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GCMRC Science Updates Part 2

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Grand Canyon Monitoring and Research Center
Southwest Biological Science Center

Adaptive Management Working Group Meeting
March 7, 2019

U.S. Department of the Interior
U.S. Geological Survey

Projects A & B
Sediment and Sandbars

- GCMRC scientists and their cooperators monitor changes in suspended sediment, sandbars, and changes in the amount of sand stored on the bed of the river

- What are the effects of dam operations on sediment mass balance and on building and maintaining sandbars?

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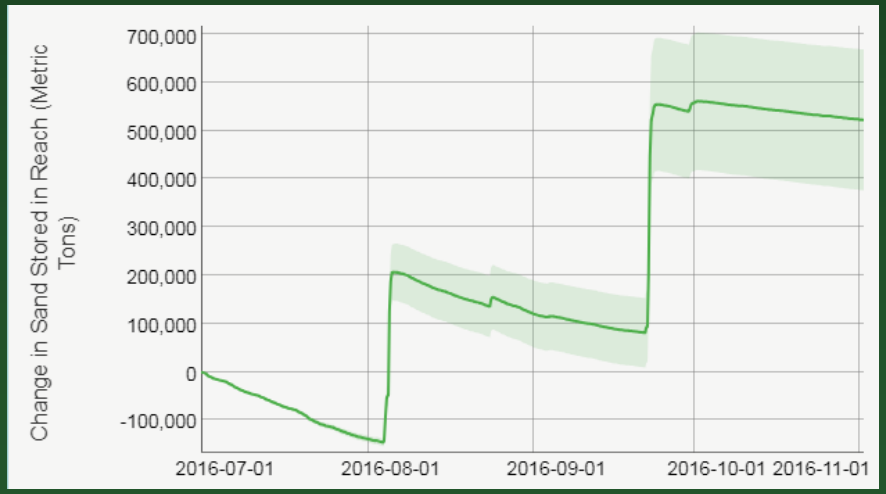
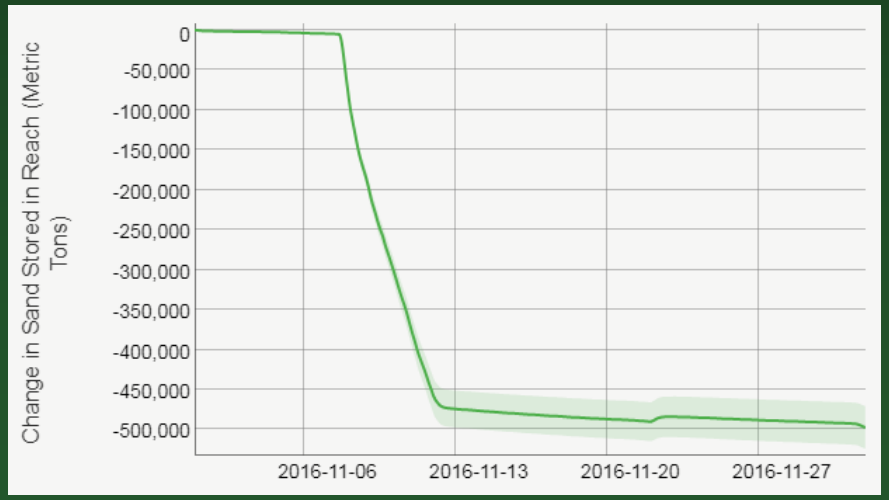
Updated Sediment Mass Balance

- Samples of some post-HFE have not been processed through the lab
- Effects of HFE on sediment mass balance won't be known for several more months





https://www.gcmrc.gov/discharge_qw_sediment/reach/GCDAMP/09380000/09383050

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Upper Marble Canyon – Nov. 7-12, 2016

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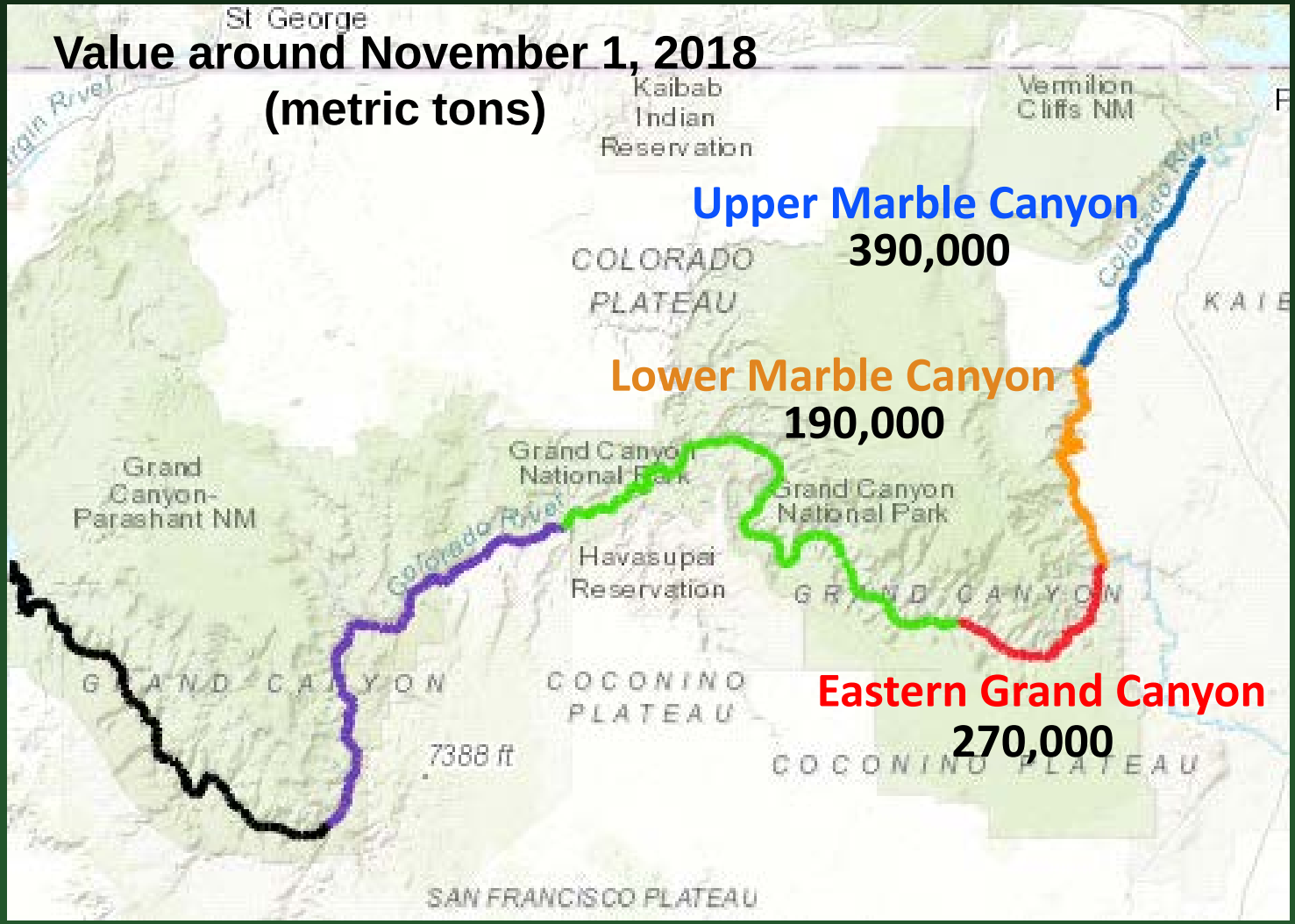
Changes in Sand Mass Balance



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

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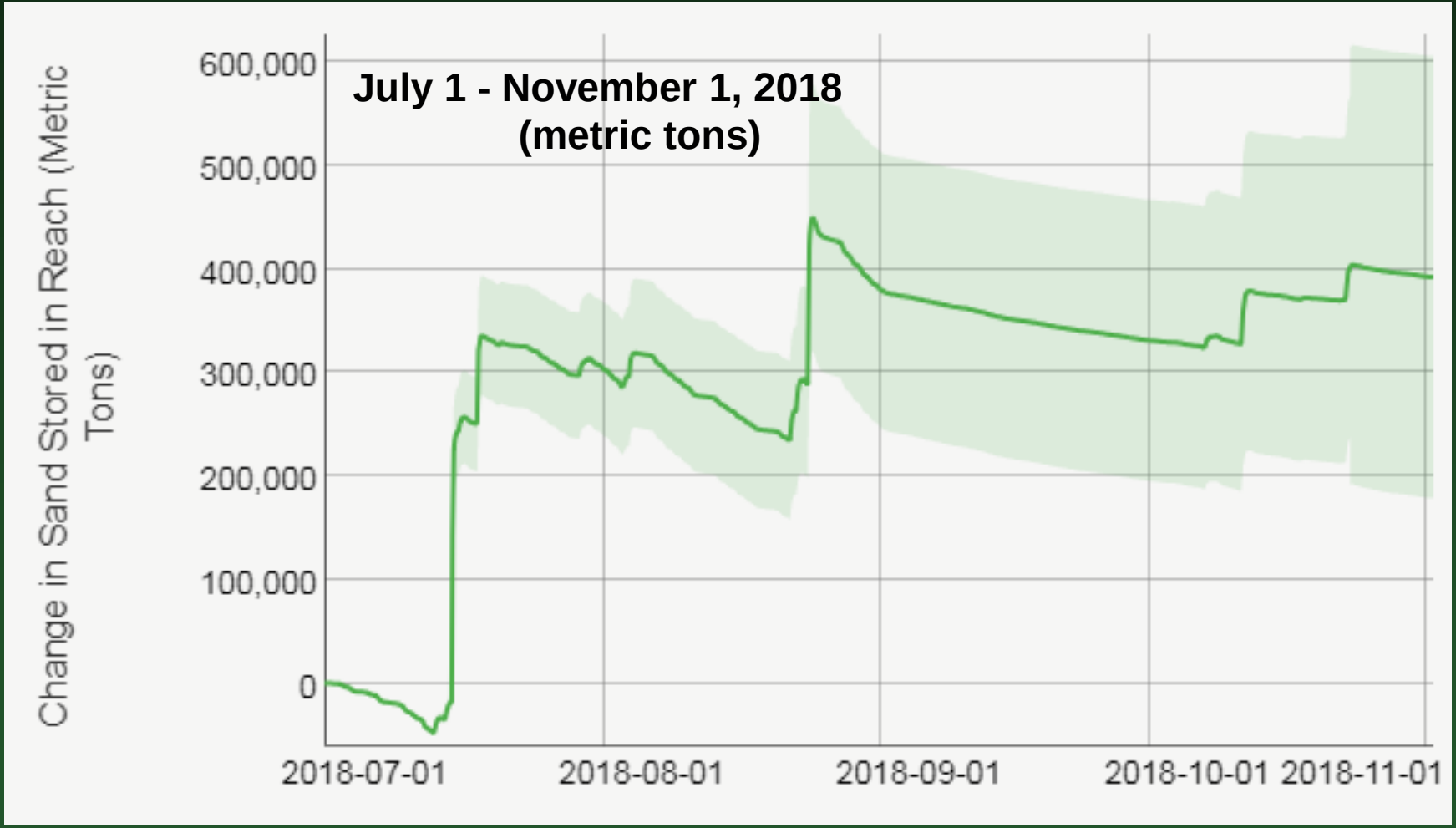
Upper Marble Canyon



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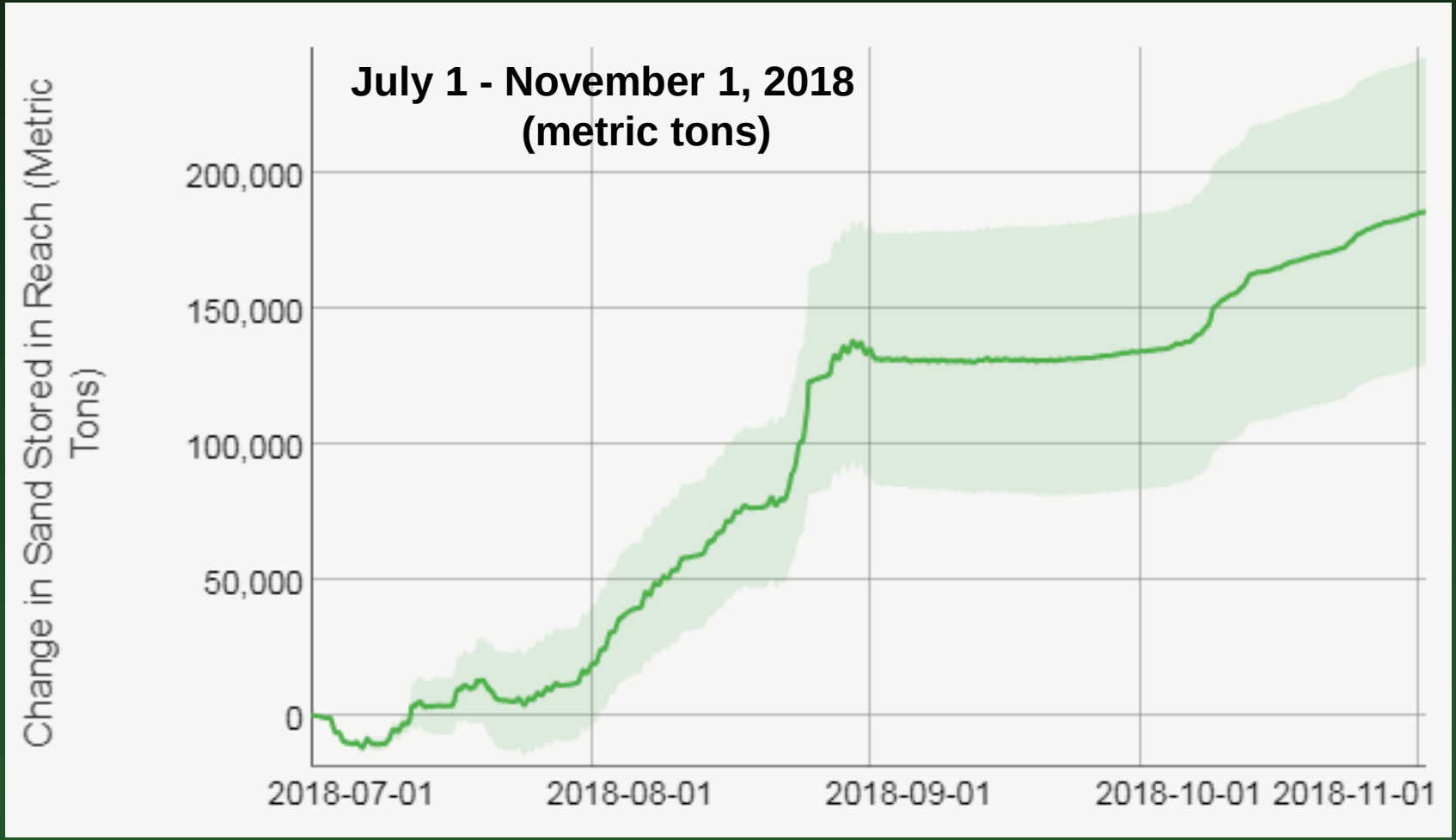
Lower Marble Canyon



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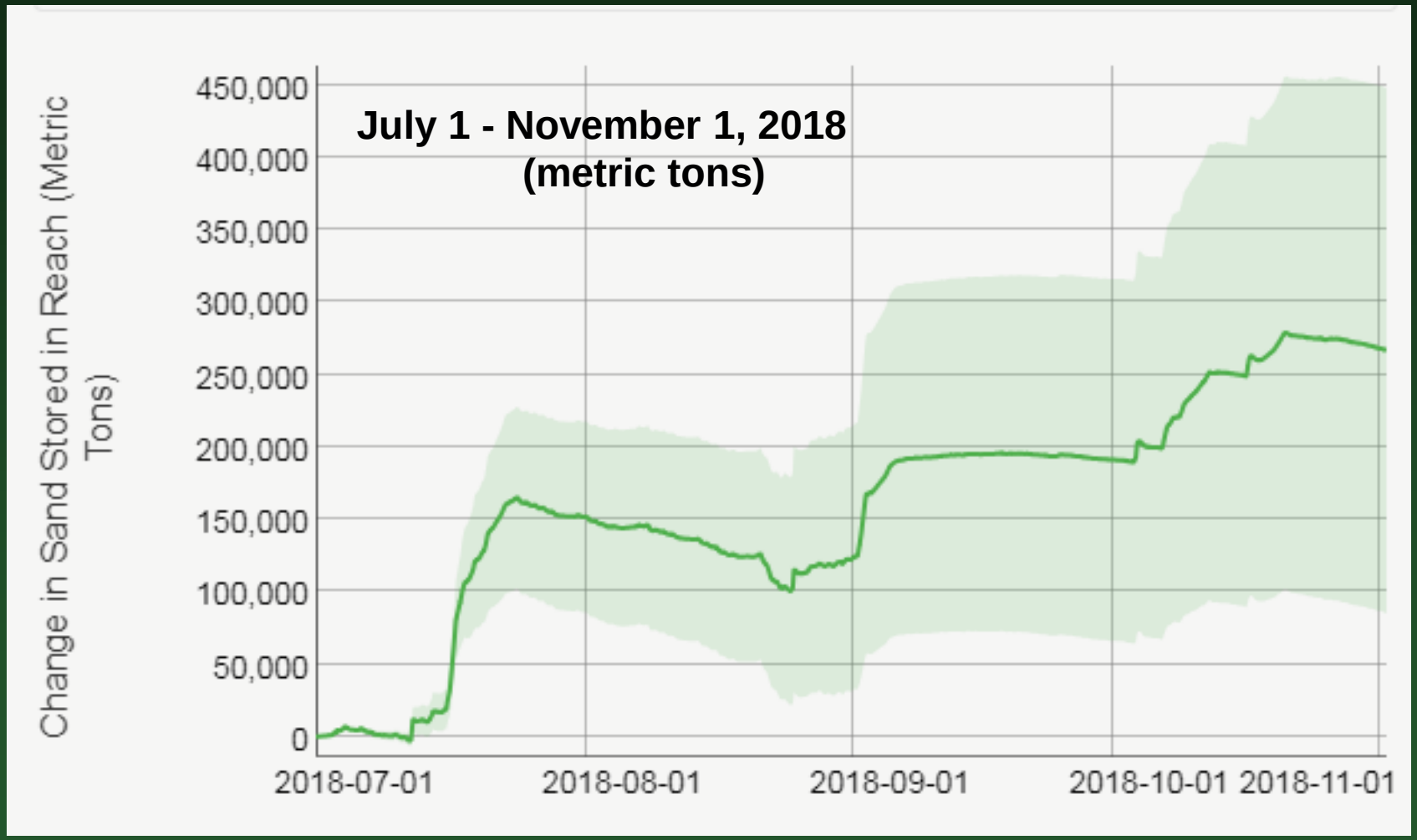
Eastern Grand Canyon



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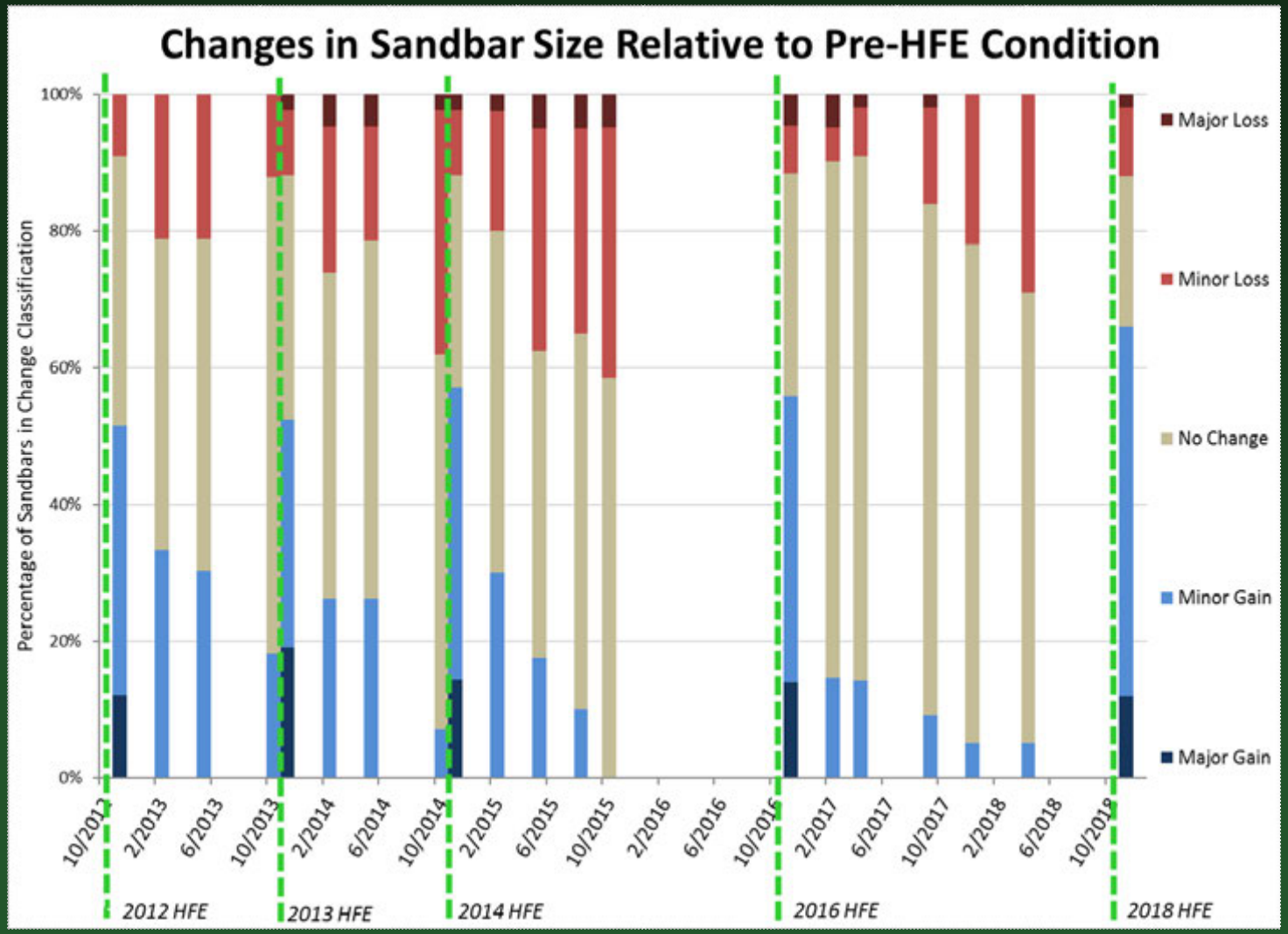
Sandbar Monitoring



Preliminary Data, Do not Cite or Quote

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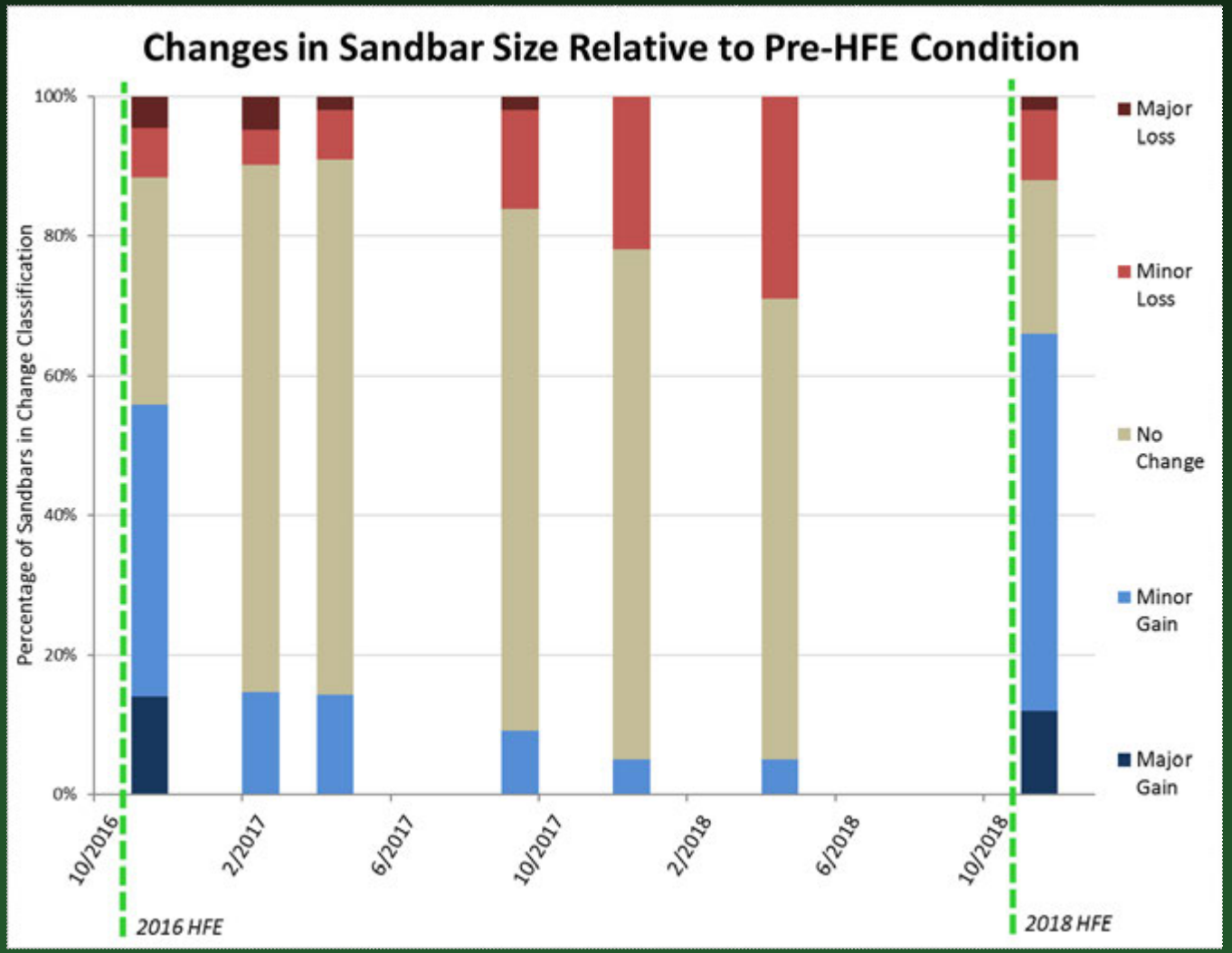
Sandbar Monitoring – Slide 1 of 2



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Sandbar Monitoring – Slide 2 of 2

	2012	2013	2014	2016	2018
Gain	51%	52%	57%	56%	66%
No Gain	39%	36%	31%	33%	22%
Loss	9%	12%	12%	12%	12%

12% Large Gain
54% Small Gain

As of 2/14/2019, only 16% show loss

22% Negligible Change
10% Small Loss
2% Large Loss

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Changes in Sandbar Conditions Following 2018 HFE

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https://grandcanyon.usgs.gov/gisapps/sandbarphotoviewer/RemoteCameraTimeSeries.html

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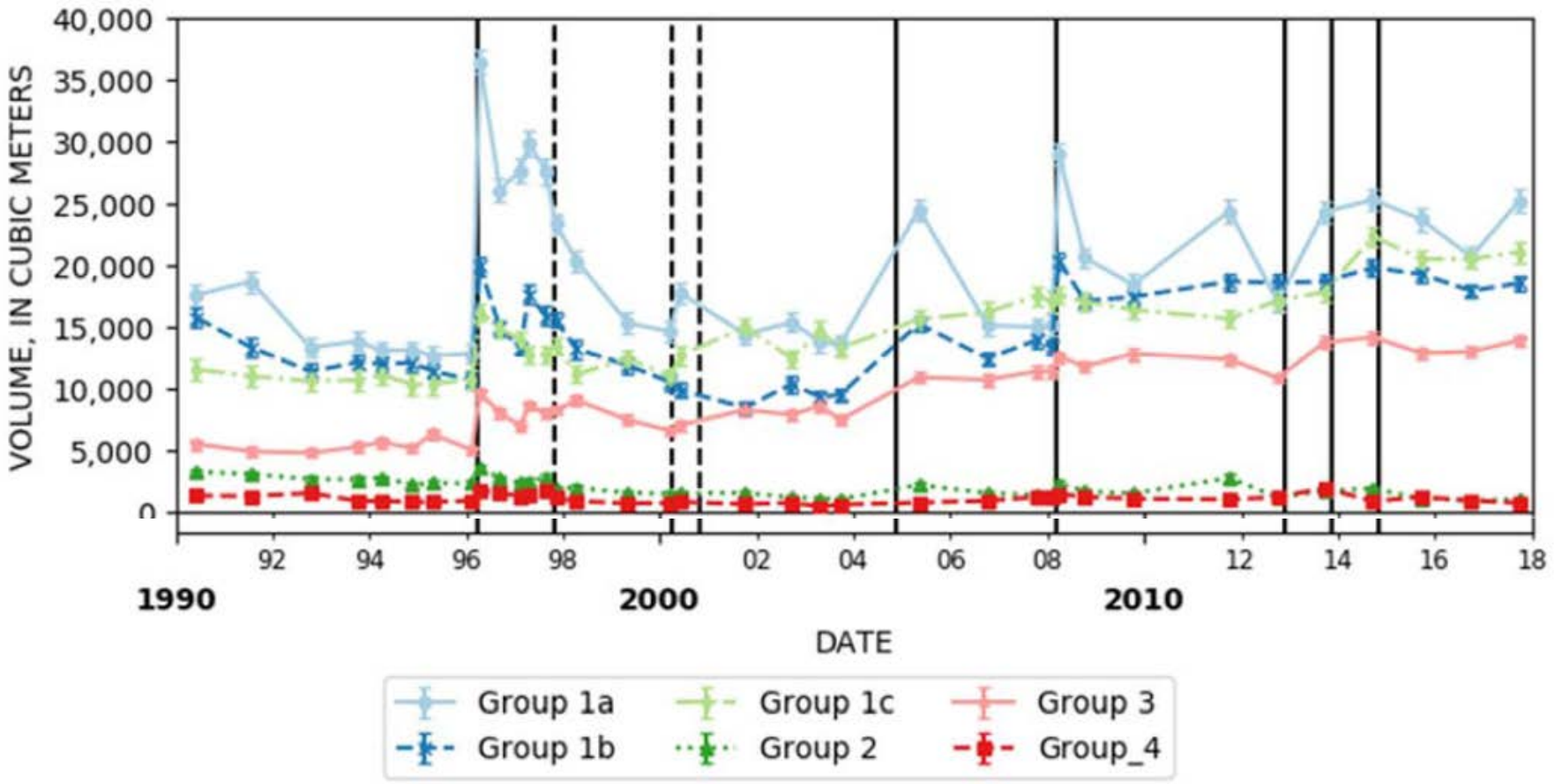
Long-Term Changes in Sandbars



Groups 1a and 1b:

- relatively large and mostly open bare sandbars

Groups 1c and 3:

- heavily vegetated bars

Groups 2 and 4:

- mostly smaller bars adjacent to debris fans

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Sand Transport Modeling

- In 2010 a method was published for modeling the sand budget of Marble Canyon

WATER RESOURCES RESEARCH, VOL. 46, W10538, doi:10.1029/2009WR008600, 2010

An approach for modeling sediment budgets in supply-limited rivers

Scott A. Wright,[1] David J. Topping,[2] David M. Rubin,[3] and Theodore S. Melis[2]

- Since publication, the model has been used in the HFE planning process for HFEs in 2012, 2013, 2014, 2016, and 2018

- Model is currently being updated with latest data; results will be presented at the Annual Reporting meeting

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Project C
Riparian Vegetation Monitoring

- GCMRC scientists and their cooperators document the amount and types of vegetation found along the river corridor and determine plant cover, species richness, and diversity

- What are the effects of dam operations on riparian vegetation?

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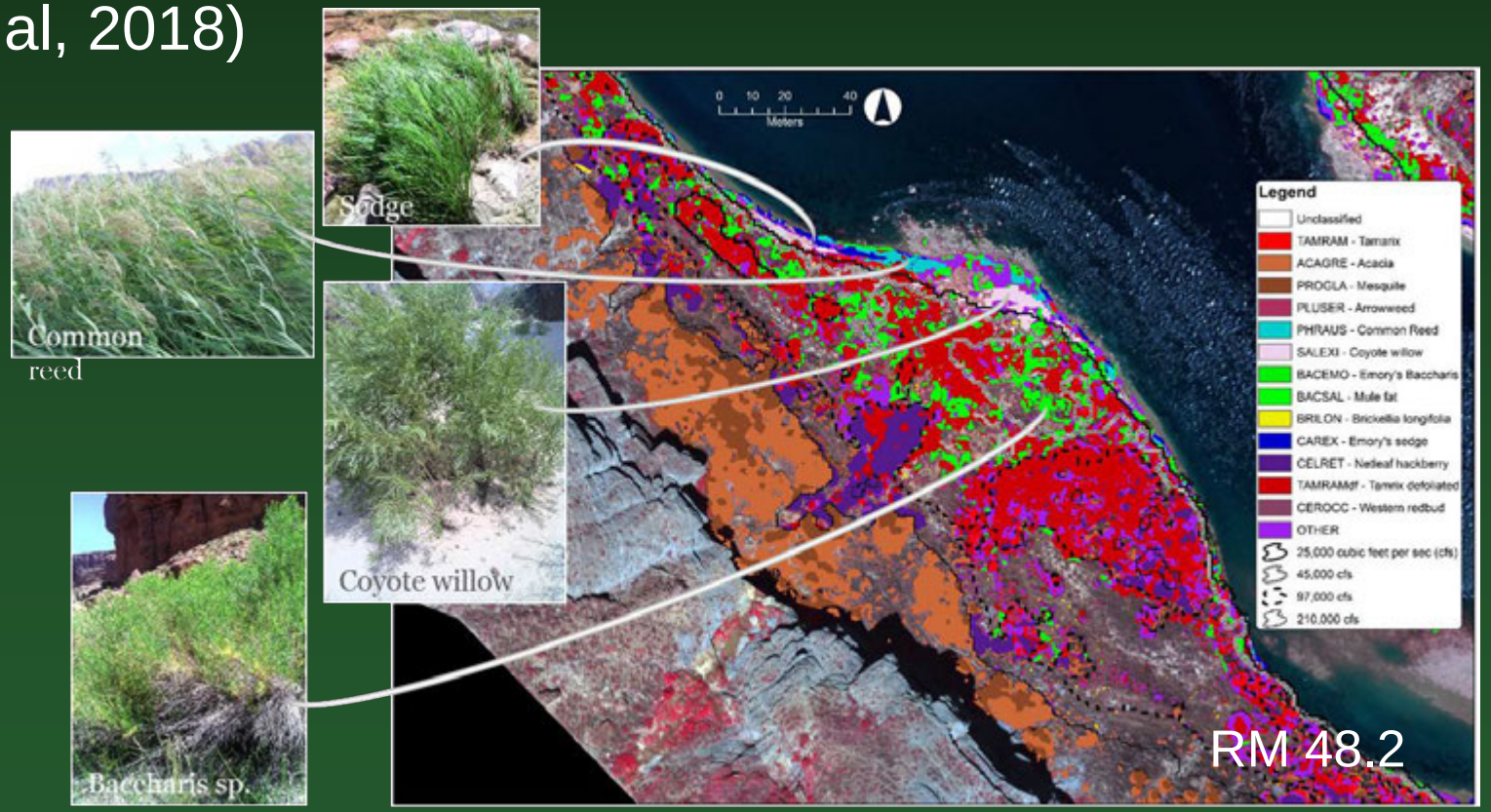
Remote Sensing – Riparian Vegetation

- Riparian vegetation species classification from Glen Canyon Dam to Lake Mead
- Published in 2018 as a USGS data series (Durning et al, 2018)



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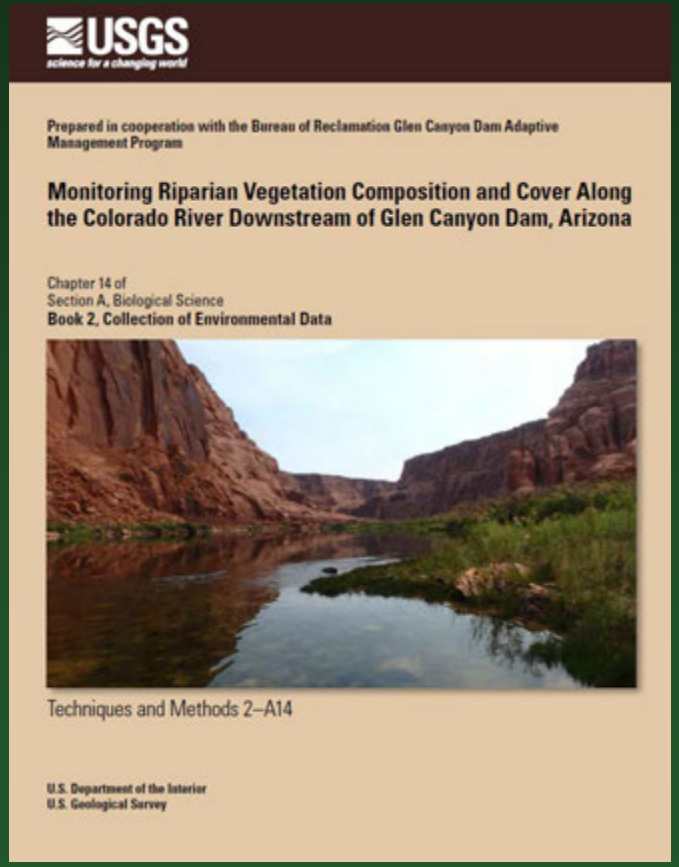
Modeling - Riparian Vegetation – Slide 1 of 2

- Riparian vegetation monitoring protocol
- Open-File Report outlining methods for (Palmquist et al., 2018):
  - Random site selection
  - Plot distribution relative to hydrological zones
  - Data collection and management
- Sufficiently detailed for application in similar river systems



https://doi.org/10.3133/tm2A14

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Modeling - Riparian Vegetation – Slide 2 of 2

- Hydrological regime and climate interactively shape riparian plant composition (Butterfield at el., 2018)

- Strong sensitivity of sandbar vegetation to:
  - minimum temperature
  - elevation above base flow
  - interaction between climate and hydrology

https://doi.org/10.1111/avsc.12390

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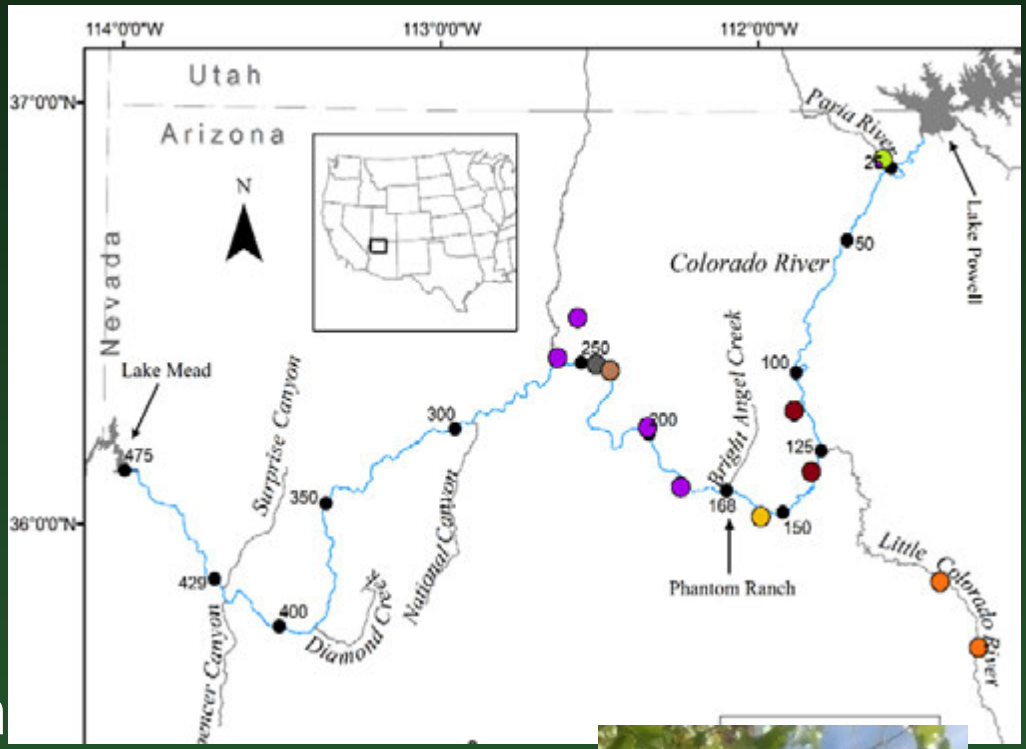
Genetic Association of Grand Canyon Plants

- Ongoing research to understand genetic similarity of plants in the Grand Canyon as it relates to geography

- Better understanding of the genetic differences will help guide the NPS in plans for re-vegetated areas with native species



Freemont Cottonwood

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Documentation of Riparian Vegetation Change using Repeat Photography

- Document riparian vegetation change along the Colorado River using repeat photography
- Focus on duplicating images from the 1923 USGS Birdseye Expedition
- 58 matches completed in May 2018; 160+ matches completed since 2016

River Mile 204, above Spring Canyon. Top photo by E. C. LaRue, Sept. 1923. Bottom image by A.H. Fairley, May 2018.

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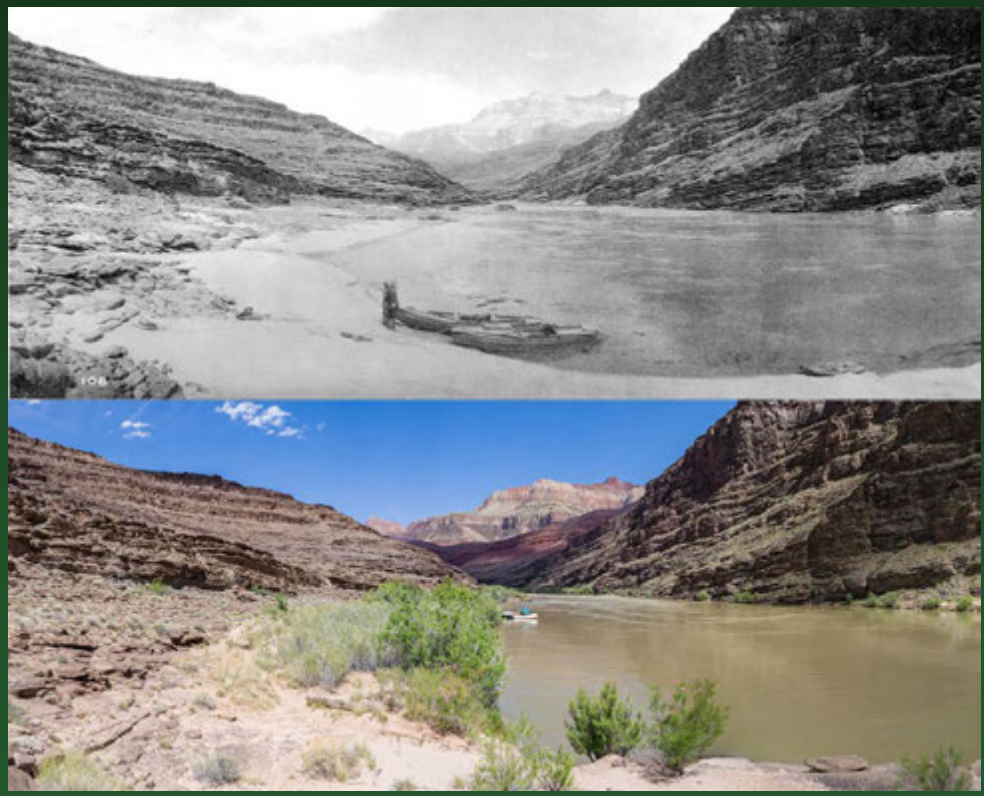
Project D
Bare Sand and Dunefields

- Bare sand is an important resource for recreation, habitat, and cultural resources in the Grand Canyon

- What are the effects of dam operations on bare sand and aeolian sand dunes?



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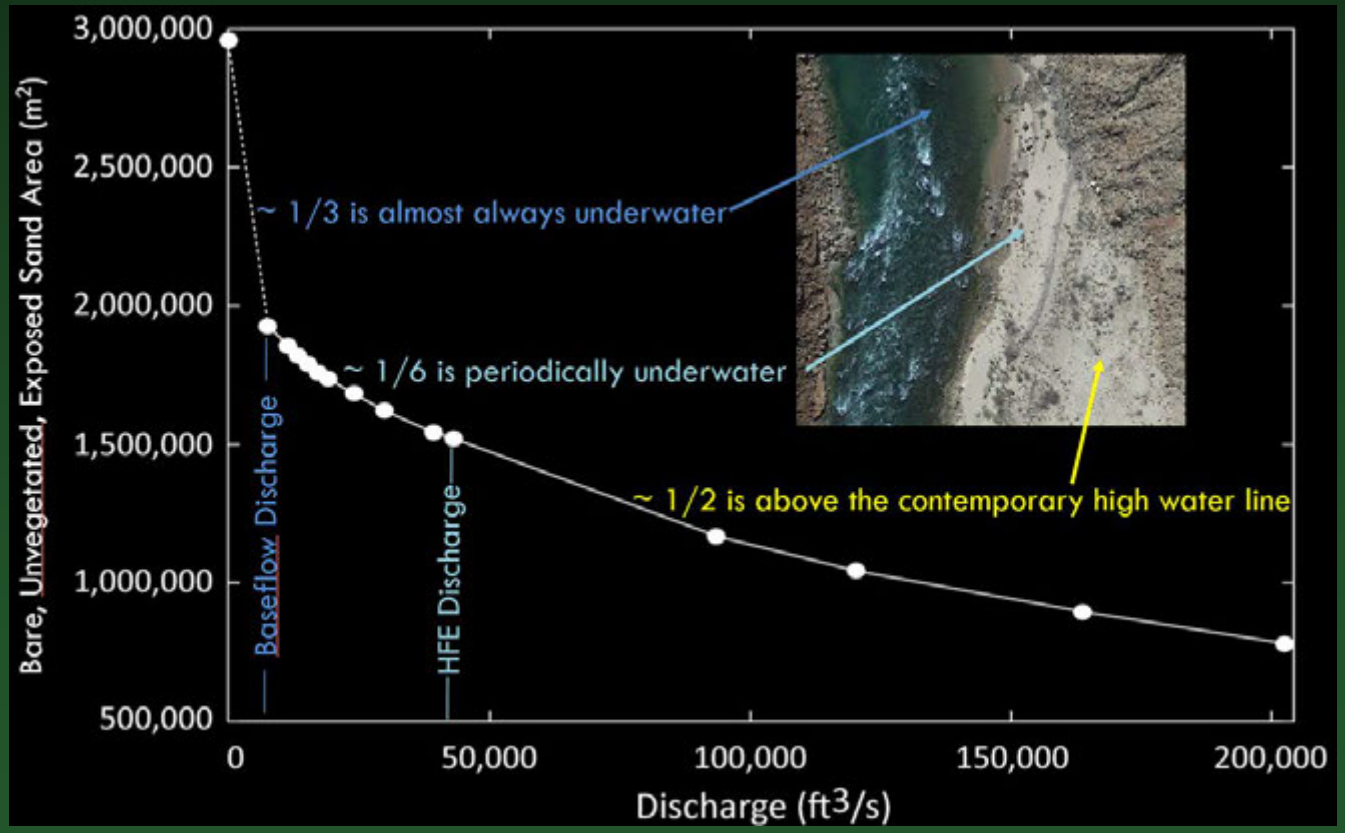
Distribution of Sand in Grand Canyon

- ½ of bare sand is found in 113 large dunefields
- HFEs supply sand for these dunefields



Kasprak et al., 2018

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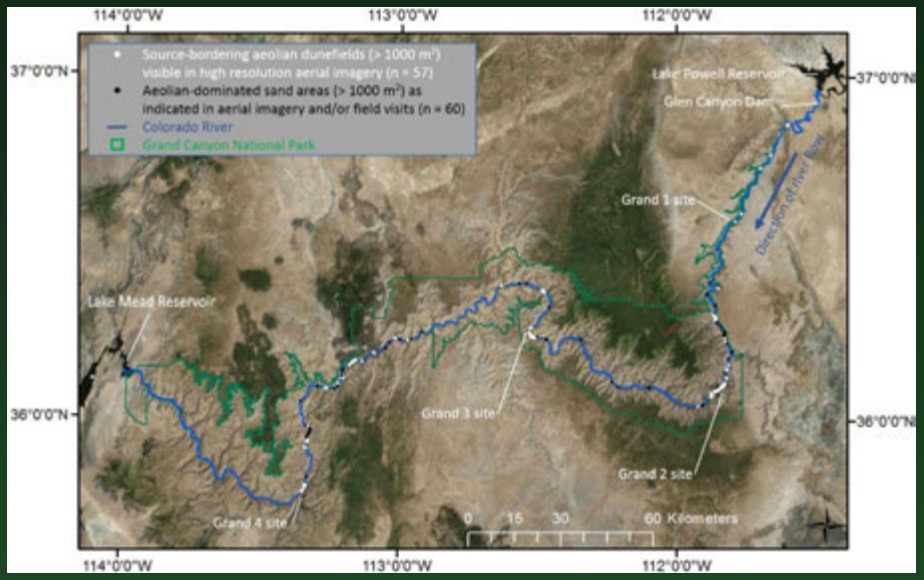
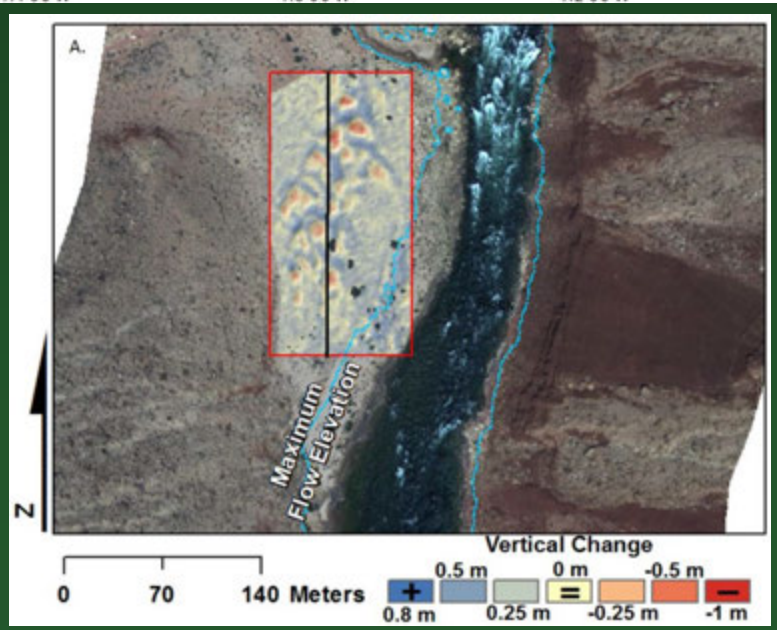
Dunefield Status

- Aeolian dunefields were resupplied with windblown sand from HFE in 2012, 2013, 2014, and 2016
- Sand resupply to dunefields by HFEs is analogous to resupply of sandbars
- Dunefield sediment storage increases cumulatively with successive HFEs





Sankey et al., 2018

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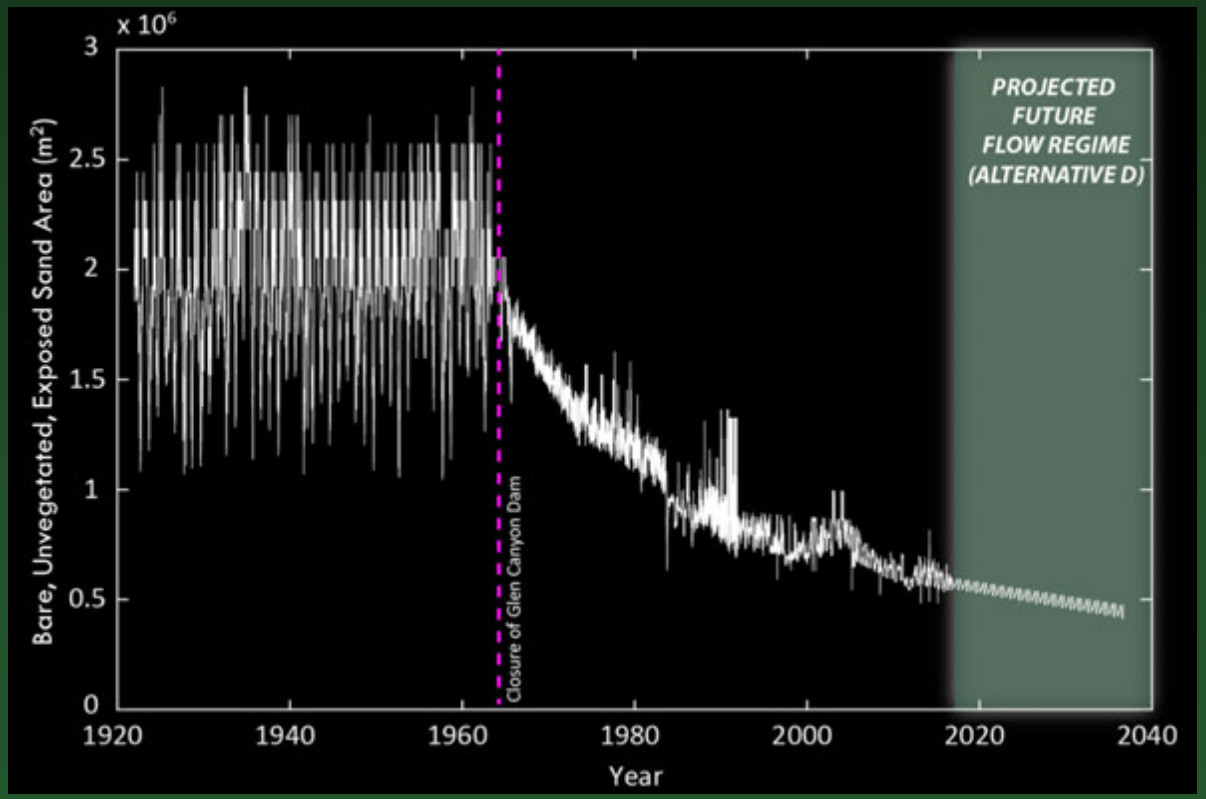
Implications and Future Work

- Bare sand area has decreased by 49% since 1965 and is projected to decrease by an additional 12% by 2037
- This is mainly due to riparian vegetation expansion and altered river flow

- GCMRC is assisting NPS in designing experimental vegetation removal treatments in Grand Canyon

- This work should increase aeolian sediment supply to several dunefields



Kasprak et al., 2018

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Projects J & N – Socioeconomic and Hydropower Research

- GCMRC scientists identify preferences and economic values of resources in the Colorado River Ecosystem

- GCMRC scientists also examine the effects of dam operations on hydropower generation

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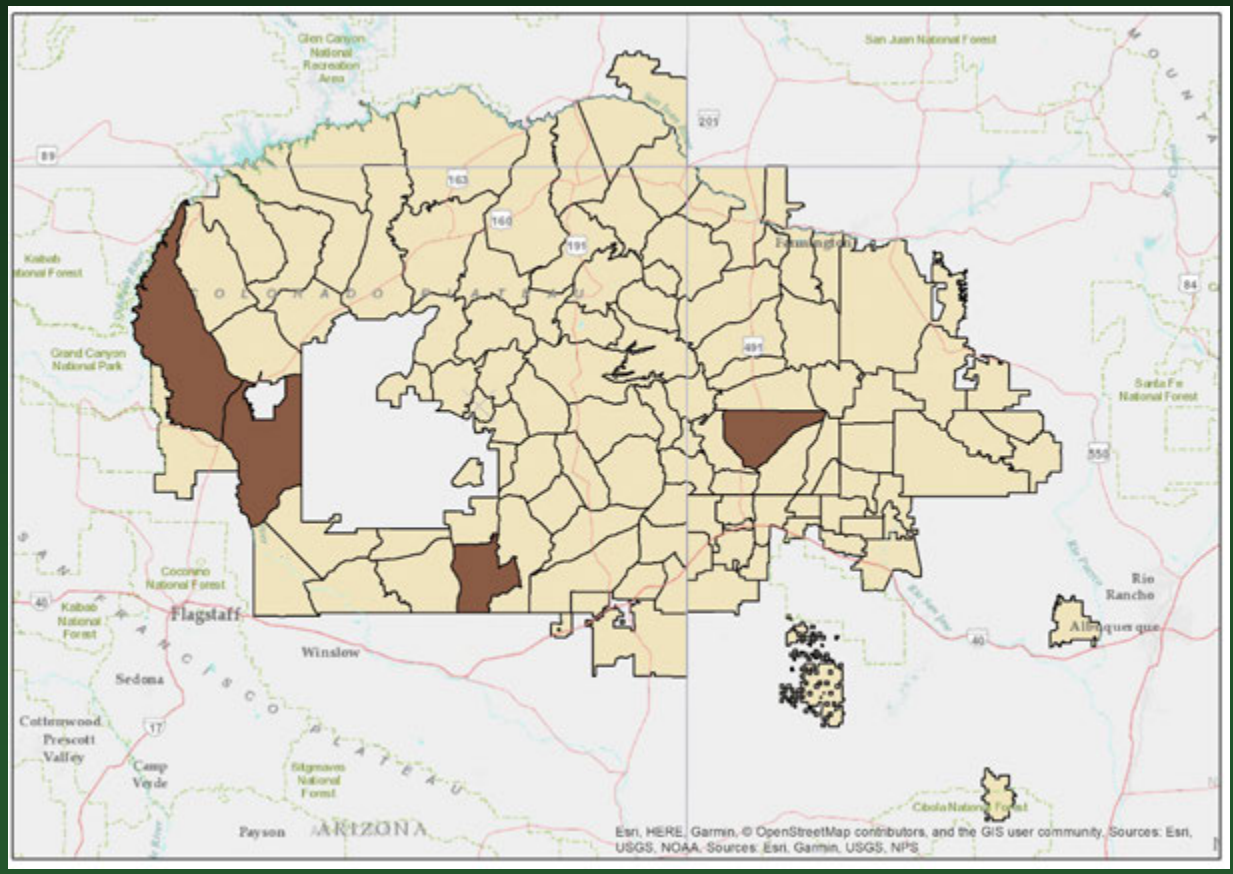
Project J – Socioeconomic Research

Navajo Nation Survey Research

- Tribal surveys of perspectives and values of resources downstream of Glen Canyon Dam
- Focus group discussions have occurred included: Bodaway-Gap, Coalmine Canyon, Tohatchi and Indian Wells Chapters



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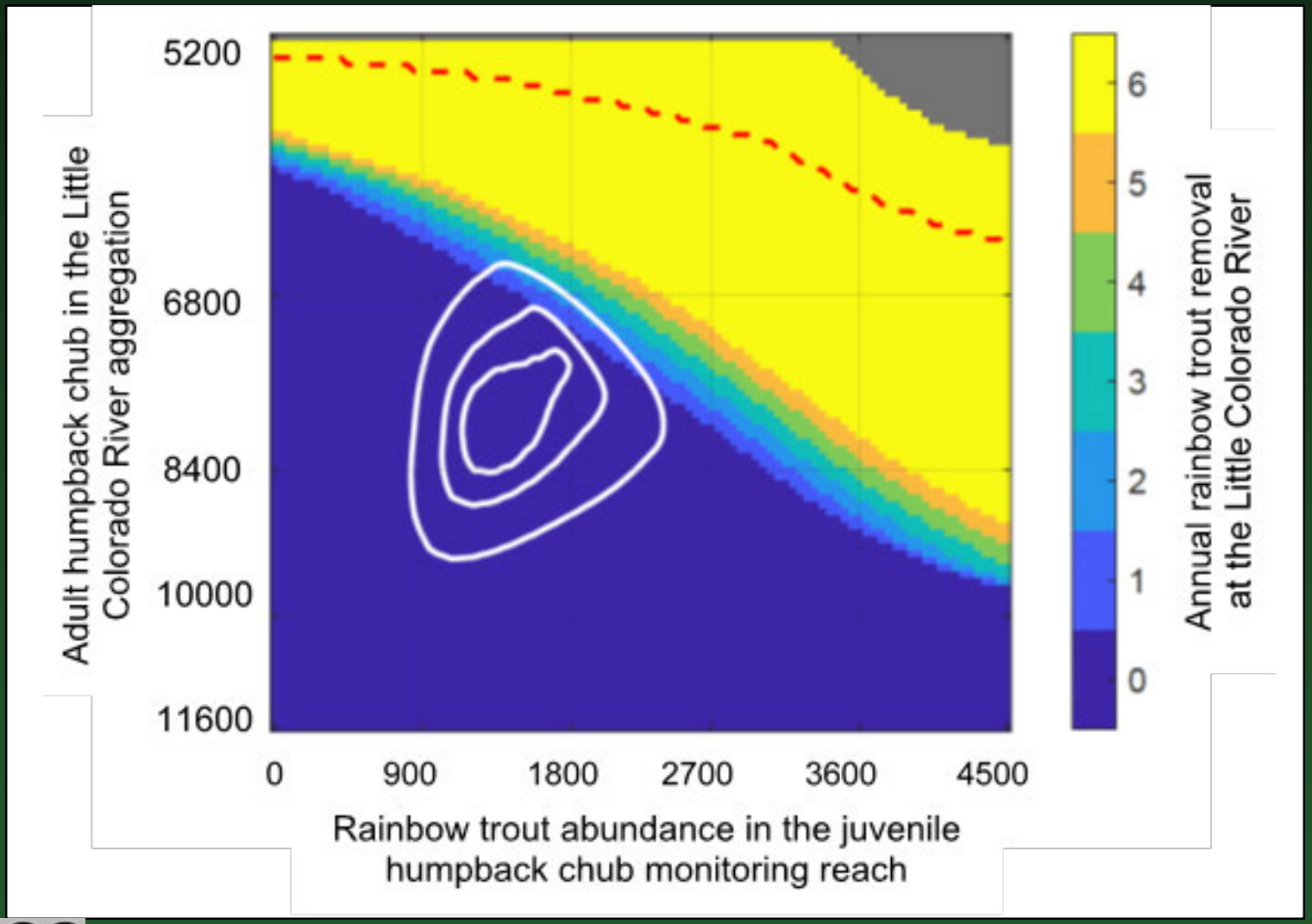
Project J – Bioeconomic Model



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Project J – Recreation and HFEs

- Recreation impacts from HFEs evaluate:
  - lost user days
  - changes in river flow
  - beach condition
- Recent studies by GCRMC have demonstrated that recreational values of angling and whitewater rafting in Glen and Grand Canyons impacted by HFEs have been consistent over the last 30 years


Southwest Fly Fishing


Grand Canyon West

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Project N – Hydropower and HFEs

- What are the impacts on hydropower of LTEMP experiments such as HFEs?
- Economic value of hydropower generation and capacity are good measures of the impact of HFEs
- The change in power system emissions from an HFE is increasingly relevant as emissions have a measurable economic cost

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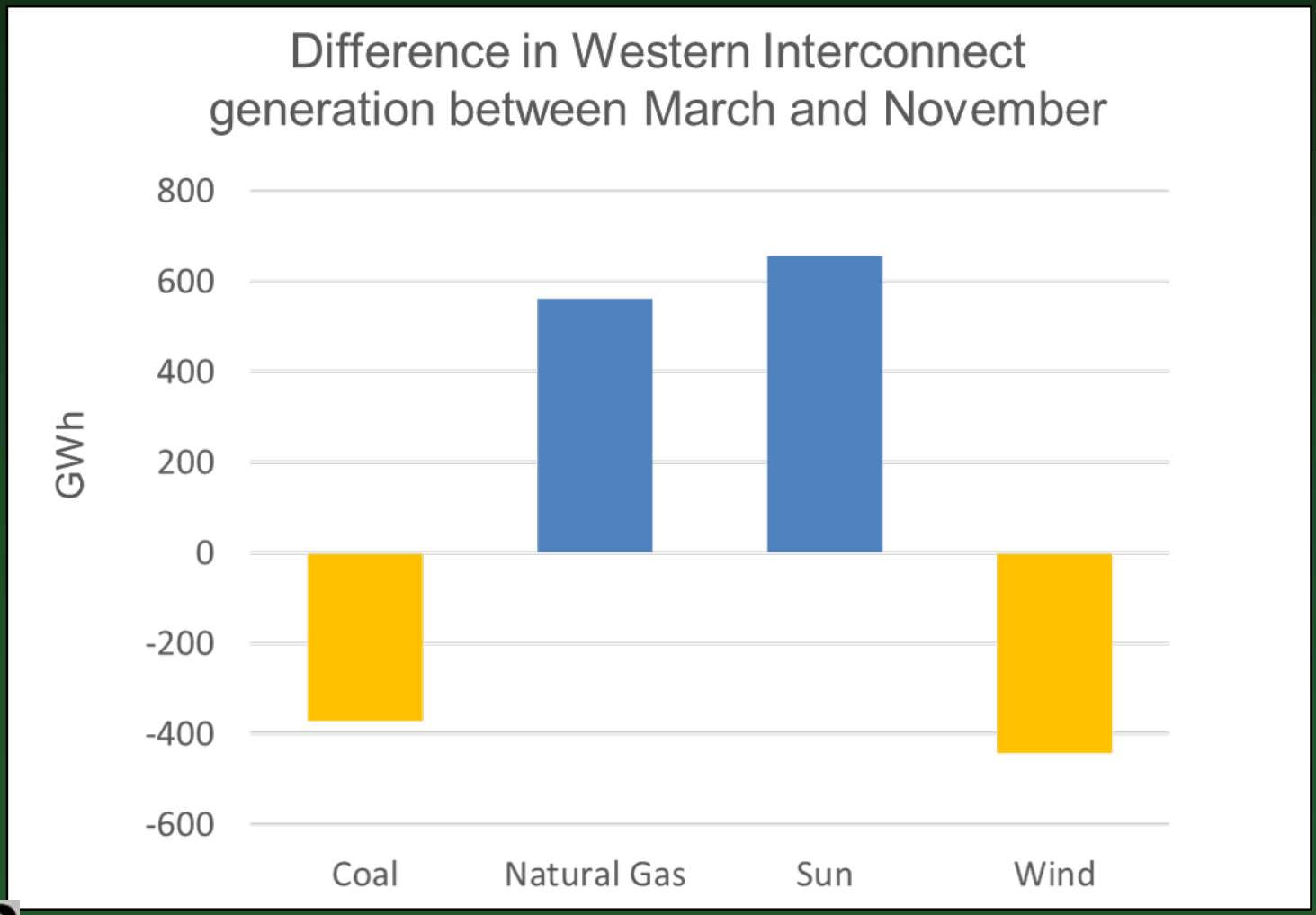
Hydropower and HFEs



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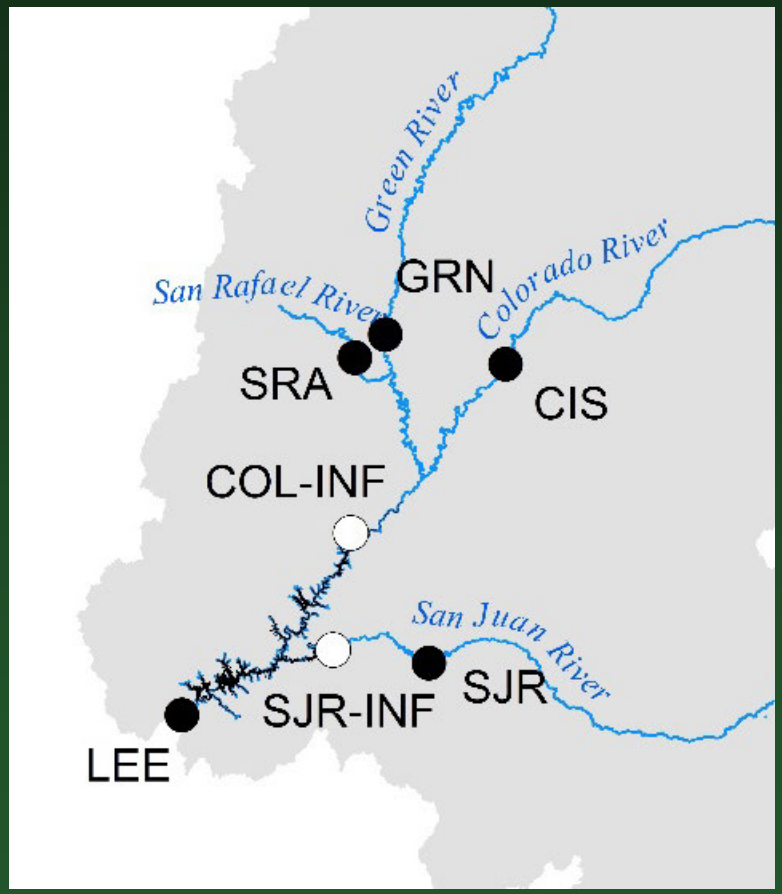
Lake Powell Water Quality

- Compared sediment mass balance inputs and outputs from Lake Powell
- Lake Powell does not retain chloride and sulfate
- Lake Powell does retain calcium and bicarbonate, which can combine to form calcite



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Significance of Mass Balance Results

- Calcite precipitation can remove phosphorus through binding
- Calcite precipitation may drive phosphorous burial in Lake Powell, contributing to low and variable phosphorous in Lake Powell outflows
- Low phosphorus levels can limit aquatic productivity in Grand Canyon

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