Glen Canyon Dam Adaptive Management Work Group
Agenda Item Information
August 26-27, 2015

Agenda Item
Grand Canyon Monitoring and Research Center Science Updates

Action Requested
Information item only; we will answer questions but no action is requested.

Presenter(s)
Scott VanderKooi and Paul Grams, Grand Canyon Monitoring and Research Center

Previous Action Taken
N/A

Relevant Science
N/A

Summary of Presentation and Background Information

Between December 1, 2014, and July 1, 2015, the sand storage in upper Marble Canyon increased by approximately 120,000 metric tons (mt) (lower and upper uncertainty bounds are: 0 to 240,000 mt), while the sand storage in lower Marble Canyon decreased by approximately 48,000 mt (-82,000 to -14,000 mt) and sand storage in eastern Grand Canyon decreased by approximately 140,000 mt (-220,000 to -57,000 mt). The increase in upper Marble Canyon is the result of Paria River floods that delivered approximately 400,000 mt of sand in early June 2015. During the 7-month period ending July 1, 2015, the amount of sand eroded from lower Marble Canyon and eastern Grand Canyon exceeded the amount of sand that accumulated in upper Marble Canyon by a small amount.

Between December 1, 2014, and March 3, 2015 (the date of the last download at RM166), sand storage in east central Grand Canyon (RM87-RM166) increased by 96,000 mt (61,000 to 130,000 mt), and sand storage in west central Grand Canyon (RM166-RM225) increased slightly by 29,000 mt (6,000 to 51,000 mt). The sand budgets for east and west central Grand Canyon will be updated through September 1, 2015, following downloads during the upcoming river trip.

Between December 1, 2014, and July 1, 2015, approximately 410,000 mt of sand (390,000 to 430,000 mt) were transported past Diamond Creek (RM225) into western Grand Canyon and the Lake Mead Delta. In summary, the amount of sand eroded from all segments between Lees Ferry and Diamond Creek in the past 7 months was approximately balanced by the late spring inputs from the Paria River.

These data are available for inspection at
http://www.gcmrc.gov/discharge_qw_sediment/reaches/GCDAMP/.

The fall 2014 HFE resulted in sandbar deposition similar to previous HFEs. Sandbar monitoring sites will be surveyed in late September/early October. Analysis of images from remote cameras showing changes between the fall 2014 HFE and September 2015 will be available by October 16. Photographs and sandbar data are available at http://www.gcmrc.gov/sandbar/.

Rainbow trout densities remain highest in Glen Canyon and the upstream third of Marble Canyon and lowest downstream of the confluence with the Little Colorado River. Abundance of rainbow trout in all these reaches decreased sharply over the last year. Trout densities downstream of the Little Colorado River confluence are now below trigger levels identified in the 2011 USFWS Biological Opinion on nonnative fish control for the first time in two years. Mark-recapture efforts in Glen Canyon before and after the November 2014 HFE indicate that most rainbow trout moved little during that period. On average, marked rainbow trout were recaptured just downstream (0.05 km) of their initial release locations. As observed in 2013 and 2014, evidence of some rainbow trout reproduction was detected in 2015 at sites downstream from Lees Ferry including near Buck Farm (RM 38-41) and the reach just upstream of the Little Colorado River confluence (RM 60-61). Catches of brown trout in the Tapeats Gorge near the confluence of the Little Colorado River remained low, similar to numbers observed in July 2014. Trout removal using elecrofishing occurred in the mainstem Colorado River near the confluence with Bright Angel Creek from February 6-17, 2015. This experimental action is being conducted in collaboration with Grand Canyon National Park, consistent with the NPS Comprehensive Fisheries Management Plan and related compliance documents. The removal effort was re-scheduled to February 2015 to avoid conflicts with the November 2014 High Flow Experiment and associated logistical constraints. As with the previous effort in late 2013, turbid conditions made electrofishing efficacy and capture probability low. Crews removed 391 rainbow trout and 84 brown trout. All harvested fish were cleaned, vacuum sealed in bags, and frozen for human consumption.

Juvenile humpback chub catches in the mainstem near the Little Colorado River in July were similar to those observed in July 2013 and 2014. Population estimates generated by the USFWS for sub-adult (150-199 mm) and adult (> 200 mm) humpback chub in the Little Colorado River were considerably lower than estimates from recent years. Spring humpback chub population estimates in the Little Colorado River were 921 (95% CI, 756 to 1,086) sub-adult fish and 3,078 (95% CI, 2,597 to 3,559 adult fish. It is unknown at this time if this represents a real decline in the abundance of adult humpback chub, or if the low estimates were the result of variability in timing of the spawning run (i.e., humpback chub may have spawned and left the system earlier in the year). Some evidence of an early spawn comes captures of age-0 fish in the Little Colorado River during May (usually not seen until later in the year). Further evidence may come from detections on the remote PIT-tag arrays anchored in the lower Little Colorado River. Data from these arrays will be available by mid-August and presented.

Status of Sediment Resources – August 2015

Paul Grams, Bob Tusso, Joe Hazel, Dan Buscombe, Matt Kaplinski, Keith Kohl, Erich Mueller, and Rob Ross [GCMRC work plan Project 3]

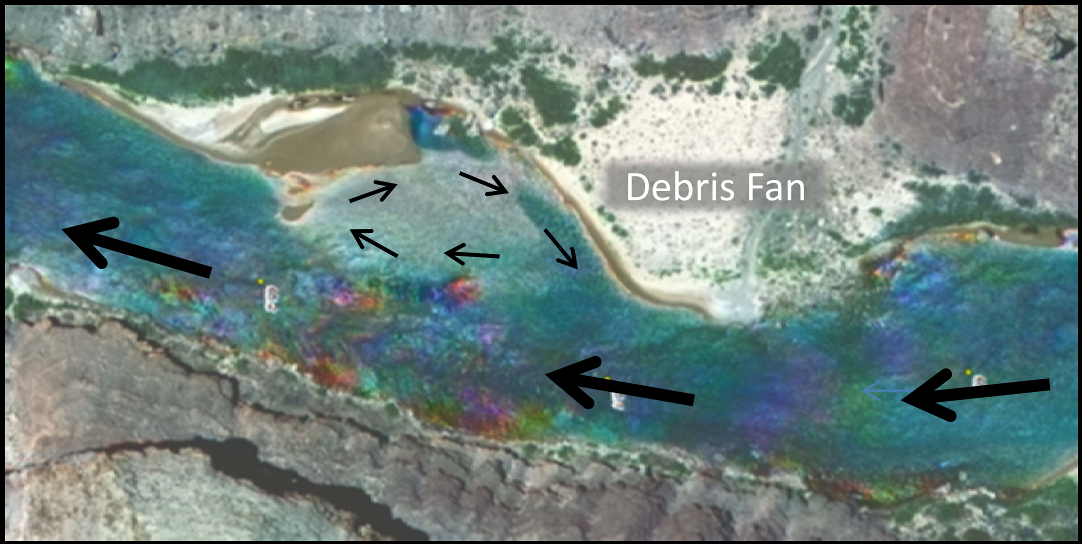
David Topping, Ron Griffiths, Tom Sabol, Dave Dean, Nick Voichick [GCMRC work plan Project 2]

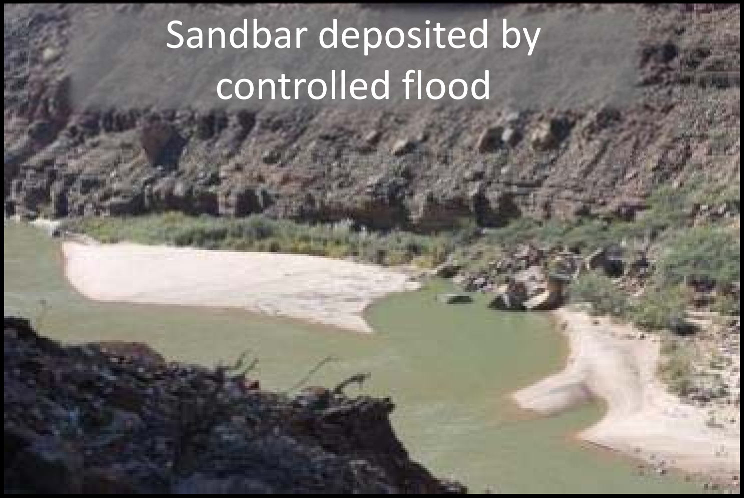
USGS Grand Canyon Monitoring and Research Center with cooperation from Northern Arizona University, Arizona Water Science Center, Grand Canyon National Park, and Grand Canyon River Guides

USGS

Eddy-deposited sandbars and High-flow Experiments

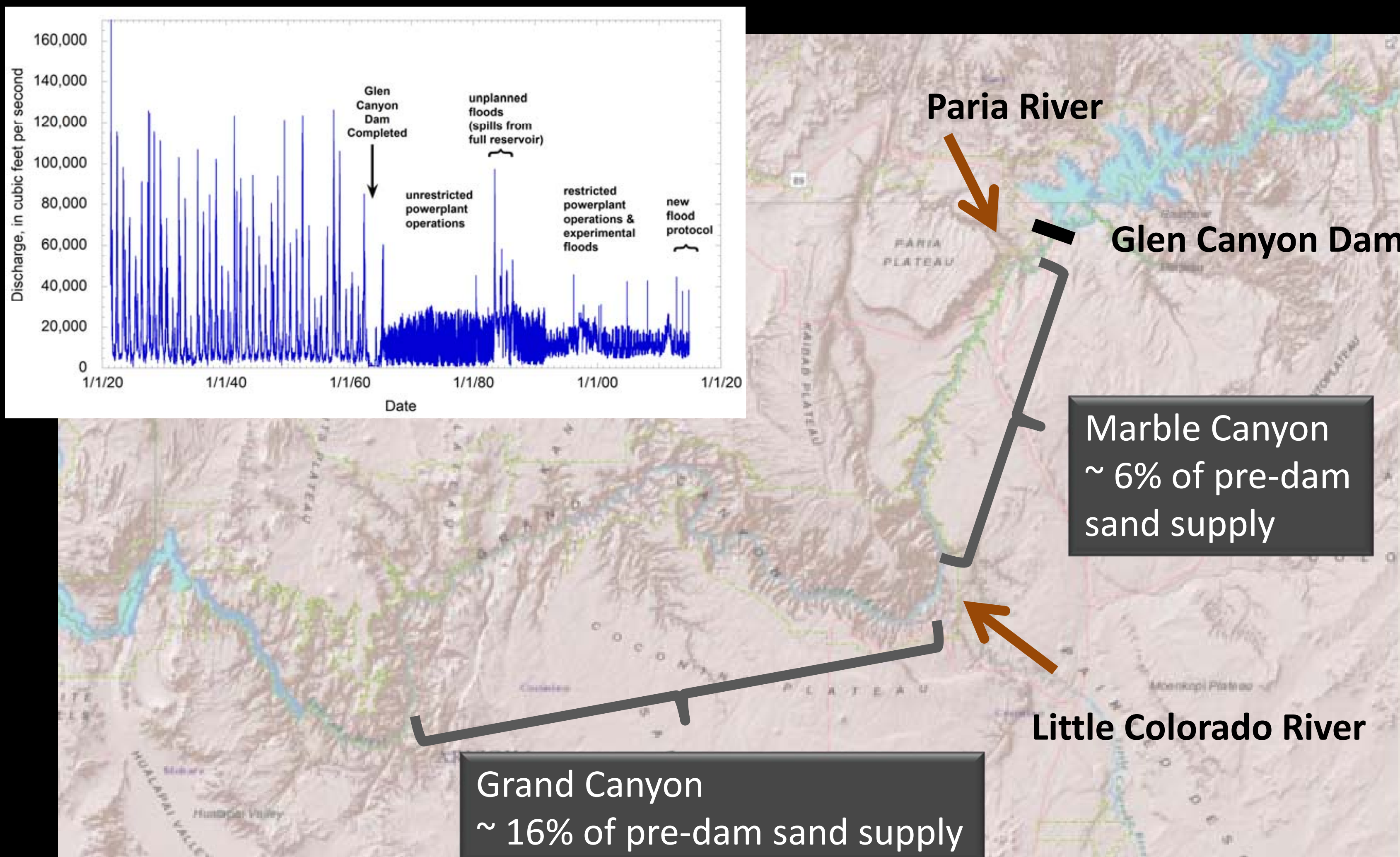
- During low flows, sand supplied by tributaries (like Paria River) accumulates on bed and in eddies
- High flows redistribute sand to build sandbars (beaches)
- Following high flows, sand erodes from beaches





- At least about 1400 eddies that may contain large sandbars between Lees Ferry and Diamond Creek (based on inspection of air photos}

Review of Problem: Sediment budget affected by disruption of sand supply and change in flow regime



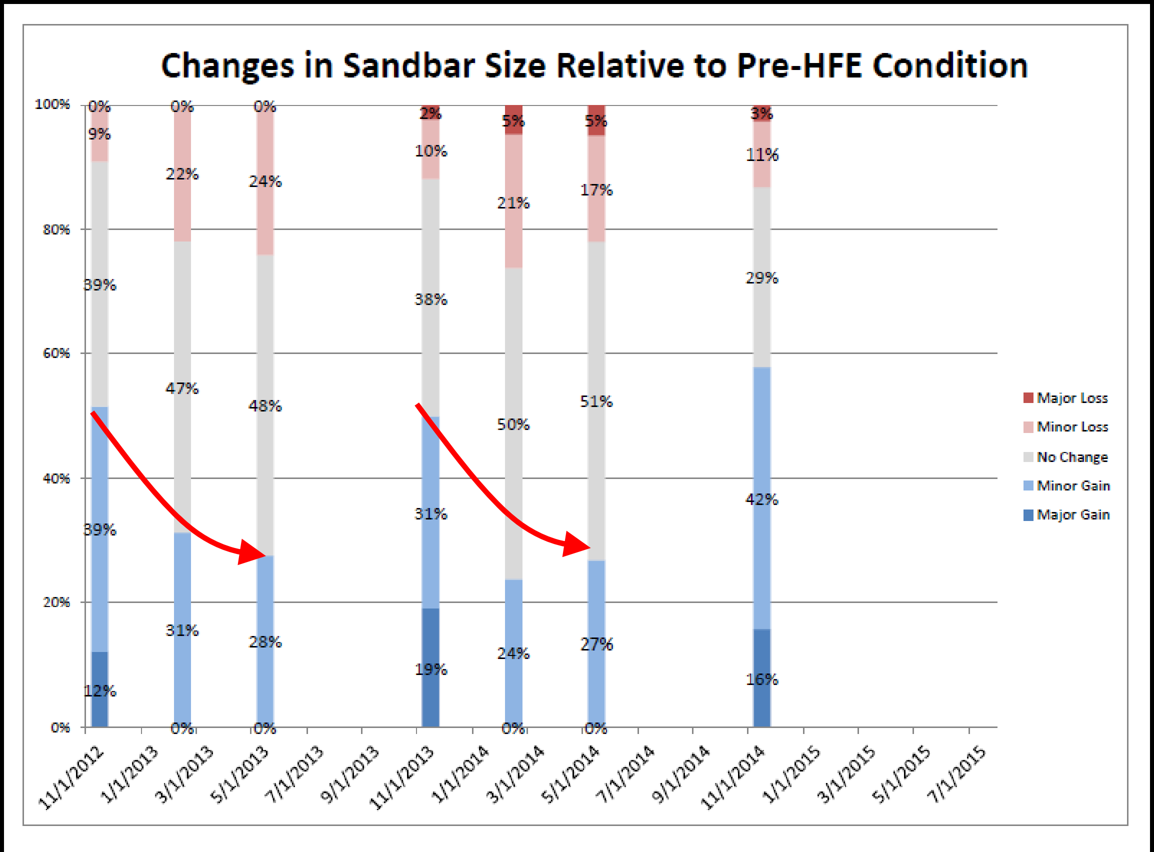
Sandbars During HFE Protocol: 2012 - 2014

Photos at www.gcmrc.gov/sandbar/

- 2014 HFE
  - 22 sites (58%) larger
  - 11 sites (29%) no change
  - 5 sites (13%) smaller

Preliminary results, subject to review and revision – do not cite

Sandbars During HFE Protocol: 2012 - 2014



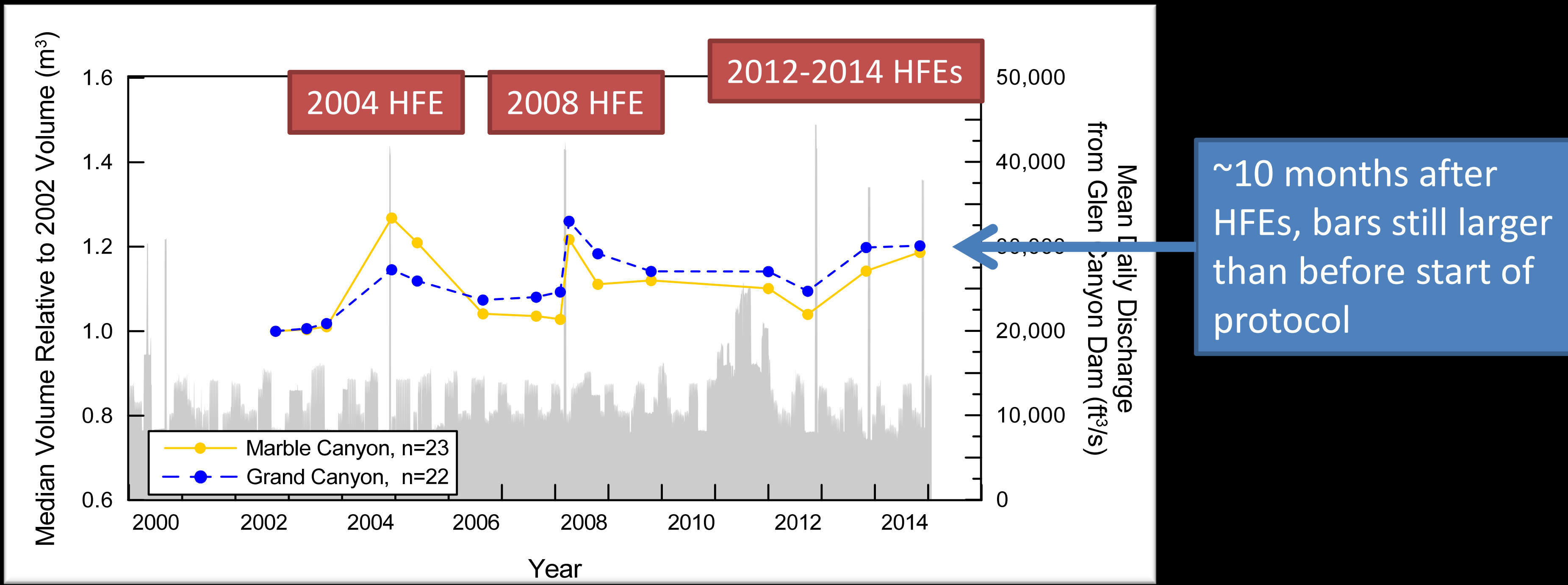
2012 HFE 2013 HFE 2014 HFE

- Each of the HFEs in the past 3 years has resulted in sandbar deposition
  - They continue to erode in following 6 to 12 months

Photos at www.gcmrc.gov/sandbar/

Preliminary results, subject to review and revision – do not cite

Sandbars: 2002-present

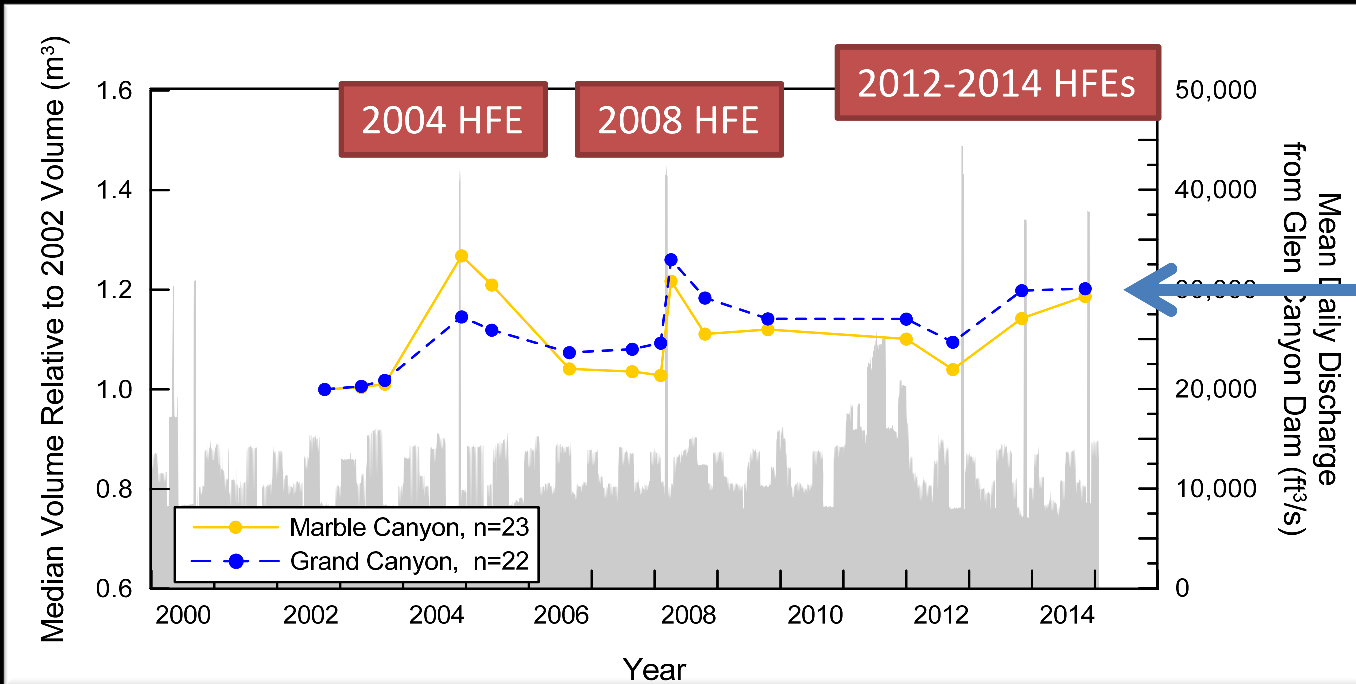


- Increase in volume in both Marble Canyon and Grand Canyon at long-term monitoring sites
  - Deposition by HFEs
  - Bars erode following HFEs, but not quite to pre-flood size
- Frequent HFEs = consistently larger bars
- Cumulative effect? No evidence yet that bars will get progressively larger.
- 2013 and 2014 HFEs were smaller than 2012 and earlier.
- www.gcmrc.gov/sandbar/

USGS

Preliminary results, subject to review and revision – do not cite

Sandbars: 2002-present



~10 months after HFEs, bars still larger than before start of protocol

Next Monitoring Trip is September 24 – October 9

- Photos from remote cameras analyzed and available by October 16.
- Data from surveys in January 2016.
- If fall 2015 HFE occurs, photos and analysis in January 2016.

USGS

- www.gcmrc.gov/sandbar/

Preliminary results, subject to review and revision – do not cite

Timing of sandbar data collection

- Currently conducted every September/October
- Suggestion to consider collecting data in spring to have data available for late summer (now)
- Pros:
  - Provide more quantitative information prior to implementing next high flow
- Cons:
  - Change in methods: Bar size depends on time since HFE. So measurements made in spring not directly comparable to measurements made in fall.
  - The 1 to 6 month period after high flows is period of greatest erosion, thus bar size most variable. By 9 months, erosion rates slow and bar size more stable.
- Plan
  - Keep discussing in context of developing monitoring plan for LTEMP
  - Leaning towards sticking with current protocol, because we think the annual measure of bars at the "minimum" size is most consistent for long-term monitoring
  - Increasing emphasis on obtaining more quantitative measures of bar size from remote cameras so that we can provide better information throughout year.

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Sand mass balance (budget) is computed for 6 reaches between Lees Ferry and Lake Mead

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)

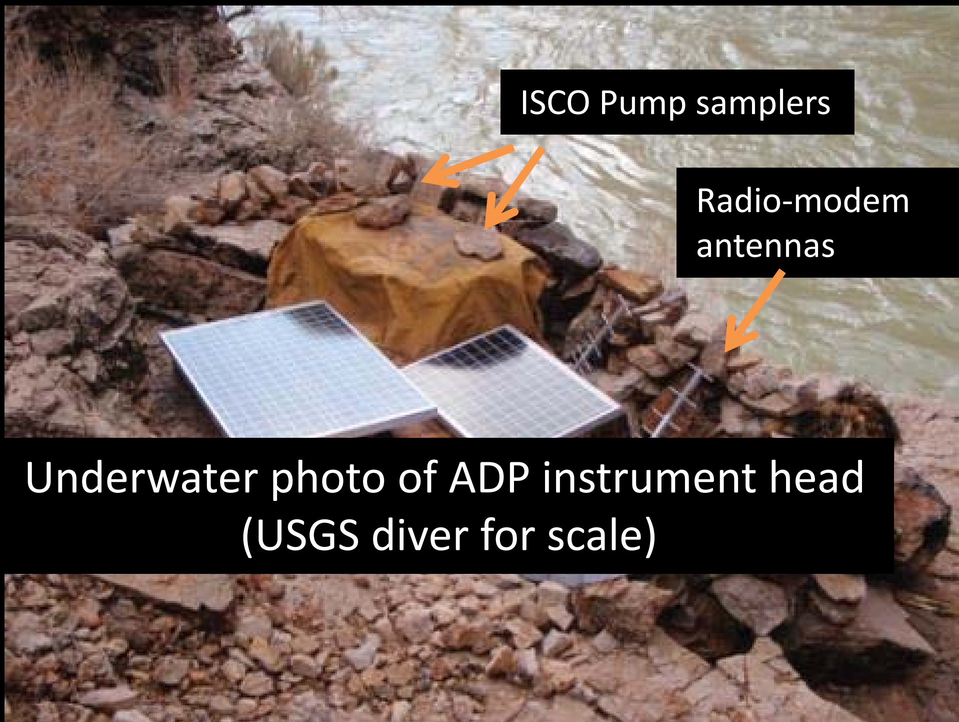
Anyone can compute the sand mass balance:

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

USGS

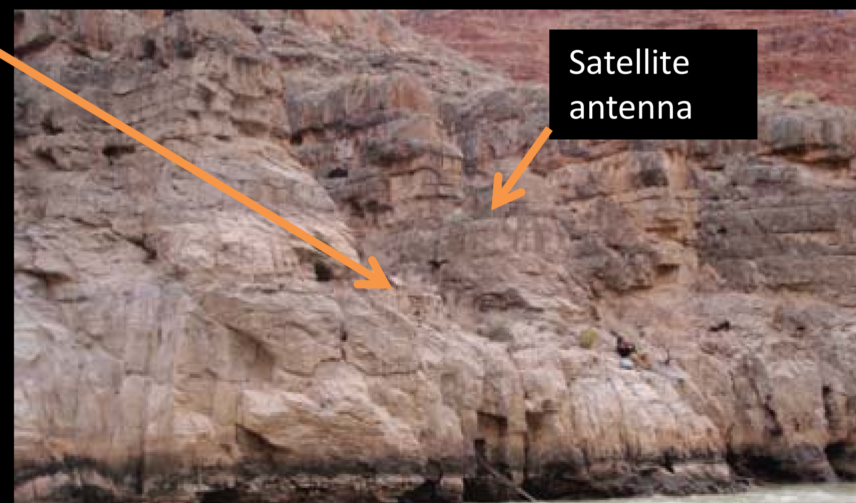
Sampling suspended-sediment

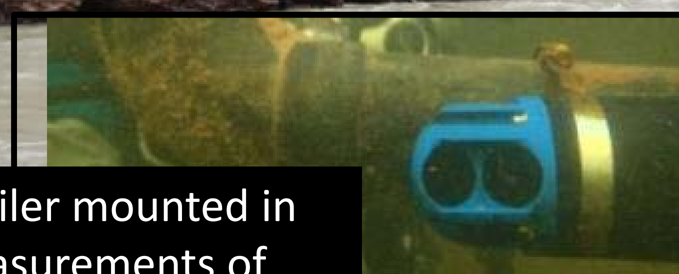
Instrumentation and site appearance at the River Mile 30 sediment-transport gage.



Configuration of instruments. The rock wall behind the instruments is used to camouflage the station.

Site appearance from river level. View is downstream. Site is concealed behind the rock wall.





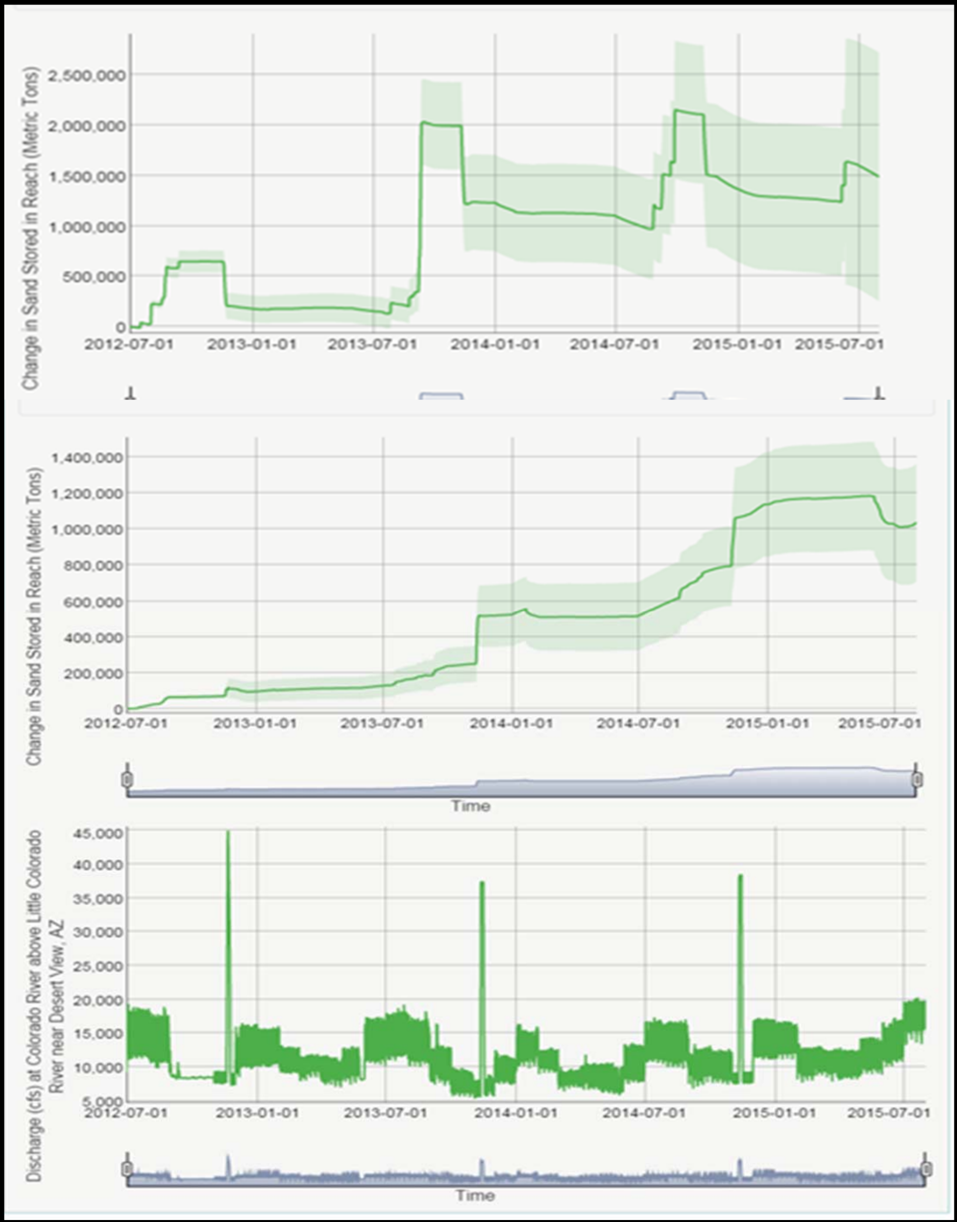
Underwater photo of ADP instrument head (USGS diver for scale)

Acoustic Doppler profiler mounted in water for 15-min. measurements of sediment concentration

Three years: three floods

- The first 3 years of the flood protocol has consisted of large sand inputs and relatively low dam releases
- Floods built sandbars AND sand accumulated in the channel

Sand budgets July 2012 to Aug 2015



Preliminary results, do not cite

USGS

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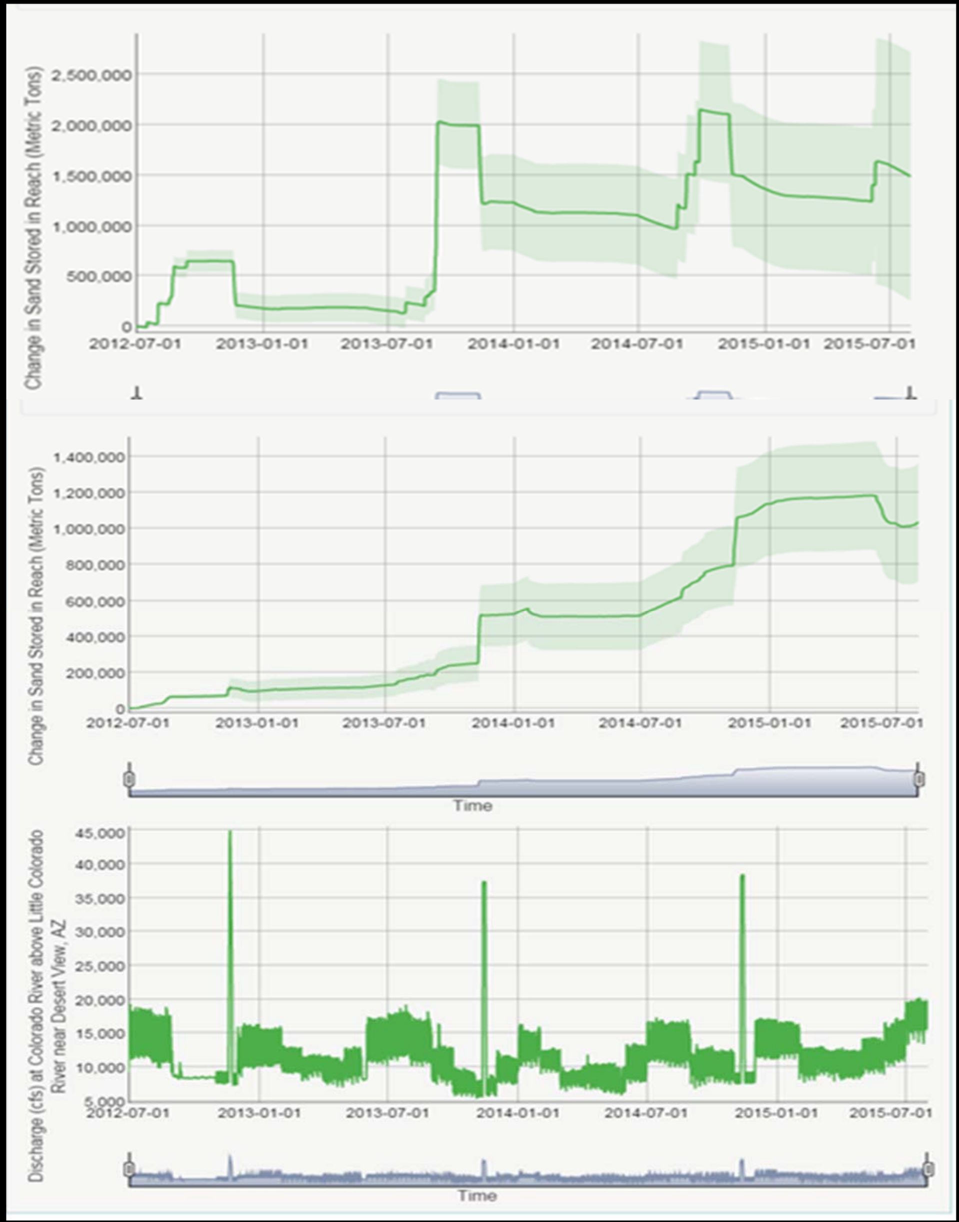

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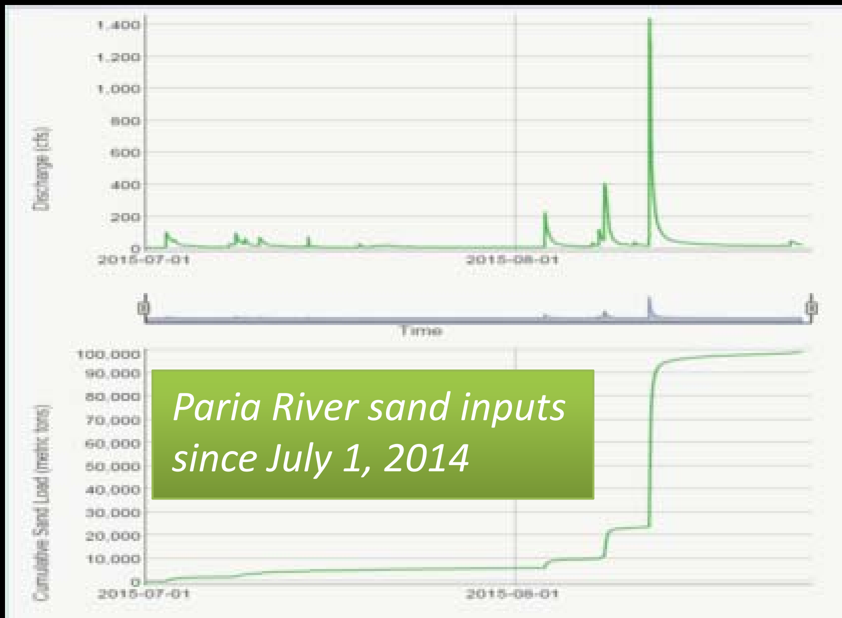
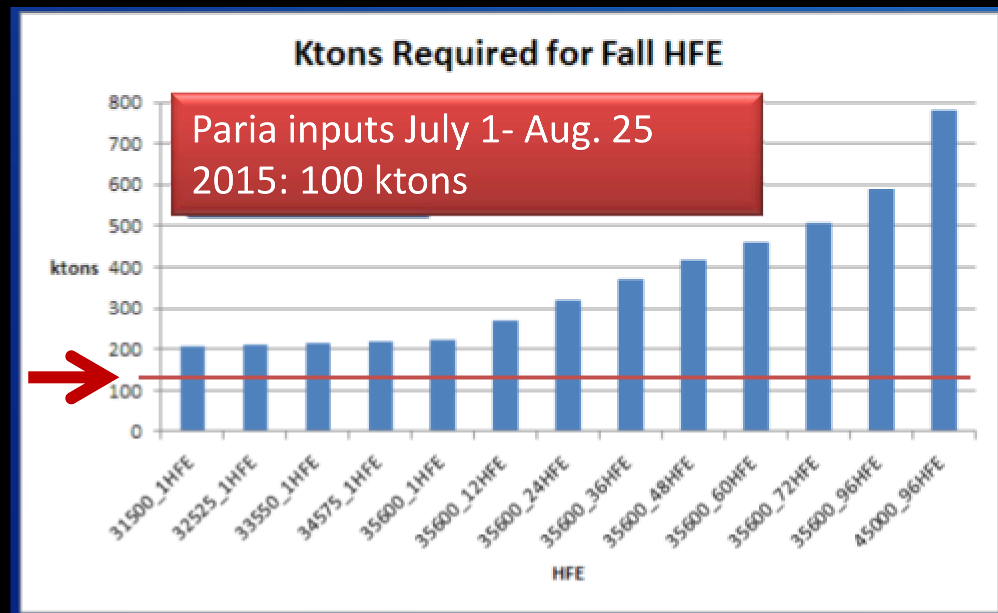
USGS





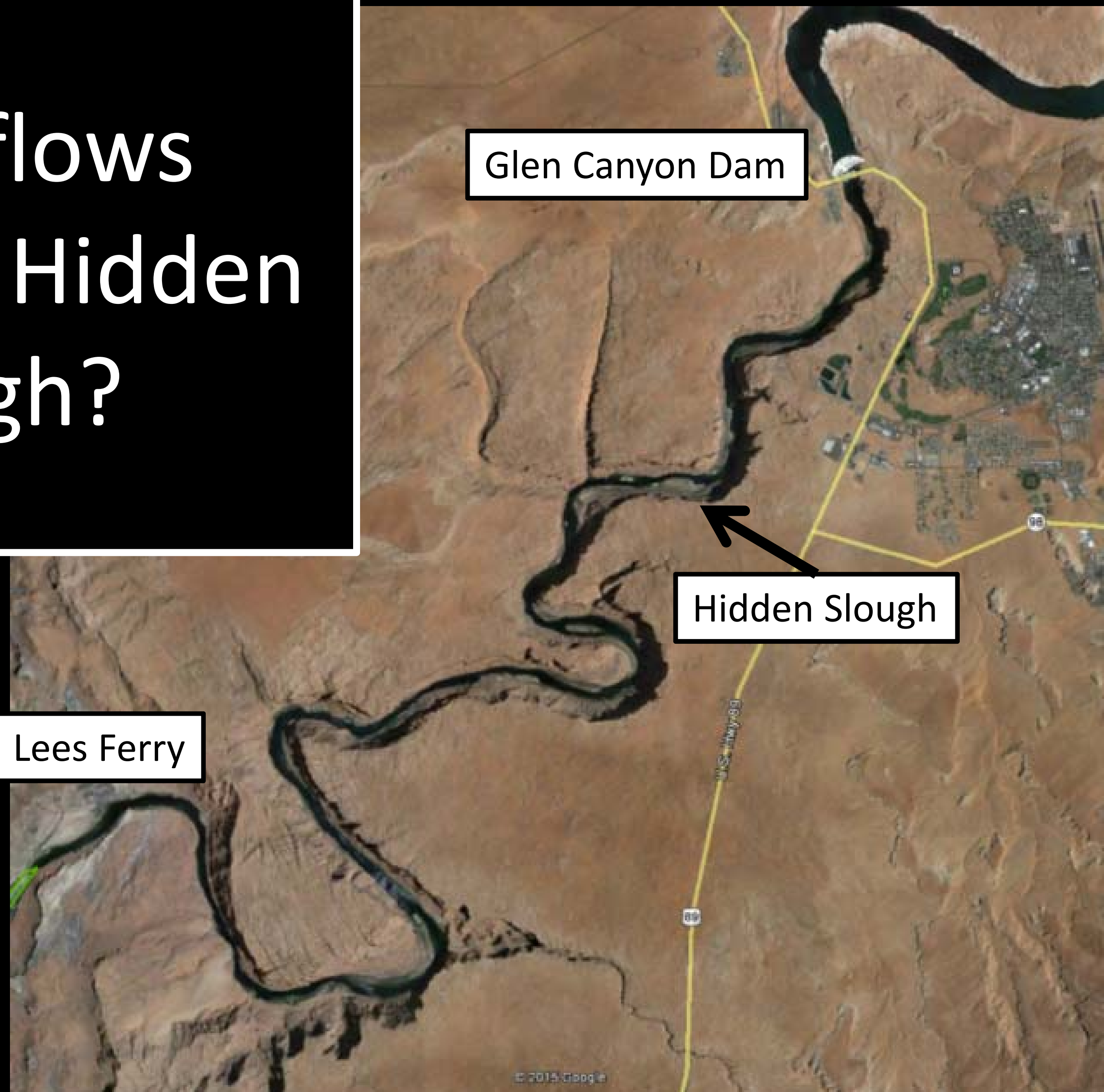
Inputs between July 1 and August 25, 2015 insufficient to trigger fall 2015 HFE

Estimated amount of sand needed to trigger HFE following HFE protocol (Nick Williams, Bureau of Reclamation)

Preliminary results, do not cite

USGS

What flows inundate Hidden Slough?



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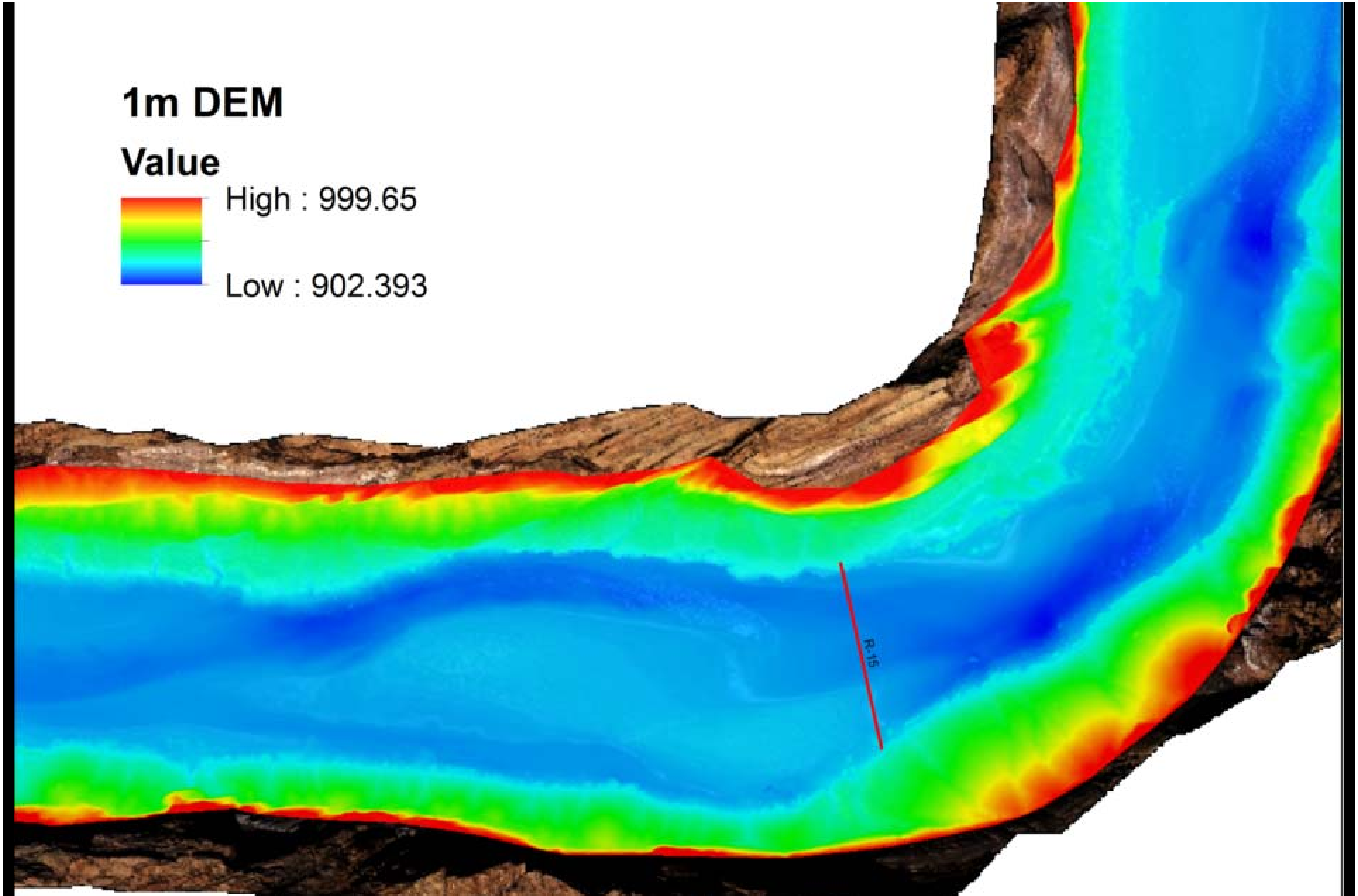
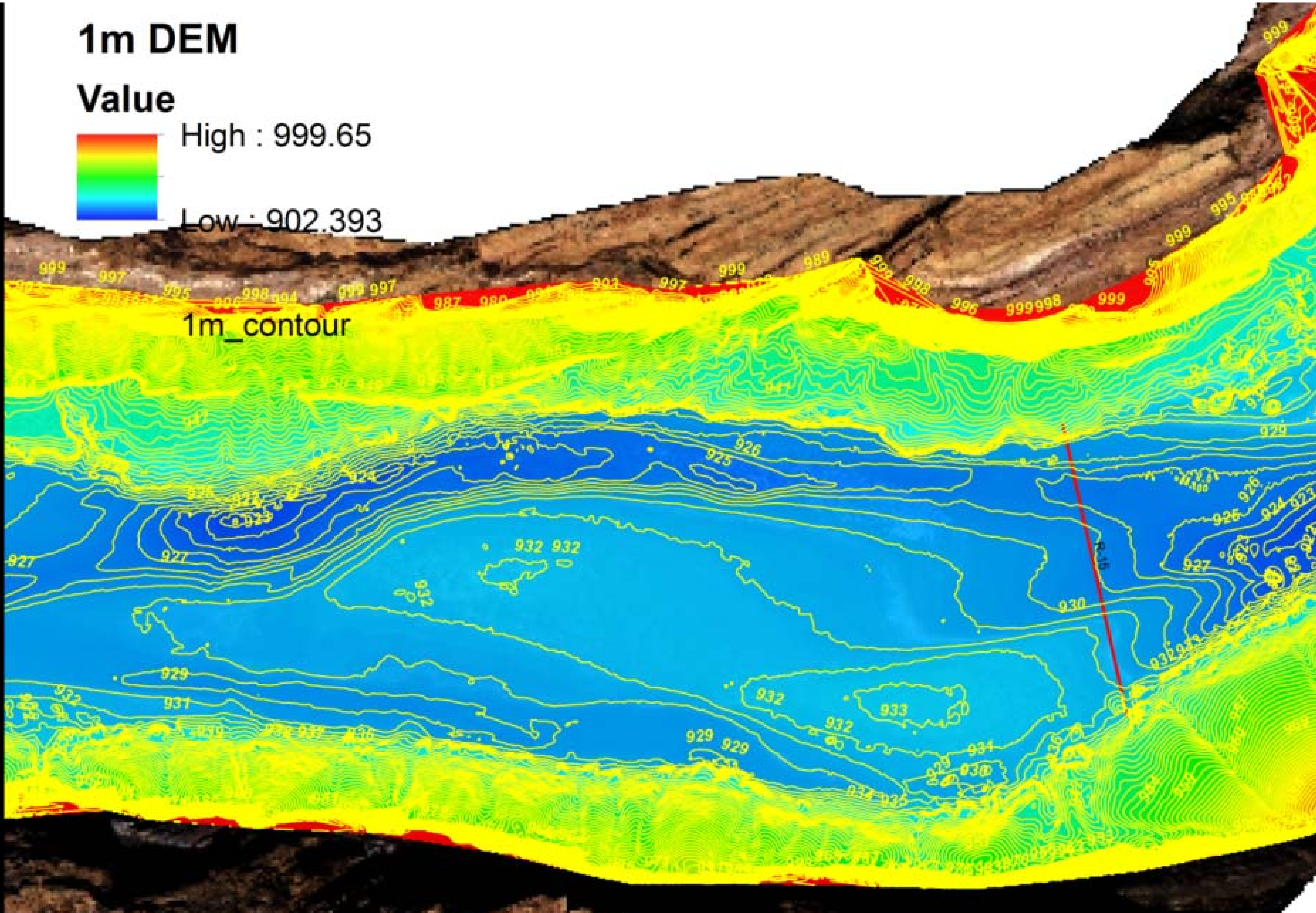
Hidden Slough

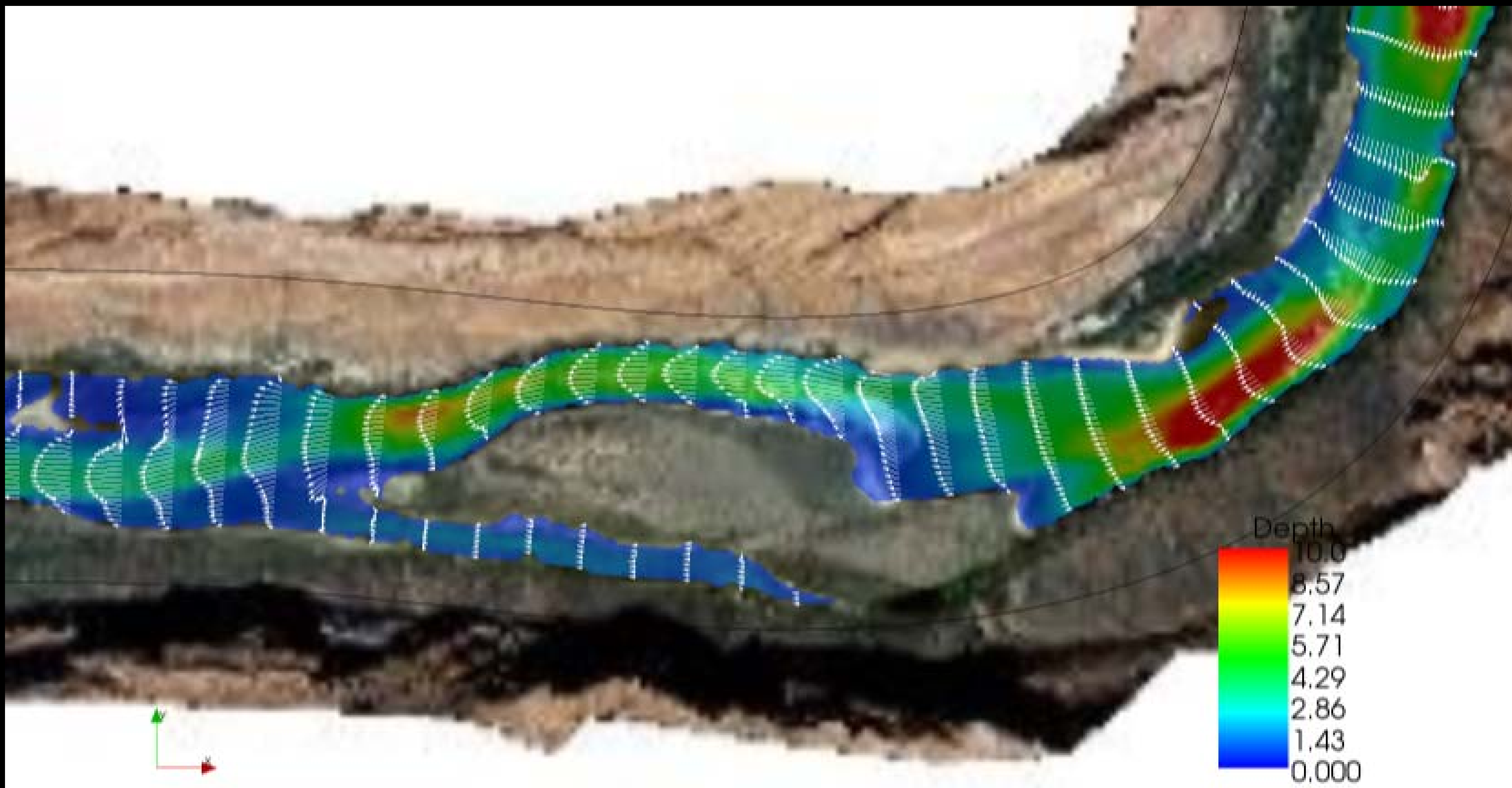


Bathymetric data collected Fall 2014, courtesy Matt Kaplinski
Topographic data collected May 2009 (Preliminary results, do not cite)



Bathymetric data collected Fall 2014, courtesy Matt Kaplinski
Topographic data collected May 2009 (Preliminary results, do not cite)

10,000 cfs

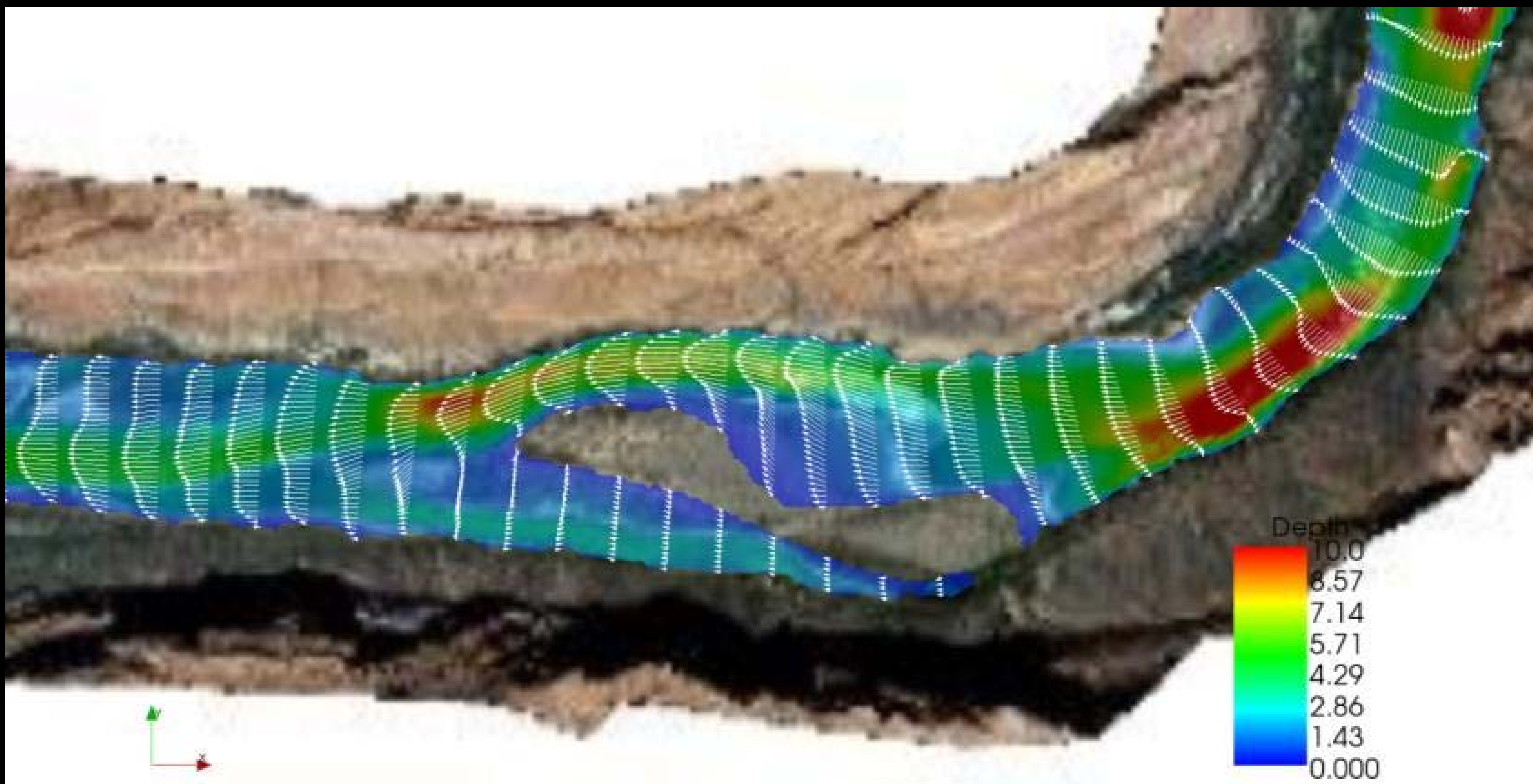


Two-dimensional streamflow model predicted water surface extent and flow depths. Model based on Fall 2014 bathymetry. Courtesy Scott Wright.

Preliminary results, do not cite

USGS

20,000 cfs

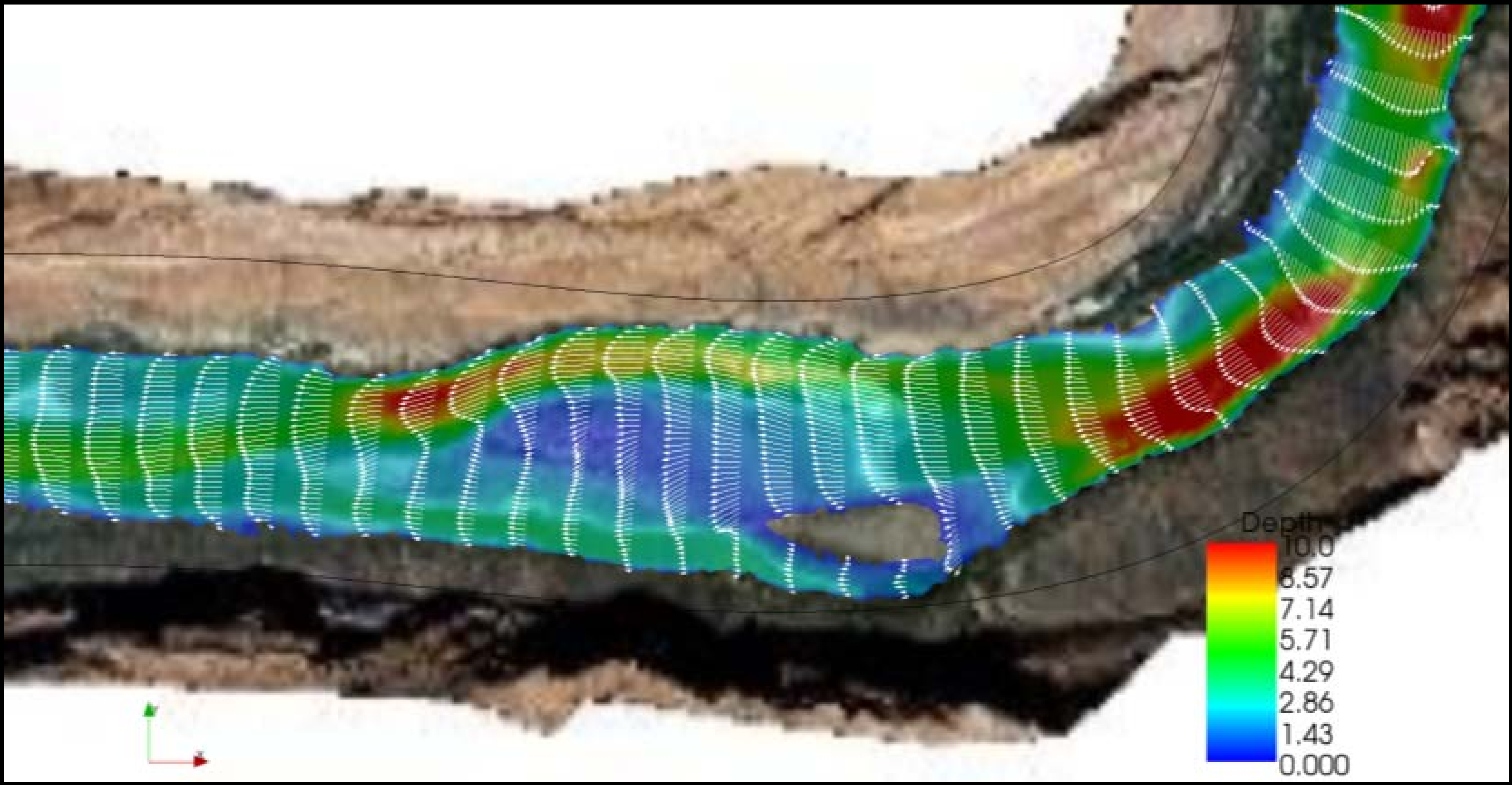


Two-dimensional streamflow model predicted water surface extent and flow depths. Model based on Fall 2014 bathymetry. Courtesy Scott Wright.

Preliminary results, do not cite

USGS

30,000 cfs



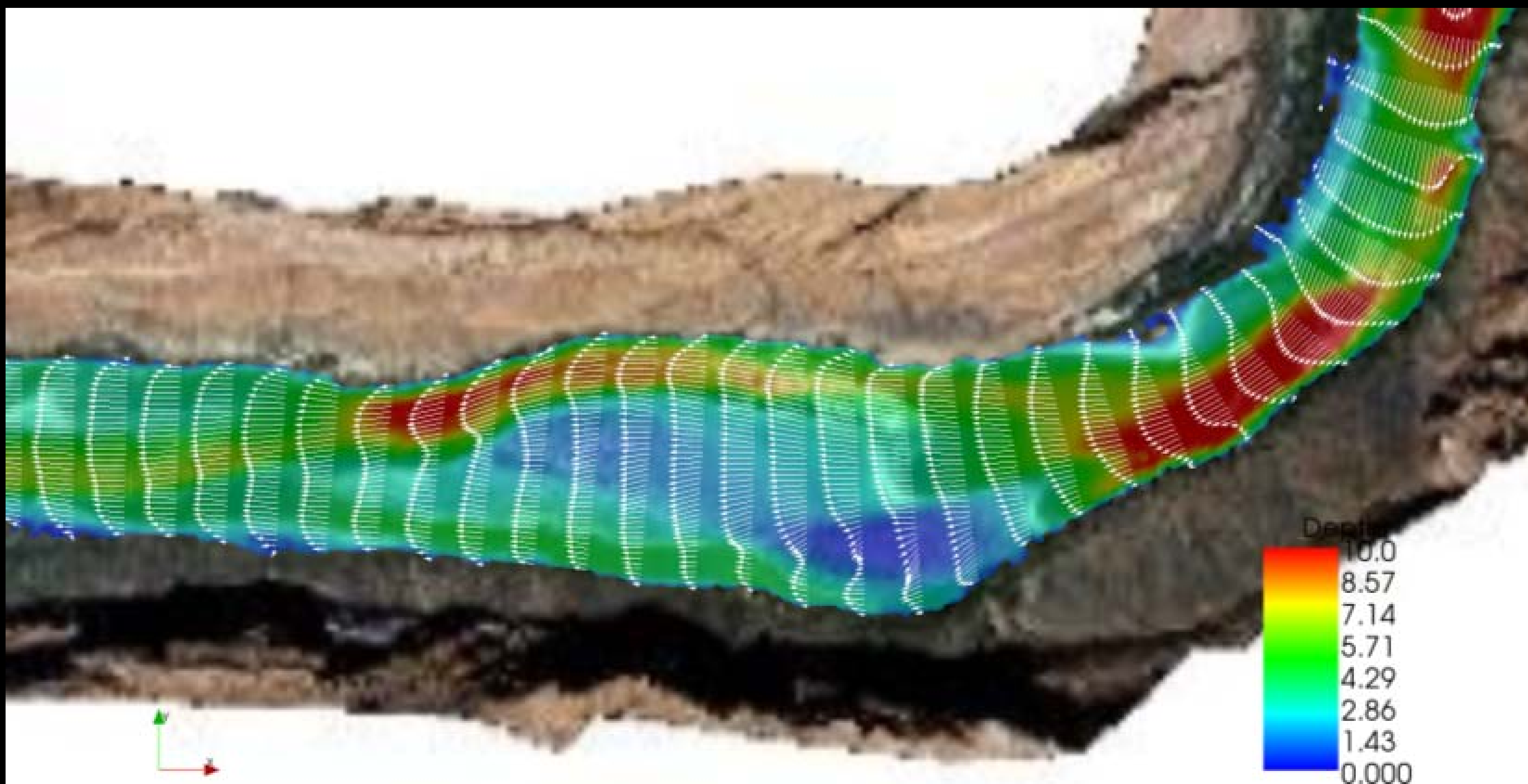
Two-dimensional streamflow model predicted water surface extent and flow depths. Model based on Fall 2014 bathymetry. Courtesy Scott Wright.

Flow through Hidden Slough between 20,000 and 30,000 cfs

Preliminary results, do not cite

USGS

40,000 cfs



Two-dimensional streamflow model predicted water surface extent and flow depths. Model based on Fall 2014 bathymetry. Courtesy Scott Wright.

Island overtopped by 40,000 cfs

USGS

Preliminary results, do not cite