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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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
- Publication of 6 peer-reviewed interpretive papers and 2 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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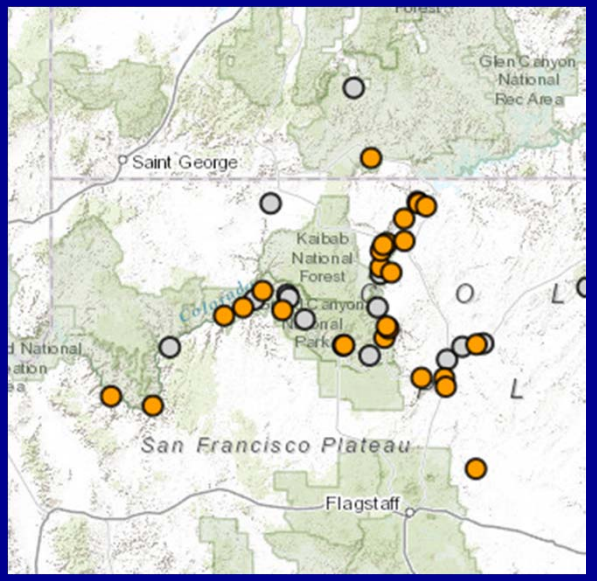
Monitoring project with some research

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

Virtually all other projects funded by the GCDAMP use these data!

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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, and more tools are being developed during the 2015-2017 workplan.

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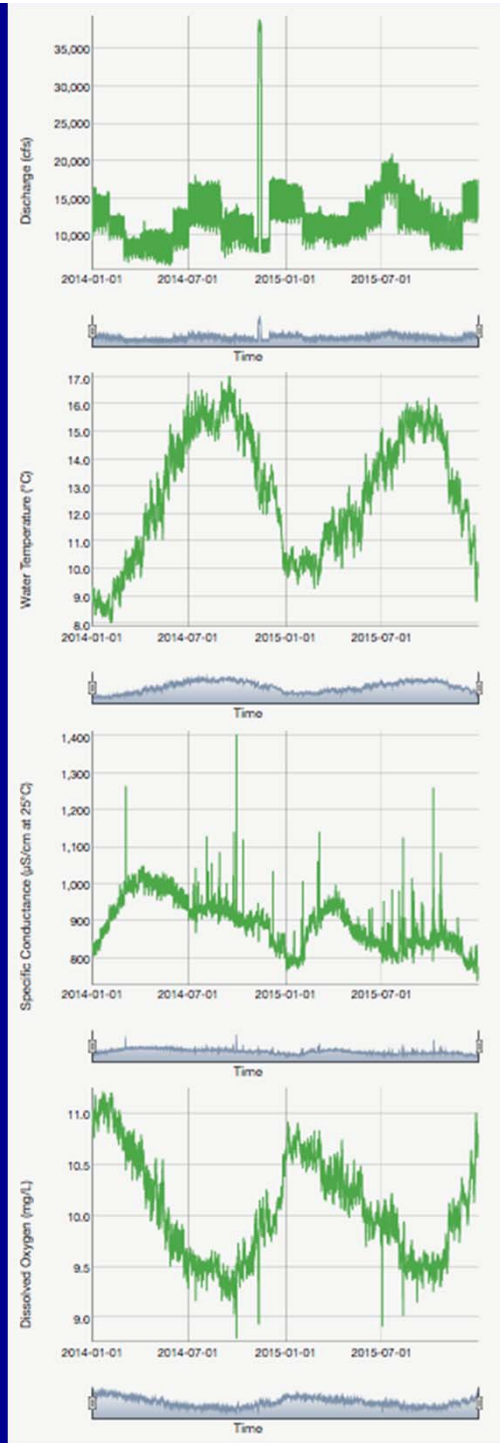
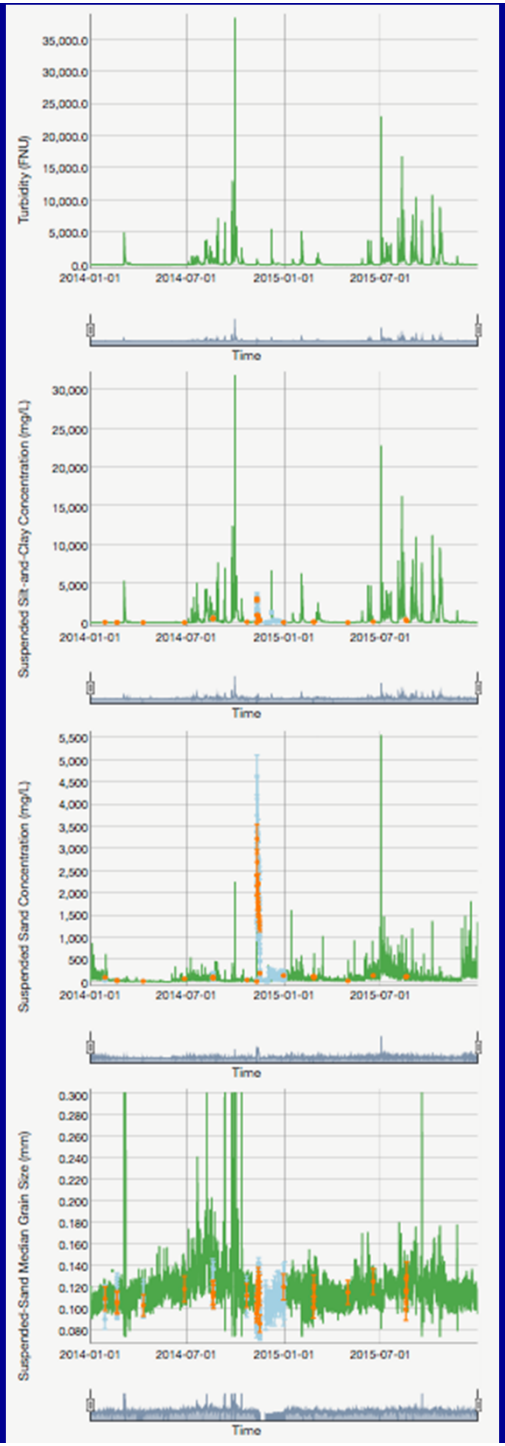
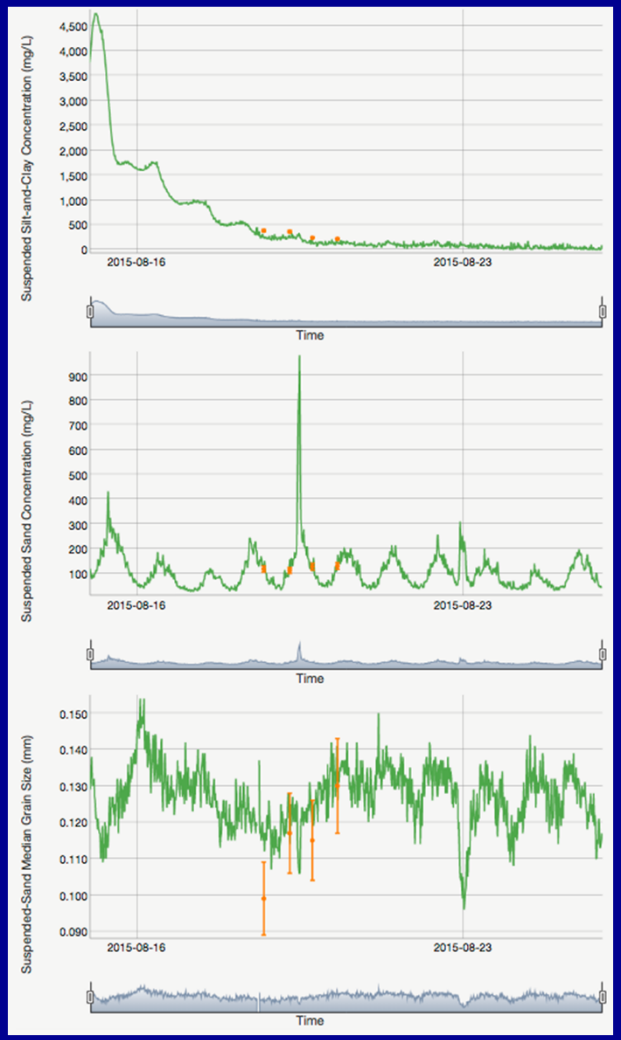
Colorado River near Grand Canyon, AZ 2014-2015







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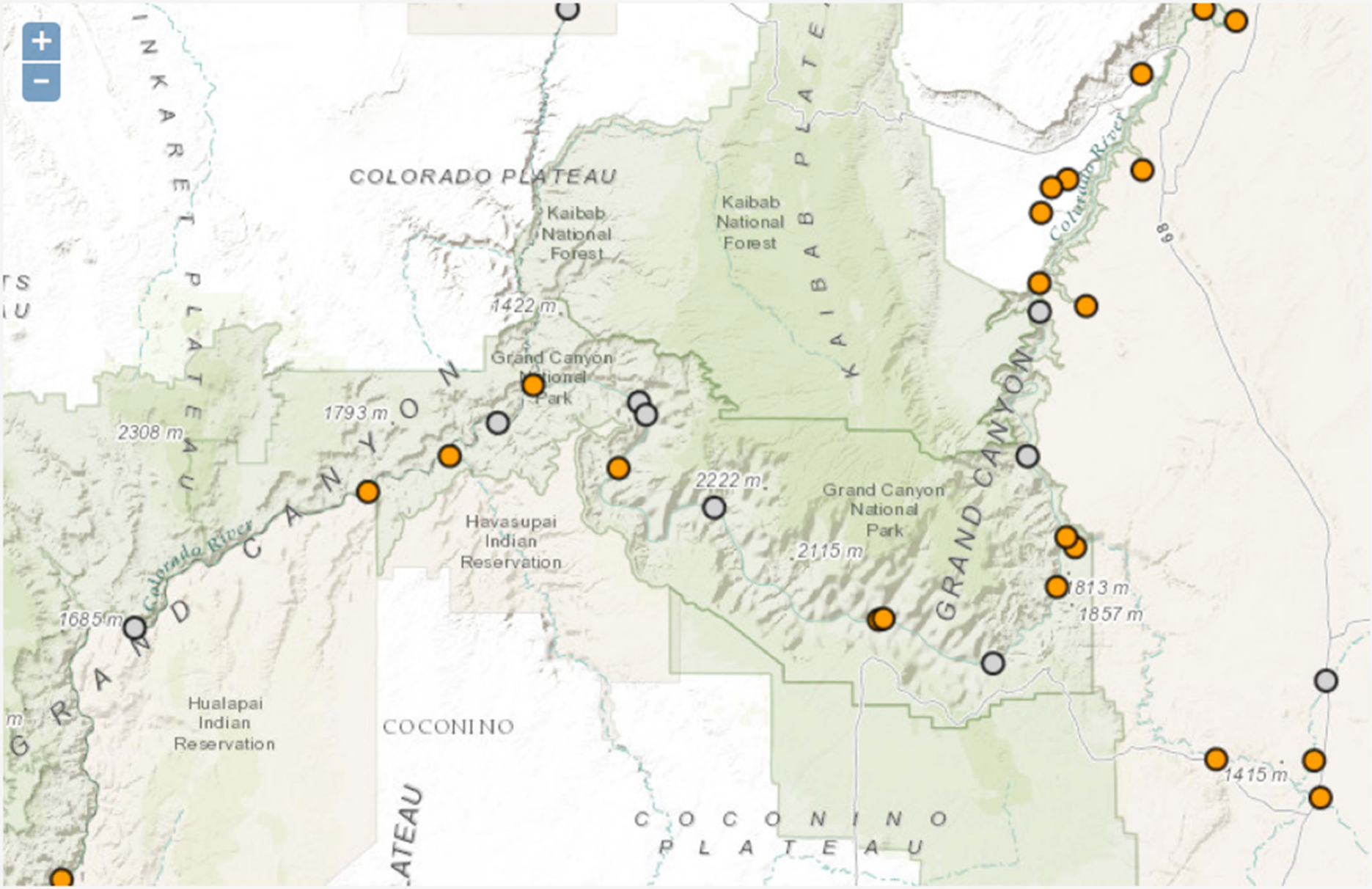

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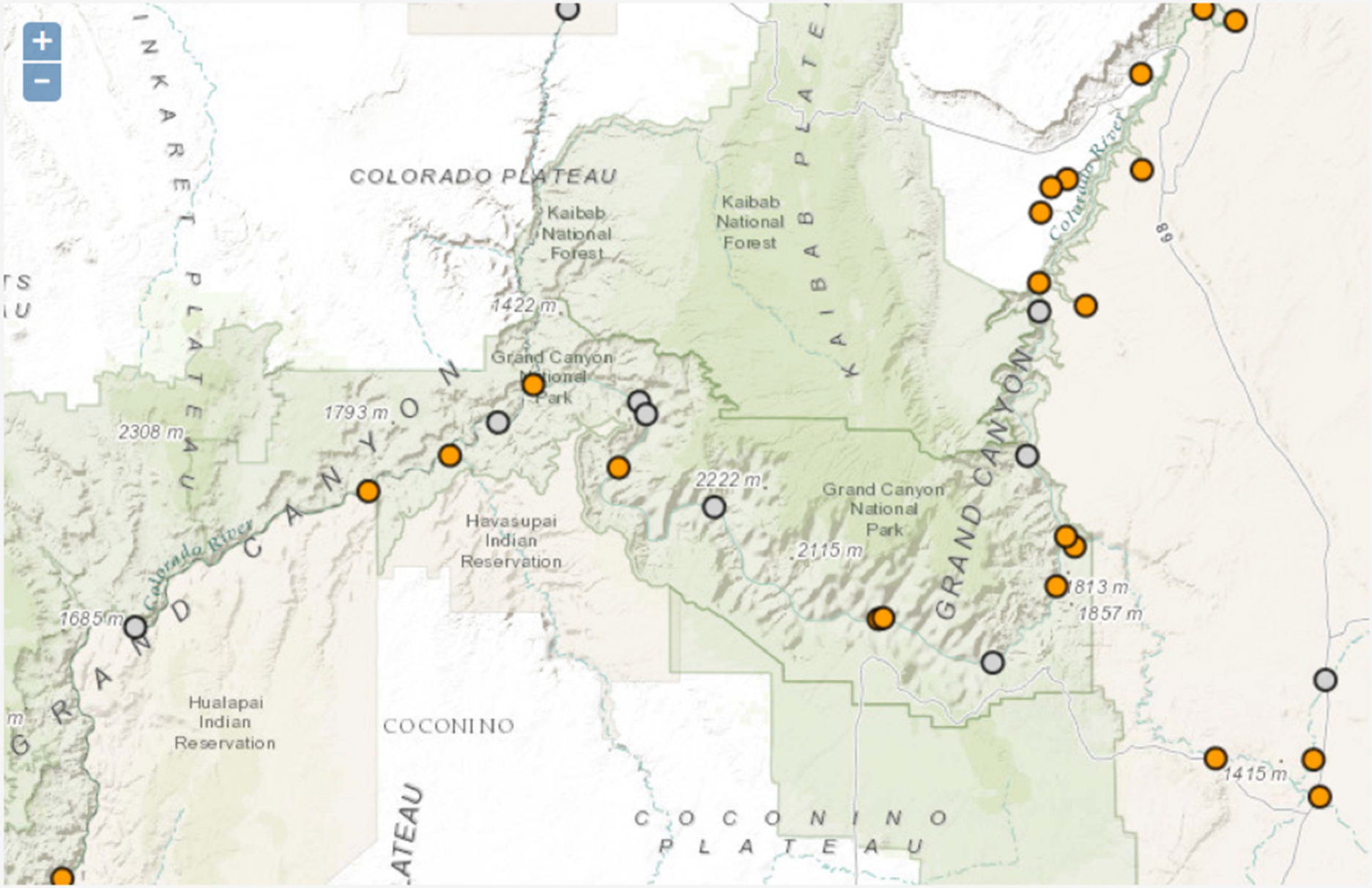

T(at Lava Cliff)

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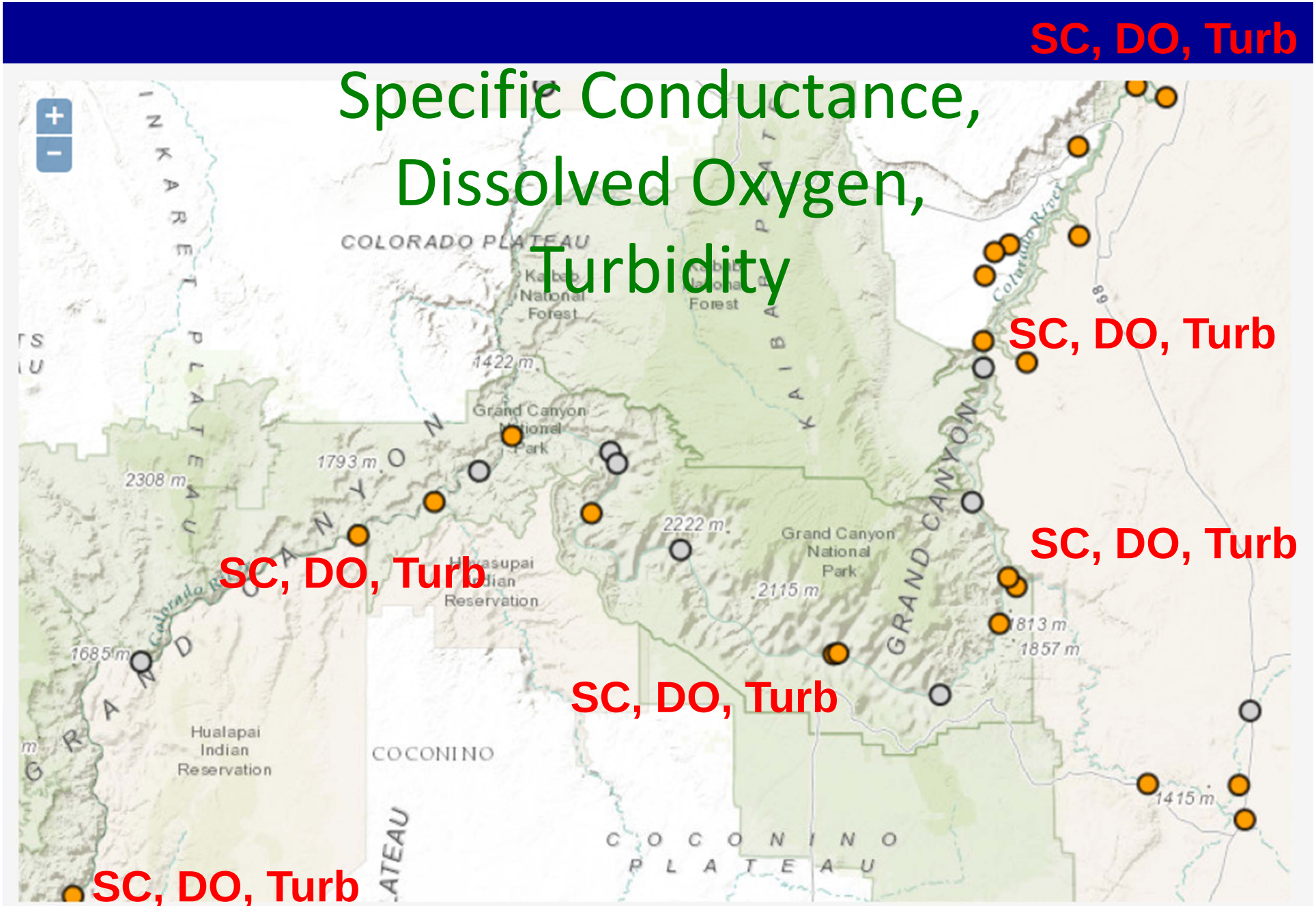

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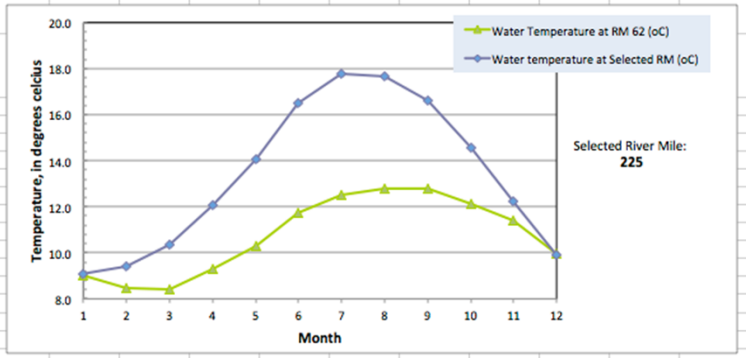
Data used to inform and verify models

- Wright, S. A., C. R. Anderson, and N. Voichick (2008), A simplified water temperature model for the Colorado River below Glen Canyon Dam, *River Research and Applications*, *25*(6), 675-686.

Month	Monthly Average Air Temperature (oC)*	Water temperature at Glen Canyon Dam (oC)	Monthly average discharge (ft^3/s)	Water Temperature at RM 62 (oC)	Water Temperature at RM 225 (oC)	Selected River Mile	Water temperature at Selected RM (oC)
January	1.4	9.0	12,570	9.0	9.1	225	9.1
February	4.9	8.0	12,570	8.5	9.4	225	9.4
March	9.2	7.5	12,570	8.4	10.3	225	10.3
April	13.9	8.0	12,570	9.3	12.1	225	12.1
May	19.4	8.5	12,570	10.3	14.1	225	14.1
June	25.2	9.5	12,570	11.7	16.5	225	16.5
July	28.4	10.0	12,570	12.5	17.8	225	17.8
August	26.9	10.5	12,570	12.8	17.7	225	17.7
September	22.1	11.0	12,570	12.8	16.6	225	16.6
October	15.1	11.0	12,570	12.1	14.6	225	14.6
November	7.3	11.0	12,570	11.4	12.2	225	12.2
December	1.8	10.0	12,570	10.0	9.9	225	9.9

*Monthly average air temperature at NOAA/NWS COOP station 026180 at Page, AZ for 1958 through 2007. May be adjusted if you have other air temperatures you would like to evaluate.

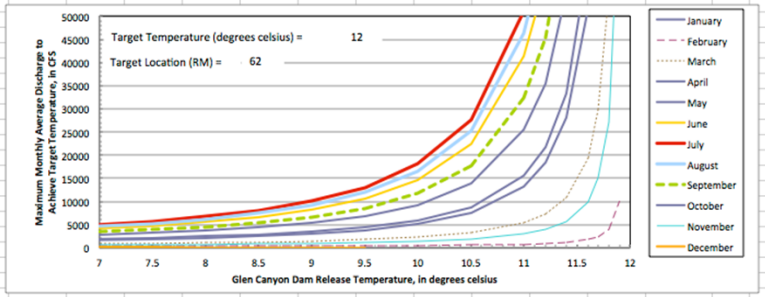


Conversion from Acre-feet per month to monthly average discharge in cubic feet per second

INPUT Monthly volume (ac-ft/month)	OUTPUT Monthly average discharge (cfs)
700,000	11,764

ENTER VALUES HERE	
Target Temp	12
Target Location (RM)	62
Target Location (m)	123913

Air temp ==>	1.4	4.9	9.2	13.9	19.4	25.2	28.4	26.9	22.1	15.1	7.3	1.8	
Month ==>	January	February	March	April	May	June	July	August	September	October	November	December	Release Temp
	88	381	919	1687	2787	4156	4994	4594	3399	1909	660	113	7
	71	390	1003	1889	3168	4765	5746	5277	3881	2147	706	97	7.5
	51	402	1111	2152	3668	5569	6739	6180	4516	2457	766	78	8
	29	418	1256	2510	4350	6669	8100	7417	5384	2879	845	55	8.5
	8	439	1459	3018	5325	8248	10056	9192	6627	3479	954	30	9
		469	1762	3785	6809	10660	13048	11907	8523	4388	1116	6	9.5
		515	2255	5053	9280	14692	18056	16447	11685	5893	1375		10
		596	3173	7452	13994	22420	27672	25159	17734	8748	1851		10.5
		771	5334	13215	25414	41226	51111	46379	32424	15623	2950		11
		912	7214	18292	35534	57941	71965	65251	45461	21689	3894		11.2
		1168	10791	28039	55039	90221	112267	101711	70618	33350	5671		11.4
		1744	19428	51803	102783	169395	211189	191173	132263	61814	9918		11.6
		2403	29815	80577	160756	265666	331530	299984	207172	96308	14986		11.7
		3940	55149	151123	303189	502445	627620	567660	391321	180931	27272		11.8
		10050	161083	447750	903410	1501337	1877203	1697143	1167801	536987	78308		11.9



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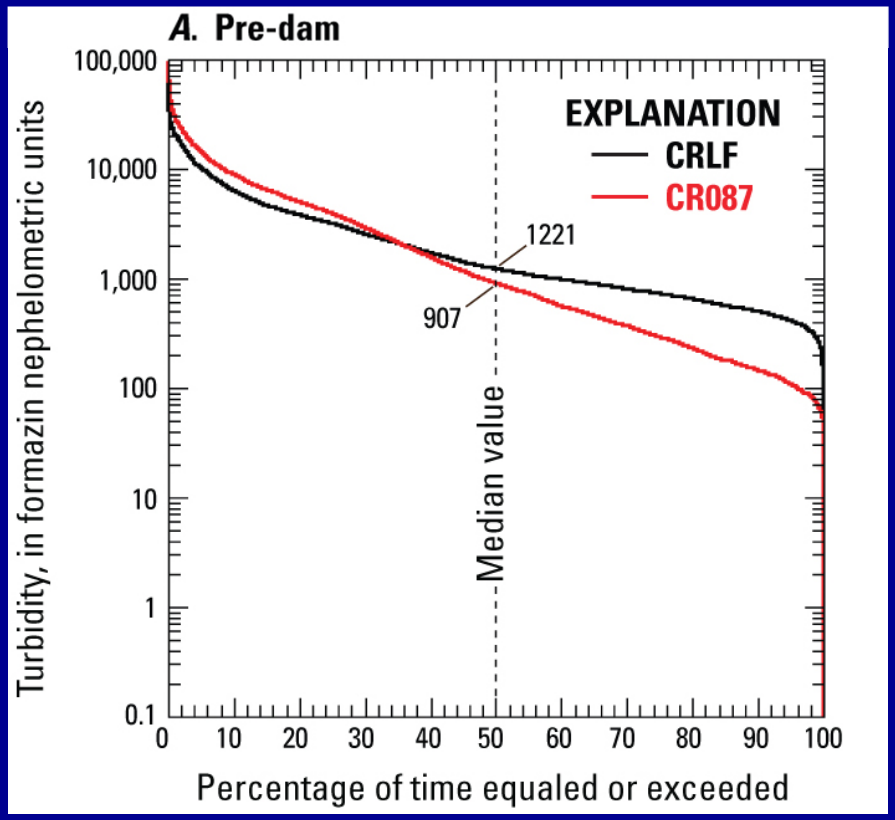

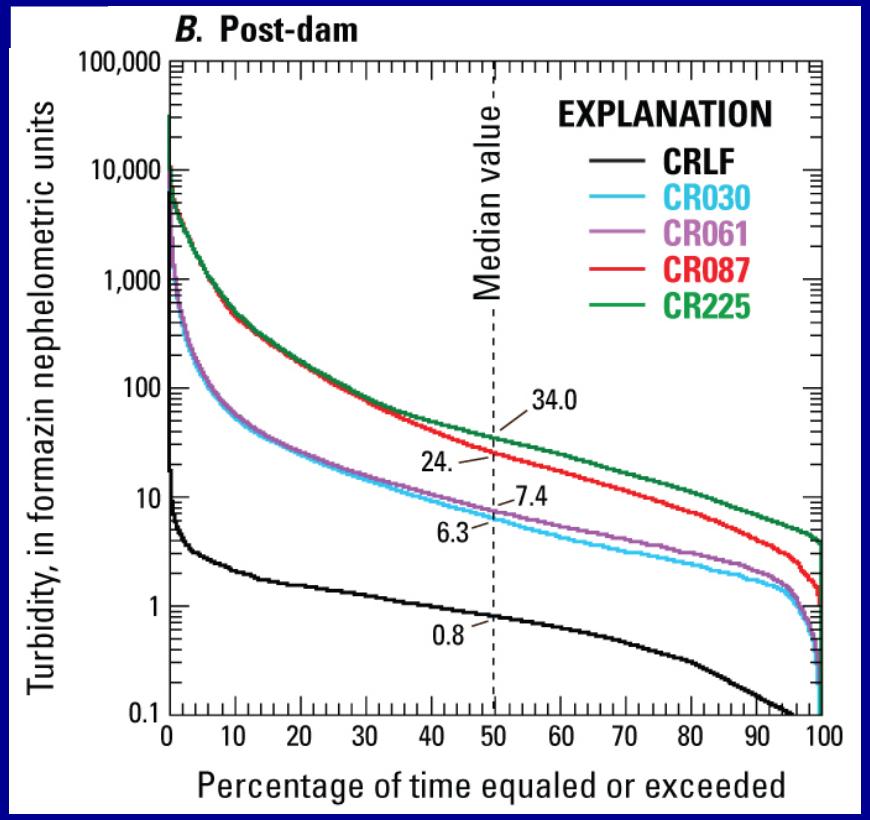

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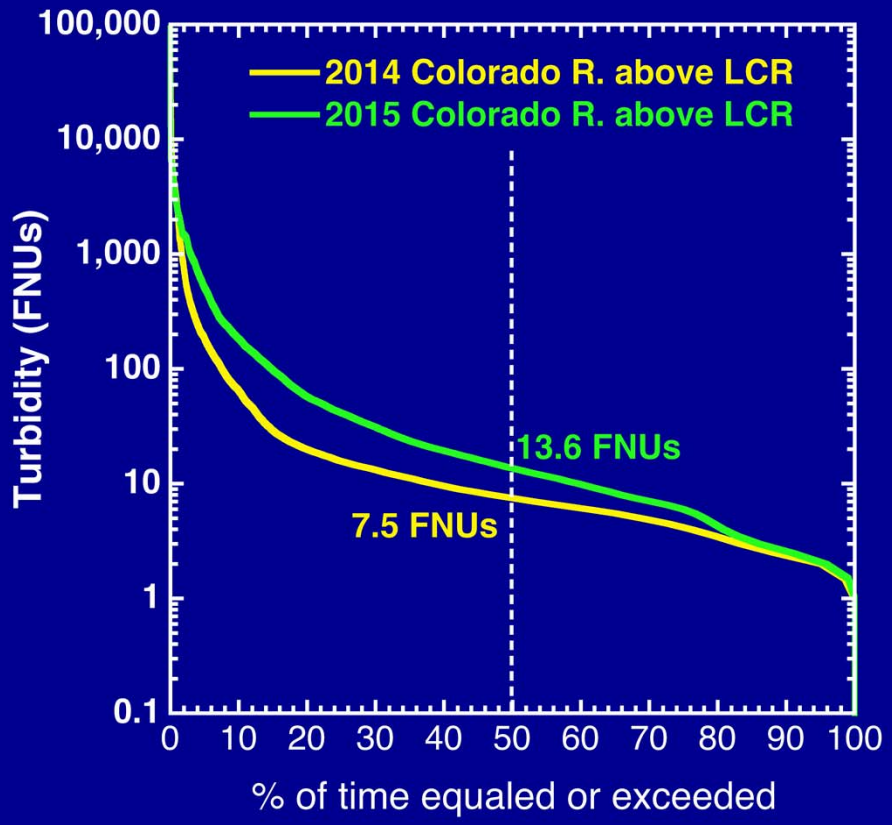
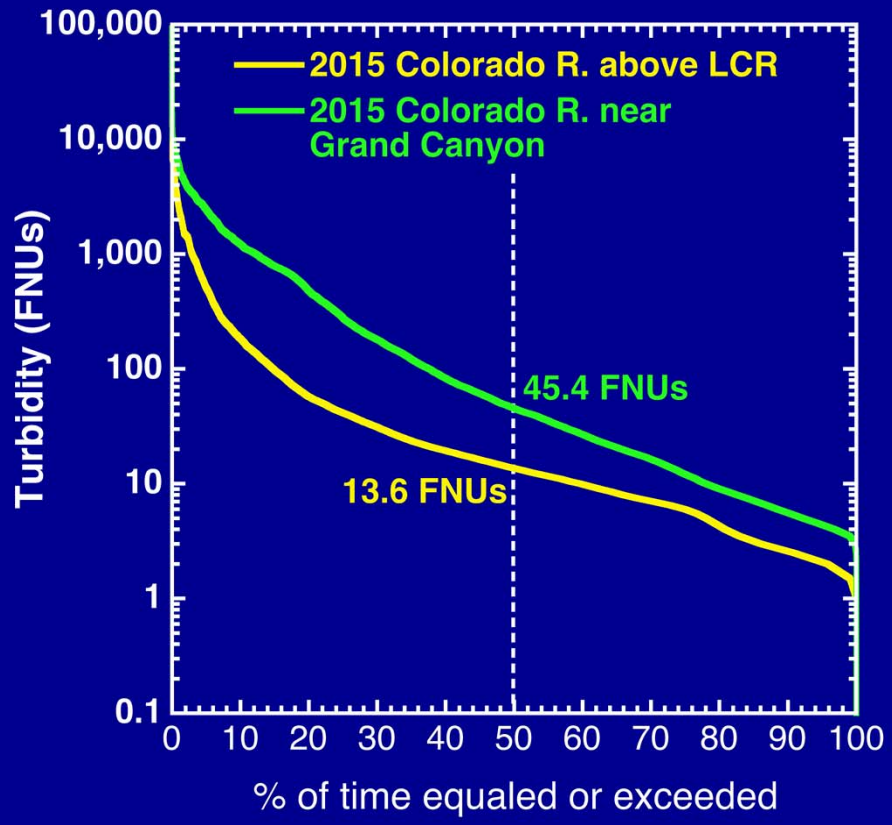
Turbidity duration curves





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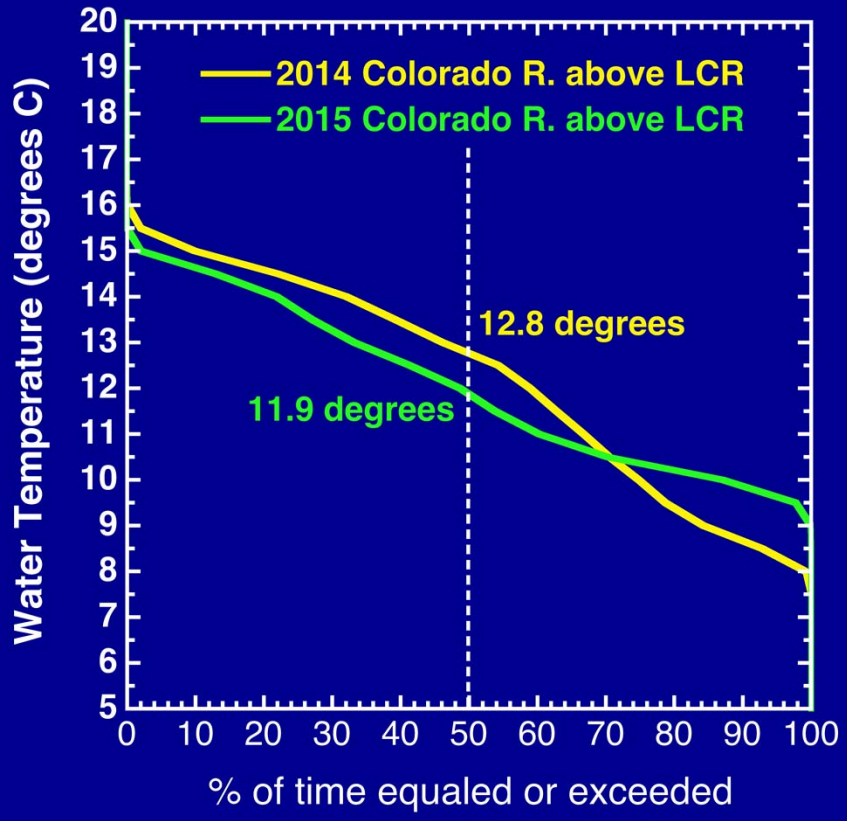
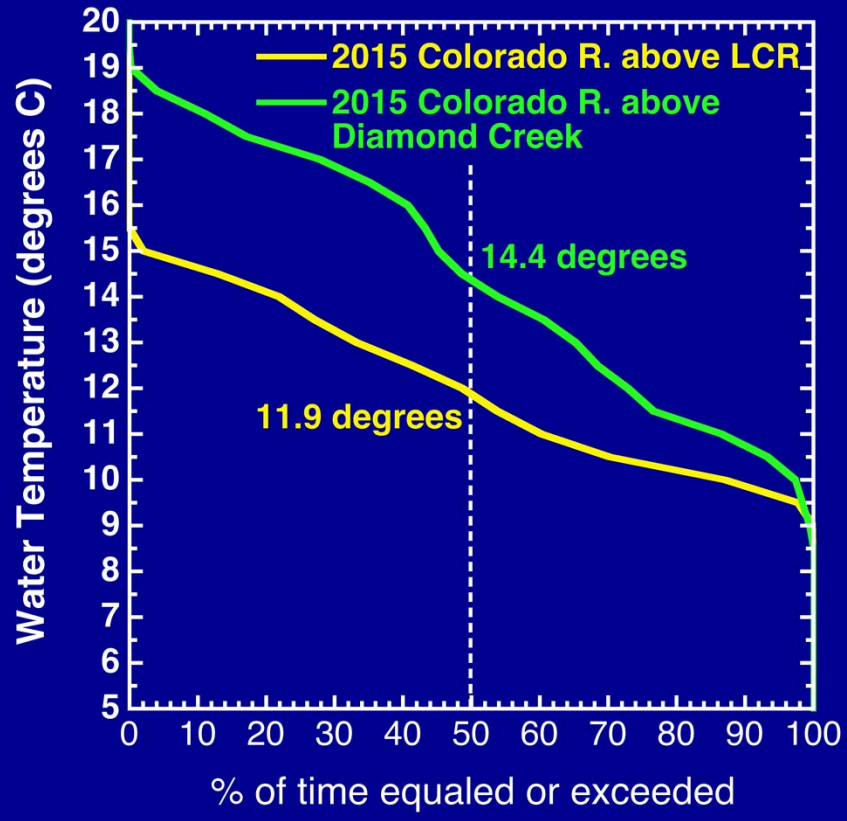
Temperature duration curves





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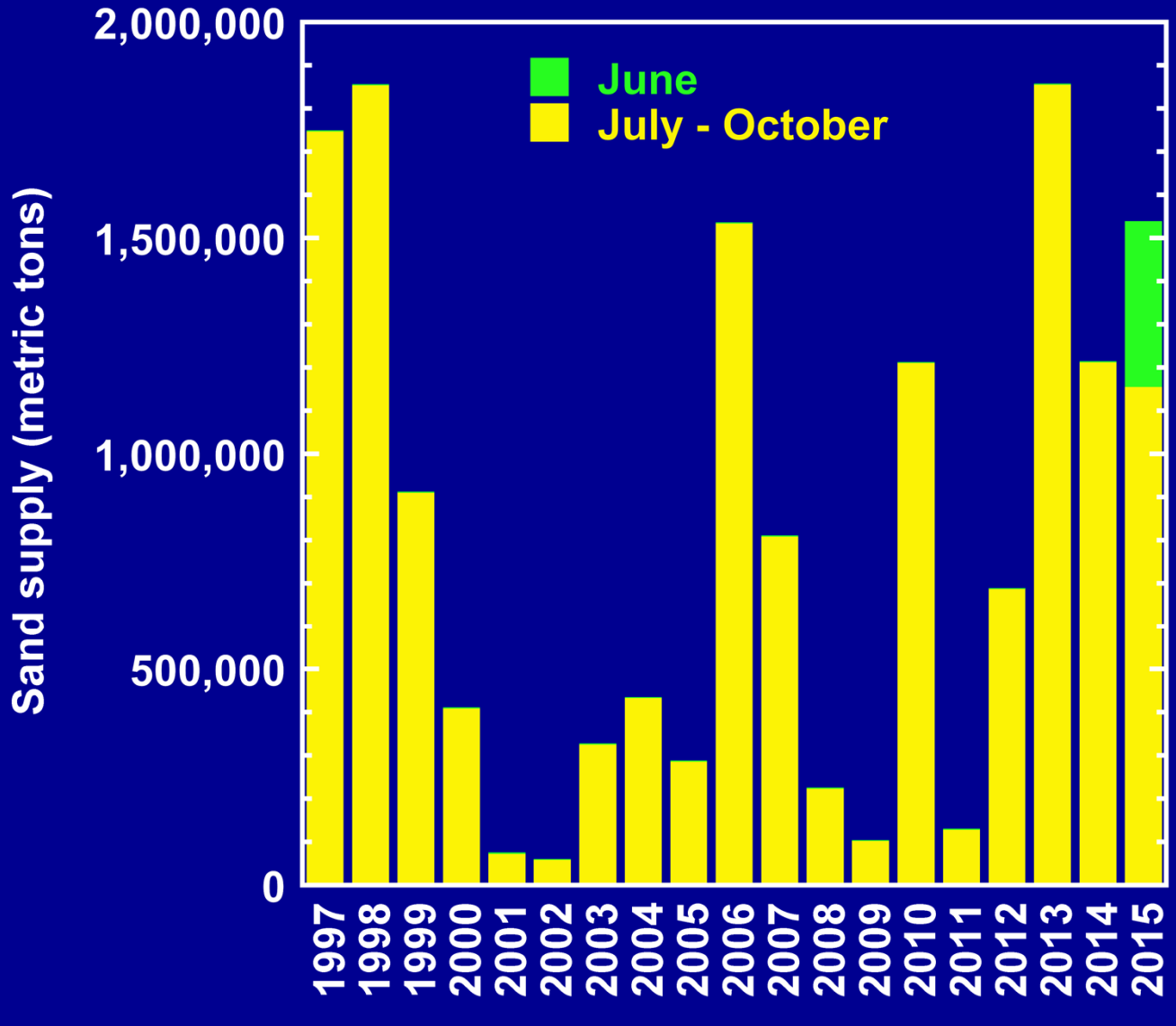

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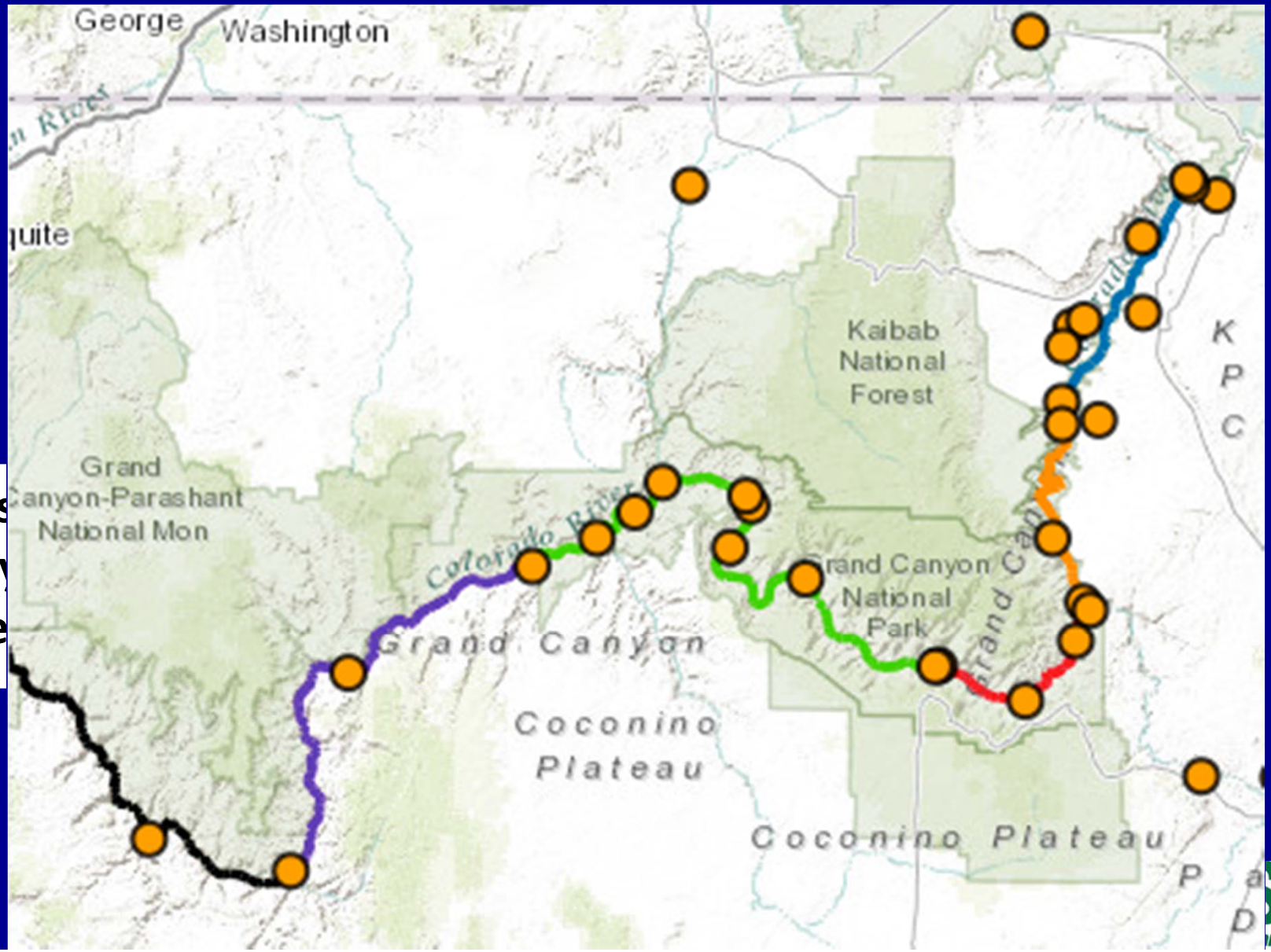
Sand budgets for the last 5-year period



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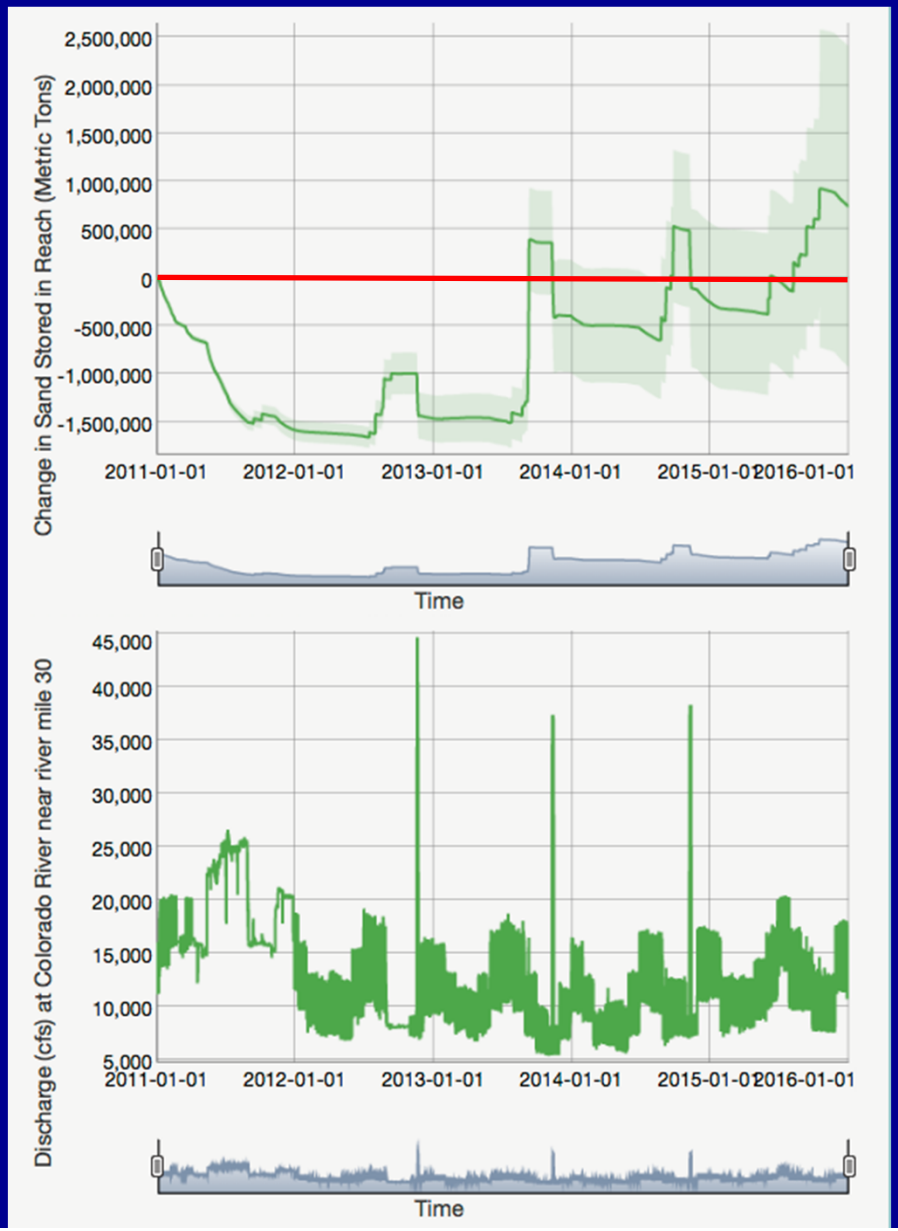
Upper Marble Canyon
1-1-2011 through 1-6-2016



Change in Sand Mass

- Zero Bias Value: **740,000 Metric Tons**
- Upper Uncertainty Bound: 2,400,000 Metric Tons
- Lower Uncertainty Bound: -930,000 Metric Tons

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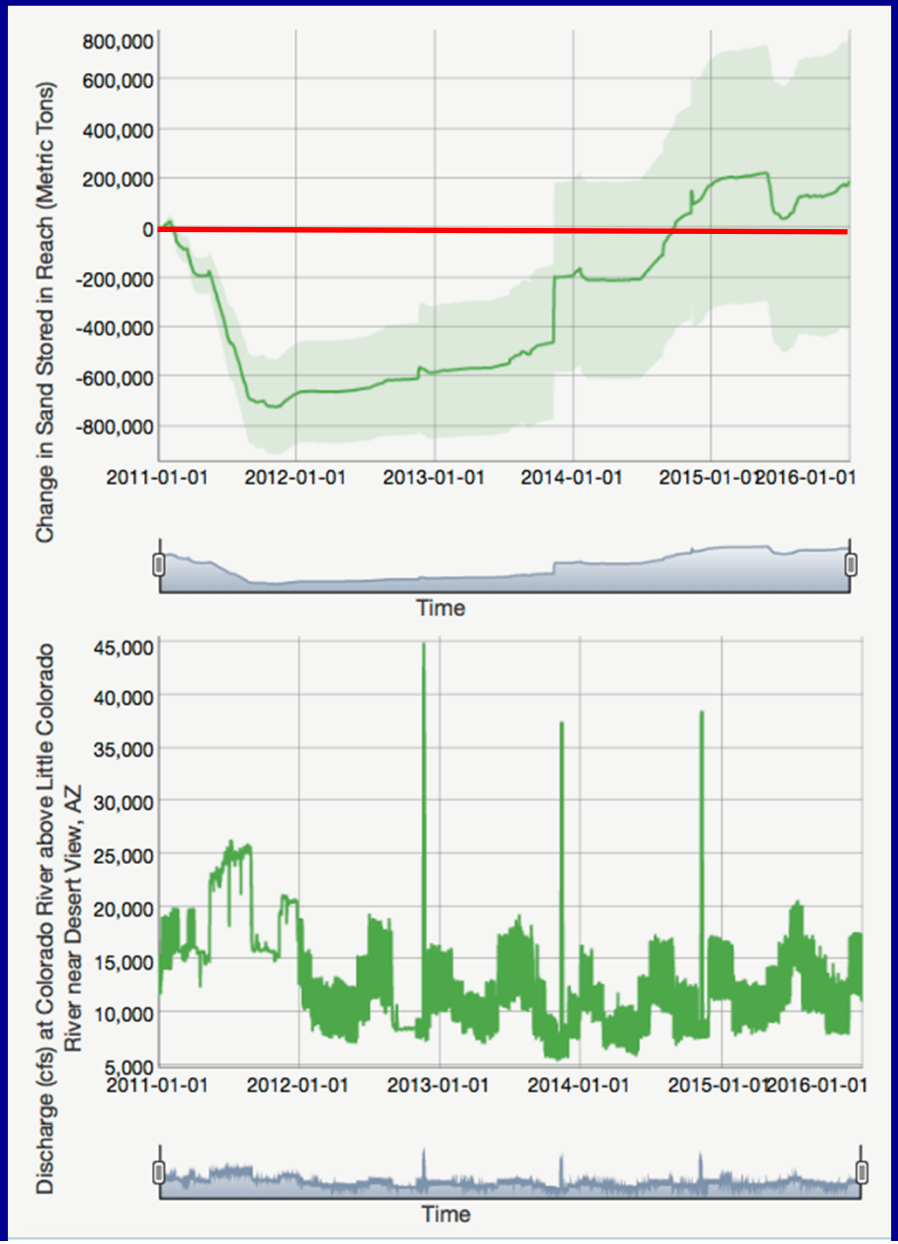
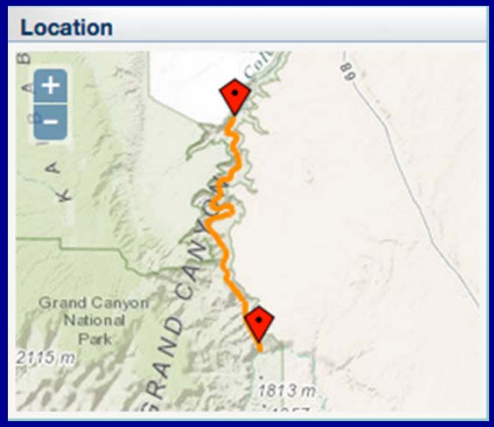
Lower Marble Canyon
1-1-2011 through 1-6-2016





Change in Sand Mass

- Zero Bias Value: **190,000 Metric Tons**
- Upper Uncertainty Bound: 770,000 Metric Tons
- Lower Uncertainty Bound: -390,000 Metric Tons

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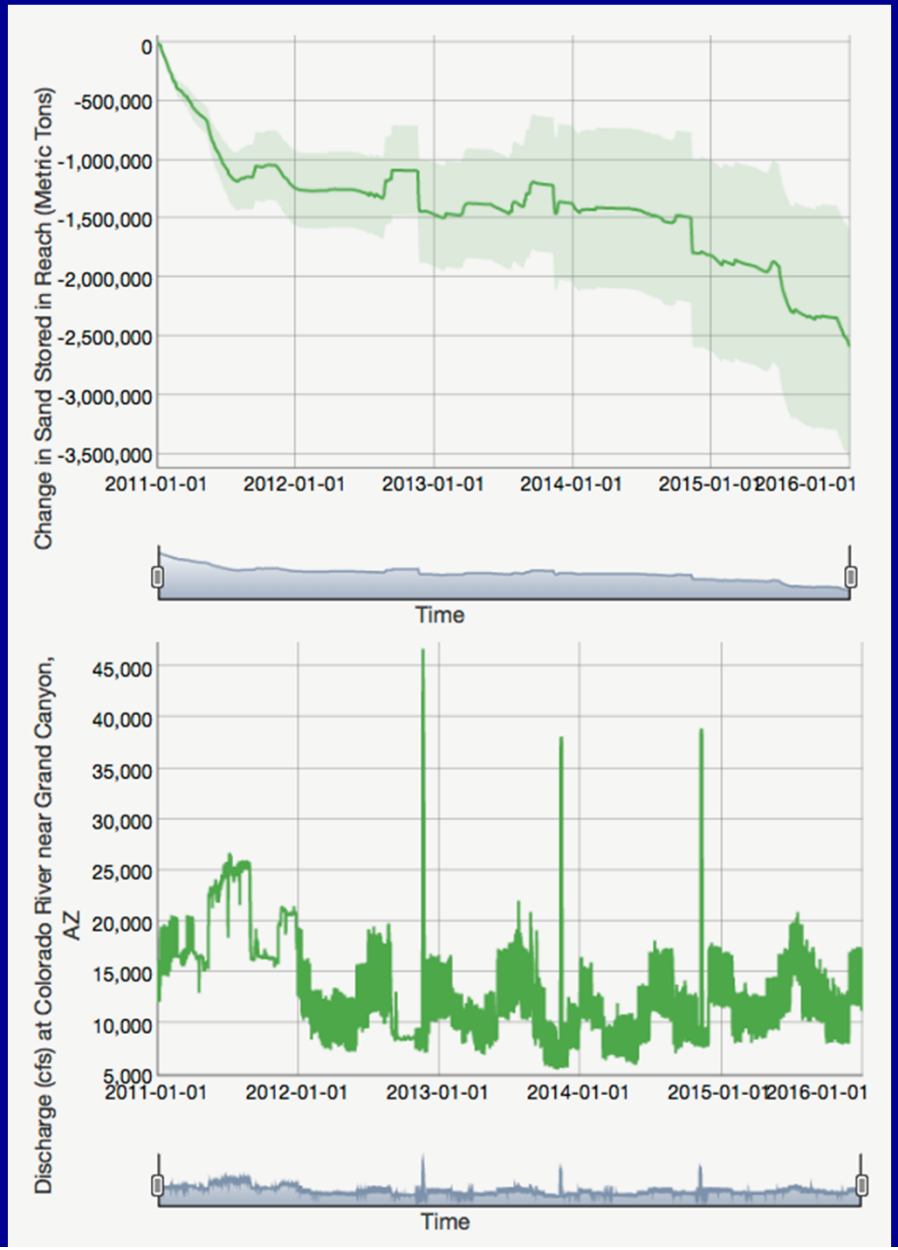
Eastern Grand Canyon
1-1-2011 through 1-6-2016



Change in Sand Mass

- Zero Bias Value: **-2,600,000 Metric Tons**
- Upper Uncertainty Bound: -1,600,000 Metric Tons
- Lower Uncertainty Bound: -3,600,000 Metric Tons

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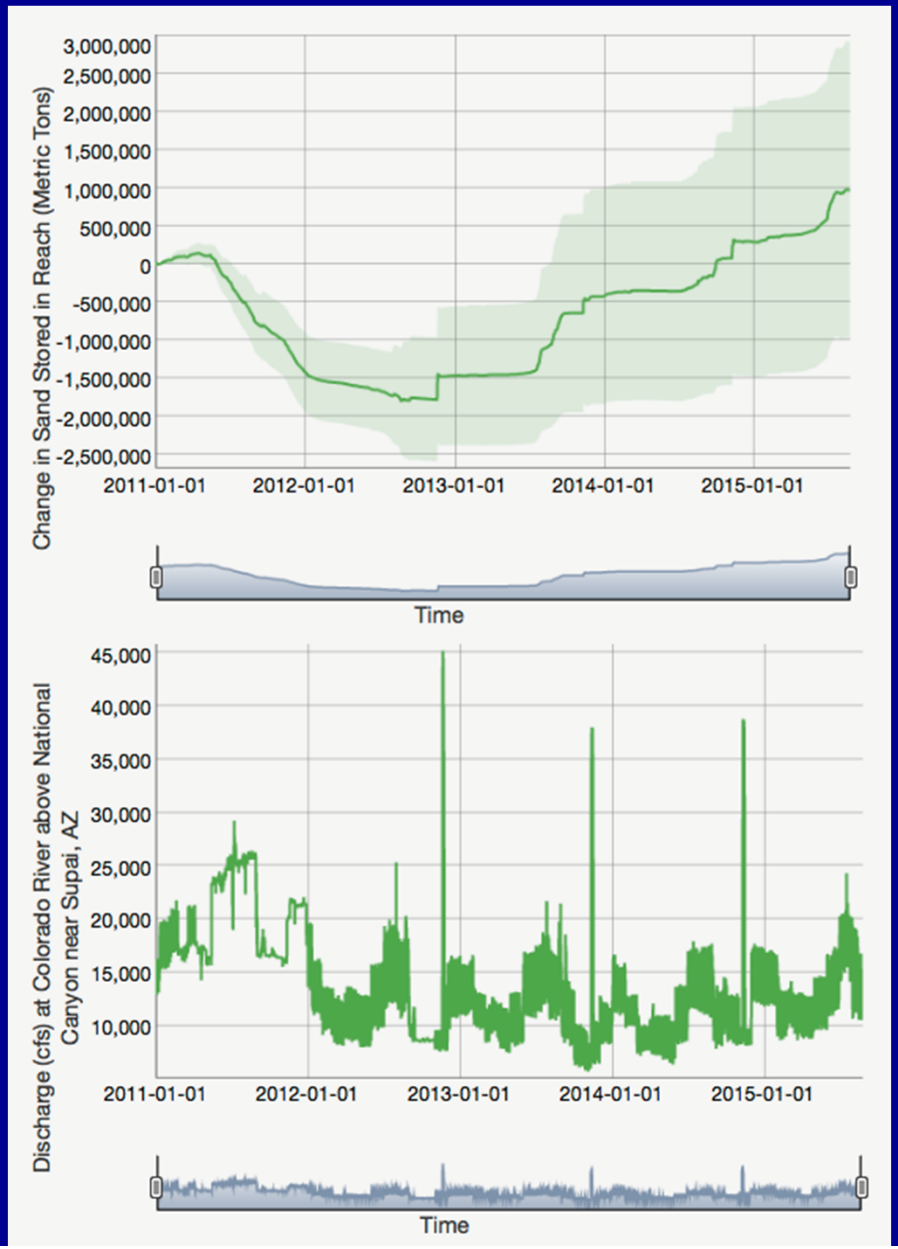
East Central Grand Canyon
1-1-2011 through 8-25-2015



Change in Sand Mass

- Zero Bias Value: **970,000 Metric Tons**
- Upper Uncertainty Bound: 2,900,000 Metric Tons
- Lower Uncertainty Bound: -980,000 Metric Tons

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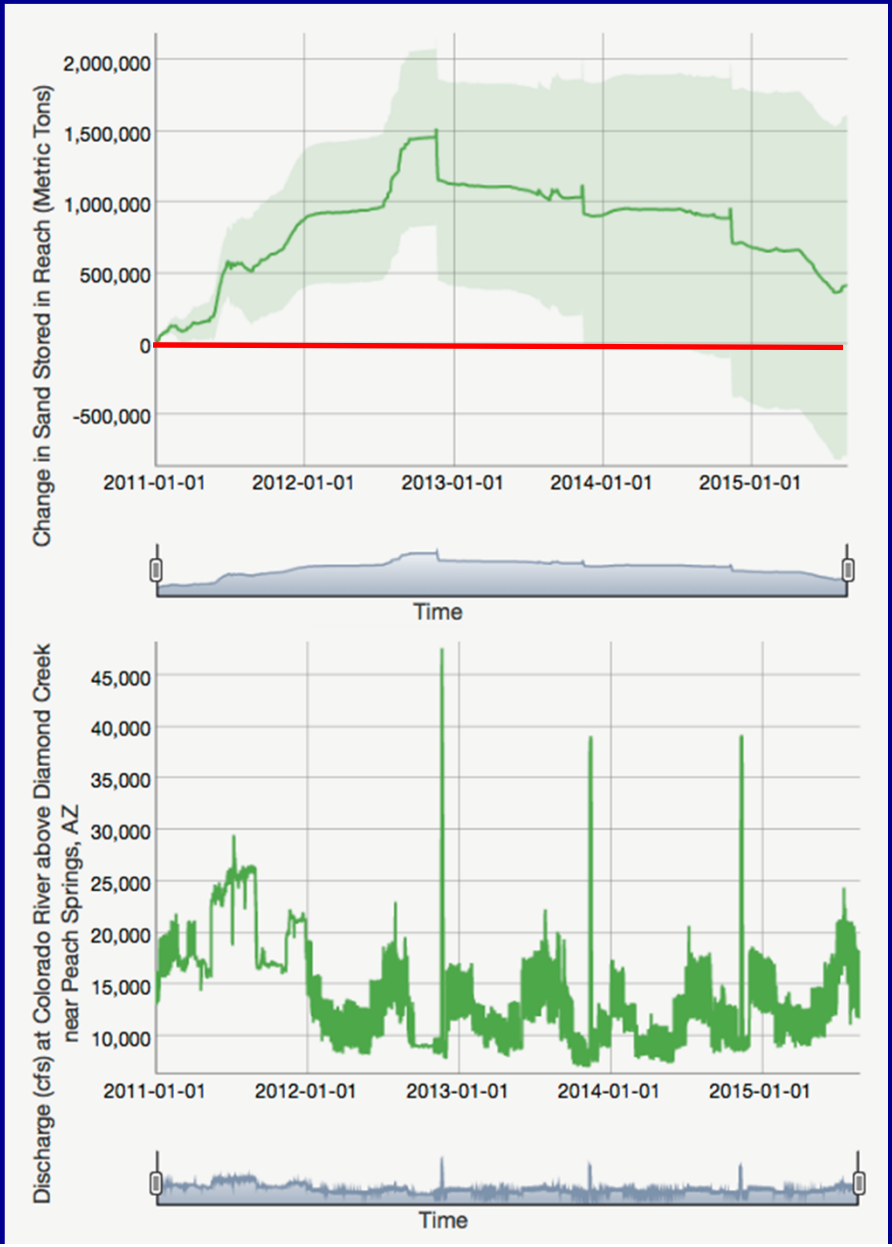
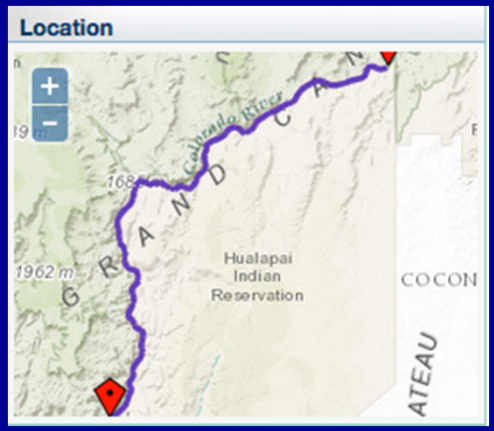
West Central Grand Canyon
1-1-2011 through 8-25-2015





Change in Sand Mass

- Zero Bias Value: **410,000 Metric Tons**
- Upper Uncertainty Bound: 1,600,000 Metric Tons
- Lower Uncertainty Bound: -790,000 Metric Tons

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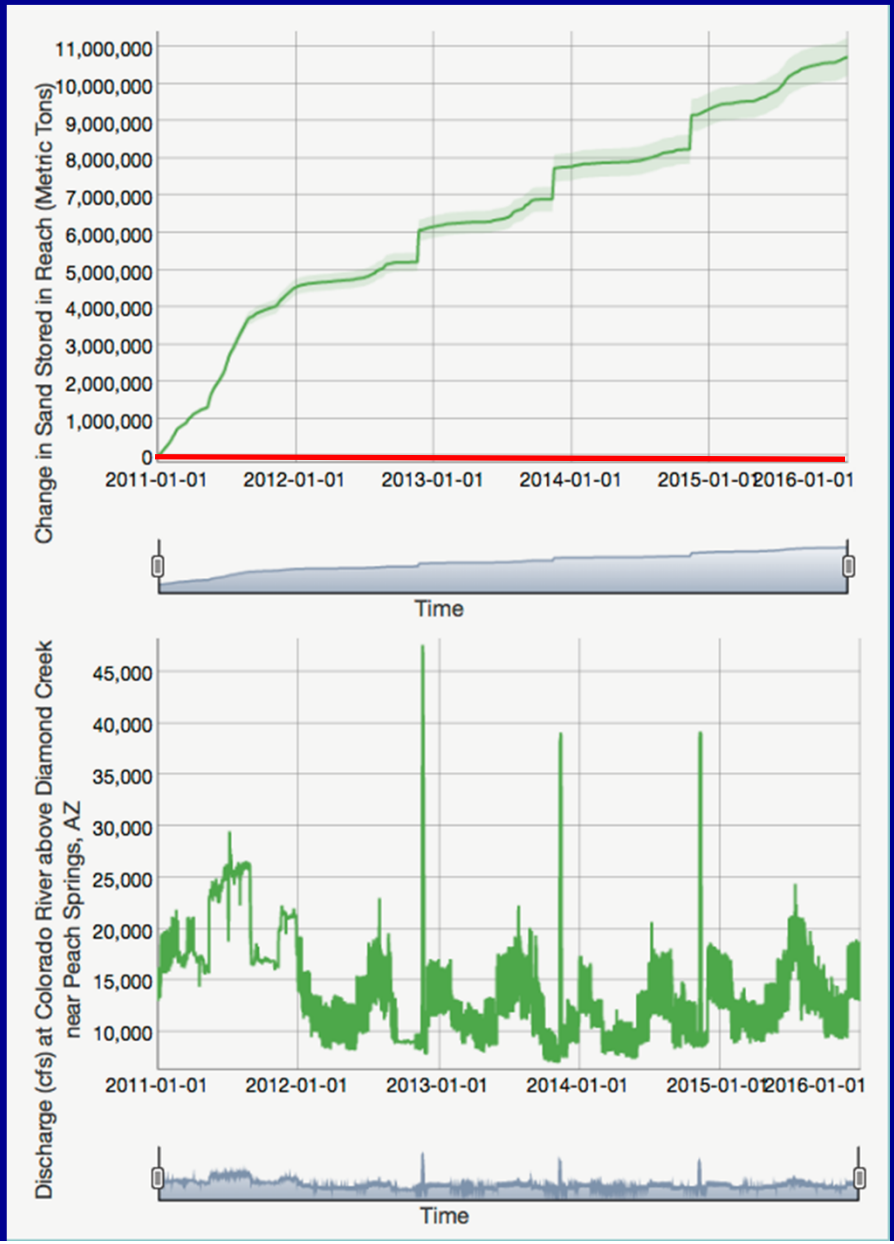
Western Grand Canyon and the Lake Mead Delta
1-1-2011 through 1-4-2016



Change in Sand Mass

- Zero Bias Value: **11,000,000 Metric Tons**
- Upper Uncertainty Bound: 11,000,000 Metric Tons
- Lower Uncertainty Bound: 10,000,000 Metric Tons

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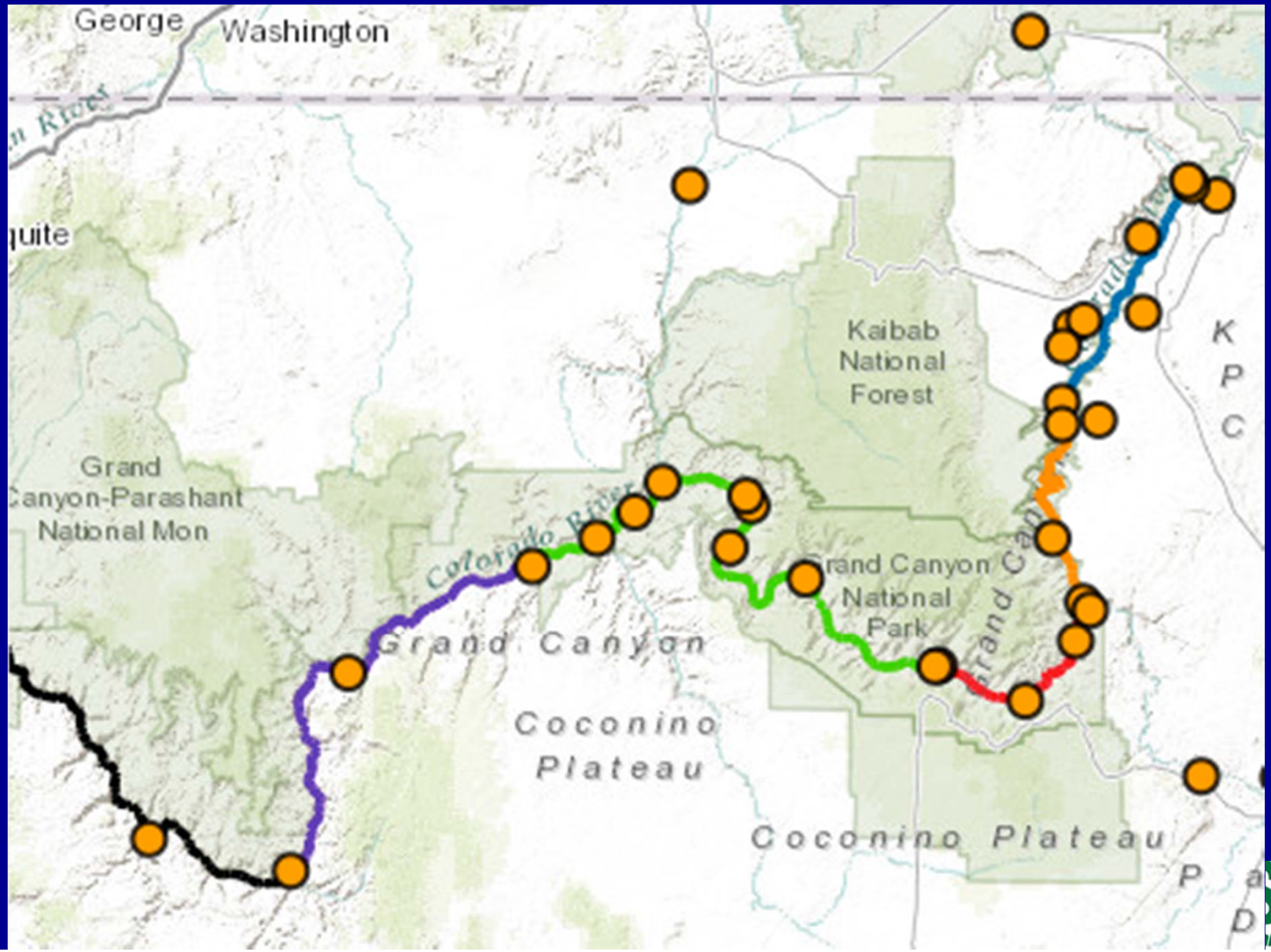
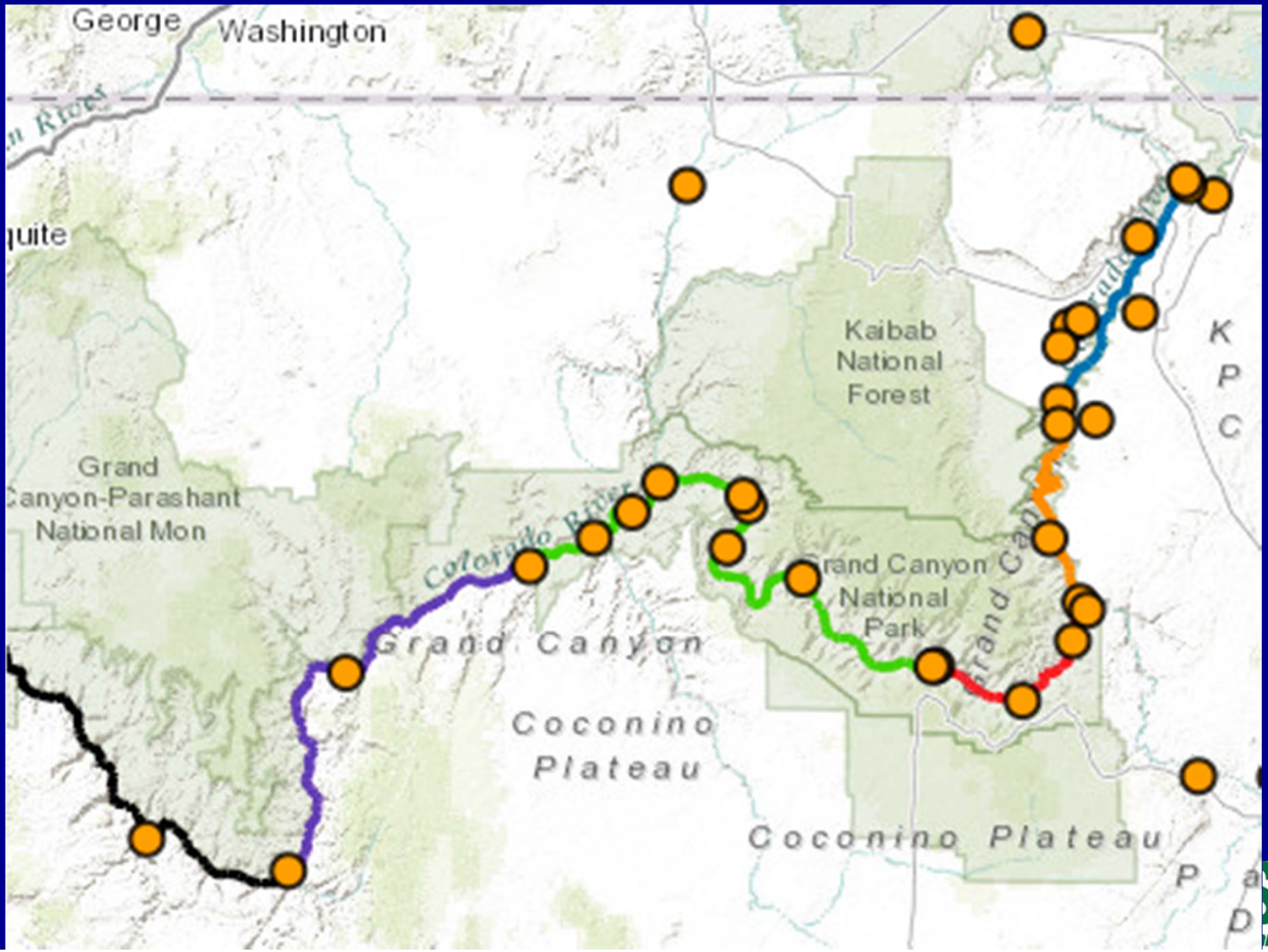
2011 – 2015 change in sand thickness by reach assuming sand covers 1/3 of bed (in cm)



July 2012 – Dec 2015 change in sand thickness by reach assuming sand covers 1/3 of bed (in cm)



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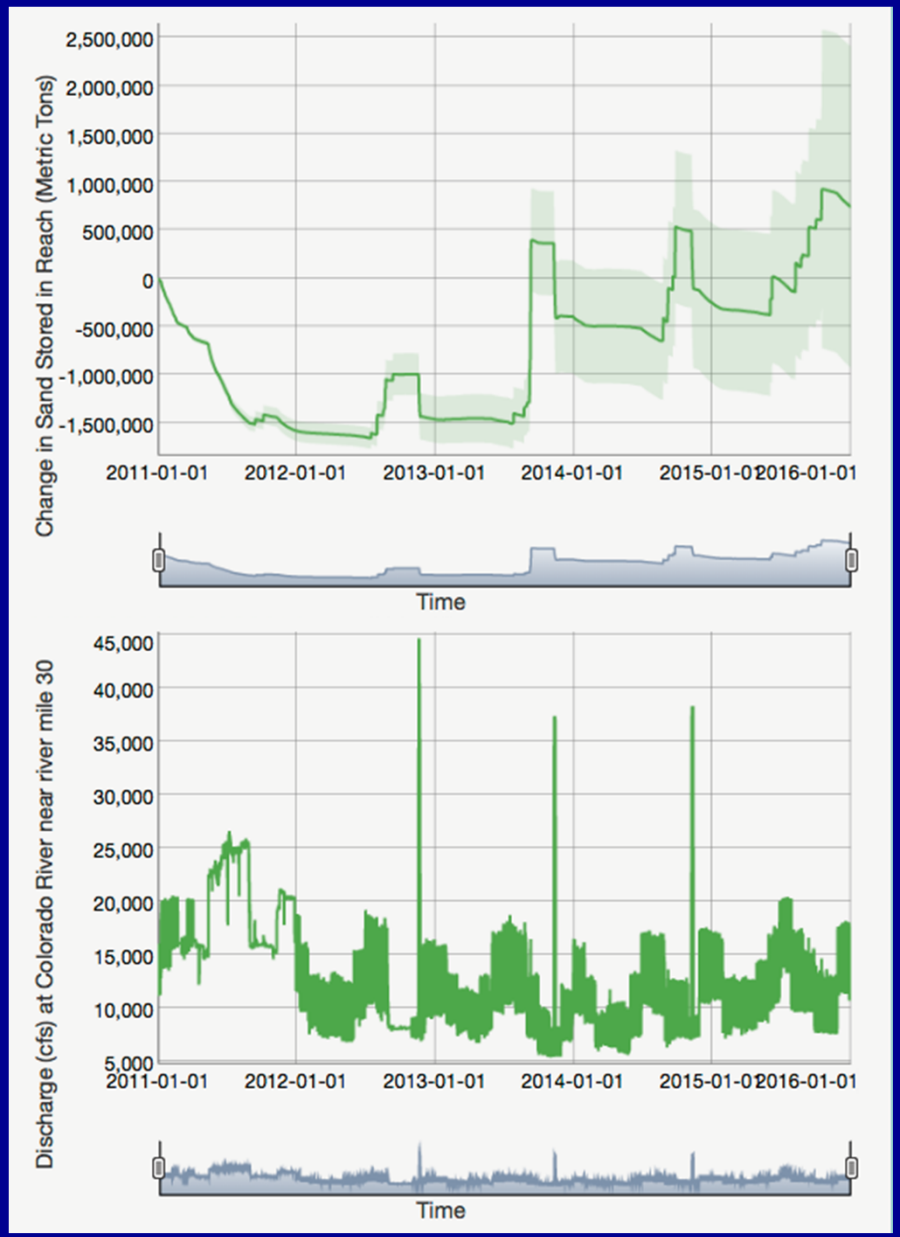
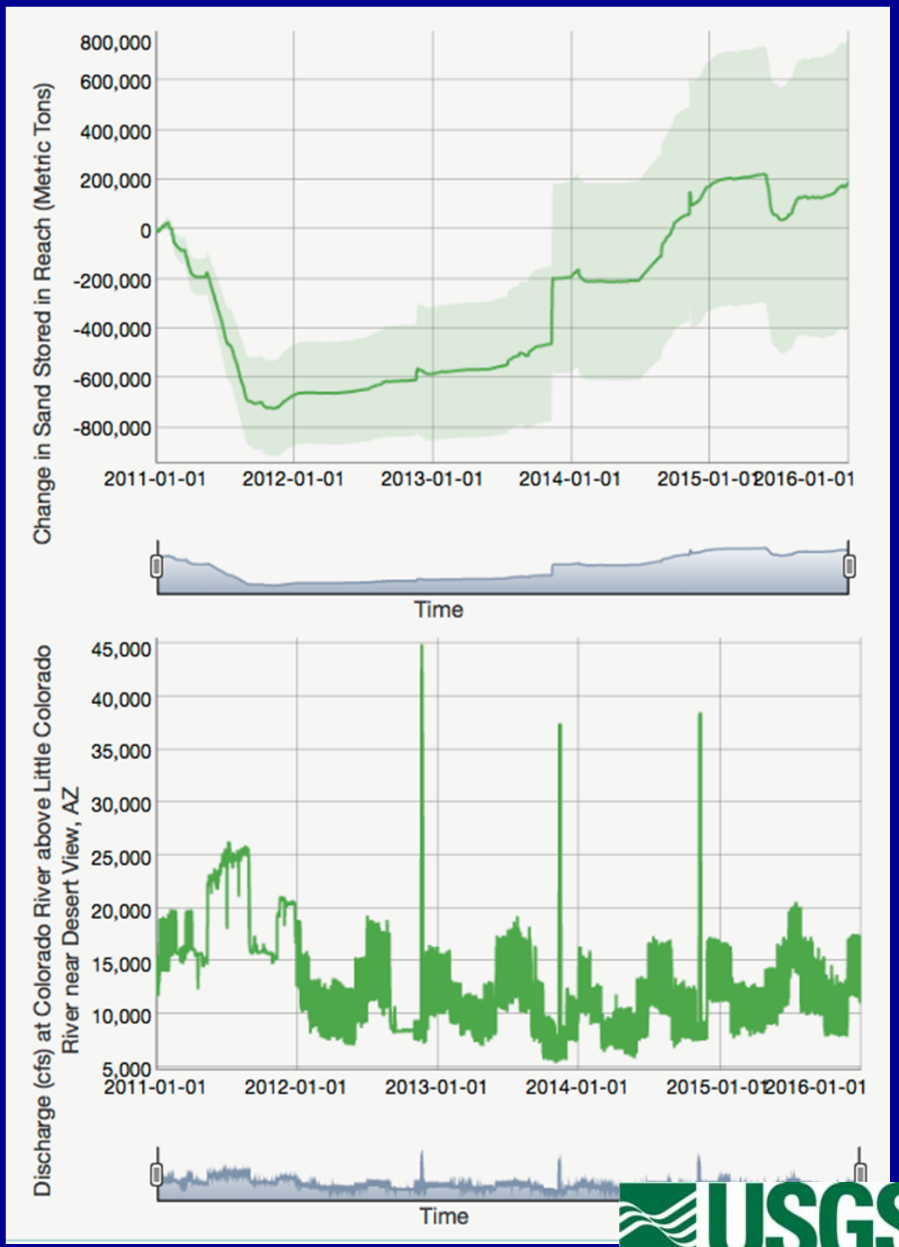
Upper Marble Canyon



Lower Marble Canyon



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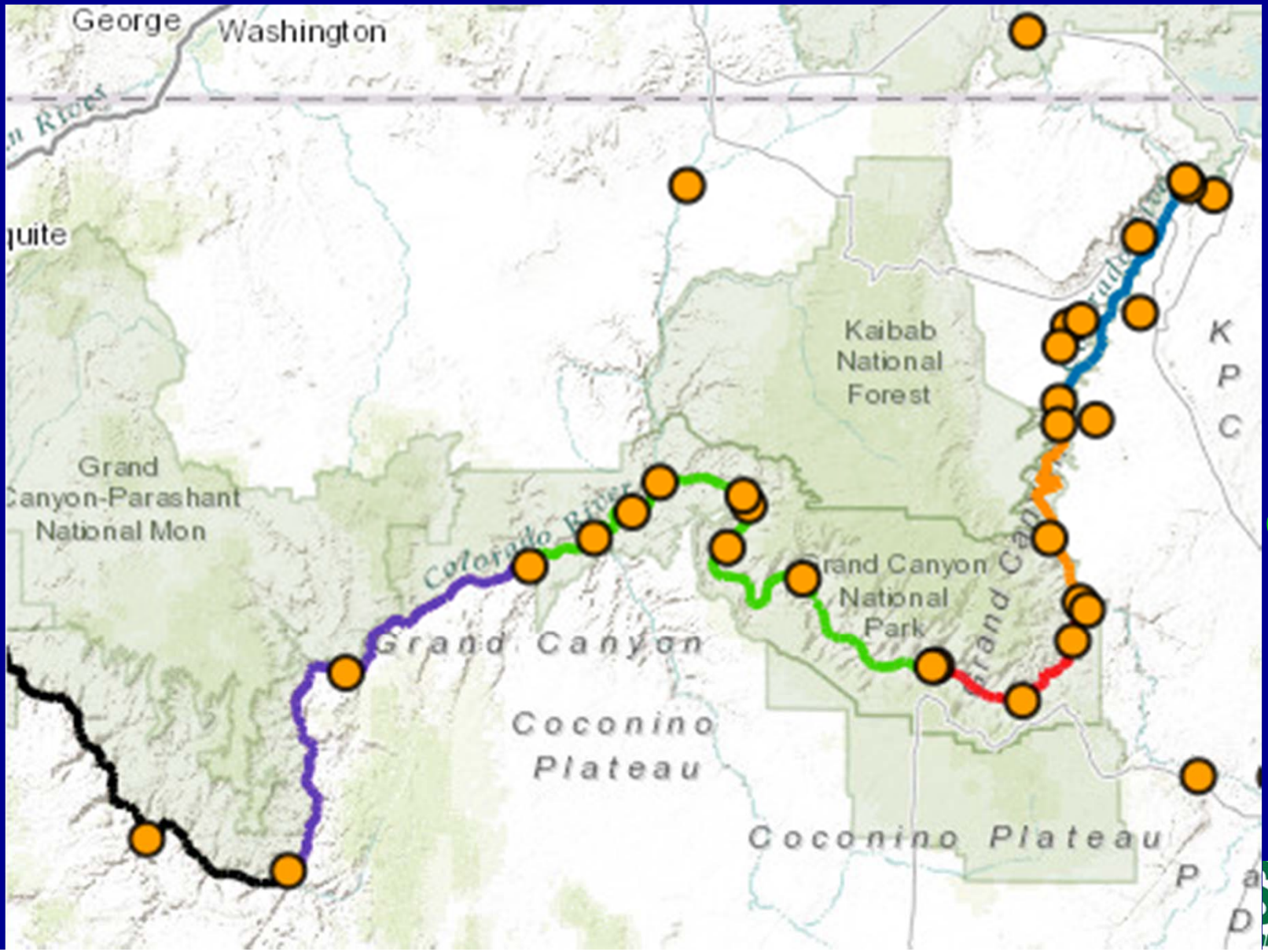
Over the flood hydrographs of each of the 2012, 2013, and 2014 HFES, the following occurred…



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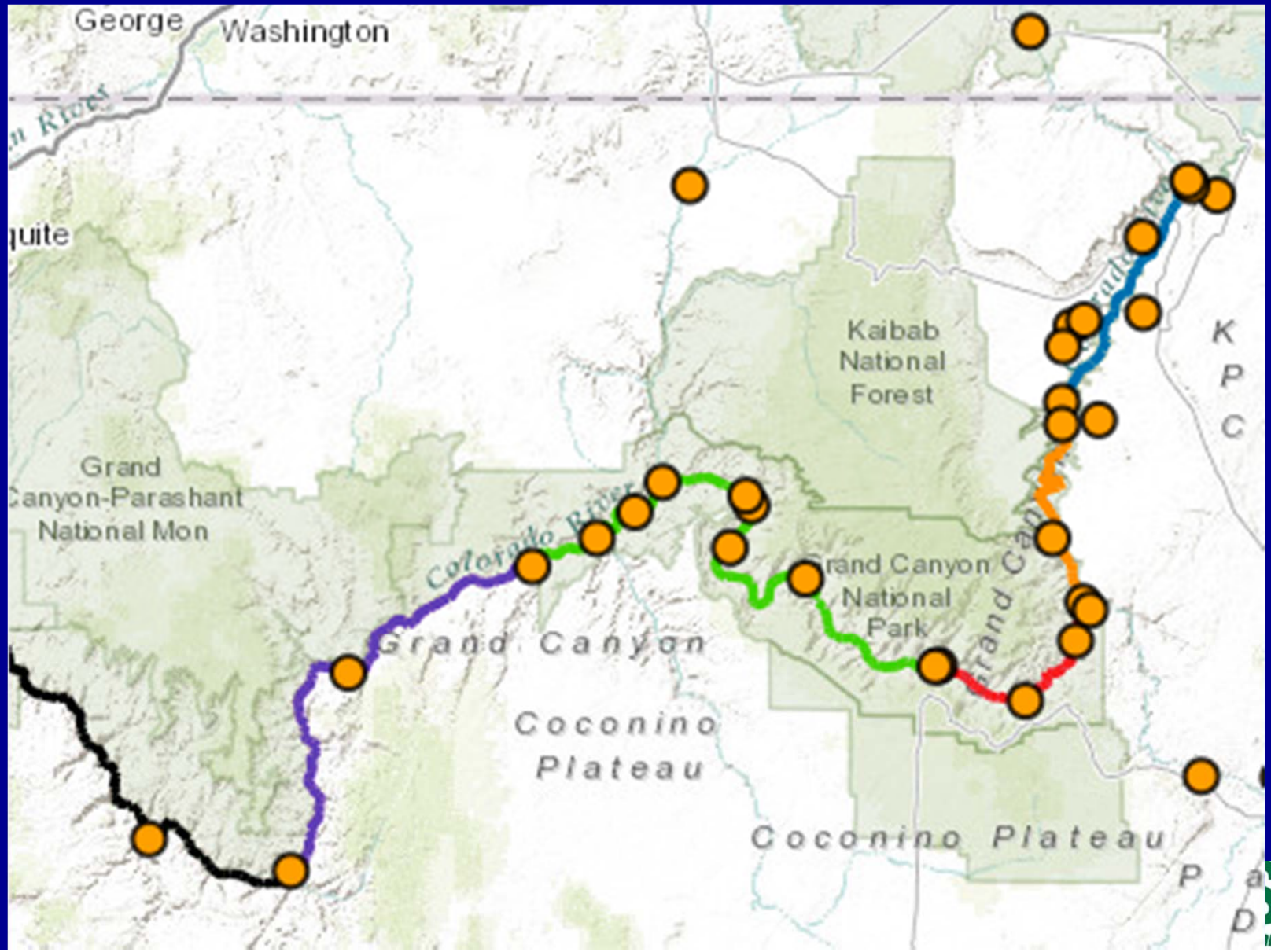
Over the flood hydrographs of the 2004 and 2008 HFES, the following occurred…



Conclusions

- Duration-curve tool being developed will allow 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?
- Systematic response of reach-scale sand budgets during HFEs appears to be emerging under the HFE Protocol
- This systematic response is different from that observed during the 2004 and 2008 HFEs likely because of the differing longitudinal distribution of the antecedent sand supply (small, all upstream in 2004; fine sand mostly downstream in 2008)


Thank you