



Landscape-scale management implications of cultural resource studies

Fairley, Helen C. (hfairley@usgs.gov)

& Draut, A. E.; Sankey, J., Collins, B., Bedford, D. & Corbett, S.

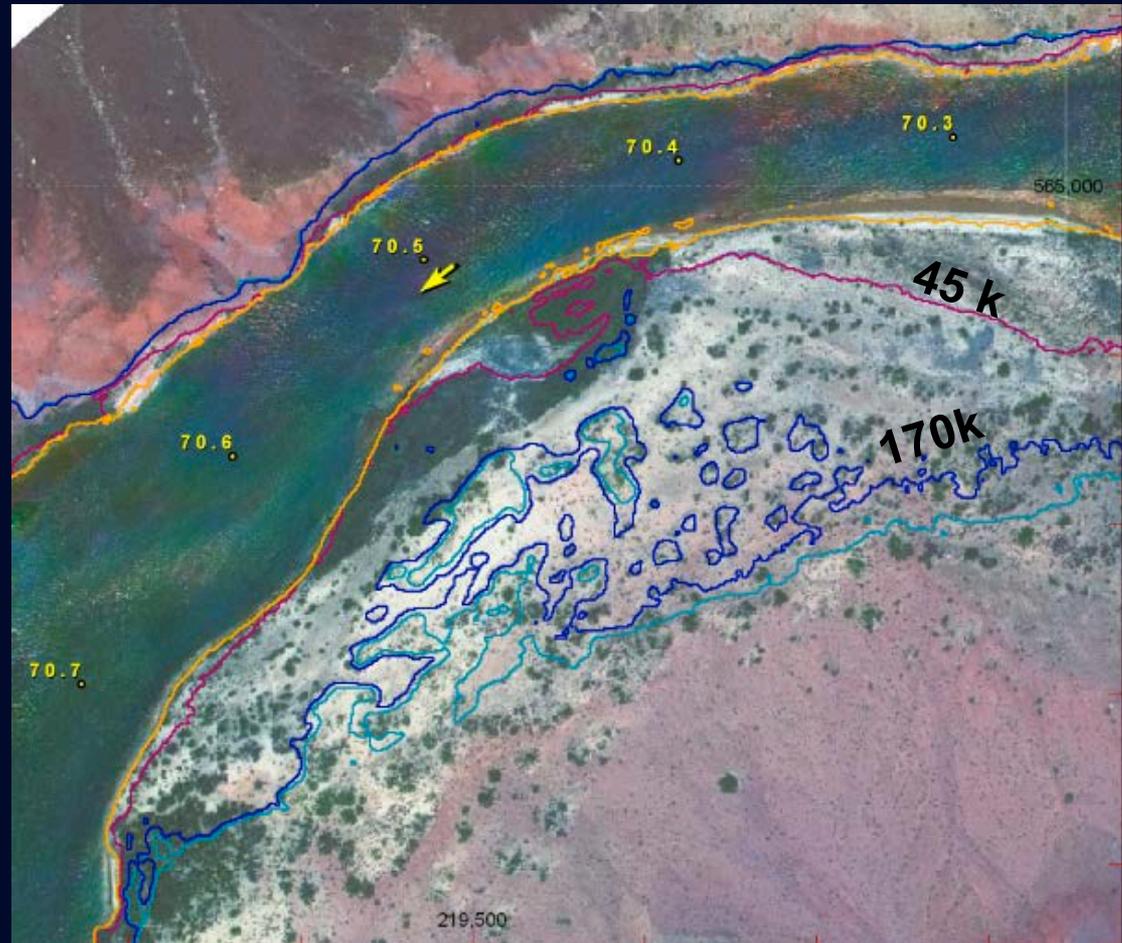
2014 Annual Reporting Meeting, Phoenix, AZ

January 29, 2014

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

River-corridor landscape & dune fields set by exceptional floods (~170k cfs)

- Current HFEs cover much smaller area than pre-dam floods
- Modern flood sands are deposited at lower elevations over smaller areas
- Transport from HFE deposits often blocked by riparian vegetation barriers
- So less connectivity between fluvial and upland landscapes today than in past



Hypothesis linking dam operations, sand supply, wind/weather & archaeological site preservation

Dam operations altered ecosystem processes & conditions that used to offset effects of rainfall-induced erosion.

- No more high floods; more vegetation; fewer open, high, dry bars
- Less high, dry sand = less aeolian sand to cover sites & backfill gullies
- Progressive deflation by wind; continuous down-cutting in gullies

HFEs & wind are only available processes for replacing high elevation sand



River-level sandbar

Vegetation
barriers

Inactive sand

“If you don’t know what the question is, you can’t figure out how to answer it.”

Jack Schmidt Interview, 1994
(BQR vol.25, no. 4, p. 39)



Project J: 2013-2014

“Big Questions”

- Are cultural sites eroding or changing faster or in a significantly different manner than they would if Glen Canyon Dam were operated differently?
- How effective is aeolian sand at preventing or counteracting rainfall-induced gully erosion?
- What number / proportion of sites have the potential to benefit from future HFE sand deposits?

J1. Glen vs. Marble & Grand Canyons

Are sites in Glen Canyon significantly more eroded than those downstream in Marble and Grand Canyon where fine-sediment supply is greater?



- Topographic change detection at 4 sites in GLCA and 4 in GRCA
- Airborne lidar mapping of 8.5 miles
- Modeling of erosion

J2. Effects of HFE/modern aeolian sand supply on archaeological sites

Is the magnitude of aeolian transport to sites and deposition at sites sufficient to offset erosion?

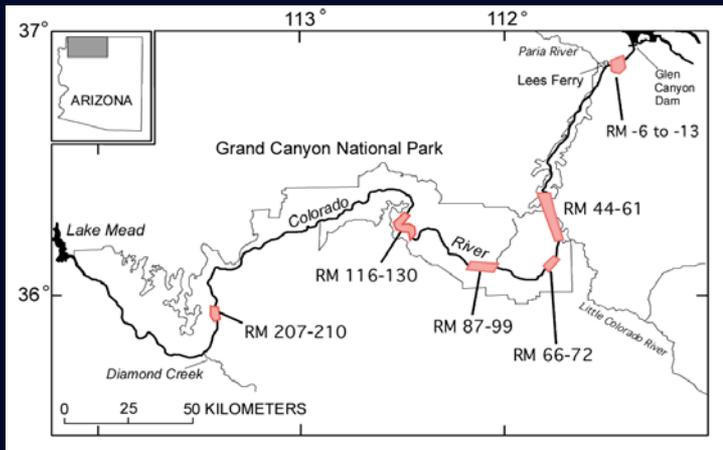
(Do sites that are favorably situated with respect to sand sources and prevailing wind direction exhibit less erosion than less favorably situated sites?)

- Measure amounts and rates of deposition/erosion at 4 sites favorably situated with respect to HFE sand bars
- Compare with topographic change (erosion/deposition) at 4 Glen Canyon sites



J3. Landscape-scale assessments

How does the degree of gully erosion differ in sediment deposits that are active vs. inactive with respect to aeolian transport?



Hypothesis: Gullies will be more extensive in inactive than in active sand.

Joel's talk....

How many archaeological sites have the potential to benefit from aeolian redistribution of HFE sand?

Of the 300+ archaeological sites in the river corridor, what is the response of each to post-dam sand supply conditions and other post-dam flow effects?

- Analyze 2012 post-HFE oblique photos, plus 1996 (pre- and post-HFE) and mid-1980s aerial photos near each site to assess and source conditions
- Short field visits to identify local wind directions from surface geomorphology

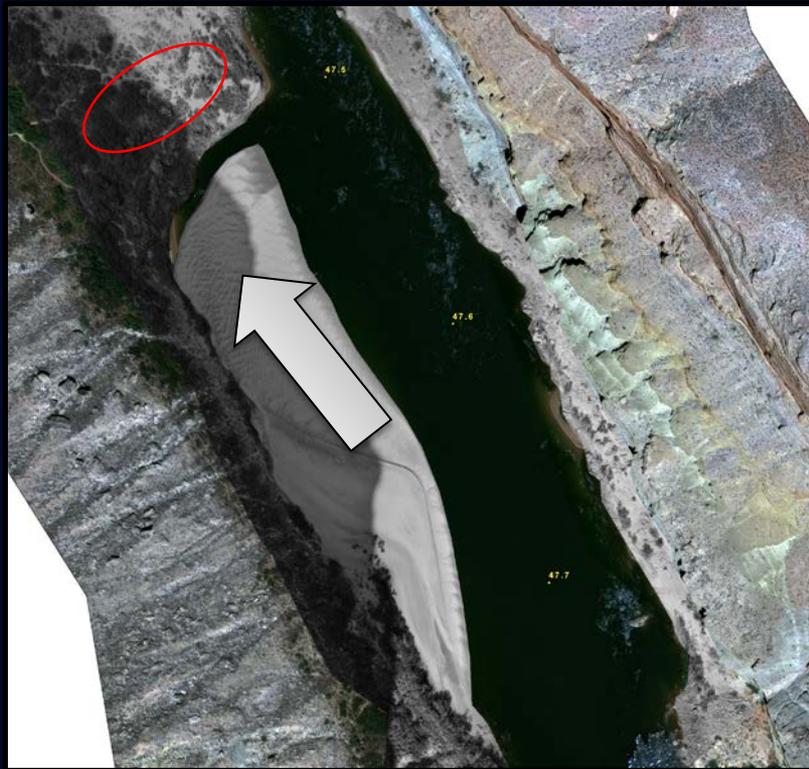


Conditions needed for archaeological sites to benefit from wind-blown sand

- Sand bars deposited where wind can entrain (dry) sand
- Prevailing wind coming from “right” direction (relative to sand source and site location)
- No physical barriers between sand source and site



Need sand deposited where prevailing wind can entrain and transport it upslope to sites



1984



2009

Hypothetical example of archaeological site downwind of large 1984 sand bar and same location in 2009

Tributary washes function as barriers to aeolian sand movement



Riparian vegetation growth inhibits movement of aeolian sand inland

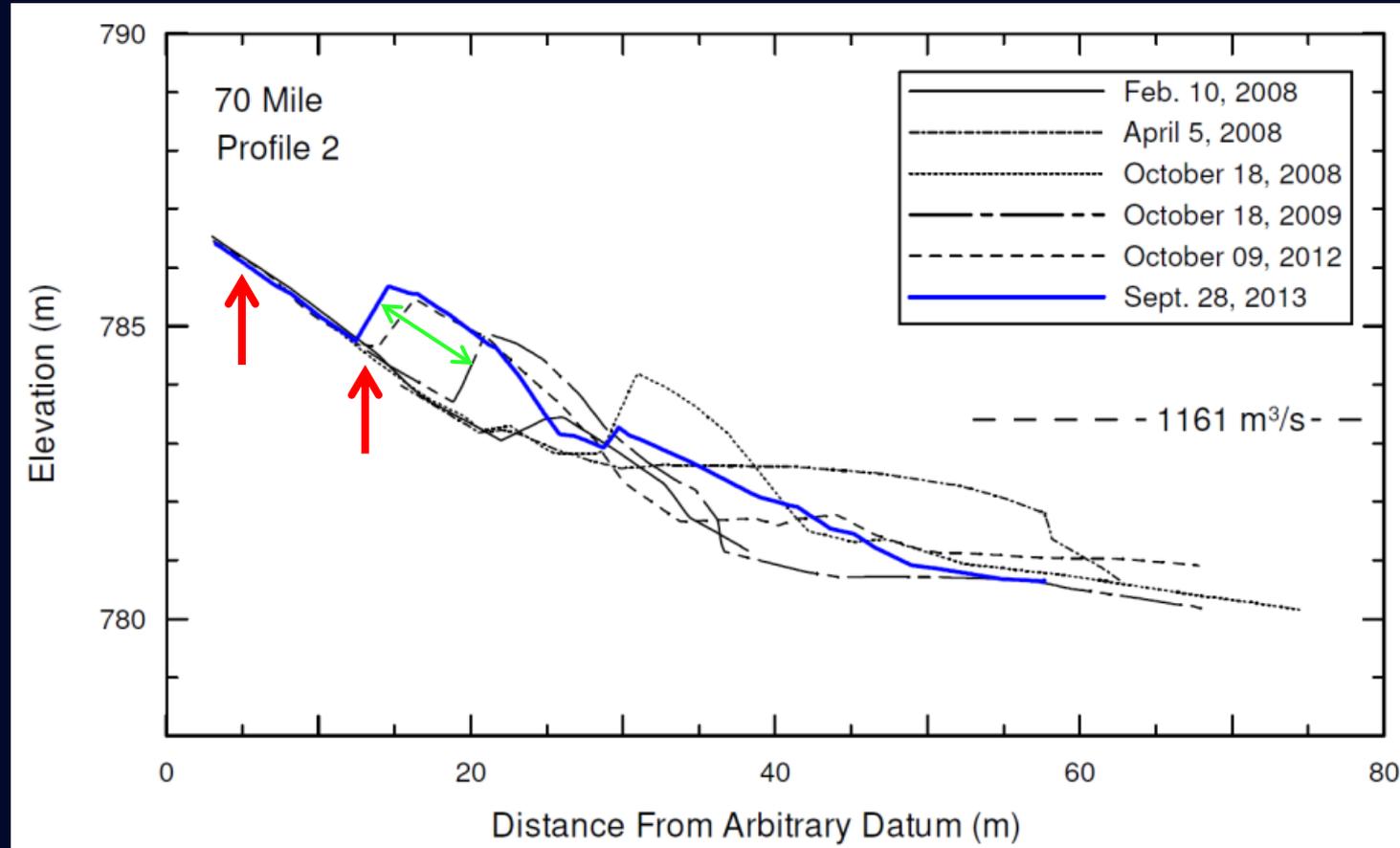
Malgosa, 2005



Malgosa, 2010

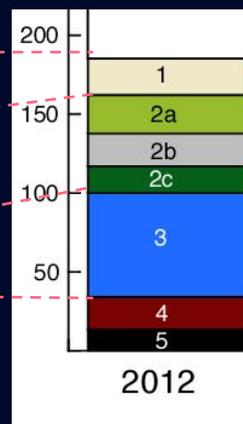
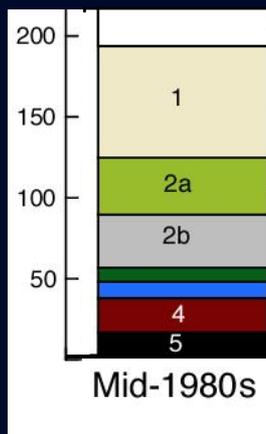
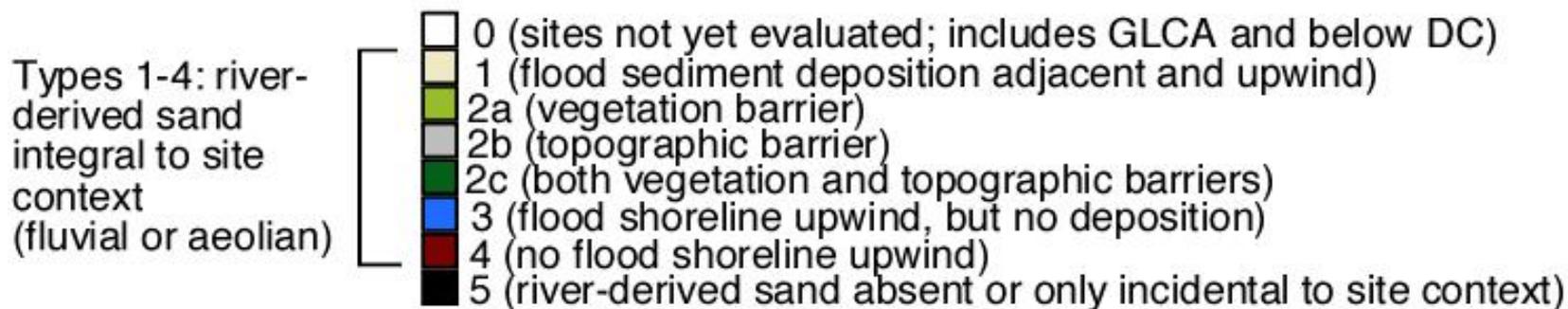


Under optimal conditions, we know that HFE sand will move upslope



J2. HFE/modern aeolian sand supply to archaeological sites

What number, proportion of archaeological sites can benefit from aeolian sand supplied by HFEs?



decrease

increase

Type	1984	1996	2012
1	34%	17%	12%
2a	18%	12%	12%
2b	17%	14%	11%
2c	4%	6%	9%
3	5%	28%	34%
4	11%	11%	11%
5	11%	11%	11%

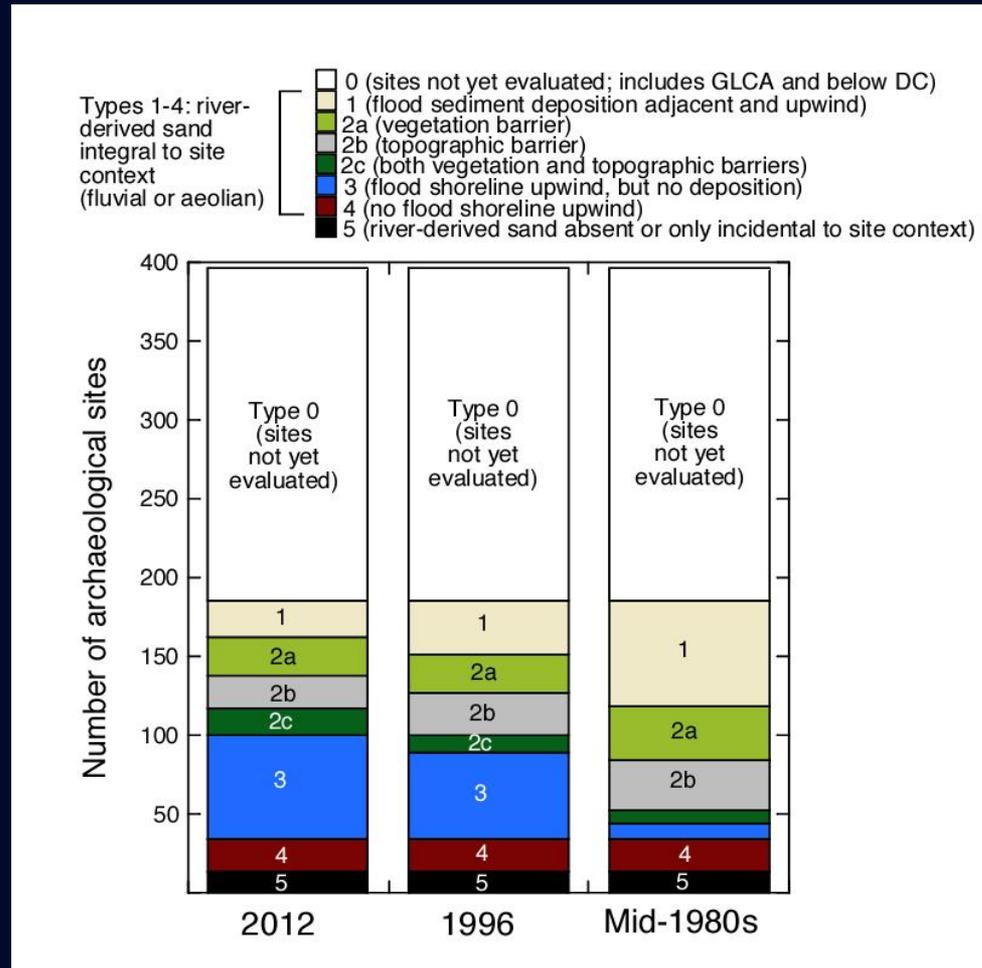


J2. HFE/modern aeolian sand supply to archaeological sites

What number, proportion of archaeological sites can benefit from aeolian sand supply caused by HFEs?

Progress as of December 2013; about half the sites analyzed so far

Preliminary Data (from A. Draut, 2013)
Please Do Not Cite

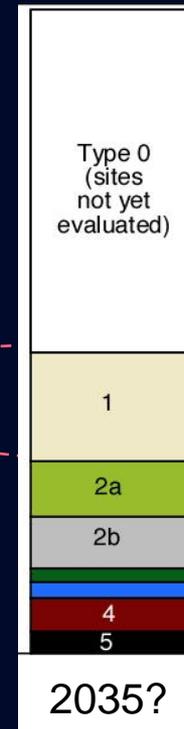
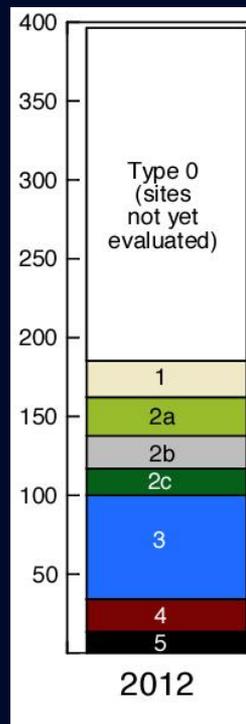
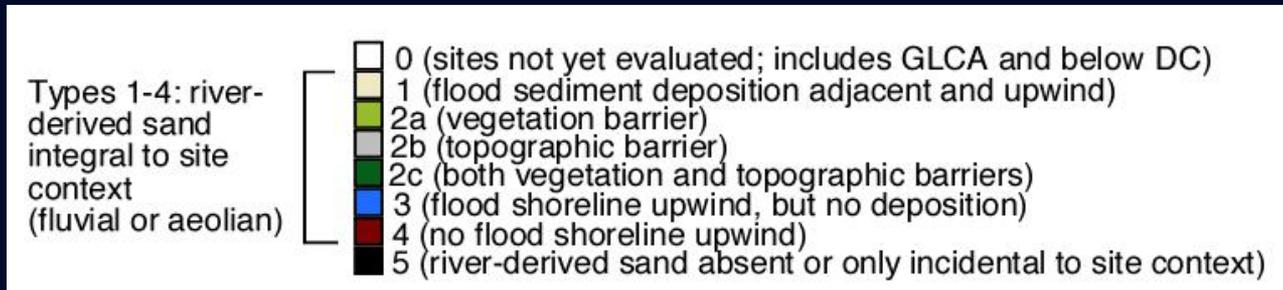


**“I think it’s high time that people stand up and articulate more clearly
“What are the objectives?”**



Jack Schmidt Interview, 1994
(BQR vol.25, no. 4, p. 45)

What are the management objectives for cultural resources? Restore? Excavate?



Reverse the trend?

HFE protocol only?
 Sediment augmentation?
 Higher high flows?
 Manual veg. management?
 Longer high flows?



Questions?

