I. Project Title: Colorado River Embeddedness Monitoring Study

II. Principal Investigator(s):
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III. Project Summary:

A program designed to monitor embeddedness of gravel and cobble substrates in the upper Colorado River initiated in 1999 continued in 2000, 2001, and 2002. Baseline embeddedness data was previously collected during 1996-1998 as part of another study. This monitoring program will be used to determine effects of various flow regimes on substrate condition. Substrate composition affects primary and secondary production in riverine ecosystems. Periphyton and invertebrates, the food base of the fish community, depend on rock surfaces for attachment sites; in addition, invertebrates depend on the interstitial voids among rocks for shelter and feeding sites. Because the transport, sorting and deposition of coarse and fine-grained sediments is largely determined by the flow regime, gaining a better understanding of the link between streamflow, substrate characteristics, and food availability will allow managers to more effectively manipulate flows to maintain and enhance native fish habitat.

Beginning in 2001, macro-invertebrate biomass data collection was added to the substrate monitoring program. This information is critical to quantifying the biological link between physical substrate characteristics and food base production. Until that time, we only had year-to-year data on changes in substrate embeddedness in relation to discharge, but did not have the data to quantify how these changes affect invertebrate production and ultimately the carrying capacity for the fish community. This additional sampling allowed discerning year-to-year changes in invertebrate production and relate these changes to depth-to-embeddedness and flow regimes. For such analyses, a relatively long-term data set is required before aspects of various flow regimes from a series of high- and low-flow years can be interpreted unambiguously. Substrate and invertebrate biomass monitoring was scheduled to continue through 2008. However, field-effort funding was curtailed by the Recovery Program after only two years (2000 and 2001) of invertebrate data collection.

During these years, monitoring was conducted in two reaches of the Colorado River in the Grand Valley, near Grand Junction. This area includes the highest concentrations of

Colorado pikeminnow in the Colorado River. Monitoring sites in four riffles and four runs were sampled in the 15-mile reach, upstream of the Gunnison River confluence, and in four riffles and four runs in the 18-mile reach, immediately downstream of the Gunnison River confluence. At each site, 20 embeddedness measurements were made on each sampling date. Sampling was conducted once prior to runoff in early spring, and three times during base flows of summer-fall.

For 2004, the Recovery Program asked that a report be written summarizing the data collected during 1996-2002. Such information could then be used by the Biology Committee and Recovery Program Director's Office to determine if such monitoring should be continued.

IV. Study Schedule: 1999-2009

V. Relationship to RIPRAP: Coordinated Reservoirs I.A.4.c(3)(c)

VI. Accomplishment of FY 02 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

Tasks

1) Prepare report on embeddedness and invetebrate monitoring.

Data analysis began in 2004 but was not completed. Analysis will continue in 2005 and preparation and completion of a report is anticipated for 2005. Initial findings indicate that total depth-to-embeddedness (DTE) in runs during base flow were similar between 1996 and 1997 in both the 15- and 18-mile reaches, but then declined significantly from 1997 to 2001. In 2002, embeddedness improved slightly to year 2000 levels. Flows in 2002, including spring runoff flows, were at record lows. Because depth-to-embeddedness did not decline further in 2002 with such low flows, this metric is likely not a function of flow alone, but responds in a dynamic manner in relation to sediment input and the ability of flows to pass it through the system. Accumulation of fines in the substrate continued until 2001 probably because fine sediment input to the system remained high but flows were inadequate to keep the majority of it from depositing in the bed. The fact that accumulation did not continue in 2002 (there was even some reduction of previously accumulated fines) despite extremely low flows suggests that there was very little fine sediment input that year. Hence, depth-to-embeddedness is dynamic and changes are likely a result of both the annual flow regime and the annual amount of fine sediment input. Rather than high sediment deposition in 2002 as a result of unprecedented low flows (as expected), low runoff may have resulted in low erosion of fine sediment from the source watershed and low mobilization of fine-sediment from upstream in-bed sources. This interpretaion is, of course, speculative, but is in keeping with what has been learned about sediment dynamics in this system.

With no pre-2001 invertebrate data, it is not known what level of invertebrate biomass can be expected when substrate conditions are relatively clean as in 1996-1997. Invertebrate monitoring began in 2001 when embeddedness conditions (low mean depth-to-embeddedness) were at the worst levels of the monitoring period. In riffles, invertebrate biomass during summer base flows appeared high in both reaches with significantly greater amounts in the 15-mile reach than in the 18-mile reach. In 2002,

biomass in the 18-mile reach was similar to that in 2001. However, in the 15-mile reach, mean biomass was consistently lower on all three sample dates in 2002 than in 2001 (differences on two of the three dates were not statistically significant). In both reaches, biomass appeared to increase in March from previous fall amounts before either declining (15-mile reach) or remaining similar (18-mile reach) in summer. In runs, biomass was fairly similar in both reaches, with slightly higher (but not significantly higher) mean amounts in the 15-mile reach in 2001 and in spring 2002. However, in summer-fall 2002 mean biomass in runs declined significantly in both reaches, and more so in the 15-reach. Values in both reaches were extremely low in runs in late 2002.

So, even though embeddedness conditions improved slightly in 2002, invertebrate biomass declined dramatically in runs, the most common habitat type. With only two years of data, no relationships between invertebrate biomass and fine sediment could be established. However, it is clear that during the extremely low flows of 2002, invertebrate standing crops declined dramatically independently of slight changes or improvement in substrate conditions. This decline occurred between April and August and standing crops remained low through the last sampling date in October. Possible causes include: 1) increased water temperatures; 2) increased contaminate concentrations (most flow in the 15-mile reach during summer consisted of agricultural return flows); 3) increased foraging intensity (per unit area) by fish concentrated in reduced habitat area.

Clearly, more years of macro-invertebrate biomass monitoring are needed before relationships between invertebrate standing crops and fine sediment can be understood. In addition, much could be learned regarding the effects of severe drought on food production, and hence, carrrying capacity for native fish communities, if monitoring were continued. Recovery goals for Colorado pikeminnow in the Colorado mainstem are based on carrying capacity estimates, yet little is known what the carrying capacity is or what effects various environmental factors have on it.

VII. Recommendations: Proceed with monitoring as before. Monitoring needs to be in place to see how the system responds when normal snowpack and flow regimes resume.

VIII. Project Status: Project is behind schedule. Report will prepared in 2005. No additional funding for this is requested.

IX. FY 2004 Budget

A.	Funds Provided:	17,600
B.	Funds Expended:	17,600
C.	Difference:	0
D.	Publication costs	0

X. Status of Data Submission: Not applicable. The database manager only requires submission of fish data.

XI. Signed: *Douglas Osmundson*, Fishery Biologist, Lead investigator
1/10/05