 / 970-385-6560

Background:

Program Management funds support Reclamation staff involved in program administration. Funds are used for the administration of funding agreements, including issuing requisitions for program supplies, and the preparation and oversight of work conducted under interagency agreements, cooperative agreements, contracts, and grants. The funds are also used for formation and participation of the technical committees, implementation of committee assignments not specifically identified in a scope of work, reporting, and coordination of water operations.

Management support for Capital fund projects, including technical oversight, budgeting, preparation of bids and funding agreements is covered in a separate scope of work

Tasks – 2005

1. Coordinate and manage the hydrology-related tasks performed by the Hydrology Committee, including administering cooperative agreements and contracts with consultants, accounting for expenditures, developing and providing status reports, and coordinating work items to ensure work is completed as planned.
2. Coordinate, administer, and manage Biology Committee and Program Coordination funding agreements (cooperative agreements, grants, interagency acquisitions, and service orders) and equipment purchase requisitions as identified in the annual Work Plan (other than those covered in Task 1.)
3. Develop Technical Proposal Evaluation Committees (TPECs) which evaluate and recommend proposals that have been submitted to the SJRIP in support of Program goals. TPECs will be recruited from both inside and outside of the Program and will serve as advisors to the Biological Committee concerning Requests for Proposals and Scopes of Work that have been submitted.

Capital Improvement Program Management
San Juan River Recovery Program
Fiscal Year 2005 Project Proposal

Principal Investigator: Brent Uilenberg
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Background:
The purpose of the San Juan Capital Improvements Program is to implement capital project which have been identified by the Program as necessary for the recovery of the endangered fish. As defined in Public Law 106-392 capital projects include "...planning, design, permitting or other compliance, pre-construction activities, construction, construction management, and replacement of facilities, and the acquisition of interests in land or water, as necessary to carry out the Recovery Implementation Programs".

Study Area:
San Juan River Basin

Objectives:

1.) Coordinate the preparation of Federal budget requests.

2.) Develop and manage cooperative agreement with the National Fish and Wildlife Foundation which provides the mechanism to utilize non-Federal cost share funds to implement capital projects.

3.) Develop and manage contracts and agreements to accomplish construction and acquisition of capital projects.

4.) Account for and provide capital project expenditure reports to the Coordination Committee.

5.) Coordinate planning, design, permitting, pre-construction, construction and acquisition of capital projects.

Products:
Financial reports will be periodically provided to the Coordination Committee documenting the status of Federal appropriations and non-Federal cost sharing contributions.

Operation of Public Service Company of New Mexico Fish Passage Structure and NAPI Ponds Management Training Fiscal Year 2005 Project Proposal

Principal Investigator: Dr. Vincent Lamarra
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and

Principal Investigator: Jeffrey Cole Navajo Nation Department of Fish and Wildlife Box 1480 Window rock, AZ 86515 (928) 871-7068
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Study Area:
Public Service Company of New Mexico Diversion Dam is located at RM 166.6. SJRIP razorback rearing ponds are located on the Navajo Indian Irrigation Project, south of Farmington, New Mexico.

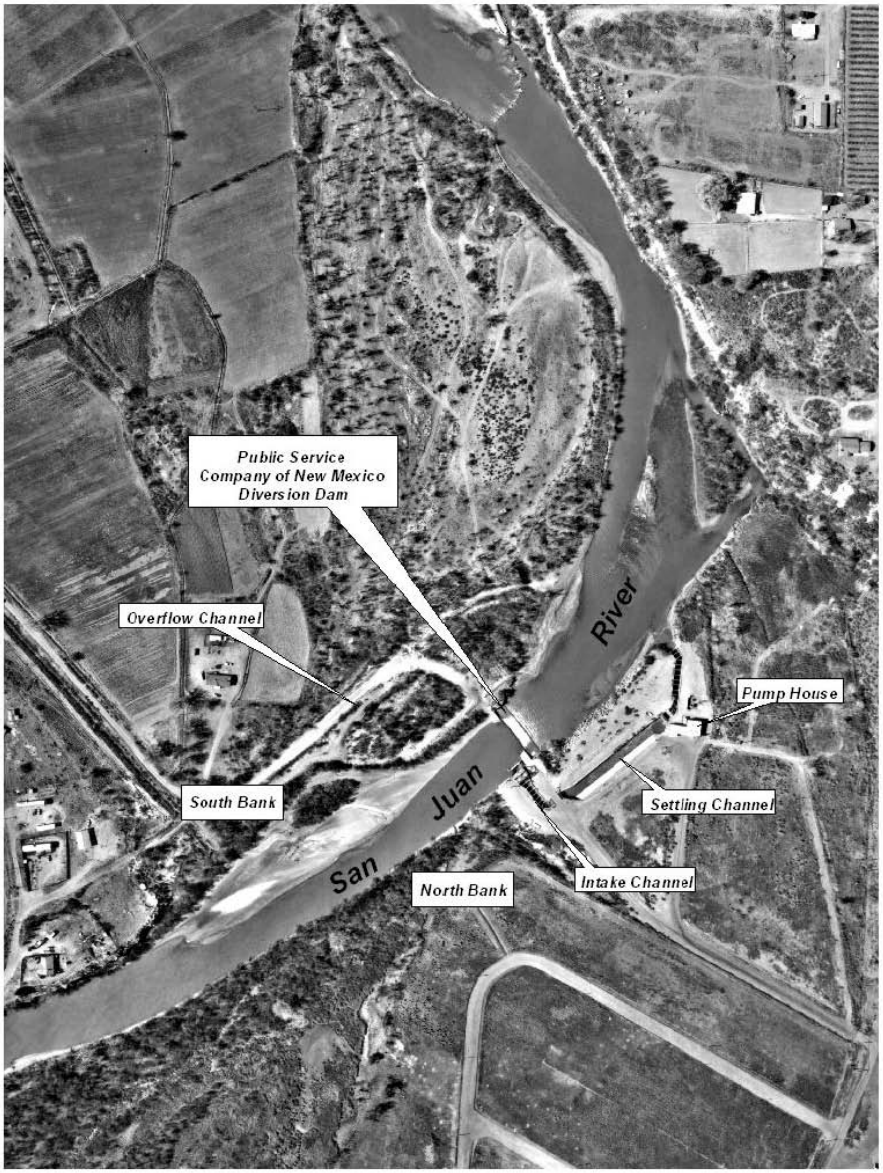
Collections:
The fish trap at the upstream end of the fish passage provides the ability to capture all fish that use the passageway. Specimens collected will be inspected to determine if any rare fishes (Colorado pikeminnow, roundtail chub, and razorback sucker) are present in the trap. All identifiable rare fish and all large-bodied native fish (i.e., flannelmouth and bluehead suckers) will be released. All other specimens will be removed from the river.

Background:
The PNM Diversion Dam (see Figure 1) was constructed in 1971. The 3.25-foot high diversion dam (weir) is located on the San Juan River about 12 miles downstream of Farmington, New Mexico near the town of Fruitland at River Mile 166.6. Facilities at the diversion include a concrete weir, a series of screened intake structures, an intake channel, a settling channel, and a pump house.

Water flows over the dam into a stilling basin created by a concrete apron. The stilling basin is the width of the river. The presence of the dam and the basin creates a barrier to fish moving upstream. As flows increase, the difference in the upstream and downstream water levels is reduced. Although water levels are reduced, water velocities increase and the weir provides an impediment to upstream fish movement. Recovery studies conducted as part of the SJRRIP have shown that some fish are able to move upstream past the weir but their specific method of movement is not known and the number of fish discouraged from upstream movement by the presence of the weir is also unknown. One possible method of upstream movement could occur during high river flows. When the flow in the San Juan River is above 7,000 cfs, some of the flow goes around the dam making it possible for fish to go around the dam at these higher flows.

A 4-foot by 6-foot sluiceway in the weir located on the north side of the river is used to sluice the inlet structure of sediment. Normal sluice gate operations have the sluice gate open between 8 and 12 inches. Trash racks and isolation gates are located at the point of diversion. A concrete settling channel about 490 feet long conveys river water to the pump house or returns it to the river. Diverted water moves through traveling screens to three pumps, together they are capable of pumping a maximum of 17,000

gallons per minute (37 cfs) to a 110-acre storage reservoir (Figure 2). From the storage reservoir, the water is pumped to San Juan Generating Station (SJGS).



The facility provides an average of approximately 1 million gallons of water per hour (24,200 acre-feet per year) to PNM for cooling operations for the SJGS (Tetra-Tech 2000).

A need has been identified by the San Juan River Basin Recovery Implementation Program (SJRRIP) to restore endangered fish passage upstream past the PNM Diversion Dam. The purpose of establishing fish passage would be to protect and recover native Colorado pikeminnow (*Ptychocheilus lucius)* and razorback sucker (*Xyrauchen texanus*) populations in the San Juan Basin while water development proceeds in compliance with all applicable Federal and State laws, including fulfillment of Federal trust responsibilities to the Southern Ute Indian Tribe, Ute Mountain Ute Tribe, Jicarilla Apache Nation and the Navajo Nation. In addition, other native fish species would benefit from restored passage.

The fish passageway will extend the range of these two native fishes upstream about 50 miles into historical habitat and may allow Colorado pikeminnow to naturally re-colonize these upstream reaches.

A fish trapping facility located at the upper end or forebay of the fishway allows researchers to sort, examine, and count fish and remove nonnative fish from the system.

Objectives:

1.) Determine the use of the fish passageway by juvenile and adult native and nonnative fishes.

2.) Identify any Colorado pikeminnow congregations that may be related to the spawning period in the San Juan River.

3.) Maintain the facility in a manner that assures long-term benefit.

End Products

1. Definitive data on passage--number of species; numbers per species; seasonal use and distribution by species.

2. Well maintained and operable fish passage facility.

Methods:

Working with the Program, Reclamation will contract with the Navajo Nation to perform the long-term operation and maintenance of the passageway. Work performed by the Nation is grouped in 2 general areas, operation and maintenance.

Fish and Wildlife Service personnel will provide necessary fish passageway training. Training will be provided in Grand Junction, Colorado at the Redlands Fish Passage on the Gunnison River. The training will assure the follow proficiencies:

1. Proper fish handling skills.
2. Species identification
3. PIT Tagging skills

Operation:

1. Operate the fish trap and passage way from April 1 through October 31 each year.

2. Passage is visited once a day to check trap, sort fish, and remove trash as needed.

Steps are as follows:

1. Lower water in trap
2. Collect fish in nets and remove from trap
3. Sort fish by native and non-native species (dispose of non-native species)
4. Enumerate and record all fish 4" in length or longer.
5. Check Colorado pikeminnow and razorback sucker for presence of a PIT tag.
6. If tag is present record number, tag fish if no tag is found.
7. Weigh and measure each Colorado pikeminnow and razorback sucker (use total length in mm, weight in grams).
8. Return all native species to the river via the fish return pipe.
9. Raise water in trap.

3. Crews checking the fish trap are also responsible for periodic cleaning of riverborne sediment in the fish trap that usually builds up during runoff.

4. Daily cleaning of surface and submerged trash, debris, and riverborne algae from the trash racks and bar screens in the forebay of the fish passageway, and aluminum conduit screens in the fish trap. The amount of algae, debris, trash, and sediment that accumulates daily at this site is seasonally variable, depending upon flow magnitude and water volume during the water year.

5. Analyze and evaluate data and prepare annual progress report.

6. Prepare draft and final report.

Maintenance:

1. Maintain the fish passage facility as necessary. Maintenance will include inspection of facilities for items that need to be repaired. Painting as necessary to control corrosion. Lubrication of moving equipment. Checking fluid levels in gear boxes and cooling radiators, if any.

2. During the first 2 years of operation representatives from the Navajo Nation, Reclamation, and FWS will inspect the facility to identify any design deficiencies and maintenance requirements.

3. After the first 2 years of operation, representatives from the Navajo Nation, Reclamation and the FWS will perform an inspection every 3 years.

4. In the event of a significant flood event, representatives from the Navajo Nation will notify Reclamation, BIA and the FWS and all parties will inspect the facility for damage.

Deliverables/Schedule:

1. Fish number will be recorded daily and a monthly fish passage report shall be submitted to the U.S. Fish and Wildlife Service by the 15th of each following month including time and date each time the trap was checked, number of species, and lengths, weights and PIT Tag numbers of each endangered fish.

2. Analyze and evaluate data and prepare annual progress report.

3. Prepare draft and final report.

NAPI Ponds Management

The individual that is operating the PNM Fish Ladder will also work with Vince Lamarra (ERI), Ron Bliesner (KBE) and BIA staff for staff training and managing the NAPI Razorback sucker grows out ponds. Manager will be responsible for daily pond inspections, and regulation of water levels. Water quality will be monitored daily for temperature, dissolved oxygen, pH and electrical conductivity. Dikes, fence, piping and ancillary equipment will be monitored weekly. Water levels will be maintained as necessary. No major maintenance is included in this budget. The ponds will be managed as per the Razorback Pond Management Plan.