Returning Rapids Project

Fall Trip Findings

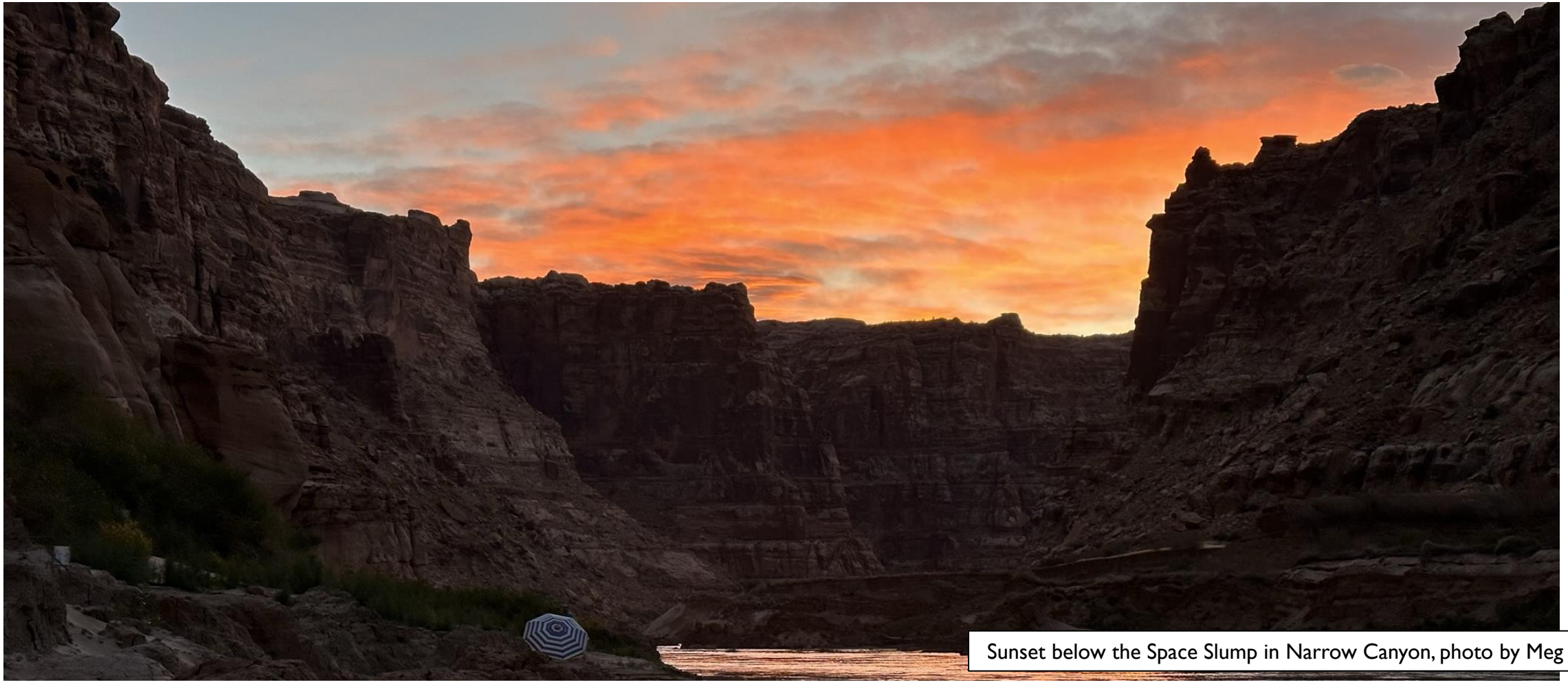
September and October 2023

All photos by Travis Custer

2023 was a very dynamic year for Cataract Canyon. In September and October, the Returning Rapids Project (RRP) completed three Cataract Canyon research trips and one North Wash-based survey effort. This year, RRP has continued to monitor changes, build a data set, and communicate the story of what we are observing along this section of the Colorado River.

The Colorado and Green River basin snowpack and resulting high runoff in lower Cataract Canyon scoured the river corridor at a rate researchers have not seen before. This led to one of the area's largest single sediment slumping incidents ever recorded. Through the lower canyon, where the river is eroding the reservoir-caused delta, the river further incised into its sediment bed. Data from survey methods confirm that this is the case.

The intent of this report is to catalog these changes.



Sunset below the Space Slump in Narrow Canyon, photo by Meg Flynn

The Return of a Drowned Rapid

Gypsum Canyon

Photos from Gypsum Canyon area
stitched together
Bill Noonan Collection, early 1980s

Panorama of Gypsum Canyon
6,430 cubic feet per second (cfs),
bridge gauge 3,577 feet,
9-5-2023, Mike DeHoff

For years, RRP has observed the slow return of Gypsum Canyon Rapid. As the reservoir has receded, the river has scoured out the sediment. Slowly, more gradient and obstacles have appeared.

During the latter half of the summer of 2023 and into the fall, trips started to tell stories of swimmers in Gypsum Canyon Rapid and of boats getting thumped by a new hole near the end of the returning rapid.

Gypsum Canyon Rapid, zoomed in, Mike DeHoff

Gypsum Canyon Rapid

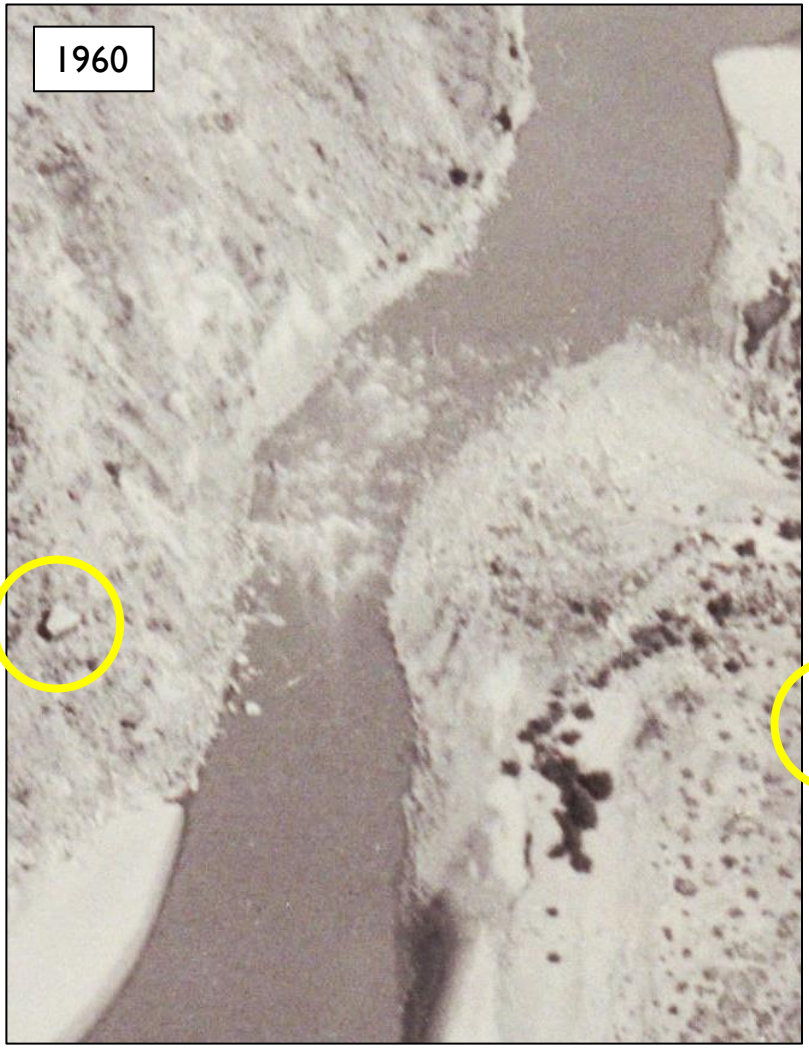
Is it almost back?

The high water and extended runoff from the winter's snowpack scoured out Gypsum Canyon Rapid.

Five years of repeat photos and ongoing review of pre-reservoir images show that Gypsum Rapid is much closer to being the whole way back.

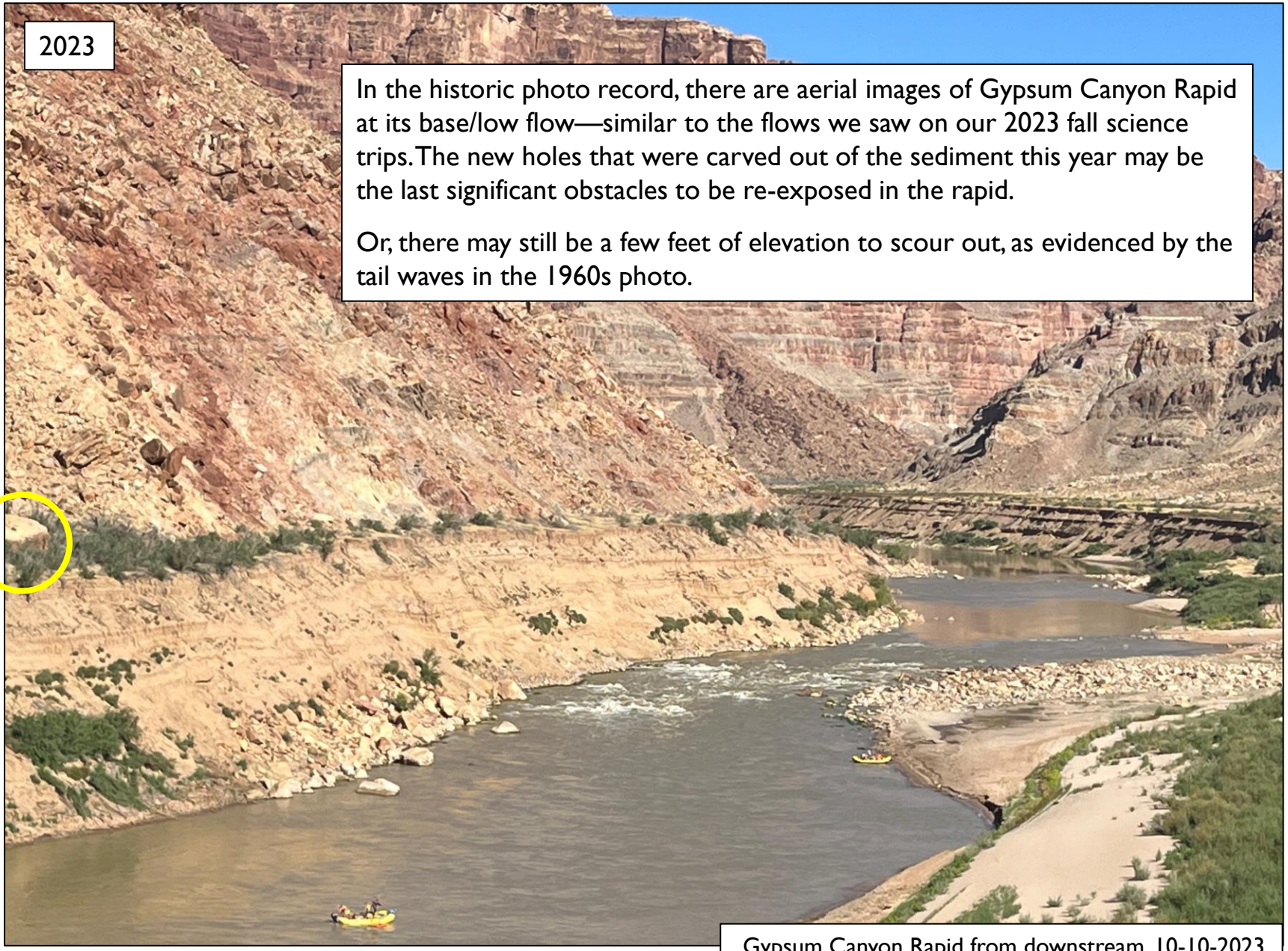
Gypsum Canyon Rapid, 7-23-2022, 4,300 cfs, Meg Flynn/Mike DeHoff

Gypsum Canyon Rapid, 10-9-2023, 6,400 cfs, Peter Lefebvre



Mile 196.1 to 197.2. Gypsum Canyon at Mile 196.6 enters from right side of photo.
P.T. Riley 9-4-1960, approximately 2,500 cfs.

Cropped_Doc Marston Collection_Huntington Library
https://hdl.huntington.org/digital/collection/p16003coll5/id/12385/rec/35



In the historic photo record, there are aerial images of Gypsum Canyon Rapid at its base/low flow—similar to the flows we saw on our 2023 fall science trips. The new holes that were carved out of the sediment this year may be the last significant obstacles to be re-exposed in the rapid.

Or, there may still be a few feet of elevation to scour out, as evidenced by the tail waves in the 1960s photo.

Gypsum Canyon Rapid from downstream, 10-10-2023, 6,400 cfs, Peter Lefebvre

Yellow circle is around "Bego's White Rock" as a reference point. Note other rocks along the river right shoreline.

Camera View Above Gypsum Canyon Rapid

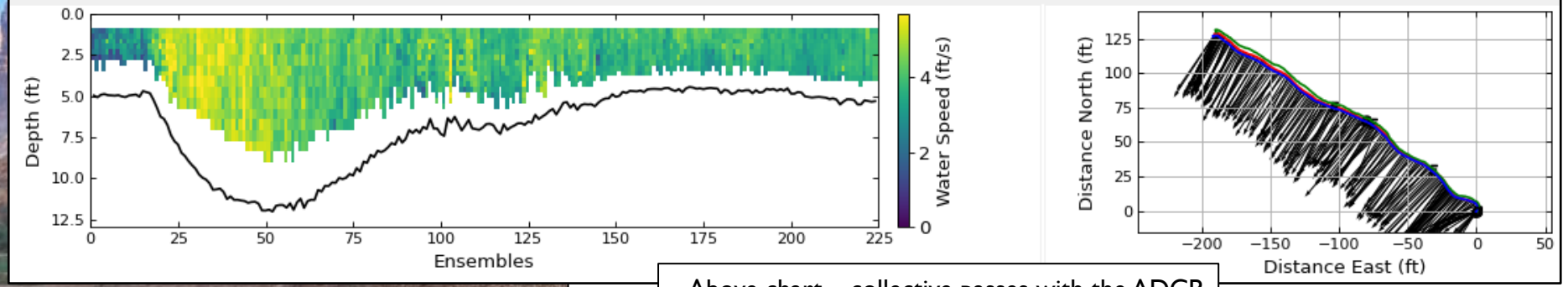
Gypsum Canyon camera view,
10-19-2022, 5,600 cfs, Peter Lefebvre

Gypsum Canyon camera view,
10-10-2023, 6,400 cfs, Peter Lefebvre

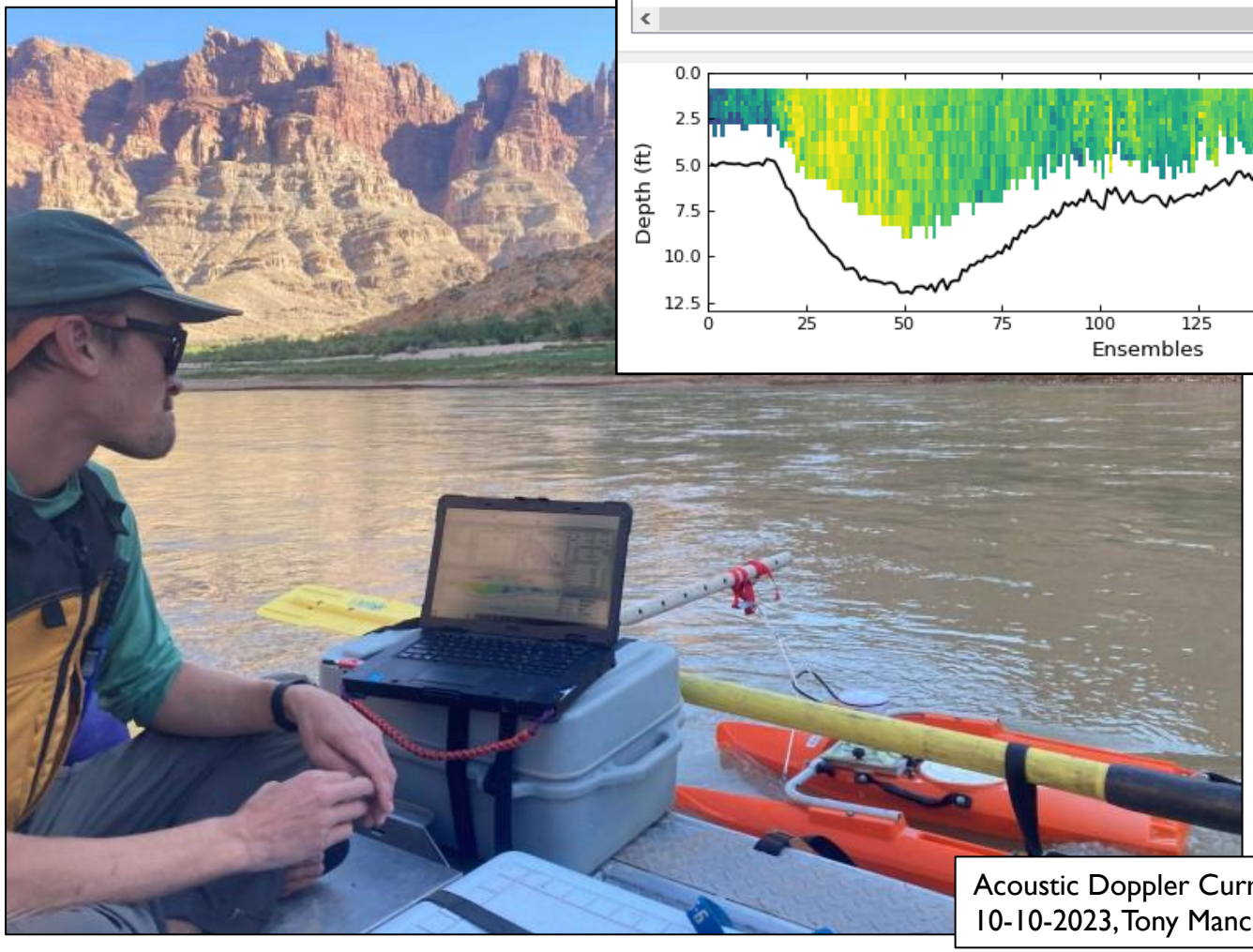
In addition to the new holes near the end of the rapid, note the new boulder on the river right bank that appeared in June/July 2023. Also, Gypsum Canyon's drainage flooded in August 2023 and scoured out the mouth.

Calibrating the New Gauge at Gypsum Canyon

Transect	Start	Bank	End	Duration (sec)	Total Q (ft3/s)	Top Q (ft3/s)	Meas Q (ft3/s)	Bottom Q (ft3/s)	Left Q (ft3/s)	Right Q (ft3/s)
Measurement (2023.10.10)	**10:37:16**		**10:51:12**	**811.1**	**6398.828**	**848.577**	**3906.856**	**1514.353**	**26.651**	**102.392**
093289600_20231010_000_23-10-10_103632	10:37:16	L	10:40:49	212.8	6459.056	870.500	3942.172	1516.925	24.589	104.870
093289600_20231010_001_23-10-10_104051	10:41:00	R	10:44:06	186.1	6406.291	833.578	3910.435	1530.098	26.103	106.077
093289600_20231010_002_23-10-10_104409	10:44:15	L	10:47:58	223.2	6318.241	850.174	3839.202	1505.852	21.332	101.681
093289600_20231010_003_23-10-10_104801	10:48:03	R	10:51:12	189.0	6411.724	840.055	3935.613	1504.537	34.579	96.940



Above chart – collective passes with the ADCP and river cross section, Troy Langworthy



Acoustic Doppler Current Profiler (ADCP) work to get a discharge reading. 10-10-2023, Tony Mancuso

U.S. Geological Survey (USGS) Utah Water Science Center staff have been working on the new gauge just upstream of Gypsum Canyon. This is part of an ongoing effort to calibrate the new gauge. On two of RRP's fall science trips, a discharge reading was taken just below Gypsum Canyon's rapid. This correlates gauge height with an actual cfs flow reading.

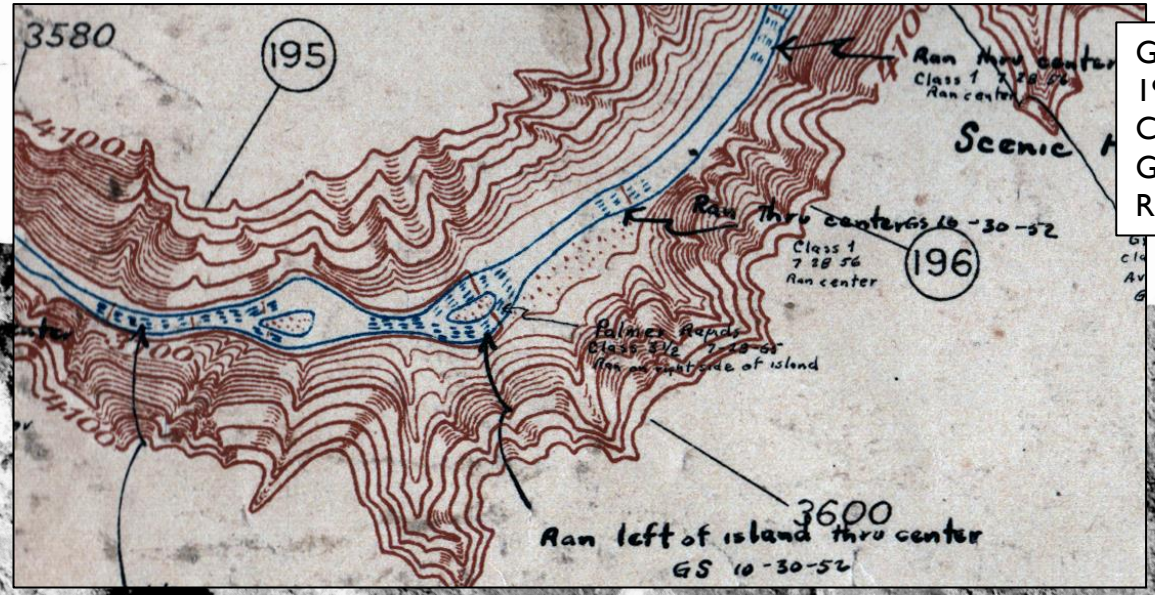
The new gauge is live and sending out real-time data:
USGS Colorado River at Gypsum Canyon near Hite

The Carving Zone is Moving Downstream of Gypsum – What to Expect

A repeat multi-beam sonar survey conducted in September 2023 revealed that more rocks in the river bed channel were exposed during the high water. Comparative imagery is not yet ready for circulation.

One exciting discovery during the survey was a rocky channel on river right near the mouth of Palmer Canyon. We suspect it was the river-right side of the island that was at the mouth of Palmer Canyon.

We will add comparative images when they are released.



George Simmons map with 1952 and 1956 notes. Cropped for detail from Gypsum to Palmer Canyon Rapids.

Gypsum Canyon Rapid

Palmer Canyon Rapid and Island

FLOW

1952 USGS overflight photo cropped for Gypsum Canyon Rapid to Palmer Canyon detail.

The White Jump in Clearwater Canyon

Sasha Reed stepping up the White Jump in Clearwater Canyon.
10-21-2021, Francisco Kjolseth

Note how much further down and into the sediment the wash has cut on looker's right.

The White Jump in Clearwater Canyon.
Meg Flynn doing her best "Sasha Reed step up." Coaching by Brenda Bowen.
10-10-2023, Mike DeHoff

The White Jump in Clearwater Canyon

Recognizable features and carving progress

PO789n01_06_014 Clearwater First jump AR Belknap 4_63
1963, Cropped and enhanced,
University of Utah J. Willard Marriot Library

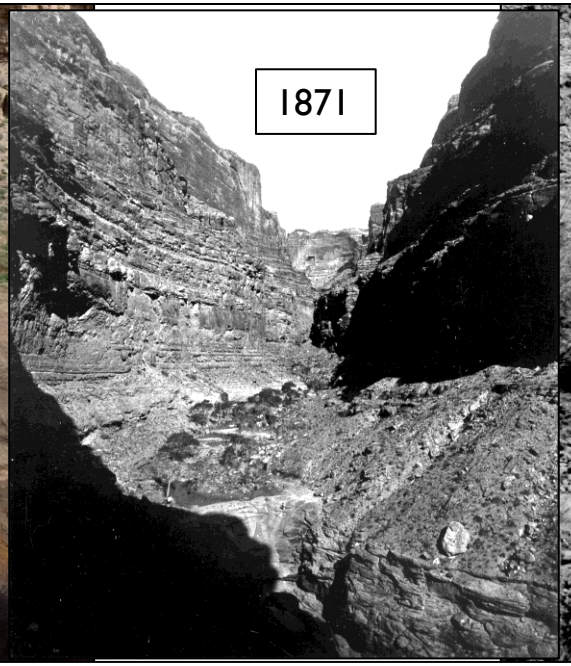
On the sediment looking down on the White Jump,
Clearwater Canyon, 10-10-2023, Meg Flynn

The White Jump in Clearwater Canyon

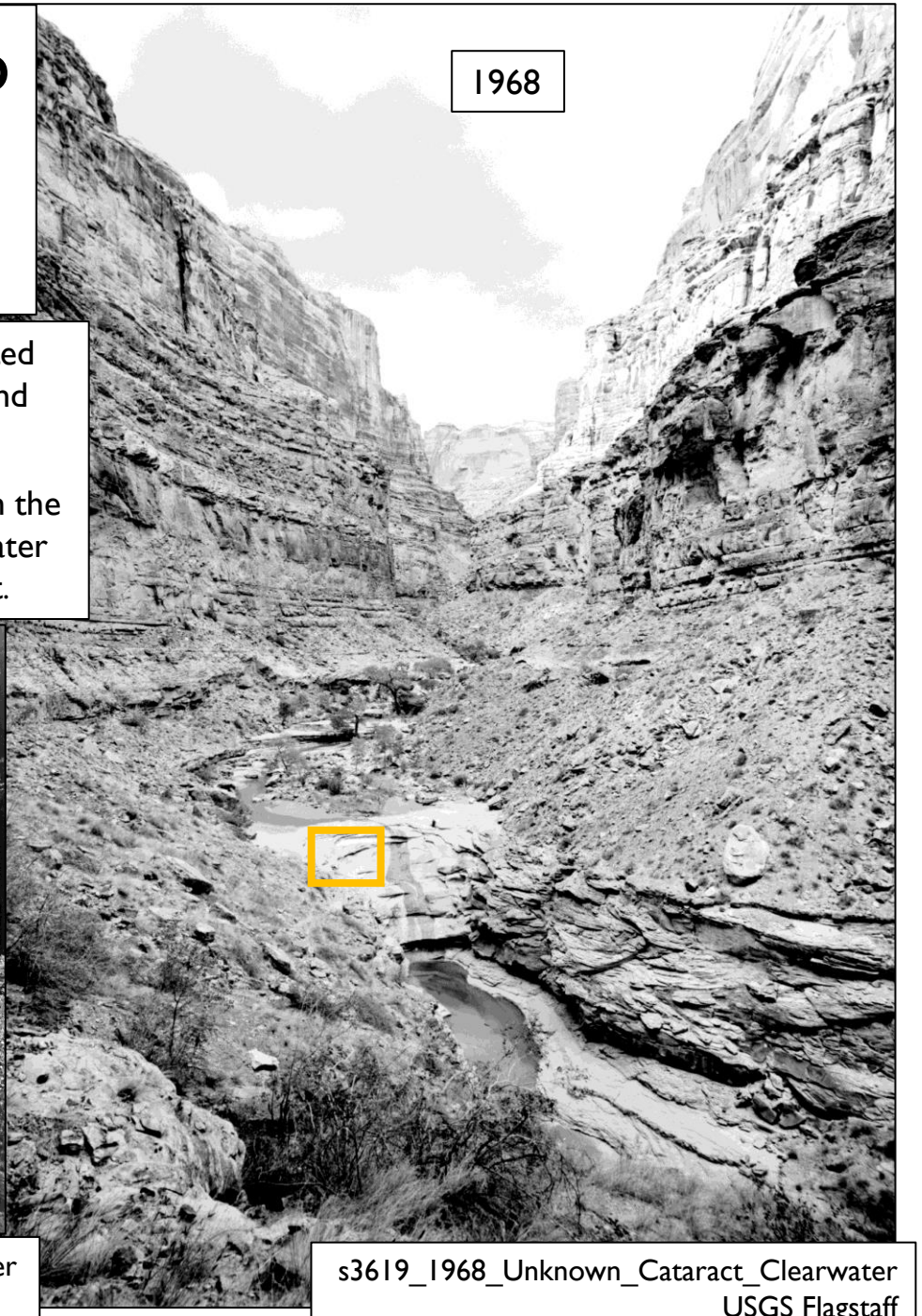
This series of repeat photography started with E.O. Beaman in 1871 on the second Powell expedition.

When the reservoir started fluctuating in the late 1990s, the sediment flats in Clearwater were exposed but not yet carved out.

s3619_1998c_Oldershaw_Cataract_Clearwater
USGS Flagstaff



s3619_1871_Beaman_Cataract_Clearwater
USGS Flagstaff



s3619_1968_Unknown_Cataract_Clearwater
USGS Flagstaff

Continued Changes at the Mouth of Dark Canyon

Dark Canyon Mouth, Point 1 mouth horizontal,
5,600 cfs, bridge gauge 3,581 feet, 10-19-2022, Peter Lefebvre

Note the various-sized debris in the alluvial fan that was from a heavy monsoon cycle.

Dark Canyon Mouth, Point 1 mouth horizontal,
6,400 cfs, bridge gauge 3,577 feet, 10-10-2023, Peter Lefebvre

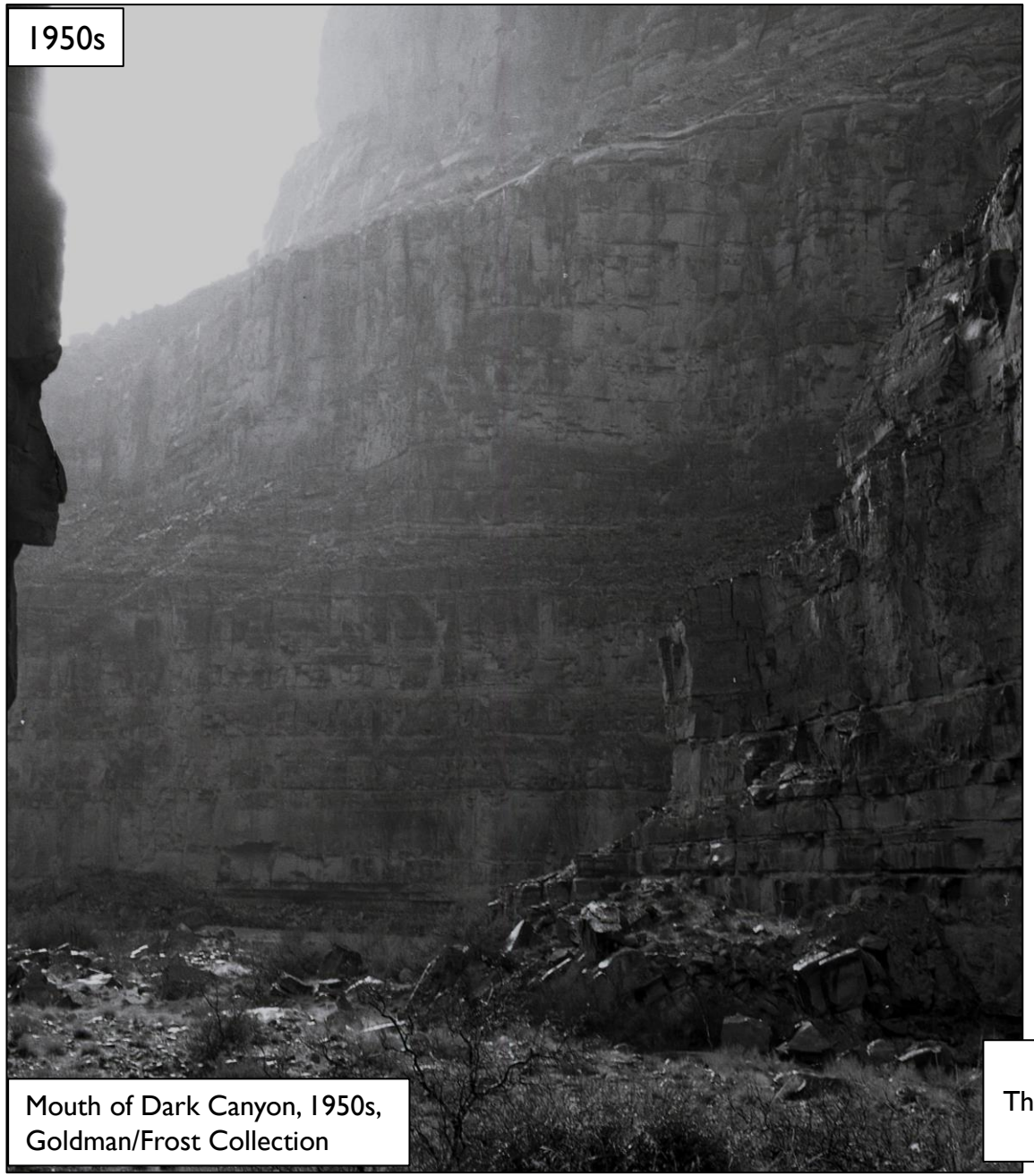
The eddy in the shade was up to 45 feet deep. All the outflow debris from the 2022 monsoon cycle was scoured away by the 2023 runoff.

Cobble Bar just Downstream of Dark Canyon

Downstream from Dark Canyon, Point 2, 5,600 cfs, bridge gauge 3,581 feet, 10-19-2022, Peter Lefebvre

Downstream from Dark Canyon, Point 2, 6,400 cfs, bridge gauge 3,577 feet, 10-10-2023, Peter Lefebvre

The river is lower in its bed at the bridge gauge. It also appears to be lower in the 2023 photo; more cobble bar is showing, but there is also 1,000 cfs more water in the river.



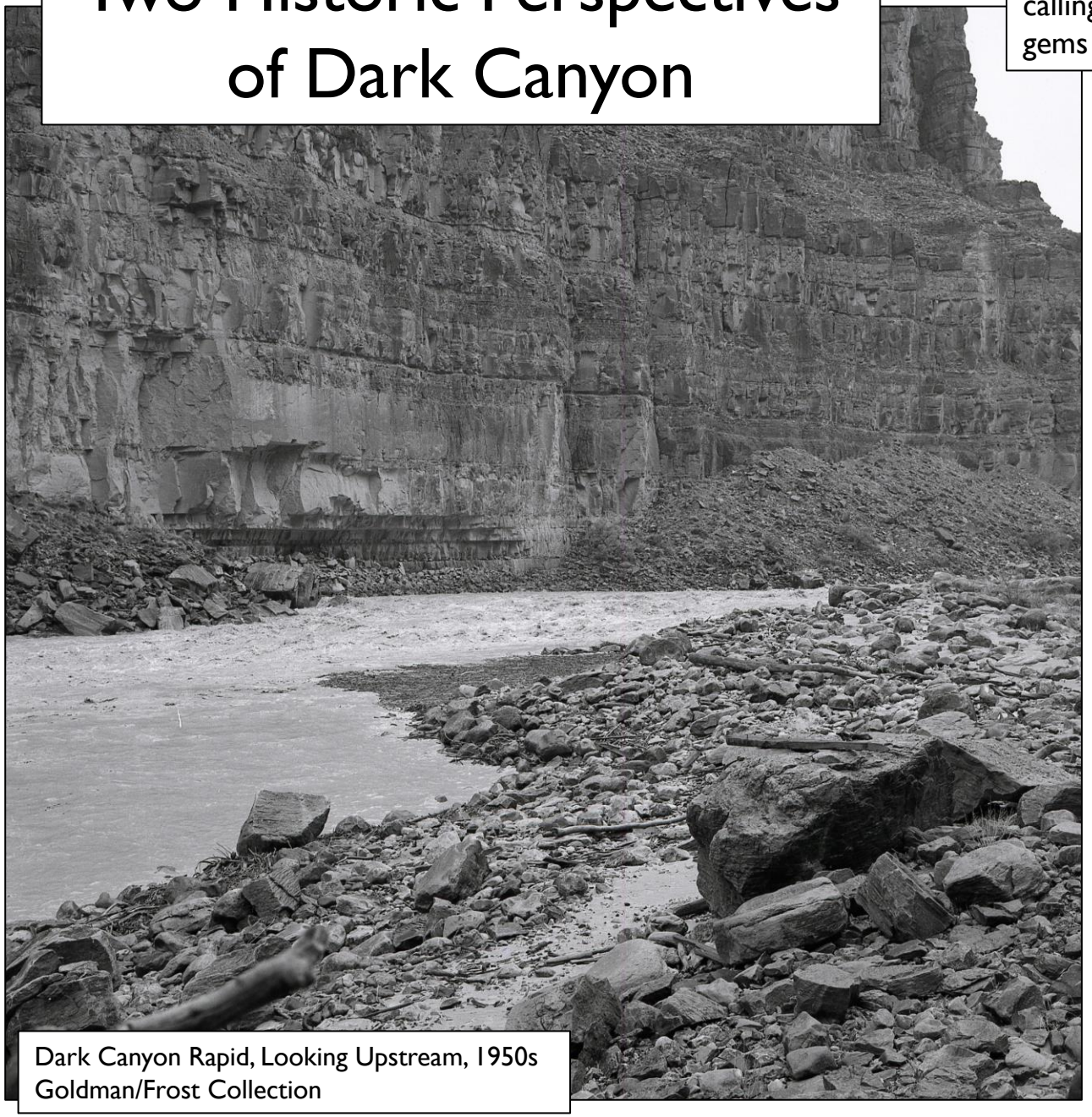
Mouth of Dark Canyon, 1950s, Goldman/Frost Collection

Looking to the River from Dark Canyon

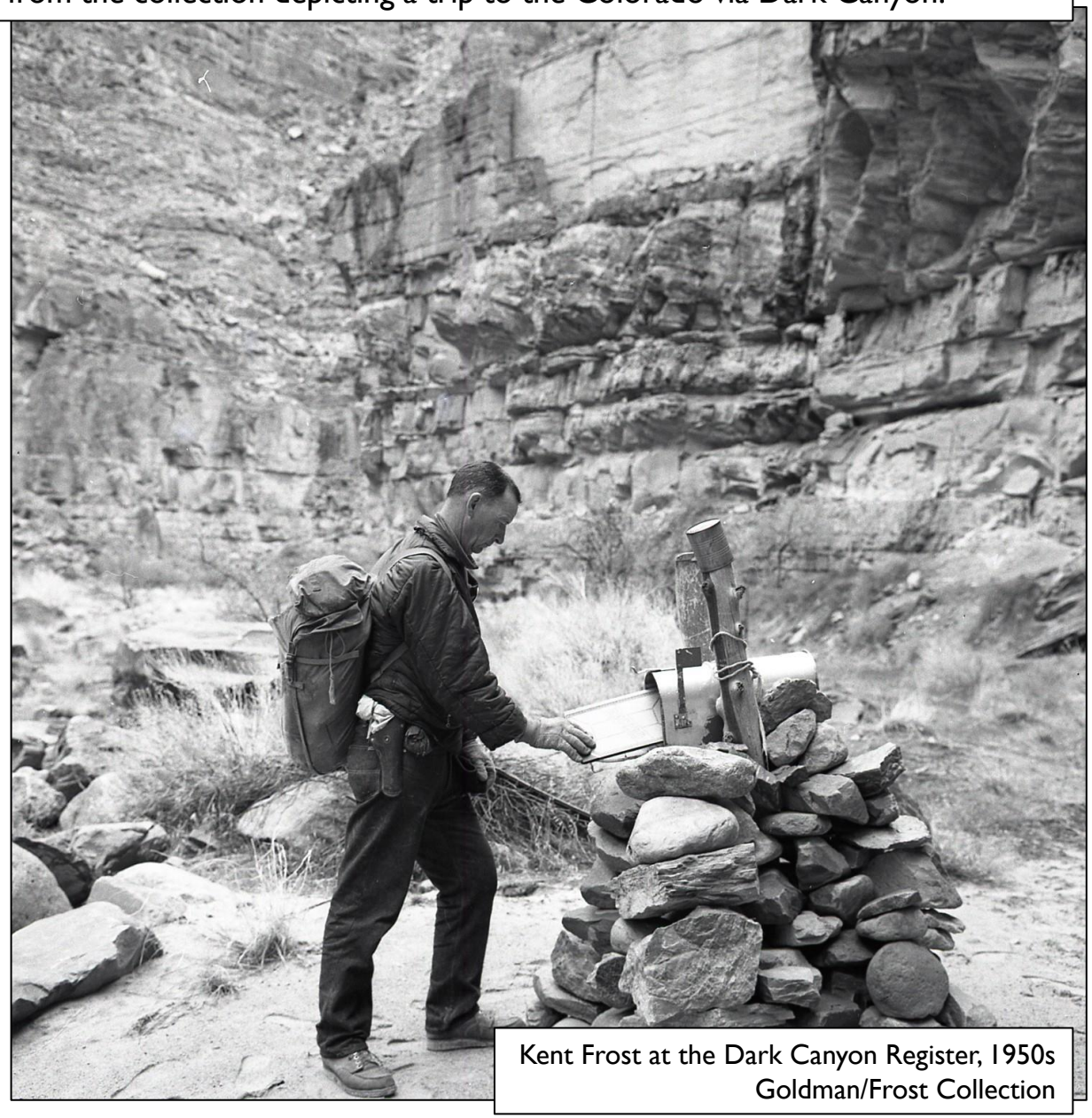
Photo match attempt of Goldman Frost Mouth of Dark Canyon photo, 10-10-2023, Mike DeHoff
The skyline could only be seen from on top of the Dominy bench approximately 150–200 feet higher than the 1950s photo location. This is also roughly 100 feet higher than the current wash mouth elevation.

Two Historic Perspectives of Dark Canyon

In the spring of 2022, we received three cardboard boxes of photos that we are calling the Melvin & Marjorie Goldman and Kent Frost collection. Here are a couple gems from the collection depicting a trip to the Colorado via Dark Canyon.



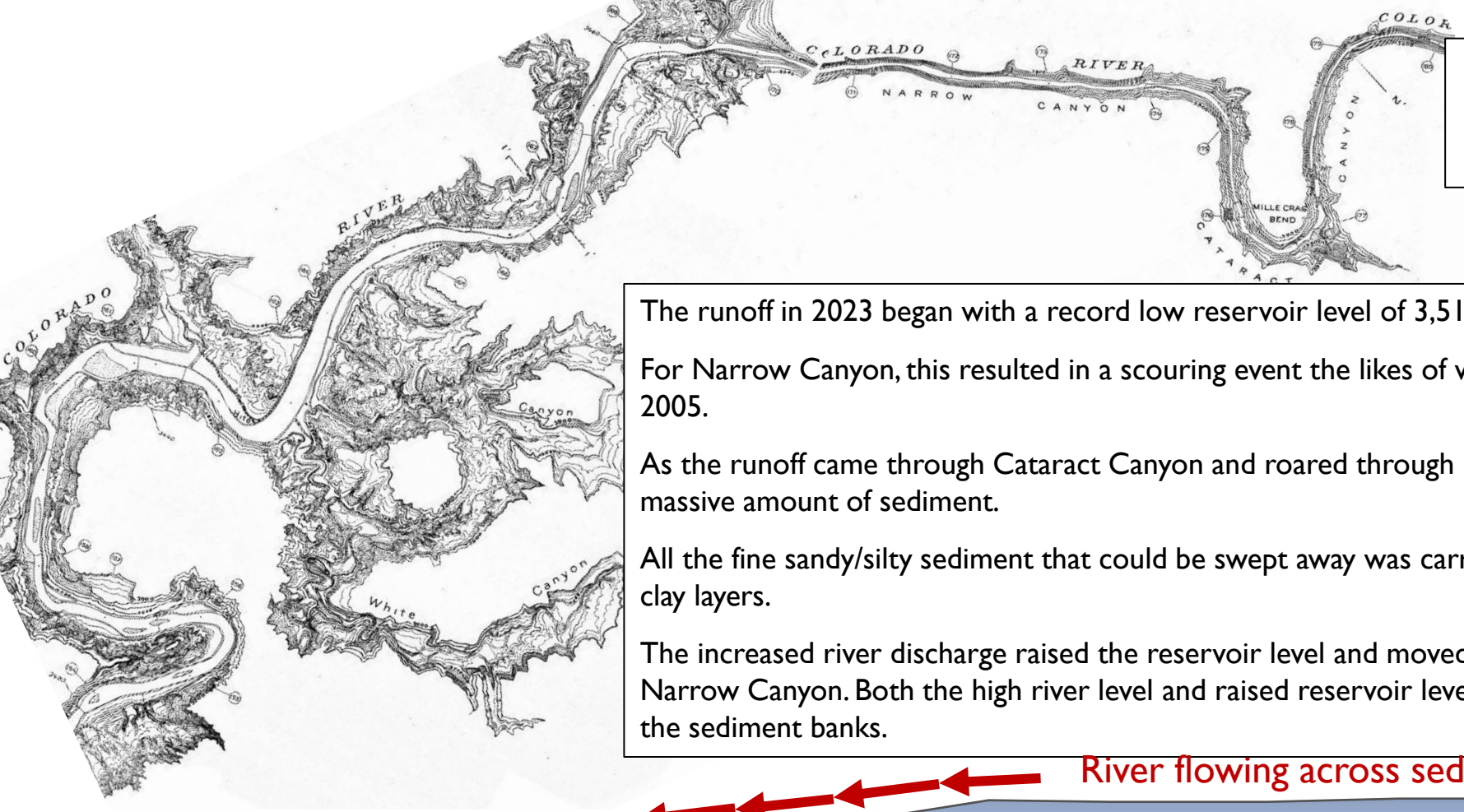
Dark Canyon Rapid, Looking Upstream, 1950s
Goldman/Frost Collection



Kent Frost at the Dark Canyon Register, 1950s
Goldman/Frost Collection

Narrow Canyon

Runoff Scour and Slumping



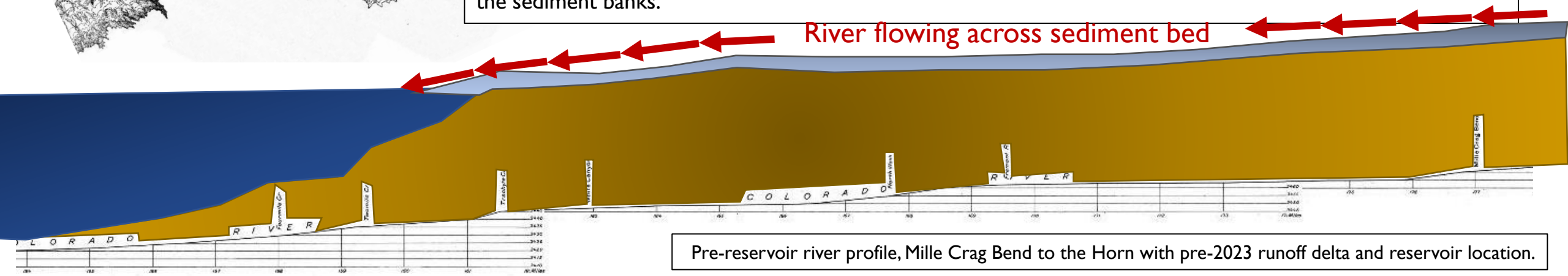
The runoff in 2023 began with a record low reservoir level of 3,519 feet and a very high snowpack.

For Narrow Canyon, this resulted in a scouring event the likes of which had not been observed since 2004–2005.

As the runoff came through Cataract Canyon and roared through Narrow Canyon, the river remobilized a massive amount of sediment.

All the fine sandy/silty sediment that could be swept away was carried away, leaving only the erosion-resistant clay layers.

The increased river discharge raised the reservoir level and moved the river-to-reservoir zone up into most of Narrow Canyon. Both the high river level and raised reservoir level caused a re-wetting and re-weighting of the sediment banks.



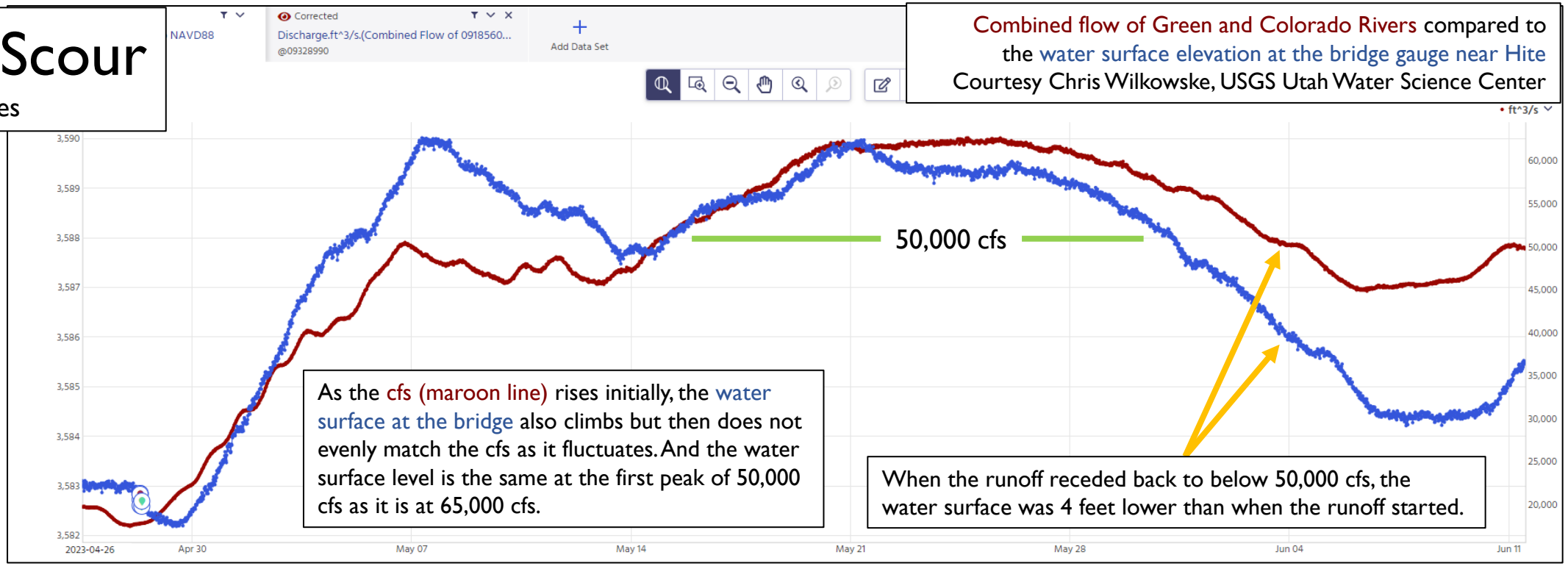
Pre-reservoir river profile, Mille Crag Bend to the Horn with pre-2023 runoff delta and reservoir location.

River Bed Scour

Two Examples

Comparing the cfs flow through Cataract Canyon with the water surface elevation at the bridge gauge near Hite you can see the river downcutting through the river bed.

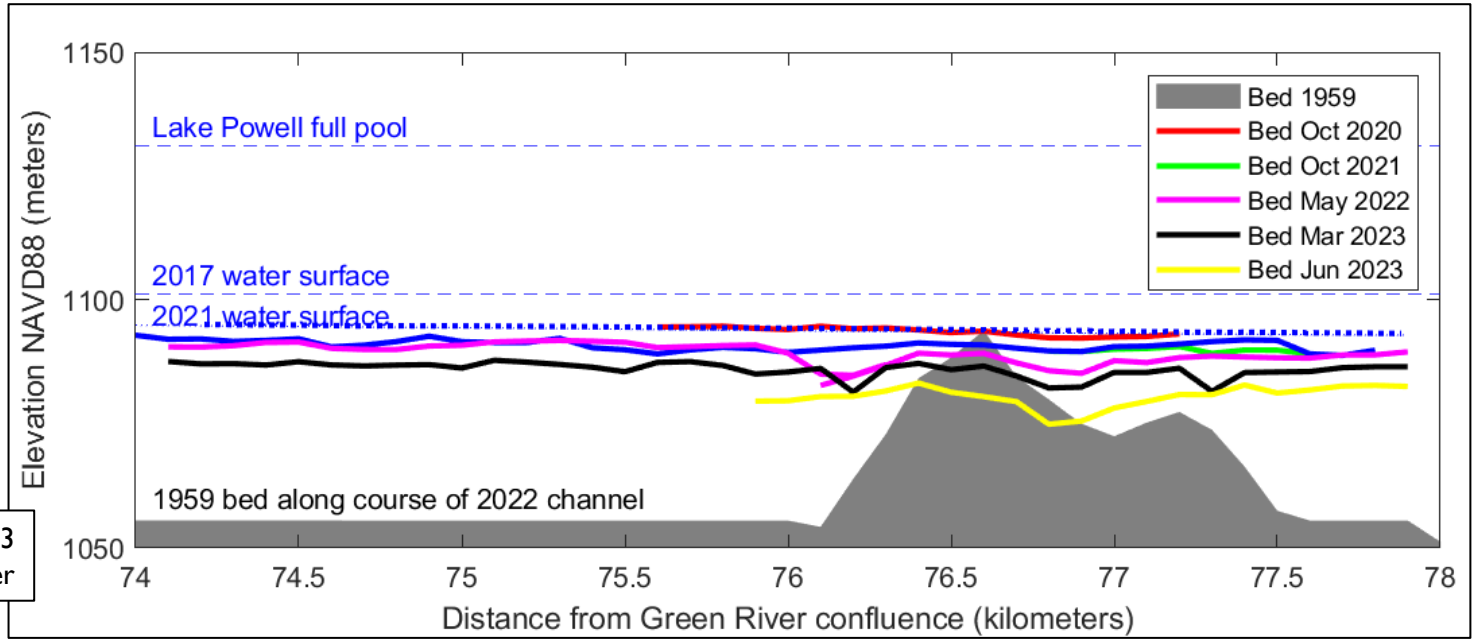
Combined flow of Green and Colorado Rivers compared to the water surface elevation at the bridge gauge near Hite
Courtesy Chris Wilkowske, USGS Utah Water Science Center



As the cfs (maroon line) rises initially, the water surface at the bridge also climbs but then does not evenly match the cfs as it fluctuates. And the water surface level is the same at the first peak of 50,000 cfs as it is at 65,000 cfs.

When the runoff receded back to below 50,000 cfs, the water surface was 4 feet lower than when the runoff started.

Repeat multi-beam sonar surveys in the reach of river near the North Wash Boat Ramp (where the river is displaced and flowing over pre-reservoir landscape for approximately 1 mile) allow us to monitor the rates of downcutting. Comparing March 2023 survey data with June 2023 data shows a substantial amount of change: as much as 10 meters of downcutting in places. The greatest rate of downcutting is in the pre-reservoir strata.



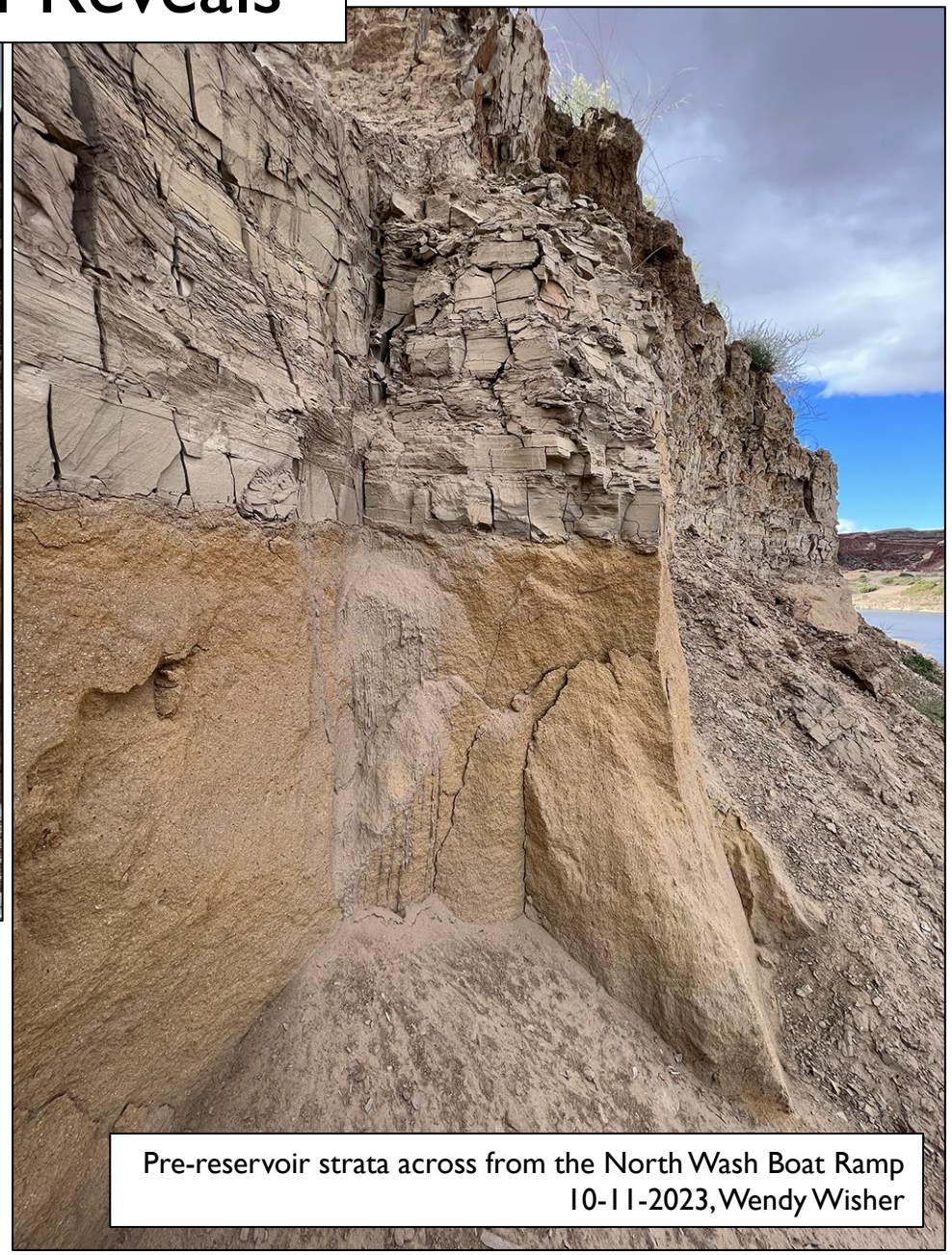
Cross section of river bed with surveyed river bed elevations Oct. 2020–June 2023
Preliminary data, Paul Grams, USGS Grand Canyon Monitoring and Research Center

Post Runoff Reveals

Mud fins in Narrow Canyon
10-11-2023, Mike DeHoff

As the high water receded over the summer, it became apparent that any fine sediment that could be swept further downstream by the river was carried off. The durable clay layers were left, and they emerged like sea monsters in the river channel.

And then something big happened…



Pre-reservoir strata across from the North Wash Boat Ramp
10-11-2023, Wendy Wisher

The Space Slump

A Massive Movement of Sediment

Between July 12 and 13, 2023, near river mile 174 in the upper end of Narrow Canyon, there was a large slump that laterally moved from river left into the river. It pushed the Colorado over into the river right bank.

Initial reports stated that it wasn't there in the morning and then appeared in the afternoon. The reporting party noted that there was mud and debris high above the waterline on the river right side of the river. The river was compressed into a single tight channel and heavily laden with sediment.

The amount of material that collapsed into the river could be seen on satellite imagery, so it earned the name Space Slump.

Panorama of the Space Slump in Narrow Canyon, 10-10-2023, Gary Gianinny

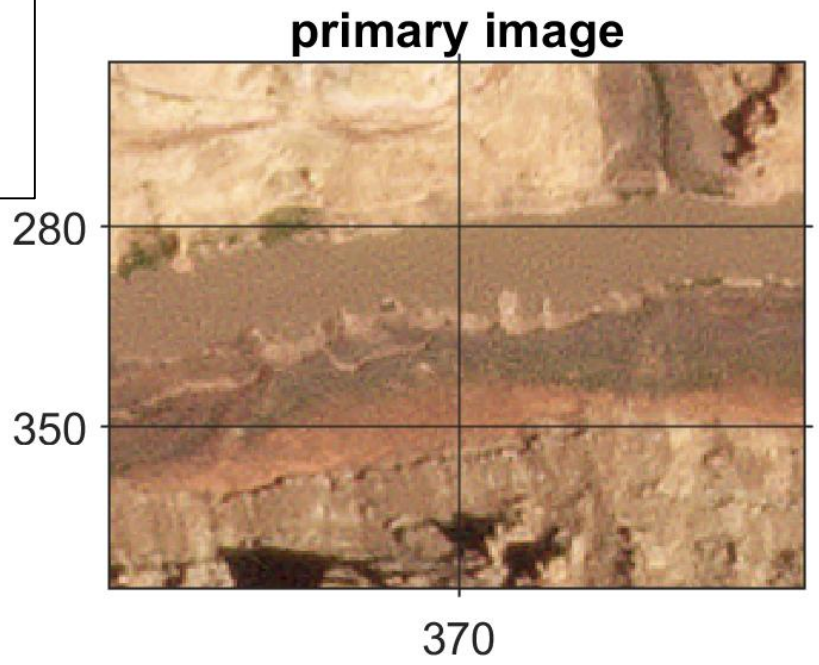
Satellite Imagery and Scales of Movement

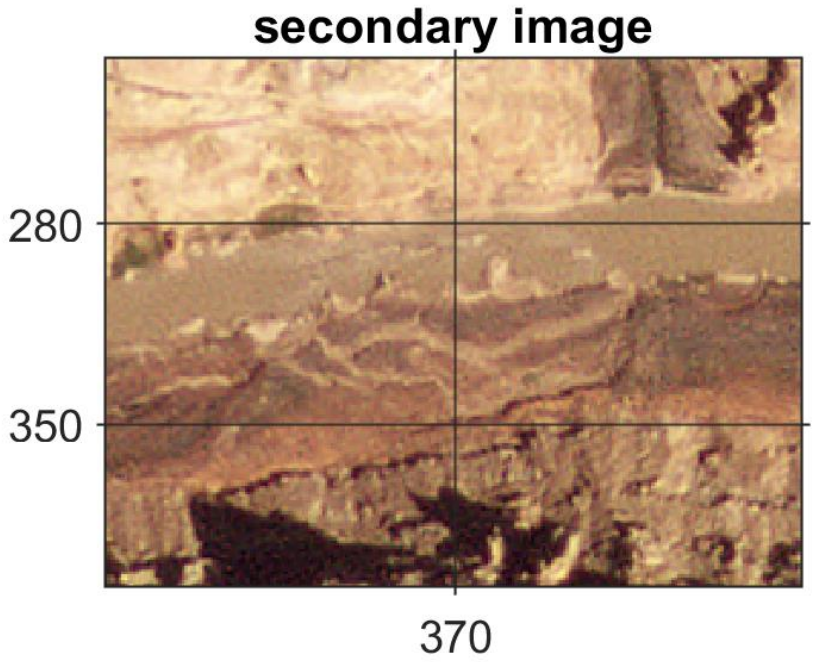
Using satellite imagery, we can track the slump's areas of movement.

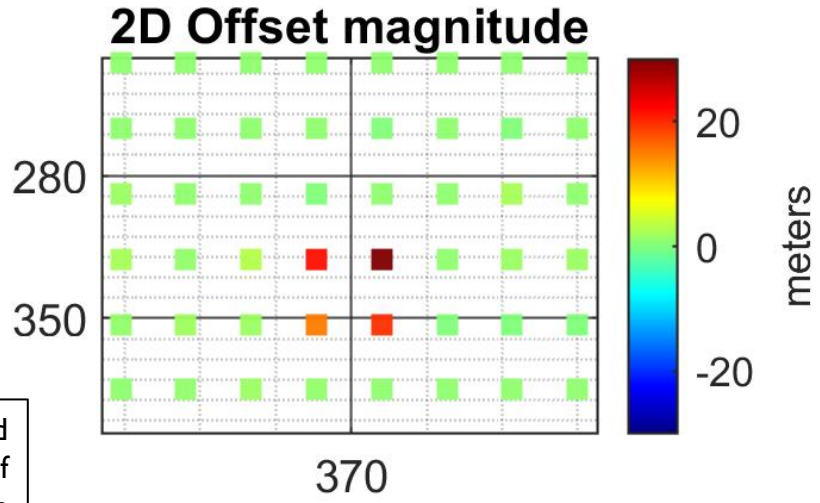
Project partners from the University of Utah made a longer time lapse that spans July to August.

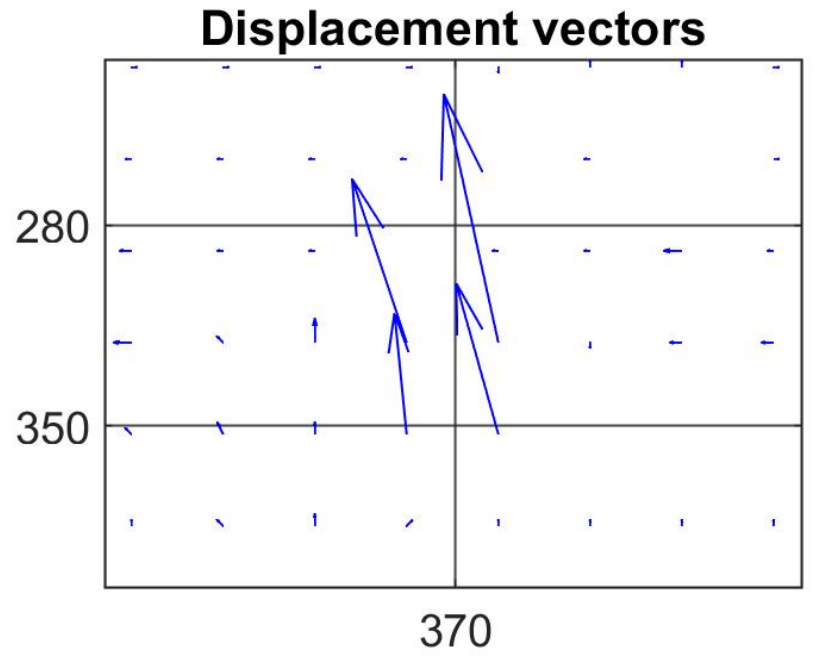
The main slump event happened on July 13.

A goal for the 2023 fall science trips was to survey the total sediment volume that moved and determine the factors that may have caused it.









Satellite imagery, movement magnitude, and vectors of the Space Slump courtesy of Jeff Moore, University of Utah

Raft in Space Slump mud rapid at mile 174,
6,430 cfs, bridge gauge 3,577 feet, 9-5-2023, Jordana Barrack

Changing Every Trip

On the September and October trips we observed that the slump area was changing on a weekly basis.

Durable clay fins would collapse and obstacles in the channels were different on each run through the slump area.

At the Space Slump (river mile [RM] 174), the river's pre-reservoir elevation was 3,465 feet. This year, the reservoir rose to an elevation of 3,586 feet, which backed water up all the way to RM 174. This tells us that at RM 174, the river is currently sitting on approximately 120 feet of sediment (elevation 3,586 minus 3,465). The area also has approximately 55 feet of exposed sediment on its banks that the river has already cut down through.

The higher runoff combined with a fluctuating reservoir level may have re-wetted and re-weighted the sediment banks in this area.

Survey Work at the Space Slump

The slump was one of the largest observed single movements of sediment on the Colorado sediment delta. To understand how much sediment moved in the event, an RTK (high tech survey instrument) was set up and the slump's perimeter was surveyed. This gave us an overall sediment volume.

RTK set up on Clay Island
10-10-2023, Wendy Wischer

Water taxi
10-10-2023, Travis Custer

Kestrel Kunz and Brenda Bowen surveying points,
10-10-2023, Meg Flynn

Panorama of the Space Slump in Narrow Canyon,
6,400 cfs, bridge gauge 3,573 feet,
10-10-2023, Peter Lefebvre

Another Contributing Factor

Groundwater: the Discovery of a Lost Spring

Saturday, June 22. Camped last night at upper end of Powell's Mille Crag Bend at Station 10580. Intended to take an observation on the North Star last night but slept too soundly so did not wake up.

It is rather curious, the effect of having as much food as one wants after living for six days on about *1/4 rations* of solid food for *six days*. At our first full supper Thursday night, I ate little, being very careful; but yesterday I ate all I wanted and last night and today I feel perfectly worn out tired and listless. It must be the effect of the stronger food getting into my system.

We resumed work at 6:30 a.m. About a mile and a quarter below, in upper end of Narrow Canyon, found two white sulphur springs. Warm spring on left bank and cold on right bank. Ran little over six miles and are camped tonight on right bank of river at two large sulphur springs and one iron, etc., etc., spring.

Stanton journal, June 22, 1889

On the river right side of upper Narrow Canyon, there are several sulphur springs that have been carved-out of the sediment. They are mentioned in pre-reservoir surveys and can be seen in historic photos. Historic documents also mention a warm spring on the left bank. When participants from the 2023 fall trip climbed onto the sediment terrace of the slump, they found a hanging pond with a spring bubbling up.

It is likely this spring lubricated the slump.

Spring source (left) and hanging pond (right) on terraces of the Space Slump
10-10-2023, Davide Ippolito

The Hanging Water in the Slump

Follow-up visit to the Slump Pond
10-26-2023, both photos Meg Flynn

On a follow-up visit to the slump (during an effort to get a water sample) the survey group obtained more perspectives of the spring-fed pool in the sediment bank.

The Springs that Feed the Pond

There were two springs that seemed to feed the pond in the slump.

One was fizzy with gas and did not seem to have much outflow (left). The other one appeared to be the main source of water (right).

Both springs were almost the same relatively cool temperature: 13.3 and 13.1 degrees Celsius (approximately 55 degrees Fahrenheit).

The pool itself was over 15 feet deep and did not appear to have an outlet to the river proper.

The group did not make an estimate of flow or discharge.

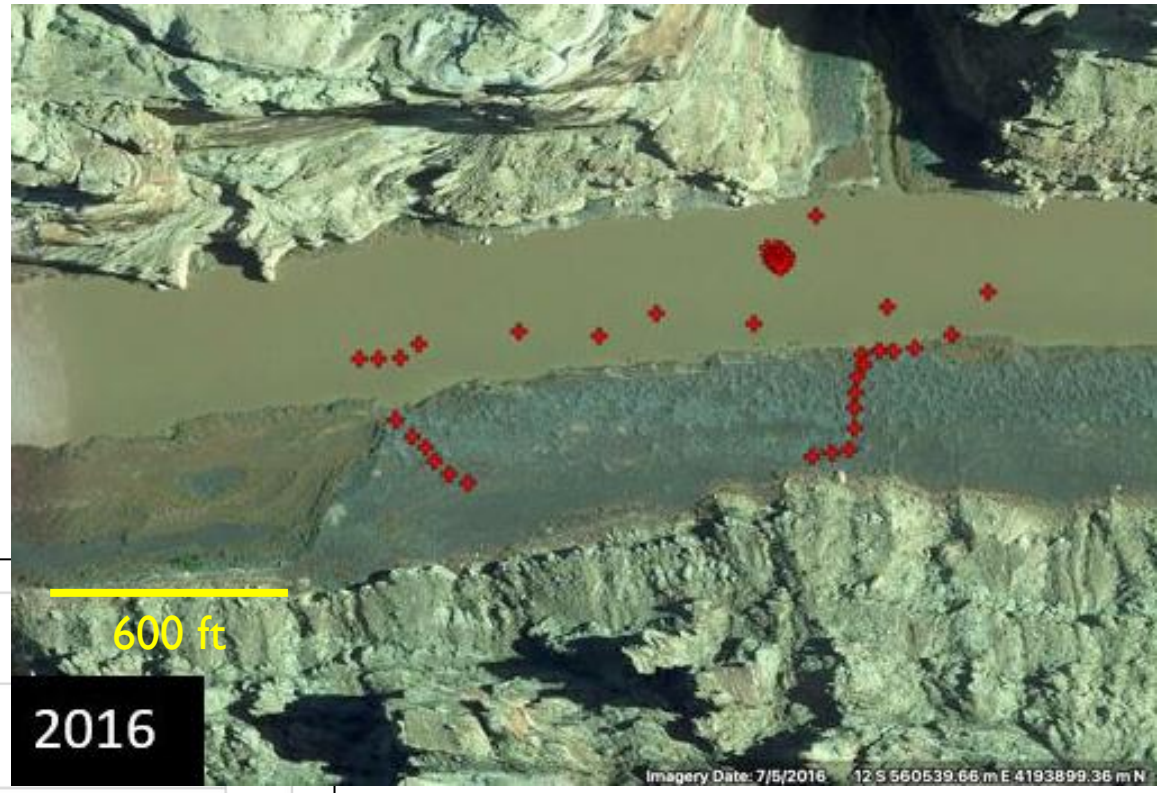
Spring sources in Slump Pond, 10-26-2023, both photos Meg Flynn

Processed Slump Survey Data

The survey points collected during the Space Slump survey give us an idea of the total amount of mass that slumped in the single July 2023 event.

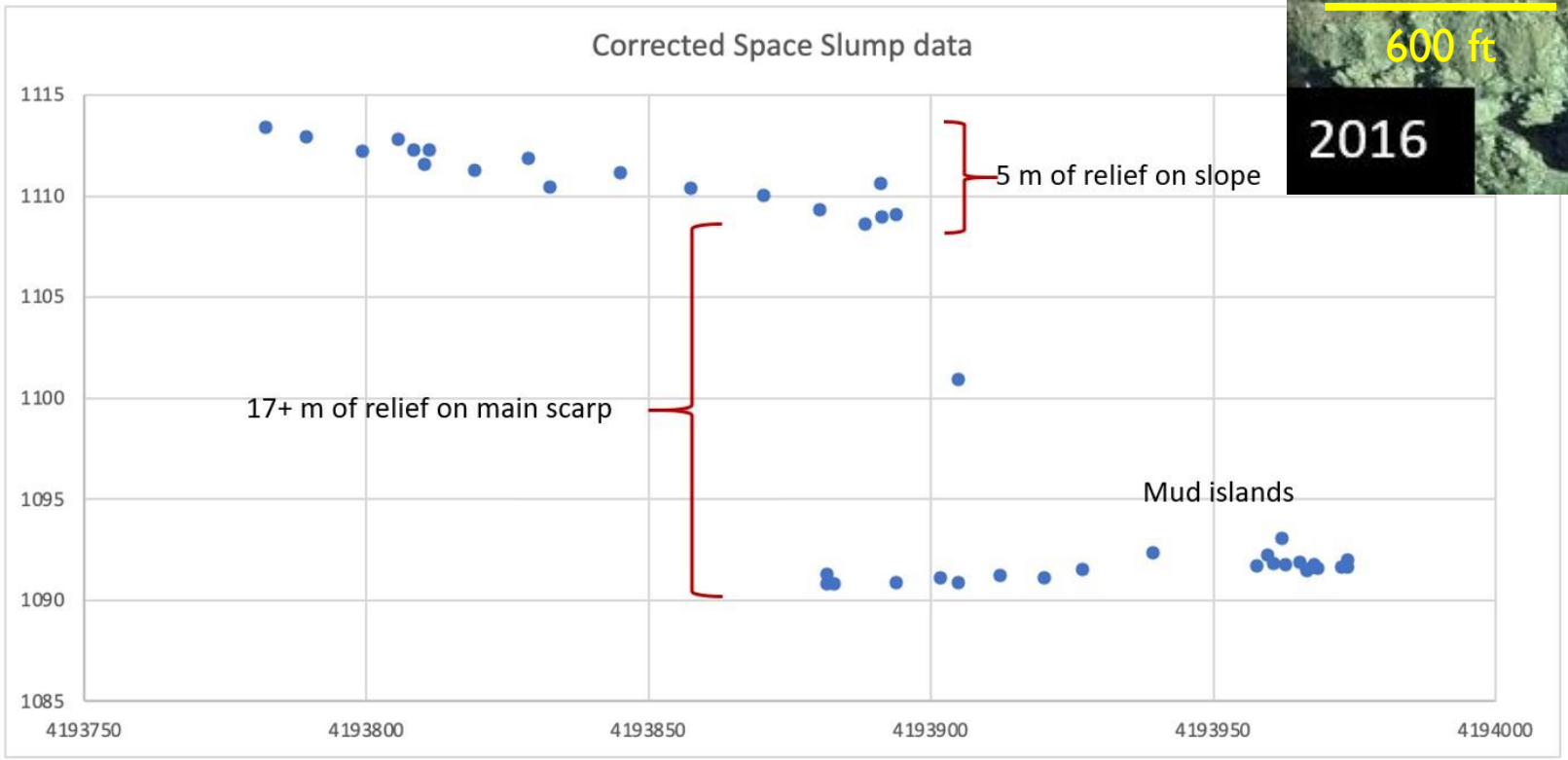
The fracture line was up to 17 meters (or 55 feet) tall, and in places the sediment moved as much as 25 meters (or 80 feet).

Survey work revealed that close to **1.32 million cubic meters** of material moved in the slump event. Keep in mind that the first reports noted that it happened within a 4-hour period! This would be the equivalent of two Costco-size buildings sliding about the length of a semi truck.



Survey points plotted on 2016 Google Earth image. The landscape imagery does not accurately reflect the current landscape, but it does help to plot an understanding of a 2-D layout of the mass of sediment that moved.

Mark Radwin and Brenda Bowen, University of Utah



Survey points plotted to represent vertical relief showing how much the sediment terraces collapsed as they slumped towards the river.

Mark Radwin and Brenda Bowen, University of Utah

Pre-Reservoir Perspectives of the Narrow Canyon Register

1953

p0766n088_Looking_out_from_Insignia_Rock-1953
University of Utah J.Willard Marriot Library

Downstream of the Space Slump at Mile 173.1 in Narrow Canyon there was a billboard where some river runners put their names after making it through Cataract Canyon.

These photos give us landmarks to help locate it within the stretch.

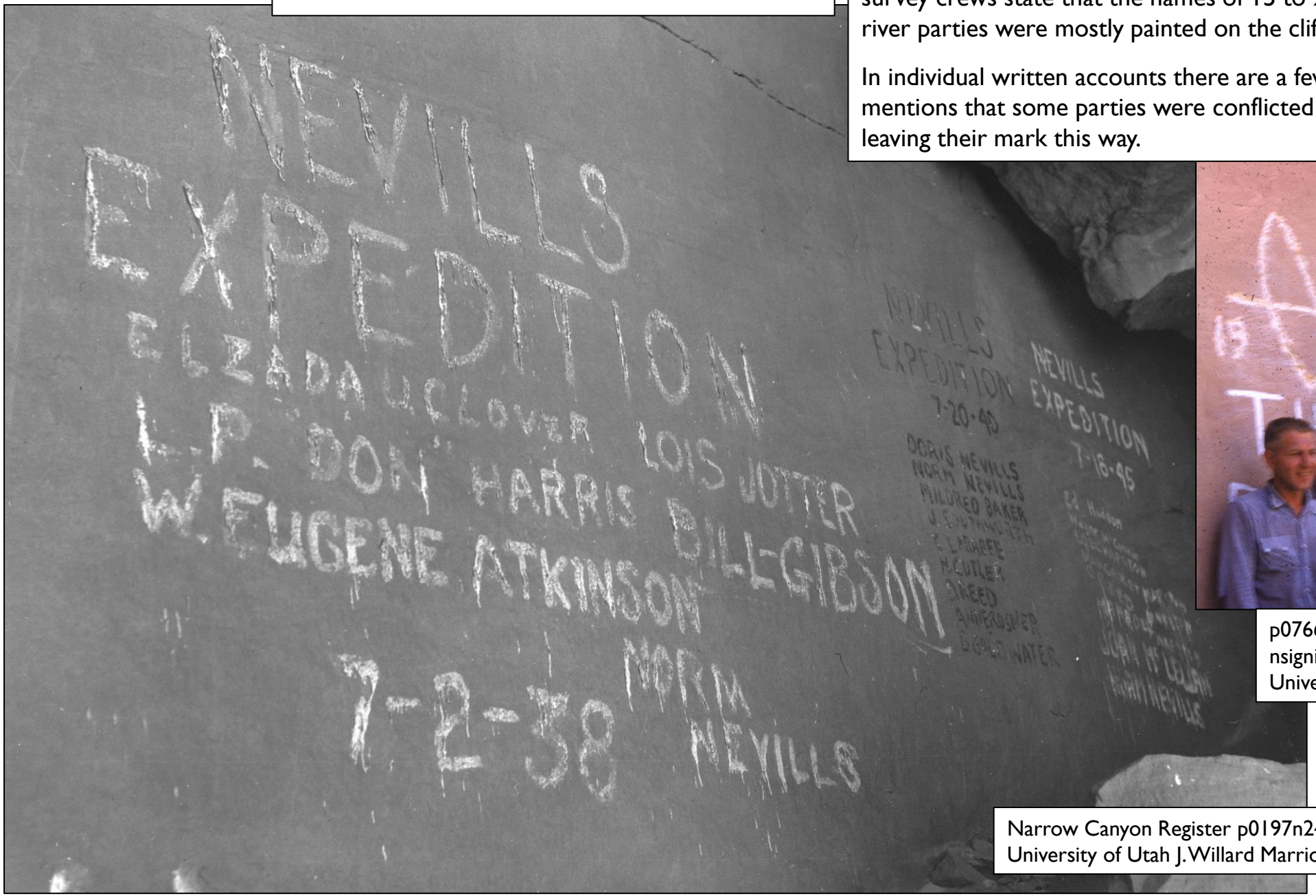
1963

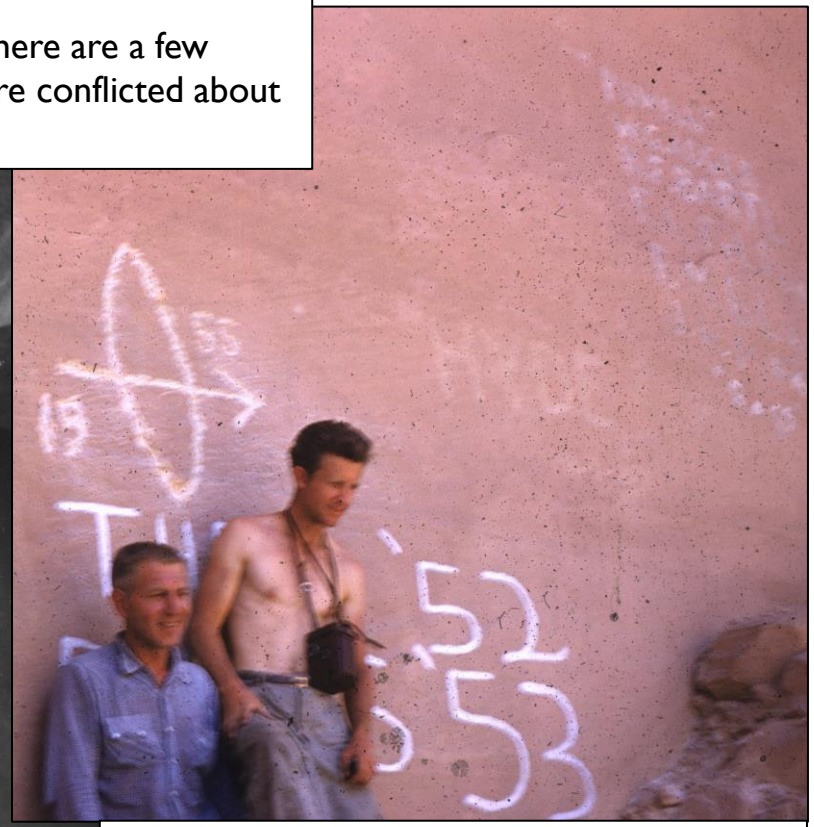
Crampton at Insignia Rock in Narrow Canyon during hasty archeological survey_cropped_5-24-1963
Gregory Crampton Collection p0197
University of Utah J.Willard Marriot Library

Views of the Billboard

Anthropological papers produced by pre-reservoir survey crews state that the names of 15 to 20 river parties were mostly painted on the cliff face.

In individual written accounts there are a few mentions that some parties were conflicted about leaving their mark this way.

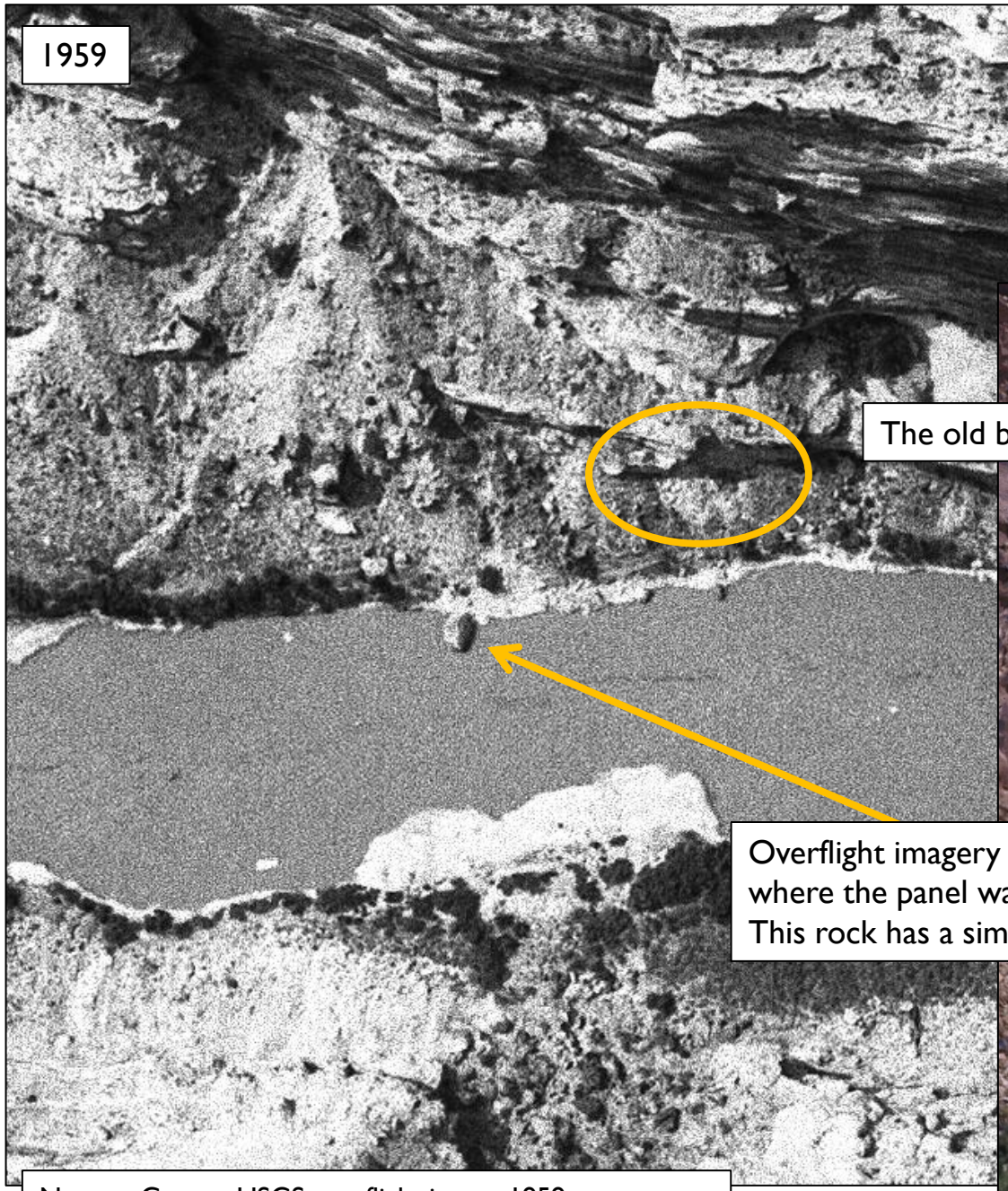




p0766n095_Don_Hatch_and_Charles_Eggert_at_Insignia_Rock-1953
University of Utah J. Willard Marriot Library

Narrow Canyon Register p0197n24_11_8448, Gregory Crampton Collection
University of Utah J. Willard Marriot Library

The Hunt for the Narrow Canyon Register Panel

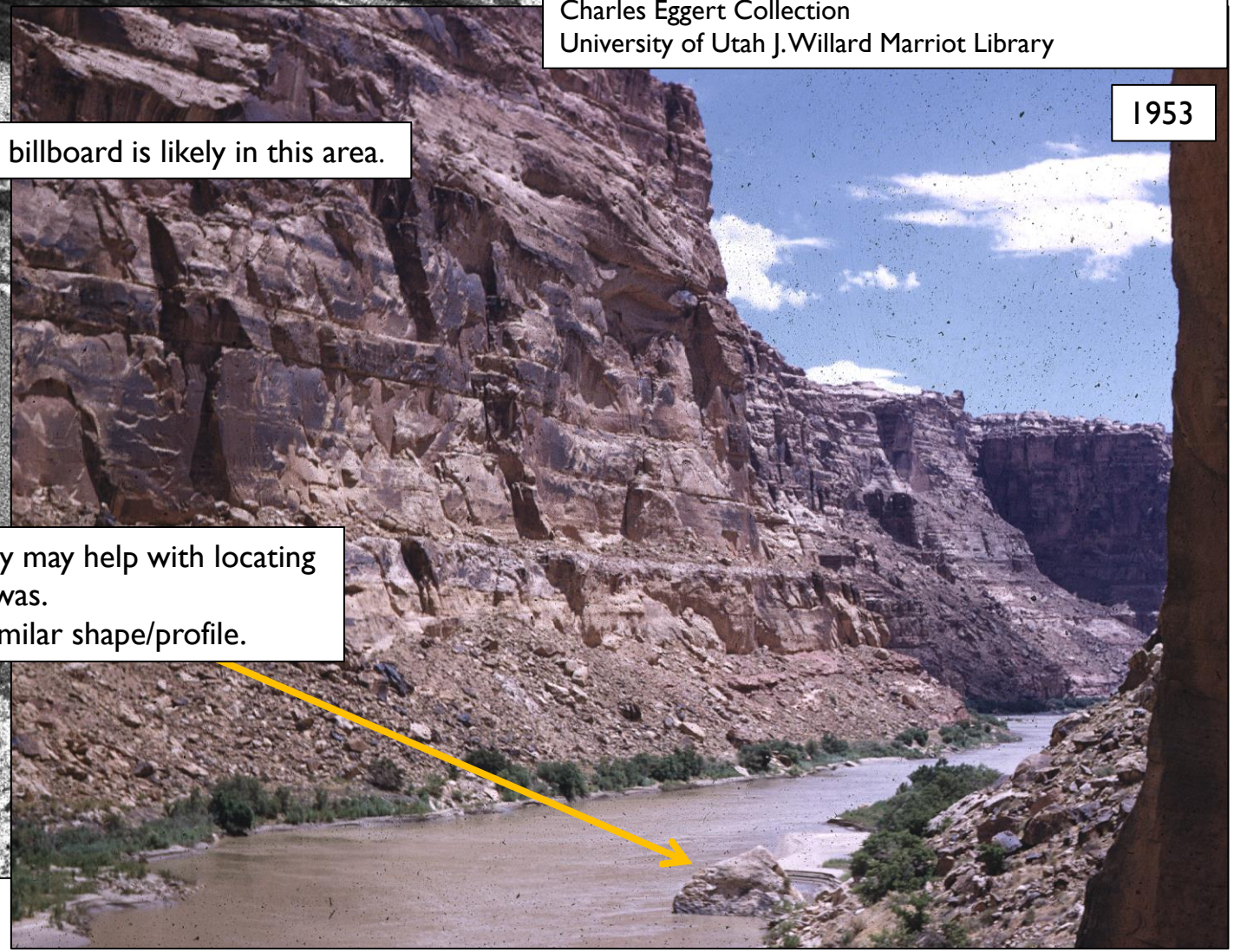


Narrow Canyon USGS overflight image, 1959
Cropped for Narrow Canyon Register detail RM 173

The old billboard is likely in this area.

Overflight imagery may help with locating where the panel was.
This rock has a similar shape/profile.

p0766n088_Looking_out_from_Insignia_Rock-1953
Charles Eggert Collection
University of Utah J. Willard Marriot Library



Early descriptions of the old Narrow Canyon billboard state that the location was approximately 40 feet in elevation higher than the old river level.

Even though there was a terrific amount of scouring and slumping away from the pre-reservoir canyon walls this year, the billboard is very likely still under the mud.

Most of the historic names at the site were painted on and some lightly scratched in with rock picks or hammers. The likelihood of finding anything intact is very low, but it is still worthwhile to take a look.

p0766n088_Looking_out_from_Insignia_Rock
Eggert Collection, 1953
University of Utah J. Willard Marriot Library

Riverside stop to look for the Narrow Canyon Register
10-11-2023, Mike DeHoff

The North Wash Boat Ramp

The water surface elevation at the deteriorating access point just downstream from the Dirty Devil River dropped 6 feet this year.

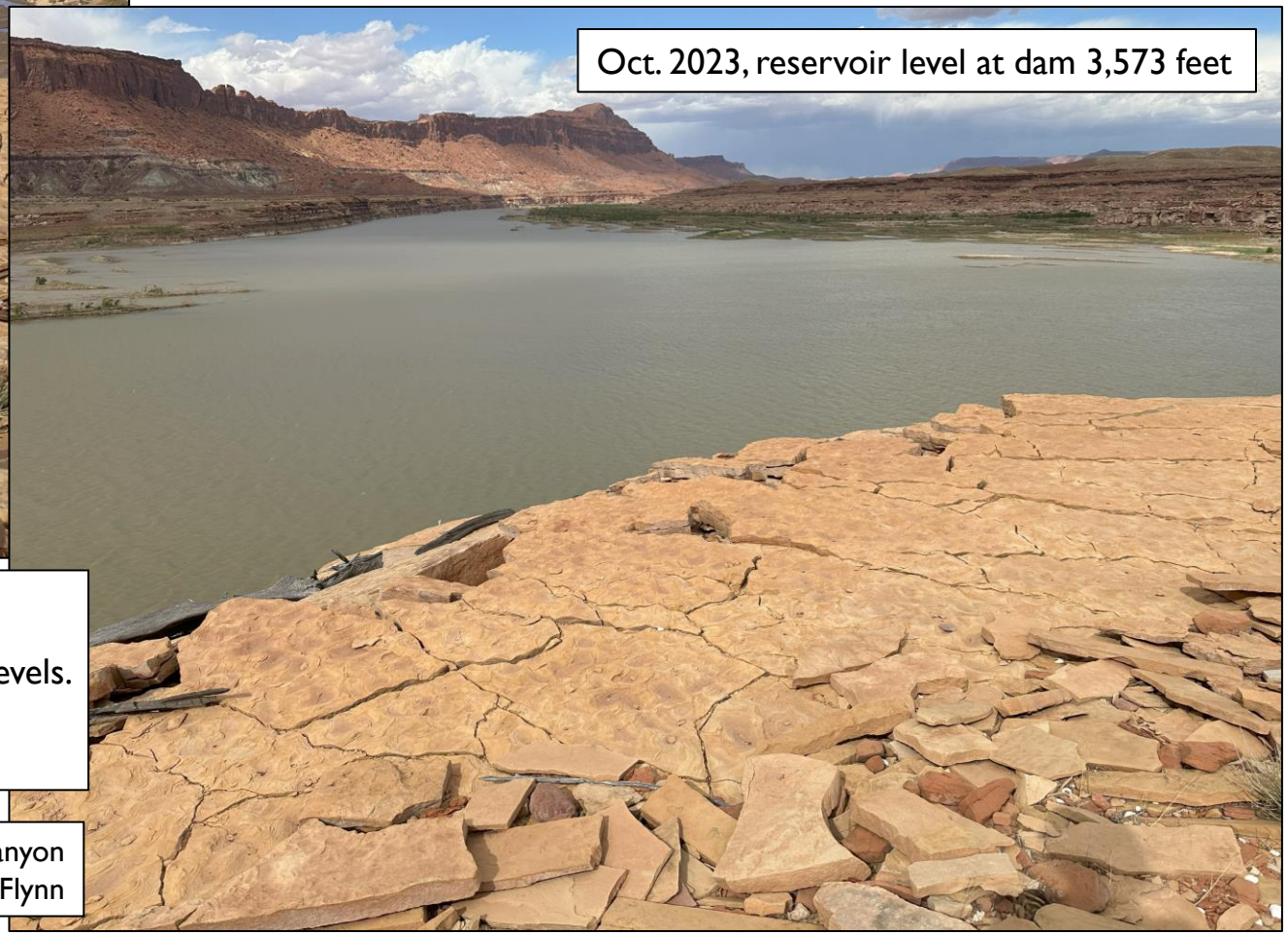
There are more rock shelves showing along the shoreline and fewer practical spots to get a boat out of the water.

North Wash Boat Ramp from across the river
6,400 cfs, bridge gauge 3,576
9-12-2023, Mike DeHoff

White Canyon Area

In 2022, the river was flowing over its sediment in this area. The reservoir had retreated, and the sediment delta had displaced the river approximately 140 vertical feet out of its historic channel.

In 2023, the reservoir rose 65 feet and re-inundated this area.



In this area many historic and cultural sites are deteriorating.

As the reservoir fluctuates from year to year, it raises and lowers the water levels. This action has swept away ancient Pueblo structures, damaged rock art, and ruined inscriptions from historic river runners.

Canyon bend downstream of White Canyon
Both photos Meg Flynn

Reservoir Rise in the White Canyon Area

Site of Ancient Structure

March 2023, reservoir level at dam 3,520 feet.

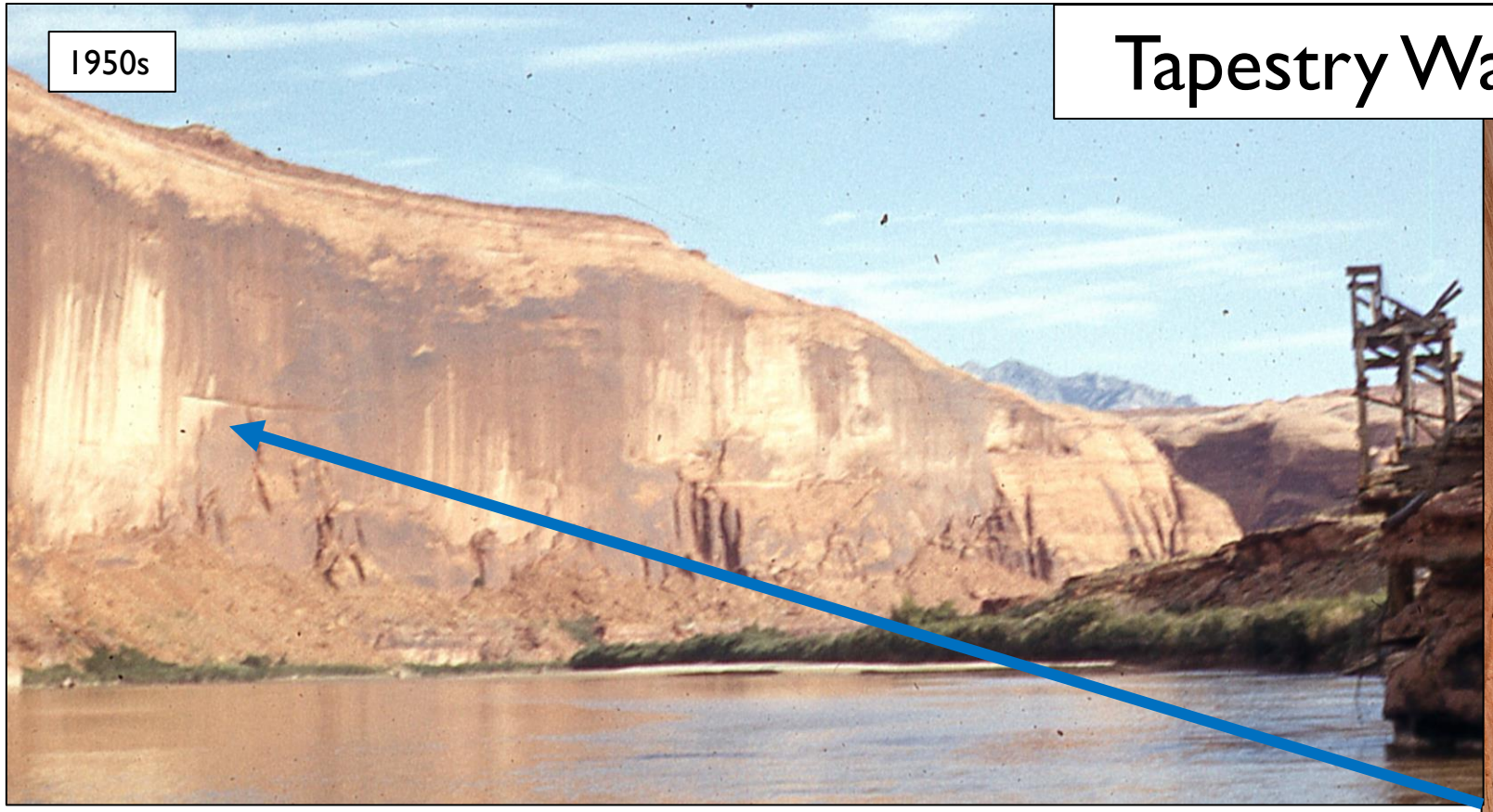
White Canyon has been a river-to-reservoir interface zone for the past 5 to 8 years. The fluctuation and advancement of the sediment deltas has caused the river to be displaced and historic and cultural sites to be damaged or destroyed.

Oct. 2023, reservoir level at dam 3,573 feet.

White Canyon area, both photos Mike DeHoff

Tapestry Wall

1950s



2023

Tapestry Wall with old structure on opposite shore
Late 1950s; George Rathbun slide #119
Cropped for ledge detail

Historic river elevation approximately 3,380 feet

Tapestry Wall ledge stop. Depth finder reading just out from wall was 189 feet deep.
Bridge gauge 3,576 feet, reservoir elevation at dam 3,573 feet
10-12-2023, Travis Custer

Subtracting the depth finder reading of 189 feet from the water surface elevation at the dam (3,573 feet) gets a result of 3,384 feet, which is close to the pre-reservoir river elevation.

That means the sediment delta isn't here yet.

Trip Data Tracker:

Trip Dates	Sept 2–6	Oct 7–13	Oct 23–27
Discharge in cubic feet per second (cfs) Colorado River at Gypsum Canyon:	6,430 cfs	6,400 cfs	7,200 cfs
Reservoir level at dam (feet above sea level [NAV88]):	3,573.5 feet	3,573.2 feet	3,572.9 feet
Highway 95 bridge gauge (feet above sea level [NAV88]):	3,577 feet	3,576 feet	3,576 feet

Space Slump clay bergs, 10-10-2023, Wendy Wischer

Space Slump group selfie, 10-10-2023, Davide Ippolito

Returning Rapids Project

Visit our donation portal

Returning Rapids Project is a research program of Glen Canyon Institute

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Any errors or oversights – please contact Mike

The Returning Rapids Project research team is
Peter Lefebvre, Chris Benson, Meg Flynn, Mike DeHoff,
and many more.

As always, very special thanks goes out to the Glen Canyon Institute.

A big THANK YOU to:

We are seeking funding.

The information gathered during our trips and accompanying research has become a valuable resource for the ongoing conversation regarding water in the southwest. In 2024, we plan to engage with research efforts that will further inform agencies, tribes, and the public about this dynamic landscape.

Our project intends to inform decision makers regarding opportunities to better care for our rivers and canyons.

Thank you for taking the time to read this. More to come.
Contact the Returning Rapids Project research team at:
contact@returningrapids.com

For more information and project updates please visit our website: returningrapids.com

December 2023

Our research project is expanding. We would like to thank some of the people who have helped us make it happen.

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