

# Proposed surrogate bedload monitoring using hydrophones, San Joaquin River, CA

by Mathieu Marineau, Toby Minear, and Scott Wright

U.S. Geological Survey, California Water Science Center, Sacramento, CA

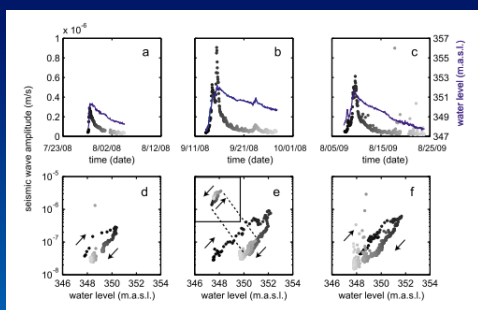
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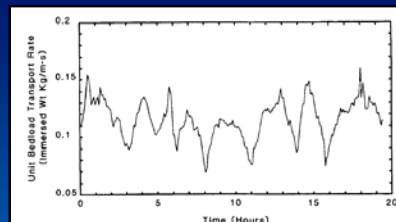
## Introduction

### Limitations of traditional bedload sampling

- Bedload transport often has high temporal variability (discharge rating curves may not be adequate)
- Physical sampling is time-consuming and expensive
- Difficult to determine start and stop of bed movement



Source: Hsu *et al.*, 2011



Source: Gomez and Hubbell, 1989

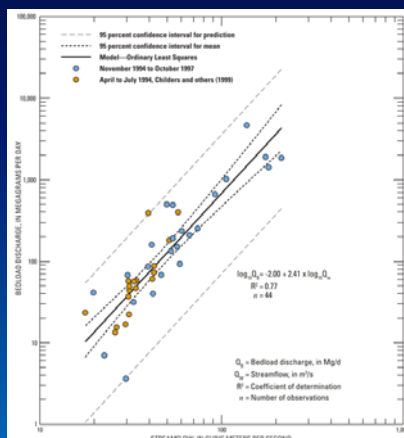
## Introduction

### Implications of inadequate sampling

- Calculations using bedload transport formulae and extrapolations from rating curves may be significantly different from actual bedload

Example from Elwha River, WA:

- 95% confidence intervals are roughly an order of magnitude higher/lower than the mean
- A lot of scatter during low discharge periods

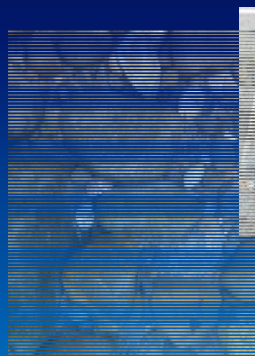


Source: Curran *et al.*, 2009

## Introduction

### Surrogate bedload monitoring using hydrophones

- Hydrophones can detect impacts of gravels and cobbles up to 15-20 meters away
- Hydrophones are relatively inexpensive and easy to deploy



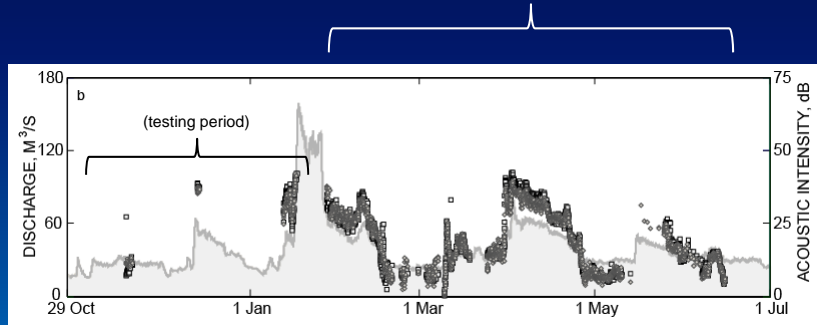
# Introduction

## Surrogate bedload monitoring using hydrophones

- Surrogate technologies can provide high-resolution bedload data
- Acoustic intensity can then be correlated to bedload samples

Example from Cedar River, WA

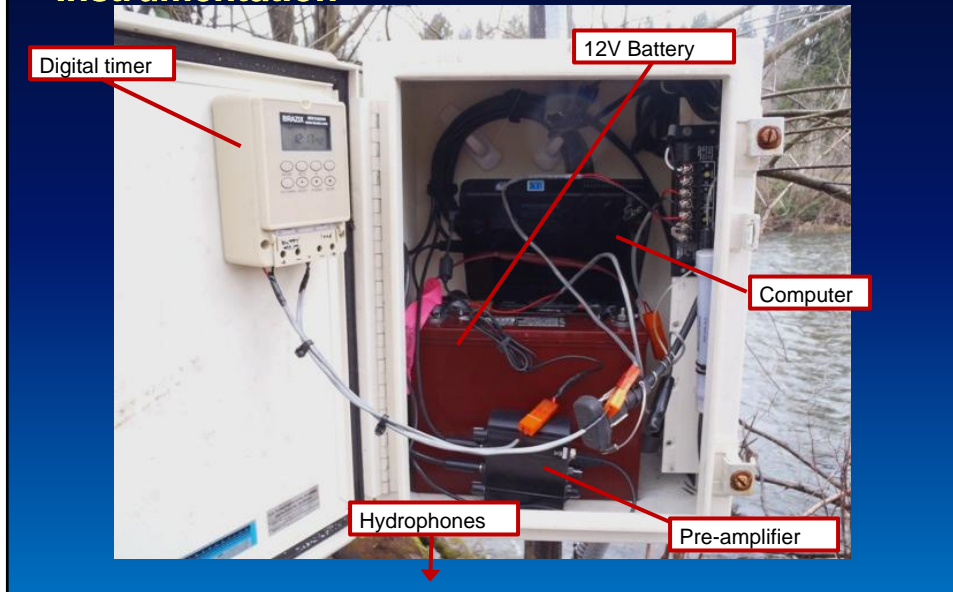
Nearly five months of hourly acoustic intensity data

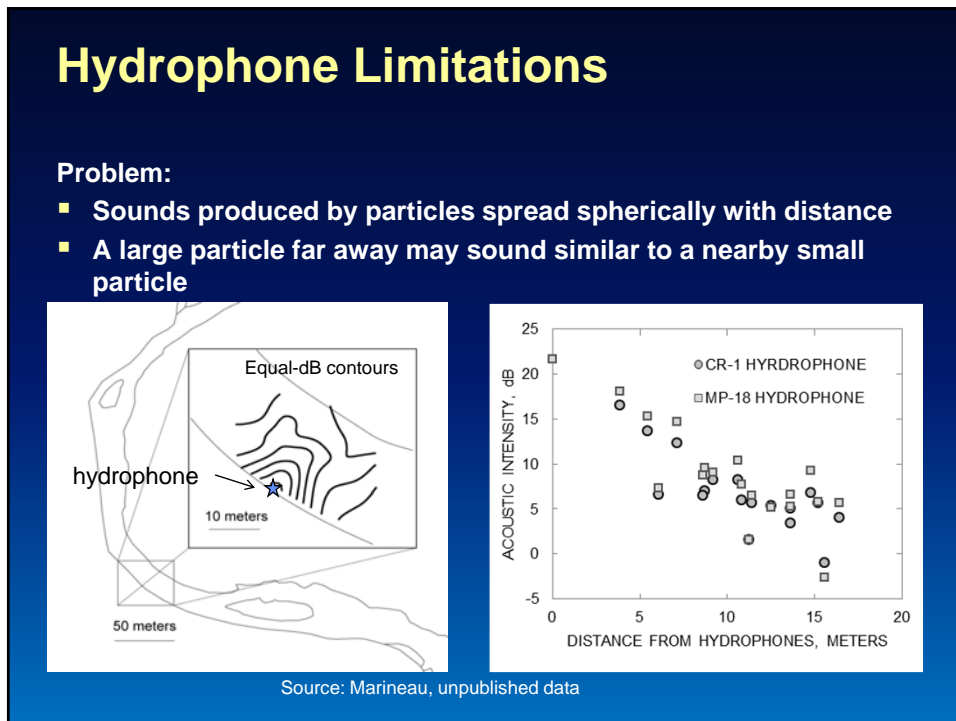
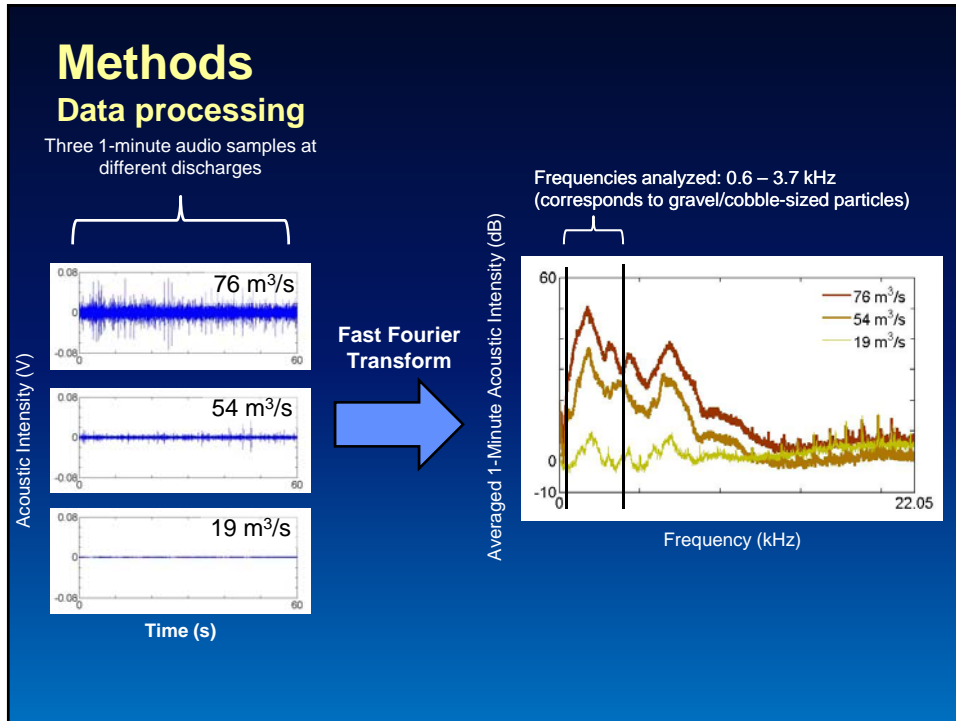


Source: Marineau *et al.*, 2012

# Methods

## Instrumentation



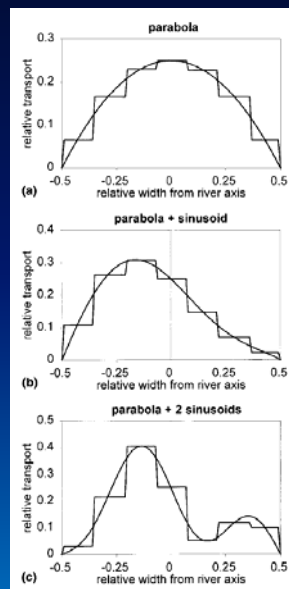


## Hydrophone Limitations

### Problem:

- Measuring acoustic energy with one hydrophone might not be representative of the entire cross-section
- Transport may also change during high-flow from one side of the channel to the other

Hypothetical distributions of sediment transport in a single cross-section



Source: Kleinhans and Brinke, 2001

## Multiple Hydrophones “quadraphone”

### Solution:

- Install a pair of hydrophone stations (one station on each bank)
- Each station has dual channel capabilities (two hydrophones)

Example site:  
Skaggs Bridge



## Multiple Hydrophones

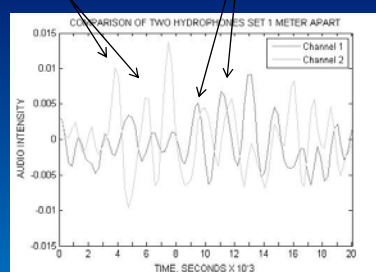
### Benefits

- Spatial average of bedload transport during medium to high flows
- More robust system (redundancy protects against data loss due to high-flow events, vandalism, equipment malfunction)
- Possibly isolate and count single particles during lower flows



Small nearby shocks detected by only one hydrophone

Larger shocks detected by pair of hydrophones



## Proposed surrogate bedload monitoring

- One pair of stereo hydrophone stations (the “Quadraphone”) will be co-located with an existing bedload monitoring site, most likely the Highway 41 sampling site
- Two stereo hydrophone stations will be installed at two other existing bedload monitoring sites
- One stereo hydrophone station will be installed at Little Dry Creek
- Two additional stereo hydrophone stations will be installed at important riffles to estimate thresholds of movement
- At the sites with co-located bedload sampling, acoustic data will be calibrated to measurements of bedload transport



## References

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