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# 2020 GCDAMP Annual Reporting Meeting Overview - Part 2a

**Michael Moran**
**Grand Canyon Monitoring and Research Center**
**Southwest Biological Science Center**

**Adaptive Management Working Group Meeting**
**February 12, 2020**

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

# Outline

- Part 1
  - Humpback Chub
  - Native and Nonnative Fishes
  - Bug Flows
- Part 2
  - Nutrients and Temperature as Ecosystem Drivers and Lake Powell
  - Riparian Vegetation
  - Warm-Water Invasive Fishes
  - Trout
- Part 3
  - Sediment
  - Archaeological Site Monitoring
  - Socioeconomics and Hydropower

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# Project E – Nutrients and Temperature as Ecosystem Drivers

## PI – Charles Yackulic

- GCMRC scientists and their cooperators measure nutrients and temperature to better understand how these affect the Grand Canyon ecosystem

- What are the effects of dam operations on nutrients and temperature as ecosystem drivers?

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# How Nutrients Affect The Aquatic Food Web

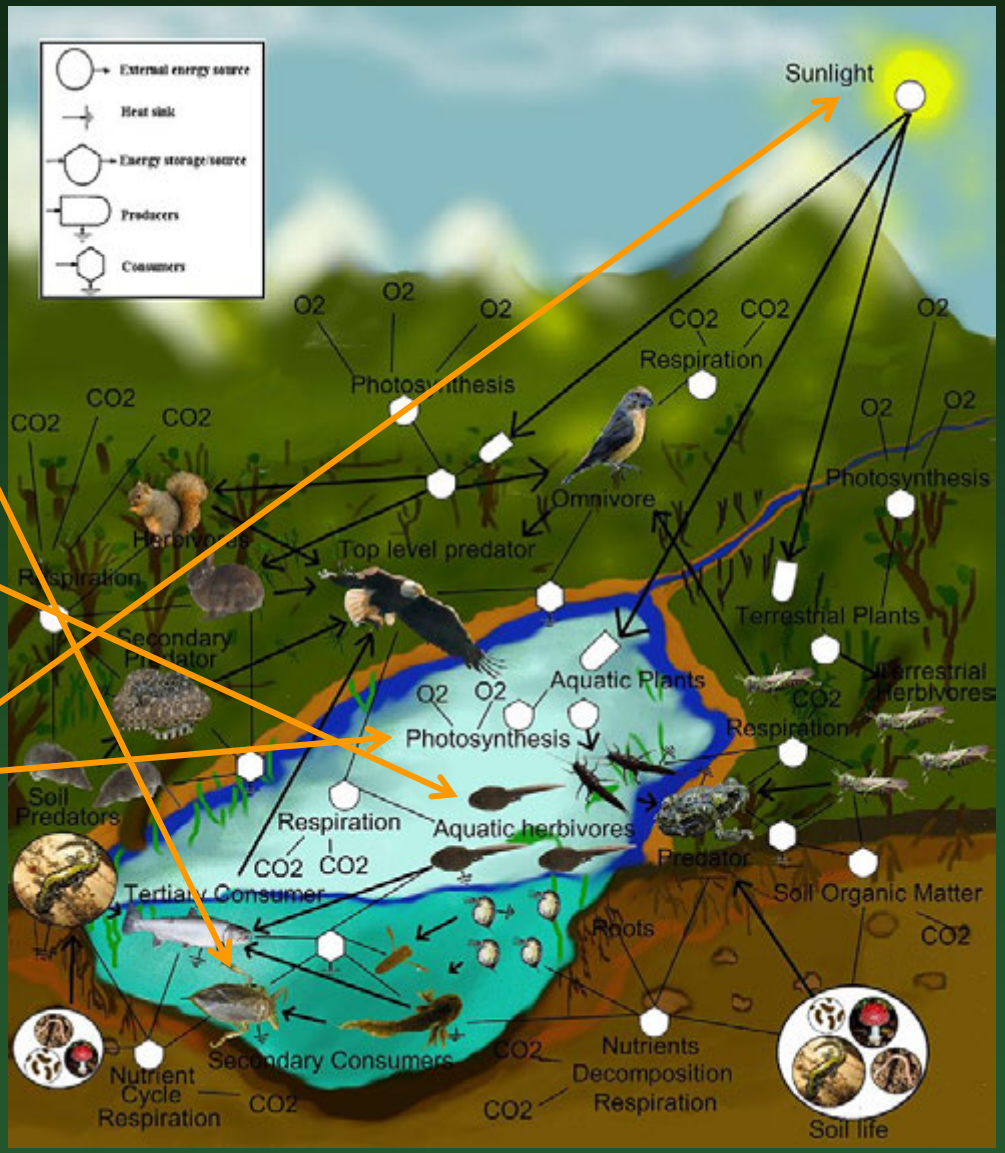
## Project Element E.1

Secondary Consumers
fish

Primary Consumers
aquatic invertebrates

Primary Producers
algae/macrophytes

Sunlight




https://en.wikipedia.org/wiki/Food_web

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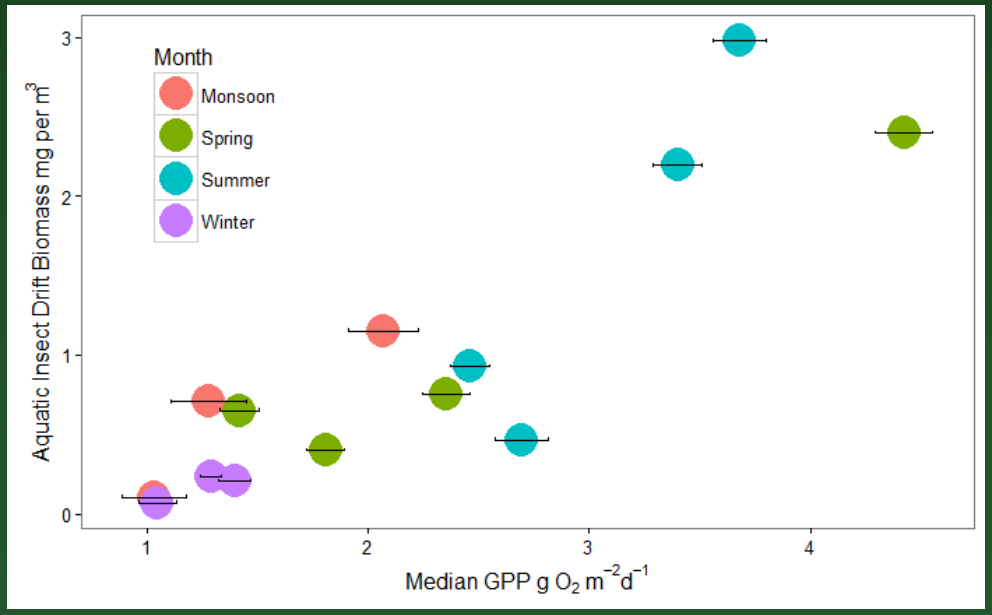
# Gross Primary Production

- Measuring dissolved oxygen as a surrogate for gross primary production (GPP)
- GPP is a measure of overall energy capture
- GPP has been linked to insect (primary consumer) density

**Take Away: GPP is a good measure of the base of the food web**




*Preliminary data, do not cite*

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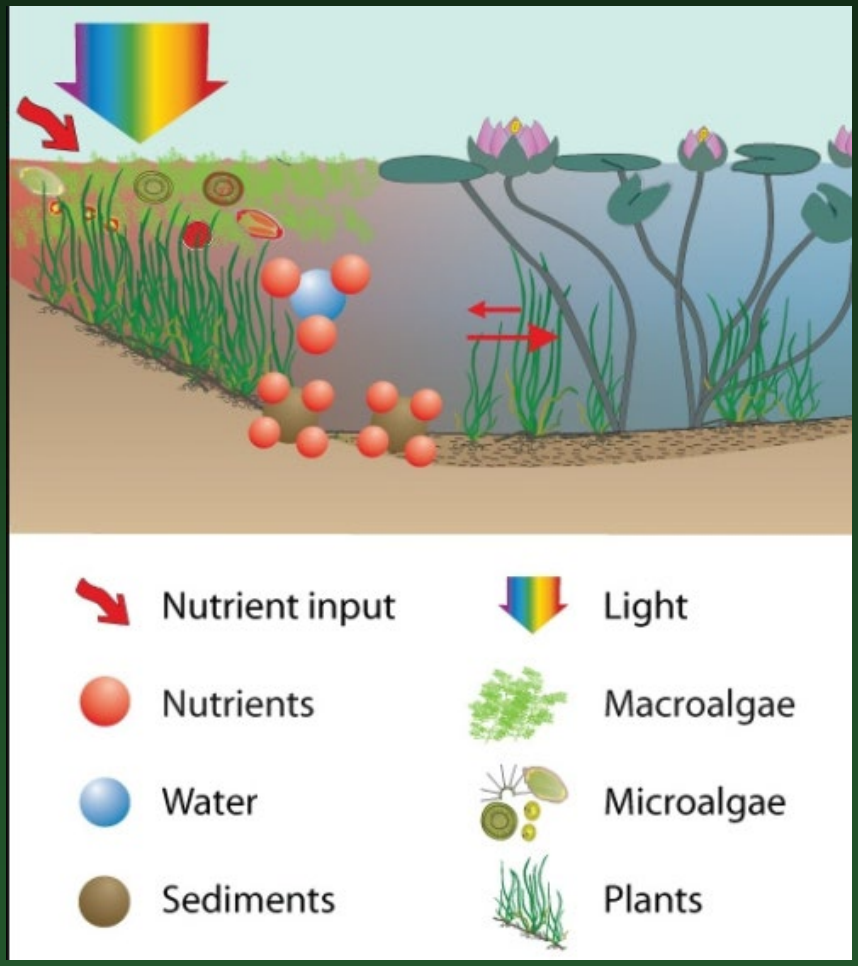
# Controls on Aquatic GPP

- Temperature
- Sunlight
- Turbidity
- Discharge
- Nutrients – such as nitrogen, CO2, and Soluble Reactive Phosphorus (SRP)

SRP – believed to be primary limiting factor in CO River




https://wetlandinfo.des.qld.gov.au/wetlands/management/pressures/lacustrine-palustrine-threats/nutrients/state.html

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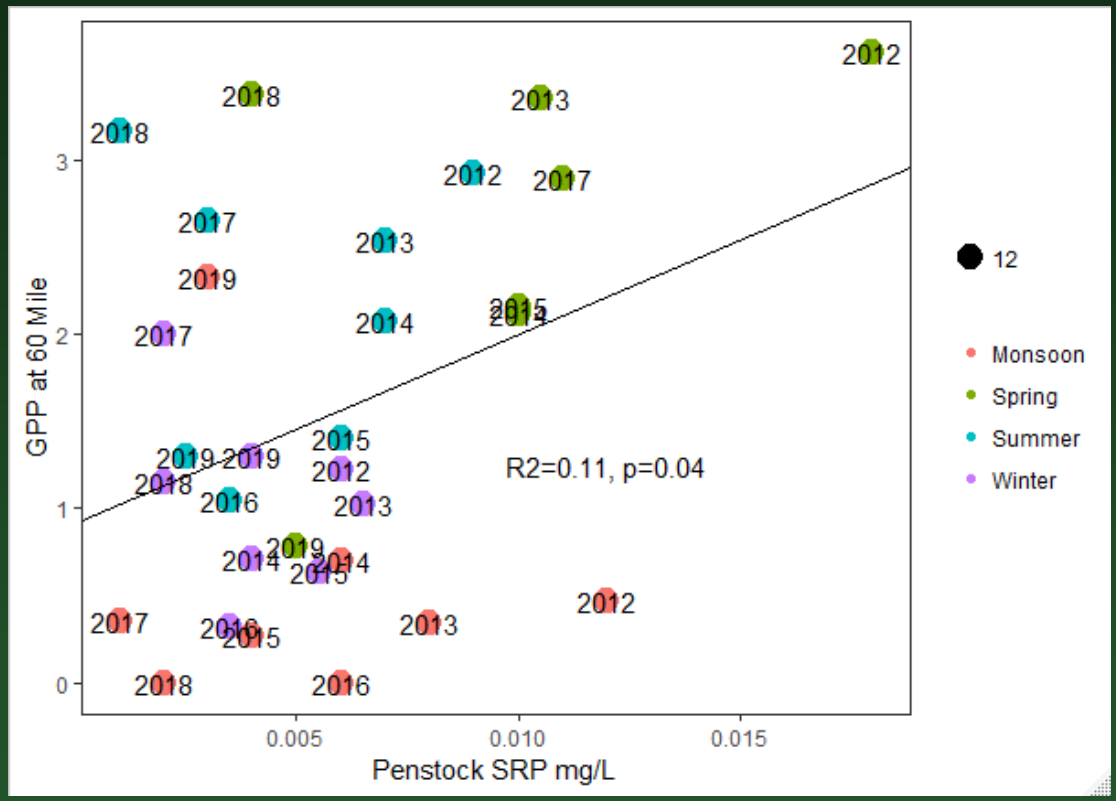
# SRP Versus GPP

- Statistically significant relation between SRP from Lake Powell penstock and GPP at river mile 60
- Other factors influence GPP including turbidity, discharge, and geographic position in the canyon




*Preliminary data, do not cite*

**Take Away: SRP is an important factor for GPP in the CO River but not the only one**

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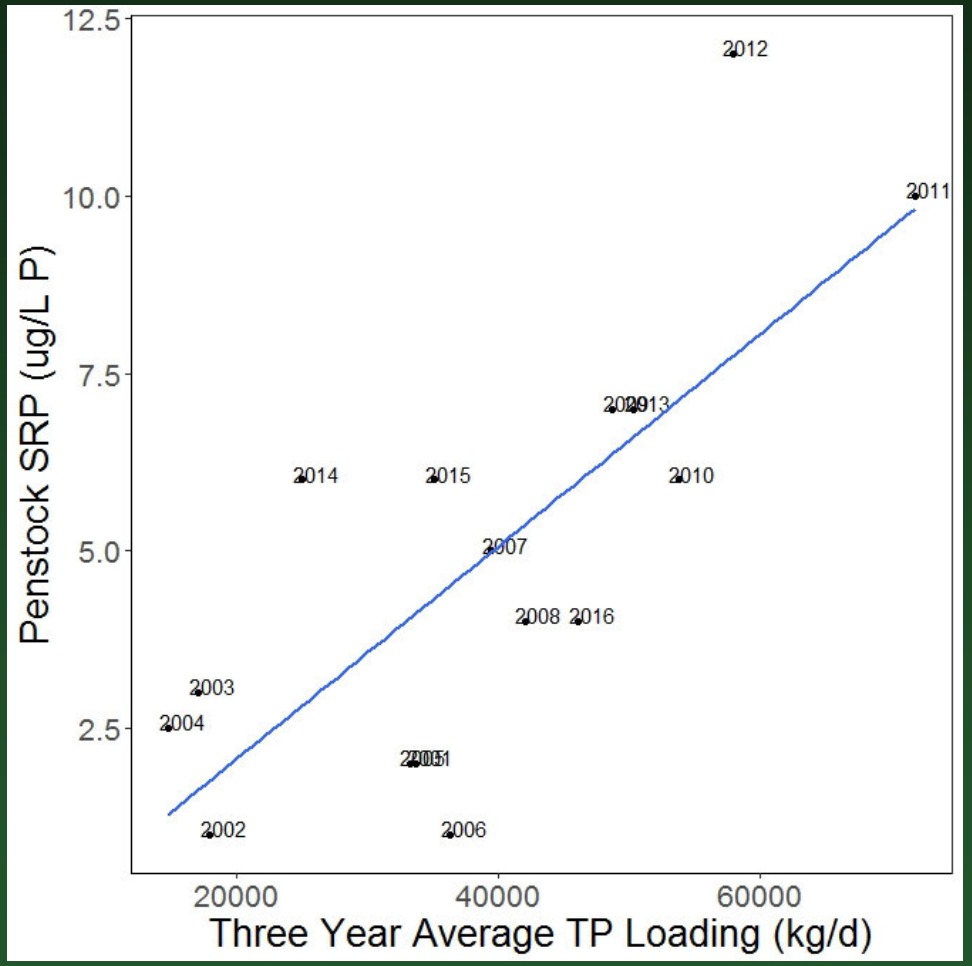
# Lake Powell Conditions Affect SRP

- SRP at the Glen Canyon Dam penstock is directly related to phosphorus input (loading) to Lake Powell
- Phosphorus loading explains ~55% of the variability in SRP

**Take Away: In Lake Powell, SRP is influenced by phosphorus input**

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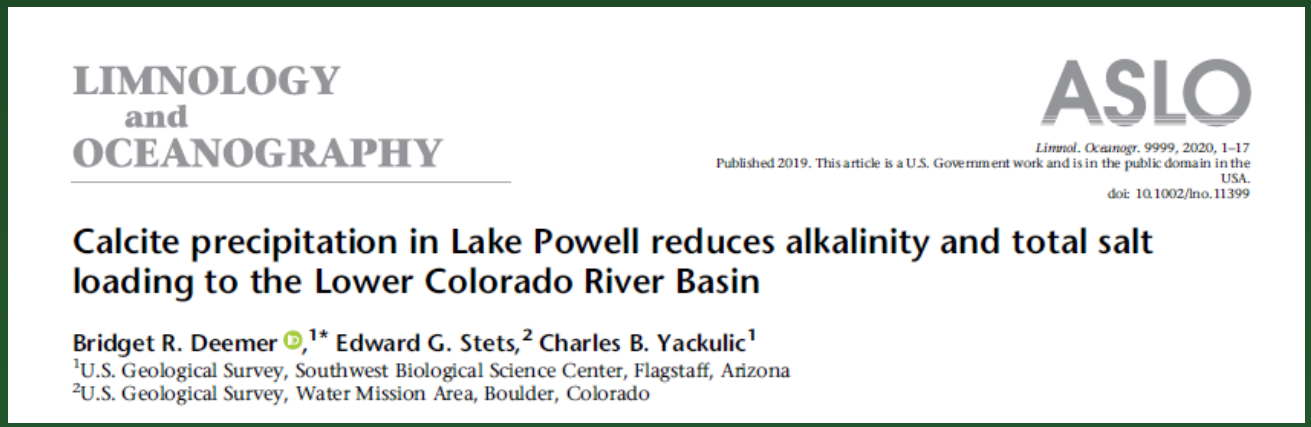
# Can We Predict Phosphorus in Lake Powell?

- Calcite precipitation in reservoirs such as Lake Powell can trap phosphorus via co-precipitation
- Phosphorus bound to calcite could be released from sediment by changes in water pH



LIMNOLOGY and OCEANOGRAPHY

ASLO

*Limnol. Oceanogr.* 9999, 2020, 1–17
Published 2019. This article is a U.S. Government work and is in the public domain in the USA.
doi: 10.1002/lno.11399

## Calcite precipitation in Lake Powell reduces alkalinity and total salt loading to the Lower Colorado River Basin

Bridget R. Deemer [1*] Edward G. Stets,[2] Charles B. Yackulic[1]
[1]U.S. Geological Survey, Southwest Biological Science Center, Flagstaff, Arizona
[2]U.S. Geological Survey, Water Mission Area, Boulder, Colorado

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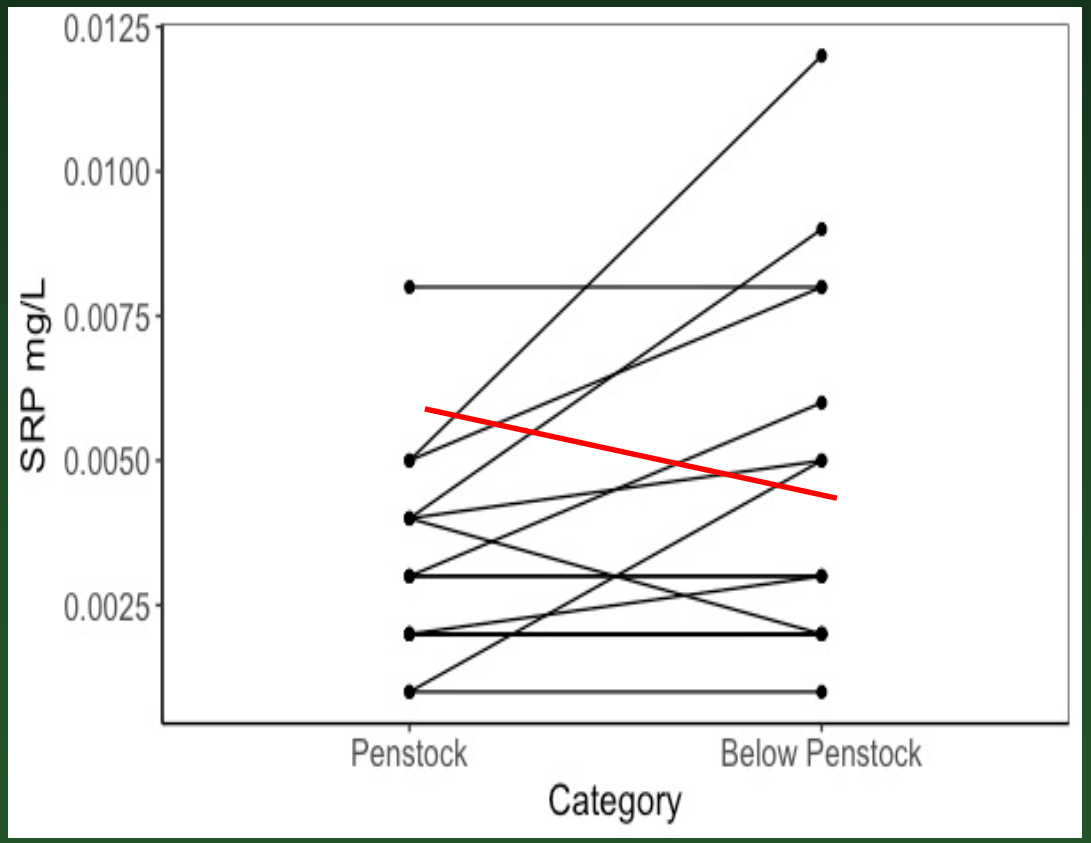
# Could SRP Be Controlled Through Dam Operations?

- SRP is almost always equivalent or higher in concentration below the penstock elevation
- Reasons unclear but may be related to SRP use in primary production in Lake Powell
- Difficult to capitalize on this through dam operations

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# Nutrients and Temperature Conclusions

- SRP is a limiting factor in Grand Canyon and exerts influence on the base of the food web
- SRP input to the CO River in Grand Canyon is controlled by inputs of phosphorus and reactions in Lake Powell
- The ability to control SRP in Grand Canyon through dam operations is unclear

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# Project C - Riparian Vegetation Monitoring

## PI – Joel Sankey/Brad Butterfield

- 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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# Ground-Based Vegetation Monitoring

## Project Element C.1

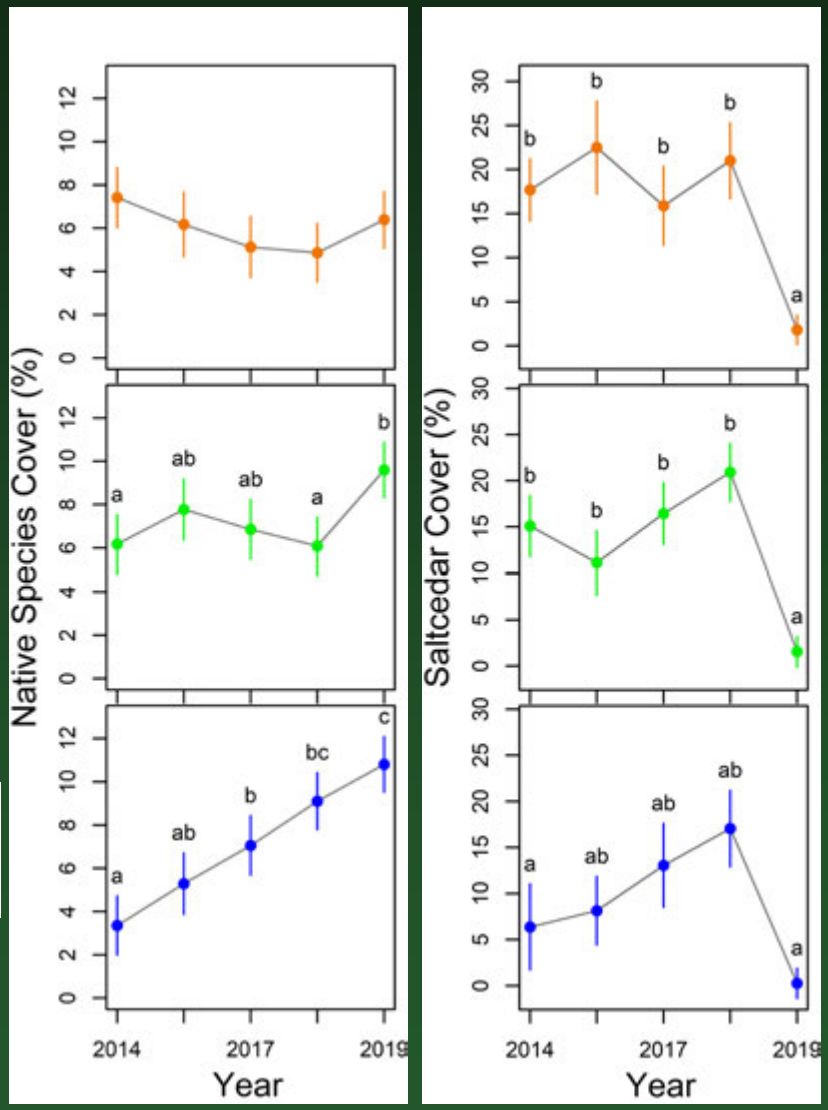
- Monitoring of NAU sandbars (43)
- Monitoring of approximately 140 other (debris fans, channel margin) sites per year since 2016
- Dramatic declines in salt cedar in 2019

**Take Away: Salt cedar has been declining while native species close to the river have been increasing**

Inactive Floodplain

Active Floodplain

Active Channel

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*Preliminary data, do not cite*

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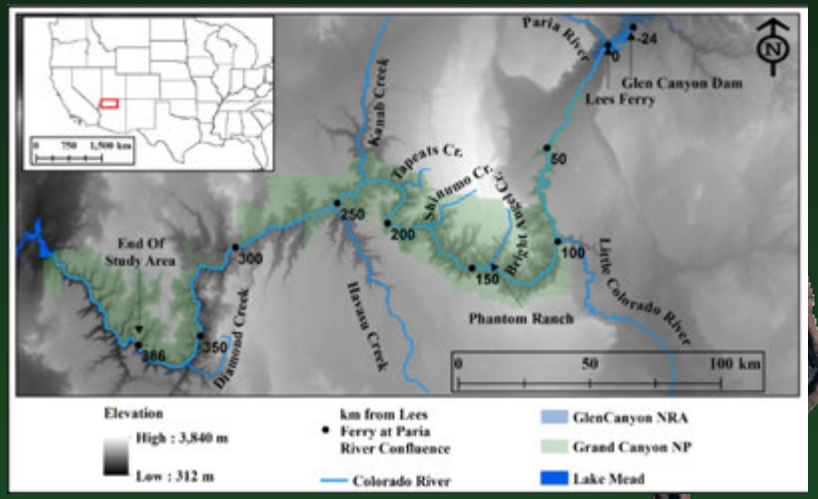
# Imagery-Based Vegetation Monitoring

## Project Element C.2

- Remote sensing provides a powerful way to evaluate environmental changes throughout the entire river corridor
- Overflight data are used universally used in the GCDAMP




Durning and others, 2016

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# Products From Modern Overflights

| Multispectral imagery | Digital topography |
| --- | --- |
| Website content and virtual online maps. | Cartographic products<br>- River map books<br>- Publication maps |
| Colorado River Centerline and River Mile System | Flowlines<br>– Extracted from low-flow water's edge (~8,000 CFS) in overflight imagery<br>- Modelled from overflight topography and water surface elevation data(Magirl, 2008) |
| Land cover classification<br>- water, sand, vegetation | Vegetation species classification |
| Campsite delineation<br>– Campsite atlas | Topography data<br>- Topographic change detection<br>- Hydrologic flow modeling. |

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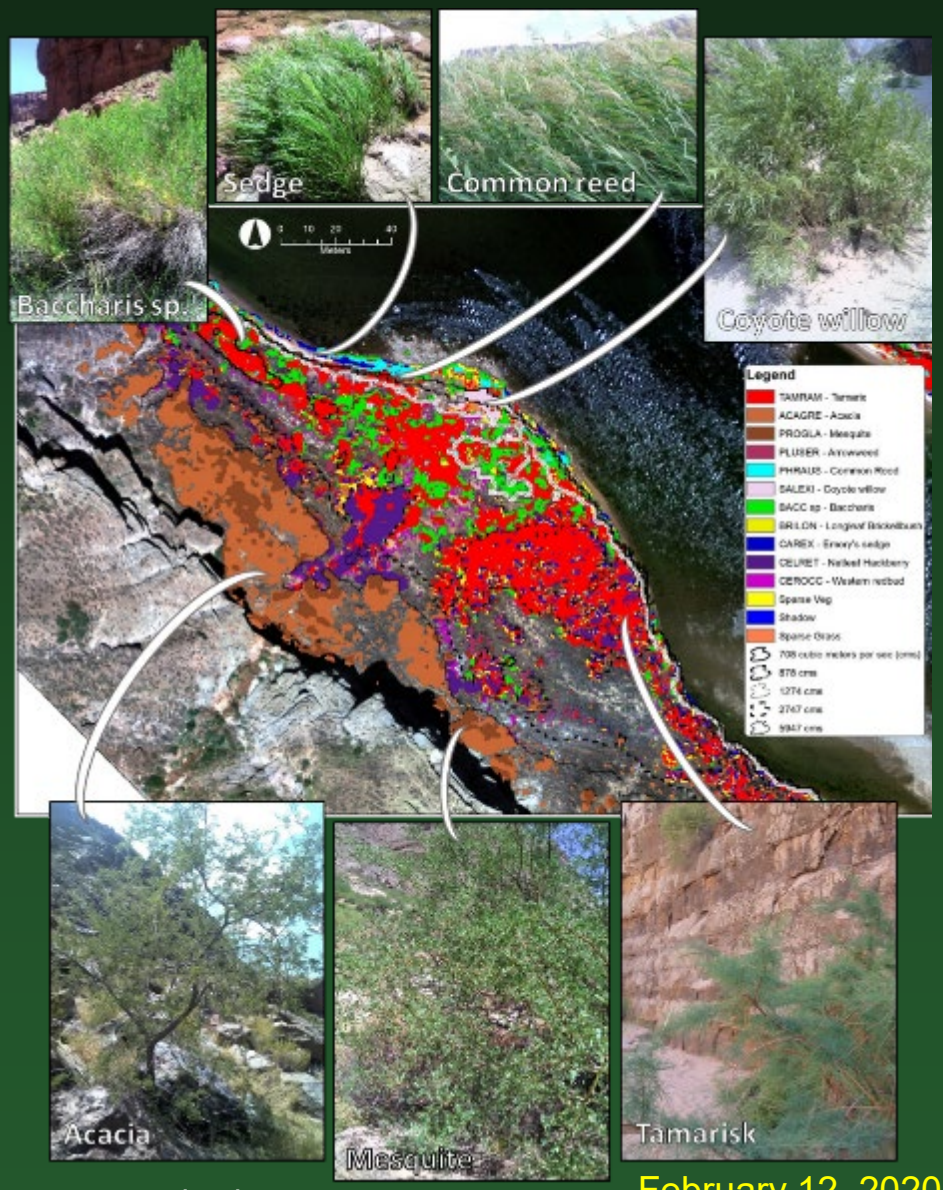
# Recently Published Overflight Product

- Riparian vegetation species classification map
- Entire river corridor from Glen Canyon to Pearce Ferry
- 26 species and 7 additional generalized vegetation classes
- Overall accuracy 71%

**Take Away: Overflight data critical for many GCMRC and GCDAMP products**




Durning and others, 2017



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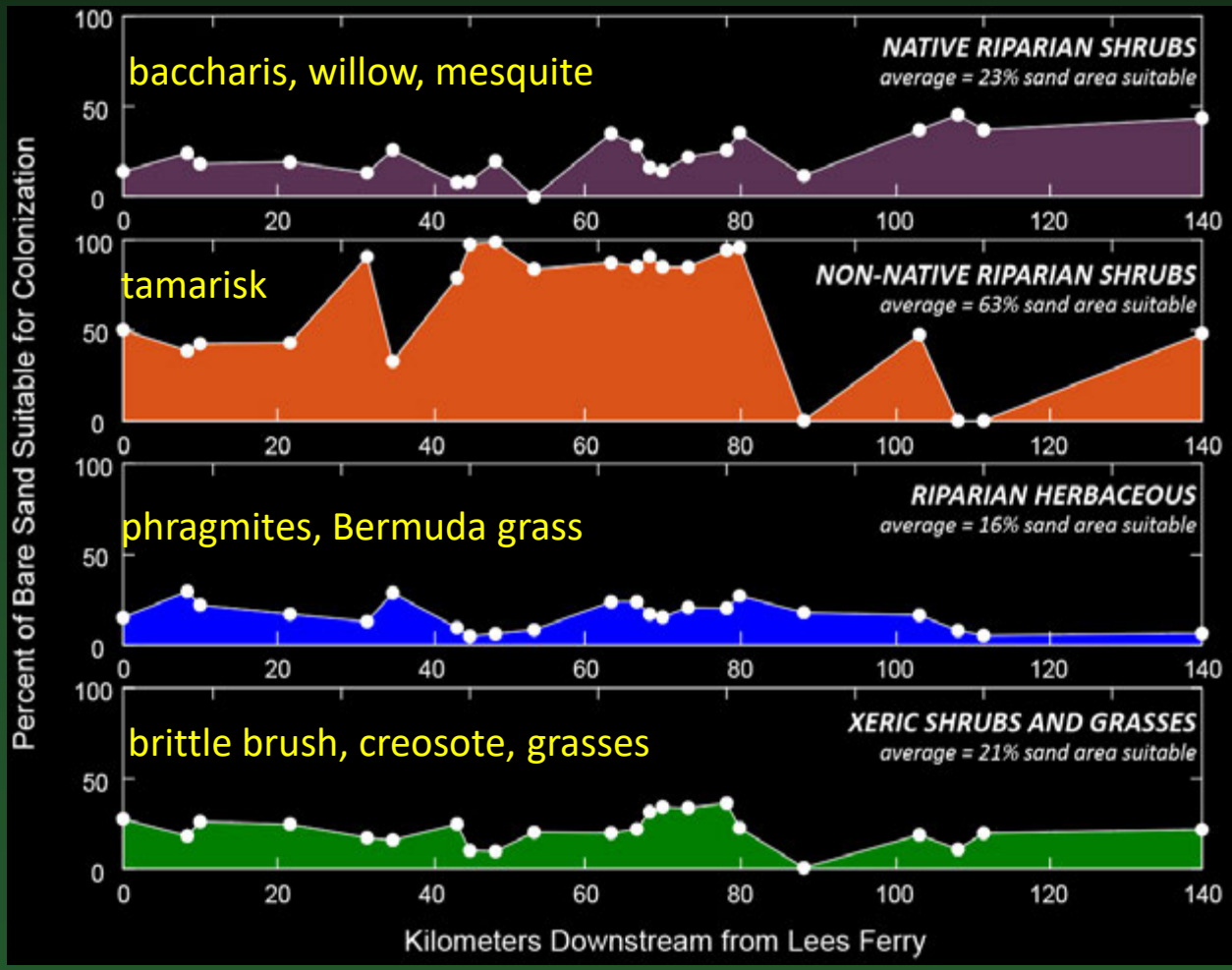
# Vegetation Responses To Hydrologic Variables

## Project Element C.3

- Niche models have been developed
- Responses of plants to hydrologic variables
- These have been used to identify habitat suitability

**Take Away: Vegetation is likely to colonize most bare sand**

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*Preliminary data, do not cite* Kasprak *et al.* In prep

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# Manipulative Experiments Outside the Canyon

- Experiments help to identify plant responses to flow conditions by strictly controlling variables
- These experiments help refine model predictions of plant responses

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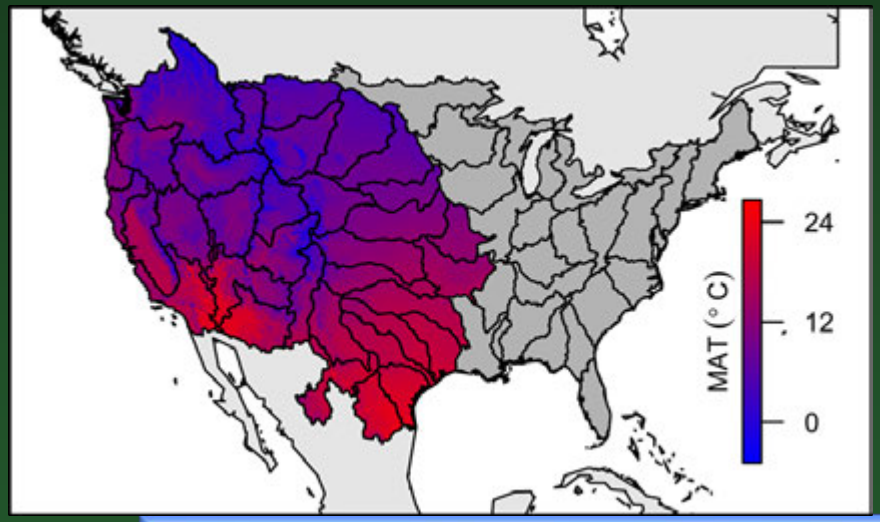
# Other Methods of Learning About Vegetation Responses to Flows

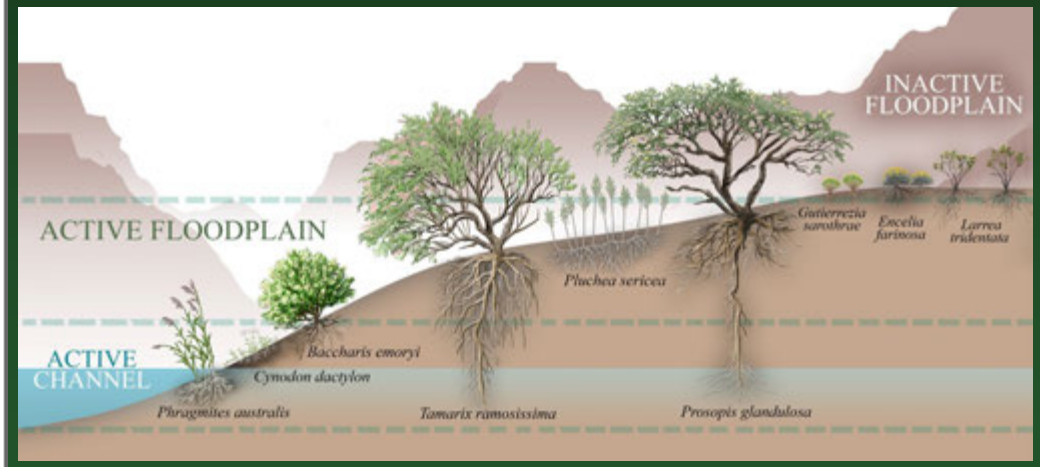
## Grand Canyon in Context

- Compare to other systems
- Harness 'big' data
- Flow regime for species

## Physiological Measurements in the Canyon

- Water isotopes
- Transpiration and photosynthesis
- Response to changes in flow




**Take Away: Combining existing regional data and local physiological measurements are needed to predict how plants will change**

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# Vegetation Monitoring Conclusions

- Salt cedar has been declining throughout the canyon while native species close to the river are increasing

- Niche modeling suggests that riparian vegetation has the potential to colonize most bare sand in the Grand Canyon

- Monitoring (C.1) tracks current conditions while manipulative experiments and comparisons with other river systems (C.3) provide data for predictions.

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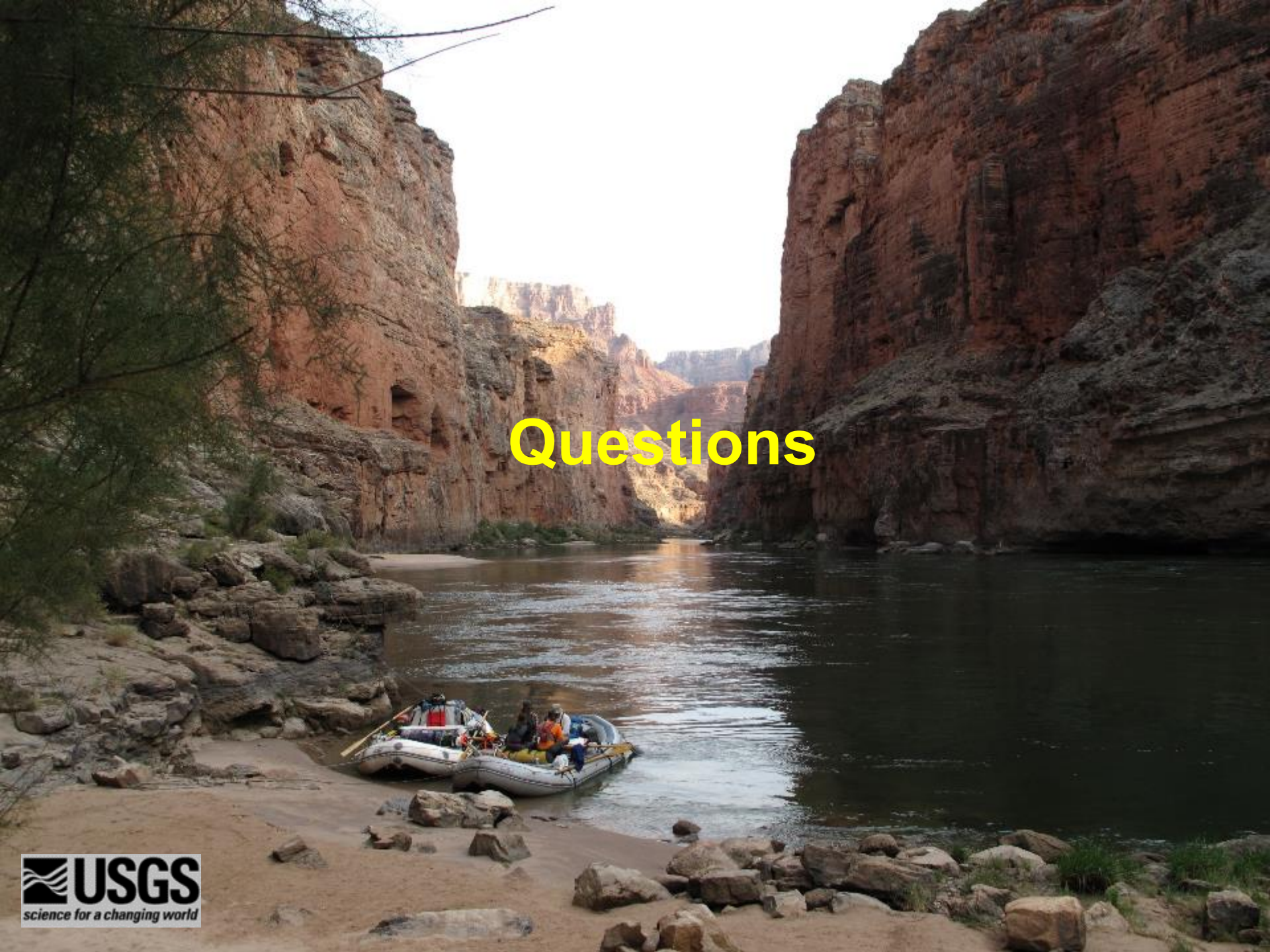
Questions
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