Sediment transport in low-order channels on the Walnut Gulch Experimental Watershed

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Outline

- Background
- Current Research
- Results
- Future Research Ideas

Representative section of an ephemeral channel.

Background

- **Southwestern United States**
  - Ephemeral channels
  - Complex sediment transport relationships

- **Baseline information needed**
  - Prediction technologies
  - Regulatory compliance
  - Management action plans

- **Research:**

  Characterize and quantify sediment transported

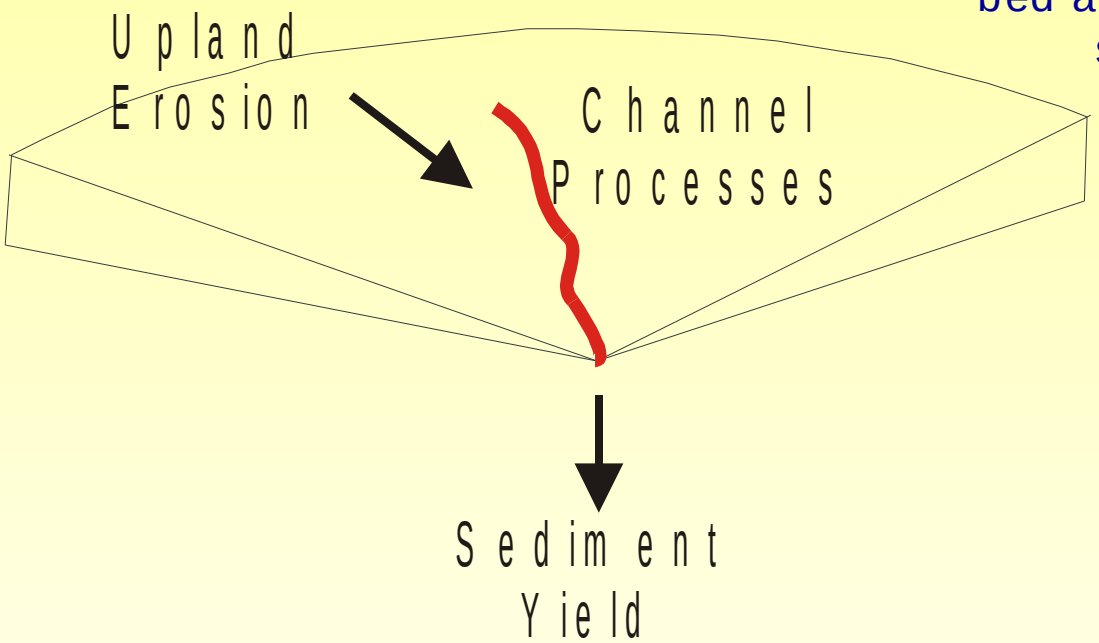
  Coarse fraction – transport and displacement

Background

- **Issues**
  - Water Quality – sediment is a primary pollutant
  - Offsite impacts
  - Total Maximum Daily Loads
  - Conservation and Restoration
- **Sediment Measurement**
  - Historic Record and Instrumentation
  - Suspended load
    - Silt and clay size particles
    - Transportation of pollutants and organic material
  - Bedload or coarse sediment
    - Gravel to cobbles and larger boulders
    - Varies with water discharge
  - Total load

Watershed erosion, transport, and yield

erosion
splash
rill, interrill
transport
deposition



bed and bank erosion
suspended
bedload
deposition

Sediment yield is the amount of eroded material that moves from a source to a downstream control point, such as a reservoir, per unit time

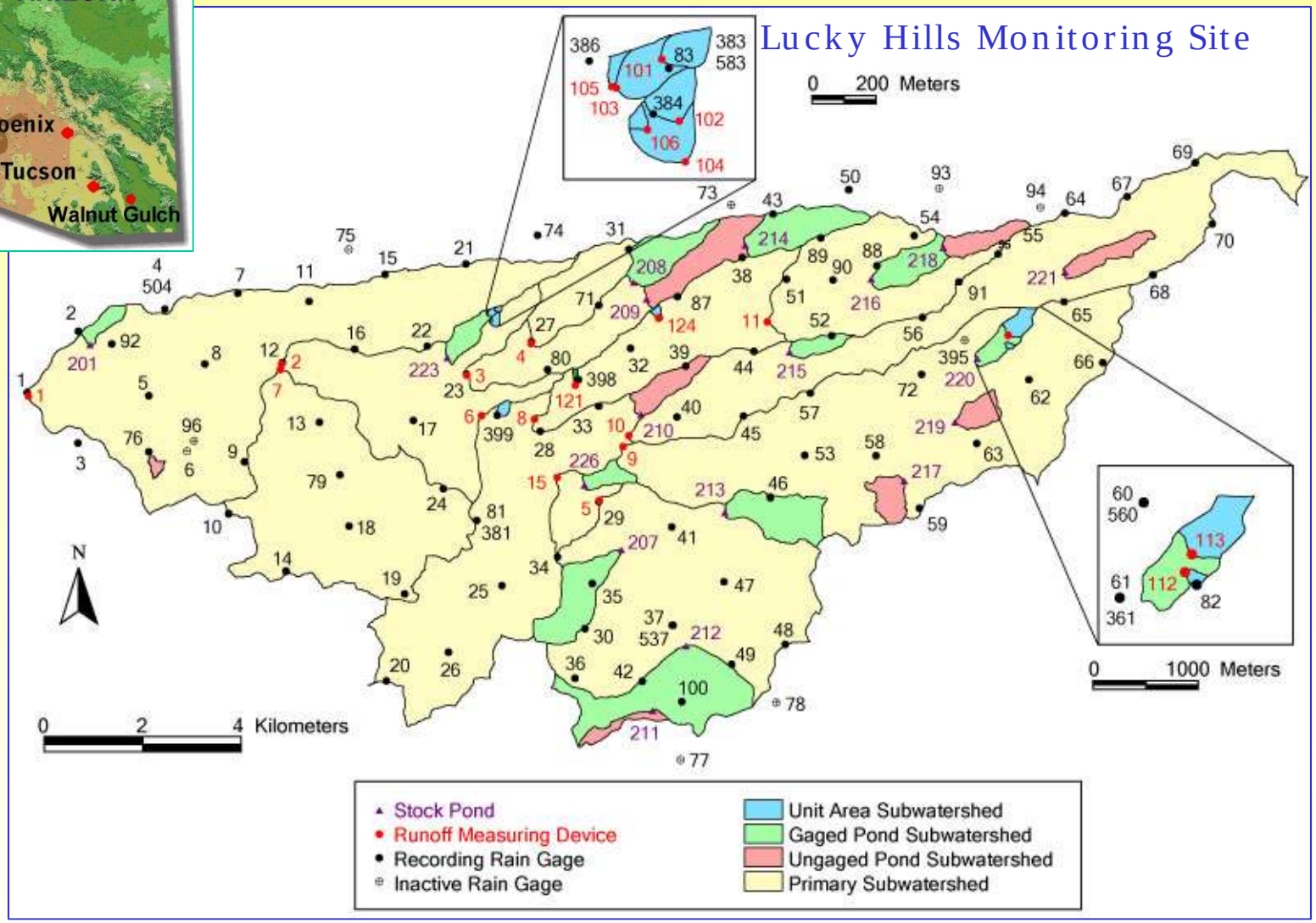
Current Research Projects

USDA – ARS Walnut Gulch Experimental Watershed

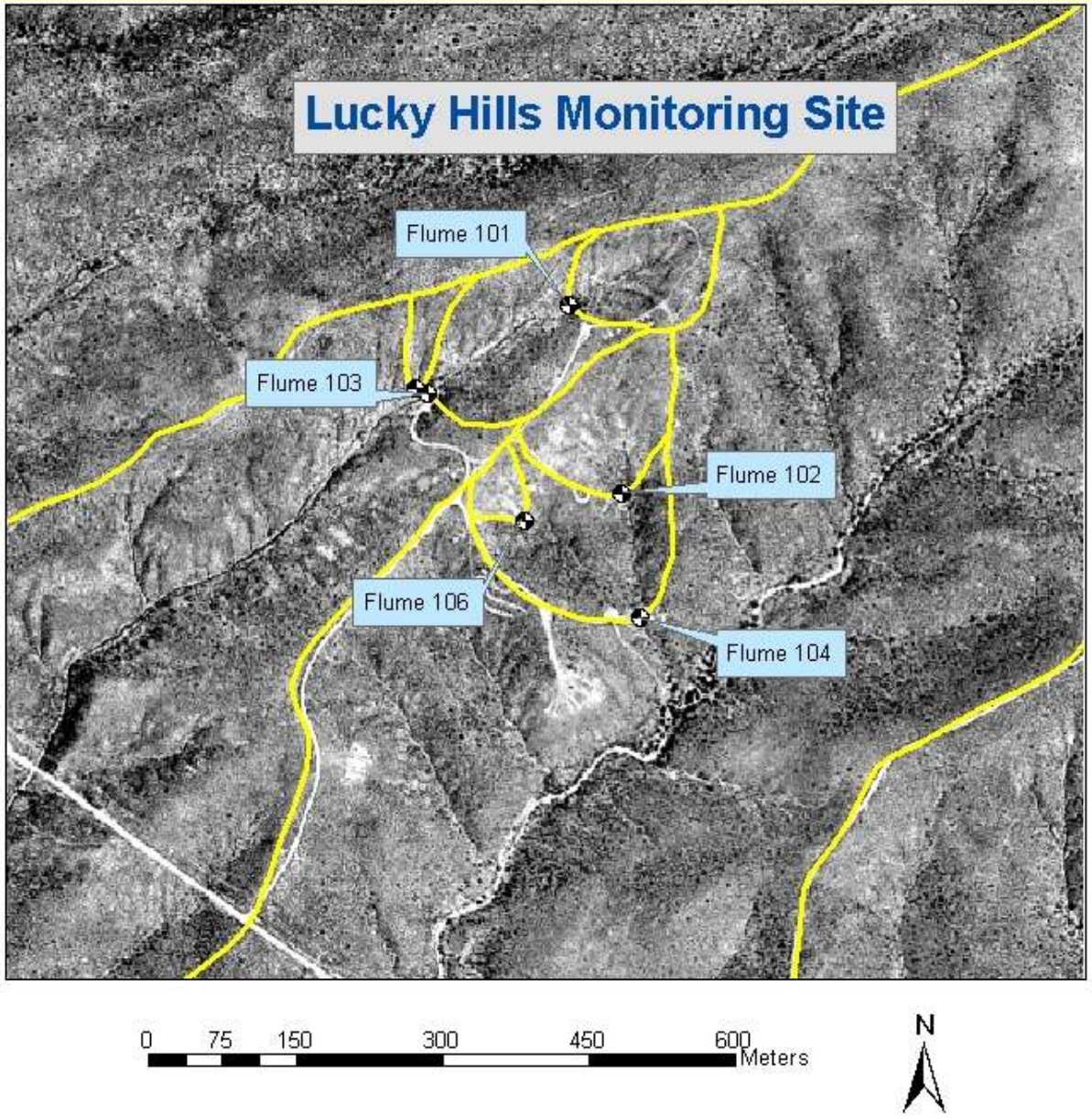
Sediment transport in low-order channels

- Coupling runoff hydrographs and developing sedigraphs
- Coarse particle transport
- Modeling multiple particle size class sediment transport

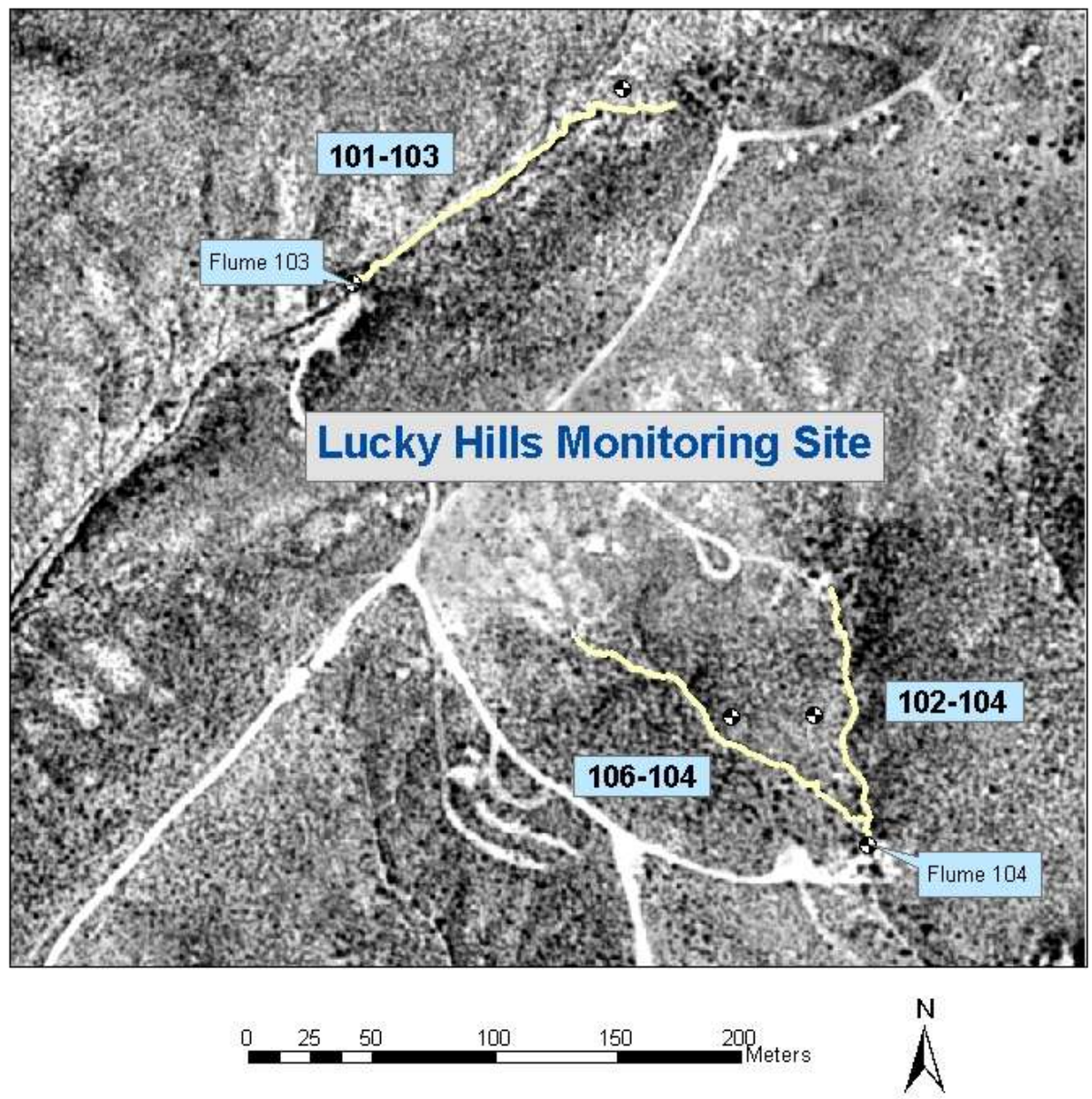
Walnut Gulch Experimental Watershed



Watershed Overview



Channels Overview



Study Site

Lucky Hills Monitoring Site:

LH 102 (1.46 ha)

LH 104 (4.4 ha)

LH 106 (0.36 ha)

- Alluvial material substrate
- Local conglomerate layer in stream channel
- Unlimited sediment supply made up of noncohesive particles ranging from clays to cobbles

Channels Overview

101 – 103

- Length of Channel:
  163.5 meters
- Elevation Gain:
  4.7 meters
- Avg. Slope:
  2.9%

102 – 104

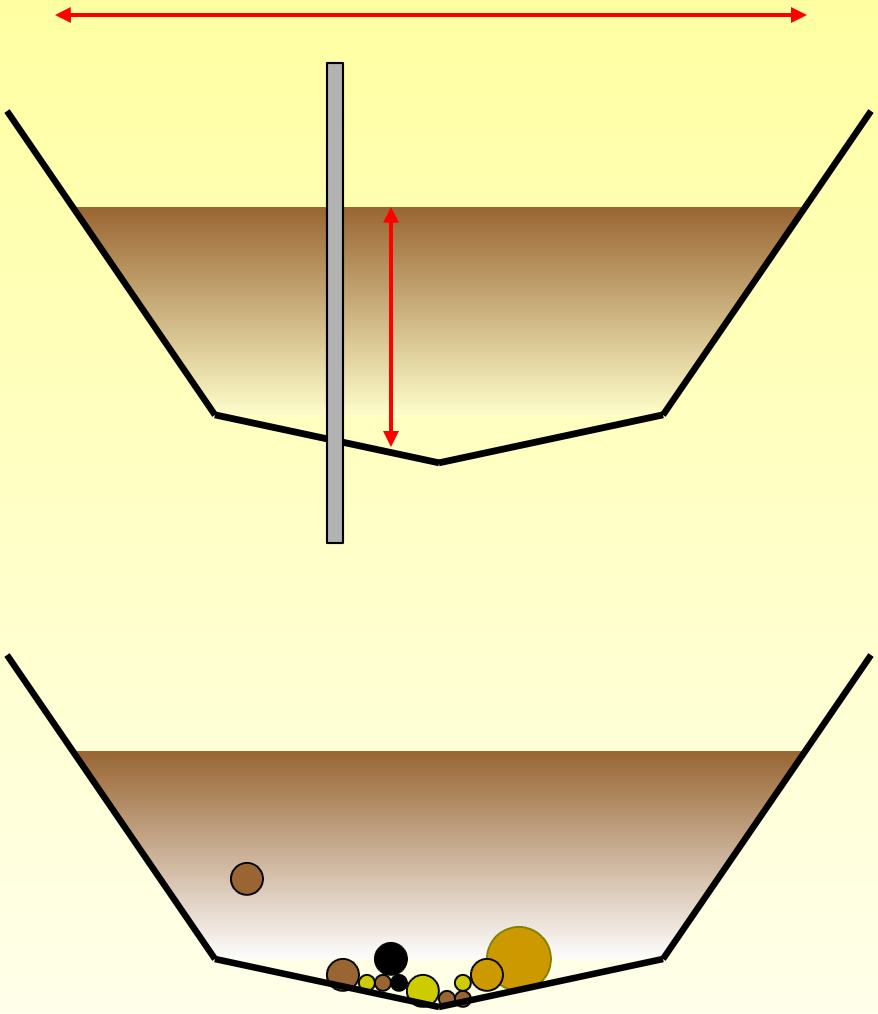
- Length of Channel:
  114.3 meters
- Elevation Gain:
  3.3 meters
- Avg. Slope:
  2.9%

106 – 104

- Length of Channel:
  161.3 meters
- Elevation Gain:
  5.8 meters
- Avg. Slope:
  3.6%

Runoff !!!

Slot Sampler



Quantify sediment transport and improve sediment transport algorithms applicable in alluvial channels

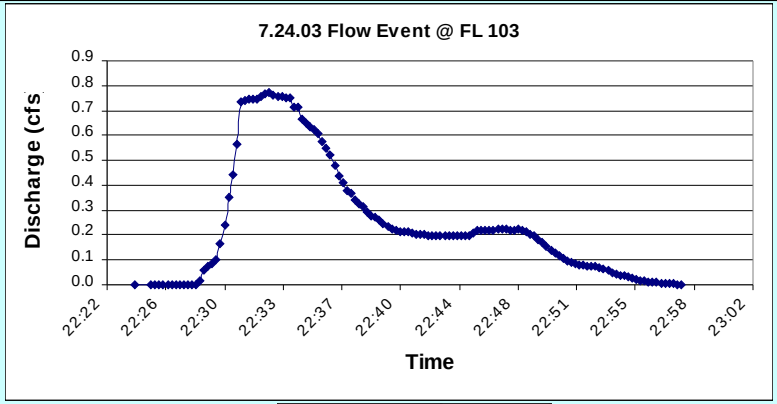
Santa Rita Flume and Coarse Load Trap

Slot Sampler

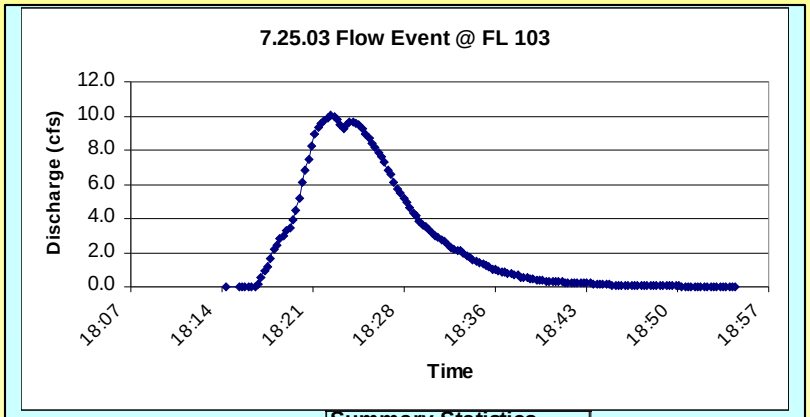
Quantify sediment transport and improve sediment transport algorithms applicable in alluvial channels

Coarse load trap after a runoff event

Sediment concentration bottle sample



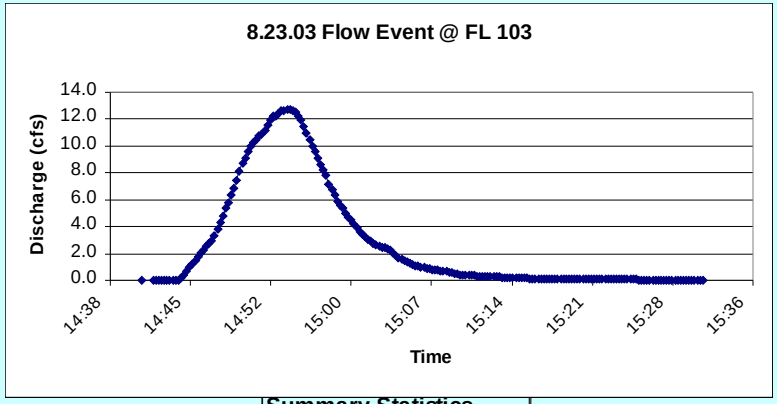
Summary Statistics	
Start	22:24:30
End	22:58:15
Duration	0:33:45
Time of Peak	22:32:45
Peak (cfs)	0.77
Total Vol (cu.ft)	487.23



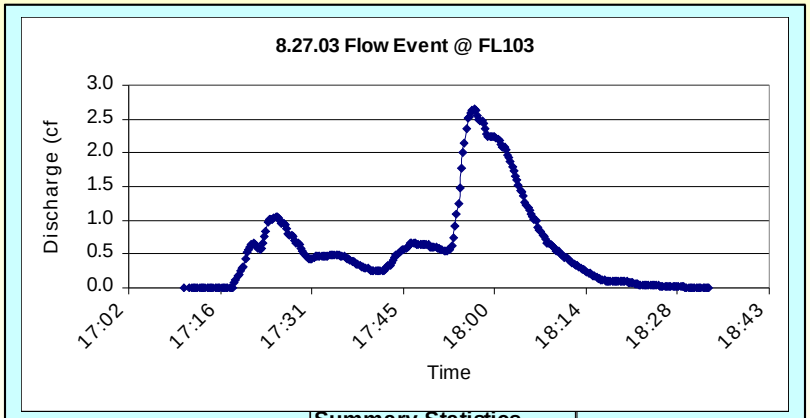
Summary Statistics	
Start	18:14:45
End	18:55:15
Duration	0:40:30
Time of Peak	18:23:00
Peak (cfs)	10.01
Total Vol (cu.ft)	5992.81

Lucky Hills Flume 103

Runoff Events in 2003



Summary Statistics	
Start	14:41:15
End	15:31:45
Duration	0:50:30
Time of Peak	14:54:30
Peak (cfs)	12.71
Total Vol (cu.ft)	8129.32



Summary Statistics	
Start	17:11:00
End	18:34:00
Duration	1:23:00
Time of Peak	17:56:45
Peak (cfs)	2.64
Total Vol (cu.ft)	2918.22

Results

- **7** runoff events during the 2002 "monsoon" season

Characteristics of seven runoff events during the 2002 monsoon season at the Lucky Hills 104 watershed on the Walnut Gulch Experimental Watershed

Date	Runoff Volume (m^3)	Peak Runoff Rate (cms)	Duration	Comments
7/19/2002	16	0.03	22m 30s	Only 1 bottle sample collected
7/26/2002	90	0.14	35m 30s	Adequate samples
8/4/2002	274	0.47	40m 30s	No total load data
8/30/2002	39	0.14	19m 15s	Slot sampler stuck in flow, analysis based on 3 samples
9/8/2002	20	0.05	20m 30s	Adequate samples
9/9/2002	0.5	0.002		No total load data
9/11/2002	94	0.27	26m 30s	No total load data

Results

- **3** runoff events yielded sufficient data to quantify the total transported load

Summary of sediment collected in a pit trap (tank) and sampled via a traversing slot sampler at the Lucky Hills 104 watershed on the Walnut Gulch Experimental Watershed

Date	# Traversing Slot Samples	Total Sediment[1] (kg)	Traversing Slot kg < 4mm (% of total)	Tank kg > 4 mm (% of total)	Tank kg > 8 mm (% of total)	Tank kg > 16 mm (% of total)
7/26/2002	6	1108	945 (85%)	163 (15%)	84 (7.6%)	35 (3.2%)
8/30/2002	3	908	804 (89%)	104 (11%)	61 (6.6%)	32 (3.5%)
9/8/2002	2	524	460 (88%)	64 (12%)	29 (5.4%)	8 (1.6%)

[1] total sediment = traversing slot < 4 mm + sediment trap > 4mm

Quantify sediment transport and improve sediment transport algorithms applicable in alluvial channels

Radio Rocks

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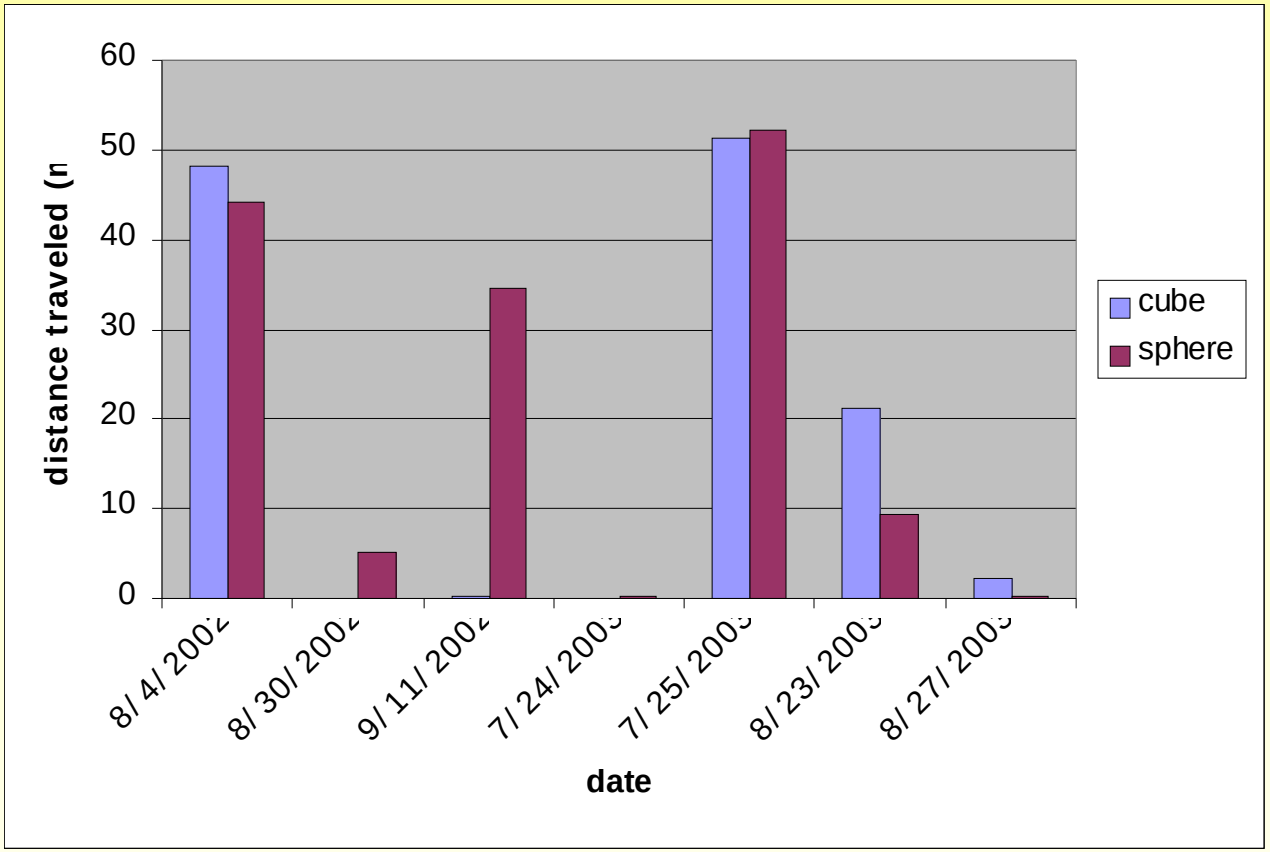
Recovery Rates

Channel Number	Particle Position	Number of Particles	
102- 104	buried	28	
	half buried	24	
	less than half buried	21	
	more than half buried	25	
	surface	44	
	missing	3	
	total number of positions		145
	recovery rate		0.98
	maximum recovery rate without RFID system		0.79
106- 104	buried	60	
	half buried	15	
	less than half buried	32	
	more than half buried	34	
	surface	42	
	missing	12	
	total number of positions		195
	recovery rate		0.94
	maximum recovery rate without RFID system		0.63

Particle Displacements



Summary

- Slot sampler underestimates coarse material sediment transport, large particles are moving
  - Sediment larger than 13 mm is not sampled
  - Particles larger than 8 mm are underrepresented
  - New field experiments will improve our understanding of basic sediment transport processes

- Continued research to:
  - quantify the total load transported across a range of discharges
  - improve sediment transport models,
  - develop sediment budgets

Acknowledgements

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