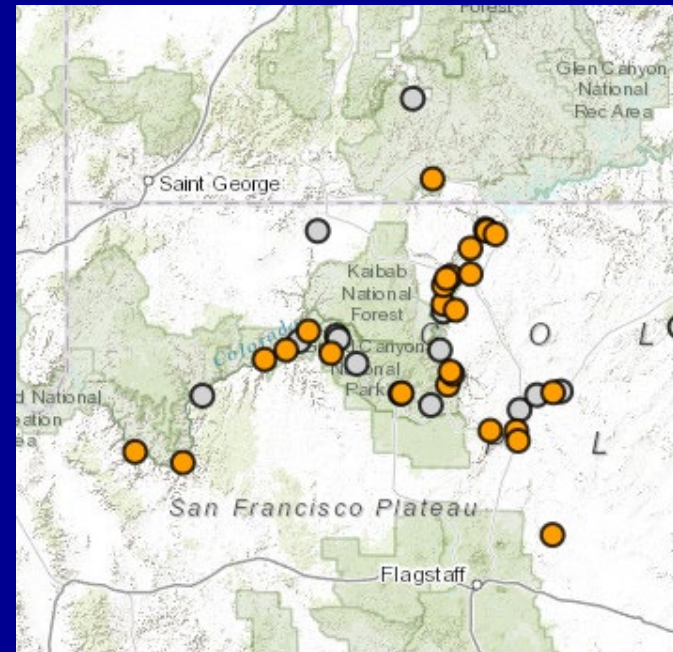
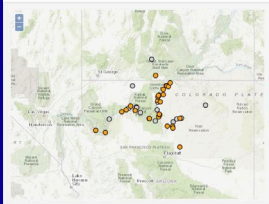


Project A: Streamflow, Water Quality, and Sediment Transport and Budgeting in the Colorado River Ecosystem

Project A collects the physical data that directly link dam operations to all resources in the downstream Colorado River; data inform 10 LTEMP goals

- **Element 1: Stream gaging**
 - Stage
 - Discharge
- **Element 2: Water quality**
 - Water temperature
 - Salinity (specific conductance)
 - Turbidity
 - Dissolved Oxygen
- **Element 3: Sediment transport and budgeting**
 - Suspended- and bed-sediment data
 - Sediment loads (silt and clay loads and sand loads)
 - User-interactive sand budgets in 6 reaches from Lees Ferry to Lake Mead
- **All elements**
 - Database and website (**currently UNSUPPORTED**)





Stations

Active Inactive

	Shim Canyon Dam near Peep, AZ 09378901
	Water Holes Canyon above the mouth GCMRC-GCLT1
	Colorado River at Lees Ferry, AZ 09380000
	Paria River near Kanab, UT 09381800
	Paria River at Lees Ferry, AZ 09380000
	Badger Creek below highway 89A near Vermilion Cliffs, AZ GCMRC-MCLT1
	Tanner Wash below highway 89A near Redging, AZ GCMRC-MCLT2
	House Rock Wash above Emerald Wash near Cliff Dwellers, AZ GCMRC-MCLT3
	House Rock Wash below Emerald Wash in House Canyon near Cliff Dwellers, AZ GCMRC-MCLT4
	North Canyon near Cliff Dwellers, AZ GCMRC-MCLT5
	Shimono Wash in Twynema Mile Canyon near Deer Ridge, AZ GCMRC-MCLT6
	Colorado River near river mile 30 09380000
	Colorado River above LESE
	Colorado River near Desert View, AZ 09383100
	Little Colorado River at Grand Path, AZ 09401000
	Little Colorado River at Cameron, AZ 09401200
	Moenkopi Wash at Moenkopi, AZ 09401200
	Moenkopi Wash near Cameron, AZ 09401500
	Little Colorado River near Cameron, AZ 09402000
	Little Colorado River above the mouth near Desert View, AZ 09402300
	Colorado River above Lees Canyon near river mile 66 09403352
	Colorado River near Grand Canyon, AZ 09403200
	Bright Angel Creek near Grand Canyon, AZ 09403000
	Colorado River below 127 Mile Creek 09403270
	Kanab Creek above the mouth near Soap, AZ 09403850
	Havasu Creek above the mouth near Soap, AZ 09404115
	Colorado River above National Canyon near Supai, AZ 09404120
	Colorado River above Diamond Creek near Peach Springs, AZ 09404200
	Colorado River above Spencer Creek at river mile 246 09404220

Major risk to GCDAMP remains unresolved

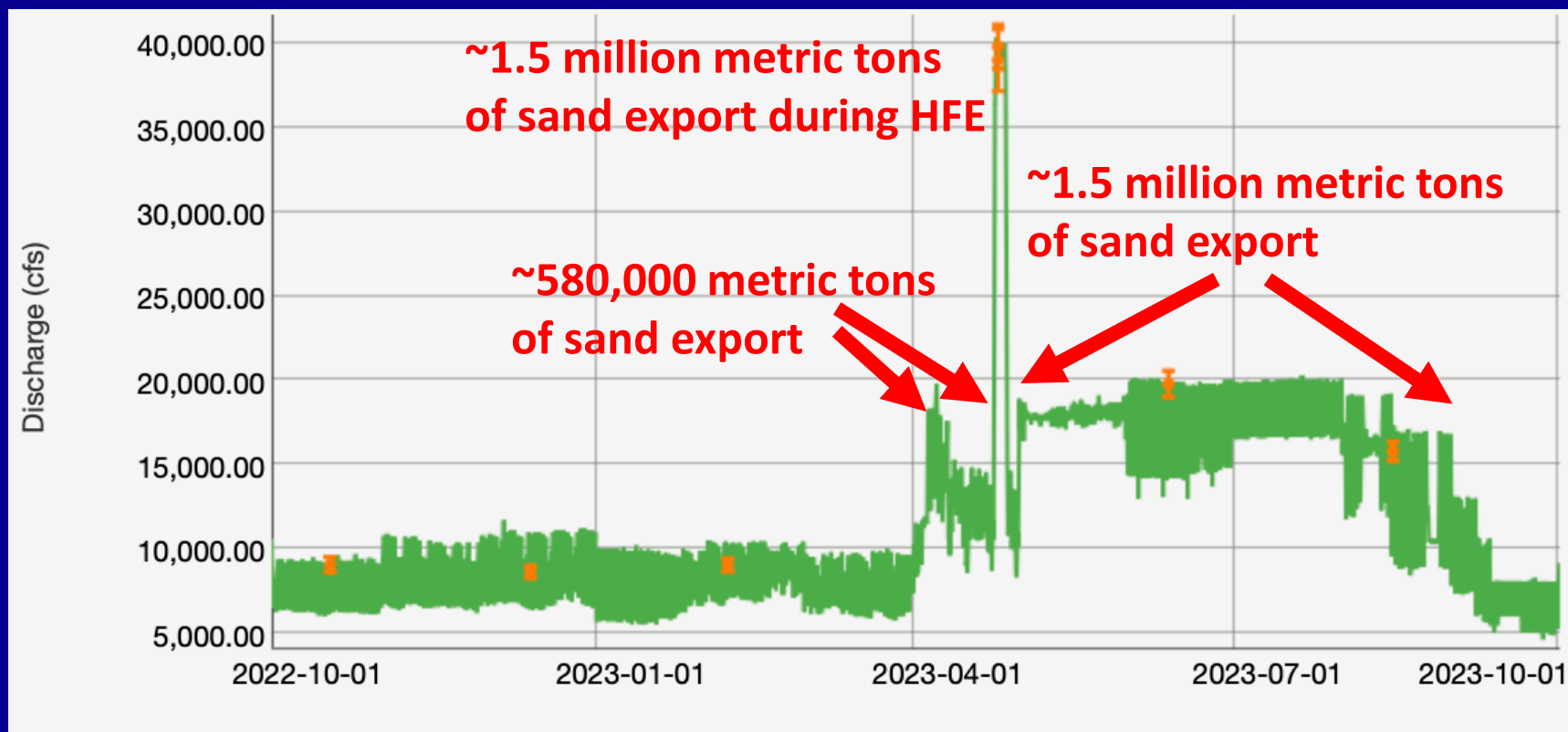
- Despite adequate GCDAMP funding, Project A's database and website have not had stable Computer Science support since 2019
- >30 million dollars of GCDAMP funding since 1990s for data that mostly exist only in this database and are available only through this website
- Database and website are breaking down
- Risk is loss of ability to relate resource changes to dam operations, inability to plan and evaluate HFEs, and loss of pre-dam and early syn-dam context (1921–1990s data are only available through website)

Only minimal QW data have been processed since June 2023

- We have still not backfilled Project A's water-quality specialist (Nick Voichick retired last June)
- Only water temperature and specific conductance at Lees Ferry and water temperature in three tributaries are QA/QCed and posted at: https://www.gcmrc.gov/discharge_qw_sediment/
- Good news is on the horizon, though...



Flows at Lees Ferry and sand export past Diamond Creek during FY 2023



High “balancing” flows that bracketed the HFE exported ~2.1 million metric tons of sand to the Lake Mead Delta

Evaluation of LTEMP sand management


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Paul E. Grams¹
Ronald E. Griffiths¹
Matt Kaplinski¹
Joel A. Unema²
David J. Dean¹
Katie A. Chapman¹

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Southwest Biological Science Center
Grand Canyon Monitoring and Research Center

²U.S. Geological Survey
Arizona Water Science Center

The information in several of these slides is preliminary and is subject to revision. It is being provided to meet the need for timely best science. The information is provided on the condition that neither the U.S. Geological Survey nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the information.

Basics of sand management

- Sand supply is <5% of natural
- Keep dam releases low for part to much of the year to accumulate sand **OR** 
- Episodic short-duration artificial floods (HFEs) to rebuild sandbars
- Avoid sustained high releases (e.g., equalization) that greatly exceed the sand supply and result in widespread erosion

RECLAMATION
Managing Water in the West

**Colorado River Ecosystem
Sediment Augmentation
Appraisal Engineering Report**

Randle and others (2007)

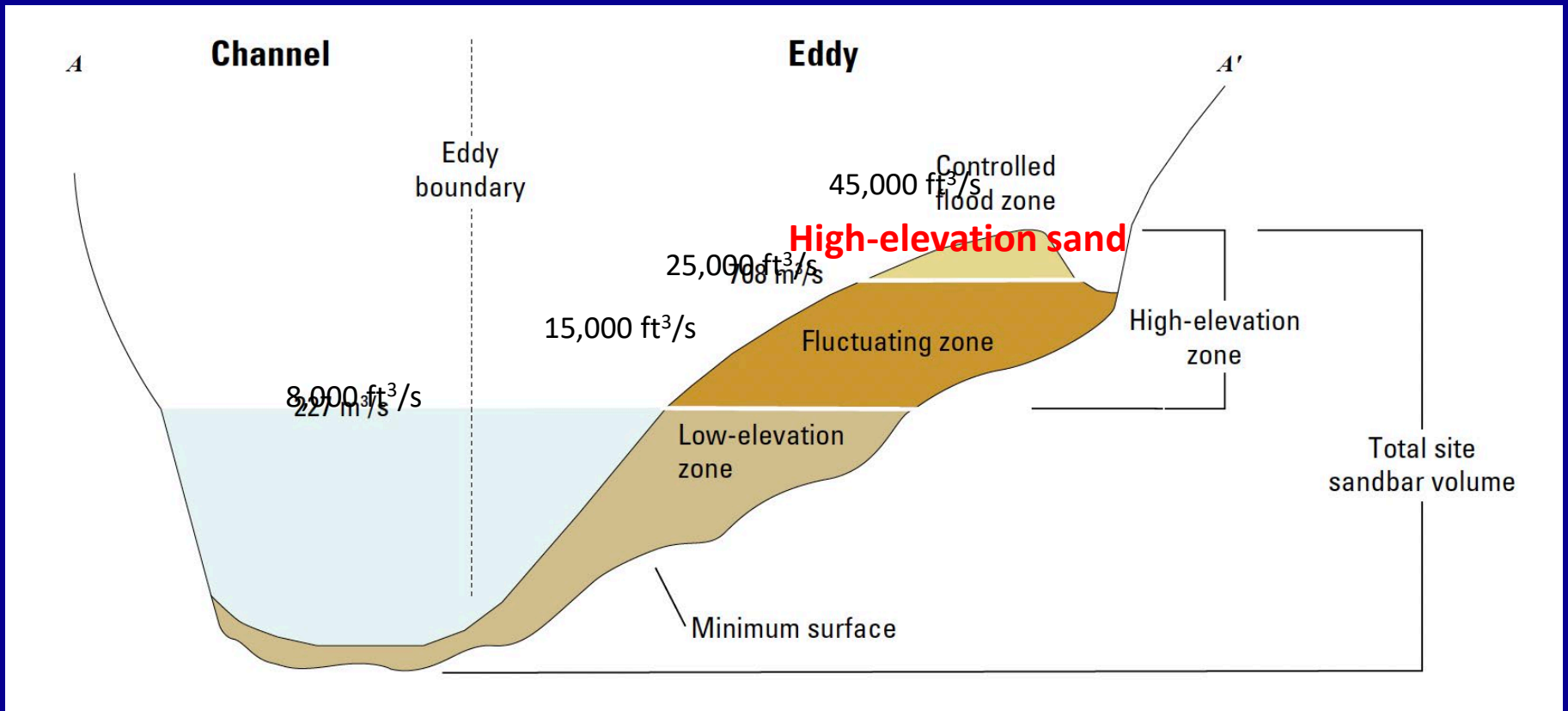


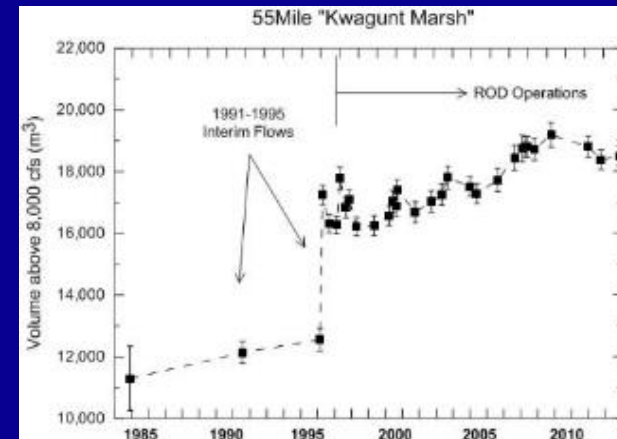
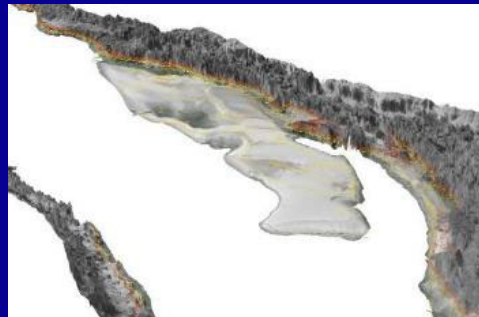
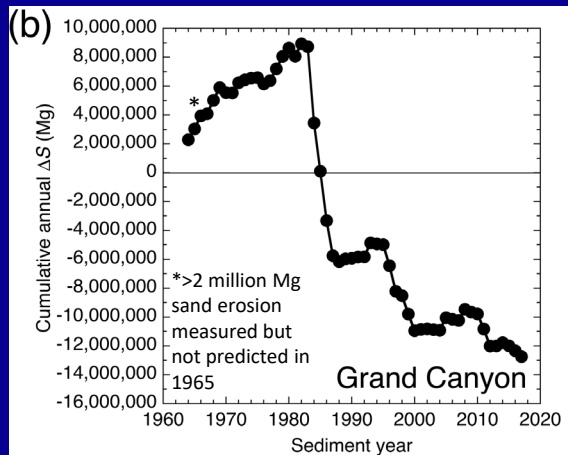
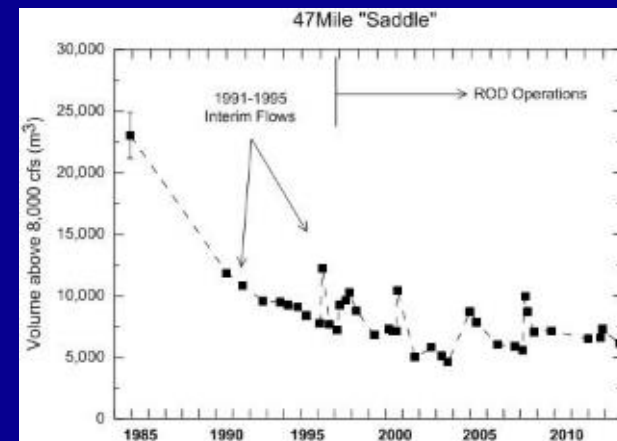
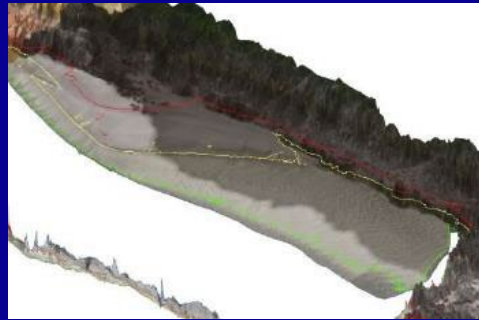
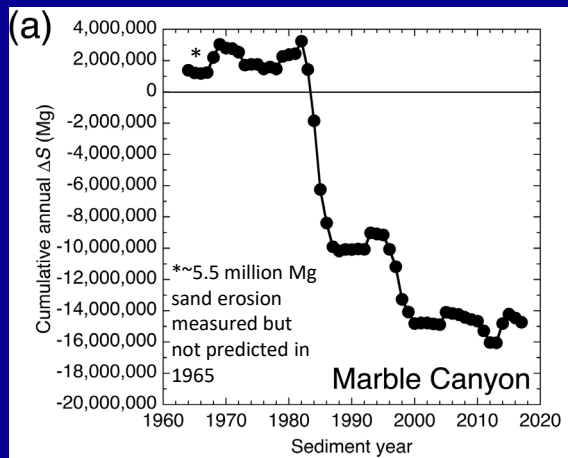
Figure modified from Hazel and others (USGS-PP, 2022)

- ~30–50% of the sand stored in sandbars is relict “pre-dam” sand (Chapman and others, *GSA Bulletin*, 2020)
- Stratigraphic and ground-penetrating-radar data indicate pre-dam sand at depth in at least some sandbars (Barnhardt and others, *USGS-OFR*, 2001)

Downward spiral has likely occurred in long-term sand mass balance... and reflected in at least some of the sandbars

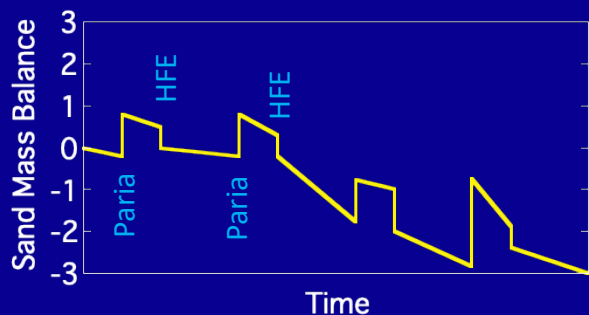
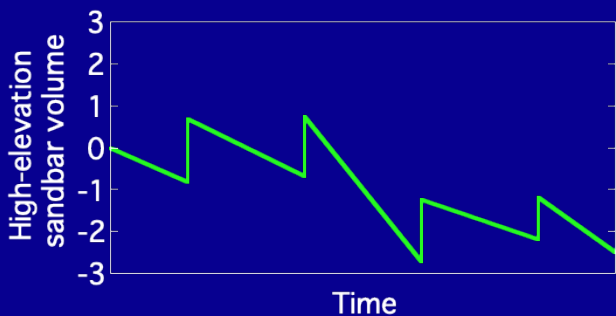
>28 million metric tons of sand eroded since 1963, mostly during 3–4 periods of high dam releases (Topping and others, *JGR*, 2021)

~12 million metric tons eroded in late 1990s alone (6 from Marble and 6 from Grand)



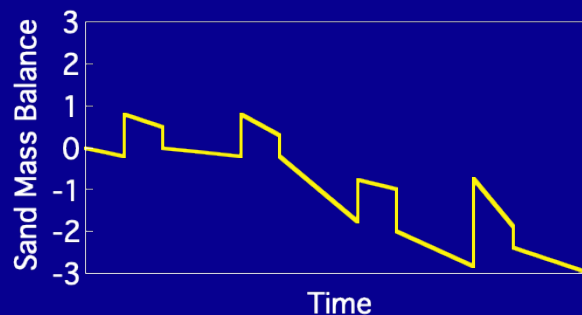
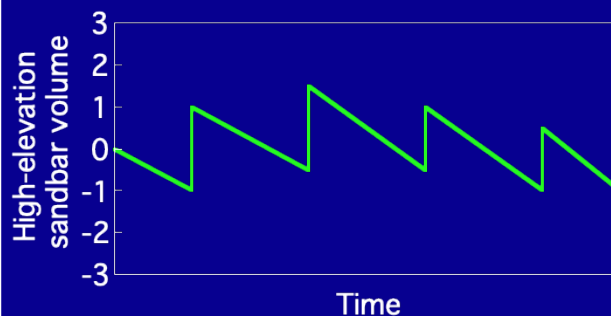
Sustainable management of sand under the LTEMP sediment goal thus requires neutral to positive trends in both the sand mass balance (i.e., the bank account) and the high-elevation sandbar volume (i.e., your expenditures) over decades

Scenario 1



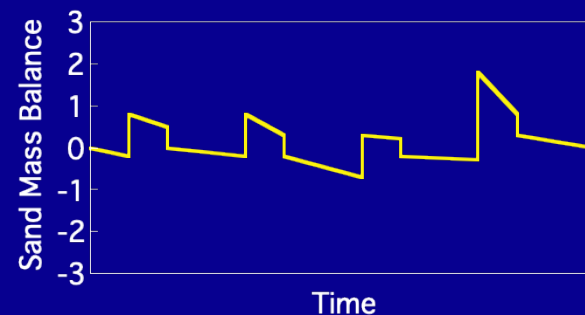
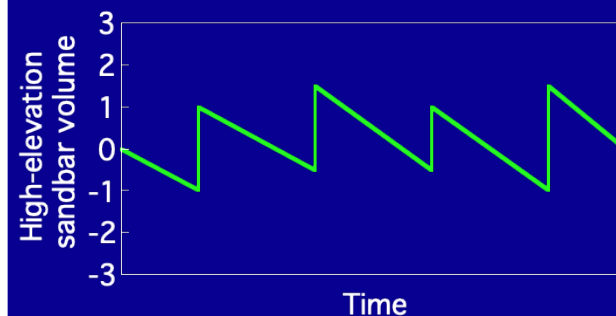
Not sustainable

Scenario 2



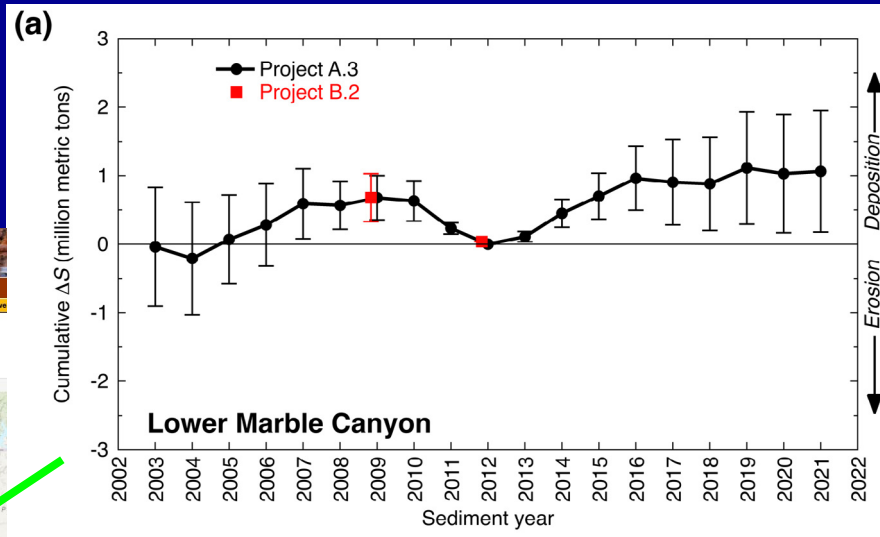
Not sustainable
Bank account mined to deposit sandbars
"Living on credit"

Scenario 3

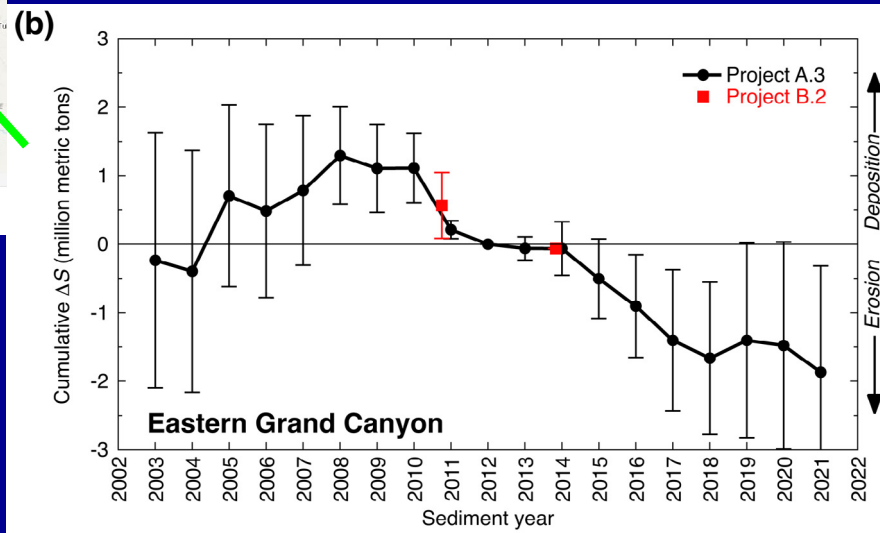


Sustainable
"Living within your means"

Metrics Example: The Bank Account

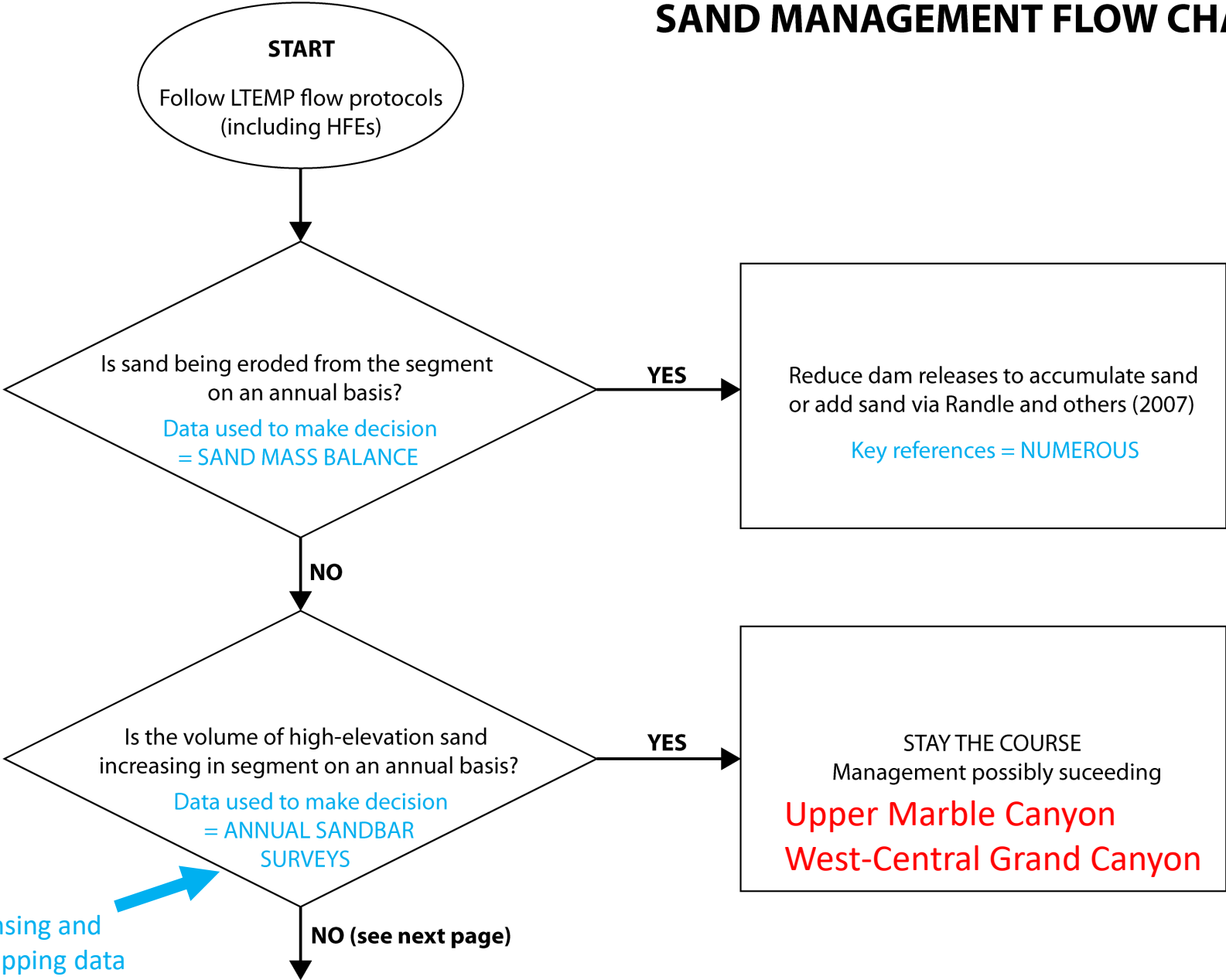


POSSIBLE SUCCESS! Sustainable in Lower Marble Canyon if high-elevation sandbar volume is positive during this period.

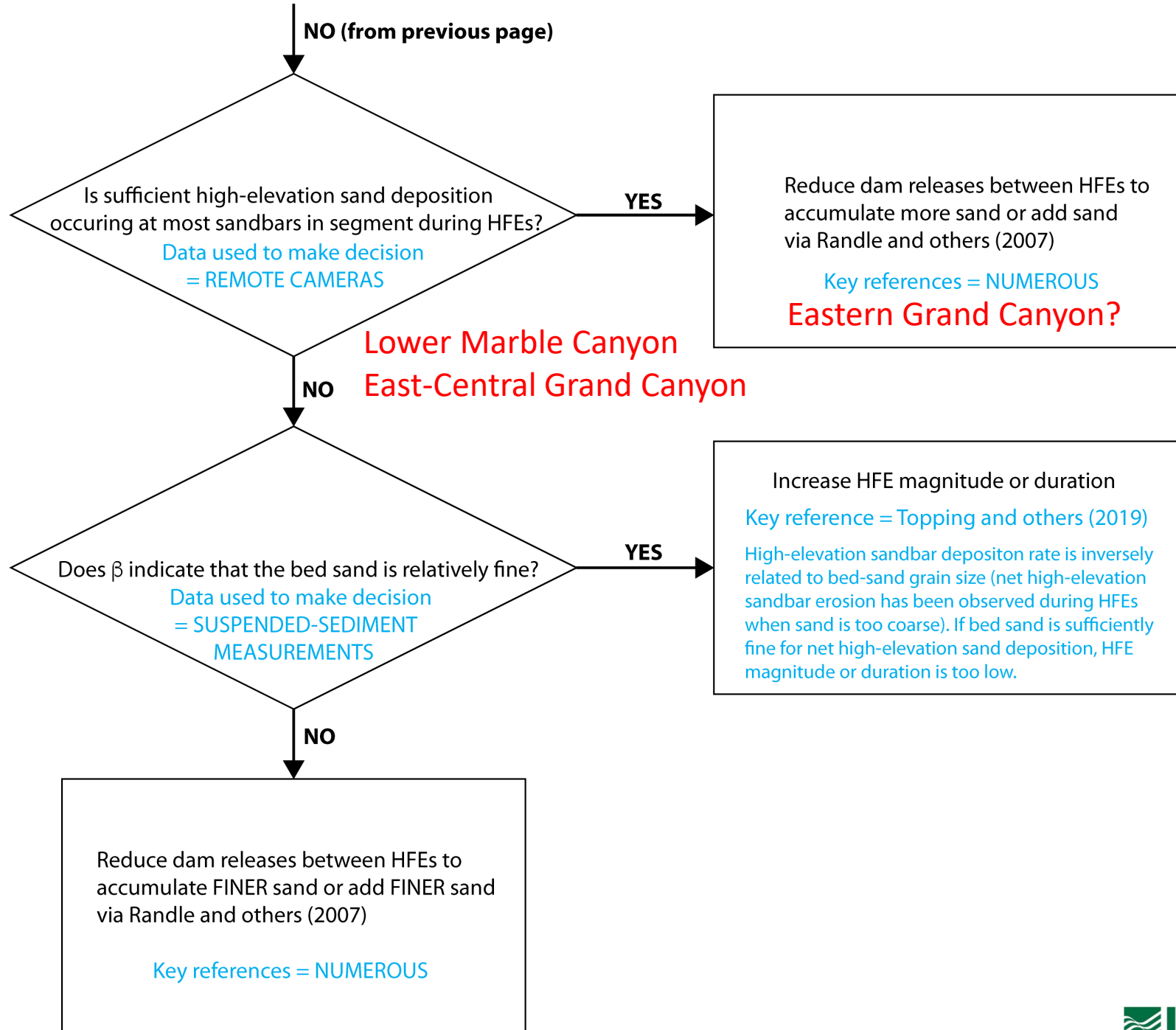


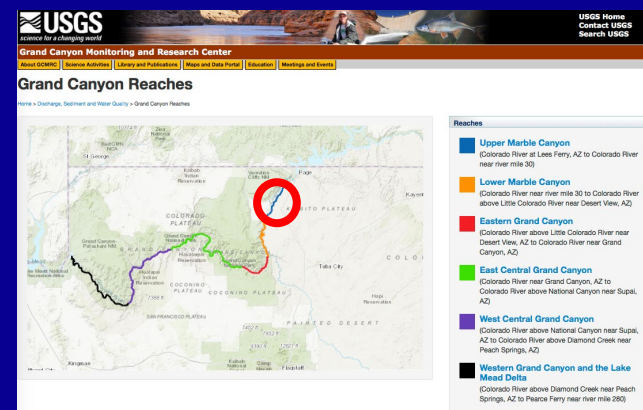
POSSIBLE FAILURE Not sustainable in Eastern Grand Canyon regardless of whether high-elevation sandbar volume is positive during this period.

SAND MANAGEMENT FLOW CHART

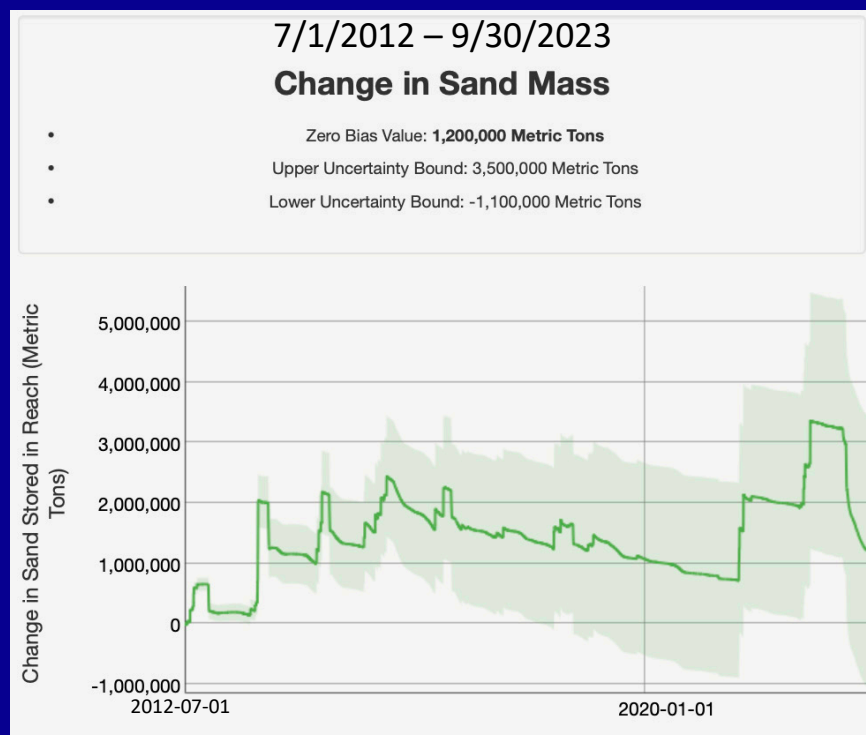


Remote-sensing and
channel-mapping data
can also inform here

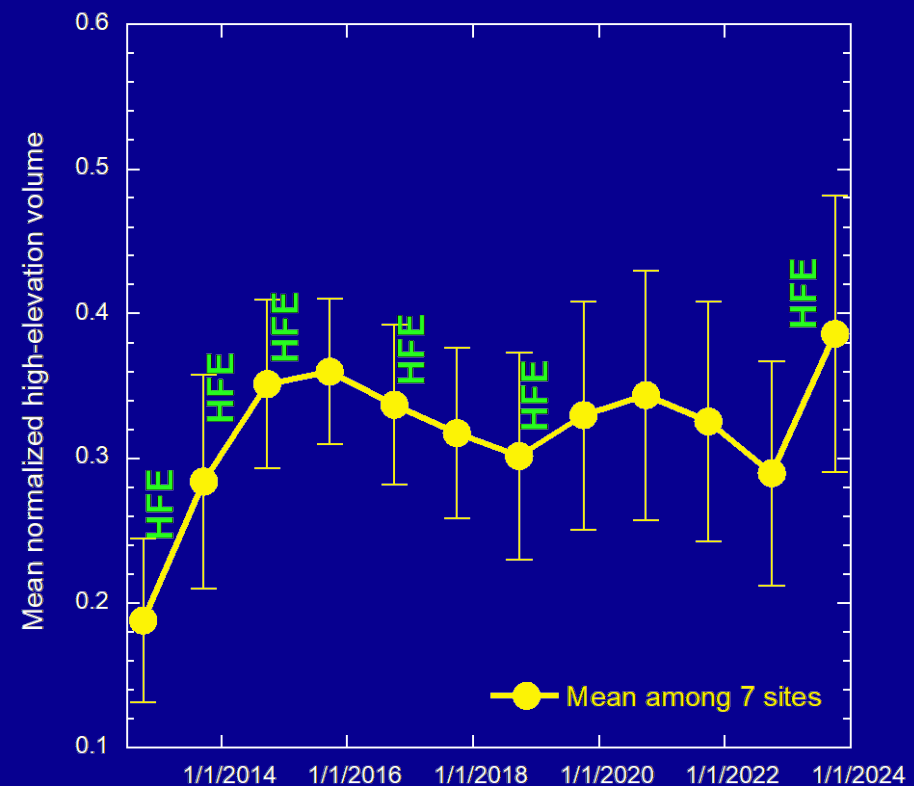




HFE-Protocol/LTEMP Period Upper Marble Canyon



POSITIVE

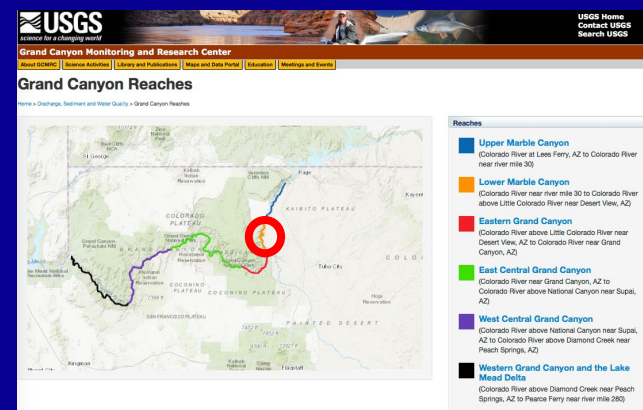


POSITIVE

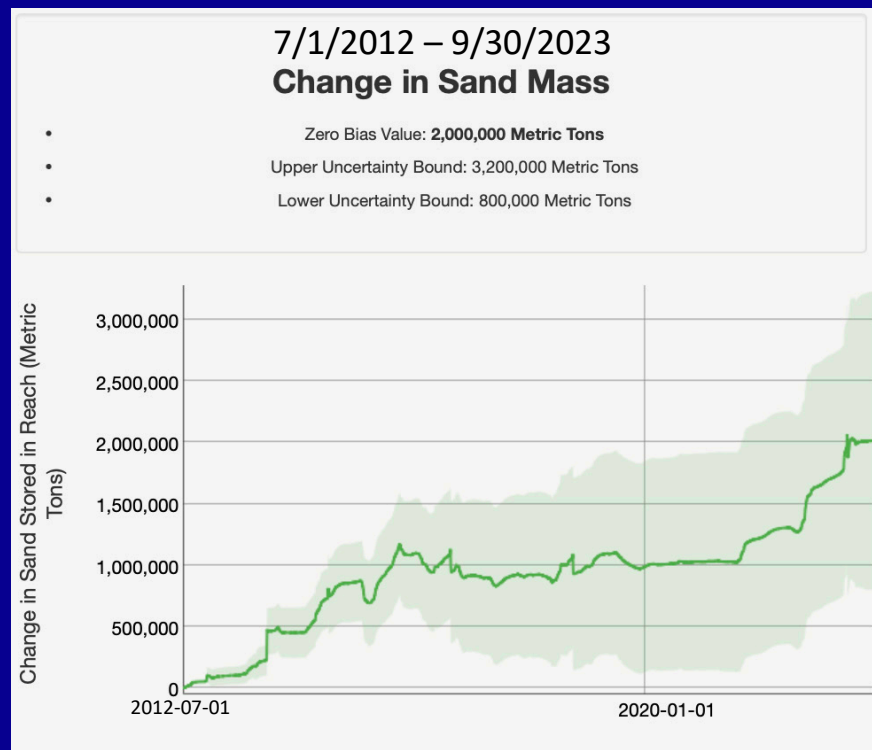
Possibly sustainable

Data from USGS (2024a, b)

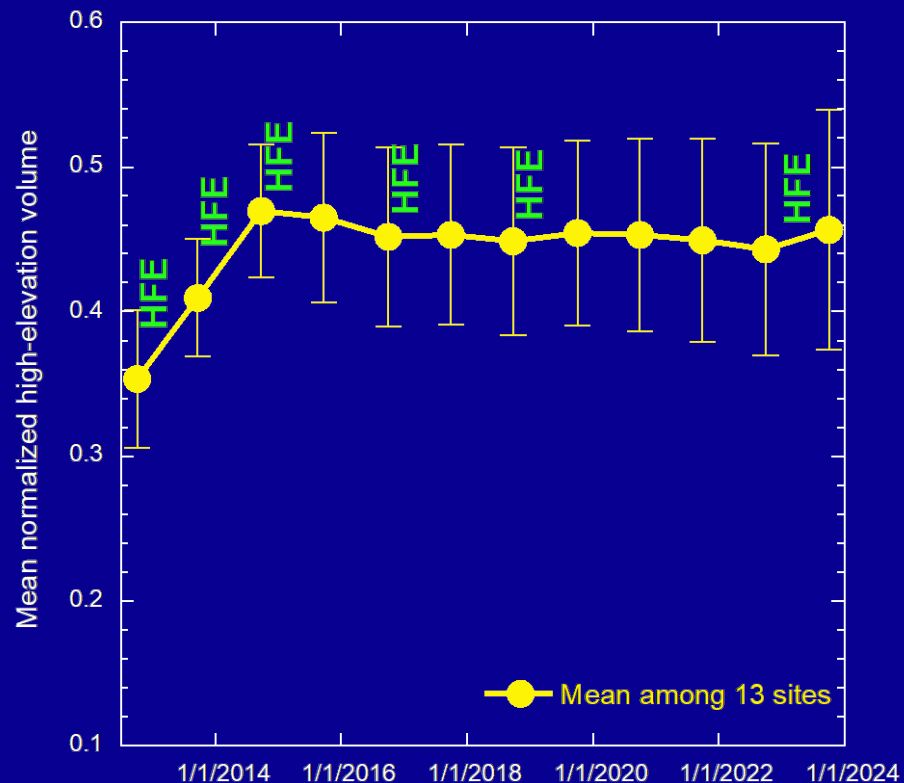




HFE-Protocol/LTEMP Period Lower Marble Canyon



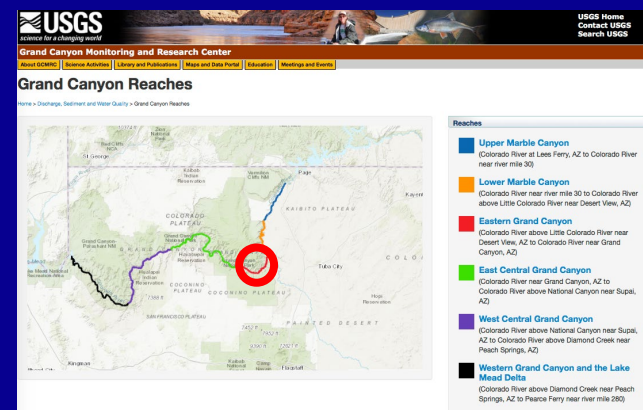
POSITIVE



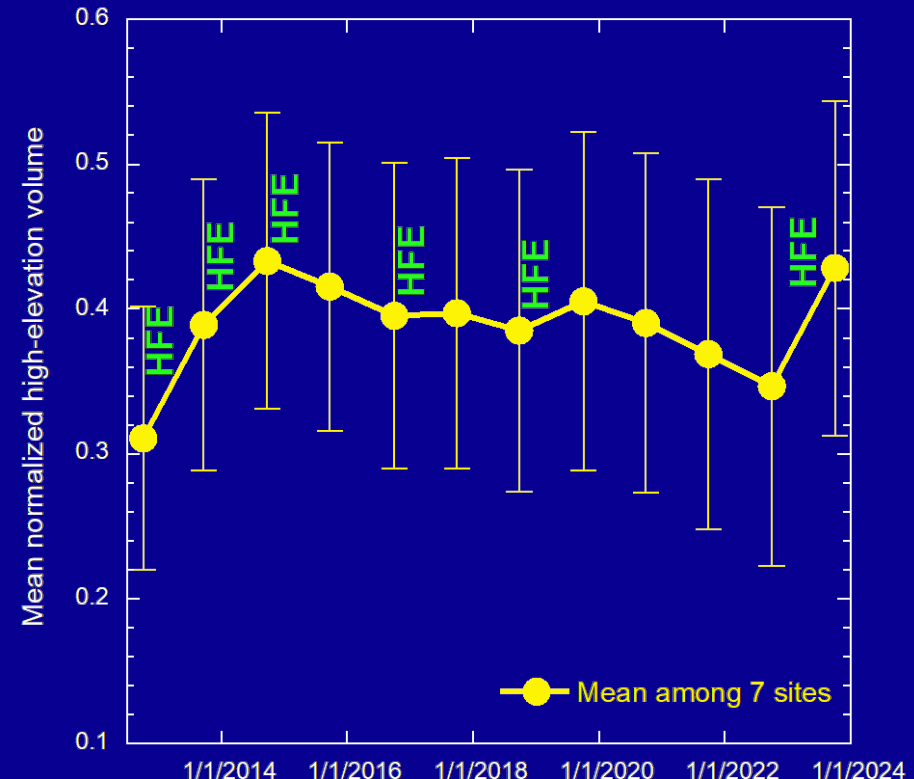
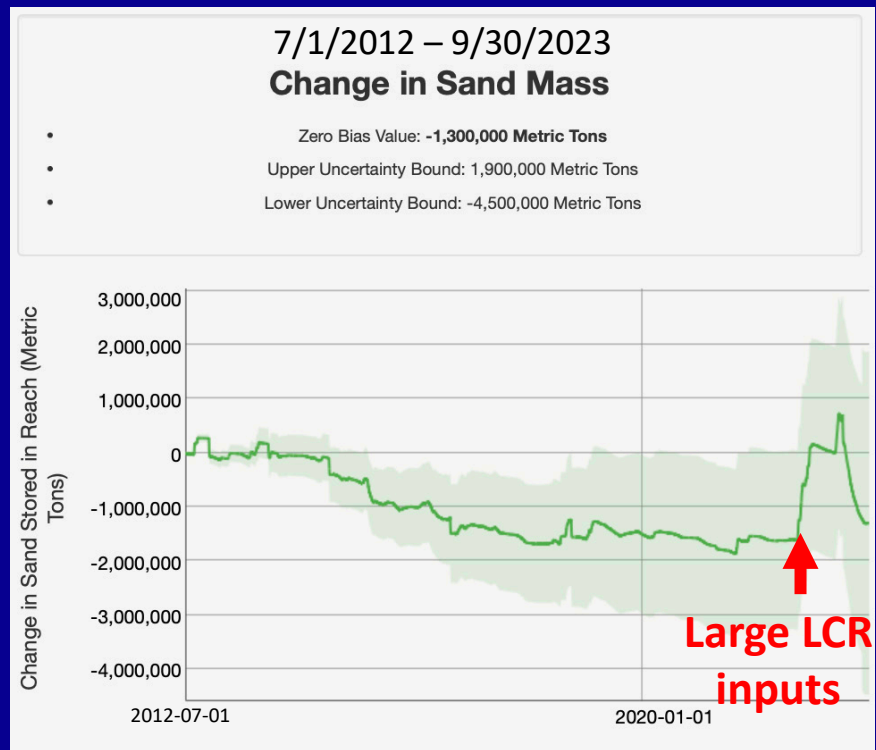
POSITIVE(?)

Insufficient HFE magnitude/duration or intervening flows too high

Data from USGS (2024a, b)



HFE-Protocol/LTEMP Period Eastern Grand Canyon

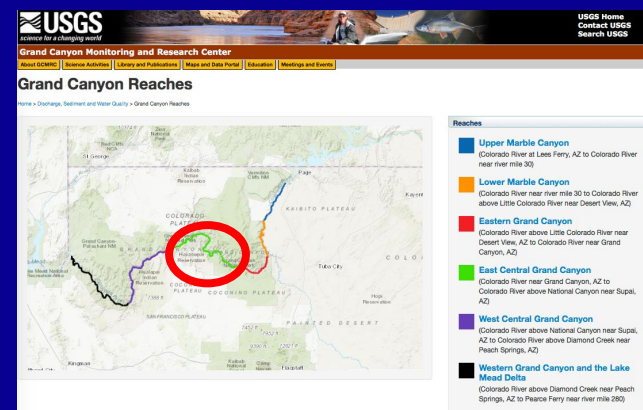


INDETERMINATE

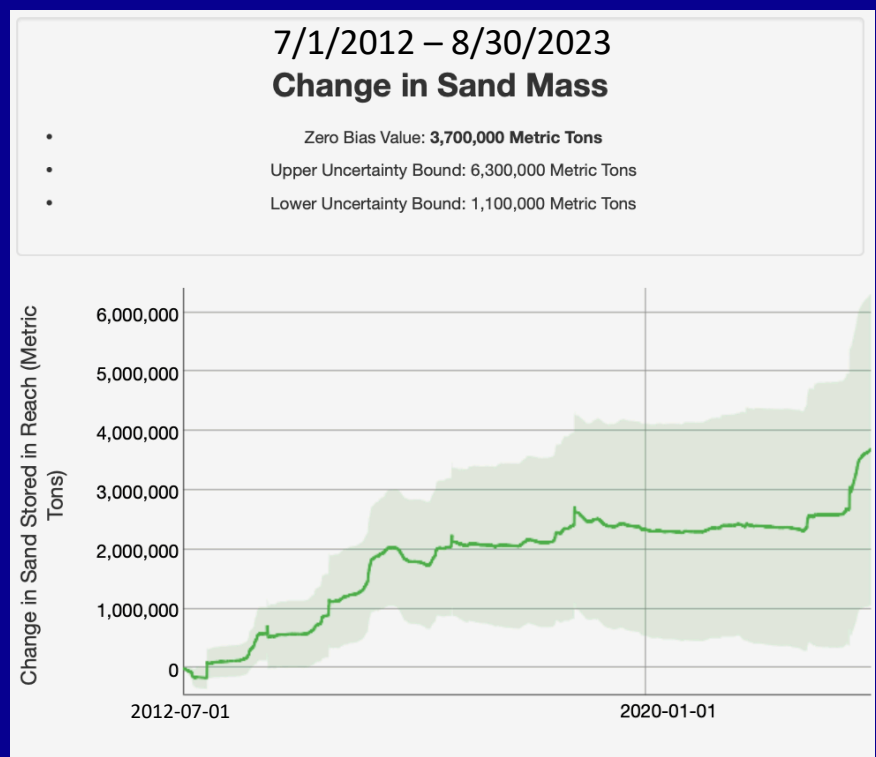
POSITIVE(?)

Intervening flows likely too high (SAVED BY THE LCR)

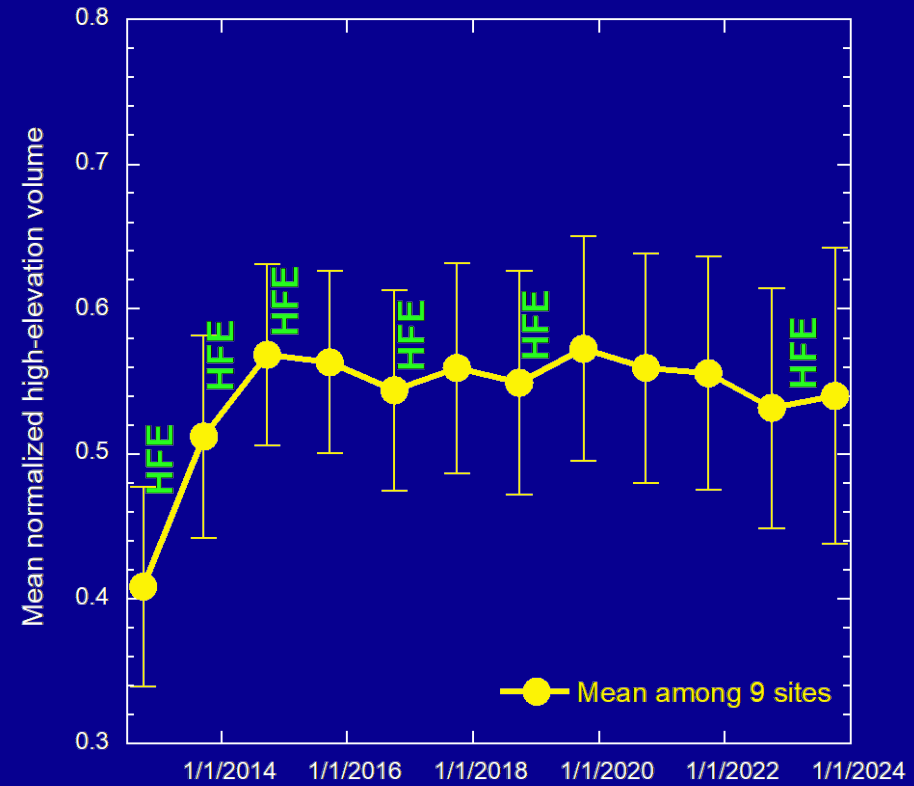
Data from USGS (2024a, b)



HFE-Protocol/LTEMP Period East-Central Grand Canyon



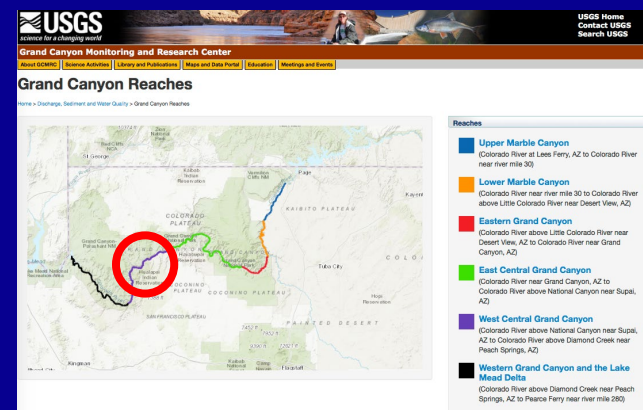
POSITIVE



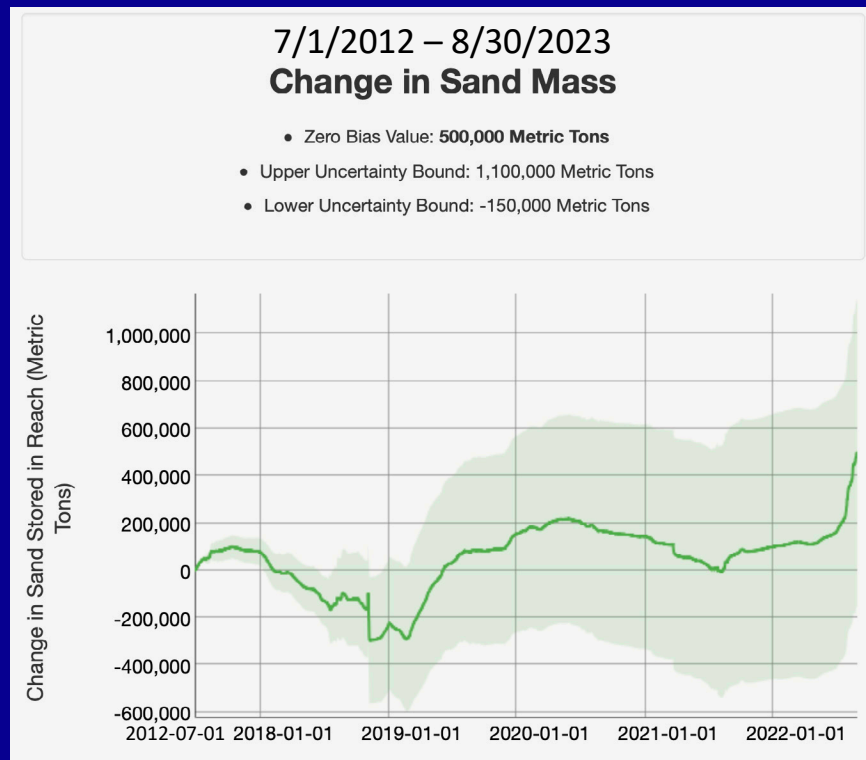
POSITIVE(?)

Insufficient HFE magnitude/duration or intervening flows too high

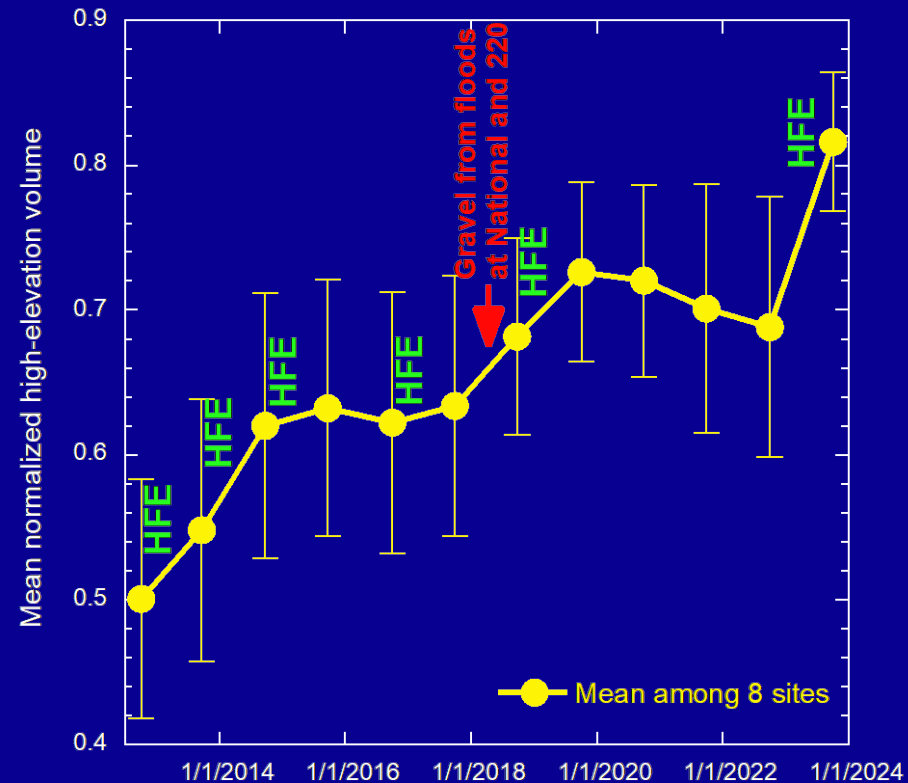
Data from USGS (2024a, b)



HFE-Protocol/LTEMP Period West-Central Grand Canyon



POSITIVE

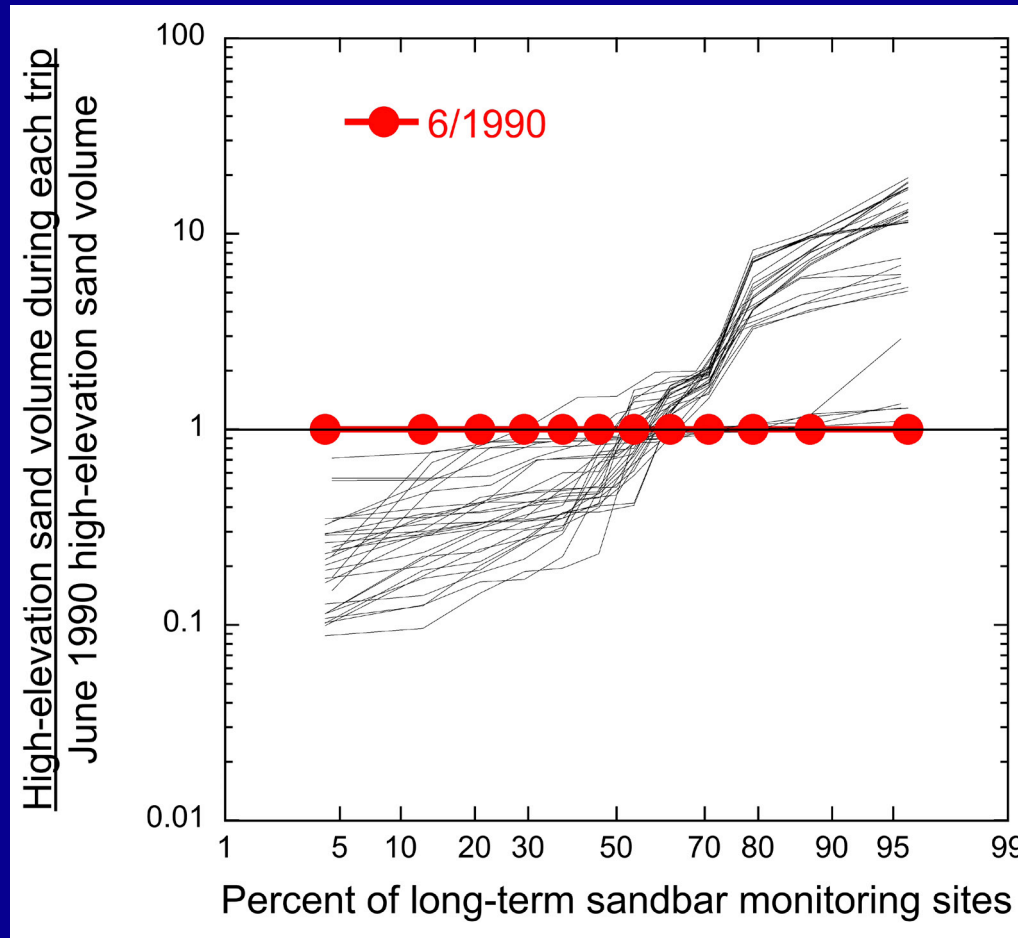


POSITIVE

Possibly sustainable

Data from USGS (2024a, b)

- Mean high-elevation normalized sand volume is unchanged between 1990 and 2023
- High-elevation sand at half of the 12 long-term sandbar monitoring sites in Marble Canyon defines a downward spiral between 1990 and 2023
- High-elevation sand at almost half of these sites defines an upward spiral



Data from USGS (2024b)

Conclusions

- High risk to GCDAMP of catastrophic data loss and inability to plan HFEs until computer-science support to Project A's database gets restored
- LTEMP sand management seems to be “working” in two segments (Upper Marble Canyon and West-Central Grand Canyon)
- LTEMP sand management may require adjustment in two segments (Lower Marble Canyon and East-Central Grand Canyon) by increasing HFE magnitude/duration or by reducing dam releases between HFEs

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science for a changing world

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Grand Canyon Monitoring and Research Center

About GCMRC | Science Activities | Library and Publications | Maps and Data Portal | Education | Meetings and Events

Grand Canyon Reaches

Home > Discharge, Sediment and Water Quality > Grand Canyon Reaches

Reaches

- Upper Marble Canyon**
(Colorado River at Lees Ferry, AZ to Colorado River near river mile 30)
- Lower Marble Canyon**
(Colorado River near river mile 30 to Colorado River above Little Colorado River near Desert View, AZ)
- Eastern Grand Canyon**
(Colorado River above Little Colorado River near Desert View, AZ to Colorado River near Grand Canyon, AZ)
- East Central Grand Canyon**
(Colorado River near Grand Canyon, AZ to Colorado River above National Canyon near Supai, AZ)
- West Central Grand Canyon**
(Colorado River above National Canyon near Supai, AZ to Colorado River above Diamond Creek near Peach Springs, AZ)
- Western Grand Canyon and the Lake Mead Delta**
(Colorado River above Diamond Creek near Peach Springs, AZ to Pearce Ferry near river mile 280)

Conclusions continued

- As with the mass balance in Eastern Grand Canyon (Topping and others, *JGR*, 2021), sandbar response in this segment during HFEs seems to be driven largely by LCR activity
- Because the LCR cannot be easily controlled, LTEMP sand management in the Eastern Grand Canyon segment may also require a reduction in dam releases between HFEs
- Evaluation of only the time series of mean sandbar volume can be misleading because of the variation in response among sandbars (this is why we need to examine sandbar response in more than one way)

The screenshot displays the USGS Grand Canyon Monitoring and Research Center website. At the top, the USGS logo is on the left, and navigation links for 'USGS Home', 'Contact USGS', and 'Search USGS' are on the right. Below the header is a navigation bar with links for 'About GMRC', 'Science Activities', 'Library and Publications', 'Maps and Data Portal', 'Education', and 'Meetings and Events'. The main heading is 'Grand Canyon Reaches', with a breadcrumb trail: 'Home > Discharge, Sediment and Water Quality > Grand Canyon Reaches'. A map of the Grand Canyon region is shown, with the Little Colorado River (LCR) highlighted in red. The map includes labels for various plateaus (Colorado, Kaibito, Coconino, San Francisco), plateaus (Painted Desert), and reservations (Kibab, Havasupai, Grand Canyon-Parashant, Grand Canyon-Redlands, Hualapai, Kaibab National, Navajo, Hopi). A list of reaches is provided on the right side of the page:

- Upper Marble Canyon** (Colorado River at Lees Ferry, AZ to Colorado River near river mile 30)
- Lower Marble Canyon** (Colorado River near river mile 30 to Colorado River above Little Colorado River near Desert View, AZ)
- Eastern Grand Canyon** (Colorado River above Little Colorado River near Desert View, AZ to Colorado River near Grand Canyon, AZ)
- East Central Grand Canyon** (Colorado River near Grand Canyon, AZ to Colorado River above National Canyon near Supai, AZ)
- West Central Grand Canyon** (Colorado River above National Canyon near Supai, AZ to Colorado River above Diamond Creek near Peach Springs, AZ)
- Western Grand Canyon and the Lake Mead Delta** (Colorado River above Diamond Creek near Peach Springs, AZ to Pearce Ferry near river mile 280)



Thank you

References

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