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Report on Current Status and Phase I Results of the Cultural Monitoring R&D Project

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

Outline of this presentation

- 1: Project Goals
- 2: Project Phases
- 3: Project Elements & Accomplishments
- 4: Next Steps
- 5: Unresolved Issues
  - NPS Permitting of Project
  - Interface with CRMP
  - Interface with PA / Section 106 compliance

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Primary Project Goals

Develop quantitative monitoring protocols to:

- objectively assess status and trends in cultural site condition system-wide
- evaluate role of dam operations in affecting cultural resource condition
- evaluate effectiveness of erosion-control treatments

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How to monitor dam effects?

- Few arch sites directly inundated by flows
- Most dam effects indirect and cumulative – impacts/instability due to ecosystem changes (sediment supply & distribution, vegetation loss/ encroachment, disturbance regime, etc.)
- Site condition affected by many factors besides dam ops – climate, weather, visitors
- Requires a multi-faceted approach and appropriate tools to accurately measure physical changes linked to dam ops

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Need for an ecological framework

- Cultural resources exist and are sustained in a ecosystem / landscape context
- Colorado River corridor landscape & ecosystem are changing due to dam operations and other environmental factors (e.g., climate, human visitors)
- Ongoing ecological changes affect cultural resource stability
- Stability is a proxy measurement for resource condition (NPS ASMIS definitions of condition)
- Ecological framework best-suited for incorporating Native American perspectives

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Dam Ops Destabilize Sites by Affecting the Sediment Supply & Ecosystem Processes

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Ranked Geomorphic Attributes

Example:
Landforms: first-ranked = debris fan; 2nd ranked = alluvial terrace; 3rd ranked = colluvial slope
Surface sediments (substrates): first-ranked = alluvium; 2nd ranked = slopewash gravels; 3rd ranked = boulder/cobbles

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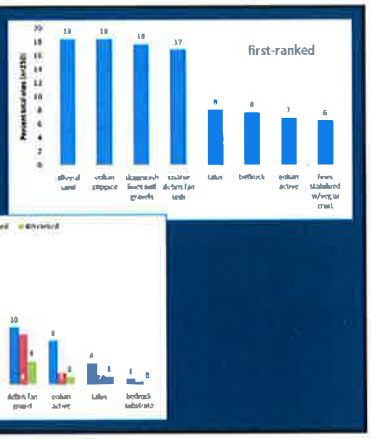
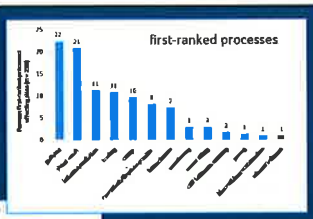
—substrates



—surface processes



Take-home points: Stability vs. Erosion

- Bedrock & coarse-grained, poorly-sorted substrates more stable; fine-grained, well-sorted sediments relatively unstable
- Overland flow dominates surficial processes; creep (rainsplash, freeze-thaw, bioturbation) is important 2nd ranked process
- Trailing is a significant process, but not at acutely eroding sites
- Stable sites show full suite of processes, but overland flow generally absent—unstable sites dominated by overland flow

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3. Monitoring "Tool Kit" R&D

- Standardized Forms (to record observational data)
- Repeat Photography (to document change)
  - Ground-based photos
  - Airborne digital imagery (over-flight data)
- GIS (for recording and analyzing spatial data)
- Survey Tools (for measuring/quantifying change)
  - Total station
  - Ground-based lidar
  - RTK GPS
  - Airborne lidar
- Weather monitoring instruments

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Need for "testing" potential survey tools

- Purpose of "testing" is NOT to determine if technology "works", but how well it works in Grand Canyon
- Will the instruments work *reliably* in deep confined canyon and extreme environmental conditions?
- Can data be collected accurately and efficiently given Grand Canyon-specific logistical constraints?
- Will methods cause unacceptable impacts?
- How can impacts be minimized?
- What are the potential trade-offs in terms of coverage, cost, efficiency, accuracy, and potential impacts?

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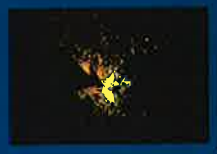
Lidar mapping process



Above: point data collected with single scan

Below: Merged point data from multiple scans

Right: Point data converted into a 3-d terrain model

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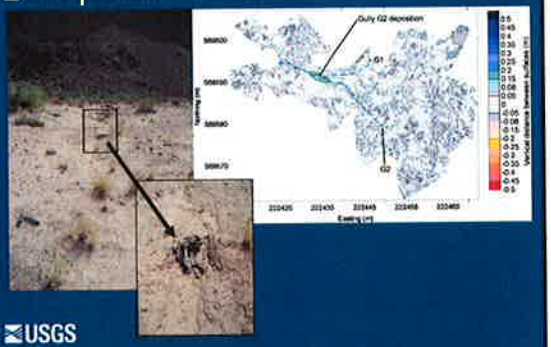
Example #1: AZ C:13:336



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Measured Change at AZ C:13:336 (May 2006-September 2007)

- Area w/ measured erosion (m2) = 0
- Area w/ measured deposition (m2) = .9
- Total % of site area w/ topo. change = .1
- Total site volume of erosion = 0
- Total site volume of deposition = .1

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Comparison of 2006-2007 Monitoring Data (CRMP data vs. Lidar data)

Fair = Site at first assessment or since last assessment "shows evidence of deterioration by natural forces and/or human activities. Without corrective treatment, site will degrade to poor condition"

Site No.	Condition	Threat or Disturbance Type	Disturb-ance Level	Measured change (in cubic m)	% Site Modeled Area w/ measured change
C:13:006	Fair	Water erosion, wind erosion, creep	Low	-0.7/+26.9	21.3%
C:13:336	Fair	Water erosion, trailing	Moderate	-0/+9.1	0.1%
C:13:348	Fair	Water and wind erosion, trailing, creep	Moderate	-0/+0	0

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Weather Monitoring Component

Status:

- 9 weather stations deployed Feb-Mar, 2007
- Various technical and software issues tackled and resolved in 2007
- 2 additional stations and 4 sand traps deployed in February, 2008 for HFE
- 2007 Data Report completed; 2008 Data report in review (final due 09/09)

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Geomorphic Process and Check Dam Effectiveness Study

- Data on soil characteristics, infiltration capacities, check dam survival collected in 2006-2007
- Draft report completed November 2008
- Reviewed winter-spring 2009; draft final being completed now
- Conclusions
  - Total station surveys alone not reliable for documenting check dam effectiveness
  - In general, check dams will work (capture sediment) during periods of low or moderate rainfall
  - Check dams not effective during intense rainfall events; may cause more damage in the long run due to flanking / scour

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Current Unresolved Issues

- Permitting

  NPS has denied Research and Collecting Permit for cultural monitoring R&D project

- Section 106 compliance monitoring

  Reclamation is out of compliance because monitoring not occurring, as required by 1994 Programmatic Agreement

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Reasons for NPS Permit Denial

- "Technical" Issues
  - Lidar documents change but does not determine cause or mechanisms of change
  - NPS wants monitoring to document where changes occur, causes of change, and determination of remediation methods to preserve sites from change
  - "Proposal mentions collecting depth and chemical characteristics but no detail about how this will occur"
  - Proposal does not identify number of trips required

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Reasons for Permit Denial, continued

- "Policy" Issues
  - "Testing" technology not appropriate on National Register-eligible archaeological sites
  - GRCA does not have internal capacity to employ lidar, therefore questions its utility for monitoring
  - AMP process does not meet needs of NPS
  - Use of generators & motors during motor season

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