



# Evaluating the Frequency of Triggered Spring High Flow Experiments (HFE's) Assumed in the Long-Term Experimental and Management Plan

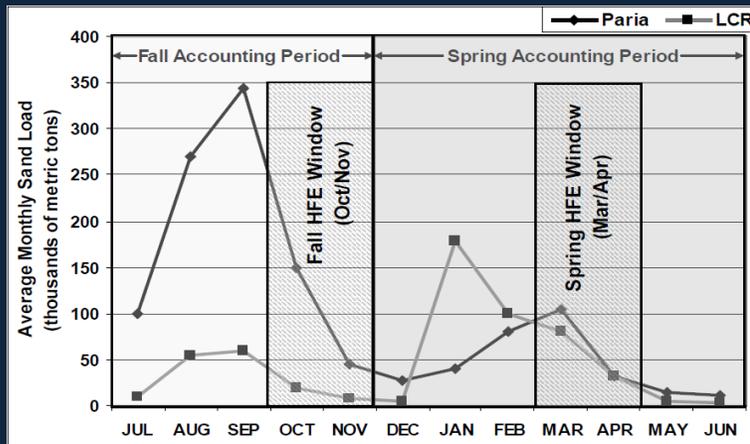
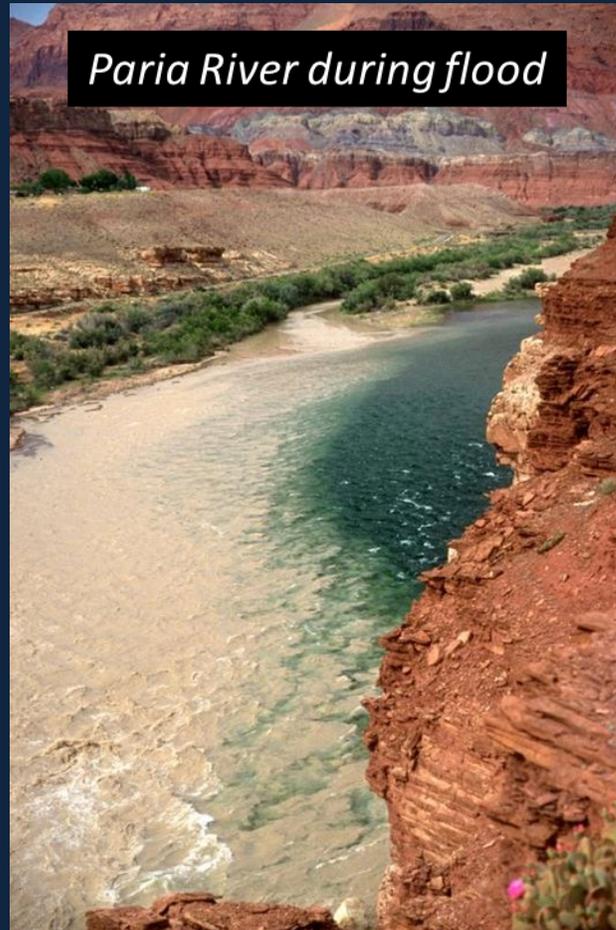
Presentation to Glen Canyon Dam Adaptive Management Program,  
Technical Working Group  
June 24, 2020

Paul Grams and David Topping

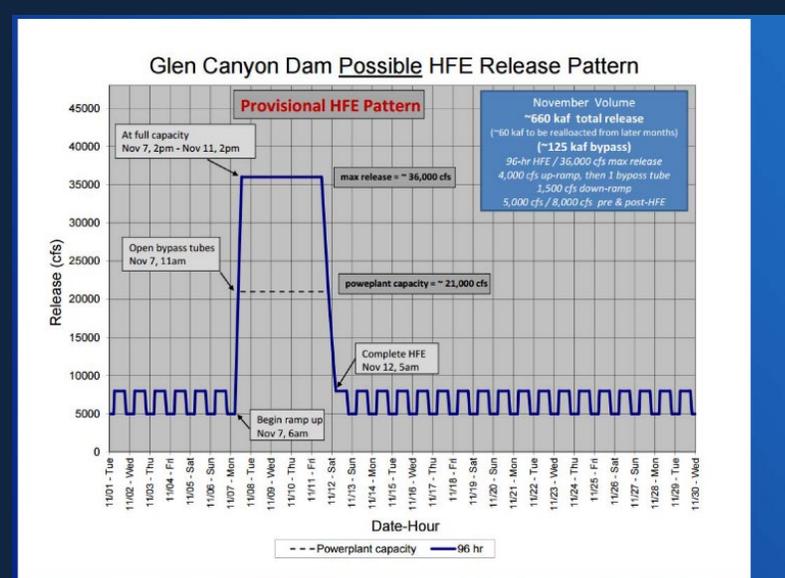
U.S. Geological Survey, Southwest Biological Science Center, Grand Canyon  
Monitoring and Research Center

# The HFE Protocol:

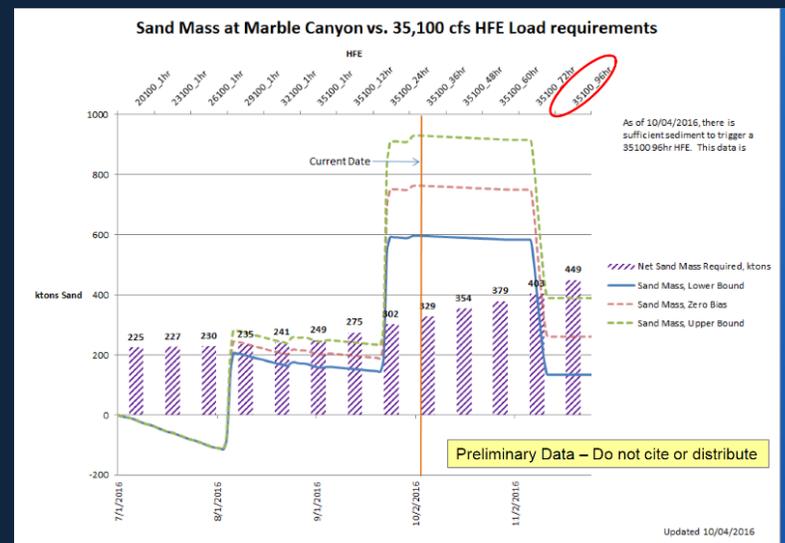
- Track sand inputs from Paria River and model sand budget during designated accounting periods
  - July 1 – Dec. 1
  - Dec. 1 – Jun. 30
- Find the magnitude and duration of HFE that “fits” the amount of sand available
- Schedule HFE



Wright and Kennedy (2011)



**RECLAMATION**  
Glen Canyon Dam Hydrograph, USBR



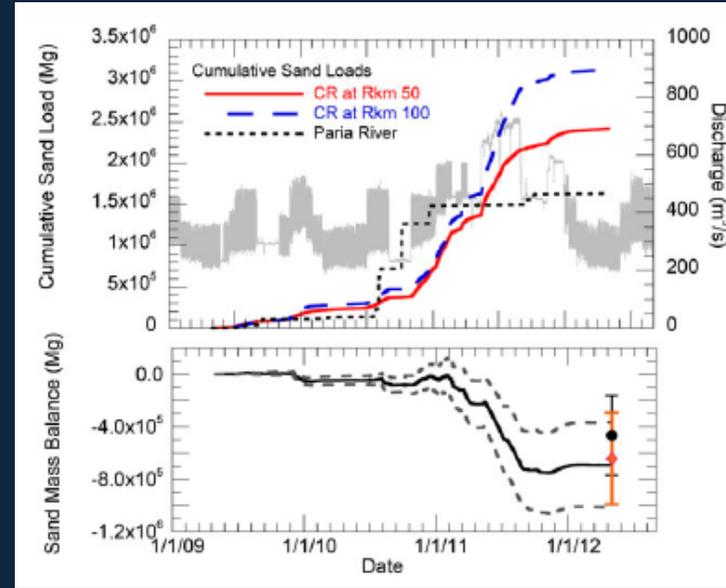
**RECLAMATION**

Preliminary data, do not cite

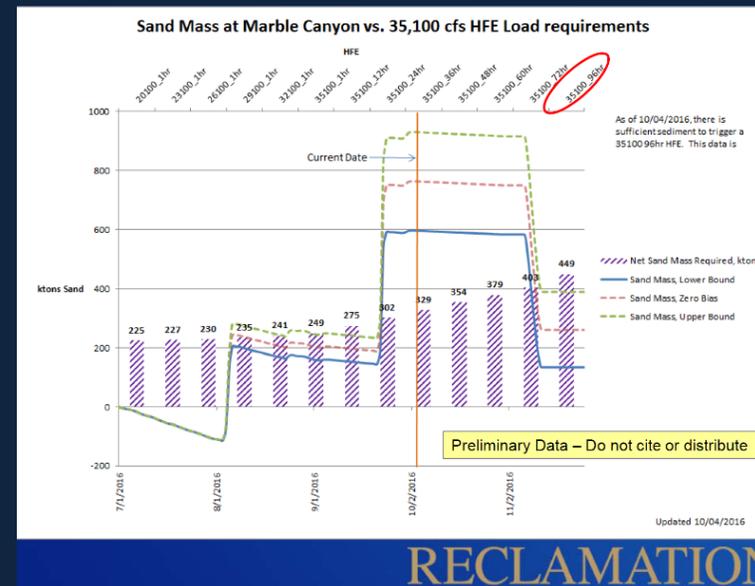


# Sand accounting periods

- The objective of the HFE Protocol in the LTEMP is to achieve sandbar building while retaining a positive sand mass balance.
- Sand mass balance is a relative measure and depends on the period over which it is computed.
  - For LTEMP alternative analysis, sand mass balance was evaluated over the duration of 20-year simulations.
    - This long-term evaluation will be the ultimate test of the HFE Protocol and is being monitored in Project B.2
  - For HFE implementation, we evaluate the mass balance over short accounting periods.
    - These accounting periods were chosen to coincide with the periods of most likely sediment inputs from the Paria River



Example of long-term sand mass balance for evaluation of dam operations over periods of many years (Grams and others, 2019)



# Sand accounting periods, cont.

## Short-term mass balance accounting windows:

- Distinct Spring and Fall accounting periods:
  - Can design HFE to “use” only recent sand inputs.
  - HFEs are implemented when storage in Upper Marble Canyon is highest
  - Simple decision process

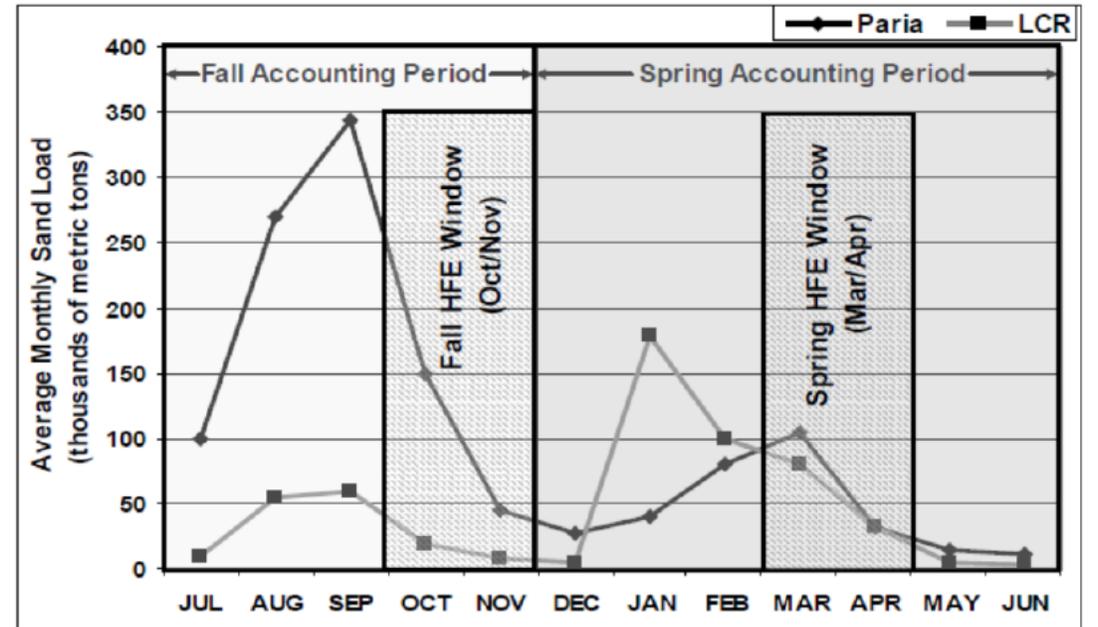


FIGURE P-1 Average Monthly Sand Load from the Paria River and Little Colorado River Showing the Fall and Spring HFE Accounting Periods and Implementation Windows

Plot from LTEMP EIS, Appendix P

# Frequency of Spring HFEs

## As estimated in LTEMP

- Simulations designed to represent the full range of historical conditions:
  - 21 hydrologic traces
  - 3 sediment traces (low, median, high)
- May be sufficient sediment input to trigger Spring HFEs in “26% of the years in the LTEMP period”

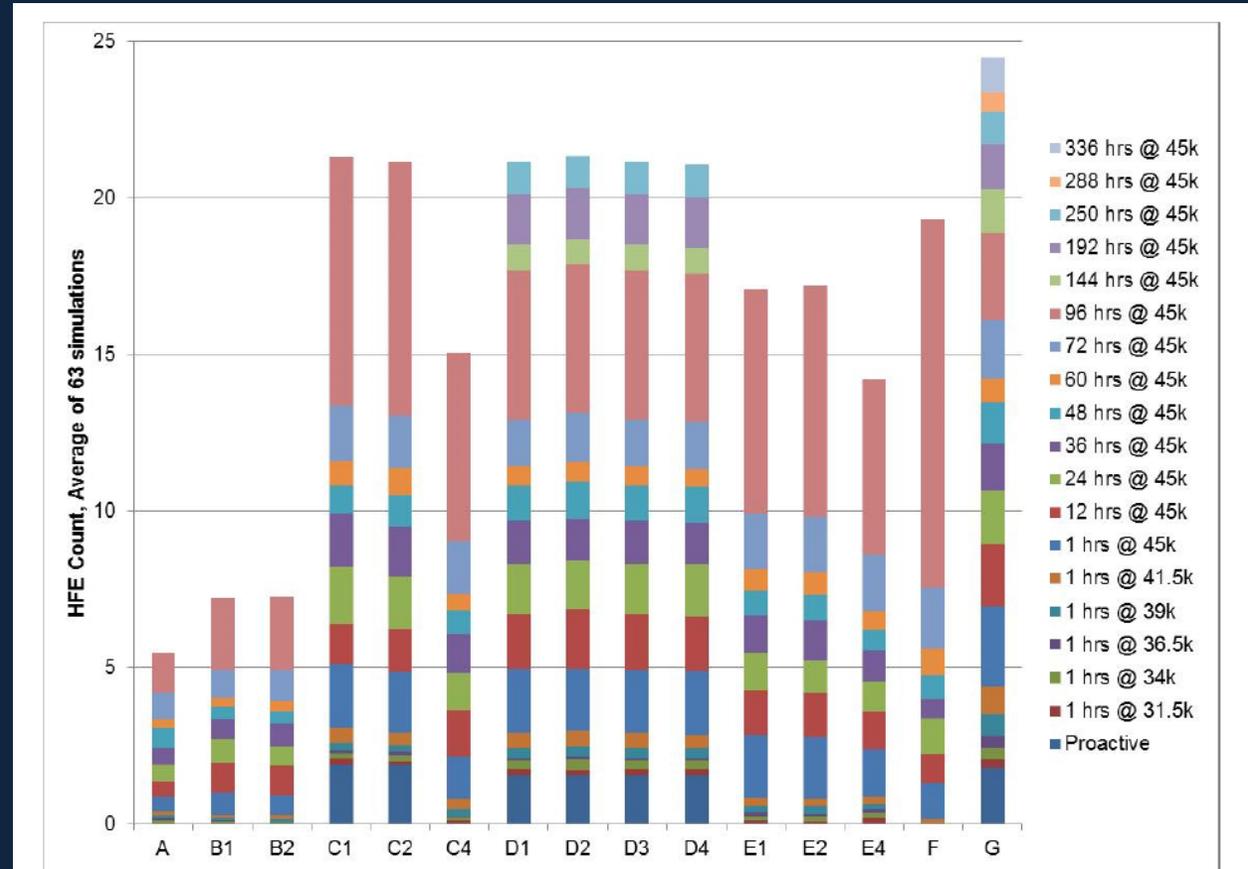


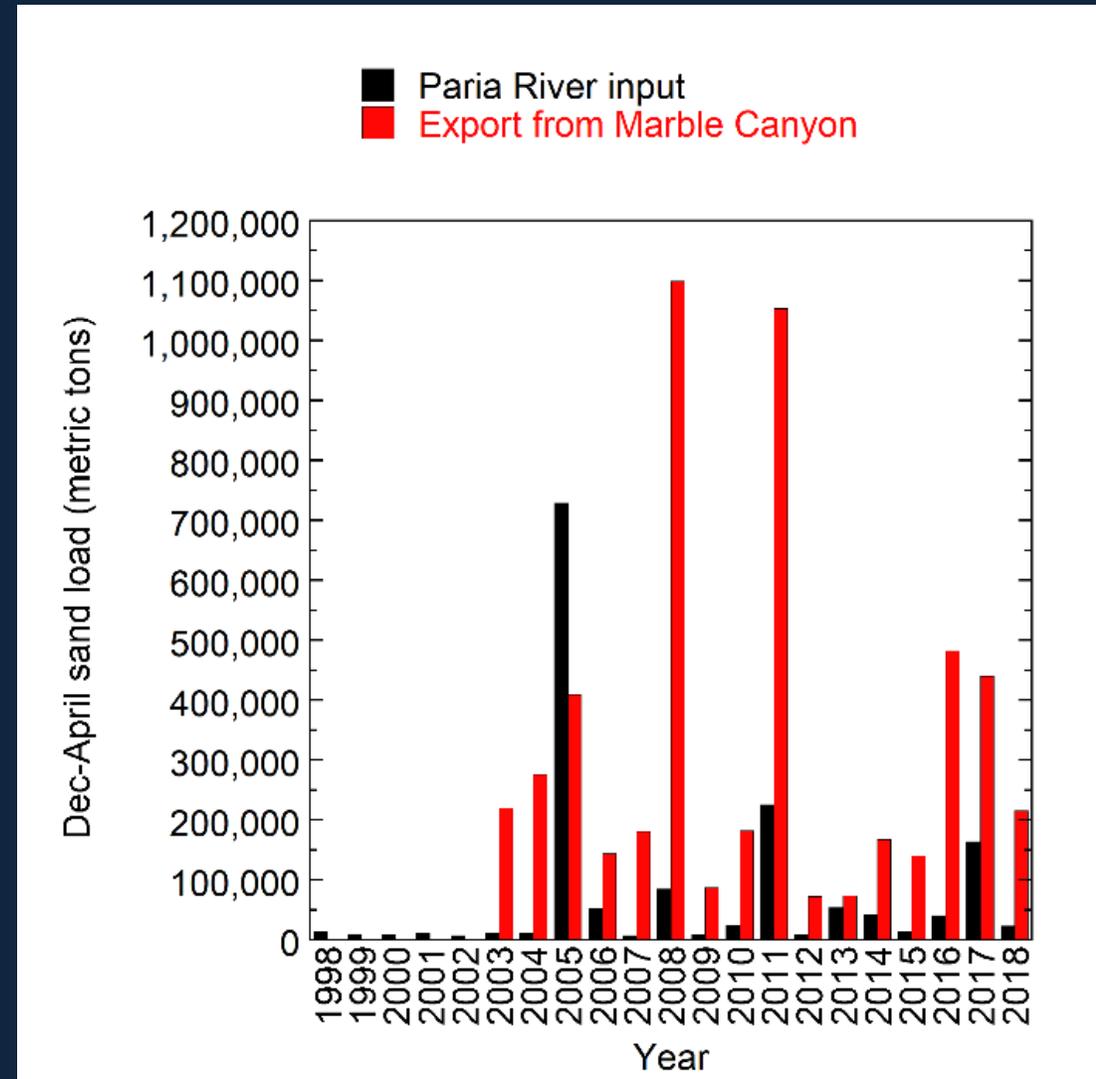
FIGURE E-8 Average Sediment and Hydrology Triggered HFE Count by Type for Each Long-Term Strategy (long-term strategies C3, E3, E5, and E6 by definition have no HFEs)

Estimated number of HFEs to occur during 20-year implementation of LTEMP (“D” was selected alternative)

# Frequency of Spring HFEs, cont.

Based on observations of past 20 years:

- Compare December – April Paria sand inputs with December to April sand export from Marble Canyon
- May have been sufficient sediment input to trigger Spring HFE: “Once since 1998”



Annual Paria River sand input (black) compared with Marble Canyon sand export (red)

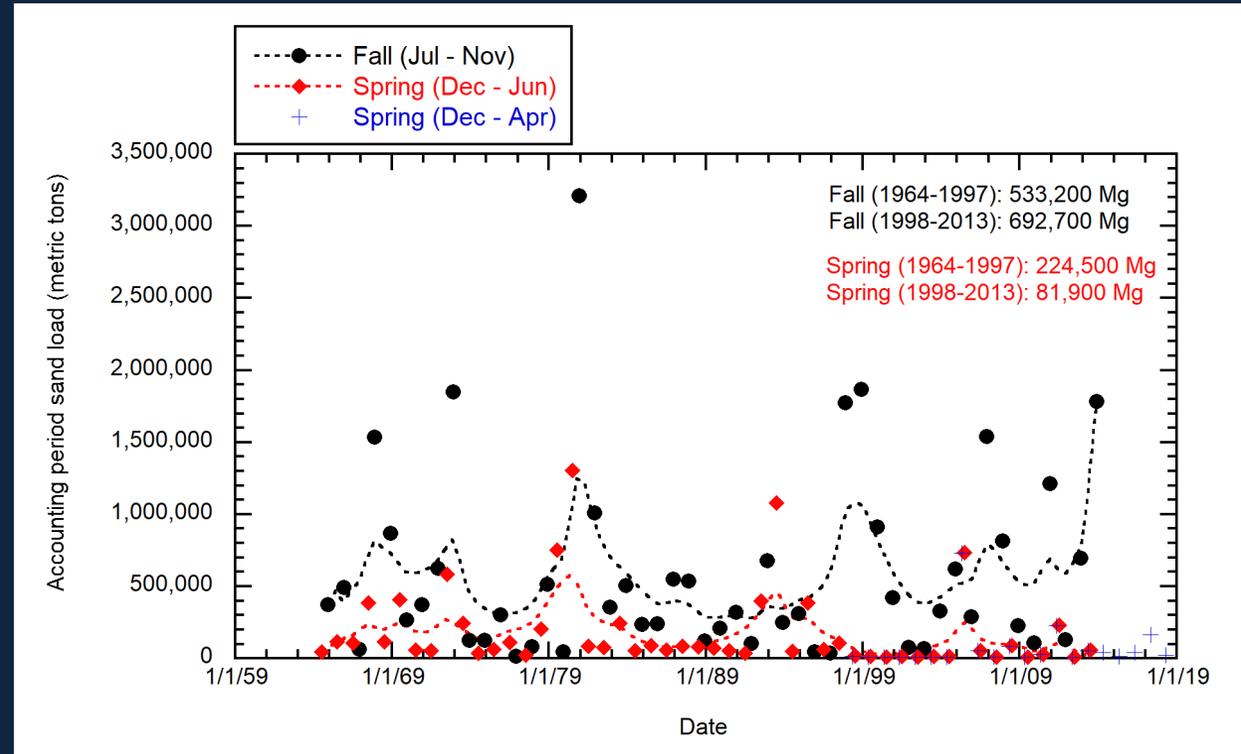
Data from: [https://www.gcmrc.gov/discharge\\_qw\\_sediment](https://www.gcmrc.gov/discharge_qw_sediment)

# Frequency of Spring HFEs, , cont. 2

## Why the difference between the two analyses?

- The LTEMP simulations considered Paria River sand inputs since 1963
- Fall (summer) sand inputs from Paria have been relatively consistent
- Spring (winter) sand inputs were at least 3 times greater between 1964 and 1997 than between 1998 and present
- Summer sand inputs have been consistent, but winter sand inputs have not been consistent

*Maybe there will be a return to larger winter floods, or maybe there has been a shift towards less winter precipitation.*



- Black circles (summer/fall inputs) and red diamonds (winter/spring inputs) are data used in LTEMP
- Blue “+” are 1998 – 2018 data we looked at (same)

# How to trigger a Spring HFE:

- Merge the separate fall and spring accounting periods to one annual accounting period:
  - Could design to implement HFE in fall or spring
  - Would need a process for deciding whether to implement HFE in Fall or Spring
  - Would likely end up with more sand export before implementing spring HFE
    - Lower dam releases in winter would result in more sand left for spring HFE
    - Can evaluate this with sand mass balance model
- Although a single annual accounting period is not the process that was described in LTEMP, it is fully consistent with the scientific basis for the “store-and-release” HFE approach that was adopted in LTEMP.

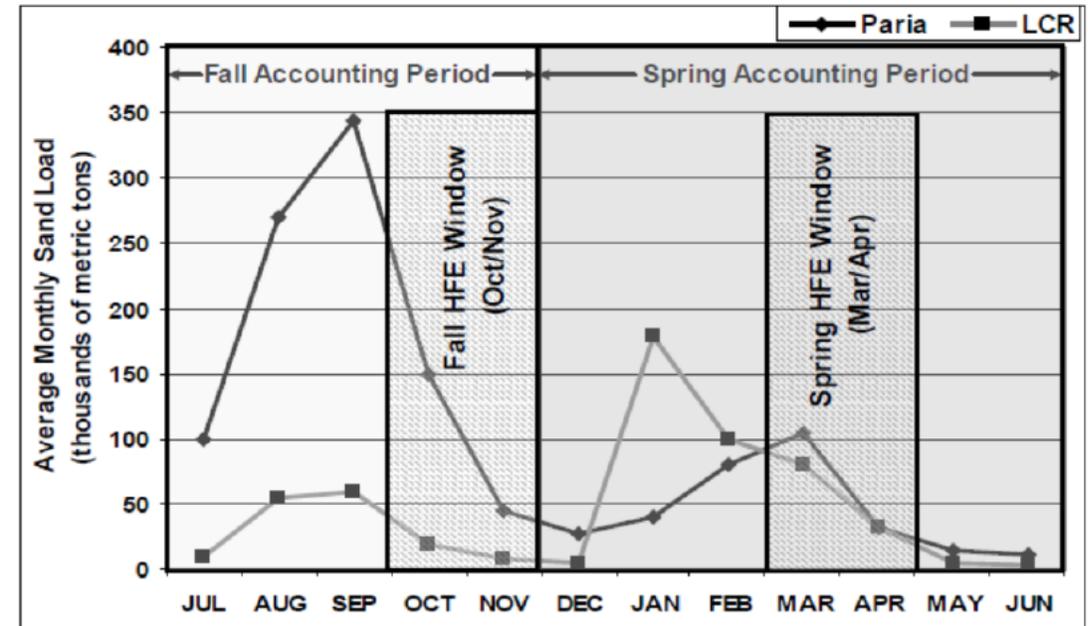


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Plot from LTEMP EIS, Appendix P

# How to trigger a Spring HFE, cont:

Looking back at sand budgets for Marble Canyon from 2002 to 2017:

- 9 years with fall sediment triggers: (> 300,000 metric tons of accumulation)
  - 1 year with winter inputs resulted in greater sand enrichment for the next spring
  - 5 years where winter inputs meant fall and spring sand enrichment in Marble Canyon were about the same
  - 2 years where sand enrichment in fall was much larger than in spring
  - 1 year where there was sand enrichment in fall and no sand enrichment in spring

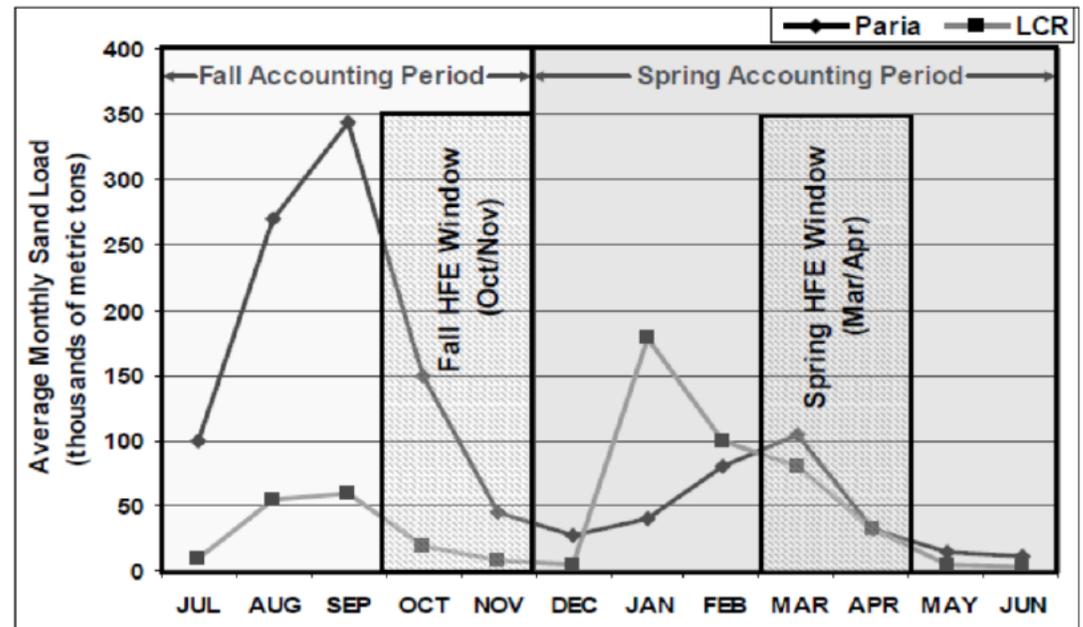


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