Glen Canyon Tailwater Fishery

"Integrating Fish and Channel Mapping"


Ted Melis, Grand Canyon Monitoring and Research Center

09:30 a.m. on April 22, 2015

Technical Workgroup Meeting, Phoenix, AZ

USGS

OUTLINE

- Glen Canyon Mapping Update
- Bed Texture Imaging & Change Update
- *As time permits*… Multiple Hypotheses about Rainbow Trout Trends, Sediment, QW & Flows

USGS

New Glen Canyon Mapping

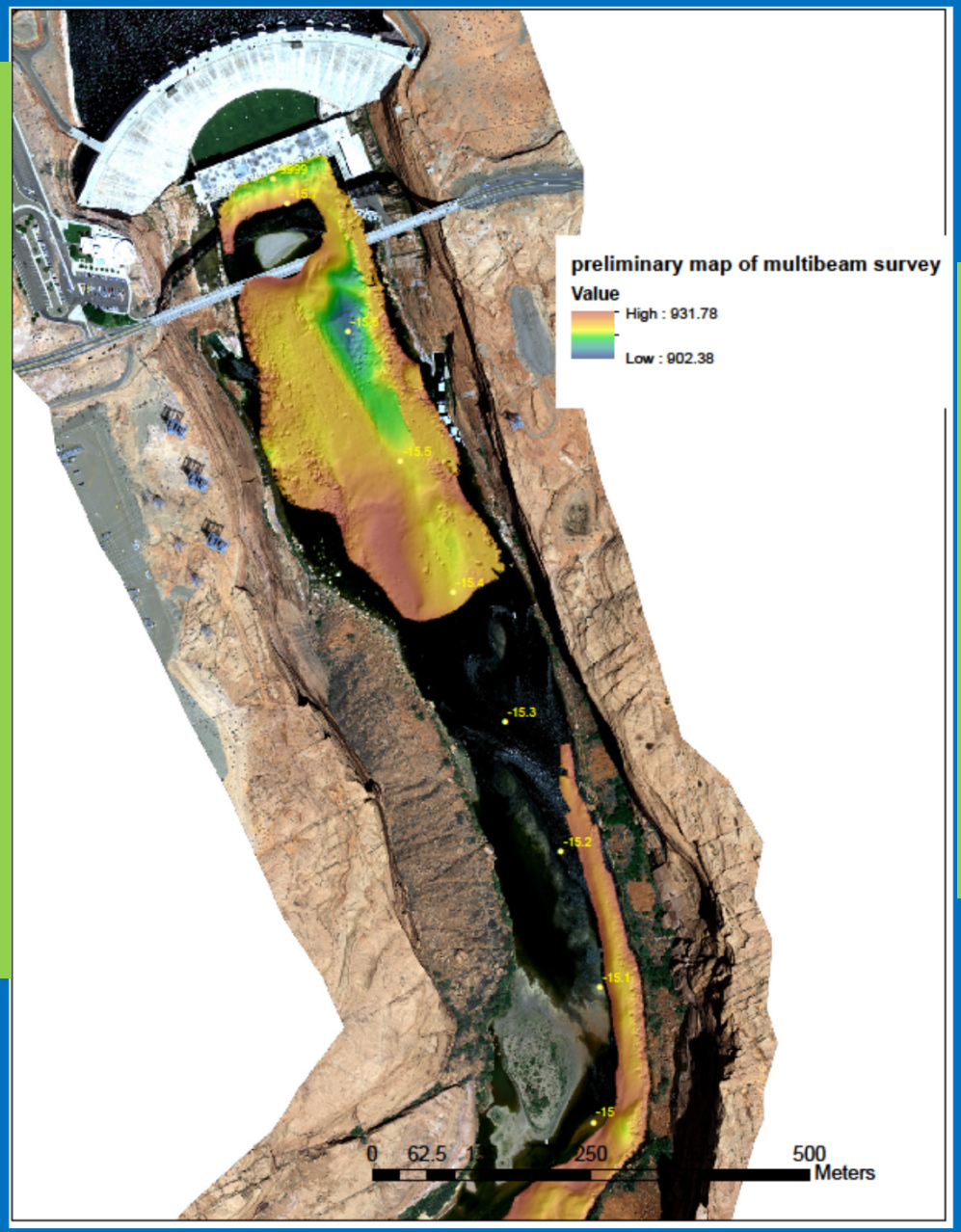
- Channel topography collected during NOV 2014 HFE (project 3 team), additional data are still being collected and merged to fill in “holes”
- Higher topography is derived from 2009 overflight imagery after vegetation removed
- Two data sets must be merged for full channel topographic map (yet to be completed in 2015)

USGS

A Quick Tour
of
Glen Canyon

Showing the
Multi-beam
Survey coverage
Collected by Project
3 Team during
NOV 2014
HFE

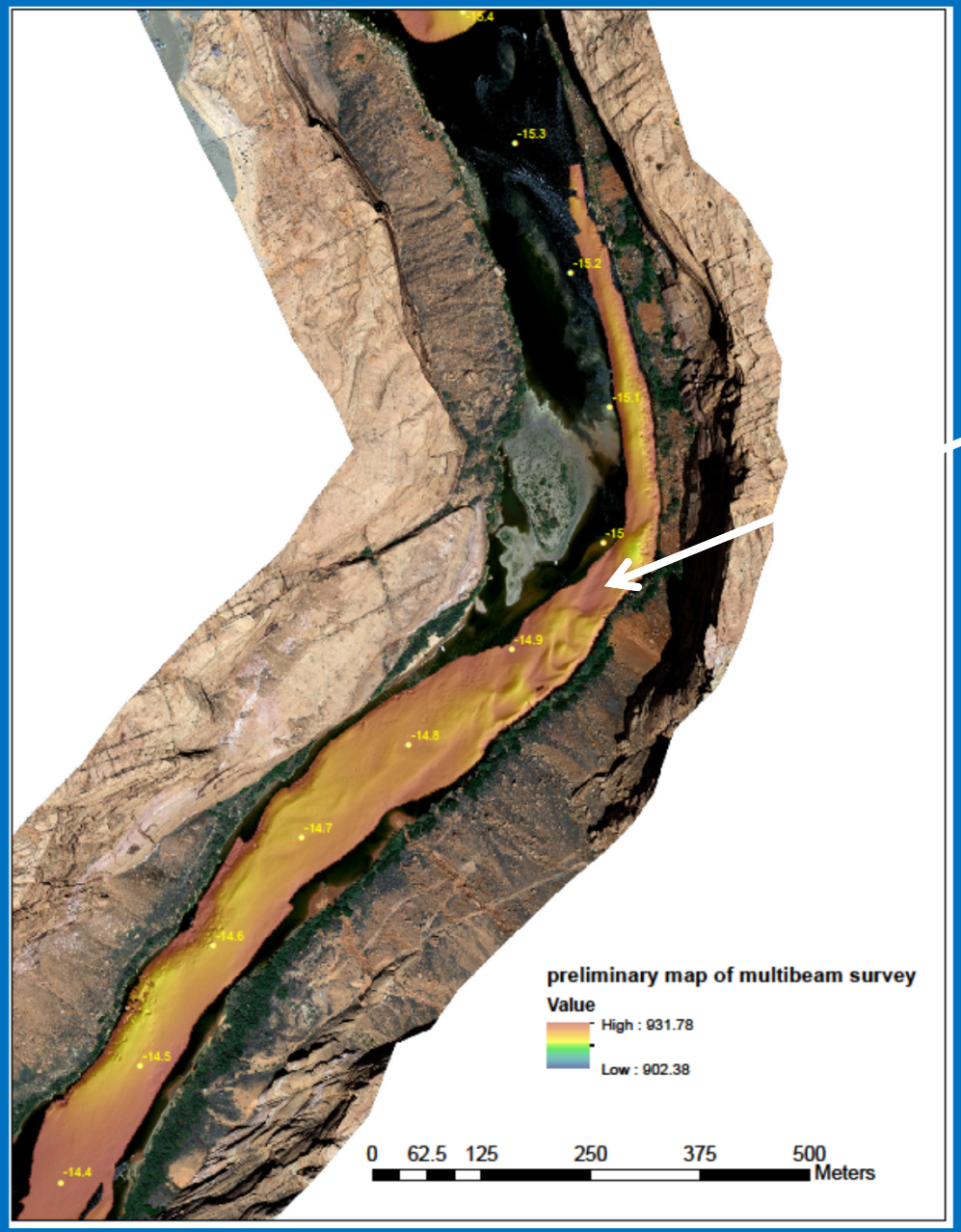
Kaplinski, Grams
Buscombe, Foster,
Kohl and many
others…



Even though
large areas of
channel margin
were inundated by
37,500 cfs, the
flow depths in
many nearshore
areas were
too shallow to
be covered by the
MB platform

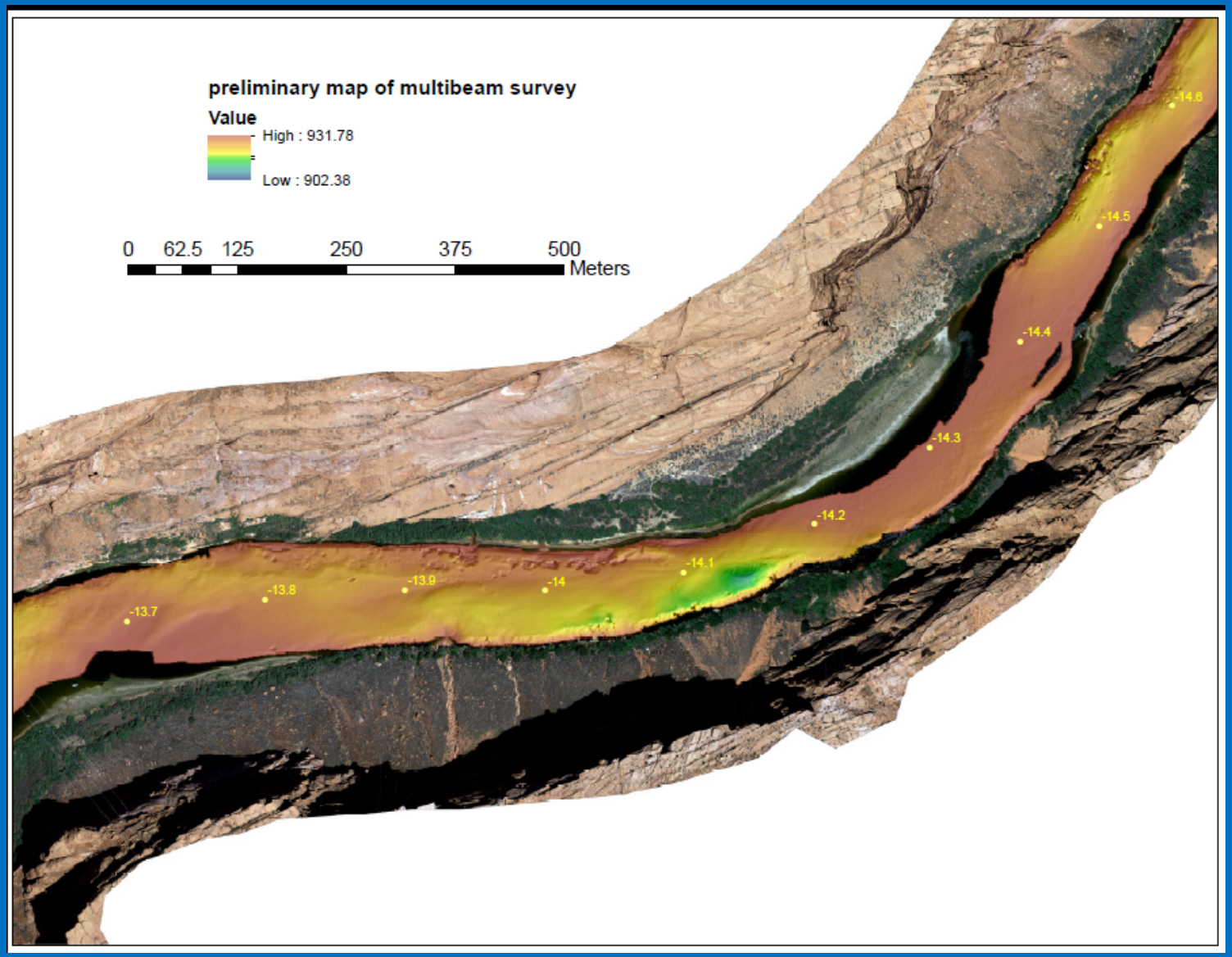
USGS

All Images Provided by Matt Kaplinski (Northern Arizona University)



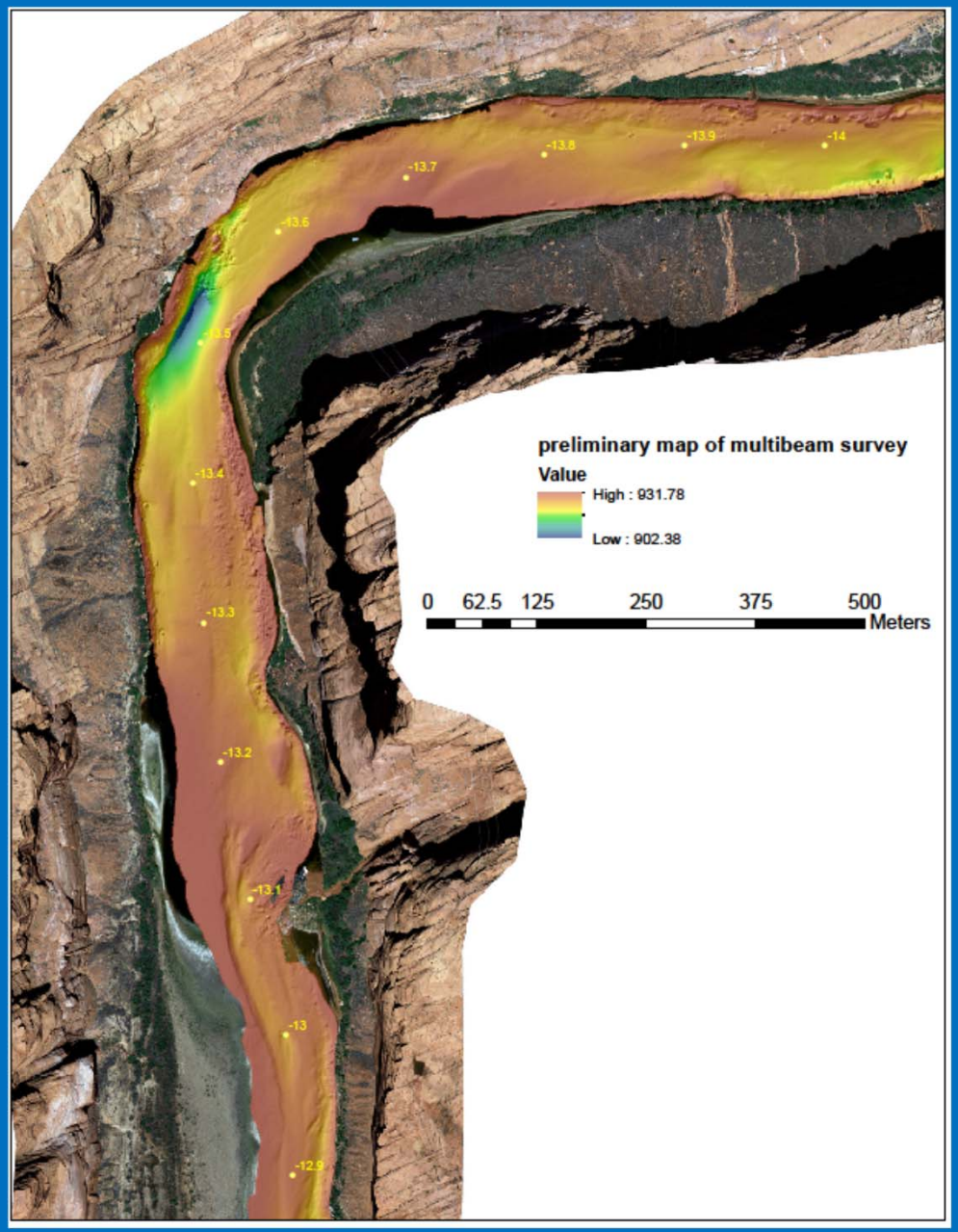
Gravel Bedforms off shore from coarse cobble bar

USGS



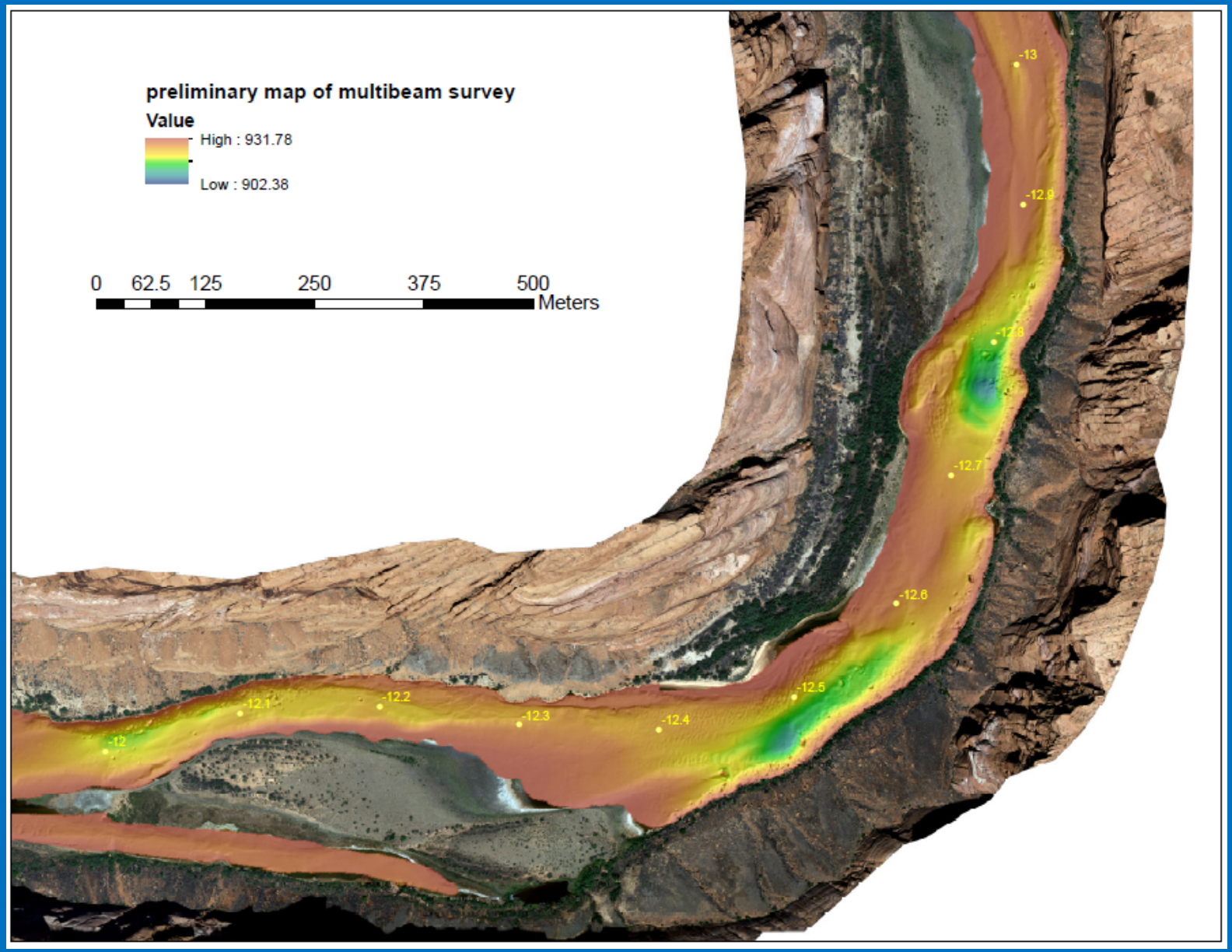
USGS

Fourteen-Mile Bar to Powerline Bar Segment



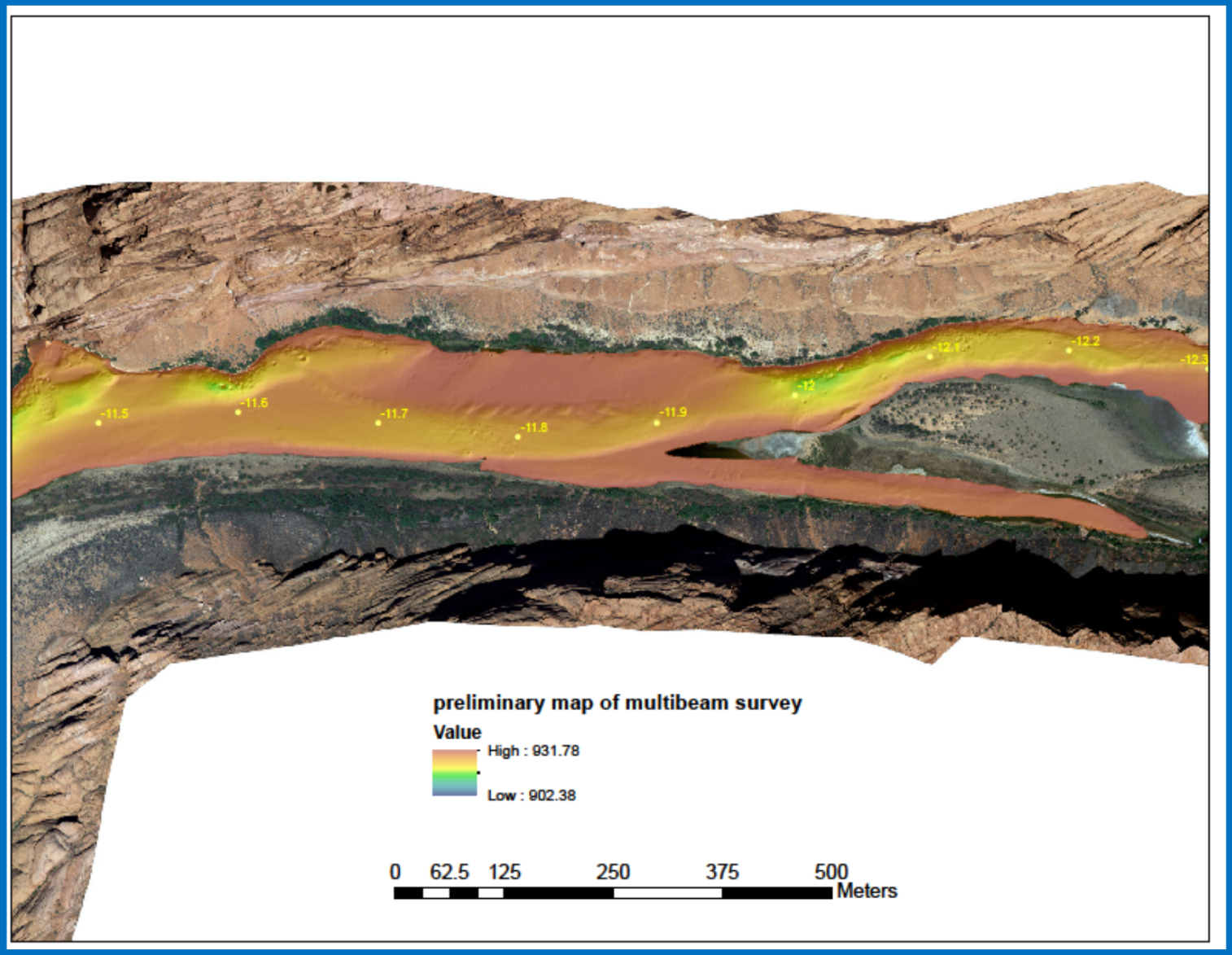
USGS

Powerline Bar to Honey Draw Segment



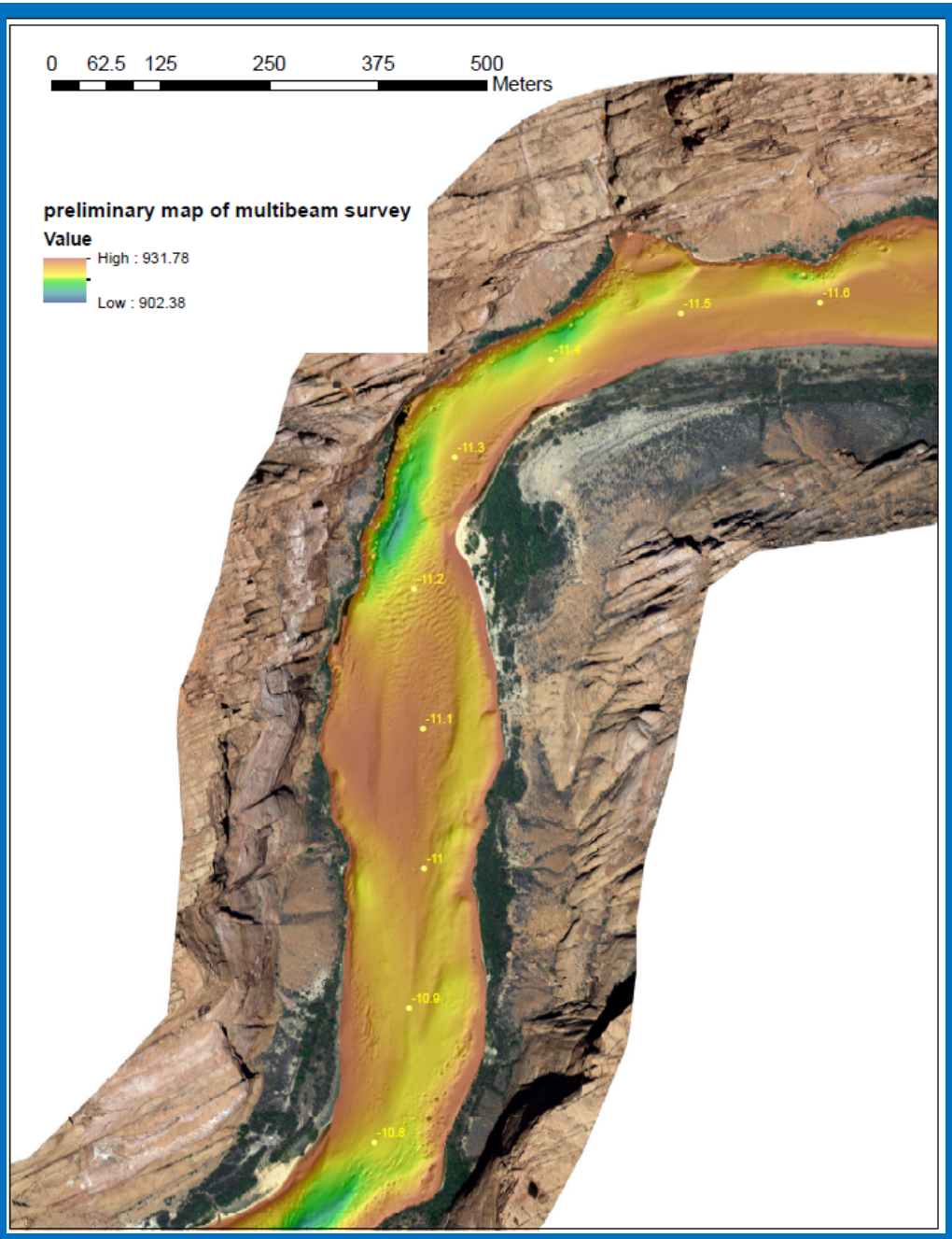
USGS

The MB crew was able to collect data in the “hidden slough” area



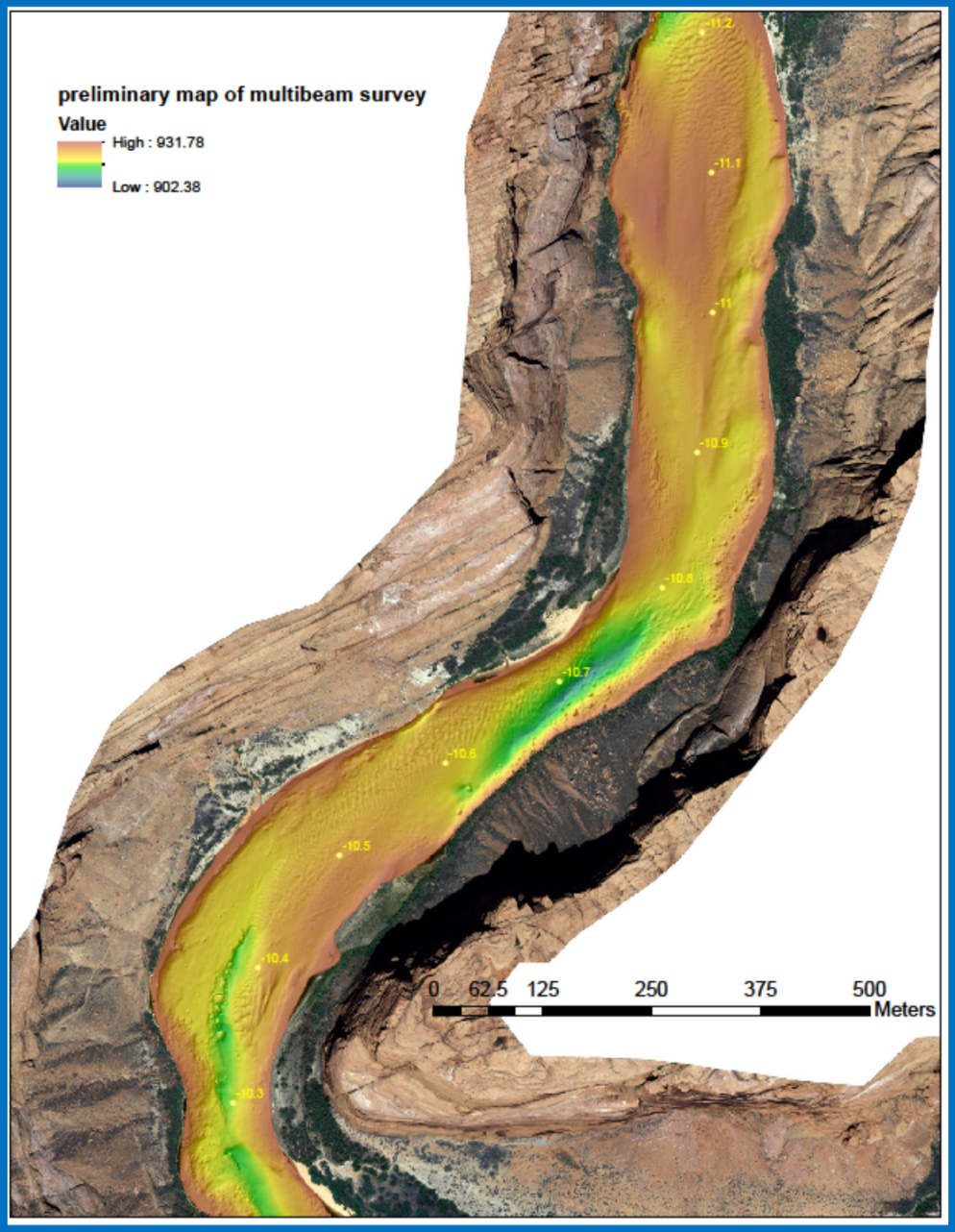
USGS

Prop Bar Segment US of Ferry Swale



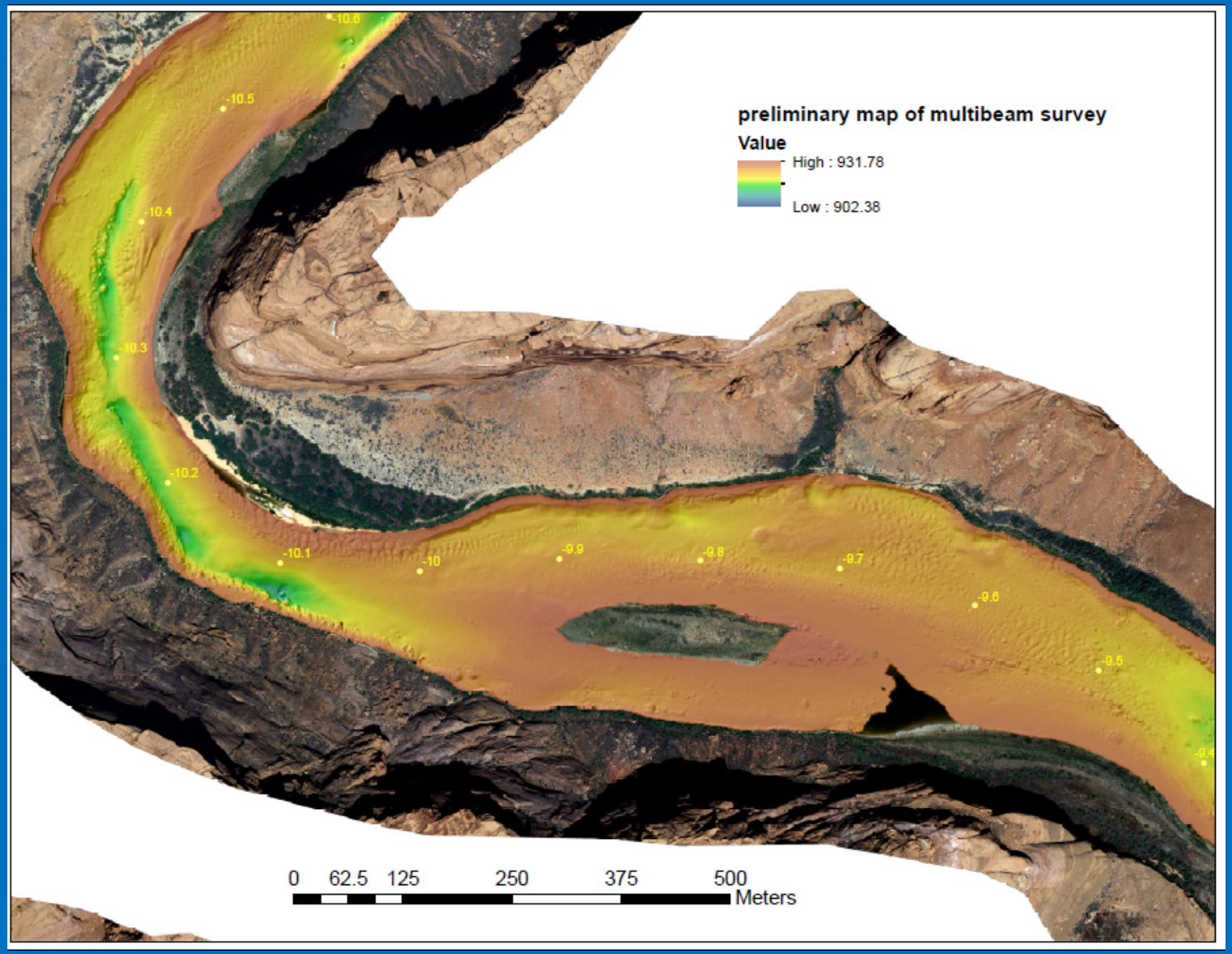
USGS

Ferry Swale Segment



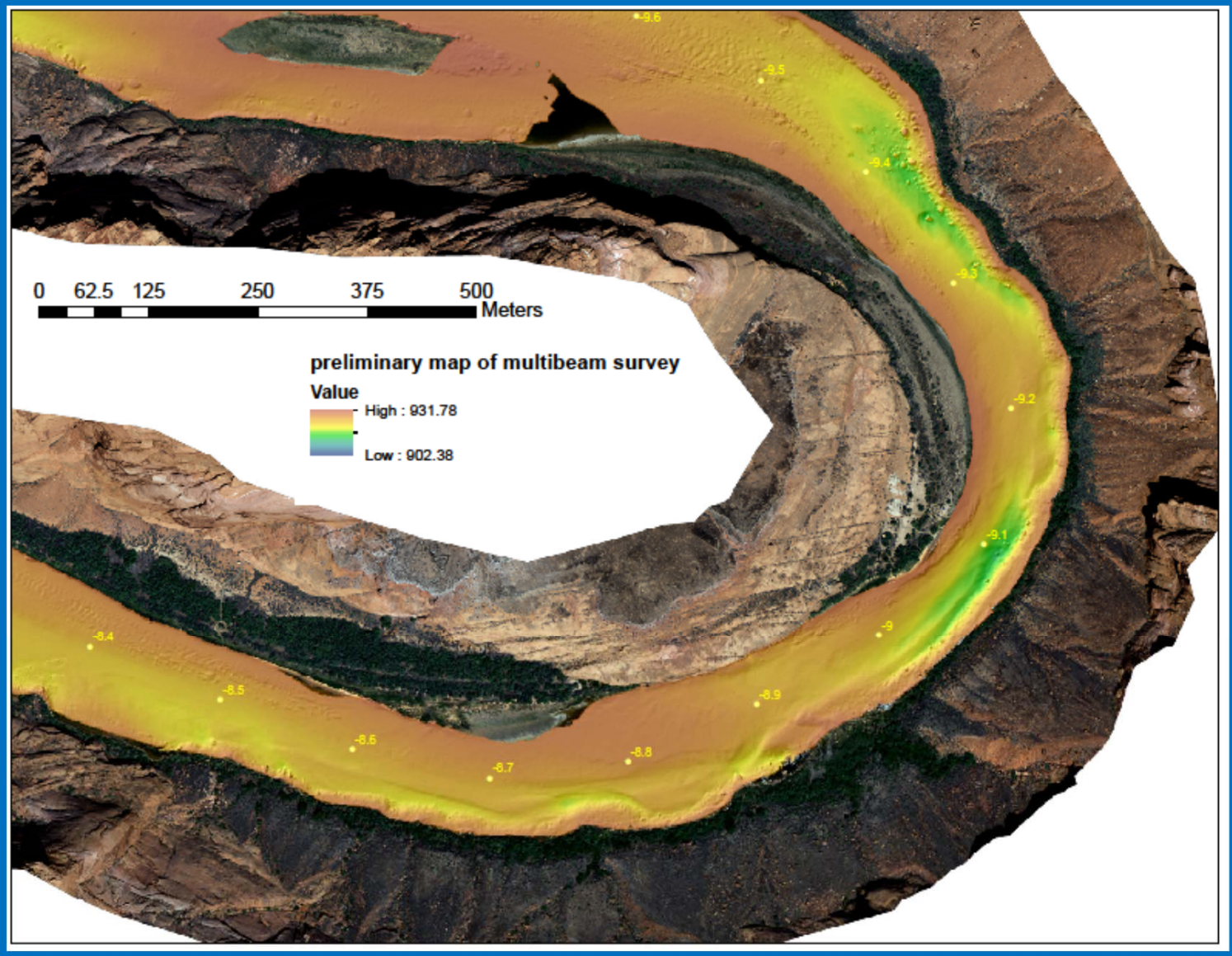
USGS

DS of Ferry Swale to Petroglyph Site



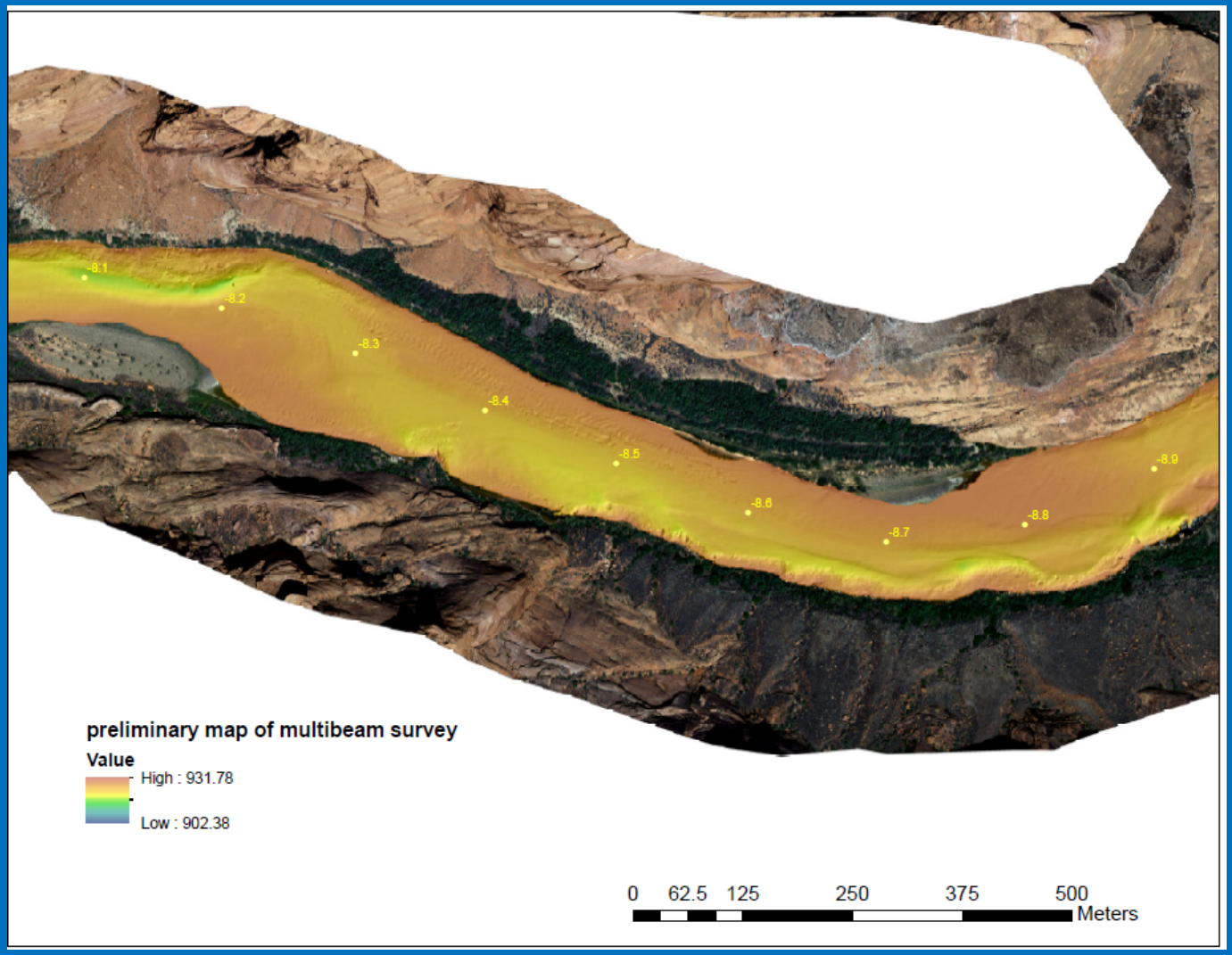
USGS

Duck Island & Upper Horseshoe Bend Segment



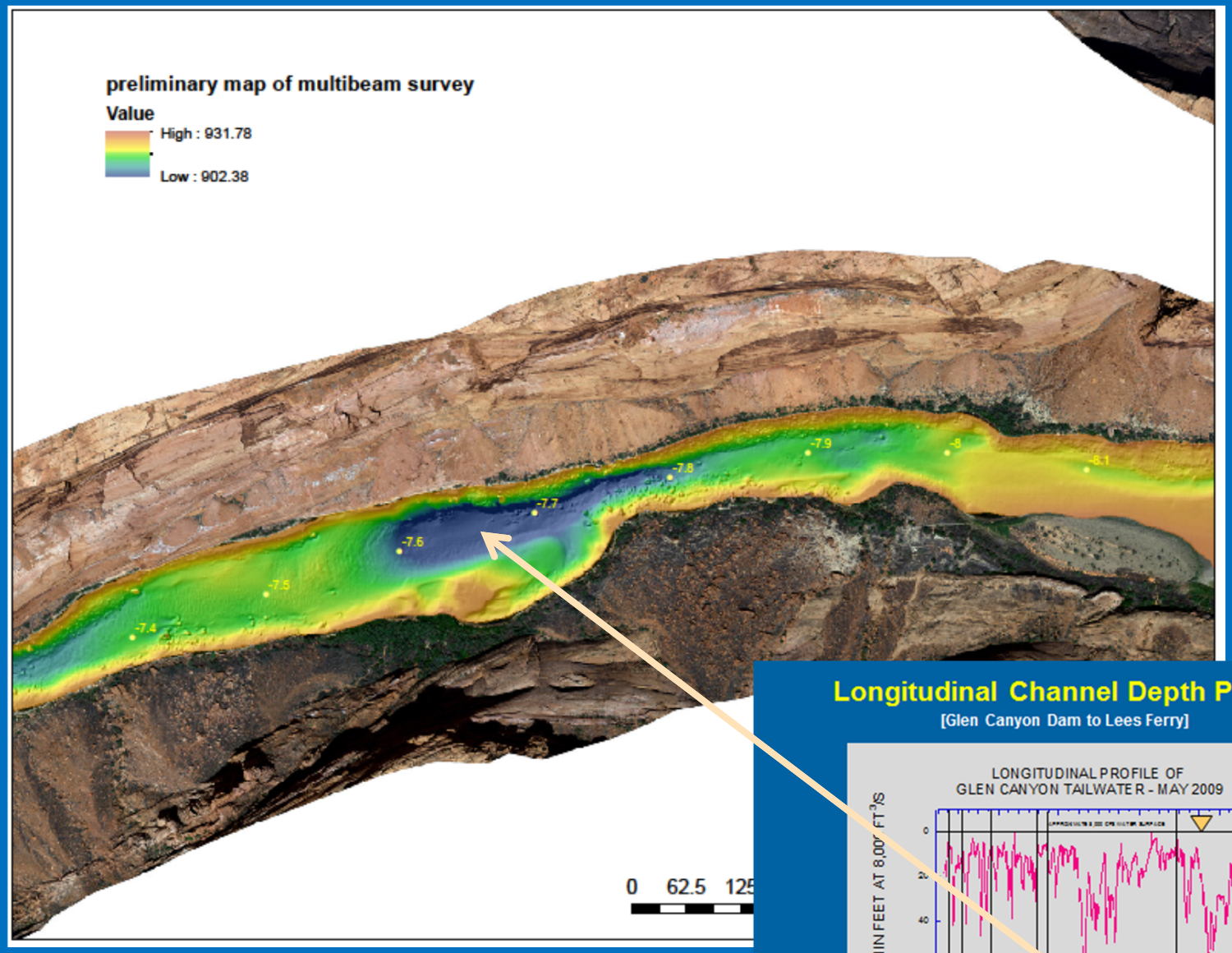
USGS

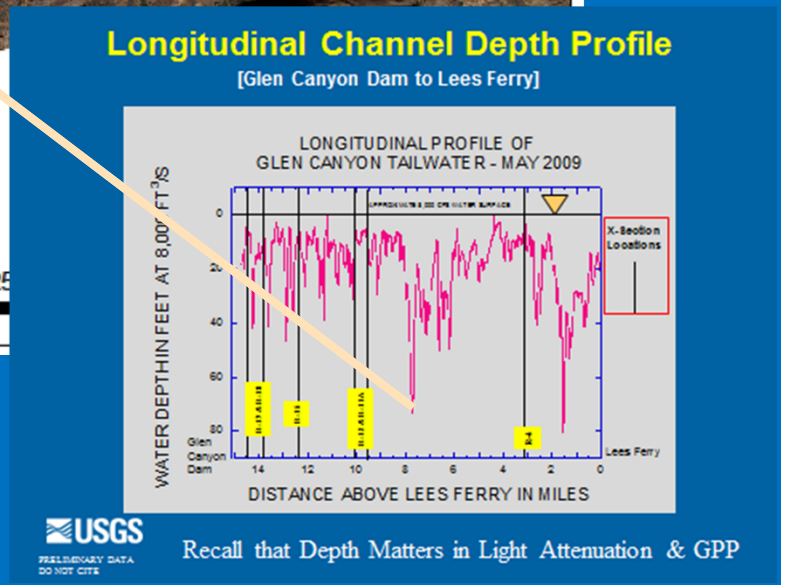
Nine-Mile Camp & Horseshoe Bend Segment



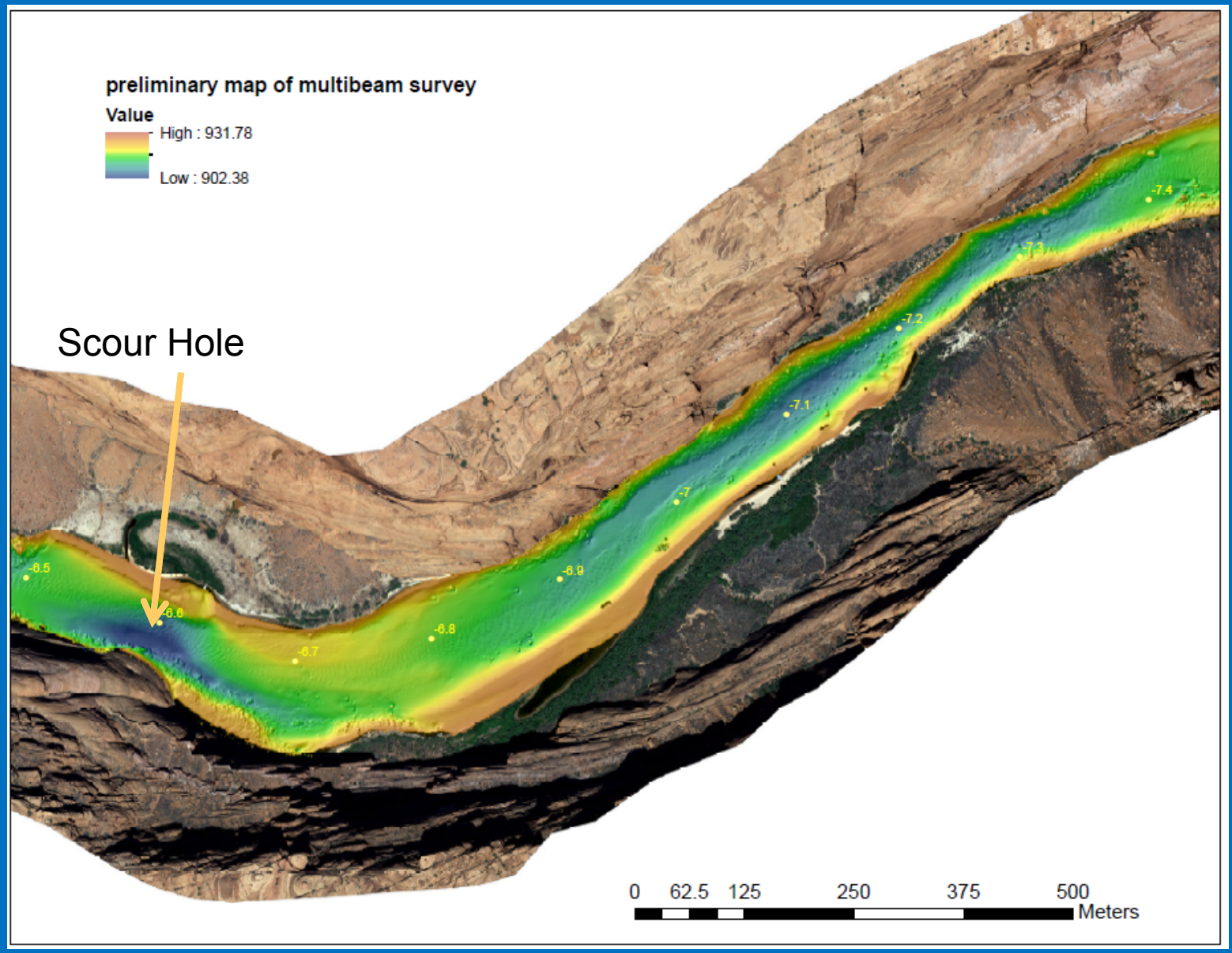
USGS

Below Horseshoe Bend to Eight-Mile Bar Segment



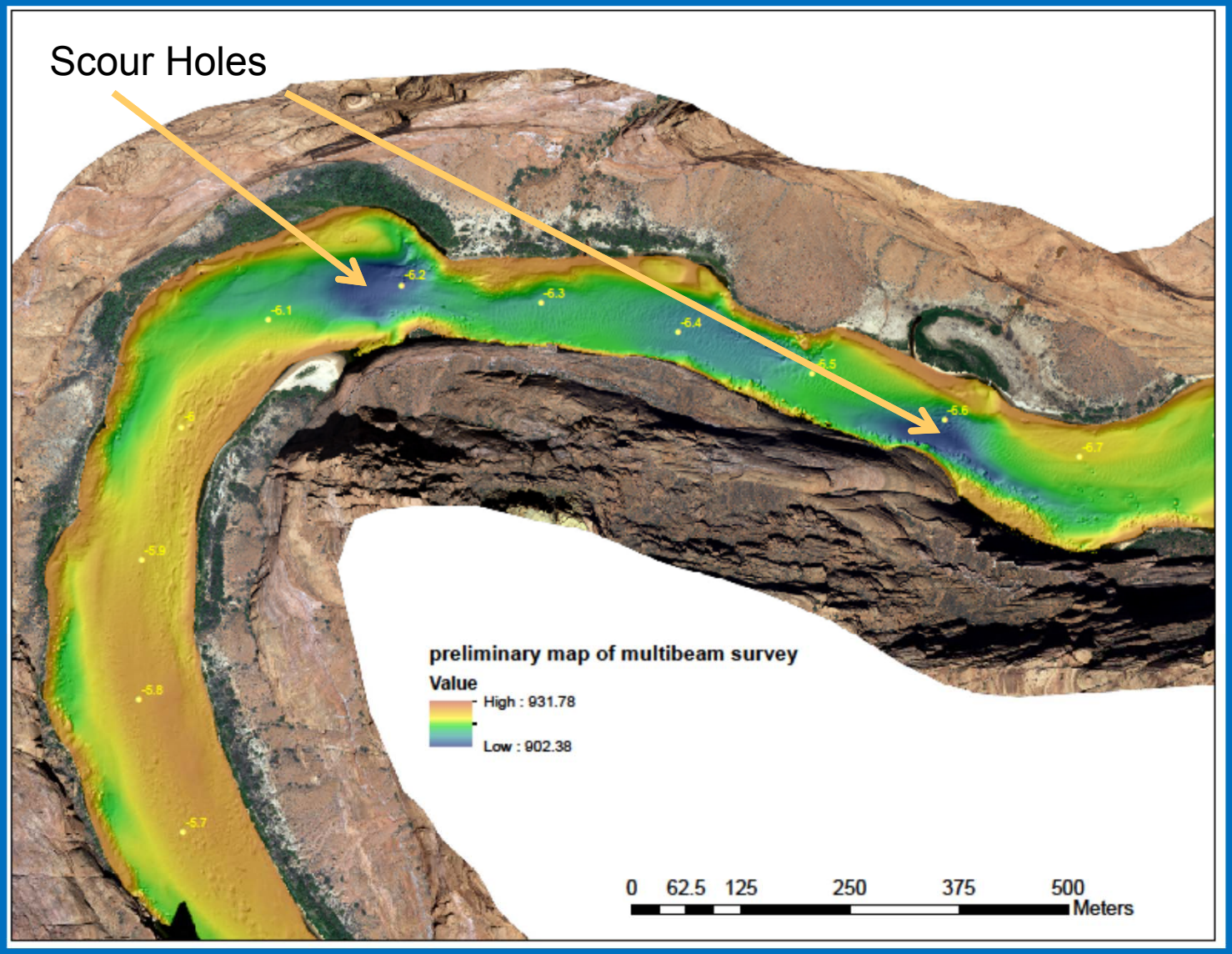


USGS Seven-Mile showing 1st "Deep Scour Hole"



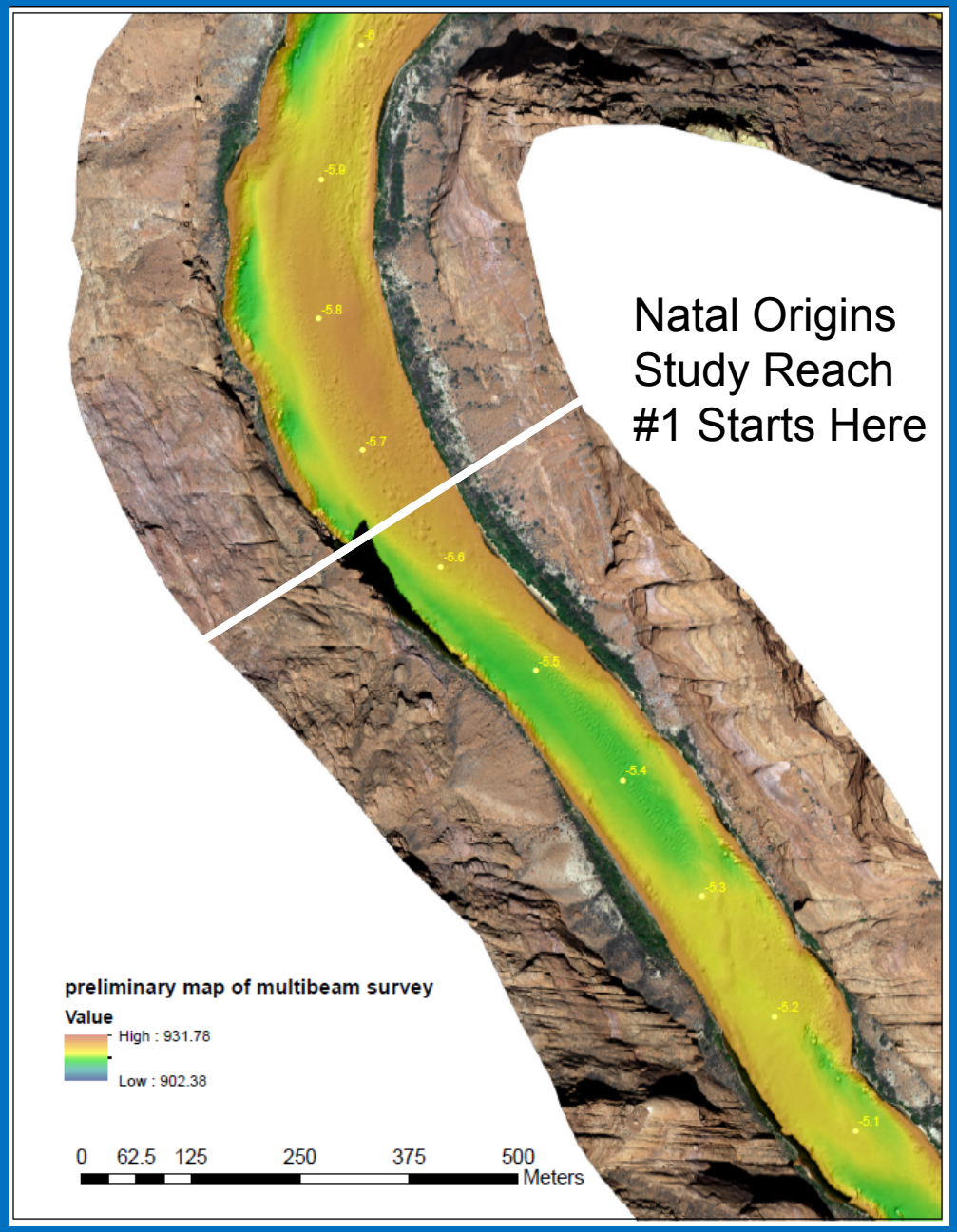
USGS

Six-Mile Sandbar & Re-vegetation Site



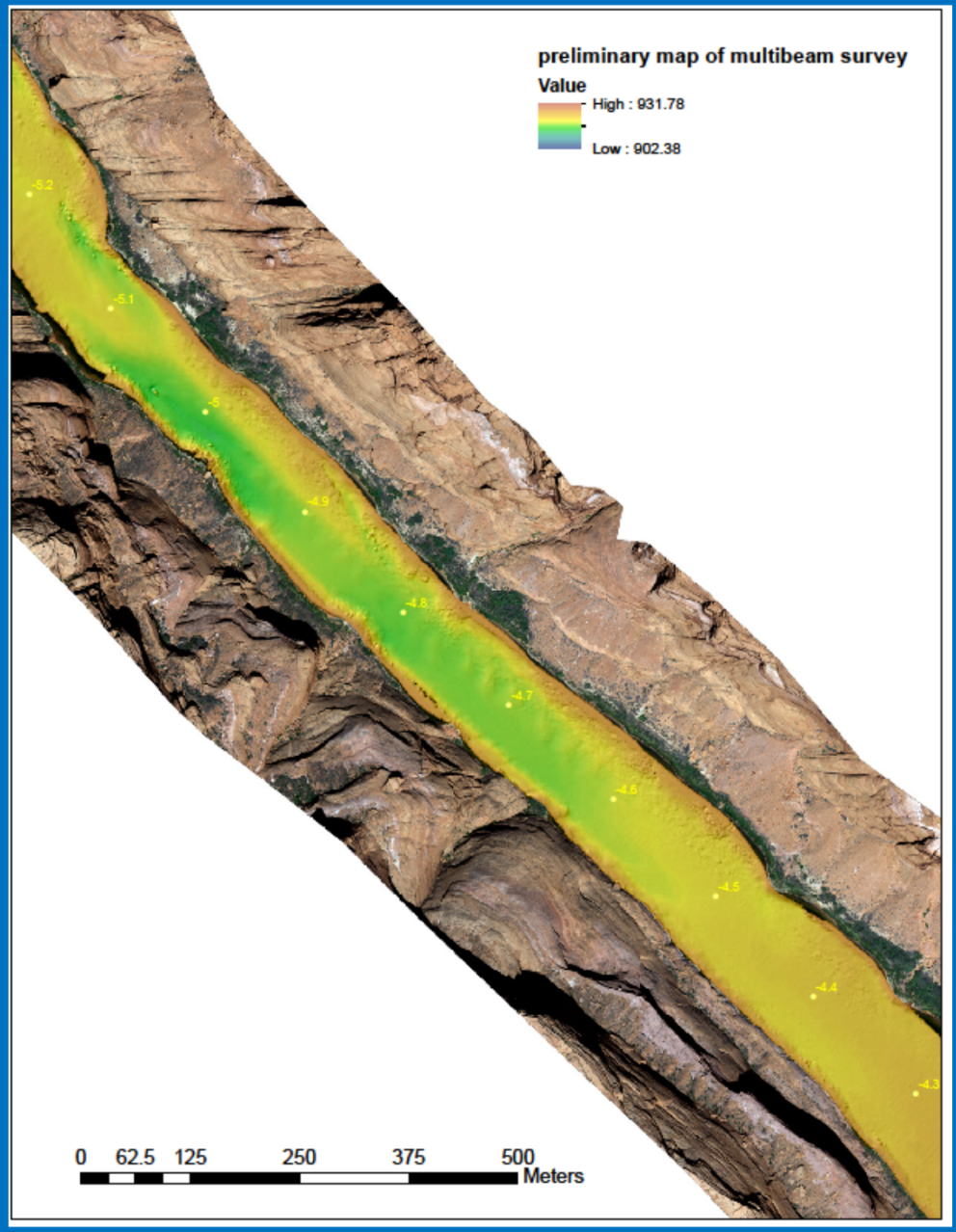
USGS

Six-Mile Bar & Top of NO Reach #1 Segment



USGS

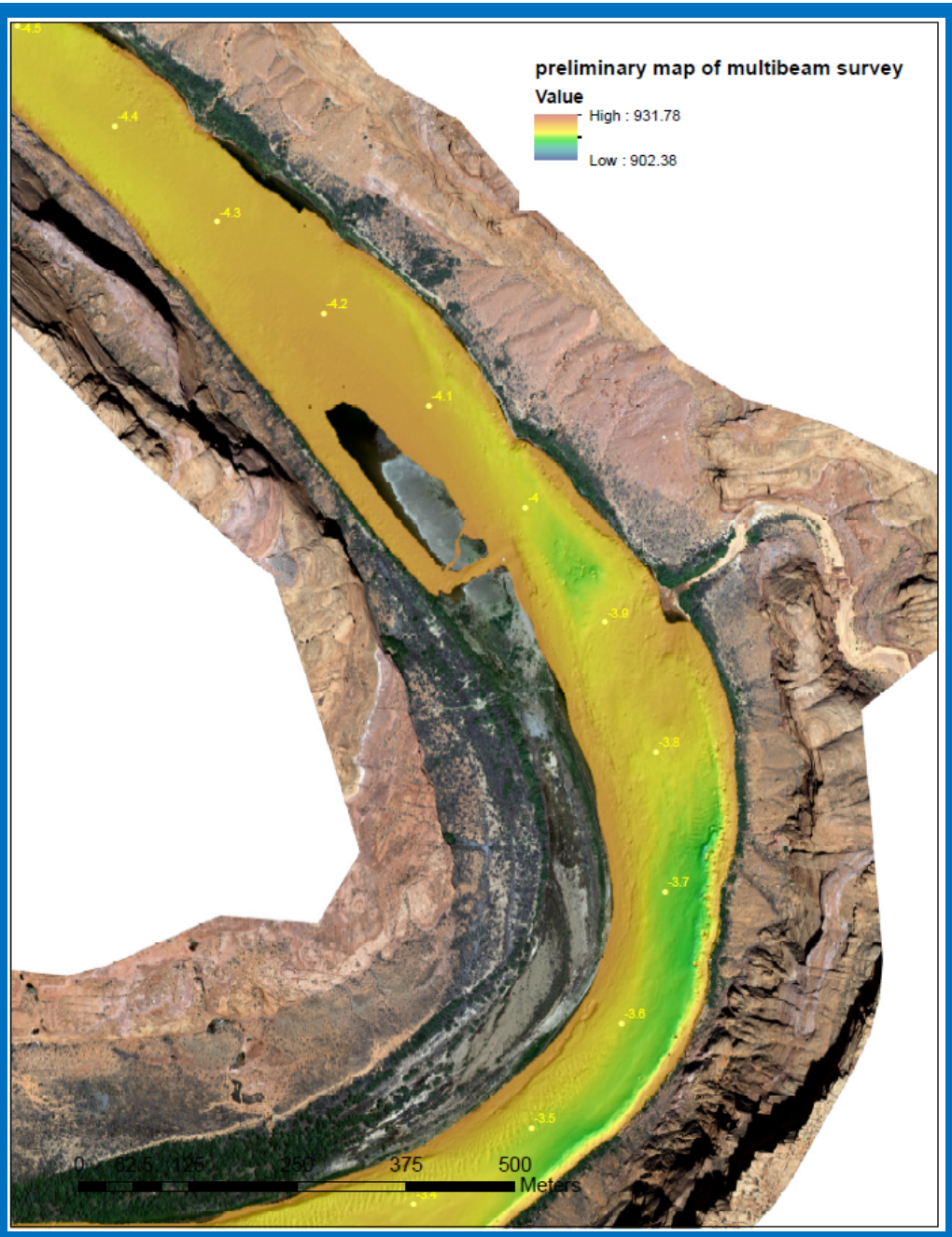
Upper Natal Origins Reach #1 Segment



USGS

NO Reach #1 US of Four-Mile Bar Segment

Middle of NO Study Reach #1

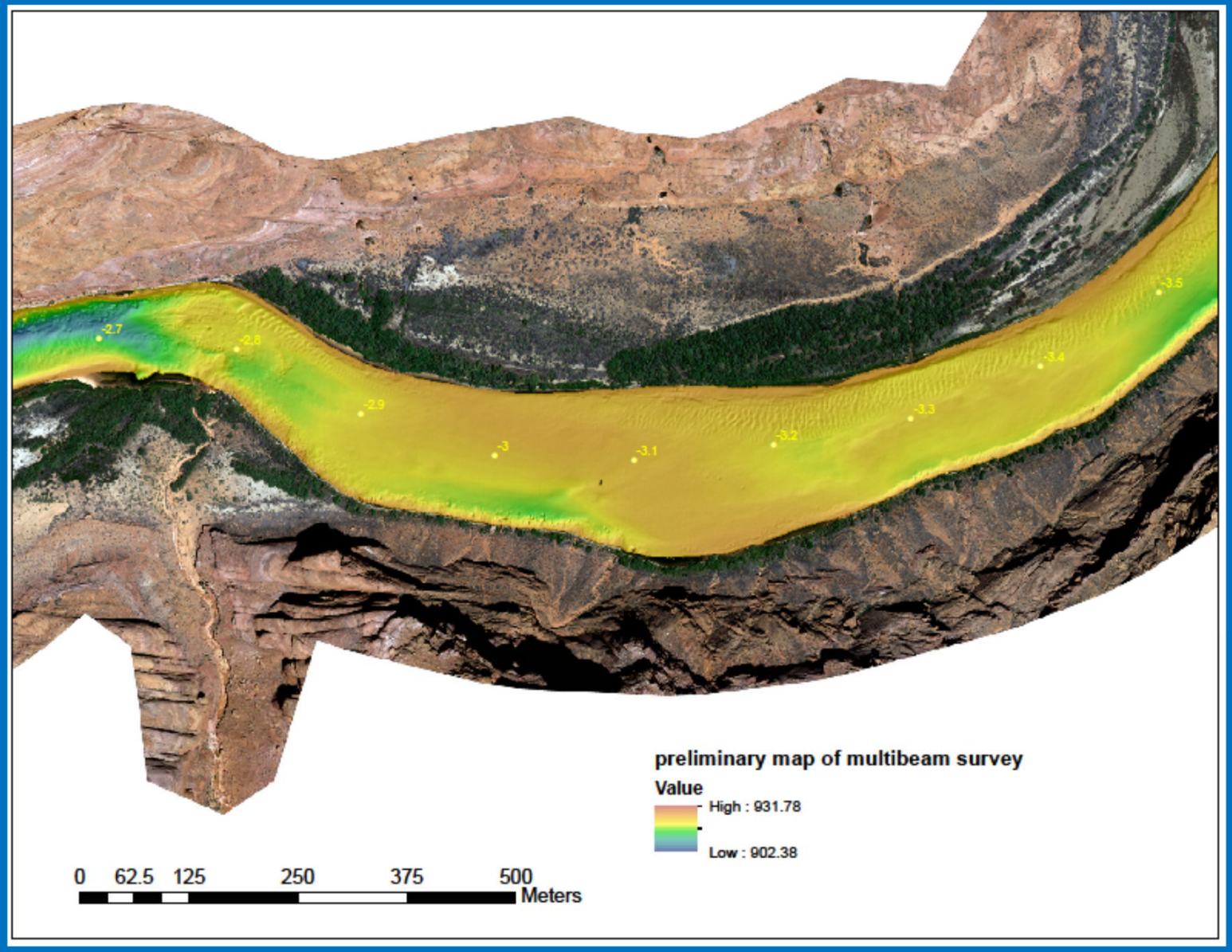


Waterholes Canyon & Upper end of Four Mile Bar

Major site for Rainbow Trout Spawning and Age-0 rearing

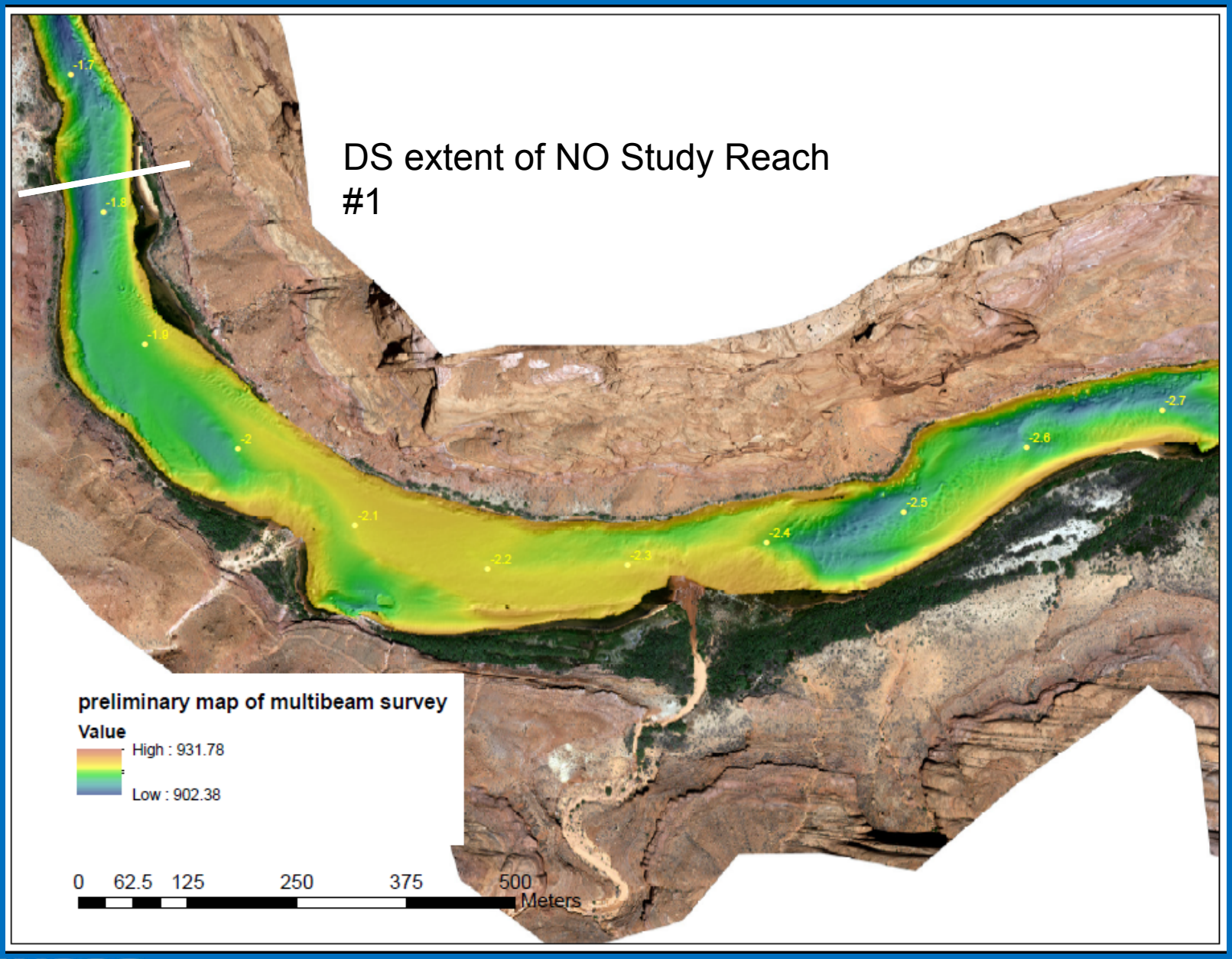
USGS

Four-Mile Bar & Waterholes Canyon Segment



USGS

Three Mile Bar US of Cove Canyon Segment

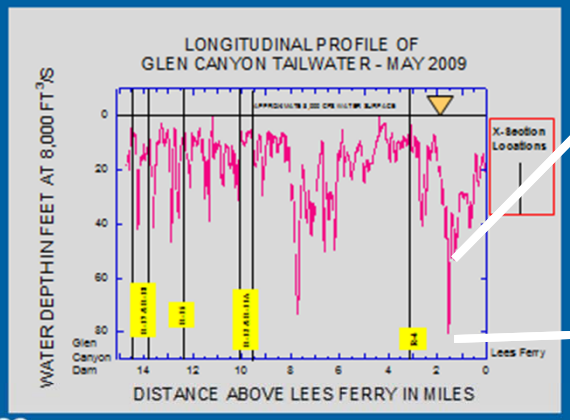


USGS

Lower NO Reach #1 (Cove and Fall Canyon Segment)

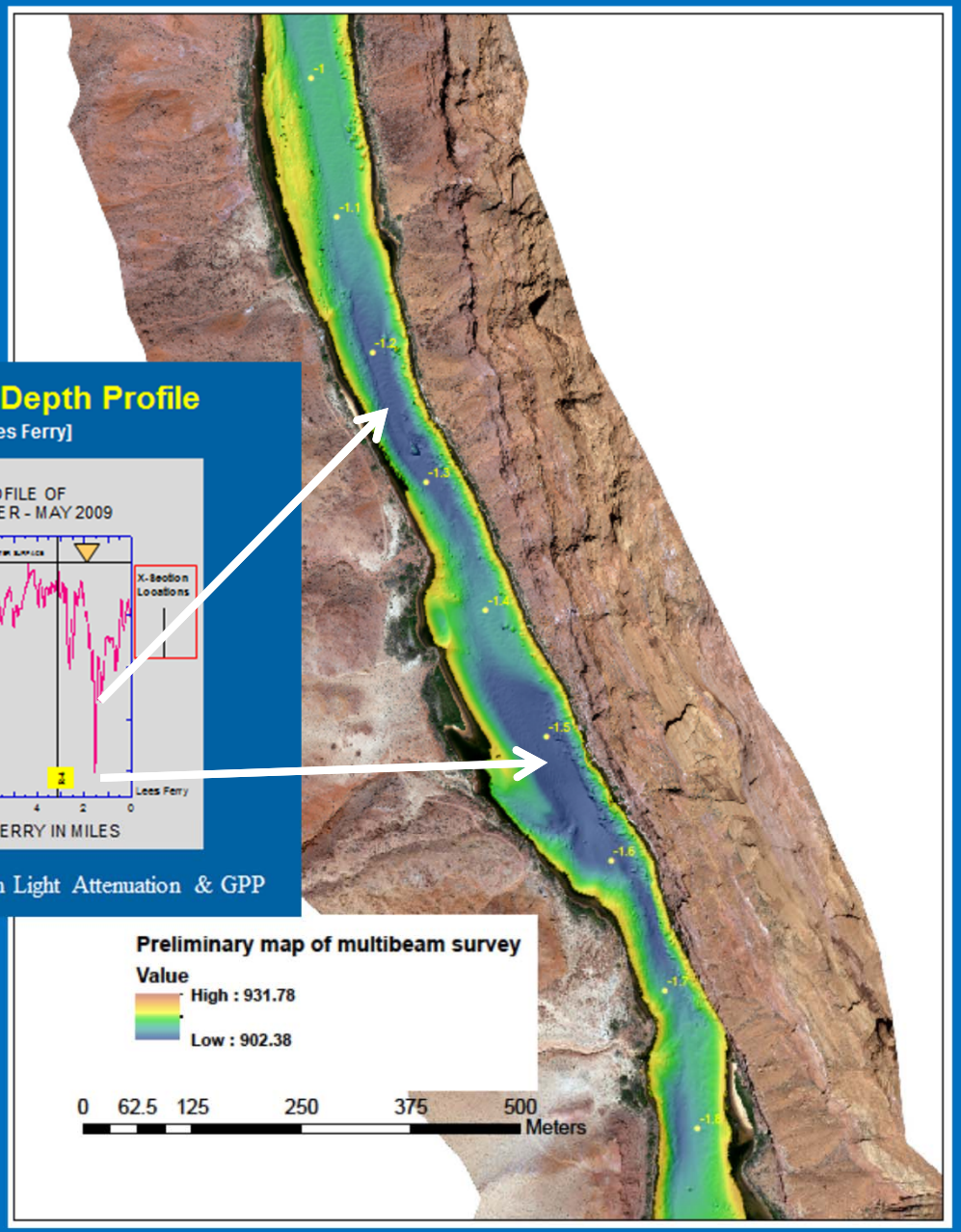
Longitudinal Channel Depth Profile

[Glen Canyon Dam to Lees Ferry]



USGS
PRELIMINARY DATA DO NOT CITE

Recall that Depth Matters in Light Attenuation & GPP



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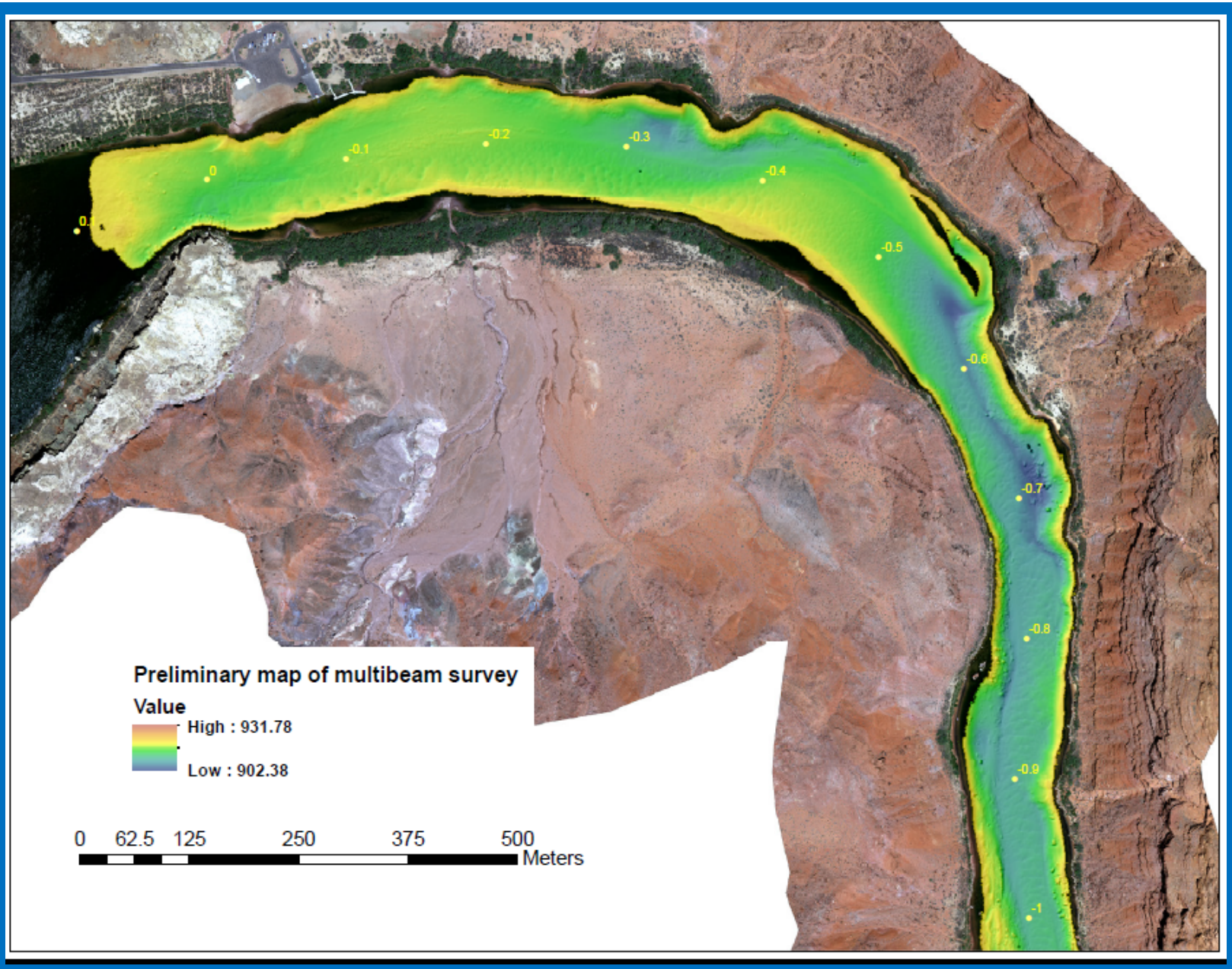
DS End of NO Reach #1 and Segment Below
Showing location of 2nd “Deep Scour Hole”



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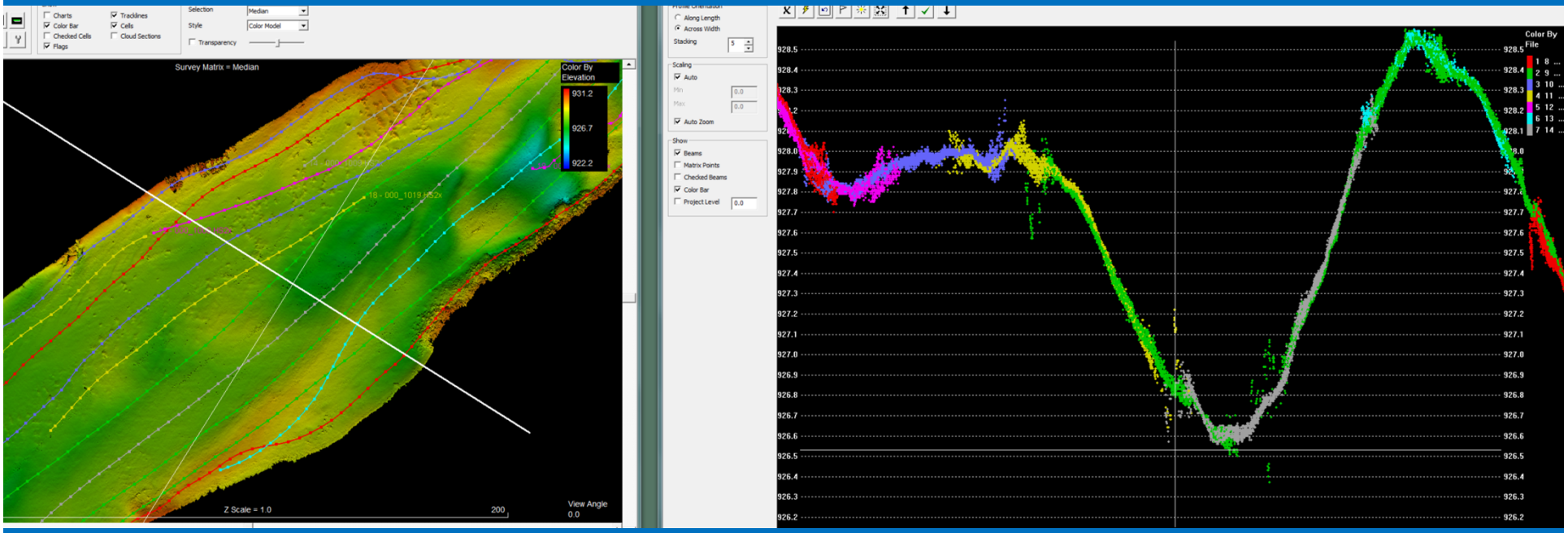
Lee Ferry Segment

Ongoing Editing of Raw Multi-Beam Acoustic Data – 2015 (Matt Kaplinski, NAU)



"Cleaning" Bathymetric Data "one line at a time"

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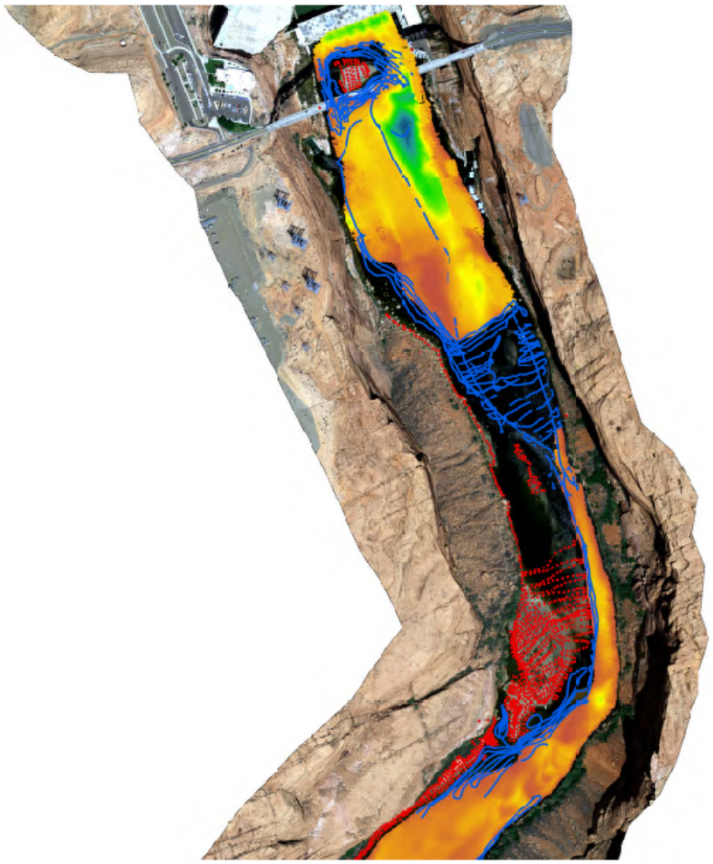
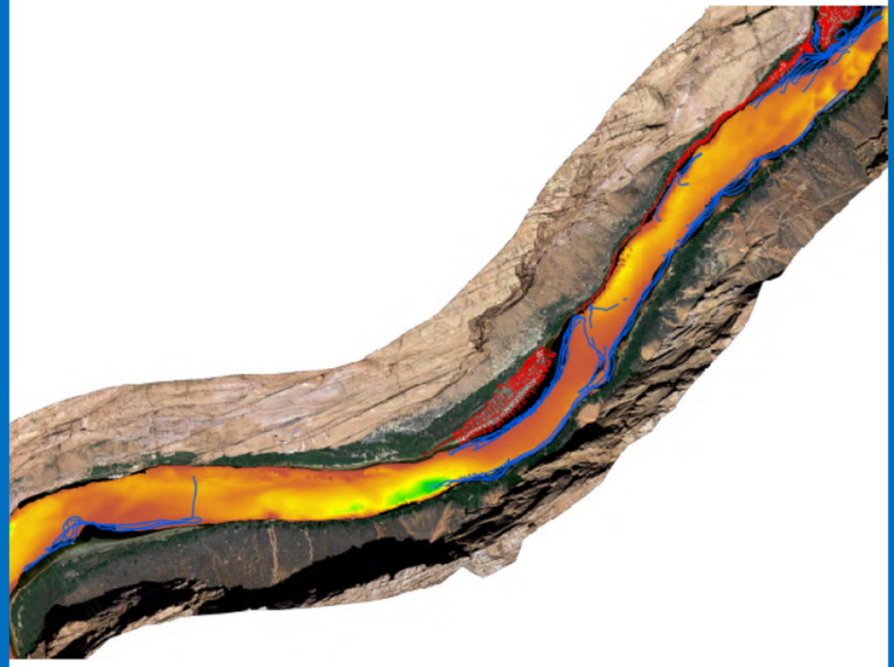
Ongoing Follow-Up Work by Project #3 Crew during Spring & Summer 2015





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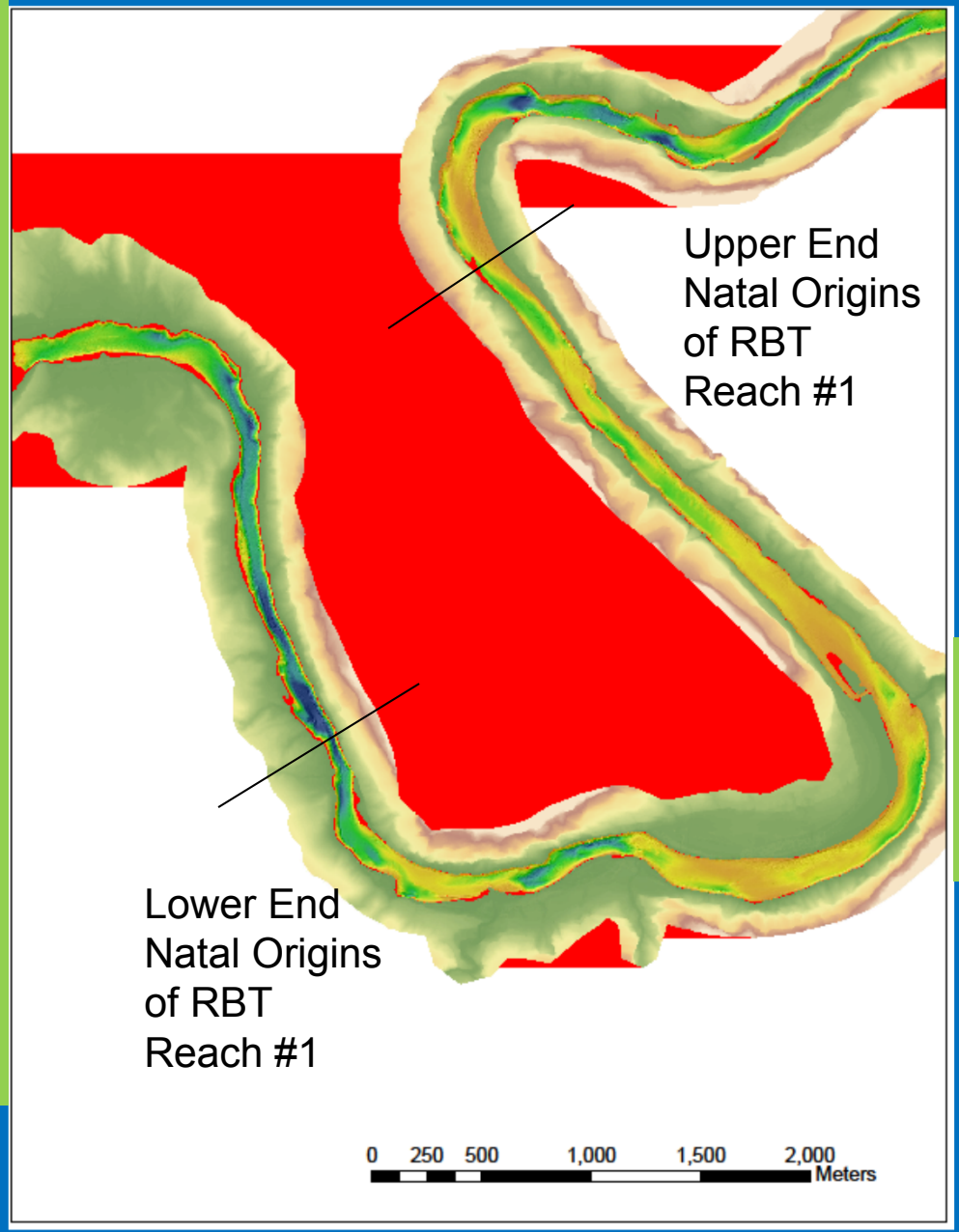
Filling In Gaps in Bathymetric Coverage w/ NAMDORs & Single Beam

- RED areas along channel margins are where elevations will need to be estimated…

- Still to be completed by GIS Project 14 & Project 3 teams in 2015

- Options for modelling Flow/Stage for the inundation of near shore areas and for other proposed research objectives are still being discussed…



HERE, THE SHORELINE TOPOGRAPHY HAS BEEN ADDED

THE DIGITAL SURFACE MODEL FROM OVERFLIGHT IMAGERY

Waterholes Canyon & Four-Mile Bar

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Final Step - Combining Bathymetric and Overflight Derived Topographic Coverages

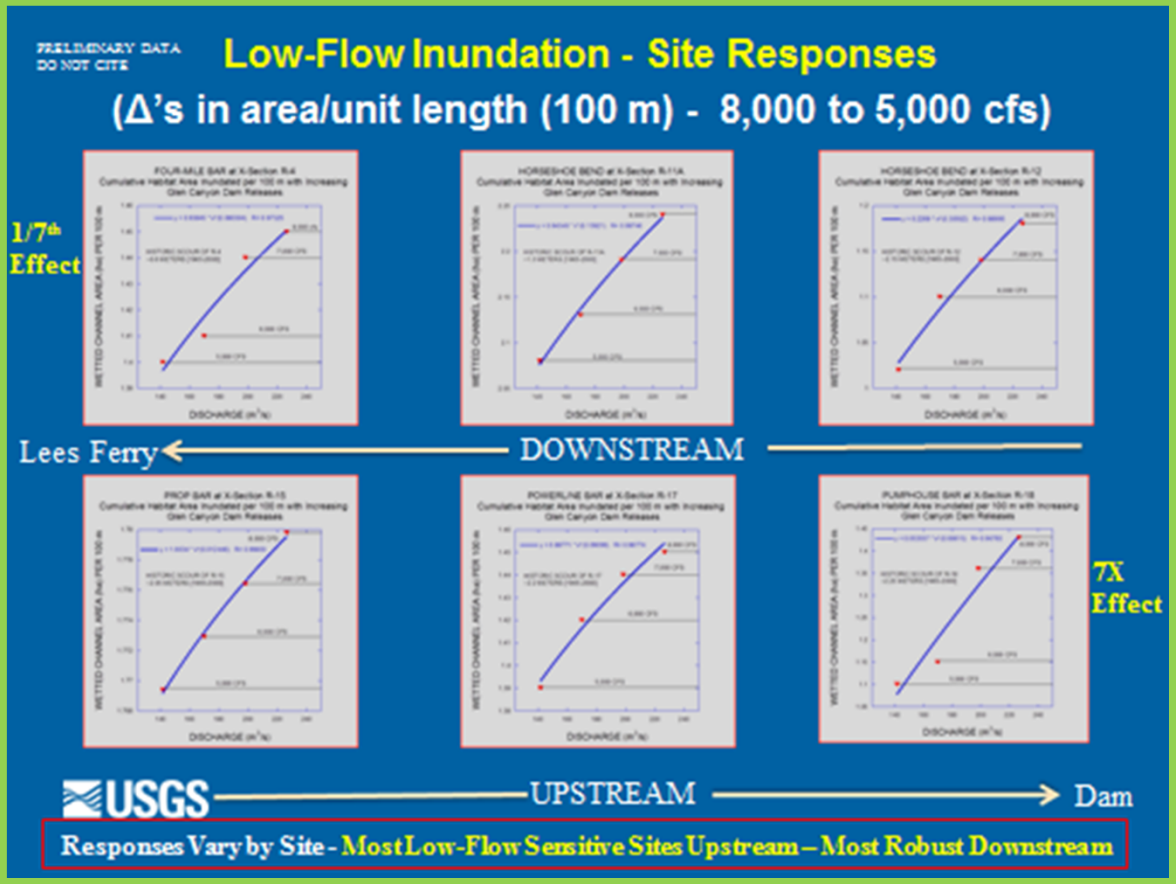
Using Channel Topography Data once Mapping is Completed?

1 - Channel Bed Inundation during Low-Flow Operations (Food & Fish)

Using the existing rating curves at available cross-sections

Or

with a new 2-D flow model



AND PERHAPS… answering other questions about future experimental management flows…

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2 - Using NO catch data & Slope Analyses to Identify the ***Lower-Angle Nearshore*** Areas used by Age-0 Trout in Late Spring & Summer

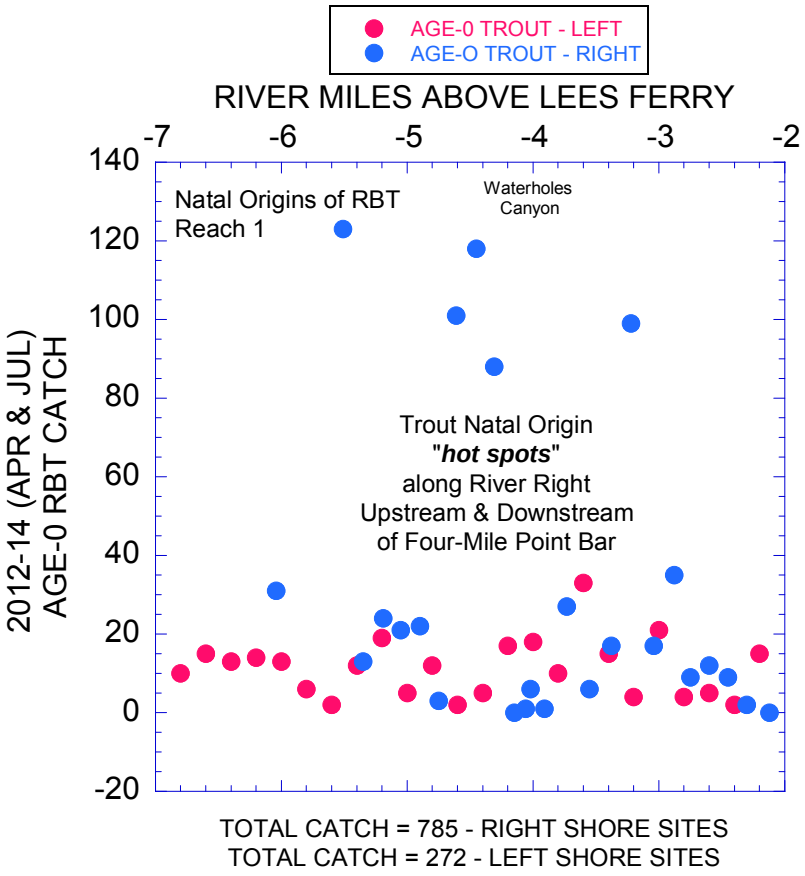
Using Channel Topography Data once Mapping is Completed?

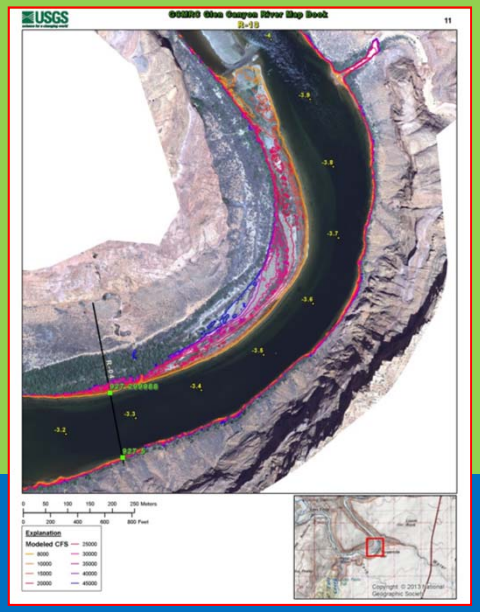
3 - Design of experimental hydrographs for LTEMP "*Trout Management Flows*"

Using the existing rating curves at available cross-sections

Or

with a new 2-D flow model

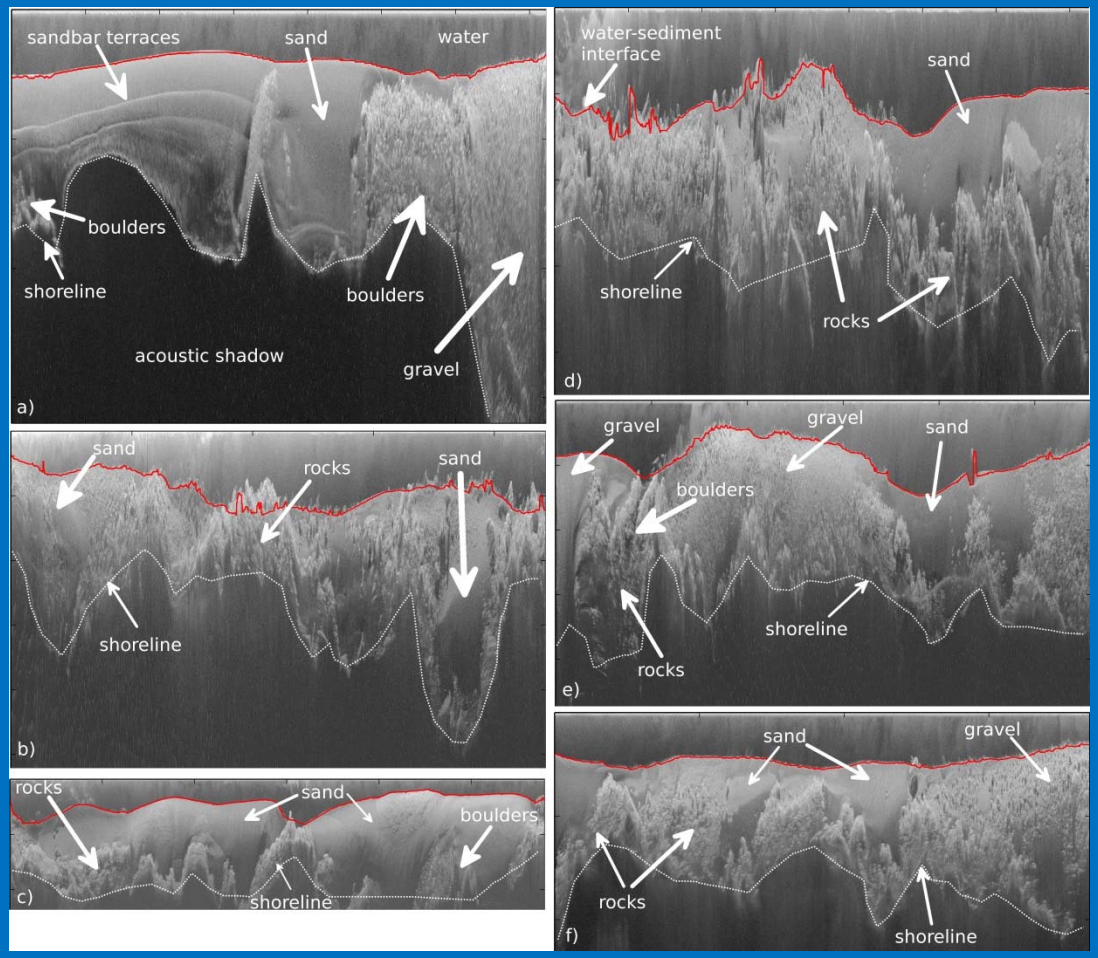




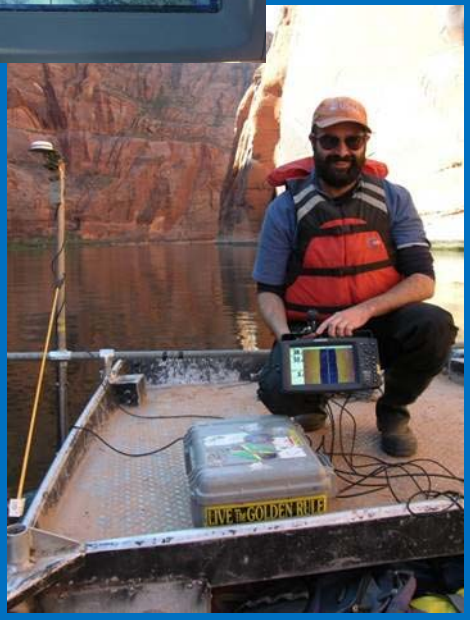
Using new maps and flow modelling can help with identifying where ***Various flow influences will be greatest on trout early life-stages***

Preliminary data – do not cite

Using side-scan sonar to map bed textures in tailwater fishery segment



Examples of how sonar can be used to map bed areas used by bugs & trout for spawning



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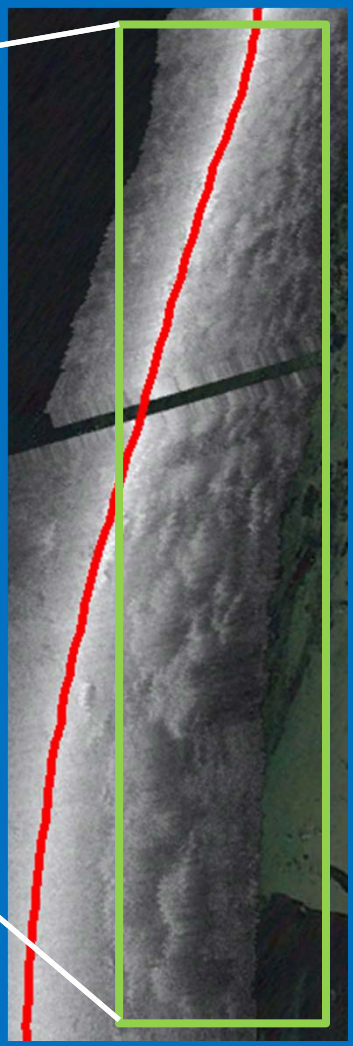
Sonar Imagery and Analyses Lead: Dan Buscombe with graduate Student Dan Hamill

Also, using side-scan sonar to map aquatic vegetation in Glen Canyon



Question: how are aquatic vegetation, trout and food base spatially related?

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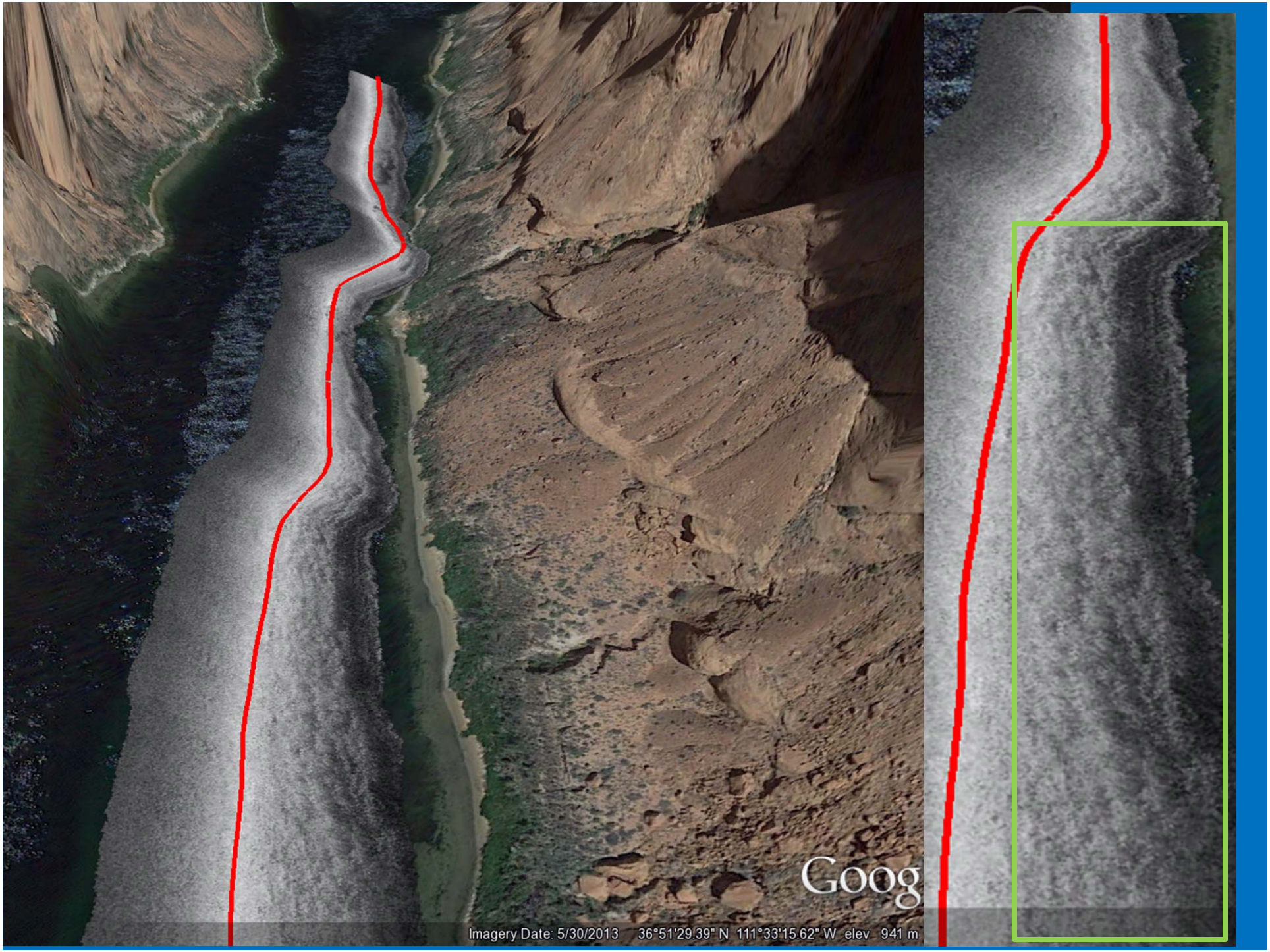
Sonar Imagery and Vegetation Analyses:
Dan Buscombe with Mike Yard

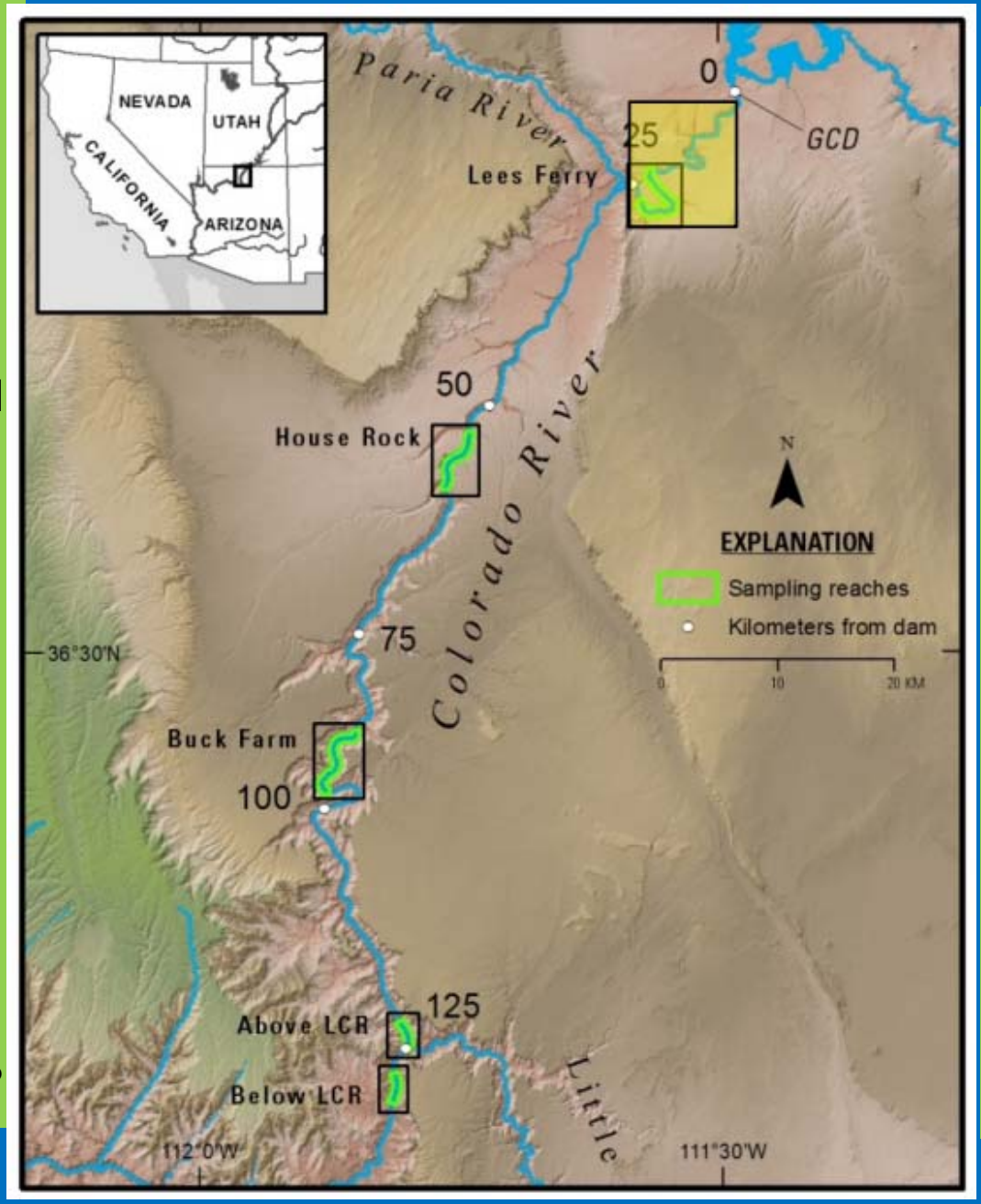

Goog
Imagery Date: 5/30/2013 36°51'29.39" N 111°33'15.62" W elev 941 m

Natal Origins
Of Rainbow Trout
Study Reaches

<u>Questions:</u>

What environmental factors most Control the DS Length of the Tailwater trout Fishery?

How do the Lees Ferry & Marble Canyon segments Change over time With evolving dam Releases and Paria Inputs of Sediment?



Reach 1

Reach 2

Reach 3

Reach 4A
Reach 4B

Additional Slides - if more time is available?

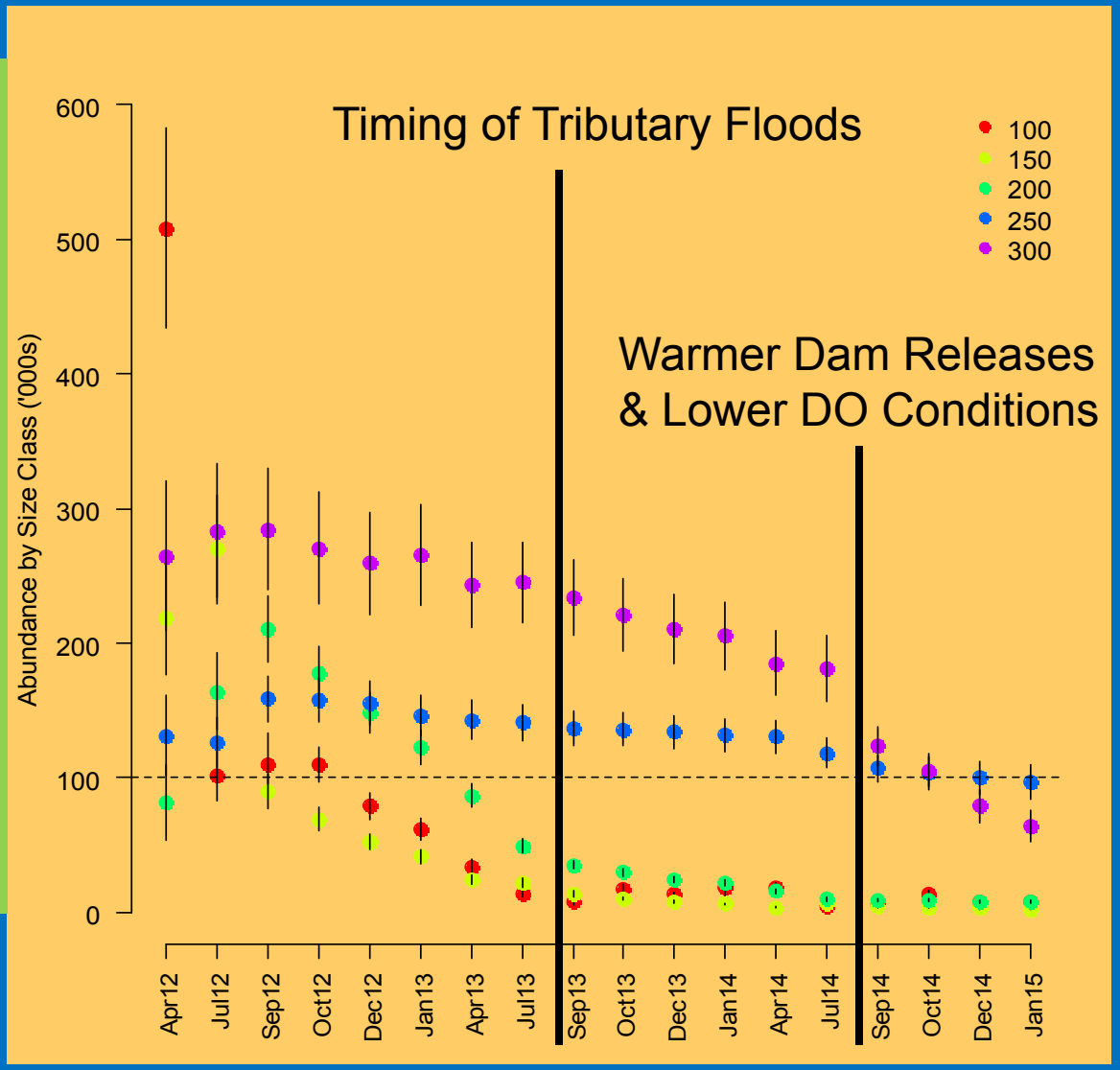
Trends in Lees Ferry Rainbow Trout Estimated Abundance

NO Reach 1

Both *Top-down* & *Bottom-up*

processes may be at work in the tailwater trout fishery here

What about the Trout below Lees Ferry?



USGS

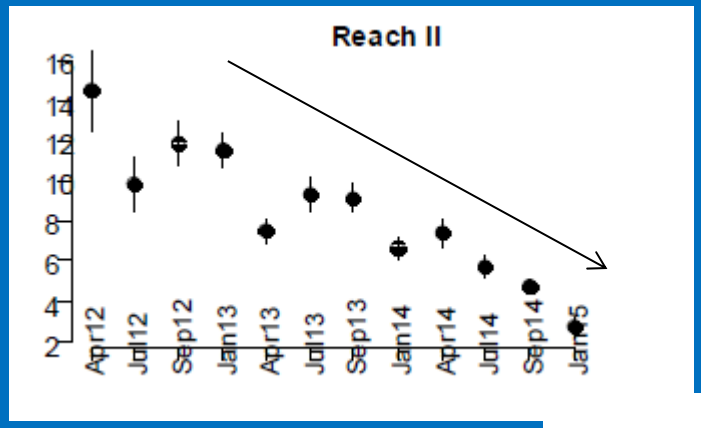
Modelling - Josh Korman
Preliminary - Do Not Cite

Shown by Size Class

Trends in Rainbow Trout between Paria River & LCR

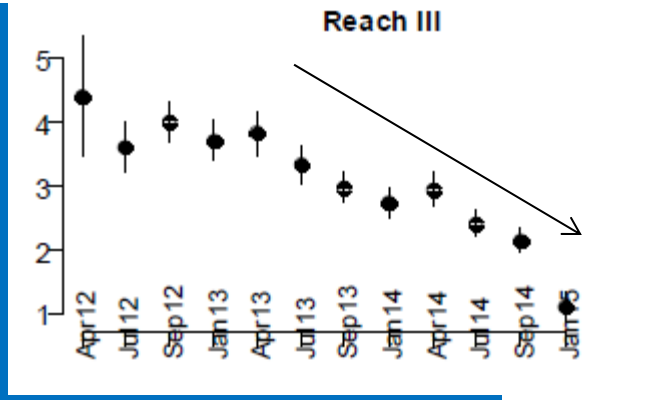
Abundance ('000s per km)

River Miles 17-20

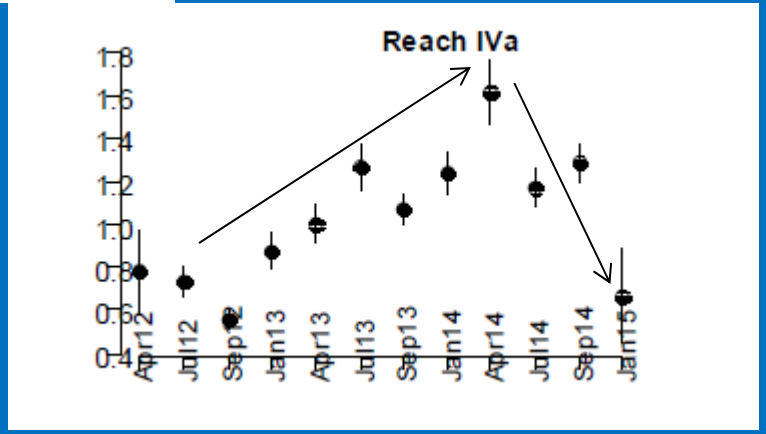


NO Sampling Trips

River Miles 37-41



River Miles 60-61



Possible Reasons for Downstream Declines in Trout Condition & Abundance Below Lees Ferry?

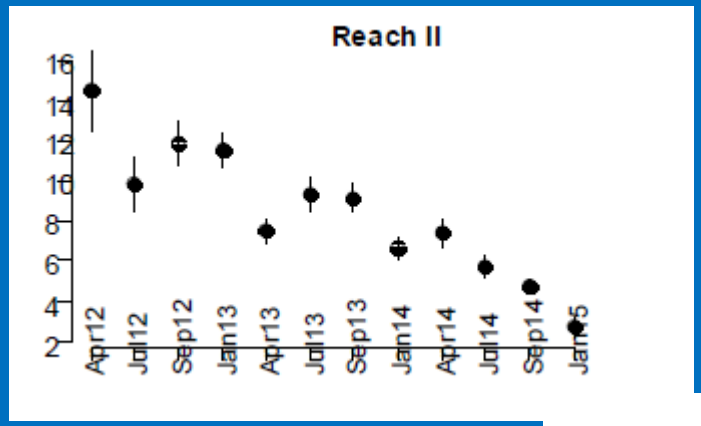
USGS

Modelling - Josh Korman

Preliminary - Do Not Cite

Trends in Rainbow Trout between Paria River & LCR

River Miles 17-20



NO Sampling Trips

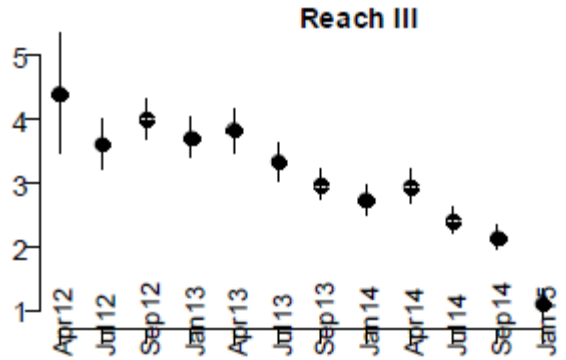
Factors that may have negatively influenced rainbow trout since 2011 population boom

"*Bottom Up*" below Lees Ferry

"Sand Loading, Temperature & Turbidity"

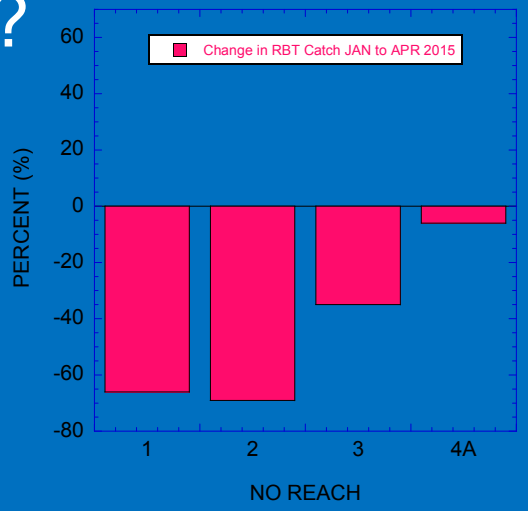
USGS

River Miles 37-41



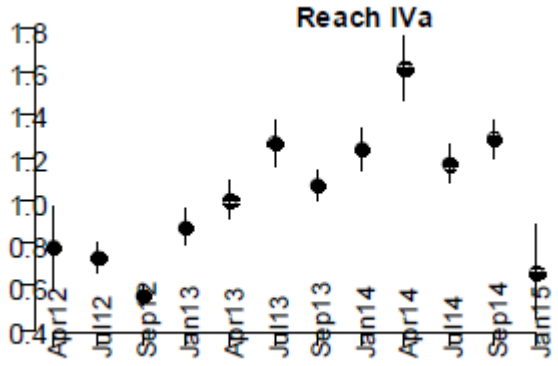
???

Catch dropped again



between JAN & APR 2015!

River Miles 60-61



Modelling - Josh Korman

Preliminary - Do Not Cite

2012 - 2014 Tributary Sediment Inputs & Influence on Tailwater

- **At start of NO Project [Fall 2011 through JUL 2012 sampling trip]**

There Existed a Sand Deficit in UMC ~ 0.6 (±0.3) Tg & ~ 0.5 (±0.3) Tg in LMC

This owed to the 12.5 MAF volume release of WY 2011 from Lake Powell

- **Afterwards, all NO monitoring was likely influenced by tributary processes [SEP 2012 through APR 2015]**

Paria Sand Inputs ~ 4.0 Tg between JUL 2012 through APR 2015

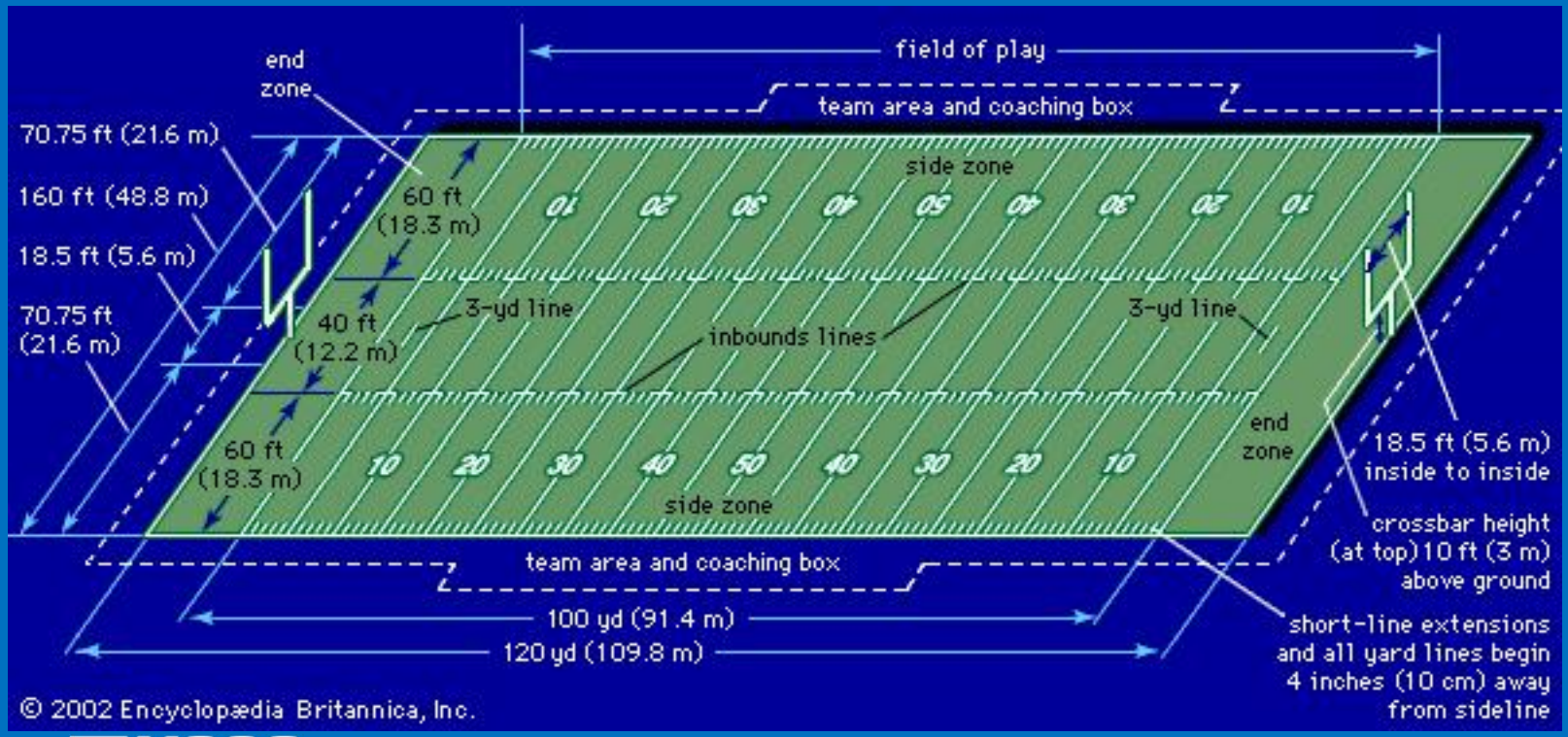
- **By spring 2015, sand transport data suggest**
  ~ 2.6 Tg surplus in Upper Marble Canyon
  & perhaps a 0.2 – 0.7 Tg surplus in Lower Marble
  (accumulations along bed & shorelines)

USGS

Project 10 asks: "How do changes in bed texture conditions associated with sand deficits & surpluses below GCD correlate with rainbow trout abundance and conditions over 125 km?

So, what does a “Teragram” (Tg) of Sand Look Like?

Well, it’s 1,000,000 metric tons…
Picture a pile of sand covering this gridiron that is 440’ high!

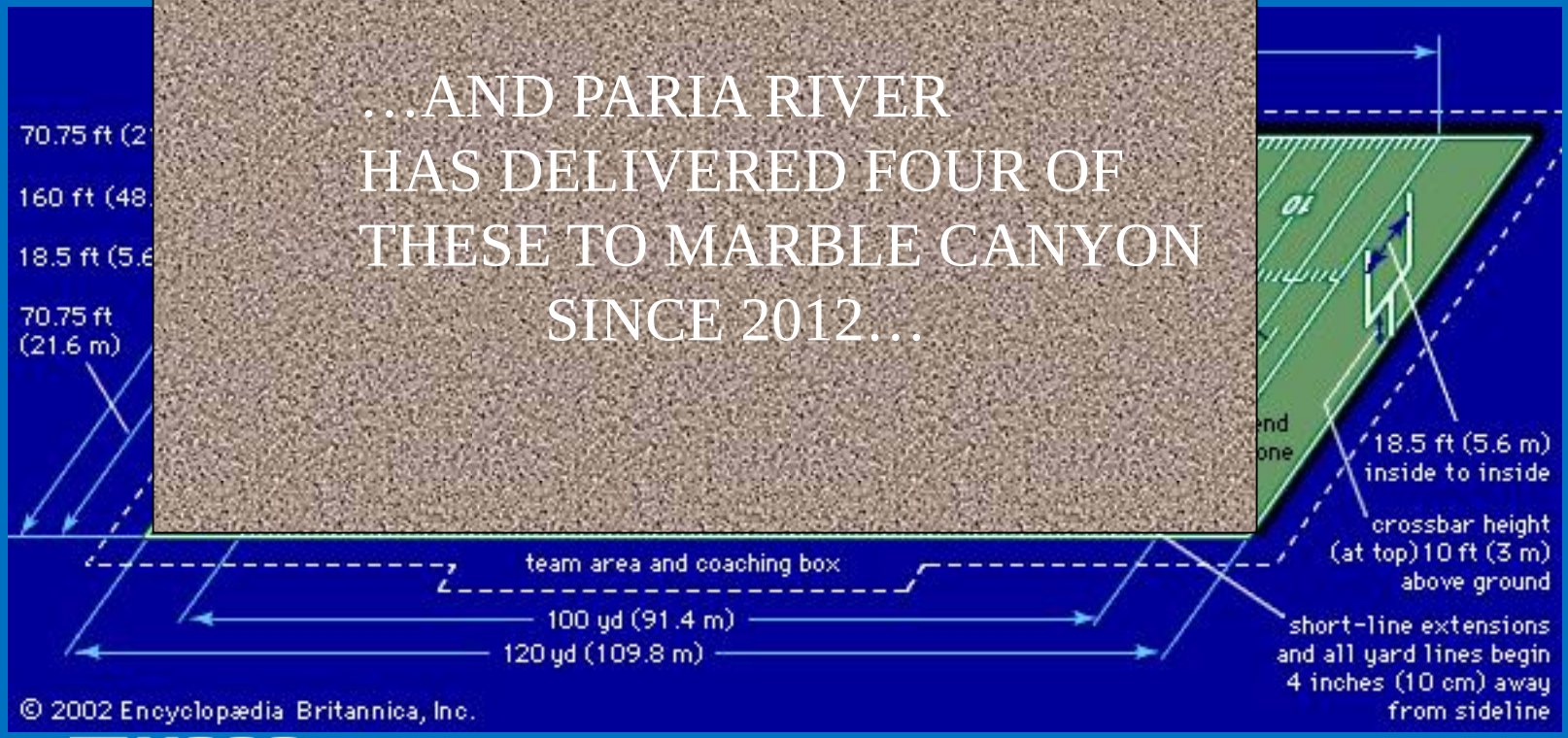


USGS

Or,
a 44 story Building that’s
160’ wide x
360’ long

A Tg OF SAND…
IS A BIG PILE OF SAND!

…AND PARIA RIVER
HAS DELIVERED FOUR OF
THESE TO MARBLE CANYON
SINCE 2012…



USGS

The Paria River added about 4 of these since 2012 to Marble Canyon – what are the fish & food influences?

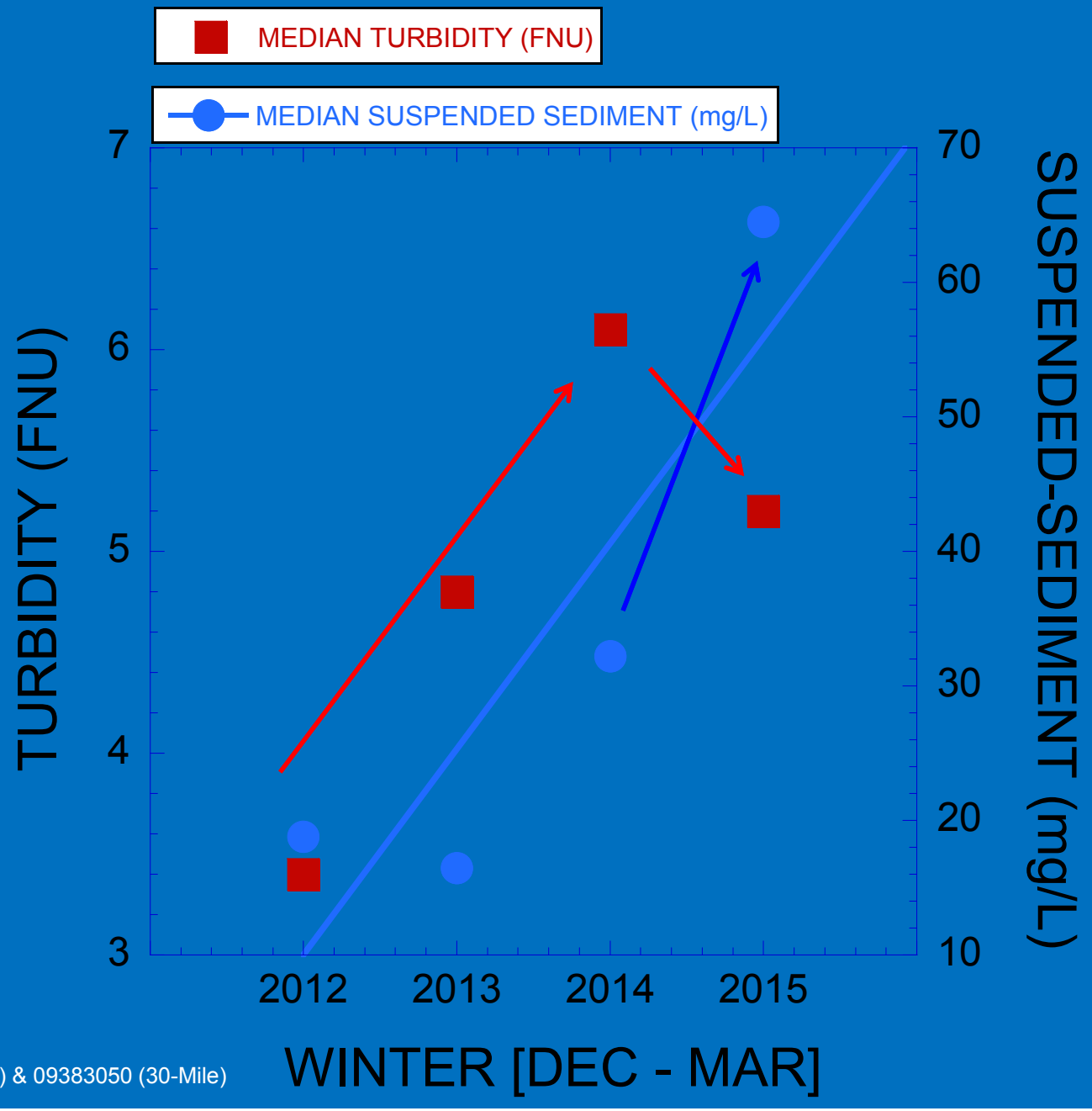
Or,
a 44 story Building that's
160' wide x
360' long

Did Sight Feeders in Upper & Mid-Marble Canyon Notice the Difference in 2014-15?

Evolution of Mainstem Water Clarity Conditions at 30-Mile

Perhaps Reflects the Water quality In NO Reaches 2 & 3

What were the conditions like In Lower Marble?



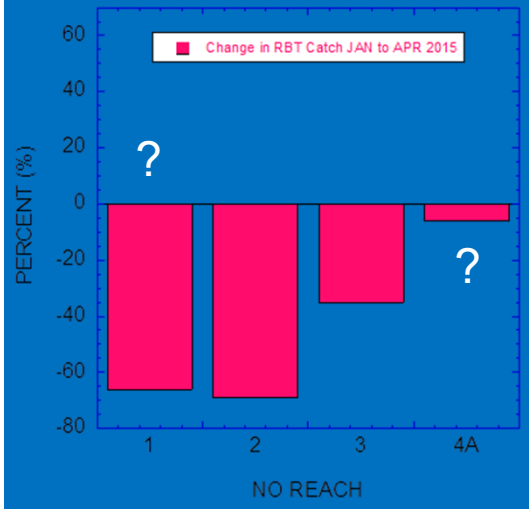
USGS

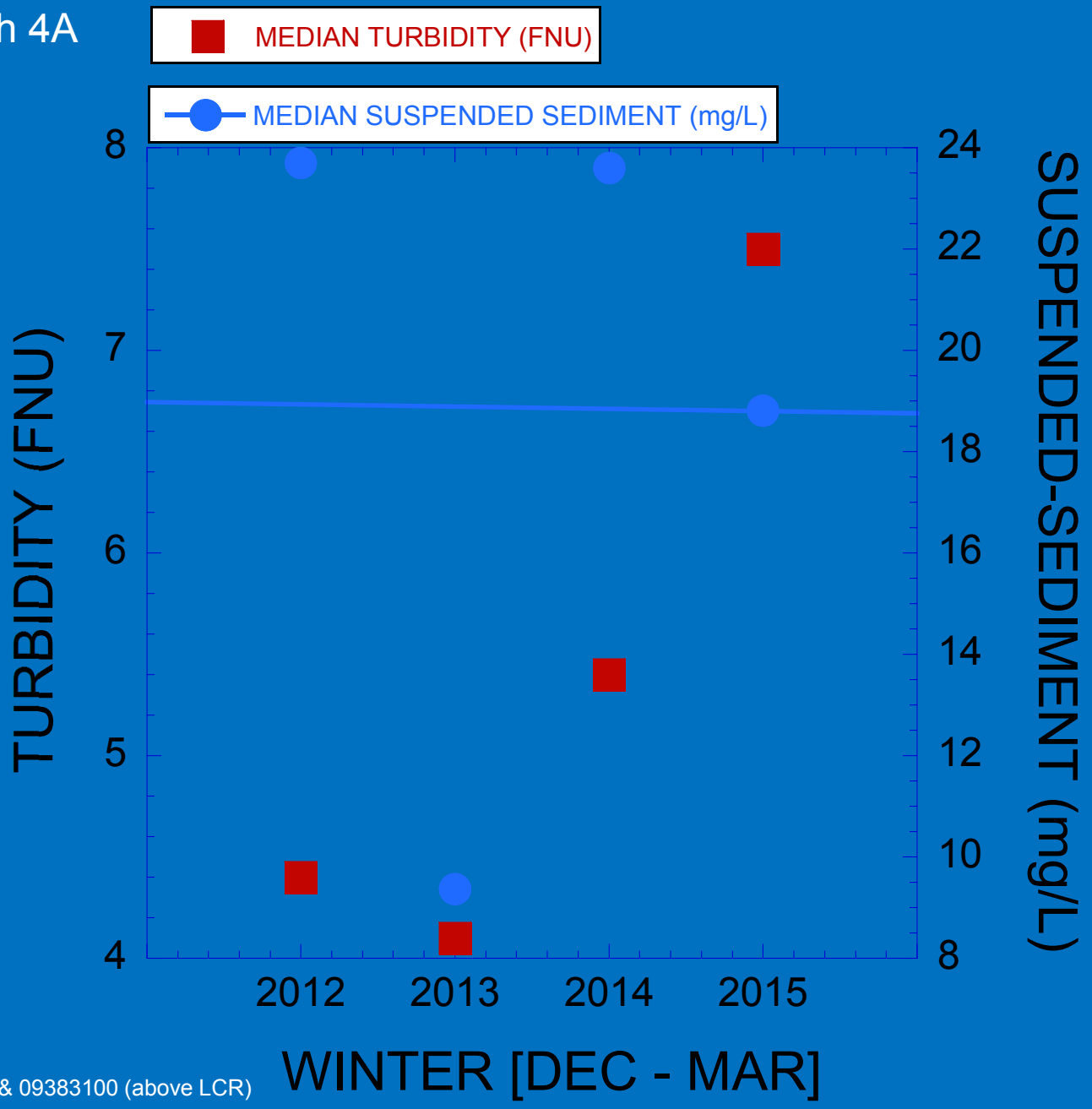
Data from USGS stations: 09382000 (Paria) & 09383050 (30-Mile)

Median Winter 2014-15 TSS Concentration only about 1/3 of Upper Marble Canyon

@ River Mile 61 – Reach 4A

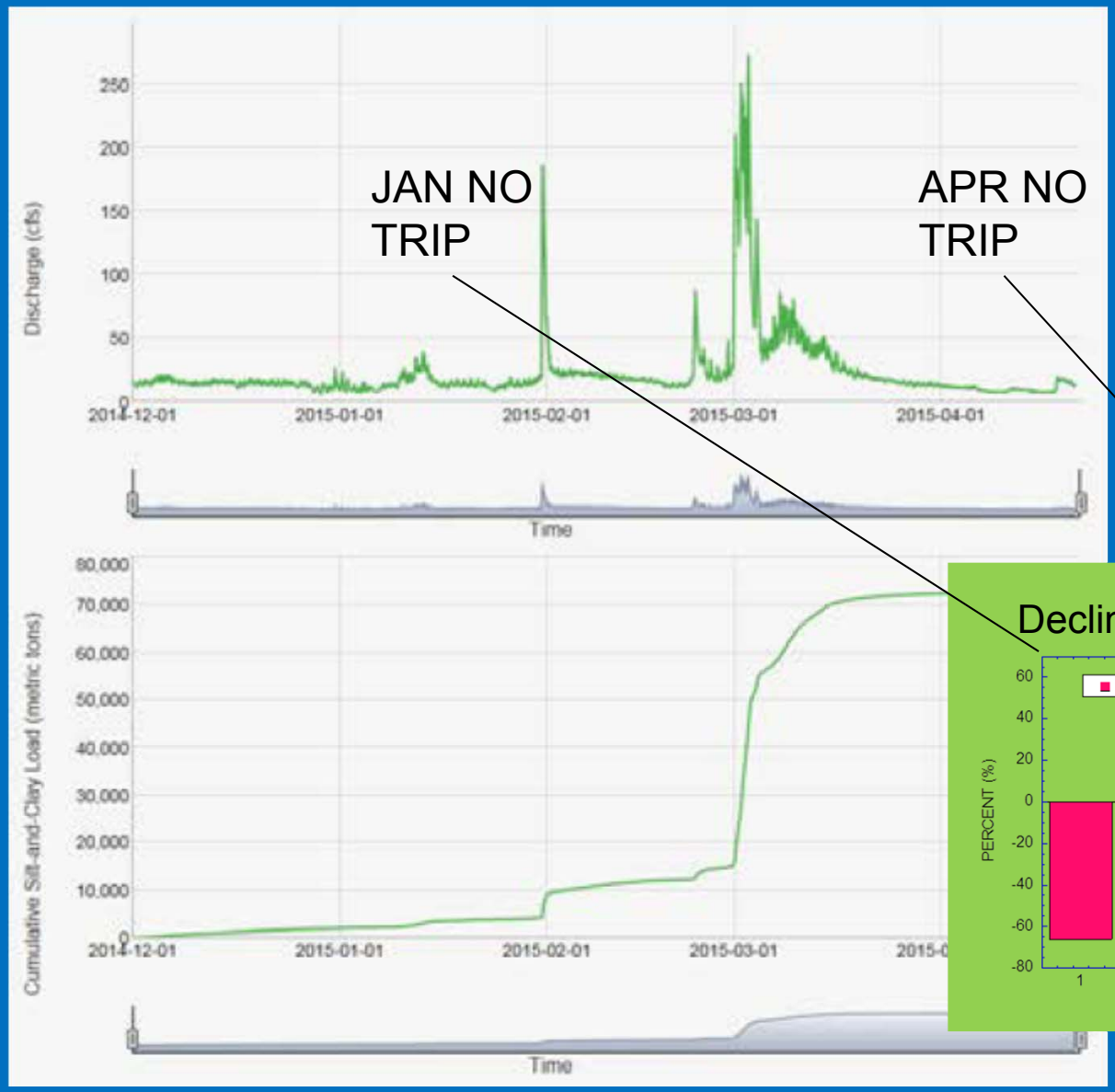
Total suspended-sediment concentrations in NO Reach 4A were not the same as in upper-Marble Canyon during winter 2014-15

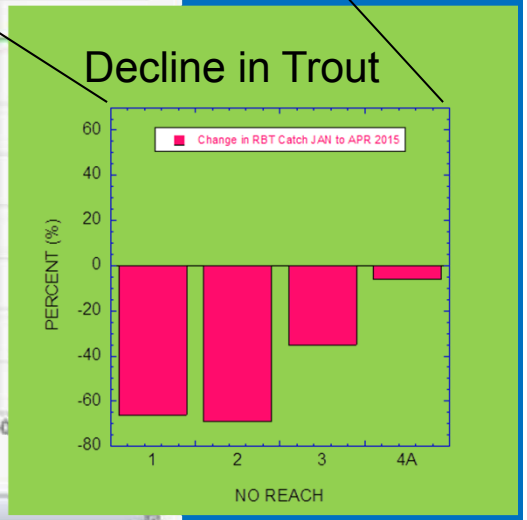




Data from USGS stations: 09382000 (Paria) & 09383100 (above LCR)

Inputs of Fines during Winter 2014-15 may have also played a role in trout declines

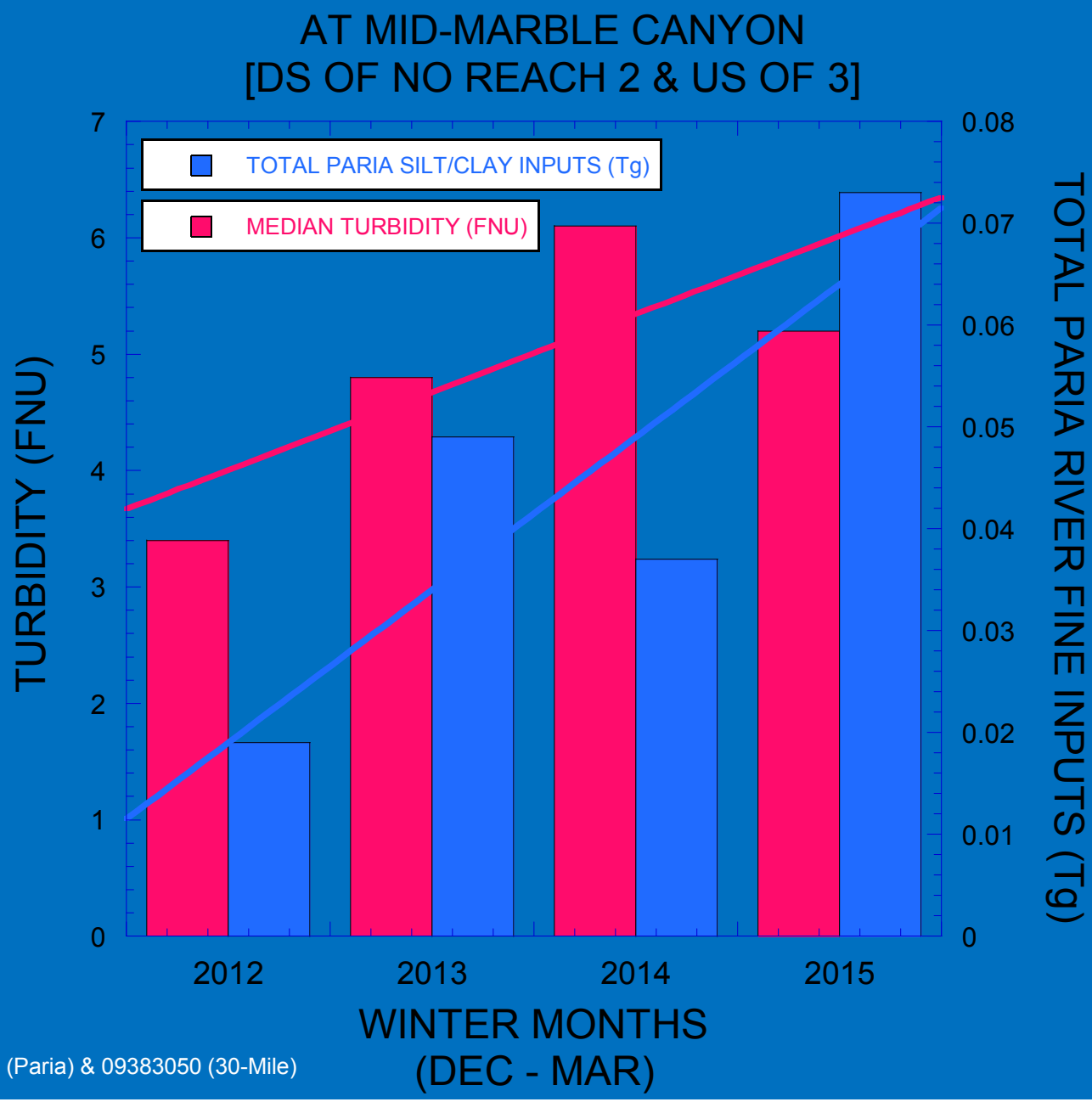




USGS

Data from USGS stations: 09382000 (Paria River near Lees Ferry, AZ

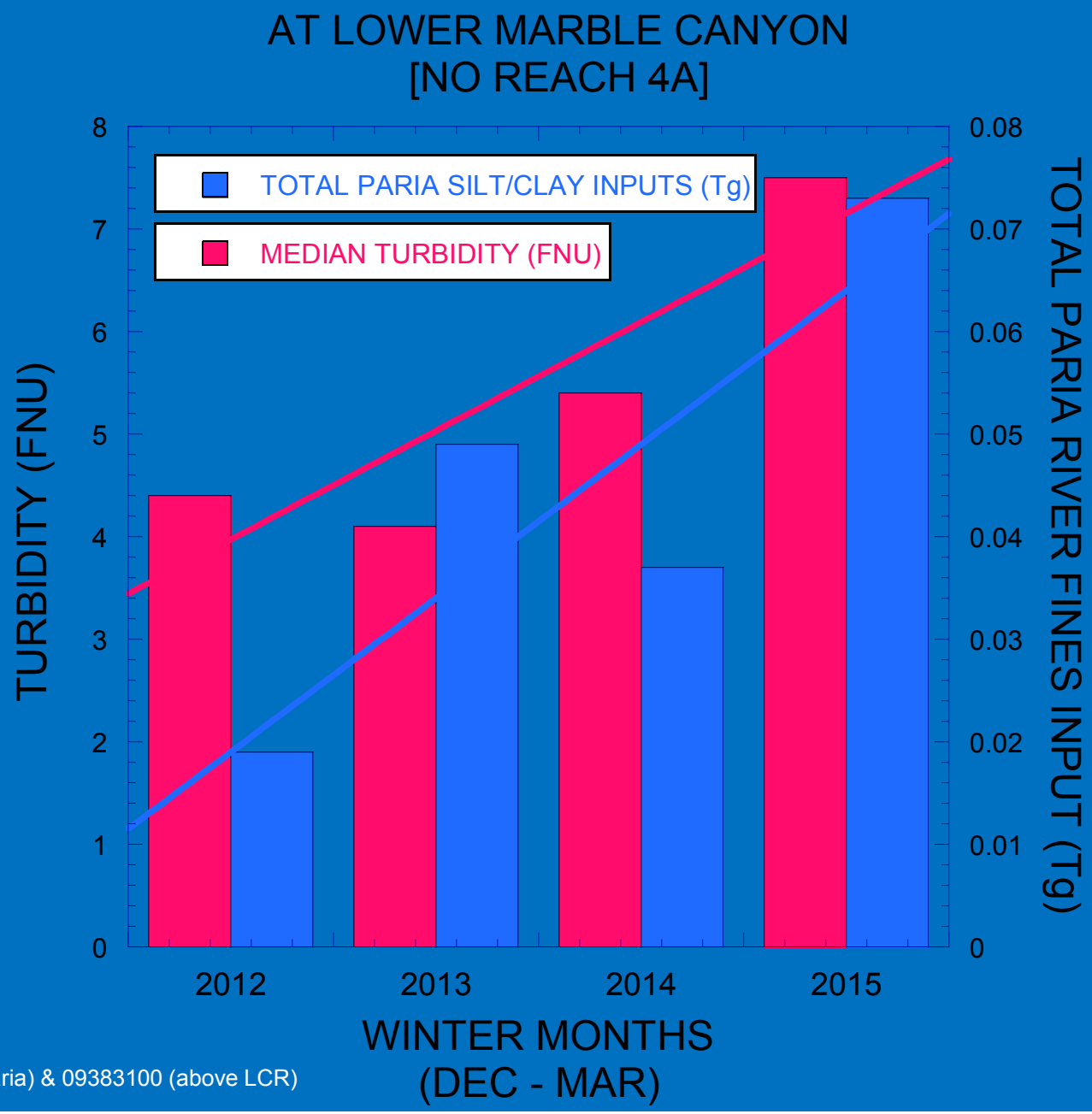
Influence of Paria River Sediment Inputs on Marble Canyon – 2011 to 2015



USGS

Data from USGS stations: 09382000 (Paria) & 09383050 (30-Mile)

Evolving Mainstem Water Clarity Conditions Above LCR



USGS

Data from USGS stations: 09382000 (Paria) & 09383100 (above LCR)

Median Summer and Fall Water Temperature @ LF

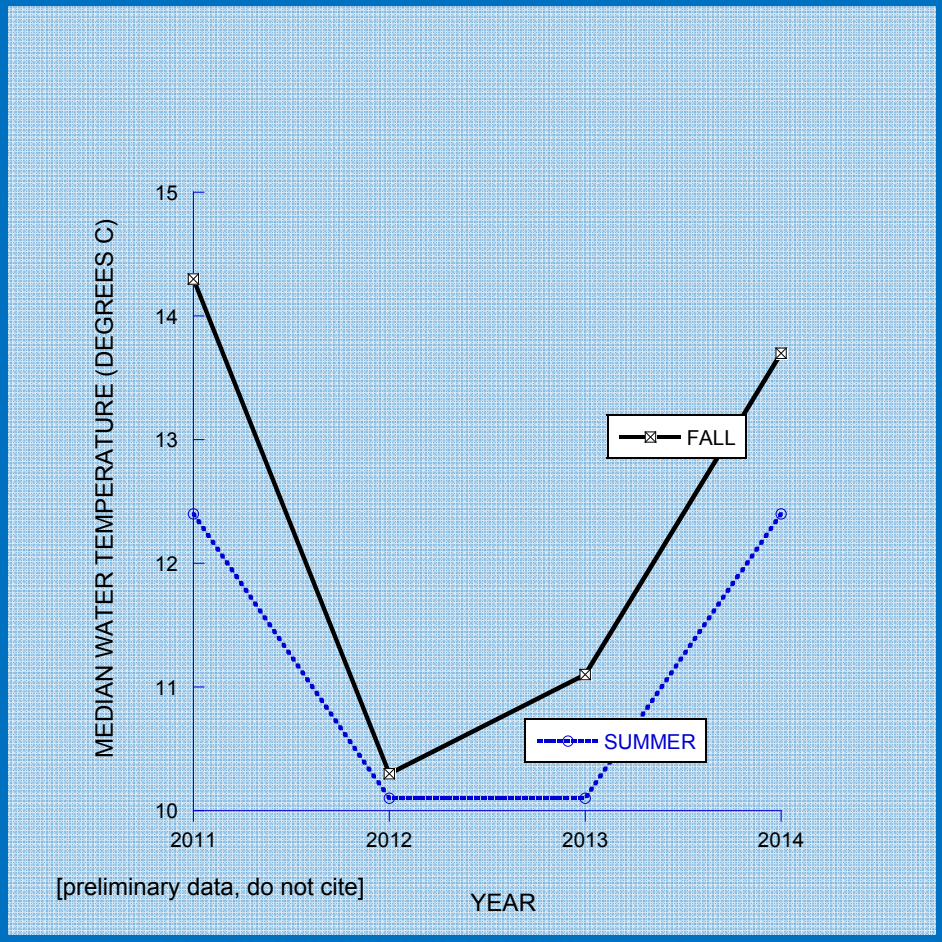
[measured at Lees Ferry, AZ, station #09380000 accessed: http://www.gcmrc.gov/discharge_qw_sediment/station/GCDAMP/09380000]

Median 2005 River Temperatures & DO

Fall = 15.2°C

Summer = 14.0°C

with Dissolved Oxygen in Fall dropping as low as 3 – 4 mg/L



TCD-like thermal regime treatment

Provided by

Annually Variable UCRB runoff

&

Lake Powell storage changes

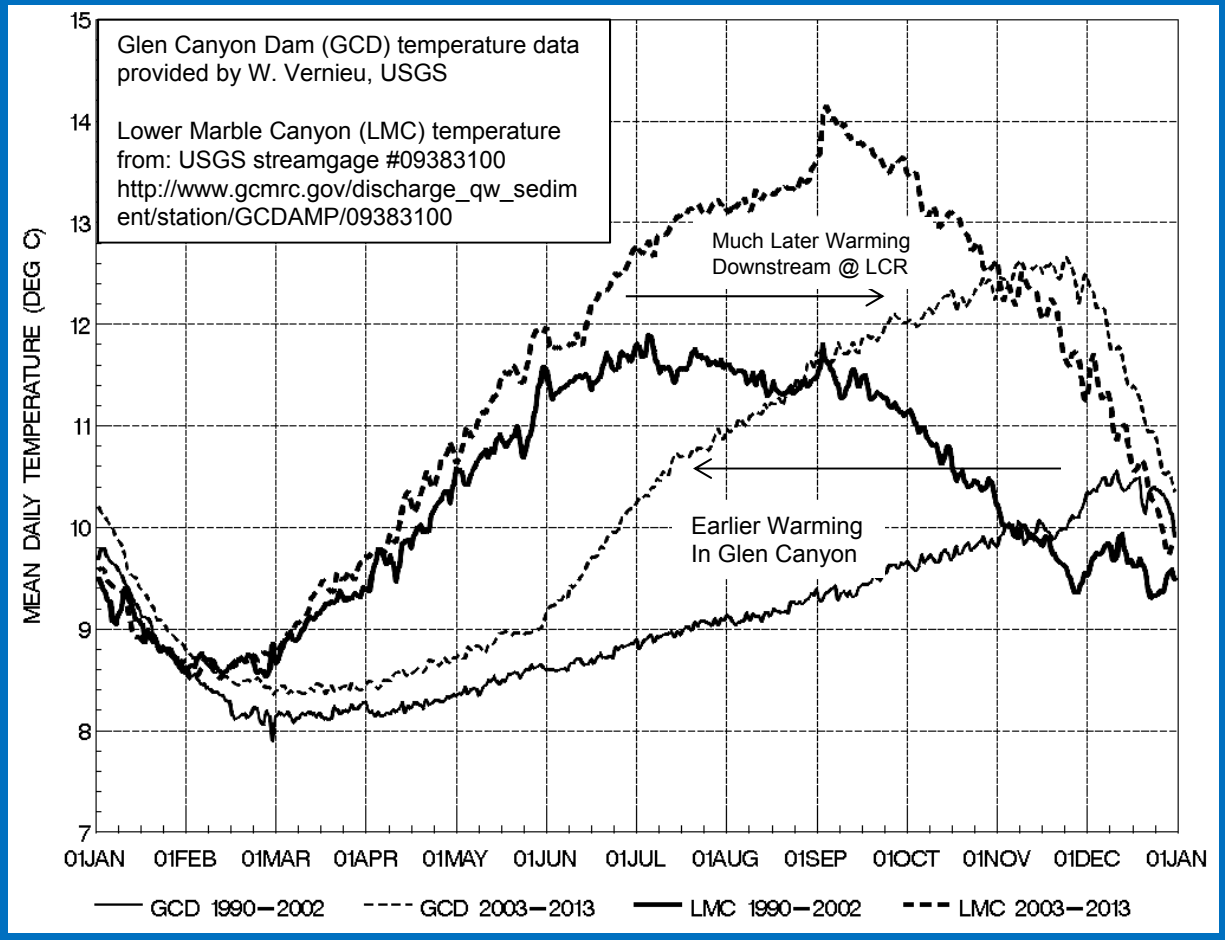
~1,200,000 RBT Recent RBT Decline **~200,000 RBT**

[Korman and Yard, written commun., USGS 2015, preliminary data, do not cite]

USGS Median temperatures drop after 2011, then increase through summer & fall 2014 – temperatures increase right when food is less available…

The River's Thermal Regime has shifted Warmer in Fall

[1990-2002 versus 2003-2013, preliminary data, do not cite]



Dam releases reach 1990-2002 annual Temp. maxima 5 mos. earlier

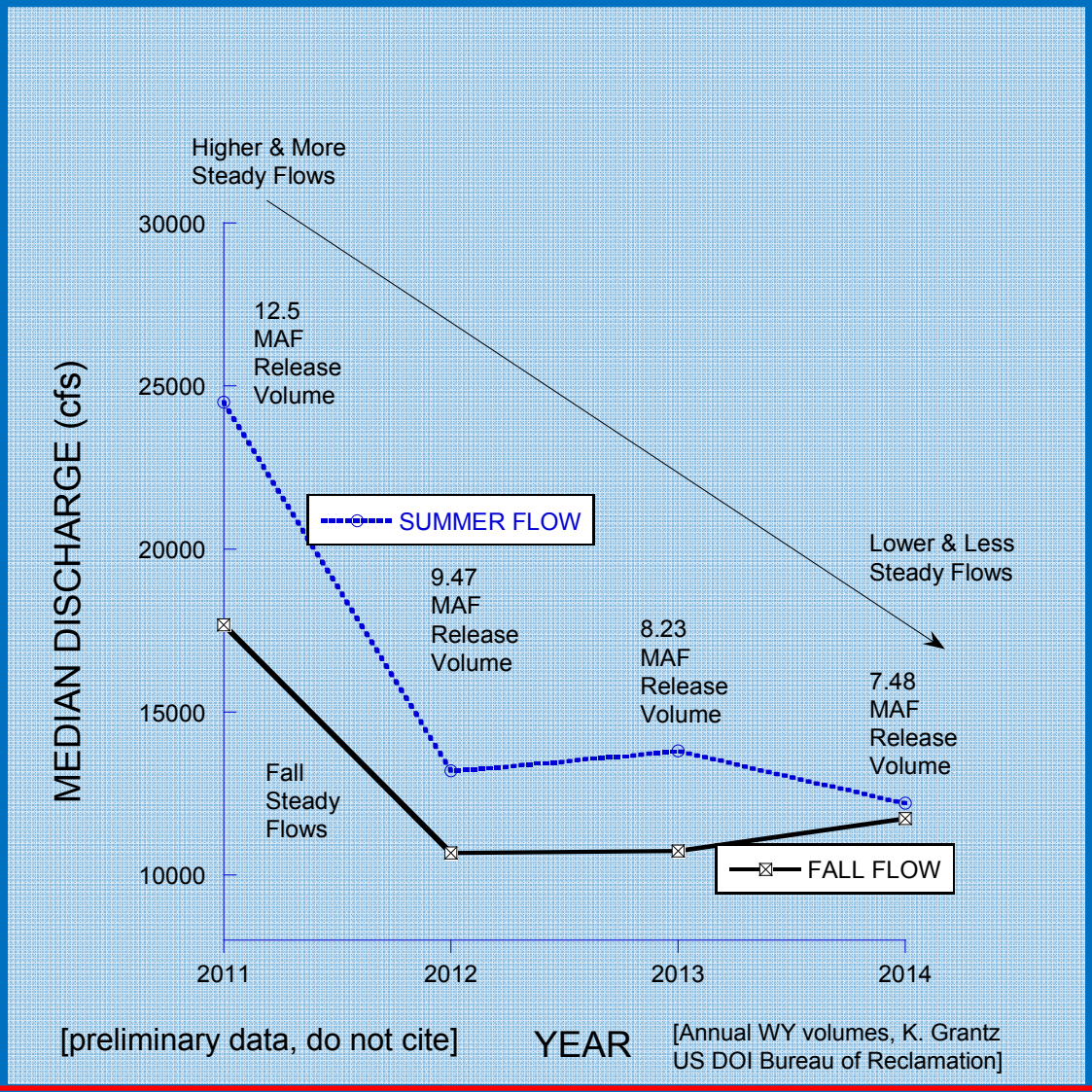
2003-13 peak Temps ~2.5°C ↑

The energy needs of larger trout go up in fall as food rations are typically decreasing

USGS

Downstream average water temperature near LCR has not only been warmer since 2003, but warmer later into fall/winter (2011 is example)

Decreased Median Summer & Fall Flow @ LF 2011 - 2014



Annual Release Volumes declined in each of the last 4 Years = lower flows

+

More frequent stable-flow periods in 2011-12 were followed by MLFF fluctuating-flow releases in 2013-14

Recall the warmer 2014 Temperatures

USGS

In APR 2012 ~1,200,000 RBT

~200,000 RBT in JAN 2015

Summary

- Channel Mapping, Fish & Flow Modelling is progressing toward answering integrated management questions
- Lees Ferry tailwater fishery (trout abundance & condition) is influenced by dam operations & thereby downstream movements
- Achieving sediment conservation objectives in Marble Canyon may be an effective strategy for mitigating trout below Lees Ferry (retaining new fine sediment and avoiding sand deficits)
- Flows that promote sandbars and limit sand export during periods of ↑ average sand inputs & ↓ average annual dam releases (2013-14) appear to have limited larger rainbow trout success in Grand Canyon (bottom up)
- Warmer fall water temperatures, sandier channel bed areas, and more turbidity in fall/winter associated with recent declining trout downstream

USGS

Integrating the “Parts”

Be “as simple as possible but no simpler” than is required for understanding and communication.

Be dynamic and prescriptive, not static and descriptive. Monitoring of the present and past is static unless it connects to policies and actions and to the evaluation of different futures.

Embrace uncertainty and unpredictability. Surprise and structural change are inevitable in systems of people and nature.

(Holling 2001).

USGS