

Status of Sediment Resources – August 2013



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USGS Grand Canyon Monitoring and Research Center with cooperation from Northern Arizona University, Grand Canyon National Park, and Grand Canyon River Guides



Guiding Goals

- AMP Goal
 - *Is there a “Flow-Only” operation (i.e. a strategy for dam releases, including managing tributary inputs with BHBFs, without sediment augmentation) that will restore and maintain sandbar habitats over decadal time scales?*
- *Desired Future Conditions (2011 DFC report)*
 - *Levels of sediment storage within the main channel and along shorelines that achieve ecosystem goals*
- HFE Protocol Science Question
 - *Can sandbar building during HFEs exceed sandbar erosion during periods between HFEs, such that sandbar size can be increased and maintained over several years?*

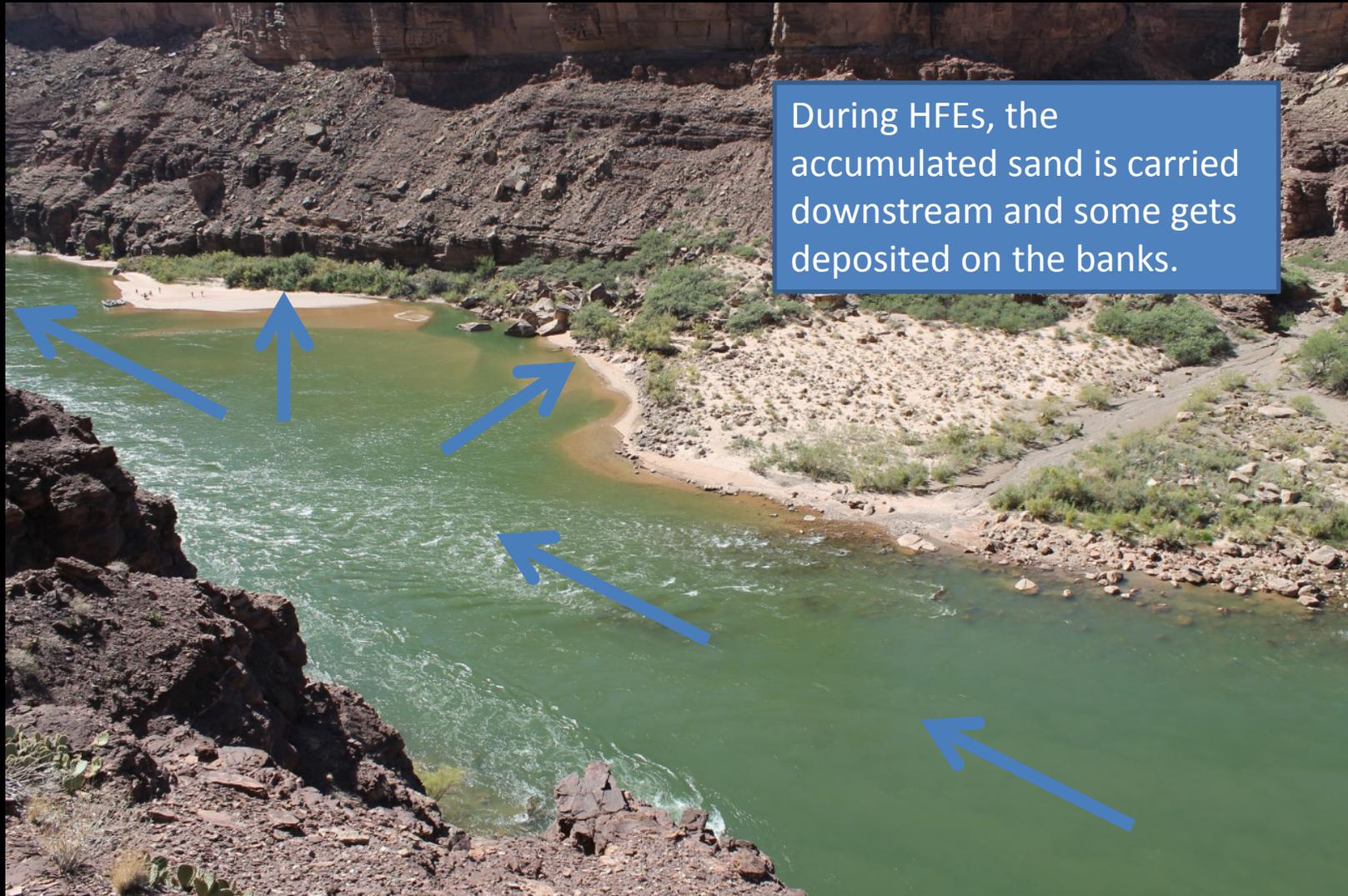
Key Monitoring Activities

- Sandbars (monitoring of sandbar resource)
 - Confirm that each HFE builds sandbars with images collected by remote cameras (We know that the high flows build sandbars and that there is variability in sandbar response → **Further quantification yields little new insight at great expense**)
 - Annual (fall) sandbar surveys at long-term sites
 - Analysis of remote sensing images every 4 years (2002, 2005, 2009, 2013...)
- Sand supply (needed to plan HFEs and evaluate effect of protocol on sand storage)
 - Monitoring sediment flux
 - In-channel sand storage monitoring

Sandbar vs. sediment: The link between “beaches” and “mass balance”



Sandbar vs. sediment: The link between “beaches” and “mass balance”



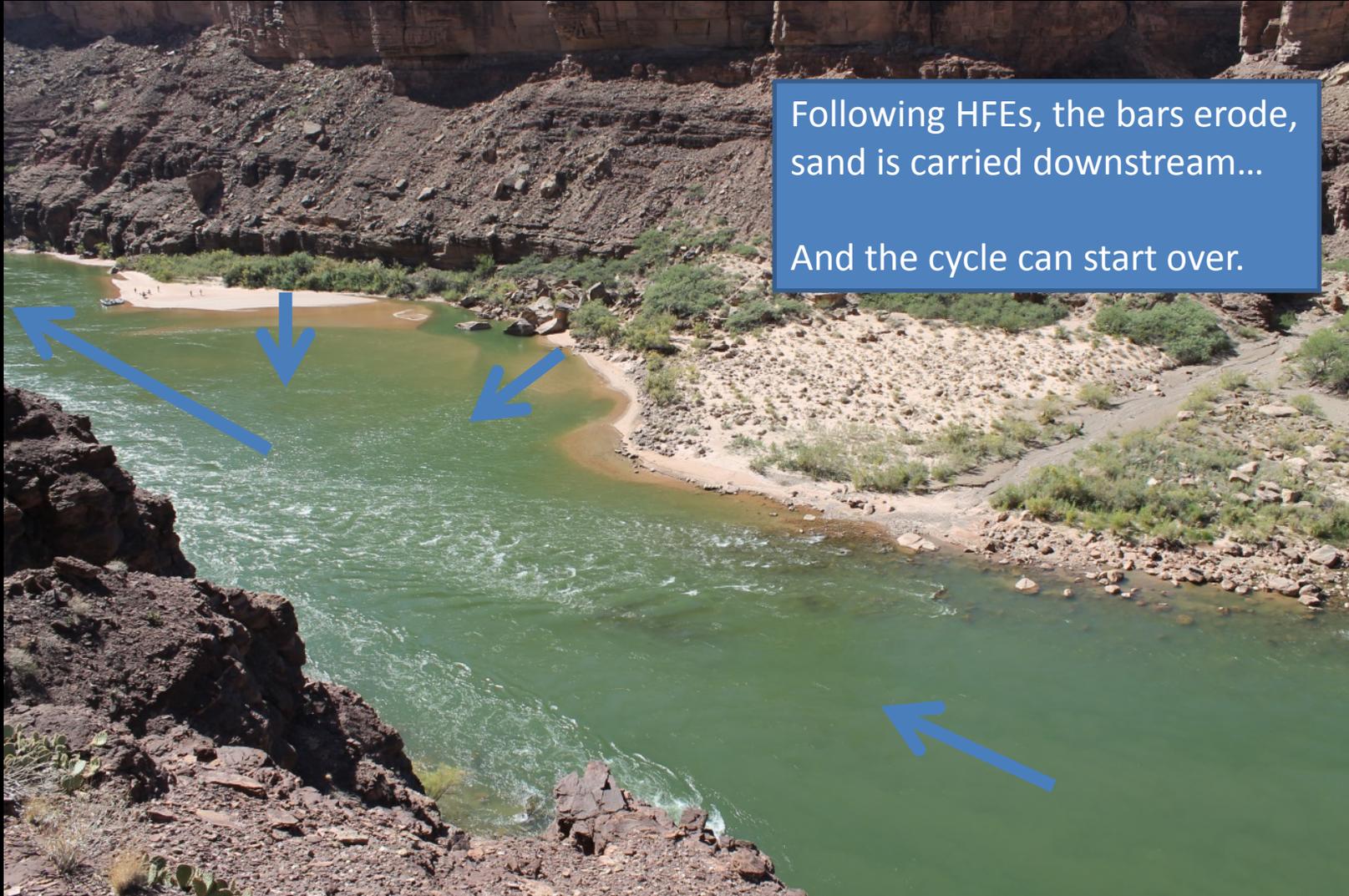
Sandbar vs. sediment: The link between “beaches” and “mass balance”



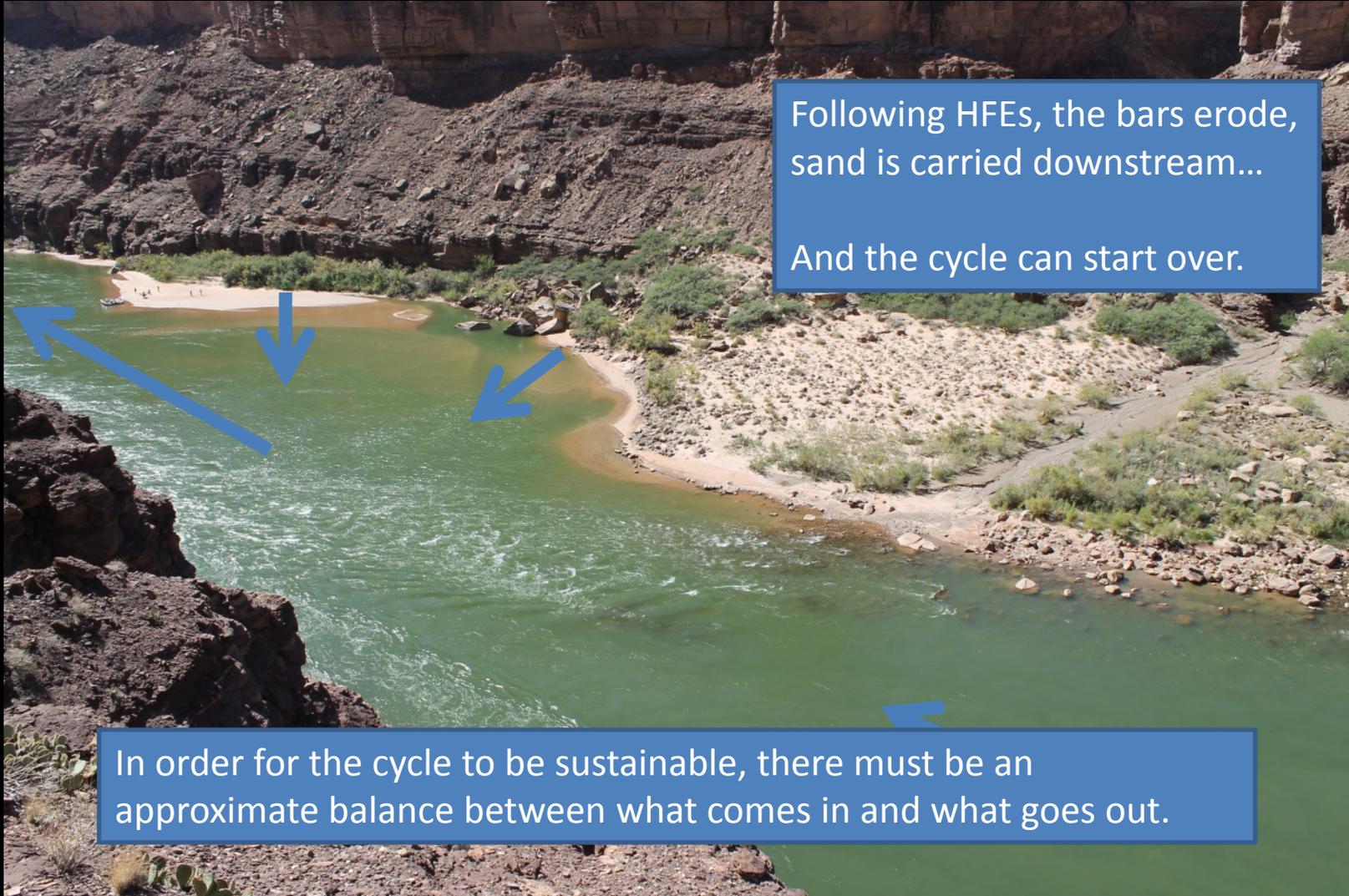
During HFEs, the accumulated sand is carried downstream and some gets deposited on the banks.



Sandbar vs. sediment: The link between “beaches” and “mass balance”



Sandbar vs. sediment: The link between “beaches” and “mass balance”

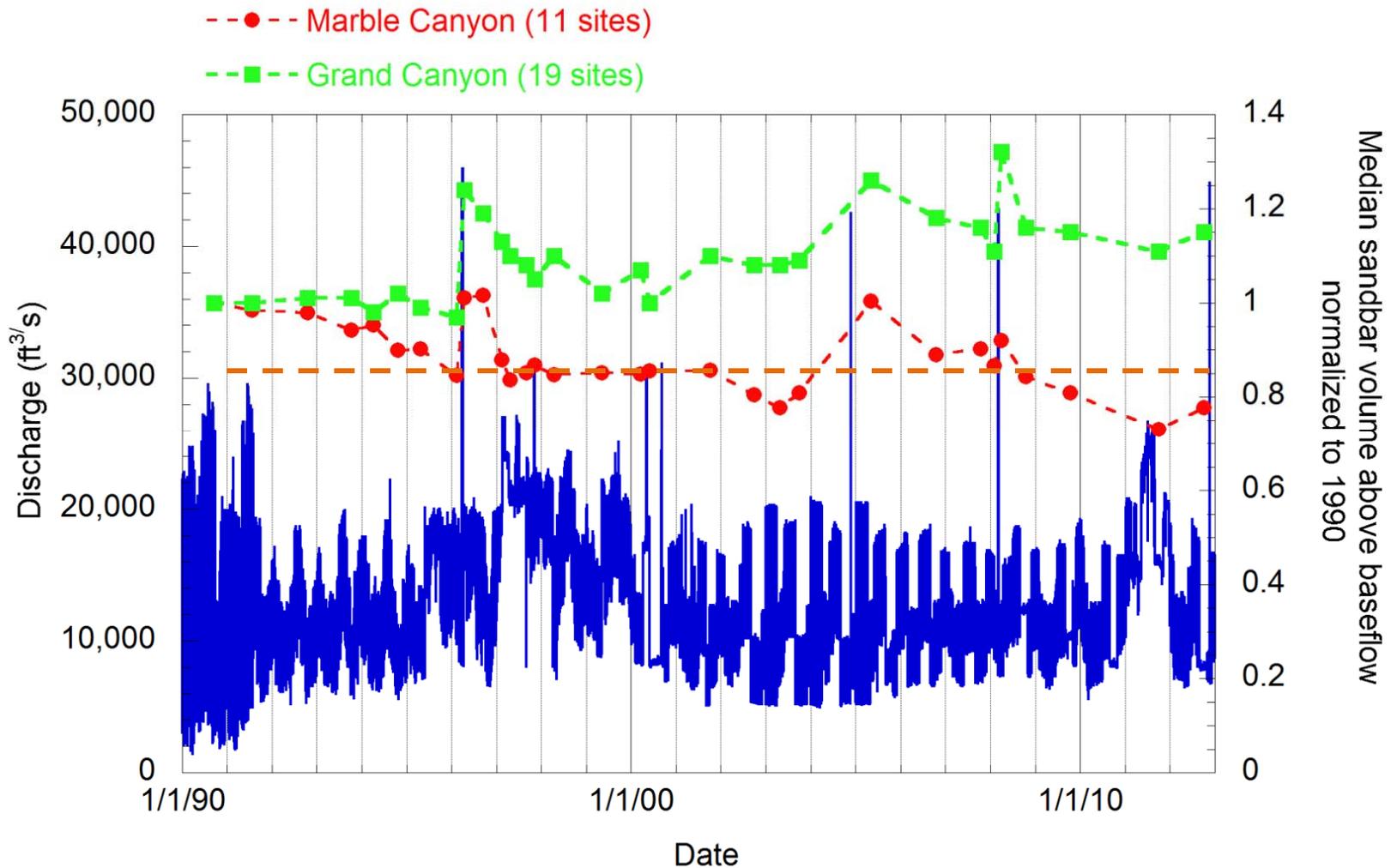


Following HFEs, the bars erode, sand is carried downstream...

And the cycle can start over.

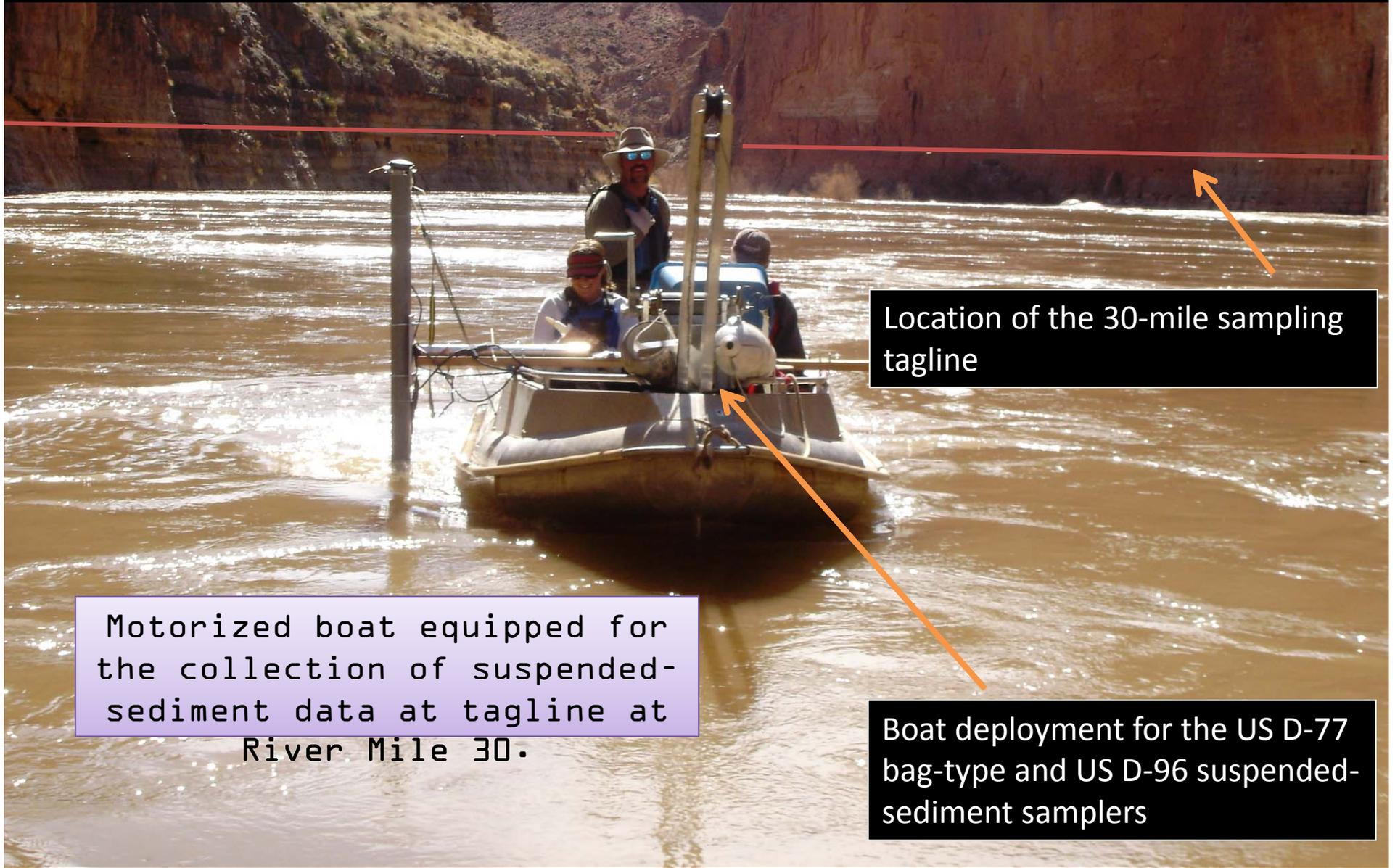
In order for the cycle to be sustainable, there must be an approximate balance between what comes in and what goes out.

Does Mass Balance Affect Sandbars?



The Marble Canyon long-term balance is likely negative while the Grand Canyon long-term balance is likely more neutral.

How do We Measure Sand Mass Balance?



Location of the 30-mile sampling tagline

Motorized boat equipped for the collection of suspended-sediment data at tagline at River Mile 30.

Boat deployment for the US D-77 bag-type and US D-96 suspended-sediment samplers

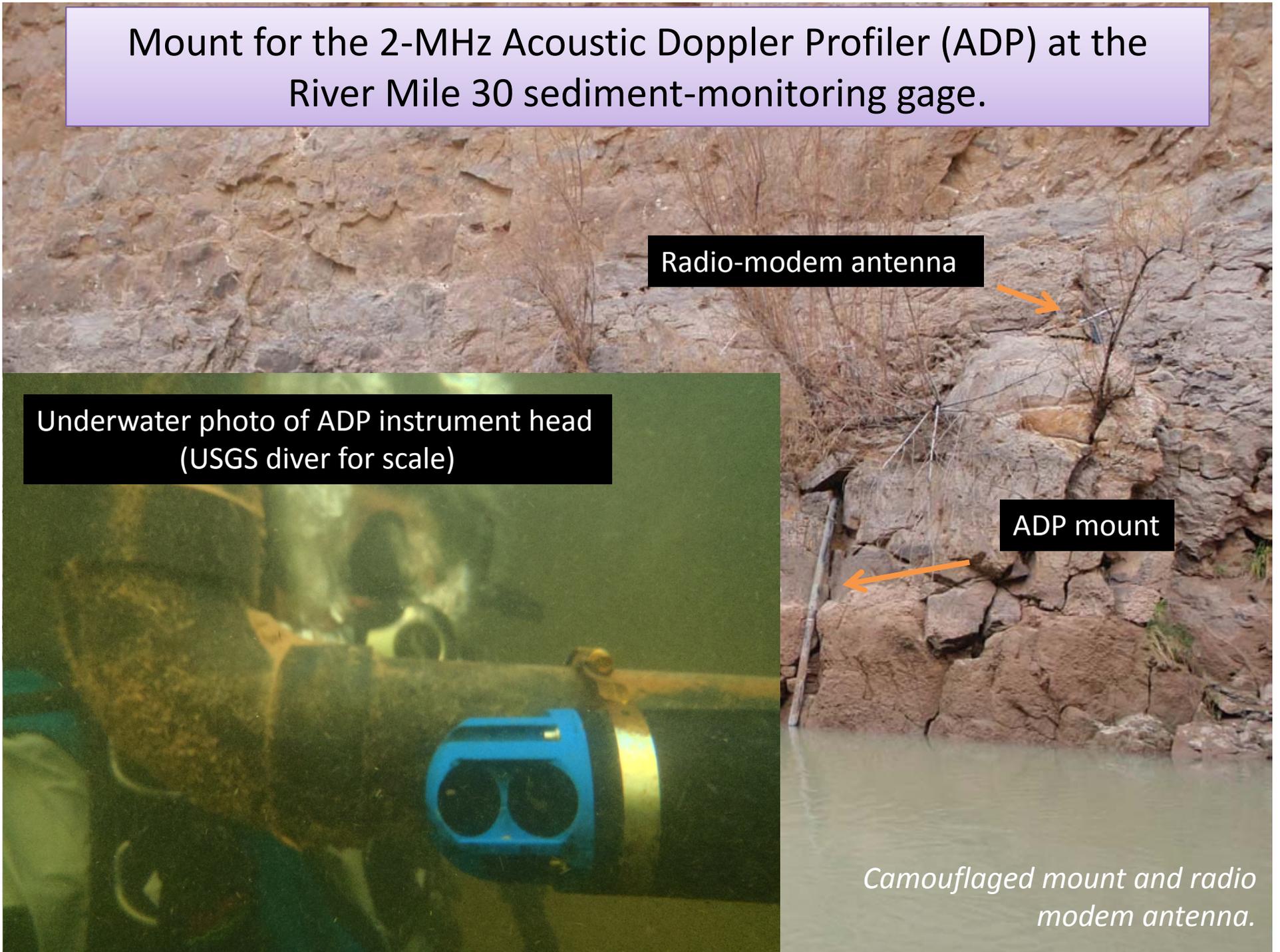
Mount for the 2-MHz Acoustic Doppler Profiler (ADP) at the River Mile 30 sediment-monitoring gage.

Radio-modem antenna

Underwater photo of ADP instrument head
(USGS diver for scale)

ADP mount

*Camouflaged mount and radio
modem antenna.*



Sand mass balance (budget) is computed for 6 reaches between Lees Ferry and Lake Mead



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)

Anyone can compute the sand mass balance:

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

Mass-balance Sand Budgets: 2002 to present

Period of budget	Upper Marble Canyon (RM 0-30)	Lower Marble Canyon (RM 30-61)	Eastern Grand Canyon (RM 61-87)
July 2002 - pre2004 flood	330,000 ± 194,000	-280,000 ± 110,000	-31,000 ± 310,000
pre2004 flood – pre2008 flood	900,000 ± 640,000	290,000 ± 350,000	72,000 ± 600,000
pre2008 flood – pre2012 flood	-1,300,000 ± 300,000 <i>(mostly during May-August 2011)</i>	13,000 ± 430,000	-4,200,000 ± 800,000 <i>(mostly during May-August 2011)</i>
pre2012 flood – Aug. 2013	-470,000 ± 70,000	68,000 ± 62,000	-270,000 ± 160,000
Entire record	-540,000 ± 1,200,000	91,000 ± 950,000	-4,429,000 ± 1,900,000

Central Grand Canyon (RM 87-225) is about neutral for 2002-2013 period.

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	<i>Mostly positive in 2000's</i>		
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	<i>Large negatives in 2011</i>		
pre2012 flood – Aug. 2013	-470,000 ± 70,000	68,000 ± 62,000	-270,000 ± 160,000
	<i>Small negative this WY – could be made up by large Paria inputs</i>		
Entire record	-540,000 ± 1,200,000	91,000 ± 950,000	-4,429,000 ± 1,900,000

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Current Status in the 2013 HFE Accounting Period (July 1 to Aug. 1)

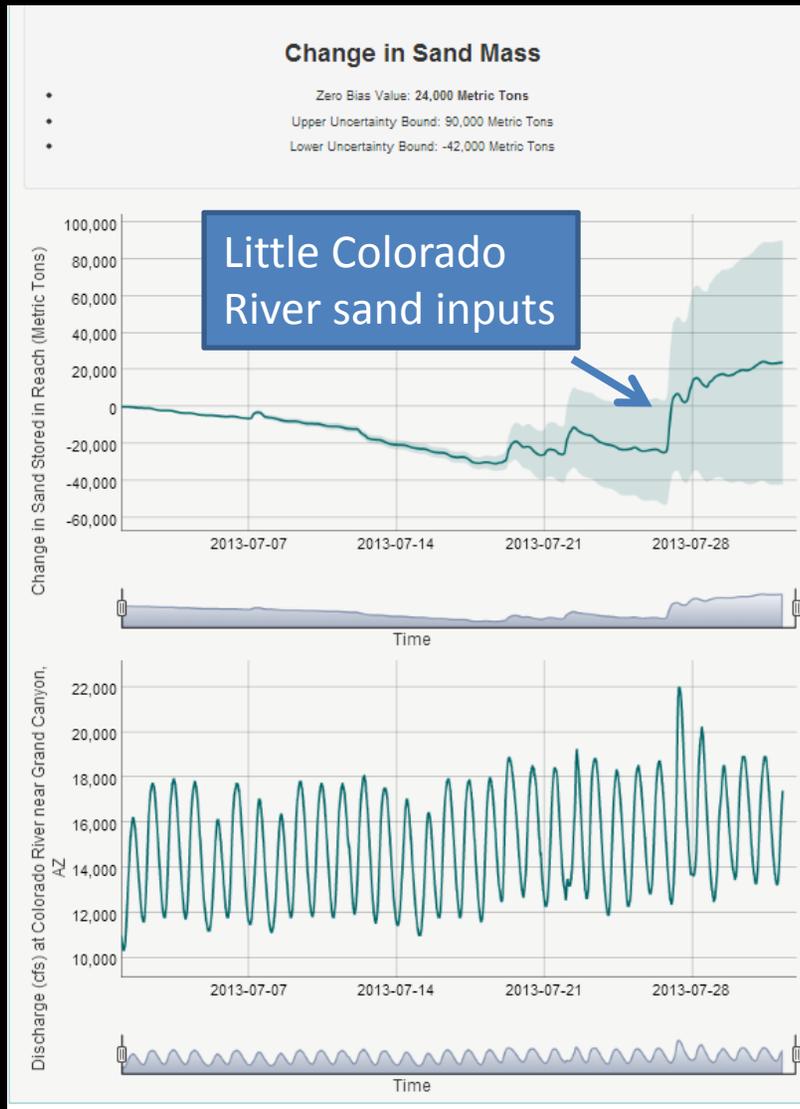


Upper Marble Canyon (+ 2000 tons)



Lower Marble Canyon (+ 15,000 tons)

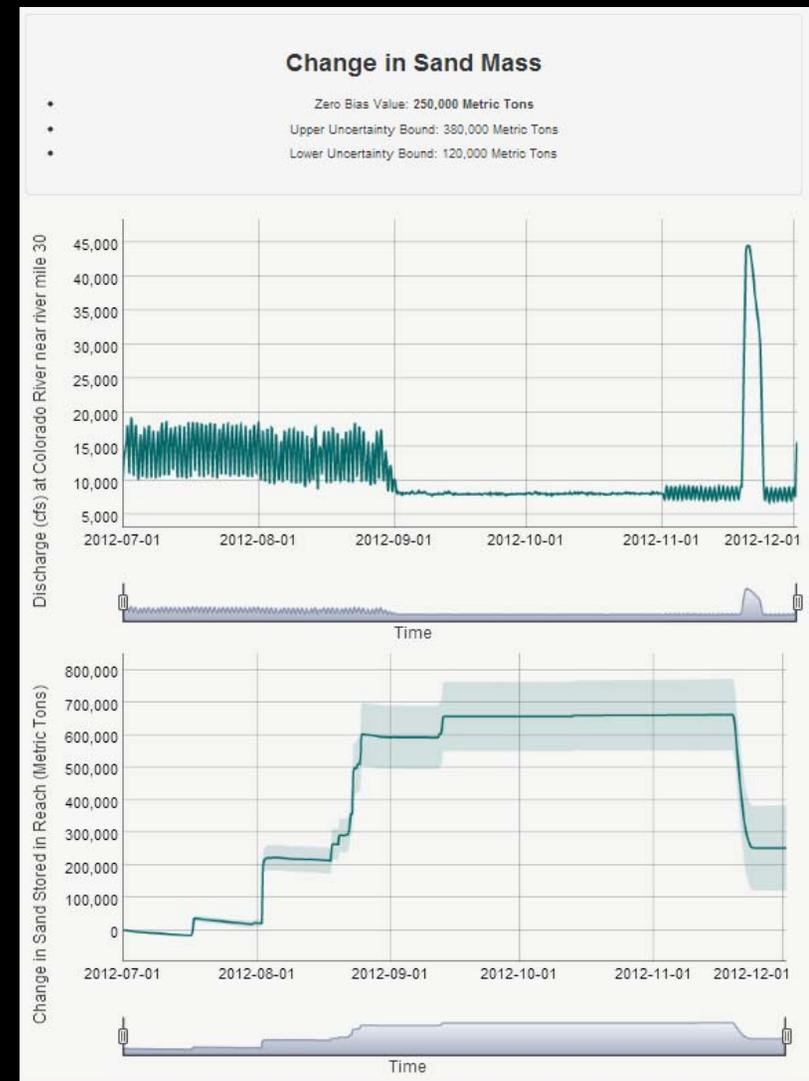
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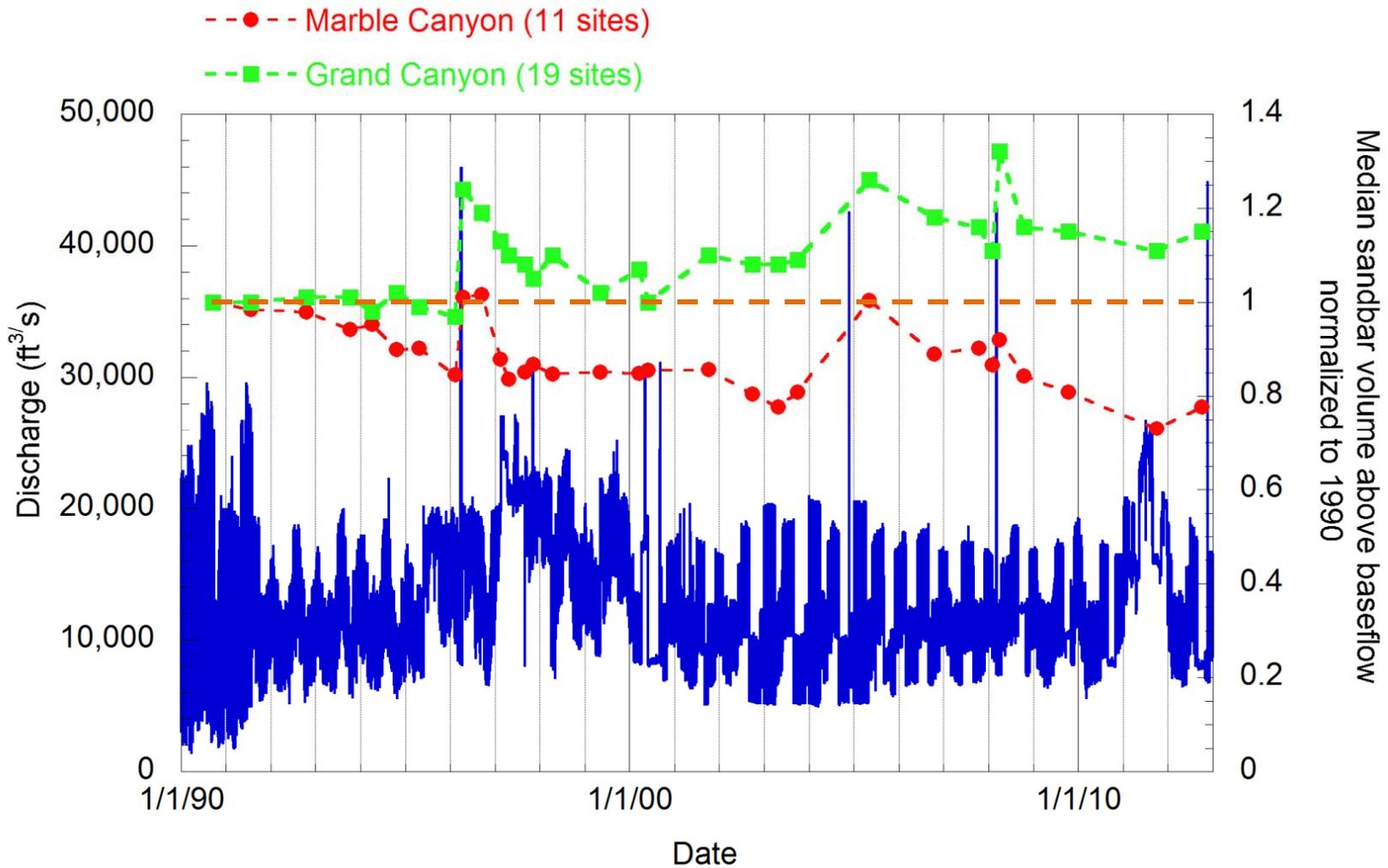
Eastern Grand Canyon (+ 24,000 tons)

The 2012 HFE Accounting Period and High Flow

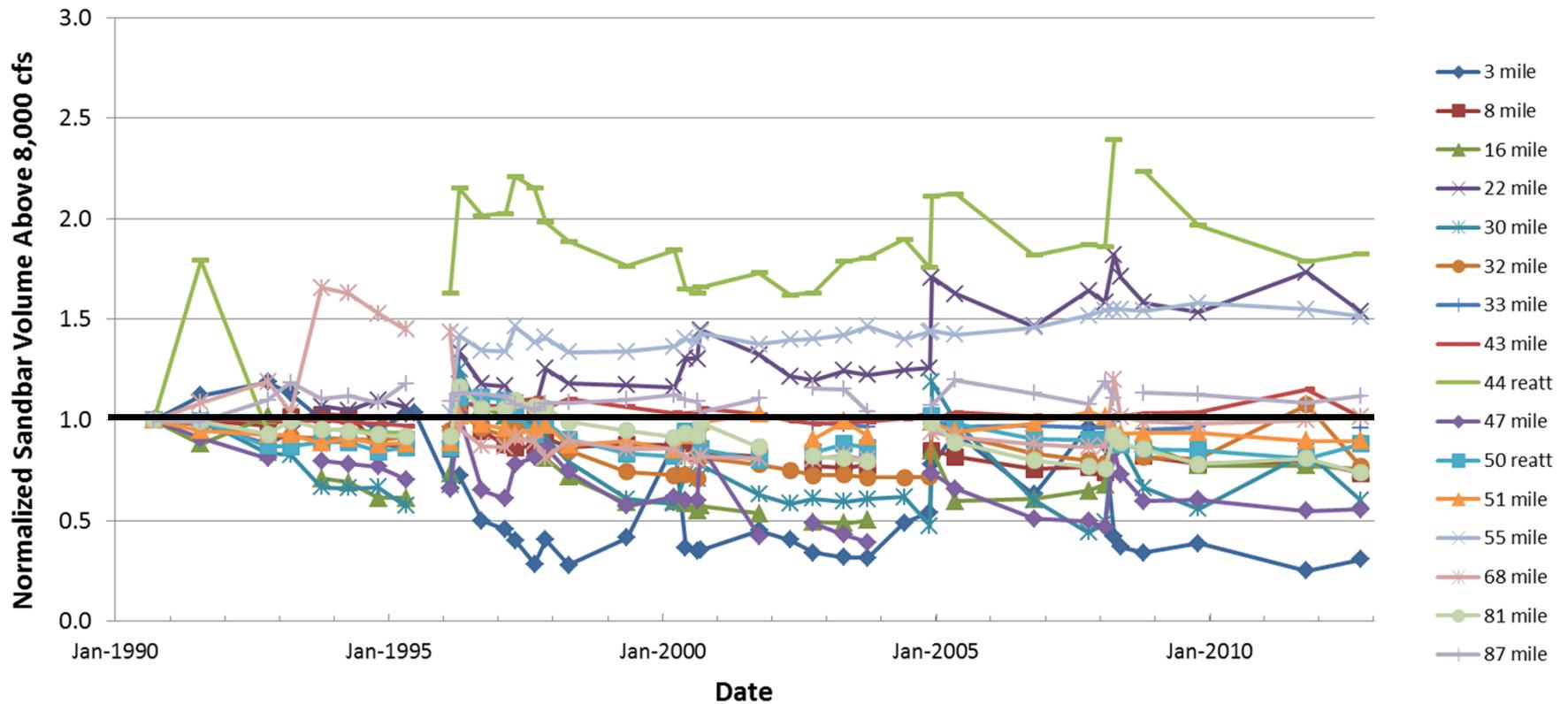
- 670,000 tons in Upper Marble Canyon
- 18,000 tons in Lower Marble Canyon
- The HFE left about 200,000 tons of sand in Upper Marble Canyon



Status of Sandbars before 2012 HFE



Although the median trend in Marble Canyon is negative, there are sites that have increased since 1990



RM 22 R – Returned to pre-HFE size by February



RM 30 R – Still a bit larger in May 2013 (most recent photo download)



RM 65 R -- Still a bit larger in May 2013 (most recent photo download)



Sandbar Response to 2012 HFE based on Analysis of Images from Remote Cameras

- **Response immediately after HFE**
 - Substantial Gain (deposition): 18 sandbars (55% of sites)
 - No substantial change: 12 sandbars (36% of sites)
 - Substantial Loss (erosion): 3 sandbars (9% of sites)
- **Sandbar condition in May 2013 (before summer fluctuations peaking at 18,000 cfs)**
 - Still somewhat larger (8 sites)
 - About the same as pre-HFE size (14 sites)
 - Smaller than pre-HFE (7 sites)

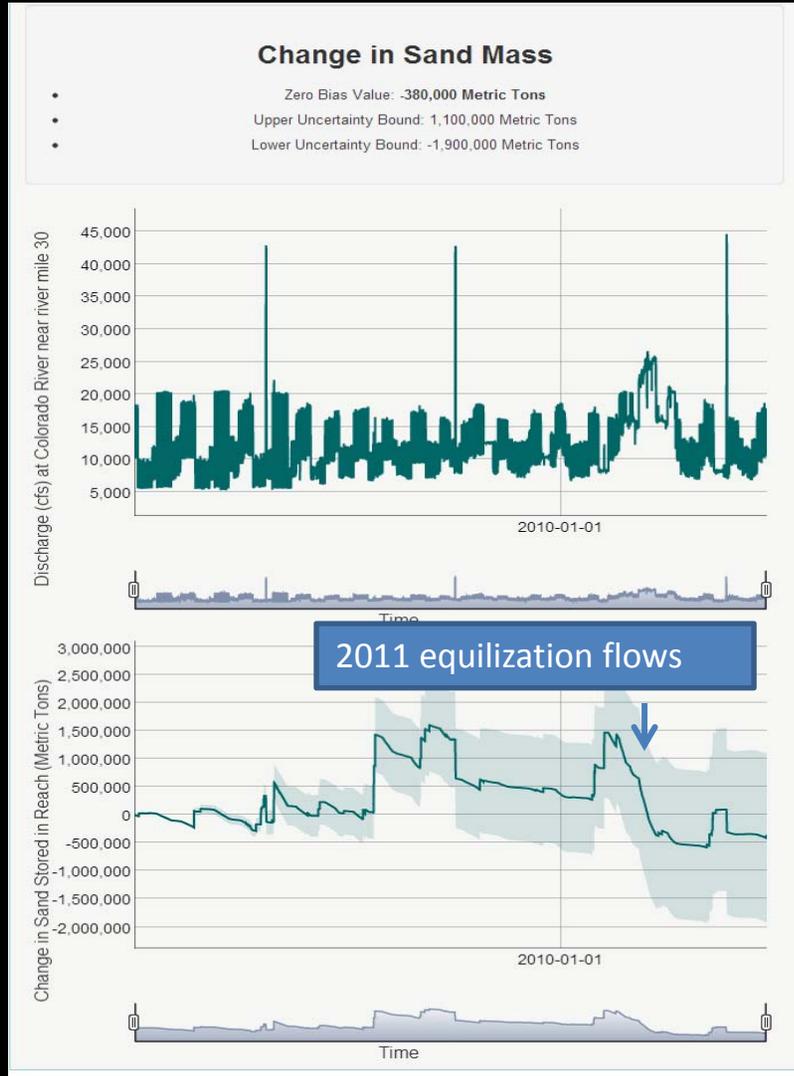
Preliminary data subject to revision – do not cite.



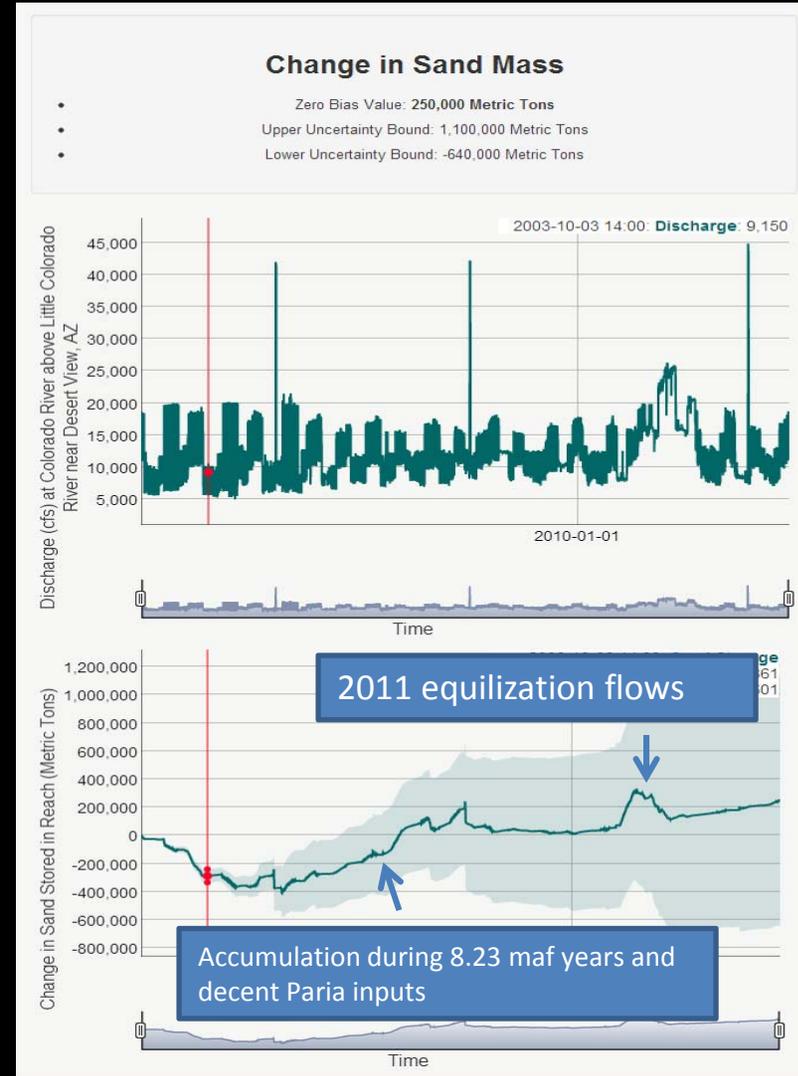
Ongoing Work in FY13 and FY14

- In work plan
 - Monitoring sediment flux
 - Monitoring in-channel sand storage
 - Mapping of bed texture with application for fish and aquatic habitat
 - Annual sandbar surveys in fall (44 sites)
 - Analysis of overflights to monitor sandbars throughout Grand Canyon
 - Effects of vegetation and changes in morphology on campsites
 - Continue work on modeling eddy sandbars
 - Interactions between sediment on bed and in suspension
- Pilot monitoring
 - Measurements of sandbar topography from remote cameras

Sand Mass Balance 2002-Present

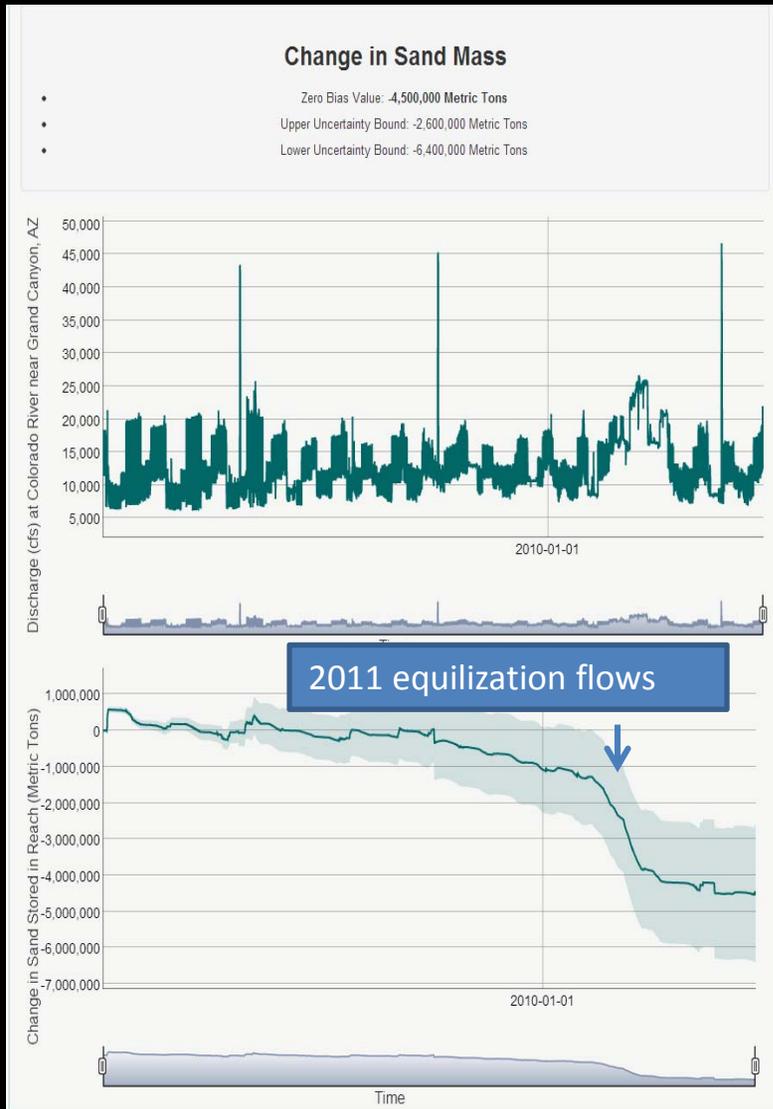


Upper Marble Canyon
(8/11/02 – 8/1/13)



Lower Marble Canyon
(8/14/02 – 8/1/13)

Sand Mass Balance 2002-Present



**Eastern Grand Canyon
(8/14/02 – 8/1/13)**



**Western Grand Canyon and Lake Mead Delta
(10/8/02 – 7/9/13)**

Sandbars Surveyed after the November 2012 HFE

