FY-2004-05 PROPOSED SCOPE OF WORK for: **Project #:** 85F
Gunnison and Green River Sediment Monitoring

Lead Agency: U.S. Fish and Wildlife Service

Submitted by: George Smith, Division of Water Resources
P.O. Box 25486, DFC, Denver, C0 80225-0486
Phone: (303) 236-4485
Fax: (303) 236-4224
george_smith@fws.gov
Cooperator USGS
Paul von Guerard, Principal Investigator
Phone 970-245-5257 ex 14

Date: March 3, 2004

Category:
_ Ongoing project
_ Ongoing-revised project
x Requested new project
_ Unsolicited proposal

Expected Funding Source:
x Annual funds
_ Capital funds
_ Other

I. Title of Proposal:

Gunnison and Green River Basin Sediment Monitoring and Evaluation Program

II. Relation to RIPRAP:
General Recovery Program Support Action Plan I.A.3&4
Gunnison River Action Plan: 1.A. Identify fish habitat and flow needs
Green River Action Plan: 1.A. Identify fish habitat and flow needs

III. Study Background/Rationale and Hypotheses:

Underlying geomorphic processes relevant to the formation and maintenance of backwater habitats are relatively poorly understood, particularly the effects of peak-flow magnitude and duration; sediment deposition and erosion; base-flow magnitude and variability; and antecedent conditions on habitat availability and conditions. Knowledge of sediment dynamics in important river reaches is critical to understanding the effects of flow regimes on endangered fish habitats.

Based upon a report entitled "Recommended Priorities for Geomorphology Research in Endangered Fish Habitats of the Upper Colorado River Basin" (LaGory et.al 2003), the Recovery Program requested proposals to conduct the sediment monitoring element of a Connected Backwaters Project, which also includes a physical habitat monitoring element involving topographic measurements of selected backwaters and adjacent exposed sandbars

in each of six river reaches. After review by the geomorphology peer review panel and the Biology Committee, this physical habitat-monitoring element of the project was deferred. However, installing and operating sediment samplers in conjunction with existing stream flow gages were found to be important to supplement and expand existing sediment knowledge.

Beginning in 1998 the Recovery Program and USGS began a 5-year program of sediment data collection for the Yampa and Green Rivers (Elliot and Anders 2004 in review). Included in Elliot and Anders are sediment-transport equations, including equations for suspended load, bedload, total-sediment load, and total-sediment load by hydrograph season. For example, 40 suspended-sediment and 40 bedload measurements were made at the Green River near Jensen, Utah, at discharges ranging from 965 ft^3/s to 22,000 ft^3/s. These data included 18 measurements during the rising-limb hydrograph season and 18 measurements during the recessional- or falling-limb hydrograph season.

While periodic sediment-transport data have been collected and sediment-transport equations adequate for sediment-budget estimation have been derived for the Green River near Jensen (Elliott and Anders, in review) no daily-sediment data have been collected. Collection of daily sediment records and associated suspended-sediment size analysis can be used to provide the basis for comparison of sediment loads computed using daily samples and sediment loads computed using the sediment-transport equations of Elliott and Anders (in review). Their sediment-transport equations are based on periodic sediment data and represent average sediment-transport conditions in a river. The average condition defined by the equations may not adequately represent episodic sediment transport and sediment concentrations that occur before or after the snowmelt hydrograph. Sediment transport characteristics in the Green River during periods of early snowmelt runoff and during rainfall runoff are usually not well defined by the average condition represented by the sediment-transport equations. The collection of daily sediment records and analysis of the distinction between sediment records computed using the two methods would be an important guide in determining sediment data collection needed to support instream habitat considerations. In addition, collection of daily suspended-sediment data and the associated periodic sediment samples, will be useful to improve existing sediment equations by supplementing existing periodic-sampling data.

Based upon a cursory review of existing Gunnison River data sources by Pitlick and others (1999), sediment data comparable to that available for the Green River at Jensen are not available for the Gunnison River near Grand Junction (here in after called the Whitewater gage). The sediment data available for the Whitewater gage are limited to periodic suspended-sediment concentrations collected between 1959 and 1999. A limited amount of sediment-size data, mostly percent of sample finer than 0.062 millimeters, is available at this site. Therefore the development of sediment-transport equations similar to those developed for the Green River near Jensen would be limited to suspended sediment concentration and perhaps percent of sample finer than 0.062 millimeters. Adequate sediment-size data are needed to develop sediment-transport equations for various sediment-size classes. Similar to the Green River near Jensen, the collection of daily

sediment records and the development of sediment-transport equations will allow for analysis of the differences between sediment records computed using each method and would be an important guide in determining sediment data collection needed to support instream habitat considerations. The Green River near Jensen represents sand-sized bed sediment and the Whitewater gage represents mostly cobble-sized bed sediment. No bedload samples have been colleted at the Whitewater gage. Bedload discharge will, in lieu of the collection of bedload samples, be estimated for the Whitewater gage using published empirical sediment-transport equations (Einstein, 1950).

Based upon discussion with the Biology Committee, Argonne National Laboratory, and other interested individuals, the USGS was requested to submit a proposal to implement sediment sampling at two locations believed to be important to support future habitat monitoring work and to address key uncertainties in existing flow recommendations for the Green and Gunnison Rivers. The two locations are 09152500 Whitewater gage (0.5 miles south of the town of Whitewater, Colorado on the Gunnison River) and 09161000 Green River near Jensen, Utah.

Study Goals, Objectives, End Products:

A. Goals:

The goal of the sediment monitoring program is to provide information with which to evaluate changes in the magnitude, timing, and size distribution of sediment delivery to the Gunnison and Green River systems resulting from water-resource development and land use changes in the basin, and their potential effects on the riverine ecosystem, specifically as they relate to recovery of the endangered fishes.

B. Objectives:

The primary objective of this sediment monitoring project is to address key uncertainties in priority reaches of the Colorado, Gunnison and Green Rivers relevant to the role of flows and sediment transport on the formation and maintenance of backwater habitats and spawning bars[1]. A secondary objective is to collect all necessary sediment data that will be needed to evaluate Service flow recommendations for the Aspinall Unit and Flaming Gorge Reservoir.

1. A retrospective analysis of historic sediment data will be done to determine the availability of historic sediment data for the key sites on the Colorado, Gunnison, and Green River near Green River Utah. This objective includes an evaluation of the data to determine their utility for developing sediment-transport equations, evaluating trends in

[1] While spawning bars were not emphasized by decision makers in 2003 they were ranked high in the priorities report LaGory 2003 and data collection to address spawning bar issues need to be collected simultaneously with data needed for backwater habitat studies.

sediment transport, and evaluating how variations (wet vs. dry years) in annual hydrographs affect sediment transport.

2. To support the evaluation of the effects of the flows and sediment movement on the morphometric and bed material characteristics of Gunnison and Green River.

3. Determine if there is any distinction between sediment load estimates computed from daily sediment data, sediment transport equations, and empirical bedload transport equations.

4. Evaluate the dynamics of sediment movement in the study reaches by collecting and analyzing data to compute sediment load, including suspended sediment using daily samples and sediment transport equations. Bed load, and bed-material samples will be collected at two sites. These data will be collected at the Whitewater gage and the Green River near Jensen Utah (Jensen). These sites represent the range in sediment conditions found in other habitat monitoring reaches (primarily cobble bottom in the Gunnison at Whitewater and a sand cobble mixture, primarily sand, found in the Green River near Jensen).

End Product:

The end products of this Scope of work will be two reports prepared by the USGS. The priority will be to prepare annual progress reports to the Recovery Program that will contain the data retrospective, annual data record summaries and in the third year preliminary sediment equations that can be used for data points for the habitat monitoring program. After the third year of data collection, in Fiscal Year 2007, the USGS will prepare a Scientific Investigations Report that summarizes the retrospective analysis of sediment data for the Green and Gunnison Rivers. This analysis will include sediment-transport equations, trend analysis, and hydrologic analysis developed using historic data. In addition, the report will evaluate the results of sediment-transport calculations derived using daily and periodic sediment samples (sediment-transport equations). This analysis will be done in concert with stream habitat professionals to determine what types of sediment-transport data support planned habitat evaluation on the Green and Gunnison Rivers. From that analysis, a sediment data-collection network will be designed and proposed. This approach will ensure that sediment data are collected in the most cost-efficient manner to support habitat investigations.

An expert panel should be assembled by the RIP to review the results of objective 1 & 2 and review the state of current knowledge relating to how sediment data can be related to the creation and maintenance of backwaters habitats. (This panel to be setup separates from this scope of work by Recovery Program staff and will use a separate funding source to pay contributors)

VI. Study Method/Approach:

This project will establish automated suspended-sediment samplers in two critical reaches of the Upper Colorado River Basin (Whitewater gage on the Gunnison River and the Green River near Jensen, Utah). Daily suspended-sediment load data at these two sites will provide information needed for: (1) an understanding of sediment budgets (sediment import and export balance); (2) the effects of flow regime on habitat maintenance; (3) the relationship between sediment load and flow, including base and peak flows; (4) the effects of antecedent conditions (if the right sequence of years is present) on sediment transport; and (5) the effect of peak-flow duration on sediment transport rates.

Sediment data previously collected at streamflow gages in the basin will be useful in resolving many of the key uncertainties associated with existing flow recommendations. A retrospective analysis of historic sediment data will be done for the key sites on the Colorado, Gunnison, and Green River near Green River Utah. This analysis will determine whether sediment-transport relations can be derived from existing data and what if any additional data may be needed to develop or improve sediment transport equations at these sites. Also, historic data will be evaluated to determine if significant trends exist in sediment transport, and the effect of variations in annual hydrographs (wet vs. dry years) on sediment transport will be evaluated.

VII. Task Description and Schedule

1. Retrospective Analysis of Historic Data

Sediment data for the Colorado River in the vicinity of the 15-mile and 18-mile reaches of the Colorado River in the Grand Valley and downstream to the confluence of Green River, the Gunnison River downstream from the confluence of the North Fork of the Gunnison River, and the Green River near Green River, Utah will be summarized. These data will be used to develop sediment-transport equations, to the extent possible, similar to those developed for the Yampa River, Little Snake River, and the Green River near the Gates of Lodore and the Green River near Jensen, Utah. Trends will be determined at sites where data are adequate for that purpose. Also, the effects of the annual streamflow hydrograph on sediment transport will be evaluated. These analyses will help to identify data gaps that would be addressed by sediment sampling done in the support of habitat evaluations. These data analyses and results from Objective 1 (comparison of two sediment data collection methodologies) will allow for crafting a sediment-sampling network to support stream habitat evaluation efforts.

2. The USGS Grand Junction office will be contracted to install and instrument two automatic sediment collection sites. The collection of daily suspended-sediment records for mid-March through mid-October (approximately 7 months) at the following USGS gage sites:

09152500 Gunnison River near Grand Junction (also known as the Whitewater gage), Colorado
09161000 Green River near Jensen, Utah.

Data collected at the sites on the Gunnison, and Green Rivers will include:

1. Point samples for suspended sediment using automatic samplers. The sampling equipment will be operated to capture the entire spring runoff period, as well as any major sediment transport (i.e., storm) events in summer and fall. A turbidity sensor would trigger sampling during such events. In addition, during site visits temperature, and conductivity will be collected.

2. Depth and width integrated suspended-sediment samples for calibrating the point sample to be representative of the stream cross section

3. About 25 percent of the automated point samples will be analyzed for suspended-sediment concentration and percent of sample that is silt and clay and the percent of sample that is sand. Suspended-sediment concentration will only be determined for the balance of the point samples.

4. Water-surface slope will be collected for incipient motion calculations for estimating the threshold for entrainment of bottom material at various stream flows.

5. Bed-material samples and depth-and width-integrated suspended-sediment samples for full-size analysis will be collected at each site for use in the modified Einstein method, which will be used to estimate bed-load transport. Because the Einstein method might not work at the Whitewater gage because the bed is mostly cobble, there might be a need to use a different methodology such as the Meyer-Peter Muller or Parker equations. These data will provide perspective regarding percent of the total sediment load represented by bedload. Estimates of bedload and corresponding calculations of critical shear stress, threshold of sediment movement (maximum grain size entrained for a given streamflow), will provide information to characterize bed-sediment entrainment and bed-load sediment transport over a range of stream flows. This analysis would provide guidance for planning if sampling of bedload in subsequent years is determined to be needed.

Schedule: It is anticipated that the sediment sampling will be for 3 years with the data summarized and interpreted in a USGS report after the third year of data collection. The data retrospective will be completed in the first year of the study.

VIII. FY-2004 to 2007 Budget Estimate

USGS coop funds	
40 % match	$77,510
Cooperator funds	
60 % match	$116,260

TOTAL	$193,770
Purchase of automatic sediment samplers by USFWS	$7,100

SUMMARY OF COSTS FOR DAILY SEDIMENT SAMPLING AND RETROSPECTIVE ANALYSIS

	COST PER WEEK	NUMBER OF WEEKS	COST		COMMENTS
PROJECT MANAGEMENT					
Principle investigator	2,841	2.4	6,818		
Subtotal for Project Management				**6,818**	
SITE INSTALLATION					
Principle Investigator	2,841	1.32	3,975		
Field Hydrologist	2,841	1.32	3,975		
Equipment			12,980		Samplers, shelters, batteries, solar panels, extra bottle sets for samplers, extra bottles for cross-section samples, intake tubing, **Cost per site = 10,465. 60% cost to RIP is 6,279 per site plus 3,550 for auto samplers per site for a total cost to RIP of 9,829 per site.**
Subtotal for Site Installation				**20,930**	
DAILY STATION OPERATION AND MAINTENANCE					
Principle Investigator	2,841	6.35	19,123		
Field Hydrologist	2,841	1.7	5,119		
Hydrologic Field Assistant	1,184	0.35	439		
Equipment			10,400		turbidimeters for triggering samplers, contingency for equipment repair, nozzles and gaskets for depth-integrating samplers
Lab			14,039		1,120 point sample concentrations (330 sand breaks), 60 cross-section sample concentrations and 60 sand-break analysis,
Shipping			2,000		Shipment of samples to LAB.
Viech and per diem			13,650		
Subtotal			64,770		

Data Management					
Hydrologic Field Assistant	1,184		4.31	5,409	Process samples for submittal to lab, associated data entry, archive, maintain files
subtotal				5,409	
Records Computation, Review, and Publication					
Principle Investigator	2,841		4.15	12,498	
Hydrologic Field Assistant	1,184		4	5,020	Verify and check data entry for samples, preparation of record for publication
Data reviewer	3,314		1.8	6,323	
Subtotal				23,841	
Subtotal for Daily Stations Operation and Maintenance				**94,020**	**Cost per site = 47,010. 60% cost to RIP is 28,206 per site**
BEDLOAD AND INCIPIENT MOTION CALCULATION					
Field Work					
Principle Investigator	2,841		1.52	4,577	
Field Hydrologist	2,841		1.52	4,577	
Lab				3,165	18 samples for full-size analysis and 18 bottom-material analyses
Office Work					
Principle Investigator	2,841		1.52	4,577	
Subtotal for Bedload and Incipient Motion Calculations				**16,896**	**Cost per site 7,025. 60% cost to RIP is 4,323 per site**
RETROSPECTIVE ANALYSIS					
Principle Investigator	2,841		13.5	40,655	
Senior Hydrologist	4,260		3.2	14,450	
Subtotal for Retrospective Analysis				**55,105**	
GRAND TOTAL				**193,770**	

Cost estimate for sediment sampling at 2 sites and preparation of annual progress report: FY2005

RIP	90,350
[1]USGS	48,650
TOTAL	139,000

Cost estimate for sediment sampling at 2 sites and preparation of annual progress report:: FY2006

RIP	96,175
[1]USGS	52,325
TOTAL	149,500

[2]Cost estimate for Scientific Investigations Report: FY2007

RIP	61,750
[1]USGS	33,250
TOTAL	95,000

[1] USGS match ratio is expected to decline to 35% in FY2005 and out years.

[2] Costs for preparing and publishing USGS report summarizing and interpreting the data.

IX. Literature Cited:

Elliott, J.G., and Anders, S.P., (in review), Summary of sediment data from the Yampa River and upper Green River basins, Colorado and Utah. U.S. Geological Survey Water-Resources Investigations Report 04-xxx.

Einstein, H.A., 1950, The Bedload Function of Sediment Transportation in Open Channel Flows, " USDA Tech. Bull. 1026,.

LaGory, K. E., J. W. Hayse, and D. Tomasko, 2003. Recommended Priorities for Geomorphology Research in Endangered Fish Habitats of the Upper Colorado River Basin. U.S. Fish and Wildlife Service Recovery Program Project Number 134, Final Report, September 2003.

McAda C. W., 2003, Flow Recommendations to Benefit Endangered Fish in The Colorado and Gunnision Rivers. U.S. Fish and Wildlife Service Recovery Program Project Number 54 Final Report July 2003.