FY 2024-25 SCOPE OF WORK PROJECT: 85f

Project Title
Suspended-sediment monitoring in the middle Green River

Bureau of Reclamation Agreement Number:
R17PG0047

Reclamation Agreement Term
Oct 1, 2023 – Sept 30, 2025

Note: Recovery Program FY22-23 scopes of work are drafted in May 2021. They often are revised before final Program approval and may subsequently be revised again in response to changing Program needs. Program participants also recognize the need and allow for some flexibility in scopes of work to accommodate new information (especially in nonnative fish management projects) and changing hydrological conditions.

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U.S. Geological Survey

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Category:
X Ongoing project
__ Ongoing-revised project
__ Requested new project
__ Unsolicited proposal

Expected Funding Source:
X Annual funds
__ Capital funds
__ Other *[explain]*

Relationship to RIPRAP:
Green River I.D.2.b.(2): Monitor changes in the magnitude, timing and size distribution of sediment.

Study Background/Rationale and Hypotheses:

This Scope of Work describes work to be completed by the U.S. Geologic Survey (USGS), Southwest Biological Science Center, Grand Canyon Monitoring and Research Center (GCMRC) for the Upper Colorado River Endangered Fish Recovery Program (UCREFRP) to continue the collection of high-resolution suspended-sediment (SS) data using multi-frequency acoustics on the Green River near the USGS gaging stations near Jensen and at Ouray, UT. Work under this Interagency Acquisition

Agreement (Agreement) will span fiscal years FY2024 through FY2025. Additional funding, tasks, and products will be developed in an annual work plan and will be detailed accordingly in future modifications to this Agreement.

Background and Introduction

Within the Green River basin, the highest reach-habitat scores for species and life stages are in the Split Mountain Canyon to Desolation Canyon segment. Habitats with high scores in this restricted-meander segment include connected backwaters, side channels, flooded tributary mouths, and flooded bottomlands (LaGory et al., 2003). All are low-velocity habitats that serve as critical nursery areas for Colorado pikeminnow and razorback suckers. The extremely dynamic nature of backwaters and side-channels demands a greater understanding of the geomorphic processes that form and maintain those instream habitats. Additional research is needed to verify the existing conceptual model of backwater formation and more fully understand underlying geomorphic processes. Studies are also needed to address the effects of both base-flow and high-flow variability (inter-annual, intra-annual, and within day), and the sediment-transport dynamics associated with those flows, on backwater and side-channel habitat availability and conditions (LaGory et al., 2003).

The Peak Flow Technical Supplement (LaGory et al., 2015) identified SS monitoring in the upper Green River with the highest priority category. Such monitoring must be conducted over a long enough period to cover the broad range of streamflow and sediment-supply conditions that occur within the Green River, especially within the Split Mountain to Desolation Canyon segment (LaGory et al., 2015). To date, this project has conducted such continuous SS monitoring at multiple stations on the Green River, two of which have been funded by the UCREFRP within the Split Mountain to Desolation Canyon segment near Jensen and Ouray, UT. The segment between Jensen and Ouray, UT is home to 16 priority floodplain wetlands (Figure 1). The Jensen and Ouray streamflow gaging stations bracket this segment. The SS data from Jensen and Ouray provide the ability to construct continuous mass-balance sediment budgets to determine whether segment-scale sediment accumulation or evacuation occurs within this important segment of the Green River. Determination of whether segments of a river system are accumulating or evacuating fine sediment (sand, silt, and clay) depends on the ability to accurately measure the mass flux of sediment entering and exiting that segment. Continuous measurement of SS transport at high temporal resolution is the only way to accurately calculate the mass flux of SS (Topping and Wright, 2016). In addition, continuous SS monitoring provides the ability to investigate patterns in SS transport that occur during discrete flood events (e.g., spring snowmelt floods, high flows driven by convective thunderstorms) and whether those patterns are caused by conditions of sediment surplus or deficit (Dean et al., 2020).

The study uses continuous SS measurements to determine whether the Jensen-to-Ouray segment, is gaining or losing sediment, and whether such changes in sediment and thus changes in sediment-associated habitat are driven by changes in flow (determined by Flaming Gorge Dam and the Yampa River), changes in the sediment supply, or both. Accumulation of sediment within this segment is hypothesized to be associated with channel simplification and loss of backwater habitat for native and endemic fish (Topping et al., in press). Conversely, evacuation of sediment from this segment is hypothesized to associated with an increase in channel complexity and an increase/improvement in backwater habitat for native and endemic fish (Topping et al., in press). This study is continuing the evaluation of this hypothesized link between changes in sediment mass balance and instream habitat in the Green River published in Topping et al. (in press).

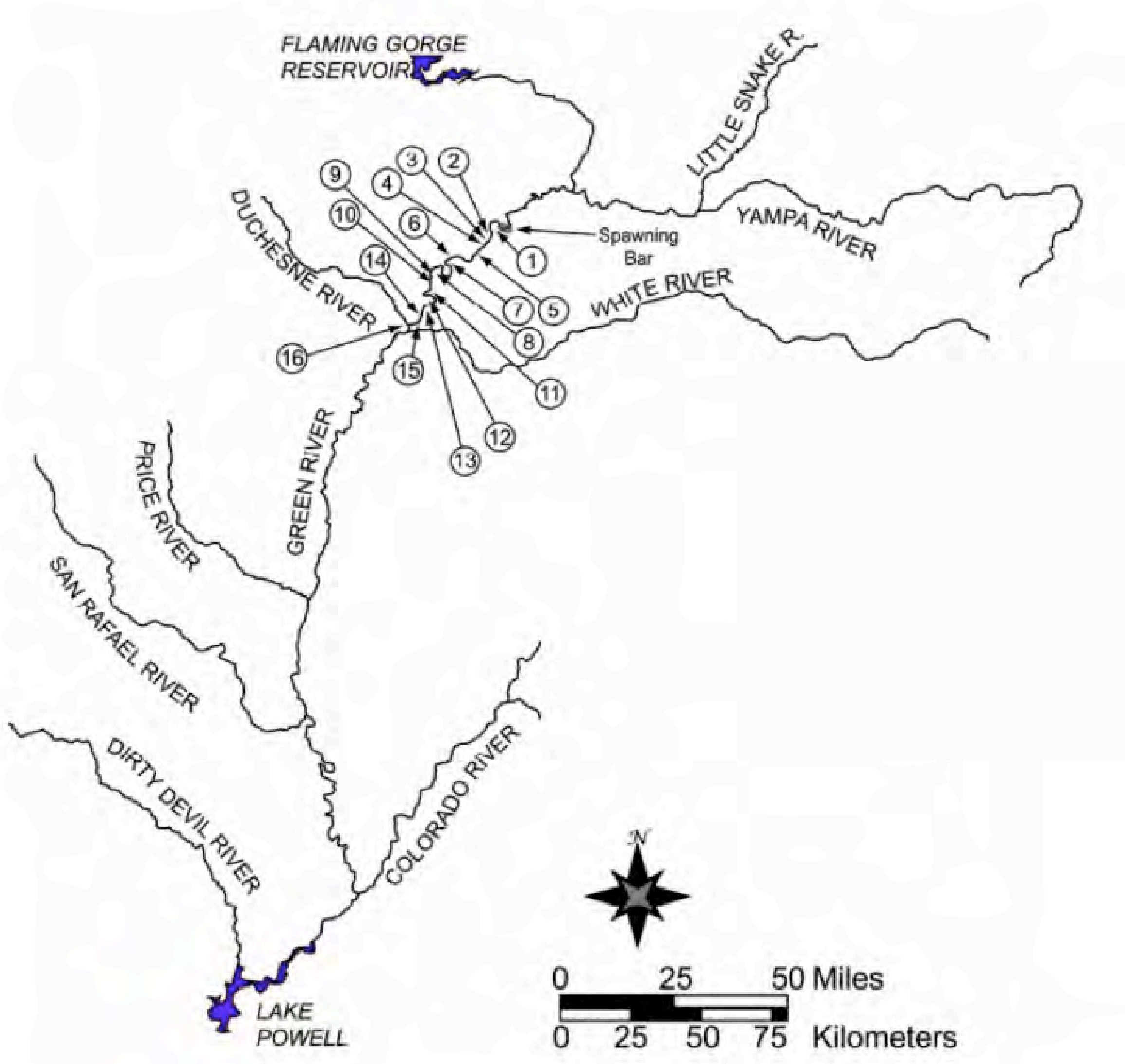

Figure 1. Green River study area showing locations of 16 priority flood plain wetlands (from Hayse et al. 2005, and Valdez and Nelson 2004). Location 1= Thunder Ranch, 2 = IMC, 3 = Stewart Lake, 4 = Sportsman's Lake, 5 = Bonanza Bridge, 6 = Richens, Slaugh, 7 = Horseshoe Bend, 8 = The Stirrup, 9 = Baser Bend, 10 = Above Brennan, 11 = Johnson Bottom, 12 = Leota ponds, 13 = Wyasket Lake, 14 = Sheppard Bottom, 15 = Old Charley Wash, 16 = Lamb Property. From Hayse et al. (2005) with permission.

Figure from: Bestgen, K. R., G. B. Haines, and A. A. Hill. 2011.

Recent data (at www.gcmrc.gov/discharge_qw_sediment) and publications (Topping et al., 2018, in press; Dean et al., 2020) indicate that paradigms about fine-sediment transport in the Green and Colorado river systems are largely based on 1950s-era measurements and need substantial revision. Because large changes in sediment transport in the Green River occur independently of water discharge as a function of changing sediment supply, ongoing continuous SS measurements are required to monitor/evaluate how dam operations and proposed upstream water development affect sediment/habitat in this river system (Topping et al., 2018, in press; Dean et al., 2020). Topping et al. (2018) showed that natural changes in sand transport associated with changes in grain size arising from the downstream migration of sand waves have affected sand transport in the Green River downstream from the Yampa River confluence as much as have operations at Flaming Gorge Dam. These sand waves are generated in tributaries over two timescales of floods: (1) the annual snowmelt flood, and (2) rarer extremely large tributary floods that occur several times per century. The sand waves generated during the annual snowmelt flood control the formation and maintenance of fish habitat in the middle Green River (Topping et al., in press), as summarized below in the *Results from this Project to Date* section, whereas the rarer extremely large tributary floods affect sand transport over multi-decadal to ~50-year timescales (Topping et al., 2018, in press; Dean et al., 2020). For example, sand waves generated during rare large floods on the Little Snake River tributary Sand Creek during March 1956, 1962, and 1966 (the largest occurring in 1962) heavily influenced sand transport in the Little Snake, Yampa, and middle Green rivers from the mid-20th century through the early 21st century. Dean et al. (2020) showed that since closure of Flaming Gorge Dam, sand transport in the Green River has been characterized by two periods of increased sand transport associated with increased tributary sand supply interspersed with longer periods of progressive decline in sand transport. The large floods in the Little Snake River basin in the early 1960s and a regional tributary flooding event in July 1977 both caused short-term fining of the sand and elevated sand-transport rates in the lower Green River. After each of these periods of elevated upstream sand supply, the sand in the lower Green River coarsened and sand transport declined independently of water discharge over decadal timescales. Following the recent abnormally wet and sustained-cold winter of 2022–2023, an extremely large flood on Sand Creek in early April 2023 likely generated the largest sand wave in the Little Snake River since the 1960s. It is expected that this event will cause elevated sand transport in the Little Snake and Yampa rivers for possibly the next several years, and thereby affect sand transport, sand storage, and fish habitat in the Jensen-to-Ouray segment of the middle Green River, as described in Topping et al. (in press).

This natural variation in the upstream sediment supply has combined with upstream water development to cause large decreases in both silt-and-clay and sand transport over multi-decadal timescales. For example, during 2014–2019, the mean-annual load of sand, silt, and clay in the Green River measured passing Mineral Bottom was ~4.4 million metric tons (https://www.gcmrc.gov/discharge_qw_sediment/station/CL/09328920#). Pre-dam sediment transport data summarized by Andrews (1986), and other 1950s-era data collected by the USGS, indicate that pre-dam transport of sand, silt, and clay past Green River, UT, was ~15 million tons/year — an amount >3 times more than that measured at Mineral Bottom in 2014–2019. Because sediment-transport changes over time in response to changes in both streamflow and the upstream sediment supply (owing to natural and human-exacerbated processes), river management cannot be based only on streamflow and previously collected SS datasets (even those <1 decade old) but rather requires ongoing continuous measurements of SS transport.

<u>Value of Data Collected</u>

Currently, the UCREFRP is engaged in multiple related efforts to understand relations between endangered fish, flow, channel habitat, and the sediment transport processes that shape these systems.

These efforts benefit from an in-depth understanding of the sediment-transport dynamics within the Green and Colorado rivers, and how those dynamics affect available critical habitat. Identification of fluvial geomorphic flow and sediment-supply thresholds above which physical processes (e.g., sediment transport, channel change, floodplain inundation) are significantly altered help identify flow thresholds associated with critical habitat features and the streamflows needed to maintain and improve riparian and aquatic ecosystems.

On the Green River the UCREFRP is interested in: (1) describing and quantifying the existing range of sediment 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 the range of sediment delivered to these river segments, which 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.

This Green River monitoring in this project provide an important tool to evaluate the Green River flow recommendations (e.g., Muth, et al. 2000) and complements similar monitoring efforts upstream and downstream of the Jensen-to-Ouray segment. On the Yampa and Green Rivers in Dinosaur National Monument, the National Park Service (NPS) and the GCMRC have worked collaboratively since 2012 to collect continuous SS data at four USGS gaging stations (Green River above Gates of Lodore, CO; Yampa River near Maybell, CO; Little Snake River near Lily, CO; and Yampa River at Deerlodge Park, CO). On the Green and Colorado Rivers near Canyonlands National Park, the NPS and GCMRC have worked collaboratively since 2014 to maintain collect continuous SS data at two USGS gaging stations (Green River at Mineral Bottom near Canyonlands National Park, UT; and Colorado River at Potash, UT). These sediment data are being used to develop relationships between Green River streamflow, sediment supply, and sediment transport during both natural floods and upstream dam releases to meet NPS management objectives in Dinosaur National Monument and Canyonlands National Park. Results from the first phases of these monitoring efforts have been published in the Journal of Geophysical Research: Earth Surface (Topping et al., 2018; Dean et al., 2020) and are in press as a U.S. Geological Survey Scientific Investigations Report (Topping et al., in press).

Results from this Project to Date

The following results are summarized from Topping et al. (in press).

The transport of sand and finer sediment in the Green and Yampa river network is typically in disequilibrium with the local sediment supply because of the partial decoupling of the sources of water and sediment: most of the water is supplied farther upstream than most of the sediment. This decoupling leads to sand being transported in the main-stem rivers as elongating sand waves following sand resupply during tributary floods. Because of the large amount of sand supplied to the Yampa River by the Little Snake River, Yampa River annual floods generate sand waves that migrate downstream in the Green River causing longitudinal patterns in bed-sand grain size that, in turn, lead to large spatial changes in sand transport. These changes in bed-sand grain size dominate over changes in the discharge of water in regulating sand transport in the sand-bedded reaches of these rivers. Furthermore, at any given discharge, these changes in bed-sand grain size dominate over all other processes in regulating sand transport in both sand- and gravel-bedded reaches of these rivers. Consequently, erosion or deposition of sand, and the associated changes in fish habitat in the Jensen-to-Ouray segment of the Green River are only indirectly related to Green River discharge and Flaming Gorge Dam operations. Consequently, larger Yampa River floods cause net sand deposition in the Jensen-to-Ouray segment and smaller Yampa River floods are associated with erosion of sand from this river segment, with lesser influence from Flaming Gorge Dam operations (figure 1). Owing to the longitudinal patterns of bed-sand grain size associated with sand-wave migration, a sequence of large, but slightly declining, annual floods on the Yampa River is thus required to increase backwater fish habitat in the Jensen-to-Ouray segment.

Cross-section resurveys indicate that the Jensen-to-Ouray segment of the Green River has undergone sand erosion caused by slight channel widening since the 1990s (a channel response in opposition to that observed farther downstream in Canyonlands National Park during this period). These resurveys indicate that sand deposition leads to a decrease in channel complexity whereas sand erosion generally leads to an increase in channel complexity. The backwaters used as native fish nursery habitat consist of deep pools downstream from and adjacent to large bank-attached sandbars; thus, more extensive backwater habitat equates to greater channel complexity. The generation of the sand wave during the first large Yampa River flood in a sequence (i.e., the year-1 flood) causes fining of the bed sand near Jensen (figure 2). The downstream coarsening associated with finer bed sand near Jensen than downstream near Ouray causes a downstream decrease in sand transport in the Jensen-to-Ouray segment, leading to net sand deposition and decreased channel complexity. Continued downstream migration of this sand wave during a lower-discharge flood the following year (i.e., the year-2 flood) then causes downstream fining, leading to erosion of sand and increased channel complexity in this segment. By definition, peak discharges of the year-2 flood and other out-year floods are less than or equal to the year-1 flood peak that begins this flood sequence.

Although the year-1 Yampa River flood supplies the sand and deposits the large sandbars required to form backwaters, and thereby sets the stage for future backwater habitat, these floods cause a temporary reduction in backwater habitat in the Jensen-to-Ouray segment because they cause net sand deposition. It is the subsequent out-year Yampa River floods that maintain or increase backwater habitat because these are the floods that convey sand through or erode sand from this segment (figure 3). Smaller out-year Yampa River floods rework the sandbars deposited during the larger year-1 annual flood, thereby leading to the increases in both backwater area and volume that have been measured upon recession of these floods. Although artificial floods released from Flaming Gorge Dam might be used to simulate the habitat maintenance achieved by out-year Yampa River floods, the limited sand supply and stage associated with such dam releases precludes their use as a replacement for the role year-1 Yampa River floods play in setting the stage for backwater habitat in the Jensen-to-Ouray segment of the Green River.

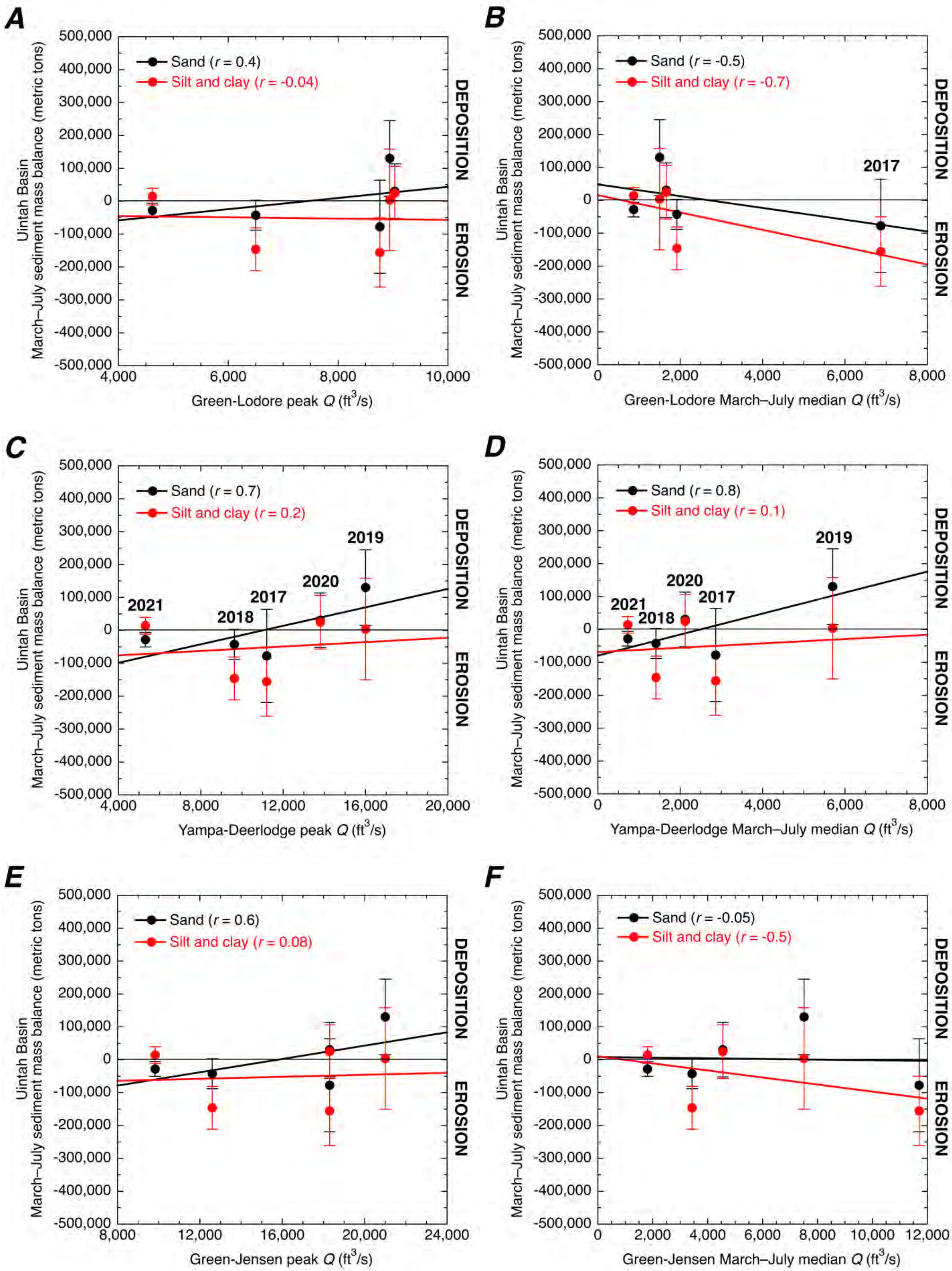
A
Sand (r = 0.4)
Silt and clay (r = -0.04)
DEPOSITION
EROSION
Uintah Basin
March–July sediment mass balance (metric tons)
Green-Lodore peak Q (ft3/s)
B
Sand (r = -0.5)
Silt and clay (r = -0.7)
2017
Green-Lodore March–July median Q (ft3/s)
C
Sand (r = 0.7)
Silt and clay (r = 0.2)
2021
2018
2017
2020
2019
Yampa-Deerlodge peak Q (ft3/s)
D
Sand (r = 0.8)
Silt and clay (r = 0.1)
Yampa-Deerlodge March–July median Q (ft3/s)
E
Sand (r = 0.6)
Silt and clay (r = 0.08)
Green-Jensen peak Q (ft3/s)
F
Sand (r = -0.05)
Silt and clay (r = -0.5)
Green-Jensen March–July median Q (ft3/s)

Figure 1 (preceding page). Changes in the sediment mass, that is, the sediment mass balance, in the Jensen-to-Ouray segment (i.e., the Uintah Basin segment) of the middle Green River during the annual-flood period of March–July plotted as a function of (***A***) peak discharge (*Q*) and (***B***) March–July median *Q* at the Green-Lodore station (representing Flaming Gorge Dam operations), (***C***) peak *Q* and (***D***) March-July median *Q* at the Yampa-Deerlodge station, and (***E***) peak *Q* and (***F***) March–July median *Q* at the Green-Jensen station. Values for sand and for silt and clay shown separately. Lines are the least-squares linear regressions fit to the zero-bias mass-balance values; correlation coefficients (*r*) associated with these regressions are shown. Error bars indicate the uncertainty in the calculated changes in sediment mass balance resulting from the propagation of the uncertainties in the sediment loads through the sediment-budget calculation. Positive values of the sediment mass balance indicate deposition whereas negative values of the sediment mass balance indicate erosion during March–July.

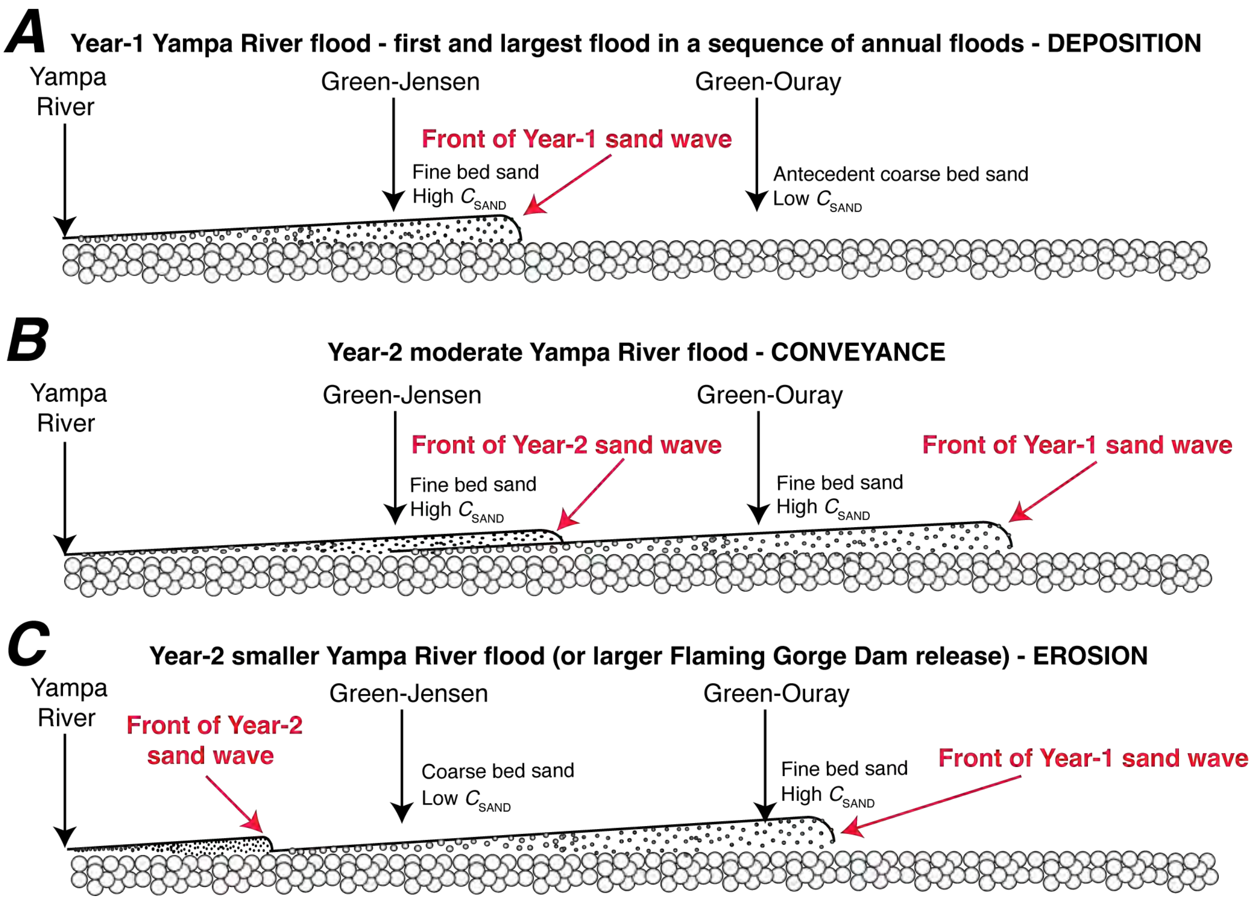

Figure 2. Conceptual model showing the longitudinal positions of the year-1 and year-2 Yampa-generated sand waves in the middle Green River during (***A***) a year-1 flood, (***B***) a moderate year-2 flood, and (***C***) either a smaller year-2 flood or larger release from Flaming Gorge Dam. The relative bed-sand grain size and suspended-sand concentration (C_{SAND}) at the Green-Jensen and Green-Ouray stations are indicated for each case. The longitudinal difference in bed-sand grain size and associated magnitude of C_{SAND} controls whether sand is (***A***) deposited in, (***B***) conveyed through, or (***C***) eroded from the Uintah Basin segment between the Green-Jensen and Green-Ouray stations.

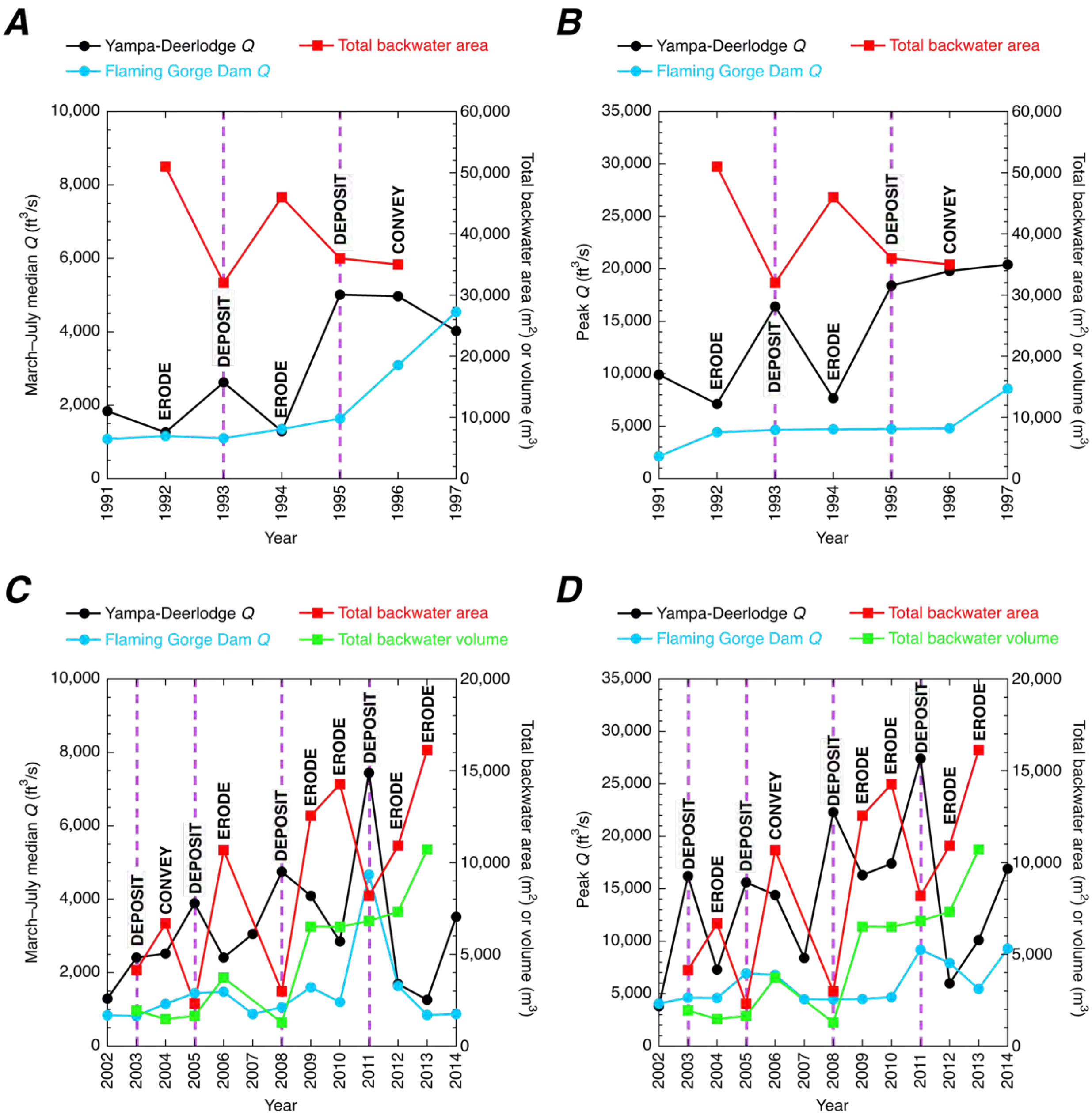

Figure 3. Comparison of the time series of March–July median discharge (*Q*) and peak *Q* with (***A***, ***B***) the 1992–1996 time series of total backwater area surveyed by Day and others (1999) and (***C***, ***D***) the 2003–2013 time series of total backwater area and volume surveyed by Grippo and others (2017) in the Uintah Basin segment following recession of the annual flood. The year-1 floods that exceed the *Q* thresholds described in Topping et al. (in press) and are predicted to deposit sand in the Jensen-to-Ouray segment are indicated by the vertical purple dashed line and the word "DEPOSIT"; the out-year floods of similar *Q* to the year-1 flood and are therefore predicted to cause conveyance of sand through this segment are indicated by the word "CONVEY"; the smaller out-year floods that are predicted to cause erosion of sand from this segment are indicated by the word "ERODE."

Study Goals and Objectives:

The purpose of this project is to continue the collection of SS data to help the UCREFRP 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. To this end, 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.

This project addresses the need to improve our understanding of how changes in sediment supply and transport associated with river regulation affects the critical habitat and life cycles of endangered fish. Riverine ecosystems are shaped by the flow regime and supplied sediment, and water development and river regulation can substantially alter both these phenomena. Potential additional water development projects on the Yampa and White rivers (including potential new dams) highlight the need to understand how changes in flow and sediment transport will affect these ecosystems. In that context, the costs and benefits of changing flow regimes must be evaluated: (1) for the direct impact of flow on ecosystem function and (2) for the indirect impact that flow exerts on sediment transport that in turn determines the quantity and quality of aquatic and riparian habitats.

Study Area:
This study is conducted in river reaches at sediment monitoring stations located upstream from the USGS Green River near Jensen, UT, and Green River at Ouray, UT, gaging stations. These sediment monitoring stations are referred to as the Green River above Jensen, UT, and Green River above Ouray, UT, stations and are located on the map at:
https://www.gcmrc.gov/discharge_qw_sediment/stations/DINO. The above Jensen station is located at the downstream end of the Split Mountain Campground in Dinosaur National Monument and the above Ouray station is located at the fish observation deck in the Ouray National Wildlife Refuge. The sediment data collected at these two sediment monitoring stations is used in conjunction with the streamflow data collected at the near Jensen and at Ouray gaging stations to the calculate continuous sediment fluxes and loads used in sediment budgeting.

The Green River near Jensen, UT, 09261000 streamflow gaging station is operated by the USGS as part of the National Streamflow Information Program in cooperation with the Central Utah Water Conservancy District and the U.S. Fish and Wildlife Service. It is in Uintah County, Utah, with a drainage area of 29,660 square miles and a contributing drainage area of 25,400 square miles just downstream of the confluence of the Green and Yampa Rivers. Both the Green and Yampa Rivers are subject to potentially substantial new water development to support extraction of nearby oil and gas resources and potential trans-basin export to satisfy municipal and industrial needs in eastern Colorado.

The Green River at Ouray, UT, 09272400 streamflow gaging station is operated by the USGS as part of the National Streamflow Information Program in cooperation with the U.S. Fish and Wildlife Service. It is in Uintah County, Utah, with a drainage area of 31,060 square miles and a contributing drainage area of 26,800 square miles. It is upstream from the confluences of the White and Duchesne Rivers.

Study Methods/Approach:
The work proposed herein is a continuation of work funded by the UCREFRP that has been conducted at the above Jensen and Ouray sediment monitoring stations since 2013 and 2017, respectively. This

work utilizes a combination of 15-minute acoustical measurements and episodic conventional and calibrated-pump SS samples to provide continuous measurements of suspended-silt-and-clay concentration, suspended-sand concentration, and suspended-sand median grain size at these two stations (Topping and Wright, 2016). These concentration data are converted to loads, which are differenced between these stations to construct continuous mass-balance sediment budgets for silt and clay and for sand for the Jensen-to-Ouray segment of the Green River (Topping et al., 2018, in press). The changes in silt-and-clay and sand mass are then interpreted to inform whether certain combinations of flow and the upstream sediment supply tend to result in infilling or evacuation of sediment from this segment.

To evaluate the connection between the net changes in silt and clay mass and sand mass identified in the continuous mass-balance sediment budgets and channel complexity/backwater habitat, ~27 cross sections established in the Jensen to Ouray segment in the 1990s were resurveyed in October 2020 (Topping et al., in press). Resurvey of these cross sections showed that relatively little net change in these cross sections had occurred since the 1990s, and showed that net accumulation of sediment was associated with channel simplification and, thus, likely loss/degradation of backwater habitat.

The acoustical SS-measurement technique used in this project is a “state-of-the-science” outgrowth of research conducted by scientists at the USGS-GCMRC in the Colorado River in Grand Canyon National Park and the Rio Grande in Big Bend National Park (Topping et al., 2004, 2006, 2007, 2016; Wright et al., 2010; Topping and Wright, 2016). In addition to being used at the above Jensen and Ouray sediment monitoring stations on the Green River, a five-station monitoring network using this approach on the Colorado River in Grand Canyon National Park informs management of Glen Canyon Dam (Griffiths et al., 2012; Grams et al., 2015; U.S. Department of the Interior, 2016a, b; Topping et al., 2021). This approach is also being used to inform river management on the Rio Grande in Big Bend National Park (Dean et al., 2016), the Green and Yampa rivers in Dinosaur National Monument (Topping et al., 2018, in press), the Green and Colorado rivers in Canyonlands National Park (Dean et al., 2020), and the Chippewa River in Wisconsin (Dean et al., 2022).

Prior to the development of the Topping and Wright (2016) acoustical technique, time-invariant relations between water discharge and sediment concentration (i.e., sediment rating curves) were typically used to estimate sediment loads. This simple and convenient approach, however, commonly result in errors in sediment transport that exceed 900% (Walling, 1977) and in errors in daily sediment loads as high as 4000% (Glysson et al., 2001) because the concentration of suspended sediment and the instantaneous discharge of water are not well correlated in most rivers. This poor correlation arises because of discharge-concentration hysteresis in one or more size classes of the suspended load during floods or periods of higher discharge. Because of this hysteresis, the only *a priori* accurate method to calculate sediment loads in rivers is to use SS measurements that are independent of water-discharge data. The acoustical technique of Topping and Wright (2016) satisfies this constraint and provides for the making of the accurate continuous SS measurements required to know whether sediment accumulation or evacuation has occurred over a long river segment, and how such changes in sediment mass balance directly relate to changes in flow and the upstream sediment supply. This information is required to predict the impact of future water development on sediment-related instream habitat with the accuracy required for making sound management decisions and recommendations.

All data collected by this project are served at the following website (Sibley et al., 2015): https://www.gcmrc.gov/discharge_qw_sediment/. At the above Jensen and Ouray sediment monitoring stations, these data include: (1) 15-minute acoustical SS measurements, (2) calculated 15-minute bedload estimates based on episodic measurements of dune migration, (3) episodic bed-sediment measurements, and (4) episodic SS measurements made using conventional depth-integrating samplers deployed across the full width of the river (i.e., EWI measurements) and calibrated automatic pump samplers. In addition, the continuous mass-balance sediment budgets for the Jensen-to-Ouray segment used to inform habitat management in this segment are served at this website (as are other sediment budgets for other segments upstream on the Green and Yampa rivers). The details of how bedload is calculated based on episodic bedform-migration measurements and EWI measurements is described in Topping et al. (2018, in press).

Task Description, Deliverables and Schedule:
This project operates and maintains 15-minute two-frequency-acoustical sediment-transport monitoring stations located upstream from the USGS Green River near Jensen, UT, and Green River at Ouray, UT, streamflow gaging stations (as described above). These sediment monitoring stations are visited multiple times each year for maintenance. During these visits, EWI calibration and verification suspended-sediment measurements, bedform-migration measurements are made. It is anticipated that 4-6 sample collection visits will occur during the year depending on field staff availability and the range in streamflow and suspended-sediment concentrations. Access to the sites will be by vehicle/foot for maintenance visits and by foot or boat during sample collection visits.

- All acoustical, and physical, suspended-sediment data are uploaded to the GCMRC website at http://www.gcmrc.gov/discharge_qw_sediment/ quarterly as proof of the work completed.
- Annual written reports and annual presentations at the Researcher's Meeting will continue to be provided to the UCREFRP.
- The results from all work at the end of this project will be published as a USGS report updating the 2013–2021 results presented in Topping et al. (in press).

Budget Summary:

FY Year	USGS-SBSC-GCMRC
2022	$34,767
2023	$37,019
2024	$37,789
2025	$39,426
2026	
Total	$149,001

Reviewers:

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SUMMARY OF PROPOSED COSTS

Name of Servicing Agency:	U.S. Geological Survey
Project Name:	85f

		YEAR 1		**YEAR 2**		**YEAR 3**		**YEAR 4**		**YEAR 5**		**TOTAL**
Enter the BEGINNING dates for each year ------>		**10/1/2023**		**10/1/2024**		**10/2/2025**		**10/2/2026**		**10/2/2027**		
		Through		Through		Through		Through		Through		
Enter the ENDING dates for each year ------->		**9/30/2024**		**10/1/2025**		**10/1/2026**		**10/1/2027**		**9/30/2028**		
DIRECT LABOR AND FRINGE BENEFIT COSTS:		**YEAR 1**		**YEAR 2**		**YEAR 3**		**YEAR 4**		**YEAR 5**		**TOTAL**
Direct Labor - Hourly		$ 19,490.90		$ 20,075.63		$ -		$ -		$ -		$ 39,566.53
Fringe Benefits - Hourly		$ 7,786.44		$ 8,020.03		$ -		$ -		$ -		$ 15,806.47
Subtotal of Direct Labor & Fringe Benefits:		**$ 27,277.34**		**$ 28,095.66**		**$ -**		**$ -**		**$ -**		**$ 55,373.00**
OTHER DIRECT COSTS:		**YEAR 1**		**YEAR 2**		**YEAR 3**		**YEAR 4**		**YEAR 5**		**TOTAL**
Materials and Supplies		$ -		$ -		$ -		$ -		$ -		$ -
Travel Costs		$ 3,445.50		$ 3,445.50		$ -		$ -		$ -		$ 6,891.00
Equipment		$ -		$ -		$ -		$ -		$ -		$ -
Contractors												$ -
Subtotal of Other Direct Costs:		**$ 3,445.50**		**$ 3,445.50**		**$ -**		**$ -**		**$ -**		**$ 6,891.00**
INDIRECT/OVERHEAD COSTS:		**YEAR 1**		**YEAR 2**		**YEAR 3**		**YEAR 4**		**YEAR 5**		**TOTAL**
Subtotal of Labor and Other Direct Costs:		**$ 30,722.84**		**$ 31,541.16**		**$ -**		**$ -**		**$ -**		
Total dollars exempt from indirect/overhead base:												
<Enter Description of Indirect/OH Cost #1>	**23.00%**	$ 7,066.25	**25.00%**	$ 7,885.29	**25.00%**	$ -	**25.00%**	$ -	**25.00%**	$ -		$ 14,951.54
Total dollars exempt from indirect/overhead base:		$ -		$ -		$ -		$ -		$ -		
<Enter Description of Indirect/OH Cost #2>		$ -	**0.00%**	$ -	**0.00%**	$ -	**0.00%**	$ -	**0.00%**	$ -		$ -
Subtotal of Indirect/Overhead Costs:		**$ 7,066.25**		**$ 7,885.29**		**$ -**		**$ -**		**$ -**		**$ 14,951.54**
		YEAR 1		**YEAR 2**		**YEAR 3**		**YEAR 4**		**YEAR 5**		**TOTAL**
GRAND TOTAL:		**$ 37,789.09**		**$ 39,426.45**		**$ -**		**$ -**		**$ -**		**$ 77,215.54**