USGS
science for a changing world

GCMRC Science Updates Part 3

Michael Moran

Grand Canyon Monitoring and Research Center

Southwest Biological Science Center

Adaptive Management Working Group Meeting

February 13, 2020

U.S. Department of the Interior
U.S. Geological Survey

Outline

- Part 1
  - Humpback Chub
  - Native and Nonnative Fishes
  - Bug Flows
- Part 2
  - Nutrients and Temperature as Ecosystem Drivers and Lake Powell
  - Riparian Vegetation
  - Warm-Water Invasive Fishes
  - Trout
- Part 3
  - Sediment
  - Archaeological Site Monitoring
  - Socioeconomics and Hydropower

USGS science for a changing world

Project A – Streamflow, Sediment Transport, and Water Quality

PI – David Topping

- GCMRC scientists and their cooperators monitor changes in suspended sediment and in the amount of sand stored on the bed of the river

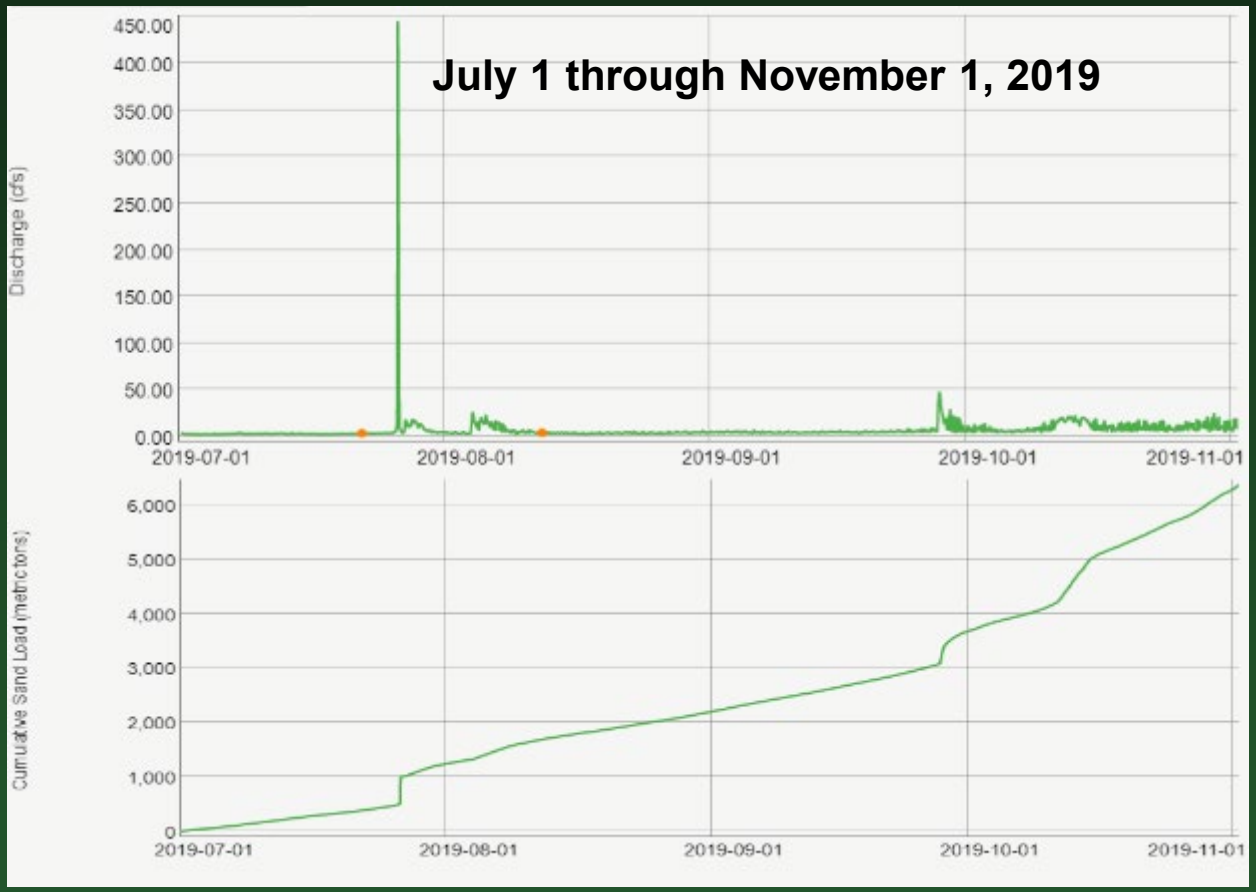
Paria River gage at Lees Ferry, USGS

USGS science for a changing world

February 13, 2020

Sediment Inputs – Fall 2019

Paria River Input



https://www.gcmrc.gov/discharge_qw_sediment/station/GCDAMP/09382000

Preliminary data, do not cite

USGS science for a changing world

Take Away: Only ~ 6,000 metric tons of sediment in fall accounting period

February 13, 2020

Was There Enough Fine Sand for HFE?

Zero bias value July 1 – November 1, 2019
(metric tons)

Take Away: Not enough sand for fall HFE

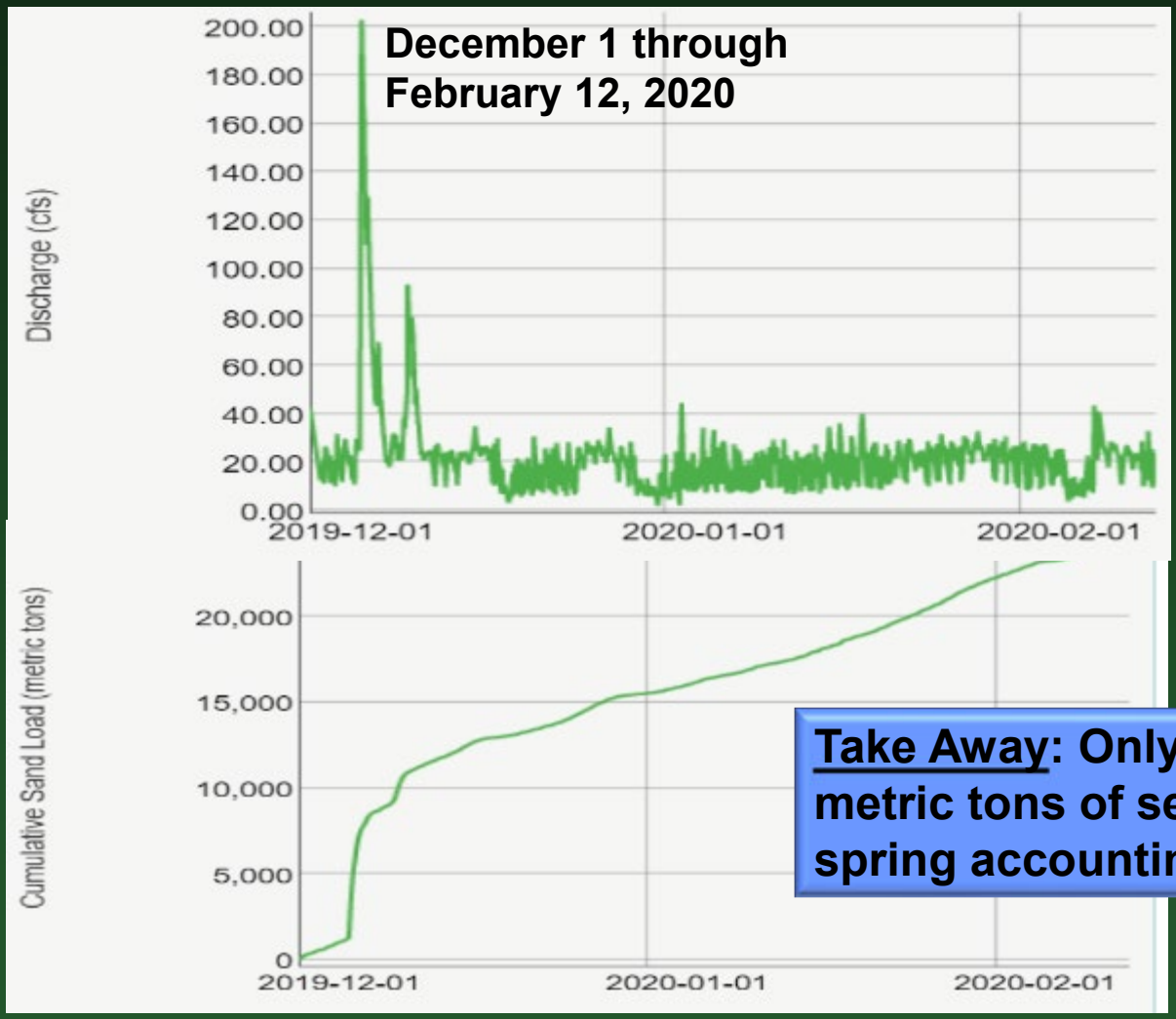
www.gcmrc.gov/discharge_qw_sediment/reaches/GCDAMP

Preliminary data, do not cite

February 13, 2020

Sediment Inputs – Spring 2020

Paria River Input



Take Away: Only ~ 22,000 metric tons of sediment in spring accounting period

www.gcmrc.gov/discharge_qw_sediment/station/GCDAMP/09382000

Preliminary data, do not cite

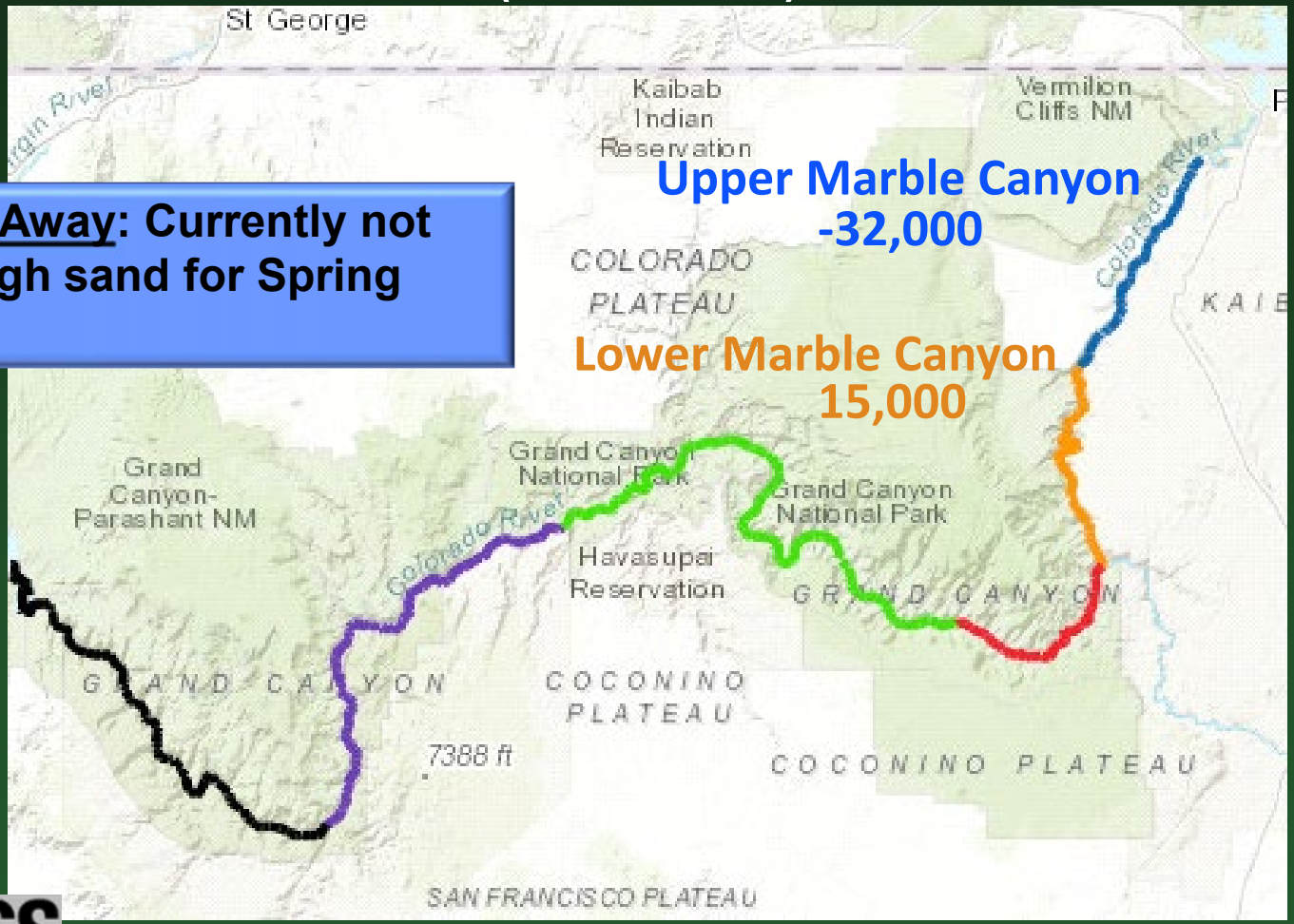
USGS science for a changing world

February 13, 2020

Is There Enough Fine Sand for HFE?

Zero bias value
December 1, 2019 – January 7, 2020
(metric tons)

Take Away: Currently not enough sand for Spring HFE



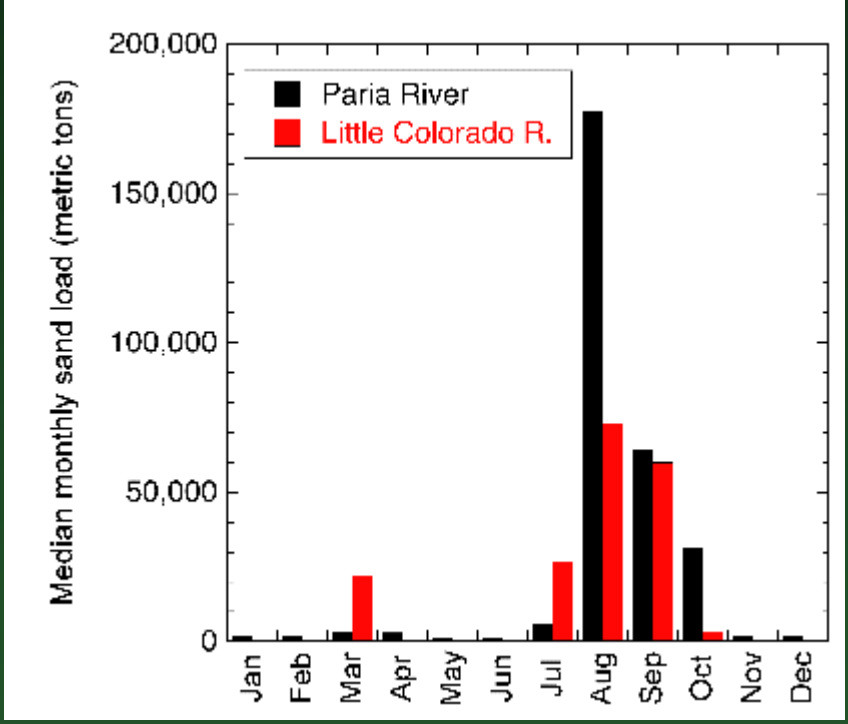
https://www.gcmrc.gov/discharge_qw_sediment/reaches/GCDAMP

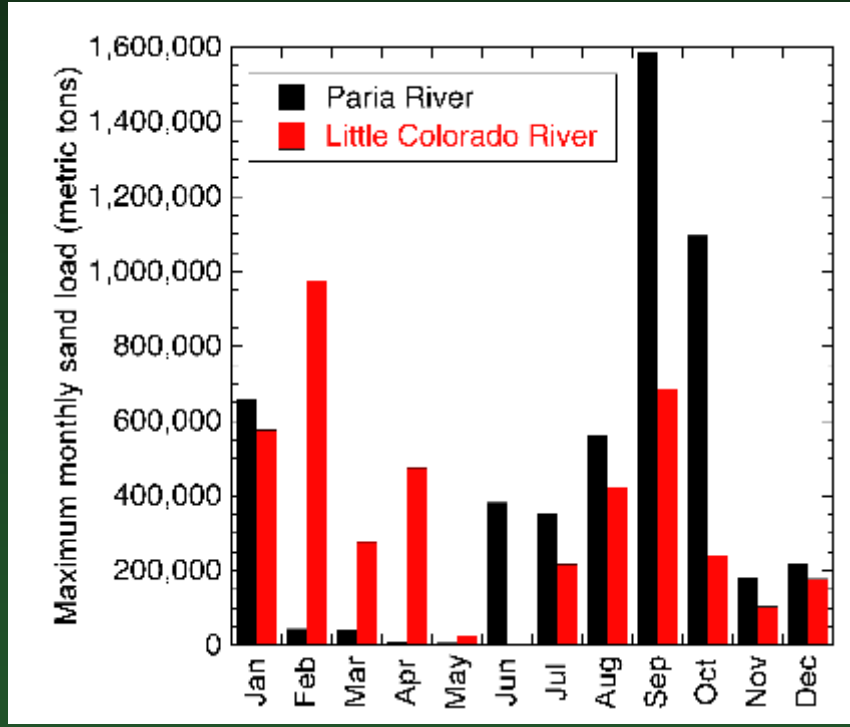
USGS science for a changing world

Preliminary data, do not cite

February 13, 2020

Monthly Median and Maximum Sand Supply of the Paria River and Little Colorado River





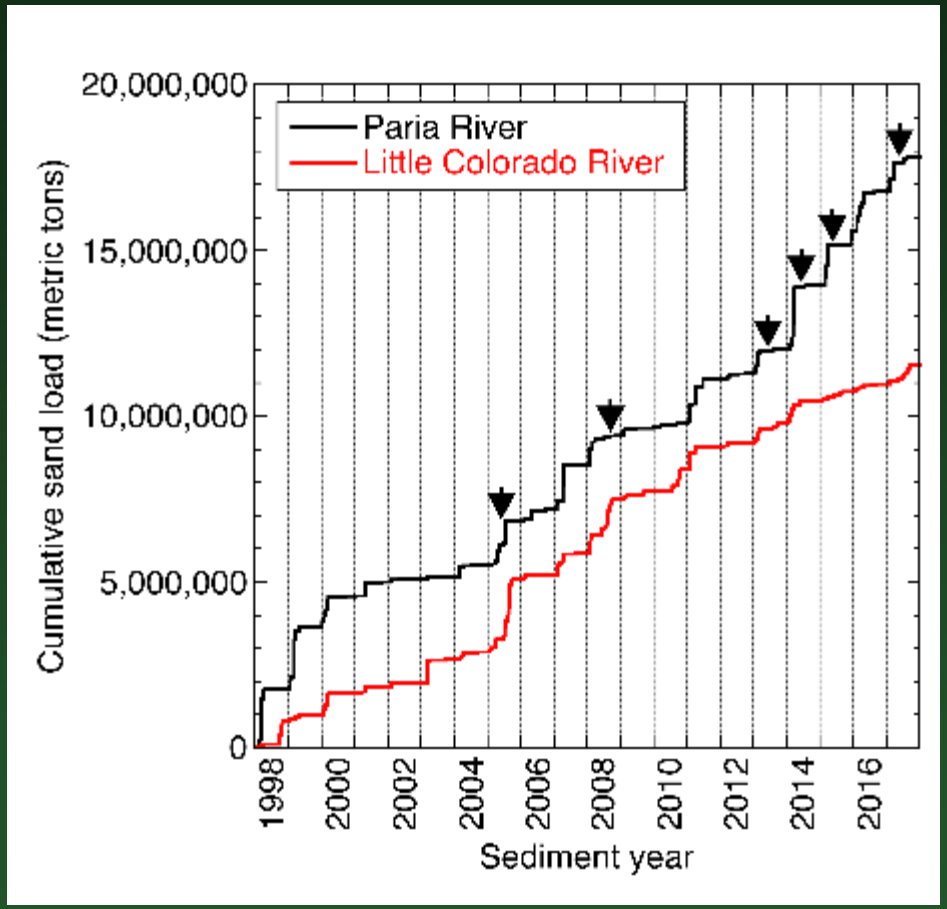
Preliminary data, do not cite

USGS science for a changing world

February 13, 2020

Long-Term Sand Management

- Tributary sand supply is very episodic
- Long periods between sand inputs when winnowing can occur



<u>Take Away</u>: Sand inputs are episodic and erosion occurs between events

Preliminary data, do not cite

USGS science for a changing world

February 13, 2020

Sediment Monitoring Conclusions

- Not enough sand for Fall 2019 HFE; currently not enough sand for Spring HFE
- Spring HFEs may rarely occur because almost all large Paria floods happen from August through October
- Multi-year sand accumulation is only possible during years of above-average tributary sand supply and below-average dam releases

USGS science for a changing world

Project B – Sandbar and Sediment Storage

PI – Paul Grams

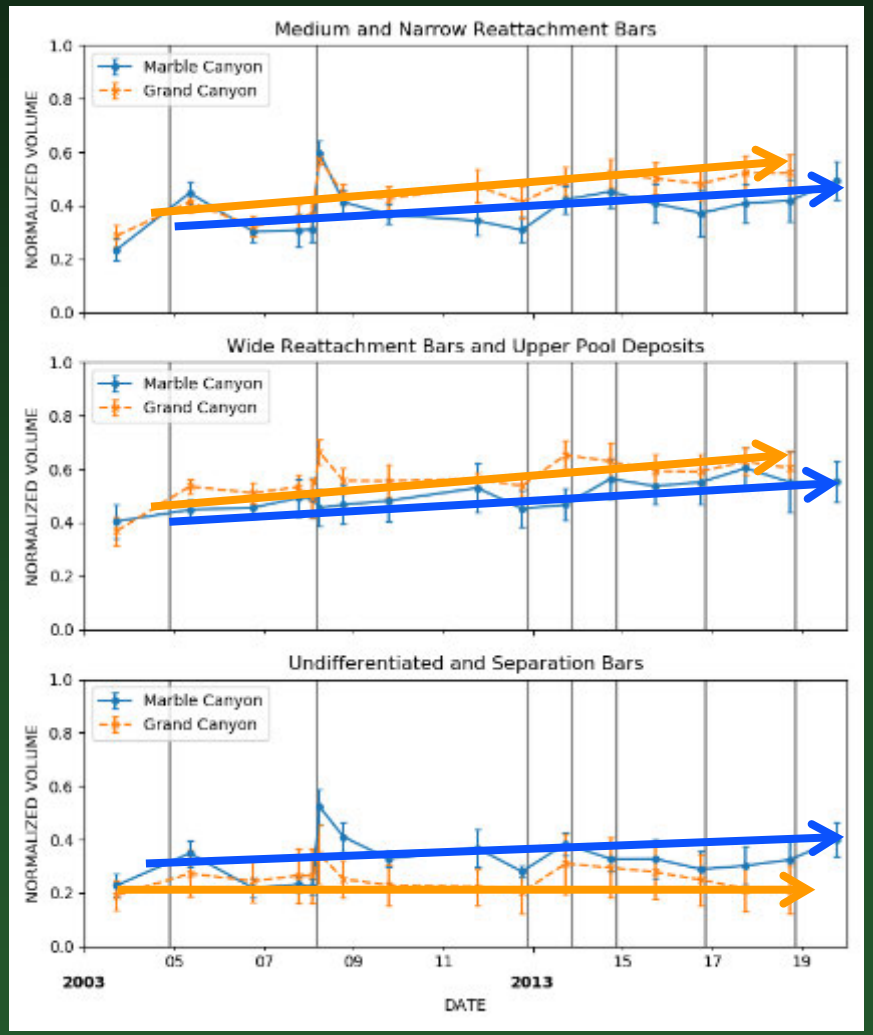
- GCMRC scientists and their cooperators monitor changes in sandbars and changes in the amount of sand available for camping and other recreation

USGS science for a changing world

Long-Term Sandbar Monitoring

Project Element B.1

- Long-term, most bar types and in both Marble and Grand Canyon show a slight upward trend in volume
- Short-term increases in sandbar volume are usually off-set by erosion that occurred between HFEs



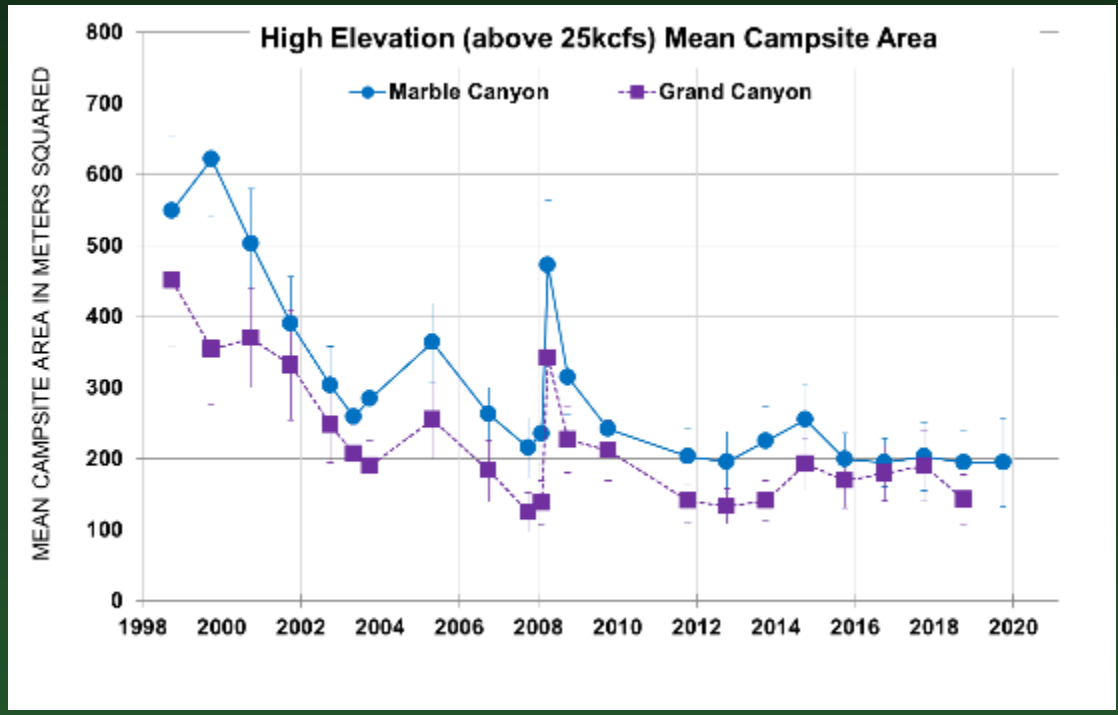
Preliminary results, do not cite

USGS science for a changing world

February 13, 2020

Campsite Areas in Marble and Grand Canyon

- Campsite areas have decreased since 1998 but HFEs help to stem the loss
- Decreases in campsite area are primarily due to vegetation expansion



Preliminary results, do not cite

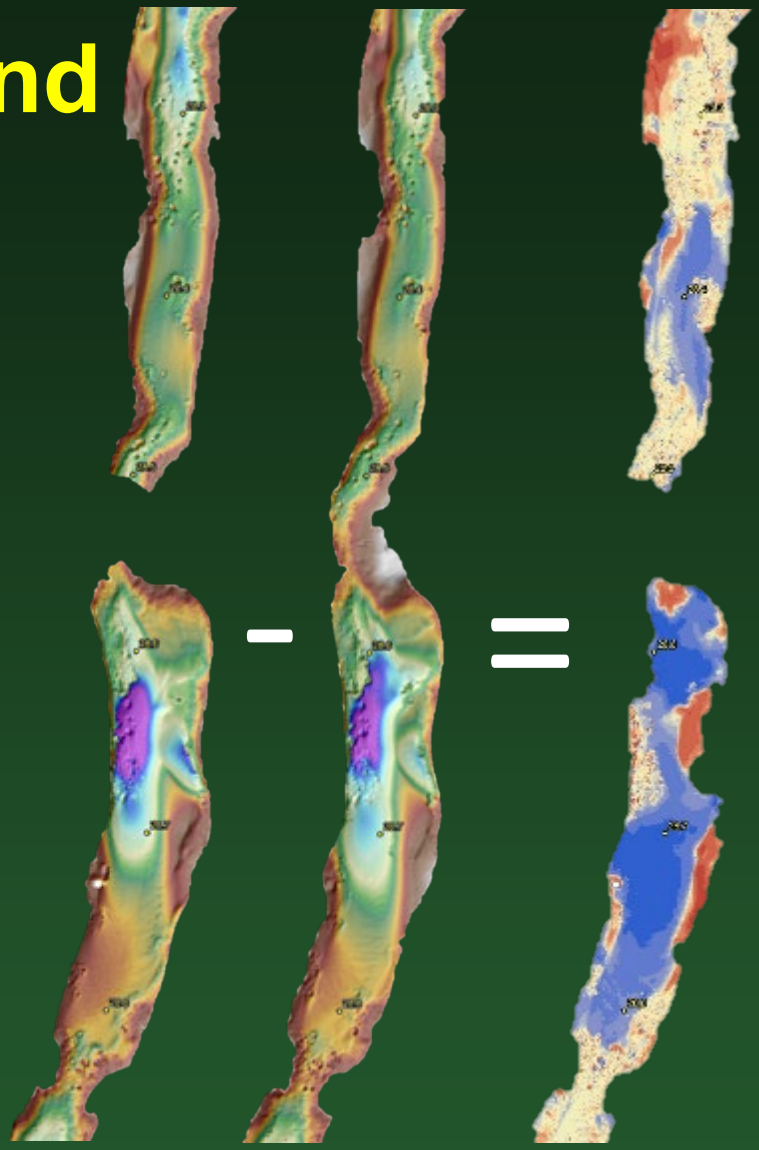
USGS science for a changing world

February 13, 2020

Channel Mapping of Sand

Project Element B.2

- Mapping of bed sediments using single and multi-beam sonar
- Topographic maps of river bed surface produced
- Difference between surfaces indicates areas of erosion and deposition



May 2016 May 2013 Difference

Blue = deposition
Red = erosion

USGS science for a changing world

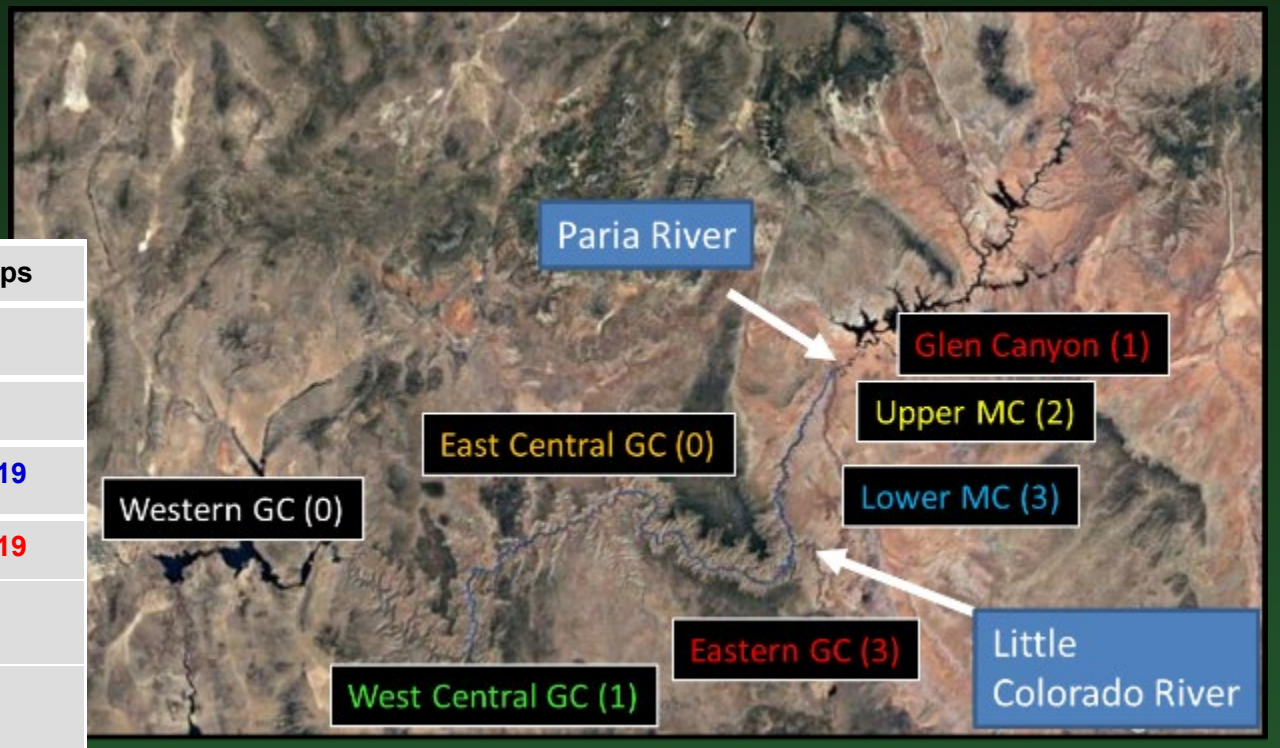
Preliminary data, do not cite

February 13, 2020

Completed Channel Mapping

Segment	Completed Maps
Glen Canyon	2014
Upper Marble Canyon	2013, 2016
Lower Marble Canyon	2009, 2013, 2019
Eastern Grand Canyon	2011, 2014, 2019
East Central Grand Canyon	*
West Central Grand Canyon	2017
Western Grand Canyon	*

Western Grand Canyon segment not yet mapped. Proposed for next workplan.



East-Central Grand Canyon to be mapped in 2021

USGS science for a changing world

February 13, 2020

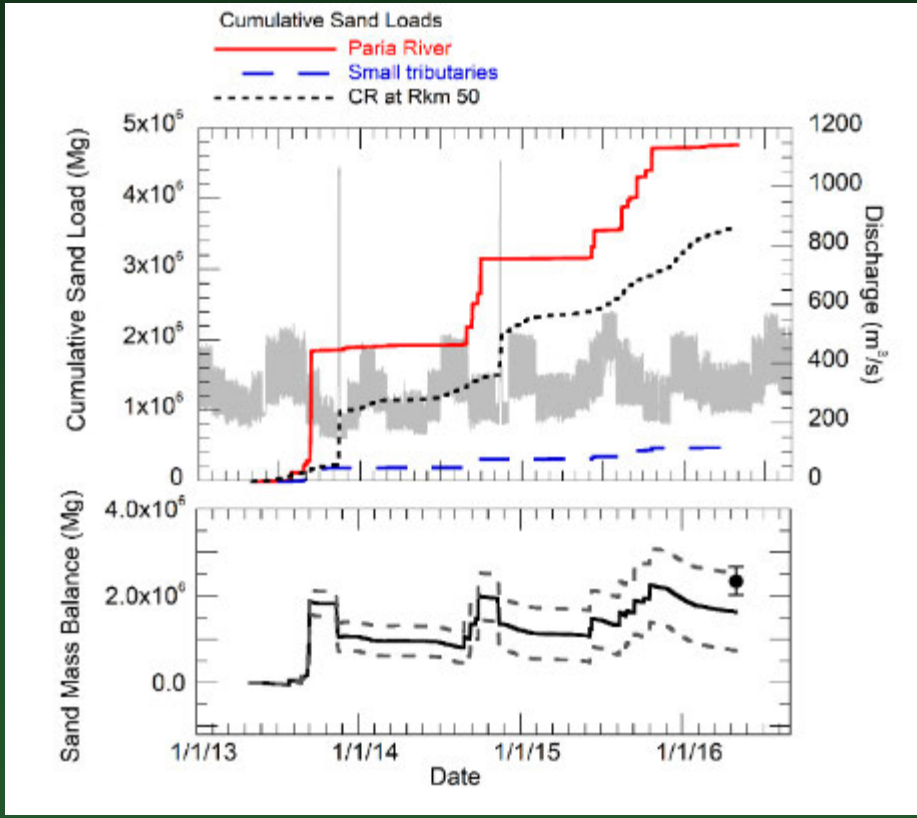
Channel Mapping Results: Upper Marble Canyon, 2013-2016

50-km reach (0-50 km downstream from Paria River)

Upper Marble Canyon, 2013-2016

- Includes 2 controlled floods
- No summer high-volume flows

<u>Take Away</u>: More sand has been deposited than eroded from this reach during this time period



Preliminary data, do not cite

USGS science for a changing world

February 13, 2020

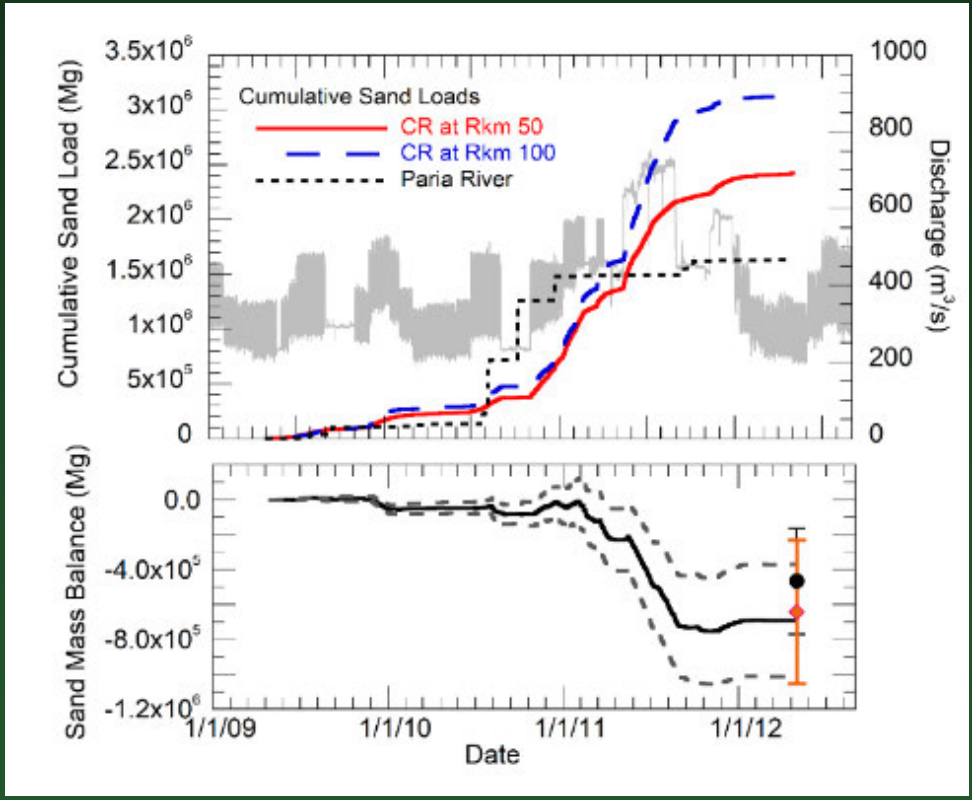
Channel Mapping Results: Lower Marble Canyon, 2009-2013

50-km reach (50-100 km downstream from Paria River)

Lower Marble Canyon, 2009-2013

- No controlled floods
- Includes 2011 equalization flows

<u>Take Away</u>: More sand has been eroded than deposited from this reach during this time period



Grams et al. (2019)

USGS science for a changing world

February 13, 2020

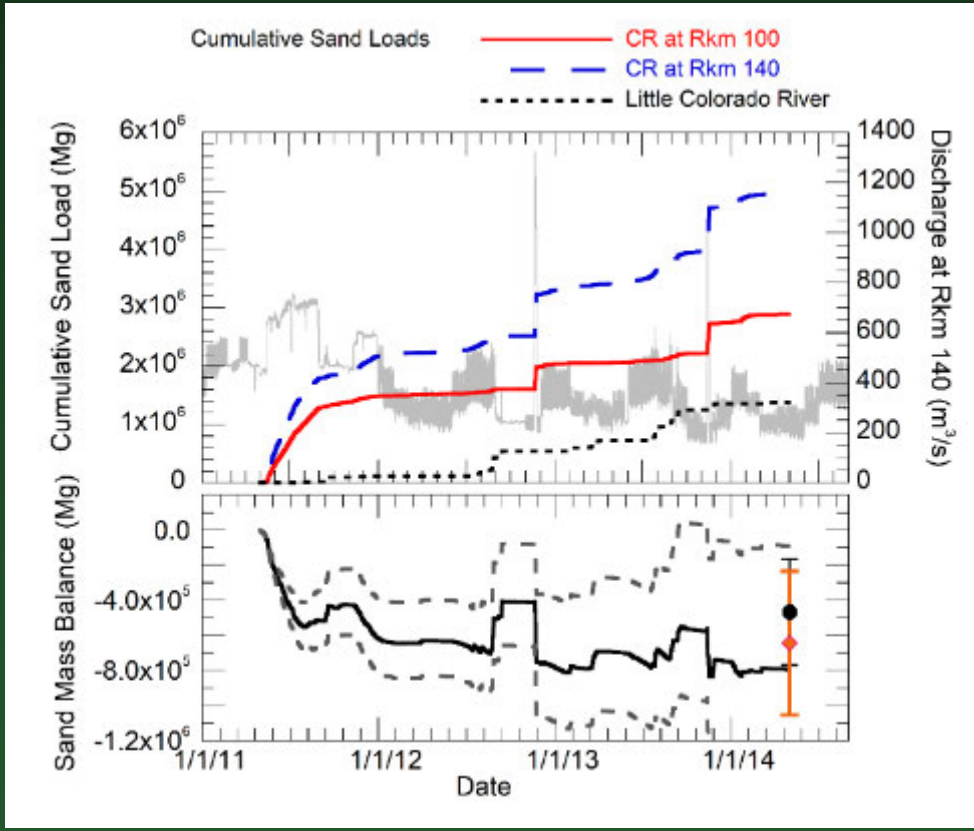
Channel Mapping Results: Eastern Grand Canyon, 2011-2014

40-km reach (100-140 km downstream from Paria River)

Eastern Grand Canyon, 2011-2014

- Includes 2 controlled floods
- Includes 2011 equalization flows

Take Away: More sand has been eroded than deposited from this reach during this time period



Preliminary data, do not cite

USGS science for a changing world

February 13, 2020

Sandbar Monitoring Conclusions

- Most sandbar volumes have been increasing through time
- Use of controlled floods for rebuilding sandbars may be sustainable if done when sufficient sand is available
- Periods with high summer release volumes will cause evacuation; periods with normal summer release volumes and strong tributary inputs result in accumulation

USGS science for a changing world

Project D – Geomorphic Effects of Dam Operations and Vegetation Management for Archaeological Sites

LTEMP Resource and Goal

- Archaeological and Cultural Resources
- Maintain the integrity of potentially affected NRHP-eligible or listed historic properties in place, where possible, with preservation methods employed on a site-specific basis

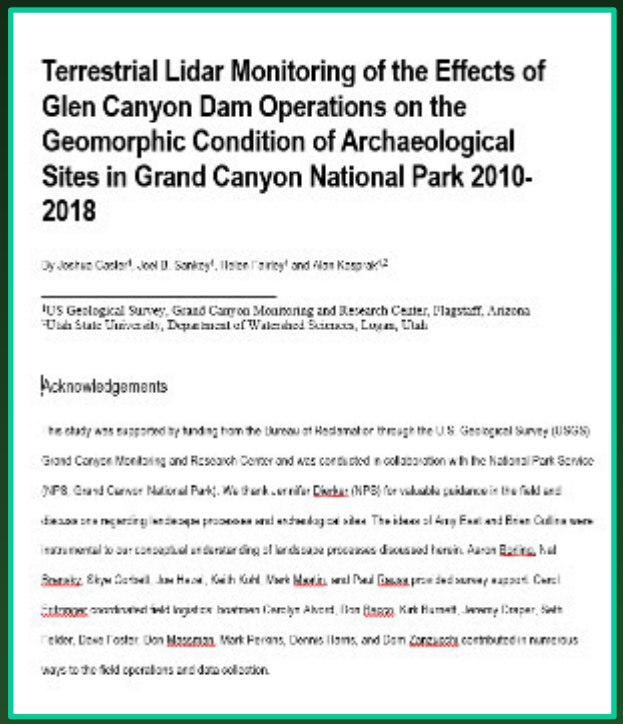
Joel B. Sankey, US Geological Survey, SBSC, GCMRC, Flagstaff, AZ
Joshua Caster, US Geological Survey, SBSC, GCMRC, Flagstaff, AZ
Helen Fairley, US Geological Survey, SBSC, GCMRC, Flagstaff, AZ
Jen Dierker, National Park Service, Grand Canyon, AZ
Mike Kearsley, National Park Service, Grand Canyon, AZ

USGS science for a changing world

February 13, 2020

Geomorphic Effects of Dam Operations and Vegetation Management for Archaeological Sites

- The geomorphic condition of archaeological sites is affected by how Colorado River sand is transferred among landforms in Grand Canyon
- Many archaeological sites are degraded by gully erosion, but river sand can provide a protective cover to preserve sites in place and thus help achieve the LTEMP goal for Archaeological and Cultural Resources
- GCMRC quantitatively monitors the geomorphic condition of archaeological sites relative to LTEMP flow (e.g., Fall HFEs) and non-flow actions (e.g., Vegetation Management)



Terrestrial Lidar Monitoring of the Effects of Glen Canyon Dam Operations on the Geomorphic Condition of Archaeological Sites in Grand Canyon National Park 2010-2018

By Joshua Caster[1], Joel B. Sankey[1], Helen Fairley[1] and Alan Kasprak[1,2]

[1]US Geological Survey, Grand Canyon Monitoring and Research Center, Flagstaff, Arizona
[2]Utah State University, Department of Watershed Sciences, Logan, Utah

Acknowledgements

The study was supported by funding from the Bureau of Reclamation through the U.S. Geological Survey (USGS) Grand Canyon Monitoring and Research Center and was conducted in collaboration with the National Park Service (NPS, Grand Canyon National Park). We thank Jennifer Ekstrom (NPS) for valuable guidance in the field and discussions regarding landscape processes and archeological sites. The ideas of Amy East and Brian Collins were instrumental to our conceptual understanding of landscape processes discussed herein. Aaron Bunting, Hal Beaney, Skye Cottrell, Joe Hazel, Keith Kohl, Mark Manone, and Paul Grams provided survey support. Carol Colhoper coordinated field logistics; boatmen Carolyn Alcock, Ron Hanna, Kirk Hurwitz, Jeremy Cooper, Seth Felder, Dave Foster, Don Mansmann, Mark Perkins, Dennis Harris, and Dom Zanfardo contributed in numerous ways to the field operations and data collection.

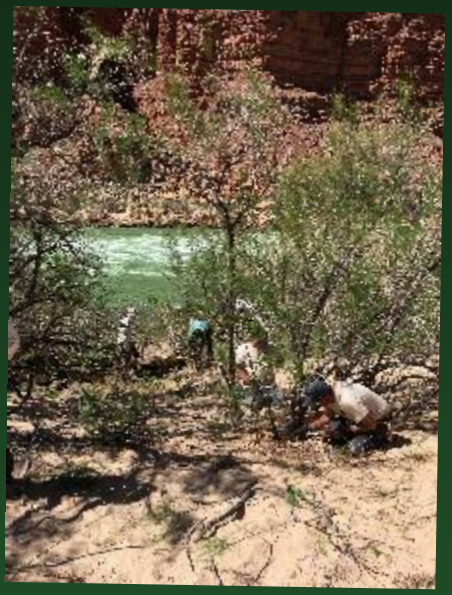
Caster and others, in press: New report summarizes monitoring completed through 2018 at 23 sites using the GCMRC protocol

USGS science for a changing world

February 13, 2020

Vegetation removal experiments

- In April, 2019 the NPS implemented experimental vegetation removal treatments on several sandbars in Grand Canyon to increase campsite area and to increase the supply of HFE sediment via aeolian processes to dunefields that host archaeological sites
- GCMRC is monitoring the outcome of the vegetation treatments relative to future HFEs

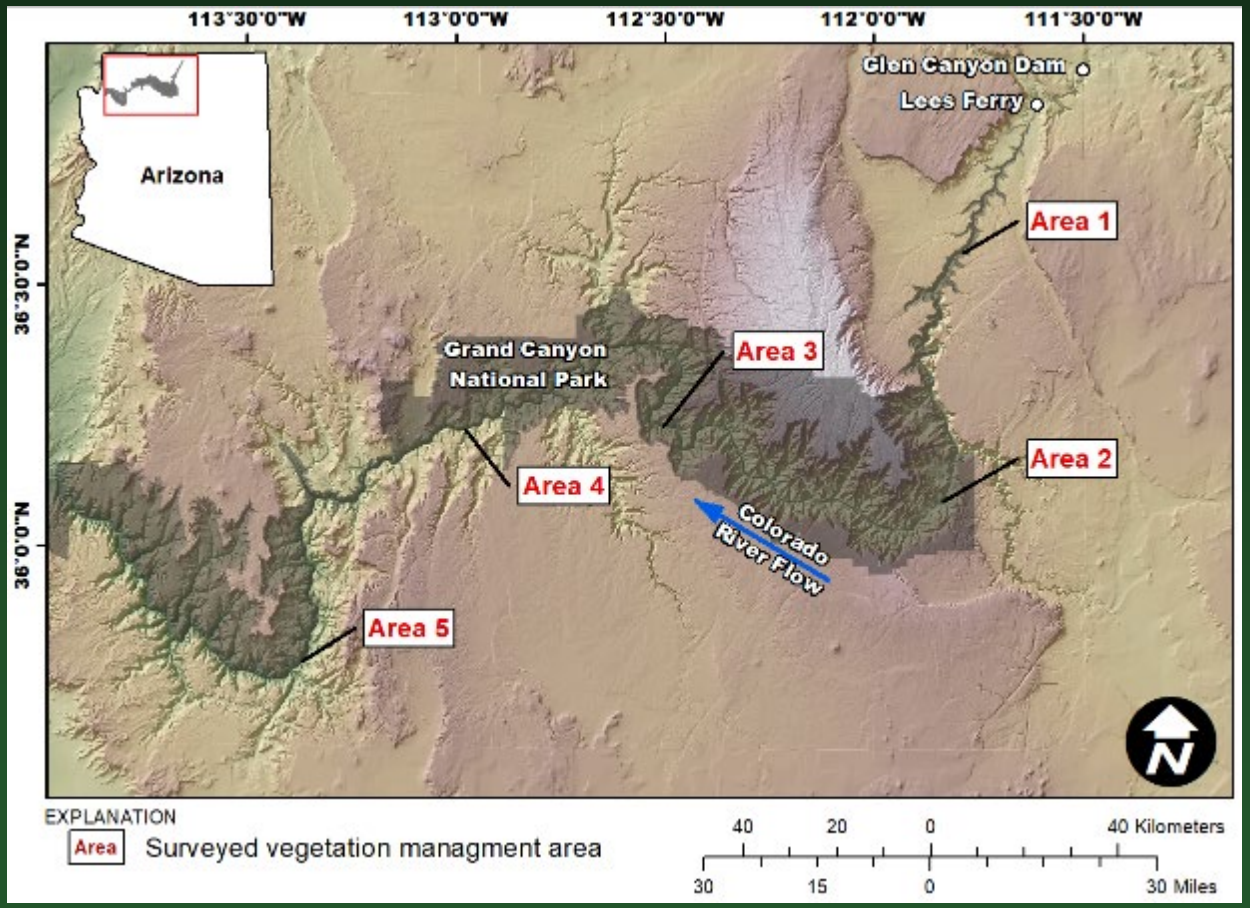


USGS science for a changing world

Vegetation removal experiments (2)

5 areas selected based on:

- NPS management priorities
- Existing GCMRC monitoring
  - Sandbars
  - Campsites
  - Arch. Sites
  - Riparian Vegetation
- Observed changes in geomorphic condition using established GCMRC protocols (e.g., lidar)



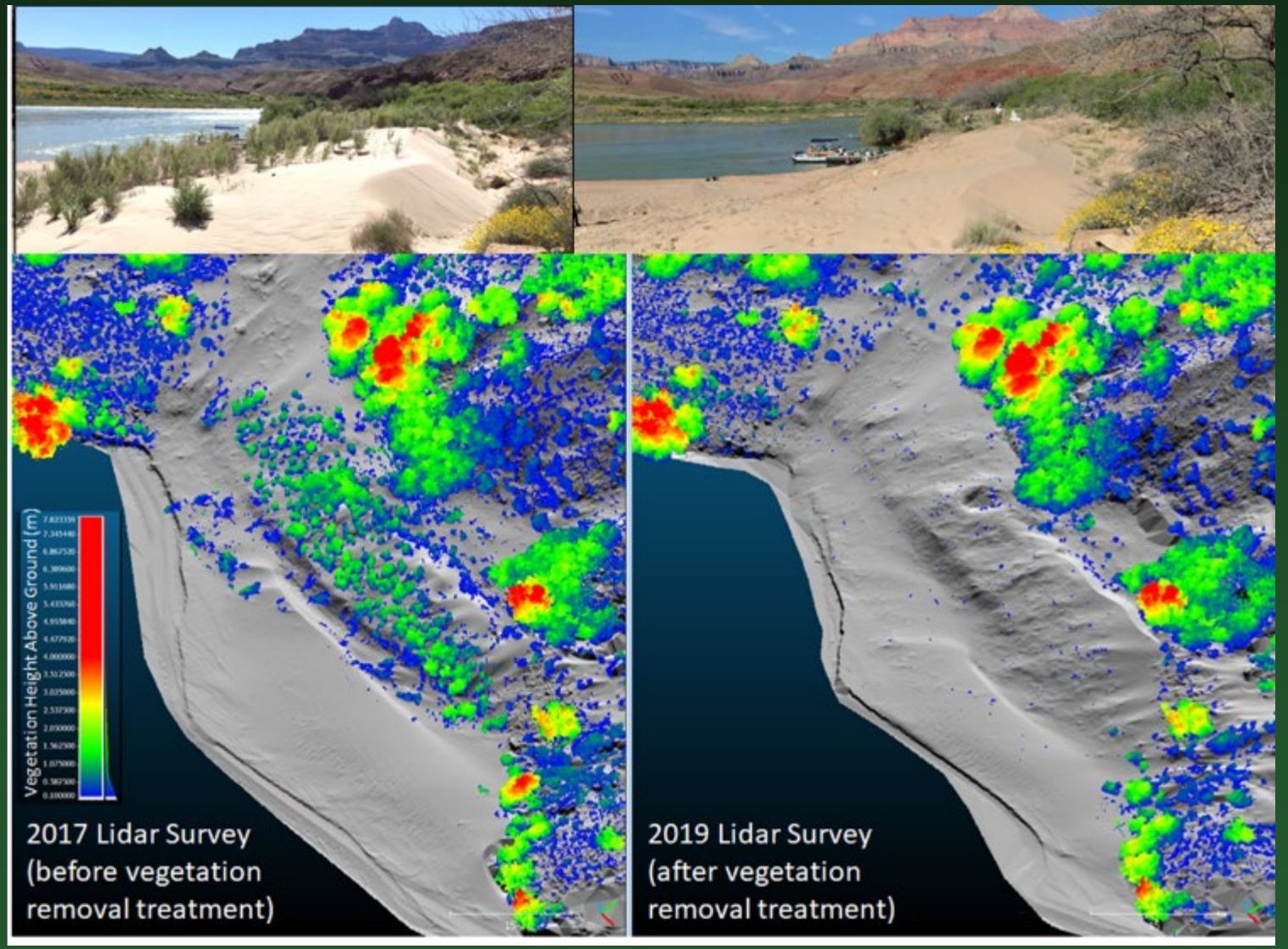
Preliminary data, do not cite

USGS science for a changing world

February 13, 2020

Vegetation removal experiments (3)

Example Area 2



USGS science for a changing world

Implications and Future Work

- In April, 2020 the NPS will revisit the sites and conduct maintenance and additional experimental vegetation removal treatments to increase aeolian sediment supply to several dunefields that host archaeological sites
- GCMRC will monitor the outcome of the treatments relative to future HFEs in ongoing monitoring of the geomorphic condition of archaeological sites

USGS science for a changing world

Project J – Socioeconomic Research

PI – Lucas Bair

- GCMRC scientists identify preferences and economic values of resources in the Colorado River Ecosystem

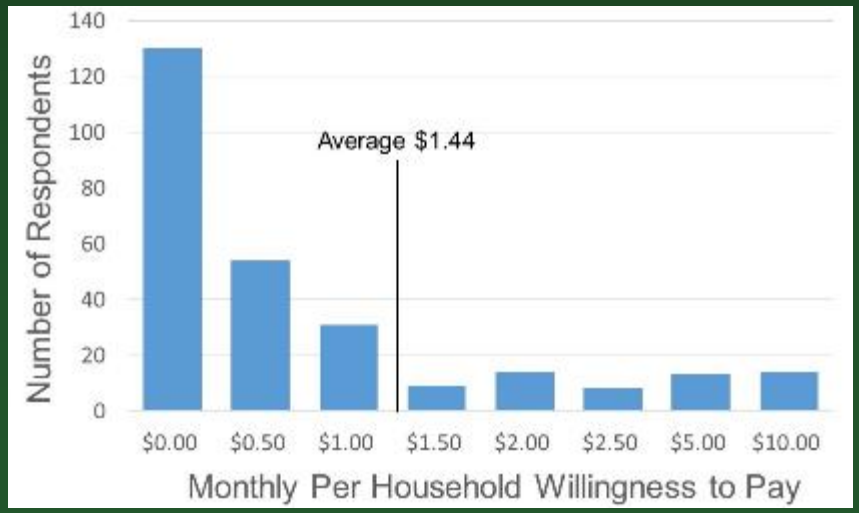
USGS science for a changing world

Tribal Perspectives and Values of Resources Downstream of Glen Canyon Dam

Project Element J.1

- Collaborative effort with Navajo Nation to recognize Navajo values for downstream resources and support the prioritization of management goals

- The majority of survey respondents value resources in Glen and Grand Canyons and support implementation of flow experiments to improve downstream resources



USGS science for a changing world

Preliminary data, do not cite

February 13, 2020

Project N – Hydropower Research

PI – Lucas Bair

LTEMP EIS Hydropower Resource

- Maintain or increase Glen Canyon Dam electric energy generation, load following capability, and ramp rate capability, and minimize emissions and costs to the greatest extent practicable, consistent with improvement and long-term sustainability of downstream resources.

USGS science for a changing world

Project N Objective

Project N will identify, coordinate, and collaborate with external partners on monitoring and research opportunities associated with operational experiments at GCD designed to meet hydropower and energy resource objectives, as stated in the LTEMP ROD.

USGS
science for a changing world

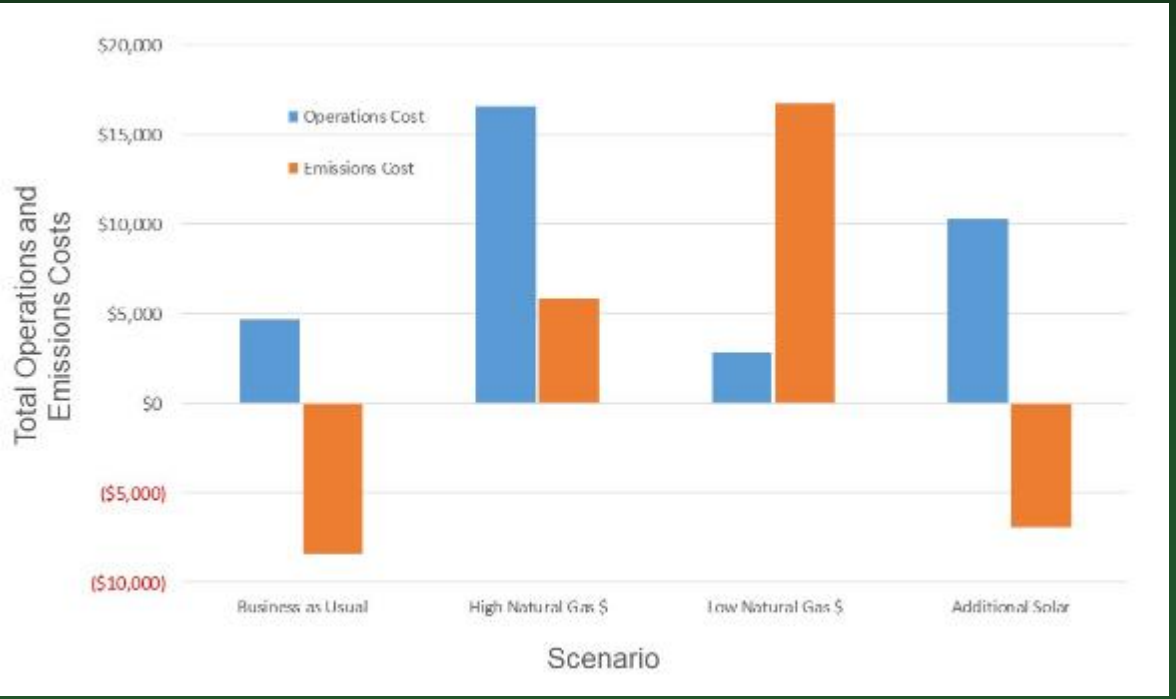
Project N Hypothesis

- Changes in the energy sector led us to the hypothesis that using Glen Canyon Dam as baseload generation will reduce total economic costs associated with electricity generation in the Western Interconnect when considering generation mix and fuel and emissions costs.
- Our implicit hypothesis is that Glen Canyon Dam baseload generation would be ‘consistent with improvement and long-term sustainability of downstream resources.’

USGS science for a changing world

Change in Operations and Emissions Costs with Flat Flows at Glen Canyon Dam (dollars in thousands)

- In the 'business as usual' scenario, the increase in operations costs are more than offset by the decrease in emissions costs
- In the other scenarios, total operations and emissions costs increase



Preliminary data, do not cite

USGS science for a changing world

February 13, 2020

Project N Conclusion

- Structural changes in the electricity sector are altering the role of hydropower and how costs associated with experimental flows might accrue.
- Total economic costs of our proxy experimental flow are significantly different when emissions costs are included.
- Decisions we make today in electricity sector expansion will impact the role hydropower plays in the sector and costs associated with environmental and adaptive management of rivers.

Preliminary data, do not cite

USGS science for a changing world

February 13, 2020


Questions
USGS
science for a changing world