Project L: Overflight Remote Sensing in Support of Long-Term Monitoring and LTEMP

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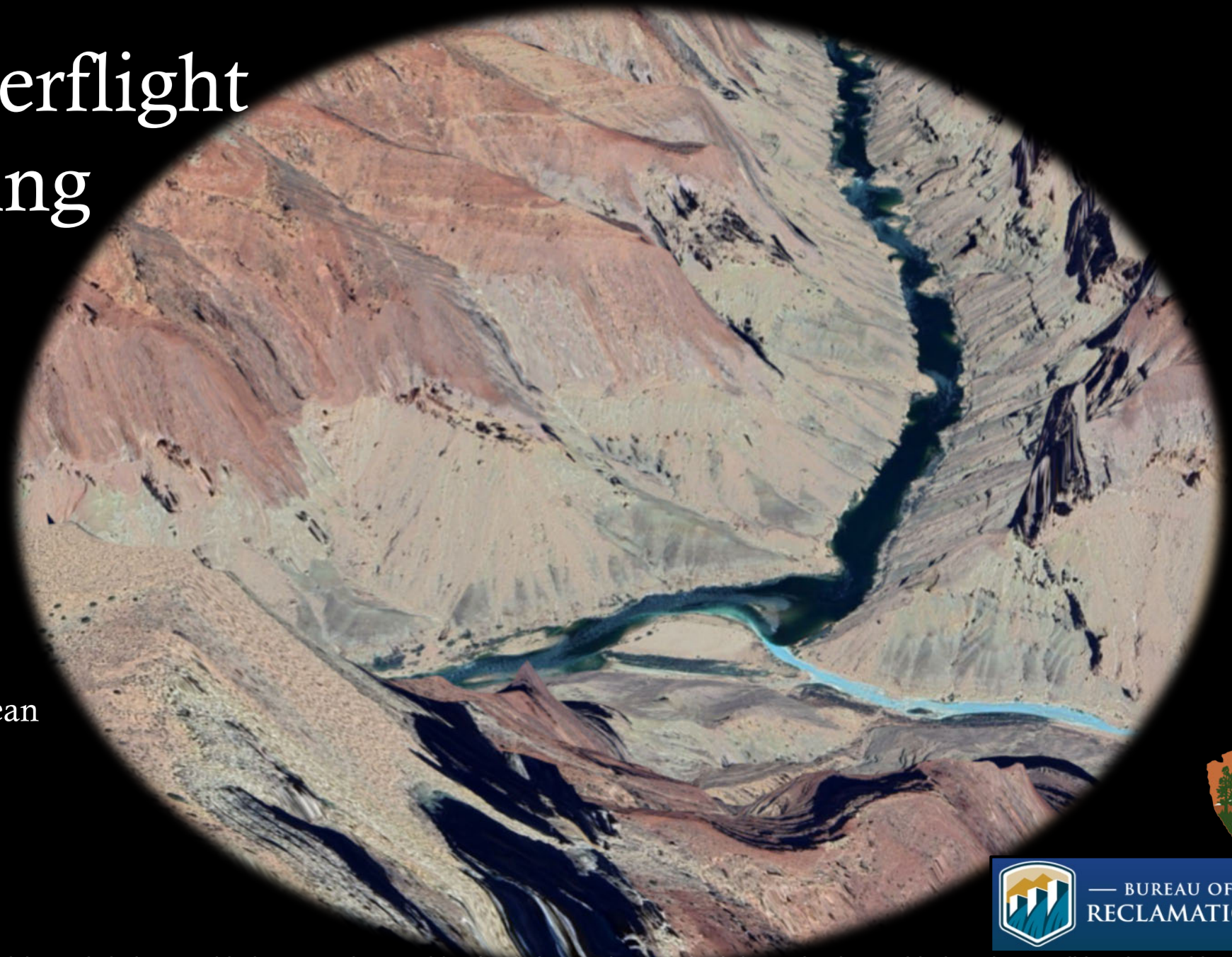
Nathaniel Bransky and David Dean

GCDAMP Annual Reporting Meeting



USGS science for a changing world
Southwest Biological Science Center
Grand Canyon Monitoring and Research Center

NATIONAL PARK SERVICE

BUREAU OF RECLAMATION

Talk Outline

1. **Project L Update**
2. Research Application *(Caster Dissertation)*

Project L Goals

Project Element L.1. Analysis and Interpretation of Overflight Remote Sensing Data

- GCMRC Triennial Workplan (TWP) Project L FY2024/25/26/27 Budget $352k/$291k/$315k/$332k
- *Imagery and derivative data products from overflight remote sensing are used either directly or indirectly by every science project proposed in the TWP to address every resource goal of the LTEMP*

2021 Orthomosaic Imagery

Project L Goals

Project Element L.1. Analysis and Interpretation of Overflight Remote Sensing Data

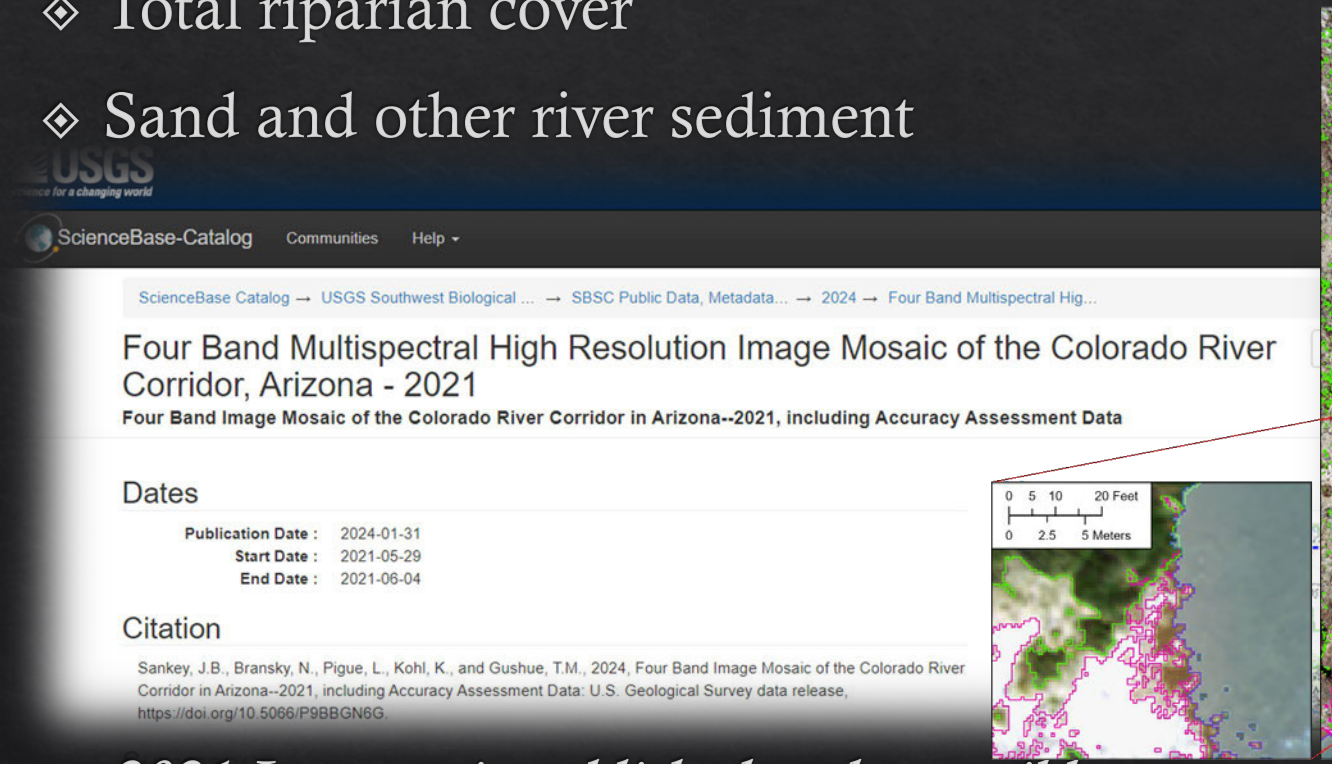
Science Questions (FY25 – 27 TWP):

- How have the system-wide area and volume of high elevation sand (LTEMP performance Metric 7.3) changed?
- Do system-wide remote sensing measurements provide a comprehensive metric of dam-related changes influence
    1. Riparian vegetation cover (LTEMP performance Metric 11.1)
    2. Other land covers
    3. Management activities, climate, or other environmental factors in the ecosystem

Project L Science Activities

Land cover classification for 2021 imagery

- ~8,000 ft/s discharge stage (base flow conditions during May 2021 imagery)
- Total riparian cover
- Sand and other river sediment

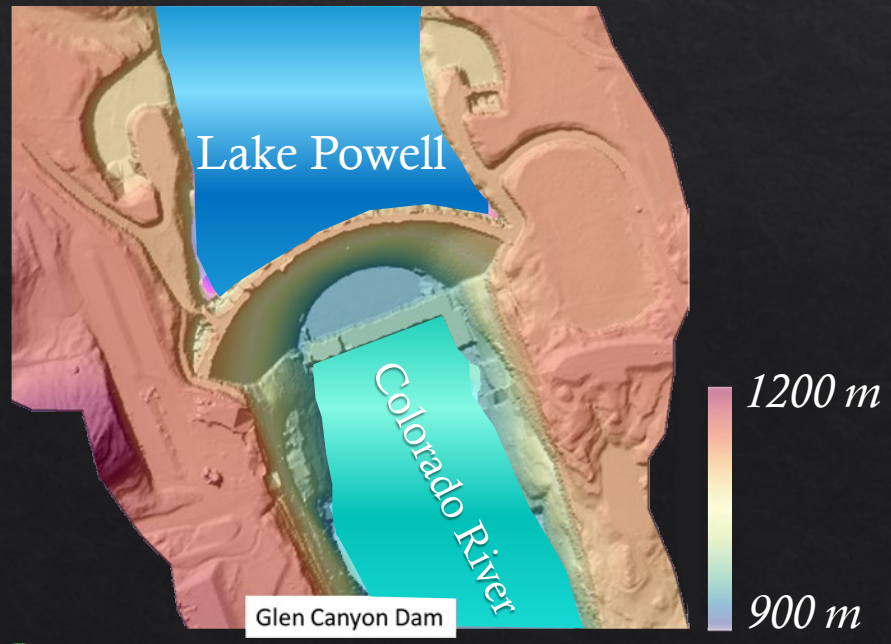


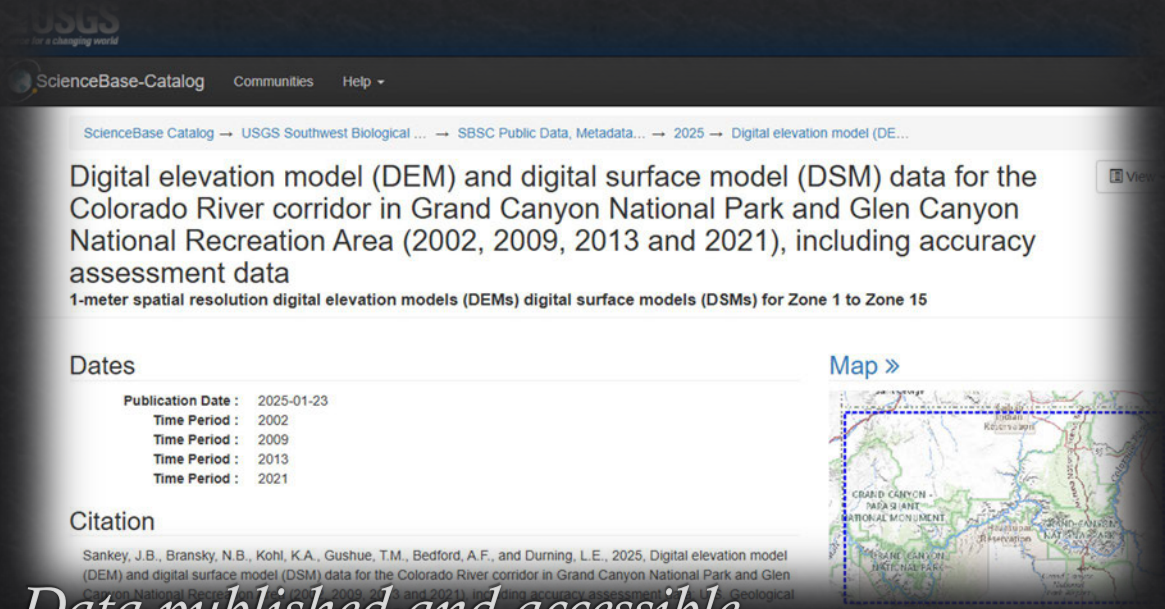
2021 Imagery is published and accessible

Project L Science Activities

Digital Topography for 2002, 2009, 2013, and 2021 overflights

- Digital Surface Models (DSM) 2002-2021
- Digital Elevation Model (DEM) 2021
- Accuracy Assessment



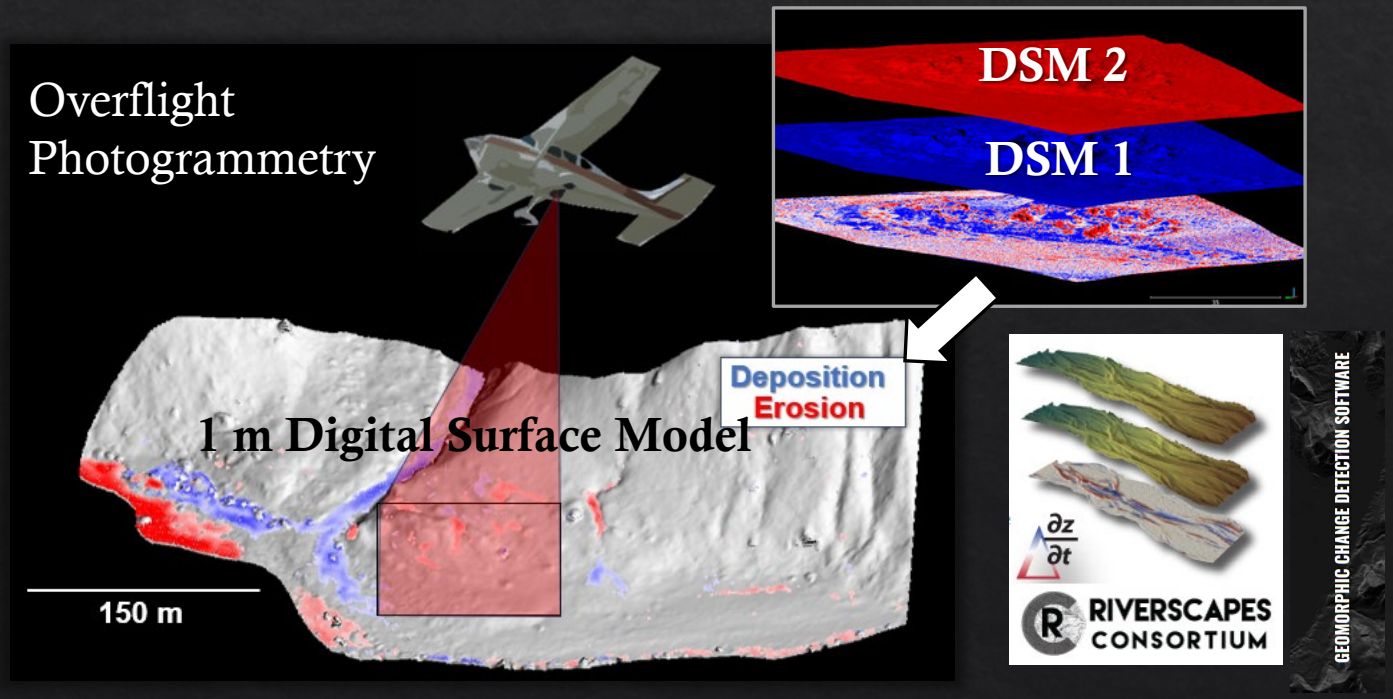


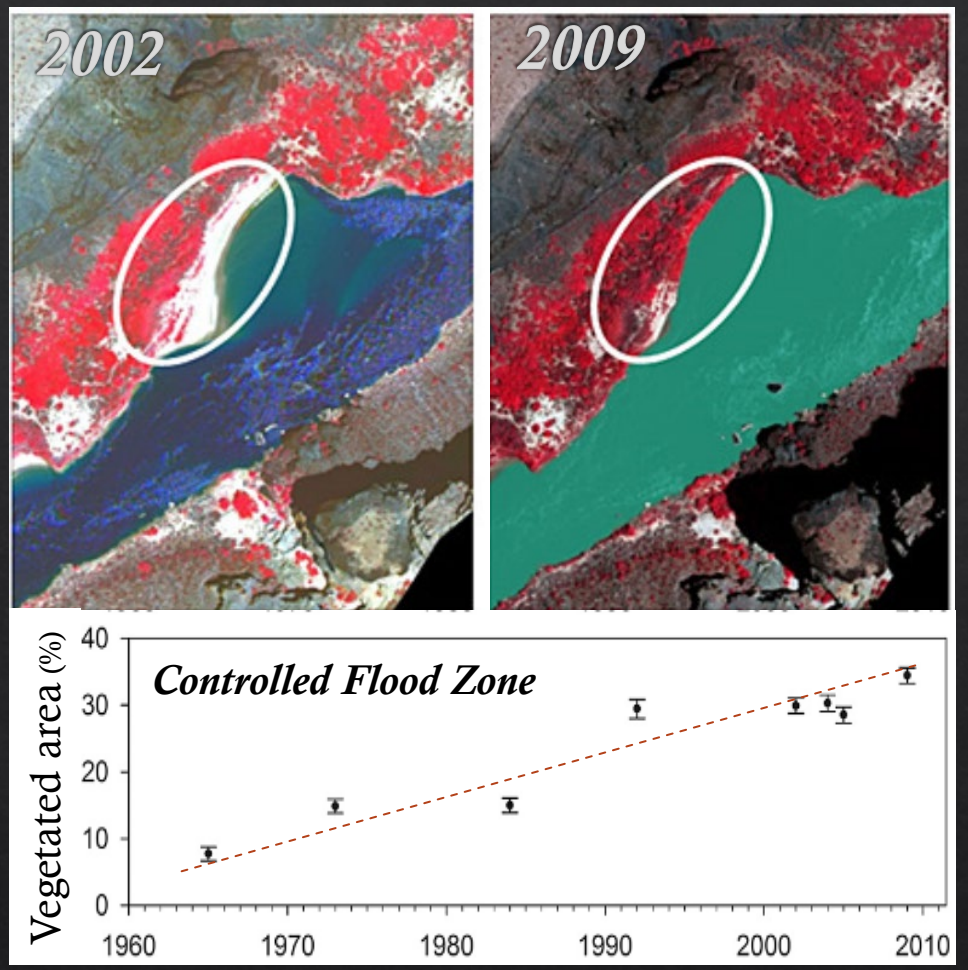
Data published and accessible

Project L Science Activities

Change Detection

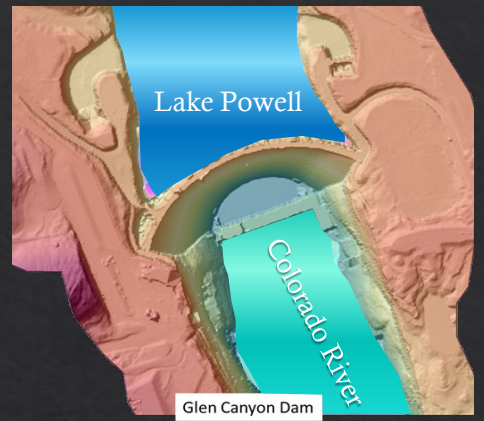
- Classified land covers
- Topography





Sankey and others, 2015

Project L Next Steps and Timeline



Fiscal Year	Project Element L.1 Science Activities
2025	• Produce CRe landcover classification maps derived from analysis of the orthomosaic of high-resolution multispectral imagery (image data release: Sankey and others, 2024). o 8,000 ft^3/s low-flow river channel o total riparian vegetation cover o sand and other river sediment
2026	• Complete change detection analysis of total riparian vegetation cover from 2021 and previous overflight classification maps for the entire 480 km of river from Glen Canyon Dam to Lake Mead at Pearce Ferry.
2027	• Conduct DSM change detection analysis for a continuous section of the river corridor. o Calculate and report on LTEMP Performance Metric 7.3 High Elevation Sand > 25,000 CFS stage that is deposited by HFEs.

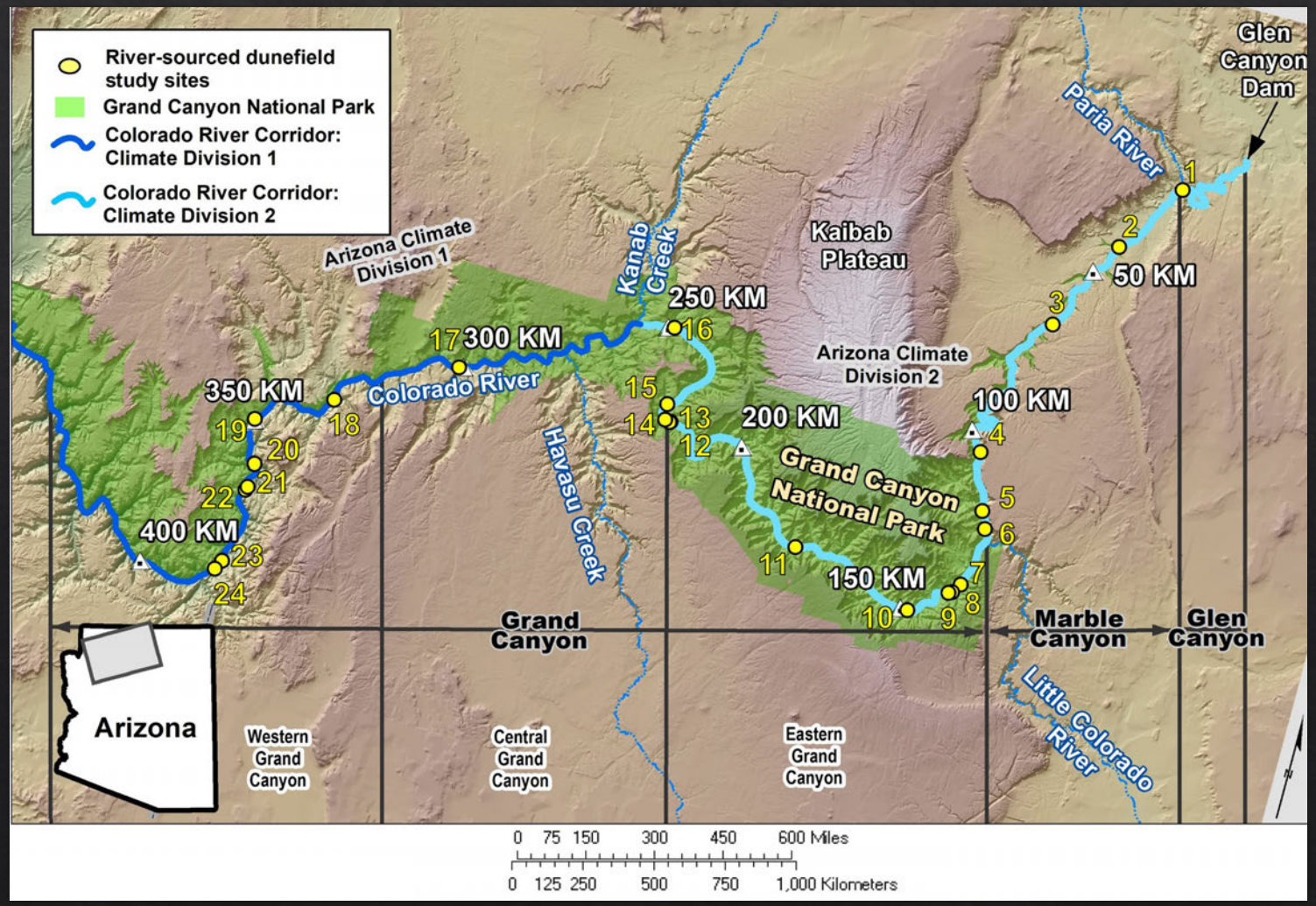
Talk Outline

1. Project L Update
2. **Research Application (Caster Dissertation)**

Evaluating long-term topographic changes in river-sourced aeolian sand *(Caster, 2024)*

PhD Dissertation (not funded by GCDAMP) using overflight remote sensing data:

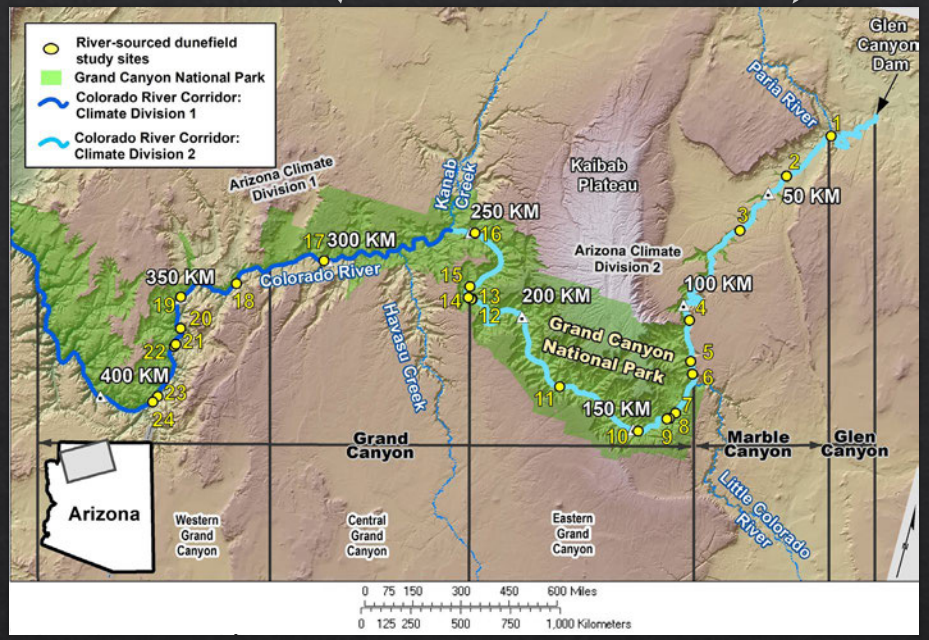
How are high-elevation sands within aeolian dunefields changing over decades of river management?



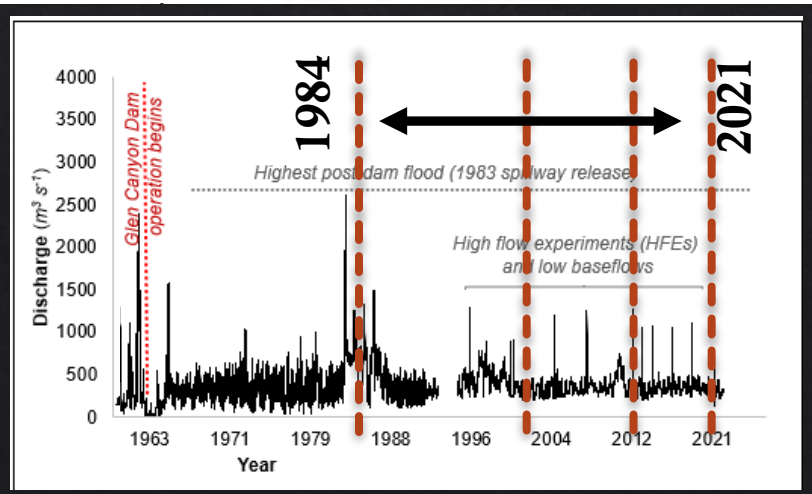
Evaluating long-term topographic changes in river-sourced aeolian sand *(Caster, 2024)*

How are high-elevation sands within aeolian dunefields changing over decades of river management?

- 2002 -2021 Digital surface models *(Published by Project L)*
- Produced new topographic dataset from 1984 imagery



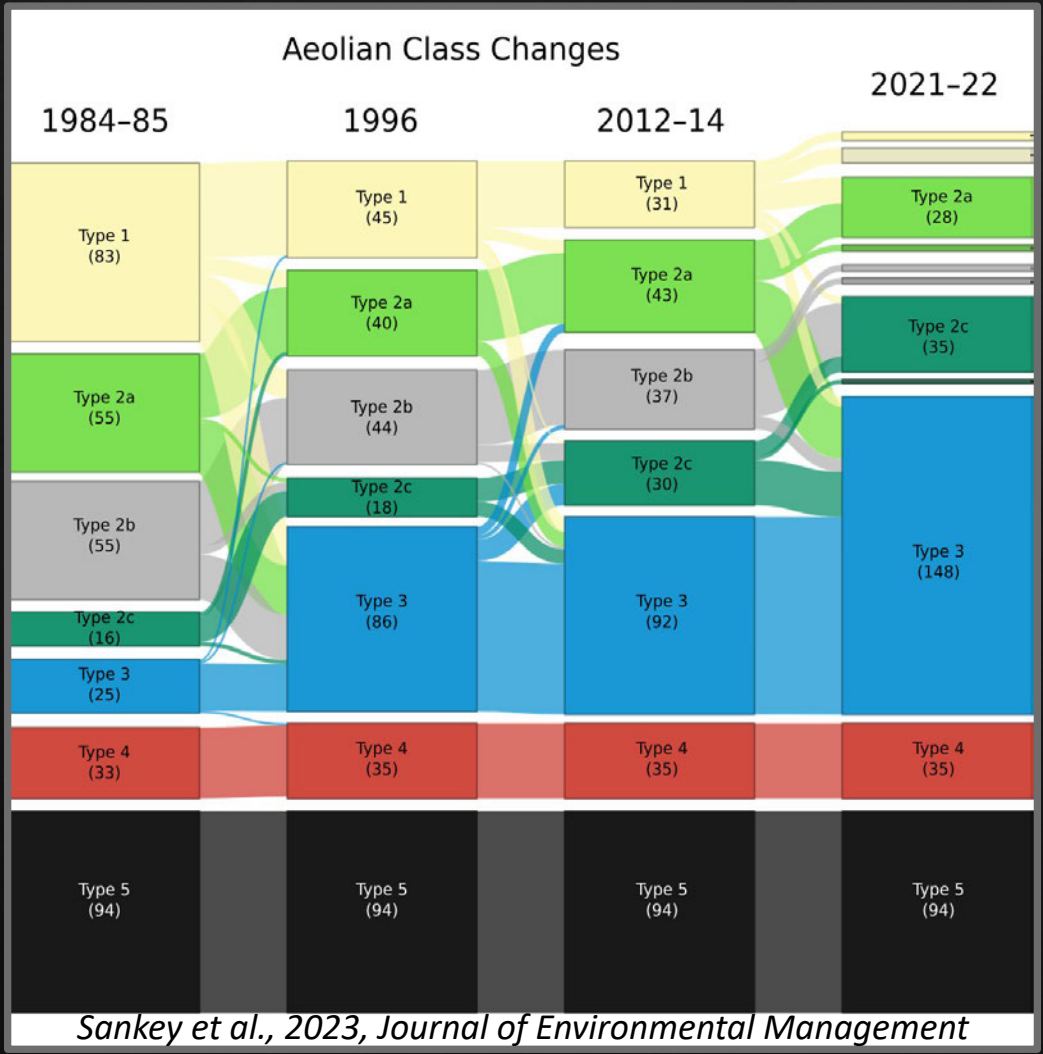
24 locations
(All of which are monitored as part of either Project B or D)



Almost 4 decades of changing river operations and topography

USGS

Changes between 1984 – 2021: In context



Sankey et al., 2023, Journal of Environmental Management

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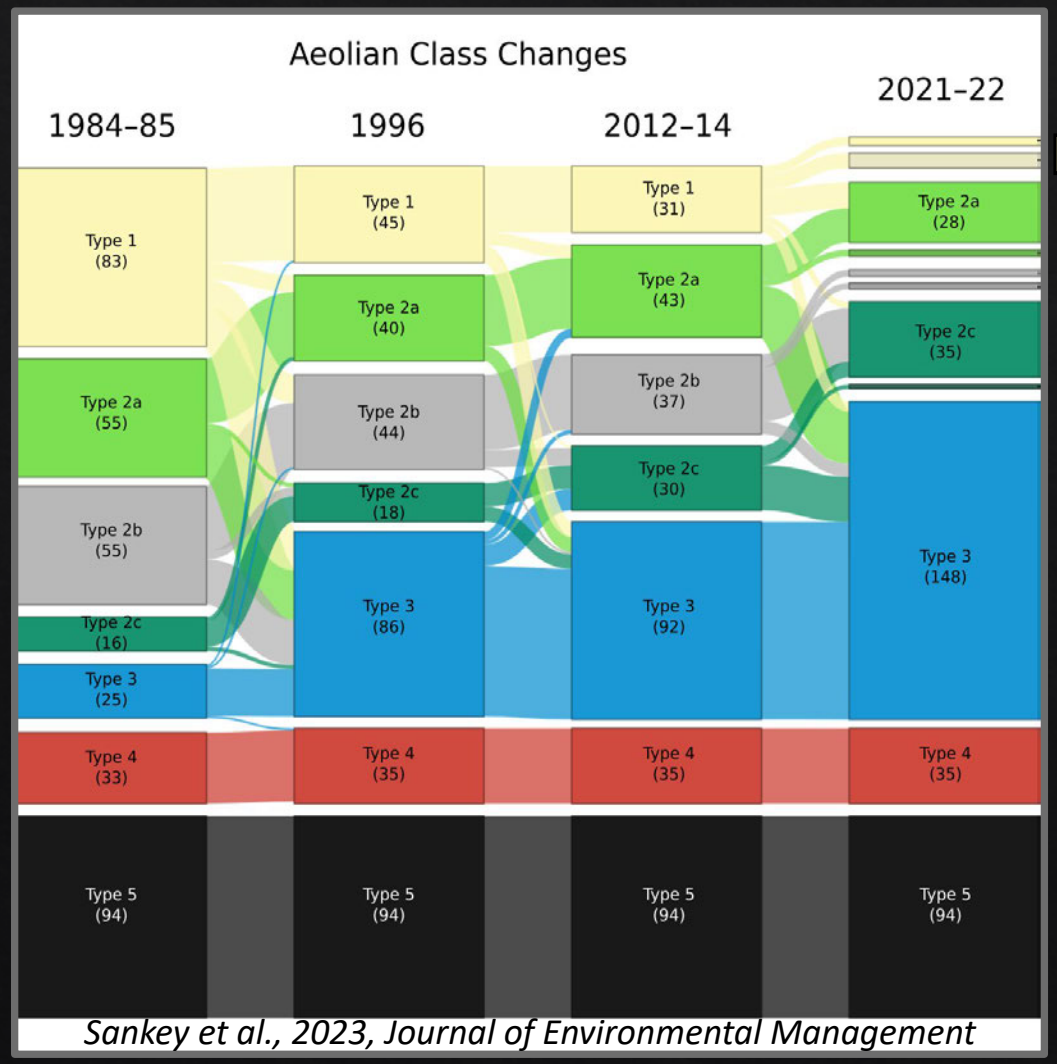

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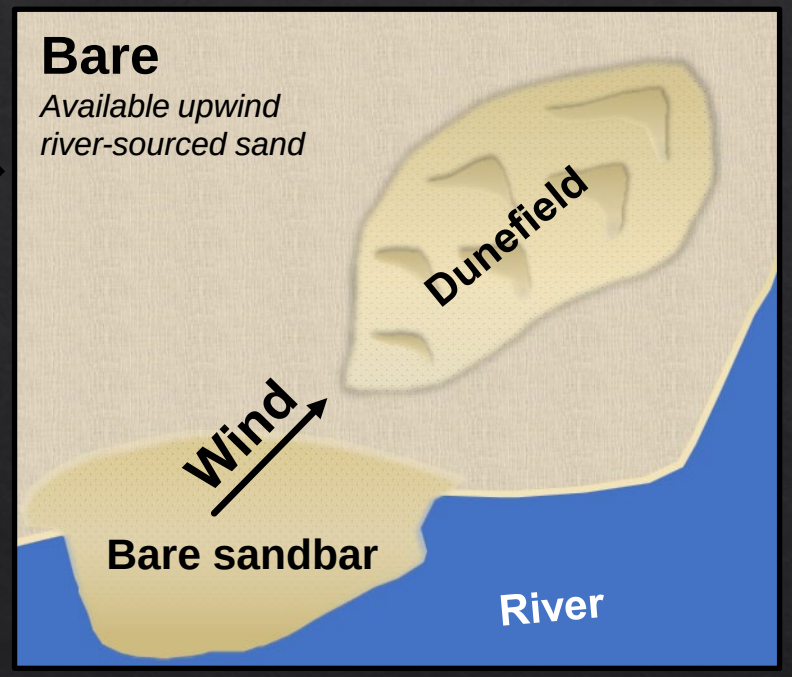
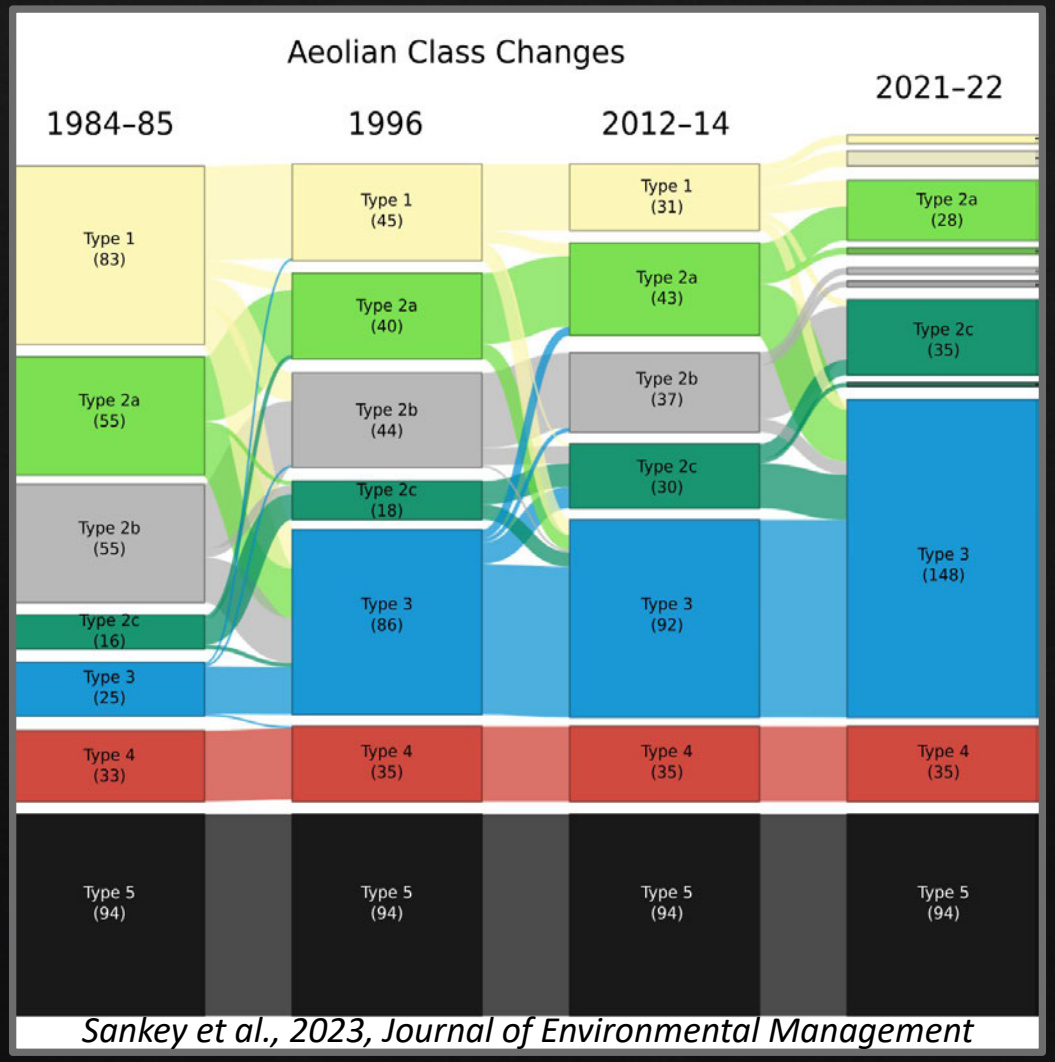


Changes between 1984 – 2021: In context



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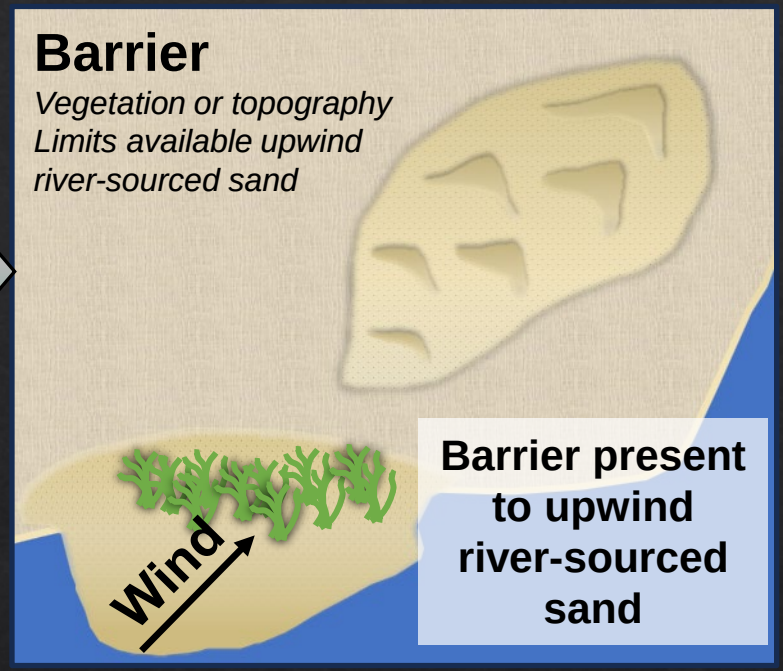

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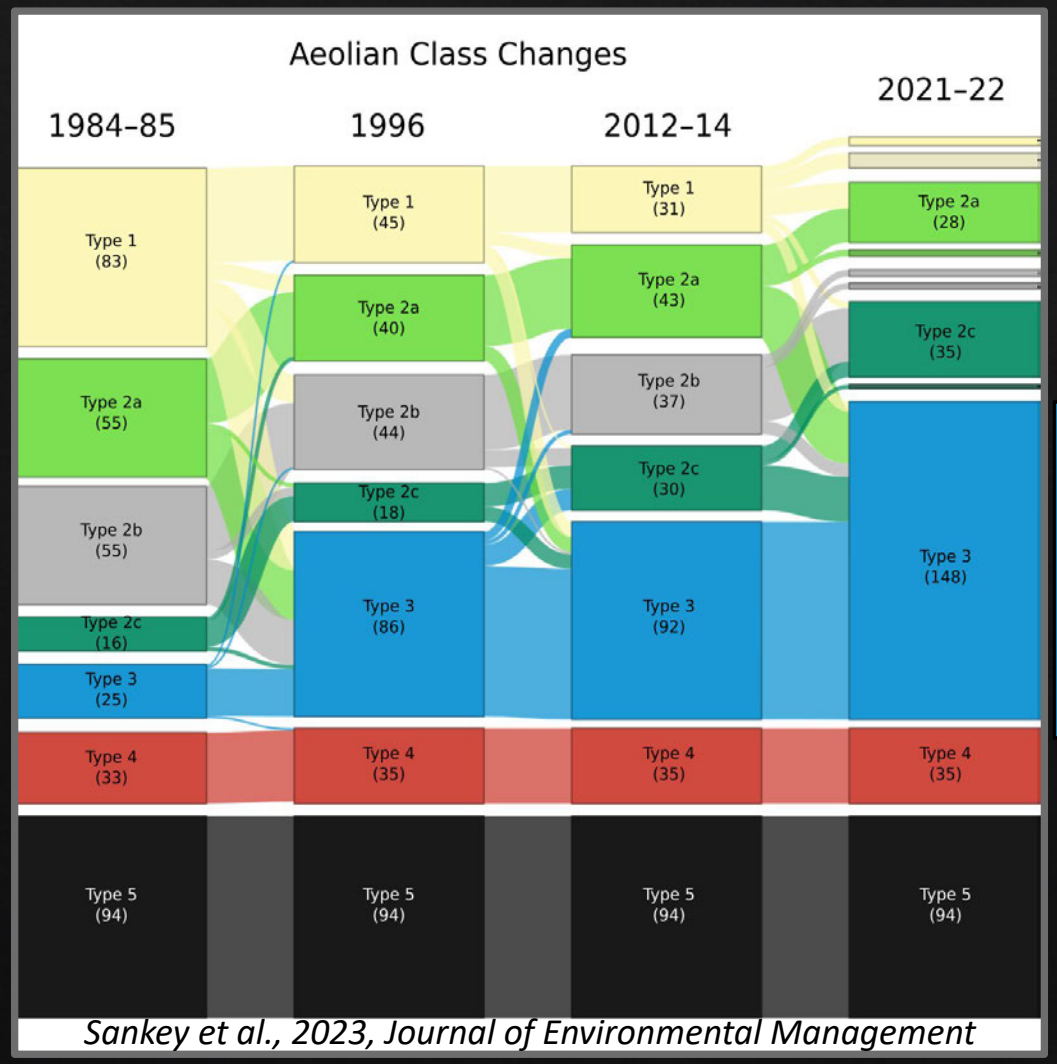

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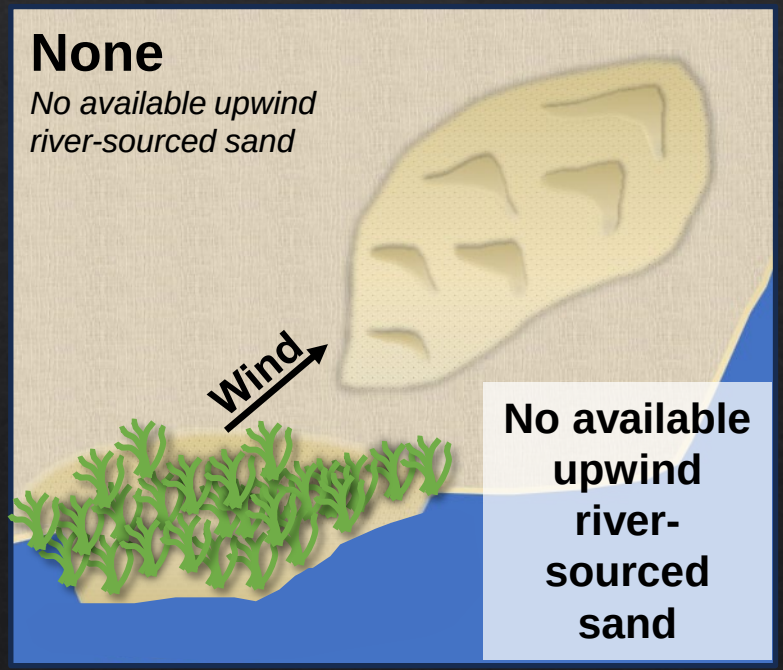
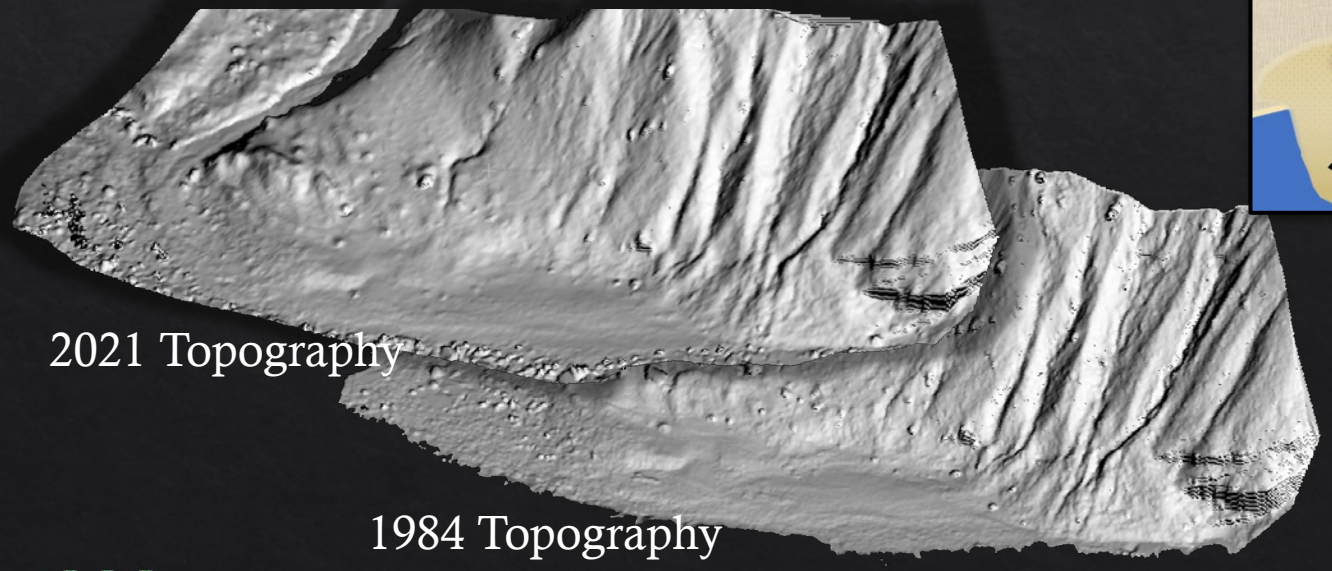


Research Question *(Caster Dissertation)*

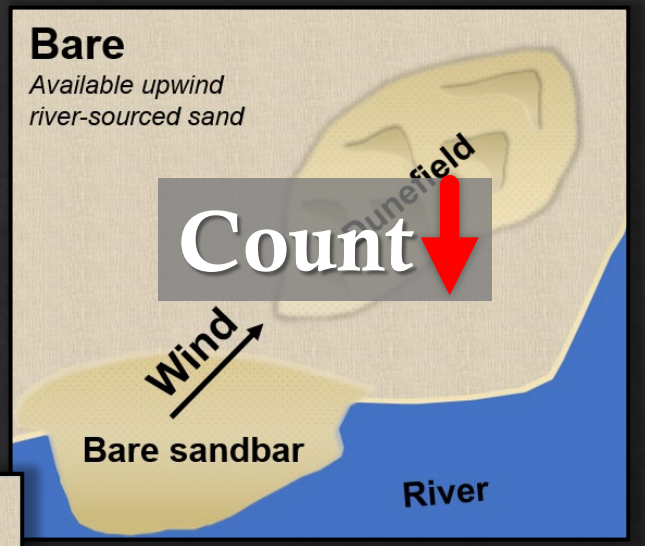
As the river and adjacent landscape become disconnected…

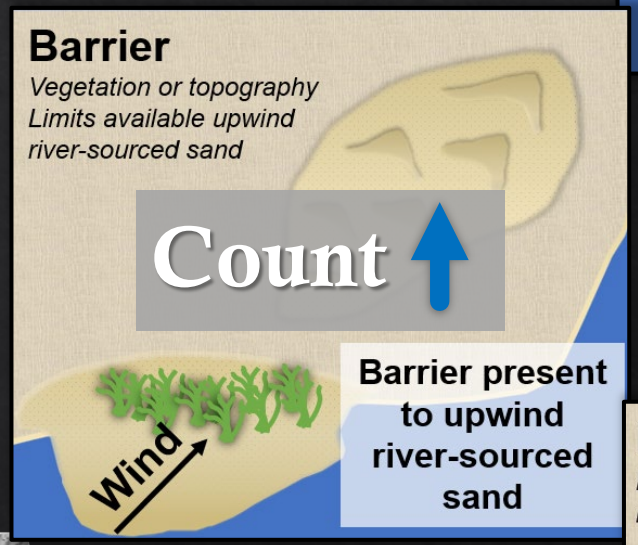
…do river-sourced sands in dunefields above the active channel measurably respond?

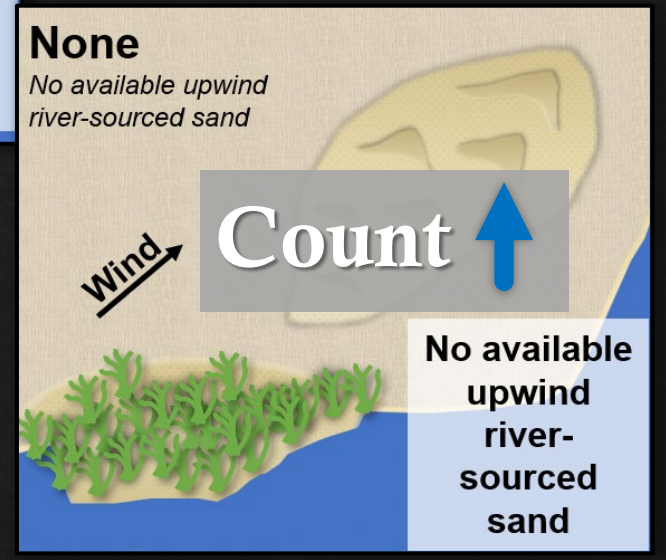


2021 Topography

1984 Topography



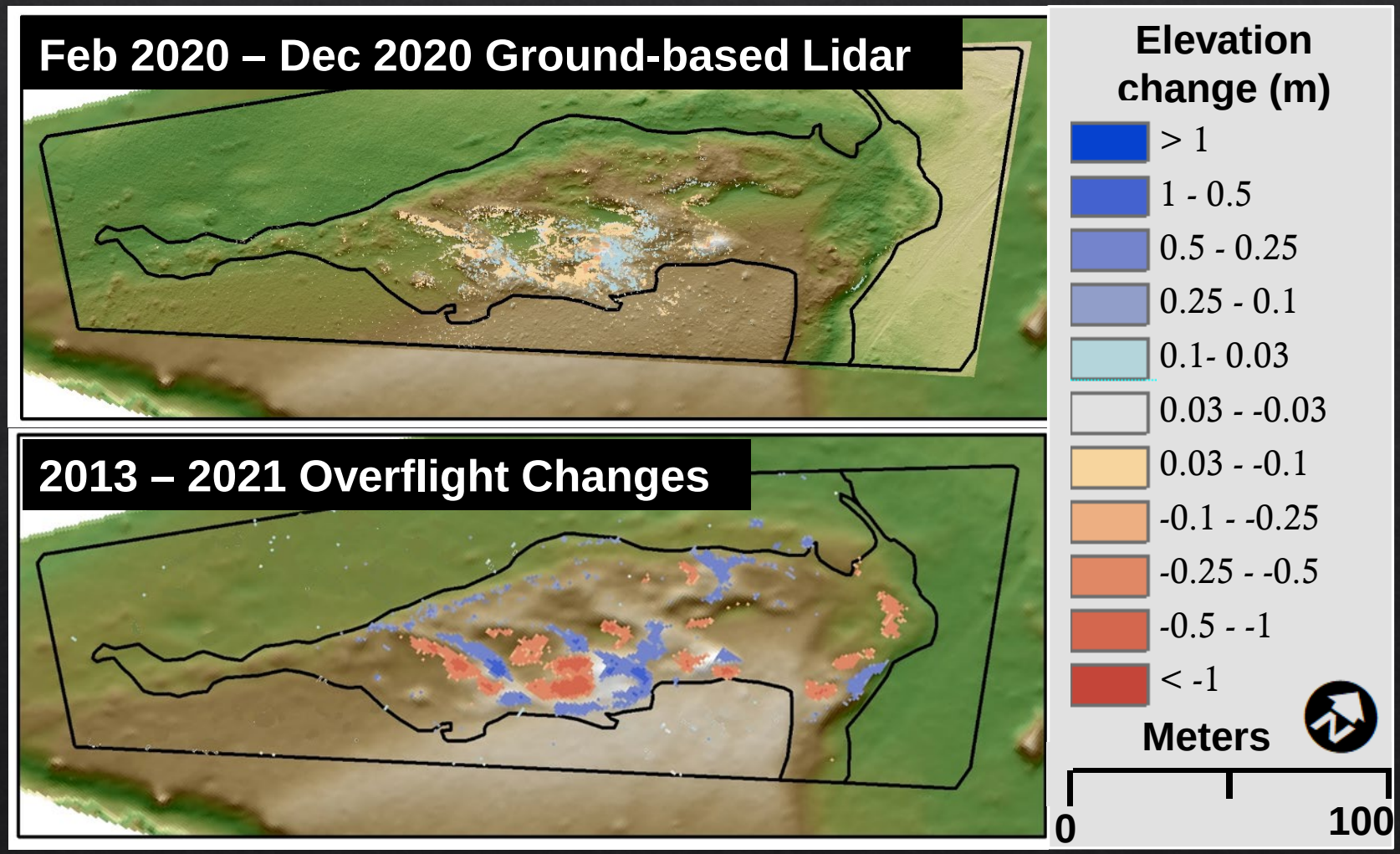




What change is “measurable” from these data?

Compared to the higher-resolution lidar remote sensing:

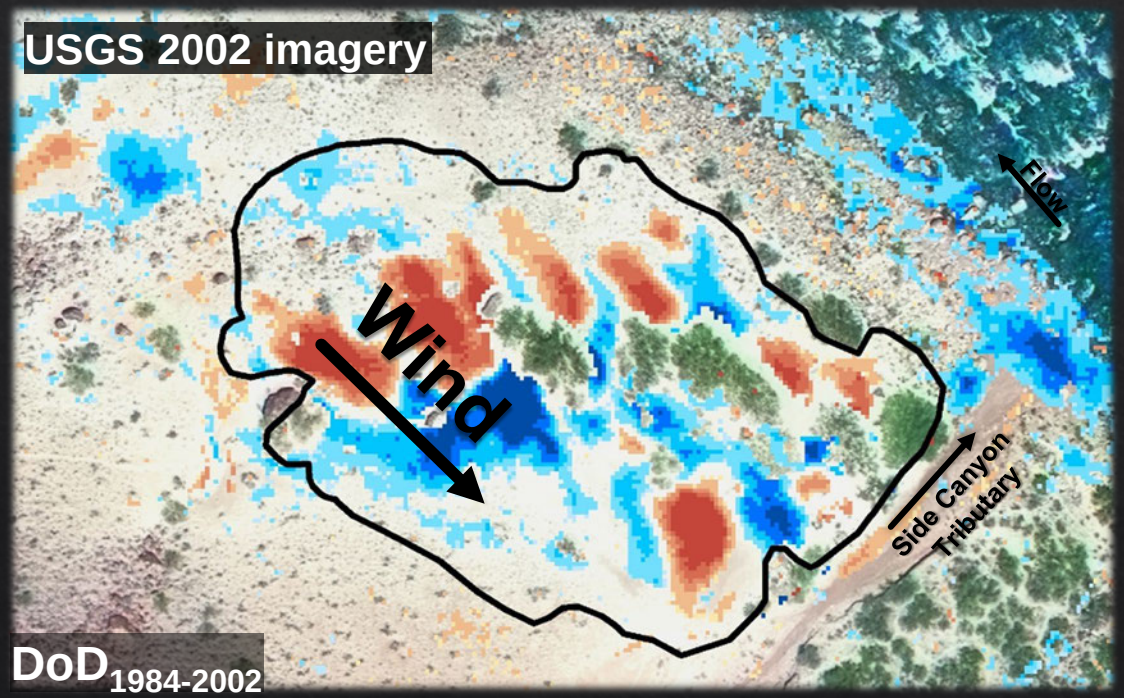
- Overflight DSMs have less detail
- Changes need to be larger to be detectable
- Common “patterns” do emerge

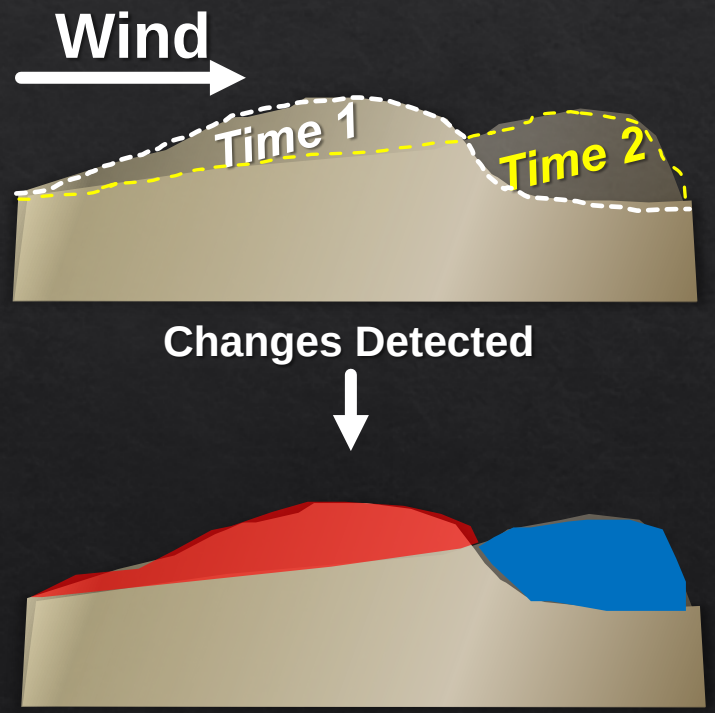


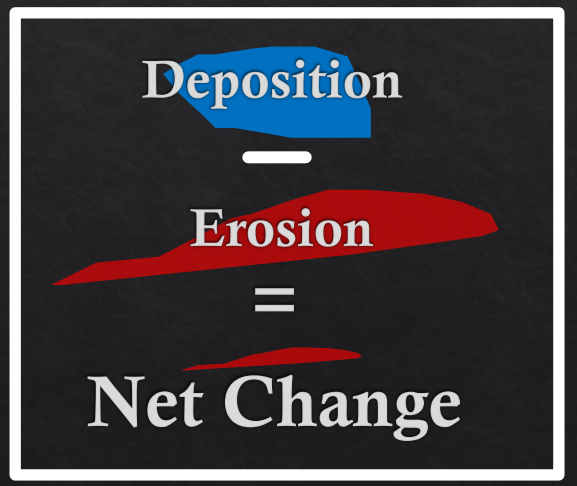
What do change "patterns" mean for river-sourced sand?

Measure 1: Net Changes

– *In sand, the net surface differences relates to sediment storage*

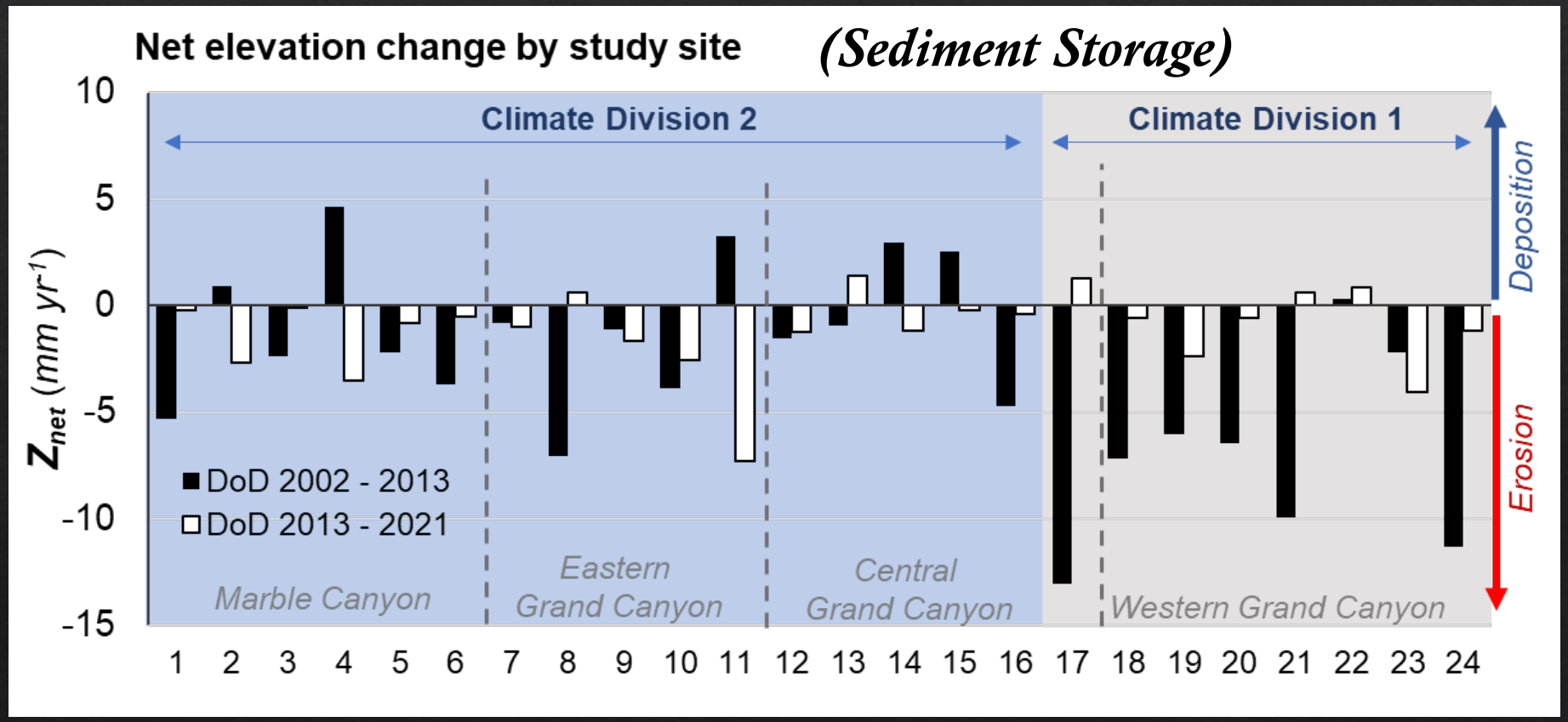






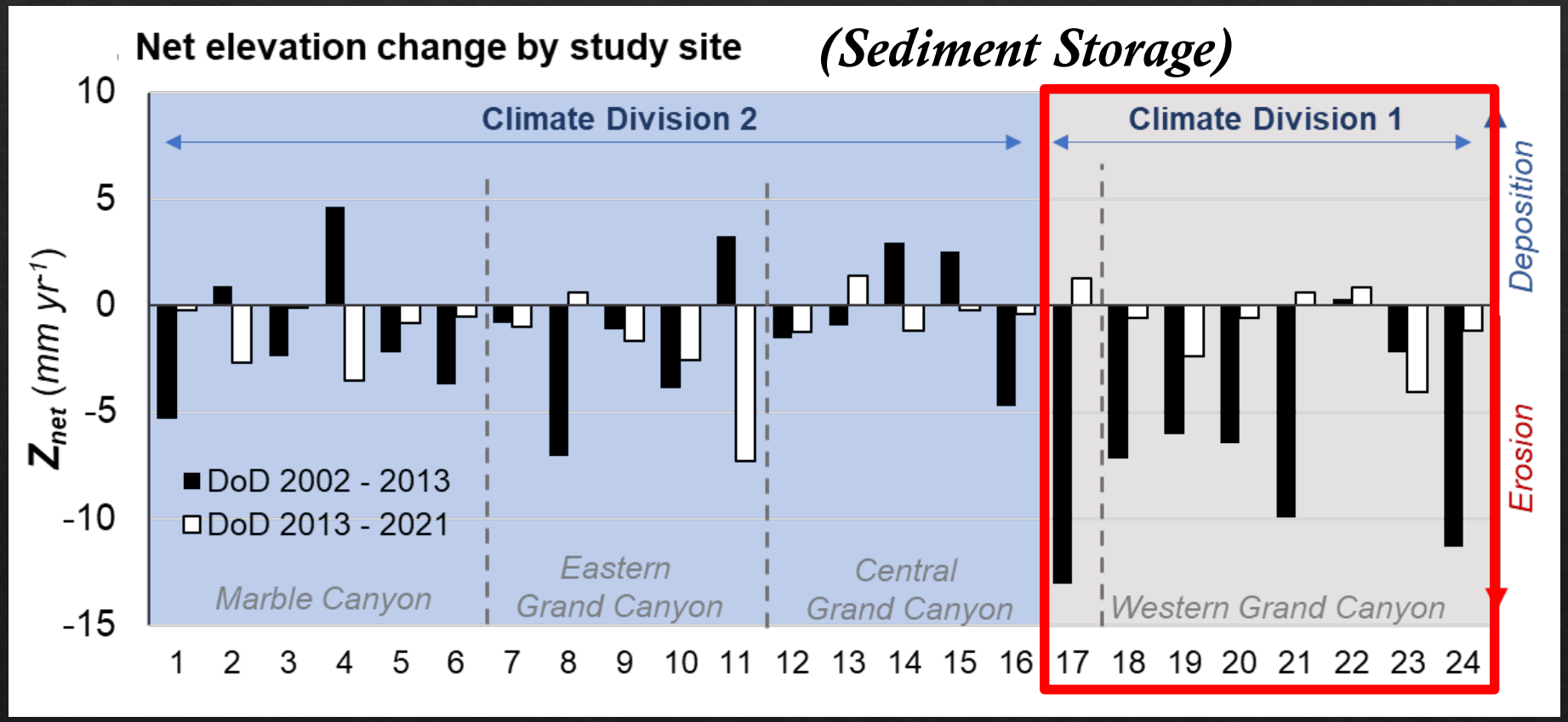
Results: River Corridor Landscape Change

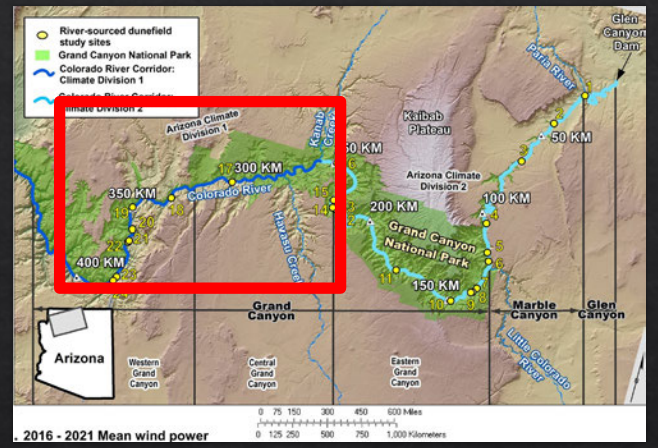
- In general, the dunefield study sites are eroding
  - *Note: ~5 mm change for a football field sized area is over 38 tons of sediment per year!*



Results: River Corridor Landscape Change

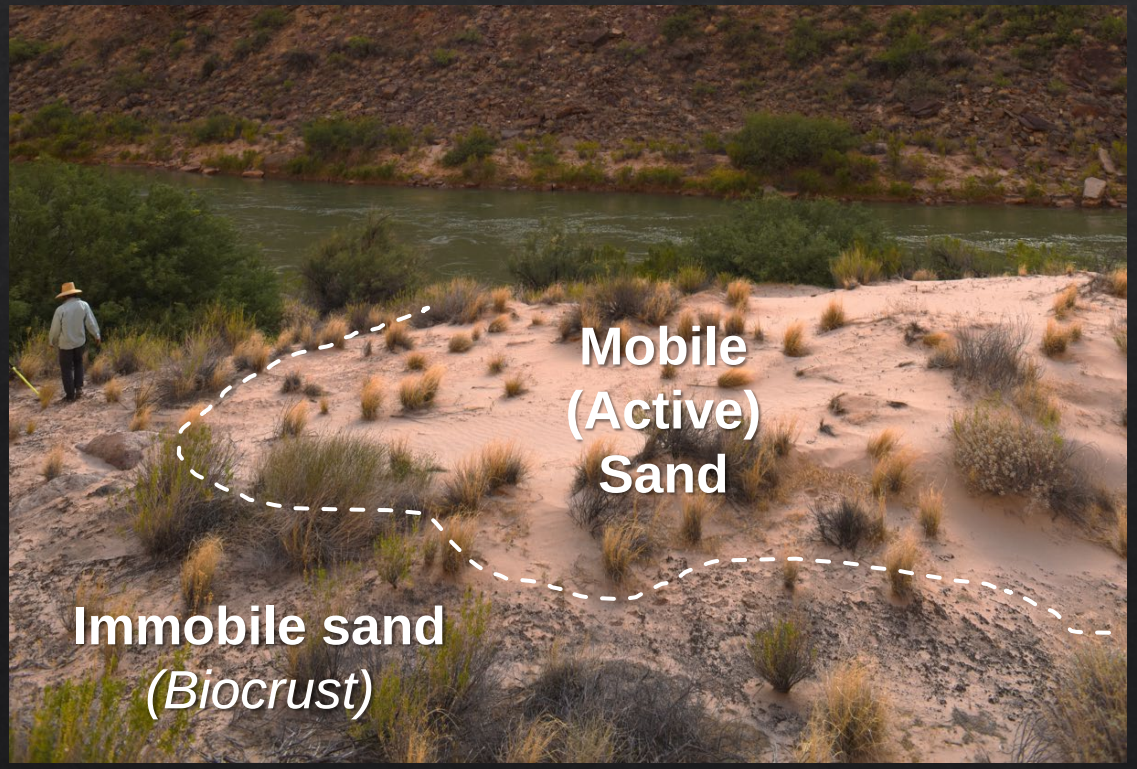
- In general, the dunefield study sites are eroding
- Western Grand Canyon sites are eroding at a higher rate…

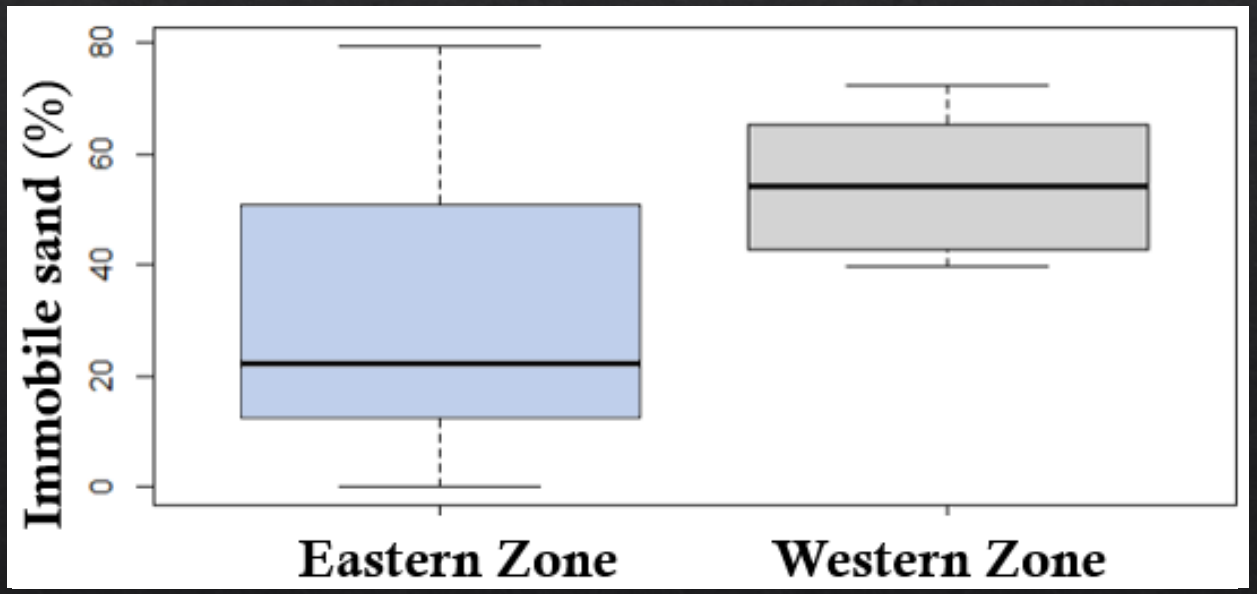




Results: River Corridor Landscape Change

- In general, the dunefield study sites are eroding
- Western Grand Canyon sites are eroding at a higher rate
- The western sites tend to have less "mobile" sediment





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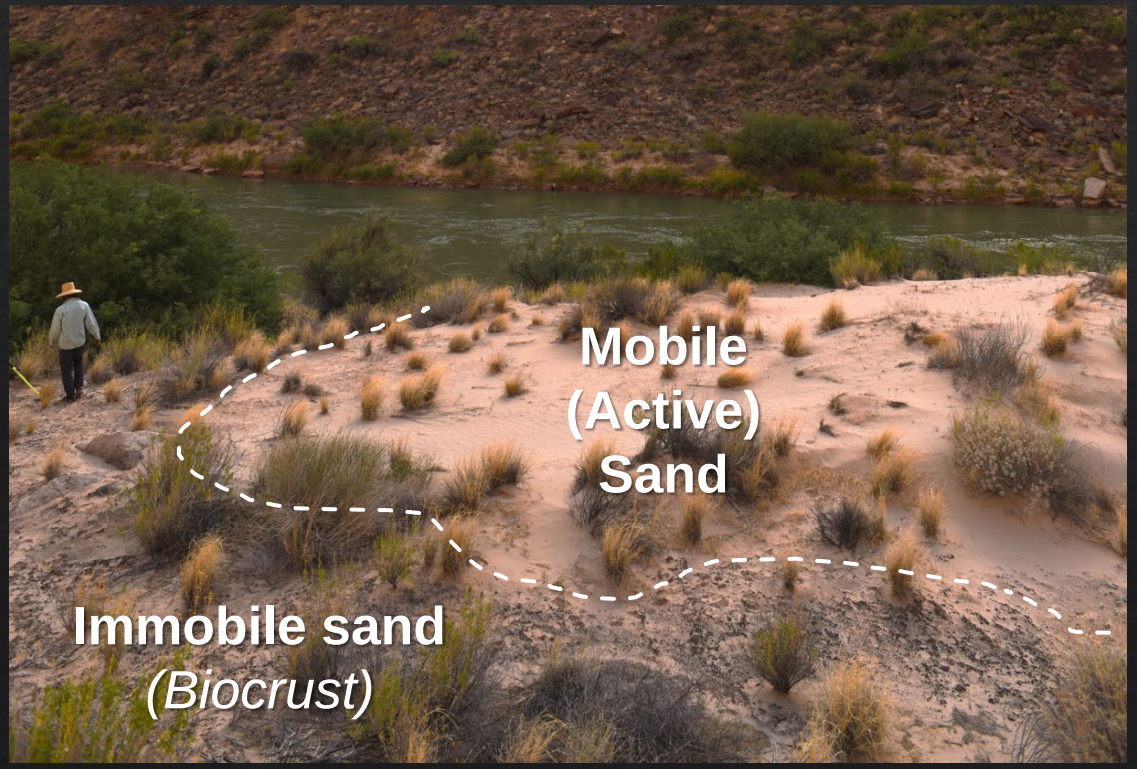
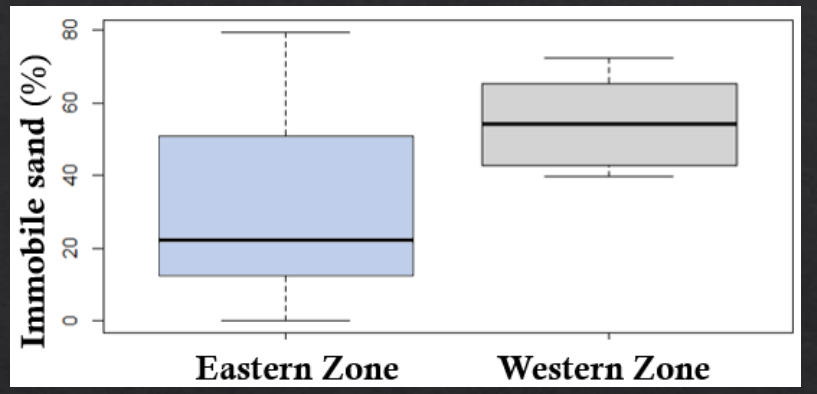
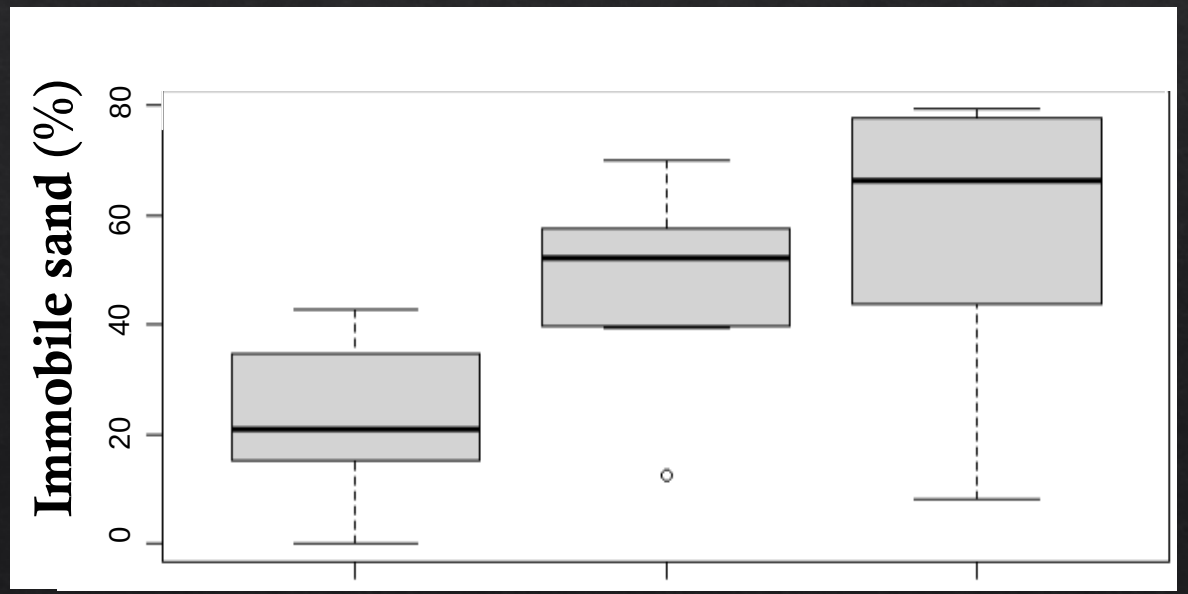


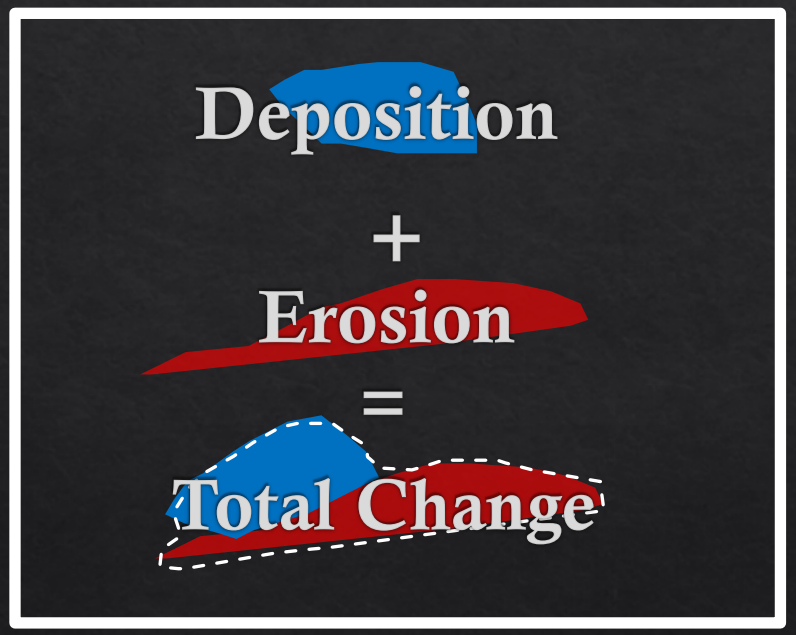




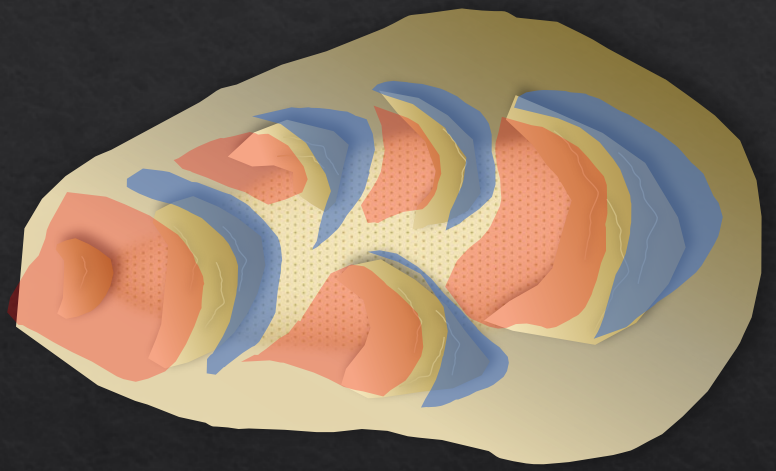
Aeolian dune field with an upwind sandbar

How would less mobility mean more erosion?

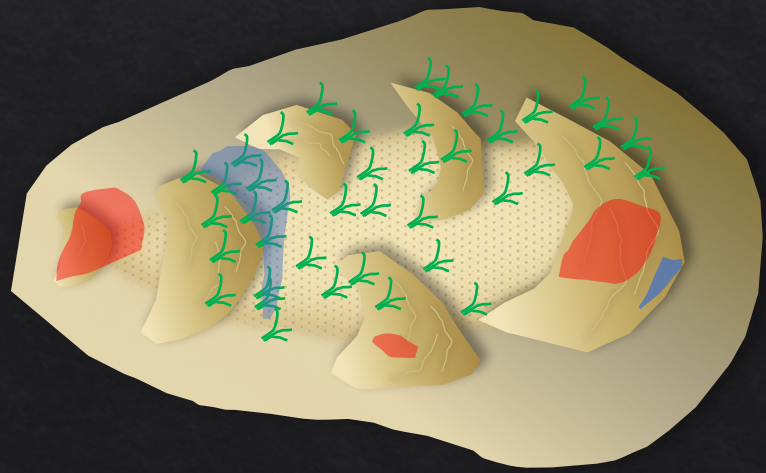
- Net volume of sand lost ≠ the total volume of sand moving



- More mobile sand
- Higher total change

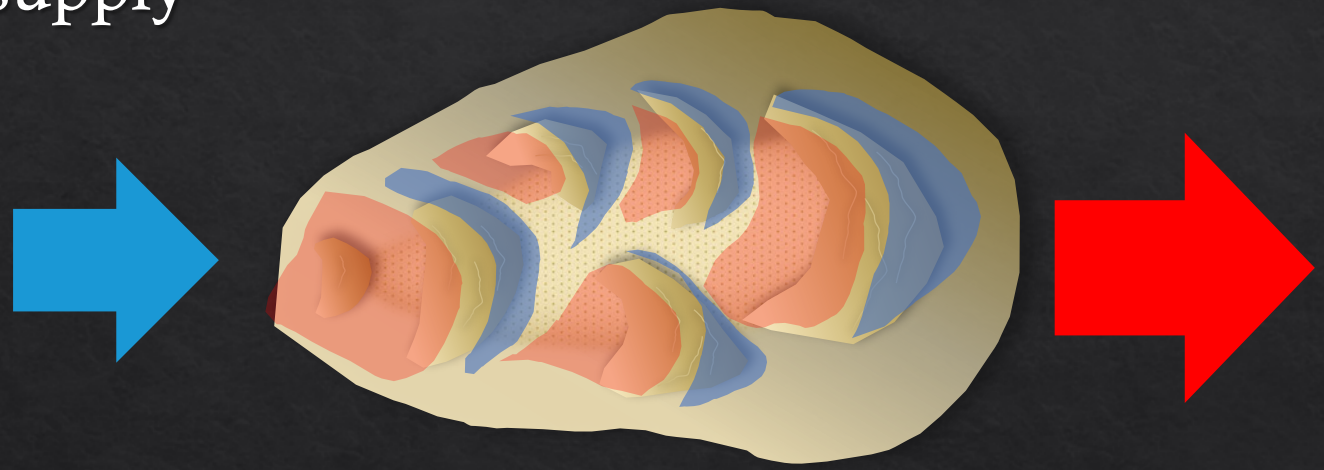


- More immobile sand
- Lower total change



How would less mobility mean more erosion?

Net change is partially driven by changes in supply



Incoming sediment

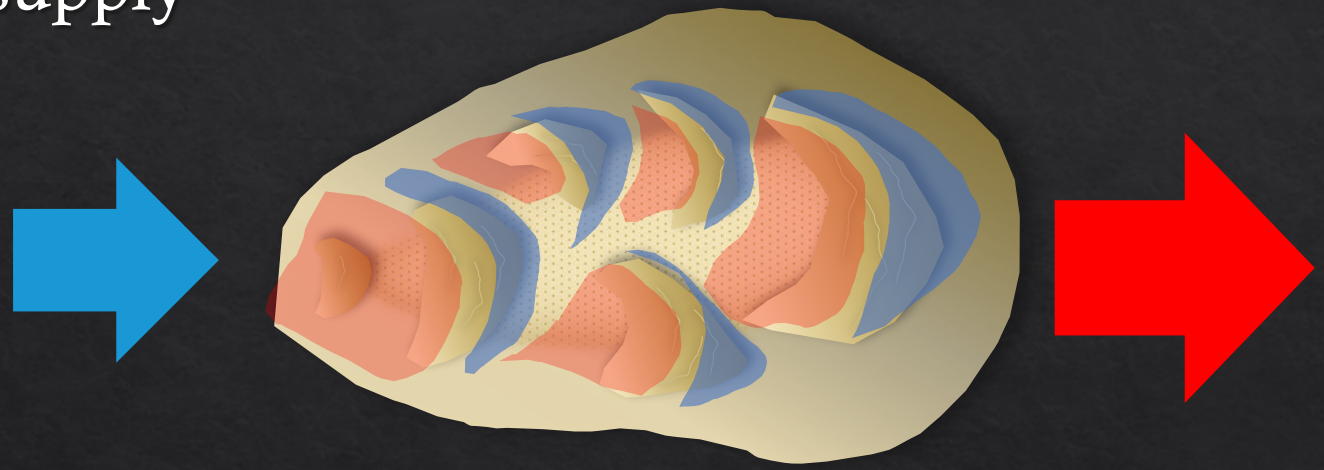
Sediment leaving

<u>Low change imbalance</u>

- High total change
- Low net change

How would less mobility mean more erosion?

Net change is partially driven by changes in supply



Incoming sediment

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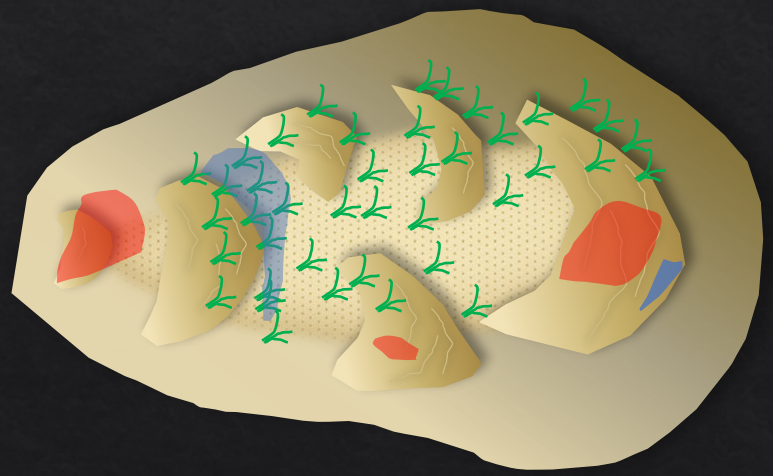


Low change imbalance

- High total change
- Low net change

High change imbalance

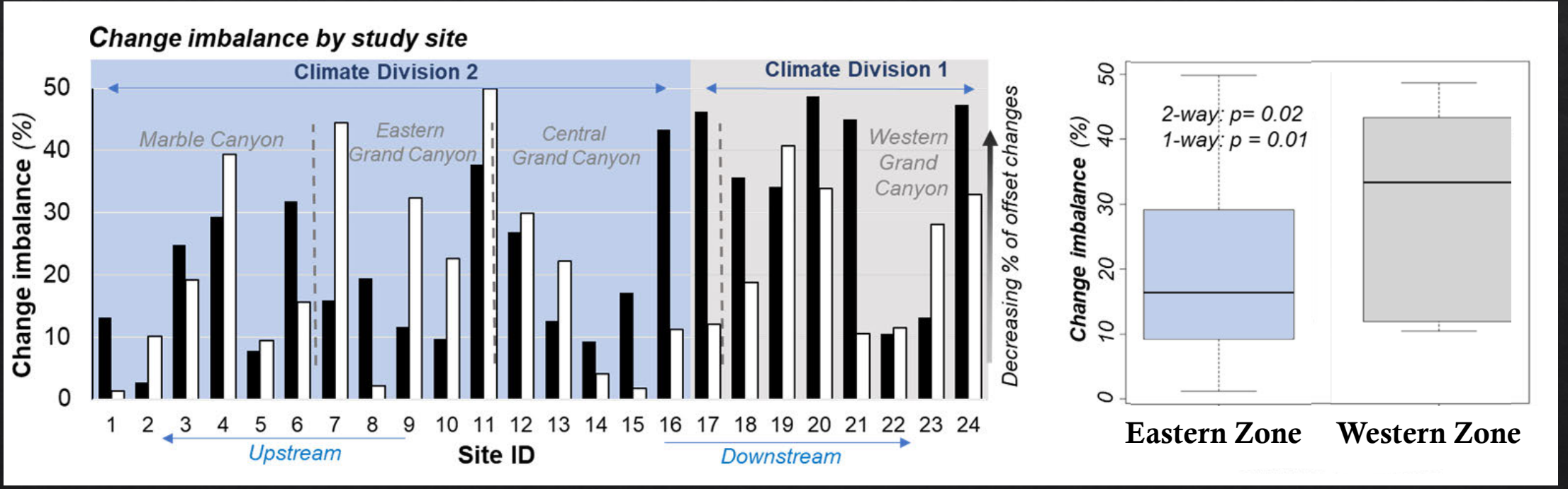
- Low total change
- Moderate net change

USGS

Results: River Corridor Landscape Change

- In general, the dunefield study sites are eroding
- Western Grand Canyon sites are eroding at a higher rate
- The western sites tend to have less "mobile" sediment…

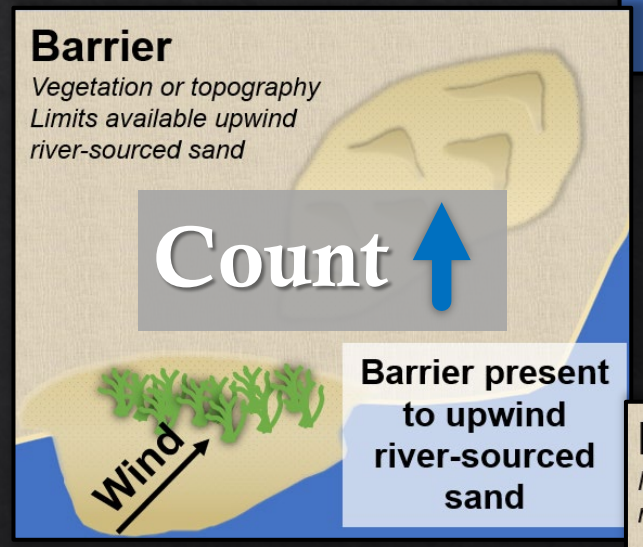
  …meaning changes might be smaller, but more is erosional

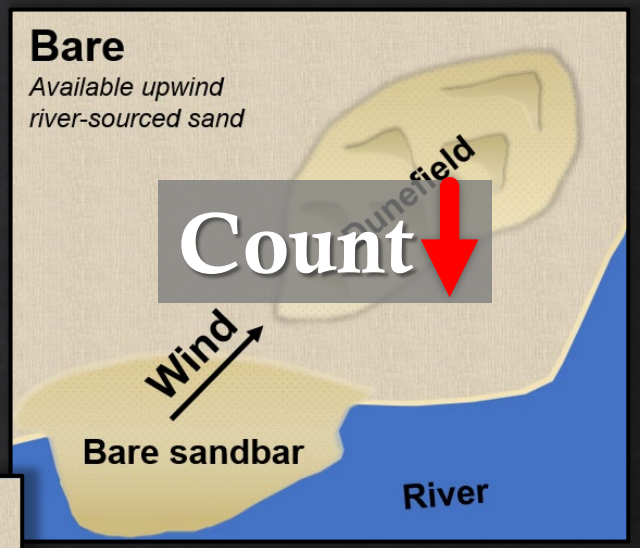


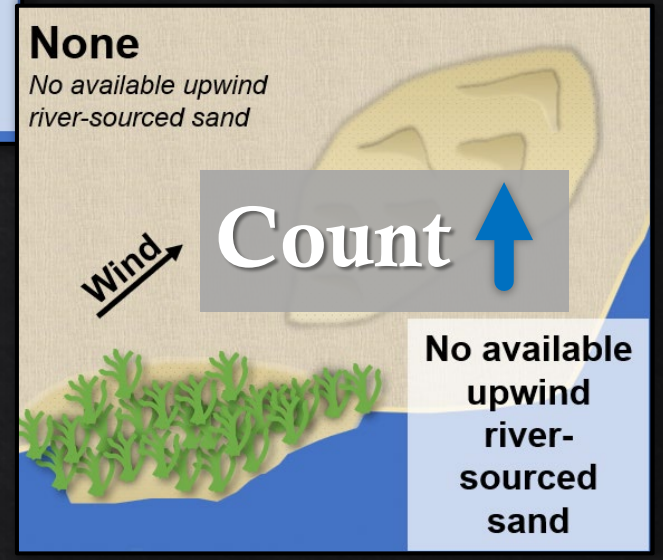
Research Question *(Restated)*

As the river and adjacent landscape become disconnected…

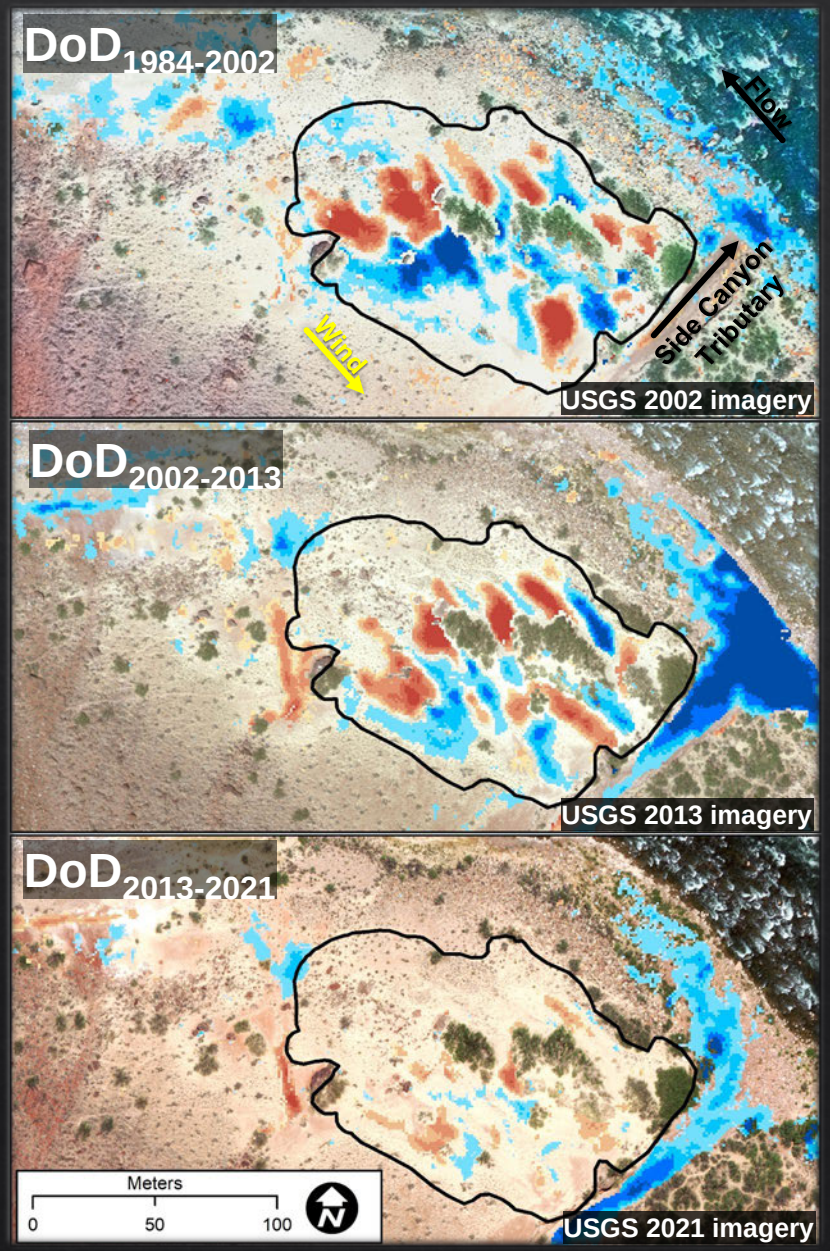
…do river-sourced sands in dunefields have less total change?

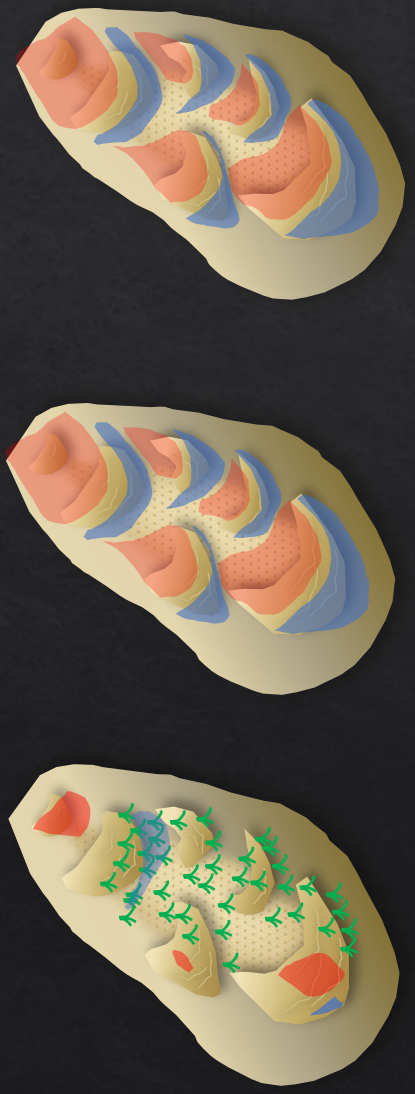




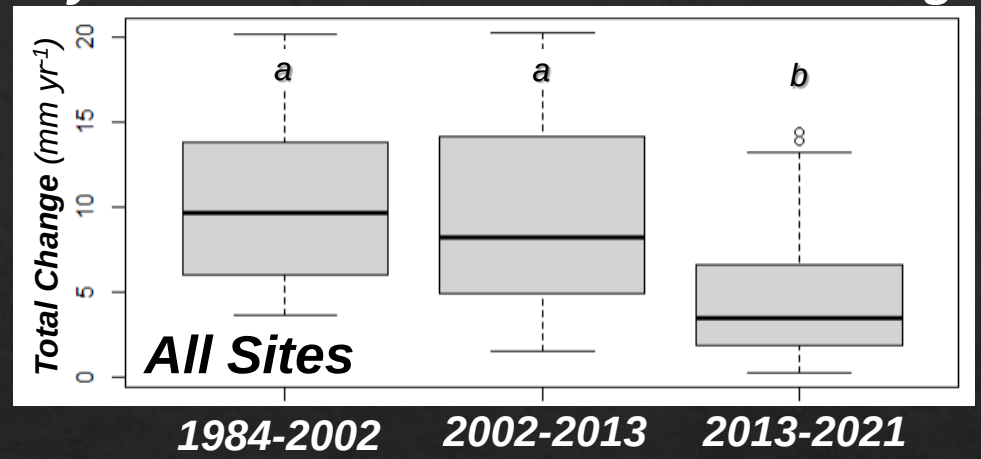


Results: Landscape Change 1984 - 2021





Survey interval and total elevation change



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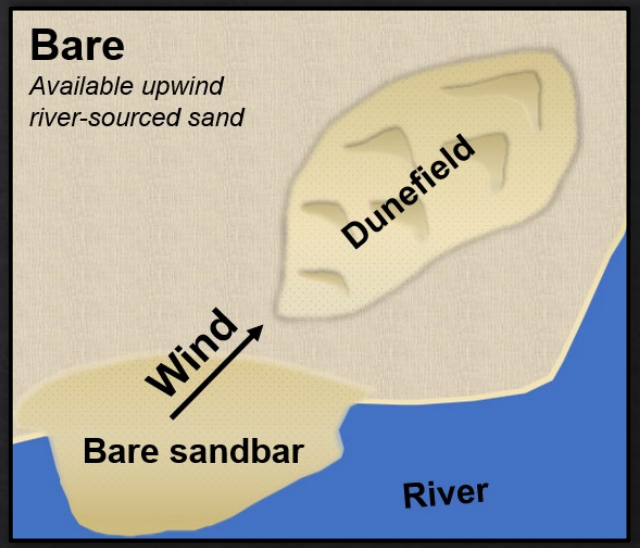

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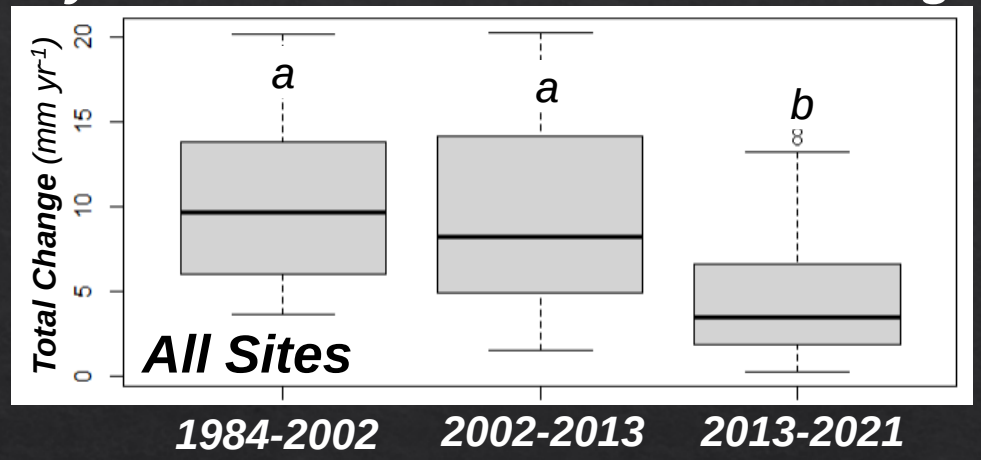
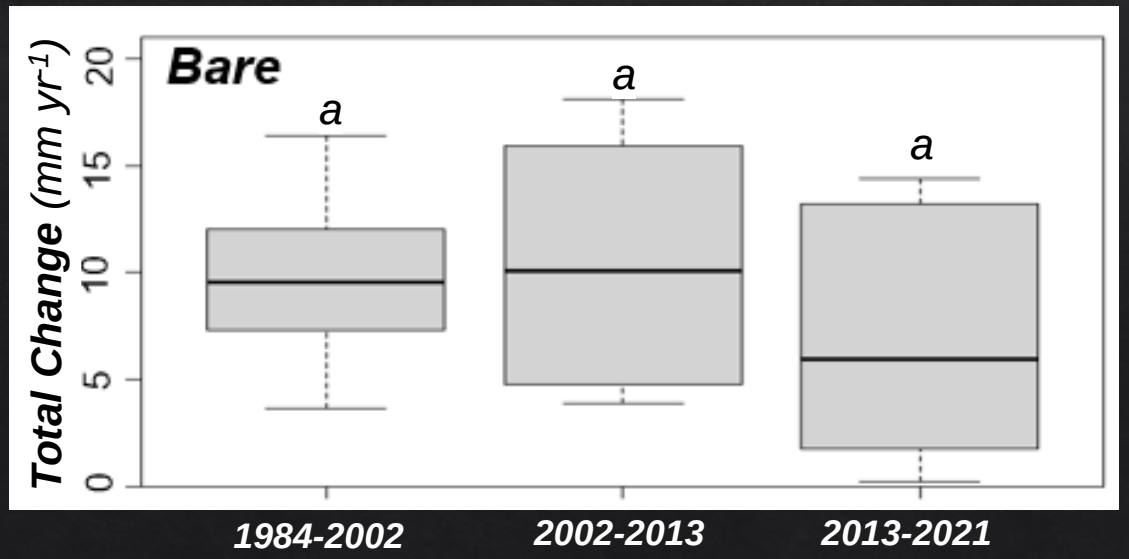
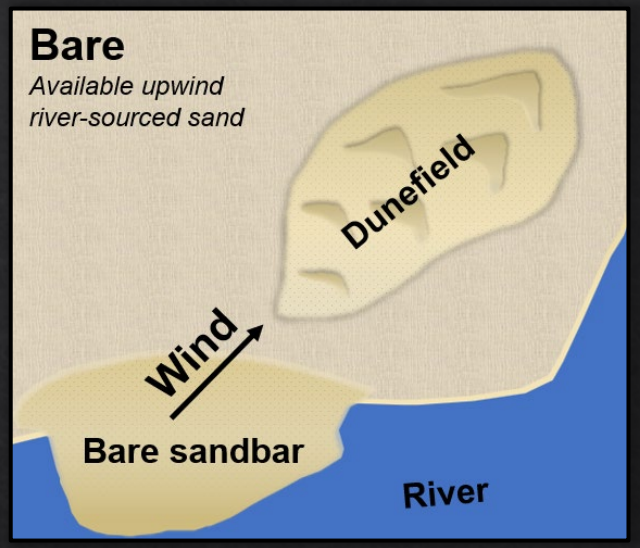
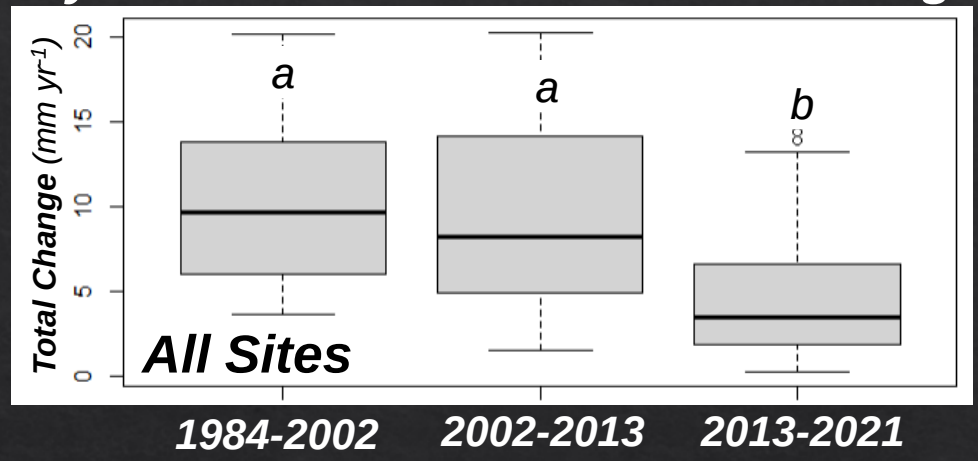


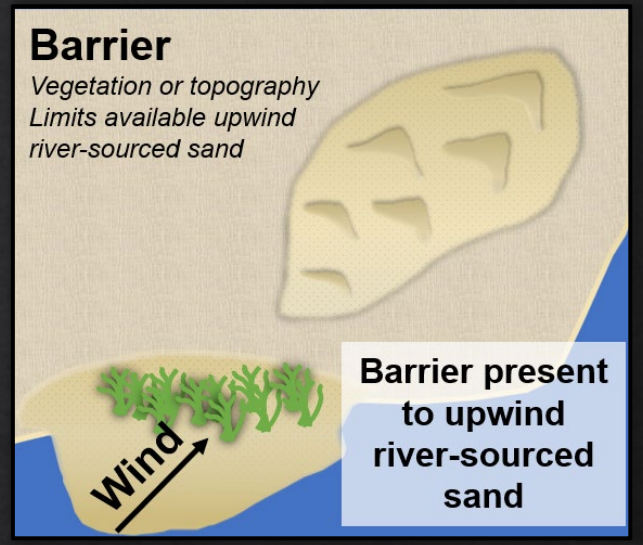


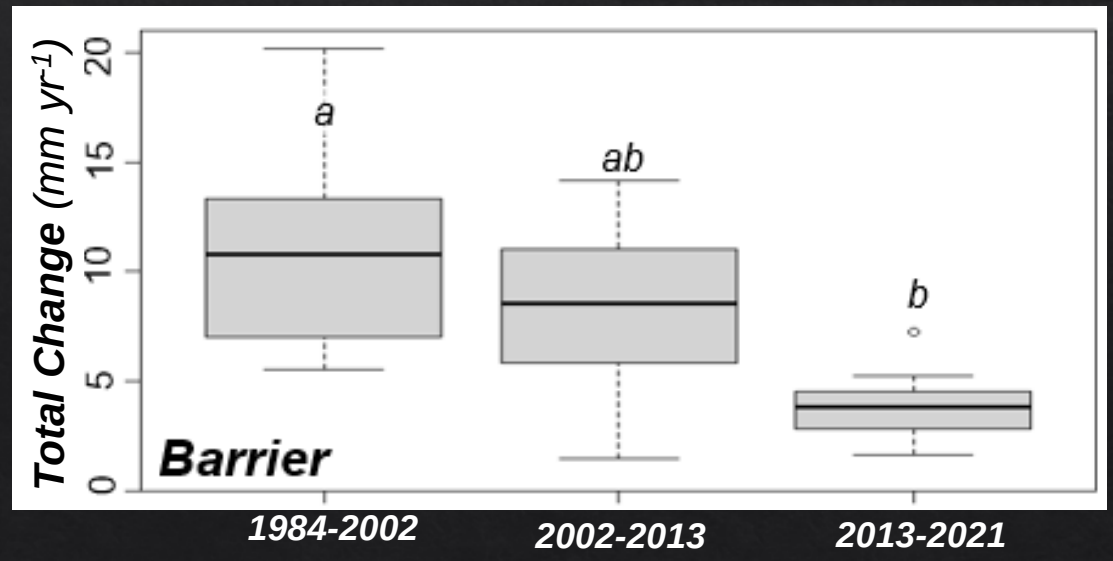
Results: Landscape Change 1984 - 2021



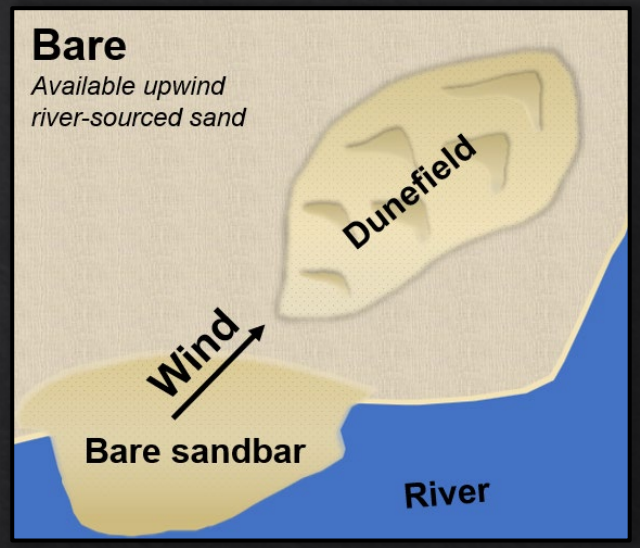
Survey interval and total elevation change



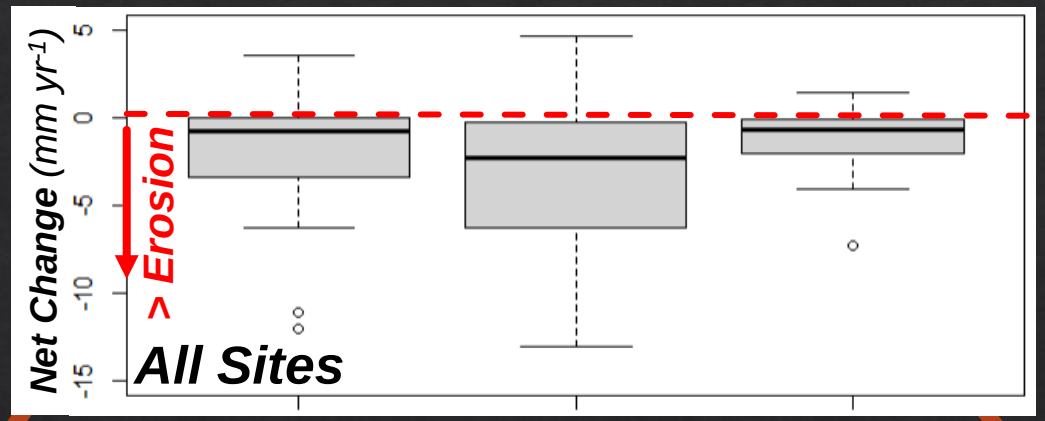


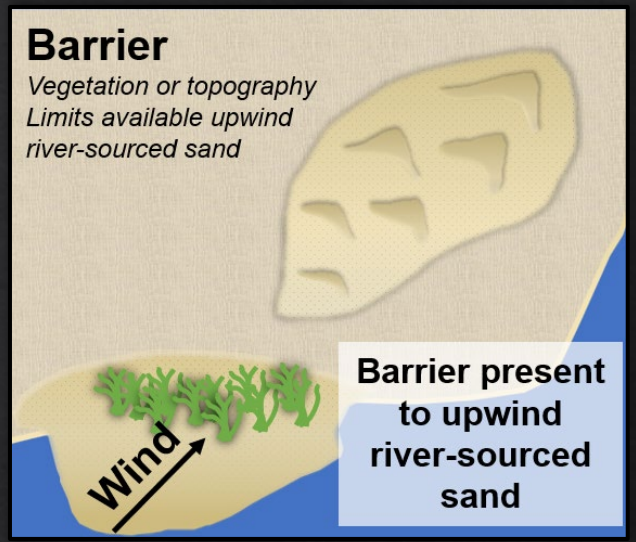


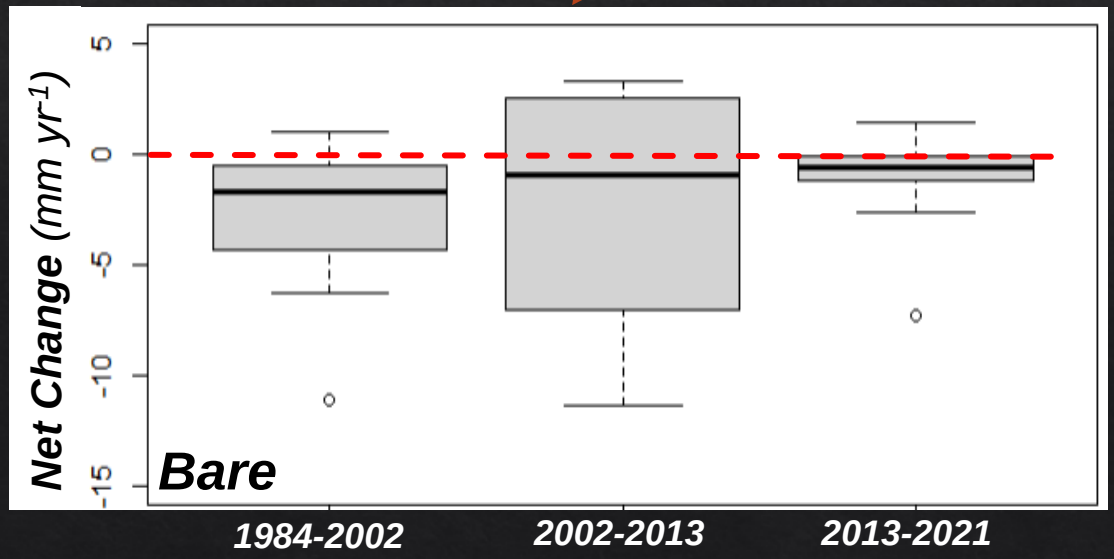
Results: Landscape Change 1984 - 2021

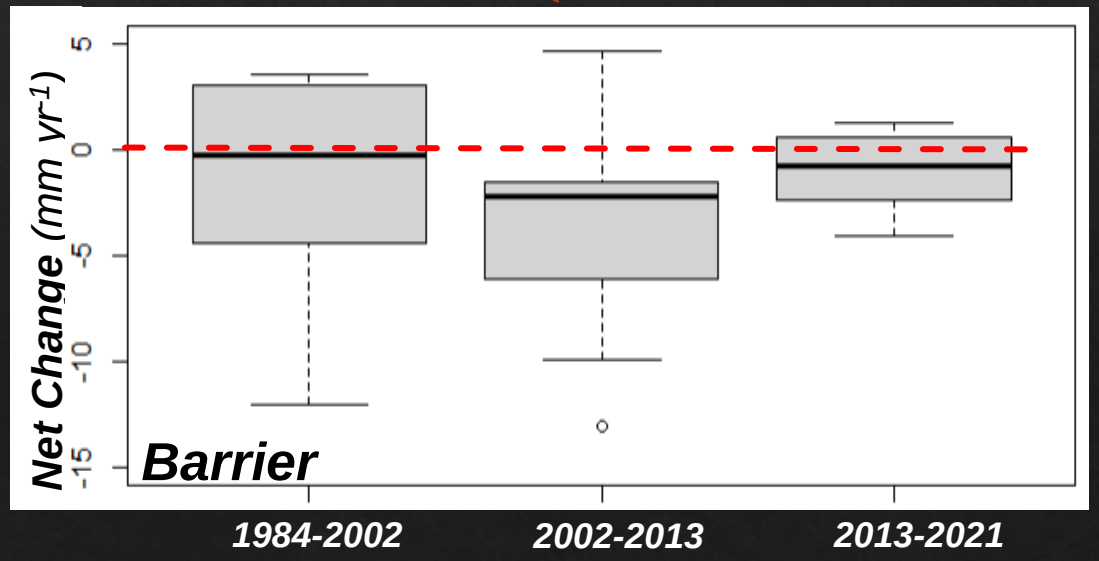


Survey interval and total elevation change





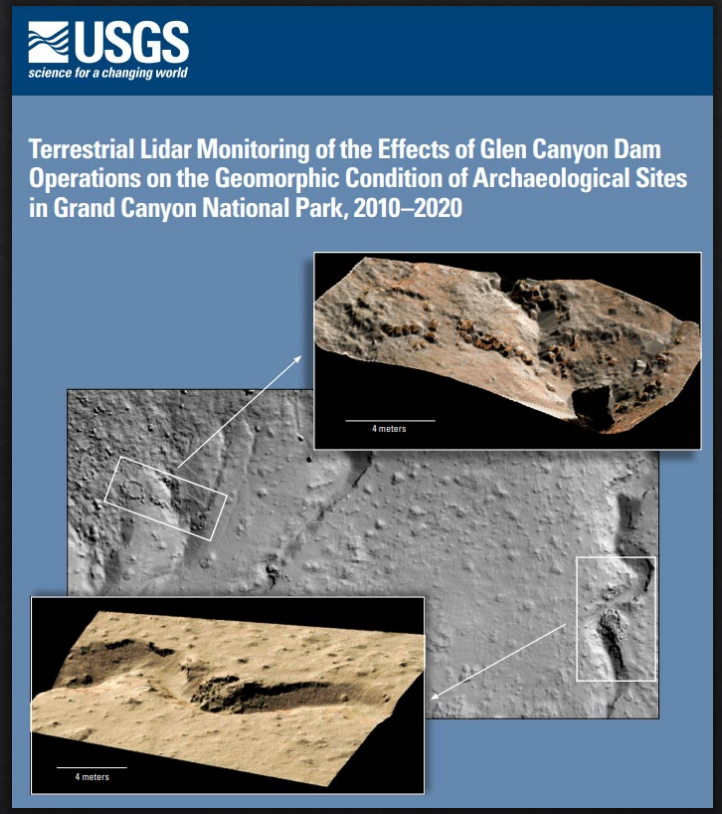




What's the point?

- River-sourced sand in aeolian dunefields is becoming less "wind mobile"

…and it is still eroding

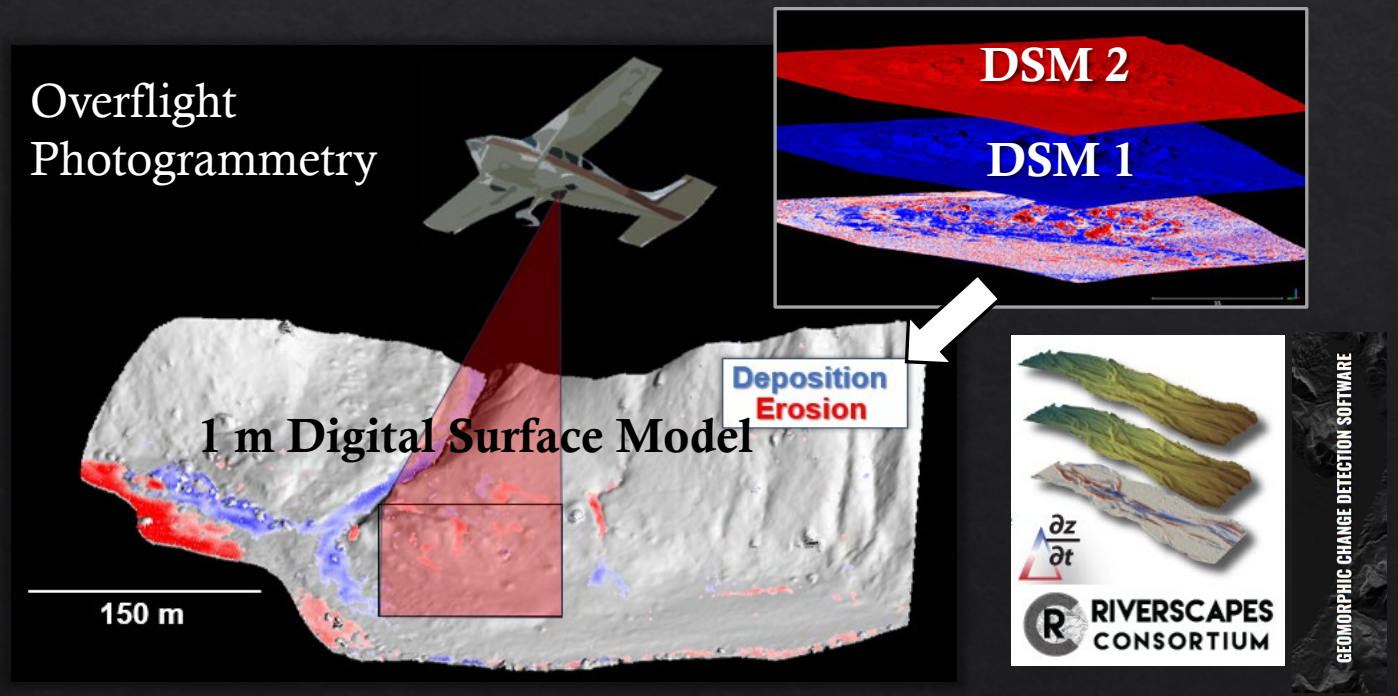


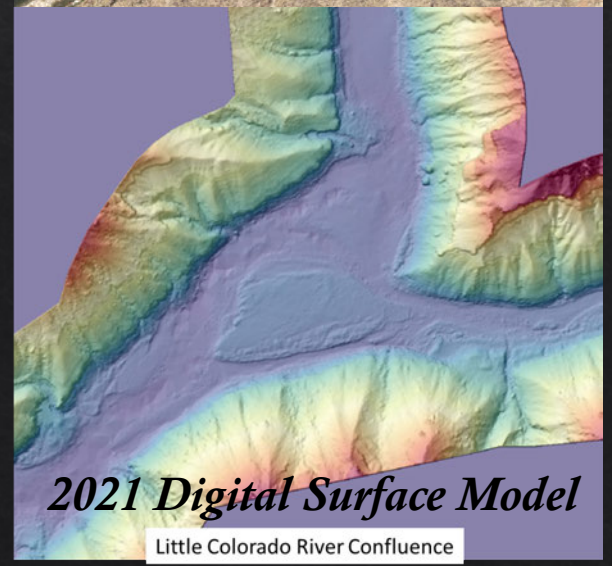
What's the point?

- Where a connection between the river and the adjacent landscape can be maintained, management actions might influence these changes

Final thought (Finally!)

- The overflight topography can provide useful insight into changes within high elevation river sand





Thank You

References:
Sankey, J.B., Bransky, N., Pigue, L., Kohl, K., and Gushue, T.M., 2024, Four Band Image Mosaic of the Colorado River Corridor in Arizona--2021, including Accuracy Assessment Data: U.S. Geological Survey data release, https://doi.org/10.5066/P9BBGN6G.

Caster, J., 2024, Do “stable” surfaces change? Bio-geomorphic interactions and surface characterization within transitional aeolian environments. Northern Arizona University *unpublished Dissertation*