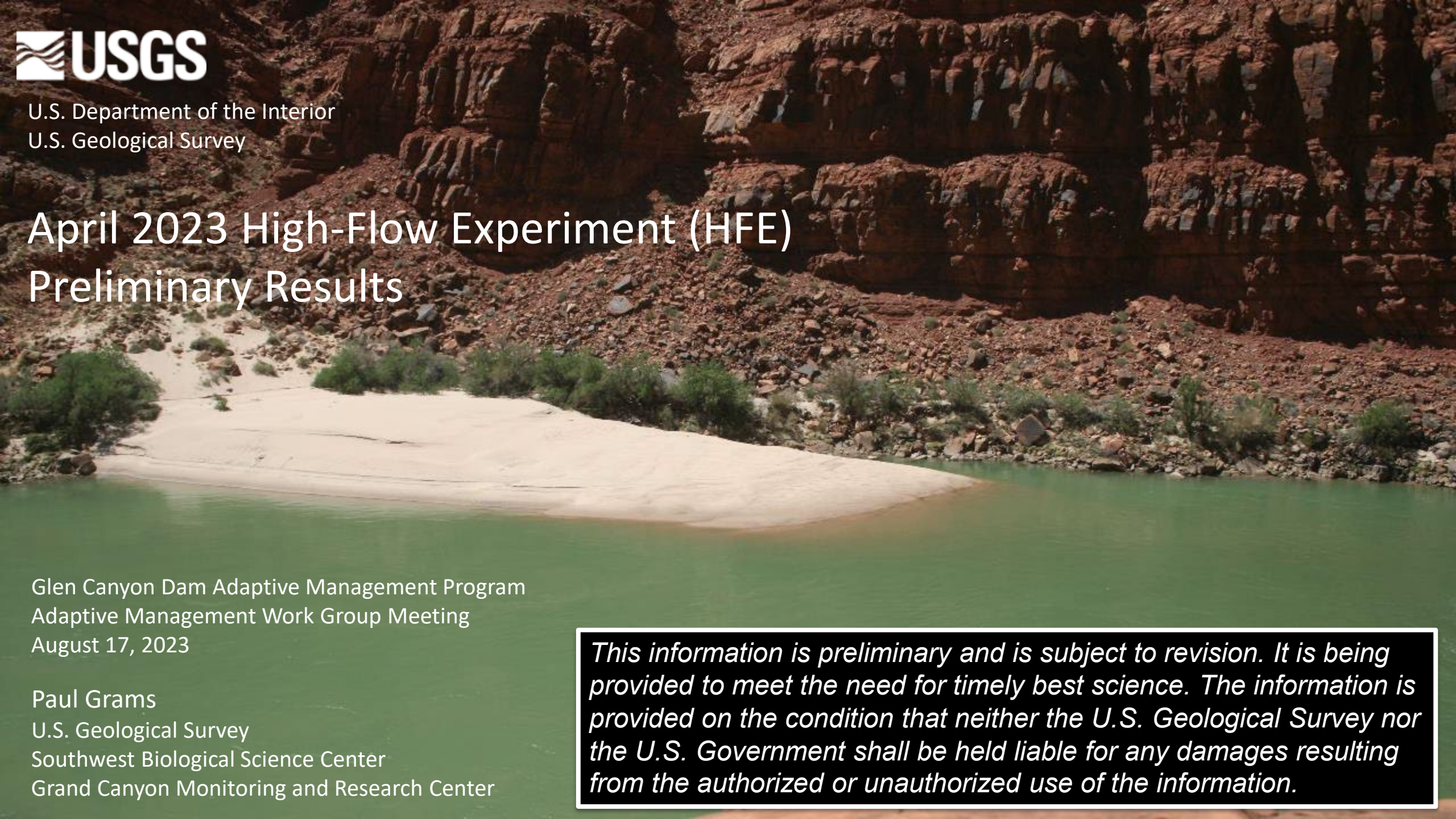


U.S. Department of the Interior
U.S. Geological Survey

April 2023 High-Flow Experiment (HFE) Preliminary Results

Glen Canyon Dam Adaptive Management Program
Adaptive Management Work Group Meeting
August 17, 2023

Paul Grams
U.S. Geological Survey
Southwest Biological Science Center
Grand Canyon Monitoring and Research Center

Acknowledgements

Website:
Bob Tusso

https://www.usgs.gov/apps/sandbar/
Or
www.gcmrc.gov/sandbar/

Suspended Sediment:
David Topping and Project A staff

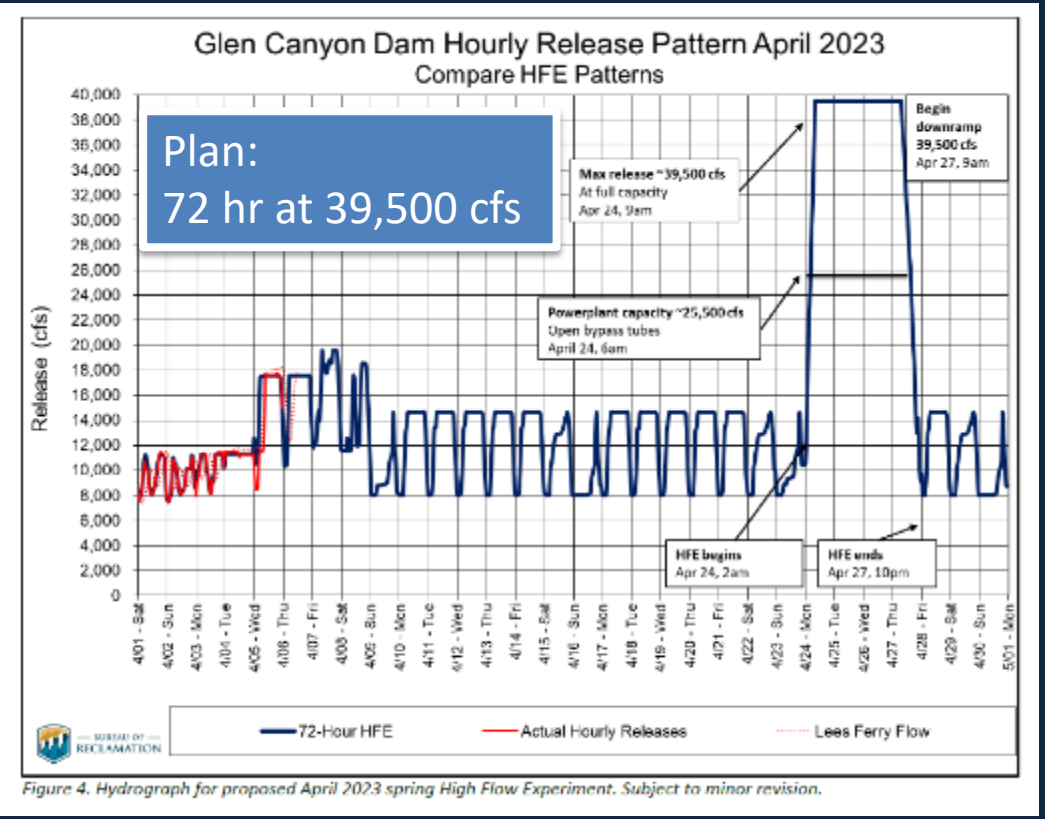
Remote Camera Downloads:
Bob Tusso and Katie Chapman

Columbine Reach Surveys:
Paul Grams, Katie Chapman, Matt Kaplinski, Erica Byerley, Gerard Salter, Shannon Sartain, Karen Koestner, and Keith Kohl

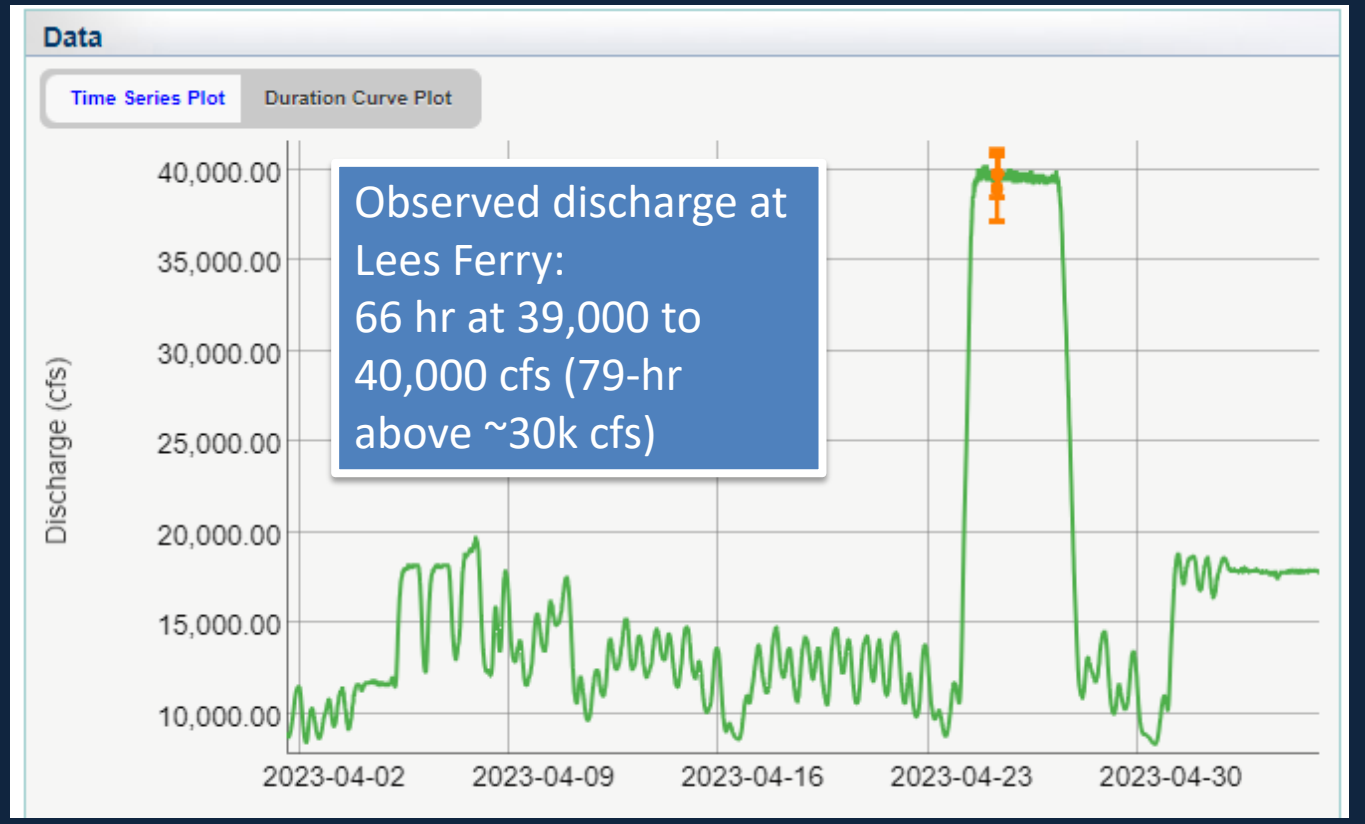
NORTHERN ARIZONA UNIVERSITY

USGS

April 2023 HFE – Planned and observed discharge



https://www.usbr.gov/uc/progact/amp/ltemp.html



+ 5,000 cfs of tributary inflows!

- ~40,000 cfs at Lees Ferry, RM 30, and RM 61
- ~42,000 cfs at RM 87
- ~45,000 cfs at RM 165 and 225

Data from www.gcmrc.gov/discharge_qw_sediment

USGS

April 2023 HFE – Sediment conditions

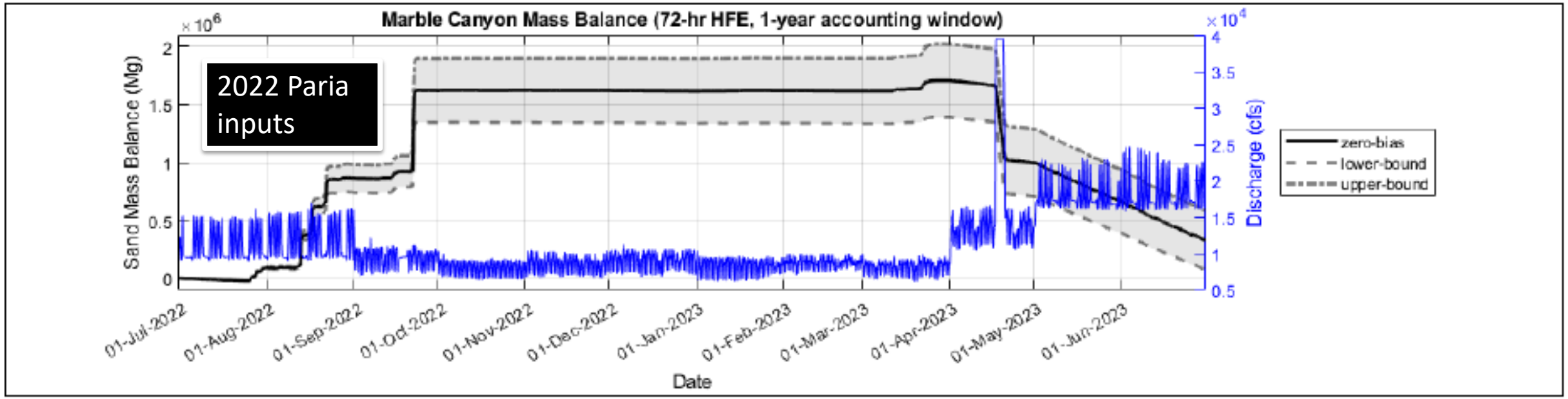


Figure 3. Mass balance in Marble Canyon predicted by the Sand Routing Model (Wright et al. 2010) with a 1-year accounting window and a 72-hour HFE in April with a maximum magnitude of 39,500 cfs.

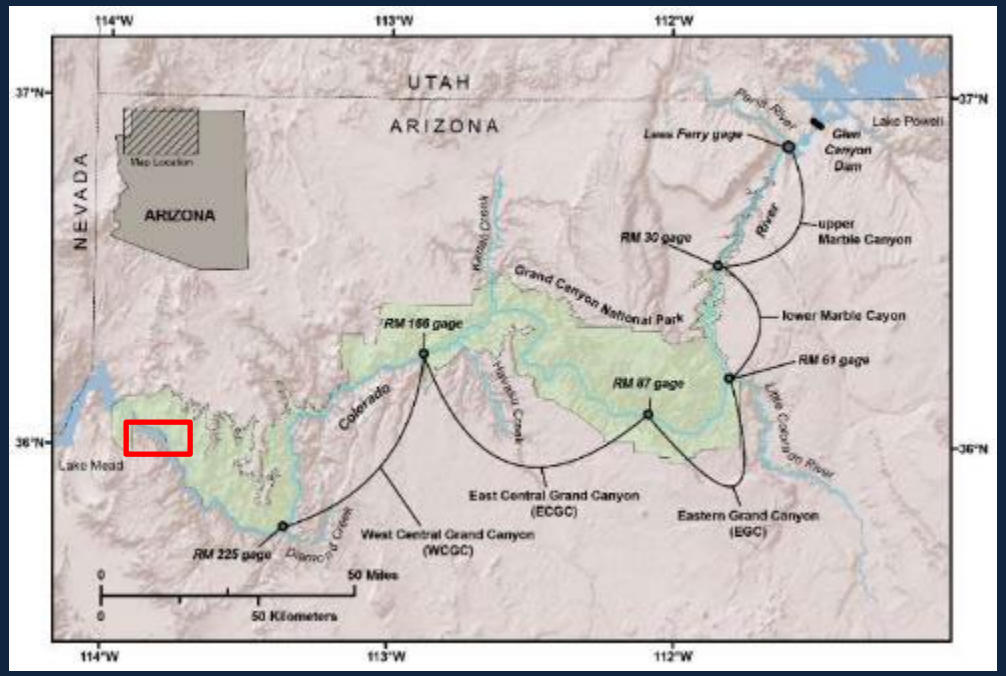
- 72-hour HFE at ~40,000 cfs designed based on sand that accumulated in Marble Canyon from July 1, 2022 through October 2022 and remained in Marble Canyon during the low winter 2022/2023 releases.

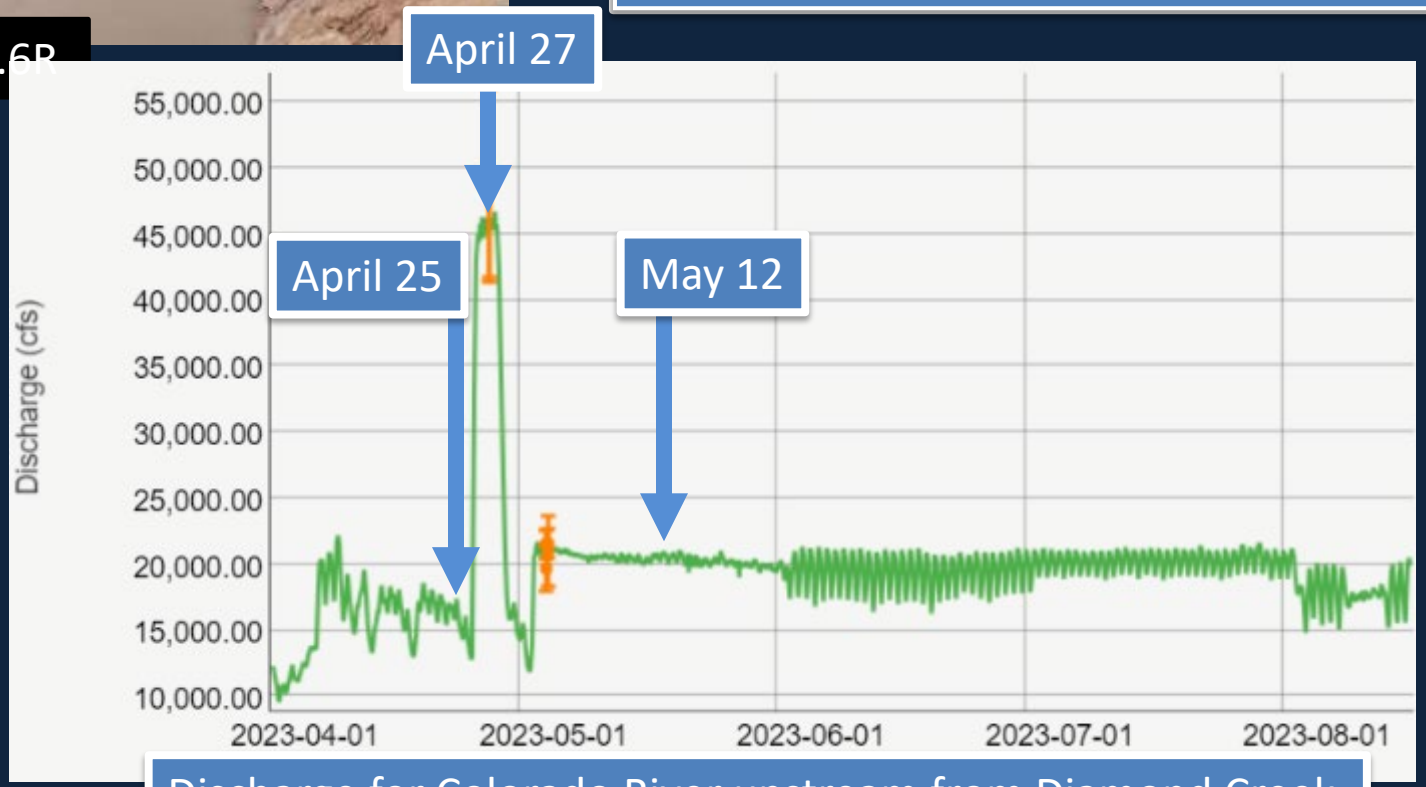
Columbine Study Reach in Western Grand Canyon

View of study reach from outside of bend at RM 273.6R

Repeat surveys to study bed elevation change and bank erosion

- Three surveys collected before, during and after HFE
- One additional survey planned for late summer or early fall





Discharge for Colorado River upstream from Diamond Creek

Preliminary results, subject to review and revision, please do not cite

USGS

Project A Preliminary HFE Results

- **Sand concentrations were higher in mid Marble Canyon** during the April 2023 HFE than during any of the 2004–2018 HFEs, but sand **grain size was slightly coarser** than during most of these earlier HFEs

- This result is consistent with Topping and others (*JGR*, 2021); there was substantial sand accumulation in upper Marble Canyon before this HFE but a generally longer interval between the Paria River sand inputs and the HFE

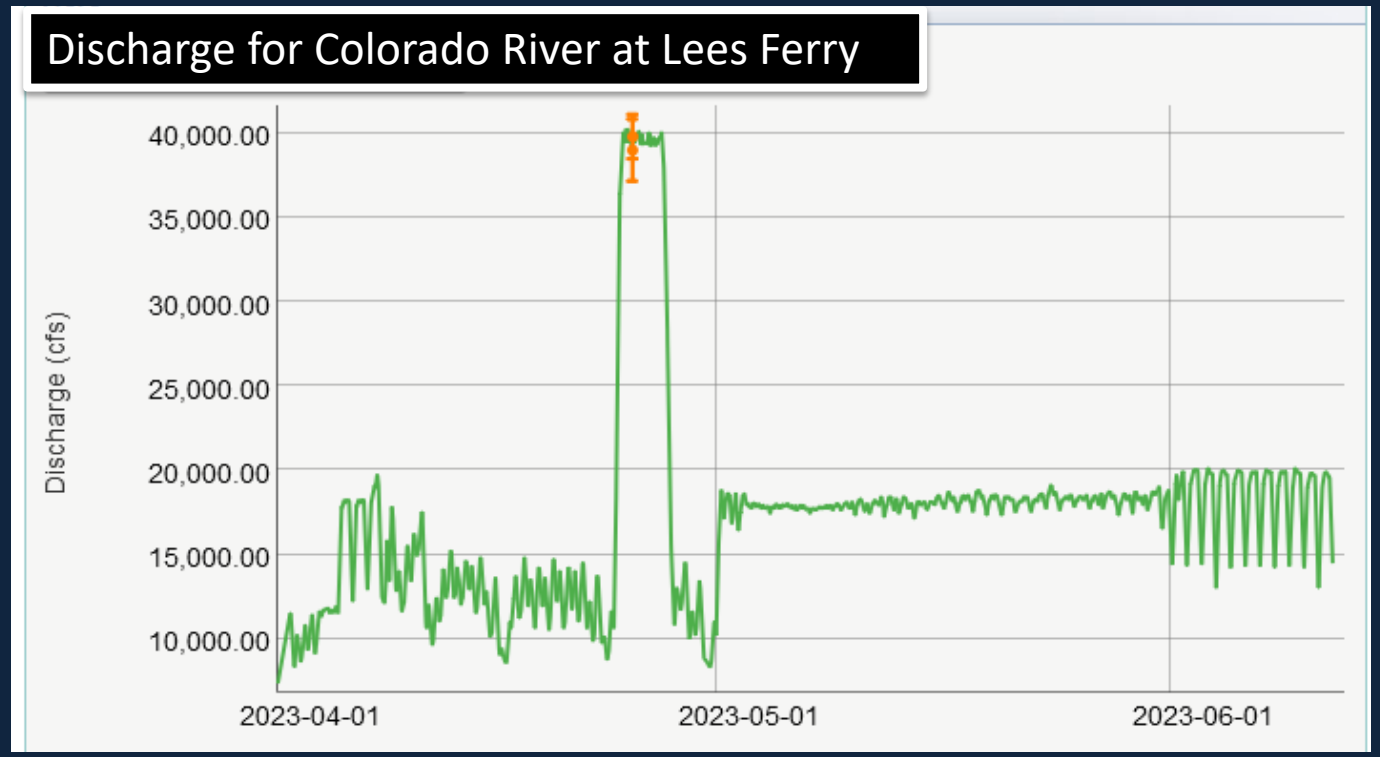
- **Sand concentrations were higher in central Grand Canyon** (at National Canyon) than during most of the 1996, 2008–2018 HFEs.

- **USGS delays in hiring lab staff continues to prevent timely reporting of results**; though we promised comprehensive sediment-transport and sand-budgeting results posted to Project A's website at (https://www.gcmrc.gov/discharge_qw_sediment/) before the August AMWG Meeting we were unable to keep this commitment.

- Although **larger-than-normal Paria River floods are likely starting next week** (from dissipating tropical cyclones) and this forecast increases the likelihood of a fall HFE trigger, roughly **200,000–400,000 metric tons of sand have been eroded from Marble Canyon since July 1 owing to high summer "balancing" releases**.

Sandbar monitoring for April 2023 HFE

- Daily photos by remote cameras (45 sites) https://www.usgs.gov/apps/sandbar/
- Grand Canyon River Guides Adopt-a-Beach program
- Annual topographic surveys in October (45 sites)



Flows
- Pre-HFE: 10,000 to 14,000 cfs
- Beginning May 1: ~18,000 cfs

That difference can result in a large decrease in the size of the exposed sandbar (25% to 50% decrease)

Data from www.gcmrc.gov/discharge_qw_sediment

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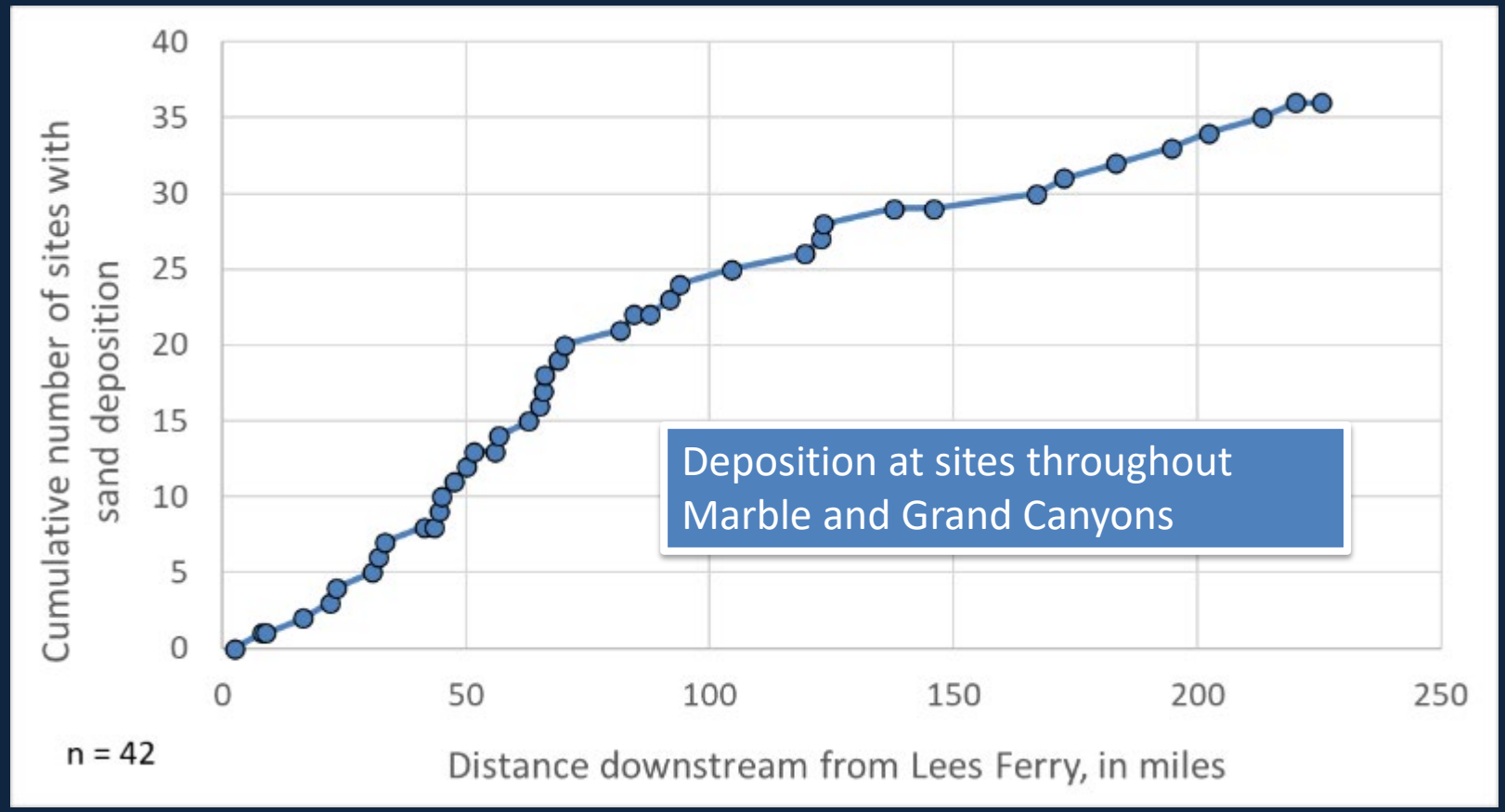
Preliminary Remote Camera Results from April HFE

- At least some deposition at more than 85% of monitoring sites with remote cameras
- At some sites, deposition was offset by erosion
- Vegetation scour or burial at many sites
- Gullies eroded by monsoon storms filled
- *Similar number of gainers compared to previous HFEs.*
  - *Different water levels make comparison with previous HFEs difficult*



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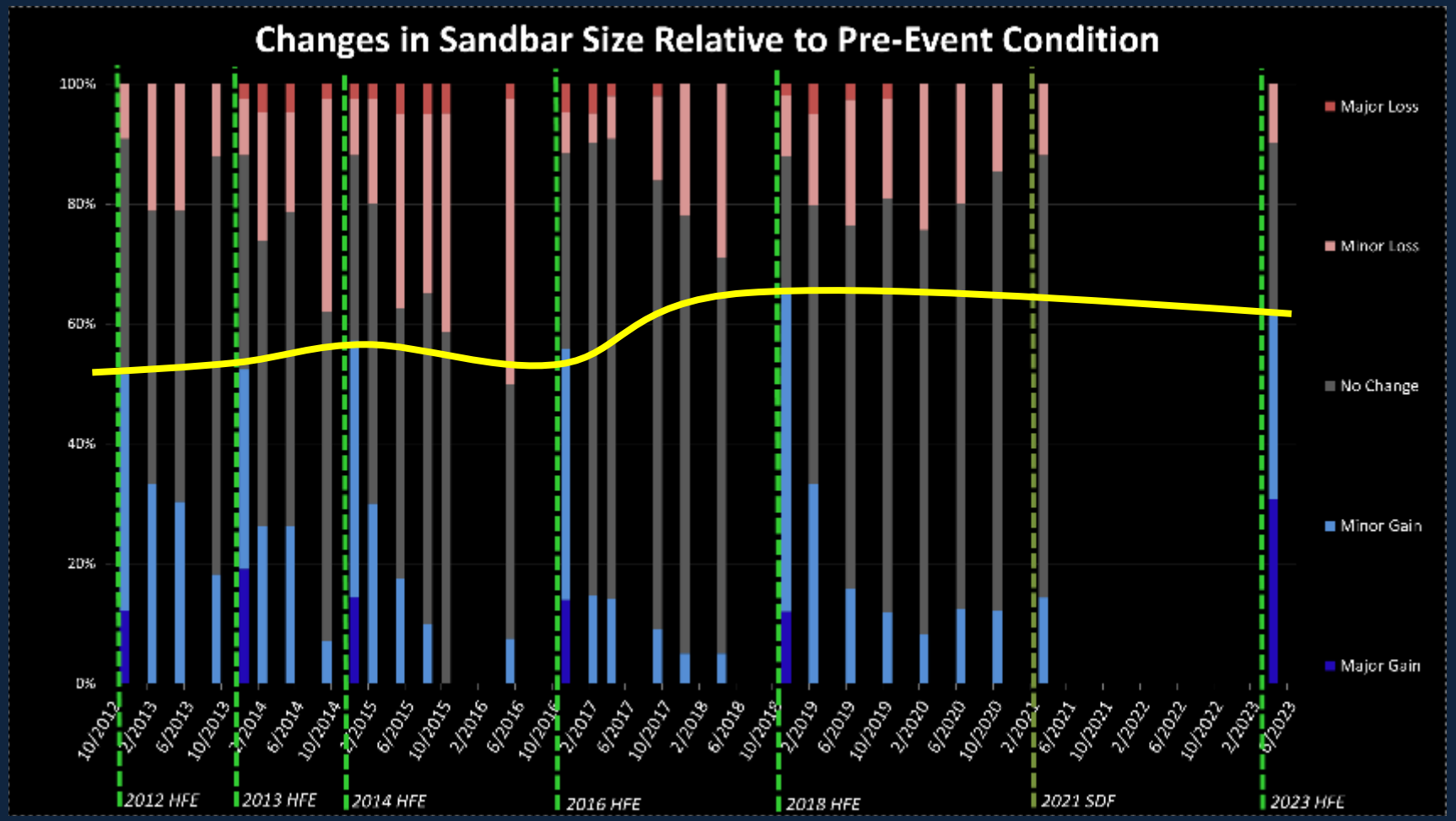

Number of sand "gainers" for each HFE

USGS

Lone Cedar Camp – River Mile 24.5, Left

Lone Cedar Camp – River Mile 24.5, Left

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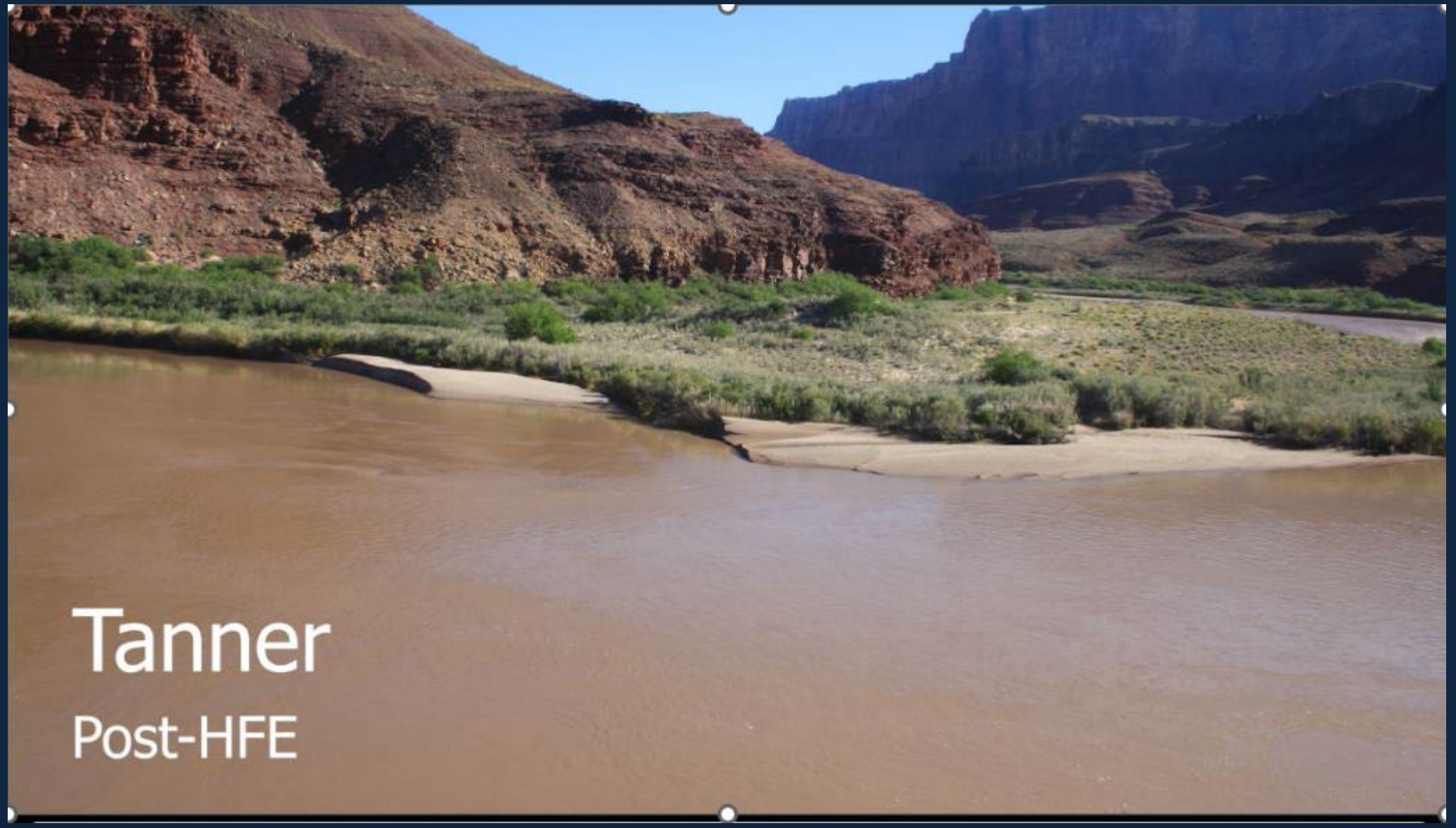
The Sand Pile – River Mile 30, Right

The Sand Pile – River Mile 30, Right

Tanner Beach – RM 68, Right

Tanner Beach – RM 68, Right

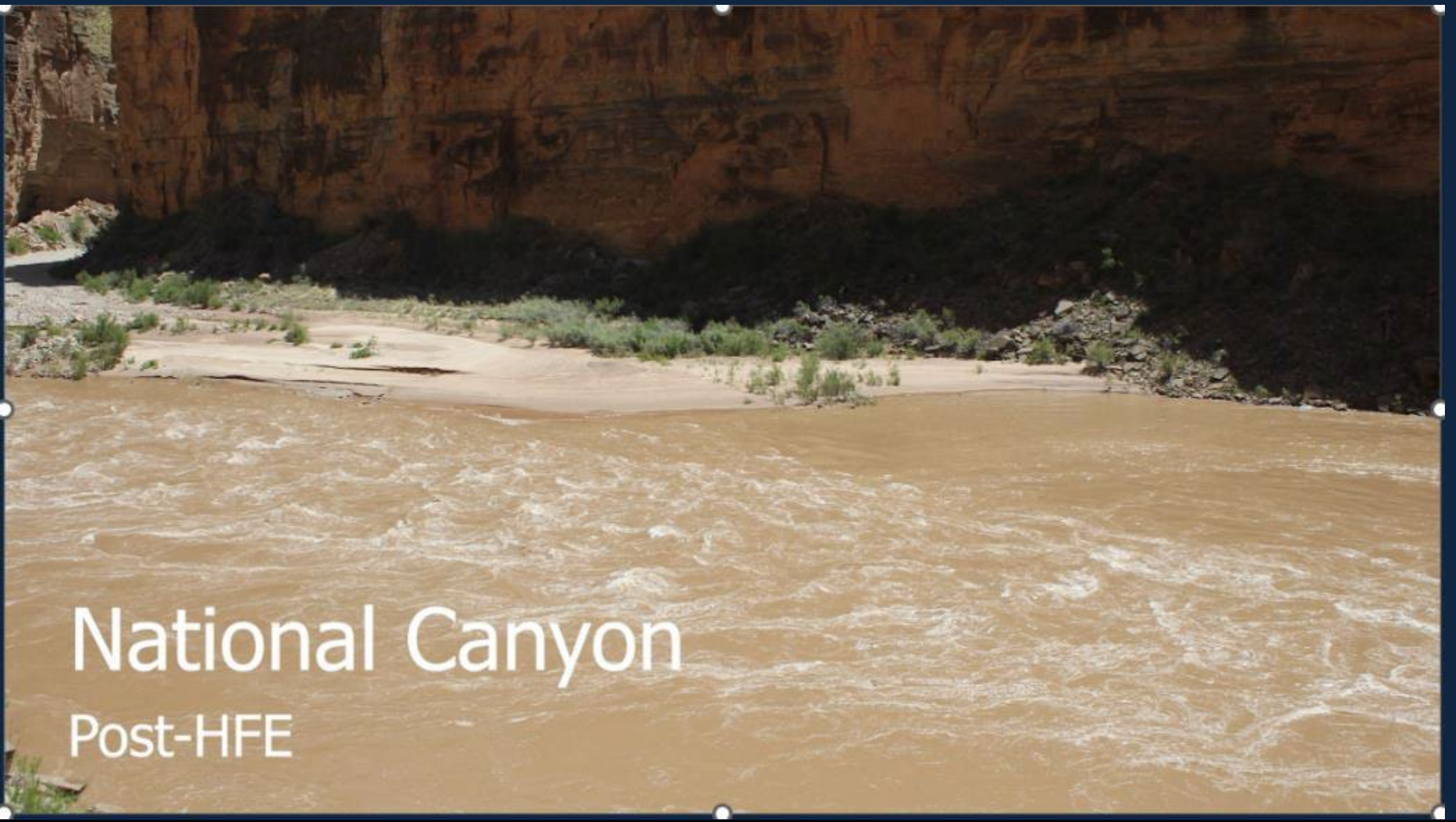


Big Dune Camp – River Mile 119, Right

Big Dune Camp – River Mile 119, Right

National Canyon – RM 166, Left

National Canyon – RM 166, Left



9-Mile Camp – River Mile 8.9, Left

9-Mile Camp – River Mile 8.9, Left

Summary

- In Marble Canyon, sand concentrations were high relative to previous HFEs though grain size was a bit coarser
  - *Lots of sample processing still to be done before final results on sand concentrations and sand budgets for HFE*
- Substantial deposition at most sites from Upper Marble Canyon to Diamond Creek
- Sandbar building appears to be “on par” with previous HFEs
- High dam releases have likely caused substantial erosion, but HFE deposits do remain
- We will conduct a complete sandbar survey in October and measure how much of the HFE deposits remain

Website:
https://www.usgs.gov/apps/sandbar/