

I. Project Title: Investigation of nonnative fish escapement from Elkhead Reservoir

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III. Project Summary:

Escapement of non-native fish from Elkhead Reservoir has been identified as a potential impact to listed fish in the Yampa River. This study provides results from monitoring escapement during runoff in 2003 and 2004. The objectives of the study were: 1) Quantify escapement of fishes from Elkhead Reservoir by species and size during spring runoff; 2) Recommend the design and operational criteria for screening reservoir outflows that would be most effective for minimizing escapement; and 3) Evaluate escapement rates of nonnative gamefish relocated from the Yampa River to the reservoir.

The majority of fish that escaped while the reservoir was spilling were bluegill and black crappie. Less than 1% of escapees were smallmouth bass and largemouth bass. The report for this study is currently undergoing review, and is expected to be finalized by March/April 2005.

IV. Study Schedule: 2003 and 2004

V. Relationship to RIPRAP:

Green River Action Plan: Yampa and Little Snake rivers

III.A. Develop aquatic management plan to reduce nonnative fish impacts while providing sportfishing opportunities.

III.A.1.a.(1) Evaluate nonnative fish escapement and control options at Elkhead Reservoir.

VI. Accomplishments of Tasks and Deliverables, Discussion of Initial Findings

Background and Study Rationale

Escapement of non-native fish from Elkhead Reservoir has been identified as a potential impact to listed fish in the Yampa River. Fish escapement from the reservoir was included in the 2001 work plan for Elkhead Reservoir enlargement studies conducted by Miller Ecological Consultants, Inc. Miller and Laiho (1997) recommended study of escapement prior to the selecting an escapement control device. The potential cost of building and installing a flexible,

Kevlar-like net, suspended in the water column to minimize fish escapement from Elkhead Reservoir is estimated near \$1 million. It is presumed that annual operating and maintenance of this screen will also be significant. These potential costs compel an evaluation of fish escapement as a pre-requisite task to justify this investment in both the recovery of the endangered Colorado River fishes and the reservoir sportfishery.

Miller Ecological Consultants, Inc. collected aquatic resource information in fall of 1995 on Elkhead Creek for fish and macroinvertebrates (Miller and Rees 1996). Two sites were studied, one downstream of the reservoir and one upstream of the reservoir. The data provided baseline information for the stream aquatic resources downstream and upstream of Elkhead Reservoir. Results of this survey demonstrated the presence of small numbers black crappie and bluegill, and relatively abundant smallmouth bass in the creek near the dam outlet. Most bass were 30-95 mm in length with only four of 192 fish exceeding 100 mm.

Colorado Division of Wildlife collected data on the reservoir fishery in 1999. They sampled with electrofishing and gill nets. The results of that survey showed that approximately 80% of the fish captured were nonnative game species. Nonnative white sucker made up the largest segment of nongame fish (15%). No native fish were collected in the reservoir.

Miller Ecological Consultants conducted a preliminary escapement study during the summer and fall of 2001 but due to the short runoff period, data was not collected during runoff. It was hypothesized that the potential for escapement is greatest during the snowmelt runoff period from May through June. This study provides results from monitoring escapement during runoff in 2003 and 2004.

Elkhead Reservoir represents the largest reservoir in the Yampa Valley with potential and opportunities for warmwater fishing recreation. Due to its size, it offers considerable capacity to serve as a receiving water for nonnative gamefish species targeted for control and removal from the Yampa River. Relocation of adult gamefish from the river to the reservoir serves a net benefit of both reducing their impacts on native riverine fish populations (including the federally endangered fish species), and providing a quality sportfishery potential in the reservoir. The procedures used in this escapement study allow for the capture and subsequent monitoring of resident fish as well as "relocated" fish within the reservoir.

Study Goals and Objectives:

Goal: Document magnitude and characteristics of escapement of nonnative fishes from Elkhead Reservoir to guide design and operational criteria for potential screening, refine sportfishery management, and evaluate translocation of nonnative fish from Yampa River removal actions.
Objectives

The objectives of the study are: 1) Quantify escapement of fishes from Elkhead Reservoir by species and size during spring runoff; 2) Recommend the design and operational criteria for screening reservoir outflows that would be most effective for minimizing escapement; and 3) Evaluate escapement rates of nonnative gamefish relocated from the Yampa River to the reservoir.

Methods

This study relied solely on nets placed in the spillway and on the reservoir outlet during high flows associated with the spring runoff to determine escapement. The nets used in this study were tailrace nets normally designed for hydro-electric projects. These nets consisted of a face frame (3 ft. x 3 ft.) and an inner and outer net similar to a fyke net in design. The nets had ¼ inch mesh with a 10 foot long bag. During 2003 one net was used on the outlet structure and one net was used on the east side of the spillway. These nets were used again in 2004, but an additional net was also used on the west side of the spillway.

Sampling during 2003 was conducted during the weeks of April 28, May 5, May 19 and June 2 (Table 1). During 2004 sampling was conducted during the weeks of May 3, May 18, May 25 and June 1. One net was always set to capture the entire release from the outlet (Figure 1). A second net was used in 2003 and 2004 on the top of the spillway adjacent to the east retaining wall (Figure 2 and Figure 3). A third net was set on the spillway adjacent to the West retaining wall during sampling conducted in 2004 (Figure 4). Each net was anchored with a metal frame and ropes to the spillway chute retaining wall. The nets were left in place during sample sessions and checked for fish every two hours. The nets were set during three or four days of each monitoring week (Table 1 and Table 2). All fish captured were identified, weighed and measured. All live fish were marked (fin clip for small fish and individual floy tag for large fish) and returned to the reservoir. Sampling crews notified CDOW of collection efforts at the end of each sample week.

Table 1. Sampling dates for the Elkhead Reservoir escapement study, 2003.

Week	Days sampled
April 28, 2003	April 29, April 30, May 1
May 5, 2003	May 6, May 7, May 8
May 19, 2003	May 19, May 20, May 21, May 22
June 2, 2003	June 2, June 3, June 4, June 5

Table 2. Sampling dates for the Elkhead Reservoir escapement study, 2004.

Week	Days sampled
May 3, 2004	May 3, May 4, May 5
May 18, 2004	May 18, May 19, May 20
May 25, 2004	May 25, May 26, May 27,
June 1, 2004	June 1, June 2, June 3



Figure 1. Elkhead Reservoir outlet capture net.



Figure 2. Net on edge of spillway.



Figure 3. View from above spillway net.



Figure 4. View of east and west spillway nets.

Results

2003

A total of 282 fish in 117 hours of netting were captured leaving the spillway of Elkhead Reservoir in 2003. No fish were captured in 112 hours of netting on the outlet (Table 3). The escapement per hour per net ranged from zero to 12.5 with an average of 2.41. The net captured three feet of the 135 foot total spillway width. The per-net captures were multiplied to estimate the range of escapement per hour and per day for the total spillway width. Eight fish species were captured during the 2003 sampling. The most abundant fish were black crappie and bluegill, which comprised 78% and 16% of the escapement respectively (Table 4). Largemouth bass, smallmouth bass and rainbow trout escapement was less than 1% of the total. Fish size classes ranged from 50 mm to 350 mm total length (Figure 5). The majority of the black crappie were in the 125 mm size class (Figure 6). The majority of the bluegill were in the 75 mm size class (Figure 7). The smallest fish captured were sand shiner and speckled dace.

The highest escapement occurred just after sunset. The highest escapement rates occurred during the week of highest runoff. The stream flow was approximately 600 cfs the week of April 28th, 2003, peaked at approximately 1000 cfs during the week of May 19th, 2003 and dropped to approximately 350 cfs the week of June 2nd, 2003. Highest escapement rates in all weeks sampled occurred between 8:00 pm to 10:00 pm in the evening.

Table 3. Summary of escapement netting at Elkhead Reservoir, 2003.

	Total Hours set	Total Fish Captured	
Outlet	112	0	
Spillway	117	282	
	Fish per Hour per net		
	Average	Maximum	Minimum
Outlet	0	0	0
Spillway	2.56	12.50	0.00
	Total fish escapement per hour		
	Average	Maximum	Minimum
Outlet	0	0	0
Spillway	115.3	562.5	0
	Total fish escapement per day		
	Average	Maximum	Minimum
Outlet	0	0	0
Spillway	2,766.8	13,500.0	0

Table 4. Total number of fish collected during 2003 escapement study.

Species	Grand Total	Percent	Average escapement number per hour	Average escapement number per day
Bluegill (<i>Lepomis macrochirus</i>)	45	16.0%	18.4	441.5
Smallmouth bass (<i>Micropterus dolomieu</i>)	1	0.4%	0.4	9.8
Largemouth bass (<i>Micropterus salmoides</i>)	1	0.4%	0.4	9.8
Sand shiner (<i>Notropis stramineus</i>)	6	2.1%	2.5	58.9
Rainbow trout (<i>Oncorhynchus mykiss</i>)	1	0.4%	0.4	9.8
Fathead minnow (<i>Pimephales promelas</i>)	7	2.5%	2.9	68.7
Black crappie (<i>Pomoxis nigromaculatus</i>)	220	78.0%	89.9	2158.5
Speckled dace (<i>Rhinichthys osculus</i>)	1	0.4%	0.4	9.8
Grand Total	282	100%	115.3	2766.8

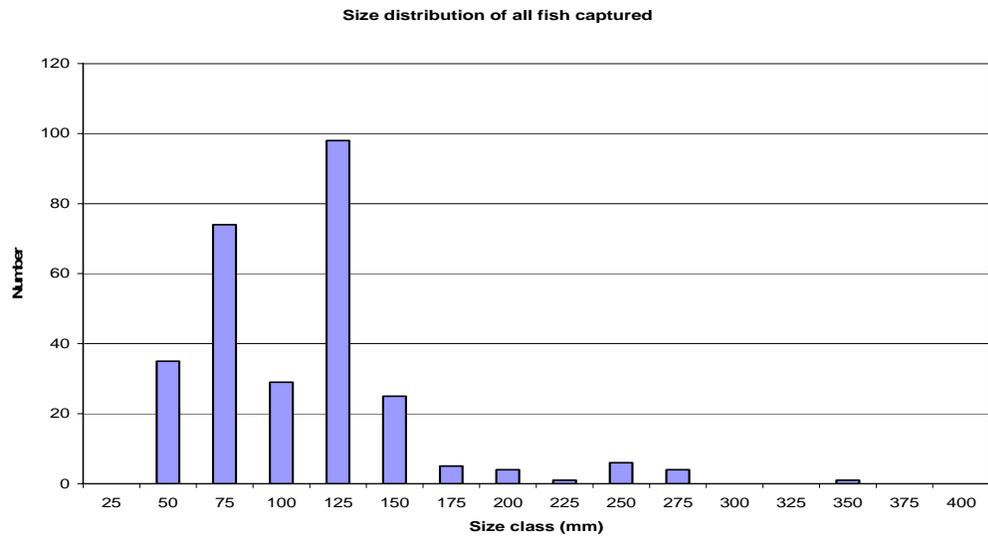


Figure 5. Size distribution of all fish captured, 2003.

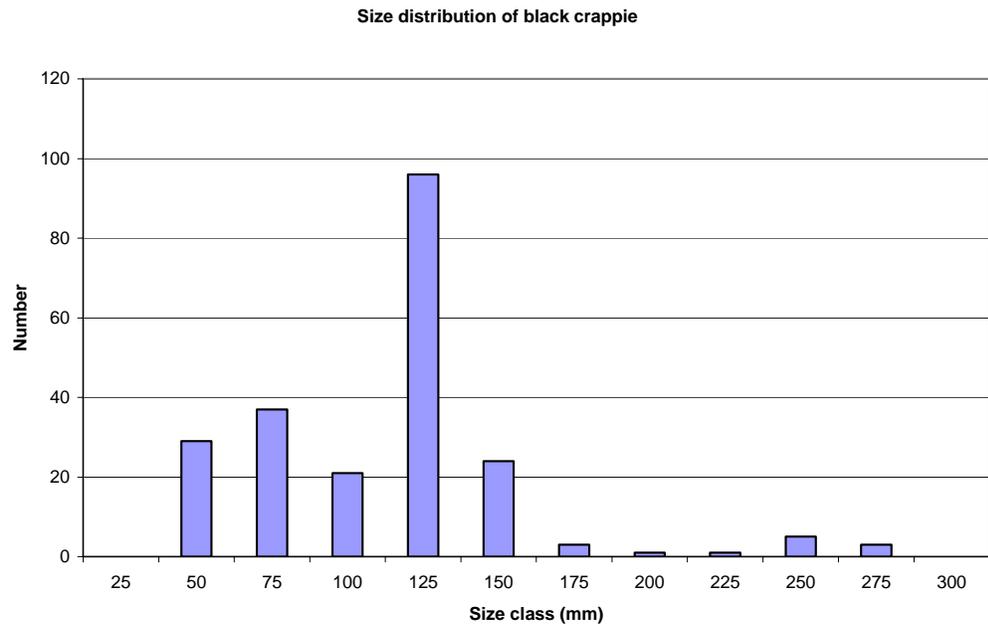


Figure 6. Size distribution of black crappie, 2003.

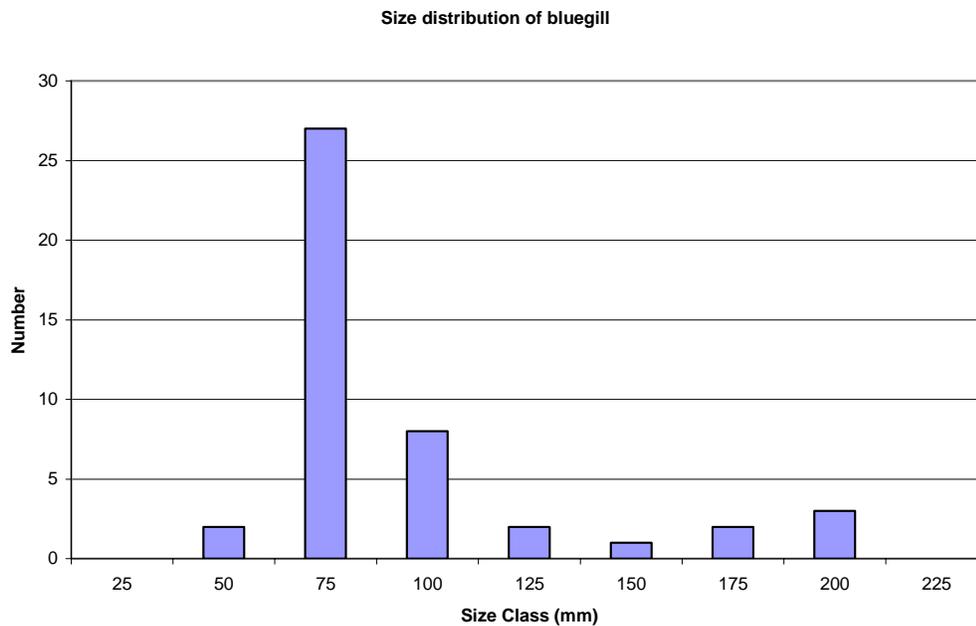


Figure 7. Size distribution of bluegill, 2003.

2004

Lower snow pack resulted in lower flows during May and June of 2004. It is likely that the lower volume of water passing over the spillway contributed to a lower catch rate. A total of 60 fish were captured moving through the spillway (249.5 hours of netting), while one fish was captured at the outlet structure (118.17 hours of netting). The per-net captures were multiplied to estimate the range of escapement per hour and per day for the total spillway width (Table 5). Five fish species were captured during the 2004 sampling. The most abundant fish were bluegill and black crappie, which comprised 47.6% and 45.9% of the escapement respectively (Table 6). Smallmouth bass, rainbow trout and fathead minnow were also collected in low numbers during the 2004 season.

Fish captured in the spillway during 2004 were generally smaller than those captured in 2003. Fish sizes in 2004 ranged from 27 mm to 297 mm (Figure 8). Size classes for bluegill ranged from 27 mm to 110 mm (Figure 9), while black crappie sizes ranged from 29 mm to 109 mm (Figure 10). The majority of the fish captured during the 2004 season were less than 100 mm. A smallmouth bass (TL = 55 mm) was the only fish captured at the outlet structure.

The time of escapement in 2004 did not reflect a consistent diel pattern, but the rate of escapement did seem to be influenced by stream flow. The highest escapement rates at the spillway were recorded between 5:15 am and 7:15 am on 5 May, and between 5:15 pm and 7:15 pm on 18 May. Discharge at these times was recorded at 344 cfs and 193 cfs, respectively. However, overall catch rate was highest during the week with the highest discharge. Of the 61 fish captured, 60 were collected during the first two weeks when flows were greater than 170 cfs. Only one fish was captured during the last two weeks when discharge fell below 110 cfs.

Table 5. Summary of escapement netting at Elkhead Reservoir, 2004.

	Total Hours set	Total Fish Captured	
Outlet	118.17	1	
Spillway	249.5	60	
	Fish per Hour per net		
	Average	Maximum	Minimum
Outlet	0.01	0.5	0
Spillway	0.24	5.50	0
	Total fish escapement per hour		
	Average	Maximum	Minimum
Outlet	0.01	0.5	0
Spillway	10.8	247.5	0
	Total fish escapement per day		
	Average	Maximum	Minimum
Outlet	0.19	12.0	0
Spillway	259.2	5,940.0	0

Table 6. Total number of fish collected during 2004 escapement study.

Species	Grand Total	Percent	Average escapement number per hour	Average escapement number per day
Bluegill (<i>Lepomis macrochirus</i>)	29	47.6%	5.2	123.45
Smallmouth bass (<i>Micropterus dolomieu</i>)	2	3.3%	0.3	8.5
Rainbow trout (<i>Oncorhynchus mykiss</i>)	1	1.6%	0.2	4.2
Fathead minnow (<i>Pimephales promelas</i>)	1	1.6%	0.2	4.2
Black crappie (<i>Pomoxis nigromaculatus</i>)	28	45.9%	5.0	119.1
Grand Total	61	100%	10.9	259.4

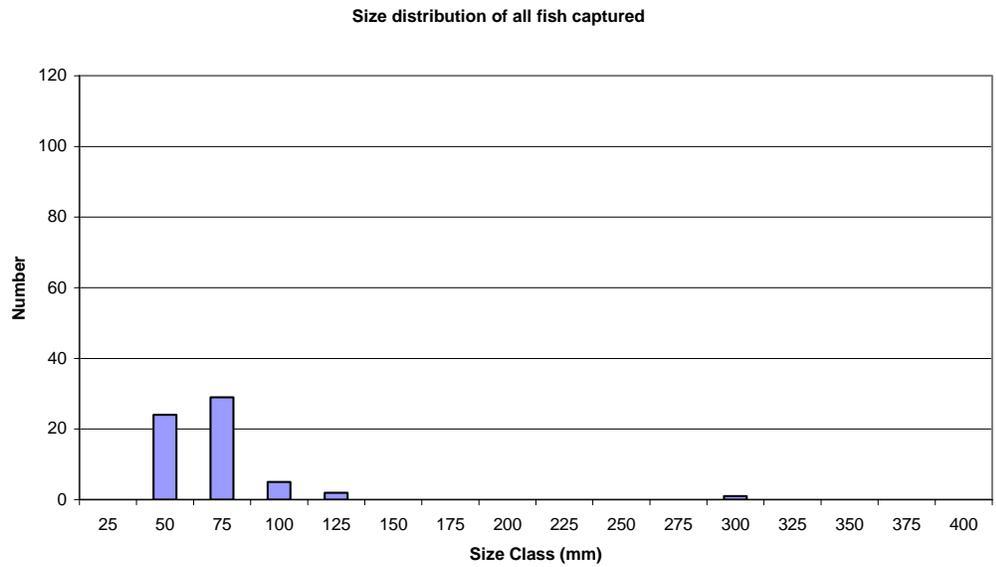


Figure 8. Size distribution of all fish captured, 2004.

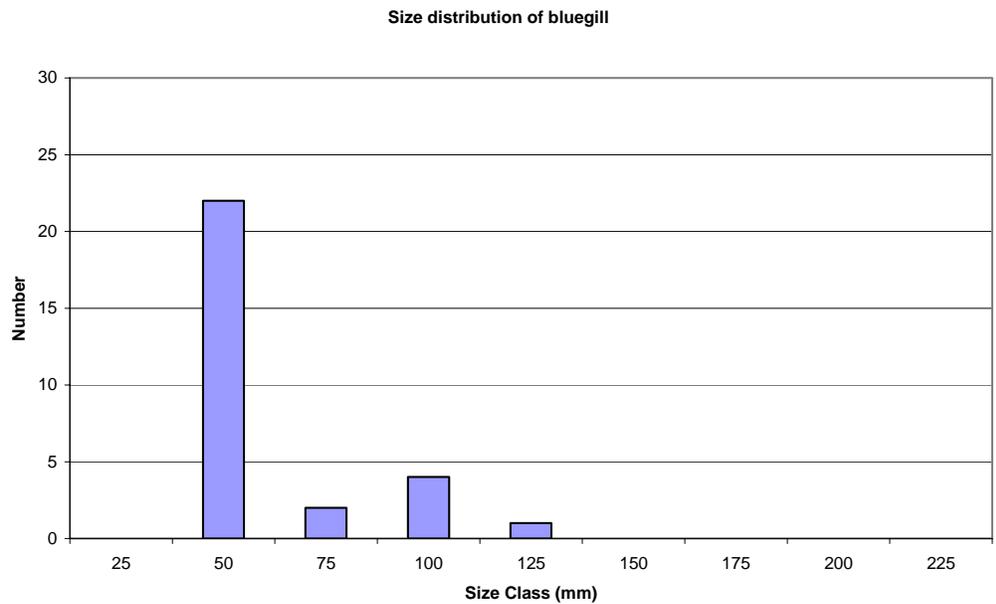


Figure 9. Size distribution of bluegill, 2004.

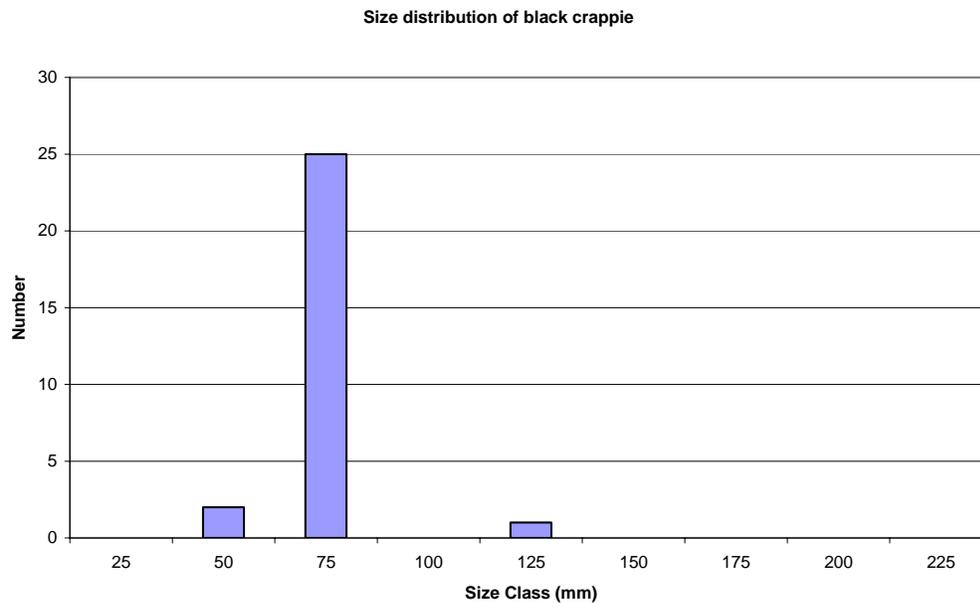


Figure 10. Size distribution of black crappie, 2004.

Discussion

The escapement sampling in 2003 and 2004 confirmed that fish leave Elkhead Reservoir during period of high flows associated with runoff. The majority of the fish captured during netting were less than 150 mm in total length during 2003 and less than 100 mm total length in 2004. The rate of escapement and the size of fish that escape appeared to be positively related to the level of discharge. Escapement was dominated by black crappie and bluegill with crappie dominating the early season catch and bluegill becoming dominant in subsequent weeks. There may be a seasonal pattern to the escapement but sampling late into the runoff (late June) would be required to verify this hypothesis. There may be a temporal pattern to escapement with the majority of the fish moving through the spillway near sunrise, sunset or after dark. This may be related to fish becoming more active with the onset of darkness thus increasing the potential for entrainment in the outflow. Very few large individual fish were captured during the study. The swimming ability of larger size classes may provide an advantage in the avoidance of entrainment. This ability may not yet be realized in younger fish of smaller size classes.

VII. Recommendations: Finalize report

VIII. Project Status: Nearing completion

IX. FY 2004 Budget Status

- A. Funds Provided: \$50.9K
- B. Funds Expended: \$50.9K
- C. Difference: 0
- D. Percent of FY 2004 work completed: 100
- E. Recovery Program funds spent for publication charges: None

X. Status of Data Submission: NA

XI. Signed: Pat Nelson for Bill Miller 1/13/05
Principal Investigator Date

References:

- Miller, W.J. and D. Laiho. 1997. Feasibility Evaluation of Non-native fish control structures. Final Report Upper Colorado River Basin Recovery Implementation Program. Prepared for Colorado River Water Conservation District, Glenwood Springs, Colorado.
- Miller, W. J., and D. E. Rees. 1996. Survey of fish, benthic macroinvertebrates, and habitat in Elkhead Creek near Craig, Colorado. Final report. Prepared for Ayres Associates, Fort Collins, Colorado.