WEST SLOPE WARMWATER FISHERIES

Federal Aid Project F-325R-1

Patrick J. Martinez
Principal Investigator

John W. Mumma, Director

Federal Aid in Fish and Wildlife Restoration

Job Progress Report

Colorado Division of Wildlife

Fish Research Section

Fort Collins, Colorado

August 1997

143 pp.

STATE OF COLORADO

Roy Romer, Governor

COLORADO DEPARTMENT OF NATURAL RESOURCES

James Lochhead, Executive Director

COLORADO DIVISION OF WILDLIFE

John W. Mumma, Director
Bruce McCloskey, Chief Administrator

WILDLIFE COMMISSION

Rev. Jesse Langston Boyd, Jr.
Rebecca Frank
Mark LeValley
Chuck Lewis
James R. Long
Armando Salazar
John Stulp
Louis Swift

FISH RESEARCH STAFF

Tom Powell, Aquatic Wildlife Researcher Supervisor
Rick Anderson, Aquatic Wildlife Researcher
Stephen Brinkman, Laboratory Technician
Patrick Davies, Aquatic Wildlife Toxicologist
John Goettl, Aquatic Wildlife Researcher
Mark Jones, Aquatic Wildlife Researcher
Patrick Martinez, Aquatic Wildlife Researcher
Mary McAfee, Aquatic Wildlife Researcher
R. Barry Nehring, Aquatic Wildlife Researcher
Rod Van Velson, Aquatic Wildlife Researcher
Harry Vermillion, Scientific Programmer/Analyst II
Judi Reeve, Administrative Assistant
Michelle Arnold, Administrative Assistant

Ted Washington, Federal Aid Coordinator

Jackie Boss, Librarian

Prepared by: Patrick J. Martinez
Patrick J. Martinez, Wildlife Researcher

Approved by: Tom M. Powell
Tom Powell, Aquatic Wildlife Researcher Supervisor

Date: 8/26/97

Job Progress Reports are preliminary and subject to change. They may not be published or cited without permission of the Director. The results of the research investigations contained in this report represent work of the authors and may or may not have been implemented as Division of Wildlife policy by the Director or Wildlife Commission.

Table of Contents

List of Tables

State: Colorado

Project No. F-325-R1

Title: Westslope Warmwater Fisheries

Period Covered: July 1, 1996 to June 30, 1997

Study Objective: To quantify and interrelate fish community responses and evaluate effectiveness of programs and techniques to alleviate negative interactions between nonnative warmwater sport/nongame fishes, found in floodplain pond, reservoir and riverine habitats, and native and threatened & endangered "big river" fish species in western Colorado rivers, and to provide guidance for maximizing angling opportunity for warmwater sport fish species in western Colorado within the constraints of identifying and implementing strategies to preserve, protect and/or recover the state's native fish resource.

Job No. 1: Effectiveness of ISMP for Sampling Centrarchids in Riverine Habitats

Job Objective: To evaluate the effectiveness of the current Interagency Standardized Monitoring Program (ISMP) fish sampling protocol in providing representative indices of centrarchid sport fish abundance in riverine habitats of the Colorado River from Palisade to the Colorado/Utah Stateline and recommend alternative sampling methods as identified.

Segment Objective 1: To develop study design to evaluate effectiveness of ISMP for developing representative trends of centrarchid abundance in riverine habitats.

Segment Objective 2: To acquire catch-per-unit-effort (CPUE) data for centrarchid and other nonnative fishes from existing ISMP data sets and evaluate variation in catch statistics within years and year-to-year to facilitate assessment of power thresholds of these data for detecting and tracking changes in abundance of target nonnative fish species.

INTRODUCTION

Annual Program Guidance (USDI 1995, 1996, 1997) for the Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin (UCRB) (USDI 1987) describes activities to be performed under each of the major components of the recovery program (Table 1). The endangered fishes include Colorado squawfish *Ptychocheilus lucius*, humpback chub *Gila cypha*, bonytail *Gila elegans*, and razorback sucker *Xyrauchen texanus*. The Recovery Program includes a component to control nonnative fishes that may access and/or proliferate in the mainstem habitats of the UCRB.

Expenditures for the nonnative fish component of the Program have been comparatively small in the past, but this portion of the annual budget has increased in recent years (Table 1) and is expected to increase substantially in upcoming years (H. Maddux, U.S. Fish and Wildlife Service, personal communication). Among the first major activities to address negative impacts of nonnative fishes in the UCRB was the negotiation, approval and implementation of Procedures for Stocking Nonnative Fish Species in the Upper Colorado River Basin (CDOW et al. 1996, Appendix A) (hereinafter called simply **Procedures**)

Table 1. Recovery elements and components, and percent of expenditures found in annual Program Guidance for Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin, fiscal years 1996-1998 (USDI 1995, 1996, 1997).

Recovery element	Components	Percent of budget		
		FY96	FY97	FY98
Instream flows	Protection Identification Recommendations	30	27	32
Habitat	Fish passage Floodplain habitat Land acquisition Selenium	29	13	24
Reduce nonnative fish and sport fish impacts	Preventive measures Active control programs	< 1.0	2	2
Propagation and genetics management	Experimental stocking Taxonomic analyses Hatchery/refugia facilities Chemoreception/imprinting	26	34	24
Research, monitoring, and data management	Standardized Monitoring Nonnative fishes	3	7	8
Information education and public involvement	Recovery Program Newsletter Congressional briefings Public involvement plans	< 1.0	1	1
Program management	Planning and support Coordination	8	14	7

Martinez (1996) presented data and information discussed between the Colorado Division of Wildlife (CDOW) and environmental groups as part of a debate about the reliability of data collected by the Interagency Standardized Monitoring Program (ISMP) (McAda 1989, McAda et al. 1994, 1995). This debate centered around the ISMP's capacity to accurately sample centrarchid relative abundance in riverine habitats, and to provide a reliable index for monitoring changes in centrarchid abundance as part of evaluating the effectiveness of the then proposed Procedures. The Procedures, since finalized and adopted in October/November of 1996 (CDOW et al. 1996), are intended to ensure that all future stocking of nonnative fishes in the UCRB is consistent with the recovery of endangered fishes.

The Procedures themselves specify that concurrent with implementing their provisions, "the Recovery Program will conduct a peer-review study to evaluate the effectiveness of the ISMP to detect changes in the survivability and/or abundance of routinely stocked fish" (Appendix A, p. 5). This discussion about the detectability of centrarchids in riverine habitats of the UCRB using the ISMP centers around the late summer seine protocol in backwater habitats where centrarchids have been shown to be most prevalent in collections (McAda et al. 1994, 1995). The Procedures provide for the stocking of largemouth bass *Micropterus salmoides*, bluegill *Lepomis macrochirus*, and black crappie *Pomoxis nigromaculatus* into

floodplain ponds within Critical Habitat and there remains concern that this stocking may result in increased escapement of these sport fish from ponds despite methods implemented to contain these fish in their pond habitats (Martinez 1996). Furthermore, the Procedures require that escapement of stocked warmwater fishes from ponds be identified, reviewed, and rectified before further stocking can occur (Appendix A, p.5).

METHODS

Dr. Kevin Bestgen, Larval Fish Laboratory, Colorado State University (CSU), prepared a draft study proposal to perform the ISMP evaluation called for in the Procedures. This draft proposal, entitled Evaluation of the Interagency Standardized Monitoring Program Sampling Technique in Backwaters of the Colorado River in the Grand Valley, Colorado (22 April 1997) was sent to nine Recovery Program participants and biologists for peer-review (Appendix B) as required by the Procedures.

RESULTS AND DISCUSSION

Three reviews were returned by the deadline of May 12, 1997 (Appendix 2) fulfilling the peer-review requirement described in the Procedures. Those individuals returning reviews were Henry Maddux and Tom Czapla of the U.S. Fish and Wildlife Service, and Tom Nesler of the Colorado Division of Wildlife. My input during the draft phase of the proposal was the need for the investigation to address Segment Objective 2 listed above, which is included in the finalized proposal (Appendix C, p. 12). The finalized proposal (Appendix C) incorporated reviewer comments and the Larval Fish Laboratory at Colorado State University has been contracted by CDOW to perform the investigation using Recovery Program funds.

Job No. 2: Fish Anti-Escapement Strategies/Devices for Ponds/Reservoirs

Job Objective: To evaluate suitability, reliability and effectiveness of various fish anti-escapement devices installed on outlets of ponds and reservoirs and their capacity to reduce nonnative fish abundance and biomass in inlets, outlets and connecting channels.

Segment Objective 1: Review techniques/structures/devices proposed for minimizing or preventing fish escapement at specific sites.

INTRODUCTION

The key to the application of the Procedures is the isolation of waters stocked with and/or containing nonnative warmwater fishes (Table 2). Because of this, several western Colorado warmwater fisheries cannot be stocked until they are brought into compliance with the fish anti-escapement provisions of the Procedures (Appendix A). This lack of stocking or continued management of traditional warmwater fishery resources in several public floodplain ponds along the Colorado River in the Grand Valley and in Elkhead Reservoir in the Yampa River basin has created great concern among individual anglers and angler organizations (United Sportsmen's Council, Sportsmen's Wildlife Fund, Yampa Valley Bassmasters).

The requirement for screening at Elkhead Reservoir poses a particular problem because of the proposed enlargement of the dam and reservoir to provide storage for late season flows in the Yampa river to off-set flow reductions due to irrigation and other diversions of flow (Hydrosphere 1993, 1995). Local anglers are aware of a Lake Management Plan prepared by the Colorado Division of Wildlife (Elmblad et al. 1994) that has not been submitted for review by the U.S. Fish and Wildlife Service. Due to the demonstrated escapement of fish from the existing dam, the provisions of the Procedures would not be met and approval to stock warmwater sport fish species would not be approved.

Elkhead Reservoir, formerly recognized for its self-sustaining smallmouth bass *Micropterus dolomuei* fishery, also contained remnant populations of black crappie, bluegill, largemouth bass, channel catfish *Ictalurus punctatus*, and northern pike *Esox lucius*. The draining of the reservoir during the winter of 1992 resulted in the flushing of many smallmouth bass and the crushing under ice of much of the standing-dead brush and shrubs that provided structure in the reservoir's bays. Thus, the current reservoir fishery is comparatively non-existent, to the dismay of anglers, and the remaining habitat and structure is diminished. Anglers hope that enlargement of the reservoir would inundate new woody vegetation and possibly contribute to the restoration or improvement of the former fishery. In addition to this question, the impending administration of the reservoir's recreation by Colorado State Parks (D. Scheiwe, Colorado State Parks, personal communication) will renew the focus on restoring some sort of productive warmwater fishery.

A recently completed evaluation of fish screening and fish anti-escapement technology and the feasibility of applying these techniques at Elkhead and Highline (near Loma, Colorado) reservoirs indicates that costs to contain fish in the reservoir could be exorbitant depending on the life stages to be prevented from leaving the reservoir (Miller and Laiho 1997). Miller and Laiho (1997) reviewed screening options ranging from prevention of passage of fish eggs and larvae to the fine mesh screens currently representing state-of-the-art in fish containment technology in large scale applications. The prevention of the escapement of fish and larvae given the dimensions of an enlarged dam and spillway at Elkhead could cost as much a $33 million. The cost of applying the current industry practice at the Elkhead Dam using 3/32 inch aperture mesh would be approximately $900,000 (Miller and Laiho 1997).

This raised the question of how various warmwater fish species proposed for stocking or already occurring in Elkhead Reservoir would fare in the enlarged reservoir scenario and how this might influence the biopolitical process of requesting funding and installing a fish screen to minimize escapement. A habitat based model entitled A Low Effort System for Planned Coolwater and Coldwater Reservoirs (McConnell et al. 1984) was applied to Kenney Reservoir, Colorado prior to completion to forecast the performance of various fish species in the newly constructed impoundment (McConnell et al. 1984). This model proved to be highly predictive following assessment of the post-impoundment fish population in Kenney Reservoir (Martinez 1986, Martinez et al. 1995).

The existing model had been developed for black crappie, common carp *Cyprinus carpio*, white sucker *Catostomus commersoni*, yellow perch *Perca flavescens* and rainbow trout *Oncorhynchus mykiss* (McConnell et al. 1984). To project the potential performance of other coolwater and warmwater sport fishes in an enlarged Elkhead Reservoir, more species had to be described within the framework of the habitat suitability model. The species of more immediate interest included northern pike, channel catfish (reproducing and stocked), smallmouth bass and largemouth bass.

Common questions posed by angler's at NEPA public meeting, Angler's Roundtable meetings (hosted by Colorado Division of Wildlife), and in personal phone calls include "why is Colorado Division of Wildlife involved in these activities to eradicate or reduce stocking of sport fish?" and "how can the agency's employees devote time to these sport fish control projects when their salaries come from license revenues and sporting equipment taxes?". Part of the response to these questions lies in the CDOW's mission which states that "all wildlife will be managed" and in other past and recently adopted policies and agreements.

Table 2. Nonnative fish stocking scenarios and fishes mentioned in the Procedures for Stocking Nonnative Fish Species in the Upper Colorado River Basin. SAL=salmonids, **BGL**=bluegill, **BCR**=black crappie, **LMB**=largemouth bass, **TGC**=triploid grass carp, **MQF**=mosquitofish, **CCF**=channel catfish, **FHM**=fathead minnow, **TGM**=tiger muskie, **RSS**=redside shiner, **SMB**=smallmouth bass, **NOP**=northern pike, **CCP**=common carp, **RSH**=red shiner, **BBH**=black bullhead, **YBH**=yellow bullhead, **WIP**=wiper, **GSF**=green sunfish, **FHC**=flathead catfish, **WCR**=white crappie.

UCRB nonnative fish management scenario	Nonnative Fish Species											Prohibited Nonnative Fish Species								
	SAL	BGL	BCR	LMB	TGC	MQF	CCF	FHM	TGM	RSS	SMB	NOP	CCP	RSH	BBH	YBH	WIP	GSF	FHC	WCR
1) Mainstem Riverine Habitats																				
Critical habitat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Above critical habitat	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2) 50 Year Floodplain within Critical Habitat (Ponds Bermed to FEMA Standards and Properly Screened)																				
Private ponds	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corn, Duke, & Connected lakes	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3) Isolated Waters within Critical Habitat but above the 50 Year Floodplain																				
Private and Public	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4) Isolated Waters above 6,500 foot msl and above the 100 Year Floodplain																				
Private and Public	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-
5) State of Colorado - Approved Lake Management Plans																				
Mack Mesa (1990)	X	X	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Purdy Mesa (1990)	X	X	-	X	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rio Blanco (1990)	-	X	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Chipeta (1987)	X	X		X		-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Crawford (1987)	X			X		-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
McPhee (1995)	X	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harvey Gap (1995)	X	-	-	-	-	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-

Table 2. Continued. Nonnative fish stocking scenarios and fishes mentioned in the Procedures for Stocking Nonnative Fish Species in the Upper Colorado River Basin. SAL=salmonids, **BGL**=bluegill, **BCR**=black crappie, **LMB**=largemouth bass, **TGC**=triploid grass carp, **MQF**=mosquitofish, **CCF**=channel catfish, **FHM**=fathead minnow, **TGM**=tiger muskie, **RSS**=redside shiner, **SMB**=smallmouth bass, **NOP**=northern pike, **CCP**=common carp, **RSH**=red shiner, **BBH**=black bullhead, **YBH**=yellow bullhead, **WIP**=wiper, **GSF**=green sunfish, **FHC**=flathead catfish, **WCR**=white crappie.

UCRB nonnative fish management scenario	Nonnative Fish Species											Prohibited Nonnative Fish Species								
	SAL	BGL	BCR	LMB	TGC	MQF	CCF	FHM	TGM	RSS	SMB	NOP	CCP	RSH	BBH	YBH	WIP	GSF	FHC	WCR
6) State of Colorado - Lake Management Plans to be Prepared																				
Jerry Creeks (?)	?	?	-	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juniata (?)	X	?	-	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7) Waters with Direct Connection to Rivers in UCRB that Must to be Screened (Lake Management Plan Required)																				
Private	X	?	?	?	?	-	?	-	-	-	-	-	-	-	-	-	-	-	-	-
Elkhead & Highline reservoirs	X	-	-	?	-	-	?	-	-	-	-	-	-	-	-	-	-	-	-	-
8) Above Flaming Gorge Dam																				
Any water	X	-	-	-	-	X	X	-	-	X	X	-	-	-	-	-	-	-	-	-
9) Above Existing Reservoirs Where Reproducing Populations of the Species Exist (Lake Management Plan Required)																				
Standing Waters	X	?	?	?	?	?	?	?	?	?	?	-	-	-	-	-	-	-	-	-
10) Warmwater Gamefish Removed from Rivers/other Problem Area and Transplanted to Waters Already Containing that Species Where Escapement is not Likely																				
Standing Waters	NA	?	?	?	-	-	?	-	?	-	?	?	-	-	-	-	-	-	-	-

Other key questions posed by anglers and angler's groups in public meetings included "on what timeframe did CDOW plan to construct berms around selected public floodplain ponds as described in the Procedures?" Three sites listed in the Procedures, Corn, Duke and Connected (upper and lower) lakes are gravel pit ponds that presently provide angling recreation for various warmwater sport fish, but are known to lie within the 50 year floodplain of Critical Habitat. Lacking estimates of the potential cost of such structures, little feedback could be given in response to these inquiries. Also, there was some concern among anglers and the Wildlife Commission about the costs of warmwater fishery management options for private ponds within the 50 year floodplain given the requirements for berms to be high enough to resist a 50-year flood event and to meeting Federal Emergency Agency (FEMA) construction specifications (Appendix A).

METHODS

A summary of policies/agreements/position papers pertaining to persistent questions about CDOW's involvement and expenditures in management and recovery activities for non-sport, native fishes was prepared for discussion with anglers and other citizens. This information was provided and explained at several meetings including NEPA public input meetings, Angler's Roundtables, and CDOW Area meetings.

A summary of regulations required to enforce the provisions of the Procedures was prepared and discussed at a Colorado Wildlife Commission workshop held in Gunnison, Colorado, 8 August 1996. Also, I prepared draft regulations for implementing and enforcing the Procedures during this segment. These discussions and regulations were needed to clarify the need to enforce the contingent in the Procedures that waters must be demonstrably "isolated" before stocking of selected fish species could be approved. The geographic extent of these draft regulations was based on the Critical Habitat designations and justifications for Colorado squawfish published in the Federal Register (Federal Register 1994).

To expand the list of species for which evaluation criteria and ratings existed for use in the model A Low Effort System for Planned Coolwater and Coldwater Reservoirs (McConnell et al. 1984), a panel of experts met several times during the winter of 1996-1997 to discuss literature, personal experience and expert opinions pertaining to the performance of northern pike, channel catfish (reproducing and stocked), smallmouth bass and largemouth bass in coolwater and coldwater reservoirs. The expert participants included Dr. Eric Bergersen of the Colorado Cooperative Fishery and Wildlife Research Unit at CSU, who served as coordinator for the effort, Dr. Steve Flickinger of CSU, James Terrell of the U.S. Geological Survey Biological Branch, Greg Langer of the U.S Fish and Wildlife Service, and myself. James Terrell (the original project officer for the model's development) reviewed the groups ratings for each species as they were developed and coordinated the computer summarizations for the model.

In the application of the model, water temperature, mineral turbidity, nonliving cover, extent and timing of drawdown, and frequency of shallow coves represent five "primary" attributes (McConnell et al. 1984). Each primary attribute is scored based on two or more secondary attributes. A five-digit number, resulting from the score assigned to each of the five primary attributes, provides a description of the reservoir. In the case of the temperature score, there are three species groups, warmwater, coolwater and coldwater fishes. Each of the three species-temperature groups has an "option" within the model that must be identified before proceeding with the development of the five-digit, reservoir description (McConnell et al. 1984). The resulting five-digit scores are located in the list of "habitat suitability" values generated for each species by the expert panel (Appendix D). These values rank the reservoirs suitability for each species individually as "high", high-medium", "low-medium" and "low" (McConnell et al. 1984). Northern pike was considered to be a coolwater species while channel catfish, smallmouth bass and largemouth bass were evaluated as warmwater species.

On 15 May 97, Eric Bergersen and I made a site visit at Elkhead Reservoir by boat to identify key model parameters. A level and staff were used to identify approximate areas of inundation should the dam on Elkhead Reservoir be modified. Ray Tenney, Colorado River Water Conservation District, Glenwood Springs, accompanied us in the afternoon to answer questions about the proposed reservoir enlargement and resulting reservoir operations.

The first step in calculating the potential costs of diking floodplain ponds in accordance with the provisions of the Procedures was to identify which ponds lied in which portions of the floodplain. This was accomplished using areal photographs, conventional and infrared, taken by USFWS during runoff in 1995. These photos were available for the Colorado River from Palisade to Loma and for the Gunnison River from its Colorado River confluence upstream to Delta. The ponds in the photos were identified on floodplain maps designating the 50 year and 100 year floodplains (CWCB 1995a, 1995b) which included a trace of the 10 year floodplain approximated by personnel of the USFWS, Denver, Colorado. Determinations of locations of individual ponds in the floodplain were made by H. Maddux, USFWS, Grand Junction, and myself. Individual ponds were then referenced to the floodplain pond description list developed by Mitchell (1995).

Calculations were made to estimate the size of the pond resource that potentially would require diking, in accordance with the Procedures (Appendix A) to accommodate stocking of selected warmwater fish species in the 50 year floodplain of the Colorado River from Palisade to Loma. The Gunnison River floodplain pond resource was not similarly analyzed due to incompleteness of available data. These calculations were used to estimate the potential cost of diking this pond resource for both public and private ponds using dike dimensions and cost estimates prepared by Bill Elmblad (Appendix E). To get a rough estimate of the lengths of dikes required, the known pond areas were used to derive the circumference of a circle of the same area and the circumference was multiplied by an estimated shoreline development factor to approximate shoreline length. An average dike height of four feet was used to calculate cost of fill and an assumption was made that one-half of the dike, that portion adjacent to or facing the river's flow, would have to be rip-rapped.

RESULTS AND DISCUSSION

Policies and Agreements Pertaining to CDOW's Endangered Fish Involvement

Basic information was provided to the public to help them understand which policies and their key provisions linked CDOW to the management and recovery of non-sport native fishes. This information is summarized below:

Endangered Species Act of 1973 (Amended 1982):

Applies to fishery management in western Colorado due to the presence of the four endangered fish species in the Upper Colorado River Basin. Based on the listing dates for the species by the ESA (Colorado squawfish - 1967, humpback chub - 1967, bonytail - 1980, and razorback sucker - 1991), concern remains about the stability and continued existence of these fishes. Furthermore, the roundtail chub and flannelmouth sucker, species formerly believed to be widespread and abundant are now candidate species being considered for listing under ESA. Purpose is to provide a means whereby the ecosystems upon which T & E species depend may be conserved and to provide a program for the conservation of T & E species. All Federal departments and agencies shall seek to conserve T & E species and shall utilize their authorities to accomplish the purposes of this Act.

Title 33 - Colorado Revised Statutes, Article 2 - Nongame, Endangered, or Threatened Species Conservation Act:

It is the policy of the state to manage all nongame wildlife for human enjoyment and welfare, for scientific purposes, and to ensure their perpetuation as members of ecosystems. Manage means to survey, protect, artificially propagate, exercise water rights, and restrict stocking as needed.

Executive Order 11987 - 1984

This Order states that federal agencies shall restrict the introduction of nonnative species into any natural ecosystem of the United States. It also restricts federal agencies from using funds, possibly Federal Aid in Sport fish Restoration Act funds, for nonnative species introductions unless it is demonstrated that there will be no adverse impact to native species, especially endangered species, and natural ecosystems. .

Sport Fishing and Boating Partnership Council - 10 Feb 1995

This is a position paper entitled Conserving Federally Threatened, Endangered, and Protected Species While Providing and Enhancing Recreational Fisheries Programs. Its primary theme is that solutions are needed to avoid conflicts, maintain recreational opportunities and high levels of participation, and at the same time maintain the diversity and health of the Nation's aquatic ecosystems.

Executive Order 12962 - 8 Jun 1995

This Order was conceived by Sport Fishing and Boating Partnership Council and sponsored by American Sport Fishing Association. The Order requires federal agencies to strengthen efforts to improve the quality of streams, rivers, and lakes supporting recreational fisheries and to promote compatibility between the protection of endangered species and recreational fishing.

Memorandum of Agreement: State of Colorado and Department of the Interior - 29 Nov 1995

This MOA commits the State and Department to an approach in their fish and wildlife conservation that uses the flexibility inherent in state and federal laws and regulations to achieve long-term conservation and development solutions. This Agreement is intended to demonstrate that the Department's flexibility in its implementation of the ESA can be used to find practical solutions that are based on sound and objective science, will reduce the need to list species, will minimize social and economic impacts, and implement a habitat and community approach to conservation.

Draft Regulation Discussion and Development for Enforcing "Procedures"

Those provisions of the Procedures anticipated to require regulations for enforcement were discussed with the Wildlife Commission are listed in Table 3. The draft regulations that I drafted and submitted to CDOW's Aquatic Section for consideration and comment are given in Appendix F. These regulations, that would also be applicable to private pondowners, were prepared for review and revision as needed by the CDOW Aquatic Section before submitting the regulations for deliberation by the Wildlife Commission.

Table 3. Key provisions and components of the Procedures for Stocking Nonnative Fish Species in the Upper Colorado River Basin discussed with the Colorado Wildlife Commission 8 August 97 potentially requiring regulatory attention Page numbers and items referenced refer to the finalized Procedures (Appendix A). BCR= black crappie, BGL=bluegill, CCF=channel catfish, FHM=fathead minnow, LMB=largemouth bass, MSF=mosquitofish, and TGC=triploid grass carp.

Provision, location or situation	Page no: section	Wildlife Commission regulatory action
No trout stocking in riverine Critical Habitat of Upper Colorado River Basin	5: IV.2.	Critical Habitat definition regulation required
Stocking only BCR, BGL, LMB & TGC in pond in 50 yr floodplain	5: IV.3.A.,B.(2)	Regulation, to define 50 yr floodplain
Berming and screening prerequisite for stocking warmwater sport fish in 50 yr floodplain	5: IV.3.A.,B.(2)	Berm and screen specification and situation regulation required
Stock LMB, BCR, BGL, MSF, TGC above 50 yr floodplain	7: IV.3.B.4.	Regulation required
Isolated waters above 6,500' msl and above 100 yr floodplain: CCF, FHM	7: IV.5.	Isolation definition regulation required
Highline and Elkhead reservoir outlet screens	8: IV.3.B.6	Screen specification regulation
No stocking of nonnative, nonsalmonid fishes in rivers within Critical Habitat	10: VII.1.	Regulation required
No stocking of nonnative, nonsalmonids in rivers having direct connection to Critical Habitat	10: VII.1.	Regulation required
Prohibited fish species	10: VII.3.	Regulation required
Transplanting of nonnative warmwater sport fish salvaged from rivers	11: VIII.2.	Regulation defining waters eligible to receive transplants
Five year review of Lake Management Plans	16: X.2.B.(3).	Corrective provisions?

A Low Effort System for Planned Coolwater and Coldwater Reservoirs

Some of the key physical characteristics of an "enlarged" Elkhead Reservoir include a new surface area of 1,080 acres, 18 miles of shoreline, a capacity of 37,00 acre-feet, a mean depth of 34.3 feet (10.5 m) and a shoreline development factor of 4.009 (E. Bergersen, Colorado Cooperative Fish and Wildlife Research Unit, personal communication). The five digit reservoir score for each fish species catergory and the corresponding "suitability" description is given in Table 4. In summary, an enlarged version of Elkhead reservoir would be little changed from the present reservoir environment. However, it is important to note

that the model proved to be highly predictive based on past experience with various fish species in the reservoir.

The reservoir rated "low" in suitability for all warmwater fish species except stocked channel catfish (Table 4). While the thermal regime of the reservoir would preclude natural reproduction of channel catfish, a handful of catfish that had been stocked in the reservoir in the 1980s and subsequently sampled during surveys in the reservoir displayed good body condition (unpublished data). Despite the ability of smallmouth and largemouth bass to reproduce in the reservoir, neither species attained great abundance and age-growth data showed growth of smallmouth bass in the reservoir was slow, with the bass reaching 15 in. (380 mm) in 9 to 10 years (unpublished data).

For the coolwater species for which the model's habitat scores have been defined, an enlarged Elkhead Reservoir ranked "low-medium" for white sucker and yellow perch, but low for northern pike (Table 4). While white sucker accounted for one of the highest percentages of fish species captured by a combination of seining, gill netting and electrofishing in 1987 (16% of 1,255 fish), it was outnumbered by native flannelmouth sucker (28%) and roundtail chub (21%), and smallmouth bass (21%) (Martinez unpublished data). Also, none of the white suckers captured in 1987 were of the larger sizes (> 400 mm) observed in other Colorado reservoirs suggesting less than favorable environmental conditions for this species. Yellow perch have never been introduced into the reservoir, and despite the higher habitat ranking for this species relative to the other species evaluated, the results of this modeling indicate that the performance of this species in the reservoir would be predictably poor.

Rainbow trout, at one time regularly stocked in Elkhead, are not part of the current Lake Management Plan prepared for the reservoir (Elmblad et al. 1994). On the basis of temperature, Elkhead is certainly suitable for trout as surface waters only reach or exceed 70° F for only short periods during summer. This thermal regime contributed to the suitability score for this species of "low-medium" (Table 4). The ease of escapement and the turbidity of the inflowing water combine such that many trout spilled from the reservoir during runoff. This scenario has made it difficult to retain trout as more than a short-term component of the fishery in most years. An enlarged Elkhead would possess these same characteristics, but installation of a screen to minimize fish escapement (Miller and Laiho 1996) may make management of the reservoir with catchable rainbow trout more effective, whether the reservoir is enlarged or not.

It is almost difficult to conceive of a reservoir which does not rank at least high-medium for some desirable sport fish or prey fish species. However, conditions in Elkhead reservoir, including a thermal regime that is neither optimum for coldwater or warmwater fish species during the summer months, is probably largely responsible for the marginal performance of species introduced to the reservoir to date. While the thermal regime might seem more favorable for coolwater species, the unique turbidity situation wherein there is surprisingly little sediment deposition or nutrient input, but rather a colloidal suspension during spring and other runoff events (R. Tenney, Colorado River Water Conservation District, personal communication), apparently restricts production.

It also appears turbidity encourages escapement of some species (e.g. northern pike and rainbow trout). However, until 1992, smallmouth bass remained in the reservoir in fairly high numbers, although escapement of primarily young-of-year bass less than 75 mm has been documented (Martinez unpublished data, Miller and Rees 1995). In 1992, draining of the reservoir for repair of the dam resulted in flushing from the reservoir an apparently high proportion of sub-adult and adult smallmouth bass (Tyus and Saunders 1996, Appendix H). This flushing of bass from Elkhead reservoir is believed to be responsible for the decline of the reservoir's bass fishery and for the stark increase in the number of smallmouth bass collected in the Yampa River in recent years (B. Elmblad, Colorado Division of Wildlife, personal communication).

Table 4. Summary of habitat suitability scores for the proposed enlargement of Elkhead Reservoir for northern pike, channel catfish (reproducing and stocked), smallmouth bass and largemouth bass based on model application found in Appendix D; and habitat suitability scores for black crappie, common carp, white sucker, yellow perch, and stocked rainbow trout based on McConnell et al. (1984).

Fish Species	Five-digit reservoir description	Habitat suitability
Warmwater fish species		
Black crappie	1 3 1 2 3	L
Largemouth bass		L
Smallmouth bass		L
Channel catfish (stocked)		LM
Channel catfish (reproducing)		L
Common carp		L
Coolwater fish species		
White sucker	1 3 1 2 3	LM
Yellow perch		LM
Northern pike		L
Coldwater fish species		
Rainbow trout (stocked)	2 3 1 2 3	LM

The characteristics of the existing reservoir and/or the enlarged version and the past and/or forecasted performance of the various sport fish species available for management in Elkhead reservoir lends insight into screening options and the requirements for retention of various fish life stages. Reproduction by catfish and northern pike appears unlikely. Reproduction by bass can be prolific (unpublished data), but recruitment appears low. Given these circumstances and the circumstantial evidence that largemouth bass survive poorly in riverine environments and that young-of-year smallmouth bass escaping the reservoir prior to 1992 did not appear to proliferate in the Yampa River, the argument could be made that the reservoir could be fitted with a screen mesh sufficient to retain Age-0 and older sport fishes.

A larger mesh screen would require a smaller structure, presumably of less initial cost and less maintenance and operation costs. Also, the provision in the Procedures whereby fish removed from riverine environments and transferred to screened, off-stem impoundments (Appendix A) could apply to an Elkhead Reservoir screened with a larger mesh since it is likely that only life stages of sport fishes older that Age-0 would be transplanted to screened impoundments. During periods of active fish removal from rivers (Yampa in particular), Elkhead could serve as a receiving water for adult sport fishes, thus restoring some of the

recreation opportunity lost since the reservoir was drained and offsetting actual or perceived losses of sport fishing opportunity in riverine habitats.

Floodplain Pond Resource, Flooding Potential, and Berming Concerns

Several key discussions occurred during the negotiation of the draft Procedures pertained specifically to concerns about maintenance or development of non-salmonid sport fisheries within the 100-year floodplain (Critical Habitat) and the construction of berms around or along ponds adjacent to the river. Among these concerns was a perception by members of the water development and environmental communities that the floodplain corridors, especially along the Colorado River within the Grand Valley could become a channelized, rip-rapped river which would preclude flooded bottomland restoration for endangered fishes and would upset key nutrient dynamics between flooded habitat and the mainstem river.

In response to these concerns about fish management within the floodplain, either for endangered or sport fishes, several comments and observations were quite relevant. First, most of the ponds in the floodplain were believed to lie within the 10 year floodplain, particularly along the Colorado River in the Grand Valley. Henry Maddux, USFWS, and I confirmed this belief upon examination of maps encompassing the river floodplains and surrounding lands along the Colorado and Gunnison rivers (Table 5). Indeed, the majority (55%) of the 246 ponds identified along the Colorado River within the Grand Valley appeared to lie in the 10-year floodplain. Another 22% of these ponds were within the 10-50 year floodplain thus totalling 77% (72% of the total pond surface acreage) within the 50 year floodplain (Table 5).

Another key point was, there is little vertical or horizontal variation within much of the floodplain between the 50-year and 100-year floodplains along the Colorado (CWCB 1995, FEMA 1992), Gunnison, White, or Yampa Rivers. This point was probably key in allowing a berm height up to the 50-year flood height to suffice for the purposes of the Procedures. Table 6 combines data found in FEMA (1992) and CWCB (1995) to illustrate the recent historic magnitude of flood events along the Colorado River within Critical Habitat.

The most recent serious floods along the Colorado River occurred in 1983 and 1984 (FEMA 1992). Note that during the 1983 flood, all ponds shown in Table 6 were within the 10-year floodplain and would be expected to connect with the river during a similar event, i.e., fish could possibly enter or leave the pond depending on the depth of the connecting water flow. Also note that during 1984, the floodplain between Palisade and Fruita experienced a 40-year flood event, but the river flow in this reach nearly equaled but did not exceed the flow estimated for a 50-year event (Table 6). These data contributed to the rationale for constructing berms along/around ponds only up to the 50-year flood stage, per the Procedures. Exceeding the 50-year elevation functionally represents berm free-board which becomes an added cost in construction.

As a result of the concerns about potentially excessive berming of the floodplain within Critical Habitat, a proposal was forwarded during negotiations surrounding the Procedures to cap the number and surface acres of ponds that could be diked and/or screened by CDOW for developing/continuing management for nonnative warmwater fish species. The key issues were that berming ponds to accommodate management for warmwater sport fish would preclude a pond's use for grow-out of endangered fish and/or flooded bottomland restoration for benefit of endangered fishes.

Table 5. Total number of ponds and numbers of ponds by floodplain or of undetermined floodplain position along the Colorado and Gunnison rivers within Critical Habitat.

River and reach		Total number of ponds and total surface acreage by reach	Ponds for which floodplain position is undetermined	Floodplain designations of interest			
				0-10 year	10-50 year	50-100 year	> 100 year
Colorado - Palisade to Loma	Number	246	None	136	55	none	55
	Percent of number			55%	22%	-	22%
	Surface acres	710	0	514	149	0	47
	Percent of acreage			72%	21%	-	7%
Gunnison - Delta to Colorado River confluence	Number	17	46	2	6	9	None
	Surface acres	18	140	3	3	12	0

Points made by CDOW included potential benefits of berming: 1) berming of ponds allows warmwater sport fish recreation within floodplain in a fashion compatible with endangered fish recovery and native fish protection, 2) berming may alleviate concerns about economic impacts due to perceived losses of fishing opportunity, 3) berming minimizes reinvasion of pond by nonnatives once it has been reclaimed to facilitate better production of sport or native fish species, and 4) berming may prevent or minimize trapping of adult endangered and other native fishes in floodplain ponds as water levels recede, thereby facilitating their continued reproductive contribution to the mainstem riverine fish population.

The response to this concern about pond berming by CDOW ranged from a voluntary moratorium on any warmwater fish management in ponds within Critical Habitat for five years (a timeframe perceived to allow floodplain restoration and/or growout ponds to be implemented) to no restrictions on the number of public ponds that might be considered for berming. In the finalized Procedures, a cap was imposed on the number of ponds eligible for berming within the floodplain of Critical Habitat. Only three sites that are currently public, Corn Lake, Duke Lake, and Connected Lakes can be pursued for continued management of warmwater sport fish species (Appendix A).

Table 6. Comparison of flood hydrologic data for river reaches and ponds managed by Colorado Division of Wildlife (CDOW) within Critical Habitat of the Colorado River in Colorado. Table contains data combined from FEMA (1992) and CWCB (1995).

Location along Colorado R.	Floodplain ponds managed by CDOW in proximity	Flood hydrologic data - cfs				1983 flood		1984 flood		1993 flood	
		10 yr.	50 yr.	100 yr.	500 yr.	cfs	Event	cfs	Event	cfs	Event
Rifle - upstream of Rifle Creek	Rifle Rest Area Pond	28,600	38,100	42,200	no data	no data	12-14 year	no data	25-40 year	no data	1.5-2 year
Parachute - upstream of Parachute Cr.	Parachute Pond	29,100	38,700	42,900	no data	no data	12-14 year	no data	40 year	no data	2-5 year
Debeque - upstream of Roan Creek	None	30,200	40,000	44,200	no data	32,300	no data	38,200	no data	22,900	2-5 year
Cameo - upstream of Plateau Creek	Island Acres Ponds	31,200	41,800	46,300	no data	36,000	22-25 year	39,300	40 year	23,300	2-5 year
Palisade - downstream of Plateau Cr.	Corn Lake 30 Road Pond	32,900	44,400	49,300	61,000	41,010	22-25 year	44,310	40 year	27,400	2-5 year
Fruita - below Gunnison R.	Duke Lake Connected Lakes	50,600	73,100	83,700	111,400	62,100	22-25 year	69,800	40 year	44,300	2-5 year

This agreed upon requirement for berming raised questions among the Wildlife Commission, CDOW administrators, and the public about the potential cost of constructing berms along/around floodplain ponds. I contacted Bill Elmblad (CDOW) and requested that he seek cost estimate for these potential construction costs. He obtained a cursory estimate from a local gravel/construction company that formed the basis for cost estimates for constructing and reinforcing berms with rip-rap (Appendix D). To expand these cost estimates, costs were summarized and described as follows:

- Cost to build dike one foot high, 15 feet wide on top, and 1,000 feet long ..... $ 9,000
- Cost to rip-rap dike one foot high on just the outside face at a thickness of 1.5 feet ..... $ 4,800
- For any dike of additional height, multiply above costs by each additional one foot increment, e.g.:
  - -- 3 foot high dike, ... $27,000
  - -- rip-rapped its entire length $14,400
  - -- total $41,400

It appears from Elmblad's example using Corn Lake (Appendix E), which was based on the review by CWCB (1995), that the entire pond perimeter would not have to be rip-rapped; only those portions of the dike affected by flowing water require rip-rap. CWCB (1995) provides suggested specifications for dike slopes and dimensions, but I am uncertain how these compare to FEMA standards.

Corn Lake is approximately 10 surface acres. I used an estimated shoreline development factor of 1.2 to calculate a shoreline length of 2,807 feet. From the CWCB report it is estimated that to protect Corn Lake for up to a 50 yr flood would require a 2,800 foot long levee system averaging four feet in height (it would still be 15 feet wide on top). Based on the flowing water criterion, Elmblad estimated that a 1,000 foot segment of the dike would have to be rip-rapped to prevent erosion. Based on this information, it would cost an estimated $100,800 to install the dike and $19,200 to protect a segment of the dike from flowing water for an estimated total cost of $120,000. Note that these cost estimates do not include installation of a screen to control fish escapement. Using estimated shoreline development factors for the eight floodplain ponds for which CDOW prepared LMPs (Elmblad et al. 1994), I calculated an estimated total cost to construct berms for these public waters (Table 7).

I took this exercise one step further by estimating the potential cost to construct berms for the privately owned pond resource within the 50 year floodplain of the Grand Valley from the town of Palisade downstream to Loma. By categorizing ponds based on surface area, < 1 acre, 1-10 acres, 10-20 acres and ponds over 20 acres, and using an overall estimate of 1.5 for shoreline development, I calculated a weighted mean shoreline length for each category of ponds and used this value multiplied by the number of ponds in each size category to estimate total shoreline length. Again, berm costs were based on an average height of 4 feet, with 1/2 of the berm length being rip-rapped to prevent erosion (Table 8). Although this exercise provides a "what-if" glimpse of potential cost of berming ponds, berm construction and rip-rap in the floodplain is generally strongly discouraged (T. Ireland, U.S. Fish and Wildlife Service, personal communication).

Table 7. Estimated cost to construct berms averaging four feet in height and to rip-rap portions of berms facing or adjacent to current (presumably one-half of the berm's length) for public ponds currently managed as sport fisheries by the Colorado Division of Wildlife. Shoreline development factors estimated visually from diagrams found in Elmblad and Satterfield (1995).

Pond name	Surface acres	Shoreline development factor	Estimated shoreline length (ft)	Estimates costs	
				4-ft berm	Rip-rap
Connected Lake - Lower	8	2.0	4,181	$ 150,516	$ 40,138
Connected Lake - Upper	55	2.0	10,971	$ 394,956	$ 105,322
Corn Lake	10	1.2	2,807	$ 101,052	$ 26,947
Duke Lake	6	2.0	3,624	$ 130,464	$ 34,790
Island Acres Pond	1	1.2	888	$ 31,968	$ 8,525
Parachute Pond	10	1.2	2,807	$ 101,052	$ 26,947
Rifle I-70 Pond	5	1.2	1,985	$ 71,460	$ 19,056
Thirty Road Pond	45	1.8	8,931	$ 321,526	$ 85,738
Total costs	140		36,194	$ 1,302,984	$ 347,463
Grand total cost: berm and rip-rap				**$1,650,447**	

Table 8. Estimated costs to isolate privately owned ponds using dikes averaging 4 feet in height and rip-rapped for one-half of their length within the 50 year floodplain of the Colorado River in the Grand Valley from Palisade to Loma. An overall estimated shoreline development factor of 1.5 was used to calculate shoreline length based on pond surface area.

Size range of ponds in acres	Ponds in 50 yr floodplain		Weighted mean shoreline length in feet	Estimated total shoreline length for all ponds	Estimated costs for construction	
	Number	Percent			4-foot high dike	Rip-rap for 1/2 of dike length
< 1	83	53%	550	45,650	$1,643,400	$ 438,240
1-10	65	42%	1,970	128,050	$4,609,800	$1,229,280
10-20	7	4.5%	4,362	30,534	$1,099,224	$ 293,126
20+	1	0.5%	5,084	5,084	$ 183,024	$ 48,806
Total/mean	156	100%	1,341	209,318	$7,535,448	$2,009,452
Grand total: dike and rip-rap					**$9,544,900**	

Job No. 3: Fish Species Composition/Biomass in Reclamation/Restoration Sites

Job Objective: To identify interrelationships between combinations of native and nonnative fish species and physical habitat characteristics in reclaimed waters to establish predictors of potential fish production for native fish habitat or sport fishery restoration.

Segment Objective 1: Examine 1996 pond reclamation sites to assess feasibility of using sampling transects to estimate fish biomass in ponds that are pumped dry as opposed to treated with rotenone.

INTRODUCTION

During the earlier drafts of the Procedures (Appendix A), there was a link between the stocking of floodplain ponds with nonnative sport fishes and a concomitant requisite to remove nonnative fishes from floodplain ponds. In otherwords, on an acre-per-acre basis, ponds had to be reclaimed to accrue "credits" in the form of surface acres before stocking of floodplain ponds with warmwater fishes could proceed. Because of the web of administration implicating the private sector, this scenario was dropped during the final development of the Procedures, but many in the Recovery Program for endangered fishes and many among the public still view all nonnative fish control efforts as one "program".

Functionally, now, there are three distinct fronts of nonnative fish control to consider: 1) preventive control via the provisions and constraints found in the Procedures (Appendix A), 2) active removal of nonnative fishes from floodplain ponds through chemical treatment or draining by pumping, and 3) active removal of nonnative fishes in mainstem riverine habitat via mechanical means. This Job Objective deals with the floodplain pond nonnative fish aspect of controlling nonnative fish and associated issues. One of the components of pond reclamation was gaining access to floodplain ponds on private land. This involved developing a "menu" of incentives to facilitate entering private land and complete fish surveys and possibly fish reclamations in selected floodplain ponds.

Among the issues associated with reclamation efforts in floodplain ponds was the contention by some anglers in public meetings that any nonnative fish control would prove futile as angry or determined anglers retaliated to removal of valued sport fish from ponds by illicitly reintroducing or introducing to new areas, fish species removed as part of the nonnative fish control program. As these discussions continued, the perception was that it was not difficult for individuals to acquire warmwater sport fish by angling and subsequently transport and restock traditional warmwater fisheries. Illicit transfer of various warmwater fish species has already occurred in western Colorado and appears to warrant immediate attention.

METHODS AND MATERIALS

Within the timeframe of this Segment, I authored/co-authored three Scopes of Work under the Recovery Plan for Endangered Fish to facilitate progress and funding for the pond reclamation portion of the nonnative fish control (Table 1). I also participated in the review and development of ideas for providing incentives for accessing private land to sample, reclaim and/or prevent escapement of fish populations. In addition, discussions with T. Nesler, CDOW's statewide native fish biologist, about illicit introductions resulted in a preliminary draft for documenting the extent of illicit stocking of nonnative sport fish, summarizing the concerns, and suggesting strategies to enforce existing regulations and combat further illegal fish transplants in western Colorado. Note that the following discourse on illicit fish introduction was intended to be adapted to an information brochure format and is written somewhat in that style.

RESULTS AND DISCUSSION

Pond Reclamation Scopes of Work

The first scope of work prepared for the Recovery Program details the ambitions and methodology of the pond reclamation nonnative fish control strategy and includes the funding request for the ISMP evaluation outlined in Appendix C (Appendix G). The Second Scope of Work detailed the pumping of two "pilot" ponds for demonstration purposes -- this project is discussed below in Segment Objective 2 of this section. The third Scope of Work (Appendix H) redefines the annual goals for the pond reclamation strategy for nonnative fish control and request funding for the second year sampling described in Appendix C. All Scope of Work have been funded by the Recovery Program.

Illicit Transfers of Nonnative Warmwater Sport Fish in Western Colorado

Illicit transfers of nonnative warmwater sport fishes among reservoirs in western Colorado may have reached epidemic proportion just as the Colorado Division of Wildlife, in cooperation with the states of Utah and Wyoming, and the U.S. Fish and Wildlife Service have developed the Procedures (Appendix A). The Procedures represent a commitment and binding agreement to oversee and regulate all (public and private) introductions and stocking of nonnative fish species in the Colorado River Basin from Glen Canyon Dam on Lake Powell upstream to its headwaters along the Continental Divide, excluding the San Juan Basin which includes portions of the Four Corners region.

Based on the most recent information, illicit transfers have resulted in confirmed catches or established populations of nonnative warm and cool water sport fishes in many reservoirs in western Colorado (Table 9). The unauthorized transfer of live fishes from one body of water to another in Colorado is illegal. By regulation, "...any fish to be released must be released into the same body of water where it was taken.". Once you place a fish on a stringer, in a container or in a live well, it becomes part of you daily bag and possession limit. Even if you are involved in a fishing tournament and intend to release your catch, your only option is to return it to the water where it was caught.

These regulations are intended to preclude the subsequent release of live fishes, inadvertently or intentionally, into other waters where they are not intended to be part of the Division of Wildlife's overall fishery management strategy.

In addition to being illegal, the unauthorized transfer of nonnative fishes pose serious threats to established fisheries maintained by natural reproduction or by stocking from the State's hatcheries. Illicit introductions also pose serious threats to native fishes through predation and competition and often frustrate efforts to recover endangered fishes. Adult northern pike and walleye, for example, rely almost exclusively on fish as food and exhibit a strong preference for soft-rayed prey which, in western Colorado, often means suckers, both native and nonnative, and salmonids. In the absence of these soft-rayed species, these predators will consume spiny-rayed fishes such as bluegill, perch, and crappie.

Predation by nonnative fish species on native fishes raises concern about native fish preservation and recovery of endangered species. Predation on trout may mean fewer trout for trout anglers, or that more trout must be stocked to offset these predation losses. Predators consuming spiny-rayed species can affect some anglers directly by reducing catches of panfish, or by resulting in competition for these important prey of bass.

Table 9. Summary of documented illicit transfer of nonnative warmwater fish species in western Colorado in 1980s and 1990s.

Reservoir or pond	Fish species		Approximate year of illicit transfer(s)	Potential source waters(s)
	Confirmed catch	Established population		
Connected Lakes	Walleye	Doubtful	Early 1990s	Rifle Gap Reservoir
Crawford	Walleye	Unknown	Early 1990s	Rifle Gap Reservoir
	Northern pike	Unknown		Harvey Gap, Paonia reservoirs
	Black crappie	Yes		Harvey Gap Reservoir
Harvey Gap	Northern pike	Yes	Late 1980s	Rio Blanco Reservoir, Yampa River
Juniata	Walleye	Yes	Early 1990s	Rifle Gap Reservoir
Kenney	Black crappie	Yes	Mid 1980s	Rio Blanco Reservoir
	Northern pike	No		
	Largemouth bass	No		
	Bluegill	No		
McPhee	Northern pike	Unknown	Early 1990s	Narraguinup, Vallecito reservoirs
	Walleye			Narraguinup Reservoir
Rifle Gap	Black crappie	Yes	Early 1990s	Harvey Gap, Rio Blanco reservoirs
	Northern pike			
	Yellow perch			Crawford Reservoir
Stagecoach	Northern pike	Yes	Early 1990s	Yampa River
Vega	Northern pike	Unknown	Mid 1990s	Harvey Gap Reservoir

The Division of Wildlife makes every attempt to listen to all angling interests in developing its management plans for specific waters and strives for balance among the various sport fishes on both biological and recreational bases. However, not all species are slated to be managed for every individual interest. Yet there remains a challenging balancing act that is increasingly difficult given the growing interest in warmwater angling opportunity, a greater emphasis on the non-trout native fishes, and the complications of reduced trout production by the State's fish hatcheries.

Those responsible for illicit introductions act selfishly, ignoring the potential damage to the native or sport fish resources of the State in favor of personal satisfaction and preference. In a few instances, a fishery for a warmwater species has resulted due to its illicit introduction. Inevitably, however, the establishment of

this species will be at the expense of another sport fish in that reservoir on in a downstream reservoir. While this replacement of one sport fish with another may not offend all anglers, these actions become even more serious when the illicit introduction results in nonnative predators escaping into riverine habitat where they become detrimental to native or endangered fish species.

The Colorado Division of Wildlife is facing even greater challenges in its fish management responsibilities as it tries to maintain a balance with its license buying public and its other constituents who wish to see all aquatic wildlife afforded management attention and protection. It is in this greater arena of public concern for Colorado's unique and magnificent aquatic resources where the ethics associated with illicit introductions will become problematic for all of the State's anglers. These illegal fish transfers are indefensible in any concept or framework of aquatic conservation and they can pose a serious threat to natural ecosystems.

Eventually, if these illegal, transfers do not stop, opposition to the management of nonnative predators may result as concern about their uncontrolled spread increases among anglers and non-anglers alike. The illegal transfer of fishes creates an image blemish for anglers which may, in the long run, begin to erode broad public support for angling recreation in general. If the problem of illicit introductions continues, or worse, becomes more widespread, the Colorado Division of Wildlife may be faced with implementing even stricter measures to curtail this reprehensible activity.

Action by CDOW to combat illicit fish introductions

Increasingly, these unauthorized fish transfers have become intolerable in the State's overall fishery management strategy. In the past, the Division of Wildlife has provided information to anglers directing them to the angling opportunities provided by fisheries which have resulted from illicit introductions. However, more than ever, it is highly inconsistent with CDOW's missions to manage both sport fish and native fishes to continue to promote any illicitly or inadvertently (via escapement or erroneous stocking) established fisheries, no matter how high profile and popular they may become.

New strategies must be employed to combat these illegal transfers of nonnative sport fish. These actions may include the suspension of bag and possession limits for fish species illicitly introduced into public waters. For some waters, it may become necessary to reduce the numbers of illicitly introduced predators to minimize their harmful effects on sport or native fishes. Additional enforcement efforts in key areas to combat nonnative fish stocking may require setting up random road or boat ramp blocks, similar to hunter check stations, to inspect boat live-wells and other receptacles that might be used to transport live fish. The message about live transport of fish being illegal must be delivered to the public. This concept alone may reduce non premeditated fish transfers whereby fish are transported live, and released elsewhere to avoid or minimize cleaning.

In highly sensitive areas, complete eradication of existing fish populations may be required to eliminate the illegally introduced fish species. This action, involving considerable expense to remove the existing fish population, could be followed up with restocking of those fish species that are part of the water's fishery management plan. If an illicit introduction reinfests the newly reclaimed water, eradication and restocking may have to be repeated. These management activities place additional strain on management dollars, most of which comes from license revenues, which might have been used for other purposes.

CDOW should also clarify within the angler education programs the meaning of resource "conservation". Potential is great for angler confusion as conservation ethics clash in situations where the Master Angler Award program recognizes catch-and-release of "trophy-sized" fishes (Knox 1997) originating from illicit introduction, or established within Critical Habitat via escapement from impoundments. Would

the State recognize individual anglers for the catch-and-release of "trophy" northern pike, channel catfish, smallmouth bass, largemouth bass, walleye or any other sport fish taken within Critical Habitat of endangered fishes in western Colorado? Furthermore, are northern pike, walleye, crappie, or any of the fish species more commonly spread via illicit stocking activity and known to have come from a body of water where the species has not been stocked or is not part of a traditional or approved management stocking scheme eligible for a Master Angler certification and recognition?

It is highly likely that instances of conflicting definitions of "conservation" and "ethics" championed by the State, will result as some CDOW employees continue efforts to explain and justify to the public endeavors to combat nonnative fish species. Applying a native species conservation ethic conflicts, in some situations, with other CDOW employees espousing catch-and-release of trophy sized fishes as the pinnacle demonstrating the best of angler ethics and resource "conservation"

Lastly, it appears important for CDOW to empower its biologists and other employees involved in fish sampling in western Colorado to remove and/or destroy any fish captured in public bodies of water where the fish has gained access outside of CDOWs prescribed management. All employees working in particular waters should be versed in the approved and or established management for particular bodies of water and authorized to at least remove, and subsequently transfer or destroy any fish species not intended to be present in the water body as part of the approved management plan or scenario. Furthermore, this activity should become routine for any of the fish species listed as "prohibited" by the Procedures (Appendix A).

Action by the Public

The public can help combat illicit introductions and the threat they pose to fishery resources. Try to increase your understanding of fishery management strategies and goals in the areas where you fish. When the opportunity arises, discuss this information with you fellow angler or other contacts. This knowledge can be gained by attending Angler's Roundtable meetings in you region. Other information is also available at Colorado Division of Wildlife Service Centers located in the larger towns of western Colorado.

If you observe, or are otherwise aware of, an illicit transfer in progress, contact your local District Wildlife Manager. If you cannot reach your local wildlife officer, call the State Patrol of Sheriff's office -- the dispatchers know which wildlife officers are on duty and capable of responding. Other options include Colorado's Operation Game Thief 1(800)-332-4155 and the nationwide number, 1 (800)-800-9273 for reporting a violation from out-of-state.

The future of fishery management for many of the species we enjoy today and the conservation of all the State's aquatic wildlife has become an important issue with the entire public. Illicit introduction of fishes poses a threat to these resources that can be overcome only if we work together to protect and preserve the State's aquatic ecosystems.

Segment Objective 2: Estimate fish biomass by species, if feasible, in ponds that are pumped dry in 1996 to remove nonnative fishes along the Colorado and/or Gunnison rivers.

INTRODUCTION

During earlier discussions about nonnative fish control, there was a suggestion from K. Kanda, Colorado Department of Natural Resources on 1 Sept 95 to perform a pilot project to reclaim the existing fish population from a public floodplain pond and to reestablish a warmwater sport fishery under the guidelines of

the Procedures. This activity was intended to demonstrate that removal of fishes from floodplain ponds could be performed safely and successfully and that the State would reestablish sport fisheries for warmwater fish species that were possibly better than that offered by the existing fish population. As this goal to perform a pilot demonstration progressed, it was decided that there would be two demonstration projects, one in the floodplain of the Colorado River and one along the Gunnison River.

As efforts to accomplish this demonstration within a short timeframe proceeded, it became evident that reclaiming public fisheries was out of the question from a public relations standpoint. There was also considerable debate among some participants of the recovery program about the merits of reclaiming ponds in different portions of the floodplain. Some opinions held that those ponds which reconnected with the river more frequently posed a more imminent threat of contributing nonnative fishes to the mainstem riverine habitats (ponds in the 0-10 year floodplain), therefore, any expanditures for reclaiming fish population within Critical Habitat should be spent on these ponds. Conversely, other perspectives believed that by proceeding with reclamation of ponds above the more frequently flooded portions of the floodplain, i.e. above the 10 year floodplain, that the treatment would have a more lasting effect since it was less likely to be reinvaded by nonnatives since it presumably would less frequently reconnect with the river during high flows, therefore, this was a better investment toward recovery of endangered fishes.

As efforts to identify ponds for the pilot reclamation demonstration continued, the issue of fish prey for migratory and resident birds became an issue to the extent that the Wildlife Commission in approving the Stocking Procedures in September, 1996, prescribed that this potential consequence of nonnative fish control (the reduction of prey for fish-eating birds) be mitigated if necessary. This issue arose for 30-Road Pond, a public pond owned by U.S. Bureau of Reclamation that lacked a recognized public fishery. Despite the absence of the fishery, several issues including recent planting of vegetation that might dry-up, potentially deleterious levels of selenium, nesting and resting site for migratory birds, and for migratory birds themselves. In the end, it was determined that performing the fish removals on private land was most feasible given the array of concerns for public resources and there was not specific expectation to follow-up with development and establishment of a public sport fishery. Time passed as these various concerns were considered making it unlikely that the permitting process for application of rotenone (Appendix G) could be completed within the timeframe of the project.

METHODS AND MATERIALS

I prepared a Scope of Work to fund the reclamation of two ponds. This proposal specified that the ponds would be reclaimed by draining of the ponds by pumping as described in Appendix F. The sum of funds supplied to this project was $84,000. The pond reclaimed by CDOW on the Gunnison River was Delta Gravel Pit #1 owned by Corn Construction Company near Delta. The pond reclaimed on the Colorado River was 22 3/4 Road Pond owned by Grand Junction Pipe and Supply Company. I inspected the pond at Delta on 19 Dec 96, after it had been drained. I inspected the pond on the Colorado on 5 Feb 97, prior to draining. In addition, in June 1997, I reviewed the draft Environmental Assessment for the overall floodplain pond reclamation project being developed jointly between USFWS (D. Wydoski, Denver) and CDOW (A. Martinez, Grand Junction) and provided written comments.

RESULTS AND DISCUSSION

Because of timing and lack of appropriate equipment, no estimates of fish biomass in either pond was accomplished. Details available about the reclamation process, fish species present and comments about the relative abundance of fishes are given in summary reports by CDOW biologist S. Hebein and B. Elmblad (Appendix I). The first strategy that I would explore, however, to quantify fish species composition, size structure and abundance would be the use of transect nets as described by Johnson et al. (1988).

An reference seemingly pertinent to the waterfowl/fish-eating bird habitat issues is found in Bouffard and Hanson (1995). I discussed the potential implications of the data and recommendations found in this reference with CDOW Habitat Biologist J. Toolen. It appears that the case could be made that it would be beneficial for bird species diversity and reproduction success to have floodplain aquatic habitats of varying sizes that both contain fish and are fishless. This information was forwarded to D. Wydoski (USFWS) for incorporation into the floodplain Environmental Assessment.

Job No. 4: Mainstem Removal of Nonnative Fishes to Benefit Native Fishes

Job Objective: To estimate comparative removal rates of different strategies targeting reductions in numbers and biomass of selected nonnative fish species in riverine and floodplain habitats.

Segment Objective 1: Review proposals for removal of nonnative fishes from mainstem riverine habitats.

INTRODUCTION

Job No. 1 and 2 dealt with the implications of the Procedures including their preventive intent in controlling nonnative fish impacts. Job No. 3 was involved with the active control measure on pond reclamation to remove and reduce impacts of nonnative fish species from Critical Habitat for the endangered fishes. Job No. 4 deals with the third component of nonnative fish control in western Colorado -- mainstem removal of nonnative fishes to reduce deleterious impact to endangered and other native fishes. The Segment Objective for this Job fit the workload as several measures to address nonnative fish control in rivers were reviewed.

METHODS AND MATERIALS

Written comments were supplied for the following proposals/documents pertaining to the issue of nonnative fish control in western Colorado rivers:

- Comments on Nonnative fishes in the upper Colorado River Basin and a strategic plan for their control (Tyus and Saunders 1996) including a compilation of comments by other CDOW administrator and biologists.
- Proposal by CDOW to liberalize bag limits for nonnative sport fish within mainstem river reaches within Critical Habitat.
- An educational flyer prepared by CDOW with funding from the Recovery Program to inform anglers about the rationale for nonnative fish control, answers to questions about specific fish removal programs, and a discussion of warmwater fishing opportunities in western Colorado.
- Three proposals from the Recovery Program including removal of fishes from ponds reconnected to the mainstem Colorado River to restore floodplain habitat, a proposal to remove channel catfish from the Yampa River within Dinosaur National Monument, and a proposal to remove nonnative fishes from the Green River, Utah,within the vicinity of Old Charlie Wash.

RESULTS AND DISCUSSION

My comments on Nonnative fishes in the upper Colorado River Basin and a strategic plan for their control (Tyus and Saunders 1996) are given in Appendix J. Tyus and Saunders (1996) contended that bag limits for riverine population of nonnative sport fish could be liberalized in Colorado's western rivers to facilitate increased angler harvest of predatory species. Furthermore, the Colorado Water Conservation Board passed a resolution in July, 1996 that included a recommendation to remove bag limits on nonnative sport fishes within Critical Habitat. My comments on the removal of bag and possession limits for nonnative sport fish within Critical Habitat in western Colorado are given in Appendix K. During discussions regarding the bag and possession limit removal before the Wildlife Commission, my research project was committed to provide an evaluation of the lifting of bag limits on nonnative warmwater sport fishes and resulting benefits to endangered fishes (Malmsbury 1997). The finalized brochure on nonnative fish control strategies and warmwater fisheries in western Colorado is given in Appendix L.

Job No. 5: Native/Nonnative Fish Trophic Economic in Riverine Habitats

Job Objective: To estimate trophic impacts of predation by selected nonnative fish fishes and size structures on selected native fishes under varying programs of nonnative fish control and floodplain habitat restoration.

Segment Objective 1: No evaluations scheduled under this Job during this segment.

INTRODUCTION

An approach that will be tested under this Job will be the use of stable isotope analysis (SIA) for food web analysis in the Colorado and Yampa rivers. Stable isotopes represent different atomic weights (neutrons) of elements. The elements C, N, S, H, and O all have more than one isotope. Isotopic composition of natural material can be measured with great precision using an isotope ratio mass spectrometer. The mass spectrometer measures the ratio of light and heavy isotopes in a sample and compares this value to a standard (Peterson and Fry 1987, Lajtha and Michener 1996).

Stable isotopes are useful in trophic studies of food webs because the isotopes move with little or predictable alteration in food chains (Angradi 1994). Typically, the ratio of $^{13}C/^{12}C$ is used to identify plant source (habitat-based food dependencies) consumed while the ratio of $^{15}N/^{14}N$ is used to delineate trophic position of an organism or differences in the lengths of food chains (France and Steedman 1996, Michener and Schell 1996). Stable isotope ratios reflect the C and N assimilated by organisms rather than simply what was consumed by an organism (Angradi 1994, Rosenfeld and Roff 1992). Because stable isotopes reflect material assimilated over a period of weeks or months, they may help overcome several shortcomings of traditional food habits investigations such as empty stomachs, regurgitated contents, unidentifiable remains of food items, rapid digestion of key diet components or seasonal shifts in food preference or availability (France and Steedman 1994).

The use of stable isotopes to track energy provenance in food webs relies on there being distinct isotopic differences between the sources of material in the environment (France and Steedman 1994, Lajtha and Michener 1996, Peterson and Fry 1987). Recent literature has debated the utility and accuracy of the stable isotope techniques for application in lotic environments since the origins and pathways for assimilating carbon and nitrogen through the foodweb may not be as distinct as in lentic environments (Doucett et al. 1996, France 1996). However, this techniques has been applied in the lower Colorado River Basin and was found to distinguish between four bases of aquatic secondary production including upland vegetation, riparian

vegetation, reservoir plankton, and benthic algae (Angradi 1994). The stable isotope methodology will hopefully prove useful under this Job to identify food web pathways among nonnative piscivores and native fishes.

A component was included in a FY 96-97 contract with Colorado State University (Dr. Brett Johnson) to provide a sampling schedule for collection of samples and tissues for preliminary evaluation of the stable isotope technique. This item in this contract simply requested a preliminary schedule for sample collection on the Colorado and Yampa river. The lack of funds to carry out this work on a large scale in either FY 96-97 or 97-98 made development of sampling schedule impractical, however, a description of techniques and a list of references was provided by Dr. Johnson (CSU). However, a smaller scale investigation of this techniques for food components within the Colorado River near Grand Junction is planned for FY 97-98. The use of nonlethal tissue sampling for fish species listed as species of special concern in the river, roundtail chub *Gila robusta*, flannelmouth sucker *Catostomus latipinnis* and bluehead sucker *Catostomus discobolus*, similar to that employed for collecting tissues for genetic analysis, will be employed if feasible. In addition to exploring the stable isotope methodology, I had a discussion with Dr. Dave Rowan, Colorado State University, about bioenergetics applications for Colorado's aquatic food webs using Cesium-137, a globally dispersed radio tracer (Rowan and Rasmussen 1996). This methodology might also offer potential for examining food web pathways in western Colorado rivers.

LITERATURE CITED

Angradi, T. R. 1994. Trophic linkages in the lower Colorado River: multiple stable isotope evidence. Journal of the North American Benthological Society 13:479-495.

Bouffard, S. H., and M. A. Hanson. 1997. Fish in waterfowl marshes: waterfowl manager's perspective. Wildlife Society Bulletin 25:146-157.

(CDOW) Colorado Division of Wildlife, Utah Division of Wildlife Resources, Wyoming Game and Fish Department, and U.S. Fish and Wildlife Service. 1996. Procedures for stocking nonnative fish species in the upper Colorado River Basin. U.S. Department of Interior, Fish and Wildlife Service, Denver, Colorado. 25 p.

(CWCB) Colorado Water Conservation Board. 1995. Colorado River flood risk analyses at Connected Lakes, Duke Lake, 30 Road Pond, Corn Lake, Island Acres Ponds, Parachute Pond, Rifle Rest Area Pond for the Colorado Division of Wildlife. The Colorado Water Conservation Board, Denver.

(CWCB) Colorado Water Conservation Board. 1995a. Floodplain information report, Volume 3: Gunnison River mainstem from Delta to its mouth. Prepared for The Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin. The Colorado Water Conservation Board, Denver.

(CWCB) Colorado Water Conservation Board. 1995b. Floodplain information report, Volume 4: Colorado River mainstem from Rifle to the Utah stateline. Prepared for The Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin. The Colorado Water Conservation Board, Denver.

Doucett, R. R., D. R. Barton, K. R. A. Guiguer, G. Power, and R. J. Drimmie. Comment: critical examination of stable isotope analysis as a means for tracing carbon pathways in stream ecosystems. Canadian Journal of Fisheries and Aquatic Sciences 53:1913-1915.

Elmblad, W., C. Sealing, C. Carothers, and J. Satterfield. 1994. Formal stocking proposals: Lake Management Plans for northwestern Colorado. Colorado Division of Wildlife, Denver. 52 p., plus appendices.

Federal Register. 1994. Part III, Department of the Interior, Fish and Wildlife Service, 50 CFR Part 17, endangered and threatened wildlife and plants: determination of critical habitat for four Colorado River endangered fishes. Final Rule.

(FEMA) Federal Emergency Management Agency. 1992. Flood insurance study: Mesa County, Colorado, unincorporated areas. Natural and Technological Hazards Division, Denver, Colorado. 38 pp. plus figures.

France, R. L. 1996. Carbon-13 conundrums:limitations and cautions in the use of stable isotope analysis in stream ecotonal research. Canadian Journal of Fisheries and Aquatic Sciences 53:1916-1919.

France, R., and R. Steedman. 1996. Transactions of the American Fisheries Society 125:512-518.

Hydrosphere. 1993. Yampa River Basin: alternatives feasibility study. Final Report. Colorado River Water Conservation District, Glenwood Springs, Colorado.

Hydrosphere. 1995. Yampa River Basin recommended alternative: detailed feasibility study. Final Report. Colorado River Water Conservation District, Glenwood Springs, Colorado.

Johnson, B. M., R. A. Stein, and R. F. Carline. 1988. Use of a quadrat rotenone technique and bioenergetics modeling to evaluate prey availability to stocked piscivores. Transaction of the American Fishery Society 117:127-141.

Knox, R. 1997. Great catch: enter the Master Angler Award Program. 1997 Fishing Guide: A Special Issue of Colorado Outdoors No. 6: 38-40.

Lajtha, K., and R. H. Michener. 1996. Stable isotopes in ecology and environmental sciences. Blackwell Scientific Publications, Oxford.

Malmsbury, T. 1997. Commission removes bag limits for warm water fish on four west slope rivers. Tracking Wildlife 8:1.

Martinez, P. J. 1986. White River Taylor Draw Project: pre- and postimpoundment fish community investigations. Contract Number 5281-X Final Report. Colorado Division of Wildlife, Grand Junction. 121 pp.

Martinez, P. J. 1996. Coldwater reservoir ecology. Colorado Division of Wildlife, Federal Aid in Fish and Wildlife Restoration Project F-242R-3, Job Progress Report, Fort Collins. 143 pp.

Martinez, P. J., T. E. Chart, M. A. Trammell, J. G. Wullschleger, and E. P. Bergersen. 1995. Fish species composition before and after construction of a main stem reservoir on the White River, Colorado. Environmental Biology of Fishes 40:227-239.

McAda, C. 1989. Evaluation of the Interagency Standardized Monitoring Program. Fish and Wildlife Service, Grand Junction, Colorado. 52 pp.

McAda, C. W., J. W. Bates, J. S. Cranney, T. E. Chart, W. R. Elmblad, and T. P. Nesler. 1994. Interagency Standardized Monitoring Program: summary of results, 1986-1992. Recovery Implementation Program for the Endangered Fishes of the Upper Colorado River Basin Final Report. U.S. Fish and Wildlife Service, Denver, Colorado. 73 pp. plus appendices.

McAda, C. W., W. R. Elmblad, T. E. Chart, K. S. Day, and M. A. Trammell. 1995. Interagency Standardized Monitoring Program: summary of results, 1994. Recovery Implementation Program for the Endangered Fishes of the Upper Colorado River Basin Annual Report. U.S. Fish and Wildlife Service, Denver, Colorado. 17 pp. plus appendices.

McConnell, W. J., E. P. Bergersen, and K. L. Williamson. 1984. Habitat suitability index models: a low effort system for planned coolwater and coldwater reservoirs (revised). U. S. Fish and Wildlife Service FWS/OBS-82/10.3A. 62 pp.

Michener, R. H., and D. M. Schell. Stable isotope ratios as tracers in marine aquatic food webs. Pages 138-157 *in* K. Lajtha and R. H. Michener, editors. Stable Isotopes in Ecology and Environmental Science. Blackwell Scientific Publications, Oxford.

Miller, W. J., and D. Laiho. 1997. Upper Colorado River Basin Recovery Implementation Program: feasibility evaluation of non-native fish control structures. Miller Ecological Consultants, Inc. Final Report. Colorado River Water Conservation District, Glenwood Springs, Colorado.

Miller, W. J., and D. E. Rees. 1995. Survey of fish, benthic invertebrates, and habitat in Elkhead Creek near Craig, Colorado. Miller Ecological Consultants, Inc. Draft Report. Ayers Associates, Fort Collins, Colorado.

Mitchell, M. J. 1995. Impact of the procedures for stocking nonnative fish species in the Upper Colorado River Basin on private landowners and the commercial aquaculture industry. Inventory of public and private ponds along the upper Colorado and lower Gunnison Rivers in Colorado. Colorado Department of Agriculture 95-0021. Queen of the River Fish Company, Inc., longmont, Colorado. 38 pp. plus appendices.

Peterson, B. J., and B. Fry. 1987. Stable isotopes in ecosystem studies. Annual Review of Ecology and Systematics 18:293-320.

Rosenfeld, J. S., and J. C. Roff. 1992. Examination of the carbon base in southern Ontario streams using stable isotopes. Journal of the North American Benthological Society 11:1-10.

Rowan, D. J., and J. B. Rasmussen. 1996. Measuring the bioenergetic cost of fish activity in situ using a globally dispersed radio tracer ($_{137}Cs$). Canadian Journal of Fisheries and Aquatic Sciences 53:734-745.

Tyus, H. M., and J. F. Saunders, III. 1996. Nonnative fishes in the upper Colorado River Basin and a strategic plan for their control. Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin. Final Report. U.S. Fish and Wildlife Service, Denver, Colorado. 85 p. plus appendices.

(USDI) United States Department of the Interior. 1987. Recovery implementation program for endangered fish species in the upper Colorado River Basin. Final. Fish and Wildlife Service, Region 6, Denver, Colorado.

(USDI) United States Department of the Interior. 1995. Recovery implementation program for endangered fish species in the upper Colorado River Basin. Fiscal Year 1996 Program Guidance. Fish and Wildlife Service, Region 6, Denver, Colorado.

(USDI) United States Department of the Interior. 1996. Recovery implementation program for endangered fish species in the upper Colorado River Basin. Fiscal Year 1997 Program Guidance. Fish and Wildlife Service, Region 6, Denver, Colorado.

(USDI) United States Department of the Interior. 1997. Recovery implementation program for endangered fish species in the upper Colorado River Basin. Fiscal Year 1998 Program Guidance. Fish and Wildlife Service, Region 6, Denver, Colorado.

APPENDIX A

Procedures for Stocking Nonnative Fish Species in the Upper Colorado River Basin

PROCEDURES
FOR
STOCKING NONNATIVE FISH SPECIES
IN THE
UPPER COLORADO RIVER BASIN

Colorado Division of Wildlife
Utah Division of Wildlife Resources
Wyoming Game and Fish Department
U.S. Fish and Wildlife Service

U.S. DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
DENVER, COLORADO

September 5, 1996

COOPERATIVE AGREEMENT
for
IMPLEMENTATION OF PROCEDURES
FOR STOCKING OF NONNATIVE
FISH SPECIES IN THE
UPPER COLORADO RIVER BASIN

NOV – 6 1996

1. Purpose. The razorback sucker, bonytail, humpback chub, and Colorado squawfish are considered "endangered" under the Endangered Species Act. The "Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin" was developed to recover these fish and was implemented via a Cooperative Agreement between the Secretary of the Interior, Governors of Colorado, Utah, and Wyoming and the Administrator of Western Area Power Administration on January 21-22, 1988. One of five elements of the Recovery Program includes control or management of nonnative fishes and sportfishing.

The "Procedures for Stocking Nonnative Fish Species in the Upper Colorado River Basin" have been developed cooperatively between the Fish and Wildlife Service and the States of Colorado, Utah, and Wyoming. The purpose of the Procedures is to ensure that all future stocking of nonnative fish will be consistent with recovery of the endangered fishes within the Upper Colorado River Basin. The Procedures fulfill the requirement established in the Recovery Program for the States and the Service to "develop procedures, including studies, for reviewing and for resolving disagreements with any proposed [fish] introductions into the Upper Basin".

The Fish and Wildlife Service issued a policy on June 3, 1996, for conserving species listed under the Endangered Species Act while providing for and enhancing recreational fisheries opportunities. The joint Stocking Procedures between the States of Colorado, Wyoming, and Utah work to minimize conflicts between recreational fisheries and the Endangered Species Act. The procedures will help to enhance existing fisheries, provide for additional future recreational fishing, and contribute to the recovery of the endangered Colorado River fishes.

The parties hereto agree to participate in and implement the stocking procedures as provided for in the document "Procedures for Stocking of Nonnative Fish Species in the Upper Colorado River Basin", dated September 5, 1996.

2. Involved parties.

Colorado Division of Wildlife
6060 Broadway
Denver, CO 80216

Utah Division of Wildlife Resources
1594 West North Temple
Salt Lake City, UT 84114

Wyoming Game & Fish Department
5400 Bishop Blvd.
Cheyenne, WY 82002

U.S. Fish and Wildlife Service
134 Union Blvd.
Lakewood, CO 80228

3. Geographic Scope. These Procedures and this Cooperative Agreement apply only to the Upper Colorado River Basin above Glen Canyon Dam, excluding the San Juan Subbasin. The San Juan River basin was not included because it is being covered under a separate recovery effort.

4. Term. This Cooperative Agreement shall remain in effect through the life of the Recovery Program, unless terminated per paragraph 5.

5. Amendment. This Cooperative Agreement and the Procedures may be extended, amended, or terminated by agreement of the parties, or any party may withdraw from this Cooperative Agreement upon written notice to the other parties and the Recovery Program.

6. Authorities and Responsibilities.

A. States: Will ensure that all State and private stocking of nonnative fishes in the Upper Colorado River Basin are in compliance with the Procedures. This will include, but not be limited to, enacting/clarifying appropriate regulations for stocking of public and private waters.

B. Fish and Wildlife Service: Will ensure that all stocking from federal hatcheries is in compliance with Stocking Procedures for the Upper Colorado River Basin and provide up to 40,000 catchable rainbow trout annually for stocking into public floodplain ponds.

C. Recovery Program: Will serve as a funding mechanism for components of the Procedures that contribute directly to the recovery of the endangered fishes. The Recovery Program will facilitate coordination of pond stocking and reclamation proposals with flooded bottomlands restoration and propagation plans. This is expected to include the use of some reclaimed ponds for rearing of endangered fishes as specified in the flooded bottomland and propagation programs.

7. No Delegation or Abrogation. All parties to this Cooperative Agreement recognize that they each have statutory responsibilities that cannot be delegated, and that this Cooperative Agreement does not and is not intended to abrogate any of their statutory responsibilities.

8. Consistency with Applicable Law. This Cooperative Agreement is subject to and is intended to be consistent with all applicable State and Federal laws and interstate agreements.

9. Funding Commitments. All funding commitments made by the Program are subject to approval of Congress and the Recovery Program. Funding commitments made by the States are subject to their normal approval process and funds being available. Funding commitments by the Service are subject to Congressional appropriations.

- The Recovery Program will fund commitments under this agreement subject to mutually acceptable cost sharing agreements.
- States will supply matching contributions, if any, in the form of cash and/or in-kind services including personnel, field equipment, supplies, etc.
- Implementation of some actions identified within these procedures are dependent upon scopes-of-work and funding approval by the Recovery Program. It is not the intent of the Procedures to require funding and implementation by the States and the Service without financial support of the Recovery Program. The Recovery Program will share the financial burden for activities associated with nonnative fish control.

Ralph Morgenweck
Regional Director, Region 6
Fish and Wildlife Service

John Mumma
Director
Colorado Division of Wildlife

Robert Valentine
Director
Utah Division of Wildlife Resources

John Baughman
Director
Wyoming Game & Fish Department

Department of the Interior
U.S. Fish and Wildlife Service

FINDING OF NO SIGNIFICANT IMPACT

PROCEDURES FOR STOCKING NONNATIVE FISH SPECIES IN THE UPPER COLORADO RIVER BASIN

In accordance with the National Environmental Policy Act of 1969, as amended, and the Council on Environment Quality's regulations for Implementing the Procedural Provisions of the national Environmental Policy Act (40 CFR Part 1500-1508), the Fish and Wildlife Service has determined that an Environmental Impact Statement is not required to enter into a cooperative agreement with the States of Colorado, Utah, and Wyoming, to implement stocking procedures. The Service has determined that their participation in the stocking procedures as analyzed in the attached environmental assessment does not constitute a major Federal action having a significant effect on the human environment. Impacts were evaluated using the best available data and assumptions. The following is a summary of impacts:

1. Aquatic Biological Resources: The stocking procedures will reduce the escapement of nonnative fishes into the rivers of the Colorado River Basin.

2. Recreation: The stocking procedures will increase recreational fishing opportunities above existing levels while providing increased protection for the endangered fishes. This includes 7 reservoirs with existing Lake Management Plans, and adding routine stocking for Corn Lake, Connected Lakes, Duke Lake, Juniata Reservoir, and Jerry Creek Reservoir. Additionally, all isolated public waters above the 50-year floodplain can be routinely stocked.

3. Recovery of Endangered Fishes: The stocking procedures will greatly reduce the escapement of nonnative fishes into critical habitat of the endangered fishes. This action will help to facilitate their recovery.

4. Economy and Human Environment: Limits on stocking of warmwater fishes in floodplain ponds will have some impact on the aquaculture industry. However, because most warmwater species reproduce in private ponds, annual stocking has not been required. Trout may still be stocked in any floodplain ponds and rivers above critical habitat. Largemouth bass, black crappie, bluegill, and triploid grass carp can be routinely stocked above the 50-year floodplain. These represent, other than trout, the most often stocked fish supplied by the aquaculture industry. Private ponds below the 50-year floodplain that are bermed and screened also can be stocked with these species.

The Service distributed the draft environmental assessment to various sportfishing, environmental, and water user interests. Three public meetings were held to receive public comment.

Terry Terrell

Regional Director
U.S. Fish and Wildlife Service
Denver, Colorado

10/10/96
Date

TABLE OF CONTENTS

LIST OF FIGURES

PREFACE

These procedures were developed cooperatively with the U.S. Fish and Wildlife Service and the States of Colorado, Utah, and Wyoming, based on an evaluation of various alternatives analyzed in the "Draft Environmental Assessment for Procedures for Stocking of Nonnative Fish Species in the Upper Colorado River Basin."

The Interim Procedures were implemented on a trial basis during the spring, summer, and fall of 1994 by application to Lake Management Plans (i.e., stocking proposals) that were developed for 12 ponds and reservoirs by the Colorado Division of Wildlife. A Review Team composed of biologists from the Service and the fish and wildlife agencies in Colorado, Utah, and Wyoming reviewed the Lake Management Plans, evaluated the Interim Procedures, and considered comments that were solicited from the public in mid-December, 1994. On January 31, 1995, the Region 6, Regional Director of the U.S. Fish and Wildlife Service and the Director of the Colorado Division of Wildlife met and discussed further options to allow the stocking of nonsalmonid, nonnative fishes in the 50-year floodplain. The proposed conditions were distributed to participants on various Recovery Program committees and to interested parties on March 6, 1995. On April 24-25, 1995, three independent biologists (i.e., not employed by the agencies represented on the Review Team) met with the Review Team to discuss the biological merits of the proposed conditions.

Public meetings were held: December 5, 1995, in Denver, Colorado; December 6, 1995, in Craig, Colorado; December 7, 1995, in Grand Junction, Colorado; and December 12, 1995, in Vernal, Utah. Stocking procedures being considered at that time were discussed and comments accepted. Additional alternative versions of the Procedures were prepared to address concerns identified during this early public review process.

A draft environmental assessment was released to the public for comment on April 30, 1996. This assessment evaluated a "no action" alternative and five action alternatives. Public meetings were held: May 21, 1996, in Grand Junction, Colorado; May 22, 1996, in Denver, Colorado; and May 23, 1996, in Craig, Colorado. The various alternatives were presented and public comment accepted. Written comments on the draft environmental assessment were due June 3, 1996. The final environmental assessment was published ?????. Sept 4, 19

The Fish and Wildlife Service issued a policy on June 3, 1996, for conserving species listed under the Endangered Species Act while providing for and enhancing recreational fisheries opportunities. The joint Stocking Procedures between the States of Colorado, Wyoming, and Utah work to minimize conflicts between recreational fisheries and the Endangered Species Act. The procedures will help to enhance existing fisheries, provide for additional future recreational fishing, and contribute to the recovery of the endangered Colorado River fishes.

PROCEDURES FOR STOCKING NONNATIVE FISH SPECIES in the UPPER COLORADO RIVER BASIN

I. BACKGROUND

The razorback sucker, bonytail, humpback chub, and Colorado squawfish are considered "endangered" under the Endangered Species Act (ESA). The "Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin" (Recovery Program; U.S. Fish and Wildlife Service 1987) was developed to recover these fish. One of five elements of the Recovery Program includes control or management of nonnative fishes and sportfishing.

The "Procedures for Stocking Nonnative Fish Species in the Upper Colorado River Basin" (Procedures) have been developed as a cooperative effort between the U.S. Fish and Wildlife Service (Service) and the States of Colorado, Utah, and Wyoming (States). The purpose of the Procedures is to ensure that all future stocking of nonnative fish will be consistent with recovery of the endangered fishes within the Upper Colorado River Basin (Upper Basin; Figure 1). The San Juan River basin was not included because it is being covered under a separate recovery effort.

The Procedures fulfill the requirement established in the Recovery Program for the States and the Service to "develop procedures, including studies, for reviewing and for resolving disagreements with any proposed [fish] introductions into the upper basin" (U.S. Fish and Wildlife Service 1987).

II. GENERAL INTENT OF THE PROCEDURES

1. The general intent of these procedures is to reduce the potential for negative impacts on the endangered fishes in the Upper Colorado River Basin (Upper Basin) and to ensure that their recovery is not inhibited by controlling stocking and escapement of stocked nonnative fishes.

2. The Procedures categorize all nonnative fish stocking in the Upper Basin into four sections:

   A. When stocking is acceptable on a routine basis (see Section IV.).

   B. When stocking will be reviewed on a case-by-case basis (see Section V.).

   C. When stocking proposals involve introductions of new fish species into the Upper Basin (see Section VI).

   D. When stocking of nonnative fishes in the Upper Colorado River Basin is unacceptable (see Section VII).

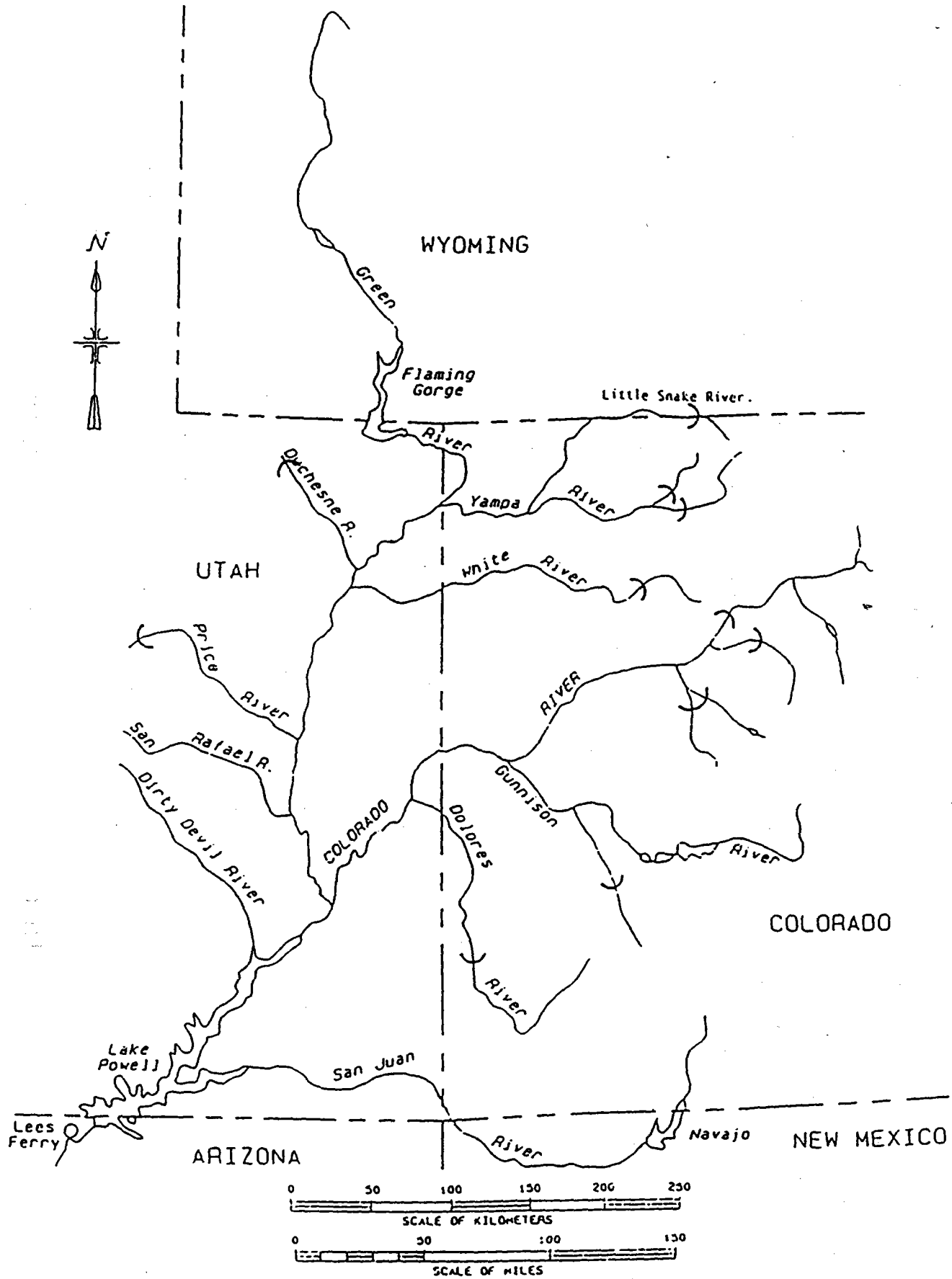


Figure 1. Approximate location of 6500-foot elevation above mean sea level on tributaries within the upper Colorado River basin (see Appendix D for township/range descriptions).

III. PRINCIPLES RELATED TO THE PROCEDURES

1. The Procedures are intended to meet the spirit of the Recovery Program:

   - o The goal of the Recovery Program is to recover the four endangered Colorado River fishes by establishing naturally self-sustaining populations and protecting the habitat upon which they depend. The Procedures are intended to support this goal while allowing nonnative fish stocking for recreational fishing and private aquaculture, provided that such stocking is compatible with recovery of the endangered Colorado River fishes.

   - o Implementation of these Procedures will contribute to fulfilling the intent for the Recovery Program to serve as the "reasonable and prudent alternative" for certain types of water development in the Upper Basin (U.S. Fish and Wildlife Service 1996).

   - o The Recovery Program directs that "stocking of nonnative species will be confined to areas where the absence of potential conflict with rare or endangered species can be demonstrated."

     The Procedures provide guidance for stocking of nonnative fishes in the Upper Basin that is consistent with recovery efforts for the endangered Colorado River fishes. They are intended as a way to integrate recreational fishery management with ongoing recovery efforts for the endangered fishes.

2. These Procedures will be implemented by a Cooperative Agreement between the Service and State fish and wildlife agencies in Colorado, Utah, and Wyoming. The roles and responsibilities of each agency will be clearly described in the Cooperative Agreement.

3. Both the Service and the States have statutory responsibilities which cannot be abrogated. The States have the responsibility for managing fish and wildlife resources that includes threatened and endangered species occurring within their boundaries. The Service has certain legislated responsibilities for conserving fish and wildlife resources through administration of the Endangered Species Act, including enforcement of section 9 "take" violations.

4. The Service's participation in the stocking procedures will require that an Intra-Service section 7 consultation be completed. Berming and stocking within the 100-year floodplain may result in an adverse modification of critical habitat. These procedures attempt to minimize the adverse modification of critical habitat. The

section 7 consultation will be completed prior to signing of the Cooperative Agreement.

5. The goal of the Service and the States is to reach consensus on issues related to stocking of nonnative fishes so that neither agency has to independently assert its authority. The Service and the States will make a concerted effort to resolve any disagreements that may arise from a stocking proposal.

6. The Procedures provide adequate opportunity and time for review and input by the public, participants in the Recovery Program, and other interested parties.

7. Habitat and biological communities have been significantly altered in the Upper Basin. While it is difficult to fully assess and quantify, the loss of habitat and the adverse impacts of nonnative, warmwater fish species are both responsible for the decline of the endangered Colorado River fishes. It is not possible to definitively identify the relative contribution that each of these factors had to the endangerment of the fishes. In many cases, the proliferation of nonnative fishes was enhanced by habitat alteration, attempts to fulfill the demand for recreational fishing, and to fulfill project purposes for recreation. All factors should be considered to provide an ecosystem perspective in recovery efforts for the endangered fishes in the Upper Colorado River Basin.

8. The Service and States recognize that nonnative fish stocking is an important component of public and private recreational sport fisheries management and commercial aquaculture in the Upper Basin. As such, an important objective of these agencies is the establishment and maintenance of sport fisheries and aquaculture activities that do not conflict with recovery efforts for the endangered Colorado River fishes.

9. The States also have certain authorities for regulating/overseeing aquaculture activities and fish introductions by private landowners. The States will incorporate these Procedures into appropriate State regulations.

10. Flooded bottomland restoration is a priority within the Recovery Implementation Program. Beginning in FY-97, an acquisition coordinator will be contacting pond owners (along Green, Colorado, and Gunnison Rivers within critical habitat) to try and obtain easements agreements. The purpose of these easement agreements would be to compensate private land owners for allowing their floodplain properties to be used to benefit the endangered fishes. Ponds where an easement is obtained would have nonnative fishes removed. More specific criteria for obtaining and reclaiming ponds is being developed through the Program. Priorities for pond use will be integrated into the flooded bottomland and propagation components of the Program. Approved Program documents or future

updates to these documents will guide the use of floodplain ponds. These documents include: *Reconnaissance Inventory and Prioritization of Existing and Potential Bottomlands in the Upper Colorado River Basin 1993-1994* (Irving and Burdick 1995); *Levee Removal Strategic Plan* (Lentsch et al. 1996); *Genetics Management Guidelines* (Williamson and Wydoski (1994); *Genetics Management Plan* (Wydoski 1995) and annual propagation plans prepared in accordance with this plan; *Augmentation Plan for the Razorback Sucker in the Middle Green River 1996-1997* (Wydoski 1996); *Stocking Plan for Razorback Sucker in the Upper Colorado and Gunnison Rivers* (Burdick et al. 1995); and all future stocking plans prepared through the Program.

11. Ponds are considered to be outside a designated floodplain if they are naturally above the floodplain in question or if they lie in the floodplain in question but have FEMA approved dikes functionally separating the pond from the floodplain.

12. Concurrent with implementing these stocking procedures, the Recovery Program will conduct a peer-review study to evaluate the effectiveness of the Interagency Standardized Monitoring Program (ISMP) to detect changes in the survivability and/or abundance of routinely stocked fish. Unless the study demonstrates that the ISMP is effective for tracking nonnative fishes, a program would have to be implemented to do so. If it is determined, by peer review analysis by the respective State and the Service, that nonnative fish escapement is occurring from an approved location, then routine stocking of that species in that location would be discontinued. Subsequent stockings at that location would then require case-by-case review by the State wildlife agency and the Fish and Wildlife Service (until the escapement problems are corrected) to ensure that escapement has been adequately addressed.

IV. ROUTINE STOCKING OF NONNATIVE FISHES THAT ALREADY OCCUR AND ARE MANAGED IN THE UPPER COLORADO RIVER BASIN

1. Nonnative fish species that occur and are managed by stocking in the Upper Colorado River Basin can be routinely stocked (i.e., are not subject to procedures outlined in Section IX) in the locations/situations identified within this section. Stocking of nonnative fish species in these locations/situations are considered to be consistent with recovery of the endangered fishes. Explanations of the terms/acronyms are provided in Appendix B.

2. Trout can be routinely stocked directly into riverine habitats upstream of critical habitat. Stocking of trout into private floodplain ponds is also allowed. Stocking of trout within riverine portions of critical habitat is not allowed under these procedures.

3. The following conditions apply to stocking of nonnative fishes within the 50-year floodplain[1]:

A. Private Ponds: The stocking of largemouth bass, bluegill, black crappie, and triploid grass carp for ponds within the 50-year floodplain in the Upper Colorado River Basin will require that the ponds be bermed to FEMA standards to the 50-year floodplain. If an outlet exists on the pond, the outlet must be screened prior to stocking. The stocking plan, screening, and berming must be approved by the appropriate State wildlife agency and the Fish and Wildlife Service. Once approved, future stocking of that pond is considered routine, not requiring further approval. Screens and berms will be inspected annually by State wildlife agency personnel. If berming or screening fail to control escapement of nonnative fishes, then that pond will require a case-by-case review prior to any additional stocking.

B. Public Waters: Stocking of nonsalmonid, nonnative fishes in public waters within the 50-year floodplain will not occur except for the following exceptions.

(1) The State of Colorado has developed lake management plans or stocking plans for the following waters in the Upper Basin, excluding the San Juan River Basin, that have been approved by the Service since the inception of the Recovery Program. Stocking of approved species into the following these waters will be routine:

Rio Blanco Reservoir, Colorado
Purdy Mesa Reservoir, Colorado (formally Hollenbeck Reservoir)
Mack Mesa Reservoir, Colorado
Chipeta Lake, Colorado
Crawford Reservoir, Colorado
McPhee Reservoir, Colorado
Harvey Gap Reservoir, Colorado

(2) Routine stocking of largemouth bass, bluegill, black crappie, and triploid grass carp can occur in Corn Lake, the upper Connected Lakes, and Duke Lake once the Colorado Division of Wildlife and the Service have approved for these waters: 1) berming to FEMA specifications to functionally remove them from the 50-year floodplain; 2) screening of the outlets; and 3) the Lake Management Plans. These waters provide important recreational fishing opportunities for kids and others through programs such as Pathways to Fishing.

---

[1] In areas where the 50- or 100-year floodplain boundary are not known, the point 5 feet above the OHWL may be used as the boundary location for the 50-year floodplain and 5 ½ feet above the OHWL can be used to represent the 100-year floodplain (see Appendix B).

(3) Lake Management Plans and stocking proposals, that have been previously approved or are evaluated and accepted under these Procedures, may be reviewed at any time by mutual agreement of the Service and the State wildlife agency to insure compatibility with recovery objectives. Approved Lake Management Plans and stocking proposals will be reviewed every five years (see Section X).

(4) Any party may petition the appropriate State wildlife agency to review an approved Lake Management Plan or stocking proposal based on new information that was not previously considered in the development or evaluation of the proposal.

Black crappie/bluegill/largemouth bass: These species are not well adapted to riverine environment and do not appear to establish self-sustaining populations in rivers upon escapement. However, there is concern that these species will flourish in flooded bottomland habitats that are being reconnected with Upper Basin rivers.

Triploid grass carp: Grass carp have been introduced into the United States as a vegetation control. Only certified triploid grass carp are being used in the Upper Basin, because they lack the ability to reproduce. This allows their numbers and distribution to be controlled. Very few triploid grass carp have been captured in the river from past stocking in isolated ponds. Grass carp are not known to prey on other fishes, but can alter habitats of other fishes by changing vegetation. Because of the expense in obtaining these fish, stocking in areas where escapement is possible is highly unlikely.

4. Isolated public and isolated private waters, having no connection to the river, that are above the 50-year floodplain can be routinely stocked with largemouth bass, black crappie, bluegill, mosquitofish, and triploid grass carp.

Mosquitofish: Routine stocking of mosquitofish is restricted to isolated ponds and reservoirs outside the 50-year floodplain because they are aggressive omnivores that have been associated with negative impacts on native fish species in the American Southwest. Mosquitofish are currently common (as a result of stocking) in habitats used as nursery areas by endangered Colorado River fish.

5. Isolated public and isolated private waters, having no connection to the river, that are above the 6,500-foot msl (Appendix D) and above the 100-year floodplain can be routinely stocked with fathead minnow and channel catfish in addition to those species approved for above the 50-year floodplain.

Fathead minnow: Routine stocking restricted to waters outside of the 100-year floodplain with no connection to the river is based on

recent information that demonstrates competition between young-of-the-year Colorado squawfish and fathead minnow. The fathead minnow is also a predator that attacks fish larvae and tears the larvae into pieces. The fathead minnows then eat the pieces so that the gape of the mouth is not important in the size of the larvae that are consumed.

Channel catfish: This species has been introduced into the mainstem rivers, lakes, reservoirs, and ponds in the Upper Colorado River. Their diet includes other fishes and are considered a threat to the endangered fishes. Channel catfish were ranked 1st on the list of 28 nonnative fish species considered to adversely impact the native fishes in the Colorado River Basin (Hawkins and Nesler 1991).

6. Public and private waters that have a direct connection to rivers in the Upper Colorado River Basin (e.g., Elkhead Reservoir, Highline Reservoir, and many ponds) will be equipped or managed with an anti-escapement device or practice acceptable to the Service and the State fish and wildlife agency. Lake Management Plans will be prepared or revised and approved by the Service and the State fish and wildlife agency before the continued stocking of nonnative, warmwater fish species will be allowed. The Program will pursue funding for equipping public reservoirs with anti-escapement devices.

V. CASE-BY-CASE STOCKING OF NONNATIVE FISHES THAT PRESENTLY OCCUR IN THE UPPER COLORADO RIVER BASIN

Stocking of nonnative fishes in public waters, not prohibited, that are not managed in the Upper Basin at the present time will require evaluation by the State wildlife agency and the Service on a case-by-case basis to ensure that the proposed stocking of these fishes will not adversely affect the endangered fishes. Minimum criteria for stocking will include: 1) no stocking of isolated ponds within the 50-year floodplain and 2) if the water has an outlet it must be screened or managed to control escapement. Stocking should be "confined to areas where absence of potential conflict with rare or endangered species can be demonstrated" (U.S. Fish and Wildlife Service 1987). The intent here will be to address escapement potential.

1. Requests to stock nonnative fish species that are not prohibited in the Upper Basin in locations or situations not listed in Section IV will be evaluated on a case-by-case basis and will include the following information:

   A. The purpose and location of the proposed stocking.

   B. The species, numbers, and rationale for selecting the species.

C. The potential for escapement, the potential for survival in critical habitat if escapement occurs, and control measures that could be implemented to reduce the risk of escapement.

D. The potential for impact to threatened and endangered species and the specific measures available to remedy any impacts that may occur including their feasibility and likelihood of success.

E. A plan for monitoring the effects of stocking nonnative fishes on the endangered Colorado River fishes.

VI. STOCKING OF NONNATIVE FISHES THAT DO NOT PRESENTLY OCCUR IN THE UPPER COLORADO RIVER BASIN

1. The States and the Service recognize that introducing new fish species, including hybrids, into an ecosystem can result in unanticipated impacts on native fishes. For this reason, few proposals, if any, to introduce new fish species or hybrids into the Upper Basin are anticipated. Introduction of new species will generally be discouraged.

   Minimum criteria for stocking will include: 1) no stocking of isolated ponds within the 50-year floodplain and 2) if the water has an outlet, it must be screened or managed to control escapement. Stocking should be "confined to areas where absence of potential conflict with rare or endangered species can be demonstrated" (U.S. Fish and Wildlife Service 1987).

2. Proposals to stock fishes that do not presently occur in the basin will be subject to case-by-case review by the State wildlife agency and the Service and will include the following minimal information:

   A. The purpose and location of the proposed stocking.

   B. The species, numbers, and rationale for selecting the species.

   C. The potential for escapement, the potential for survival in critical habitat if escapement occurs, and control measures that could be implemented to reduce the risk of escapement.

   D. The potential for impact to threatened and endangered species and the specific measures available to remedy any impacts that may occur including their feasibility and likelihood of success.

   E. A plan for monitoring the effects of stocking nonnative fishes on the endangered Colorado River fishes.

3. Any proposal to introduce new fish species into the Upper Basin shall also follow the rationale and justification of the American

Fisheries Society policy statement "Introductions of Aquatic Species" (Appendix C; Items a-g on Page 24).

VII. LOCATIONS, SITUATIONS, AND SPECIES WHERE STOCKING OF NONNATIVE, WARMWATER FISH WOULD NOT BE ACCEPTABLE

1. Stocking of nonnative, nonsalmonid fish species in rivers within critical habitat or having a direct connection to critical habitat of the Upper Colorado River Basin is unacceptable.

2. Stocking of nonnative, nonsalmonid fish species in the 0- to 50-year floodplain is unacceptable, except as provided in Section IV.

3. The following fish species would be prohibited from being stocked in any waters in the basin: northern pike, common carp, red shiner, black bullhead, yellow bullhead, wiper, green sunfish, flathead catfish, and white crappie. However, this prohibition does not include fish removed from the river or other problem areas and transplanted to waters already containing these species where escapement is not likely possible or waters created as part of a fish removal plan (subject to the minimum criteria in Section V and State and Service approval).

VIII. SPECIAL CASES

1. Channel catfish, mosquitofish, redside shiner, and smallmouth bass may be stocked in any water above Flaming Gorge Dam.

   Channel catfish: The Flaming Gorge outlet structure precludes virtually all warmwater fish escapement.

   Redside shiner: Currently used as forage in some Wyoming ponds above Flaming Gorge Dam. This species is not likely to pass through the reservoir environment and outlet structure because the deep reservoir release at Flaming Gorge Dam precludes virtually all escapement of warmwater fishes.

   Smallmouth bass: The same rationale was provided for redside shiner above Flaming Gorge Dam (i.e., outlet structure precludes virtually all warmwater fish escapement).

2. Lake Management Plans will be prepared for Jerry Creek Reservoir and Juniata Reservoir. After these plans are accepted (following criteria in Section V) by the Colorado Division of Wildlife and the Fish and Wildlife Service, these waters will be stocked on a routine basis.

3. Warmwater species may be stocked into standing waters (with Lake Management Plans approved by the State wildlife agency and the

Service) above existing reservoirs where a reproducing population of that species exist. This includes reservoirs up the Escalante arm of Lake Powell. In cases where escapement is occurring, the escapement will be addressed per Section IV.6.

4. Warmwater gamefish that are removed from the river or other problem areas can be transplanted to waters already containing that species and where escapement is not likely possible as determined by the involved State and Fish and Wildlife Service or waters created as part of a fish removal plan (subject to the minimum criteria in Section V and State and Federal approval).

IX. STEPS IN THE REVIEW OF STOCKING PROPOSALS AND LAKE MANAGEMENT PLANS

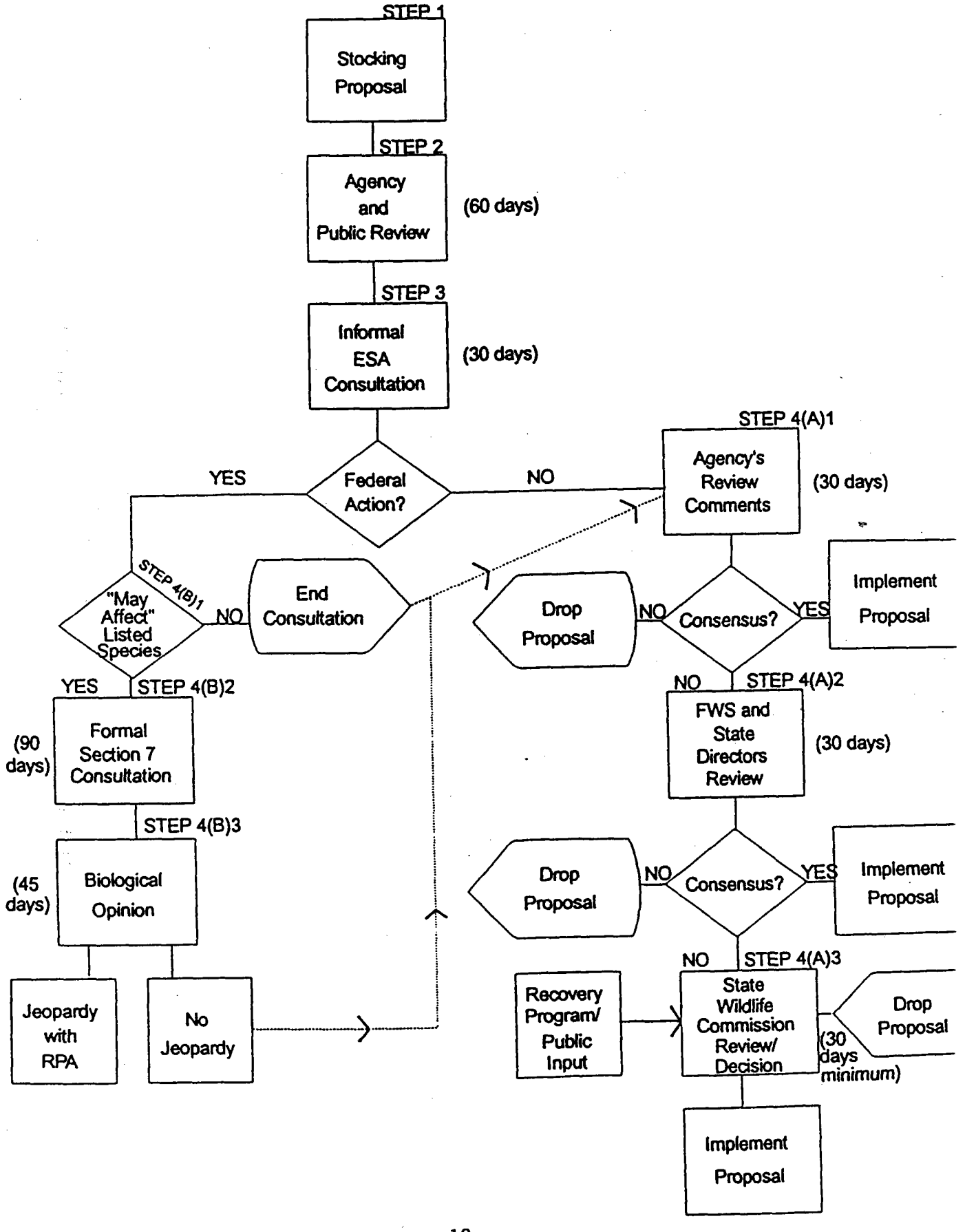
The steps or process for reviewing stocking proposals developed under Sections IV.3.A, IV.6, V, VI, and VIII.2, .3, and .4 of these Procedures are summarized in Figure 2 and are explained below:

Step 1. Formal Stocking Proposal. The review process is initiated with a formal stocking proposal developed in accordance with the guidelines outlined in Sections IV.3.A, IV.6, V, VI, and VIII.2, .3, and .4 of the Procedures.

Proposals to stock nonnative fishes will be founded on sound biological evaluations and contain sufficient information to allow for an objective and complete evaluation.

Proposals to stock private waters should be submitted through the appropriate State agency.

Figure 2. Nonnative fish stocking review procedures.



Step 2. Public and Agency Review. Stocking proposals will be submitted to the Service, the States, participants in the Recovery Program and other interested parties for review and comment for a 60-day period. Evaluations by the Service and the States will be based on sound biological principles and the criteria in Sections V and VI. Furthermore, if the Service or State agency objects to a stocking proposal, that agency will make a concerted effort to identify reasonable alternatives (i.e. different species, screening, berming, different location).

Step 3. Informal ESA Consultation. The proponent of the proposal (Federal agency) will, within 30 days of receiving the stocking proposal from the State wildlife agency, contact the Service to determine (a) if any Federally listed or candidate species may be affected by the stocking proposal, (b) if a review of the stocking proposal pursuant to section 7 of the Endangered Species Act is required, and (c) other ESA requirements, if any, that need to be addressed during the review of the stocking proposal. The proponent of a stocking proposal may elect to withdraw or modify a proposal based on the results of the informal ESA consultation.

Step 4(A) Proposals Not Subject to Section 7, ESA Consultation.

Stockings of nonnative fishes classified as routine that are initiated by State or private parties and do not require Federal approval, authorization, funding, etc., would not require a review pursuant to section 7 of the ESA. Reviews of stocking proposals that do not require section 7 consultation would be in accordance with the following process:

Step 4(A)(1). At the conclusion of the 60-day comment period, the States and the Service would review the comments and within 30 days indicate whether they support or oppose the proposed stocking. These parties will make a concerted effort to resolve any disagreements or objections to the proposal. If none of these parties objects to the proposal, if disagreements over the proposal are resolved, or the proposal is modified sufficiently to address the concerns, then the proponent can proceed to implement the proposal. The proponent of the proposal may also elect to withdraw the proposal based on identified concerns.

Step 4(A)(2). In the event that an agency(s) still objects to a proposal and the proponent still desires to proceed, the proposal and the review comments will be submitted to the Regional Director of the Service and the Directors of the State Wildlife agencies. Within 30 days, these parties will make a concerted effort to resolve any disagreements or objections to the proposal. The Regional Director of the Service and the Directors of the State wildlife agencies may, at their discretion, meet as a panel to discuss the proposal and accept public comment. If objections are resolved, or the proposal is

modified sufficiently to address the concerns, then the proponent can proceed to implement the proposal. The proponent of the proposal may also elect to withdraw the proposal based on identified concerns.

Step 4(A)(3). In the event that the disagreements cannot be resolved and the proponent still desires to proceed, the stocking proposal and all agency comments on the proposal will be distributed to the appropriate State Wildlife Commission for final review and decision. The State Wildlife Commission will provide at least a 30-day notice before taking action on the proposal. The States, Service, other participants in the Recovery Program, and other interested parties will be notified of State Wildlife Commission hearing and be invited to provide comments to the Commission on the stocking proposal. The Service will advise the Commission if there is a potential for "take" as defined by the ESA, as amended. The basis for the final decision by the State Wildlife Commission will be documented and distributed to the public on the Recovery Program's mailing list, members of the Recovery Program, and other interested parties.

Step 4(B) Proposals Subject to Section 7, ESA Consultation.

Section 7 consultation will only be required prior to proceeding with any stocking in cases where the Service, in consultation with the lead Federal agency, determines that there is a Federal action and/or Federal discretionary involvement in the stocking proposal that "may affect" an endangered fish or result in "an adverse modification" to its critical habitat. Examples of proposals which may require section 7 consultation include projects where a Federal permit is needed to stock fish on Federal lands, the stocking is paid for partially or wholly with Federal funds, and/or the fish are being provided from a Federal fish hatchery.

Section 7 consultation will be conducted by the Service in accordance with the ESA section 7 Regulations (50 CFR Part 402), as summarized below.

Step 4(B)(1). The Service in consultation with the Federal agency that is responsible for approving the project will determine if the proposed stocking may affect any listed species or adversely modify critical habitat. If the stocking proposal is not likely to adversely affect a listed species or modify critical habitat, the section 7 consultation ends. In this event, the proposal would be reviewed in accordance with Step 4(A), above.

Step 4(B)(2). If a "may affect" determination is made, the Service would then enter into formal section 7 consultation with the lead Federal agency to determine if the proposed stocking

jeopardizes the continued existence of any listed species or adversely modifies their critical habitat. The Service has 90 days to complete formal section 7 consultation.

Step 4(B)(3). The Service will issue its biological opinion within 45 days after completion of section 7 consultation. The Service's biological opinion will include a detailed discussion of the effects of the action on listed species and critical habitat and the Service's opinion on whether the action is or is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of its critical habitat.

If the biological opinion concludes the project will jeopardize and/or result in adverse modification of critical habitat, "reasonable and prudent alternatives" if available will be provided. An alternative is considered to be "reasonable and prudent" if it (a) can be implemented in a manner consistent with the intended purpose of the project, (b) can be implemented within the scope of the Federal agency's authority or jurisdiction, (c) is technologically feasible, and (d) avoids jeopardy to the species or adverse modification of critical habitat.

Upon issuance of the biological opinion, the Federal agency shall determine whether and in what manner to proceed with the project. If the project concludes with a no jeopardy biological opinion the proponent would submit the stocking proposal to the other States for a 30-day review. Resolution of any issues over a stocking proposal among the States would be in accordance with Step 4(A), above.

X. REPORTING

1. Annual reporting

A. Nonsalmonid, nonnative fish species that are stocked into the Upper Colorado River Basin, following these Procedures, must be reported to the Service (who will then forward a copy to the Recovery Program Director) by the respective wildlife agency no later than December 31st of the year in which the stocking occurs. The report will include all nonsalmonid, nonnative fishes stocked in routine stocking covered in Section IV and any waters approved after case-by-case review. The report will include the results of the annual inspection of screens and berms on both public and private waters, recommendations for addressing any problems noted or foreseeable problems, and actions taken or planned to correct these problems.

B. At a minimum, the reporting will include the following information on nonnative fish species that are stocked into the Upper Colorado River Basin:

(1). Species;

(2). Location;

(3). Number Stocked;

(4). Size of Fish Stocked (mean total length or numbers/pound);

(5). Criteria Used for Routine Stocking from Section IV or the written proposal submitted for case-by-case review.

2. Five-Year Review

A. Five years after implementation of these procedures, and every five years thereafter, a Program review will be conducted to determine:

(1). Adequacy of procedures to protect endangered fishes;

(2). Effects of procedures on private landowners;

(3). Effects on aquaculture industry;

(4). Impacts on warmwater fishing.

B. Once a Lake Management Plan or stocking proposal has been approved, it will be reviewed every 5 years thereafter and submitted to the Service by the respective State wildlife agency with the following determinations:

(1). Did the body of water reconnect with the river during the previous 5 years?

(2). Is escapement occurring?

(3). Recommendations for addressing escapement, if it is occurring.

If escapement has not occurred during the previous 5 years, modification of the stocking proposal or Lake Management Plan will not be required.

XI. MODIFICATIONS OF THESE PROCEDURES

The States of Colorado, Utah, and Wyoming or the Service can request a review or update of these Procedures at any time.

XII. REFERENCES

Burdick, B. D., R. S. Wydoski, and C. W. McAda. 1995. Stocking plan for razorback sucker in the Upper Colorado and Gunnison Rivers. U.S. Department of the Interior, Fish and Wildlife Service, Grand Junction, Colorado. 13 pp.

Hawkins, J. A. and T. P. Nesler. 1991. Nonnative fishes of the upper Colorado River basin: An issue paper. Final Report. Colorado State University and Colorado Division of Wildlife, Fort Collins, CO. 72 pp.

Irving, D. B. and B. D. Burdick. 1995. Reconnaissance inventory and prioritization of existing and potential bottomlands in the Upper Colorado River Basin. U.S. Department of the Interior, Fish and Wildlife Service, Vernal, Utah. 57 pp + appendices.

Lentsch, L., T. Crowl, P. Nelson, and T. Modde. 1996. Levee removal Strategic Plan. Utah Department of Natural Resources, Division of Wildlife Resources, Salt Lake City, Utah. 21 pp.

U.S. Fish and Wildlife Service. 1987. Recovery implementation program for endangered fish species in the Upper Colorado River Basin. U.S. Department of the Interior, Fish and Wildlife Service, Denver, Colorado. 6 Sections, Various Pagination.

U.S. Fish and Wildlife Service. 1996. Section 7 consultation, sufficient progress, and historic projects agreement and recovery action plan. U.S. Department of the Interior, Fish and Wildlife Service, Denver, Colorado. 52 pp + appendix.

Williamson, J. H. and R. S. Wydoski. 1994. Genetics Management Guidelines. U.S. Department of the Interior, Fish and Wildlife Service, Denver, Colorado. 40 pp.

Wydoski, R. S. 1995. Genetics Management Plan. U.S. Department of the Interior, Fish and Wildlife Service, Denver, Colorado. 58 pp.

Wydoski, R. S. 1996. Augmentation Plan for Razorback Sucker in the Middle Green River 1996-1997. U.S. Department of the Interior, Fish and Wildlife Service, Denver, Colorado. 12 pp.

APPENDIX A

FAMILY, SCIENTIFIC NAME, AND COMMON NAMES OF FISHES MENTIONED IN THESE PROCEDURES

Scientific Name	Common Name
Family	
Esox lucius	northern pike
Esox lucius X *Esox masquinongy*	tiger muskie
Cyprinidae (Minnows)	
Ctenopharyngodon idella	triploid grass carp
Cyprinus carpio	common carp
Gila cypha	humpback chub
Gila elegans	bonytail
Cyprinella lutrensis	red shiner
Pimephales promelas	fathead minnow
Ptychocheilus lucius	Colorado squawfish
Richardsonius balteatus	redside shiner
Catostomidae (Suckers)	
Xyrauchen texanus	razorback sucker
Ictaluridae (Catfishes)	
Ictalurus melas	black bullhead
Ictalurus natalis	yellow bullhead
Ictalurus punctatus	channel catfish
Pylodictis olivaris	flathead catfish
Poeiliidae (Livebearers)	
Gambusia affinis	mosquitofish
Percichthyidae (Temperate Basses)	
Morone chrysops X *Morone saxatilis*	wiper
Centrarchidae (Sunfishes)	
Lepomis cyanellus	green sunfish
Lepomis macrocheilus	bluegill
Micropterus dolomieui	smallmouth bass
Micropterus salmoides	largemouth bass
Pomoxis nigromaculatus	black crappie
Pomoxis annularis	white crappie

APPENDIX B
TERMS OR ACRONYMS USED IN THESE PROCEDURES

Critical habitat: River reaches formally designated as critical in accordance with the Endangered Species Act of 1973, as amended. Includes portions of the Colorado, Green, Duchesne, White, Yampa, and Gunnison Rivers and portions of the associated 100-year floodplains that contain areas essential to recovery of the endangered fishes.

Direct Connection: Waters that flow directly into critical habitat. This does not include waters above reservoirs where escapement has been addressed in accordance with these Procedures.

ESA: Acronym for Endangered Species Act.

FEMA specifications: Dikes built to isolate ponds from flooding must have a minimum of three feet of freeboard above the baseflood elevation. They must have a minimum of one additional foot of freeboard if the dike is within 100 feet of an area where the water is constricted. The upstream end of the dike must have a minimum of an additional one-half foot elevation of dike. The dike must be designed and constructed in accordance with recognized and accepted engineering methodologies. The dike must be "watertight, substantially impermeable to the passage of water, and be capable of withstanding hydrodynamic and hydrostatic forces, and the effects of buoyancy." For existing dikes to qualify, they must be certified via a written report by a qualified engineer. The report will consider depth of flooding, floodplain elevation, duration of flooding, embankment geometry, embankment and foundation materials, embankment compaction, penetrations, other design factors affecting penetration, channel constriction, and any other factors that may effect the ability of the dike to withstand flood events.

Ordinary High Water Line (OHWL): This is the water level which represents the water surface elevation during a normal (annual) high water event. The physical evidence denoting the OHWL is the point where perennial hydrophytic plant life converges with bare substrate (rock, gravel, sand, fines) or with substrate interspersed with annual vegetation.

5 feet above ordinary high water line: This term refers to the vertical distance from the lowest point on the natural (or artificial/man-made) dike that forms the isolated pond to the ordinary high water line (OHWL) of adjacent streams. This height above the OHWL approximates the 50-year floodplain that is based on professional judgment and field observations of State and Service hydrologists and gaging tables for the Upper Colorado River Basin. Five and one-half feet above the OHWL approximates the 100-year floodplain. This is a relatively simple method for approximating the 50- and 100-year floodplains that is accurate and definable during on-site visits.

Isolated Ponds or Waters: Ponds or waters that have no connection with the river (no outlet).

APPENDIX C

AMERICAN FISHERIES SOCIETY - INTRODUCTIONS OF AQUATIC SPECIES

APPENDIX C

INTRODUCTIONS OF AQUATIC SPECIES

Christopher C. Kohler and Walter R. Courtenay, Jr.

A. Issue Definition

The increased frequency of inter- and intranational transfers of aquatic species carried out over the last two decades has prompted concern relative to the potential for debasement of integrity of aquatic communities. Past introductions, intentional or otherwise, have run the full gamut from spectacular booms (e.g., Pacific salmon to the Great Lakes) to spectacular busts (e.g., the waterweed hydrilla to portions of the United States). Considering the manifestations of such extremes in terms of ecological *and* economical impacts, it is not surprising that opposing viewpoints exist with respect to the relative pros and cons of effectuating introductions of aquatic species. Nevertheless, natural resource managers concur that substantially improved measures can and should be taken to increase the odds that benefits of a given introduction will exceed risks. Currently, a number of international commissions have adopted or are considering adopting formal "codes of practice" for regulating the introduction of aquatic species (see Sindermann 1986; Welcomme 1986; Kohler and Courtenay 1986). Implementation of such codes (protocols, guidelines, etc.) can ensure that decisions regarding future introductions are based on sound ecological evidence, and that introductions effectuated are properly evaluated.

B. Negative Impacts on Aquatic Communities

The impacts of introduced aquatic organisms on native aquatic communities in North America have been summarized by Contreras and Escalante (1984) for Mexico, by Taylor et al. (1984) for the continental United States, and by Crossman (1984) for Canada. These impacts can be classified into five broad categories: habitat alteration, trophic alteration, spatial alteration, gene pool deterioration, and introduction of diseases.

Habitat Alteration

Introduced plants such as water hyacinth (see Table 1 for scientific names of organisms cited in text), Eurasian watermilfoil, alligator weed, and hydrilla have seriously infested a number of water bodies in North America (Shireman 1984). Excessive vegetation interferes with swimming and fishing activities, upsets predator-prey relationships by providing too much cover, causes water quality problems during growth and decomposition, and is aesthetically unpleasant (Noble 1980). Ironically, exotic fishes, particularly grass carp and the tilapias, are frequently used as biological controls. Both the grass carp and the tilapias have reproducing populations in North America, although the habitat requirement for larval grass carp has so far proved to be limiting and the tilapias are basically limited to the southern extreme of the United States and to Mexico.

Although grass carp have proven to be an excellent biological control for aquatic vegetation, a risk exists that aquatic plants (including native forms) might become overly decimated as a result of grass carp predation which in turn would limit nursery areas for juvenile fishes, cause bank erosion, and accelerate eutrophication through release of nutrients previously stored in the plants. A risk also exists that grass carp could adversely impact waterfowl habitat and rice fields. However, no major adverse impacts associated with grass carp have yet been documented.

Although common carp was not introduced to North America for aquatic weed control, its foraging behavior results in vegetation removal both by direct consumption and by uprooting due to its proclivity to dig through substrate in search of food. The latter activity also results in increased water turbidity. The common carp is the most often cited nuisance introduced fish in North America (Kohler and Stanley 1984) with millions of dollars having been spent for control and eradication, but with little success (Laycock 1966; Courtenay and Robins 1973).

Besides grass carp, only the redbelly tilapia has been widely used in weed control programs in North America. No effects on native communities have yet been attributed to vegetation removal by any of the tilapias (Taylor et al. 1984), though increases in turbidity have been attributed to digging activities of the blue tilapia (Noble et al. 1975) and to organic enrichment through fecal decomposition by redbelly tilapia (Hickling 1961; Phillippy 1969).

Trophic Alteration

Taylor et al. (1984) speculated that the introduction of any species into a novel environment should alter community trophic structure, with the nature and extent of such changes being complex and unpredictable. Though this aspect is not well documented, there is little doubt that when an introduced fish exhibits explosive population increases, as has occurred with the tilapias (Germany 1977; Knaggs 1977; Shafland 1979), substantial changes in native communities must occur. Likewise, several dozen studies have documented dietary overlap between introduced and native fishes (see Taylor et al. 1984). However, these studies only demonstrate that the potential for competition exists. Linking dietary overlap to competition has proven to be a difficult task for all but the most controlled ecological studies regardless of whether non-native species are involved.

Documentation of predation by introduced species on native species serves as the most definitive example of impacts on communities. The most frequently cited example in North America concerns declines in populations of native trouts attributable to brown trout predation (see Moyle 1976a,b; Sharpe 1962; Alexander 1977, 1979). Several other introduced fishes have been implicated as major causes of mortality among native fishes, including pike killifish (Miley 1978; Turner 1981; Anderson 1981, 1982), oscar (Hogg 1976), and the bairdiella (Quast 1961). Though frequently cited as a potential threat of

considerable consequence, predation on eggs or young by introduced fishes has not been demonstrated to be a common occurence (Taylor et al. 1984).

Spatial Alteration

Concommittant overlap in usage of space by non-native and native fishes may lead to competititve interaction if space is in limited supply or of variable quality. Evidence exists implicating displacement of brook trout by brown trout, but in general, displacements are largely inferential (Taylor et al. 1984). Conversely, high densities of introduced fishes have been shown to exert negative effects on native fishes. For example, Noble et al. (1975) observed that largemouth bass populations in Trinidad Lake, Texas, declined with no evidence of recruitment as densities of blue tilapia rose to approximately 2,240 kg/ha^{-1} during the period of 1972-1975.

Gene Pool Deterioration

Through reduction of heterogeneity through inbreeding is clearly a threat to any species being produced in a hatchery (Philipp et al. 1983), the risk is most acute with species of intercontinental origin because the initial broodstock invariably represent limited gene pools at the outset. The larger the stocking program, the more inbreeding among original broodstock is necessary. Thus species introduced to a novel habitat may or may not have the genetic characteristics necessary for them to adapt and/or perform as predicted.

Fortunately, hybridization events among introduced and native species in open waters are rare (Taylor et al. 1984). Nevertheless, the possibility of native gene pools being altered through such hybridization does exist. For example, brown trout are known to hybridize with native forms in North America (Schwartz 1972, 1981; Dangel et al. 1973; Chevassus 1979).

Introduction of Diseases

Diseases caused by bacteria, viruses, and parasites are all too often conveyed along with introduced aquatic species (see Hoffman and Schubert 1984; Shotts and Gratzek 1984 for reviews). This aspect represents one of the most severe threats that an introduced species may pose to a native community. Transfer of diseased fish was no doubt responsible for introduction of whirling disease into North America from Europe. Recently, infectious hypodermal and hematopoietic necrosis virus (IHHNV) has been spread to a number of countries in conjunction with shipments of live penaeid shrimp. IHHNV was first diagnosed in 1981 at shrimp culture facilities in Hawaii among shrimp introduced from Panama (Sindermann 1986). Even "ich," one of the most common fish diseases worldwide, caused by a ciliated protozoan, is thought to have been transferred from Asia throughout the temperate zone with shipments of fishes (Hoffman 1970, 1981).

C. Courses of Action

Introduction of species to aquatic communities are commonly employed as a fisheries management tool or occur as a result of escapes from aquaculture or ornamental fish holding facilities. It is not feasible, nor desirable, to legislate against all such introductions. What is needed is more education on the role that introduced species can and should play in the context of aquatic resources management. The more informed natural resource managers are about such issues, the less likely that mistakes will be made or that legislation will be necessary to enforce an "attitude of caution." The following actions toward that end are recommended.

Table 1. Organisms cited in text.

Common Name	Scientific Name
Plants	
hydrilla	*Hydrilla verticillata*
water hyacinth	*Eichornia crassipes*
Eurasian watermilfoil	*Myriophyllum spicatum*
alligator weed	*Alternanthera philoxeroides*
Fish	
Pacific salmon	*Oncorhyncus* sp.
grass carp	*Ctenopharyngodon idella*
common carp	*Cyprinus carpio*
tilapias	*Oreochromis, Sarotherodon* and *Tilapia* sp.
blue tilapia	*Oreochromis aureus* (= *Tilapia aureau*)
redbelly tilapia	*Tilapia zilli*
brown trout	*Salmo trutta*
pike killifish	*Belonesox belizanus*
oscar	*Astronotus ocellatus*
bairdiella	*Bairdiella icistia*
brook trout	*Salvelinus fontinalis*
largemouth bass	*Micropterus salmoides*
coho salmon	*Oncorhyncus kisutch*
striped bass	*Morone saxatilis*
walking catfish	*Clarias batrachus*
Other	
whirling disease	*Myxosoma cerebralis*
"ich"	*Ichthyopthirius multifiliis*

A. The membership reaffirms its endorsement of the 1972 "Position of the American Fisheries Society on Introduction of Exotic Aquatic Species" as modified:

Position of American Fisheries Society on Introduced Aquatic Species.

Our purpose is to formulate a broad mechanism for planning, regulating, implementing, and monitoring all introductions of aquatic species.

Some introductions of species into ecosystems in which they are not native have been successful and others unfortunate.

Species not native to an ecosystem will be termed "introduced." Some introductions are in some sense, planned and purposeful for management reasons; others are accidental or are simply ways of disposing of unwanted pets or research organisms.

It is recommended that the policy of the American Fisheries Society be:

1. Encourage fish importers, farmers, dealers, and hobbyists to prevent and discourage the accidental or purposeful introduction of aquatic species into their local ecosystems.

2. Urge that no city, county, state, province, or federal agency introduce, or allow to be introduced, any species into any waters within its jurisdiction which might contaminate any waters outside its jurisdiction without official sanction of the exposed jurisdiction.

3. Urge that only ornamental aquarium fish dealers be permitted to import such fishes for sale or distribution to hobbyists

The "dealer" would be defined as a firm or person whose income derives from live ornamental aquarium fishes.

4. Urge that the importation of fishes for purposes of research not involving introduction into a natural ecosystem, or for display in public aquaria by individuals or organizations, be made under agreement with responsible government agencies. Such importers will be subject to investigatory procedures currently existing and/or to be developed, and species so imported shall be kept under conditions preventing escape or accidental introduction. Aquarium hobbyists should be encouraged to purchase rare ornamental fishes through such importers. No fishes shall be released into any natural ecosystem upon termination of research or display.

5. Urge that all species considered for release be prohibited and considered undesirable for any purposes of introduction into any ecosystem unless that species shall have been evaluated upon the following bases and found to be desirable:

a. RATIONALE. Reasons for seeking an import should be clearly stated and demonstrated. It should be clearly noted what qualities are sought that would make the import more desirable than native forms.

b. SEARCH. Within the qualifications set forth under RATIONALE, a search of possible contenders should be made, with a list prepared of those that appear most likely to succeed, and the favorable and unfavorable aspects of each species noted.

c. PRELIMINARY ASSESSMENT OF THE IMPACT. This should go beyond the area of RATIONALE to consider impact on target aquatic ecosystems, general effect on game and food fishes or waterfowl, on aquatic plants and public health. The published information on the species should be reviewed and the species should be studied in preliminary fashion in its biotope.

d. PUBLICITY AND REVIEW. The subject should be entirely open and expert advice should be sought. It is at this point that thoroughness is in order. No importation is so urgent that it should not be subject to careful evaluation.

e. EXPERIMENTAL RESEARCH. If a prospective import passes the first four steps, a research program should be initiated by an appropriate agency or organization to test the import in confined waters (experimental ponds, etc.)

f. EVALUATION OR RECOMMENDATION. Again publicity is in order and complete reports should be circulated amongst interested scientists and presented for publication.

g. INTRODUCTION. With favorable evaluation, the releases should be effected and monitored, with results published or circulated

Because animals do not respect political boundaries, it would seem that an international, national, and regional agency should be involved at the start and have the veto power at the end. Under this procedure there is no doubt that fewer introductions would be accomplished, but quality and not quantity is desired and many mistakes might be avoided

B. The Society encourages international, national, and regional natural resource agencies to endorse and follow the intent of the above position

C. The Society encourages international harmonization of guidelines, protocols, codes of practice, etc., as they apply to introduction of aquatic species

D. Fisheries professionals and other aquatic specialists are urged to become more aware of issues relating to introduced species.

Literature Cited

Alexander, G. R. 1977. Consumption of small trout by large predatory brown trout in the North Branch of the Au Sable River, Michigan. Michigan Department of Natural Resources, Fisheries Research Report 1855:1-26.

_____ 1979. Predators of fish in coldwater streams. Pages 153-170 *in* H. Clepper, ed. Predator-prey systems in fisheries management. Sport Fishing Institute, Washington, DC

Anderson, R. S. 1981. Food habits of selected non-native fishes: stomach contents. First annual performance report, Non-Native Fish Research Laboratory, Florida Game and Fresh Water Fish Commission, Boca Raton, FL. 16 pp.

_____ 1982. Food habits of selected non-native fishes: stomach contents. Second annual performance report, Non-Native Fish Research Laboratory, Florida Game and Fresh Water Fish Commission, Boca Raton, FL. 22 pp.

Chevassus, B. 1979. Hybridization in salmonids: results and perspectives. Aquaculture 17:113-128.

Contreras-B. S., and M. A. Escalante-C. 1984. Distribution and known impacts of exotic fishes in Mexico. Pages 102-130 *in* W. R. Courtenay, Jr. and J. R. Stauffer, Jr., eds. Distribution, biology, and management of exotic fishes. The Johns Hopkins Univ. Press, Baltimore, MD.

Courtenay, W. R., Jr., and C. R. Robins. 1973. Exotic aquatic organisms in Florida with emphasis on fishes: a review and recommendations. Trans. Am. Fish. Soc. 102:1-12.

Crossman, E. J. 1984. Introduction of exotic fishes into Canada. Pages 78-101 *in* W. R. Courtenay, Jr. and J. R. Stauffer, Jr., eds. Distribution, biology, and management of exotic fishes. The Johns Hopkins Univ. Press, Baltimore, MD.

Dangel, J. R., P. T. Macy, and F. C. Withler. 1973. Annotated bibliography of interspecific hybridization of fishes of the subfamily Salmoninae. U.S. Department of Commerce, NOAA Technical Memorandum NMFSFC-1. 48 pp.

Germany, R. D. 1977. Population dynamics of the blue tilapia and its effects on the fish populations of Trinidad Lake, Texas. Doctoral dissertation, Texas A&M University, College Station, TX. 55 pp

Hickling, C. F. 1961. Tropical inland fisheries. John Wiley and Sons, New York, NY. 287 pp.

Hogg, R. G. 1976. Ecology of fishes of the family Cichlidae introduced into the fresh waters of Dade County, Florida. Doctoral dissertation, University of Miami, Coral Gables, FL. 142 pp.

Hoffman, G. L. 1970. Intercontinental and transcontinental dissemination and transfaunation of fish parasites with emphasis on whirling disease (*Myxosoma cerebralis*). Am Fish Soc Spec Publ 5:69-81

_____ 1981. Recently imported parasites of baitfishes and relatives. Pages 45-46 in Third annual proceeding Catfish Farmers of America research workshop, Las Vegas, NV.

Hoffman, G. L. and G. Schubert. 1984. Some parasites of exotic fishes. Pages 233-261 in W. R. Courtenay, Jr. and J. R. Stauffer, Jr. eds. Distribution, biology, and management of exotic fishes. The Johns Hopkins Univ. Press, Baltimore, MD

Knaggs, E. H. 1977. Status of the genus *Tilapia* in California's estuarine and marine waters. California-Nevada Wildlife Transections 1977:60-67

Kohler, C. C., and W. R. Courtenay, Jr. 1986. Regulating introduced aquatic species: a review of past initiatives. Fisheries 11(2): 34-35

Kohler, C. C., and J. G. Stanley. 1984. A suggested protocol for evaluating proposed exotic fish introductions in the United States. Pages 387-406 *in* W. R. Courtenay, Jr. and J. R. Stauffer, Jr., eds. Distribution, biology, and management of exotic fishes. The Johns Hopkins Univ. Press, Baltimore, MD

Laycock, G. 1966. The alien animals. Natural History Press, Garden City, NY. 240 pp.

Miley, W. W., II. 1978. Ecological impact on the pike killifish, Belonesox belizanus Kner (Poeciliidae), in southern Florida. Master's thesis, Florida Atlantic University, Boca Raton, FL. 55 pp.

Moyle, P. B. 1976a. Inland fishes of California. University of California Press, Berkeley, CA. 405 pp.

_____ 1976b. Fish introductions in California: history and impact on native fishes. Biol. Conserv. 9:101-118.

Noble, R. L. 1980. Management of lakes, reservoirs, and ponds. Pages 265-295 in R. T. Lackey and L. A. Nielsen, eds. Fisheries Management. John Wiley and Sons, New York, NY.

Noble, R. L., R. D. Germany and C. R. Hall. 1975. Interactions of blue tilapia and largemouth bass in a power plant cooling reservoir. Proc. Annu. Conf. Southeast. Assoc. Game Fish Comm. 29:247-251.

Philipp, D. P., W. F. Childers, and G. S. Whitt. 1983. A biochemical genetic evaulation of the northern and Florida subspecies of largemouth bass. Trans. Am. Fish. Soc. 112:1-20.

Phillippy, C. L. 1969. *Tilapia melanopleura* as a control for aquatic vegetation. Mimeographed report, Florida Game and Fresh Water Fish Commission. 13 pp.

Quast, J. C. 1961. The food of the bairdiella. Calif. Dep. Fish Game Fish. Bull. 113:153-164.

Schwartz, F. J. 1972. World literature to fish hybrids with an analysis by family, species, and hybrid. Publication no. 3, Gulf Coast Research Laboratory and Museum, Ocean Springs, MS. 328 pp.

_____1981. World literature to fish hybrids with an analysis by family, species, and hybrid. Supplement 1. NOAA Technical Report no. 750, NMFS, Special Scientific Report-Fisheries. 507 pp.

Shafland, P. L. 1979. Non-native fish introductions with special reference to Florida. Fisheries 4(3):18-24.

Sharpe, F. P. 1952. Some observations of the feeding habits of brown trout. Prog. Fish-Cult. 24(2):60-61

Shireman, J. V. 1984. Control of aquatic weeds with exotic fishes. Pages 302-312 in W. R. Courtenay, Jr. and J. R. Stauffer, Jr., eds. Distribution, biology, and management of exotic fishes. The Johns Hopkins Univ. Press, Baltimore, MD.

Shotts, E. B., Jr., and J. B. Gratzek. 1984. Bacteria, parasites, and viruses of aquarium fish and their shipping waters. Pages 215-232 in W. R. Courtenay, Jr. and J. R. Stauffer, Jr., eds. Distribution, biology, and management of exotic fishes. The Johns Hopkins Univ. Press, Baltimore, MD.

Sindermann, C. J. 1986. Strategies for reducing risks from introductions of aquatic organisms: a marine perspective. Fisheries 11(2):10-15.

Taylor, J. N., W. R. Courtenay, Jr., and J. A. McCann. 1984. Known impacts of exotic fishes in the continental United States. Pages 322-373 in W. R. Courtenay, Jr. and J. R. Stauffer, Jr., eds. Distribution, biology, and management of exotic fishes. The Johns Hopkins Univ. Press, Baltimore, MD.

Turner, J. S. 1981. Population structure and reproduction in the introduced Florida population of the pike killifish, *Belonesox belizanus* (Pisces: Poeciliidae). Master's thesis, University of Central Florida, Orlando, FL. 56 pp.

Welcomme, R. L. 1986. International measures for the control of introductions of aquatic organisms. Fisheries 11(2):4-9

APPENDIX D

LOCATION BY SECTION, RANGE, AND TOWNSHIP FOR THE 6,500-FOOT ELEVATION ON THE COLORADO AND GREEN RIVERS AND THEIR TRIBUTARIES IN THE UPPER COLORADO RIVER BASIN

GREEN RIVER

Little Snake River: Northeast Corner, Section 14, Township 12 North, Range 89 West, Fly Creek Quadrangle, Colorado

Yampa River: Northwest Corner, Section 18, Township 6 North, Range 86 West, Cow Creek Quadrangle, Colorado

White River: Southwest Corner, Section 14, Township 1 South, Range 93 West, Veatch Gulch Quadrangle, Colorado

Duchesne River: Northeast Corner, Section 31, Township 1 South, Range 7 West, Tabiona Quadrangle, Utah (note: This location is 6,500 feet, not 6,520 feet)

Price River: Southeast Corner, Section 16, Township 12 South, Range 9 East, Kyune Quadrangle, Utah

Muddy Creek: Northwest Corner, Section 16, Township 21 South, Range 6 East, Emery West Quadrangle, Utah

Three Main Branches of the San Rafael River

Ferron Creek: Southeast Corner, Section 29, Township 19 South, Range 6 East, Ferron Canyon Quadrangle, Utah

Cottonwood Creek: Southwest Corner, Section 31, Township 17 South, Range 7 East, Mahogany Point Quadrangle, Utah

Huntington Creek: Northwest Corner, Section 31, Township 17 South, Range 8 East, Hiawatha Quadrangle, Utah

COLORADO RIVER

Colorado River: Northwest Corner, Section 7, Township 2 South, Range 84 West, Blue Hill Quadrangle, Colorado

Gunnison River: Southwest Corner, Section 10, Township 49 North, Range 7 West, Grizzly Ridge Quadrangle, Colorado

Dolores River: Northwest Corner, Section 24, Township 39 North, Range 17 West, Yellow Jacket Quadrangle, Colorado

APPENDIX B

Peer-reviewed Study to Evaluate the Effectiveness of the Interagency Standardized Monitoring Program

STATE OF COLORADO
Roy Romer, Governor
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE
AN EQUAL OPPORTUNITY EMPLOYER
John W. Mumma, Director
6060 Broadway
Denver, Colorado 80216
Telephone: (303) 297-1192

711 Independent Avenue
Grand Junction, CO 81505
970-248-7175

For Wildlife–
For People

April 25, 1997

Dear Reviewer,

The Procedures for Stocking Nonnative Fish Species in the Upper Colorado River Basin require that a peer-reviewed study be conducted to evaluate the effectiveness of the Interagency Standardized Monitoring Program (ISMP). The need for this evaluation originally centered around the ability of the ISMP sampling performed in backwaters to detect changes in the survivability and/or abundance of centrarchid sport fish stocked into floodplain ponds and subsequently escaping into backwater habitats.

Recent discussions about the ISMP also identified the importance of examining the effectiveness of the ISMP protocol in sampling other nonnative fish species. The enclosed proposal, Evaluation of the Interagency Standardized Monitoring Program Sampling Technique in Backwaters of the Colorado River in the Grand Valley, Colorado, was prepared by Kevin Bestgen to fulfill the evaluation described in the Stocking Procedures.

The funding for this investigation was included in the Recovery Program scope-of-work entitled Removal and Control of Nonnative Fishes in Colorado and Gunnison River Floodplain Source Ponds submitted by the Colorado Division of Wildlife. This investigation, to begin in 1997, is anticipated to require another year of field sampling in 1998 and another one-half year to complete analyses and reporting in 1999.

You are being asked to be part of the peer-review process. Please review the enclosed proposal and return your written comments to Patrick J. Martinez at the Grand Junction address above by May 12. 1997. Your time and effort are greatly appreciated.

Sincerely,

Patrick J. Martinez
Aquatic Researcher

APPENDIX C

Evaluation of the Interagency Standardized Monitoring Program Sampling Technique in Backwaters of the Colorado River in the Grand Valley, Colorado

Evaluation of the Interagency Standardized Monitoring Program Sampling Technique in Backwaters of the Colorado River in the Grand Valley, Colorado

A proposal submitted to:

Patrick J. Martinez
Colorado Division of Wildlife
711 Independent Avenue
Grand Junction, Colorado 81505

prepared by

Kevin R. Bestgen
Larval Fish Laboratory
Department of Fishery and Wildlife Biology
Colorado State University
Fort Collins, Colorado 80523

9 June 1997

Background

Does the young-of-year (YOY) portion of the Interagency Standardized Monitoring Program (ISMP) accurately estimate the abundance and size-structure of centrarchid fishes in backwaters in the Grand Valley portion of the Colorado River? This question was motivated by discussions about escapement of centrachid sport fishes from floodplain ponds and how that additional predator load may affect endangered fish species in backwaters of the Colorado River. Additional details on the evolution of this issue can be found in Martinez (1996). This issue was also discussed in a scope-of-work for Capital Project 18 entitled "Removal and control of non-native fishes in Colorado and Gunnison River floodplain source ponds" (submitted by P. Martinez and T. Nesler, Colorado Division of Wildlife) and is the primary question that this research proposal considers. Because non-native predaceous fishes may represent a substantial source of mortality for early life stages of endangered fishes, any increase in their abundance in rivers as a result of escapement from floodplain ponds is viewed as a negative consequence of floodplain ponds that are stocked for fishing opportunity. A monitoring program that accurately tracked abundance of these non-native species would be a means to determine trends in escapement.

Some form of YOY sampling in backwater habitat has been conducted in the Colorado River in the Grand Valley since 1982 and the ISMP has been in place since 1986 (McAda et al. 1994). The ISMP was developed to "monitor population trends of two endangered fishes from the Colorado River Basin-Colorado squawfish and humpback chub" (McAda et al. 1994) and not necessarily abundance of centrarchid fishes. The YOY Colorado squawfish portion of the ISMP

employs seining in autumn to sample fishes in a subset of the backwaters present in four main river reaches in the upper Colorado River Basin, including one in the Grand Valley that extends from the mouth of the Gunnison River downstream to the Utah-Colorado state line. The main goal of that sampling was to "provide an annual index of the relative reproductive success of Colorado squawfish and survival of the young fish through their first growing season" (McAda et al. 1994). Each of the four main reaches is divided into eight-km-long sub-reaches. The standard protocol is to sample the first two backwaters encountered in each sub-reach that exceed 30 m^2 in area and are $\geq$ 30 cm deep (unless it is turbid) with two non-overlapping seine hauls (4.6 m long seine, 3 mm-mesh). Although data are collected that describe the abundance of species other than the target endangered ones in some backwaters, it is unknown if ISMP protocol is capable of estimating the abundance and size-structure of centrarchids to the degree needed by the Recovery Program. In fact, because the ISMP protocol has never been rigorously evaluated, the accuracy with which ISMP measures abundance and size-structure of any species in backwaters is unknown.

Abundance measurements of populations inherently have natural variation caused by shifts in habitat availability or time (year) effects and variation due to sampling. Although biologists in the Recovery Implementation Program are most interested in how populations respond to differences in backwater habitat quantity or quality or in discharge levels across years, sampling error may confound actual abundance estimates because they are inextricably tied. Assessing sampling error is the only way to disentangle these two sources of variation.

Fishes exhibit differential susceptibility to capture depending on factors such as fish body size, habitat complexity, environmental conditions, and the gear type used (Larimore 1961,

Hayes 1983, Reynolds 1983). In general, no single gear type is suitable for estimating the species richness, abundance, and size-structure of even relatively simple fish communities (Dauble and Gray 1980, Bramblett and Fausch 1991, Vadas and Orth 1993) although electrofishing may have the least bias in some situations (Simonson and Lyons 1995). Most cypriniforms typically inhabit open water and as a result are relatively easy to capture with seines (Dauble and Gray 1980, pers. obs), the exclusive gear type used in YOY ISMP sampling. In contrast, centrarchids can be particularly hard to sample in riverine backwaters because of their affinity for deep water and cover such as undercut banks, large woody debris, or concrete rip-rap (Larimore 1961, Dauble and Gray 1980, Bayley et al. 1989, pers. obs). In such circumstances, seining is effective only if specialized techniques such as kick-seining is employed. This involves surrounding the cover or undercut bank and vigorously disturbing the area by repeated kicking to flush individuals out of the cover and into the seine, and then sweeping the seine up as close to the cover as possible. Because these techniques are not part of the sampling protocol, ISMP may sample centrarchids in representative numbers only in shallow and structurally simple habitat.

Accuracy of abundance estimation of non-native cyprinids may also be of interest to managers because these species are also predators and competitors with native species. Because the distribution of these species in backwaters is often not uniform due to environmental conditions it is unknown if the standard two seine haul approach will sample these taxa in a manner that reflects both their abundance and size-structure. Because of the importance of accurate data collection in long-term monitoring, I propose a study that will evaluate the accuracy and precision of the ISMP approach to sampling fishes in backwaters. This study will

center on the Grand Valley portion of the Colorado River but will have implications for the relevancy of the YOY ISMP technique wherever it is used.

Study Design

General Sampling Approach.--In this study, a double-sampling approach (Thompson 1992) will be used where species richness and fish density in a backwater will be estimated with a quantitative but low effort (ISMP uses catch-per-unit-effort as basis) and high effort (quantitative estimation) technique. Understanding how well the low effort ISMP approach characterizes the actual population requires that a reliable estimate of the actual fish population be obtained. I am equating "reliable" with an estimate that is accurately measured and has small variance. Employing both levels of sampling will allow quantification of bias of the ISMP approach. When I say "ISMP sampling" or "ISMP approach" I mean sampling that duplicates that protocol but not what is necessarily completed by biologists that do the regular ISMP sampling.

In a hypothetical scenario, the two-level sampling scheme in backwaters may proceed as follows. A backwater that conforms to ISMP standards for area and depth is selected and closed to the main river with a block net. While this is not a normal part of ISMP sampling, isolating the backwater fish population to prevent immigration or emigration during post-ISMP sampling is critical to fulfilling assumptions of closed population estimation techniques (Otis et al. 1978; White et al. 1982). Two seine samples are then completed within the backwater according to

ISMP protocol. Typical seine sample localities within backwaters will be determined by interviews with biologists experienced with these techniques when they are not present for sampling. Some backwaters will be sampled in conjunction with biologists that typically conduct ISMP sampling but most will not. This is true because only two days are usually required to complete ISMP sampling in the Grand Valley of the Colorado River (pers. comm., B. Elmblad, Colorado Division of Wildlife) but quantitative sampling of individual backwaters will take much longer. This should not diminish the comparisons proposed because this proposal specifically deals with the question of whether the sampling protocol used adequately samples fish in proportion to their abundance. Considerations of how changes in weather or river conditions affect sampling are important as well, but those issues require a scope of study wider than that of the backwater at a given point in time. For instance, determining if changes in weather or water temperature affect whether centrarchids move into or out of backwaters would require a separate study all together.

Following ISMP sampling within a backwater, the second-level quantitative sampling will proceed using either depletion or capture-recapture population estimation. Depletion sampling will likely be the primary method in backwaters that can be completely sampled three to five times (passes) in a day. A pass will consist of completely sweeping all areas of the backwater with seine hauls which are enumerated during each pass. Backwaters with extensive cover or moderate to deep water will also be sampled by electrofishing on each pass. The electrofishing unit used will be dictated by water depth and other habitat conditions but may consist of a backpack unit, a bank shocker with a generator and cable reel, or a boat-mounted unit if conditions permit.

Fish captured in ISMP sampling (which is considered part of the first pass catch in depletion samples) and on subsequent passes will be held and processed separately. Samples will be scanned thoroughly for native fishes, centrarchids, and other relatively rare taxa (e.g. catfishes) and those will be removed, measured individually, and weighed. The remainder of the sample will likely consist almost wholly of small non-native cyprinids such as sand shiner *Notropis stramineus*, red shiner *Cyprinella lutrensis*, and fathead minnow *Pimephales promelas*. Small to moderate-sized samples will be either identified, measured, and weighed en masse in the field or preserved in 10% formalin for laboratory analysis. Extremely large samples may need to be subsampled after the mass of the whole sample is determined. Subsamples would be handled in the same manner as small or moderate-sized samples. The abundance of species in the total sample would be determined by the proportion of the total mass that each taxa represented in the subsample. If an accurate subsampling scheme can not be experimentally determined, the whole sample will be preserved. Subsampling schemes will be tested prior to the sampling season and will determine if the subsample represents the abundance, total length, and mass characteristics of the whole. Disposition of non-native fishes that are processed in the field will be at the discretion of the Colorado Division of Wildlife. Area and mean and maximum depth of backwaters will be measured and cover and other notable physical habitat characteristics will be described.

About 10% of backwaters in the Grand Valley reach of the Colorado River have areas that are too deep to effectively sample with a seine (pers. comm., B. Elmblad, Colorado Division of Wildlife). Some backwaters are also extremely large. If these deep or large backwaters are routinely sampled by biologists in the conduct of ISMP, and are important to evaluate as

potential habitat for centrarchids, capture-recapture techniques with different sampling techniques may need to be employed. This would necessarily be the case when fish populations (e.g. cyprinids) are so large that they cannot be readily depleted with moderate effort. In those instances, gear might include seines for shallow areas, and electrofishing, minnow traps, and small fyke nets for deeper areas. The initial capture sample would be as large as possible, processed as described above, marked with a fin clip, and released. A minimum of two subsequent recapture samples would be made, with unique marks being used on each recapture pass. Multiple clips on individual fish may affect their behavior and probability of capture. However, a study to evaluate that aspect of capture-recapture studies is beyond the scope of this study and may be only a minimal problem if large deep backwaters that require capture-recapture sampling and marking (instead of removal) are indeed rare. Time delay between recapture samples (probably a day) would be sufficient to allow dispersal by marked animals and may also depend on the reliability of the block net to close the population.

Potential bias of quantitative estimates.--Abundance estimates for the actual population usually employ different sampling methods than those used to obtain the estimates to be calibrated (ISMP). This is done because some fish will likely be less susceptible to the capture technique as sampling proceeds because of increased avoidance (Bayley et al. 1989, Riley and Fausch 1992). Increased avoidance violates the assumption of equal probability of capture for animals across capture occasions in removal estimation. The simple, seinable habitat of most backwaters and use of electrofishing should remedy problems of fish avoidance of gears and violation of assumptions.

The possibility exists that some taxa may avoid even multiple gear types on consecutive sampling passes. This will be assessed relatively early in the sampling program by depletion sampling of two or more backwaters according to the normal protocol and following that effort with complete sampling. Complete sampling often involves use of fish toxicants (Bayley et al. 1989) a technique which is not feasible where endangered species occur. Instead, saturation sampling with additional gear types including fyke nets, baited minnow traps, and perhaps entanglement gear will be employed to determine bias. If abundance of fish remaining after depletion sampling does not correspond with that predicted from estimates, sampling will be adjusted appropriately.

Precision of quantitative estimates.--Regardless of whether removal or capture-recapture estimation is used, the number of sampling passes required will depend upon probability of capture of animals on each pass and the size of the population being estimated. Simulations using program CAPTURE (White et al. 1982) and a removal estimator were implemented with different hypothetical populations sizes and probabilities of capture in order to determine the number of passes needed to reach specific estimation goals. The goal of these simulations was to identify effort necessary to get accurate abundance estimates that had coefficients of variation (CV; standard deviation/mean*100) that were 10-15% of the mean. That level of precision is adequate to answer most research level questions, while levels higher than about 20-25% are not considered reliable (White et al. 1982).

These simulations suggested that populations of 1,000 animals would be reliably estimated with 4-5 passes if capture probability was relatively low (0.2) or with 3 passes if

capture probability was moderate at 0.35 (Table 1). Populations of 100 would be reliably estimated with 4-5 passes if capture probability was 0.35. Small populations (≤ 30) may require 6 or more sampling occasions for reliable estimation and even at that level of effort confidence intervals are likely to be relatively wide. In those cases, the estimate of population size is often the number of animals caught. One of the benefits of this type of sampling and estimation is that results can be calculated in the field if numbers of marked and recaptured animals are known. If the precision of estimates does not meet objectives more passes can be completed.

Population sizes of centrarchids may often be small so the level of effort needed to detect and accurately estimate abundance may need to be refined from pilot field studies. The cost of reliable estimation is of course the time needed to increase probability of capture or the number of sampling passes or both. That additional time could be spent sampling more backwaters so a balance will need to be reached regarding the number of backwaters sampled and the intensity of sampling within a backwater.

Timing and Allocation of Effort.--Most sampling will occur in September and October although some preliminary sampling to will be conducted earlier. Compared to sampling conducted in early to mid-July, sampling then time will allow fish to grow to sizes that approximate those collected in normal ISMP operations and will also allow for native species to be large enough to be identified and handled without high mortality. Efforts will be timed so that overlap with regular ISMP sampling occurs. Efforts will also be coordinated so that backwaters selected for depletion sampling are not the same ones chosen for ISMP sampling. Earlier

sampling will concentrate on assessing the reliability of seining and electrofishing to deplete populations, to determine sub-sampling procedures, and other preliminary work.

I suggest that the two-level sampling described above be implemented to estimate abundance of centrarchid populations in 20-30 backwaters in the study area. That level of sampling exceeds the number of backwaters sampled annually by ISMP (11-20, McAda et al. 1994) and represents about 50% of the number of backwaters found in the reach in any given year (pers. comm. B. Elmblad). The number chosen needs to be flexible depending on the effort required to sample these backwaters as described.

Because the presence and density of centrarchids may be affected by habitat features such as size or depth of backwaters and presence of cover, backwaters sampled should be stratified by size. Dimensions of backwaters typical for the Grand Valley reach will be determined from the ISMP database. An initial design may be to divide backwaters into small, medium, and large classes and with equal numbers of each will be sampled. This will allow estimation of the effect of backwaters size and habitat characteristics, including presence and amount of cover, on presence and density of centrarchids. If field surveys or ISMP data suggest that only a two size classes are realistic, then sampling will proceed in that manner. Issues of abundance of centrarchids related to size or depth-dependence of backwaters can be dealt with in the analysis.

A subset of 10-15 backwaters quantitatively sampled for centrarchids should be chosen for abundance estimation of all species including non-native cyprinids. The number sampled needs to be especially flexible, because the number of cypriniform fishes collected could be immense. Backwaters chosen for quantitative assessment of the entire assemblage will be equally allocated among small, moderate, and large backwater sizes.

Data analysis.--Species richness (number of species) and density by taxa will be determined for individual backwaters for both ISMP and quantitative sampling. Estimates of fish density for ISMP samples will be determined by dividing the number of individuals captured by the area seined to facilitate comparison with past data. Estimates of fish density for quantitative samples will be determined by dividing the estimated abundance of each taxa by backwater area. Abundance estimates will be calculated with appropriate estimators in program CAPTURE or MARK. Bias is calculated as the ratio of species richness or fish density in the ISMP samples compared to that for quantitative samples, percent bias is that ratio multiplied by 100. The number of times that ISMP sampling detected the presence of centrarchids in backwaters compared to that for quantitative sampling will be analyzed with logistic regression with centrachid presence/absence as the binomial response variable. Backwater physical habitat variables and distance from potential source areas will be included as model covariates to determine if detection capability was related to backwater area (small, moderate, or large) or depth. Rank-order or chi-square analyses will determine how accurately ISMP sampling measures species composition compared to the actual population. Data gathered in this study and historical (1986-1997) ISMP data collected in primary and secondary backwaters will be compared with appropriate procedures to determine differences in species composition, density, and size-structure of fish captured. This will aid determining whether and to what degree ISMP sampling procedures are biased.

The basic assumptions that this proposal was developed under follow. If these assumptions are found false after sampling has been initiated, the study design will need to be altered. The approach described thus far assumes that the appropriate unit of investigation is the

backwater and further assumes that most centrarchids in the Colorado River will occupy backwaters and do not move extensively among backwaters or in and out of backwaters on a diel basis. However, if these assumptions do not hold, the reach scale may be a more appropriate to test this idea. Repeated sampling of one or two backwaters over several months time may give some insights into movement dynamics and validity of these assumptions. If data collected the first year indicate that fish movements may be important, repeated backwater sampling could be conducted at the expense of sampling other backwaters.

Expected benefits.--Expected benefits of this project include determining bias of the ISMP technique for measuring centrarchid and other fish abundance in backwaters of the Colorado River in the Grand Valley. This will allow determination of whether ISMP is capable of monitoring escapement and abundance of centrarchid fishes in the Colorado River. Two field seasons are recommended with an additional half year of funding for data analysis and preparation of a final report. Two years of sampling will allow assessments to be made for the reach that will likely be affected by different habitat and spring flow conditions. A second year of sampling would also allow for development of sampling guidelines if present ISMP techniques are found inadequate.

Literature Cited

Bayley, P. B., R. W. Larimore, and D. C. Dowling. Electric seine as a fish-sampling gear in streams. Transactions of the American Fisheries Society 118:447-453.

Bramblett, R. G., and K. D. Fausch. 1991. Fishes, macroinvertebrates and aquatic habitats of the Purgatoire River in Pinon Canyon, Colorado. Southwestern Naturalist 36:381-394.

Dauble, D. D., and R. H. Gray. 1980. Comparison of a small seine and a backpack electroshocker to evaluate nearshore fish populations in rivers. Progressive Fish-Culturist 42:93-95.

Hayes, M. L. 1983. Active fish capture techniques. Pp. 123-146. *In* Fisheries Techniques, L. A. Nielson and D. L. Johnson, (eds.). American Fisheries Society, Bethesda, Maryland. 468 pp.

Larimore, R. W. 1961. Fish population and electrofishing success in a warm-water stream. Journal of Wildlife Management 25:1-12.

Martinez, P. J. 1996. Federal Aid report. Colorado Division of Wildlife.

McAda, C. W., and others. 1994. Interagency standardized monitoring program: summary of results, 1986-1992. U. S. Fish and Wildlife Service, Grand Junction, Colorado. 73 pp, + appendices.

Otis, D. L., K. P. Burnham, G. C. White, and D. R. Anderson. 1978. Statistical inference from capture data on closed animal populations. Wildlife Monograph 62:1-135.

Reynolds, J. B. 1983. Electrofishing. Pp. 147-164. *In* Fisheries Techniques, L. A. Nielson and D. L. Johnson, (eds.). American Fisheries Society, Bethesda, Maryland. 468 pp.

Riley, S. C., and K. D. Fausch. 1992. Underestimation of trout population size by maximum likelihood removal estimates in small streams. North American Journal of Fisheries Management 12:768-776.

Simonson, T. D., and J. Lyons. 1995. Comparison of catch per effort and removal procedures for sampling stream fish assemblages. North American Journal of Fisheries Management 15:419-427.

Thompson, S. K. 1992. Sampling. John Wiley and Sons, New York, New York.

Vadas, R. L., and D. J. Orth. 1993. A new technique for estimating the abundance and habitat use of stream fishes. Journal of Freshwater Ecology 8:305-317.

White, G. C., D. R. Anderson, K. P. Burnham, and D. L. Otis. 1982. Capture-recapture and removal methods for sampling closed populations. LA-8787-NERP, Los Alamos National Laboratory, Los Alamos, New Mexico. 235 pp.

Budget (July 1 1997-30 June 1998)

Salary	
Principal Investigator (6 mos, including benefits)	24,000
Technicians (6 man-months, including benefits)	9,000
Travel	
Vehicle	2,000
Motel and per diem	3,500
Equipment	
Waders, fyke nets, seines, block nets, jars, solutions, miscellaneous sampling and lab gear, holding pens, fuel, equipment and boat repairs	3,000
	$41,500
Colorado State University overhead (10%)	4,150
First Year Total	$45,650
Second year budget (less $2,000 equipment)	$43,450
Third year (part-year for data analysis and report prep, some travel)	$24,000
Grand total	$113,100

This budget assumes that equipment such as electrofishing boats and other major gear will be available for loan from Colorado Division of Wildlife and U. S. Fish and Wildlife Service in Grand Junction.

Table 1.--Results of simulations (N = 100 reps) from program CAPTURE (White et al. 1982) for a depletion estimate that depicts the number of sampling occasion (passes) needed to achieve various coefficients of variation (CV) with large (N = 1000), moderate (N = 100), and small (N ≤ 30) population sizes (N) and low (0.20) or moderate (0.35) capture probabilities (Pcap). Data are the mean population size (CV) in simulations with three, four, or five sampling occasions.

		Sampling Occasions		
N	Pcap	3	4	5
1000	0.20	1035 (19.9)	1015 (13.9)	1010 (14.0)
1000	0.35	1005 (6.5)	998 (4.2)	1010 (3.3)
100	0.35	103 (25.2)	101 (14.9)	99 (8.1)
30	0.35	30 (28.3)	30 (26.0)	30 (17.0)

APPENDIX D

A Low Effort System for Planned Coolwater and Coldwater Reservoirs
AN ADDENDUM:
The Addition of Five Additional "Species" to the Model

HABITAT SUITABILITY INDEX MODELS: A LOW EFFORT SYSTEM FOR PLANNED COOLWATER AND COLDWATER RESERVOIRS (Revised)

AN ADDENDUM:

The Addition of Five additional "species" to the Model--smallmouth bass, largemouth bass, northern pike, reproducing channel catfish, and stocked channel catfish.

Fort Collins, Colorado
April 1997

Acknowledgements

The time and effort panel members put into this task is greatfully acknowledged. The competent programming skills of Brian Cade greatly simplified the work of the panel and was very much appreciated.--EPB.

In 1984 the U.S. Fish and Wildlife Service published a paper entitled Habitat Suitability Index Models: A low effort system for planned coolwater and coldwater reservoirs (Revised) by McConnell, Bergersen, and Williamson (McConnell et al. 1984). Described in this publication was a new approach for measuring reservoir habitat suitability based on patterns of primary reservoir habitat attributes. To demonstrate the utility of the approach, reservoir habitat suitability for five selected fish species was described. While the model can be used to rank the suitability of a reservoir for any species, it is not a trivial endeavor to add new species to the model. Much must be known about the life history of the fish as well as how it might respond to a whole host of interacting habitat variables. The rules governing how well a particular fish would be expected to perform in a given reservoir were developed using an informal "expert system" approach. This approach remains the best way to deal with additions of more species to the model. In response to a request to expand the model to include more species, a group of "expert" fish biologists was brought together to address this task. This addendum to the original paper documents this effort.

The five additional fish added to the model included smallmouth bass, largemouth bass, northern pike, naturally spawning channel catfish and stocked channel catfish. The "expert" panel convened included Jim Terrell (USGS-BRD-Midcontinent Ecosystem Research Center), Greg Langer (U. S. Fish and Wildife Service, Rocky Mountain National Wildlife Refuge), Patrick Martinez (Colorado Division of Wildlife, Aquatic Research Section), Stephen Flickinger (Colorado State University, Department of Fishery and Wildlife Biology), and Eric Bergersen (USGS-BRD Colorado Cooperative Fish and Wildlife Research Unit). During a series of

meetings, rules for each species were developed by consensus of panel members. Differences of opinion that occurred during the rule making process were resolved by open discussion and scrutiny of the issue by all members until a unanomous consensus was reached. As rules emerged from the panel discussions, they were applied to the 234 reservoir descriptions to classify each as being high, high medium, low medium, or low in terms of overall habitat quality for each species. After this was done, each reservoir description and its corresponding habitat suitability rating was reexamined by the panel to check for any inconsistencies. Where found, group consensus was again used to generate appropriate rules to resolve the differences.

The five primary attributes used in the model and corresponding to the positions A, B, C, D, and E in Table 1 were:

A--Temperature;

B--Mineral turbidity;

C--Nonliving cover (structure);

D--Maximum drawdown and timing of drawdown;

E--Frequency of shallow coves.

One secondary habitat attribute used in the original model was modified during the addition of the five new fish described here. The low range of the shoreline development factor (SDF) was changed to better reflect the distribution of SDF values commonly encountered in north temperate reservoirs. The low range was changed from <5 to <2 and the intermediate range from 5-10 to 2-10. All other secondary attributes were unchanged.

Rules used to define habitat suitability for each species are given below:

Smallmouth Bass

If A=1 or D=1 or (C=1 and E=1) then let SMB=L
If not (A=1 or D=1 or (C=1 and E=1)) and (B=1 or C=1 or E=1) then let SMB=LM
If A=3 and B>1 and C=3 and D=3 and E=1 then let SMB=HM
If not (SMB=L or SMB=LM or SMB=HM) then let SMB=H
If SMB=H and (A=2 or C=2) then let SMB=HM

Largemouth Bass

If A=1 or D=1 then let LMB=L
If not (A=1 or D=1) and (E=1 or A=2) then let LMB=LM
If not (LMB=L or LMB=LM) then let LMB=H
If LMB=H and (B=1 or C=1 or E=2) then let LMB=HM
If A=3 and B=2 and C=2 and D=2 and E=3 then let LMB=HM

Northern Pike

If A=1 or B=1 or D=1 or (B=2 and E=1 and C=1 and D=2) then let NP=L
If not (A=1 or B=1 or D=1 or (B=2 and E=1 and C=1 and D=2)) and (B=2 or D=2 or (E=1 and C=1)) then let NP=LM
If not (NP=L or NP=LM) then let NP=H
If NP=H and (A=2 or E=1 or C=1) then let NP =HM
If A=3 and B=2 and C=3 and D=3 and E=3 then let NP=HM
If A=3 and B=3 and C=3 and D=2 and E=3 then let NP=hm

Reproducing Channel Catfish

If A=1 then let CCR=L
If A=2 and B=1 and C=1 and D=1 and E=1 then let CCR=L
If A=2 and B=3 and D=1 and E=1 then let CCR=L
If A=2 and B=3 and C=1 and D=1 and E<3 then let CCR=L
If A=2 and B=3 and C=1 and E=1 then let CCR=L
If A=2 and B=3 and C=3 and D=1 and E<3 then let CCR=L
If A=2 and B=1 and C<3 and (D=1 or E=1) and not (CCR=L) then let CCR=LM
If A=2 and B=1 and not (CCR=L or CCR=LM) then let CCR=HM
If A=2 and B=1 and E=1 and CCR=HM then let CCR=LM
If A=2 and B=2 and (D=1 or E=1) then let CCR=LM
If A=2 and B=2 and D>1 and E>1 then let CCR=HM
If A=2 and B=3 and not (CCR=l) then let CCR=LM
If A=2 and B=3 and C=2 and D>1 and E=3 then let CCR=HM
If A=3 then let CCR=HM
If A=3 and C=1 and D=1 then let CCR=LM
If A=3 and B=3 and C=1 and D>1 and E<3 then let CCR=LM
If A=3 and B=1 and C=2 and D=2 and E>1 then let CCR=H
If A=3 and B=1 and C=2 and D=3 then let CCR=H
If A=3 and B<3 and C>1 and D>1 then let CCR=H
If A=3 and B=1 and C=2 and D=2 and E=1 then let CCR=HM

Stocked Channel Catfish

If A=1 and E=1 then let CCS=L
If A=1 and E>1 then let CCS=LM
If A=2 and (D=1 or E=1) then let CCS=LM
If A=2 and D>1 and E>1 then let CCS=HM
If A=3 then let CCS=H
If A=3 and B<3 and D=1 then let CCS=HM
If A=3 and B=3 and C=1 then let CCS=HM
If A=3 and B=3 and D=1 then let CCS=HM
If A=3 and B=3 and C=2 and D=2 and E=1 then let CCS=HM
If A=3 and B=1 and C=1 and D>1and E=1 then let CCS=HM
If A=3 and B=1 and C=2 and D=2 and E=1 then let CCS=HM
If A=3 and B=3 and C=3 and D=2 and E=1 then let CCS=HM

These rules were applied to each reservoir description to determine reservoir suitability for each species (Table 1).

Table 1. Reservoir descriptions and habitat suitability ratings for smallmouth bass (SMB), largemough bass (LMB), northern pike (NP), reproducing channel catfish (CCR), and stocked channel catfish (CCS). Numerical patterns corresponding to A=temperature, B=mineral turbidity, C=non-living cover, D=extent and timing of drawdown, and E=shallow cover frequency describe reservoirs habitat conditions.

Reservoir Descriptions					"Species"				
A	B	C	D	E	SMB	LMB	NP	CCR	CCS
1	1	1	1	1	L	L	L	L	L
1	1	1	1	2	L	L	L	L	LM
1	1	1	1	3	L	L	L	L	LM
1	1	1	2	1	L	L	L	L	L
1	1	1	2	2	L	L	L	L	LM
1	1	1	2	3	L	L	L	L	LM
1	1	1	3	1	L	L	L	L	L
1	1	1	3	2	L	L	L	L	LM
1	1	1	3	3	L	L	L	L	LM
1	1	2	1	1	L	L	L	L	L
1	1	2	1	2	L	L	L	L	LM
1	1	2	1	3	L	L	L	L	LM
1	1	2	2	1	L	L	L	L	L
1	1	2	2	2	L	L	L	L	LM
1	1	2	2	3	L	L	L	L	LM
1	1	2	3	1	L	L	L	L	L
1	1	2	3	2	L	L	L	L	LM
1	1	2	3	3	L	L	L	L	LM
1	1	3	1	1	L	L	L	L	L
1	1	3	1	2	L	L	L	L	LM
1	1	3	1	3	L	L	L	L	LM
1	1	3	2	1	L	L	L	L	L
1	1	3	2	2	L	L	L	L	LM
1	1	3	2	3	L	L	L	L	LM
1	1	3	3	1	L	L	L	L	L
1	1	3	3	2	L	L	L	L	LM
1	1	3	3	3	L	L	L	L	LM
1	2	1	1	1	L	L	L	L	L
1	2	1	1	2	L	L	L	L	LM
1	2	1	1	3	L	L	L	L	LM
1	2	1	2	1	L	L	L	L	L
1	2	1	2	2	L	L	L	L	LM
1	2	1	2	3	L	L	L	L	LM
1	2	1	3	1	L	L	L	L	L
1	2	1	3	2	L	L	L	L	LM
1	2	1	3	3	L	L	L	L	LM
1	2	2	1	1	L	L	L	L	L
1	2	2	1	2	L	L	L	L	LM
1	2	2	1	3	L	L	L	L	LM
1	2	2	2	1	L	L	L	L	L
1	2	2	2	2	L	L	L	L	LM
1	2	2	2	3	L	L	L	L	LM
1	2	2	3	1	L	L	L	L	L
1	2	2	3	2	L	L	L	L	LM
1	2	2	3	3	L	L	L	L	LM

Reservoir Descriptions					"Species"				
A	B	C	D	E	SMB	LMB	NP	CCR	CCS
1	2	3	1	1	L	L	L	L	L
1	2	3	1	2	L	L	L	L	LM
1	2	3	1	3	L	L	L	L	LM
1	2	3	2	1	L	L	L	L	L
1	2	3	2	2	L	L	L	L	LM
1	2	3	2	3	L	L	L	L	LM
1	2	3	3	1	L	L	L	L	L
1	2	3	3	2	L	L	L	L	LM
1	2	3	3	3	L	L	L	L	LM
1	3	1	1	1	L	L	L	L	L
1	3	1	1	2	L	L	L	L	LM
1	3	1	1	3	L	L	L	L	LM
1	3	1	2	1	L	L	L	L	L
1	3	1	2	2	L	L	L	L	LM
1	3	1	2	3	L	L	L	L	LM
1	3	1	3	1	L	L	L	L	L
1	3	1	3	2	L	L	L	L	LM
1	3	1	3	3	L	L	L	L	LM
1	3	2	1	1	L	L	L	L	L
1	3	2	1	2	L	L	L	L	LM
1	3	2	1	3	L	L	L	L	LM
1	3	2	2	1	L	L	L	L	L
1	3	2	2	2	L	L	L	L	LM
1	3	2	2	3	L	L	L	L	LM
1	3	2	3	1	L	L	L	L	L
1	3	2	3	2	L	L	L	L	LM
1	3	2	3	3	L	L	L	L	LM
1	3	3	1	1	L	L	L	L	L
1	3	3	1	2	L	L	L	L	LM
1	3	3	1	3	L	L	L	L	LM
1	3	3	2	1	L	L	L	L	L
1	3	3	2	2	L	L	L	L	LM
1	3	3	2	3	L	L	L	L	LM
1	3	3	3	1	L	L	L	L	L
1	3	3	3	2	L	L	L	L	LM
1	3	3	3	3	L	L	L	L	LM
2	1	1	1	1	L	L	L	L	LM
2	1	1	1	2	L	L	L	LM	LM
2	1	1	1	3	L	L	L	LM	LM
2	1	1	2	1	L	LM	L	LM	LM
2	1	1	2	2	LM	LM	L	HM	HM
2	1	1	2	3	LM	LM	L	HM	HM
2	1	1	3	1	L	LM	L	LM	LM
2	1	1	3	2	LM	LM	L	HM	HM
2	1	1	3	3	LM	LM	L	HM	HM
2	1	2	1	1	L	L	L	LM	LM
2	1	2	1	2	L	L	L	LM	LM
2	1	2	1	3	L	L	L	LM	LM
2	1	2	2	1	LM	LM	L	LM	LM

Reservoir Descriptions					"Species"				
A	B	C	D	E	SMB	LMB	NP	CCR	CCS
2	1	2	2	2	LM	LM	L	HM	HM
2	1	2	2	3	LM	LM	L	HM	HM
2	1	2	3	1	LM	LM	L	LM	LM
2	1	2	3	2	LM	LM	L	HM	HM
2	1	2	3	3	LM	LM	L	HM	HM
2	1	3	1	1	L	L	L	LM	LM
2	1	3	1	2	L	L	L	HM	LM
2	1	3	1	3	L	L	L	HM	LM
2	1	3	2	1	LM	LM	L	LM	LM
2	1	3	2	2	LM	LM	L	HM	HM
2	1	3	2	3	LM	LM	L	HM	HM
2	1	3	3	1	LM	LM	L	LM	LM
2	1	3	3	2	LM	LM	L	HM	HM
2	1	3	3	3	LM	LM	L	HM	HM
2	2	1	1	1	L	L	L	LM	LM
2	2	1	1	2	L	L	L	LM	LM
2	2	1	1	3	L	L	L	LM	LM
2	2	1	2	1	L	LM	L	LM	LM
2	2	1	2	2	LM	LM	LM	HM	HM
2	2	1	2	3	LM	LM	LM	HM	HM
2	2	1	3	1	L	LM	LM	LM	LM
2	2	1	3	2	LM	LM	LM	HM	HM
2	2	1	3	3	LM	LM	LM	HM	HM
2	2	2	1	1	L	L	L	LM	LM
2	2	2	1	2	L	L	L	LM	LM
2	2	2	1	3	L	L	L	LM	LM
2	2	2	2	1	LM	LM	LM	LM	LM
2	2	2	2	2	HM	LM	LM	HM	HM
2	2	2	2	3	HM	LM	LM	HM	HM
2	2	2	3	1	LM	LM	LM	LM	LM
2	2	2	3	2	HM	LM	LM	HM	HM
2	2	2	3	3	HM	LM	LM	HM	HM
2	2	3	1	1	L	L	L	LM	LM
2	2	3	1	2	L	L	L	LM	LM
2	2	3	1	3	L	L	L	LM	LM
2	2	3	2	1	LM	LM	LM	LM	LM
2	2	3	2	2	HM	LM	LM	HM	HM
2	2	3	2	3	HM	LM	LM	HM	HM
2	2	3	3	1	LM	LM	LM	LM	LM
2	2	3	3	2	HM	LM	LM	HM	HM
2	2	3	3	3	HM	LM	LM	HM	HM
2	3	1	1	1	L	L	L	L	LM
2	3	1	1	2	L	L	L	L	LM
2	3	1	1	3	L	L	L	LM	LM
2	3	1	2	1	L	LM	LM	L	LM
2	3	1	2	2	LM	LM	LM	LM	HM
2	3	1	2	3	LM	LM	LM	LM	HM
2	3	1	3	1	L	LM	LM	L	LM
2	3	1	3	2	LM	LM	HM	LM	HM

Reservoir Descriptions					"Species"				
A	B	C	D	E	SMB	LMB	NP	CCR	CCS
2	3	1	3	3	LM	LM	HM	LM	HM
2	3	2	1	1	L	L	L	L	LM
2	3	2	1	2	L	L	L	LM	LM
2	3	2	1	3	L	L	L	LM	LM
2	3	2	2	1	LM	LM	LM	LM	LM
2	3	2	2	2	HM	LM	LM	LM	HM
2	3	2	2	3	HM	LM	LM	HM	HM
2	3	2	3	1	LM	LM	HM	LM	LM
2	3	2	3	2	HM	LM	HM	LM	HM
2	3	2	3	3	HM	LM	HM	HM	HM
2	3	3	1	1	L	L	L	L	LM
2	3	3	1	2	L	L	L	L	LM
2	3	3	1	3	L	L	L	LM	LM
2	3	3	2	1	LM	LM	LM	LM	LM
2	3	3	2	2	HM	LM	LM	LM	HM
2	3	3	2	3	HM	LM	LM	LM	HM
2	3	3	3	1	LM	LM	HM	LM	LM
2	3	3	3	2	HM	LM	HM	LM	HM
2	3	3	3	3	HM	LM	HM	LM	HM
3	1	1	1	1	L	L	L	LM	HM
3	1	1	1	2	L	L	L	LM	HM
3	1	1	1	3	L	L	L	LM	HM
3	1	1	2	1	L	LM	L	HM	HM
3	1	1	2	2	LM	HM	L	HM	H
3	1	1	2	3	LM	HM	L	HM	H
3	1	1	3	1	L	LM	L	HM	HM
3	1	1	3	2	LM	HM	L	HM	H
3	1	1	3	3	LM	HM	L	HM	H
3	1	2	1	1	L	L	L	HM	HM
3	1	2	1	2	L	L	L	HM	HM
3	1	2	1	3	L	L	L	HM	HM
3	1	2	2	1	LM	LM	L	HM	HM
3	1	2	2	2	LM	HM	L	H	H
3	1	2	2	3	LM	HM	L	H	H
3	1	2	3	1	LM	LM	L	H	H
3	1	2	3	2	LM	HM	L	H	H
3	1	2	3	3	LM	HM	L	H	H
3	1	3	1	1	L	L	L	HM	HM
3	1	3	1	2	L	L	L	HM	HM
3	1	3	1	3	L	L	L	HM	HM
3	1	3	2	1	LM	LM	L	H	H
3	1	3	2	2	LM	HM	L	H	H
3	1	3	2	3	LM	HM	L	H	H
3	1	3	3	1	LM	LM	L	H	H
3	1	3	3	2	LM	HM	L	H	H
3	1	3	3	3	LM	HM	L	H	H
3	2	1	1	1	L	L	L	LM	HM
3	2	1	1	2	L	L	L	LM	HM
3	2	1	1	3	L	L	L	LM	HM
3	2	1	2	1	L	LM	L	HM	H

Reservoir Descriptions					"Species"				
A	B	C	D	E	SMB	LMB	NP	CCR	CCS
3	2	1	2	2	LM	HM	LM	HM	H
3	2	1	2	3	LM	HM	LM	HM	H
3	2	1	3	1	L	LM	LM	HM	H
3	2	1	3	2	LM	HM	LM	HM	H
3	2	1	3	3	LM	HM	LM	HM	H
3	2	2	1	1	L	L	L	HM	HM
3	2	2	1	2	L	L	L	HM	HM
3	2	2	1	3	L	L	L	HM	HM
3	2	2	2	1	LM	LM	LM	H	H
3	2	2	2	2	HM	HM	LM	H	H
3	2	2	2	3	HM	HM	LM	H	H
3	2	2	3	1	LM	LM	LM	H	H
3	2	2	3	2	HM	HM	LM	H	H
3	2	2	3	3	HM	H	LM	H	H
3	2	3	1	1	L	L	L	HM	HM
3	2	3	1	2	L	L	L	HM	HM
3	2	3	1	3	L	L	L	HM	HM
3	2	3	2	1	LM	LM	LM	H	H
3	2	3	2	2	H	HM	LM	H	H
3	2	3	2	3	H	H	LM	H	H
3	2	3	3	1	HM	LM	LM	H	H
3	2	3	3	2	H	HM	LM	H	H
3	2	3	3	3	H	H	HM	H	H
3	3	1	1	1	L	L	L	LM	HM
3	3	1	1	2	L	L	L	LM	HM
3	3	1	1	3	L	L	L	LM	HM
3	3	1	2	1	L	LM	LM	LM	HM
3	3	1	2	2	LM	HM	LM	LM	HM
3	3	1	2	3	LM	HM	LM	HM	HM
3	3	1	3	1	L	LM	LM	LM	HM
3	3	1	3	2	LM	HM	HM	LM	HM
3	3	1	3	3	LM	HM	HM	HM	HM
3	3	2	1	1	L	L	L	HM	HM
3	3	2	1	2	L	L	L	HM	HM
3	3	2	1	3	L	L	L	HM	HM
3	3	2	2	1	LM	LM	LM	HM	HM
3	3	2	2	2	HM	HM	LM	HM	H
3	3	2	2	3	HM	H	LM	HM	H
3	3	2	3	1	LM	LM	HM	HM	H
3	3	2	3	2	HM	HM	H	HM	H
3	3	2	3	3	HM	H	H	HM	H
3	3	3	1	1	L	L	L	HM	HM
3	3	3	1	2	L	L	L	HM	HM
3	3	3	1	3	L	L	L	HM	HM
3	3	3	2	1	LM	LM	LM	HM	HM
3	3	3	2	2	H	HM	LM	HM	H
3	3	3	2	3	H	H	HM	HM	H
3	3	3	3	1	HM	LM	HM	HM	H
3	3	3	3	2	H	HM	H	HM	H
3	3	3	3	3	H	H	H	HM	H

Literature Cited

McConnell, William J., Eric P. Bergersen, and Kathryn L. Williamson. 1984. Habitat suitability index models: a low effort system for planned coolwater and coldwater reservoirs (Revised). U.S. Department of Interior, Fish and Wildlife Service. FWS/OBS 82/10.3A. 62pp.

APPENDIX E

Costs of Constructing Dikes Around Ponds

To: MartineP@AQ-Research@DNRDOWNERO
Cc: LangloiD@SW-Region@DNRDOWSWRO
Bcc:
From: ElmbladB@NW-Region@DNRDOWNWRO
Subject: Costs for constructing dikes around ponds
Date: Monday, July 1, 1996 14:24:18 MDT
Attach:
Certify: N
Forwarded by:

Pat - I talked with Peter Siegmund today with United Sand and Gravel in Grand Junction about the costs for constructing dikes around floodplain ponds. Peter is the person who constructed the dikes around Connected Lake after the area was flooded 1983-84. If you need to talk with him, his phone number is 243-4900.

Consider these estimates to be "ballpark" only. They would apply to ponds in the Grand Junction area. The cost to build a one foot high dike that is 15 feet wide and 1,000 feet long would be $9,000.00. The cost to riprap this same dike on just the outside at a thickness of 1.5 feet would be $4,800.00. For a similar dike that is three feet high, the costs would triple. Likewise, a five feet high dike would cost about $45,000.00, plus $24,000.00 for riprap.

Let's use Corn Lake as an example. In a 1995 report by the Colorado Water Conservation Board entitled "Colorado River Flood Risk Analyses at ... Corn Lake ..., it is stated "The levee is approximately 3.5 to 4.5 feet below 50-year elevations...." Further it states that to protect Corn Lake from a 50-year flood it would require a "2,800 foot long levee system with an average height of 5 feet". I was told the 5 feet high dike would provide a foot of freeboard above the 50-year elevation.

Using the above figures, the cost to protect Corn Lake from a 50-year flood (5 feet high dike) would be $126,000 ($45,000 x 2.8), plus I estimate riprap along 1,000 feet ($24,000) for a total cost = $150,000.00. A one foot high dike to protect Corn Lake from a 10-year flood would be $30,000.00.

In addition, we would need to get an Army Corps of Engineers 404 permit and a FEMA Floodplain permit from Mesa County. We might need to do some wetlands mitigation for the 404 permit, more potential wetlands impact and mitigation for the five feet high dike because it would need to be wider at the base than the one foot dike to have a 15 feet wide top. We probably would be OK with FEMA at Corn Lake but at other sites where removing an area from the floodplain could increase the risk for damage to private property elsewhere, then mitigation (?) might be necessary. At the very least we would need to have an engineer put together a set of plans to submit with the permit applications.

Concerning the 404 permit, the Army Corps of Engineers is putting together a General Permit which could make their process easier and maybe eliminate the need for mitigation if the U.S. Fish and Wildlife Service will state in their comments to the proposed General Permit that this diking activity around warmwater fisheries will enhance the recovery of endangered fishes. This is something to talk with USFWS about. The proposed General Permit could be distributed for review this autumn. Call Ken Jacobson with the Army Corps of Engineers for details at 243-1199.

APPENDIX F

Draft Regulations for Implementing and Enforcing the Procedures for Stocking Nonnative Fish Species in the Upper Colorado River Basin

Issues, existing regulations, suggested edits and additions in *REGULATIONS - General Provisions, ARTICLE IX RELEASE OF WILDLIFE, #009, RELEASE OF LIVE WILDLIFE, section C* pertinent to full implementation and enforcement of Procedures for Stocking Nonnative Fish Species in the Upper Colorado River Basin (UCRB) hereinafter referred to as the Procedures.

Issue 1: **DEFINITIONS**

Terminologies unique to the Procedures that are needed for clarification and streamlining in development of regulations.

Existing statute(s)/regulation(s): Nonnative -- The *GENERAL PROVISIONS, ARTICLE IX - RELEASE OF WILDLIFE, #009 - RELEASE OF LIVE WILDLIFE, B.1.* defines "exotic" aquatic species as those not currently found in the drainage in question. This definition is deficient given the intentions of the Procedures. Using the wording in the *STATUTES, TITLE 33, ARTICLE 1* to define nonnative fish species, I find it more appropriate for the purposes and intent of the Procedures to define "nonnative" (*ARTICLE 1, 29.5*) as species "*not defined to be native*" (*ARTICLE 1, 28.5*).

It also appears necessary to provide definitions for "Upper Colorado River Basin", "Critical Habitat" (as defined by U.S. Fish and Wildlife Service), "Nonsalmonid Fish Species", "Isolated Water", and "Routinely Stocked".

One of the components necessary for defining "*Isolated Water*", screening to prevent fish escapement, is currently required (if necessary) for waters managed under a commercial lake license or a private lake license (*REGULATIONS, CHAPTER 12, #1203 - APPLICATION AND LICENSING PROCEDURE, D.*). This regulation, however, appears inadequate given the intentions of the Procedures to restrict most fish escapement (requiring definition of an effective screen aperture) and to require an annual inspection to ensure that the screen is in place and functional.

Proposed regulation(s):

Upper Colorado River Basin -- The Procedures specifically exclude the San Juan River Basin, although it is part of the UCRB. The suggested wording, if "Upper Colorado River Basin" is incorporated into ***REGULATIONS*** is: *The Upper Colorado River Basin is that portion of the Colorado River drainage above Glen Canyon Dam, Arizona, excluding the San Juan River Basin, that lies within the boundaries of the state of Colorado.*

Critical Habitat -- Defining "Critical Habitat" is needed to link the provisions outlined in the Procedures to regulations that will be used to enforce the Procedures in Colorado.

Suggested wording, modified from the Federal Register to pertain only to Colorado: *Critical Habitat, as defined in the Federal Register (Vol. 59, March 21, 1994, PART 17-[AMENDED], 17.11 [Amended], Colorado squawfish Ptychocheilus lucius), includes in Colorado: the Yampa River and its 100-year flood plain in Moffat County from the State Highway 394 Bridge to the confluence with the Green River, the Green River and its 100-year flood plain in Moffat County from its confluence with the Yampa River to the Colorado/Utah stateline, the White River and its 100-year flood plain in Rio Blanco County from Rio Blanco Lake Dam to the Colorado/Utah stateline, the Gunnison River and its 100-year flood plain in Delta and*

Mesa Counties from the confluence with the Uncompahgre River to the confluence with the Colorado River, and the Colorado River and its 100-year flood plain in Garfield and Mesa Counties from the Colorado River Bridge at exit 90 north off Interstate 70 to the Colorado/Utah stateline. The 100-year flood plains are detailed in Flood Insurance Rate Maps (FIRM) published by and available through the Federal Emergency Management Agency (FEMA). In those areas where a FIRM is not available to define the 100-year flood plain boundary, the point five and one-half feet above the overall high water line [the water level which represents the water surface elevation during a normal (annual) high water event that is denoted by the point where perennial hydrophytic plant life converges with bare substrate (rock, gravel, sand, fines) or with substrate interspersed with annual vegetation] can be used to represent the 100-year flood plain elevation.

Nonsalmonid Fish Species -- Defining nonsalmonid in the context of regulations pertaining to the Procedures appears helpful: *Non-salmonid means any fish species that is not a member of the family salmonidae.*

Isolated Water -- Defining "Isolated Water" appears helpful in streamlining the wording to be used for several of the regulations needed to control fish stocking. Suggested wording for this definition: *An Isolated public or Isolated private Water in the Upper Colorado River Basin, as determined by inspection by the Colorado Division of Wildlife, or its authorized representative, must meet, or be modified to meet, all of the following criteria:*

1. *the banks or dikes/berms of a pond must lie above the 50-year flood plain as indicated by a FIRM, or have an existing, modified, or constructed dike meeting the Federal Emergency Management Agency standards for resistance of a flood event not exceeding the 50-year stage (in those areas where a FIRM is not available to define the 50-year flood plain boundary, the point five feet above the overall high water line can be used to represent the 50-year flood plain elevation);*

2. *must be isolated such that no outflow provides a connection allowing downstream passage of any nonsalmonid fish species that is not defined to be native between the stocked water and any mainstem riverine habitats;*

3. *any outlets that flow into channels providing connection to mainstem riverine habitats must possess a screen of no larger than 3/32 inch bar measure; and*

4. *an annual inspection of the outlet screen(s) must be performed. In addition, the annual screen inspection will be required for ten years following the last date of stocking with any non-salmonid fish species that is not defined to be native.*

Note that the suggested screen mesh is quite small. Common screen openings range from 3/32 inch to 1/2 inch. The arguments against larger screen opening include the passage of the young-of-year of all warm water sport fishes and all minnows. The argument against the smallest mesh is outflow velocities must be very low at all times (<0.5 cfs), it will trap most debris (potentially requiring frequent cleaning), and algal growth may, in some situations, rapidly choke the screen (potentially requiring frequent maintenance). The 3/32 inch screen opening is the smallest in current industry practice and it is approximately 90% effective at preventing fish escapement (Miller, W. J. and D. Laiho. 1996. Feasibility evaluation of non-native fish control structures.

Colorado River Recovery Program, DRAFT REPORT. Colorado River Water Conservation District, Glenwood Springs, Colorado.).

Routine Stocking/Routinely Stocked -- The Procedures provide for "routine stocking" of "isolated waters" with trout and certain warmwater sport fish species. However, the Procedures intend for "routine stocking" to be contingent upon confirmation of a ponds position in the flood plain and the proper placement and function of screens to control fish escapement which are inspected upon installation and annually thereafter. It appears that some sort of "permit" certifying that the appropriate inspection has been performed may be required for routine stocking to occur. The following wording for such a regulation/definition is suggested: *An isolated water may be routinely stocked following confirmation of its position in the flood plain and the condition of its dikes, and following initial and annual inspection of the function of screens placed to control fish escapement by the Colorado Division of Wildlife, or its authorized representative. Routine stocking will not be permitted unless these inspections have been performed and any noted deficiencies are corrected and approved during subsequent inspection by the Colorado Division of Wildlife or it authorized representative. The stocking of salmonids, in accordance with other pertinent regulations, shall be considered routine in all waters of the Upper Colorado River Basin, except in mainstem riverine habitats within Critical Habitat.*

Procedures for Stocking Nonnative Fish Species in the Upper Colorado River Basin -- The Procedures provide an outline for preparation and review of proposals to stock nonnative fishes that either presently occur, or do not presently occur, in the Upper Colorado River Basin. Since these provisions have a minimum criteria precluding the stocking of even isolated ponds within the 50-year flood plain with fish species other than those specified in the Procedures, it appears necessary to reference the Procedures as a "legal document" to avoid incorporating its full language into the Regulations. I remain unfamiliar with the appropriateness of this strategy in the development of these regulations. Assuming that the Procedures can be referenced, I suggest the following wording for a regulation/definition: *The Procedures for Stocking Nonnative Fish Species in the Upper Colorado River Basin were approved and adopted by the Wildlife Commission on September 19, 1996.*

Issue 2: **RIVERINE HABITAT**

Precluding the stocking of any nonnative fish species into riverine habitats within Critical Habitat.

Existing regulation(s): Private stocking cannot technically occur without the Division being informed and issuing a permit, except in aquaria and small isolated ponds: *CHAPTER 12 - LAKE LICENSES.* However, these regulations do not clearly address stream stocking and it appears necessary to specifically address stocking of riverine habitats in the case of the Procedures.

Proposed regulation(s): *No person shall release any fish species not defined as native (STATUTES, ARTICLE 1, 28.5) into mainstem riverine habitats within Critical Habitat of the Upper Colorado River Basin.*

Issue 3: **PROHIBITED SPECIES**

Declaring certain nonnative fish species to be prohibited in the Upper Colorado River Basin within Colorado.

Existing regulation(s): *GENERAL PROVISIONS, ARTICLE IX - RELEASE OF WILDLIFE, #009 - RELEASE OF LIVE WILDLIFE, C.* This regulation prohibits the release of northern pike and tiger muskie into any waters of the state without expressed written approval of the Director.

Proposed regulation(s): The intent of the Procedures was to prohibit certain fish species from being introduced or further stocked or transplanted within the UCRB. Northern pike is among the fish species on this list of prohibited species. My suggestion is to deal with northern pike as presently treated in *REGULATIONS* as stated above because the Procedures also provide for northern pike salvage and transplant as part of approved fish removal endeavors; therefore, it should remain at the Director's discretion to allow the "stocking" of northern pike salvaged from riverine or other habitats into alternate angling sites for this species.

To address the other prohibited species listed in the Procedures, it needs to be decided if they should be outright banned, or their release into waters of western Colorado should be subject to the Director's approval. Some of these species are already widespread in the UCRB (e.g. common carp, red shiner, green sunfish) while flathead catfish should be strictly prohibited. Complete banning of all the prohibited species (except as provided for northern pike) would send a strong message, probably viewed most positively by the water user and environmental communities. Providing for the release of prohibited species only via Director's approval has the advantages of not making it appear that northern pike are dealt with any differently than other nonnative fish species agreed upon as prohibited in the Procedures and it may facilitate other unforseen circumstances involving experimentation with one or more of the prohibited species in a controlled environment. This latter scenario may involve studies directed at finding efficient physical or biological means of reducing or controlling numbers of these prohibited species.

In any case, the list of prohibited species must also include, per the Procedures, the following nonnative fish species:

Common carp	*Cyprinus carpio*
Red shiner	*Cyprinella lutrensis*
Black bullhead	*Amerius melas*
Yellow bullhead	*Amerius natalis*
Wiper	*Morone chrysops x Morone saxtalis*
Green sunfish	*Lepomis cyanellus*
Flathead catfish	*Pylodictus olivaris*
White crappie	*Pomoxis annularis*

Issue 4: **STOCKING IN 100-year FLOOD PLAINS**

Specifying nonnative fish species and pond conditions for stocking within the 100-year flood plains of the Upper Colorado River Basin.

Existing regulation(s): There are no existing regulations specific to this provision of the Procedures.

Proposed regulation(s): To preclude the stocking of all nonnative fishes, except those approved by the Procedures for stocking in the 50-year flood plain, the following regulation is suggested: *No person shall release any non-salmonid fish species that is not defined to be native in the Upper Colorado River Basin (ARTICLE 1, 28.5) into the 100-year flood plains of the Upper Colorado River Basin. The exceptions to this Regulation allows the routine stocking of bluegill Lepomis machrochirus, black crappie Pomoxis annularis, largemouth bass Micropterus salmoides, and certified triploid grass carp Ctenopharyngodon idella into isolated waters. In addition, isolated waters above the 50-year flood plains of the Upper Colorado River Basin can also be stocked with mosquito fish Gambusia affinis, or other species approved by following the review process outlined in the Procedures for Stocking Nonnative Fish Species in the Upper Colorado River Basin.*

Issue 5: **STOCKING OUTSIDE THE 100-YEAR FLOOD PLAINS**

Specifying nonnative fish species and pond/reservoir conditions for stocking outside the 100-year flood plains of the Upper Colorado River Basin.

Existing regulation(s): There are no existing regulations specific to this provision of the Procedures.

Proposed regulation(s): To provide for the stocking of all nonnative fishes, except those prohibited by the Procedures, in isolated waters outside the 100-year flood plains, the following regulation is suggested: *Isolated waters that lie above the 100-year flood plains and above 6,500 feet in elevation (mean sea level) in the Upper Colorado River Basin may be routinely stocked with salmonids, fish species native to the Upper Colorado River Basin, bluegill Lepomis machrochirus, black crappie Pomoxis annularis, largemouth bass Micropterus salmoides, certified triploid grass carp Ctenopharyngodon idella, mosquito fish Gambusia affinis, fathead minnow Pimephales promelas, and channel catfish Ictalurus punctatus. Other species not defined as native can also be stocked if they are included in existing Lake Management Plans that have been prepared by the Colorado Division of Wildlife, approved by the Director and specified in the Procedures for the Stocking of Nonnative Fish Species in the Upper Colorado River Basin. Proposals to stock or introduce other fish species not defined to be native must be approved by following the review process outlined in the Procedures for Stocking Nonnative Fish Species in the Upper Colorado River Basin.*

APPENDIX G

FY-1997 PROPOSED SCOPE OF WORK
Removal and Control of Non-Native Fishes in the Colorado and Gunnison River Floodplain Source Ponds

COLORADO RIVER RECOVERY PROGRAM
FY-1997 PROPOSED SCOPE OF WORK

Project No.: CAP-18

Lead Agency: Colorado Division of Wildlife

Category (check one):
_ Ongoing project
_ Ongoing-revised project
X Requested new start

Submitted by: Pat Martinez, Tom Nesler

Address: Colorado Division of Wildlife
317 W. Prospect
Fort Collins, CO 80526

Phone: 970-484-2836, X352 or 357
FAX 970-490-6066

Capital Funds

Date: June 1, 1996

I. Title of Proposal:

Removal and control of non-native fishes in Colorado and Gunnison River floodplain source ponds.

II. Relationship to RIPRAP:

This proposal will primarily address the chronic escapement of centrarchid sport fish from floodplain ponds. Centrarchid sport fishes known to occur in these ponds, including largemouth bass and black crappie, typically seek backwater or slow moving side channel habitats upon entering the main stem river. It is in these riverine habitats that these centrarchid sport fish are believed to pose a significant predatory threat to the young life stages of endangered and other native fishes. Overall, this strategy is intended to greatly reduce the number of chronic sources of centrarchid sport fishes accessing riverine habitats, thereby contributing to the recovery of endangered fishes.

General Recovery Program Support Action Plan:

III. Reduce negative impacts of nonnative fishes and sport fish management activities.

III.A.2. Identify and implement viable control measures.

III.A.2.c. Implement and evaluate the effectiveness of viable active control measures.

III.B. Reduce negative impacts to endangered fish from sport fish management activities.

III. Study Background/Rationale and Hypotheses:

Floodplain corridors bordering the mainstem rivers in the Upper Colorado River Basin are considered an integral and necessary element in the recovery of the four endangered big river fish species. Lentic habitats comprised by backwaters, embayments created by flooded terraces, and ponds created in depressions all have been identified as a critical habitat component in the life histories of the listed species, and generally important to the native fish community and ecological

functions supporting the endangered fishes (Irving and Maddux 1995). Nonnative fish species are present throughout the Upper Basin, and can present adverse impacts to recovery progress for the endangered fishes through predation or competition at critical life stages or in critical locales. These concerns come into focus with the negative interactions between certain nonnative fish species and young life stages of the endangered fishes in floodplain nursery habitats.

Research evidence exists documenting predation or competition impacts between larval and young-of-the-year Colorado squawfish and razorback sucker with nonnative fishes known to occur in floodplain ponds such as green sunfish, red shiner, channel catfish, black bullhead, fathead minnow, and largemouth bass (Tyus and Saunders 1996). Hybridization between razorback sucker and nonnative white sucker is also a potential concern (Tyus and Saunders 1996). Results of field studies and the Interagency Standardized Monitoring Program indicate the presence of centrarchid fishes in Colorado River backwaters may be largely the result of escapement from adjacent perennial ponds and small lakes. Nonnative fish species commonly found in these floodplain ponds sampled by the Colorado Division of Wildlife include reproducing populations of black bullhead, white sucker, green sunfish, common carp, and largemouth bass. A survey of the pond resource within the river reaches encompassed by critical habitat along the Colorado and Gunnison rivers (Mitchell 1996) identified 314 ponds. Of these, 253 occur along the Colorado River from Rifle to the state line in Mesa and Garfield counties. Another 61 occur along the Gunnison River along the Gunnison River from Austin to the confluence with the Colorado River in Mesa and Delta counties. Along the Colorado River, an estimated 229 ponds are in private ownership. Along the Gunnison River, it is estimated that 27 ponds are in private ownership (Mitchell 1996). At least one-third of the ponds contain fish. Fish species present in these ponds reportedly included largemouth bass, bluegill, black crappie, catfish/bullhead, rainbow trout, minnows, brook trout, brown trout, suckers, grass carp, and threatened and endangered fishes (Mitchell 1996). The T&E species mentioned by private landowners referred to those known to occur in their ponds as a result of USFWS/CDOW investigations (H. Maddux, USFWS, personal communication).

While the abundance of some of these nonnative fish species may be periodically depressed, or held in check due to the natural combinations of high flows, unsuitable thermal regime, lack of available low-velocity habitats, and dramatic fluctuations in a variable riverine environment; the restoration of floodplain nursery habitat for the benefit of the endangered fishes as nursery areas could create optimal habitat conditions as well for the survival or expansion of populations of the nonnative fish species listed above. Recovery Program priorities include the restoration of razorback sucker populations and floodplain nursery habitats for Colorado squawfish and razorback sucker in select reaches in both the Colorado and Gunnison rivers in Colorado. Action items concerning reintroductions and site restoration of habitat are already underway.

Control of nonnative fishes to minimize negative impacts to endangered fishes will be implemented under two categories: (1) reduction of nonnative fish abundance in riverine habitat and (2) reduction in escapement from waters serving as sources of nonnative fishes determined to be problematic in critical habitat reaches. Floodplain pond habitat along these two rivers represents a chronic source of nonnative fish species having documented or presumed negative impacts on the early life stages of Colorado squawfish and razorback sucker, and would have a counterproductive influence on the success of both habitat restoration for endangered and native fishes and removal efforts for nonnative fish in floodplain river reaches. Reclamation of these pond resources would include removal of existing nonnative fish species by chemical reclamation, and installation of escapement prevention devices as appropriate to the target water and its future management objectives. Future management objectives may be aligned with native fish conservation or sport fishery development goals. Reclaimed waters developed for sport fishery purposes would be

monitored for re-occurrence of unwanted nonnative fish species, and evaluated in terms of sport fishery recreation goals (e.g catch rates, harvest, use). The scope of this proposed control project involves reclamation of nearly 50% of the floodplain pond habitat over a six year period and the evaluation of its effectiveness as both a control effort in the ponds and in the reduction of nonnative fishes in the riverine environment.

IV. Study Goals, Objectives, End Product:

Goal- to reduce proliferation of nonnative fish species in floodplain habitats and minimize chronic escapement of nonnative fishes from perennial ponds.

Objectives:

1. To chemically reclaim up to 150 floodplain ponds within the 50 yr floodplain of the Colorado and Gunnison rivers through 2002 (up to 25 ponds in 1997).

2. To minimize reinvasion of ponds and escapement of fishes from treated ponds and ponds outside the treatment area by screening or other anti-escapement device.

3. To monitor potential reinvasion of nonnative fish species in floodplain ponds and escapement of nonnative species from ponds managed as sport fisheries.

4. To determine if nonnative fish control in floodplain ponds on a river-reach scale contributes significantly to reductions in the abundance of nonnative fishes in existing riverine nursery habitats.

End Product:

1. Reduction in the number of floodplain ponds serving as sources of nonnative fishes into native fishes riverine habitat.

2. Expanded numbers of pond habitats available for restoration as native and endangered fish nursery habitat through physical habitat restoration or temporary grow-out facilities.

3. Demonstrated compatibility of endangered fish recovery, native fish conservation, and sport fish recreational uses.

V. Description of past performance on this or similar projects.

There have been no similar projects of this nature conducted by CDOW.

VI. Study Area:

Colorado River: Rifle to state line, 50 yr floodplain.
Gunnison River: Austin to Colorado River confluence, 50 yr floodplain.

VII. Study Methods/Approach:

A. Pond reclamation planning

This proposal targets reclamation of 150 ponds within the 50 yr floodplain, but an adaptive approach to prioritizing individual ponds for removal of existing fish populations will be followed. Examination of 246 ponds in available floodplain areal photos taken in 1995 along the Colorado River from Palisade to Loma showed 55% (136 ponds = 514 surface acres) of the ponds in the 10 yr floodplain and 22% (55 ponds = 149) of the ponds in the 10-50 yr floodplain. Areal photos from the Gunnison River in 1995 showed 17 ponds from Delta to the Colorado River of which 12% (2 ponds = 3 surface acres) lied within the 10 yr floodplain and 35% (6 ponds = 3 surface acres) were in the 10-50 yr floodplain. Note that the preceeding figures do not include the entire count of ponds identified in the Mitchell (1996) pond survey because areal photos were not available for the entire river lengths encompassed by critical habitat. As reclamation prioritization proceeds, ownership status and floodplain position of targeted ponds will have to be confirmed.

Two strategies to remove existing fish populations are envisioned, 1) chemical treatment with the piscicide rotenone, and 2) pond draining by pumping. The following information portrays an "average scenario" given current knowledge of average pond dimensions and anticipated conditions at the time of rotenone treatment. Ponds would be treated at 3 ppm rotenone (powdered = 7 % active ingredient; 5.8 lbs powder/acre-foot) at $1.55/pound. The average pond capacity is 72 ac-ft based on a mean surface area of 12 acres and mean depth of 6 ft, and will cost $650/pond for rotenone and $ 1,265/pond to detoxify with potassium permanganate.

An option to chemical reclamation is draining a pond by pumping it dry to kill the fish it contains. This strategy was employed by USFWS at 29 5/8 Road Pond in the Grand Valley in 1995. This 10 acre pond required 5 days of pumping to render it "dry" and seining was employed to effect complete removal of remaining fishes (some were salvaged and transferred to approved waters). The effluent was discharged to the river and a 0.25 inch mesh screen was employed to screen entrained fish from entering the pump. The current itemized cost to pump a given volume of water is presently unknown as CDOW has not performed such a task. However, it is known that, depending on the on-site availability of a 3-phase electric power source, pond pumping is either slightly less, or potentially nearly double the projected cost of treatment with rotenone. If 3-phase electric hook-ups are unavailable, contractors must bring a diesel generator on-site, thus doubling the daily cost rate of pumping. The personnel-hour saving resulting from pumping vs. rotenone treatment are canceled by the daily expense of operating, servicing, and monitoring a pump(s). An advantage of pumping is that the permitting process may be less complex and time-consuming. An Environmental Assessment may not be needed if "no significant impacts to human or biotic environments" can be demonstrated, thereby qualifying the project for a "Categorical Exclusion". The CE is required for dewatering wetland and/or floodplain habitat and, in addition, a discharge permit for the pumped water must be obtained.

The projected schedule for removal of fishes from floodplain ponds calls for two ponds to be treated per week over the 13 week period of July to September to achieve a target of 25 ponds/year. This summertime scheduling of pond reclamations is probably more critical for rotenone application (less effective in cold water) than for pumping which could possibly be performed in the Grand Valley in all but the coldest months (NOV-FEB). Pumping during

the colder months may include benefits such as lower pond levels, reduced subsurface flows, freezing or winterkill of remaining standing pools following pumping, and less conflict with private uses including recreation, irrigation and livestock watering. Six years will be required to complete the reclamation of the 150 pond goal. One-third of the ponds have outlets connecting them to the mainstem Colorado River and will require protective screening to prevent escapement. Costs of screening are presently unknown, but this is anticipated to be an additional expense commencing in 1998.

The sequence of activities described below combines this standard protocol with added Recovery Program expectations. These include:

Activities common to pond reclamation with rotenone and by pumping

- Develop calendar of events.
- Public notification of and meetings with Potentially Affected Interests for information collection-review, potable, and livestock water sources.
- Collect on-site data to document fish population composition and collect data for summary of treatment effectiveness.
- Acquisition of conservation easements, private property access.
- Acquisition of federal permit for Section 4 exemption of incidental take of endangered fishes present.
- Media contacts informing PAIs of date of treatment, safety considerations, and fish disposal.
- Approval of stocking management through Nonnative Fish Stocking Procedures.
- Follow-up media contacts summarizing project.

Activities to be accomplished for rotenone treatments

- Collect data for and prepare Environmental Assessment including T&E concerns, critical habitat, wetlands-floodplain, private lands, and coordination with federal and other public land agencies under NEPA.
- Media announcement of EA and project review and 45 day EA decision notice or EA modifications and additional review.
- Obtain training and licensing for DoT HazMat and DoA Qualified Supervisor or Certified Applicator.
- Collect second set of on-site data and develop Operations Plan for preparation of Application for Fish Control including calculations for conditions, treatment and detoxification.
- Contact CDOW Help Committee and purchase treatment chemicals.
- Prepare Emergency Plan for toxicant escape and send completed AfFC to Water Quality Control Division and CDOW 30 days prior to project.
- Prepare fish control project site plan for personnel, assignments, equipment and supplies, including on-site training and equipment testing under direction of certified Qualified Supervisor.
- Perform project treatment, assessment of chemical effectiveness, implement follow-up treatment if needed, evaluate treatment success.
- Prepare final report and submit to CDOW within 60 days.

Activities to be accomplished for pond draining by pumping

- Obtain National Pollution Discharge Elimination System 402 permit administered under Clean Water Act.
- Obtain Categorical Exclusion under NEPA documenting no significant impact on human or biotic environment.
- Solicit and finalize commercial contracts for pumping.

B. Evaluation of treated ponds

Rotenone:

Effectiveness of kill will be evaluated with two approaches. The first will be determination of species and biomass removed via stratified random placement of bottom salvage nets to sample a known percentage of the pond bottom area. An estimate of biomass/species that sinks to the pond bottom will be determined. Shoreline recovery of dead fish will be performed to make a similar estimate of biomass/species, and added to pond bottom estimate. Following the initial 24-48 hour period of effective toxic action, experimental-mesh gill nets will be placed throughout the pond area over an additional 48-120 hours to document any survival. Seining of shallow shorelines will also be conducted if turbidity prevents visual searches for the presence of small fishes.

Draining by Pumping:

Effectiveness of kill will be evaluated examining drained ponds for remaining standing pools and fishes. Drainage of remaining pools will be facilitated by digging channels to pump-sites. Any remaining pools will be seined to ensure complete fish kill. Determination of fish species and biomass removed will be estimated by examination of stranded fish density and estimates of dead fish settling in remaining pools on bottom salvage nets placed to sample a known percentage of the remaining pool bottom area.

C. Monitoring of sport fishery ponds for escapement/reinvasion.

Ponds that have been treated for removal of fish populations will be reexamined for reinvasion by fishes from the adjacent rivers or other ponds. Several fish sampling techniques, netting, seining, electrofishing, and any other appropriate techniques will be employed within three years following removal of the fish population unless it is documented that the river has connected with the pond in spite of fish exclusion/escapement devices possibly reinoculating it with undesirable nonnative species. Such ponds will be sampled within one year of "breach" to assess the potential rate of reinvasion by fishes. It is recommended that selected ponds in the 10 year floodplain, be sampled annually if they are known to more frequently reconnect with the river due to river inflow through connecting channels or overflow of breached dikes. Costs for this vital component of pond reclamation will have to be anticipated and estimated as fish populations are removed from ponds and the ponds are fitted with anti-escapement and/or anti-reinvasion structures. A portion of this investigation will target fish sampling in the channels and ditches that provide potential connection of a pond to the mainstem river habitats. Initially, this investigation will focus on pond reinvasion, until stocking of approved fish species resumes or evaluation of an anti-escapement device is needed. This sampling protocol will remain adaptive, but once specific

sites have been identified, sampling designs will be drafted and released for review by the Recovery Program. It is expected that these evaluations will not begin until 1997.

D. Riverine monitoring

The removal of existing fish populations from ponds is expected to be an expensive activity under the Recovery Program and its effectiveness must be evaluated as pond reclamations are accomplished to determine if there is a net reduction in the distribution and numbers of targets nonnative species in the mainstem rivers. Due to ongoing debate about the efficiency of data collected during the Interagency Standardized Monitoring Program for detecting or collecting centrarchid sport fish, an investigation to address this controversy is recommended. Initially, the study would entail depletion sampling of the fish communities in a subsample of backwater representative of the backwaters present in given river reaches (large backwaters vs small backwaters, shallow vs. deep, hiding cover vs. little cover, etc.). Using this approach and employing a variety of sampling gear, especially around areas of cover, it should be feasible to determine the representativeness of the current ISMP sampling protocol in detecting centrarchid sport fish. If this evaluation demonstrates that practical modifications to the current ISMP protocol would improve the effectiveness of the program in documenting nonnative fish population trends, then a modified protocol would be developed for peer-review and adoption by the cooperating agencies. If additional sampling is warranted, a specific protocol will be developed, taking into account the potential incidental capture of native fishes, to facilitate consistent application among rivers and reaches for the development of the appropriate indices needed to evaluate the effectiveness of pond reclamations, anti-escapement devices, and trends in nonnative sport fish population trends. This evaluation should be undertaken in 1997 and recommendations developed, reviewed and implemented by 1998.

VIII. FY Task Description and Schedule:

<u>FY 1997:</u>

Task 1. Develop strategy for prioritizing which ponds by river reach and floodplain position will be scheduled for reclamation including considerations of potential for ponds to reconnect with the river, development of incentives for private pond owners, implemetation of Stocking Procedures, feasibility of pond isolation/screening and/or inclusion in reclaimed pond in bottomland restoration (NOV 96-DEC 96).

Task 2. Select ponds for reclamation in 1997, identify equipment, chemical, fish sampling and personnel needs, and obtain required permits (JAN 97-MAR 97).

Task 3. Perform fish sampling and fish removal in selected ponds (APR 97-OCT 97).

Task 4. Investigate the potential screening options to be applied to floodplain ponds and develop costs taking into consideration discharge volume, screening aperture, outlet configuration, and maintenance of screening device.

Task 5. Perform sampling and analysis to evaluate effectiveness of the current ISMP fish sampling protocol in providing representative indices of centrarchid sport fish abundance in riverine

habitats of the Colorado River from Palisade to the CO/UT stateline and recommend alternative sampling methods as identified (APR-MAY & SEP-OCT 97).

Task 6. Investigate and recommend appropriate statistical probability analysis (power analyses) to evalute effectiveness of pond reclamation efforts in contributing to reductions in target nonnative fish species in target river reaches and habitats (JAN 97-JAN 98).

IX. Budget:

FY 1997-2002:

Budget estimates based on an expectation of reclamation of 25 ponds/year.

A.	Personnel:	
	Wildlife Manager V (10%)	$ 5,200
	Wildlife Manager III (12 mo)	38,000
	Utility Worker I (24 months/yr)	34,500
	Wildlife Researcher IV (25%)	13,000
	University contractor (Treatment effectiveness)	40,000
B.	Equipment and Operations:	
	Vehicle operation	$ 4,000
	Boat, motor	5,000
	Sampling equipment (nets, anchors, floats)	5,450
	Fuel	2,000
	Miscellaneous equipment (pumps, protective clothing, etc.)	5,000
C.	Rotenone/Pumping	
	Rotenone up to 20 ponds/year @ $650	$ 13,000
	Detoxify up to 20 treated ponds/year @ $1,265	25,300
	Pump 5 ponds/year @ $4000 average cost	20,000
	Grand Total/year- reclamation only (A,B,C)	**$ 220,450**
	CDOW 50% Cost share - reclamation only	**$ 110,225**
D.	Pond Screening: 15 ponds @ $3,000	$ 45,000
E.	Total cost does not include potential costs of conservation easements and restocking of private ponds	
	19 ponds @ $5,000 each	$ 95,000
F.	Fish restocking of private ponds	

X. Budget Summary

FY 1997 $ 155,225
FY 1998 $ 163,000
FY 1999-2002: Cost dependent on outcomes of pond prioritization for reclamation and findings from ISMP and statistical evaluations.

Literature Cited

Irving, D. B., and B. D. Burdick. 1995. Reconnaissance inventory and prioritization of existing and potential bottomlands in the Upper Colorado River Basin: 1993-1994. Recovery Implementation Project for Endangered Fishes in the Upper Colorado River Basin Final Report. U.S. Fish and Wildlife Service, Denver, Colorado.

Mitchell, M. J. 1996. Impact of the Procedures for Stocking Non Native Fish Species in the Upper Colorado River Basin on private landowners and the commercial aquaculture industry/inventory of public and private ponds along the upper Colorado and lower Gunnison rivers in Colorado. Colorado Department of Agriculture Contract 95-0021, Denver.

Tyus, H. M., and J. F. Saunders, III. 1996. Nonnative fishes in natural ecosystems and a strategic plan for control of nonnatives in the Upper Colorado River basin. Recovery Implementation Program DRAFT REPORT. Cooperative Agreement No. 14-48-006-95-923. U.S. Fish and Wildlife Service, Denver, Colorado.

APPENDIX H

FY-1998 PROPOSED SCOPE OF WORK
Removal and Control of Non-Native Fishes in the Colorado and Gunnison River Floodplain Source Ponds

COLORADO RIVER RECOVERY PROGRAM
FY-1998 PROPOSED SCOPE OF WORK

Project No.: CAP 18/19

Lead Agency: Colorado Division of Wildlife

Category (check one):
X Ongoing project
_ Ongoing-revised project
_ Requested new start

Submitted by: Patrick J. Martinez

Address: Colorado Division of Wildlife
711 Independent Ave.
Grand Junction, CO 81505
Phone: 970-248-7175
FAX 970-243-4611

Date: May 20, 1997

I. Title of Proposal:

Removal and control of non-native fishes in Colorado and Gunnison River floodplain source ponds.

II. Relationship to RIPRAP:

This proposal will primarily address the chronic escapement of centrarchid sport fish from floodplain ponds. Centrarchid sport fishes known to occur in these ponds, including largemouth bass and black crappie, typically seek backwater or slow moving side channel habitats upon entering the main stem river. It is in these riverine habitats that these centrarchid sport fish are believed to pose a significant predatory threat to the young life stages of endangered and other native fishes (Tyus and Saunders 1996). Overall, this strategy is intended to greatly reduce the number of chronic sources of centrarchid sport fishes and possibly other nonnative fish species accessing riverine habitats, thereby contributing to the recovery of endangered fishes.

General Recovery Program Support Action Plan:

III. Reduce negative impacts of nonnative fishes and sport fish management activities.

III.A.2. Identify and implement viable control measures.

III.A.2.c. Implement and evaluate the effectiveness of viable active control measures.

III.B. Reduce negative impacts to endangered fish from sport fish management activities.

III. Study Background/Rationale and Hypotheses:

Floodplain corridors bordering the main-stem rivers in the Upper Colorado River Basin are considered an integral and necessary element in the recovery of the four endangered big river fish species. Lentic habitats comprised by backwaters, embayments created by flooded terraces, and ponds created in depressions all have been identified as a critical habitat component in the life histories of the listed species, and generally important to the native fish community and ecological functions supporting the endangered fishes (Irving and Burdick 1995). Nonnative fish species are present throughout the Upper Basin, and can present adverse impacts to recovery progress for the endangered fishes through predation or competition at critical life stages or in critical locales. These concerns come into focus with the negative interactions between certain nonnative fish species and young life stages of the endangered fishes in floodplain nursery habitats.

Control of nonnative fishes to minimize negative impacts to endangered fishes will be implemented under two categories: (1) reduction of nonnative fish abundance in riverine habitat and (2) reduction in escapement from waters serving as sources of nonnative fishes determined to be problematic in critical habitat reaches. Floodplain pond habitat along these two rivers represents a chronic source of nonnative fish species having documented or presumed negative impacts on the early life stages of Colorado squawfish and razorback sucker, and would have a counterproductive influence on the success of both habitat restoration for endangered and native fishes and removal efforts for nonnative fish in floodplain river reaches. Reclamation of these pond resources would include removal of existing nonnative fish species using piscicides and/or draining by pumping, and installation of escapement prevention devices as appropriate to the target water and its future management objectives. Future management objectives may be aligned with native fish conservation or sport fishery development goals. Reclaimed waters developed for sport fishery purposes would be monitored for re-occurrence of unwanted nonnative fish species, and evaluated in terms of sport fishery recreation goals (e.g catch rates, harvest, use). The scope of this proposed control project involves reclamation and or isolation of nearly 50% of the floodplain pond habitat over a six year period and the evaluation of its effectiveness as both a control effort in the ponds and in the reduction of nonnative fishes in the riverine environment.

IV. Study Goals, Objectives, End Product:

Goal- to reduce proliferation of nonnative fish species in floodplain habitats and minimize chronic escapement of nonnative fishes from perennial ponds.

While the goal of this proposal remains the same, numerous events in 1996-1997 involved with implementing this strategy must be mentioned briefly as they delayed and/or directed the course of this project. Pond pumping proved successful, but comparatively expensive depending the intended use of the pond following reclamation. Chemical reclamation of ponds with rotenone may be minimally successful during winter due to cold water temperatures. Pond pumping remains an option during the winter months within the project area. The use of chlorine as a piscicide for effecting a 100% fish kill in ponds pumped during winter was implemented and evaluated by CDOW biologists and was deemed successful. An overall Environmental Assessment was deemed necessary and is being prepared with assistance from CDOW. An issue about potential adverse effects of floodplain pond reclamation on birds in general and fish-eating birds in particular was raised with the

Colorado Wildlife Commission and represents a significant issue that may require some mitigation. The training and certification of personnel for pesticide transport, storage, and application is underway. A "matrix" identifying key pond attributes will be developed and applied to identify, prioritize and schedule ponds for reclamation. A menu of private pond-owner incentives for gaining access to privately held ponds and for encouraging voluntary participation the pond reclamation effort will also be developed. Coordination with Colorado State Parks and the Flooded Bottomland project is required to facilitate purchase or lease of ponds without jeopardizing ongoing/future monetary negotiations or confusing pond-owners about activities associated with the Recovery Program.

Objectives:

1. To conduct reclamation/isolation of at least ten ponds in 1998.

2. To chemically/mechanically reclaim/isolate up to 150 floodplain ponds within the 50 yr floodplain of the Colorado and Gunnison rivers through 2002.

3. To minimize reinvasion of ponds, escapement of fishes from treated ponds and escapement of fishes from ponds outside the treatment area by screening or other anti-escapement device/strategy.

4. To monitor potential reinvasion of nonnative fish species in floodplain ponds and escapement of nonnative species from ponds managed as sport fisheries.

5. To determine if nonnative fish control in floodplain ponds on a river-reach scale contributes significantly to reductions in the abundance of nonnative fishes in existing riverine nursery habitats.

End Product:

1. Reduction in the number of floodplain ponds serving as sources of nonnative fishes into native fishes riverine habitat.

2. Expanded numbers of pond habitats available for restoration as native and endangered fish nursery habitat through physical habitat restoration or temporary grow-out facilities.

3. Demonstrated compatibility of endangered fish recovery, native fish conservation, and sport fish recreational uses.

V. Description of past performance on this or similar projects.

Two ponds were successfully reclaimed in 1996-1997 by CDOW. Both ponds were privately owned by local gravel pit companies. The first pond, adjacent to the Gunnison River near Delta (9 surface acres/308 acre-feet), was pumped and treated with chlorine in December/January for a total cost of $35,000. The second pond, adjacent to the Colorado River near Grand Junction (5 surface acres), was pumped and treated with chlorine in March 1997 January for a total cost of $17,000. It is important to note that several ponds were considered for reclamation prior to selection of the two that were reclaimed. Concerns about floodplain position of the target ponds, permission to access ponds, the bird issue, and compatibility with other public concerns heavily influenced pond

selection. It is also important to note that the cooperation of the gravel-pit companies was linked to their need to remove the water in their pits to resume gravel extraction. In both cases the gravel companies preferred not to have public fisheries for liability reasons.

VI. Study Area:

Colorado River: Rifle to state line, 50 yr floodplain and outlying ponds.

Gunnison River: Austin to Colorado River confluence, 50 yr floodplain and outlying ponds.

VII. Study Methods/Approach:

A. Pond reclamation planning

This proposal targets reclamation/isolation of ponds within the 50 yr floodplain and isolation of ponds outside of the 50 year floodplain. However, and adaptive approach to prioritizing individual ponds for reclamation/isolation will be followed. Examination of 246 ponds in available floodplain areal photos taken in 1995 along the Colorado River from Palisade to Loma showed 55% (136 ponds = 514 surface acres) of the ponds in the 10 yr floodplain and 22% (55 ponds = 149 surface acres) of the ponds in the 10-50 yr floodplain. Of the 191 ponds within the 50 year floodplain between Palisade and Loma, 156 are privately owned. Of these, 53% (83) are less than one acre in size, 42% (65) are 1-10 acres in size and 5% are over 10 surface acres with only one pond exceeding 20 surface acres. Areal photos from the Gunnison River in 1995 showed 17 ponds from Delta to the Colorado River of which 12% (2 ponds = 3 surface acres) lied within the 10 yr floodplain and 35% (6 ponds = 3 surface acres) were in the 10-50 yr floodplain.

Note that the preceding figures do not include the entire count of ponds identified in the Mitchell (1996) pond survey because areal photos were not available for the entire river lengths encompassed by critical habitat. As reclamation prioritization proceeds, ownership status and floodplain position of targeted ponds will have to be confirmed.

Several strategies are available for removing and or containing existing fish populations in floodplain ponds. The application of these techniques either singly or in various combinations will depend on case-by-case considerations of pond characteristics, treatment cost and intended pond use following evaluation/reclamation.

1. Rotenone: powdered form less expensive than liquid formulation; detailed permitting required before application; maximum effectiveness compromised by low water temperatures.

2. Pumping: seems expensive in comparison to powdered rotenone but is suitable in situations where chemical escapement, dilution or effectiveness are concerns; may be necessary where intended use of pond following reclamation require reconfiguration of pond with heavy equipment.

3. Chlorine: not temperature sensitive in comparison to rotenone; potential for use on small ponds or in conjunction with pumping.

4. Screening: many ponds lie outside the 50 year floodplain, but may represent chronic sources of nonnative; screening alone may be employed to contain existing fish population in ponds outside the 50 year floodplain.

B. Riverine monitoring

The removal of existing fish populations from ponds is expected to be an expensive activity under the Recovery Program and its effectiveness must be evaluated as pond reclamations are accomplished to determine if there is a net reduction in the distribution and numbers of targets nonnative species in the main-stem rivers. Due to ongoing debate about the efficiency of data collected during the Interagency Standardized Monitoring Program for detecting or collecting centrarchid sport fish, an investigation to address this controversy is required by the Procedures for Stocking Nonnative Fish Species in the Upper Colorado River Basin. A proposal for this investigation has been drafted, peer-reviewed, and will be finalized and funded as part of this pond reclamation project. The investigation will be performed by CSU-Larval Fish Laboratory and CDOW will serve as contract administrator and cooperator.

VIII. FY Task Description and Schedule:

FY 1998:

Task 1. Implement strategy for prioritizing which ponds by river reach and floodplain position will be scheduled for reclamation including considerations of potential for ponds to reconnect with the river, application of incentives for private pond owners, implementation of Stocking Procedures, feasibility of pond isolation/screening and/or inclusion in reclaimed pond in bottomland restoration (NOV 97-DEC 97).

Task 2. Select ponds for reclamation in 1998, identify equipment, chemical, fish sampling and personnel needs, and obtain required permits (DEC 97-AUG 98).

Task 3. Perform fish sampling and fish removal in selected ponds (JAN 98-OCT 98).

Task 4. Perform sampling and analysis to evaluate effectiveness of the current ISMP fish sampling protocol in providing representative indices of centrarchid sport fish abundance in riverine habitats of the Colorado River from Palisade to the CO/UT stateline and recommend alternative sampling methods as identified (NOV 97-OCT 98).

IX. Budget:

FY 1997-2002:

Budget estimates based on successful public involvement program, functional landowner incentive menu, timely permitting, and agreeable pond prioritization facilitating an optimum goal for reclamation/isolation of up to 25 ponds/year.

A. Personnel:

Utility Worker I (24 months/yr)	$36,000
University contractor (ISMP effectiveness)	43,450

B. Equipment and Operations:

Vehicle rental	10,000
Vehicle operation & maintenance	4,000
Boat operation & maintenance	1,000
Misc.(pump & protective clothing maintenance, areal photos)	2,000
Pond Screening up to 10 ponds @ $4,500 or operations as needed	45,000

C. Rotenone/Pumping

Rotenone up to 20 ponds/year @ $800	16,000
Detoxify ($KmNO_4$) up to 20 ponds/year @ $1,300	26,000
Pump up to 5 ponds/year @ 15,000	75,000
Chlorine up to 5 ponds/year @ 1,500	7,500
Grand total/ year - reclamation only (A,B,C)	**265,950**
CDOW Cost Share	**-95,950**

Amount requested from Recovery Program $170,000

D. Total cost does not include potential costs of conservation easements and restocking of private ponds.

X. Budget Summary

FY 1997	$ 220,450
FY 1998	$ 265,950

FY 1999-2002: Cost dependent on outcomes of pond prioritization for reclamation

Literature Cited

Irving, D. B., and B. D. Burdick. 1995. Reconnaissance inventory and prioritization of existing and potential bottomlands in the Upper Colorado River Basin: 1993-1994. Recovery Implementation Project for Endangered Fishes in the Upper Colorado River Basin Final Report. U.S. Fish and Wildlife Service, Denver, Colorado.

Mitchell, M. J. 1996. Impact of the Procedures for Stocking Non Native Fish Species in the Upper Colorado River Basin on private landowners and the commercial aquaculture industry/inventory of public and private ponds along the upper Colorado and lower Gunnison rivers in Colorado. Colorado Department of Agriculture Contract 95-0021, Denver.

Tyus, H. M., and J. F. Saunders, III. 1996. Nonnative fishes in natural ecosystems and a strategic plan for control of nonnatives in the Upper Colorado River basin. Recovery Implementation Program DRAFT REPORT. Cooperative Agreement No. 14-48-006-95-923. U.S. Fish and Wildlife Service, Denver, Colorado.

APPENDIX I

Nonnative Fish Control Project
Corn Construction Company Delta Gravel Pit #1

22 3/4 Road Pond
Pond Pumping and Fish Removal Project Completion Report

Status Report
Non-Native Fish Control Project
Corn Construction Company Delta Gravel Pit #1

The contract with Corn Construction Company and Grand Junction Pipe and Supply for pumping the water out of the Delta Gravel Pit was signed and executed during the last week of November, 1996. A verbal notice to proceed was delivered to the contractor (Grand Junction Pipe and Supply) and pumping began on December 9. The water level in the pit fell much faster than anticipated, probably because of the minimal winter flows in the Gunnison River and the cessation of irrigation several weeks prior to the project, and a mobile crane was used daily to move the pump deeper into the pit.

In compliance with the USFWS ES/TE Permit officially issued on December 20 as Subpermit 96-40 (incidental take), the pit was electrofished on December 17. Although no threatened or endangered fish were taken, eighteen adult roundtail chubs were captured and released alive in the Gunnison River adjacent to the pit. Numerous non-native fish (carp, black bullheads, green sunfish, largemouth bass, sand shiners, fathead minnows and white suckers) were encountered during the electrofishing and some were removed from the pit.

The pump was operated continuously until the morning of December 19 when a verbal order was given to the contractor's employees to discontinue pumping. They disconnected the pump's outlet tubing, moved the pump to a safe location and then continued with their gravel extraction activities in an upper section of the pit.

Fifty pounds of three-inch trichloro-s-triazinetrione "pucks" were placed in the seep areas around the pit's water line to effect a constant release of chlorine into the inflowing fresh water. Twenty-five pounds of granular "HTH" brand calcium hypochlorite was dissolved and pumped evenly into the remaining water (about 12 acre-feet) by boat-mounted pumps. The pucks dissolved *very* slowly and the chlorine they released was inadequate to deter fish migration into the areas of fresh water inflow,or to kill the non-native fish in their immediate vicinity. To correct the situation, an additional quantity of "HTH" granular material (140 lbs) was purchased and distributed by boat, and the pucks collected, pulverized and then returned to their seep area locations. The "total chlorine" concentration in the pit water immediately after the second application averaged slightly over the target of one part per million but fell quickly as the chlorine was degraded by environmental conditions.

There were literally thousands of dead non-native fish scattered at the pit waterline the morning of December 20, the day after the chemical treatment. Chlorine tests showed that less than 0.5 ppm total chlorine remained in the water, which had risen about one inch per hour since the pump had been shut down. Fifty pounds of granular sodium thiosulfate was dissolved and pumped evenly into the pit water to remove the remaining chlorine and the pit pump reactivated to permit additional gravel extraction activities. Water samples taken from the pump outfall and tested for chlorine showed that there was no residual chlorine present in the water.

Gravel extraction work continues at the Delta pit and arrangements have been made for the contractor to notify the Divison of Wildlife in advance of their plans to shut down and remove the pump. Rechlorination with granular calcium hypochlorite will take place after the pump is removed from the pit and the contractor's employees are at a safe distance. All of the fish remaining in the pit are expected to be removed as a consequence of this retreatment.

Conclusions:

1. The inflow of ground water to this gravel pit is approximately 3 cfs and is a significant factor to be considered when planning and executing a fish control project.
2. Chlorine (as calcium hypochlorite) can be a very effective fish control agent if applied properly and is environmentally non-persistant. Chlorine can be easily removed by the application of sodium thiosulfate.
3. Employees applying chlorine must be equipped with adequate personal safety exposure and breathing equipment.
4. Close cooperation and coordination between the pumping contractor and the State is imperative.

COLORADO DIVISION OF WILDLIFE
FISH CONTROL FINAL REPORT

NAME OF WATER: Corn Construction Company Delta Gravel Pit #1
DATE TREATED: First Treatment: December 19, 1996
Second Treatment: January 20, 1997
WATER CODE: 93398
SURFACE AREA: Approximately 8.8 surface acres at full pool; 4.4 surface acres at minimum pool.
VOLUME: 12 acre feet at pump down; 308 af at full pool.
STREAM MILES: 0.1
STREAM FLOW: 3 CFS
TOXICANT: First Treatment: Granular calcium hypochlorite (HTH©) and trichloro-s-triazinetrione 3" pucks.
Second Treatment: Granular calcium hypochlorite (HTH©)
AMOUNT OF TOXICANT: First Treatment: 140 lbs. HTH© and 50 lbs. trichloro-s triazinetrione.
Second Treatment: 540 lbs. HTH©
CONCENTRATION: Target concentration of free chlorine is 1.0 PPM.
TOXICITY OF TOXICANT: 68% available chlorine.
COST: $1,050.00
PERIOD OF TOXICITY: 24 to 96 hours
AMOUNT OF DETOXICANT: First Treatment: 50 lbs. sodium thiosulfate.
Second Treatment: 500 lbs. sodium thiosulfate.
ESTIMATED TOTAL COST OF RECLAMATION PROJECT (including labor, travel, chemicals etc.): $35,000.00

FISH ERADICATED:

Species	Number	Size	Pounds	Percent of fish eradicated(approx.)
FMW	≥10,000	1"-4"	≅ 100	100% by number
WHS	≥ 1,000	3"-14"	≅ 25	100% by number
CPP	≥100	8"-30"	≥100	100% by number
SNF	≥10,000	0.5"-10"	≥100	100% by number
SAH	≥10,000	0.3"-4"	≥ 100	100% by number
LMB	2	18"-24"	4	100% by number
RTC	18	8"-18"		Released alive to the Gunnisor River
BBH	≤ 20	8"-14"	≅ 10	100% by number

REMARKS: YOUR NARRATIVE GOES HERE

Division of Plant Industry
Restricted Use Pesticides
Limited Public Applicator Record Of Application

. **Name and address of person for whom application was made:**
N/A

2. **Location where application was made:**
Corn Construction Company Delta Gravel Pit #1. SE 1/4-7-15-95

3. **Target Pests:**
White sucker *Catostomus commersoni*, fathead minnow *Pimephales promelas*, carp *Cyprinus carpio*, green sunfish *Lepomis cyanellus*, sand shiner *Notropis stramineus* , black bullhead *Ameiurus melas*, largemouth bass *Micropterus dolomieu*.

4. **Site, crop, commodity or structure treated:**
Corn Construction Company Delta Gravel Pit #1. SE 1/4-7-15-95

5. **Specific pesticide applied:**
Olin HTH© dry granular chlorinator
Active ingredients:

Calcium hypochlorite	68%
Inert ingredients	32%
Available chlorine	68%

No lot numbers
EPA Registration No. 1258-1069
EPA Establishment No. 1258-TN-1
Olin Pool Products
Olin Corporation
P.O. Box 4500
501 Merritt 7
Norwalk, CT 06856-4500

6. **Dilution rate:**
The dry chemical was continuously sprinkled into a large bucket that was supplied with a constant source of fresh water from the pressure side of the Honda 30 water pump. The resulting solution was educted into the outlet side of the pump and applied evenly over the water surface.

7. **Application rate:**

First Treatment: 140 lbs of dry HTH© granular product was applied over the water surface area and 50 lbs. of three inch diameter trichloro-s-triazinetrione pucks were placed in seep and spring areas.
Second Treatment: 450 lbs of HTH© granular product was applied over the water surface area by pumping and 90 lbs of HTH© granular product was applied to seeps and spring areas.

8. **Carrier:**
Water.

9. **Date and time of application:**
First Treatment:
Start: **12/19/1996 @ 10:00 am** we distributed 50 lbs of trichloro-s-triazinetrione 3" pucks to wetspots and flowing seeps. **12/19/1996 @ 10:45 am** we began pumping operations and distributed 50 lbs of HTH© granular material evenly over the standing water surface, followed by boat agitation of the pond to further distribute the toxicant chemical.
Finish: **12/19/1996 @ 11:45 am** finished pump application of HTH©. Evaluated the initial treatment by using the Hach Test Cube and found less than 1.0 ppm total chlorine. We purchased and

applied an additional 90 lbs of HTH© granular material an found total chlorine concentrations of less than 2.0 ppm. W collected the remaining trichloro-s-triazinetrione 3" puck that had not dissolved, mechanically granulated them an returned the material to the water.

12/20/1996 @ 10:45 am we applied 50 lbs of sodium thiosulfat to the standing water by pump and tested the water fo chlorine using the Hach Test Cube. We found that the chlorin test concentrations were below detectable limits and w informed the employees of Grand Junction Pipe and Supply Co that it was safe to restart the pump for continued grave extraction activities. Subsequent testing of the pump outflo failed to show detectable chlorine concentrations.

Second Treatment:

Start: **01/20/1997 @ 8:30 am** we distributed 90 lbs of HTH© dr granular powder to seeps and areas of flowing water **01/20/1997 @ 9:45 am** we began pumping operations an distributed 450 lbs of HTH© granular material evenly over th standing water surface, followed by boat agitation of the pon to further distribute the toxicant chemical.

Finish: **01/24/1997 @ 10:00 am.** We applied 500 lbs of sodiu thiosulfate to the standing water by pump, and following boa agitation of the standing water, we tested the water fo chlorine using the Hach Test Cube. We found that the tota chlorine test concentrations were below detectable limits.

22 3/4 ROAD POND PUMPING AND FISH REMOVAL PROJECT COMPLETION REPORT

by William R. Elmblad

The project began December 11, 1996, with an inquiry to the landowner about removing fish from the pond. The project ended March 31, 1997, when the fish toxicant in the pond was detoxified.

A contract was made with the landowner, Grand Junction Pipe and Supply Company, to pump water from the pond for $11,790.00. Pumping began March 5, 1997. Pumping was finished the morning of March 25 when the pump was shut down prior to application of the fish toxicant. About three surface acres of water remained from approximately five surface acres when full. Most of the remaining water was less the one foot deep. Maximum depth was about 10 feet.

On March 24 a three person crew set three gill nets and three trammel nets to collect and remove fish. Thirty-two fish were captured: five largemouth bass, one black crappie, one green sunfish, three white suckers, 12 black bullheads, and 10 common carp. The bass, crappie, and bullheads were given to an angler.

The fish toxicant was chlorine. A total of 1,140 pounds of chlorine was applied March 25 and 26 with boat mounted water pumps or broadcast in shallow areas by hand. The chlorine concentration (total) in the pond at the end of the second day was 0.5 ppm. The chlorine was allowed to stay in the pond until March 31 when it was detoxified with sodium thiosulfate. Prior to detoxification, the chlorine level in the pond was too low to be measurable with our test kit. Five hundred and fifty (550) pounds of sodium thiosulfate were applied to the pond using the boat mounted pumps.

Fish species found in the pond were common carp, black bullhead, green sunfish, white sucker, largemouth bass, black crappie, and channel catfish. The observed kill of sportfish were six largemouth bass, four black crappie, and one channel catfish. Approximately 75% of the fish killed were carp, comprising about 95% of the fish biomass. No native fish were seen in the pond.

Labor was 62 hours for project preparation; i.e. obtain agreement with landowner, do contract for pumping, write fish removal application and operations plan, order and pick up chemicals. Labor to net the pond, apply chlorine, and detoxify pond was 98 hours. Total labor was 160 hours, with 140 hours performed at the Wildlife Manager III level and 20 hours at Wildlife Manager I.

The total project cost was:	Labor	$ 3,823
	Chemicals	$ 1,987
	Pumping	$11,790
		$17,600.

APPENDIX J

Comments on the Strategic Plan for Control of Nonnatives in the UCRB

STATE OF COLORADO
Roy Romer, Governor
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE
AN EQUAL OPPORTUNITY EMPLOYER

John W. Mumma, Director
6060 Broadway
Denver, Colorado 80216
Telephone: (303) 297-1192

AQUATIC RESEARCH
317 West Prospect
Fort Collins, Colorado 80526

For Wildlife--
For People

August 1997

John Hamill
U.S. Fish and Wildlife Service
P.O. Box 25486
Denver Federal Center
Denver, CO 80225

Dear John,

Below are my comments on the Strategic Plan for Control of Nonnatives in the UCRB. Also attached is an outline of strategies proposed by the Colorado Division of Wildlife that Tom Nesler assembled with input from CDOW fishery biologists. I believe Tom had sent this collective input to H. Tyus for inclusion in the final Strategy document, but I was unable to clearly identify that the attached components had been incorporated in 29 Apr 96 draft. Due to our recent schedules, Tom and I have not had the chance to discuss the draft Strategy in detail and it is possible that Tom spoke with Harold, but I am unaware of this. Therefore, I have provided the attachment to reiterate nonnative control strategies, potential problems/conflicts, and potential actions/resolutions considered by CDOW. My comments include:

1) Rotenone is the only means mentioned in the Strategy for removing fish populations from floodplain ponds. A SOW submitted to the Recovery Program for 1996 describes the use of pumps by CDOW to drain floodplain ponds as an alternative to rotenone. Pumping was used in 1995 by Service personnel to drain a floodplain pond near Grand Junction and this reclamation was deemed successful. Pumping alleviates concern in some situations about the potential escape of rotenone into riverine habitats. This method should be included in the Strategy.

2) My comments on a previous draft of the Strategy recommended removing the statement "stop stocking nonnative fish in the 100 yr floodplain". On page 43 of the current draft, this statement remains for the Colorado River, including the floodplain reach encompassed by the draft Stocking Procedures. Once again it appears the draft Strategy intends to undermine the intensive efforts to develop stocking procedures for nonnative sport fish in the UCRB. This statement should either be removed or modified to recommend that stocking and management of nonnative fishes be performed in accordance with the finalized Stocking Procedures. Even if the Strategy's authors defend the inclusion of the 100 yr floodplain restriction as an idealistic recommendation, it stands contrary to the collective effort to increase compatibility of endangered fish and nonnative sport fish management.

3) The States and the Service should work cooperatively to secure alternate sites to receive nonnative sport fish removed from critical habitat in an effort to maintain or replace angling opportunity that is or will be lost or reduced in west slope rivers. Page 21 of the draft Strategy addresses transporting nonnatives to other locations so that sport fish are retained for recreational purposes. While opportunities for both agencies to work cooperatively on this particular issue may not be readily apparent, there may be situations on private, municipal, or corporate lands where joint agency incentives could result in acquisition of new angling sites to serve as replacement for reduced fishing opportunity in main stem rivers. While this topic is discussed in the draft Strategy on page 46, I would like to see cooperation among agencies emphasized for this activity.

4) The poor access, remoteness, and lack of most types of support facilities (grocery, boat service, etc.) along most of the rivermiles in the UCRB contribute to a bleak scenario for enticing, establishing, or sustaining commercial harvest pressure on channel catfish numbers. However, this strategy should probably be tested to see if it is effective and manageable. It appears prudent to "test" a commercial fishery for channel catfish in Utah, as opposed to Colorado, for several reasons. This activity would require implementation of appropriate regulations and Utah has experience in regulating the commercial brine shrimp egg industry on the Great Salt Lake. Because commercial catfish harvesting may be controversial where ever it is implemented, the comparative remoteness of many river reaches in Utah would probably minimize sport vs. commercial fishing conflicts. The most important factor is that Utah offers more rivermiles of channel catfish habitat and perhaps greater catfish densities; therefore, these conditions may offer the highest probability of success for a private enterprise. Presumably, any interested commercial fishing venture would want the opportunity to "pre-fish" the catfish populations in the UCRB to determine if their efforts could prove profitable. Providing such an opportunity, in a legal manner, should be considered. Another consideration would be whether to subsidize a commercial venture if it was determined that the UCRB would provide adequate numbers and sizes of catfish, but transport and marketing prove cost ineffective.

5) Page 45 implies that current fishing regulations restrict the take of nonnatives and that these regulations "can and should be changed". From Colorado's perspective, clarification on this issue is required. Colorado formerly restricted the seining, netting or dipping of fish in the Green, Colorado, Yampa, White, and Gunnison rivers to prevent inadvertent harvest of T&E fishes. Beginning in 1996, this same restriction now applies to all natural streams and springs statewide to protect a greater number of native species. While anglers collecting fish for bait with seines probably captured more nonnative than native fishes, especially in western Colorado, this activity still appears incompatible with protection of native fishes and should remain prohibited. For sport fishes such as channel catfish and northern pike in Colorado, the rationale to dispense with bag limits is not supported by available creel survey data or angler's reported success. Few, if any, anglers in Colorado catch, let alone harvest, full daily bag limits of either species in any river in Colorado. Current bag limits for catfish and pike in western Colorado rivers are 10 daily, 10 in possession, but admittedly, it is unknown how many anglers would be interested in stocking their freezers if the possession limit were suspended. Further, eliminating bag limits on any given species openly tells the public that the agency wishes to greatly reduce or eliminate current population levels. The result may be that those anglers most adept at catching piscivorous species become more self-regulating to preserve their angling recreation. It is conceivable that some anglers may respond to the prospect of stock-piling more catfish or pike in their larders and in some accessible river reaches harvest may make inroads into the target nonnative populations. Another consideration, however, is that unless angling pressure subsides as sport fish numbers are reduced, the incidence of angling mortality on native fishes caught inadvertently may rise. Thus, suspending existing regulation may require more monitoring than anticipated to determine if other types of angling restrictions become warranted to protect native fishes. Lastly, page 42 recommends suspending creel limits and providing incentives (bounties?) to increase harvest of nonnative fishes in the Green River in Utah. I suspect that providing incentives to encourage and increase harvest of nonnative sport fish will also have to be an option for the Colorado River -- this is not included on page 43.

I hope you find my comments constructive and useful. If there are any questions about the information or opinions I have provided, please do not hesitate to contact me.

Sincerely,

Patrick J. Martinez
Wildlife Researcher

cc: E. Kochman, P. Evans, T. Nesler, D. Langlois, H. Maddux, T. Powell

APPENDIX K

Bag & Possession Limits for West Slope Rivers - Bio-Political Rationales

Divisional Correspondence Only

STATE OF COLORADO
DIVISION OF WILDLIFE
DEPARTMENT OF NATURAL RESOURCES

DATE: August 6, 1996

TO: Dave Langlois

FROM: Pat Martinez

SUBJECT: Bag & Possession Limits for West Slope Rivers - Bio-Political Rationales

This memo is in response to your 5 Aug 96 e-mail. My following comments are based on my experiences in helping draft the Stocking Procedures and my involvement in the 1996-2000 fishing regulations. Both of these events include ongoing contentious issues that, I believe, provide pertinent and analogous rationales for expanding the liberalization of the current warmwater fish regulations beyond critical habitat. I also offer some perspectives below that I believe are part of the "where's the biological basis" for the proposed bag and possession (B&P) regulation liberalization. Eddie, Robin, Nesler, Graul, Mumma and I had a discussion about some of these items last week in Denver.

Point 1). None of the warmwater sport fish species that are being targeted by regulation liberalization would be prescribed as recovery/preservation agents for T&E/native fishes in the UCRB.

a). This initial biological rationale supporting the reduction of the numbers of these nonnative fishes is also linked to their distribution and sources in the UCRB. If CDOW intends to cost share in the removal of warmwater sport fish in floodplain ponds, the screening of impoundments containing warmwater fishes, and the physical removal of these fishes in the mainstem, it seems contrary to these efforts to maintain protection of any of these species in any upstream source, particularly in the mainstem rivers.

b). Liberalization of B&P limits only in critical habitat may be perceived by some as the State naively or belligerently downplaying the obvious concern about the propensity of nonnative sport fish to move downstream. Liberalization of B&P limits on warmwater sport fish should extend upstream of critical habitat, including mainstem reservoirs, to encompass chronic sources of warmwater species.

c). The argument will arise that CDOW should only liberalize B&P limits in critical habitat to appease the Recovery Program as this would be more politically expedient and defensible with some of our publics. This seems short-sighted since it does not adequately address protection of native fishes whose distributions extend further upstream. I fully appreciate the public relations challenge that lies ahead, but in this case I don't think political expedience will be defensible in the long run. This no longer appears to be solely a T&E fish issue -- it now applies to applies to native fishes as well.

Point 2). The <u>current</u> B&P regulations for nonnative warmwater sport fishes in western Colorado have no biological basis.

a). The question being posed about "Where is the biological basis for liberalizing the current B&P limits?" begs the question of "What is the biological basis of the existing B&P regulations?" No

population size or age/size-structured data for any warmwater sport fish species has ever been considered or applied in establishing B&P limits for western Colorado rivers.

b). Presumably, the two arguments for the existing B&P are statewide fishing regulation consistency and an institutional perception of "what would someone do with more than 10 catfish or 10 pike?". For B&P liberalization to contribute to the fullest extent possible to the goal of reducing current population levels of nonnative sport fish in the mainstem rivers, these long-held beliefs that have been instilled internally and externally will have to be overcome.

c). The current draft of the Stocking Procedures prohibits stocking of nonsalmonid, nonnative fishes in any mainstem river or stream in the UCRB. If CDOW wouldn't willingly introduce or stock nonnative warmwater sport fish species in these stream segments, why would we protect (or portray protection of) these species in any of the mainstems?

Point 3). The "accountability" applied to whether or not native fishes are adequately protected to prevent their listing now lies, in part, with outside authorities and may no longer be solely at the discretion of the CDOW.

a). In the State's sport fish management, CDOW deliberately or understatedly changes fishery management goals. In some cases, there is no "accountability" to previously established, understood, or written management goals, the management simply changes to emphasize other species in place of, or at the expense of, another. Whether this is done for fishery, environmental, or user group reasons, the discretion, and often the "accountability", lies totally within CDOW. The analogous scenario in west slope rivers is that if another native species becomes federally listed, or worse yet, another T&E species becomes extirpated in one of the State's rivers, the concept of "accountability" no longer appears to lie solely within CDOW.

b). The new wrinkle concerning the State's native fishes is in the "accountability" of "what" management actions such as the B&P liberalization are supposed to help accomplish and the "who" that expects this action to be part of nonnative fish control. The Romer/Babbit MOA seems pretty clear in its intent to protect, preserve and recover native fishes. What isn't clear is any unseen teeth that exist, are implied, or may develop in the MOA if the State fails to maintain or achieve these goals. Failing to protect and preserve riverine native sport fishes could result in significant unforseen political consequences in the form of lost management authority.

c). The case that the target nonnatives are of no measurable biological consequence to the State's native fishes in its western rivers is not necessarily more convincing than the alternate perception that nonnative sport fish pose a serious threat to native fishes. Given the external scrutiny being given to CDOW's actions in this arena, it seems highly prudent to error on the side of the native fishes. B&P liberalization may well be the "easiest" to implement of all the nonnative fish control actions; therefore, its potential biological benefits for native fishes should be maximized by application of the liberalized regulation to mainstem upstream sources.

Point 4. Liberalization of B&P limits should be viewed as part of the overall strategy to reduce target populations of nonnative warmwater sport fish species in west slope rivers.

a). The greatest initial affect of suspending the B&P limits will be CDOW conveying to the public that it would prefer that warmwater sport fishes not be in the west slope rivers. In reality, this may now be

the appropriate position as it appears that DNR is among those expecting CDOW to facilitate, if not orchestrate, the reduction of nonnative fishes, including the sport fish, in the State's west slope rivers..

b). In the case of the west slope rivers, the positive effects of suspending the B&P in the recovery or preservation of native fishes will be debated by those with differing perspectives on this issue. Despite the ensuing controversy, other means of reducing nonnative sport fish will be proposed, and possibly implemented, to accomplish what many believe regulation liberalization alone cannot not achieve.

c). Many fish control efforts that strive for reduction or elimination of target fish populations incorporate temporary B&P liberalization to allow licensed anglers to be part of the fish control effort through salvage. If mechanical or other means to remove warmwater sport fishes from west slope rivers are to be implemented, it seems reasonable to facilitate angler participation in this overall removal by suspending B&P regulations.

My intent here is to constructively offer some perspectives to aid in the ensuing "bio-political" discussion that will be part of this regulation issue. I hope you find this feedback useful in this important assignment.

cc: Kochman, Knox, Nesler, Powell

APPENDIX L

Copy of nonnative fish control brochure

COLORADO DIVISION OF WILDLIFE

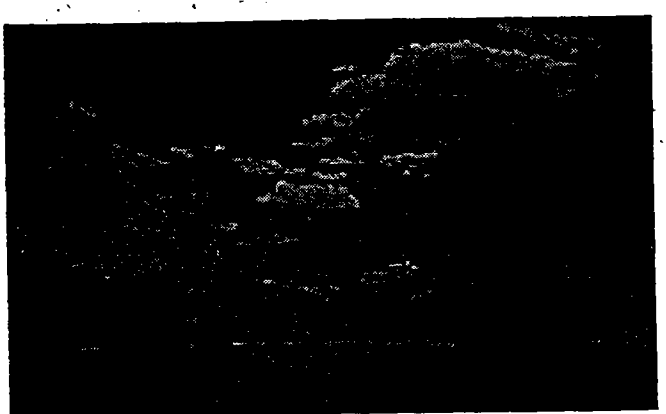
FACT SHEET

Colorado and the Recovery Program for the Endangered Fish of the Upper Colorado

March 1997

What is the Recovery Program for Endangered Fish of the Upper Colorado River Basin?

The program exists because four of the 14 native fish species in the upper basin are federally listed as endangered. It is a 15-year program aimed at re-establishing self-sustaining populations of Colorado squawfish, humpback chub, bonytail and razorback sucker while providing for continued water development within the Colorado River Basin.



Colorado River photo by Lynn Starnes, U.S. Fish & Wildlife Service ©.

Why are Colorado and the Division of Wildlife involved?

The state, through the governor, has signed the recovery program agreement. The Division of Wildlife is involved in this program to guide and implement recovery actions for the listed fish in Colorado waters. The Division is equally concerned about conservation management of the remainder of the fish community in the Colorado River system, of which three more species are considered candidates for federal listing (Colorado River cutthroat trout, roundtail chub, and flannelmouth sucker), and two more are state species of special concern (bluehead sucker and mountain sucker).

The mission of the Colorado Division of Wildlife is to perpetuate the wildlife resources of the state and provide people the opportunity to enjoy them. In service to that mission the Colorado Wildlife Commission adopted a Long Range Plan that was approved in March 1994 and provided the following policy direction:

1 Our foremost aim will be to protect and enhance the viability of all Colorado's wildlife species.

2 We will lead efforts involving a variety of agencies and organizations to prevent wildlife species from declining to threatened or endangered status. The Division will cooperate with others in the recovery of threatened and endangered species.

3 We will encourage the broadest, deepest participation in wildlife-related [recreation] activities that is feasible. The Division will provide quality opportunities for...fishing, hunting, wildlife viewing and other forms of wildlife recreation and enjoyment, consistent with the goal of protecting the wildlife resource.

The Long Range Plan also establishes the following goals for the Division of Wildlife:

1 Increase participation in fishing "by providing a diversity of fishing opportunities."

2 Protect wildlife species that may be at risk of becoming threatened or endangered.

3 Prioritize threatened and endangered species for which recovery plans will be cooperatively developed.

4 Cooperate with federal, state, county and local government agencies, private landowners and other government organizations in the timely development and implementation of recovery plans for high-priority species.

So, the Division is trying to both protect native fishes, including the Colorado squawfish, bonytail, humpback chub and razorback sucker, and to promote diverse fishing opportunities, including those provided by introduced sport fish, such as northern pike, channel catfish, crappie and bass.

What does the Recovery Project include?

The recovery program includes coordinated federal, state and private efforts to improve habitat for the endangered fish, by providing streamflows at times and locations critical to the life cycles of the endangered fish; reducing conflicts with non-native predatory fish species; stocking endangered fish to augment wild populations; building fish ladders to improve fish movement; and restoring riverside nursery habitat for young fish.

Can we have both sport fishing and endangered fish?

Yes. But having both in certain designated and critical reaches of the river will be difficult. Some of these non-native sport fish prey on the threatened and endangered native species.

"The direction in our work is quite clear:
Do what we can to contribute to the protection of native fishes
and at the same time provide the maximum amount of sport fishing."

Pat Martinez, biologist
Colorado Division of Wildlife

Following are some of the principles included in the Recovery Program Cooperative. Agreement concerning control of non-native fish species:

1 Stocking and management of non-native species will be carefully monitored and controlled through a cooperative effort between state wildlife agencies and the U.S. Fish and Wildlife Service to minimize negative interactions, known now as "The Non-native Fish Stocking Procedures."

2 Stocking of non-native species will be confined to areas where absence of potential conflict with rare or endangered species can be demonstrated.

3 The states and U.S. Fish & Wildlife Service will develop procedures for reviewing and resolving disagreements with any proposed introductions into the upper basin.

4 If competition and predation from any non-native species is determined, the states and Fish & Wildlife Service will assess the feasibility of selectively removing those non-native species from areas considered to be essential to listed species.

To provide sport fishing, the Division of Wildlife is approving management plans for lakes outside the 50-year floodplain of each of the rivers where warm-water fishing is feasible. Harvey Gap, near Rifle, already provides pike, tiger muskie, channel catfish and crappie fishing. Purdy Mesa, Mack Mesa, Rifle Gap, McPhee, Crawford, and other West Slope reservoirs will continue to provide additional warm-water fishing opportunities. The Division of Wildlife has no intention of abandoning warm-wafer fishing opportunities. In fact, efforts in the UCRB will focus on identifying future warm-water sites within the scope of the recovery program.

Will the state stop stocking warm-water fish species in these rivers?

For the most part, Colorado has NOT stocked warm-water fish in these rivers, although there are historical records to indicate that largemouth bass and catfish were stocked into mainstream rivers near the turn of the century. Those warm-water species found in these rivers today—northern pike in the Yampa, for example, or channel catfish in the Colorado—escaped there after being stocked in connected reservoirs. Because these non-native fish may escape from impoundments, the recovery program has asked the Division to limit future stockings of these species to selected approved waters and attempt to remove those already in the river systems designated as critical habitat.

Will the Division remove all non-native fish from the river systems?

No. This is not feasible, but there are things that can be done. The recovery program calls for non-native fish removal from rivers where competition between the threatened and endangered fish and non-natives is a problem. The DOW is currently looking at options for fish removal, but no firm decisions on actually removing fish have been made.

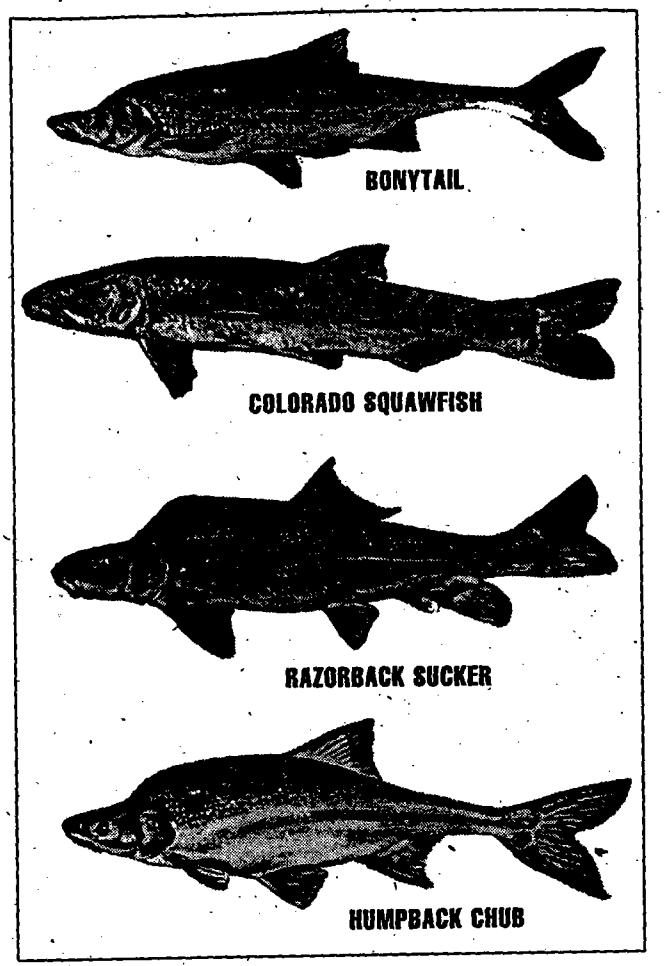
Will the Division remove bag limits on non-native fish in the river systems?

The Colorado Wildlife Commission recently considered a draft regulation covering non-native fish bag limits. This regulation calls for removing bag and possession limits for warm-water sport species in several streams in the upper Colorado River Basin that have been declared critical habitat by the recovery program. The removal of bag limits is intended to encourage harvest of sport fish species that may compete with the four endangered fishes in critical habitat reaches of the Colorado, Gunnison, White, Green and Yampa rivers. The regulation is set for final approval in January 1997.

How does the approved stocking procedures affect privately owned ponds?

That policy calls for removal of non-native fish from all ponds below the 50-year floodplain on the Colorado and Gunnison Rivers and potentially restocking a few warm-water sport fish species only in those ponds above the 50-year floodplain or ponds that have been bermed to the 50-year flood level.

Some ponds could be left barren, stocked with rainbow trout or used as nurseries for endangered native fish. Most ponds in question are on private property. A few hold sport fish now. Representatives from the recovery program will negotiate with these private landowners to eliminate non-native fish from their ponds and possibly use the ponds in the recovery effort. **PRIVATE LANDOWNER PARTICIPATION IS VOLUNTARY.**



Whirling disease has had a major negative impact on trout stocking on the West Slope. Now the state is going to stop stocking most warm-water fish species. Will there be any sportfishing at all in these waters?

Warm-water sport fish will continue to be stocked in ponds and reservoirs with approved management plans. The Division of wildlife has also made arrangements to stock 50,000 disease-free rainbow trout in waters in these lower drainages annually. Plus, many waters at higher elevations affected by whirling disease contain good populations of brown, brook and native trout, and will be stocked with rainbow trout as they become available.

COLORADO DIVISION OF WILDLIFE
CELEBRATING
100
1897 YEARS 1997
OF MANAGING YOUR WILDLIFE

This fact sheet cost 5 cents each to print. 50,000 copies were printed.