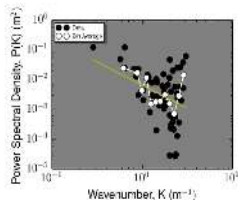
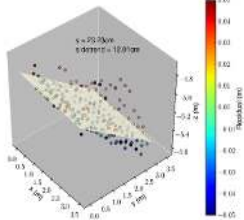
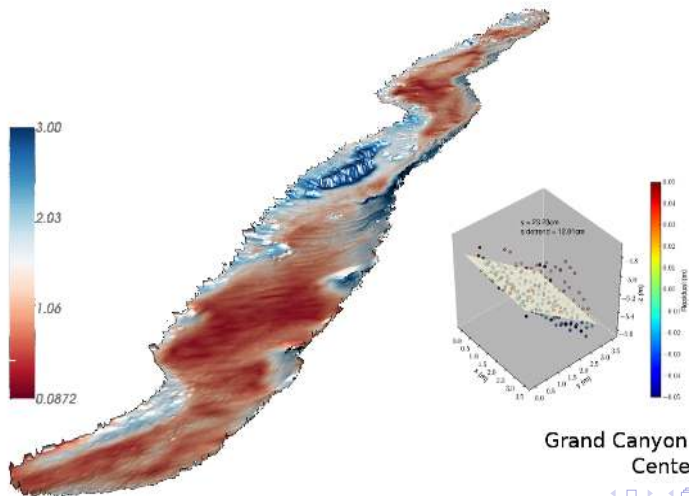


Topographic and Acoustic Estimates of Grain-Scale Roughness from High-Resolution Multibeam Echo-sounder

Examples from the Colorado River in Marble Canyon

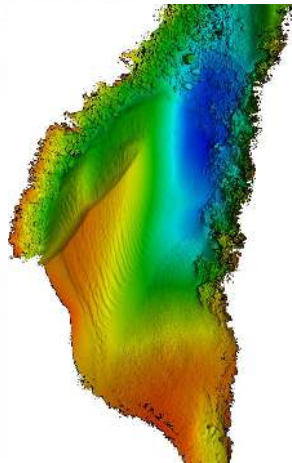


Daniel Buscombe,
Paul E. Grams,
Grand Canyon Monitoring and Research
Center, U.S. Geological Survey.

Multibeam echosounder measures depth & echo strengths

High-Resolution Multibeam Echo-sounding Examples from the Colorado River

- ▶ High-resolution soundings ...
- ▶ Submerged aquatic vegetation
- ▶ Definition of physical habitats
- ▶ Bed substrate classification
- ▶ Appeal of backscatter = hardness + roughness (?)
- ▶ Topography, Acoustic Backscatter, or both?



Bathymetry at RM 61, Marble Canyon, May 2014

Multibeam echosounder measures depth & echo strengths

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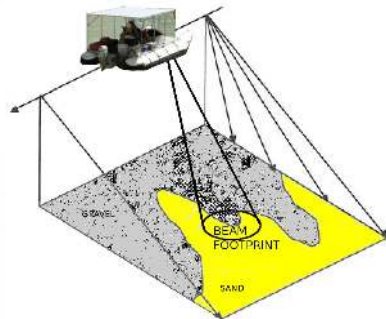


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Paul E. Grams,
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Multibeam echosounder measures depth & echo strengths

High-Resolution Multibeam Echo-sounder Examples from the Colorado River in Marble Canyon

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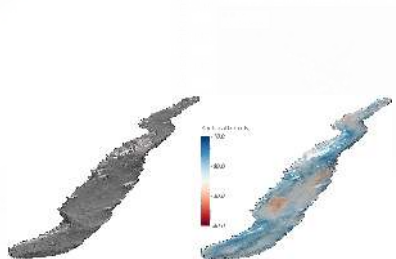


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Paul E. Griggs
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Multibeam echosounder measures depth & echo strengths

High-Resolution Multibeam Echo-sounder Examples from the Colorado River in Marble Canyon

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Paul E. Grams,
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Talk Outline

High-Resolution Multibeam Echo-sounder Examples from the Colorado River in Marble Canyon

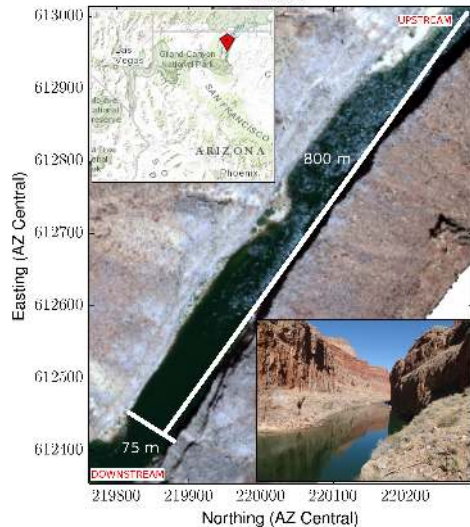
- ▶ What are the relevant deterministic and stochastic descriptions of riverbed?
- ▶ What's the relationship between them?
- ▶ What's the relationship to sediment type?

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Paul E. Grams,
Grand Canyon Monitoring and Research
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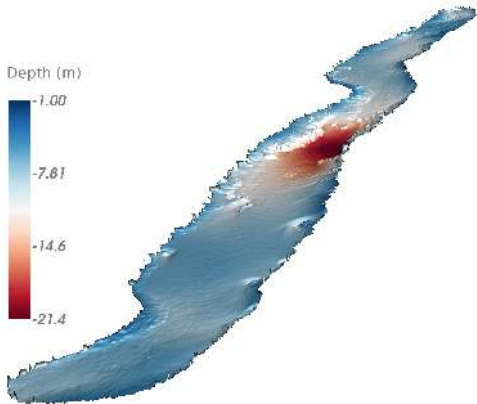
RM30, Marble Canyon, August 2013

Hydrographic Surveying Multibeam Echo-sounding

RM30



Depth (m)

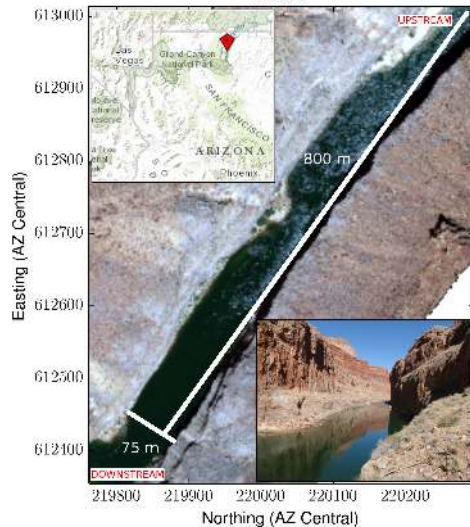


11 million soundings
25 cm grid

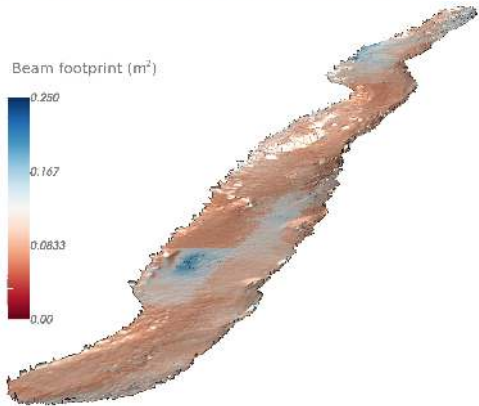
RM30, Marble Canyon, August 2013

Hydrographic Survey Multibeam Echo-sounding

RM30



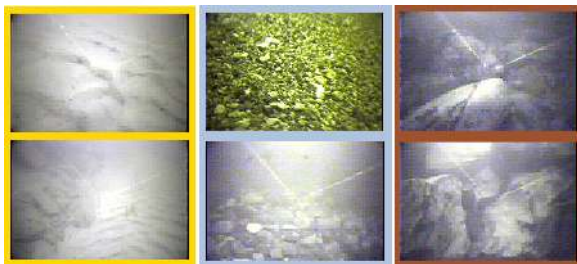
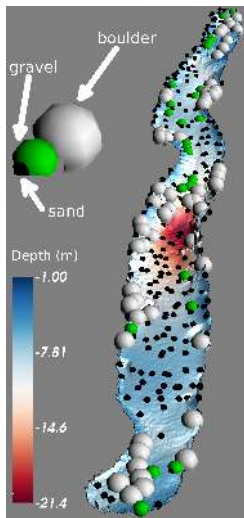
Beam footprint (m^2)



11 million soundings

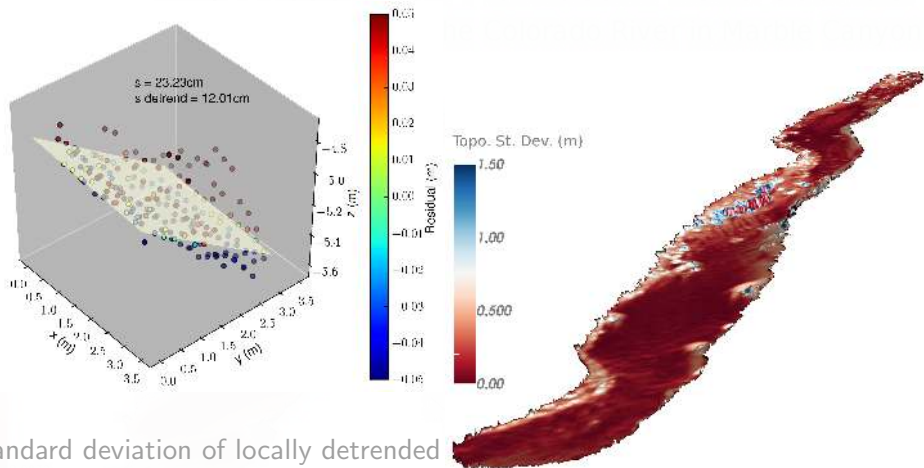
25 cm grid

Wentworth sediment type



Daniel Buscombe
Paul E. Grooms
Grand Canyon Monitoring and Research
Century U.S. Geological Survey

Topography: deterministic geometry

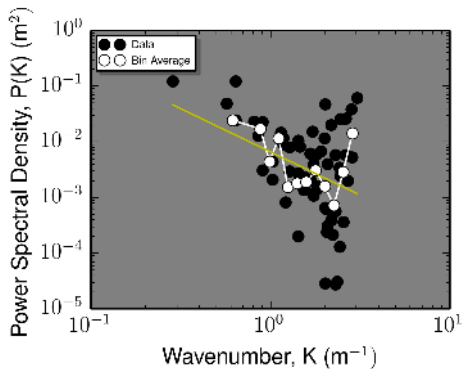
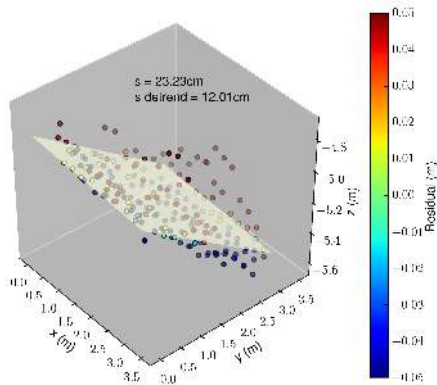


Standard deviation of locally detrended
elevations

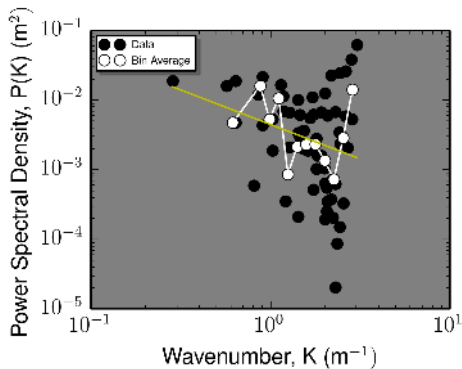
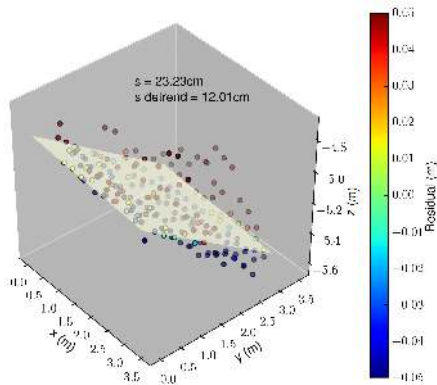
Brasington et al 2012, WRR

Paul E. Gearing
Grand Canyon Monitoring and Research
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Topography power spectrum: 1) 'global' detrend

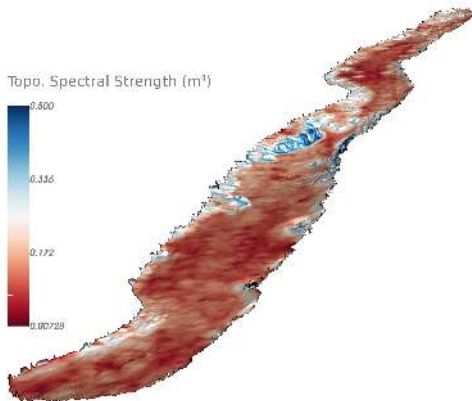
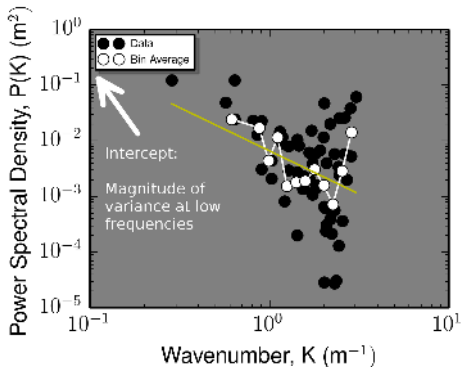


Topography power spectrum: 2) local detrend with plane



Stochastic geometry. 1) Spectral Strength

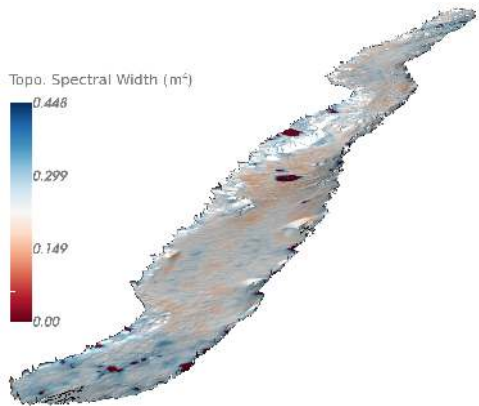
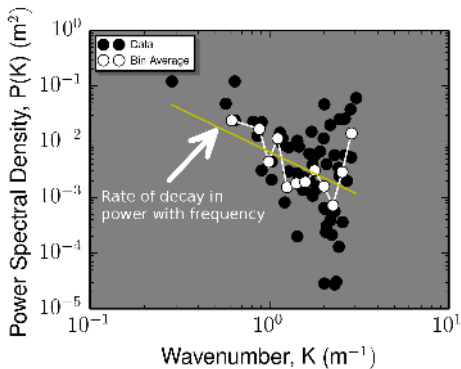
$$\widehat{P_1(\mathbf{K})} = \frac{\omega_1}{(h_0|\mathbf{K}|)^{\gamma_1}}$$



Paul E. Grams,
Grand Canyon Monitoring and Research
Center, U.S. Geological Survey

Stochastic geometry. 2) Spectral Width

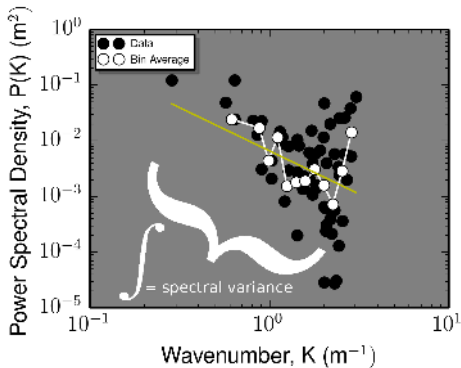
$$\widehat{P_1(\mathbf{K})} = \frac{\omega_1}{(h_0|\mathbf{K}|)^{\gamma_1}}$$



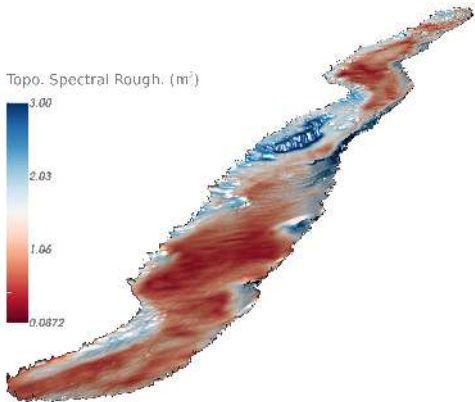
Paul E. Grams,
Grand Canyon Monitoring and Research
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Stochastic geometry. 3) Spectral Variance

$$\sigma_1^2 = 2 \sqrt{\int_{K_0} P_1(K) dK}$$

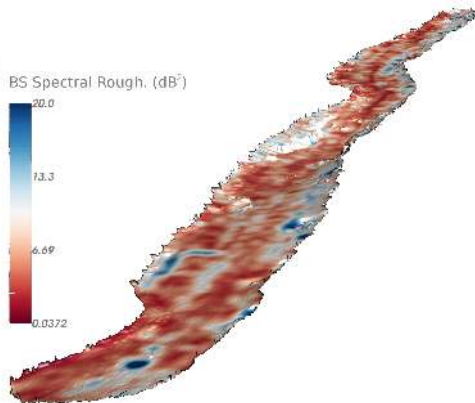
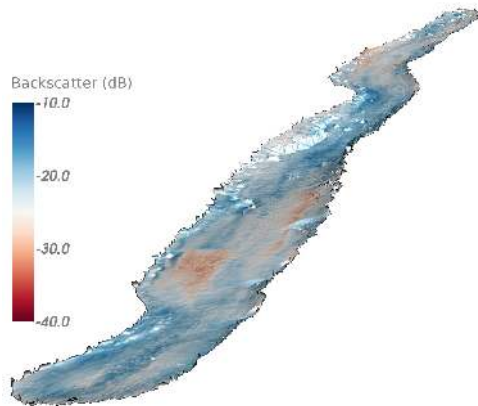


Topo. Spectral Rough. (m^2)



Median Backscatter & Spectral Variance

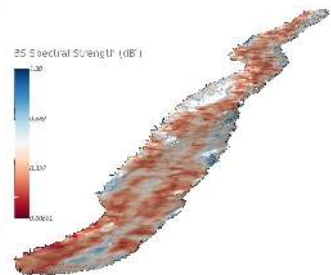
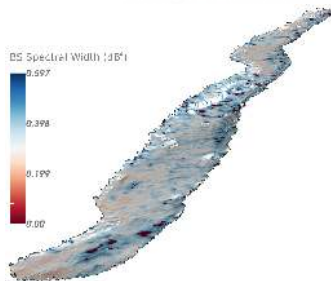
High-Resolution Multibeam Echo-soundings
Examples from the Colorado River in Marble Canyon



Paul E. Grams,
Grand Canyon Monitoring and Research
Center, U.S. Geological Survey

Backscatter Spectral Width & Strength

High-Resolution Multibeam Echo-sounders



AGU PUBLICATIONS

Journal of Geophysical Research: Earth Surface

RESEARCH ARTICLE

10.1002/2014JF003397

This article is a U.S. Government work and, as such, is in the public domain in the United States of America.

Keywords

Characterizing riverbed sediment using high-frequency acoustics: 1. Spectral properties of scattering

D. Macosko¹, R. R. Green¹, and M. A. Kapteke²

AGU PUBLICATIONS

Journal of Geophysical Research: Earth Surface

RESEARCH ARTICLE

10.1002/2014JF003397

Key Points

- Riverbeds exhibit high-frequency backscatter spectral properties and sediment types.
- Spectral width and strength of backscatter are related to sediment type.
- Spectral width and strength are related to sediment type.

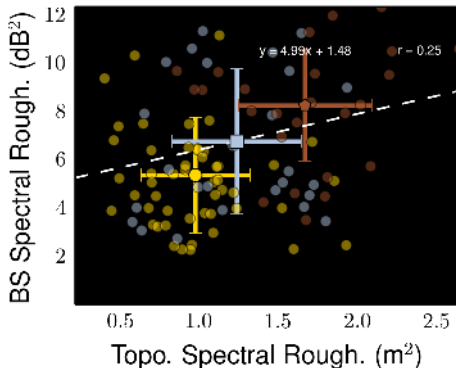
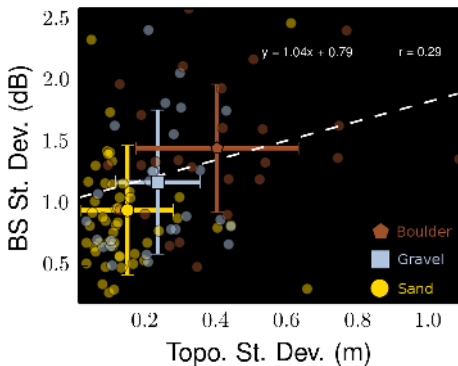
Characterizing riverbed sediment using high-frequency acoustics: 2. Scattering signatures of Colorado River bed sediment in Marble and Grand Canyons

D. Macosko¹, R. R. Green¹, and M. A. Kapteke²

¹Center for Earth and Environmental Science, Southwest Fisheries Science Center, U.S. Geological Survey, Pacific Fisheries, National System of Public Lands, 3500 La Jolla Village Drive, San Diego, California, 92161, USA; ²Department of Earth and Atmospheric Sciences, University of Colorado, Boulder, Colorado, 80509, USA

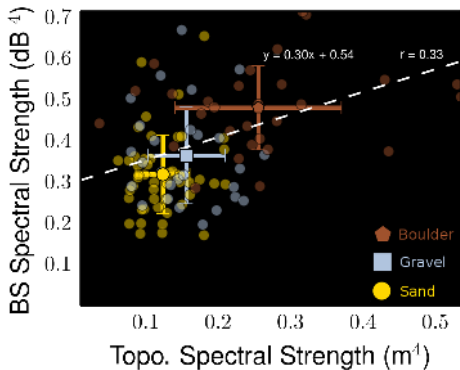
Relationship between sediment type & 'roughness'

High-Resolution Multibeam Echo-sounders
Example from the South Atlantic Ocean



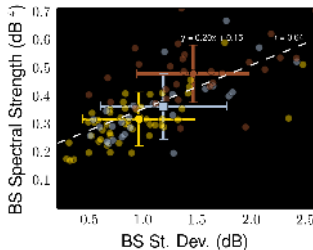
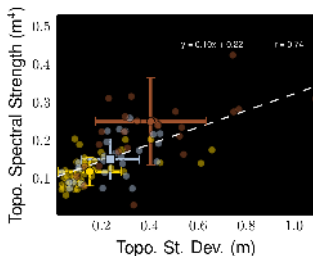
Variance in fluctuating part of both the topographic and backscatter signal increase with increasing clast size

Relationship between sediment type & spectral strength



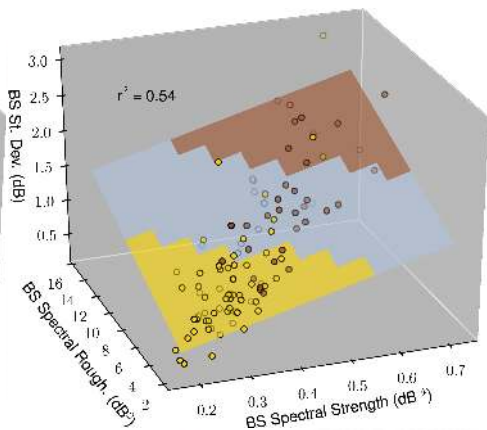
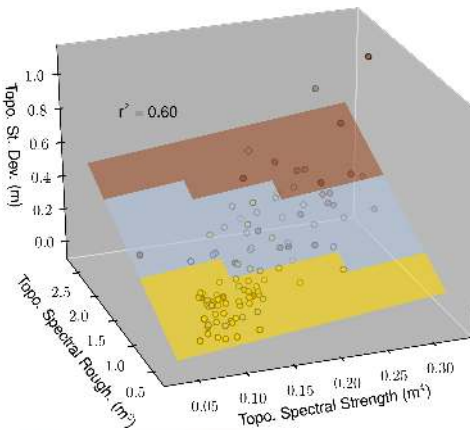
Low-frequency component increases with increasing clast size

Strong relationships with roughness



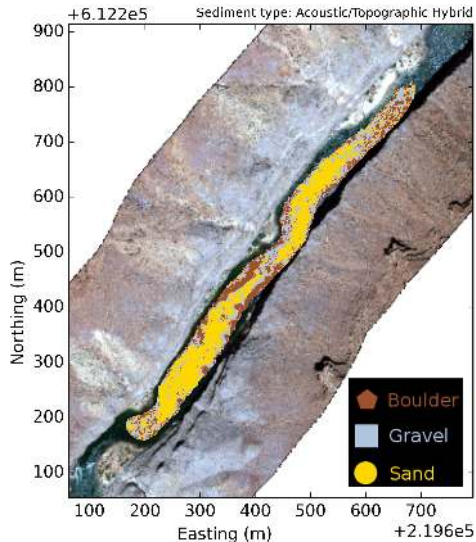
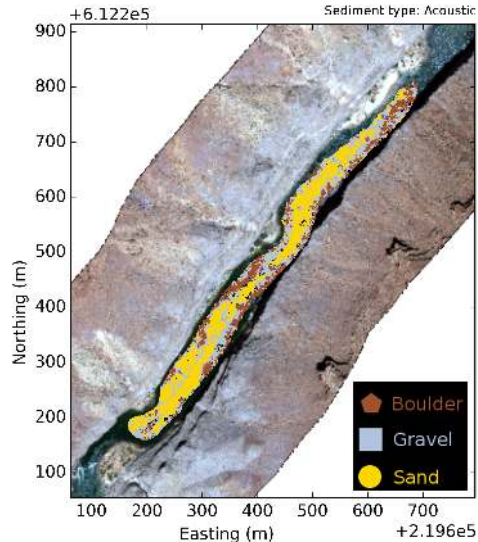
Linear relationships on a continuum

High-Resolution Multibeam Echo-sounders
Examples from the Colorado River of the Gila River



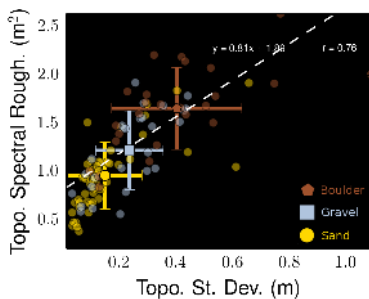
Colorado River Monitoring and Research
University of Arizona

Sediment classification - either/or/both



Summary

- ▶ High-resolution MBES data from a non-cohesive riverbed
- ▶ A suite of statistical parameters relate to sediment type
- ▶ Applicable to both topography and backscatter
- ▶ Lots of options for acoustic bed sediment classification
- ▶ Relative proportions of sand and gravel in mixtures?
- ▶ How would this change with silt/clay, or vegetated bottoms ?

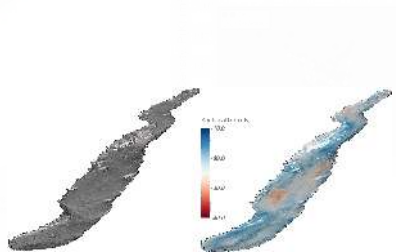


Daniel Buscombe,
Paul E. Grams,
Grand Canyon Monitoring and Research
Center, U.S. Geological Survey

Summary

High-Resolution Multibeam Echo-sounder Colorado River in Marble Canyon

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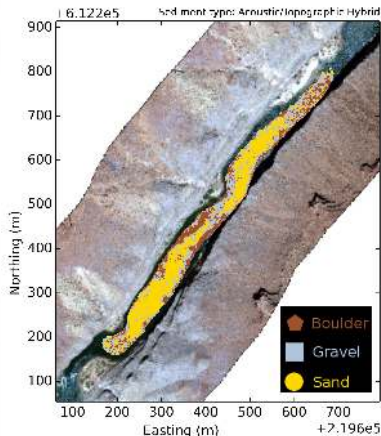


Daniel Buscombe,
Paul E. Grams,
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Summary

High-Resolution Multibeam Echo-sounder Sediment Type Classification

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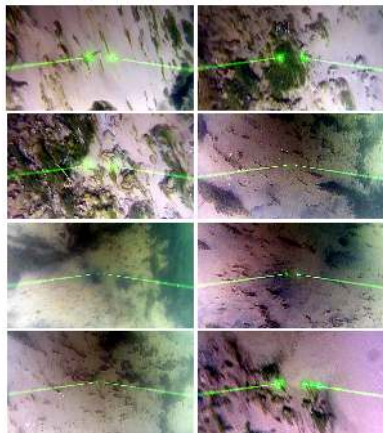


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Summary

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Sandy gravels in Glen Canyon, Dec 2014

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Paul E. Grams
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Thanks for listening

High-Resolution Multibeam Echo-sounder River in Marble Canyon



2nd annual
**Multibeam Echosounder in
Rivers Workshop**,
25-27 March 2015,
Flagstaff, AZ.
Email dbuscombe@usgs.gov
if you're interested in
attending.

dbuscombe@usgs.gov | pgrams@usgs.gov

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Center, U.S. Geological Survey