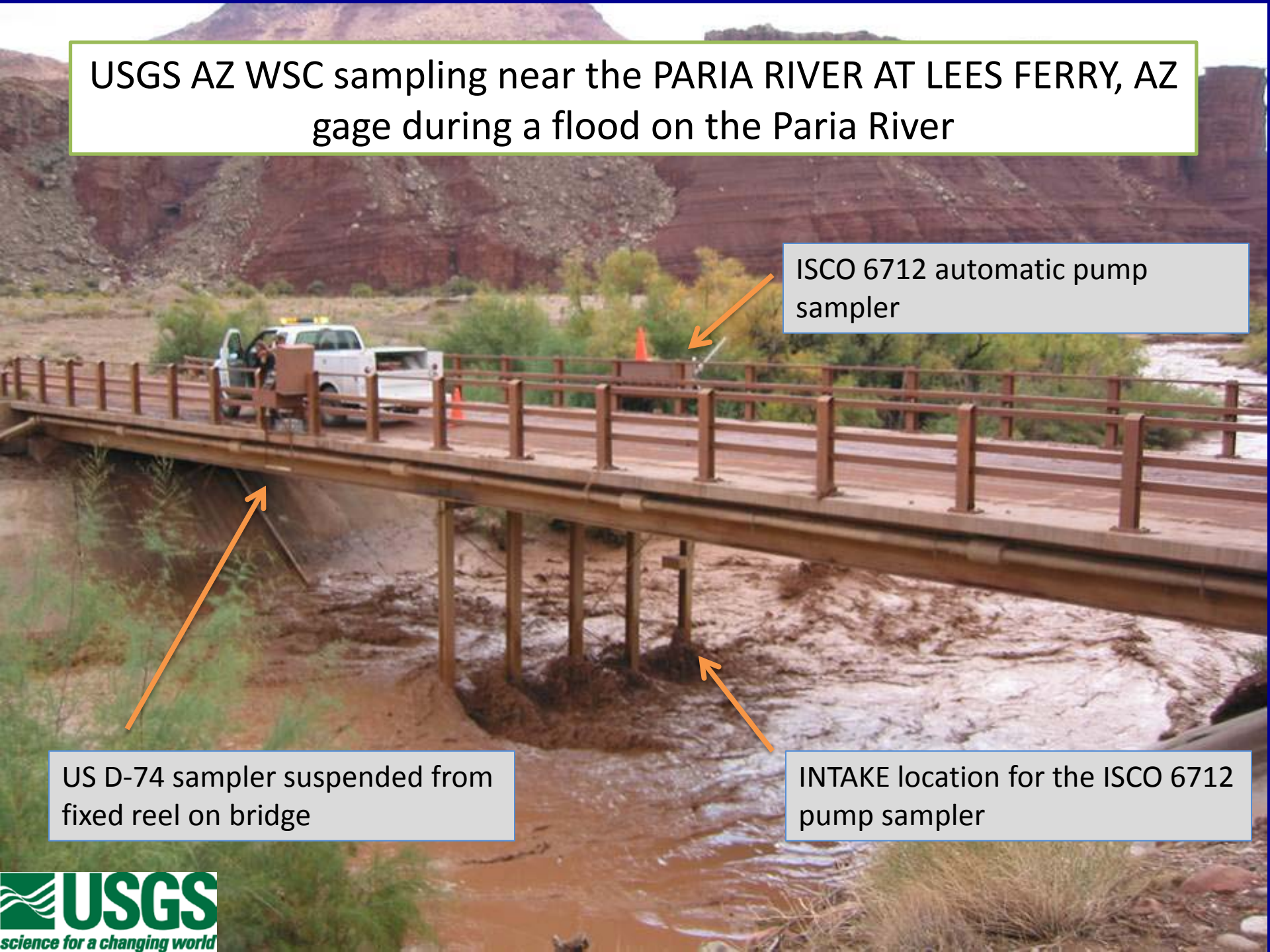
USGS AZ WSC sampling near the PARIA RIVER AT LEES FERRY, AZ gage during a flood on the Paria River
ISCO 6712 automatic pump sampler
US D-74 sampler suspended from fixed reel on bridge
INTAKE location for the ISCO 6712 pump sampler
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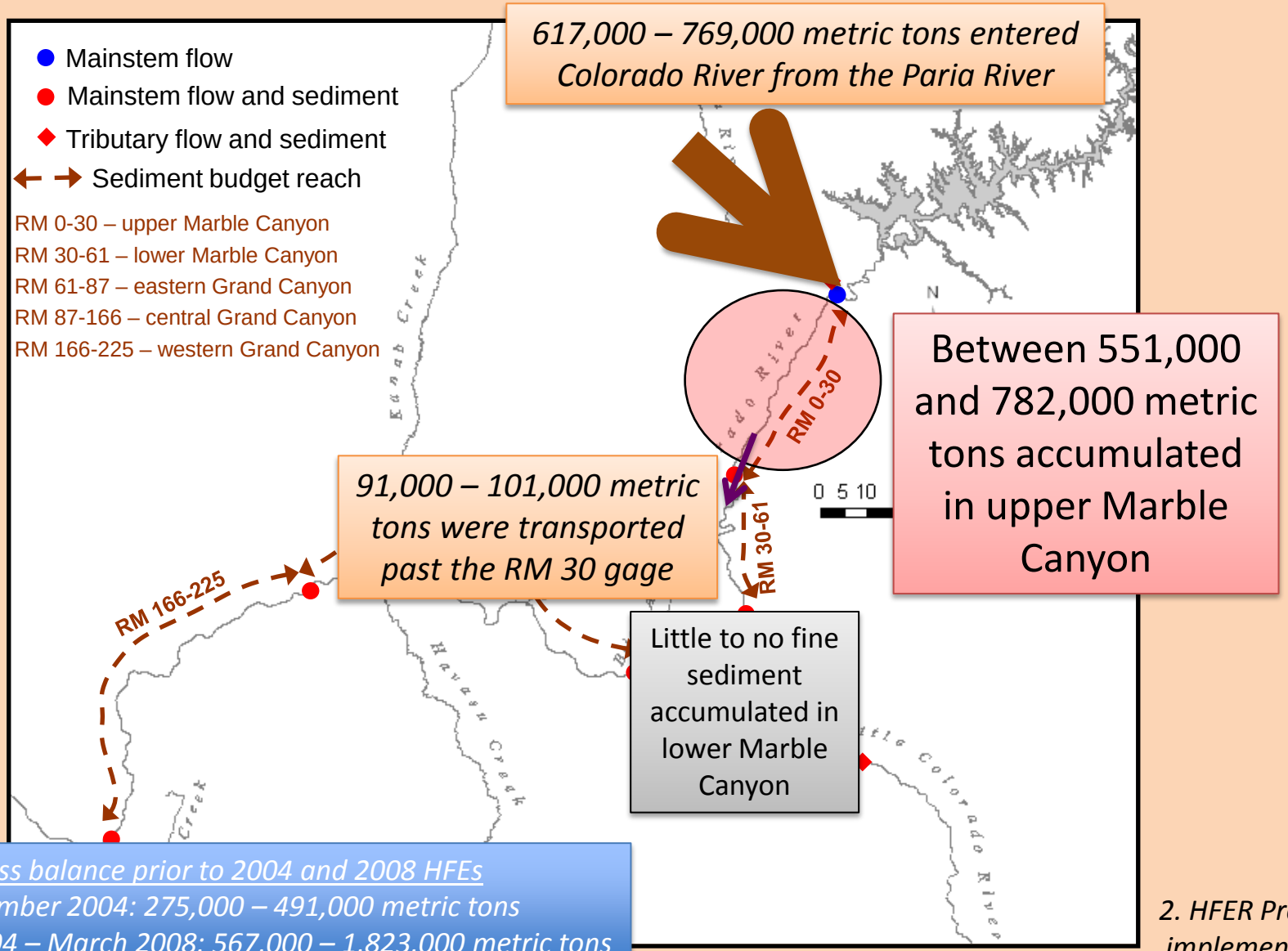
Between July 1 and November 17, 2012, …



Mass balance prior to 2004 and 2008 HFEs

July 1 to November 2004: 275,000 – 491,000 metric tons

December 2004 – March 2008: 567,000 – 1,823,000 metric tons

2. HFER Protocol implementation

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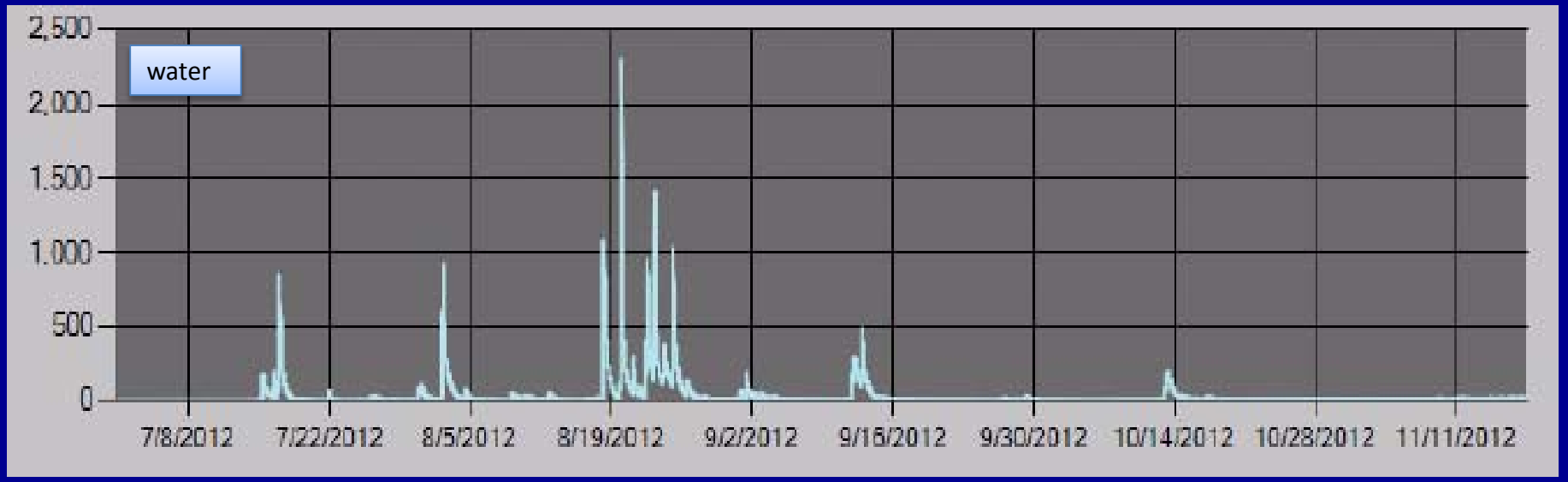
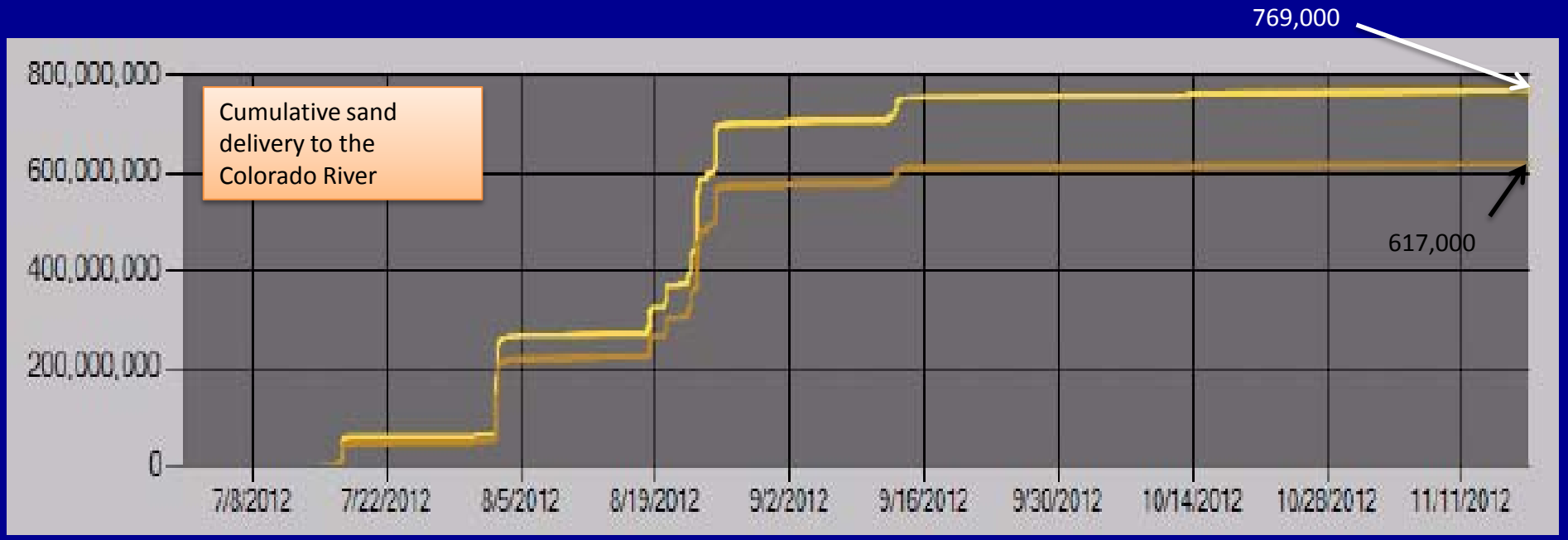
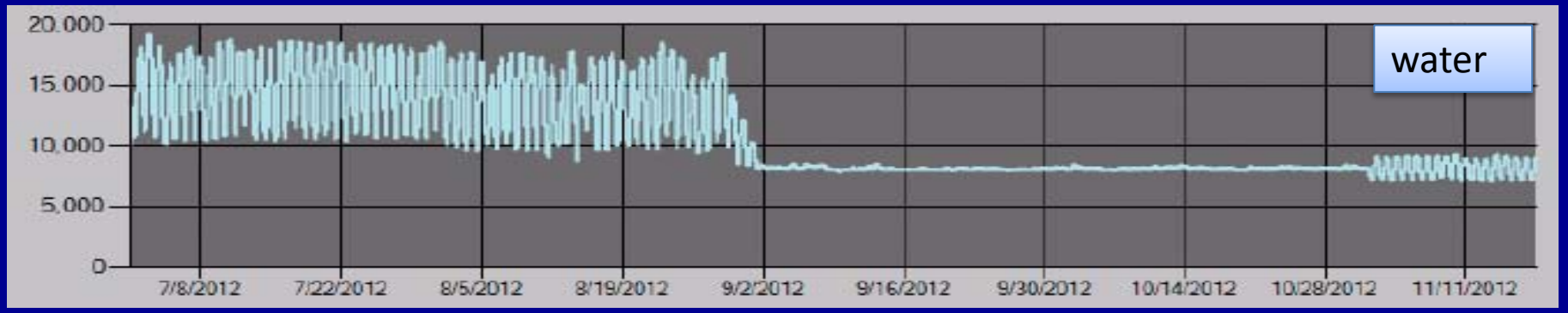
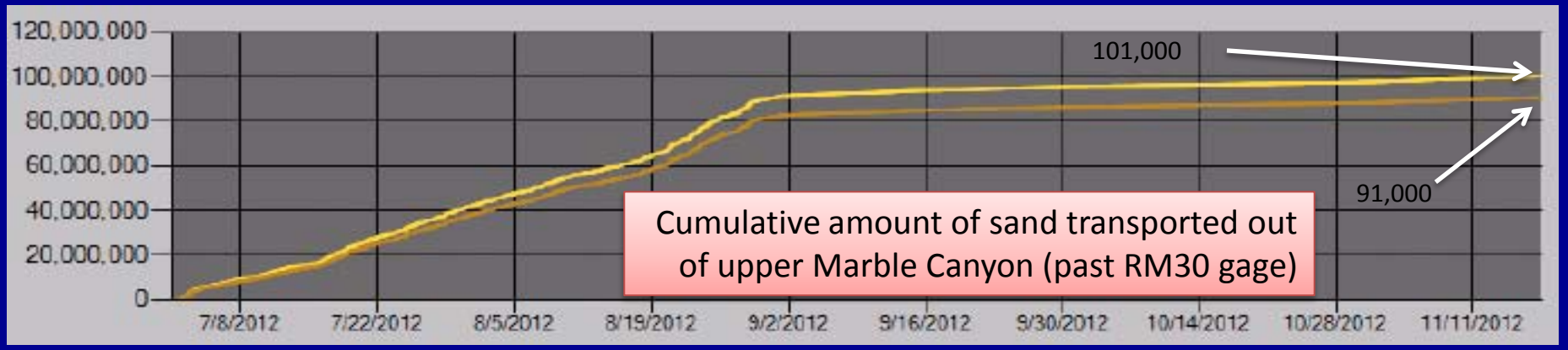
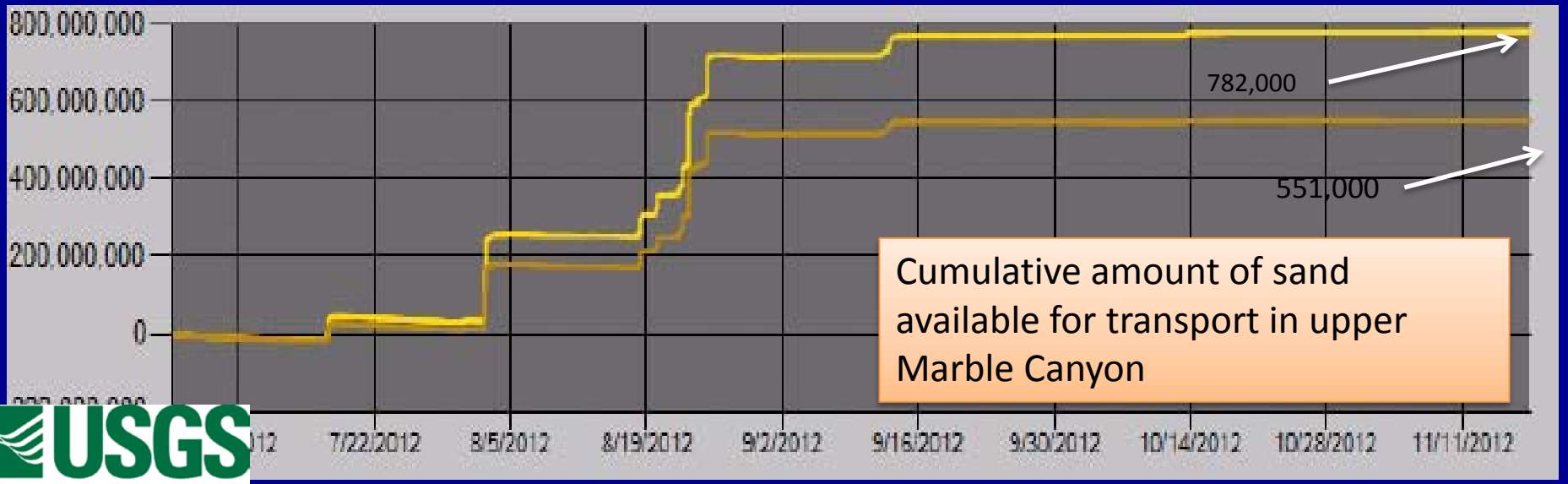
Paria River at Lees Ferry











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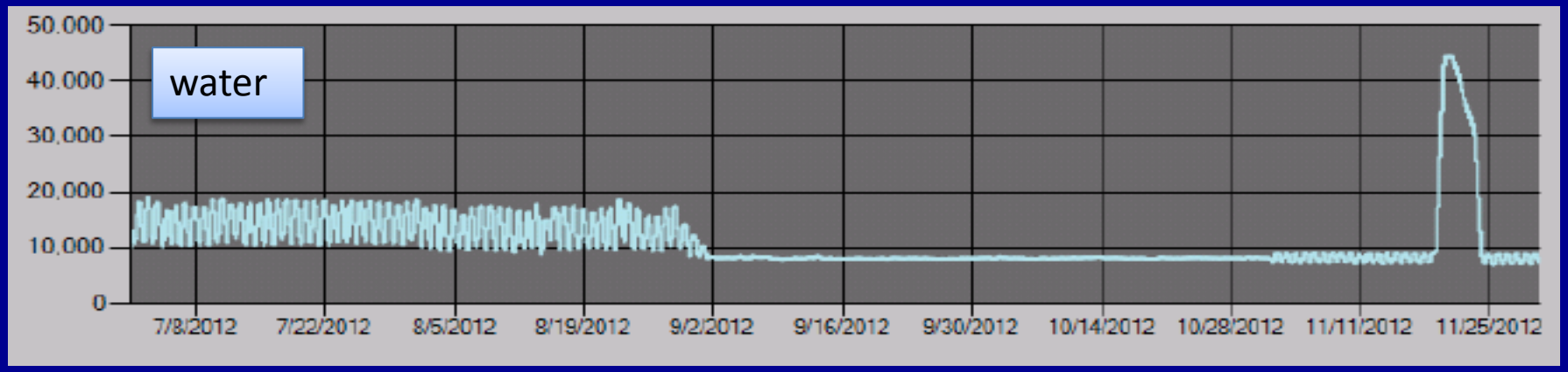

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Review from last year's knowledge assessment

From scale analysis of Exner equation, sandbar deposition rates depend on spatial changes in sand flux (depth-integrated product of flow and concentration) into eddies, which in turn depend on

- flow conditions
- bed-sand grain size
- bed-sand area (amount)

FLOW BED SAND

$$\frac{\Delta \eta}{\Delta t} \propto -\frac{\Delta\left(u_*^{4.5} h A_b D_b^{-2.5}\right)}{\Delta x}$$

- Spatial decrease in "flow" leads to deposition
- Spatial increase in bed-sand grain size leads to deposition
- Spatial decrease in bed-sand area (amount) leads to deposition
- Greatest deposition rates occur in eddies when greatest flow "deceleration" occurs between channel and eddy, and sand in upstream channel is as fine as possible and amount on upstream channel bed is relatively large

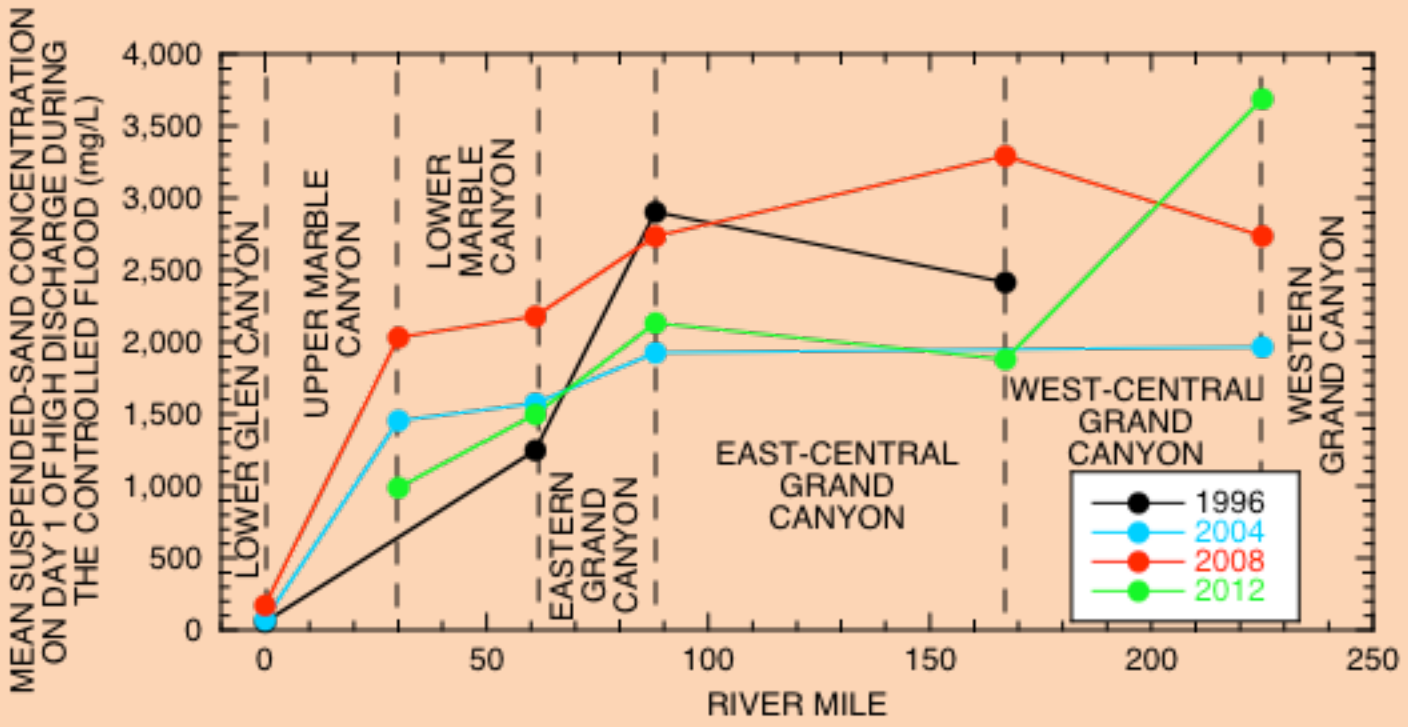
In the previous slide, there is no distinction made between new tributary supplied sand and background sand storage, both are combined in D_b and A_b.

Thus, if background sand storage in a reach of the Colorado River decreases in volume or coarsens over time, then similar magnitudes of tributary sand inputs will result in progressively lower eddy-sandbar deposition rates over a series of artificial floods released from Glen Canyon Dam.

Conversely, if background sand storage remains constant over time, then similar magnitudes of tributary sand inputs will result in similar eddy-sandbar deposition rates over a series of artificial floods released from Glen Canyon Dam.

And, if background sand storage in a reach of the Colorado River increases in volume or fines over time, then similar magnitudes of tributary sand inputs will result in progressively higher eddy-sandbar deposition rates over a series of artificial floods released from Glen Canyon Dam.

Suspended-sand concentration



(after Topping and others, *USGS OFR 2010-1128*, 2010)

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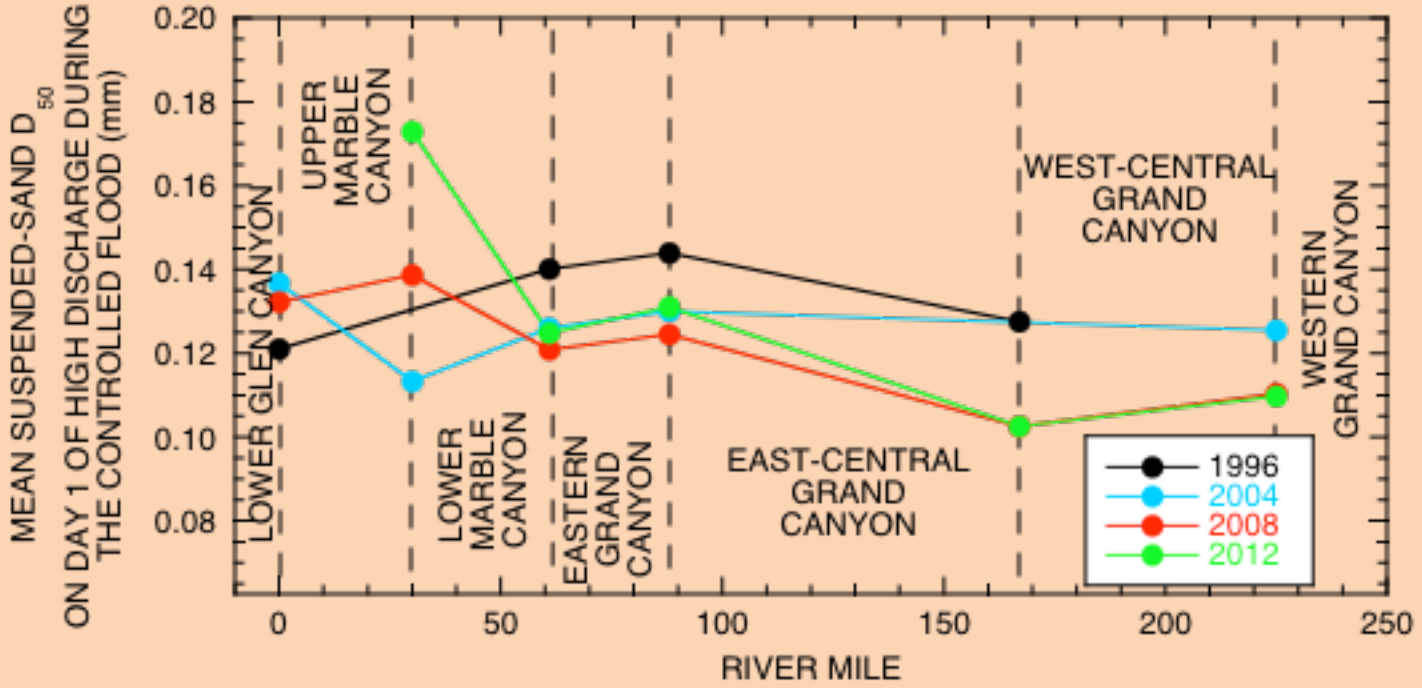
Suspended-sand median grain size



(after Topping and others, *USGS OFR 2010-1128*, 2010)

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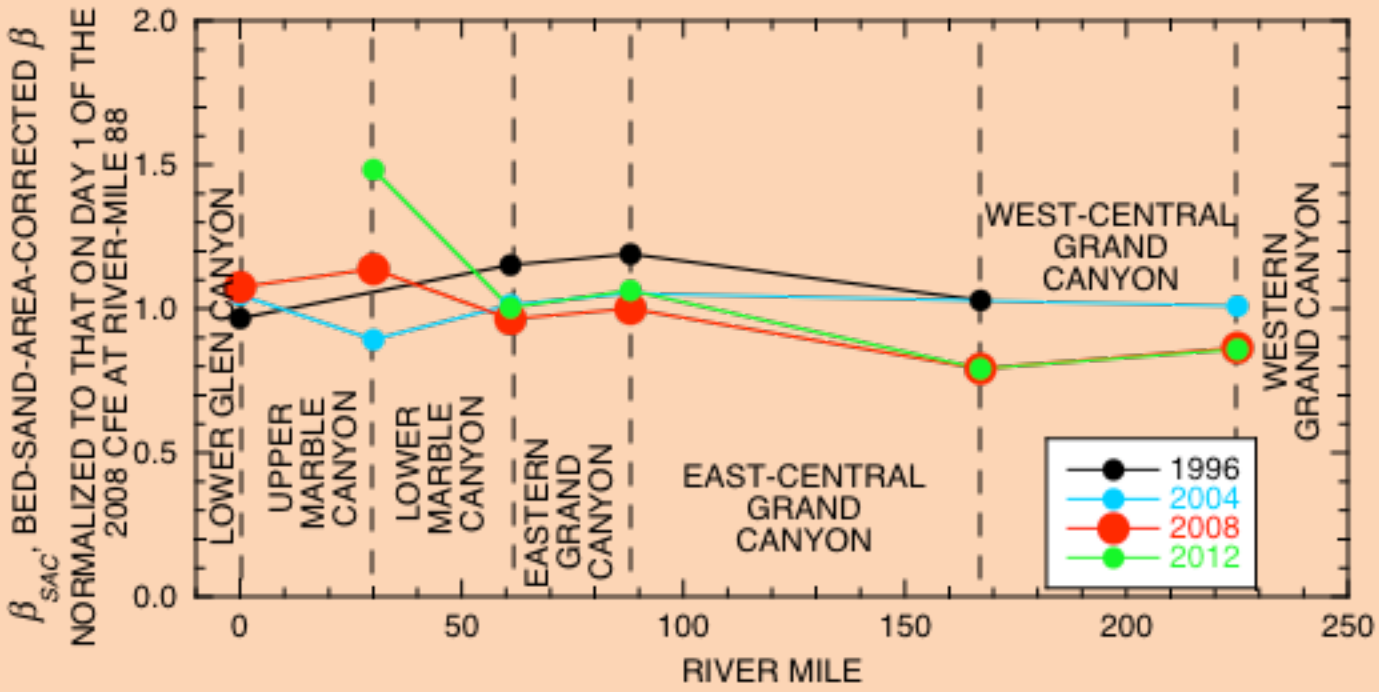
Bed-sand median grain size



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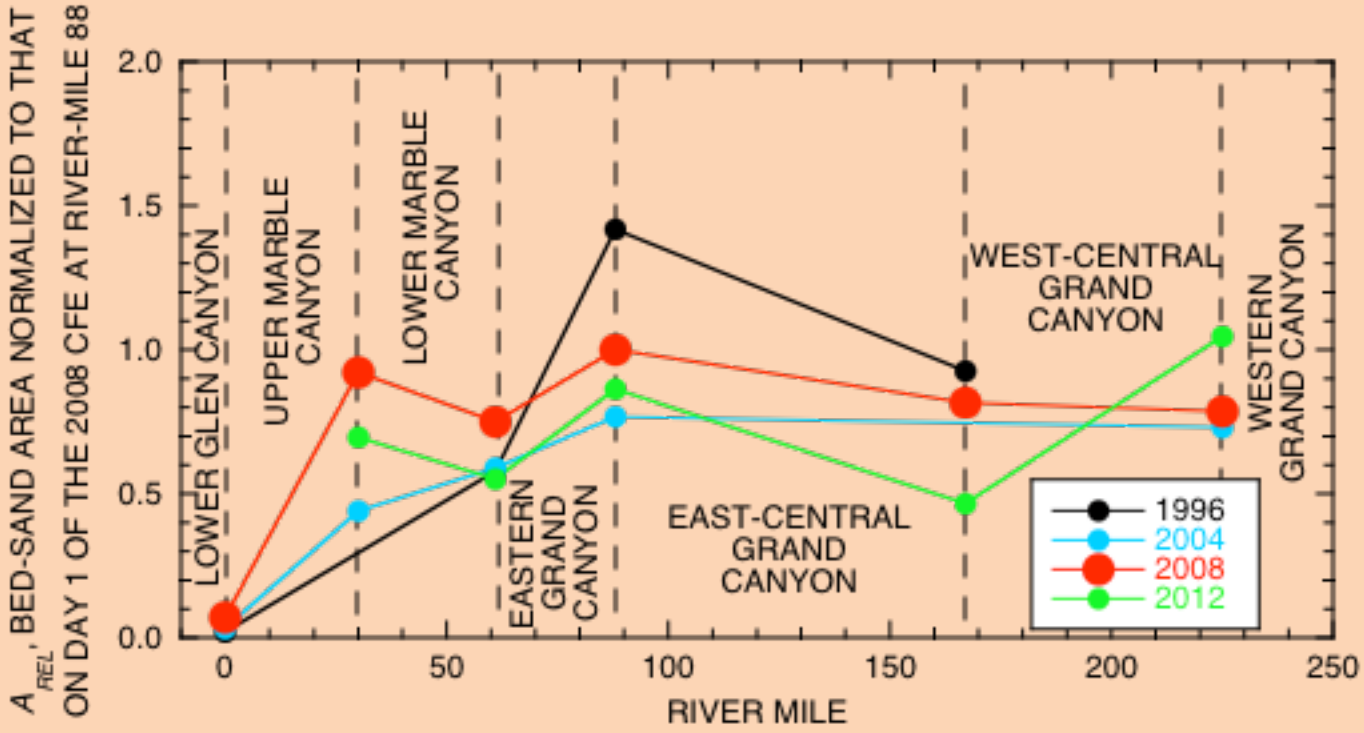
Bed-sand area (amount)



(after Topping and others, *USGS OFR 2010-1128*, 2010)

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Sand-concentration ranking of controlled floods

RM 0	RM 30	RM 61	RM 87	RM 166	RM 225
2008	2008	2008	1996 ≈ 2008	2008	**2012**
2004	2004	2004 ≈ **2012**	**2012** ≈ 2004	1996	2008
1996	**2012**	1996		**2012**	2004

- 75% of sand-concentration rankings agree with bed-sand area (amount) analysis
- Only 40% of sand-concentration rankings agree with bed-sand grain-size analysis
- Mass-balance sand budgets should teach us more...

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Sand mass-balance context

Shown are changes in sand mass (metric tons)

Period of budget	Upper Marble Canyon	Lower Marble Canyon
July 2002 - pre2004 flood	**330,000 ± 194,000**	**-280,000 ± 110,000**
pre2004 flood – pre2008 flood	**900,000 ± 640,000**	**290,000 ± 350,000**
pre2008 flood – pre2012 flood	**-1,500,000 ± 620,000** (mostly during May-August 2011)	**-12,000 ± 430,000**
July 2012 – pre2012 flood	**670,000 ± 120,000**	**18,000 ± 15,000**
during 2012 flood	**-320,000 ± 13,000**	**-78,000 ± 36,000**

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Relations between sand mass balance and sand concentrations during controlled floods

	Upper Marble Canyon		Lower Marble Canyon	
	Cumulative post-July 2002 sand mass before flood (metric tons)	% of sand concentration during 2004 flood	Cumulative post-July 2002 sand mass (metric tons)	% of sand concentration during 2004 flood
2004 flood	330,000	100%	-280,000	100%
2008 flood	1,230,000	140%	10,000	140%
2012 flood	-270,000	68%	-2,000	95%
post 2012 flood	-590,000		-80,000	

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Intervening dam operations greatly affect sand concentrations and therefore sandbar deposition rates during controlled floods...
Should sand accounting be reset to zero every July?

- Twice as much sand accumulated in upper Marble Canyon during the months preceding the 2012 flood than during the months preceding the 2004 flood.

- But sand concentrations at RM30 during the 2012 flood were only ~68% of those during the 2004 flood.

This apparent paradox was the result of the scour of >1 million metric tons of sand from upper Marble Canyon during the high equalization flows of May-August 2011.

New tools for this year

- Sand budgets on web by April 2013
- Station discharge, QW, and sediment data on web at selected stations now at

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

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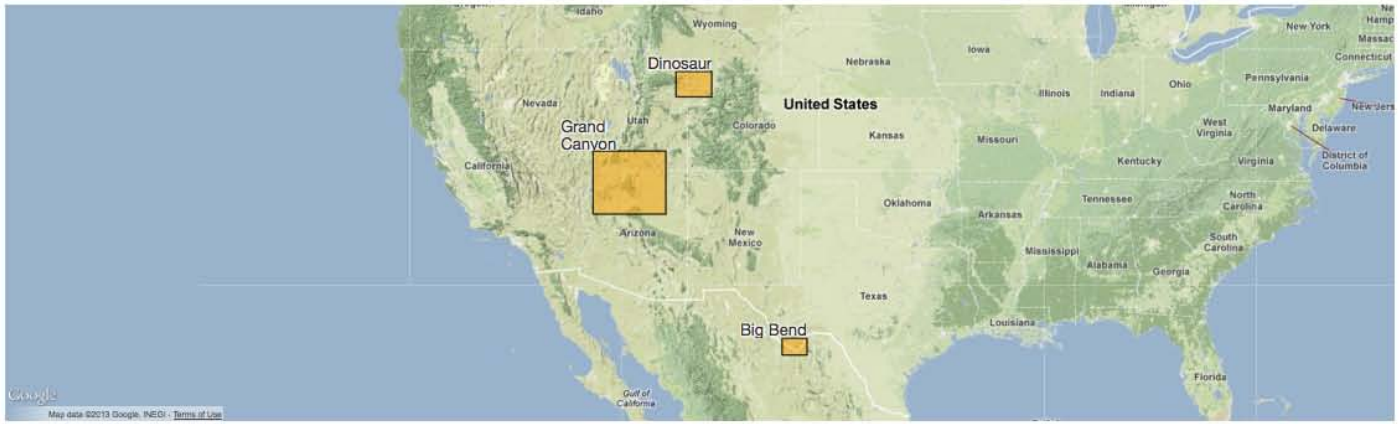

Networks

Grand Canyon
- Monitoring Stations
- Sand Budget Reaches

Dinosaur
- Monitoring Stations
- Sand Budget Reaches

Big Bend
- Monitoring Stations
- Sand Budget Reaches

For Additional Information

For additional information, please contact

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- Grand Canyon Monitoring Research Center
- Contact dtopping@usgs.gov or (928)556-7396

Database Designer/Programmer

Brad Garner
- USGS Arizona Water Science Center

Website Design and Programming

CIDA
USGS Center for Integrated Data Analytics
- Contact cida_gcmrc@usgs.gov

Cooperating Agencies and Academic Institutions

- Bureau of Reclamation
- National Park Service
- Bureau of Land Management
- Commission for Environmental Cooperation
- Utah State University

Cooperating USGS Water Science Centers

- Arizona Water Science Center
- Utah Water Science Center
- Colorado Water Science Center
- Texas Water Science Center

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www.gcmrc.gov/discharge_qw_sediment/stations/GCDAMP

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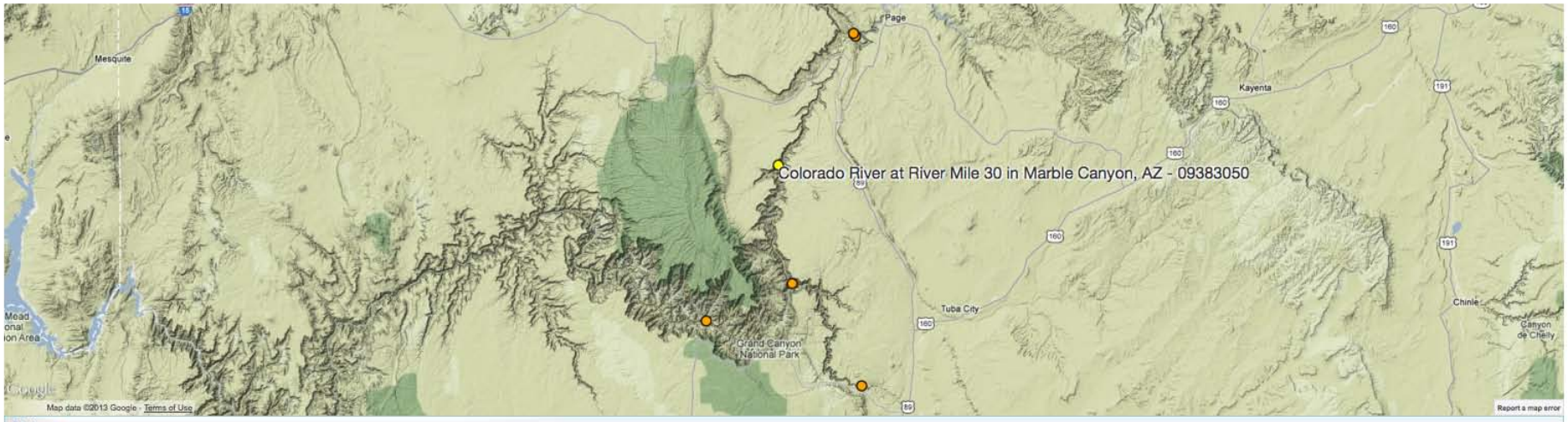

Stations

- Colorado River at Lees Ferry, AZ - 09380000
- Paria River at Lees Ferry, AZ - 09382000
- Colorado River at River Mile 30 in Marble Canyon, AZ - 09383050
- Colorado River above Little Colorado River near Desert View, AZ - 09383100
- Little Colorado River near Cameron, AZ - 09402000
- Colorado River near Grand Canyon, AZ - 09402500

Style: Graphical Version | Text Version

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Colorado River at River Mile 30 in Marble Canyon, AZ 09380002

Parameter Availability

Gage Height
- Feet (ft)
- 2022-07-28 to 2023-01-02

Discharge
- Cubic Feet Per Second (cfs)
- 2022-07-28 to 2023-01-02

Water Temperature
- Degrees Celsius (°C)
- 2022-10-26 to 2022-10-17

Specific Conductance
- Microsiemens Per Centimeter at 25 Degrees C (uS/cm at 25 °C)
- 2022-10-26 to 2022-08-19

Turbidity
- Formazin Nephelometric Units (FNU)
- 2022-08-26 to 2022-03-15

Acoustic Suspended-Silt-and-Clay Concentration
- Milligrams Per Liter (mg/L)
- 2022-08-11 to 2023-01-02

Acoustic Suspended-Sand Concentration
- Milligrams Per Liter (mg/L)
- 2022-08-11 to 2023-01-02

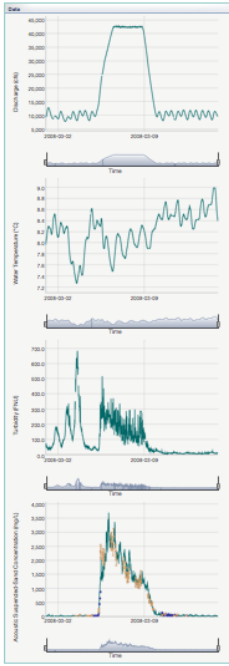
Acoustic Suspended-Sand Median Grain Size
- Millimeters (mm)
- 2022-08-11 to 2023-01-02

Date Range

Start: 2008-03-01
End: 2008-03-10

Build Graph | Download

Data



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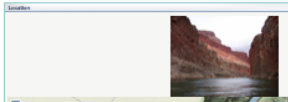

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- Data provided by: USGS Grand Canyon Monitoring and Research Center
- Search for Publications about this area.
- Find data for this site in NWIS

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www.gcmrc.gov/discharge_qw_sediment/station/GCDAMP/09383050#

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- Feet (ft)
- 2002-07-08 to 2013-01-02

Discharge
- Cubic Feet Per Second (cfs)
- 2002-07-08 to 2013-01-02

Water Temperature
- Degrees Celsius (°C)
- 2002-10-26 to 2012-10-17

Specific Conductance
- Microsiemens Per Centimeter at 25 Degrees C (uS/cm at 25 °C)
- 2002-10-26 to 2012-08-19

Turbidity
- Formazin Nephelometric Units (FNU)
- 2005-05-28 to 2012-03-15

Acoustic Suspended-Silt-and-Clay Concentration
- Milligrams Per Liter (mg/L)
- 2002-08-11 to 2013-01-02

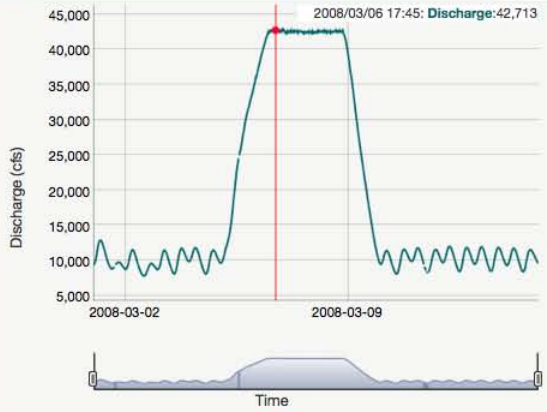
Acoustic Suspended-Sand Concentration
- Milligrams Per Liter (mg/L)
- 2002-08-11 to 2013-01-02

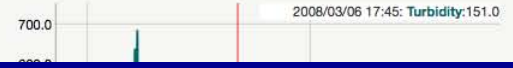
Acoustic Suspended-Sand Median Grain Size
- Millimeters (mm)
- 2002-08-11 to 2013-01-02

End 2008-03-15

Build Graph | Download

Data





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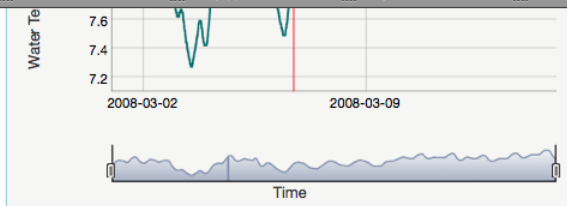

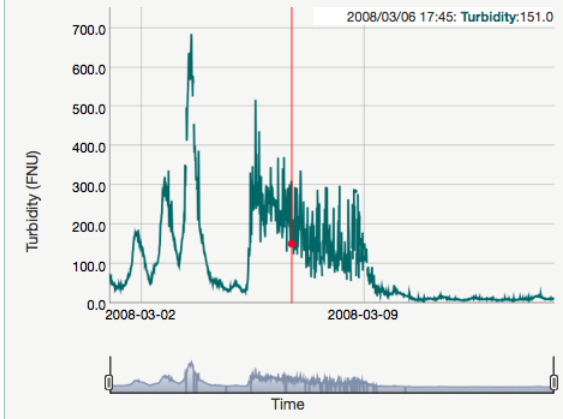

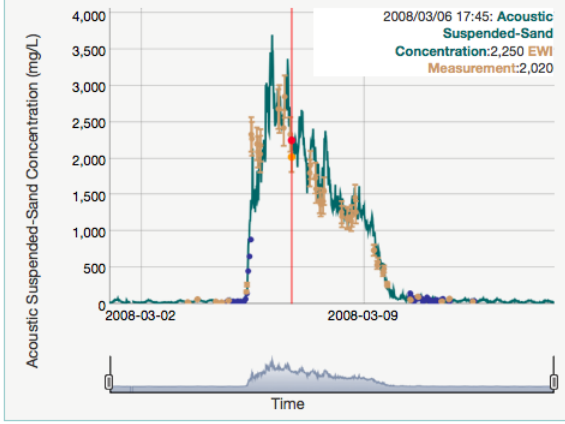

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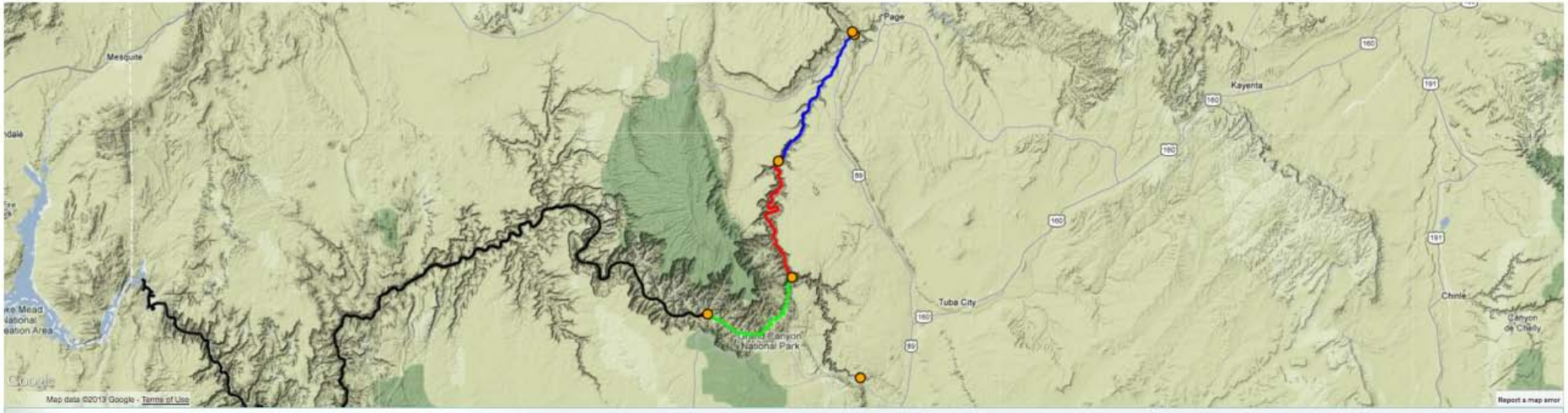

Reaches

- Upper Marble Canyon (Colorado River between Lees Ferry, AZ and River Mile 30 in Marble Canyon, AZ)
- Lower Marble Canyon (Colorado River between River Mile 30 in Marble Canyon, AZ and Little Colorado River near Desert View, AZ)
- Eastern Grand Canyon (Colorado River between Little Colorado River near Desert View, AZ and Grand Canyon, AZ)

Style: Graphical Version | Text Version

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Upper Marble Canyon

Colorado River between Lees Ferry, AZ and River Mile 30 in Marble Canyon, AZ

Adjustable Bedload

Bedload Coefficient for River Sand Loads

0% — 5% — 10%

Adjustable Uncertainty

Magnitude of Possible Persistent Bias in Measured River Loads

0% — 5% — 25%

Magnitude of Possible Persistent Bias in Measured Major Tributary Loads

0% — 10% — 25%

Magnitude of Possible Persistent Bias in Lesser Tributary Loads

0% — 50% — 50%

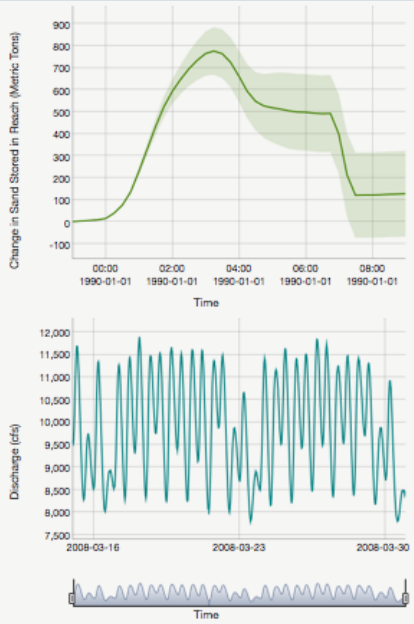
Date Range

Start: 2008-03-15

End: 2008-03-31

Build Graph

Data



Location

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