TWG Activities – Ad-Hoc Group Update: *Sediment*

Matt Kaplinski
Grand Canyon River Guides – TWG Representative
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Outline

1) Concept Review of MLFF and Sand Management (TWG)
2) Summary of Fine-Sediment Resource Data (GCMRC)
3) TWG's Response to the Rubin et al. Memorandum (TWG)
4) Ad-Hoc's Recommendations to the AMWG (TWG)

TWG sediment ad-hoc

Formed in response to Rubin et al. (2000) memo to GCMRC at November 2000 TWG

"to work with GCMRC to develop a white paper on the current understanding of sediment storage and transport and what that means to the AMP"

November 2001 TWG - White paper unanimously approved white paper and recommendations forwarded to AMWG.

I - Concept Review of MLFF and Sand Management

Matt Kaplinski
Grand Canyon River Guides

Overview

- Understanding Sand- Storage Concepts
- EIS Assumptions About Sand Conservation
- Two Key Assumptions About Bar Restoration
- Critical Need for Sustainable Sand Supplies

Sand storage concepts

Particle sizes affected by dam operations

Sand Storage Locations

EIS Sediment Budget
And Conservation Strategy

Particle sizes

Clay (less than 0.0039 mm)

Silt (0.0039 mm to 0.0625 mm)

Sand (0.0625 mm to 2 mm)

- fine sand (0.0625 mm to 0.025 mm)
- medium to coarse (0.025 mm to 2mm)

Larger (2mm to 3+ meters)

Silt and clay are readily suspended by all flows

Larger size classes are only affected by BHBF

Sediment budget = Sand Budget

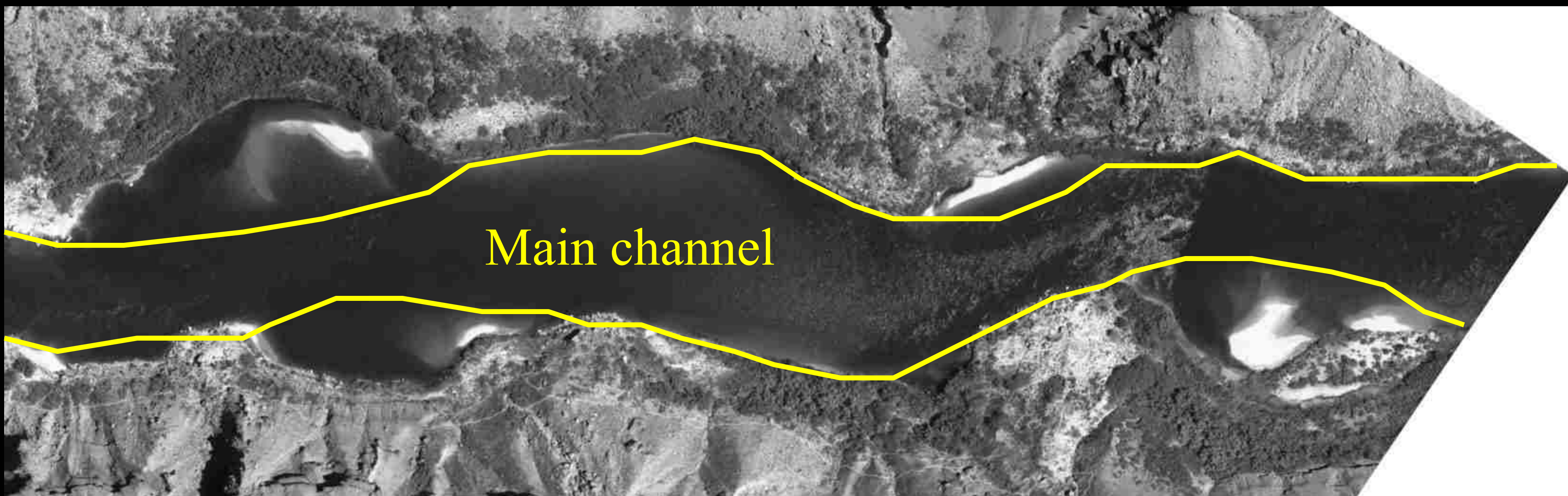
Paria River inputs

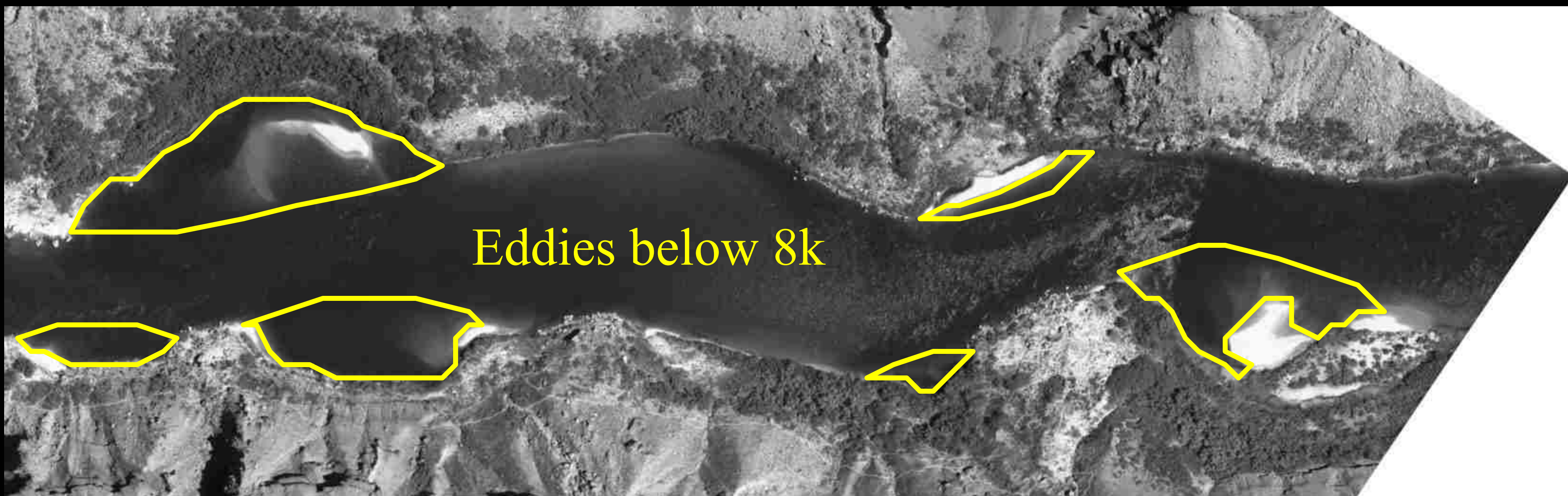
50/50 silt-clay/sand

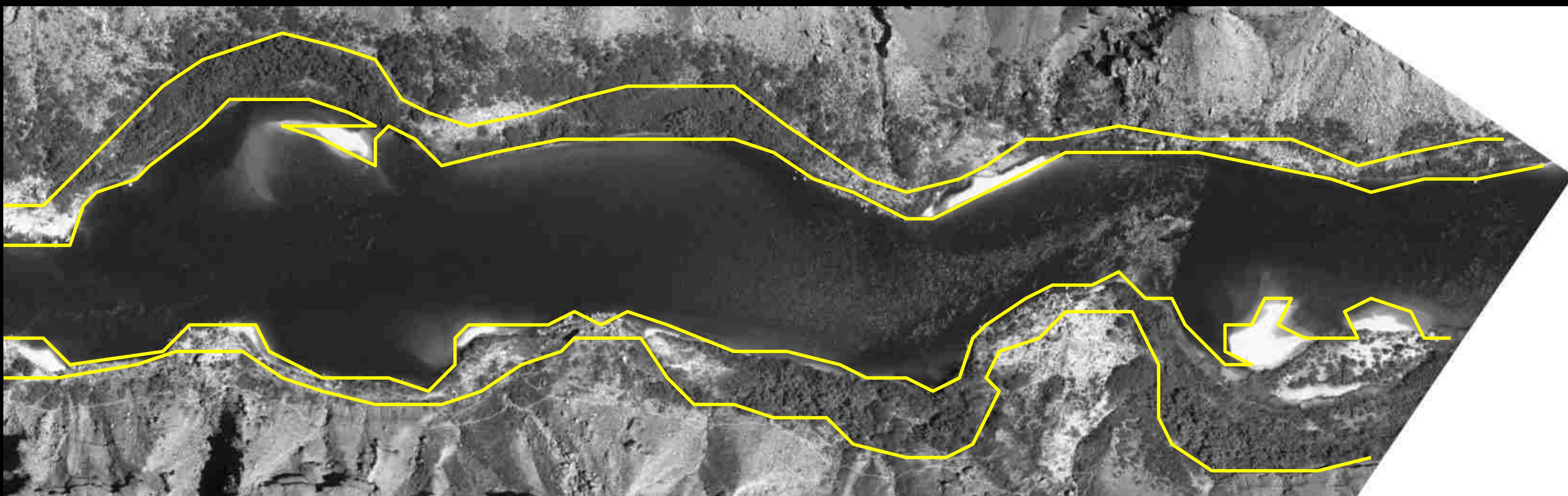
Sand fraction – 80% fine, 20% medium to coarse

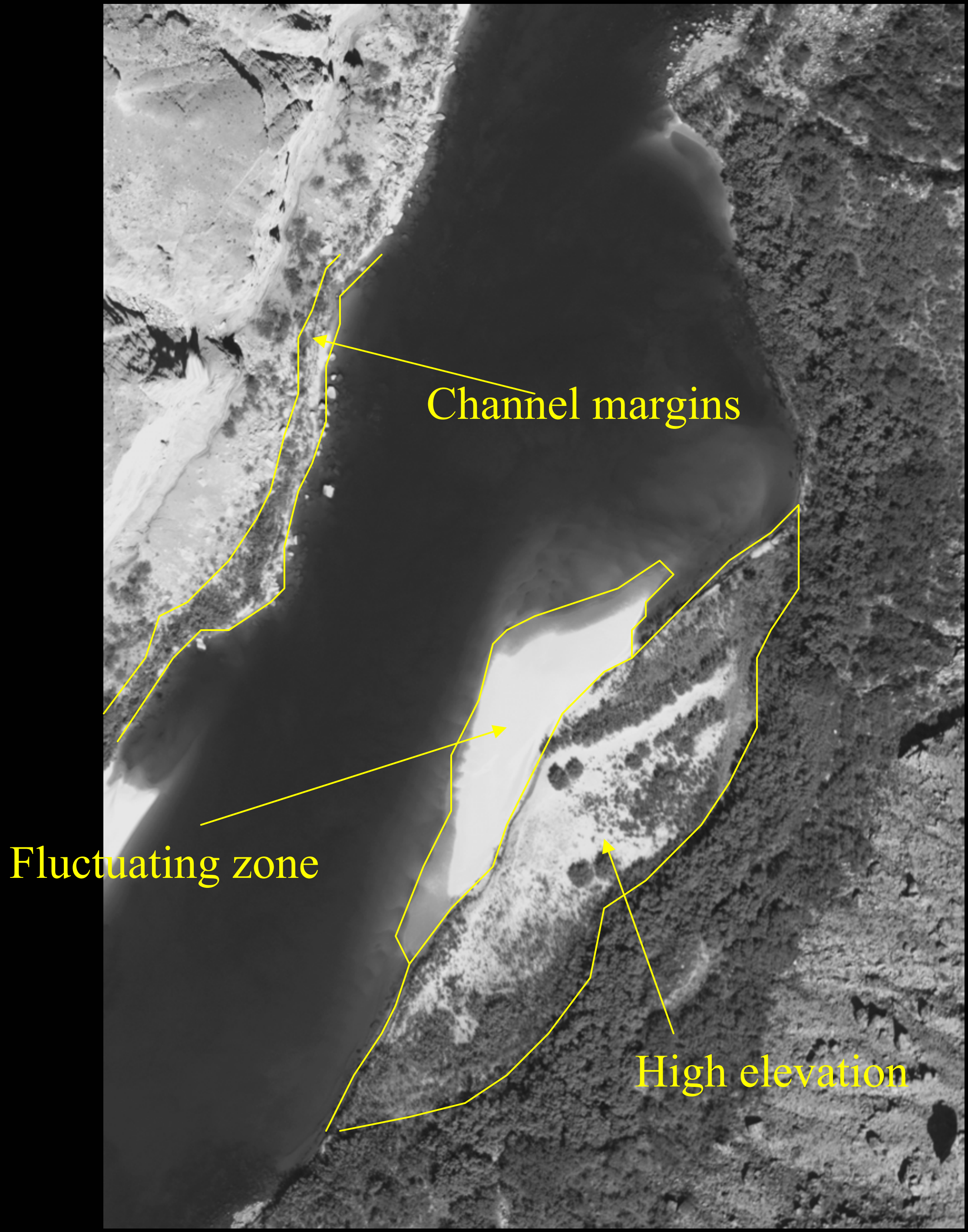
Median grain size = 0.13 mm, or fine sand

Sand storage locations


Main channel


Eddies below 8k




Channel margins
Fluctuating zone
High elevation

EIS Strategy for sediment conservation

1. Multi-year accumulation of sediment in channel

2. Use periodic BHBF's to transfer sediment to banks

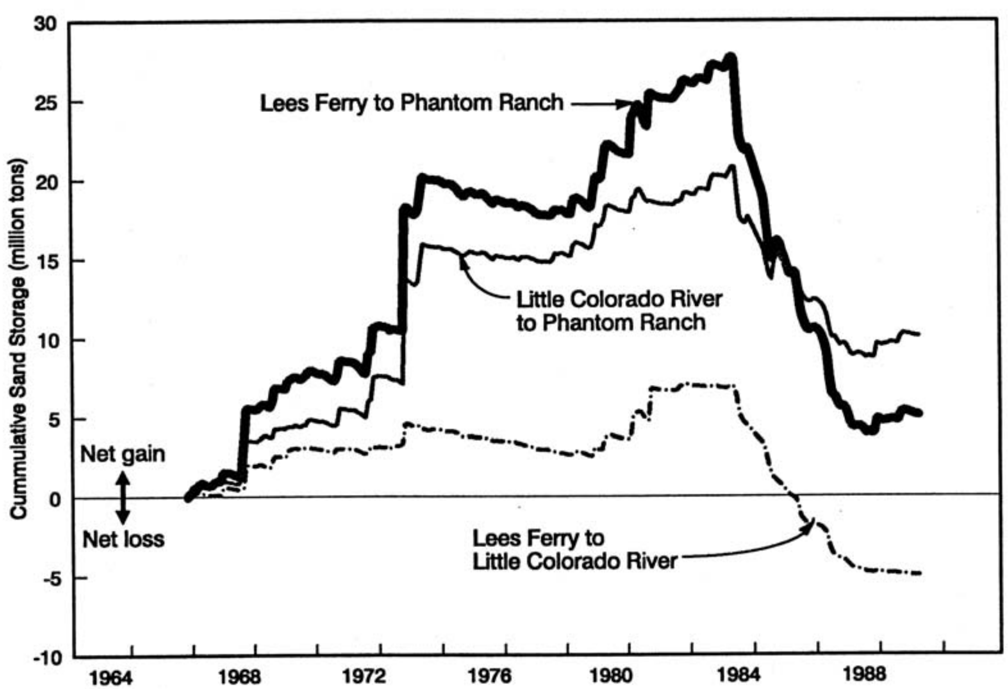


Figure III-15.—Cumulative sand storage between Lees Ferry and Phantom Ranch. Sand accumulated in the river during the relatively low releases while Lake Powell was filling, coupled with large sand contributions from the Paria and Little Colorado Rivers in 1972, 1979, and 1980. Sand was eroded from the channel during the 1983-86 high water years. Computation method is described in text.

Multi-year accumulation of sediment in channel

False! No multi-year accumulations

Sediment transport is dependent on grain size
i.e. the finer the sediment, the more readily it is transported

Sediment inputs are rapidly transported through the system under MLFF

Need to transfer new sediment inputs to the banks immediately following tributary floods

II. Monitoring and Research Activity Report: *Sand Resources*

Ted Melis
Physical Science Program Manager

Acknowledging Science Cooperators

USGS (Rubin, Topping, Wiele et al.)

Utah State University (Schmidt et al.)

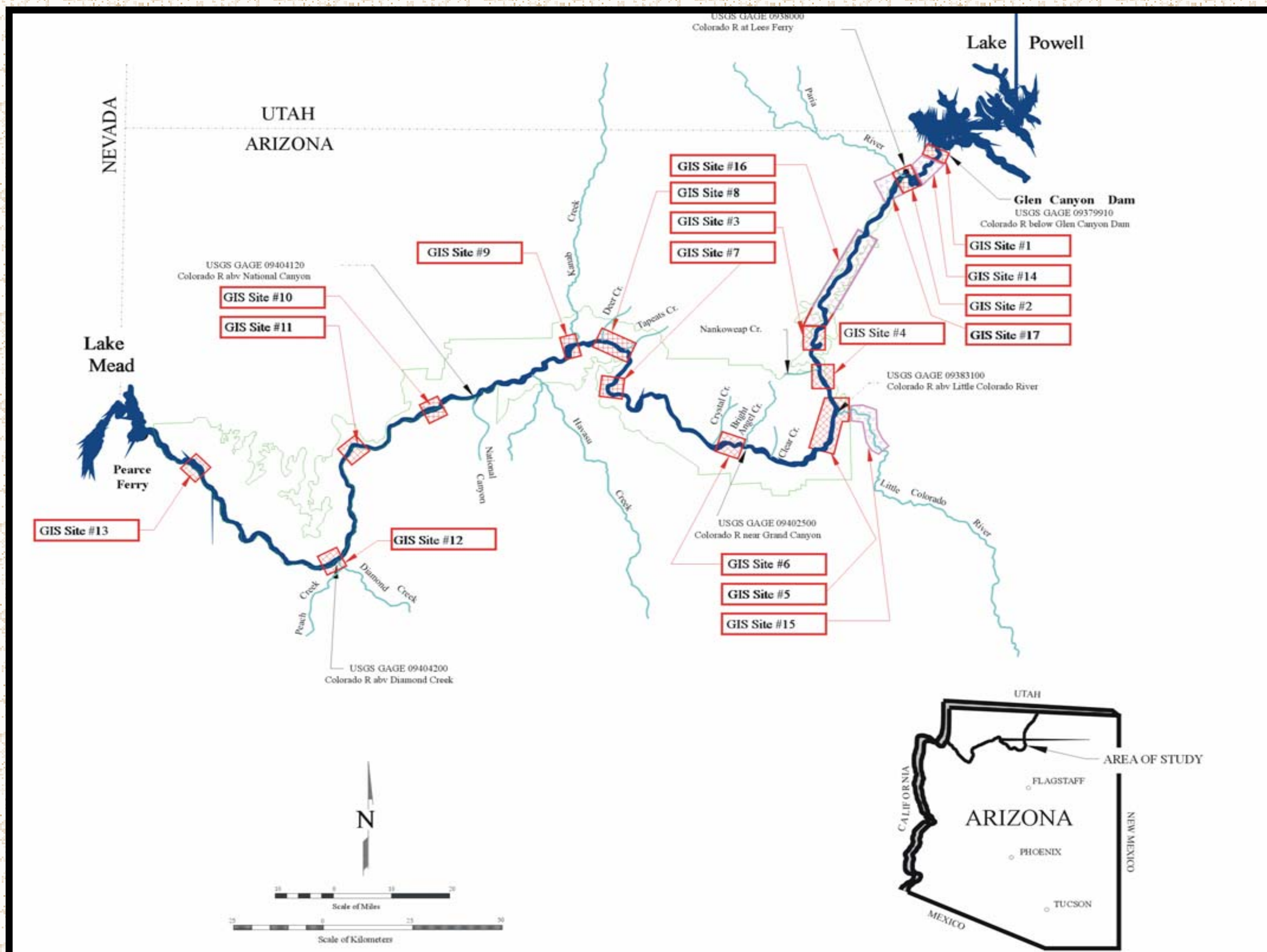
Northern Arizona University (Parnell et al.)

USGS
science for a changing world

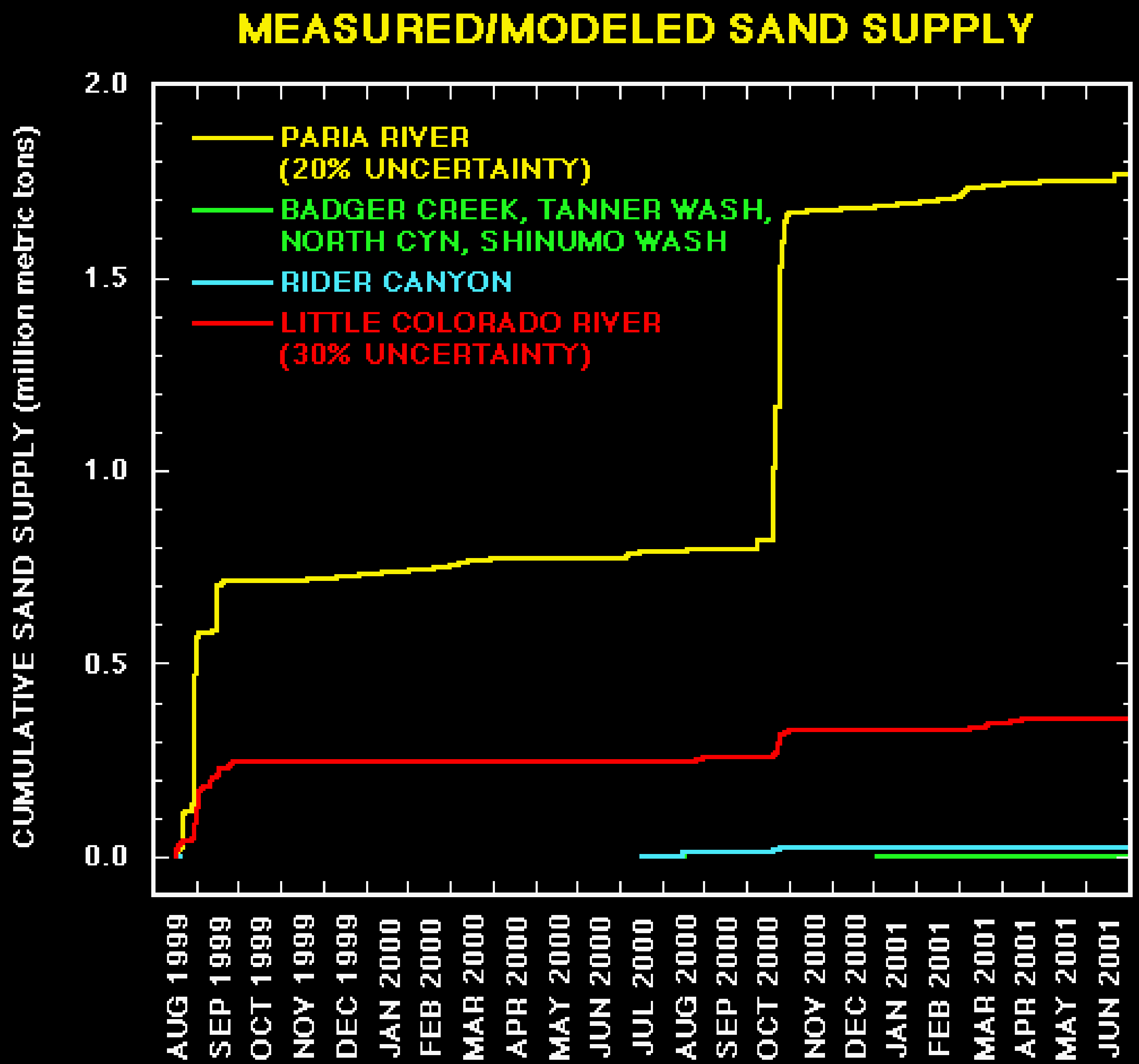
Sand Bar Responses to Modified Low-Fluctuating Flows at Glen Canyon Dam

- <u>Results of Cumulative Sand Mass Balance</u>
  - *Sand Inputs vs. Main Channel Export ('90-'01)*
- <u>Data on Annual Sand Bar Changes</u>
  - *Sand Bar Areas and Volumes Within and Above the "Active Zone" of Fluctuating Operations*
- <u>Final-EIS Predictions for Sand under MLFF</u>
  - *Sand Bar Responses In and Above Active Zone*
  - *Cumulative Sand Supply within Main Channel*

STUDY AREA

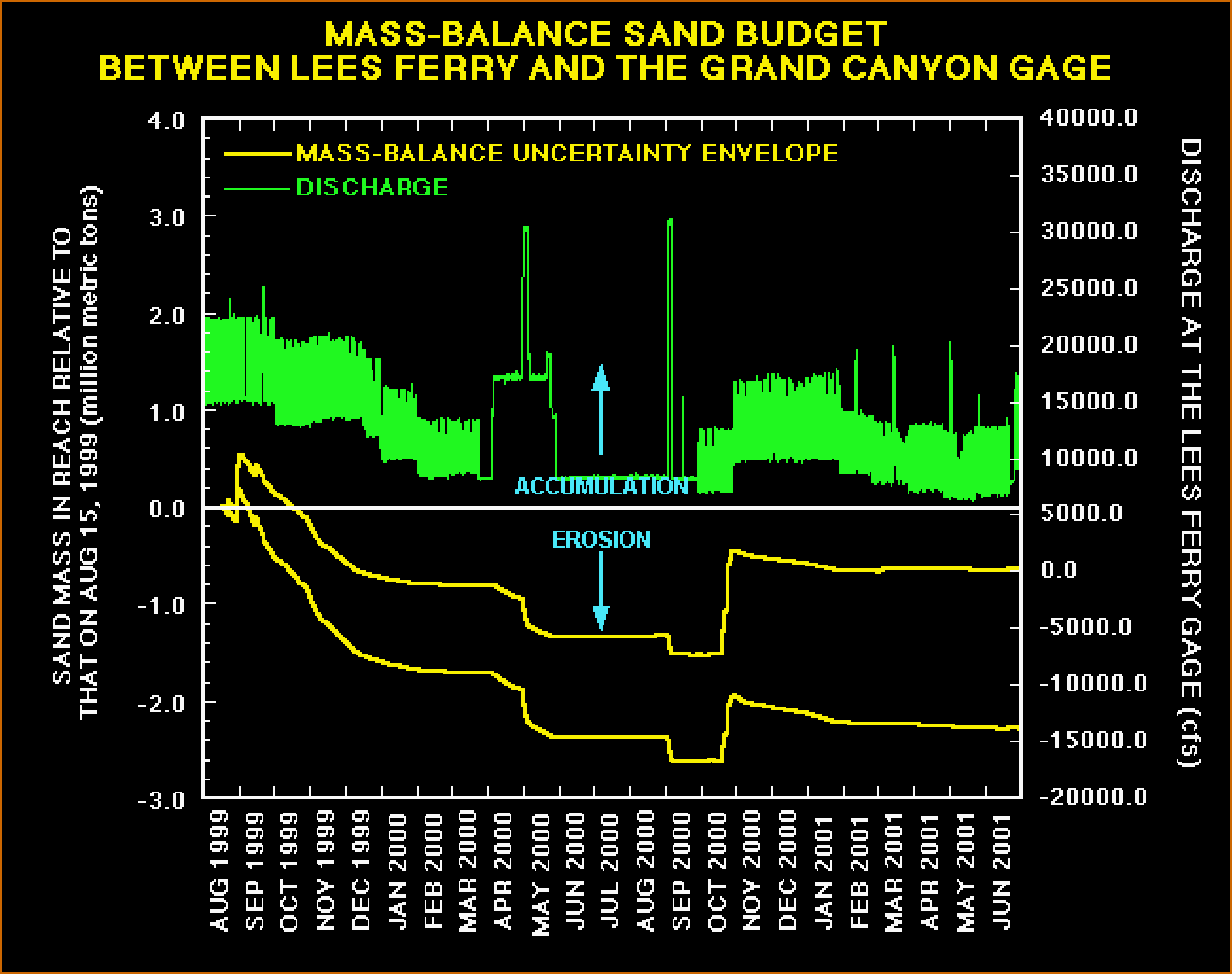


USGS GAGE 0938000
Colorado R at Lees Ferry
Lake Powell
NEVADA
UTAH
ARIZONA
Paria
River
Creek
Kanab
GIS Site #16
GIS Site #8
GIS Site #3
GIS Site #7
GIS Site #9
Glen Canyon Dam
USGS GAGE 09379910
Colorado R below Glen Canyon Dam
GIS Site #1
GIS Site #14
GIS Site #2
GIS Site #17
GIS Site #4
USGS GAGE 09404120
Colorado R abv National Canyon
GIS Site #10
GIS Site #11
Deer Cr.
Tapeats Cr.
Nankoweap Cr.
USGS GAGE 09383100
Colorado R abv Little Colorado River
Lake Mead
Pearce Ferry
Havasu
Creek
National
Canyon
Crystal Cr.
Bright Angel Cr.
Clear Cr.
Little Colorado River
GIS Site #13
GIS Site #12
Diamond Creek
Peach Creek
USGS GAGE 09402500
Colorado R near Grand Canyon
GIS Site #6
GIS Site #5
GIS Site #15
USGS GAGE 09404200
Colorado R abv Diamond Creek
N
Scale of Miles
Scale of Kilometers
UTAH
AREA OF STUDY
FLAGSTAFF
CALIFORNIA
ARIZONA
NEW MEXICO
PHOENIX
TUCSON
MEXICO


MEASURED/MODELED SAND SUPPLY
CUMULATIVE SAND SUPPLY (million metric tons)
2.0
1.5
1.0
0.5
0.0
PARIA RIVER
(20% UNCERTAINTY)
BADGER CREEK, TANNER WASH,
NORTH CYN, SHINUMO WASH
RIDER CANYON
LITTLE COLORADO RIVER
(30% UNCERTAINTY)
AUG 1999
SEP 1999
OCT 1999
NOV 1999
DEC 1999
JAN 2000
FEB 2000
MAR 2000
APR 2000
MAY 2000
JUN 2000
JUL 2000
AUG 2000
SEP 2000
OCT 2000
NOV 2000
DEC 2000
JAN 2001
FEB 2001
MAR 2001
APR 2001
MAY 2001
JUN 2001

Our Renewable Sand Supply

- Significant Paria River Inputs, 1990-2001
  - *About 14 Million Tons (long-term average ~ 1.5)*
- Paria Sand Loads vs. Little Colorado River
  - *Paria Inputs Dominate Supply Since 1993*
- Characteristics of Tributary Sand Inputs
  - *Arrive as Discrete Packets in Summer/Fall*
  - *Fine Grain-Size of Sand = Rapid Transport*
  - *High Variability in Loads Year-to-Year*
  - *Annual Inputs are ~ 10% of Pre-Dam Supplies*

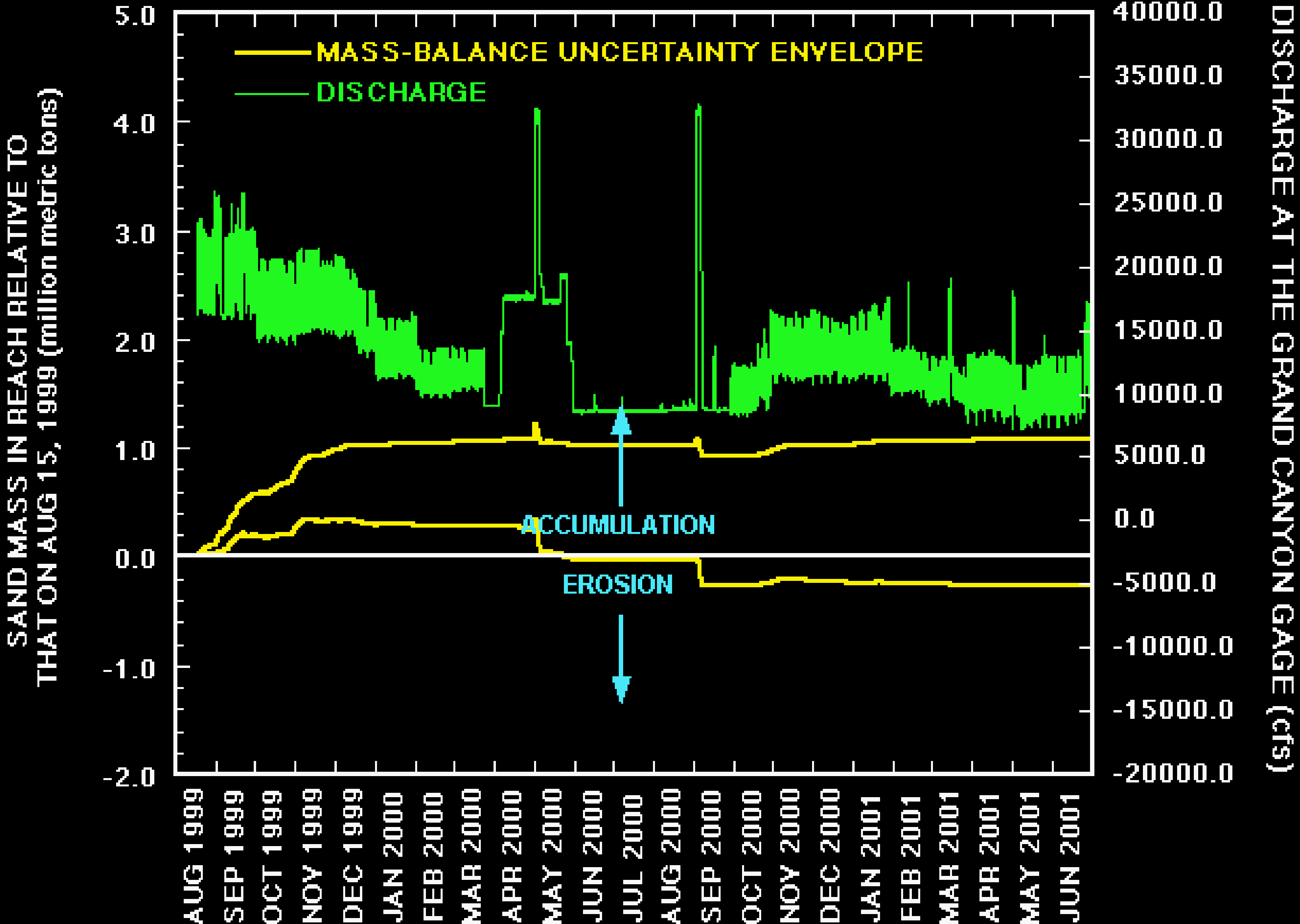


MASS-BALANCE SAND BUDGET
BETWEEN LEES FERRY AND THE GRAND CANYON GAGE
MASS-BALANCE UNCERTAINTY ENVELOPE
DISCHARGE
ACCUMULATION
EROSION
SAND MASS IN REACH RELATIVE TO THAT ON AUG 15, 1999 (million metric tons)
DISCHARGE AT THE LEES FERRY GAGE (cfs)
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
40000.0
35000.0
30000.0
25000.0
20000.0
15000.0
10000.0
5000.0
0.0
-5000.0
-10000.0
-15000.0
-20000.0
AUG 1999
SEP 1999
OCT 1999
NOV 1999
DEC 1999
JAN 2000
FEB 2000
MAR 2000
APR 2000
MAY 2000
JUN 2000
JUL 2000
AUG 2000
SEP 2000
OCT 2000
NOV 2000
DEC 2000
JAN 2001
FEB 2001
MAR 2001
APR 2001
MAY 2001
JUN 2001

Sand Mass Balance Between Lees Ferry and Phantom Ranch (River Miles 0-87)

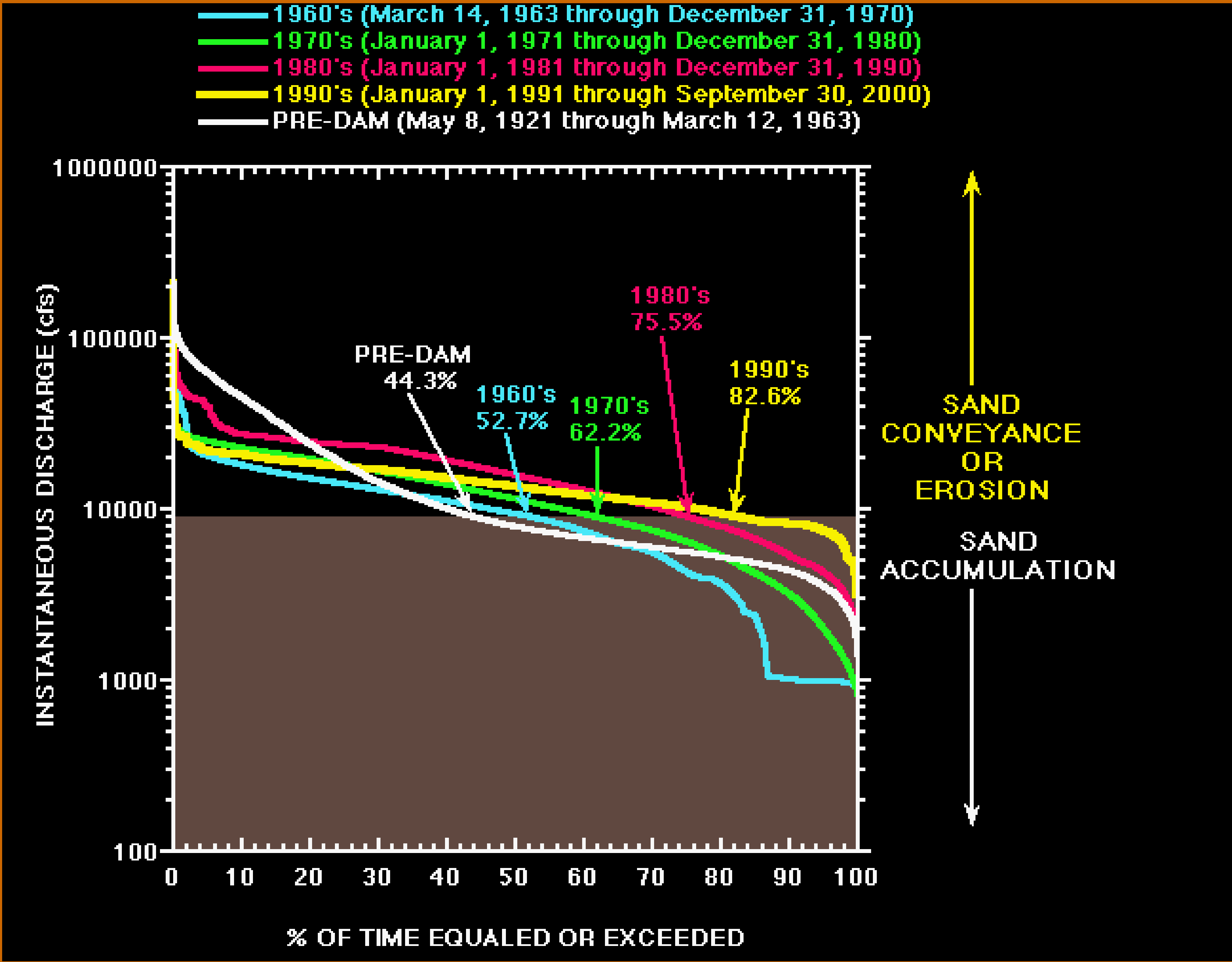
- Indicates Mostly Erosion of Upstream Sites
  - *About 1.4 Million Tons Eroded from Upper Third of the Ecosystem During 1999-2001*
- Likely Sources of Exported Sand
  - *Mostly From "Active Zones" in Marble Canyon*
- Fate of Tributary Sand Inputs
  - Results Show Limited Residence Times for Inputs
  - No Evidence of Multi-Year Accumulation on Bed
  - Export Despite Relatively "Dry" Hydrology

MASS-BALANCE SAND BUDGET BETWEEN THE GRAND CANYON AND ABOVE DIAMOND CREEK GAGES



Mass Balance From Phantom Ranch to Diamond Creek (River Miles 87-226)

- <u>Even Mass Balance</u>
  - *No Clear Sign of Accumulation or Export "Pipe"*
- <u>Likely Sources for Influx = Efflux</u>
  - *Additional Inputs, Plus Upstream Erosion*
- <u>Prolonged Fate of Tributary Sand Inputs</u>
  - Longer Period Required for Export of New Sand
  - Greater Opportunities for Managing Sand Inputs
  - Still No Evidence of Multi-Year Accumulation



1960's (March 14, 1963 through December 31, 1970)
1970's (January 1, 1971 through December 31, 1980)
1980's (January 1, 1981 through December 31, 1990)
1990's (January 1, 1991 through September 30, 2000)
PRE-DAM (May 8, 1921 through March 12, 1963)
INSTANTANEOUS DISCHARGE (cfs)
1000000
100000
10000
1000
100
0
10
20
30
40
50
60
70
80
90
100
% OF TIME EQUALED OR EXCEEDED
PRE-DAM 44.3%
1960's 52.7%
1970's 62.2%
1980's 75.5%
1990's 82.6%
SAND CONVEYANCE OR EROSION
SAND ACCUMULATION

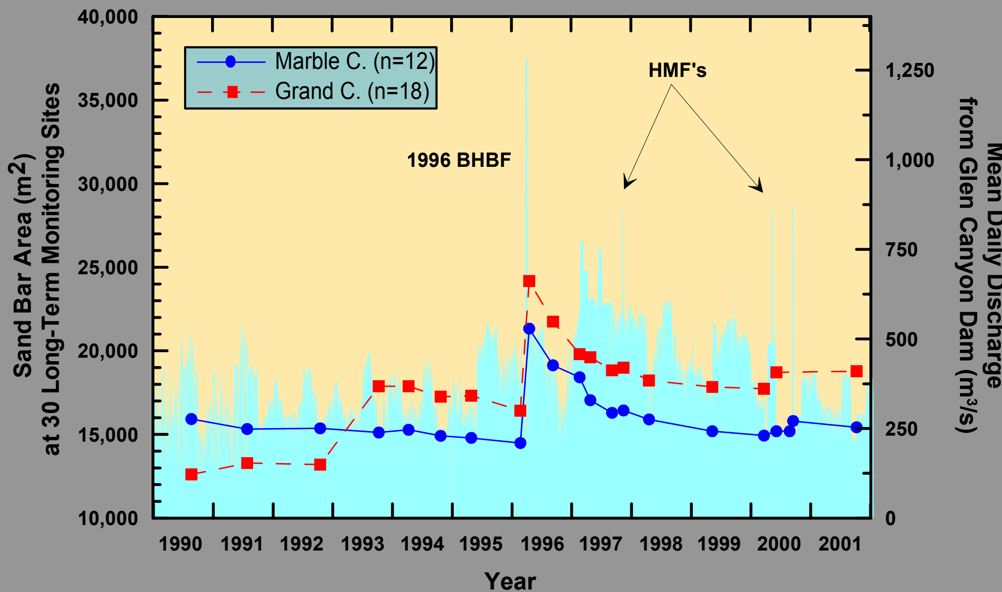
Progressive Influence of Regulation on the Frequency/Duration of Low Flows

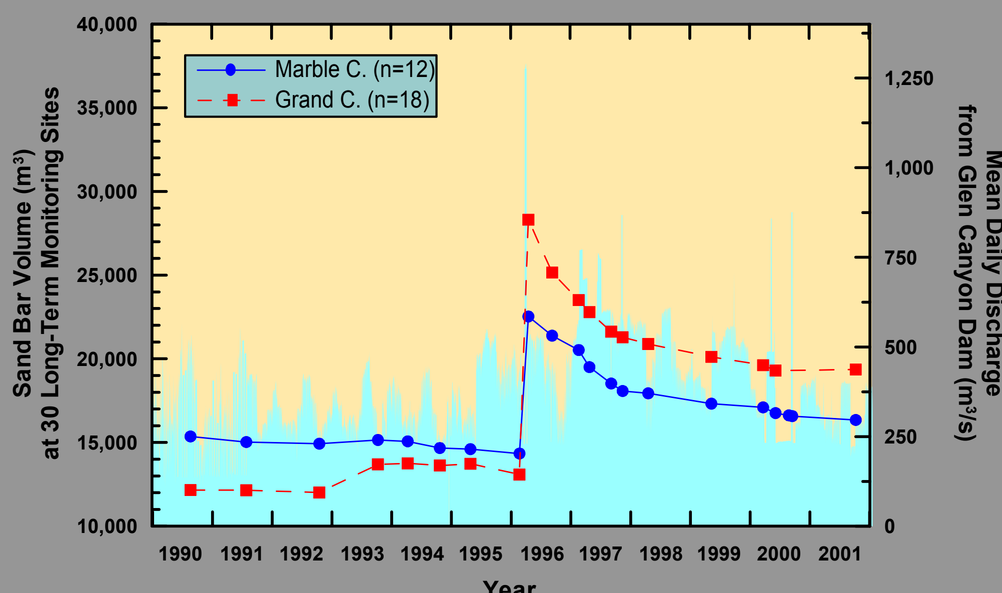
- Threshold for Sand Transport
  - *About 9,000 cfs (Topping and others, 2000)*
- Pre-Dam Era
  - *9,000 cfs Equaled or Exceeded ~44% of Time*
- No-Action Era
  - *9,000 cfs Equaled or Exceeded ~52-75% of Time*
- MLFF Era
  - *9,000 cfs Equaled or Exceeded ~82% of Time!*

Monitoring of Main Channel Cross Sections 1992 -1999

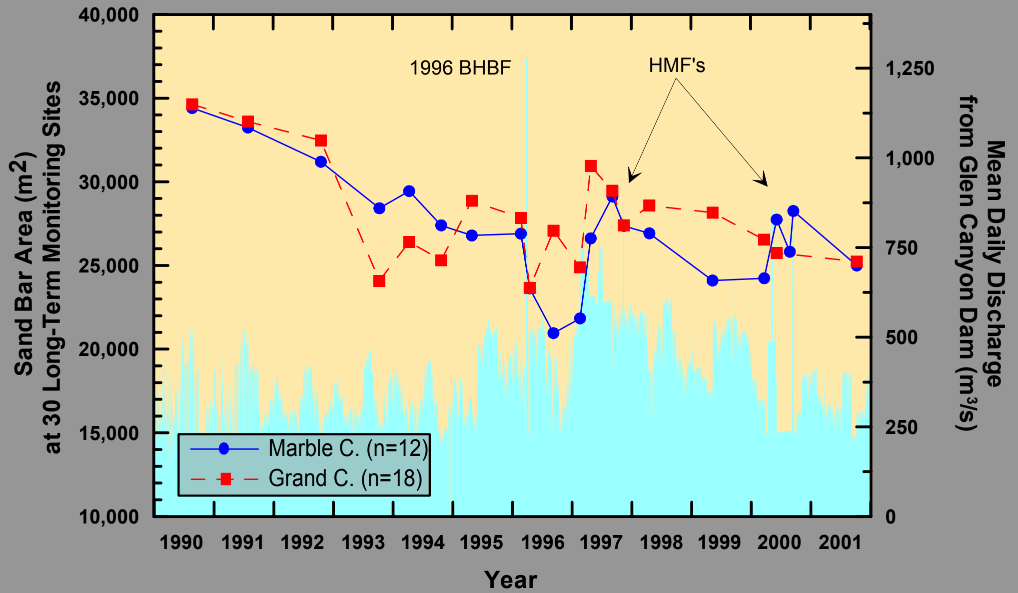
- USGS Cross-Section Data
  - *Time Series of Channel Geometry Does Not Show Multi-Year Accumulation of Sand, Instead, Most Show Erosion (USGS Report in Review)*
- Channel Response to Sand Inputs
  - *Cross Sectional Response to Sand Inputs is Ephemeral (sand supplies not cumulative)*
  - *Data Support Conclusions Stated in Rubin et al. Memorandum Delivered to GCMRC (Aug. 2000)*

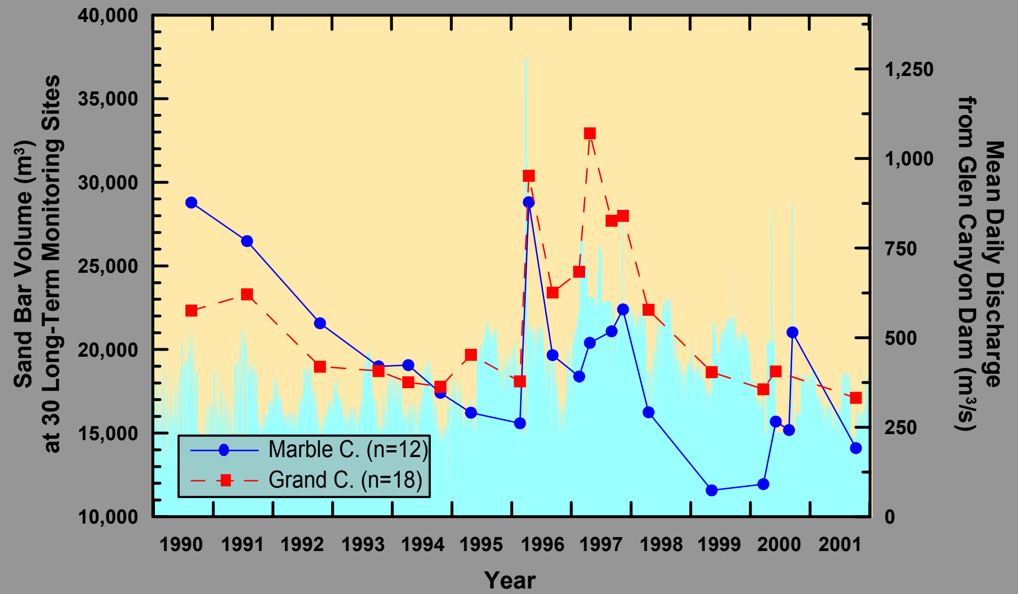
NAU Sand Bar Areas and Volumes (above 25,000 ft^3/s)



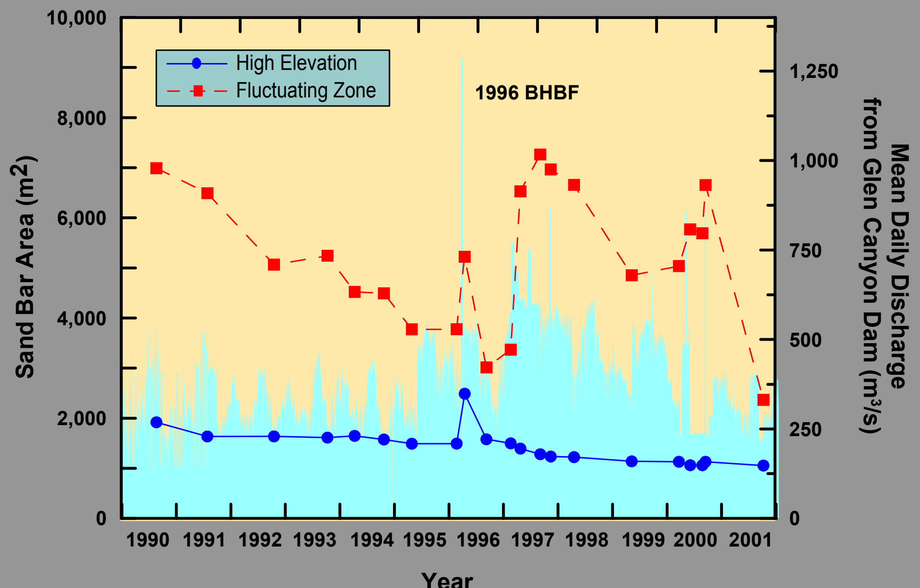


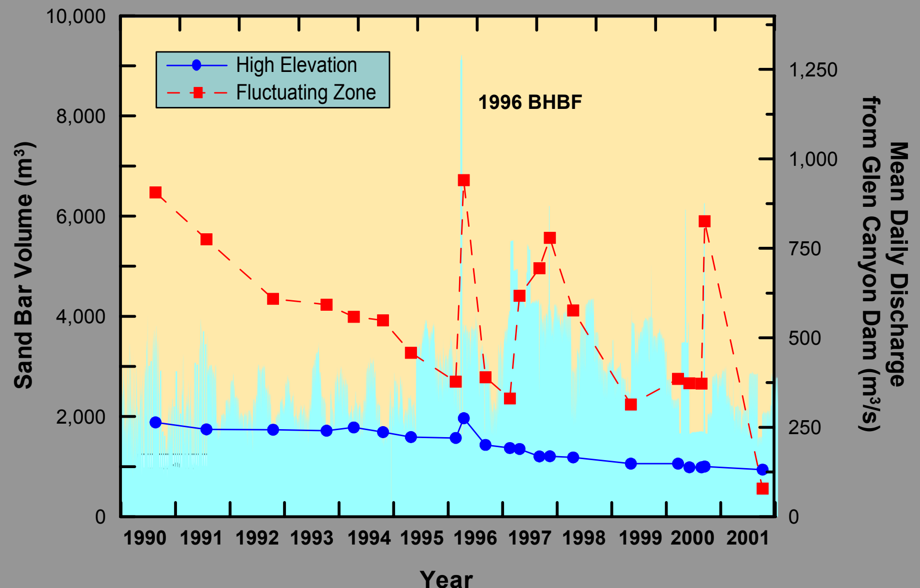
NAU Sand Bar Areas and Volumes in Active Zone (8,000 to 25,000 ft^3/s)



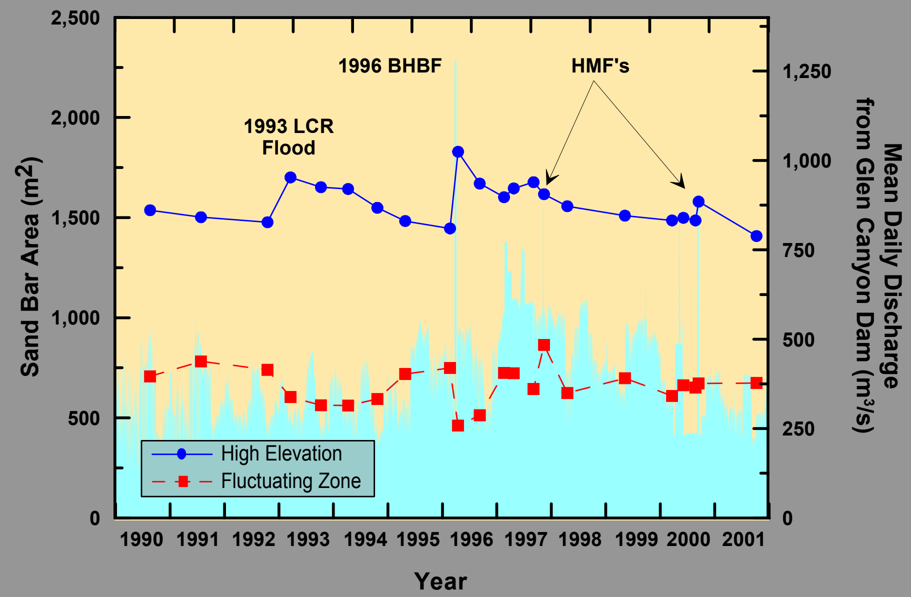


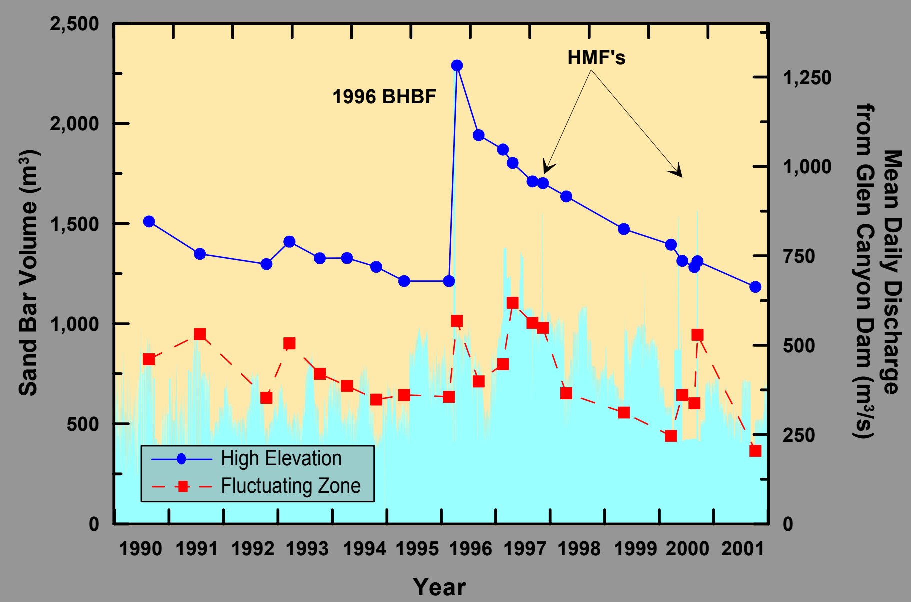
NAU Sand Bar Areas and Volumes - 47-Mile Site (Saddle Canyon)

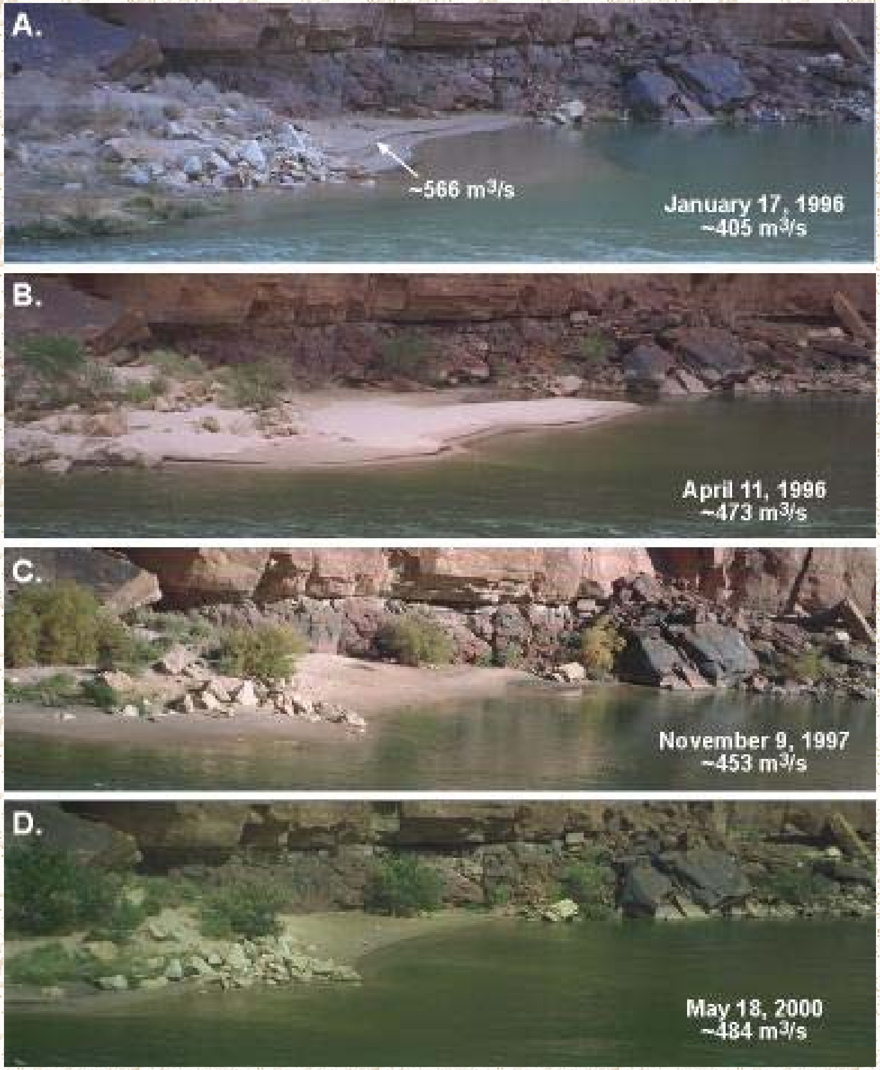




NAU Sand Bar Areas and Volumes - 81-Mile Site (Grapevine Camp)







The Effect of HMF-Type Flows and the 1996 Controlled Flood at the 16 Mile Sand Bar

Results of Sand Bar Monitoring 1990 - 2001

- High Resolution Data at 30 Sites
  - *Sand Bars in Active Zone have Mostly Decreased*
  - *Upstream Bars Show Less Benefit from BHBF*
- Fine-Sediment Export Reflected in Bar Data
  - *Active Zone Sand Being Depleted System-Wide*
  - *1996 High Bar Responses in Grand Canyon Possibly Occurred at Cost to Marble Canyon*
  - *Marble Canyon Acts as "Third Major Tributary"*

Final-EIS Predictions for Sand under MLFF vs. No-Action

- <u>Sand-Bar Width & Height Expected to Decrease within Active Zone under MLFF</u>
  - *Sand Bar Areas and Volumes in Active Zone have <u>Decreased</u> under MLFF*
- <u>73% Probability of Sand Inputs Accumulating within Main Channel over 50-Year Period under MLFF</u>
  - *Sand Mass Balance and X-Sections Indicate <u>No Net Accumulation</u> in Channel During MLFF*
  - *Sand Bar Trends in Active Zone Suggest Continued Loss of Sand Resources under Continued MLFF Operations.*

Future of Colorado River Ecosystem Sand Bars?

- <u>Beach/Habitat-Building Flows</u>
  - *Require Surplus Sand Supply for Restoration*
  - *BHBF's Without Sand Supply Force Export*
  - *Where Will Future Sand Come From for BHBF's?*
- <u>Effectiveness of Habitat-Maintenance Flows</u>
  - *Three 31,500 cfs Releases Since 1996 Have Not Mitigated Sand Loss Within Active Zone (8-25K)*
  - *HMF's Have Not Increased Sand Storage Significantly Above Active Zone (above 25kcfs)*

III. TWG's Response to the Rubin et al. Memorandum (TWG)

Matt Kaplinski
Grand Canyon River Guides

TWG response

Good Stuff – Important New Information

Concur with the conclusions

Modified recommendations slightly

Forwarded a series of flow experiments to the TWG experimental flow ad-hoc to test new hypotheses

Rubin et al. (2000) recommendations

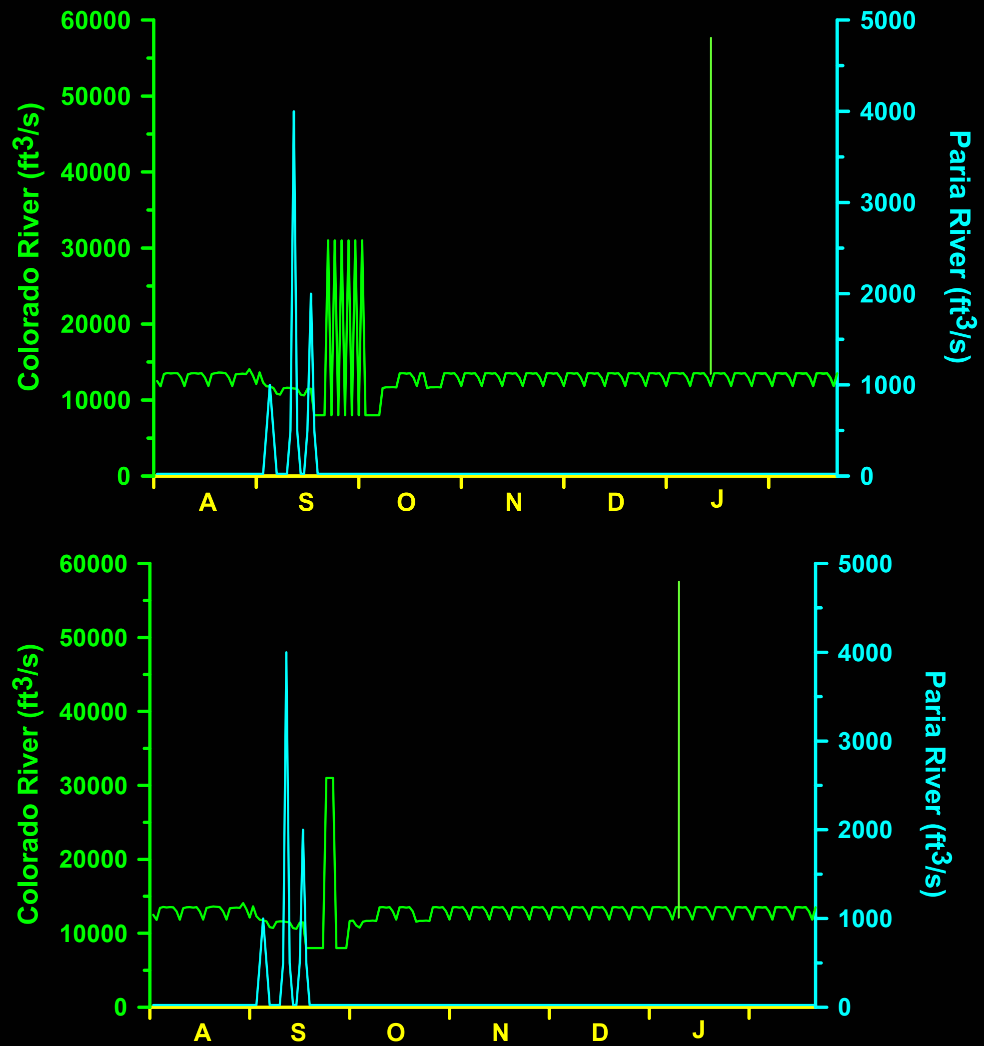
1. Implement releases above power-plant capacity discharge (BHBF) immediately following substantial inputs of fine-sediment from tributaries

2. Maintain low flows following fine-sediment inputs until releases above power-plant discharge (BHBF) can be implemented

3. Add sediment downstream from the dam

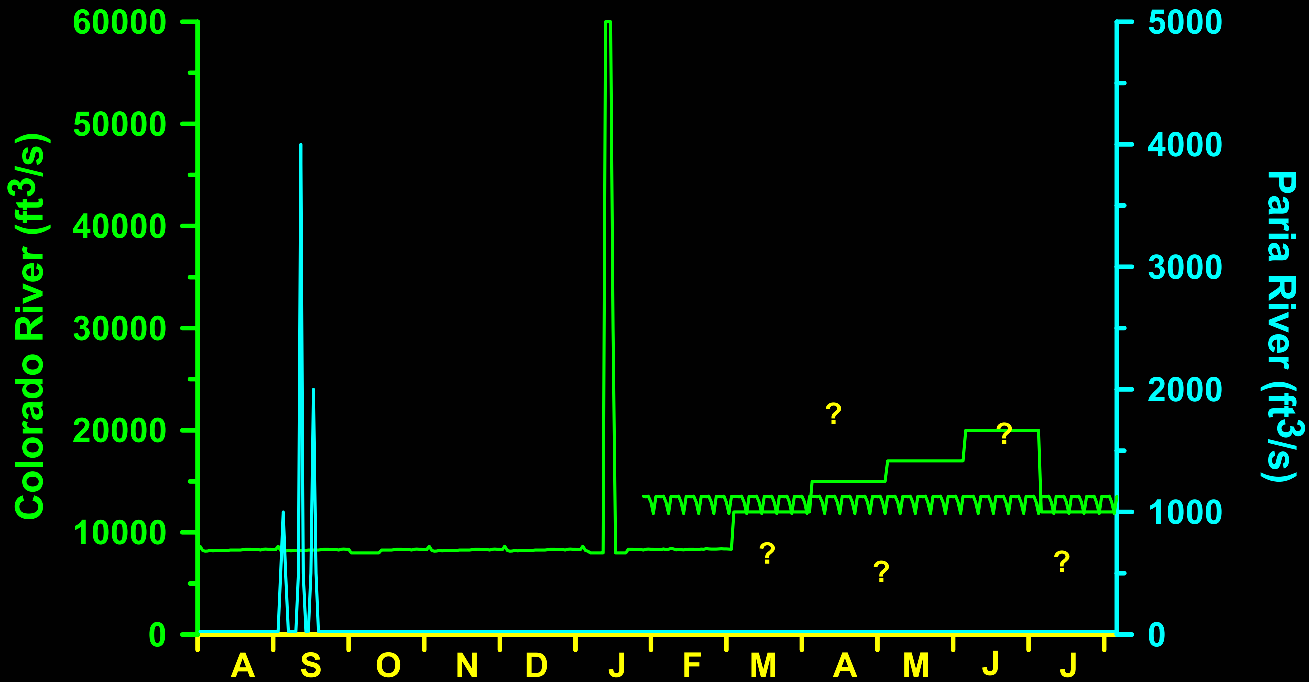
Proposed Flow Experiments

1. Load following or HMF following tributary input



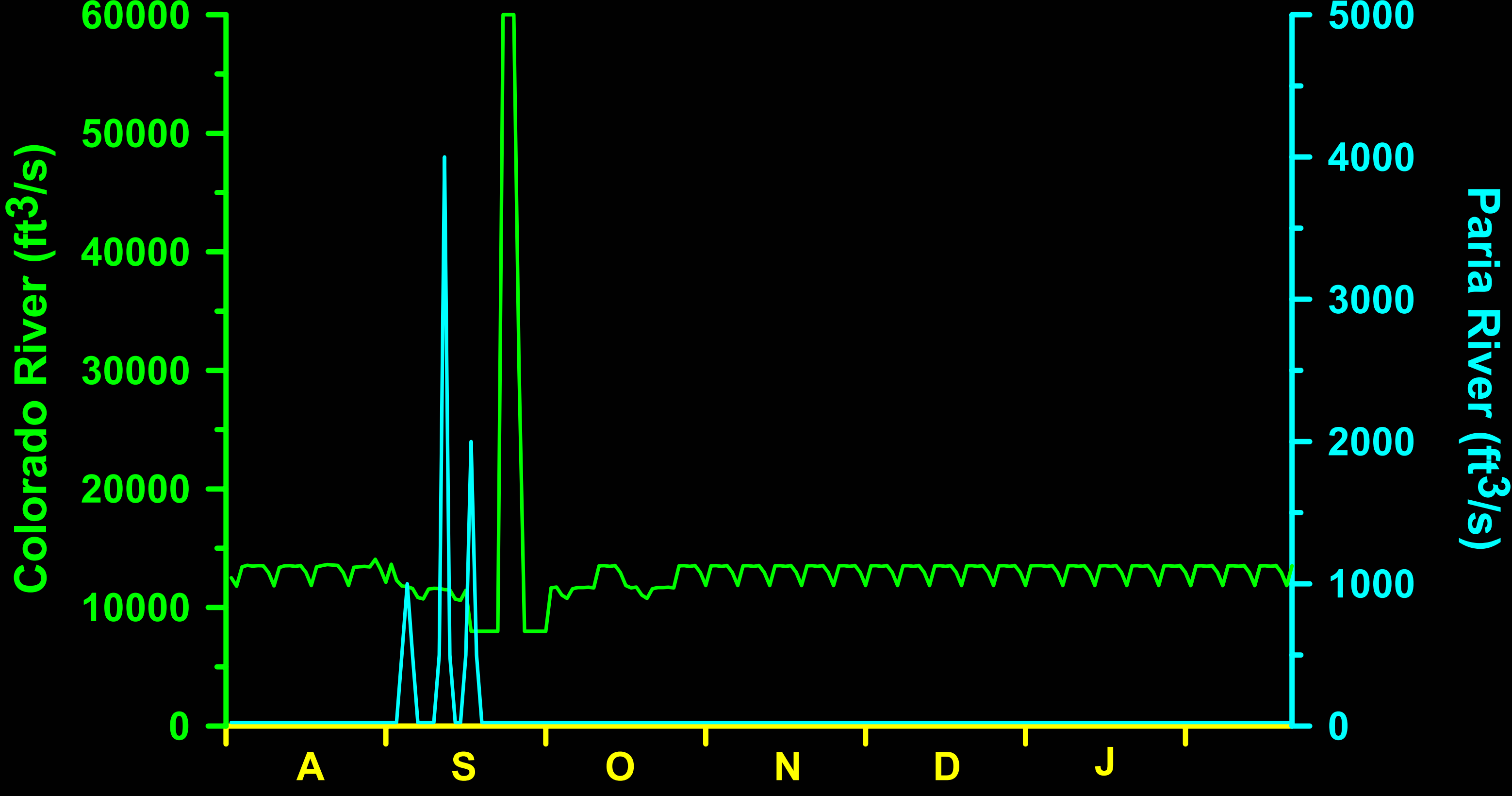
Proposed Flow Experiments

2. Low flows (below 10,000 cfs) following tributary inputs, followed by BHBF in January. Combined with RPA (native fish) flow experiment.



Proposed Flow Experiments

3. BHBF following tributary input



TWG response

3. Add sediment downstream from the dam

Has merit – *IF*: A) program of experimental flows shows that there is no other option;
and 2) sediment storage characteristics of the river are important to the program

Implications to Program

Monitoring program works – way to go GCMRC!

Represents a challenge in meeting program goals
We need to do something about it!

Untested process of integrating new findings into the adaptive management process.

A challenge for communication and coordination between scientists and managers to test new hypothesis, incorporating new knowledge and applying that knowledge correctly to management decisions that greatly affect the future of the CRE

TWG sediment ad-hoc recommendations

1. Concur with findings of Rubin et al. (2000)

2. Approve proposed experimental flow program

3. Establish TWG sediment ad-hoc as a standing group to integrate new information

THANK YOU FOR YOUR ATTENTION

Grand Canyon Monitoring and Research Center

And

TWG – Sediment Ad-Hoc