Assessing 50 years of ecological changes at campsites along the Colorado River in Grand Canyon

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Project Background

- Project D, Element 2: Monitoring Landscape-Scale Ecological Change with Repeat Photography
- Use repeat photography methods and analysis of matched images to document changes in riparian cover throughout the Colorado River ecosystem in Glen and Grand Canyon to refine current understanding of how vegetation growth and expansion has evolved and affected availability of open sand/aeolian sand sources.
- FY2022 Budget: \$35,654 (\$23k salary, plus travel, ops, burden)
- Initial photo matching focused on images from the 1923 Birdseye Expedition (pre-dam condition)
- More recently (2021-2022) we have focused on matching photographs from the 1973 Borden-Weeden campsite inventory (showing early postdam condition, ~10 years after dam construction)





Summary

~240 photos from 1973; 122 matched so far; 108 analyzed here

we precisely match the historical views

photo matches provide unambiguous record of change over time

document & categorize geomorphic and vegetation changes

summarize categorical assessments [after R.H.Webb (1990)]

Main Objectives

Evaluate broad-scale changes in:

- 1) sand supply and exposure
- 2) vegetation cover
- 3) dominant vegetation composition
- Evaluate connectivity between river sediments and terrestrial ecosystems
- Document on-going vegetation responses to flow management



RM 20.2L Original photo July 1973 Matched by A.H. Fairley 4/29 /2022





WUSGS

USGS Examples: Beach Front Erosion



RM 19.4L, top: original photo, July 1973 Bottom: match by A.H Fairley, 4/29/22

RM 31.9R, top: original photo, July 1973 Bottom: match by A.H Fairley, 4/29/22

USGS

Examples of Deflation



RM 44.1L, top photo: July 1973 Bottom photo: A.H Fairley, 5/8/21



RM 37.9L, top photo: July 1973 Bottom photo: Camille Diab, 5/1/22





RM 114.9R, top: original photo, July 1973 Bottom: match by A.H Fairley, 5/8/22

RM 115.1R, top: original photo, July 1973 Bottom: match by A.H Fairley, 5/8/22

Both inflation and deflation may be evident



RM 124.2L. Top photo: July 1973 Bottom photo: A.H Fairley, 5/11/22 RM 133.7L. Top photo: July 1973 Bottom photo: A.H Fairley, 5/8/22



≥USGS More examples of inflation/deflation





RM 26.9L, Top photo: July 1973 Bottom photo: A.H Fairley, 5/7/21

RM 119.5L. Top photo: July 1973 Bottom photo: A.H Fairley, 5/15/21

Preliminary Results

- Shoreline erosion/bank steepening at >50% sites
- Sand deflation at 56% of sites examined
- Sand inflation at 37% of sites examined
- Sand surfaces generally less active due to reduction in sand deposition, soil crust development, vegetation increase

RM 219, RB, original photo July 1973 Photo match by A.H. Fairley, 05/21/2021

EXAMPLE SET USGS Preliminary Results – subject to revision. Not for distribution or citation.

Subscription Subscription Strate and USGS Vegetation encroachment is prevalent. Density varies by substrate and use Examples of two popular camps with light vegetation encroachment



Nautiloid, RM 35.1L. Top: July 1973; Bottom photo: A.H. Fairley 5/1/22



Lower Fossil, RM 126.1L. Top: July 1973; Bottom photo: A.H. Fairley 5/1/22

≥USGS Examples of camps with medium vegetation encroachment



RM 136.8L. Top photo: July 1973 Bottom photo: A.H. Fairley, 5/12/22



RM 37.7R. Top photo: July 1973 Bottom photo: A.H Fairley, 5/1/22

Examples of heavy vegetation encroachment



RM 170.5L. Top photo: July 1973 Bottom photo: A.H Fairley, 5/12/22



RM 122.9L. Top photo: July 1973 Bottom photo: A.H Fairley, 5/10/22

Results

- Vegetation cover > at 98% of sites
- Density of total cover varied





More Results

Medium to dense nearshore vegetation cover present at 92% of sites

Nearshore vegetation encroachment contributes to bank steepening/retreat



RM 199.2L, Top photo: E.C. LaRue 9/18/1923 Bottom photo: A.H. Fairley, 5/19/2021







Zone 1* vegetation

Bank armoring

Photograph by M. Scott, April 30, 2018

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- discharge range: 226-708 m³/s (8,000-25,000 cfs) (post-dam modified low fluctuating flow regime)
- obligate riparian shrubs (*Baccharis* spp, *Salix exigua, Pluchea sericea*)
- + herbaceous species are armoring banks

* Defined by Sankey et al 2015

Results: Zone 1 NMDS ordination, Bray-Curtis dissimilarity



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Results: Zone 1

- Out of 139 species, 26 unique to Zone 1
- 6 of 10 most abundant species: non-natives
- 6 of 10 most abundant species: facultative or obligate wetland species
- Species of note....



Schedonorus arundinaceus (tall fescue)



- Present at 80% of sites
- Robust, non-native perennial; invasive
- Participating in bank armoring
- Similar to other flowregulated rivers

Photograph from https://soilcropandmore.info/crops/Grasses/Tall_fescue/086.jpg.



Conclusions

- Sand deflation at 56% of sites examined
- Sand inflation at 37% of sites examined
- Shoreline erosion/steepening at >50% sites
- Sand flux variable across sites
- Vegetation cover ↑ at 98% of sites
- Zone 1 vegetation present at 92% of sites
- Compositionally distinct (exotic & wetland)
- Tall, rhizomatous, perennial herbs favored by reduced flow variability

Future Steps

Complete matching the remaining 1973 photos

- Further analysis of categorical ecological changes
- Link 1973 campsites to bar types per Mueller et al. 2018
- Use 1973 photos to "ground truth" open sand area in 1973 aerial images

• Publish 1923 and 1973 matched images with interpretation of ecological changes

• Serve matched images via GCMRC website

Match additional photo sets:

- 1940 Goldwater photos
- 1963 Low Water photos



Many thanks to our dedicated volunteers!





