Glen Canyon Dam Adaptive Management Work Group
Agenda Item Information
February 25-26, 2015

Agenda Item

Updates from the 2015 Glen Canyon Dam Adaptive Management Program Technical Work Group Annual Reporting Meeting

Action Requested

Information item only

Presenters

Scott VanderKooi, Acting Chief, Grand Canyon Monitoring and Research Center
Paul Grams, Research Hydrologist, Grand Canyon Monitoring and Research Center

Previous Action Taken

N/A

Relevant Science

N/A

Background Information

The January 2015 Annual Reporting meeting was conducted under the auspices of a Technical Work Group meeting. The two-day meeting included presentations by GCMRC staff, cooperators and collaborators, staff of sister federal agencies, and Tribal representatives. Speakers presented summaries of findings from work conducted as part of the FY2013-14 GCDAMP budget and workplan and discussed insights of management significance. Some of the latter are summarized below.

Each of the high flows implemented under the high-flow protocol since July 2012 has resulted in sandbar deposition in Marble and Grand Canyons. Although sandbars have also eroded following each high-flow, the long-term monitoring sites were larger 10 months following each of the high flows than at any other time between 2009 and 2012. Because Paria River sand inputs have been relatively large and annual release volumes from Lake Powell relatively low, there has been maintenance or accumulation of sand in all segments of Marble and Grand Canyons since July 2012.

Project J of the FY2013-14 biennial workplan examined effects of dam operations on cultural sites in Glen and Grand canyons. One key finding is that gully development and the risk of gully erosion can exceed what would occur without river regulation in some locations. However, management actions that increase aeolian deposition of fluvially-sourced (e.g., HFE) sand can limit gully erosion within cultural sites as indicated by a variety of analyses that included lidar change detection, field mapping, air photo interpretation, digital topographic modelling, and site investigations. While HFEs can reduce gully extent in areas with upwind sandbars, sites with the greatest potential to receive windblown HFE sand still undergo gully erosion on seasonal time scales. In Glen Canyon, lidar monitoring showed that the November 2012 HFE caused erosion of a steep cut bank adjoining one cultural site that is adjacent the river. It is possible that erosion of the cutbank could influence geomorphic processes that occur farther upslope in the cultural site, for example, by shortening the length and consequently steepening the gradient of existing gullies that cross the site.

Riparian vegetation monitoring and the analysis of vegetation data in order to identify vegetation response guilds indicates that most vegetation from sample plots can be placed into seven categories or guilds based on morphological traits and physiological traits including rooting depth (shallow to deep) and drought tolerance (high to low). Grouping species based on shared traits increases the power to detect a direction of vegetation response to changes in a flow regime when compared with evaluating single species responses. Nonetheless, the annual data collection, while informing response guild development, can also be used to track individual species of interest and general trends in species richness among the three river segments (Marble Canyon, Eastern Grand Canyon and Western Grand Canyon).

Annual estimates of spring abundance of humpback chub in the Little Colorado River for fish >150 mm and >200 mm exceed 5,000 in each case, and trends remain stable. Juvenile humpback chub survival estimates in the mainstem Colorado River near the Little Colorado River confluence for the interval from July 2013 to July 2014 were similar to those observed for the July 2012 to July 2013 interval. The estimated total abundance of rainbow trout between Glen Canyon Dam and Lees Ferry in January 2015 was approximately 200,000 fish, which represents a decline in abundance of over 80% since April 2012. In addition to declines in abundance, relative condition of rainbow trout has declined as have growth rates for fish larger than approximately 175 mm. As observed in recent years, the majority of the population of rainbow trout occurs upstream from River Mile 20. In contrast to observations upstream, abundance estimates for rainbow trout near the Little Colorado River confluence have increased, with three of four 2014 estimates exceeding trigger levels identified in the 2011 Biological Opinion for Nonnative Fish Control. No action is warranted at this time since other triggering criteria have not been met.

January 2015 Annual Reporting Meeting

Streamflow, Water Quality, and Sediment Transport

David Topping, GCMRC; Ron Griffiths, GCMRC; Nick Voichick, GCMRC; Tom Sabol, GCMRC; Dave Dean, GCMRC; Nancy Hornewer, AZ Water Science Center; Jon Mason, AZ Water Science Center; Brad Garner, AZ Water Science Center; Dave Sibley, CIDA; Megan Hines, CIDA

Sandbars and Sediment Storage

Paul Grams[1], Tim Andrews[1], Daniel Buscombe[1], Tom Gushue[1], Dan Hadley[2], Dan Hamill, Joseph Hazel[2], Matt Kaplinski[2], Keith Kohl[1], Erich Mueller[1], Robert Ross[1], Robert Tusso[1]
[1]U.S. Geological Survey, Grand Canyon Monitoring and Research Center
[2]Northern Arizona University

Cultural Resource Monitoring and Research

Amy Draut, Joel Sankey, Helen Fairley, and Brian Collins

Riparian Vegetation Monitoring and Research

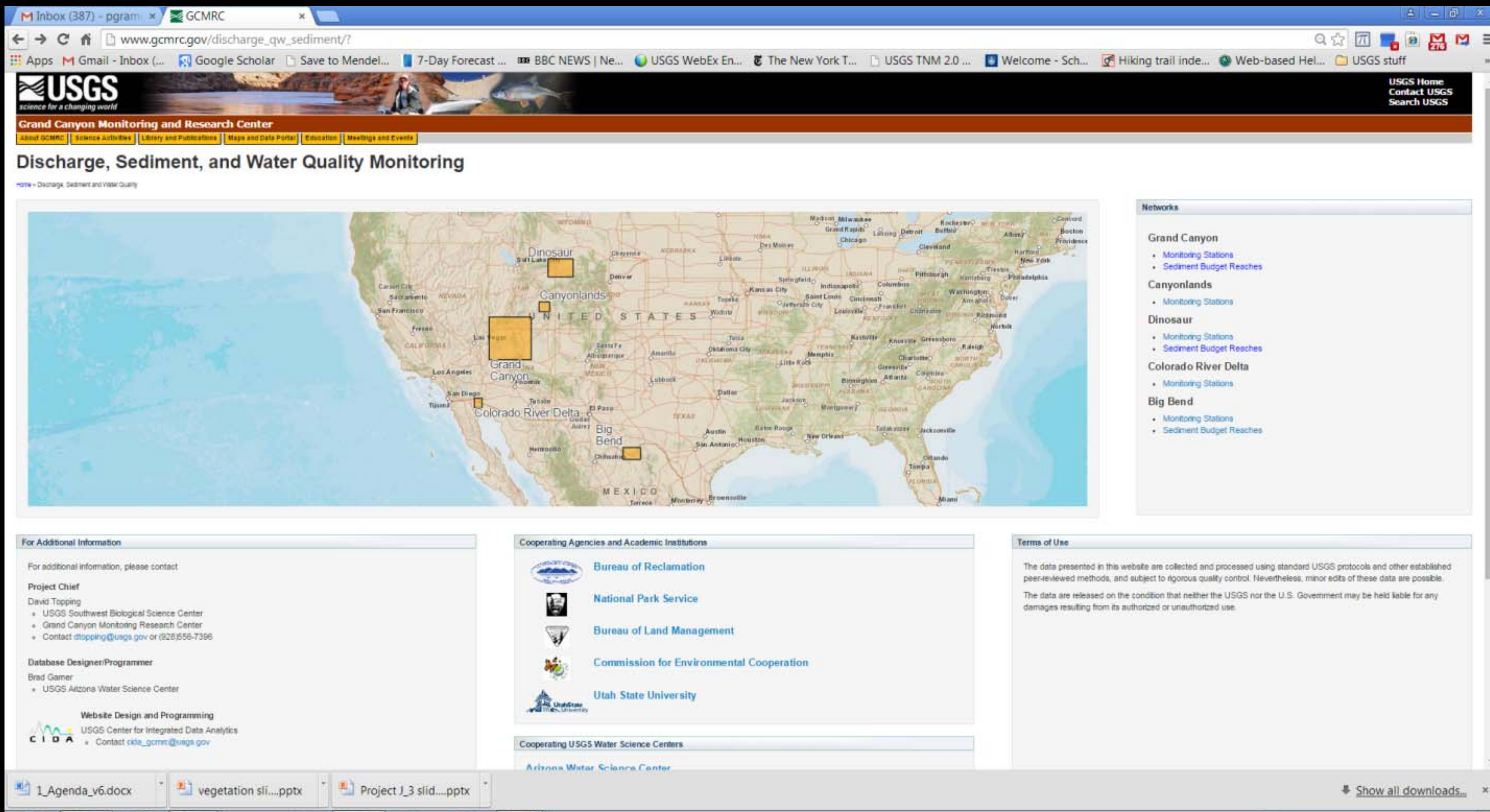
Barb Ralston, Daniel Sarr, Emily Palmquist, David Merritt, and Patrick Shafroth

USGS

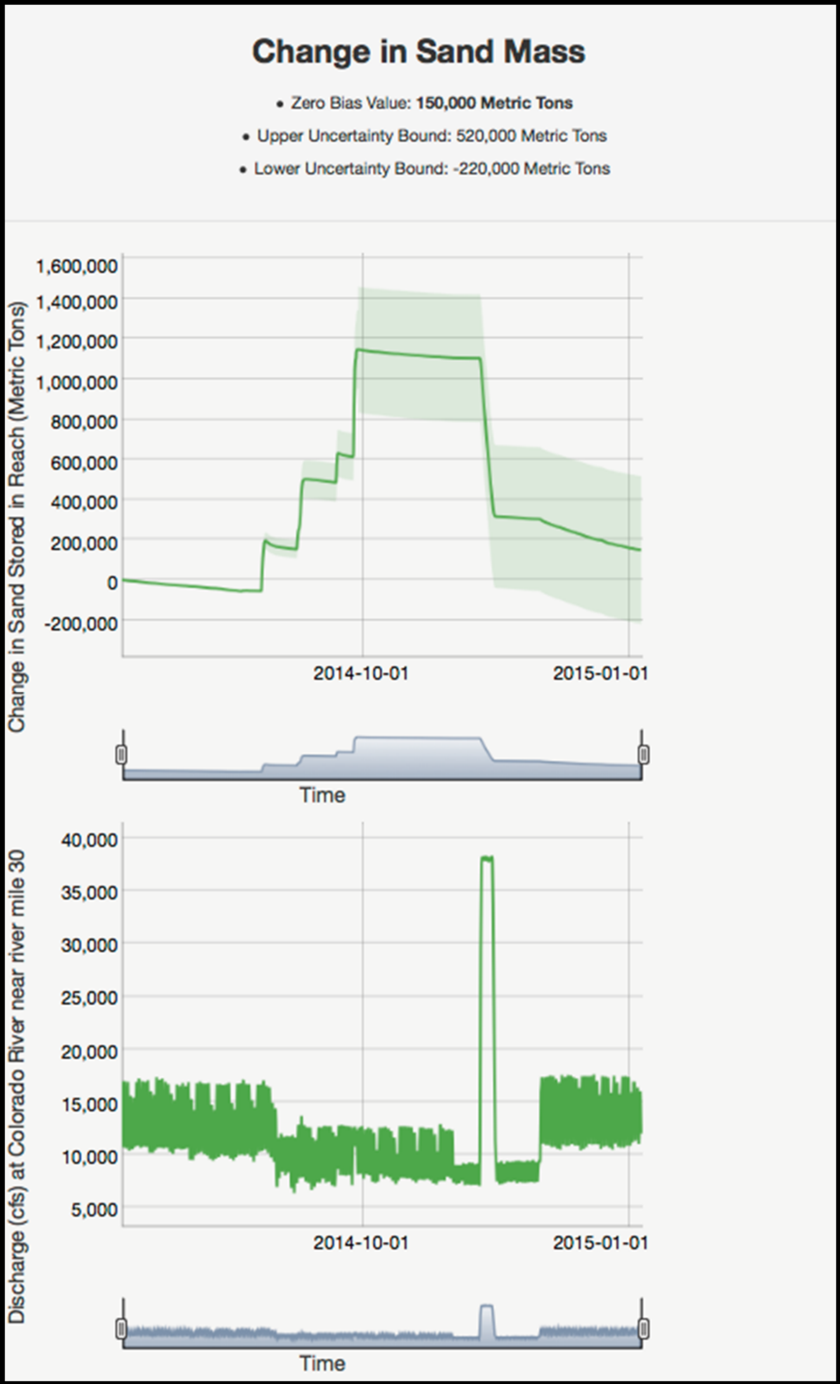
Project B: Streamflow, water quality, and sediment transport

- The basic physical data nearly all projects rely upon
- This now mature monitoring program is the result of sustained efforts that began 15 years ago
- Completion of database and publically accessible website is HUGE accomplishment
- The data demonstrate that sand evacuation occurs during periods of sustained high releases (equilization flows) and sand accumulation during periods of sustained low releases
  - *To be covered in more detail in HFE workshop*

USGS



http://www.gcmrc.gov/discharge_qw_sediment/



This project collects and processes the data used to trigger HFEs

Upper Marble Canyon sand budget

July 1, 2014 to January 5, 2015

http://www.gcmrc.gov/discharge_qw_sediment/

Project A: Sandbar Monitoring and Sediment Storage Dyanamics

- Sandbar monitoring
  - *HFE response by network of remote cameras*
  - *Annual sandbar monitoring by topographic surveys*
  - *Development of new sandbar monitoring database and website*
- Sand budget
  - Effect of equalization flows
  - Effect of HFEs since 2012
- Modeling, Methods for bed texture classification, Sandbar geochemistry, interactions between bed sediment and suspended sediment (won’t get to these)

USGS

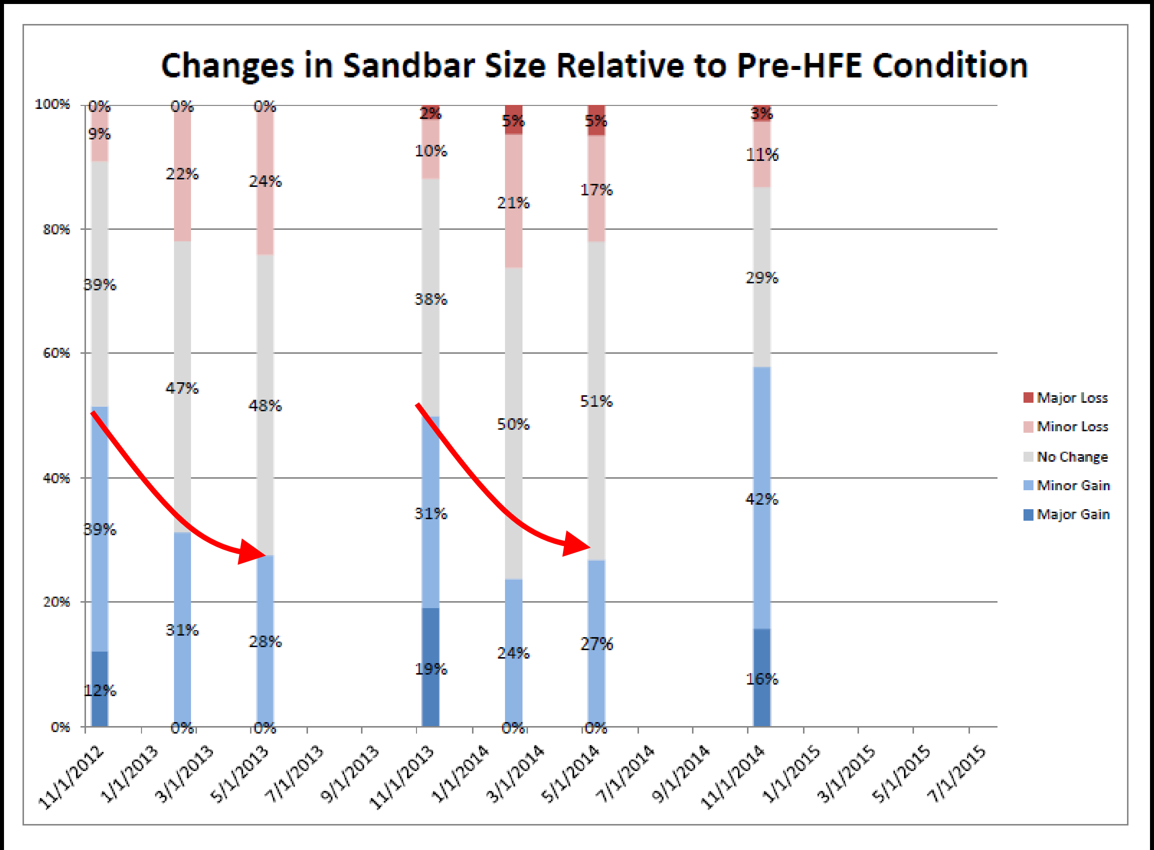
2014 HFE

- 22 sites (58%) larger
- 11 sites (29%) no change
- 5 sites (13%) smaller

Photos at www.gcmrc.gov/sandbar/

USGS

Response to HFE Protocol



2012 HFE   2013 HFE   2014 HFE

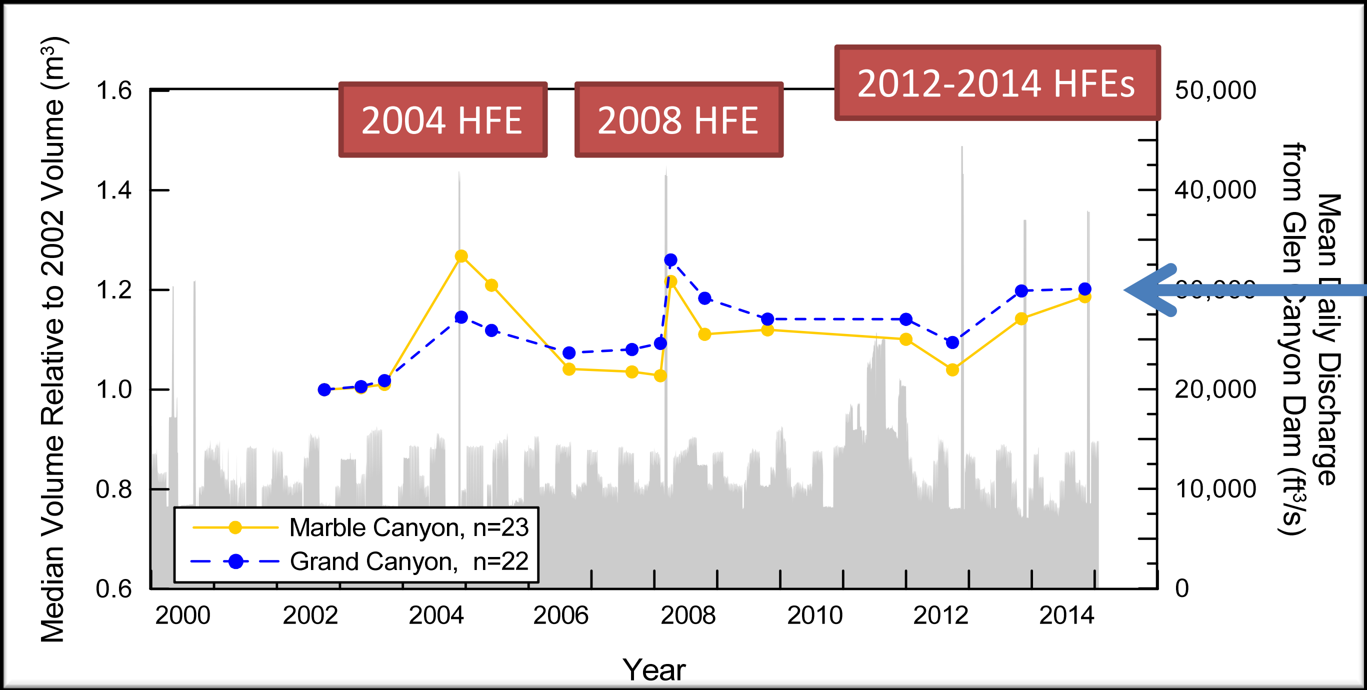
- Each of the HFEs in the past 3 years has resulted in sandbar deposition
  - They continue to erode in following 6 to 12 months

Photos at www.gcmrc.gov/sandbar/

USGS

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

Sandbars: 2002-present

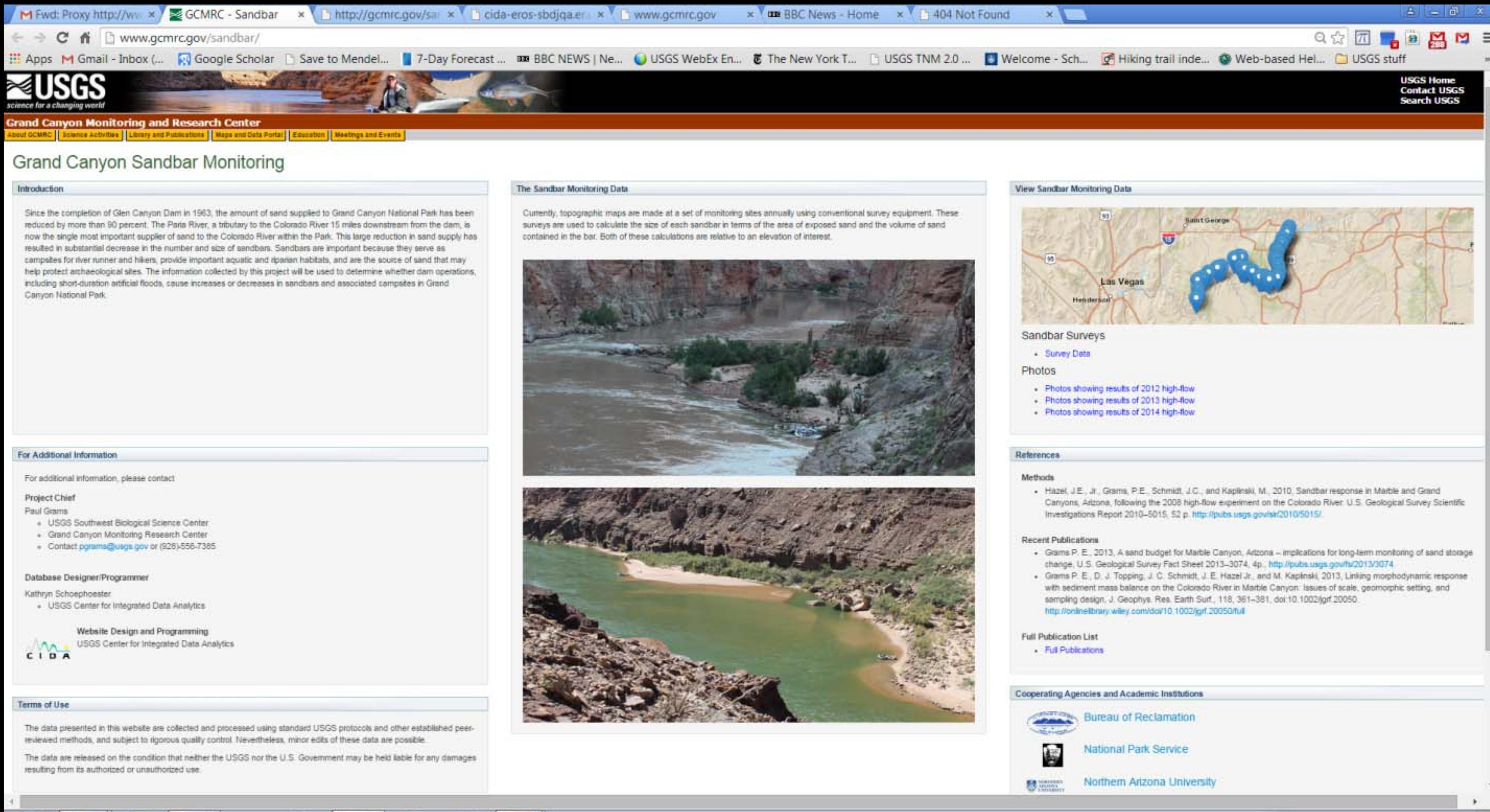


~10 months after HFEs, bars still larger than before start of protocol

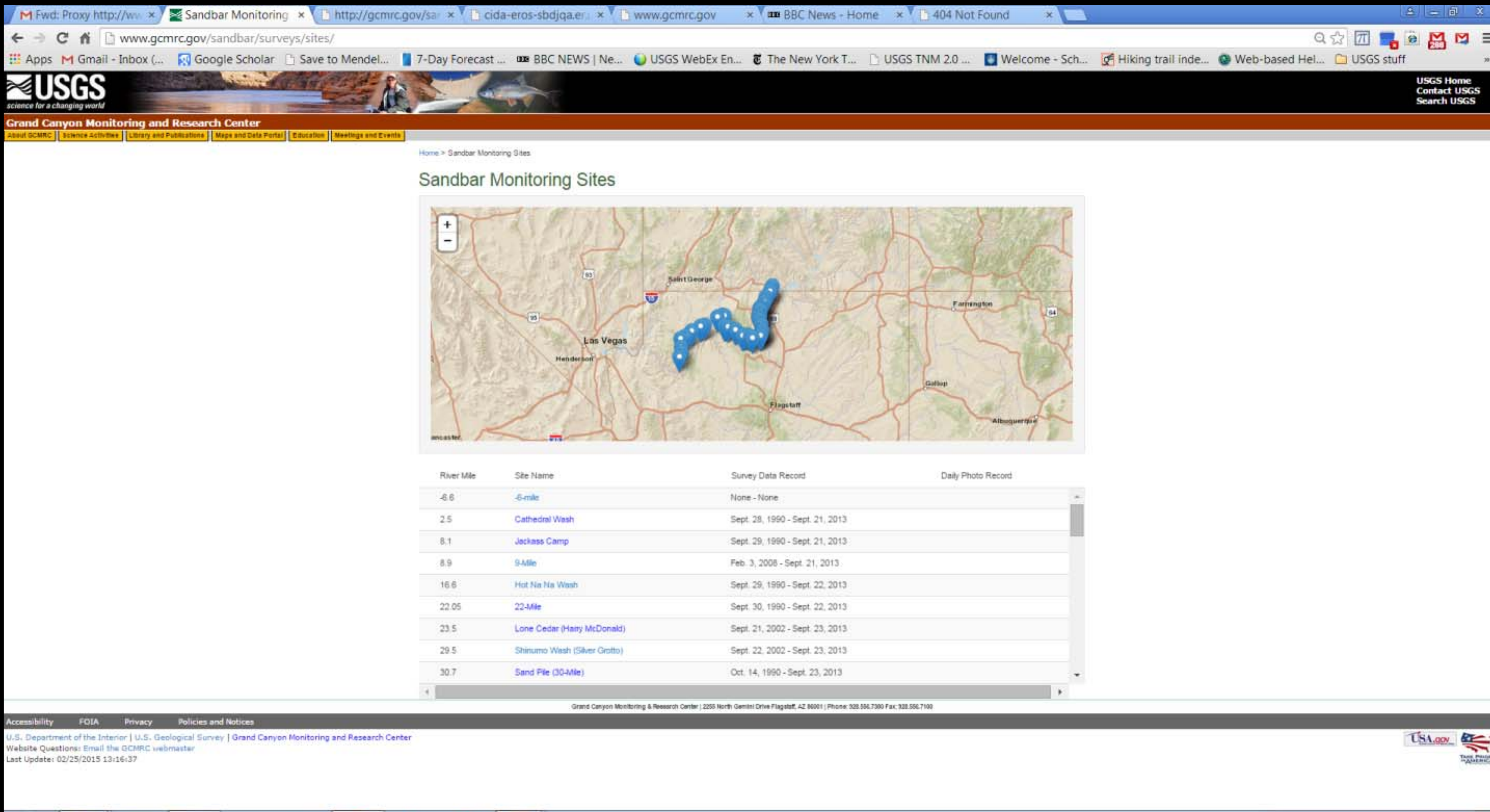
- Increase in volume in both Marble Canyon and Grand Canyon at long-term monitoring sites
  - Deposition by HFEs
  - Bars erode following HFEs, but not quite to pre-flood size
- Frequent HFEs = consistently larger bars
- Cumulative effect? No evidence yet that bars will get progressively larger.
- 2013 and 2014 HFEs were smaller than 2012 and earlier.
- Data now on website!!

USGS

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



www.gcmrc.gov/sandbar/



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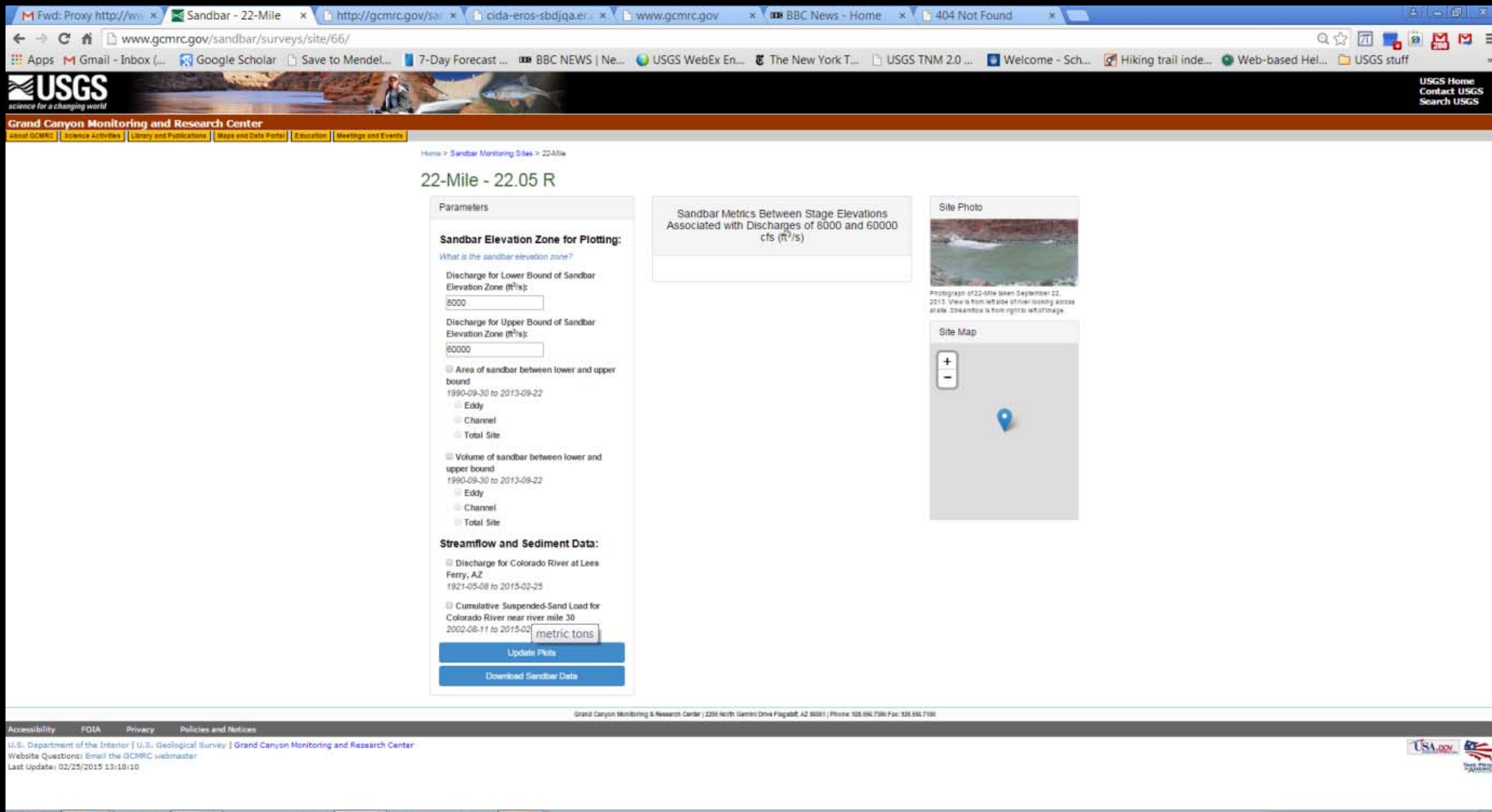

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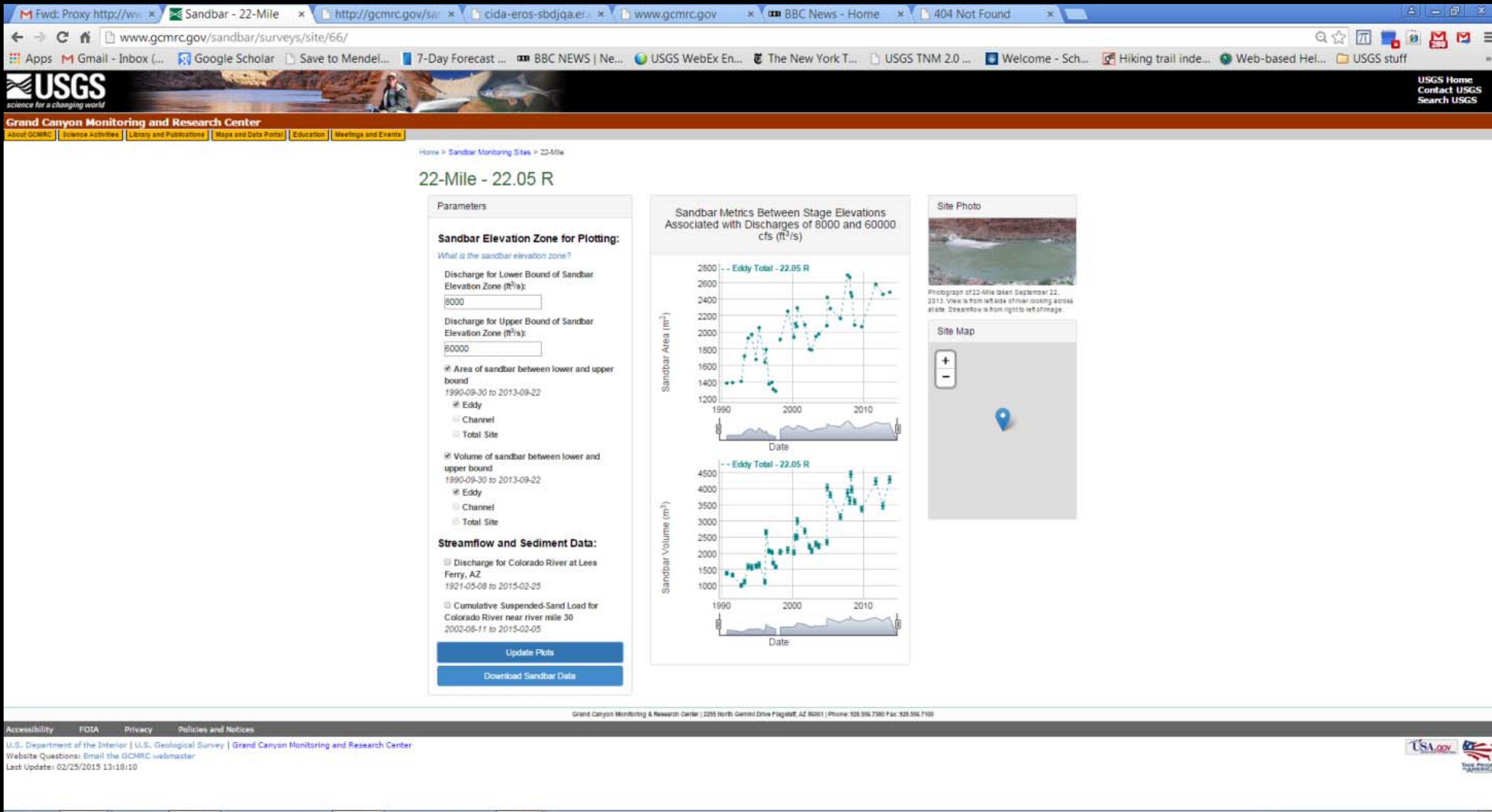
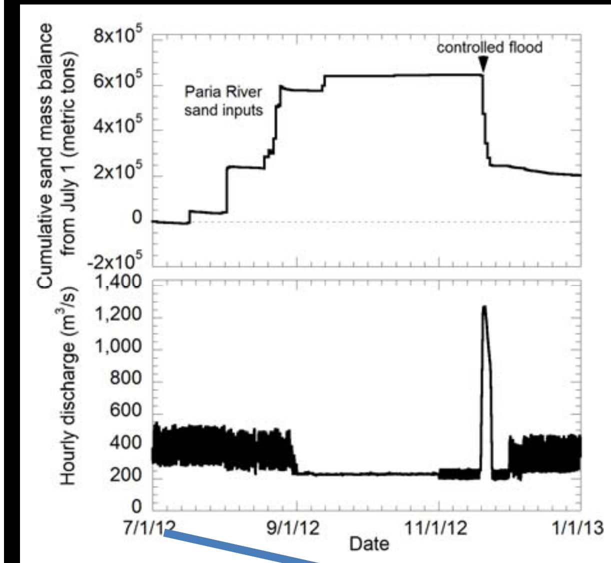


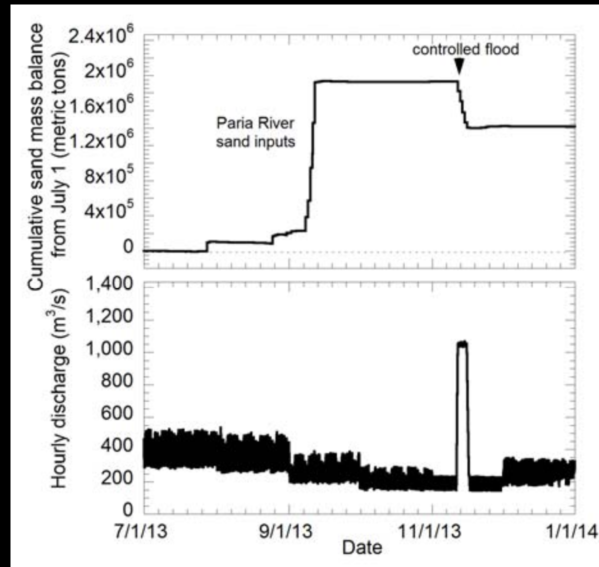
www.gcmrc.gov/sandbar/

USGS

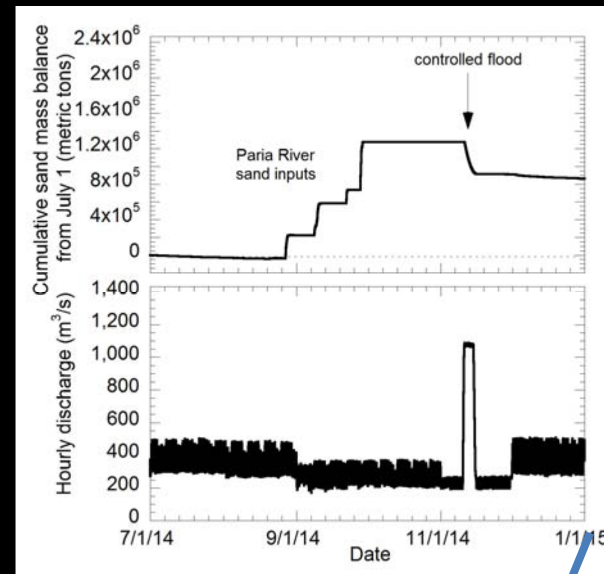
Sand Storage in Marble Canyon During HFE Protocol



2012 HFE

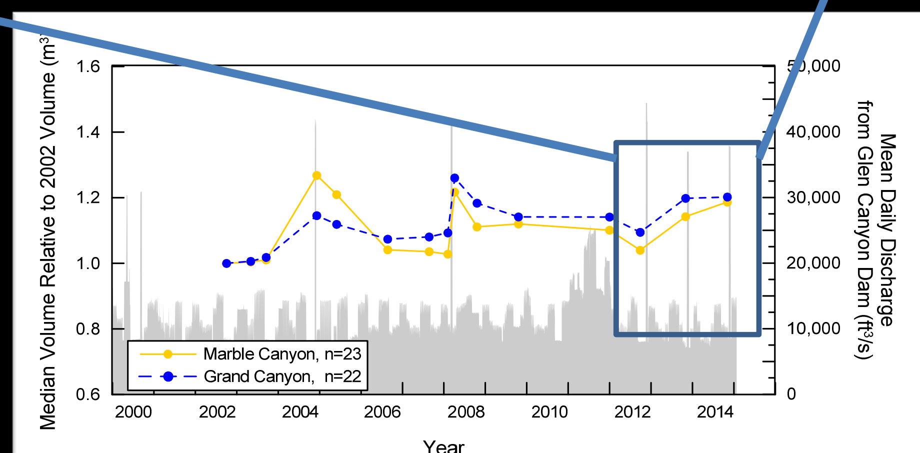


2013 HFE



2014 HFE

- Since 2012, each year has had enough sand accumulation to have a controlled flood and have sand accumulation
- Accumulation has more than replaced "evacuation" that occurred in 2011



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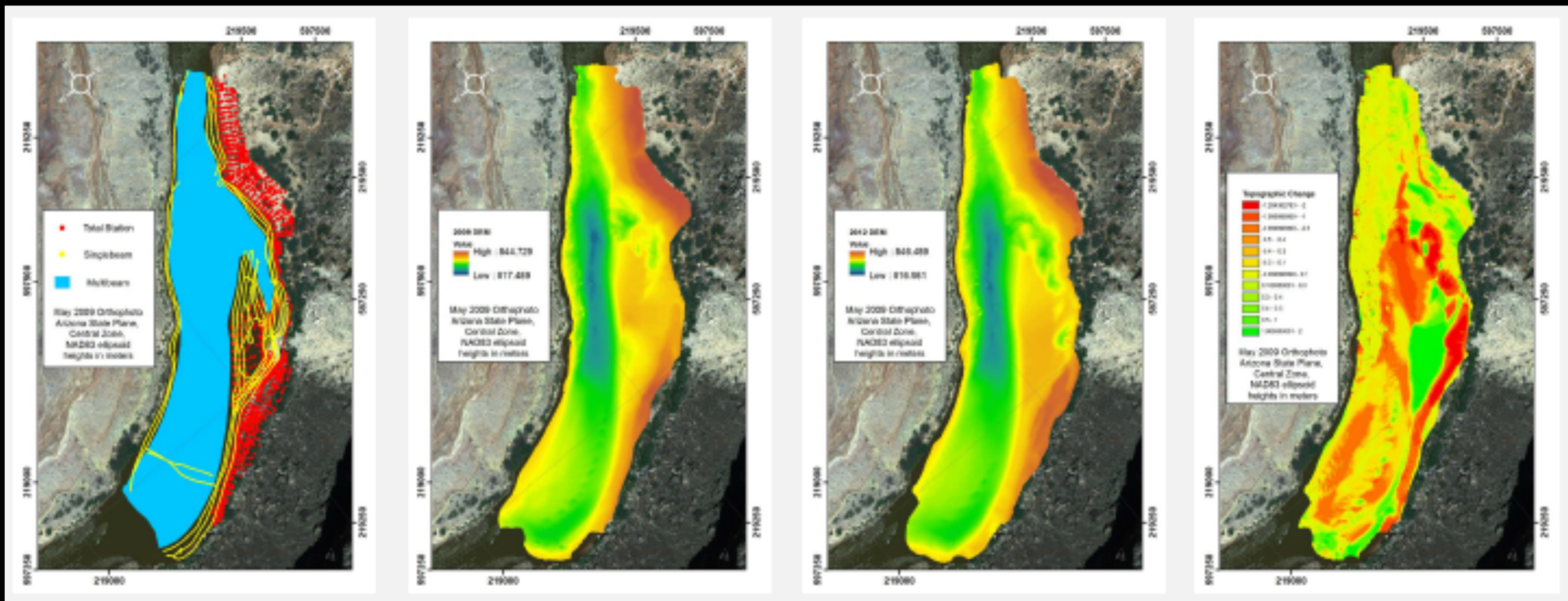
USGS

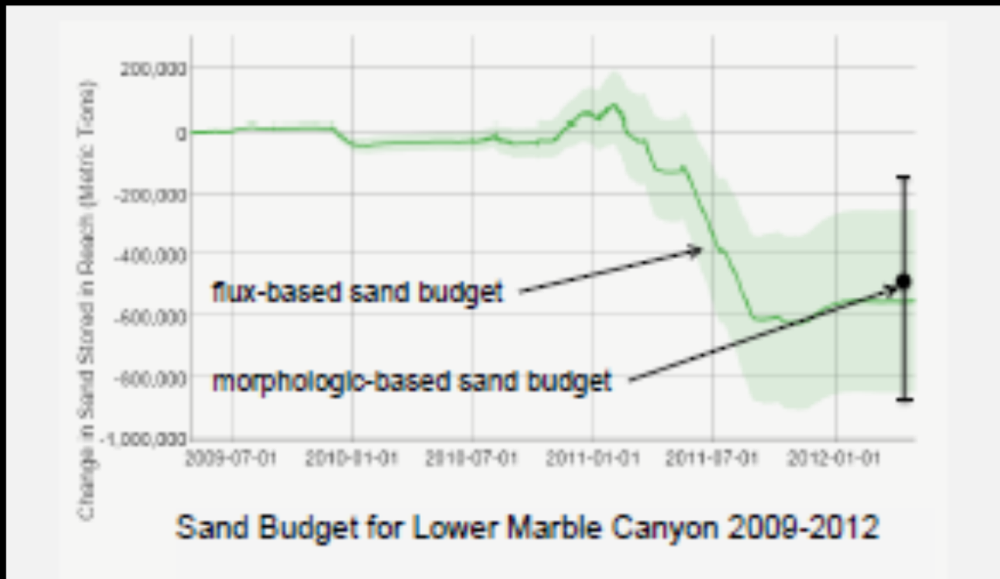
Sand Storage in Lower Marble Canyon: 2009-2012

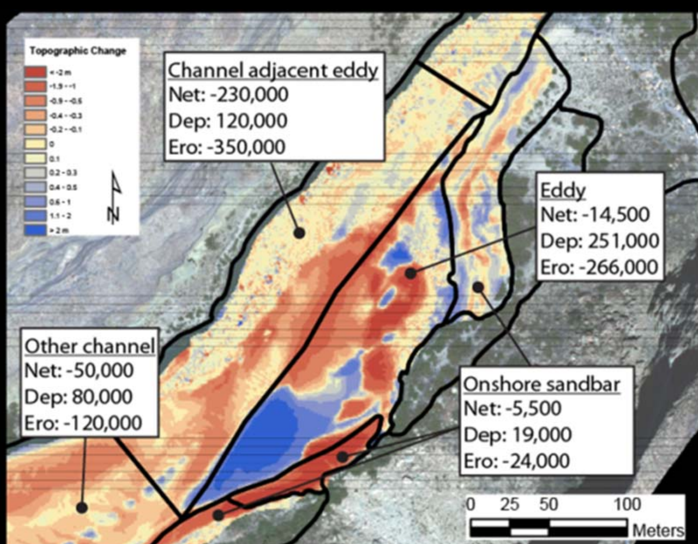


- Repeat maps of river bed used to track changes in sand storage and changes in bed texture
- Show where changes in storage occur

USGS

Sand Storage in Lower Marble Canyon: 2009-2012





- Sand loss during equalization flows
  - Over short (3-year) period have similar uncertainty to flux measurements)
  - Over long (10-20 year) period have much less uncertainty than flux measurements
- Most erosion from channel
  - Erosion of high-elevation bars (above 8,000 cfs stage)
  - No net loss from eddies

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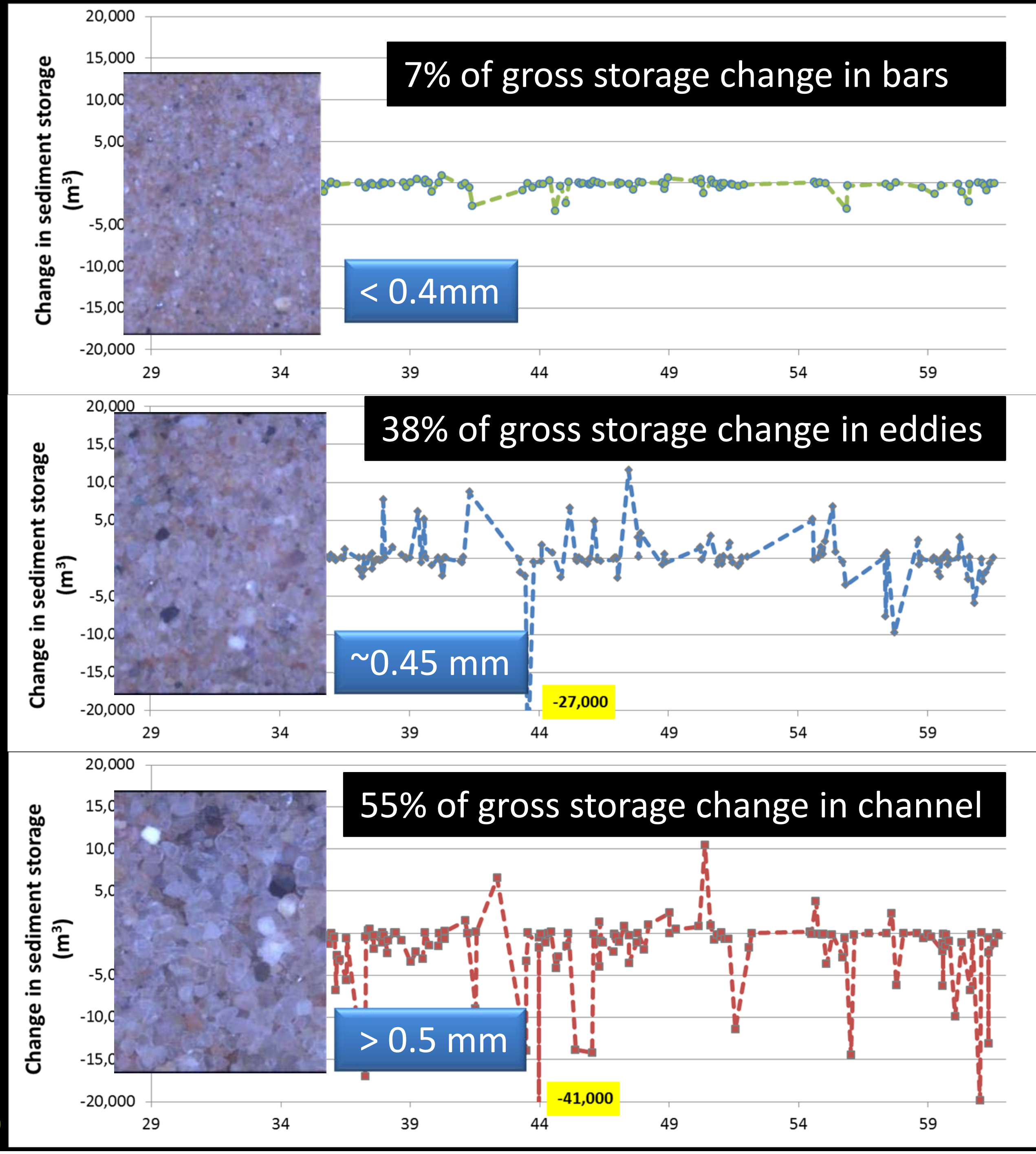
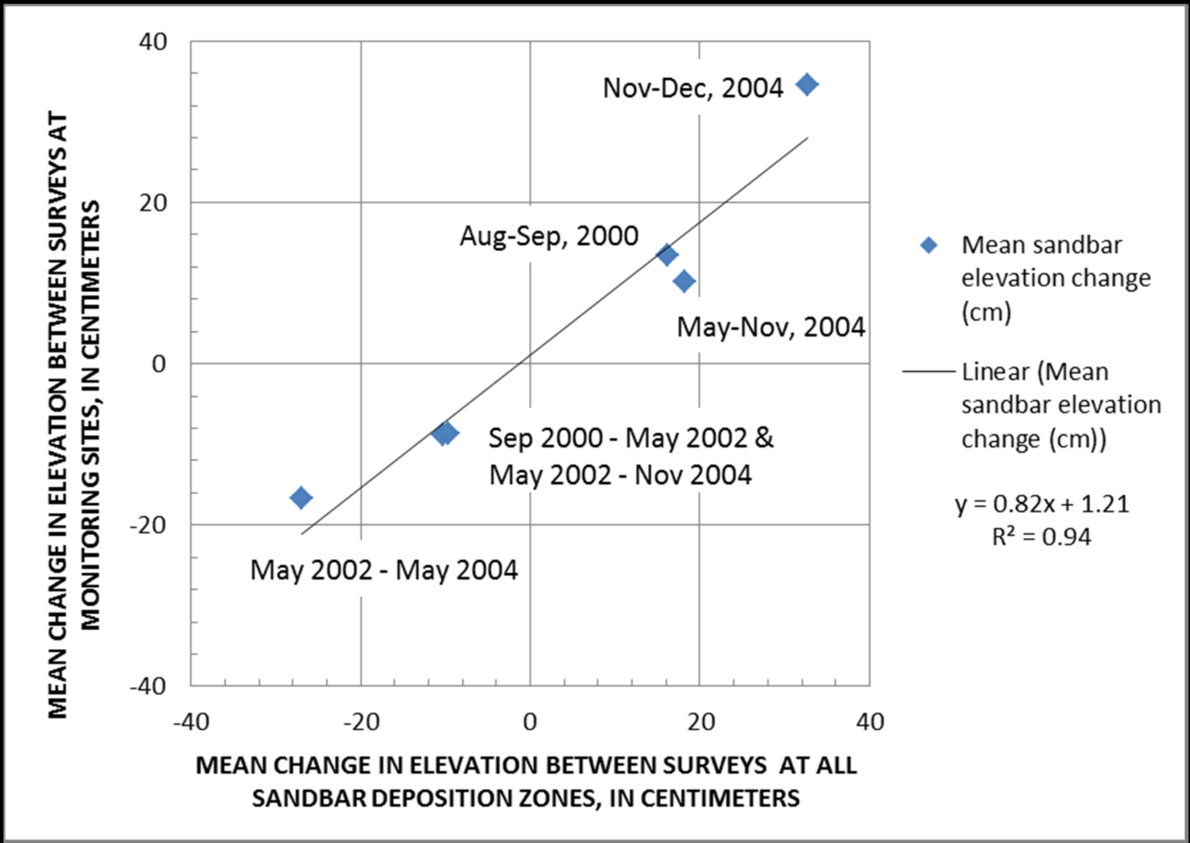
Grams et al. (2015)



Grams et al. (2015)

Sandbar Monitoring Sites Compared to all Sandbars in 6 Short Reaches

Positive correlation between response at monitoring sites and response for encompassing 2-mi reach (between RM 0 and 87)



Conclusion: *Monitoring sites provide a good representation of both sandbar erosion and sandbar deposition at relatively large eddy sandbars above the 8,000 cfs stage when averaged over long reaches.*

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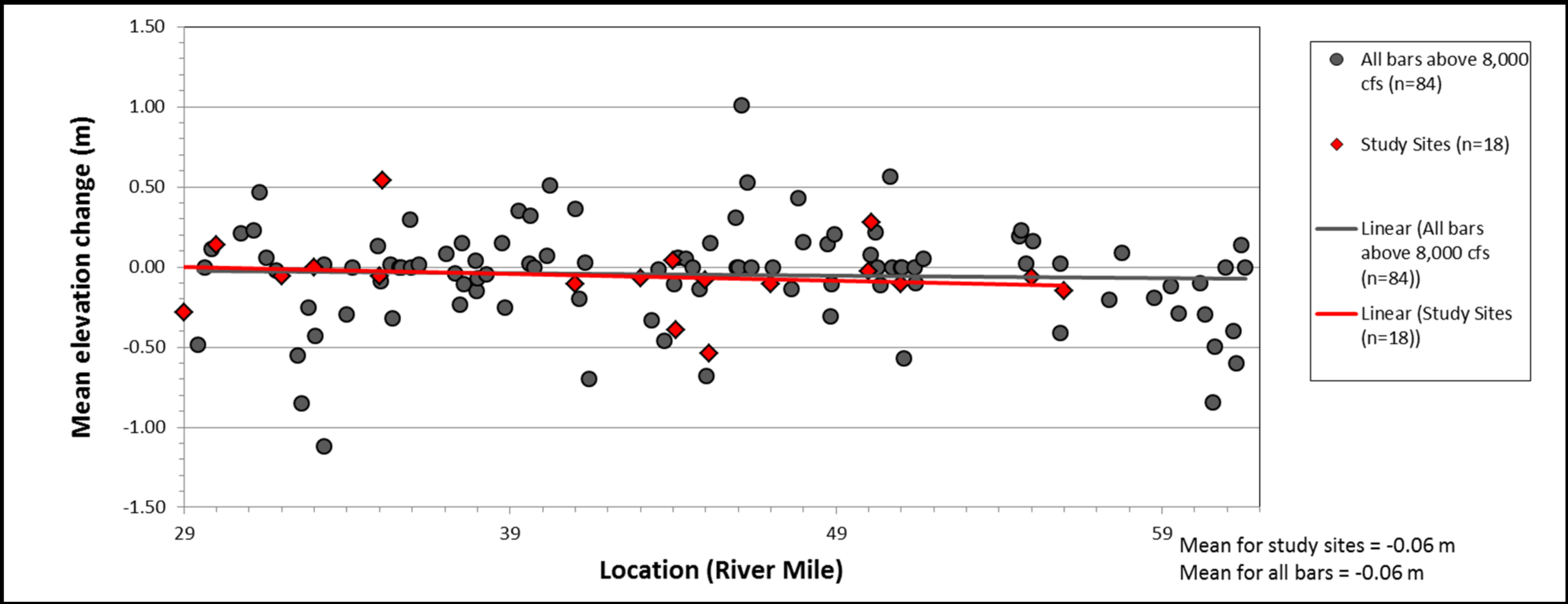
Preliminary results, subject to review and revision – do not cite

Comparison with Long-term Sandbar Monitoring (NAU) Sites – Only for changes above 8,000 ft^3/s stage elevation



	Mean Change	Maximum Deposition	Maximum Erosion	Standard Deviation
Monitoring Sites	-0.06 m	0.54 m	-0.54 m	0.23 m
All Bars above 8,000 ft^3/s elevation	-0.06 m	1.01 m	-1.12 m	0.35 m

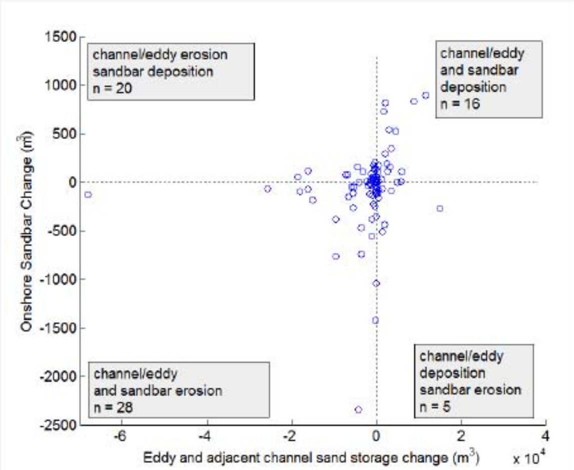
Grams et al. (2015)

What is the relation between sand storage in the channel and sandbar response?

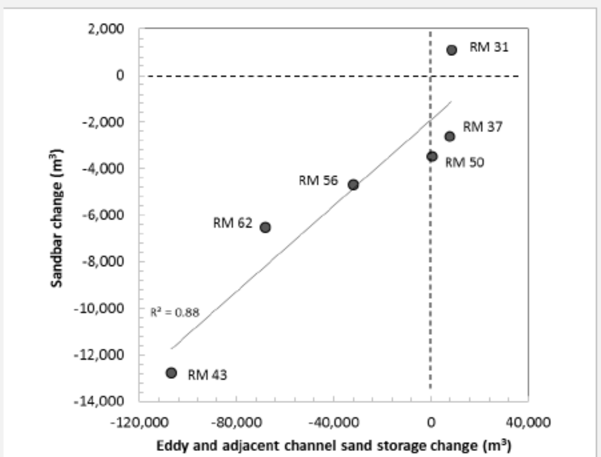
- Building sandbars requires a sand supply
- Although the Paria River is the source of the sand, it has to travel through the river channel to get to a sandbar

USGS

What is the relation between sand storage in the channel and sandbar response?



Change in onshore sandbar volume as function of change in channel and eddy storage for the corresponding eddy.



Correlation between sandbar change and eddy/adjacent channel change for 10km segments of study reach.

- At scale of individual eddies, sandbar response not predictable based on change in sand storage in adjacent eddy and channel

- Sandbar response is predictable based on change in sand storage in adjacent eddy and channel when averaged over a 10 km reach

Grams et al. (2015)

USGS

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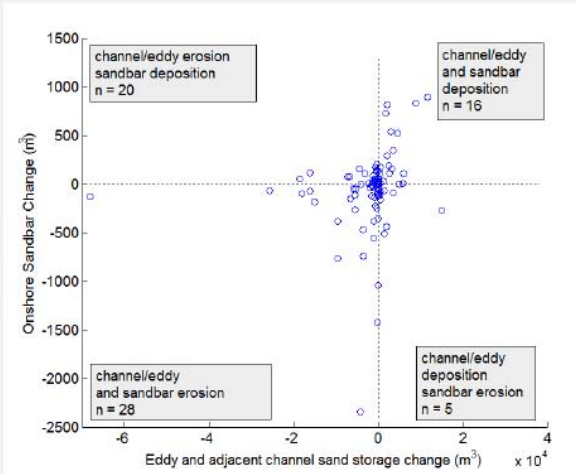

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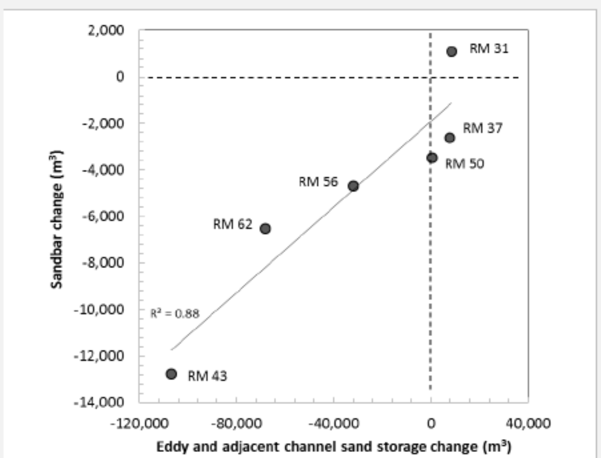


Correlation between sandbar change and eddy/adjacent channel change for 10km segments of study reach.

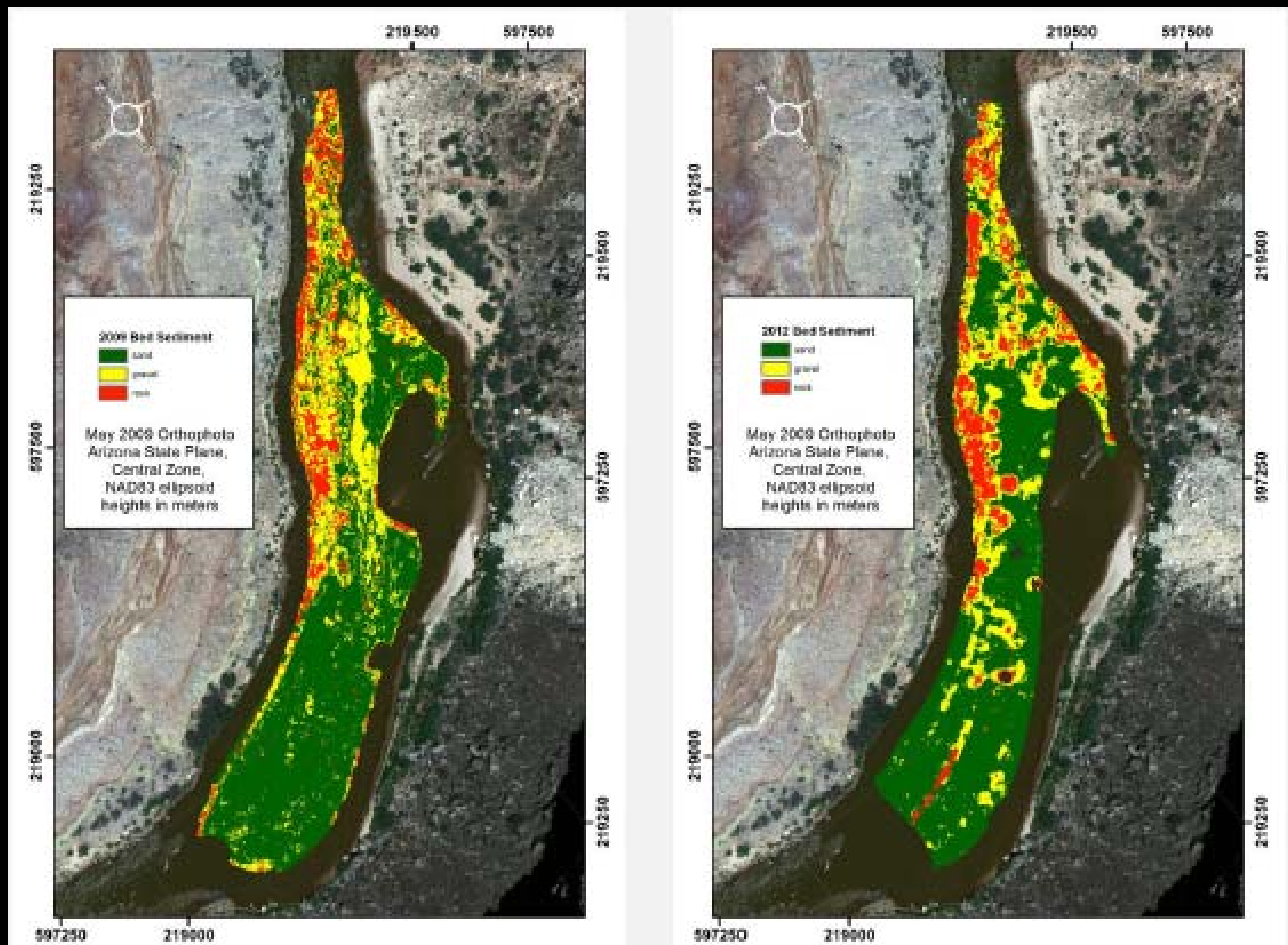
- Sandbar response is predictable based on change in sand storage in adjacent eddy and channel when averaged over a 10 km reach

Positive sand budget = larger sandbars
Negative sand budget = smaller bars

Grams et al. (2015)

USGS

Advances in Mapping Bed Texture

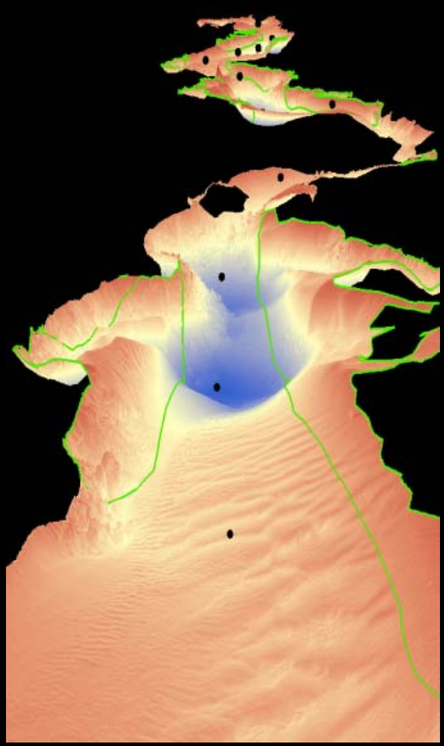


- Maps of bed texture based on acoustic properties
- Automated methods for applying classification to entire river segments
- Extending the methods for use with data collected by simple and inexpensive equipment for studying aquatic habitat

Buscombe et al. (2014)

Summary

- Sandbar Trends: 2002 to 2014
  - Based on looking at lots of sandbars on air photos, bar area about the same, but variable depending on when you're looking (how long since most recent HFE)
  - Based on looking at NAU long-term monitoring sites (45 sites in Marble and Grand Canyons), bar volume larger now than 2002
- Equalization flows cause sand evacuation
  - The eddies appear to provide a large buffer during periods of evacuation
- First three years of HFE protocol has been a period of low annual release volumes and good tributary sand supply
  - Bar deposition without depleting sand from storage
  - Sand has accumulated in Marble Canyon, replenishing sand evacuated during 2011 equalization



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

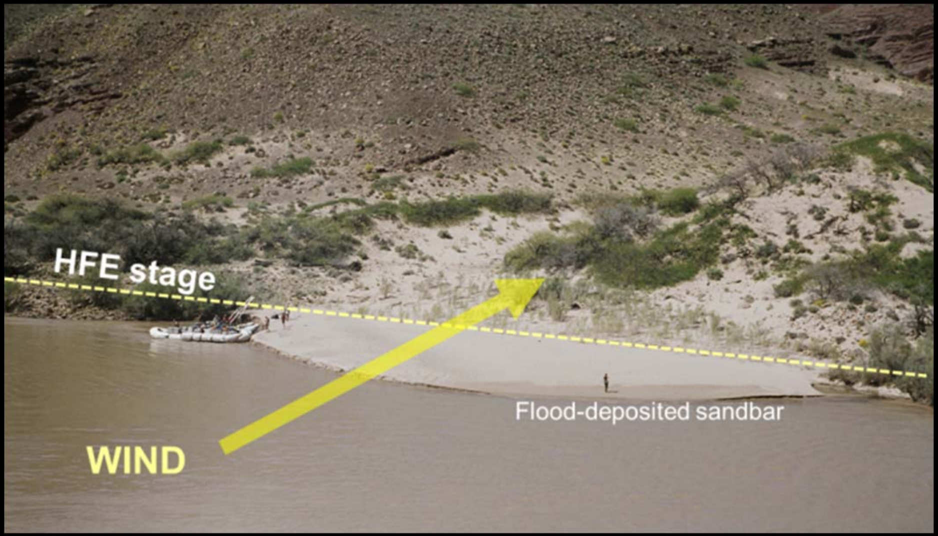
USGS

Cultural Resource Monitoring and Research: FY 2013-2014
Summary of Findings

- Topographic changes occurred between 2013 and 2014 at all sites monitored by lidar.
- HFE-deposited sand, subsequently transported to upland locations by wind, temporarily fills some gullies.
- Although gullies runoff generated by seasonal rains may still cause erosion, gully infilling provides a self-regulating mechanism ("annealing") than has the potential to slow or arrest progressive erosion.

- The November 2012 HFE caused erosion along a steep cut bank that is adjacent the river and adjoins a cultural site.

More at HFE workshop

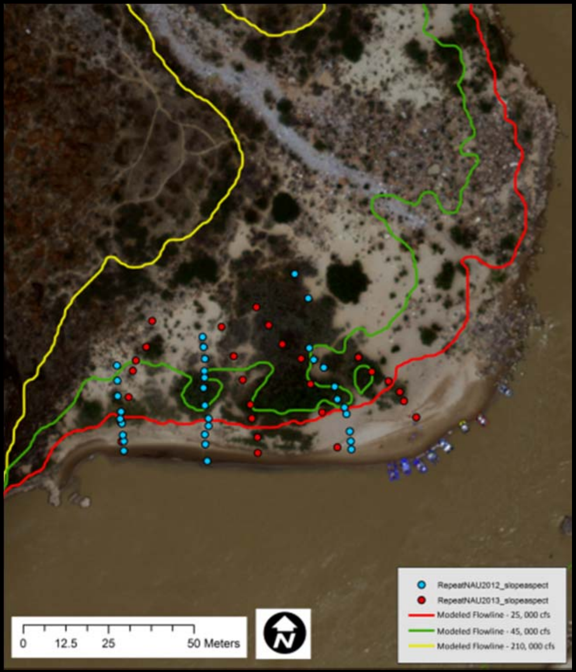


Preliminary results, subject to review and revision – do not cite

USGS

Riparian Vegetation Monitoring and Research

- Over past 3 years, we have developed and implemented a riparian vegetation monitoring program that is based on protocols consistent with those being used throughout the Colorado River Basin
  - Annual sampling in July-September
  - Mix of random and fixed sites between dam and RM 240
  - Fixed sites co-located with annual sandbar monitoring sites

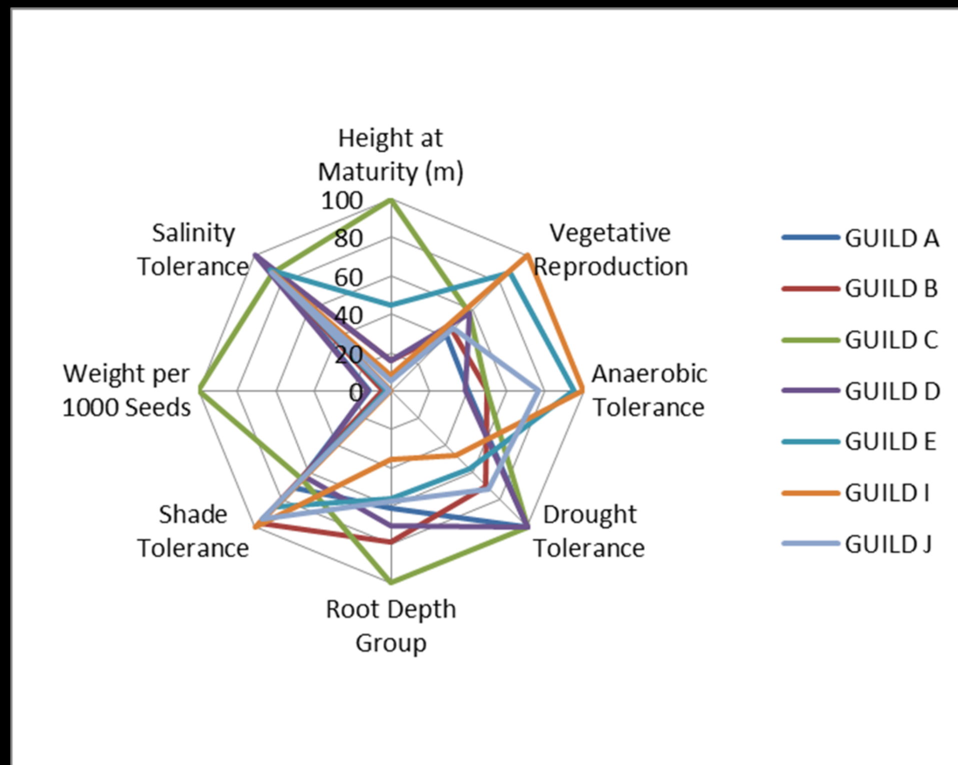


USGS

Riparian Vegetation Monitoring and Research

- Most vegetation from sample plots can be placed into 7 categories or guilds based on morphological and physiological traits using heirarchical cluster analysis

- Traits include:
  - rooting depth (shallow to deep) and
  - drought tolerance (high to low).



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

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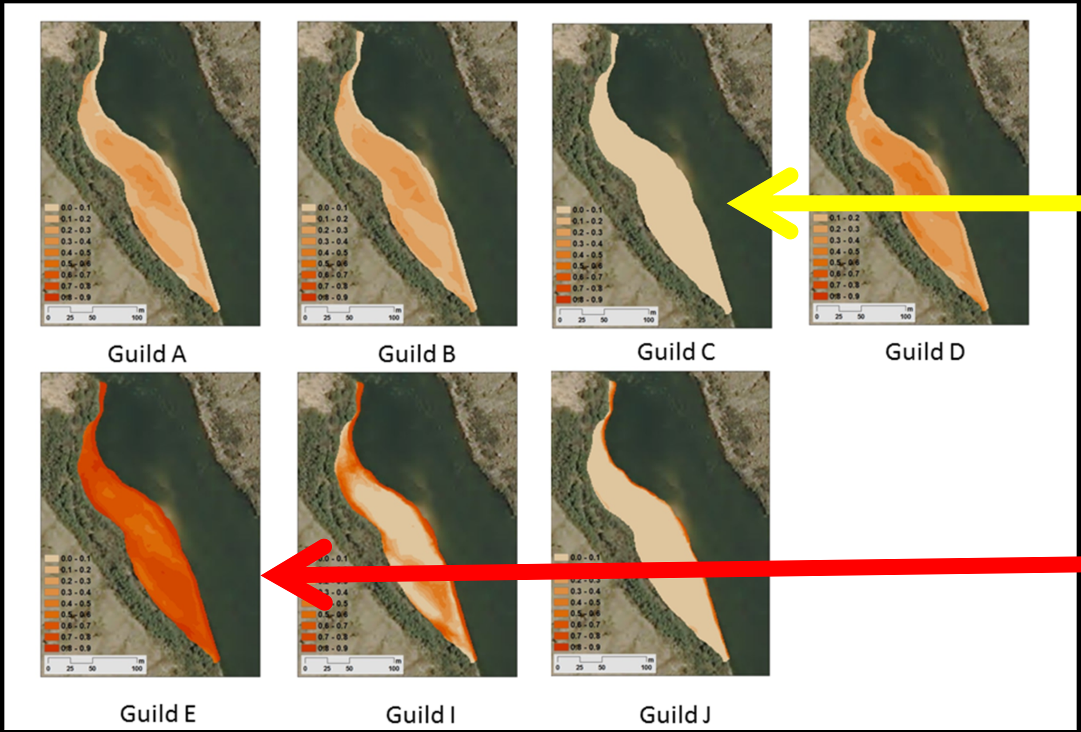
Riparian Vegetation Monitoring and Research

- Grouping species based on shared traits increases the power to detect a direction of vegetation response to changes in a flow regime
- Monitoring also tracks individual species of interest and general trends in species richness



Modeled probabilities of occurrence for the guilds A-J.

Guild C (includes hackberry) has lowest probability

Guild E (includes Phragmites, coyote willow) has highest probability.

Merritt et al. (preliminary results)

USGS