Lee Traynham
US Bureau of Reclamation

Michael Moran
US Geological Survey

# Potential LTEMP Experiments Fall - Water Year 2022

## Technical Work Group Meeting
## October 14, 2021

# Purpose for HFE's in the LTEMP

LTEMP Goal for sediment:

- *"Increase and retain fine sediment volume, area, and distribution in the Glen, Marble, and Grand Canyon reaches above the elevation of the average base flow for ecological, cultural, and recreational purposes."*

LTEMP Alternative:

- *"Alternative D includes spring and fall HFEs, which are intended to occur frequently to maintain and improve beaches, sandbars, and associated habitat."*

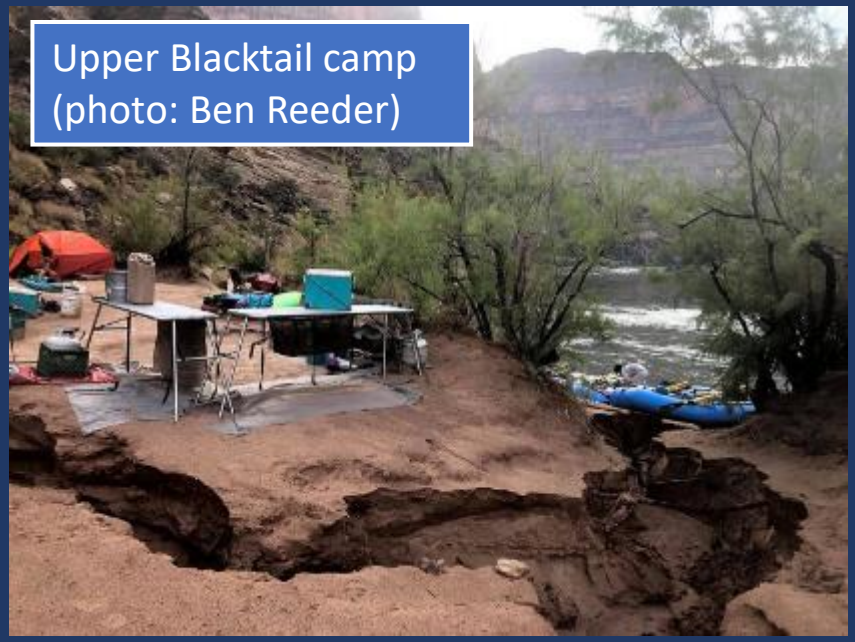
Science question from HFE Protocol:

- *"Can sandbar building during HFEs exceed sandbar erosion during periods between HFEs, such that sandbar size can be increased and maintained over several years?"*

USGS

# Current conditions: many sandbar camps eroded by summer 2021 thunderstorms

Tatahatso camp
(photo: Ben Reeder)

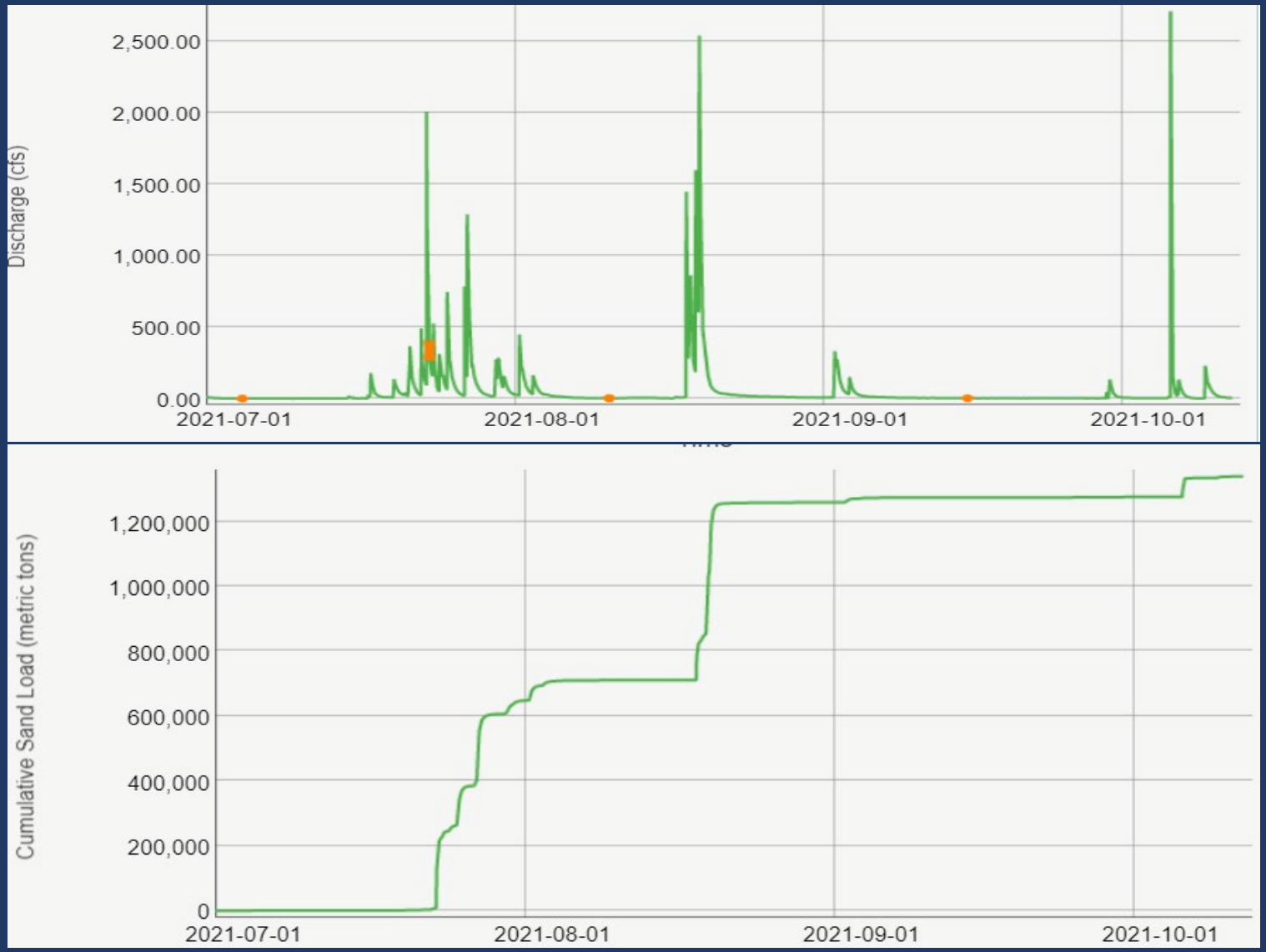


Upper Blacktail camp
(photo: Ben Reeder)

Upper 220-mile camp
(photo: anonymous)

USGS

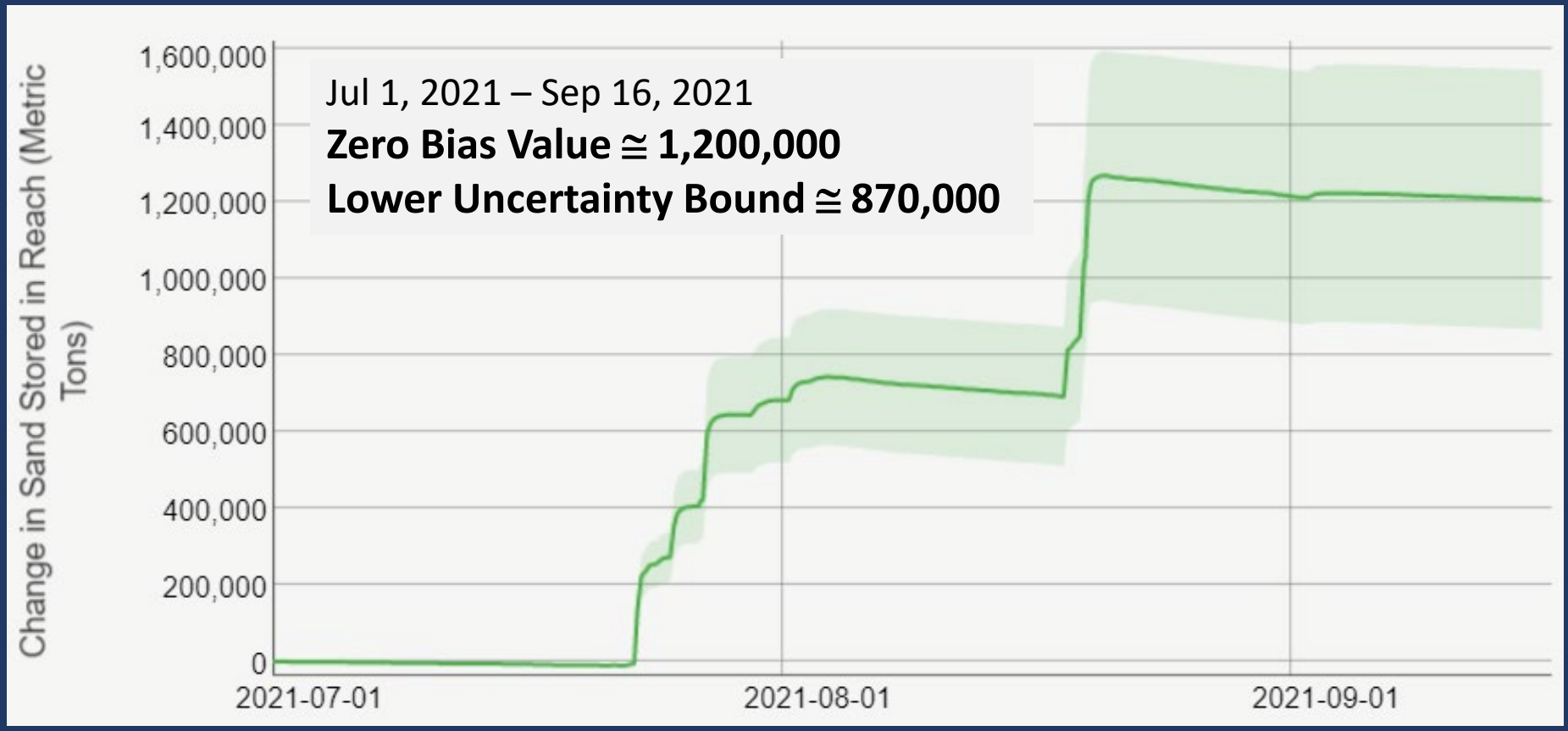
# Paria River Discharge & Sand Inputs




*USGS Preliminary Data, 2021. Do Not Cite.*

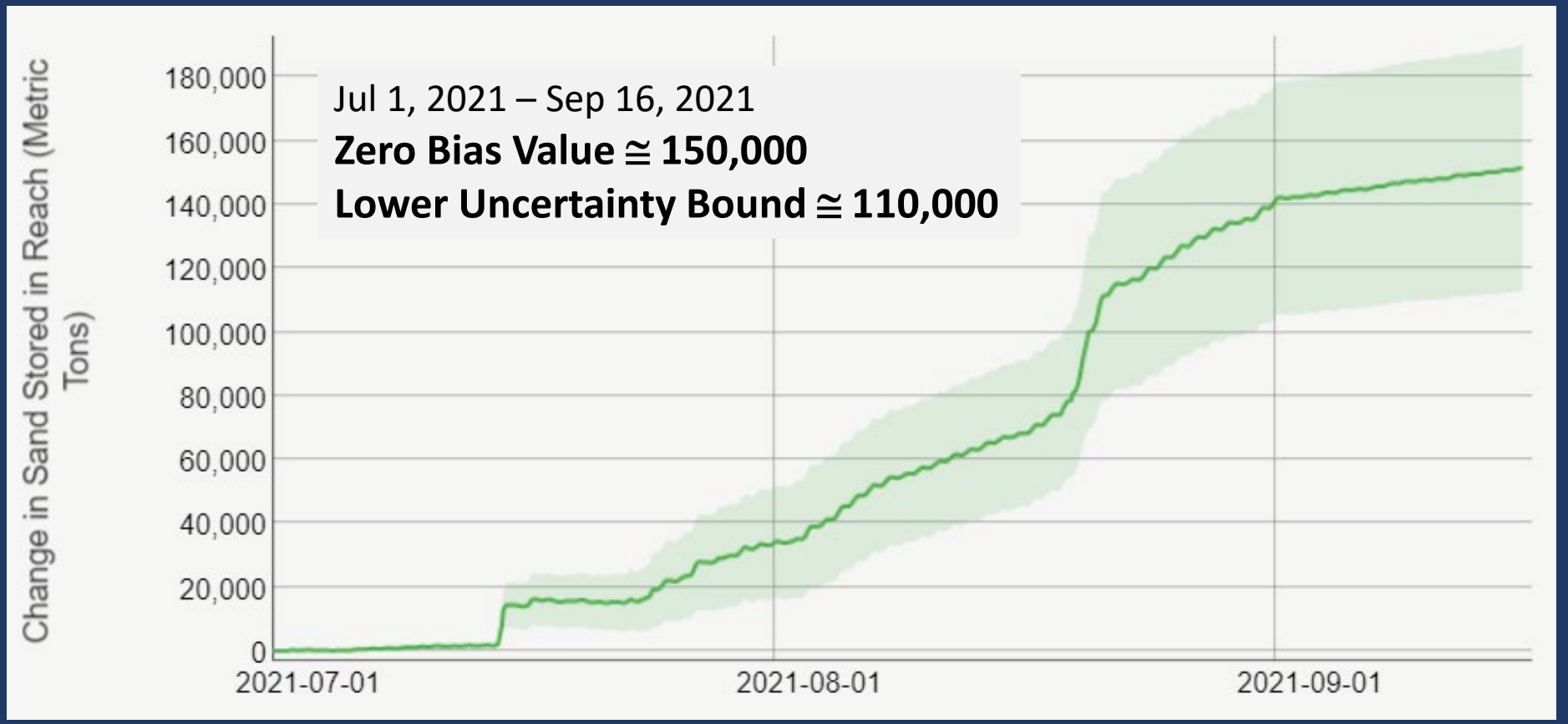
*(https://www.gcmrc.gov/discharge_qw_sediment/station/GCDAMP/09382000# )*

# Upper Marble Canyon Sand Mass Balance




*USGS Preliminary Data, 2021. Do Not Cite.*
*(https://www.gcmrc.gov/discharge_qw_sediment/reach/GCDAMP/09380000/09383050#)*

# Lower Marble Canyon Sand Mass Balance




*USGS Preliminary Data, 2021. Do Not Cite.*

*(https://www.gcmrc.gov/discharge_qw_sediment/reach/GCDAMP/09383050/09383100#)*

# Fall High Flow Experiment

- Hydrograph characteristics
  - Implement in early November (11/1)
  - Peak release: ~33,900 cfs (6 hydro units, 4 bypass tubes)
  - Peak release duration: from 1 hr up to 192 hrs (8 days)
  - Ramp rates: 4,000 cfs/hr up; 2,500 cfs/hr down
- Resource Considerations
  - LTEMP resource evaluation
- Hydrograph Alternatives
  - 192-hour extended duration
  - 96-hour
  - 60-hour

**TABLE 1 List of HFEs Available for Sediment-Triggered Experiments (fall, extended-duration fall and spring) under the Selected Alternative**

| HFE ID | Peak Discharge (cfs) | Duration at Peak (hours) |
|---|---|---|
| 1 | 45,000 | 250 |
| 2 | 45,000 | 192 |
| 3 | 45,000 | 144 |
| 4 | 45,000 | 96 |
| 5 | 45,000 | 72 |
| 6 | 45,000 | 60 |
| 7 | 45,000 | 48 |
| 8 | 45,000 | 36 |
| 9 | 45,000 | 24 |
| 10 | 45,000 | 12 |
| 11 | 45,000 | 1 |
| 12 | 41,500 | 1 |
| 13 | 39,000 | 1 |
| 14 | 36,500 | 1 |
| 15 | 34,000 | 1 |
| 16 | 31,500 | 1 |

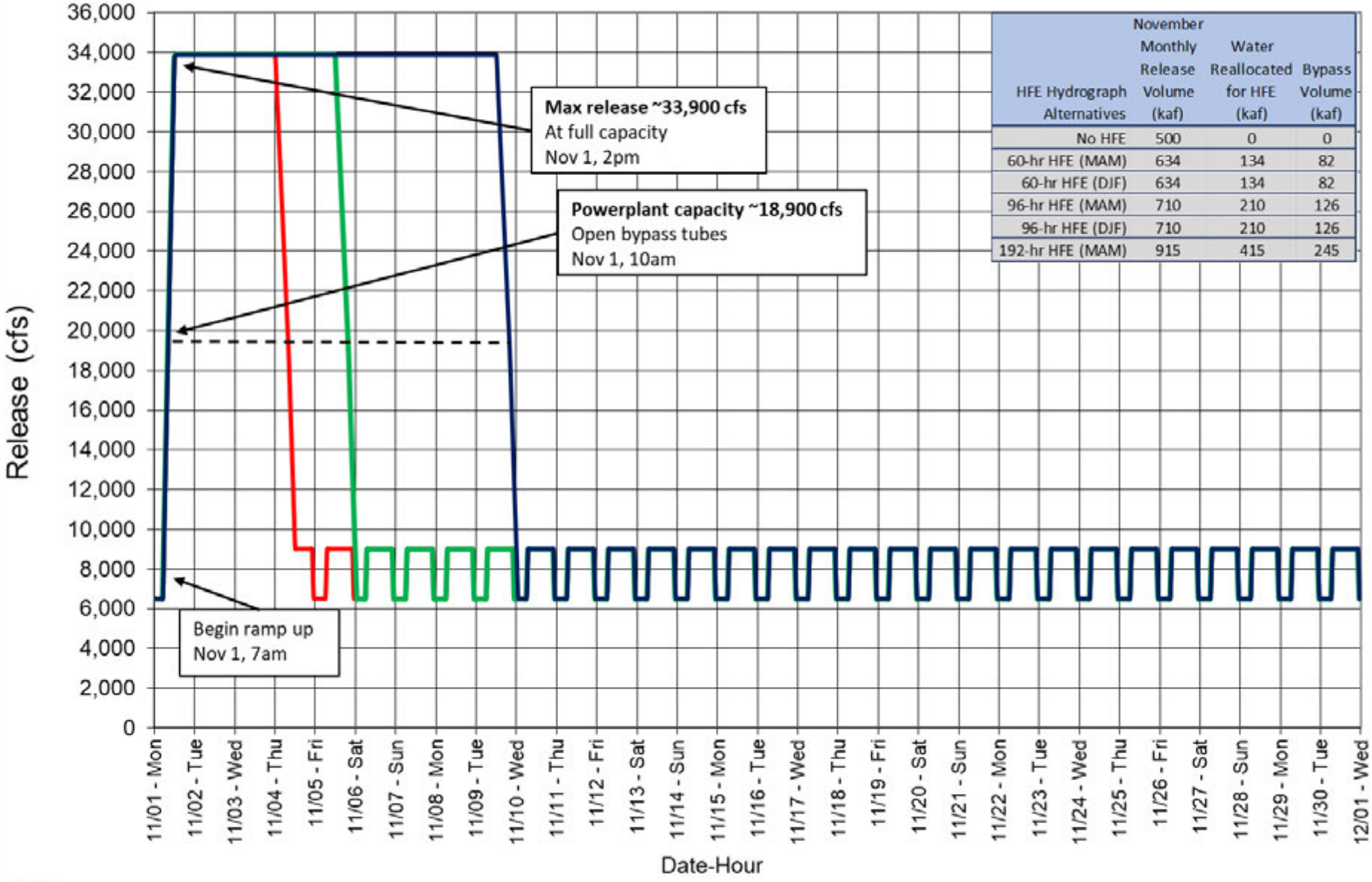
# Resource Considerations

1. Water quality and water delivery
2. Humpback Chub
3. Sediment
4. Riparian Ecosystems
5. Historic properties and traditional cultural properties
6. Tribal Concerns
7. Hydropower production and WAPA's assessment of the status of the Basin Fund
8. Rainbow Trout Fishery
9. Recreation
10. Other Resources

Reference: 2016 LTEMP ROD, p. B-8,

Section 1.3 Implementation Process for Experiments Under Alternative D

# Glen Canyon Dam Potential Hourly Release HFE Patterns November 2021




| HFE Hydrograph Alternatives | November Monthly Release Volume (kaf) | Water Reallocated for HFE (kaf) | Bypass Volume (kaf) |
|---|---|---|---|
| No HFE | 500 | 0 | 0 |
| 60-hr HFE (MAM) | 634 | 134 | 82 |
| 60-hr HFE (DJF) | 634 | 134 | 82 |
| 96-hr HFE (MAM) | 710 | 210 | 126 |
| 96-hr HFE (DJF) | 710 | 210 | 126 |
| 192-hr HFE (MAM) | 915 | 415 | 245 |

BUREAU OF RECLAMATION

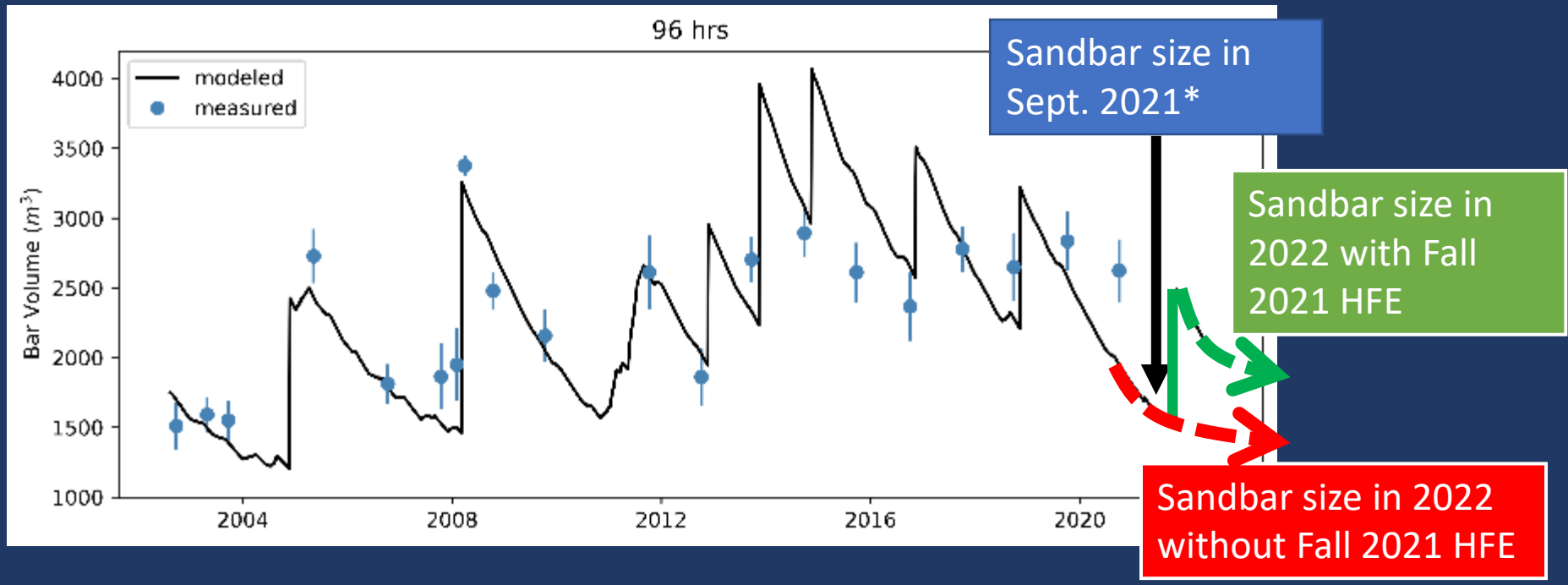
60-hr HFE | 96-hr HFE | 192-hr HFE | Actual Hourly Releases | Lees Ferry Flow

# Fall HFE Hydrograph Alternatives

| Fall HFE Hydrograph Alternatives | Water Release | | Pool Elevation[2] | | | Relative Impact to Basin Fund |
|---|---|---|---|---|---|---|
| | November Total Release Volume (kaf) | Bypass Volume (kaf) | End of November Elevation (ft) | Number of Additional Days below 3525 ft | WY 2022 Minimum (ft) Difference from No Action | |
| **No HFE** | 500 | 0 | 3540.70 | 0 | 3518.58<br>-- | -- |
| **60-hr HFE (MAM)[3]** | 634 | 82 | 3538.85<br>(1.85) | 15 | 3517.89<br>(0.69) | $(1.30M) |
| **60-hr HFE (DJF)[3]** | 634 | 82 | 3538.85<br>(1.85) | 0 | 3518.58<br>-- | $(3.04M) |
| **96-hr HFE (MAM)** | 710 | 126 | 3537.79<br>(2.91) | 20 | 3517.50<br>(1.08) | $(1.94M) |
| **96-hr HFE (DJF)** | 710 | 126 | 3537.79<br>(2.91) | 0 | 3518.59<br>0.01 | $(4.66M) |
| **192-hr HFE (MAM)** | 915 | 245 | 3534.92<br>(5.78) | 34 | 3515.42<br>(3.16) | $(3.70M) |

1 – Peak capacity for all alternatives is 33,900 cfs.
2 – Assumes most probable hydrology as indicated in the September 24 Month Study.
3 – Refers to the months in which less water would be released in order to balance a November HFE: March, April, May (MAM) or December, January, February (DJF).

# Predicted results: sandbar model run with 96-hr HFE in fall 2021

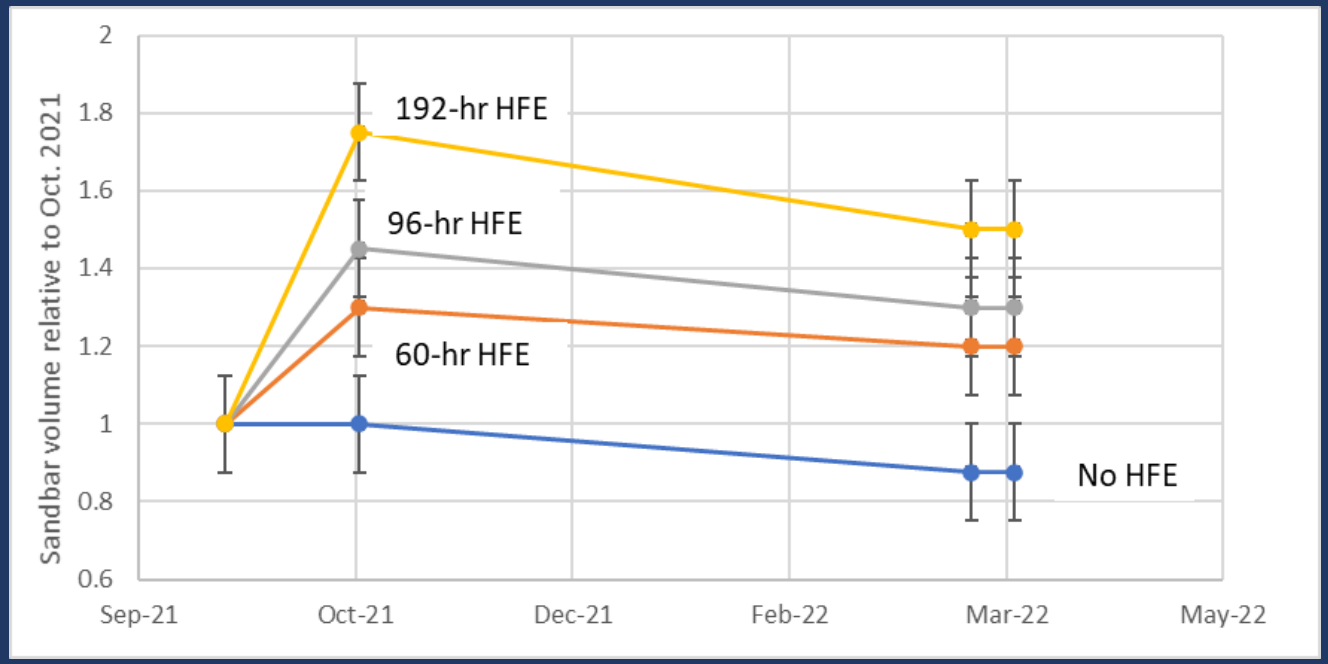



*Current sandbar size estimated from model and will be measured in October, 2021. The Mueller and Grams (2021) model predicts sandbar response for narrow reattachment bars (the "group 1a" sites of Mueller et al., 2018). It was calibrated using data from 9 narrow reattachment bars located throughout Marble and Grand Canyon. Other sandbar types tend to be less responsive.

*Based on Mueller and Grams (2021); Preliminary results, subject to review, do not cite*

USGS

# Predicted sandbar volume in April 2022 relative to October 2021 for the four HFE scenarios




| Event | Expected sandbar size immediately after HFE | Expected sandbar size in April 2022 |
|---|---|---|
| 192-hr HFE | + 75% | + 50% |
| 96-hr HFE | + 45% | + 30% |
| 60-hr HFE | + 30% | + 20% |
| No HFE | + 0% | - 10% |

*Based on Mueller and Grams (2021); Preliminary results, subject to review, do not cite*

USGS

# Native and Non-native Fish

***Although the best available science indicates a fall HFE may result in small benefits to undesired non-native species, these effects were highly uncertain (see rainbow trout section below) or the marginal impact was expected to be small (see brown trout section). Thus, expert opinion among fishery biologists was that a 60 hour fall HFE would not substantively increase risk to endangered and native fishes in Grand Canyon above the existing level of risk.***

**Reference:** Page 3, *Final Recommendation Regarding a Fall 2021 High Flow Experiment (HFE) at Glen Canyon Dam, November 2021*

USGS

# Recommendation

***By consensus, the PI Team is opposed to recommending that the Department implement a 192-hour extended duration HFE in fall 2021.***

***Technical representatives were divided in the assessment of a shorter duration 60-hour HFE, having evaluated the alternative for its ability to reduce negative resource impacts while still providing sufficient benefit to the sediment resource in terms of learning and effectiveness. The majority of representatives on the PI Team are opposed to recommending that the Department implement a 60-hour HFE this fall, several members support recommending that the Department implement a 60-hour duration HFE this fall, and two members have abstained from making a recommendation.***

# DOI Decision: No Fall HFE in 2021

- Decision Memo issued Oct 5, 2021
- Key Points
  - Assessment of Resources
    - Positive: Sediment
    - Negative: Pool Elevation, Basin Fund
  - Unprecedented Drought Conditions
    - Drought Response Operations: ongoing releases from Initial Units
    - Additional action may be necessary to protect critical levels
    - Basin Fund support: deferred maintenance, a proposed rate increase, a one-time pursuit of appropriations for environmental program base funding.
  - Lack of consensus to implement


BUREAU OF
RECLAMATION
USGS
science for a changing world

# HFE References

- LTEMP ROD - HFE Protocol (Attachment C)
- Science & Modeling References
  - HFE Sediment Modeling
  - January 2020 – Changes in Sandbars and Campsites during HFE Protocol
  - January 2020 - Effects of Dam Releases on in-channel sediment storage and sandbar dynamics
- 2018 Planning Team Report and Recommendation

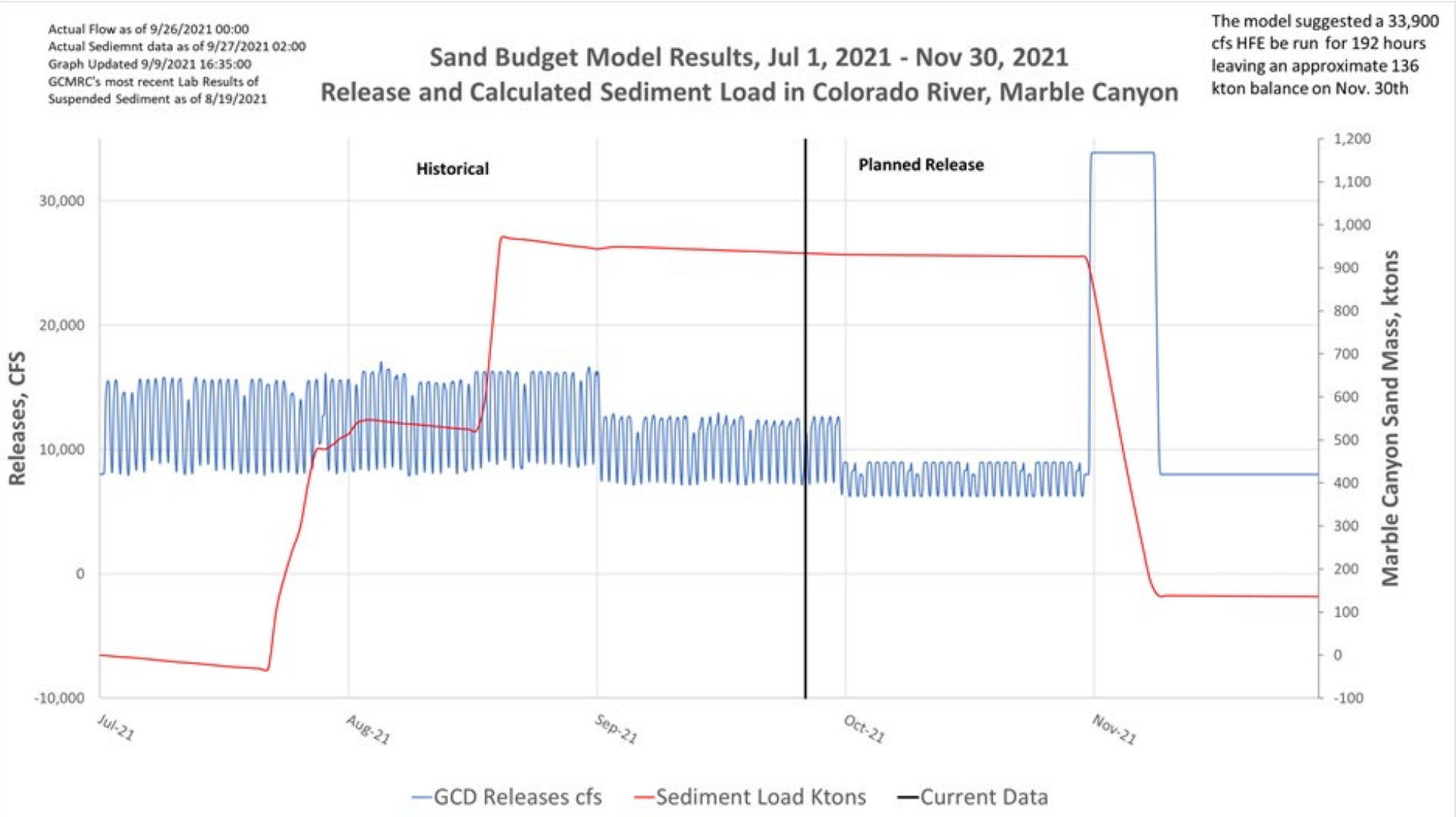
# Summary of Past HFEs

https://www.usbr.gov/uc/rm/gcdHFE/

**HFE Comparison**

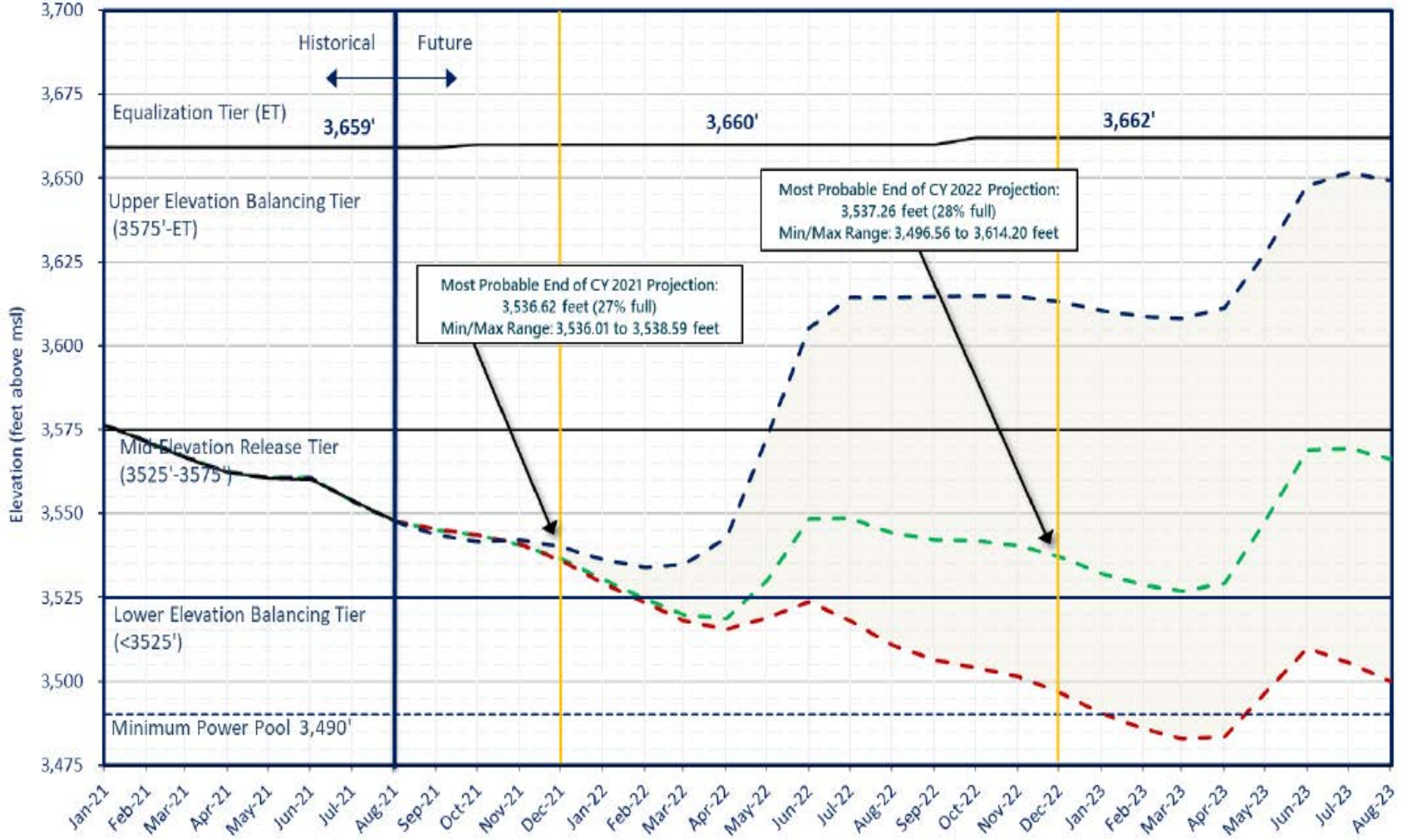
| Date | Mar-96 | 4-Nov | 8-Mar | 12-Nov | 13-Nov | 14-Nov | 15-Nov | 16-Nov | 18-Nov |
|---|---|---|---|---|---|---|---|---|---|
| Duration | 7 days, 16 hours | 3 days and 19 hours | 3 days and 16 hours | 3 days and 19 hours | 5 days and 5 hours | 5 days and 5 hours | NO HFE | 5 days | 3 days 10 hours |
| Peak (cfs) | 45,000 | 40,000 | 40,800 | 43,000 | 37,000 | 37,500 | Green Sunfish | 36,500 | 38,100 |
| Peak Duration | 168 hrs (7 Days) | 60 hrs (2.5 Days) | 60 hrs (2.5 Days) | 24 hrs (1 Day) | 96 hrs (4 Days) | 96 hrs (4 Days) | | 96 hrs (4 Days) | 60 hr (2.5 Days) |
| PP Capacity Peak (cfs) | 30,000 | 24,800 | 26,000 | 28,000 | 20,000 | 23,000 | | 21,300 | 23,100 |
| Units Available | | | | | | | | | |
| Elevation @ Begin (ft) | 3675 | 3570 | 3589 | 3615 | 3590 | 3605 | | 3610 | 3590 |
| Up Ramp (cfs/hr) | 4,000 cfs/hr until Power Plant Capacity (PPC) and then 4000 cfs/hr until peak. | 4,000 cfs/hr until 15,000 cfs release, then 1,500 cfs/hr until Power Plant Capacity (PPC) and then ~1,850 cfs/3 hr until peak. | 1,500 cfs/hr until Power Plant Capacity (PPC) and then 1,875 cfs/3 hr until peak. | 1,500 cfs/hr until Power Plant Capacity (PPC) and then 1,500 cfs/hr until peak. | 4,000 cfs/hr until Power Plant Capacity (PPC) and then 2,000 cfs/hr until peak. | 4,000 cfs/hr until Power Plant Capacity (PPC) and half-bypass tube ~1,875 cfs/hr until peak. | | 4,000 cfs/hr until Power Plant Capacity (PPC). | 4,000 cfs/hr until Power Plant Capacity (PPC). |
| Down Ramp (cfs/hr) | 1,500 to PPC; 1,000 to 20,000 cfs/hr total release, then 500 cfs/hr until base flow of 8,000 cfs/hr was reached | 1,500 cfs/hr to PPC and then 1500 cfs/hr to normal operations. | 1,500 cfs/hr to PPC and then 1,500 cfs/hr to normal operations. | 200 cfs/hr to 27,500 total release and then 1,000 cfs/hr to PPC then 1,500 cfs to normal operations. | 1,500 cfs/hr to normal operations. | 1,500 cfs/hr to normal operations. | | 1,500 cfs/hr to normal operations. | 2,500 cfs/hr to normal operations. |
| Pre/Post flows (cfs) | 8,000 cfs steady before and after. | 8,000 cfs steady before and after | Between 7,000 to 15,000 cfs before, 7,000 cfs to 13,000 cfs after. | Between 7,000 cfs and 9,000 cfs before and after. | Between 5,000 cfs and 8,000 cfs before and after. | Between 7,000 cfs and 9,000 cfs before and after. | | Between 6,500 cfs and 9,000 cfs before and after. | Between 6,500 cfs and 9,000 cfs before and after. |
| Total Bypass (ac-ft) | 216,721 | 92,738 | 92,991 | 77,755 | 143,930 | 132,030 | | 126,436 | 77.156 |

# Sand Budget Model Results



# Lake Powell End of Month Elevations

Projections from the September 2021 24-Month Study Inflow Scenarios




— BUREAU OF —
RECLAMATION

- September 2021 Most Probable - Lake Powell release of 8.23 maf in WY2021 and 7.48 maf in WY2022
- September 2021 *DROA Minimum Probable - Lake Powell release of 8.23 maf in WY2021 and 7.48 maf in WY2022
- September 2021 *DROA Maximum Probable - Lake Powell release of 8.23 maf in WY2021 and 7.48 maf in WY2022
- Historical Elevations

*The Drought Response Operations Agreement (DROA) can be found here: https://www.usbr.gov/dcp/finaldocs.html