Project 2: Streamflow, Water Quality, Sediment Transport, and Sand Budgets in the Colorado River Ecosystem

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The USGS team

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- Jon Mason, AZ Water Science Center
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- Eric Everman, CIDA
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How do operations at Glen Canyon Dam affect flows, water quality, sediment transport, and sediment resources in the Colorado River Ecosystem?

- Continued development of database and website with user-interactive tools for data visualization and downloading (NEW TOOL THIS YEAR)
- Publication of 3 peer-reviewed interpretive books/papers and 5 abstracts presented at AGU
- Real-time to monthly posting of all discharge, qw, and sediment data on WEBSITE
- Monthly updates of the mass-balance sand budgets on WEBSITE

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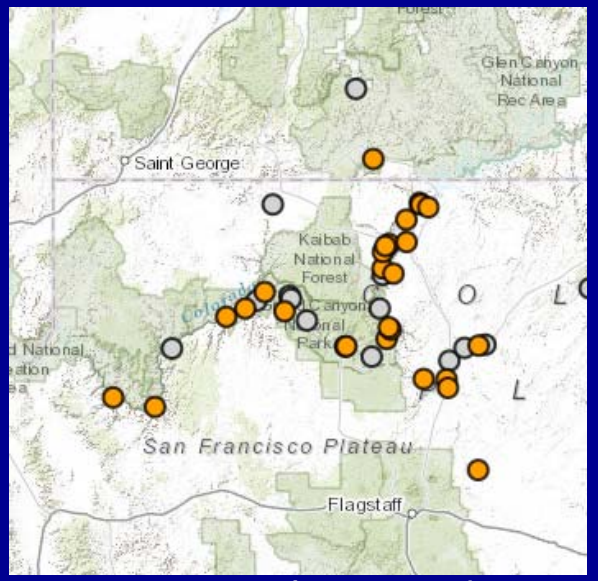
Monitoring project with some research

We collect, post, and analyze the following data at stations located through the Colorado River Ecosystem, including key tributaries…



- Stage
- Discharge
- Water temperature
- Salinity (specific conductance)
- Turbidity
- Dissolved Oxygen
- Suspended- and bed-sediment data
- Sediment loads (silt and clay loads and sand loads)
- User-interactive sand budgets in 6 reaches from Lees Ferry to Lake Mead
- User-interactive duration-curve tool for any continuous parameter

All other GCDAMP-funded projects use these data, and data from this project inform LTEMP

Citation for data and plots on most slides:

U.S. Geological Survey, 2016, Discharge, sediment, and water quality monitoring, Grand Canyon Monitoring and Research Center: accessed on January 20, 2017, at http://www.gcmrc.gov/discharge_qw_sediment/.

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We have continued to add new datasets and make improvements to the new database and website.

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

http://cida.usgs.gov/gcmrc/discharge_qw_sediment/

The user-interactive tools available at this website to visualize and operate on the data are unique in the world, with our newest tool (the duration-curve tool) now online.

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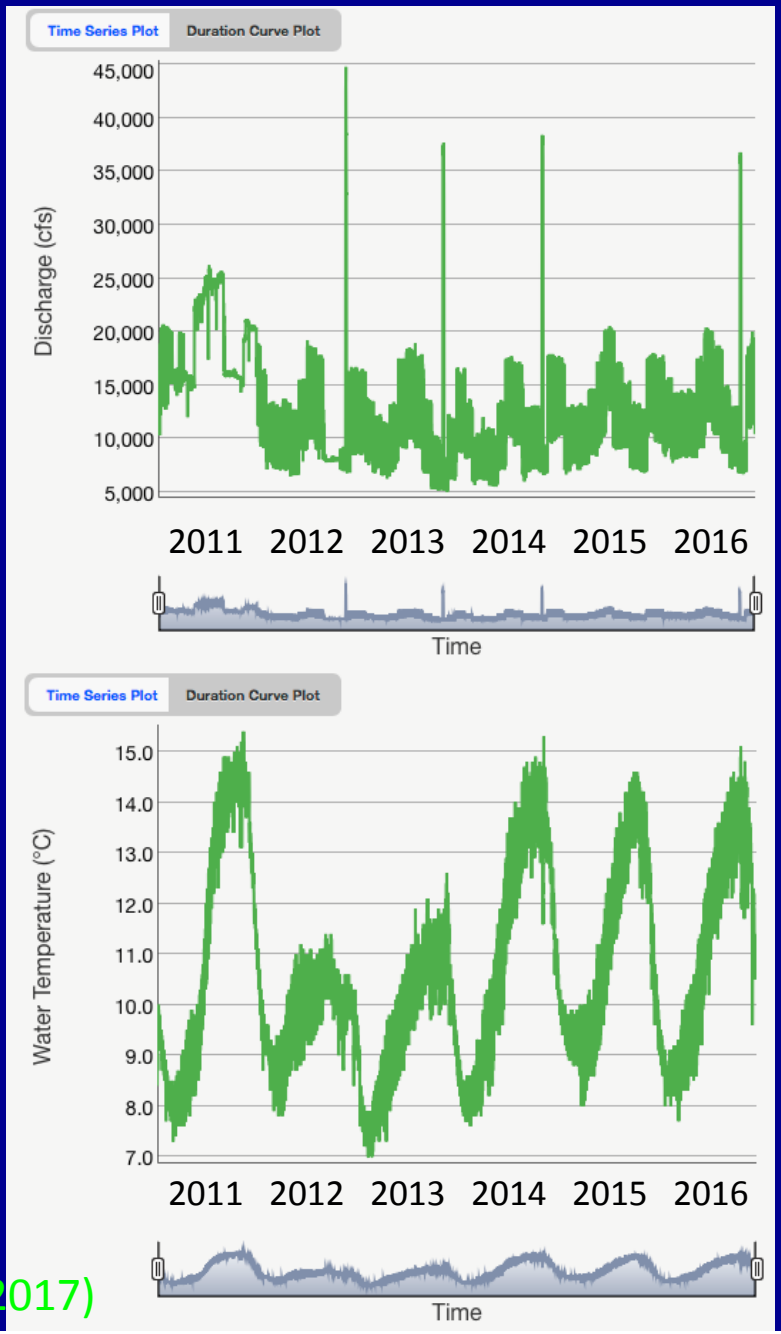
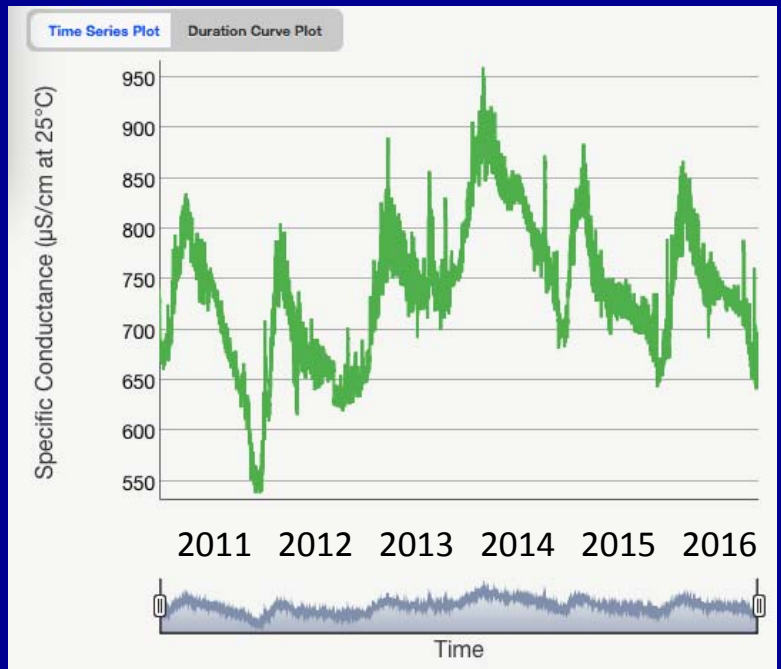
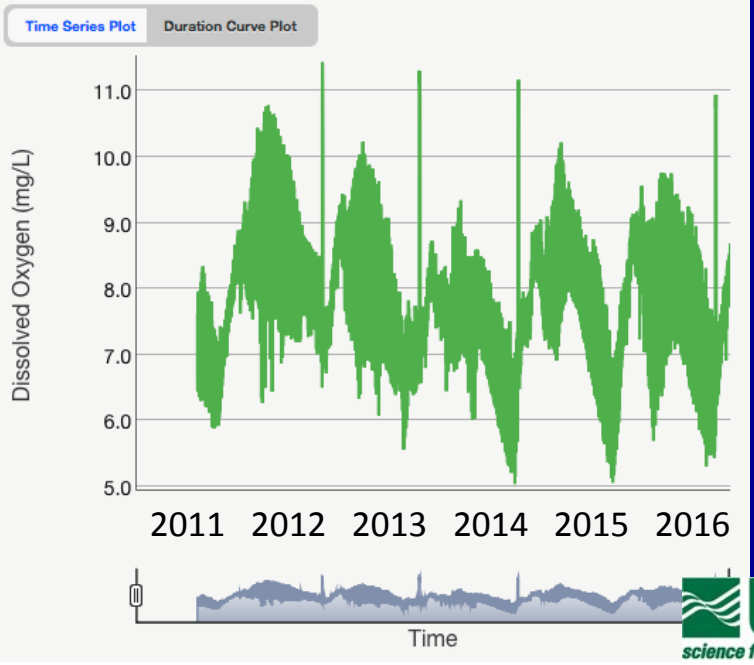
Colorado River at Lees Ferry 2011-2016







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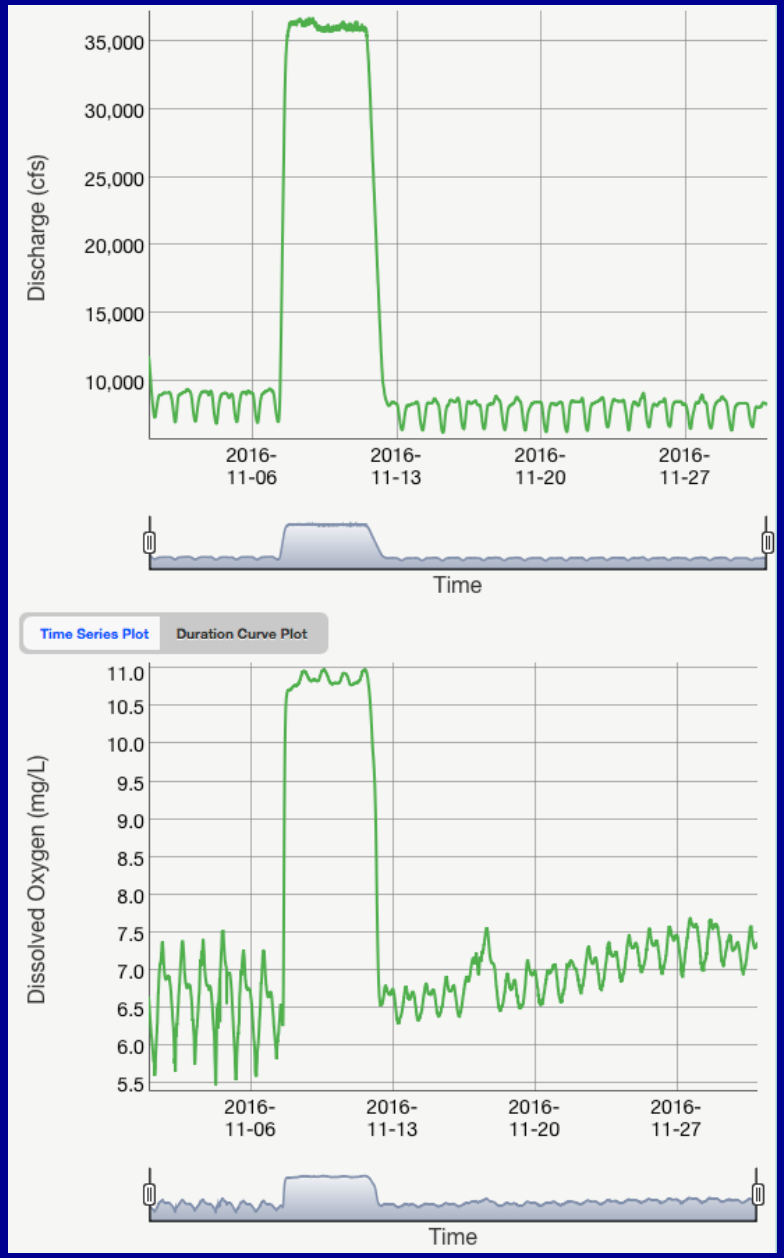

HFEs increase DO

November 2016 HFE caused increase in dissolved oxygen at Lees Ferry during and after event

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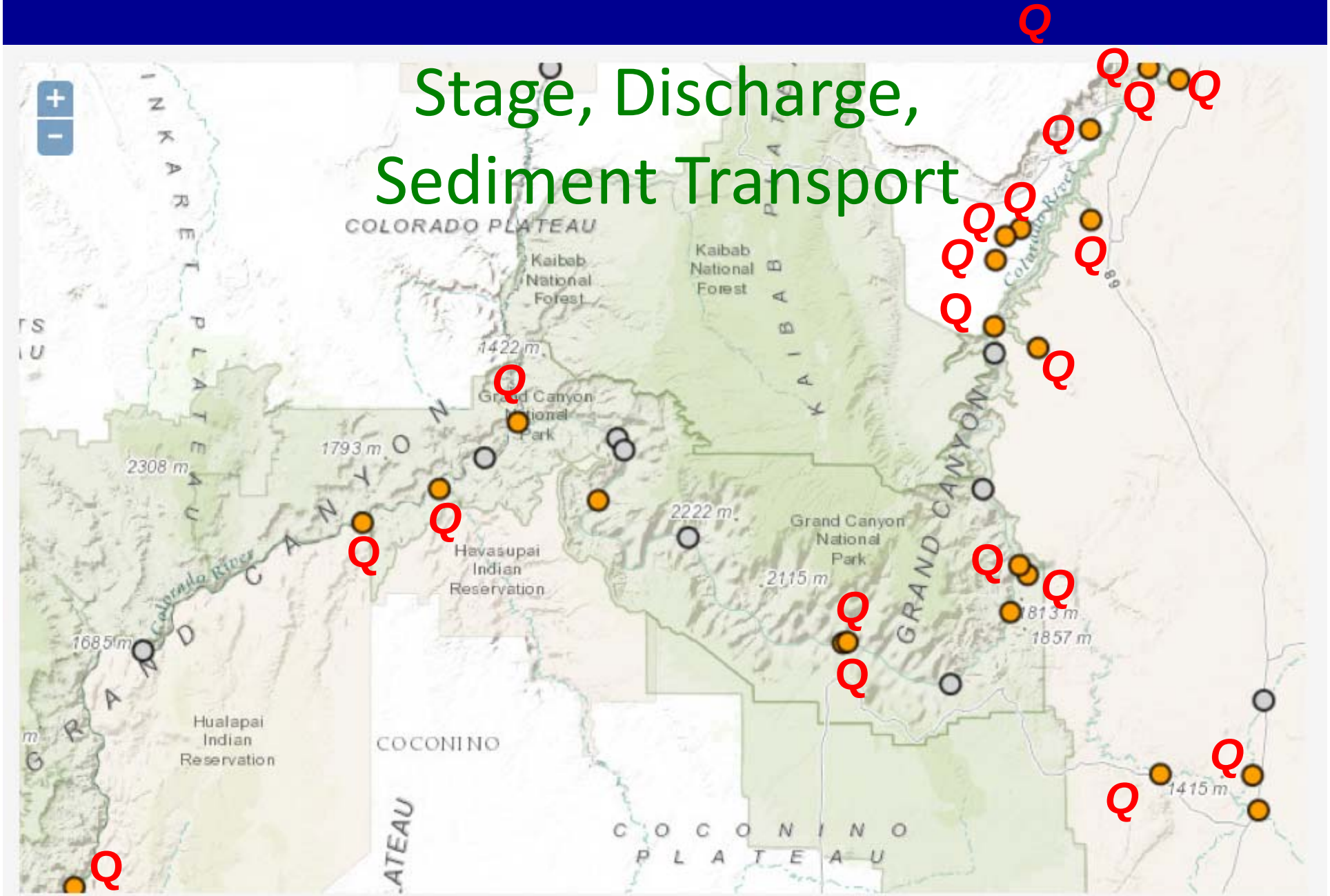
Stage, Discharge, Sediment Transport



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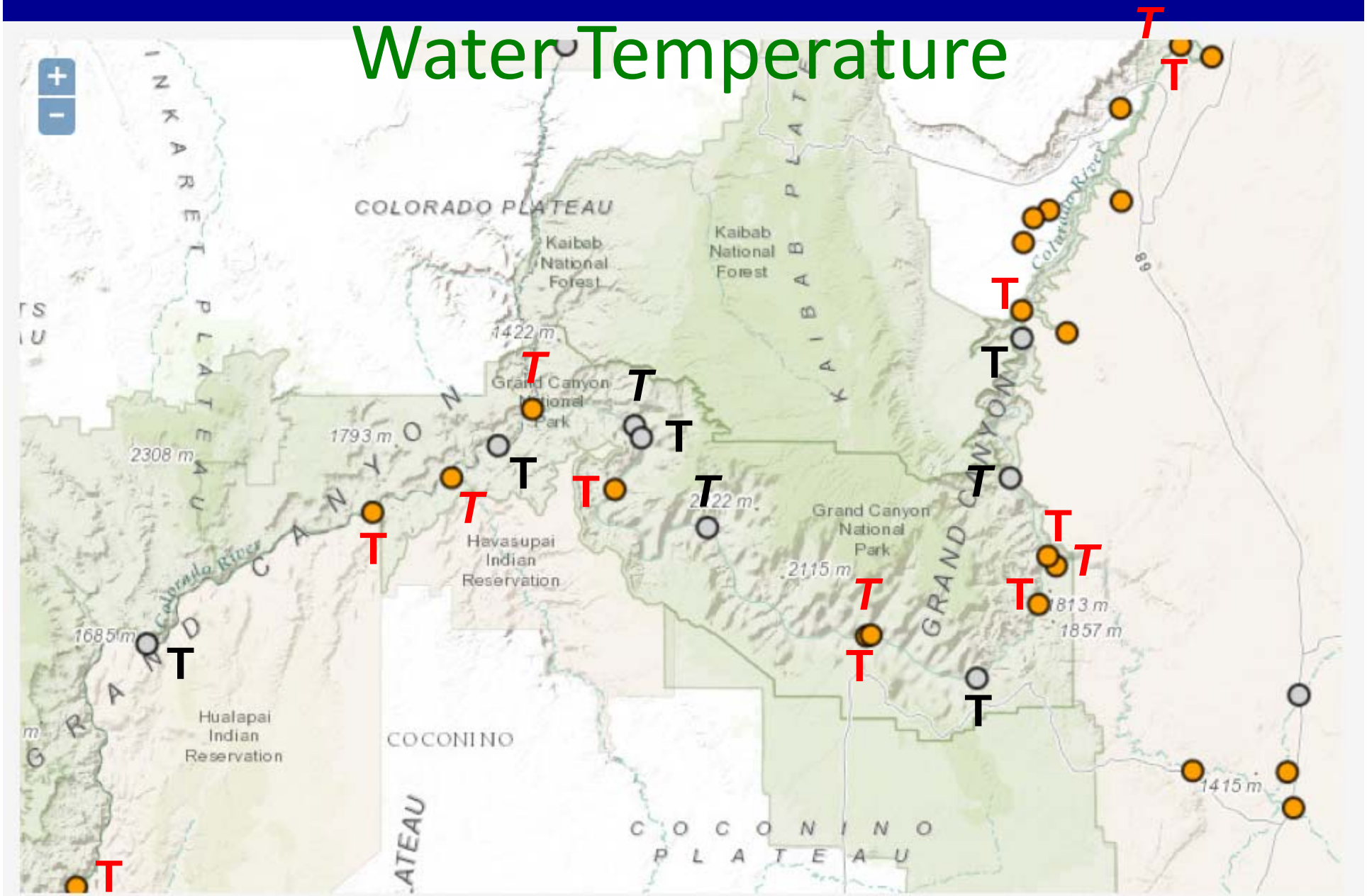
Water Temperature



T(at Lava Cliff)

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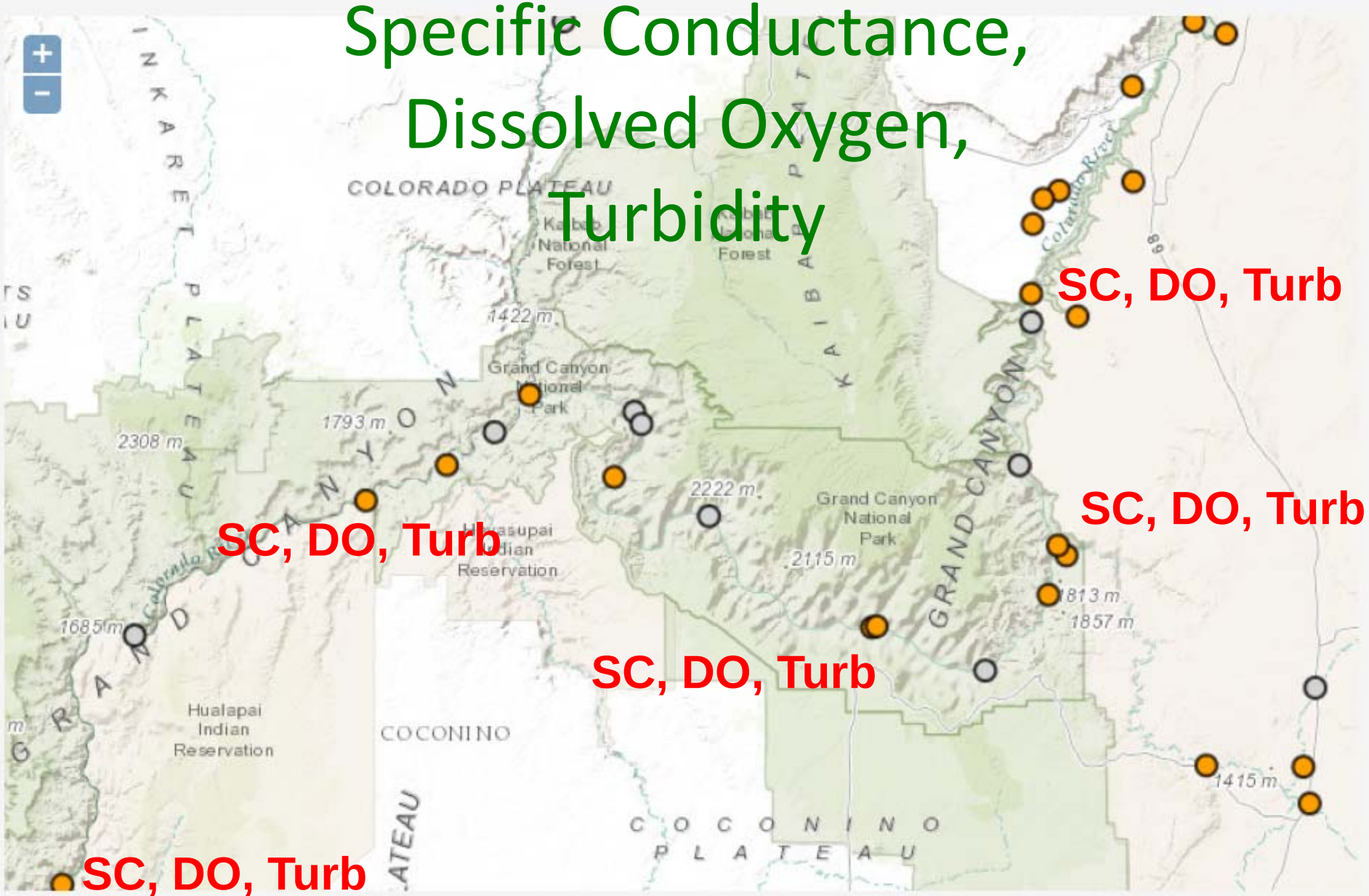
Specific Conductance, Dissolved Oxygen, Turbidity



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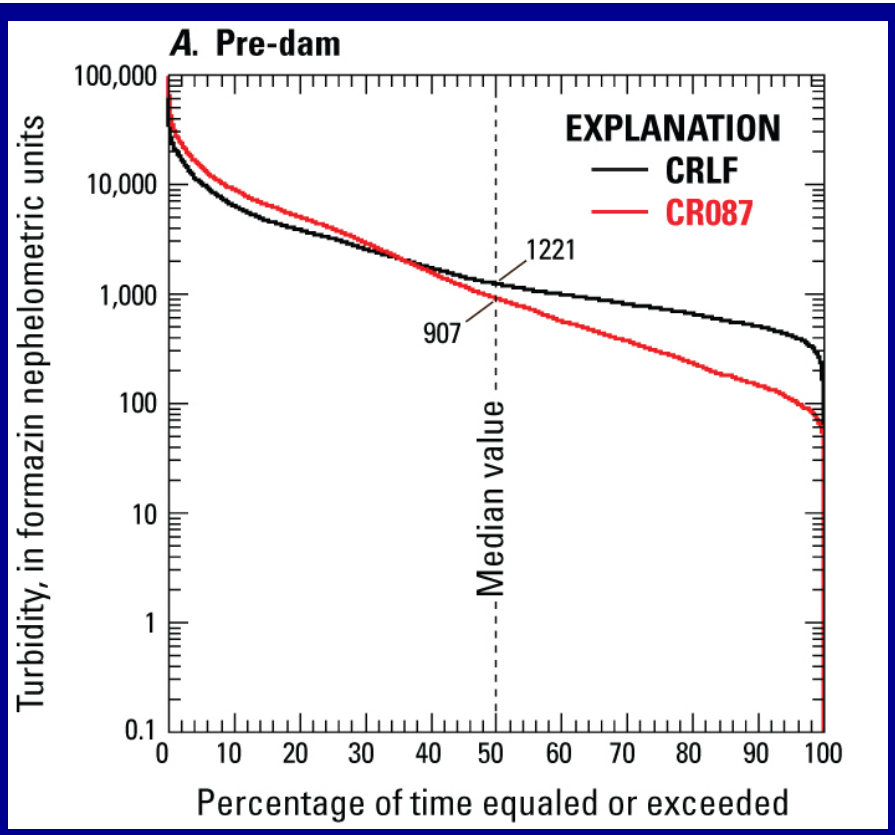

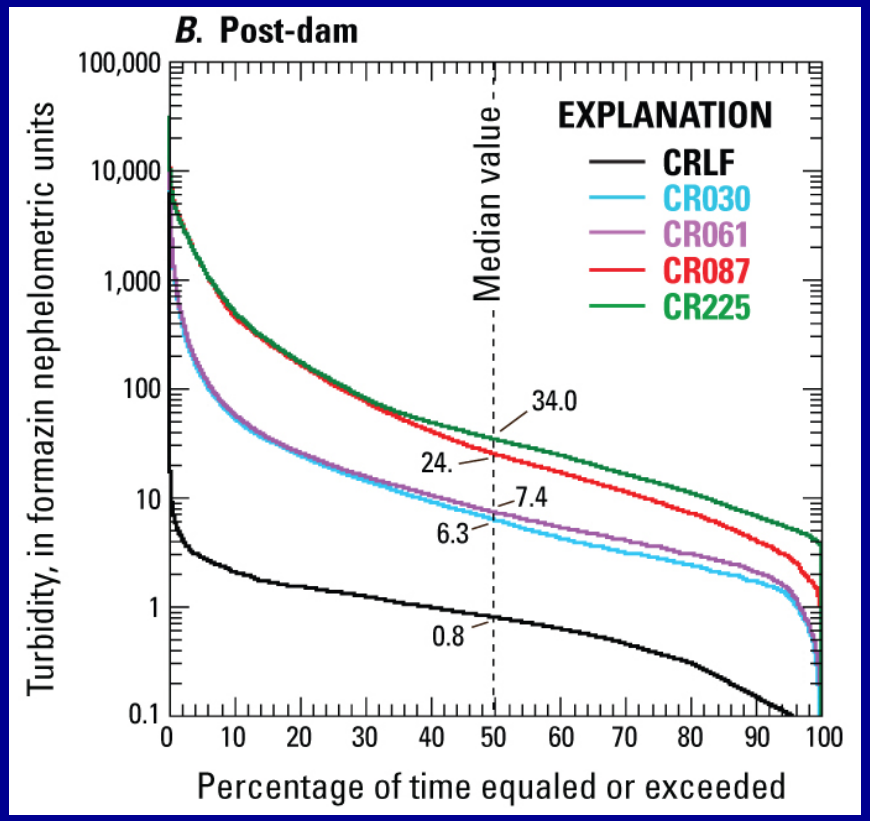

Voichick and Topping (2014)

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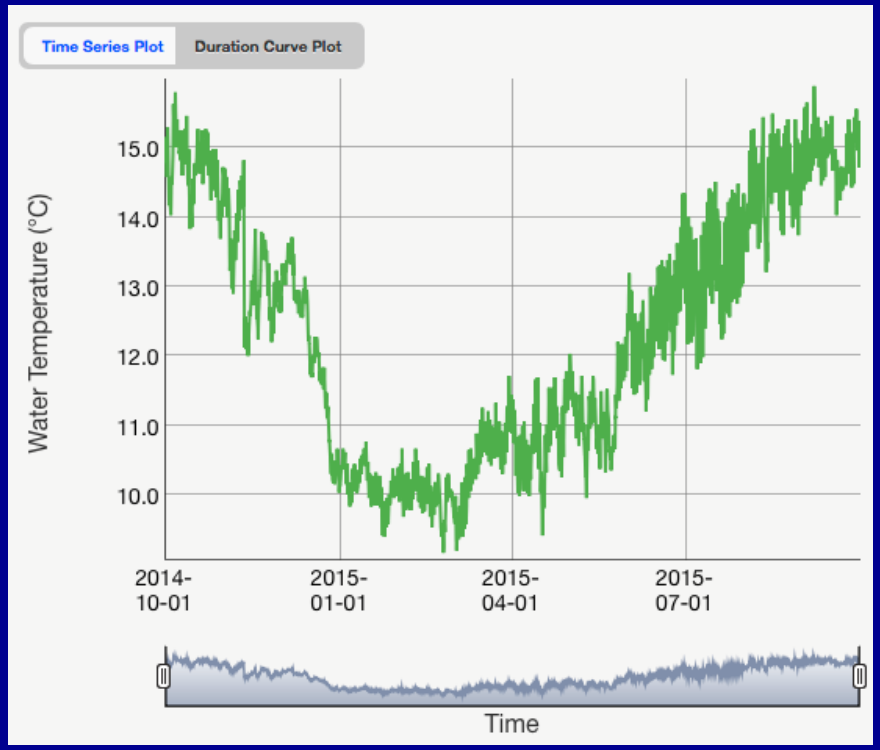
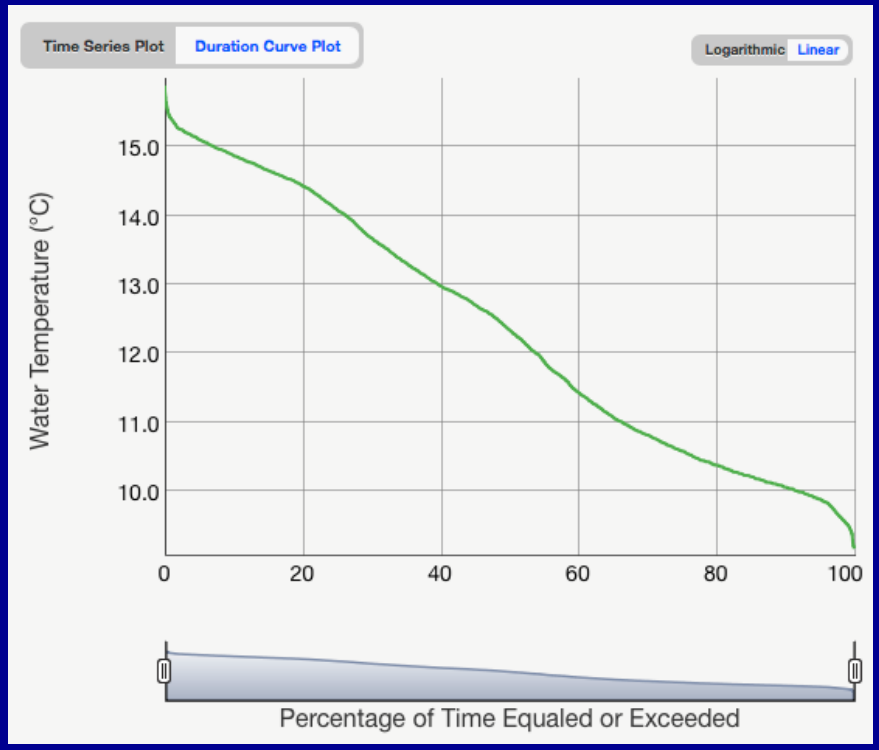
Duration-curve tool

WY 2015 Colorado River near river mile 66
below the mouth of the Little Colorado River





After USGS (2017)

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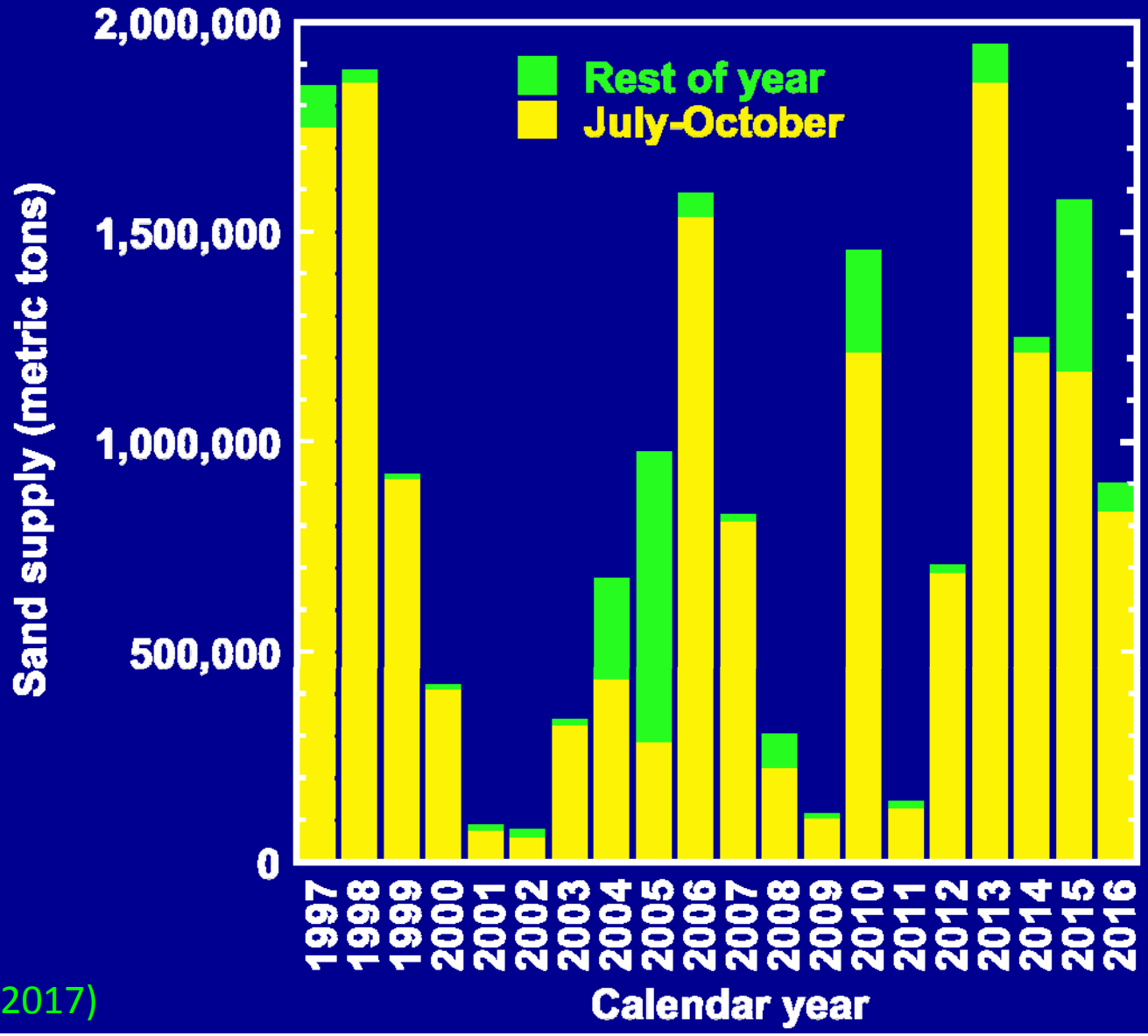
2016 July-October Paria River sand inputs were the 9th largest since 1996



After USGS (2017)

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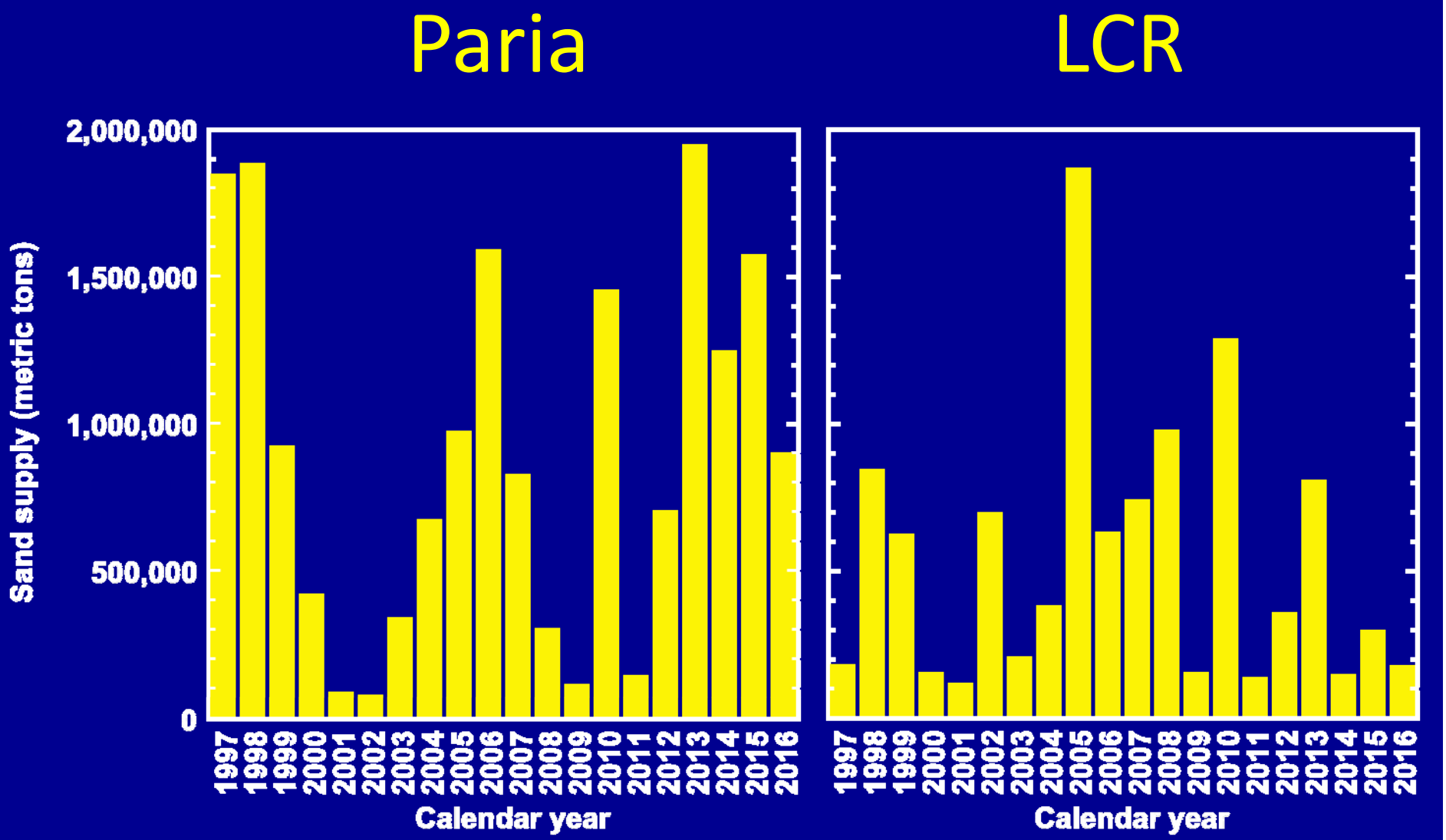
Temporal pattern of sand supply very different between tributaries



After USGS (2017)

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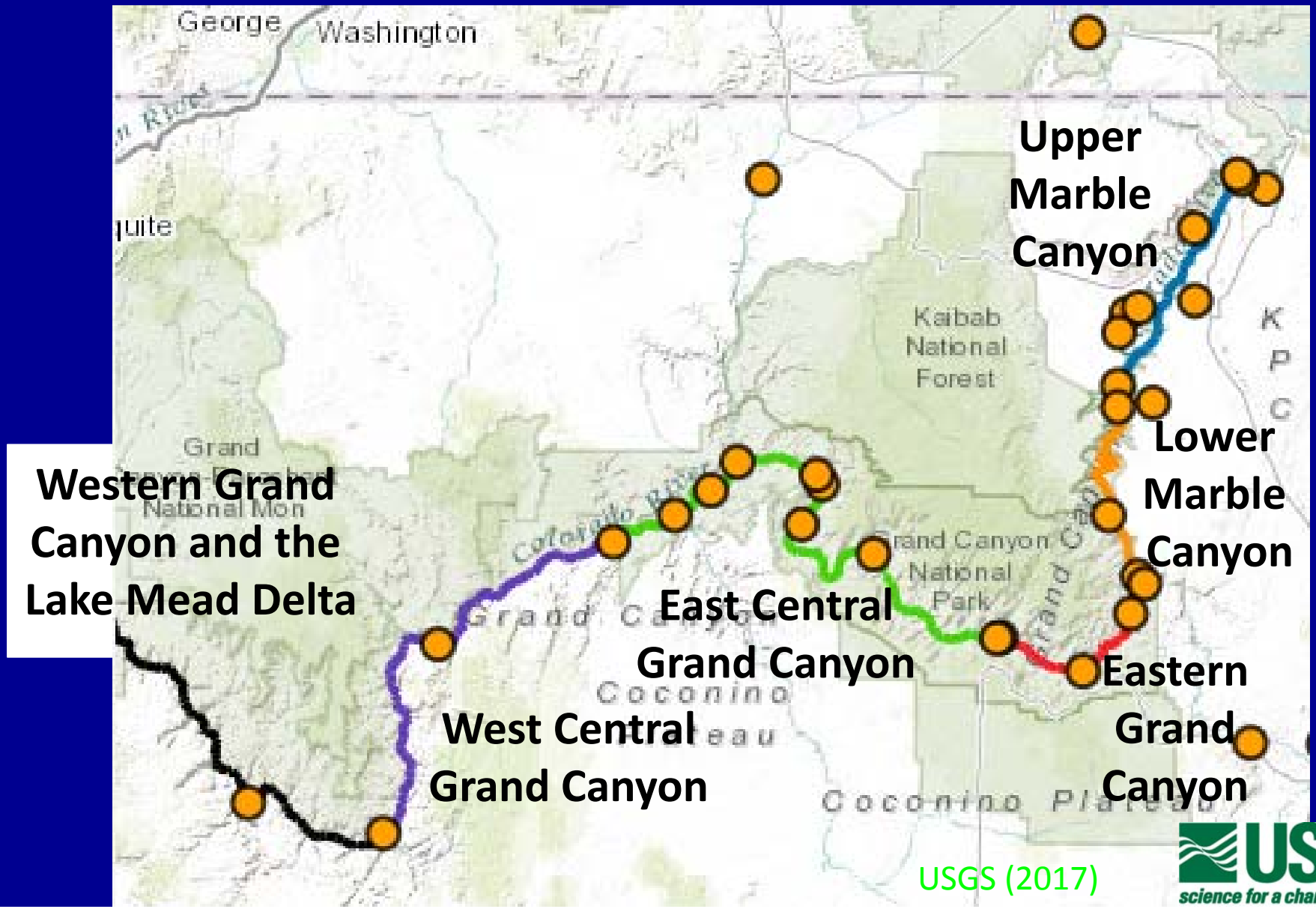
Sand budgets for the last 6-year period



USGS (2017)

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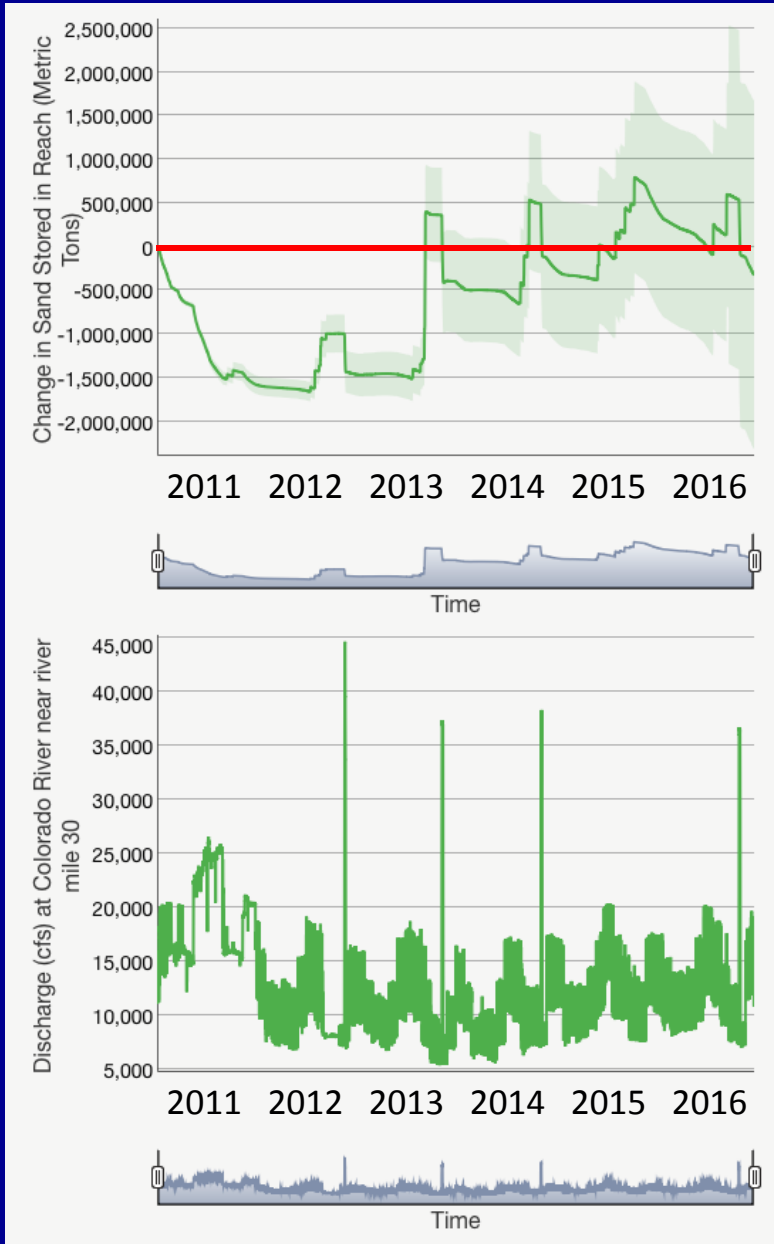
Upper Marble Canyon
1-1-2011 through 1-1-2016



Change in Sand Mass

Zero Bias Value: **-320,000 Metric Tons**

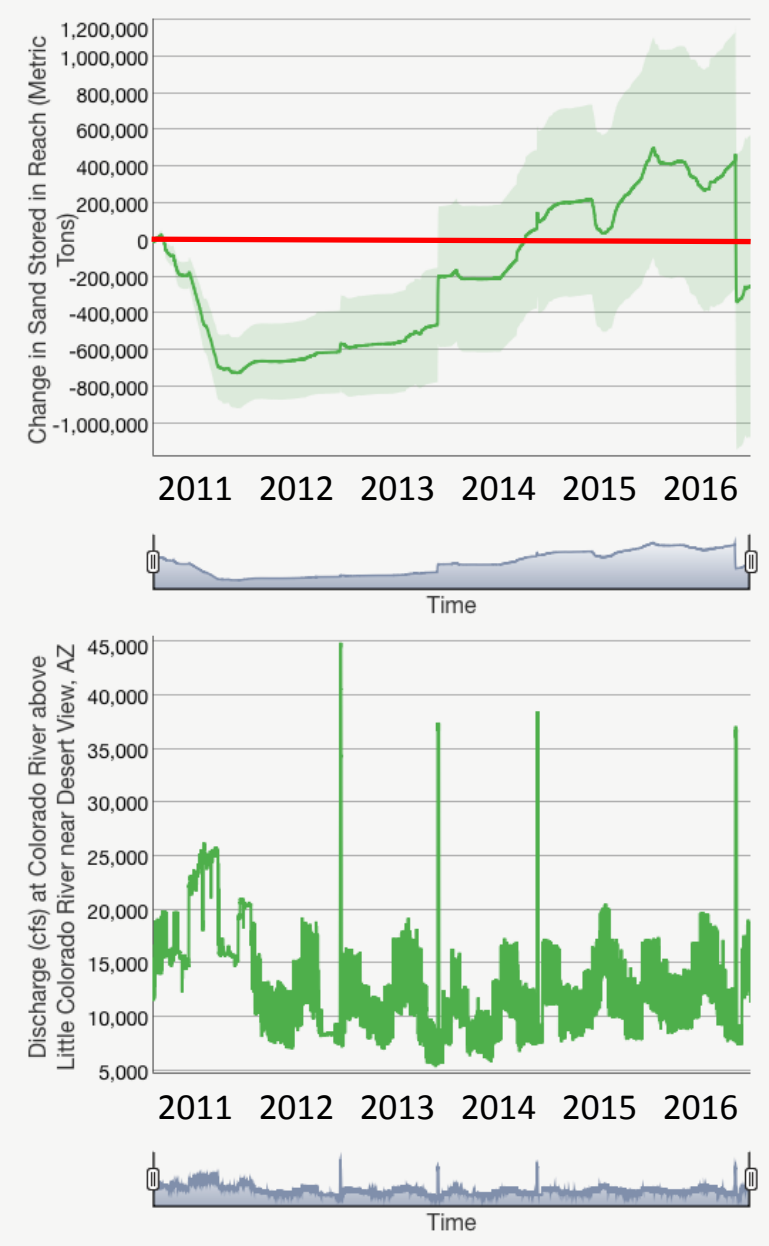
Upper Uncertainty Bound: 1,700,000 Metric Tons

Lower Uncertainty Bound: -2,300,000 Metric Tons

USGS (2017)

USGS science for a changing world

Lower Marble Canyon
1-1-2011 through 1-1-2017



Change in Sand Mass

Zero Bias Value: **-250,000 Metric Tons**

Upper Uncertainty Bound: 570,000 Metric Tons

Lower Uncertainty Bound: -1,100,000 Metric Tons

USGS (2017)

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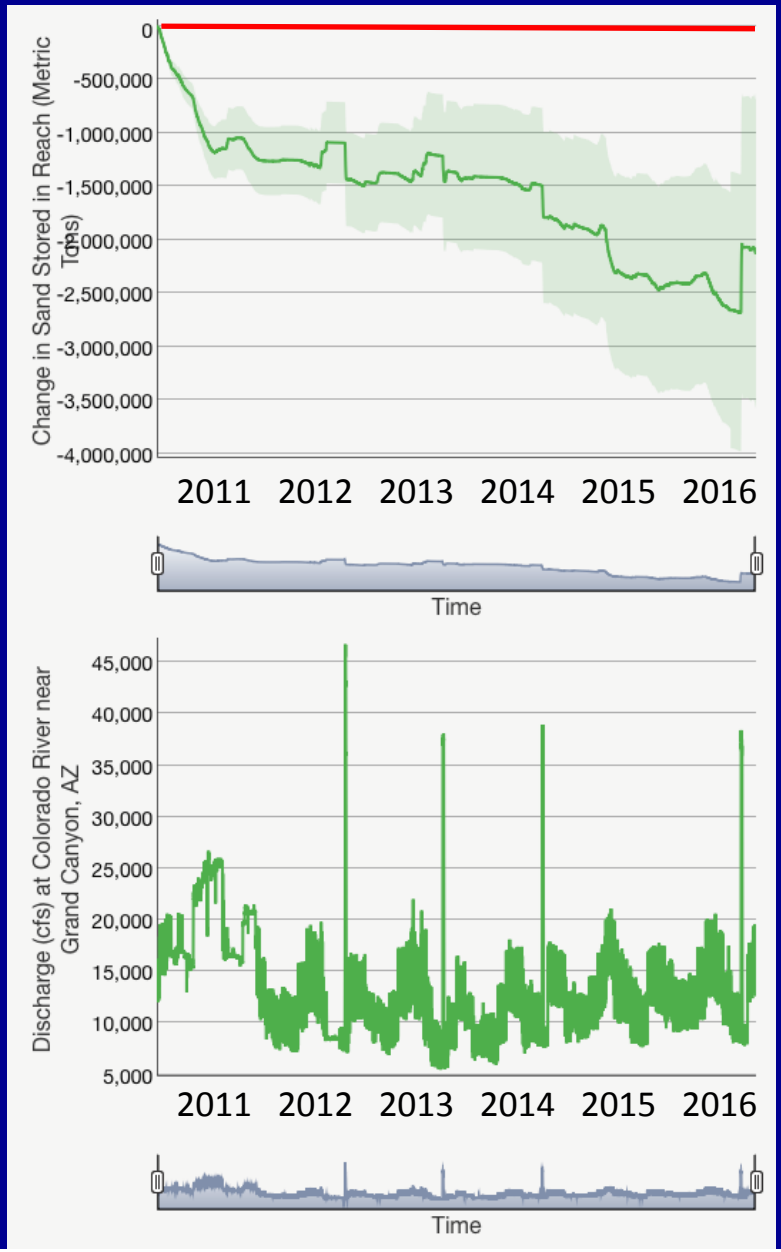
Eastern Grand Canyon
1-1-2011 through 1-1-2017



Change in Sand Mass

Zero Bias Value: **-2,100,000 Metric Tons**

Upper Uncertainty Bound: -690,000 Metric Tons

Lower Uncertainty Bound: -3,600,000 Metric Tons

USGS (2017)

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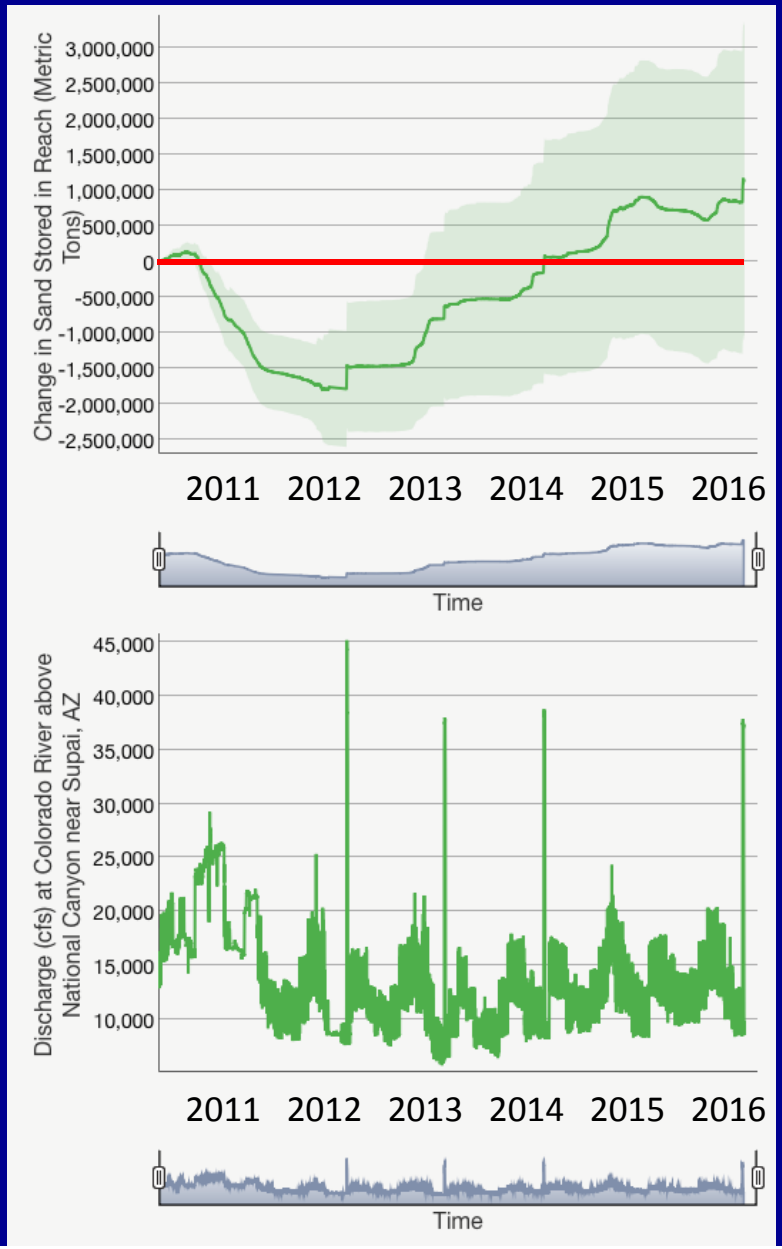
East Central Grand Canyon
1-1-2011 through 11-15-2016



Change in Sand Mass

Zero Bias Value: **1,100,000 Metric Tons**

Upper Uncertainty Bound: 3,300,000 Metric Tons

Lower Uncertainty Bound: -1,100,000 Metric Tons

USGS (2017)

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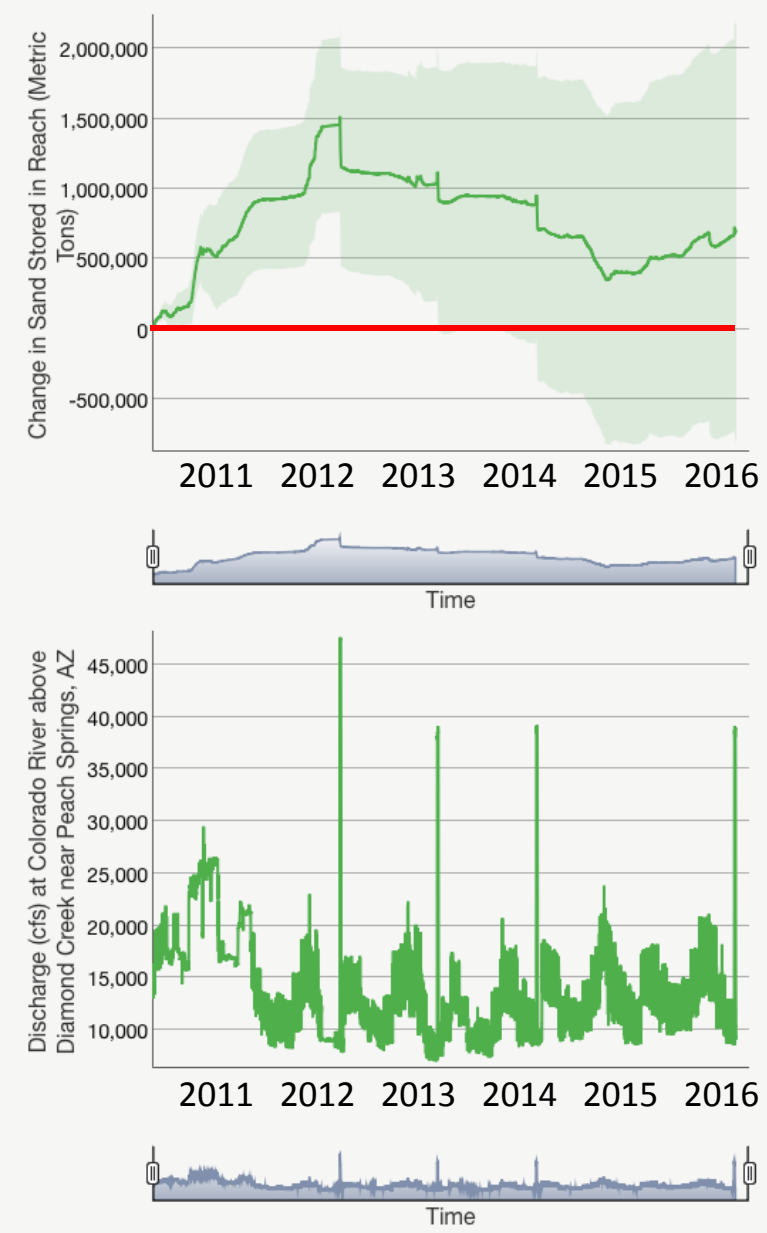
West Central Grand Canyon
1-1-2011 through 11-15-2016



Change in Sand Mass

Zero Bias Value: **690,000 Metric Tons**

Upper Uncertainty Bound: 2,200,000 Metric Tons

Lower Uncertainty Bound: -800,000 Metric Tons

USGS (2017)

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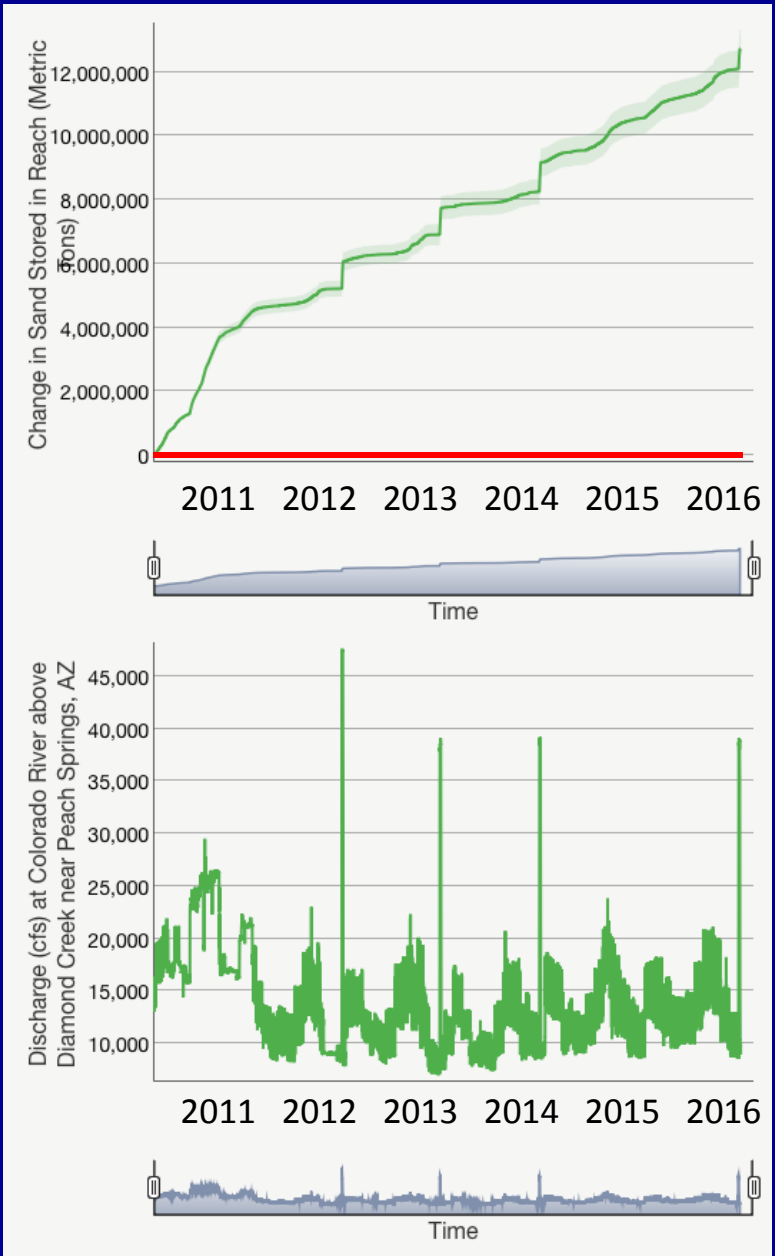
Western Grand Canyon and the Lake Mead Delta
1-1-2011 through 11-16-2016



Change in Sand Mass

Zero Bias Value: **13,000,000 Metric Tons**

Upper Uncertainty Bound: 13,000,000 Metric Tons

Lower Uncertainty Bound: 12,000,000 Metric Tons

USGS (2017)

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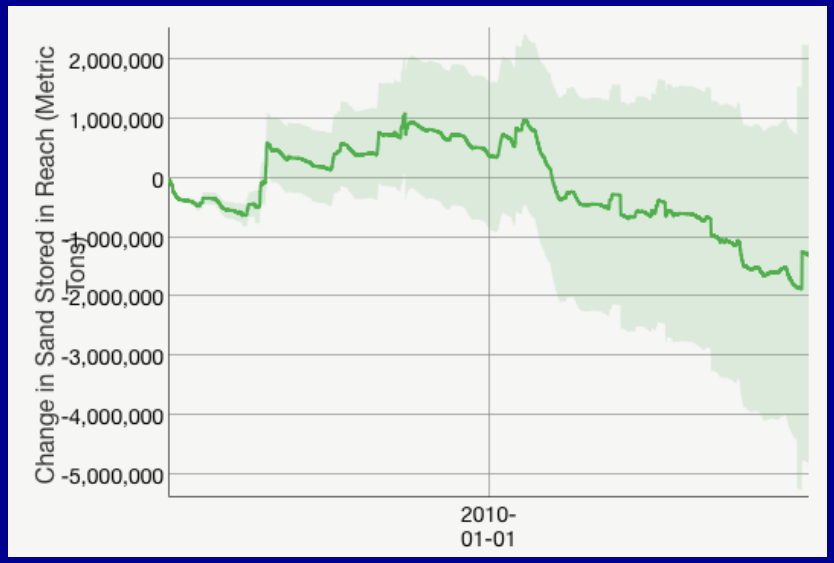
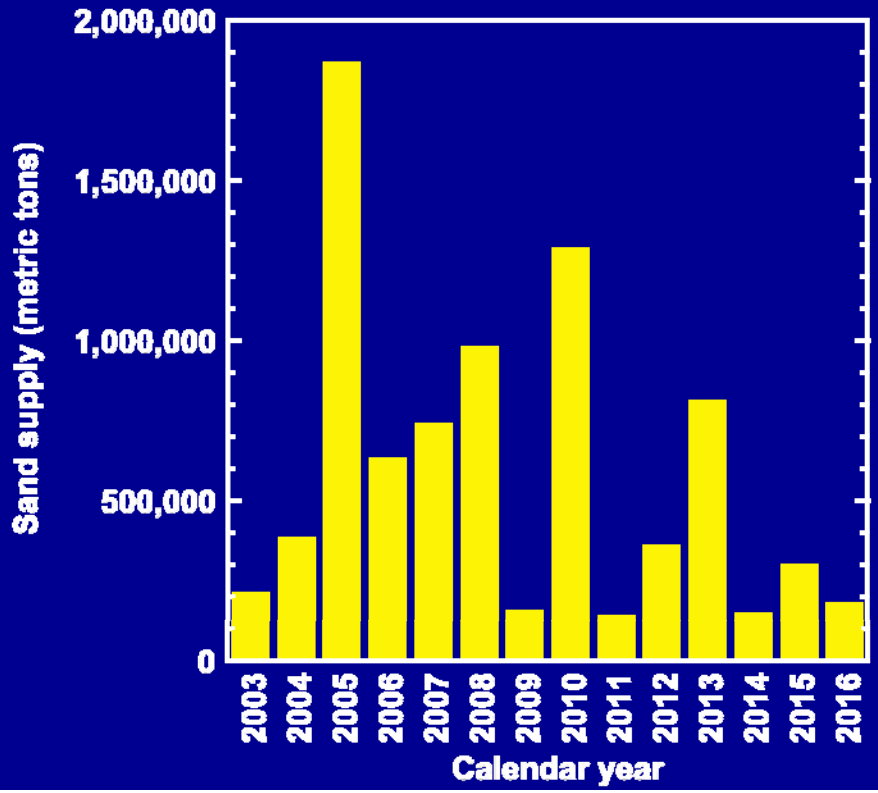


Eastern Grand Canyon sand budget



LCR sand input

After USGS (2017)

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Although sandbars have generally been built in each

sand budget in each reach

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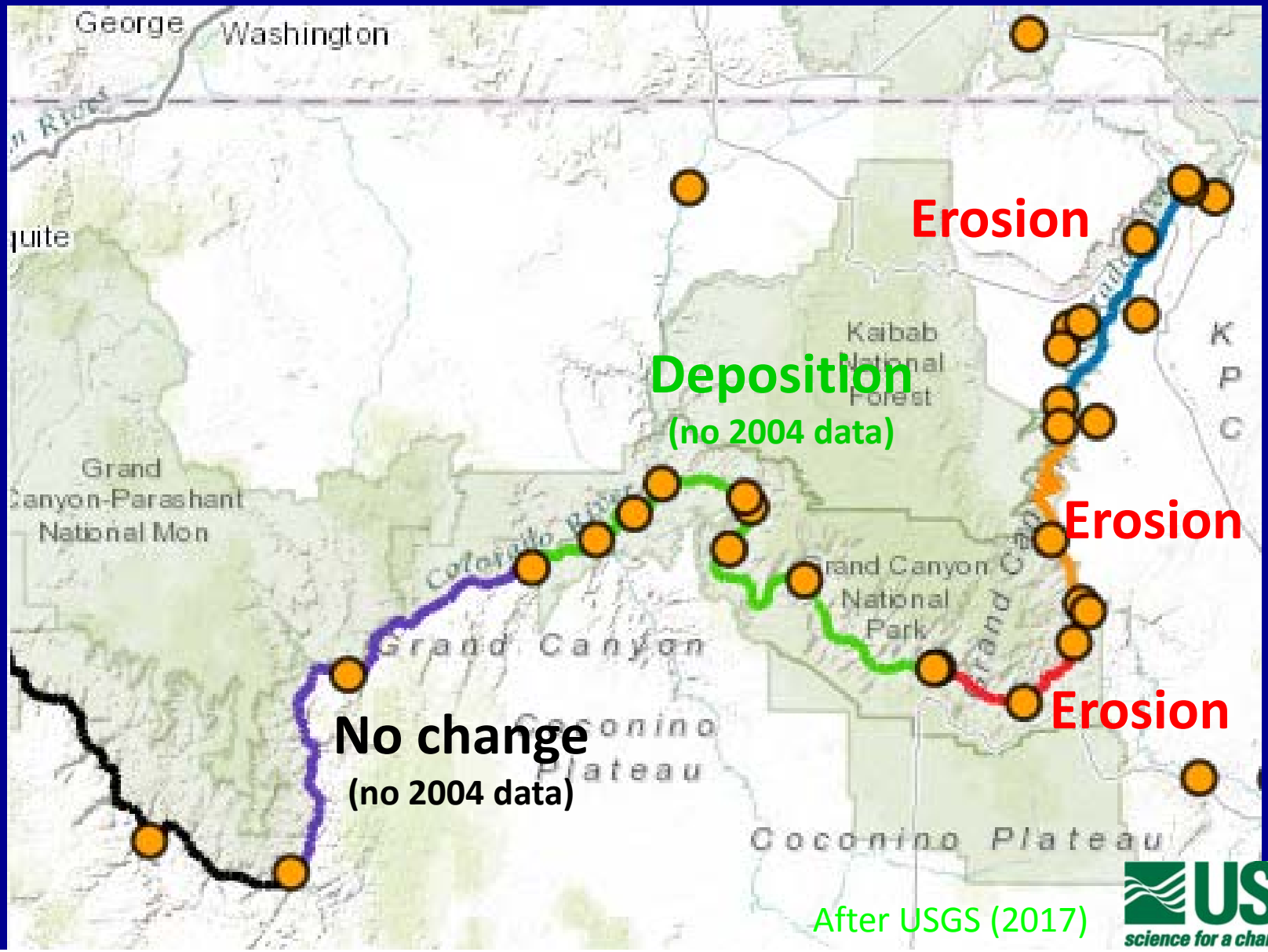
Over the flood hydrographs of the 2004 and 2008 HFES, the following occurred…



After USGS (2017)

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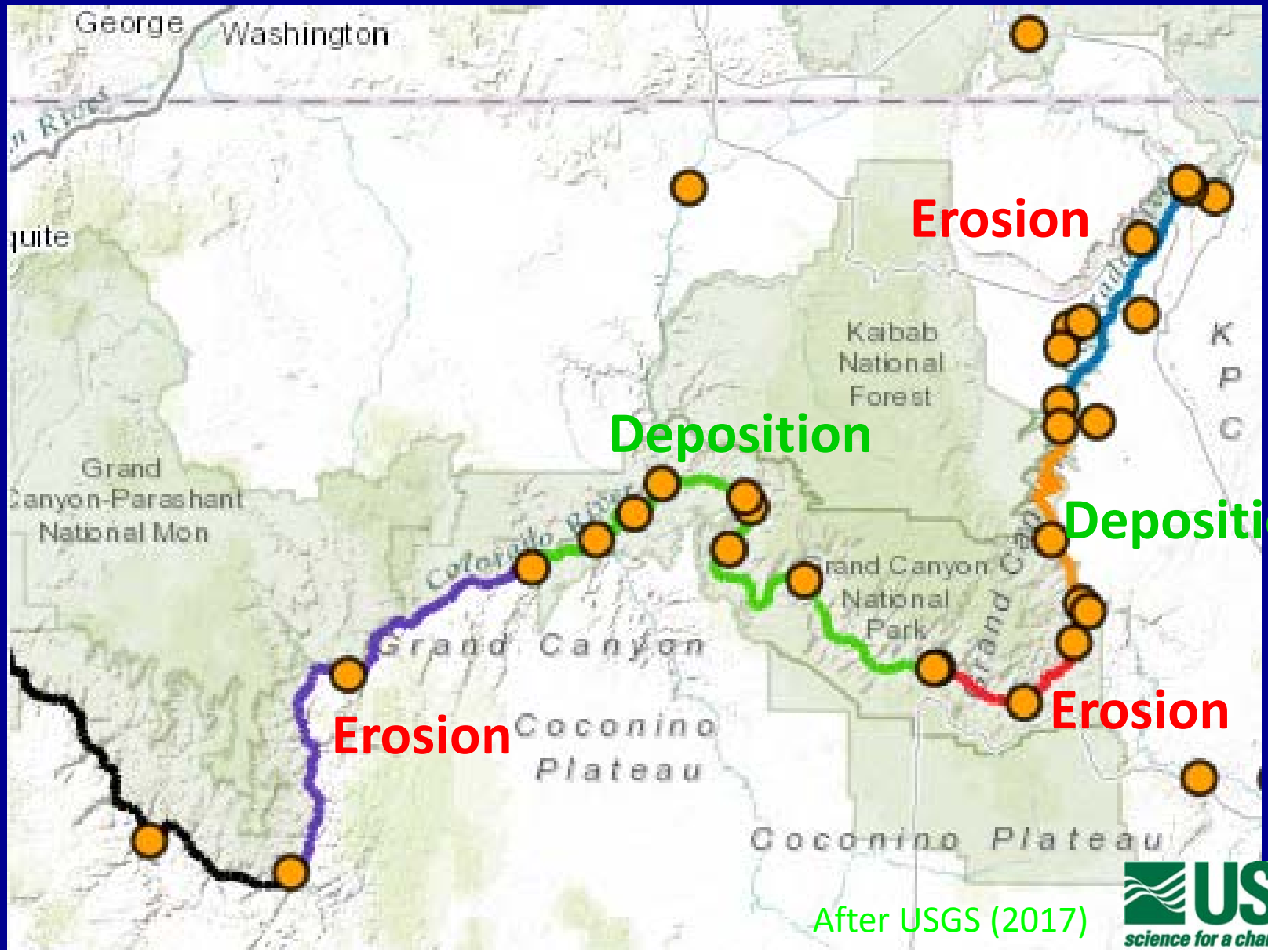
Over the flood hydrographs of each of the 2012, 2013, and 2014 HFES, the following occurred…



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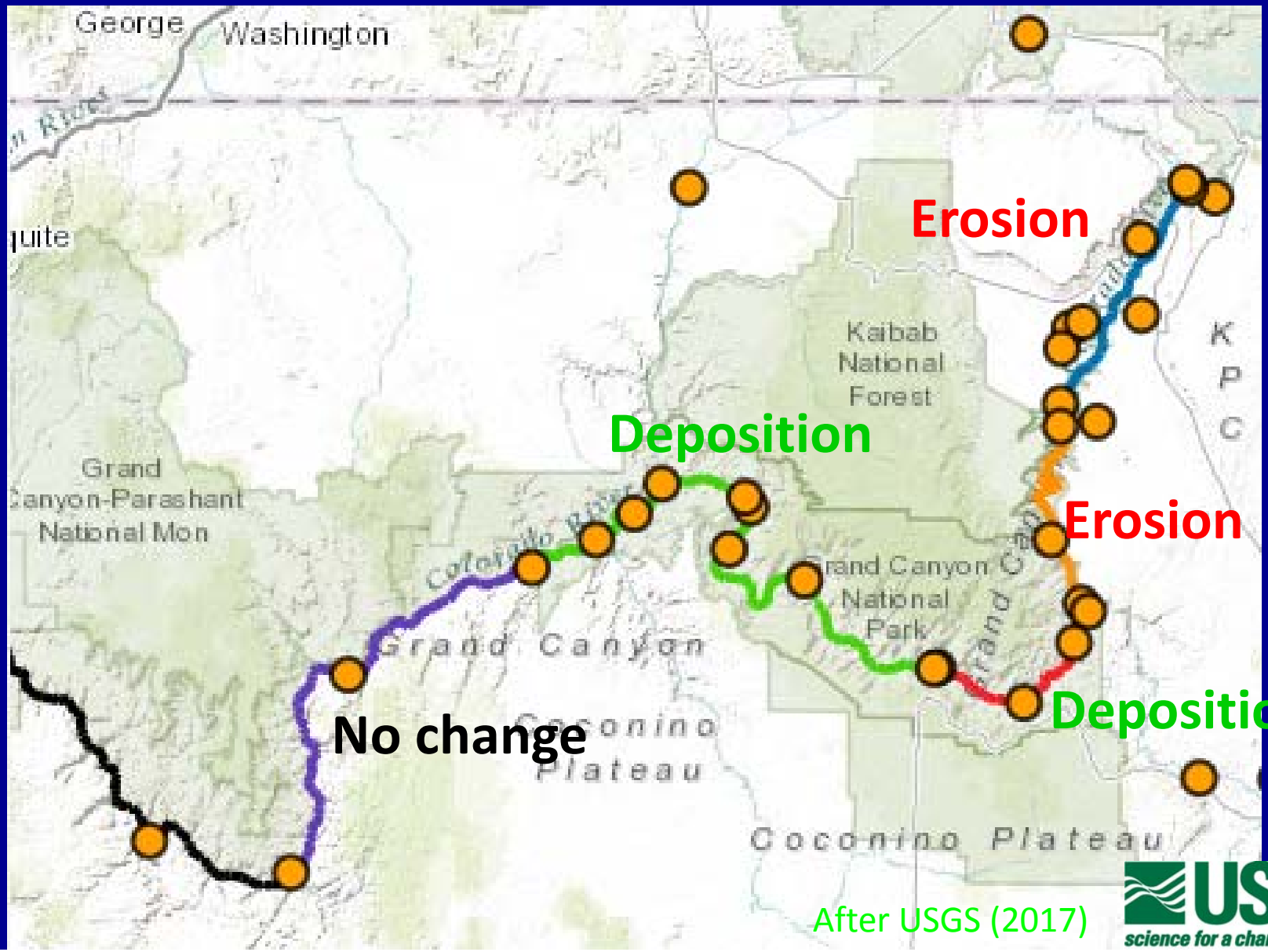
Over the flood hydrograph of each of the 2016 HFE, the following different response occurred…



After USGS (2017)

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Conclusions

- Duration-curve tool allows easy comparison of flow, water-quality, and sediment-transport data between years
- Sand resources (amount) appear to be sustainable over the long-reach scale except in higher release years
- Eastern Grand Canyon? Dam operations or **LCR**?
- Systematic response of reach-scale sand budgets during HFEs appeared to be emerging under the HFE Protocol until the 2016 HFE
- Different responses arise from differing longitudinal distributions of the antecedent sand supply

Publications in progress

- Measured lesser-tributary sediment supply – Griffiths (submitted to journal)
- LCR hydrology article – Dean
- Colorado River sediment transport and storage during last decade of dam operations – Topping
- Historical Colorado River flood inundation levels from field surveys - Sabol-Griffiths
- LCR geomorphic change article – Dean
- Sediment storage changes at damsites – Topping
- Turbidity-measurement bias – Voichick

Proposed interpretive focii of next workplan

- Antecedent-sediment-condition control on sediment response during HFEs (with Grams' projects)
- Paria River hydrology, geomorphic change, and sediment transport
- Evaluation of sediment transport and storage during LTEMP releases
- LCR sediment-transport article
- LCR flood and sediment routing, with implications for habitat change in lowermost segment of LCR utilized by Humpback Chub and other native fish


Thank you