COLORADO RIVER RECOVERY PROGRAM Project No.: 140
FY-2006–2007 PROPOSED SCOPE OF WORK for:

Evaluating effects of non-native predator removal on native fishes in the Yampa River

Lead Agency: Larval Fish Laboratory
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Category: ______

Expected Funding Source:

__ Ongoing project
X Ongoing-revised project
__ Requested new project
__ Unsolicited proposal

X Annual funds
___ Capital funds
___ Other (explain)

I. Title of Proposal: Evaluating effects of non-native predator removal on native fishes in the Yampa River, Colorado.

II. Relationship to RIPRAP:

Green River Action Plan: Yampa and Little Snake Rivers

III.A.1. Implement Yampa Basin aquatic wildlife management plan to develop nonnative fish control programs in reaches of the Yampa River occupied by endangered fishes. Each control activity will be evaluated for effectiveness and then continued as needed.

III. Study Background/Rationale and Hypotheses:

Control actions for several non-native fish predators have been implemented in several rivers of the upper Colorado River Basin but effects of those removals on restoration of native fishes is unknown. Understanding the response of the native fish community to predator removal is needed to understand if removal programs are having the desired effect. Strong scientific inferences can be obtained only from studies conducted with a valid methodology. Some of the critical components of an experimental design to assess effects of non-native predator fish removal include estimating the level and precision of the nonnative removal effort, achieving a large treatment (removal) effect, quantifying the response by native fishes to fish removal, comparing results in treatment and reference (control) reaches, replicating those treatments and controls in space and time, and controlling for extraneous confounding variables. I include some discussion of those points below to serve as the basis and justification for a proposed study design.

A general hypothesis for this work might be whether non-native fishes affect native ones or not. A goal would be to determine how much of an effect there is.

Critical Component # 1. Estimate the level of the treatment (reduction of non-native fishes) being imposed and the level of confidence that you have in that estimate.

A critical component of a non-native fish removal investigation is assessing the level of removal by some reliable estimation technique. This concept is similar to measuring water temperature in a study of effects of water temperature on fish growth. Absence of such a metric confounds interpretation of the results. Assessing the level of removal would also allow managers to calculate costs/benefit tradeoffs of removal efforts and determine the methodology most likely to have the desired effect. Associated with estimating the level of treatment effect should be some assessment of confidence for that estimate. A coefficient of variation (CV, standard deviation/mean)*100)) of 10-20 % is most likely to yield desirable results while estimates with substantially more variation may not be considered reliable. The CV for a given estimate is generally inversely proportional to the probability of capture of animals in a sampling pass and the number of sampling passes in a study area and is directly proportional to the variation in the probabilities of capture among samples passes.

It would be desirable to employ several levels of removal in different areas, but because of the lack of suitable and similar areas for comparison and cost, perhaps progressively higher levels of removal could be imposed in the same reach in subsequent years. Such a design may give some insights into appropriate levels of control. It is also important to maintain the level of the removal treatment through time which may change due to fish movement into the reach.

Critical Component # 2. Have a big removal effect.

It is also important in large scale field studies such as these to have a big treatment (fish removal) effect because a significant and measurable response will have a higher chance of detection (statistical power will be increased). Small variations in populations may be attributable to factors (measurement error, weather, discharge, etc.) other than the removal which would make it difficult to state with certainty that the response observed in these studies was due to fish removal.

Although the exact level of treatment to impose is difficult to determine, it is doubtful that removing less than 50% of the abundant target non-native fish predators will result in a measurable response by the native fish community. This is true because other sources of mortality, natural or otherwise, may compensate for reductions in mortality caused by removal of target non-native fish, again reinforcing the notion that a big effect is desirable. Removal levels imposed should also consider the initial abundance of target species compared to "average" levels. Hypothetically, if no recruitment of the target native taxa occurs when predator density averages 5/river mile in most years, there is no reason to expect a native fish response when 50% of the fish are removed but the initial target fish density was an abnormally high at 10 fish/river mile.

It is presently unknown what level of removal effort will be needed to reduce the abundance of the target population on the order of 50%. In order to calculate the effort needed, the probability that an individual fish will be captured in a given sampling pass must be known. This data may be available from current studies that are marking fish in river reaches with a goal of estimating their abundance. In general, the number of passes (N) needed to deplete a population to a desired level can be estimated by the following formula:

$$N = R/P$$

where;

R = log(proportion of the population to be removed) and;

P = log(1 - the probability of capture).

For example, if probabilities of capture for northern pike averaged 0.10 per pass, and the desired population reduction was 50%, a total of 7 passes (log(0.50)/log(.90) = 6.58 = 7 passes) would be necessary to achieve the desired removal. This level of effort may require that relatively small reaches be used for experimental fish removal so that large removals can be achieved.

Critical Component # 3. Estimate the level of the response to the treatment and the level of confidence that you have in that estimate.

Assuming that the desired treatment levels has been achieved and estimated with some precision, the response to such as a change in abundance of some component of the fish community now needs to be measured. It is unlikely that catch/effort data will be sufficient to estimate the response of native fish to predator removal. Capture-recapture studies that use marked animals are more likely to yield useful estimates of abundance. It would also seem logical to estimate a response for a species that has the most potential for negative interactions with the species targeted for removal.

Critical Component # 4. Have a reference (control).

Only by comparing the level of response in each of treatment and reference reaches can inferences be validly made about the effects of fish removal. Even if all of the assumptions discussed above were fulfilled and techniques described were implemented, the lack of a meaningful experimental reference reach probably would confound any results obtained. The main idea of having both a reference and treatment areas is to be able to clearly separate the effects of the removal on the response of interest from effects that are present throughout the river. Inclusion of a reference reach makes it possible to assess whether a response was due to the removal or if conditions river-wide promoted a change in abundance of the native fish community. An associated concern is finding treatment and reference reaches of similar size that have comparable habitat and similar pre-treatment populations of fishes. This is a smaller problem than having no reference at all.

Critical Component # 5. Replicate the reference-treatment sequence.

Replication of this reference reach-removal reach design in several geographic localities allows determination of the repeatability and generality of the treatment over a range of habitat types. Three comparison reaches seems reasonable but even one properly done reach is far more worthwhile than three poorly done ones. Replication in time (e.g., across years) offers similar advantages. It may even be beneficial to swap reference and treatment reaches in alternating years in case some aspect of the habitat or fish community is fundamentally different and affects the outcome of the treatment. For instance, an upstream reach may be the reference reach in one year and the treatment reach in another. Other more imaginative reference-treatment reach designations may be possible.

Critical Component # 6. Timing of removal sampling and maintaining the effect.

Timing of removal sampling, pre- or post-runoff. Assuming that removal sampling is targeting processes such as Colorado pikeminnow recruitment which happens mostly in summer, pre-runoff removal sampling is of dubious value unless careful post-runoff sampling is conducted to confirm pre-runoff results. This is true because spring runoff may re-distribute non-native species and destroy the treatment effect. Runoff may by itself importantly influence the abundance of the target species and thus it is important to consider when the time of year to implement fish removal. Removal in spring seems an obvious choice so that young-of-year native fishes have the summer growth period to potentially benefit from predator removal.

Another potentially important issue is the re-distribution of predator fishes over time, potentially in response to high spring flows or simply dispersal over time. Not maintaining a known level of removal would be akin to allowing water temperature to fluctuate, randomly and unknowingly, in an experiment designed to assess effects of water temperature on fish growth.

Clearly, this is not a simple problem. There are probably other issues of concern that I have missed but I would be happy to discuss proposal revisions and perhaps collaborative ventures in experimental design and implementation, and data analysis with any interested parties. I do feel strongly that the program should resist the urge to go ahead with fish removal projects that are not designed to provide valid conclusions because managers will be unable to determine if they are having an effect, if the effect is due to their actions, what alternative treatment methods are available, and at what cost. The result of simply implementing “fish removal” without well designed research that defines the likelihood of obtaining specific management goals may be procedures that are either ineffective and a waste of resources or ones that are perhaps counterproductive to the recovery goals of the program. Conversely, risky projects such as these can also provide very significant new information if appropriate designs are employed. This general area of research provides an excellent opportunity to assess a primary question that has plagued the program since its inception. That question is whether survival and recruitment of native fishes is hindered by effects of non-native fishes. A critical experiment designed to test these hypotheses and answer that question may guide recovery efforts well into the future.

IV. Study Goals, Objectives, End Product: The goal of this work is to reliably estimate the response of resident native fishes to a known, relatively large, and well-estimated level of predator removal.

Specific objectives necessary to achieve that goal for Yampa River fish removal evaluation studies follow.

1. Select treatment and reference areas for study.
2. Implement removal of smallmouth bass and northern pike in treatment reaches in spring (mostly conducted in a different study).
3. Assess abundance of predators in treatment and reference reaches to determine removal effects.
4. Conduct additional removals prior to summer if removals were not sufficient or if the removal effect was transitory.
5. Estimate response of native fishes in autumn after spring-summer predator removal.

End Product: RIP annual reports submitted following the 2004 and following field seasons. We anticipate a three-year field evaluation followed by a portion of the following year for data analysis and reporting. A draft final project report will be submitted to the Program Directors office by 31 March 2007, to peer and Biology Committee review by 1 May, and a final report to the Biology Committee by 15 July 2007.

V. Study area: Yampa River, Colorado

Treatment and reference reaches have been established in the Yampa River as a part of non-native predator removal studies. The upper study area consists of a 24 mile (RM 125-101)beginning upstream of Morgan Gulch and ending downstream of Little Yampa Canyon. One 12 mile reach has been designated the removal reach, and the other 12 miles has been designated the reference reach. This reach was chosen because it is relatively accessible and the reference reach has a sampling history (R. Anderson, Colorado Division of Wildlife) that will be valuable to assessing trends in fish abundance over time. The other treatment-reference area is a 12-mile river reach upstream of Cross Mountain Canyon, half as treatment and half as reference.

Study reach length is a potential weakness of this study design because the relatively short reaches may promote enough movement into the reach so that the treatment is confounded. Nonnative predator fish movement data should be gathered and analyzed to determine this and study reach lengths increased to accommodate this eventuality.

VI. Study Methods/Approach:

Study reaches have been designated in spring 2003 following discussions with personnel from the Colorado Division of Wildlife. This includes assignment of reference and treatment reaches. Removals will be implemented in spring from designated reaches during sampling designed to assess abundance and ultimately, remove, non-native predators. Additional sampling and removal will occur during sampling to estimate abundance of Colorado pikeminnow.

The plan at present is to mark predator fish on one or more passes in all reaches to assess their distribution, abundance, and size-structure. Removal efforts in treatment reaches will likely commence later in spring and will add to the data available to estimate abundance of predator fishes in reference and treatment reaches. A final pass will be conducted post-runoff to assess fish abundance and enhance removal efforts. Recapture data will also be used to assess movement of fishes between reference and control reaches over time. We anticipate that a total of 3-5 sampling passes will be completed in the sampling area; the number of marking and removal passes is yet unknown.

Capture-recapture data collected in the sampling reaches will be used to generate estimates of abundance of non-native predator fishes following spring and early-summer sampling. These estimates will allow us to determine if we have achieved target levels of reduction for fish predators. Additional summer removals may be conducted if feasible.

Beginning 1 October 2003 (the beginning of the new FY-2004 fiscal year), we will begin to assess the response of native fishes to removal of non-native predators. This work will attempt to evaluate two main components of the native fish community, small-bodied fish in backwaters and large-bodied fishes in the main channel. Success of much of this component depends on accessibility of the reach by our various sampling gears, which is primarily dependent upon water levels.

Small-bodied fishes evaluation.–In each of the reference and treatment reaches, we will identify suitable low-velocity channel margin areas for sampling. Depending on the number available, we will randomly select up to six areas in each reach for assessment of small-bodied fish abundance. Backwaters would be the most suitable areas to sample because they can be isolated with block nets for closed-capture abundance estimation sampling. We may also choose areas that appear like they will be available from year to year for sampling if similar areas can be found in each of the reference and treatment reaches. An effort will also be made to choose sampling areas in treatment and reference reaches that are similar in size and habitat characteristics. Each sampling area will be isolated with a block-net, and we will attempt three-pass removal sampling with seines, bank electrofishing, or some combination of gears. Areas with low habitat complexity will be seine sampled, areas with higher habitat complexity will be sampled with seines and electrofishing. This approach was successfully used in the Colorado River to accurately and precisely estimate abundance of resident fishes in backwaters (Bundy and Bestgen 2001). During that sampling, an average of 90% of fish in backwaters were captured. Samples of each species captured would be measured and weighed so that comparisons of size structure could be made. Non-native predators captured in treatment areas would be removed, fish captured in reference areas would be returned to backwaters. We would attempt to generate abundance estimates for all species captured, including non-native cyprinids, because these species may also show a response to removal of non-native fish predators in the reach. Sampling area and other aspects of the habitat would be quantified so that comparisons could be made between control and reference areas. Data available for comparison among treatment and reference areas would be fish community composition, abundance estimates, density estimates (for those species that were too rare to obtain abundance estimates), and community size-structure.

Large-bodied fishes.–In autumn in each reference and treatment areas, we would attempt 2-3 pass capture-recapture sampling of the adult fish community. Sampling gear would be either boat or raft-electrofishing, depending on water levels. Other sampling gears may be used as conditions permit. Target species would include flannelmouth and bluehead suckers, roundtail chubs, and non-native white suckers and their hybrids. Fish captured on each sampling pass would be batch marked with an external mark (likely a fin punch), measured, and released. We would attempt to capture and estimate abundance of relatively small fish 150 mm TL or larger. We view this as important because that size fish may be the most responsive to removal of fish predators. Effort will be estimated for each sampling pass. Data available for comparison among treatment and reference areas would be fish community composition, abundance estimates, density estimates (for those species that were too rare to obtain abundance estimates), and community size-structure. We should also be able to generate estimates of abundance of non-native fish predators with this sampling. Comparison of spring and autumn data will allow us to assess whether spring removal sampling has had a lasting effect. Fish predators captured in the treatment reach will be removed, those captured in the reference reach will be returned to the water.

We anticipate that three years of field study will be necessary (FY 2004-2006) followed by a portion of a year (FY 2007) for reporting. This time period should give the native fish community adequate time to respond to predator fish removals in the study areas. Field sampling in FY 2004 will need to be flexible and duration of such may depend on when funding is available for work to begin. A reduced effort may be appropriate in autumn 2003 especially is predator fish removal effort in spring 2003 is inadequate. In that case, we would re-write the budget and scope of work to reflect a pilot effort in a reduced study area. Obtaining adequate levels of fish removal, which are funded under other scopes of work, is a key to the success of this effort. Levels of effort needed to remove fish in the study area may need to be flexible for this work to be successful.

VII. Task Description and Schedule

Task 1. Prepare sampling equipment, obtain landowner permissions, scout sample sites.
Task 2. Small-bodied fish sampling.
Task 3. Large-bodied fish sampling.
Task 4. Data entry and analysis.
Task 5. Annual reporting.
Task 6. Final reporting.

VIII. FY-2006/2007 Work

- Annual report /early December each year.

Larval Fish Laboratory, 2006 Budget. Salaries include 20.8 % fringe rate. Overhead is calculated on all items (including salary plus fringe rate) at 17.5%, except for equipment > $5,000.

FY-2006 Budget

Task 1, Prepare sampling equipment

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	7	425		$2,975
Senior technician (d)	21	176		$3,696
Technician (d)	10	140		$1,400
			subtotal	$8,071
Travel				
Per diem (d)	4	20		$80
Mileage (miles)	750	0.37		$278
			subtotal	$358
			Total	$8,429

Task 2 and 3, sample large- and small-bodied fishes

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	20	425		$8,500
Senior technician (d)	100	176		$17,600
Technician (d)	104	140		$14,560
			subtotal	$40,660
Travel				

Per diem (d)	130	25		$3,250
Mileage (miles)	7200	0.37		$2,664
			subtotal	$5,914
Supplies				
gas	200	2.25		$450
oil	20	2.5		$50
props	2	200		$400
nets, seines, pens	9	52		$468
preservative	1	33		33
misc camp gear	1	175		175
Misc sampling gear	1	200		200
			subtotal	$1,776
			Total	$48,350

Task 4, data entry and analysis

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	5	425		$2,125
Senior technician (d)	17	176		$2,992
Technician (d)	5	140		$700
			subtotal	$5,817

Task 5, annual report preparation

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	5	425		$2,125
Senior technician (d)	8	176		$1,408
Technician (d)	1	140		$140
			subtotal	$3,673
Travel				
Annual mtg	2	500		$1,000
			subtotal	$1,000
			Total	$4,673
			Total tasks 1-5	$67,269

Task 2 and 3, complete field sampling October-Nov. 2006

Task 2 and 3, sample large- and small-bodied fishes

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	15	425	$6,375
Senior technician (d)	17	176	$2,992
Technician (d)	82	140	$11,480

			subtotal	$20,847
Travel				
Per diem (d)	100	25		$2,500
Mileage (miles)	2500	0.37		$925
			subtotal	$3,425
Supplies				
gas	90	2.25		$203
oil	5	2.5		$13
props	0	200		$0
nets, seines, pens	2	52		$104
preservative	1	33		33
misc camp gear	1	175		175
Misc sampling gear	1	200		200
			subtotal	$727
			Total	$24,999
		FY 2006 Budget Total		**$92,268**

Larval Fish Laboratory, FY 2007, budget

Task 6, final report preparation

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	60	425		$25,500
Senior technician (d)	35	176		$6,160
Technician (d)	14	140		$1,960
			subtotal	$33,620
Travel				
Annual mtg	2	500		$1,000
			subtotal	$1,000
		FY 07	**Total**	**$34,620**

IX. Budget Summary *[Provide total AND break-out by funding target (e.g. station)]**

FY-2004 $59,050
FY-2005 $59,623
FY-2006 $92,268
FY-2007 $34,620
Total: $255,561

X. Reviewers *[For new projects or ongoing-revised projects, list name, affiliation, phone, and address of people who have reviewed this proposal.]*

XI. References

Bundy, J. M., and K. R. Bestgen. 2001. Evaluation of the Interagency Standardized Monitoring Program Sampling Technique in Backwaters of the Colorado River in the Grand Valley, Colorado. Unpublished report to the Recovery Implementation Program for Endangered Fishes in the Upper Colorado River Basin. Larval Fish Laboratory Contribution 119.