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

II. Principal Investigator

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III Project Summary:

The objective of this investigation is to define the relation between streamflow and sediment transport to aide in the evaluation of Service flow recommendations for the Aspinall Unit and Flaming Gorge Reservoir as it relates to endangered fish habitat. Findings from a retrospective assessment determining sediment-data availability and applicability for use in development of sediment-transport equations were presented in 2004. Collection of daily suspended-sediment data is has been completed for 3 years at the Green River near Jensen, Utah, and Gunnison River near Grand Junction, CO, USGS streamflow-gaging stations. Incorporation of a Multi-Dimensional Surface-Water Modeling System (MD-SWMS) Demonstration project was done to determine the utility of using computer models of streamflow and sediment transport to understand how streamflow relates to endangered-fish habitat; the results of the study were presented during the 2007 USFWS Researcher Meeting. Final publications of project findings are anticipated to be released as a USGS Digital Data Series Report (Data Report) in 2008 and Scientific Investigations Report (Interpretive Report) in 2009.

IV. Study Schedule: Initial Year 2004 Final Year 2009

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 2007:

Sediment data collection FY 2007:

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 mid-March through mid-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 2007 were 1.2 years for Whitewater (based on peak streamflow for water years 1968-2007) and 1.33 years for Jensen (based on peak streamflow for water years 1965-2007).

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. In 2007, at Whitewater 14 monsoonal rain events were sampled; and at Jensen 12 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 375 pump samples collected at Whitewater along with 11 equal-width interval cross-sectional samples (2 additional samples for Quality Assurance); about 330 pump samples were collected at Jensen along with 10 equal-width interval cross-sectional samples (4 additional samples for Quality Assurance). 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 in FY08 through the determination of bed-material size, cross-sectional depths, and water-surface slopes 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.

Sediment records calculations FY 2007:

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 and 2006 data collection guided collection efforts in FY 2007. Sample collection efforts in FY 2007 followed FY 2006 guidance.

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 were included in the SWMS sediment mobility modeling.

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).

January 17-18, 2007, Preliminary findings from the MD-SWMS were presented during the 28th Annual Researcher Meeting in Grand Junction, CO, to demonstrate the ability of MD-SWMS to related streamflow and sediment transport to spawning-habitat suitability analysis.

Using the Multi-Dimensional Surface-Water Modeling System (MD-SWMS), a surface-water hydraulics and sediment-transport model, an analysis of the transport of sediment on known razorback sucker spawning habitat in the Green River near Jensen, Utah, was done for streamflow conditions representative of the spring 2006 spawning and larval emergence period (April 21-May17). MD-SWMS models were developed to calculate the capacity and mode of sediment transport for streamflows of 8,800 and 10,600 ft^3/s. To characterize the hydraulic and sediment-transport

conditions for these streamflows, the modeled conditions were compared to field measurements in the spawning habitat and to available water-quality and streamflow data from the USGS streamflow-gaging station located 4 miles upstream (09261000 – Green River near Jensen, UT). Field measurements and sediment-transport modeling of the streamflows indicates that sand was present in areas generally considered to be important as spawning habitat and that the sand was mobilized primarily as bedload (migrating dunes). Previous investigations show that sand dunes are not ideal substrate for spawning success because the fertilized eggs can become smothered by the migrating dunes and are also more susceptible to downstream transport and predation.

VII. Recommendations:

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 final year of data collection is complete and the sediment-monitoring stations and turbidity monitors have been removed. The final set of FY 2007 suspended-sediment samples will shipped for laboratory analyses by late October and results are expected to be returned from the laboratory within 60 days of sample arrival. The sediment record for FY 2005-2007 will be competed and reviewed this winter and published in a USGS Data Report by the end of FY08.

The Multi-Dimensional Surface-Water Modeling System (MD-SWMS) Demonstration project was completed and presented at the 28th Annual Researchers Meeting in Grand Junction January 16-17, 2007; final publication will occurs as a case study in the USGS Scientific Investigations Report (SIR) scheduled for completion in FY 2009.

Data collection of water-surface slope, cross-sectional depths, and bed-material size analysis will continue into FY 2008 and will be used in calculations of entrainment potential and bedload estimates presented in the FY 2009 USGS SIR along with all other interpretive analysis.

IX. FY 2007 Budget Discussion

A. Table 1. Funds provided

Funding Source	FY 2007 – Provided
Recovery Program-BOR	$107,600
State of Wyoming	$24,900
USGS COOP	$22,500
Total Funding	$155,000

B. Table 2. Funds expended

Funding Source	FY 2007 – Expended
Recovery Program-BOR	$107,600
State of Wyoming	$12,900
USGS COOP	$10,500
Total Expenditure	$131,000

A portion of the State of Wyoming and USGS COOP FY 2007 funding was carried over into FY 2008 to cover the cost of continued data collection during October, analytical costs for sediment sample ($6-9K), computation of the FY 2006-2007 daily suspended-sediment records (in FY 2008), and for bed-load calculation efforts. All carry-over funding will be used in the completion of these tasks in FY 08. All tasks are on schedule and with in budget.

X. Status of Submissions N/A

XI. Signed _Cory Williams_ __10/31/2007__
Principal Investigator Date