# Processing fine sediment transport data: procedures, processing, and bottlenecks

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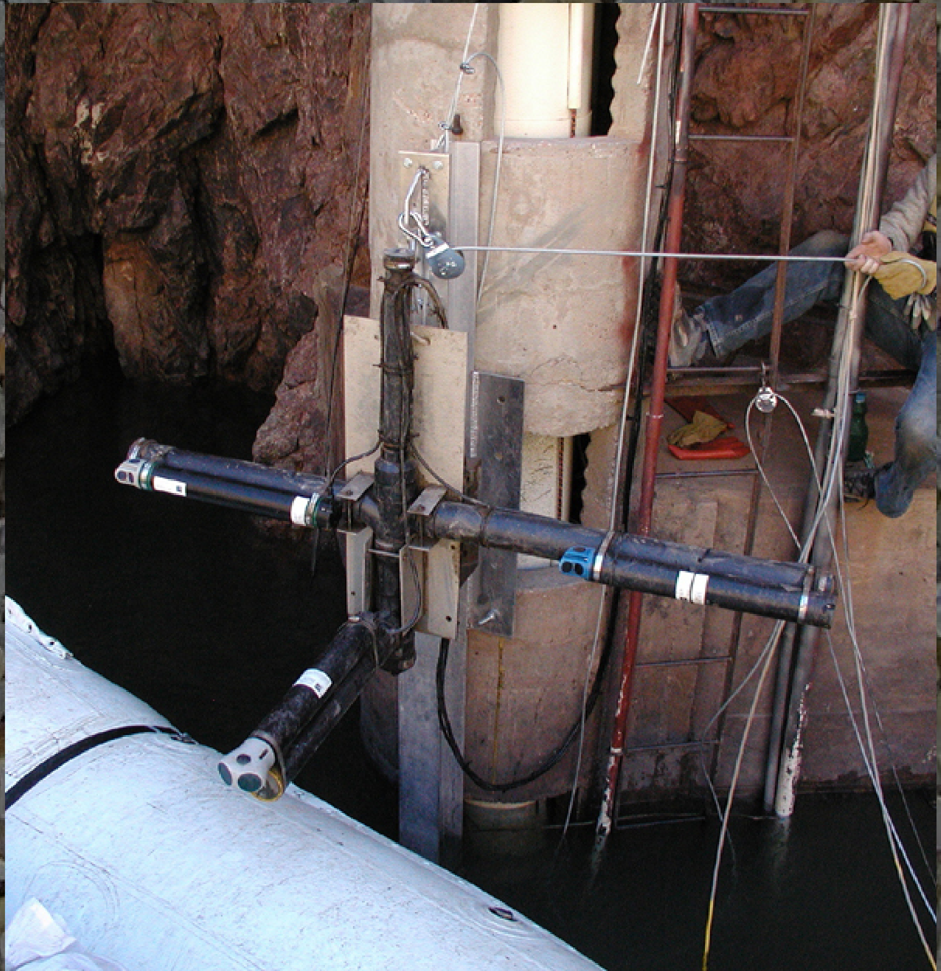

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# A quick downstream tour (July 1, 2013 – Jan 1, 2014)

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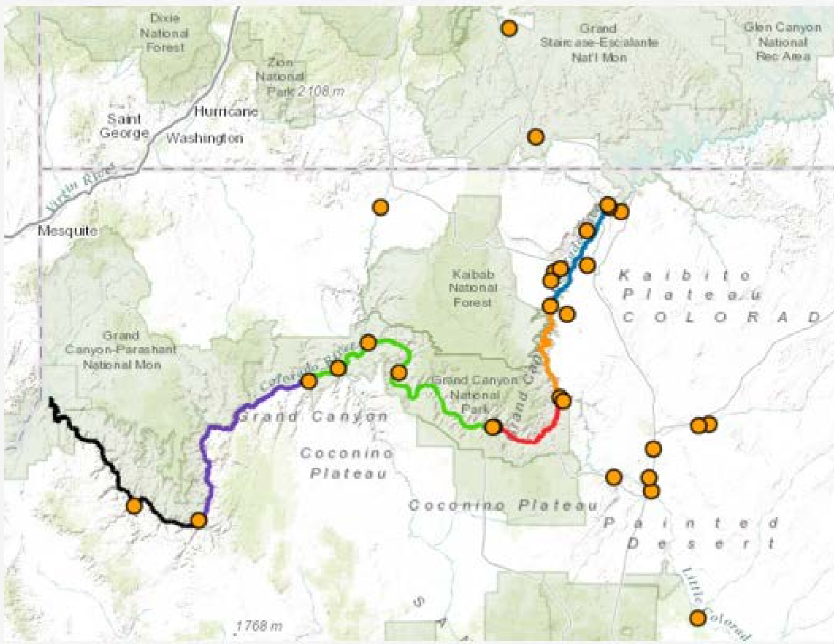
## Grand Canyon Reaches

Home > Discharge, Sediment and Water Quality > Grand Canyon Reaches




**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)

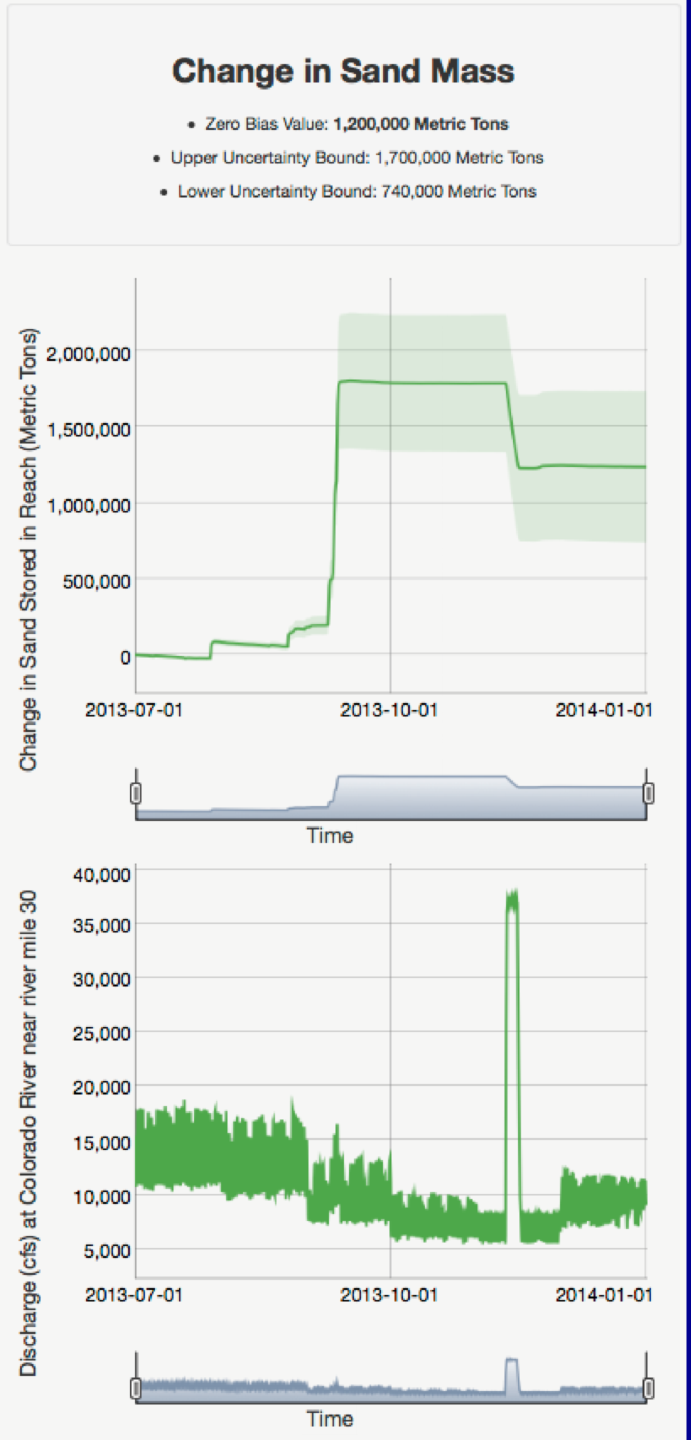
**East Central Grand Canyon**
(Colorado River near Grand Canyon, AZ to Colorado River above National Canyon near Supai, AZ)

**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)

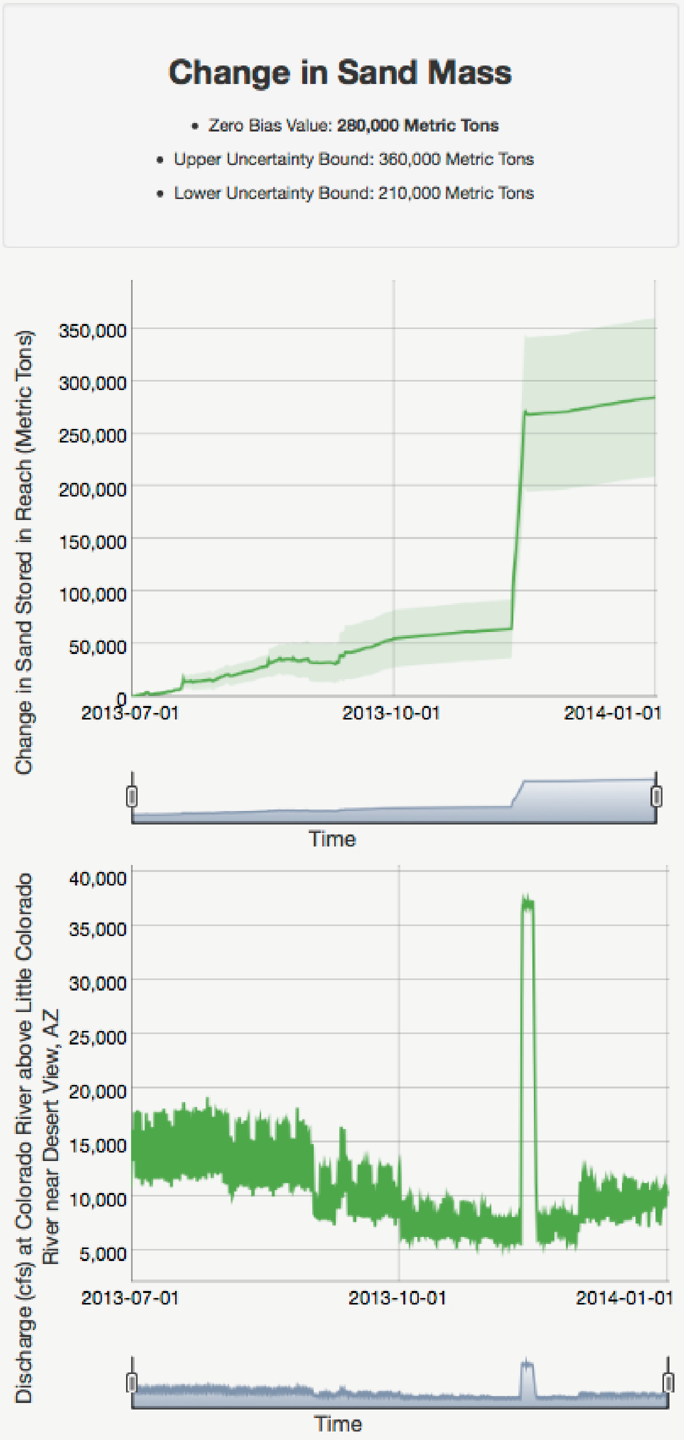
# Upper Marble Canyon

# RM0 – RM30



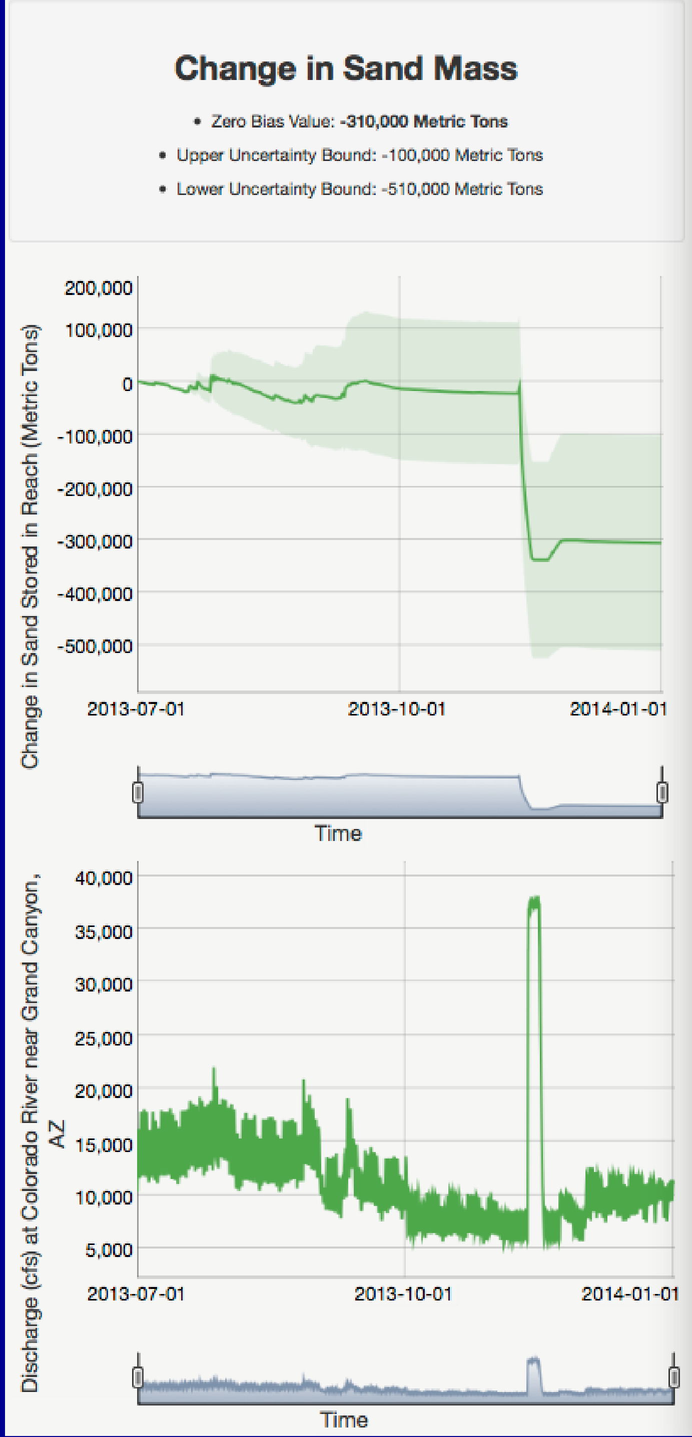
Lower Marble Canyon

RM30 – RM61



Eastern Grand Canyon

RM61 – RM87

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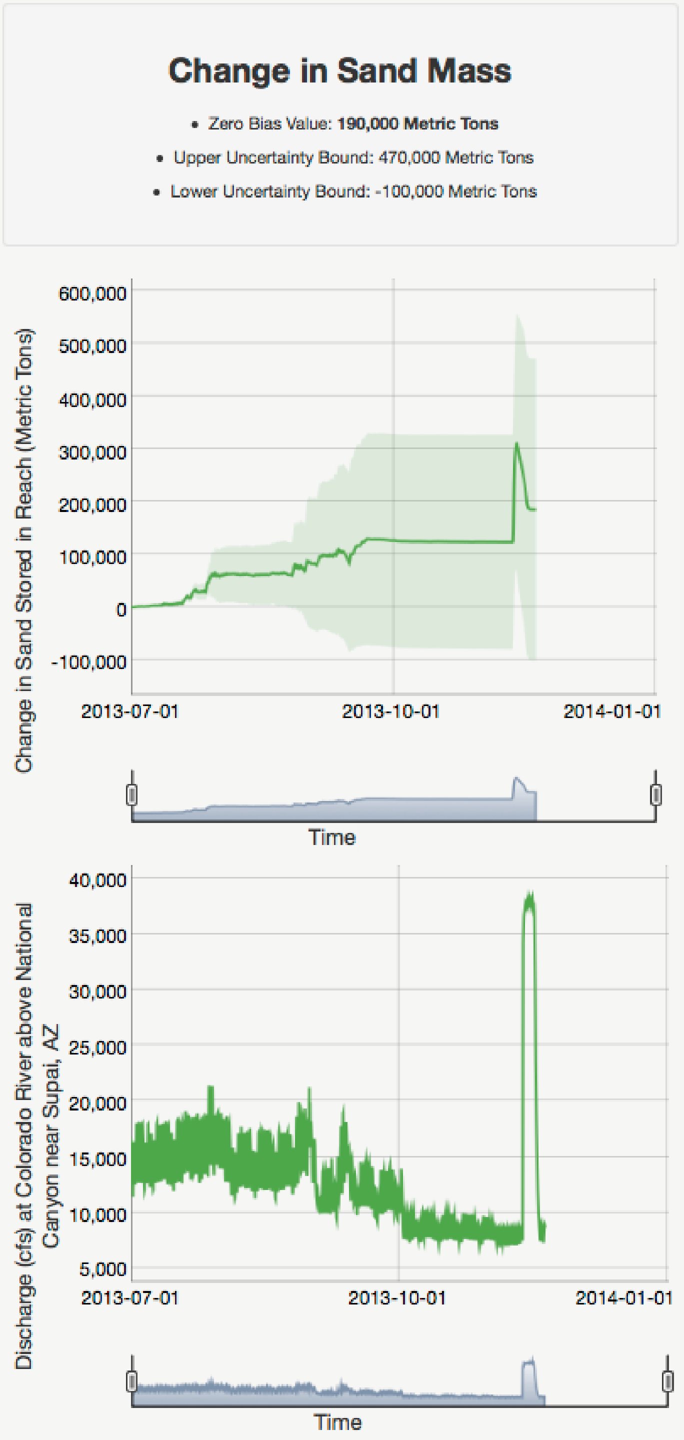
East Central Grand Canyon

RM87 – RM166

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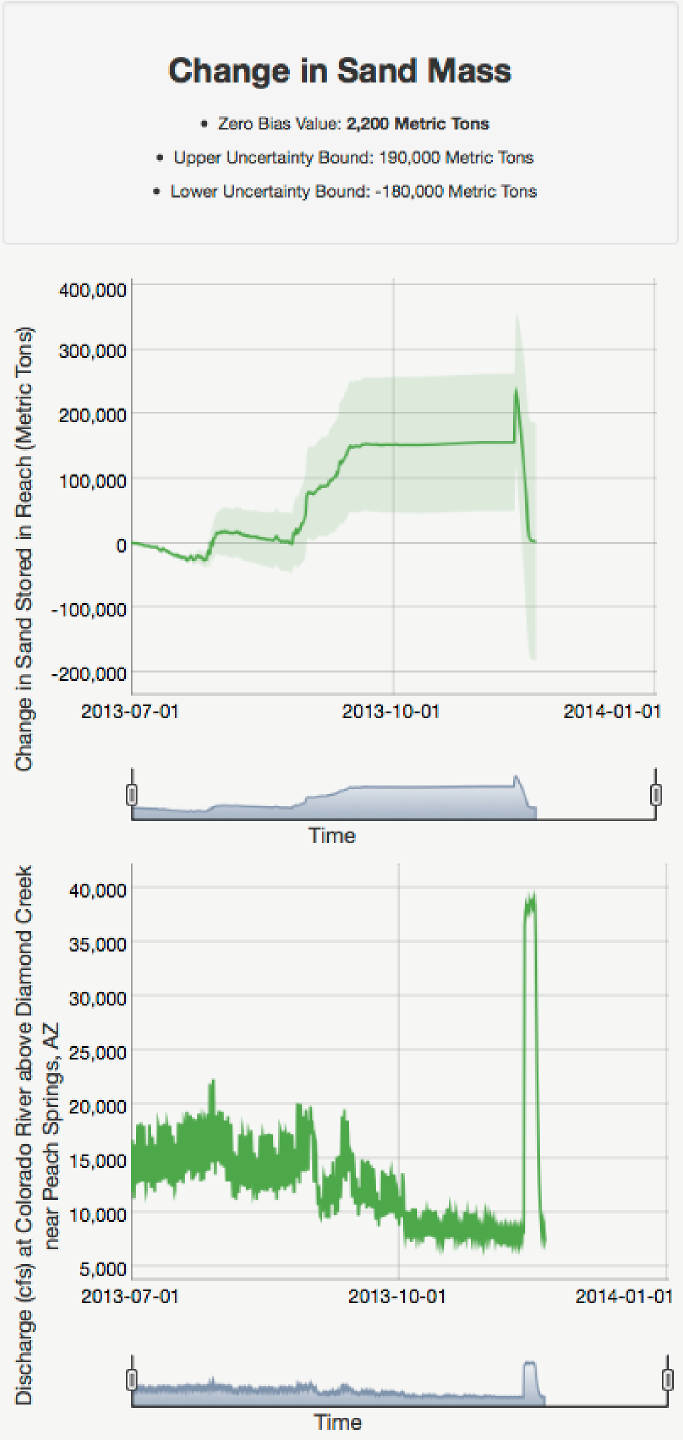
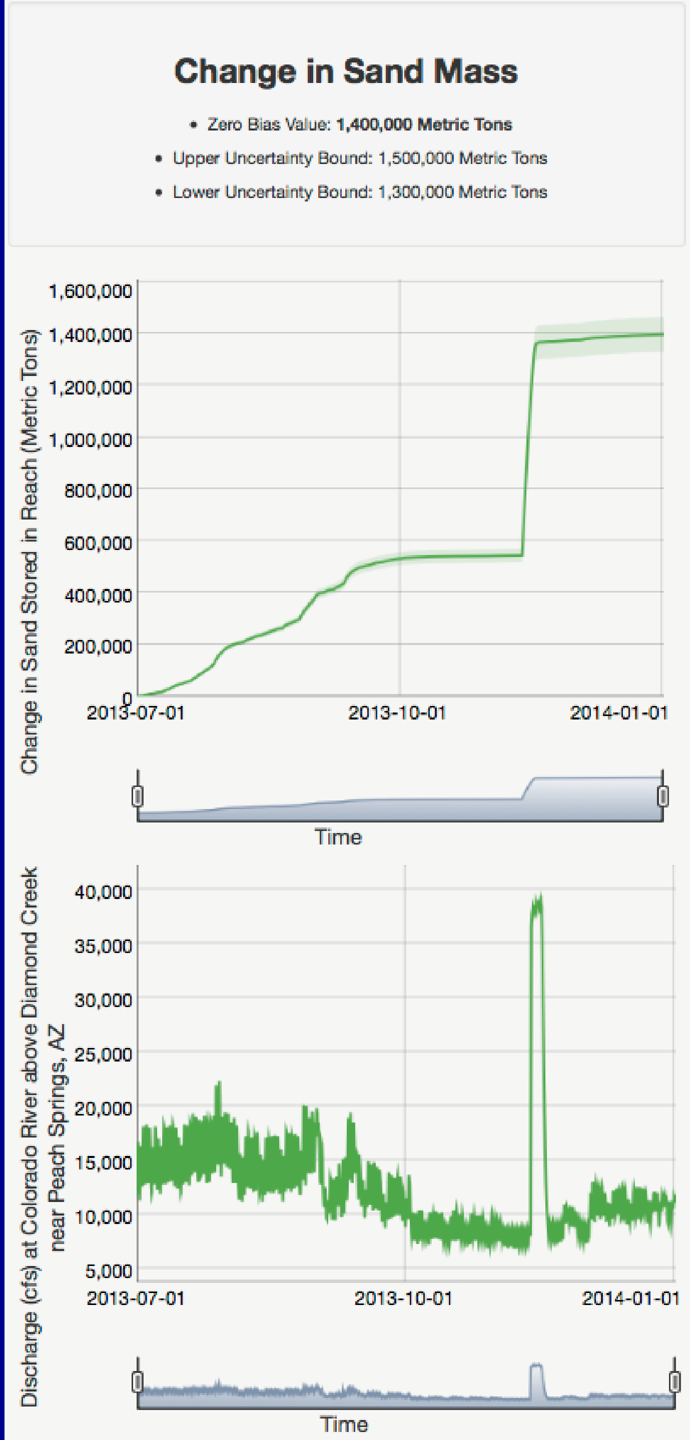
# West Central Grand Canyon

# RM166 – RM225



Western Grand Canyon and the Lake Mead Delta

>RM225

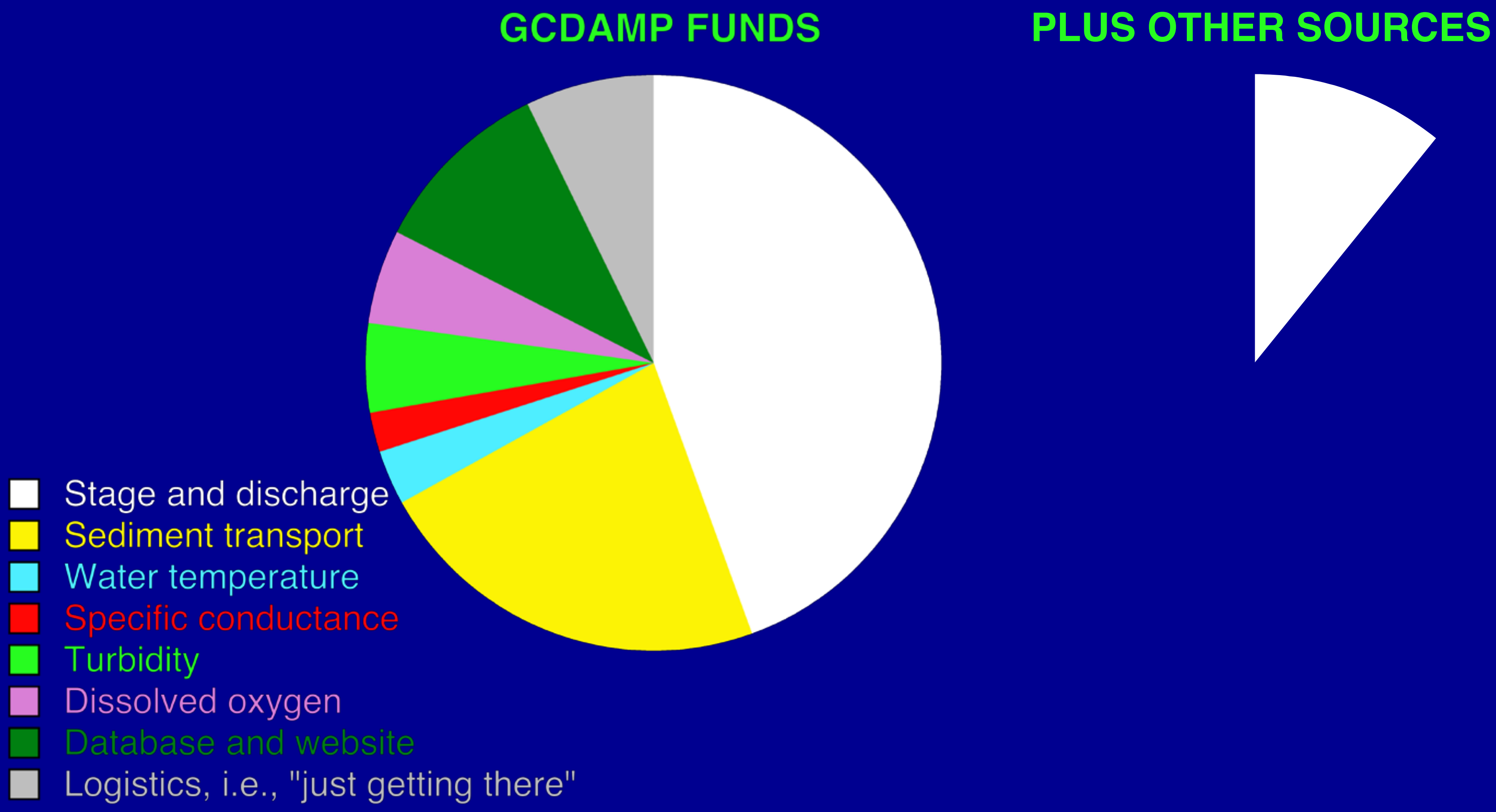


Overall change in sand mass in the Colorado River between RM0 and RM225 (Lees Ferry to Diamond Creek) during July 1, 2013 – January 1, 2014 was:
+1.4±1.2 million metric tons (on the basis of grain size, likely mostly in sandbars in Marble Canyon and East Central Grand Canyon, RMs 0-61 and 87-166)

Overall change in sand mass in the Colorado River below RM225 (below Diamond Creek) during July 1, 2013 – January 1, 2014 was:
+1.4±0.1 million metric tons

(Agreement between these numbers is a coincidence)

# Project B: Streamflow, Water Quality, and Sediment Transport
## Project is more than just sediment



The following 15-minute data are current at all sites at:
www.gcmrc.gov/discharge_qw_sediment/

- Gage height
- Discharge
- Water temperature
- Specific Conductance
- Dissolved Oxygen
- Turbidity
- Suspended-silt-and-clay concentration
- Suspended-sand concentration
- Suspended-sand grain size
- Silt and clay loads
- Sand loads

The following data have been recently revised

- Paria River peak discharges

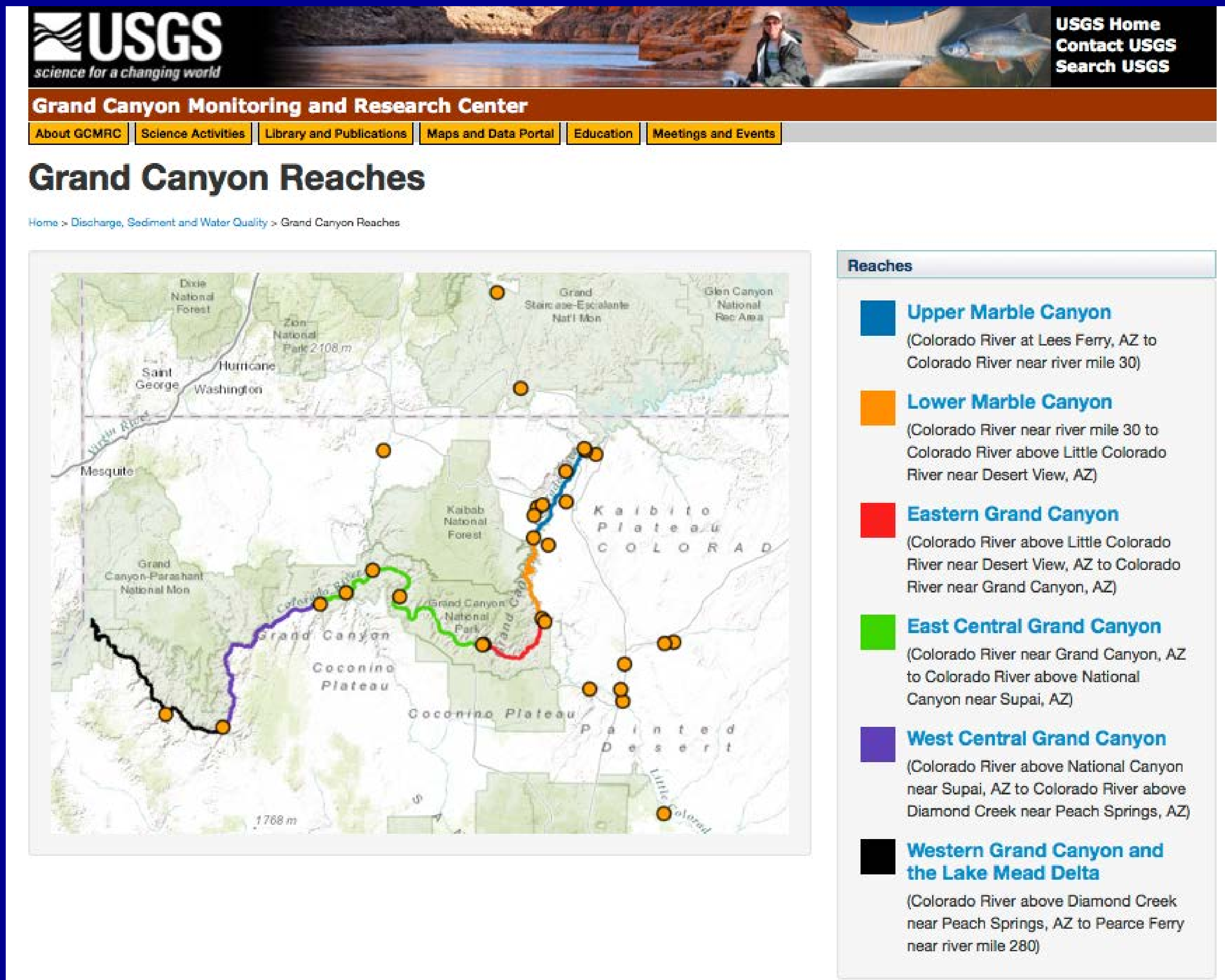
AZ Water Science Center decreased this by about 25% relative to what was on the web this fall. This resulted in a slight reduction in the reported amount of sand supplied during 2013.

The following data are still being processed (delivered by March)

- Suspended-sediment samples from Paria and Little Colorado Rivers

Completion of this processing will not likely result in much change in reported loads but will reduce uncertainty in 2013 sediment loads and sand budgets.

# Steps involved in computing sediment loads and constructing sand budgets: Examples from Upper Marble Canyon



## Step 1: Calculate discharge at 15-minute intervals and perform QA/QC

Gage height is measured at 15-minute intervals at three stations

Stage-discharge relations are used to convert gage-height measurements to discharge.

Episodic discharge measurements are made to evaluate and possibly revise stage-discharge relations.

15-minute discharges reported in real-time on website are usually good to within several percent, but sometimes major revisions are necessary….

All revisions of discharge during a water year (October-September) are finalized (by USGS standard protocols) by March of the following year.

## Step 2: Measure suspended-sediment concentrations and grain-size distributions in major tributaries

For the Upper Marble Canyon Reach, the only major tributary is the Paria River.

Initial suspended-silt-and-clay and sand concentrations are estimated by the physically based sediment-transport model of Topping (1997).

Model predictions of suspended-silt-and-clay and sand concentrations are typically within 40% of the measured concentrations during most floods.

Because no new technology has been found to replace physical suspended-sediment samples during the extreme sediment conditions that typify Paria River or Little Colorado River floods, the only way to actually "know" the sediment concentrations during floods on these rivers is to collect MANY physical suspended-sediment samples.

Processing these samples through the laboratory is the ONLY MAJOR BOTTLENECK in this project.

It takes roughly 3 person-hours to process each Paria River or Little Colorado River suspended-sediment sample through the laboratory.

Given the number of Paria and Little Colorado River samples needed each year, it would take 1 person 23 full-time weeks to process all of these samples.

We only have 2 full-time GCDAMP-funded employees in the lab…and we have many other samples to process for this project.

## Step 3: Calculate major tributary sediment loads

Sediment loads are the product of discharge and sediment concentration, plus bedload.

Initial calculated sediment loads have possible persistent biases as high as ~40%.

As samples get processed through the laboratory, modeled sediment concentrations are adjusted to agree with the measured concentrations in the samples, reducing the maximum possible persistent biases.

Once discharges are finalized and all suspended-sediment samples have been processed, final Paria River sediment loads are calculated.

Final Paria River sediment loads have possible persistent biases that are likely $\leq$10%.

Given the level of staffing in the laboratory and the number of samples yet to be processed, 2013 Paria River sediment loads will not be final until March 2014.

# Paria River at Lees Ferry, AZ 09382000

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Home > Discharge, Sediment and Water Quality > Grand Canyon Stations > 09382000

## Parameter Availability

**Gage Height**

- feet (ft)
- 1985-10-01 to 2014-01-25

**Discharge**

- cubic feet per second (cfs)
- 1980-10-16 to 2014-01-25

**Water Temperature**

- degrees celsius (°C)
- 1997-02-14 to 2013-08-18

**Suspended Silt-and-Clay Concentration**

- Sample-adjusted Modeled Data and Physical Samples
- Physical Samples Only
- milligrams per liter (mg/L)
- 1996-10-01 to 2014-01-25

**Suspended Sand Concentration**

- Sample-adjusted Modeled Data and Physical Samples
- Physical Samples Only
- milligrams per liter (mg/L)
- 1996-10-01 to 2014-01-25

**Suspended-Sand Median Grain Size**

- Physical Samples Only
- millimeters (mm)
- 1997-08-10 to 2013-09-12

**Instantaneous Silt-and-Clay Load**

## Date Range

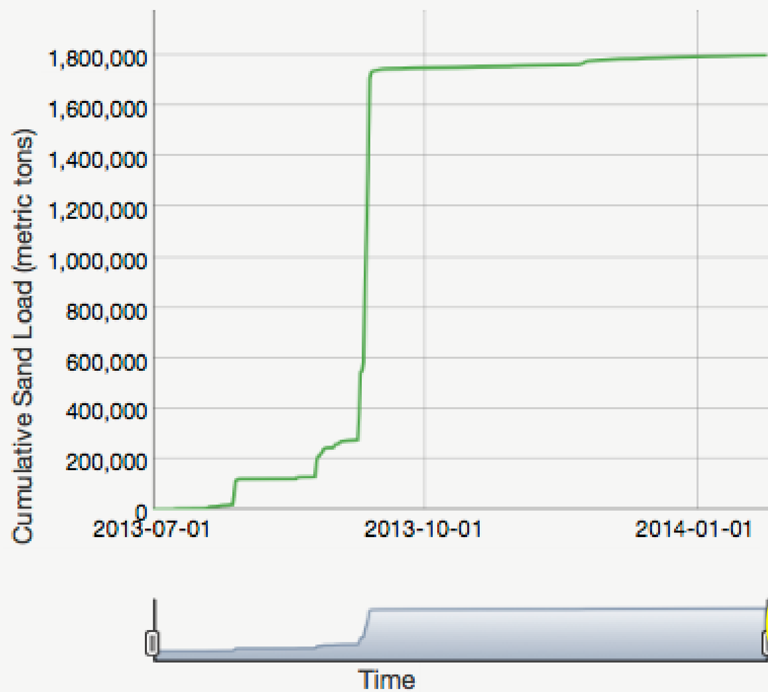
Start 2013-07-01

End 2014-01-25

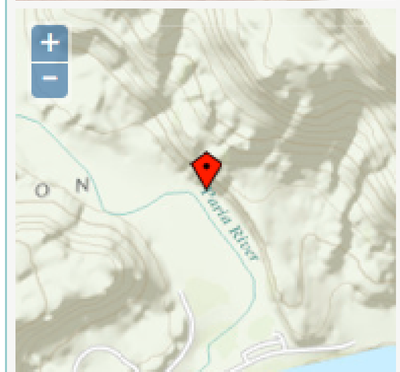
Build Graph | Download

## Data

Due to the length of your request, some timesteps may be filtered from the graph. You may still download the unfiltered dataset, or shorten the date range of your request. ×




## Location




## Additional Information

**Data provided by:**

- USGS Arizona Water Science Center
- USGS Grand Canyon Monitoring and Research Center
- Find data for this site in NWIS

## Data Status

- End of complete lab-processed suspended-sediment record for Paria River: 2013-07-28
- Most recent suspended-sediment sample from Paria River used in calculations: 2013-09-12

## Step 4: Measure 15-minute suspended-silt-and-clay concentrations, suspended-sand concentrations, and suspended-sand grain size at gaging stations on the Colorado River and perform QA/QC

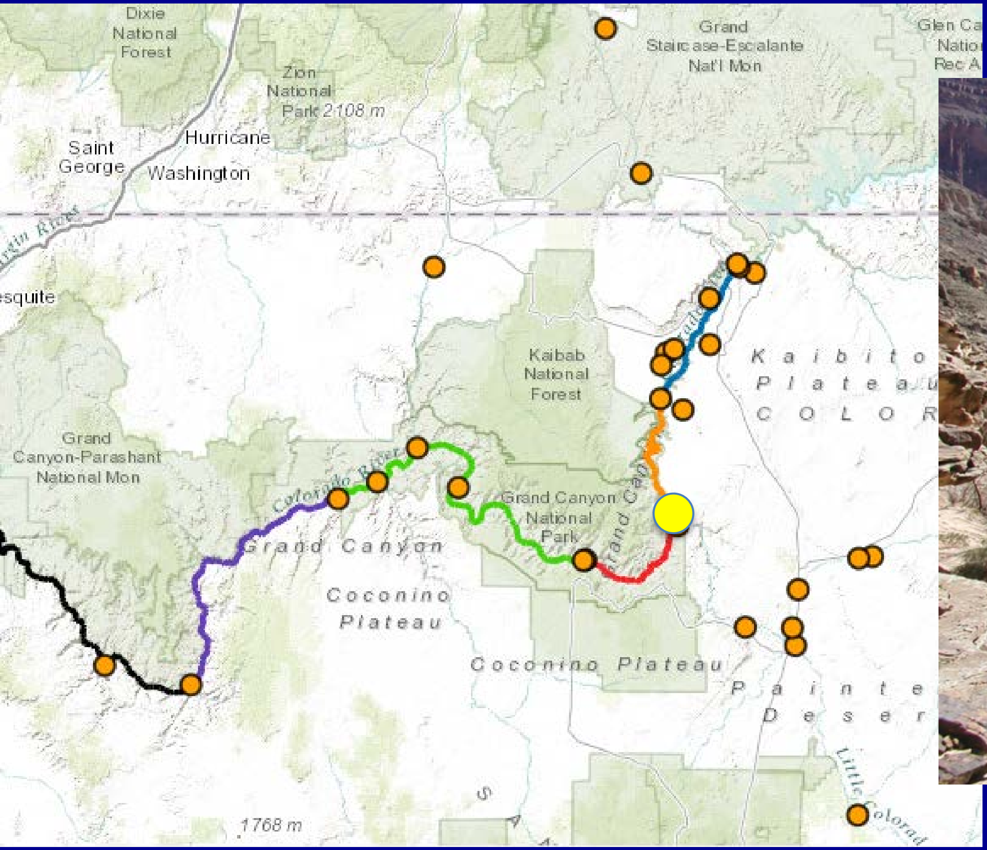
Discharge-independent changes in suspended-silt-and-clay concentration and suspended-sand concentration exceeding several orders of magnitude occur in the Colorado River over timescales <1 hour

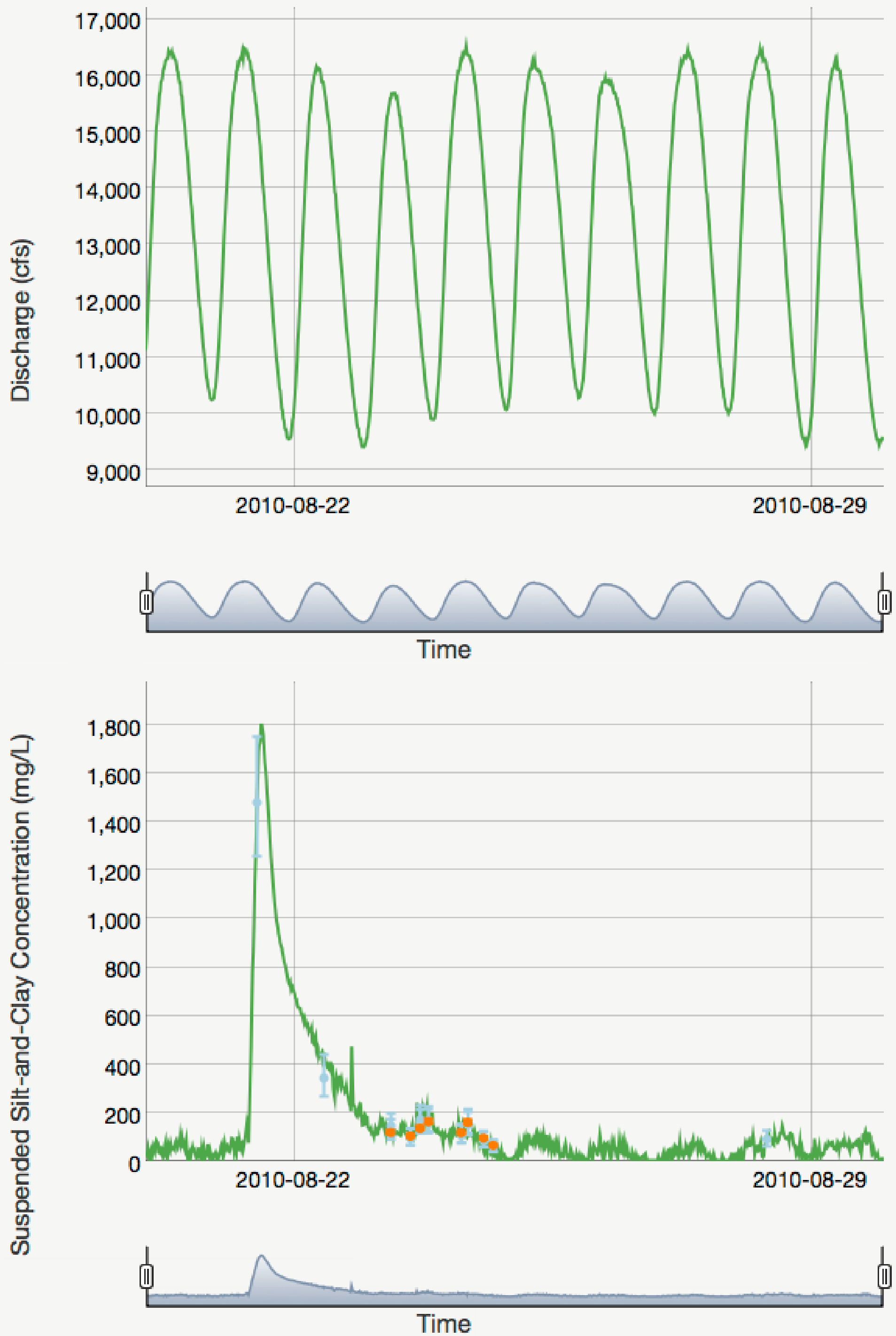
We use multi-frequency acoustics to make 15-minute measurements of suspended-silt-and-clay concentration, suspended-sand concentration, and suspended-sand grain size.

These acoustic measurements are verified using episodically collected physical samples (processed through the lab) with known error
(Topping and others, 2011, USGS-Professional Paper 1774).

Analyses indicate that the maximum possible persistent biases in the acoustically-measured sand concentrations are roughly 5%.

# Example from Colorado River above Little Colorado River near Desert View, AZ, 09383100

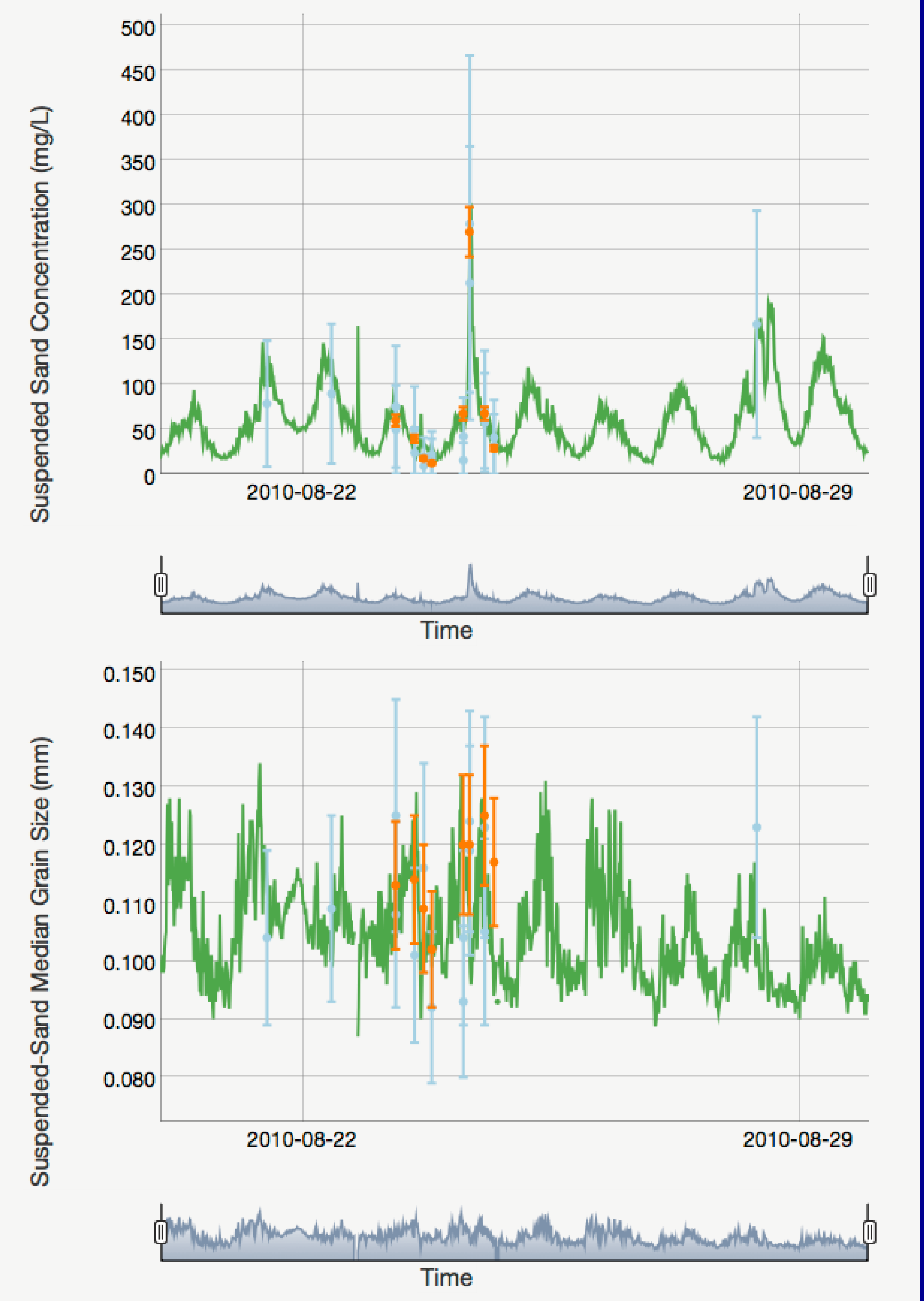



ORANGE = EWI measurement made using a US D-96-A1 depth-integrating sampler

BLUE = calibrated pump measurement

ERROR BARS = 95% confidence-level field + lab error




ORANGE = EWI measurement made using a US D-96-A1 depth-integrating sampler

BLUE = calibrated pump measurement

ERROR BARS = 95% confidence-level field + lab error

Step 5: Calculate 15-minute suspended-silt-and-clay and suspended-sand loads at the Colorado River gaging stations using the 15-minute discharge and acoustic sediment-concentration data

Step 6: The relatively small estimated contributions of sand to the Colorado River from lesser tributaries are verified every 6 months using data collected in these tributaries (covered in last nights poster session). Maximum possible persistent biases assigned to the lesser tributary sand loads in the sand budgets are 50%.

## Step 7:  Construct mass-balance sand budgets (SAND IN minus SAND OUT)

Tributary supply of sand to the reach is calculated by integrating the sand loads in the major and lesser tributaries, accumulating uncertainties set equal to the maximum possible persistent biases in these loads.

The default values of these uncertainties are 10% for the finalized major tributary sand loads and 50% for the lesser tributary sand loads.

Colorado River supply and export of sand from the reach is calculated by integrating the suspended-sand loads at the gaging stations bracketing the reach.  At each of these gaging stations, bedload is estimated as a percentage of the suspended-sand (Rubin and others 2001).  The measured suspended-sand load is combined with the estimated bedload to yield the total sand load.

The default values of the uncertainties in the suspended-sand loads are 5%.  The default value of the bedload multiplier is 5%.

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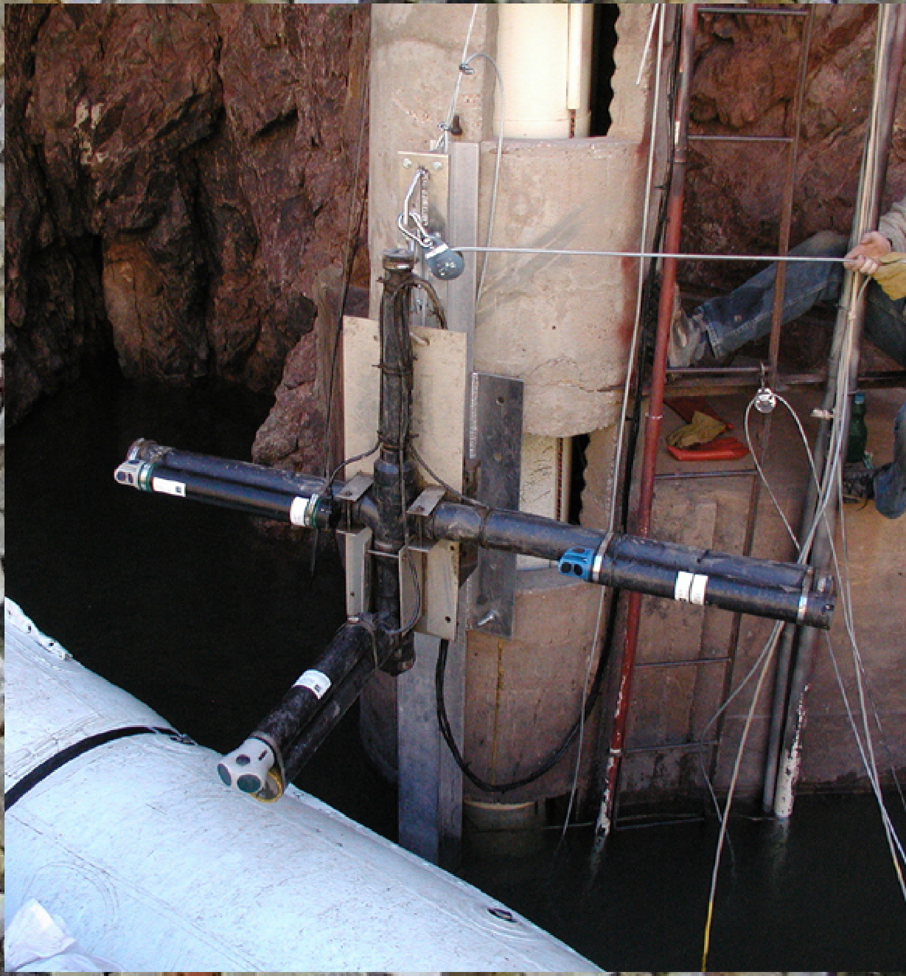
# Questions?



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