I. Project Title: Gunnison and Green River Basin Sediment Monitoring and Evaluation Program

II. Principal Investigator

Cory Williams
USGS Hydrologist
764 Horizon Drive
Grand Junction, Colorado 81506

Ph 970-245-5257 ext 31
FAX 970-245-1026
email cawillia@usgs.gov

III Project Summary:

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 streamflows and sediment transport on the formation and maintenance of backwater habitats and spawning bars[1]. A secondary objective is to collect the necessary sediment data to aide in the evaluation of 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 also includes an evaluation of the data to determine their utility for developing sediment-transport equations **(These were completed and presented at the habitat workshop in March 2005).** In addition, an evaluation of trends in sediment transport, and how variations (wet vs. dry years) in annual hydrographs affect sediment transport will be included in the SIR **(to be written in FY 2008)**.

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

[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.

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. Water-surface slope and bed-material samples will be collected at two sites to support bedload calculations. 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 R. at Whitewater and a sand cobble mixture, primarily sand, found in the Green R. near Jensen).

5. Collect necessary topology data near the Jensen site for use in a Surface Water Modeling System (SWMS) Demonstration Project to determine the suitability of this type of modeling of sediment transport as it relates to current and future efforts to monitor habitat for the endangered fishes. An added utility of the proposed work is the opportunity, at a later date, to incorporate output from the SMWM into existing habitat models to further relate streamflow and sediment transport to recovery efforts for the endangered fishes.

IV. Study Schedule: Initial Year 2004 Final Year 2008

V. Relationship to Riprap:

General Recovery Program Support Action Plan I.A.3&4
Gunnison River Action Plan: 1.A. Identify fish habitat and streamflow needs
Green River Action Plan: 1.A. Identify fish habitat and streamflow needs

VI. Accomplishments for 2006:

Sediment data collection FY 2006:

To better understand the sediment loading dynamics in the Gunnison and Green River Basins, along with other river basins with similar characteristics, data collection began in FY 2005 with the installation of sediment automatic-pump samplers at Gunnison River near Grand Junction, Colorado (Whitewater); and the Green River near Jensen, Utah (Jensen). Suspended-sediment samples were collected at Whitewater and Jensen from late March through October. Sample collection intervals were based on variations in streamflow as well as time between samples, prior to and during the snowmelt runoff peak. Recurrence intervals for the snowmelt runoff peaks observed in 2005 were 1.4 years for Whitewater (based on peak streamflow for water years 1968-2005) and 2.5 years for Jensen (based on peak streamflow for water years 1965-2005).

Following the snowmelt runoff peak, an emphasis was placed on monitoring sediment transport during monsoonal rain events. Use of a turbidity sensor facilitated the collection of suspended-sediment samples indicative of monsoonal rain events where minimal increases in streamflow coincided with substantial increases in suspended-sediment concentrations. To date, in 2006, at Whitewater 15 monsoonal rain events were sampled; and at Jensen 9 monsoonal rain events were sampled.

In order to determine the daily suspended-sediment load for each site, a combination of daily pump samples and periodic cross-sectional samples were collected. Pump samples define suspended-sediment concentrations at one location in the stream cross section; cross-sectional samples define the average concentration of the entire cross section. These samples define the relation between the pump-sample concentrations and the cross-sectional sample concentrations. Suspended-sediment sample collection at the two sites consisted of about 300 pump samples collected at Whitewater along with 12 equal-width interval cross-sectional samples; about 300 pump samples were collected at Jensen along with 11 equal-width interval cross-sectional samples. Grain-size analysis was computed for all of the Whitewater cross-sectional samples and several of the pump samples. Grain-size analysis was computed for all of the Jensen cross-sectional samples and several of the pump samples.

To estimate the bed-load portion of the total sediment load at these sites, data collection continued this FY through the determination of bed material size for use in incipient motion calculations and for use in the modified Einstein, Meyer-Peter Muller, or Parker equations to estimate bed-load transport. These data will provide perspective regarding percent of the total sediment load represented by bed load and the mechanics of sediment movement (maximum grain size entrained for a given streamflow), over a range of streamflows. Bed-material samples were collected during the MD-SWMS data collection efforts in May, 2006, at Jensen. Where the collection of bed-material was not possible, pebble-count data were collected.

Sediment records calculations FY 2006:

Preliminary sediment records for Whitewater and Jensen were completed for FY 2005 and presented to George Smith in early spring 2006. Evaluation of FY 2005 data collection guided collection efforts in FY 2006. A reduction in quality assurance samples was warranted and allowed for an increase in the number of equal-width interval cross-sectional samples collected during the year. The increase in sampling frequency may help better quantify any seasonal differences in the relation between cross-section samples and pump samples.

Multi-Dimensional Surface-Water Modeling System Demonstration Project:

In March, 2005, the Sediment Sampling Workgroup discussed the need to better understand the mechanisms controlling channel-morphology progression as it relates to changes in streamflow. The adaptation of the Multi-Dimensional Surface-Water Modeling System (MD-SWMS), an existing hydraulic model produced from the USGS National Research Program, was discussed as a possible method to meet this need. Collaboration between personnel from this project and the USGS National Research Program personnel began in 2005 and efforts to produce a demonstration project continued in early FY 2006. In May, 2006, a project was put in place to demonstrate the use of MD-SWMS in USFWS Recovery Program efforts.

On May 8-12, 2006, a five-person survey team comprised of USGS and USFWS personnel collected topological data for use in the Multi-Dimensional Surface-Water Modeling System (MD-SWMS) Demonstration Project. The topological data consisted of bathymetry and flood-plain mapping for a 1.5-mile reach of the Green River near Jensen, UT. The primary focus of the data collection was the collection of topology data relevant to SWMS modeling of sediment mobility in the vicinity of a critical spawning-bar identified by the Recovery Program and USFWS. Existing LIght Distance And Ranging (LIDAR) data was obtained and used as the framework for the flood-plain surveying efforts and RTK-GPS surveying was completed along shallow and exposed bars and in other areas likely to have been significantly changed following the LIDAR imagery collection date (November, 1999).

Bathymetry mapping was conducted using a boat-mounted Acoustic Doppler Current Profiler (ADCP) and echo sounders. The ADCP and echo sounder were used in conjunction with real-time differential-corrected (RTK) GPS rovers to allow for the measurement of bed elevation at each location, relative to a reference datum. Longitudinal and cross-section bathymetry data were collected in two spatial patterns resulting in a grid of bathymetry data comprised of ADCP longitudinal surveys and Echo sounder cross-sections. The ADCP longitudinal surveys were collected from the upstream reach boundary to the downstream reach boundary parallel to the shoreline. The longitudinal survey paths were spaced approximately 40 feet apart, with 15 longitudinal surveys total. In addition, the ADCP was also used at 5 cross-sections to measure velocity and signal backscatter data for use as a verification dataset for the SWMS modeling. Echo sounder cross-sections were collected throughout the reach perpendicular to the shoreline and were spaced approximately 100 feet apart, with approximately 140 cross-sections total.

Three temporary water-surface elevation gages were installed May 16, 2006, to monitor water-surface changes throughout the snowmelt-runoff period. These gages were downloaded on June 16, 2006; at which time two of the sensors were repositioned at a lower elevation to continue to monitoring water-surface

elevations during the summer. The temporary gages were downloaded and removed on July 27, 2006; and covered a range of streamflow values from 1,200 to 19,000 cubic feet per second (cfs) including the streamflow peak for Water Year 2006. The comparison of these gage records to the streamflow-gaging station record was used to determine a stage-discharge relation within the study reach.

To determine the size distribution of bed material at various locations within the study reach, 15 bed-material samples were collected. These data will be included in the SWMS sediment mobility modeling. Bed material size information results are not expected back from the laboratory until later this year.

Multi-Dimensional Surface-Water Modeling System calibration began with the correction and referencing of the topography data to a curvilinear grid system for data interpolation and computational-grid mapping. This series of steps interpolates and fills the topology data set into a seamless 5x5-meter curvilinear computation grid. This grid was then used in conjunction with the water-surface elevation data measured using RTK-GPS rovers and the temporary water-level gages to generate 5 hydraulic models representing 5 specific streamflows. The primary model was derived from the May 8-12, 2006, data collection corresponding to a streamflow of 8,800 cfs. The data sets collected at this streamflow have the most complete water-surface elevation data and were used to gain insight into the hydraulics of the study reach. These insights were useful as a guide for the modeling of the other streamflows (10,600 cfs; 14,100 cfs; 17,700 cfs; and 19,000 cfs). A comparison of water-surface elevations (temporary gages) and discharge conservation (conservation of mass) was used to calibrate the hydraulic models for the remaining streamflows. Calibration of each model was achieved for discharge variation of less than 3 percent from normalized discharge for all five streamflow models (no more than +/– 3-percent variation in streamflow among the cross-section locations was found in the calibrated models).

VII. Recommendations:

An evaluation and discussion of the MD-SWMS Demonstration project is planed for this winter between appropriate members of the USGS and the Recovery Program. The evaluation should include 1) an assessment of the utility of this technology in support of existing and future Recovery Program efforts 2) feasibility/utility of incorporating MD-SWMS with existing work or future efforts 3) cost assessment of future work/expansions.

One potential application for MD-SWMS to support an existing Recovery Program effort would be a sensitivity analysis on immature-larvae drift from the Jensen spawning bar to downstream backwater habitats.

One potential application for MD-SWMS to support future Recovery Program efforts would be a study of channel evolution as it relates to backwater habitat creation and maintenance.

VIII. Project Status:

The project has completed the preliminary retrospective analysis of historic data and a summary was presented to the Sediment Sampling Workgroup in March, 2005. A revised handout from the meeting was sent out at the end of December, 2005.

The second year of data collection is nearly complete and the sediment automatic-samplers will be shutdown for the winter by the end of October. The final set of FY 2006 suspended-sediment samples will shipped for laboratory analyses early in November and results are expected to be returned from the laboratory within 60 days of sample arrival. The sediment record for FY 2006 will be computed and reviewed this winter so that any modifications to the sampling strategy deemed appropriate can be incorporated into FY 2007 sampling work plan. Efforts continue to improve the efficiency of the automatic-samplers though computer programming and use of surrogate technologies including turbidity monitoring and acoustic-Doppler technologies.

The Multi-Dimensional Surface-Water Modeling System (MD-SWMS) Demonstration project completed the topology-data collection efforts. Generation and calibration of 5 hydraulic models representing 5 specific streamflows (8,800 cfs; 10,600 cfs; 14,100 cfs; 17,700 cfs; and 19,000 cfs) is complete. Verification of velocity data will be completed in early FY 2007 for the 8,800 cfs model at 5 locations. Verification will be achieved through the comparison of measured velocity data (collected during the topological-data collection effort) to model outputs (predicted velocity).

IX. FY 2006 Budget Discussion

A. Table 1. Funds provided

Funding Source	FY 2006 – Provided
Argonne National Laboratory	$15,000
Recovery Program	$117,000
State of Wyoming (also Recovery Program $)	$24,000
USGS COOP	$13,000
Total Funding	$169,000

B. Table 2. Funds expended

Funding Source	FY 2006 – Expended
Argonne National Laboratory	$13,240
Recovery Program	$87,000
State of Wyoming	$19,000
USGS COOP	$8,000
Total Expenditure	$127,240

C. A portion of the Recovery Program and State of Wyoming FY 2006 funding was carried over into FY 2007 to cover the cost of continued data collection during October, computing the FY 2006 daily suspended-sediment records in FY 2007, and for bed load calculation efforts. A portion of the recovery Program and Argonne Laboratory FY 2006 funding was carried over into FY 2007 to complete the MD-SWMS Demonstration project.

Preliminary suspended-sediment records and the MD-SWMS Demonstration project will be completed in early FY 2007.

X. Status of Submissions N/A

XI. Signed _Cory Williams_ __10/23/2006__
Principal Investigator Date