I. Project Title: Suspended Sediment Monitoring in the Upper Green River

II. Bureau of Reclamation Agreement Number(s): R17PG0047

Project/Grant Period: Start date (Mo/Day/Yr): 10/1/2016
End date: (Mo/Day/Yr): 9/30/2021
Reporting period end date: 9/30/2021
Is this the final report? Yes _____ No _X__

III. Principal Investigator(s):

David J. Topping
Research Hydrologist
USGS Grand Canyon Monitoring & Research Center
2255 North Gemini Drive Flagstaff, AZ 86001
E-mail: dtopping@usgs.gov
Phone: (928) 556-7396
Fax: (928) 556-7100

IV. Abstract:

The purpose of this project is to collect suspended sediment data that will help the Program better understand geomorphic processes that form and maintain habitats important to Colorado pikeminnow and razorback suckers in the Green River, including connected backwaters, side channels, and flooded bottomlands.

On the Green River, the Recovery Program is interested in: (1) describing and quantifying the existing sediment equilibrium conditions (or range of equilibrium conditions) as a function of the magnitude and timing of inputs of sediment and water; and (2) understanding if/how sediment balance/imbalance propagate downstream. This requires developing a sediment mass balance as a function of historical and existing flows, and determining the annual flow volume and nature of streamflows required to transport sediment delivered to these river reaches. This in turn requires a robust sediment monitoring campaign using continuous measurements at high temporal resolution, such that the sediment evacuation/accumulation can be measured independently without relying on inherently inaccurate sediment rating curves.

For this purpose, this project collects high-resolution suspended-sediment data using multi-frequency acoustics, calibrated pump samples, and conventional equal-width-increment (EWI) measurements near the USGS gages on the Green River near Jensen and at Ouray, UT. These data have been collected since late March 2017 and show that net erosion of silt and clay and net erosion of sand have occurred from the segment of the Green River between the near Jensen and at Ouray gages during both FY 2017 and FY

2018. These results suggest that the streamflows that occurred during each of these years were more than sufficient to convey the upstream sediment supply through this long river segment.

V. Study Schedule:

Collection of sediment-transport data for this project began at both Green River sites in FY 2017. These sites will continue to be visited by field staff multiple times each year through FY 2021 for equipment maintenance, collection of suspended-sediment samples for the calibration and verification of acoustical sediment-transport data, and for tracking bedform migration to estimate the bedload component of total sediment transport.

VI. Relationship to RIPRAP:

General Recovery Program Support Action Plan I. Provide and Protect Instream Flows

VII. Accomplishment of FY 2018 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

During FY 2018, 15-minute, two-frequency acoustical suspended-sediment measurements were made at the Green River above Jensen, UT, station (located just downstream from the Split Mountain Campground in Dinosaur National Monument) and the Green River above Ouray, UT, station (located at the fish observation deck in the Ouray National Wildlife Refuge). These stations are located upstream from the USGS gages near Jensen, UT (#09261000) and at Ouray, UT (#09272400), respectively, approximately 69.5 river miles apart. In addition to the acoustical measurements, 25 calibrated-pump suspended-sediment samples were collected at the above Jensen station and 57 calibrated-pump suspended-sediment samples were collected at the above Ouray station, and 5 EWI measurements (measurements made using depth-integrating samplers deployed across the entire cross section) were made at each of these stations. All of pump and EWI physical suspended-sediment samples have been processed through the GCMRC sediment laboratory for concentration and grain size. Owing to a sandbar deposited during the high releases of 2017 blocking the beams of the acoustical instruments at the above Ouray station, sediment loads at the above Ouray station during 2018 were computed using the calibrated-pump and EWI measurements. This sandbar was fully eroded by October 2018, after which the acoustical measurements were again used to compute the sediment loads. Based on the October 2018 configuration of the channel at the above Ouray station, we expect to obtain continuous high-quality acoustical suspended-sediment measurements during FY 2019, as we previously did during most of FY 2017.

Both sites were visited multiple times FY 2018 for operation and maintenance purposes, including visits to collect suspended-sediment samples used for calibration and verification of the acoustic sampler data, and tracking of bedform migration for estimating the bedload component of sediment transport. The above Jensen station was visited 3 times and the above Ouray station was visited 5 times. Bed-sediment measurements were made during each of these visits and bedform migration

measurements were made at the above Ouray station during 3 visits. Each of these stations was visited again, with additional EWI, bed-sediment, and bedform-migration measurements made during October 2018 (with funds carried over from FY 2018).

Results indicate that, during FY 2018, between 110,000 and 260,000 metric tons of silt and clay and between 44,000 and 180,000 metric tons of sand were eroded from the segment of the Green River between the above Jensen and above Ouray stations. The ranges in these numbers reflect the propagated uncertainty in measurements of silt and clay loads and sand loads at these two stations. All measurements and user-interactive sediment budgets for FY 2018 are available at our website at either: https://www.gcmrc.gov/discharge_qw_sediment/ or https://cida.usgs.gov/gcmrc/discharge_qw_sediment/. Sediment budgets for the segment of the Green River between the above Jensen and above Ouray stations can be constructed on demand by clicking on "Uintah Basin."

VIII. Additional noteworthy observations:

During both FY 2017 and 2018, in the segment of the Green River between the above Jensen and above Ouray stations, most of the erosion of silt and clay occurred during periods of higher discharge, whereas most of the erosion of sand occurred during periods of lower and moderate discharge. It will be interesting to see if this pattern holds during the remainder of our study.

IX. Recommendations:

We have hypothesized that net erosion of sediment (i.e., sand, silt, and clay) from an alluvial river segment is associated with an increase in channel complexity and thus maintenance or an increase in fish habitat. Conversely, we have also hypothesized that net deposition of sediment in an alluvial river segment is associated with channel simplification and thus infilling of secondary channels and a decrease in fish habitat. To date, we have tested this 2-part hypothesis in the Deerlodge Park segment of the Yampa River. Resurvey of repeat cross sections in the Deerlodge Park segment confirm that our negative mass-balance sediment budgets for this segment (i.e., budgets that show ongoing erosion of sand) are, in fact, associated with net channel widening and an increase in channel complexity. NPS has funded us to conduct resurveys of repeat cross sections in Echo and Island parks this summer to see if channel simplification has occurred in these reaches (as predicted by our slightly positive Dinosaur mass-balance sand budget). We thus recommend that resurveys of repeat cross sections in the above Jensen to above Ouray segment of the Green River be conducted as soon as possible and again before the end of our study in 2021 to see if our negative mass-balance sediment budgets that show net erosion of silt and clay and of sand during FY 2017 and FY 2018 are, in fact, associated with an increase in channel complexity. We know that this effort would be tractable because Christina Leonard (a graduate student at USU) found the endpoints of 28 of these cross sections during March 2018. Thus, it would be relatively straightforward to resurvey these cross sections if funding could be obtained, and these resurveys would provide an immense amount of learning.

X. Project Status:

Ongoing

XI. FY 2018 Budget Status

A. Funds Provided: $39,731 plus $12,016 carryover from FY 2017
B. Funds Expended: $43,284
C. Difference: $8,463 (Carried over into FY 2019, most of this amount has already been used to cover work on this project during October 2018)
D. Percent of the FY 2018 work completed, and projected costs to complete: 100%
E. Recovery Program funds spent for publication charges: Zero

XII. Status of Data Submission (Where applicable): All data have been posted to our website, where data can be plotted and downloaded, and mass-balance sediment budgets can be constructed and viewed. This website can be accessed at: https://www.gcmrc.gov/discharge_qw_sediment/ or https://cida.usgs.gov/gcmrc/discharge_qw_sediment/.

XIII. Signed: David J. Topping
Principal Investigator Date: December 3, 2018