Monitoring Coarse Bed Sediment Transport and Aquatic Macroinvertebrate Communities to Inform the Sustainable Rivers Program

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Willamette Fisheries Science Review
April 4, 2024
Corvallis, Oregon

Sustainable Rivers Program Background

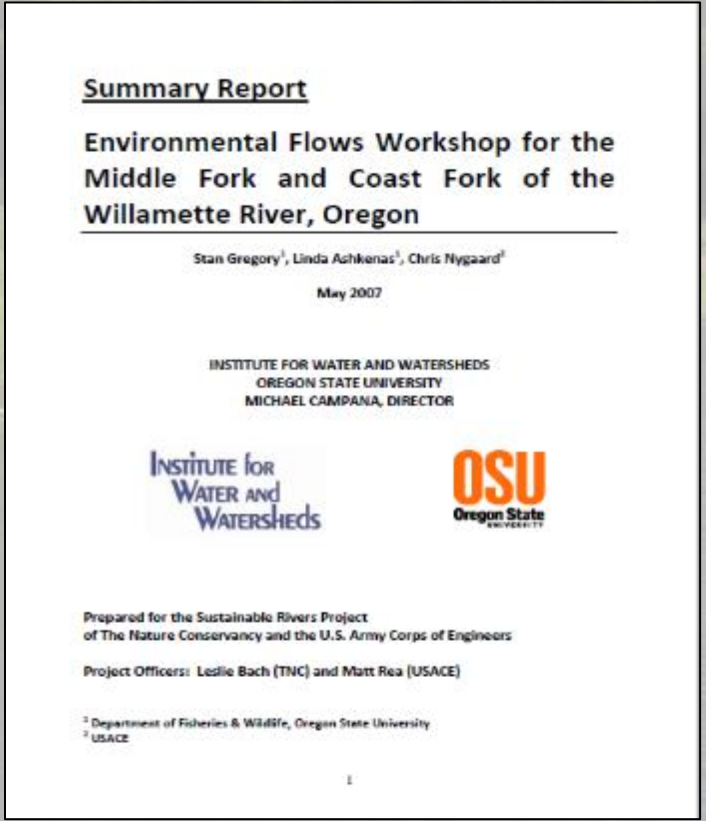
Adaptively managed program developed by the US Army Corps of Engineers and The Nature Conservancy designed to enhance aquatic habitats downstream of USACE projects through environmental flow releases

Figure from The Nature Conservancy

USGS

Sustainable Rivers Program Background

- Willamette SRP began ~2007 through a series of stakeholder workshops and subsequent flow recommendations
- 63 unique flow targets identified in reports
- Recommendations are in three separate reports using different approaches/formats


Summary Report

Environmental Flows Workshop for the Middle Fork and Coast Fork of the Willamette River, Oregon

Stan Gregory[1], Linda Ashkenas[1], Chris Nygaard[2]

May 2007

INSTITUTE FOR WATER AND WATERSHEDS
OREGON STATE UNIVERSITY
MICHAEL CAMPANA, DIRECTOR

Institute for Water and Watersheds

OSU Oregon State University

Prepared for the Sustainable Rivers Project
of The Nature Conservancy and the U.S. Army Corps of Engineers

Project Officers: Leslie Bach (TNC) and Matt Rea (USACE)

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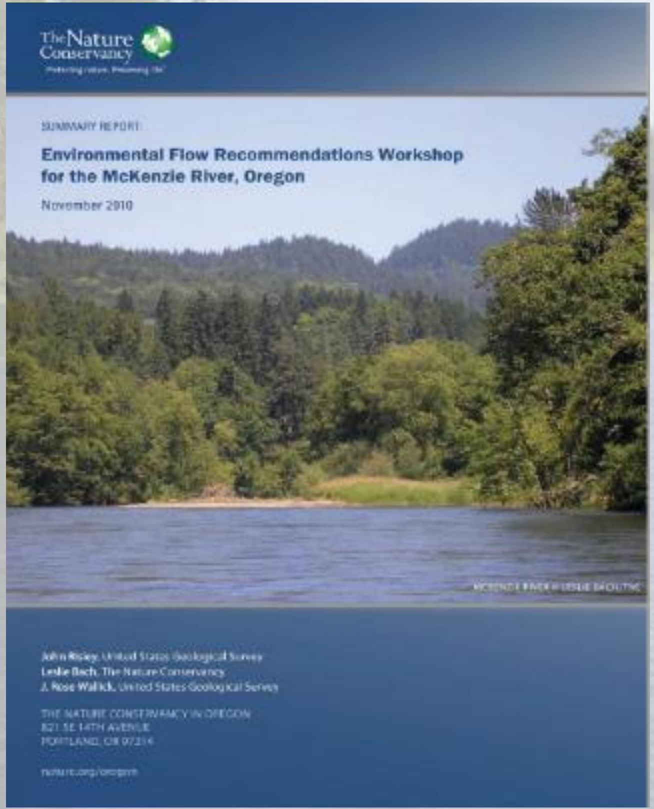

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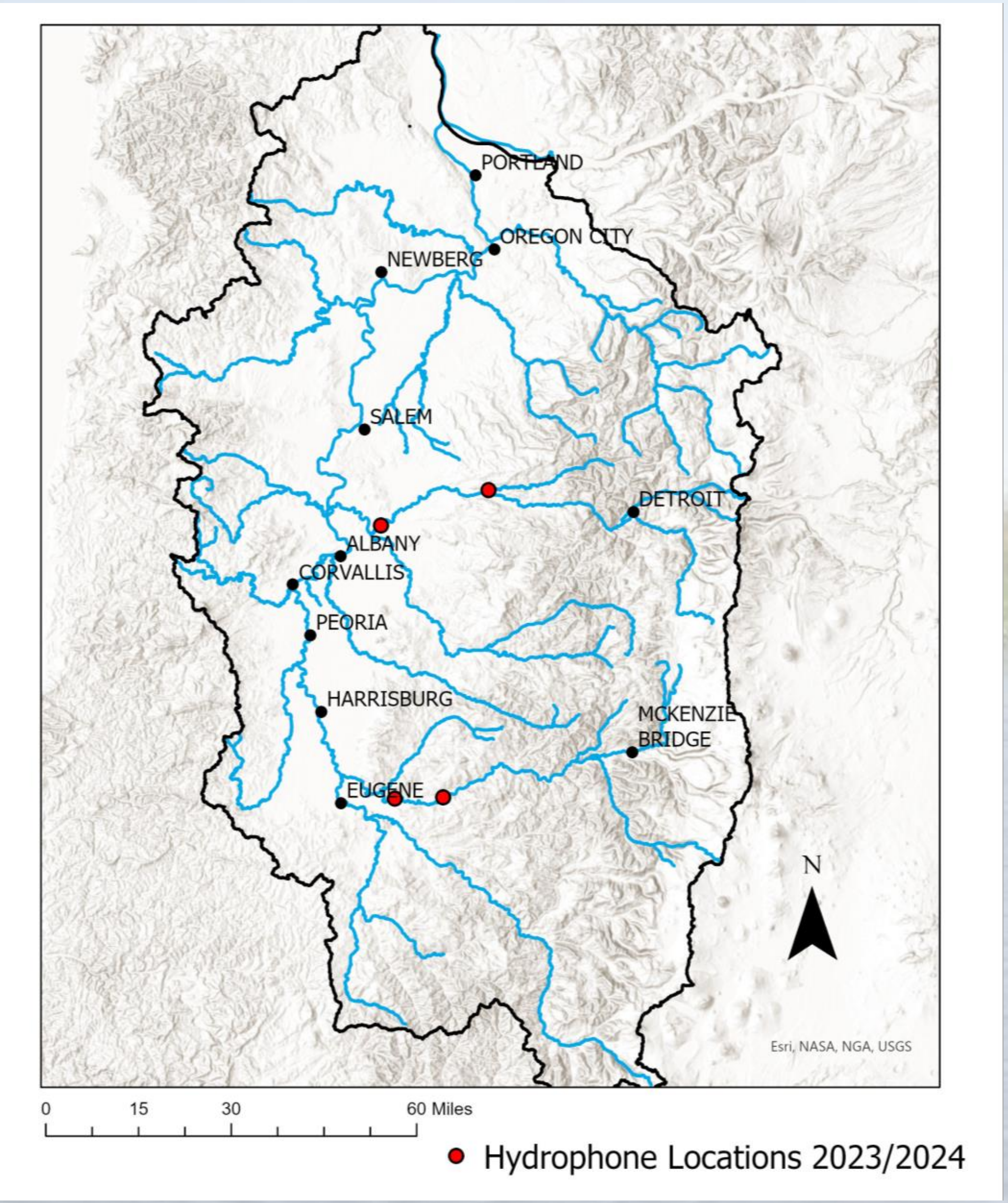
Evaluating physical and biological responses to streamflow

Goal:

Evaluate how effective streamflow targets are at meeting select ecological outcomes

- Conduct macroinvertebrate monitoring to quantify how macroinvertebrate populations respond to streamflow and/or bedload movement
- Monitor bedload transport using passive acoustic monitoring ("hydrophones") to develop relative bedload transport relations in four SRP reaches



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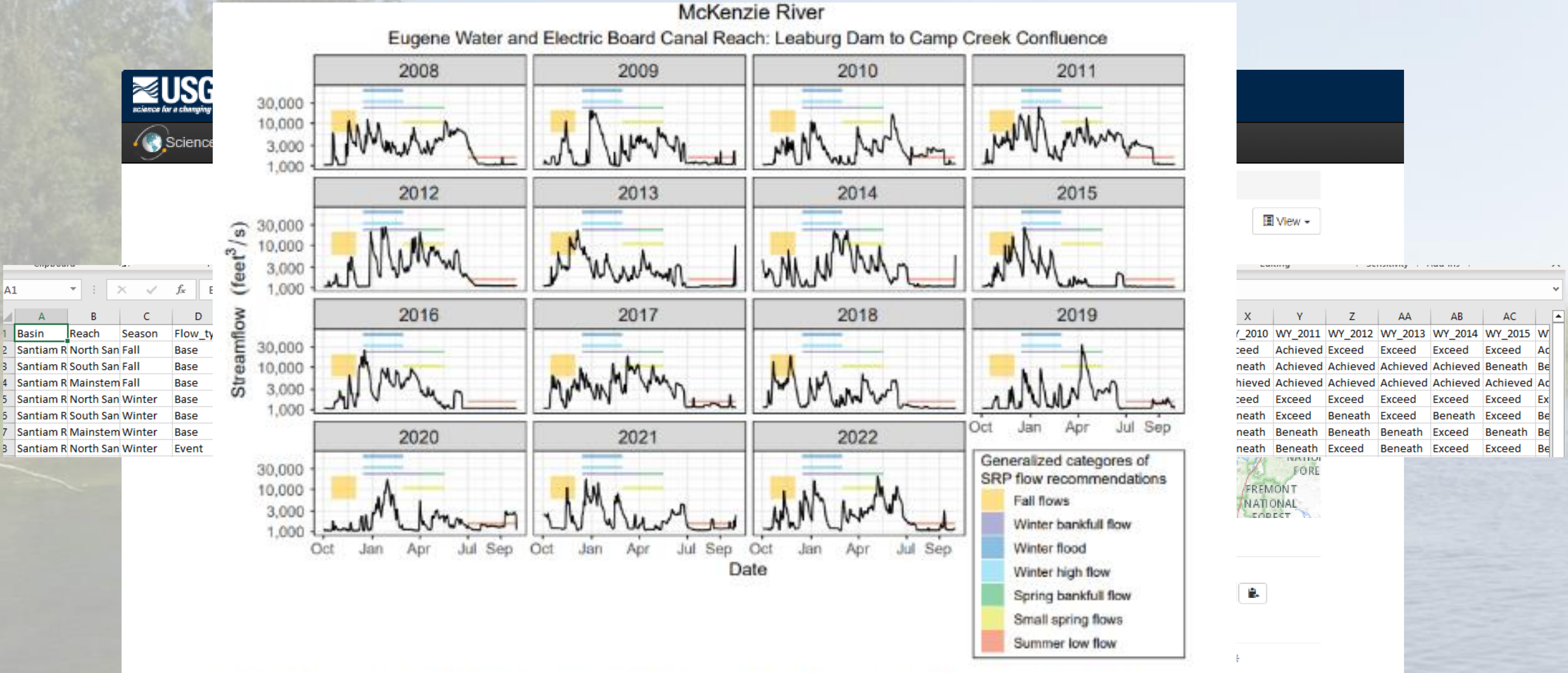
Compiling flows since Willamette SRP inception

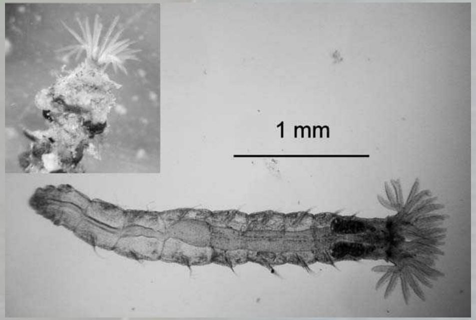


Comparison of measured streamflow at USGS gaging station 14163900, McKenzie River near Walterville, for water years 2008-2022, with stakeholder-defined seasonal streamflow targets, displayed in boxes, established through the Sustainable Rivers Program. See Risley and others, 2010 for descriptions of reach boundaries and stake-holder defined environmental flow recommendations.

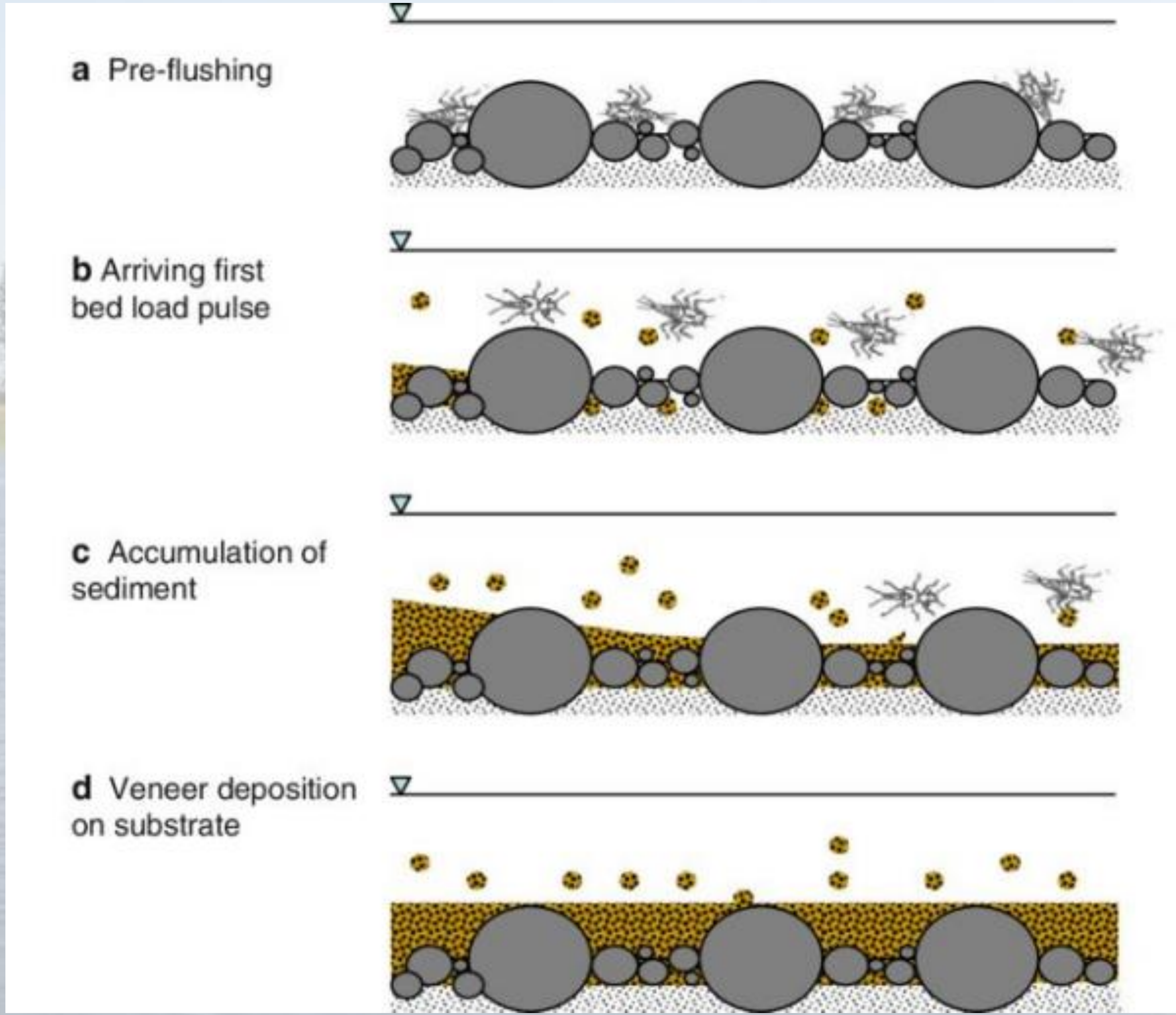
White et al., 2023

SRP Invertebrate Sampling

- Benthic macroinvertebrates (‘bugs’)
  - Short-lived
- Responsive to flow and sediment
  - Well-described ecological indicators
- Important to ecological integrity
  - Food for fish, incl. juvenile salmon
  - Vectors of disease, such as *C. shasta*



Malakauskas *et al.* 2013



Gomi *et al.* 2013

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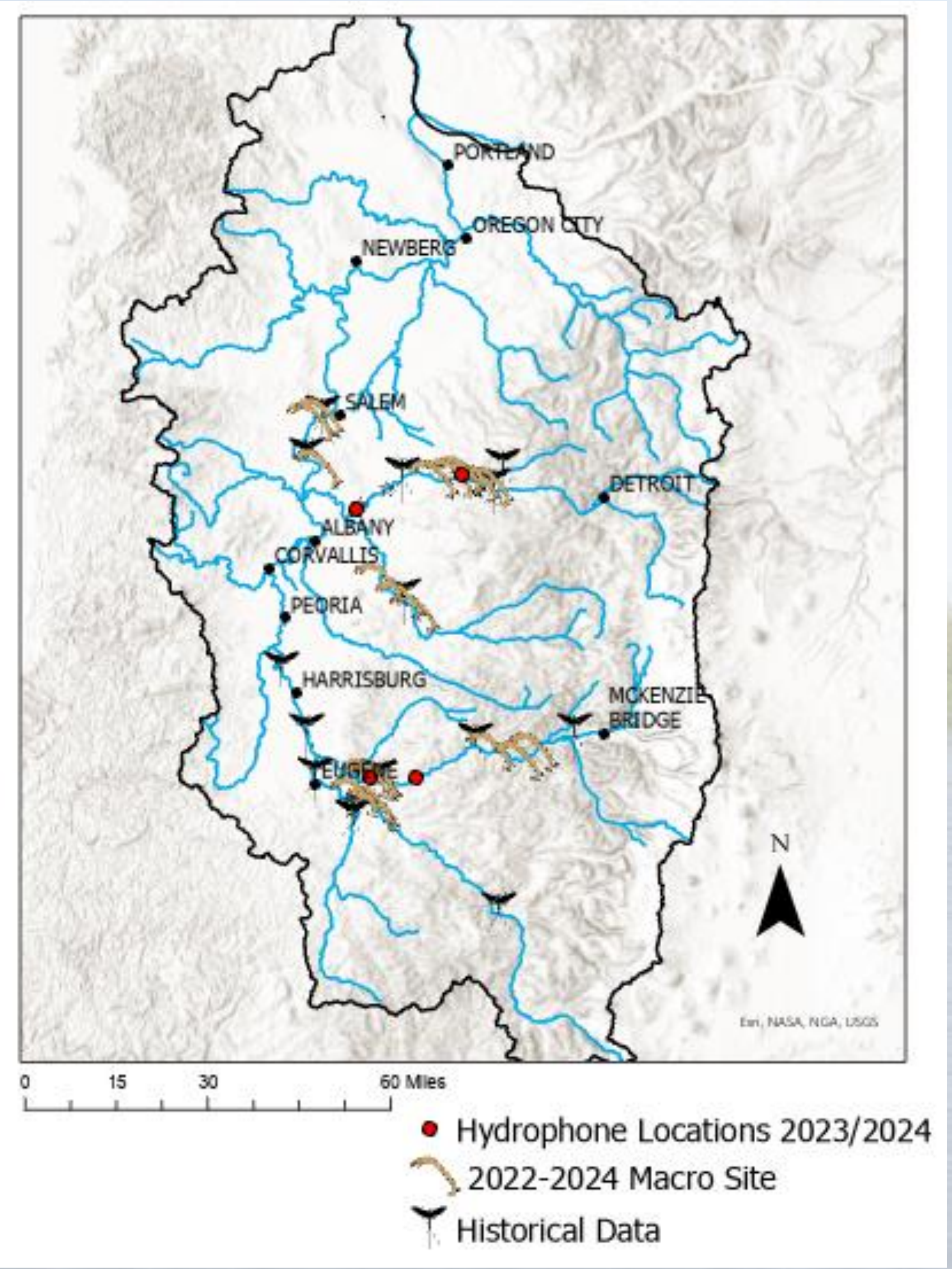
SRP Invertebrate Sampling

Annual sampling 2022-2024

- Summer (July-September)
- Kick-net
  - Genus ID and Biomass
- Modified pebble counts
- Expanded trait database (Murphy et al. 2020)

- Historical EPA data 2006-2018
  - ID only (no biomass)



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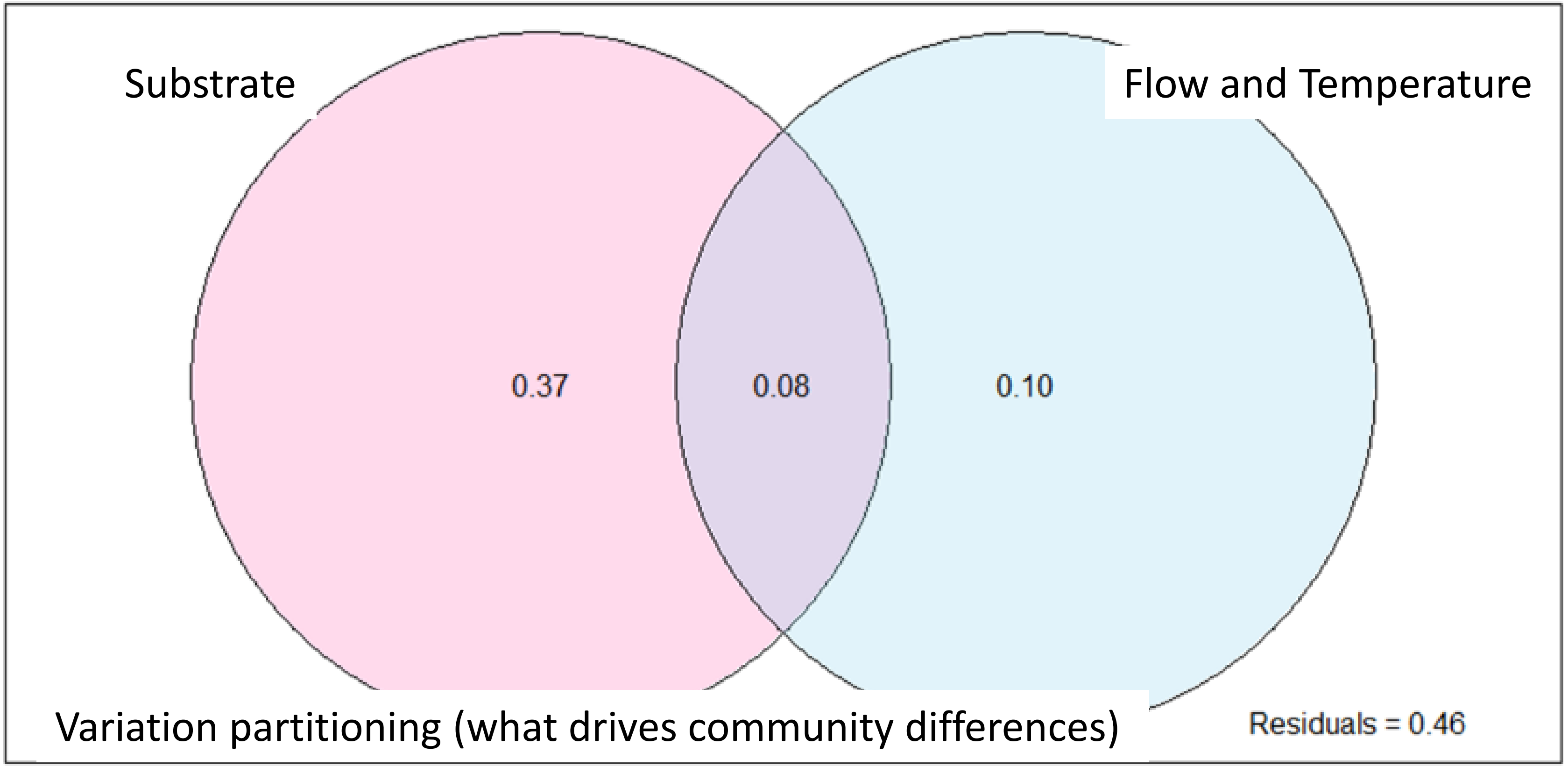
Unexpected limited relationship with flow targets

- Thresholds are important in ecological models
- Lack of relationship - flow targets do not appear be ecological thresholds



Variation partitioning (what drives community differences)

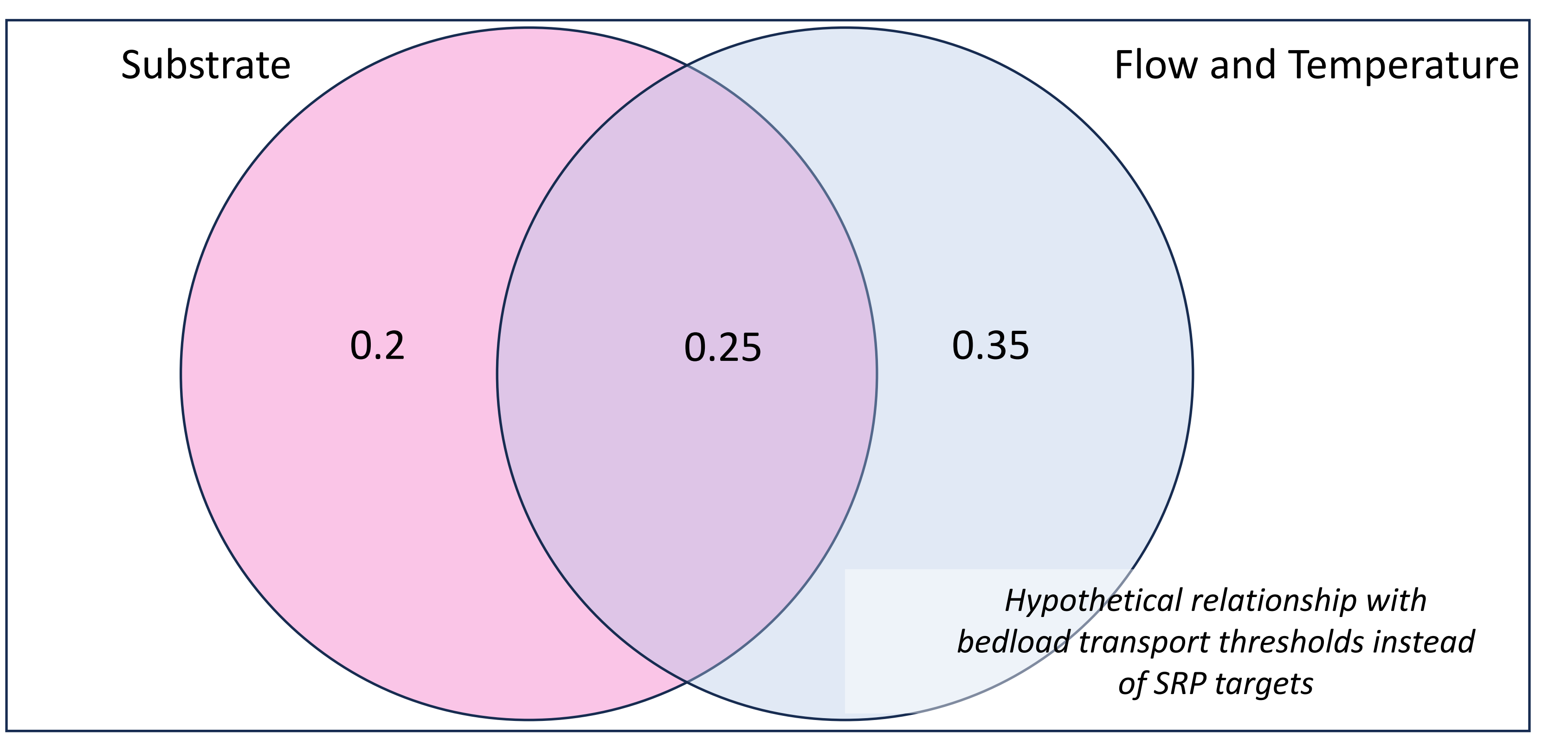
Preliminary results. Do not cite

USGS

Unexpected limited relationship with flow

Hypothesis that linking model to bedload transport thresholds from hydrophone analysis will significantly improve predictive power compared to current SRP targets

Explicit link between streamflow and ecological outcomes can help refine flow targets and advance the adaptive management cycle



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Evaluating physical and biological responses to streamflow

- Over half of the 63 stakeholder generated flow targets focus on flows necessary to mobilize bed sediment
- Flow targets identified based on general empirical relations between relative streamflow and bed movement
    - Very little bedload data were available in Willamette Basin → highly uncertain response to flow targets
- Direct linkage of bedload transport to aquatic habitats not well defined in Willamette Basin

USGS

Why is bedload transport hard to monitor?

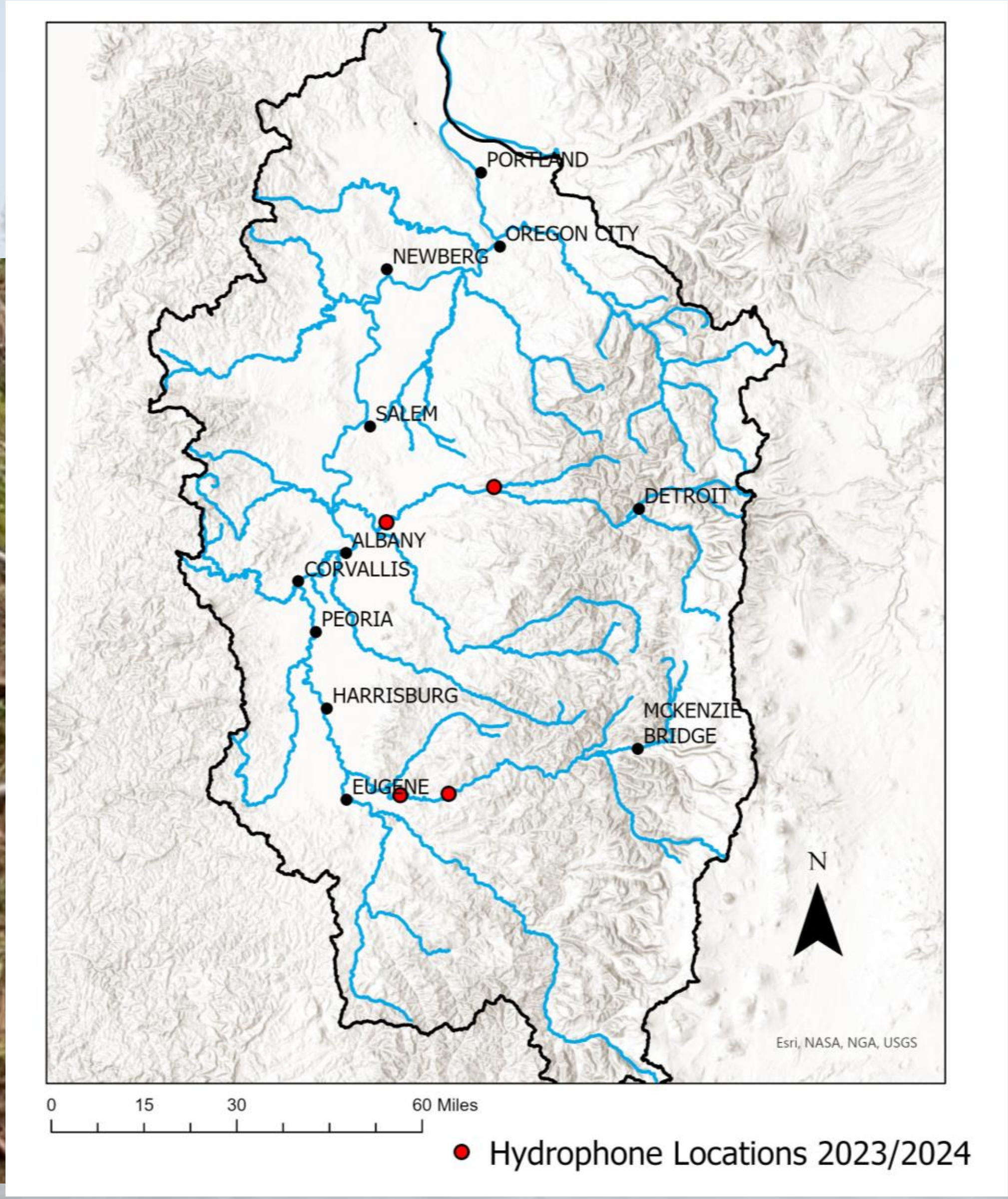
- Happens episodically - only during high-flow events
- Challenging and expensive to measure directly
  - Requires crews of 3-6 people and specialized equipment
- Gravel-bed rivers are high-energy environments
  - Logistically difficult
  - Hard on equipment – gear can be lost or destroyed
- Stage an indirect and unreliable surrogate
  - Bedload transport strongly affected by hysteresis

Bedload sampling on the Chetco River, photographs by J. O'Connor; from Wallick and others, 2010

USGS

Monitoring bedload transport

Hydrophone

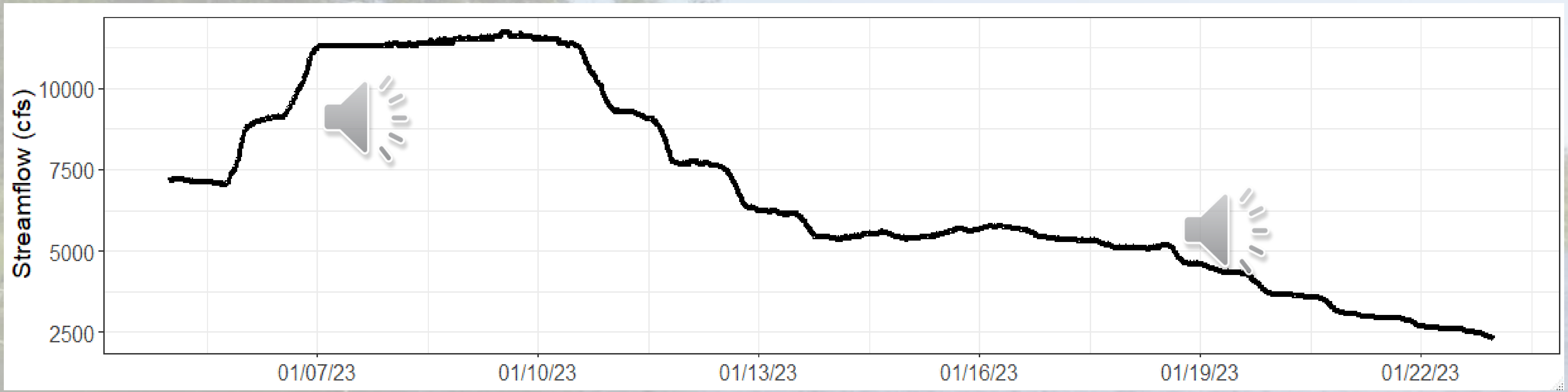


Field Deployment

Processor and preamp

Monitoring bedload transport

North Santiam at Greens Bridge (14184100)



Streamflow data from: [USGS Current Conditions for Oregon _ Streamflow]

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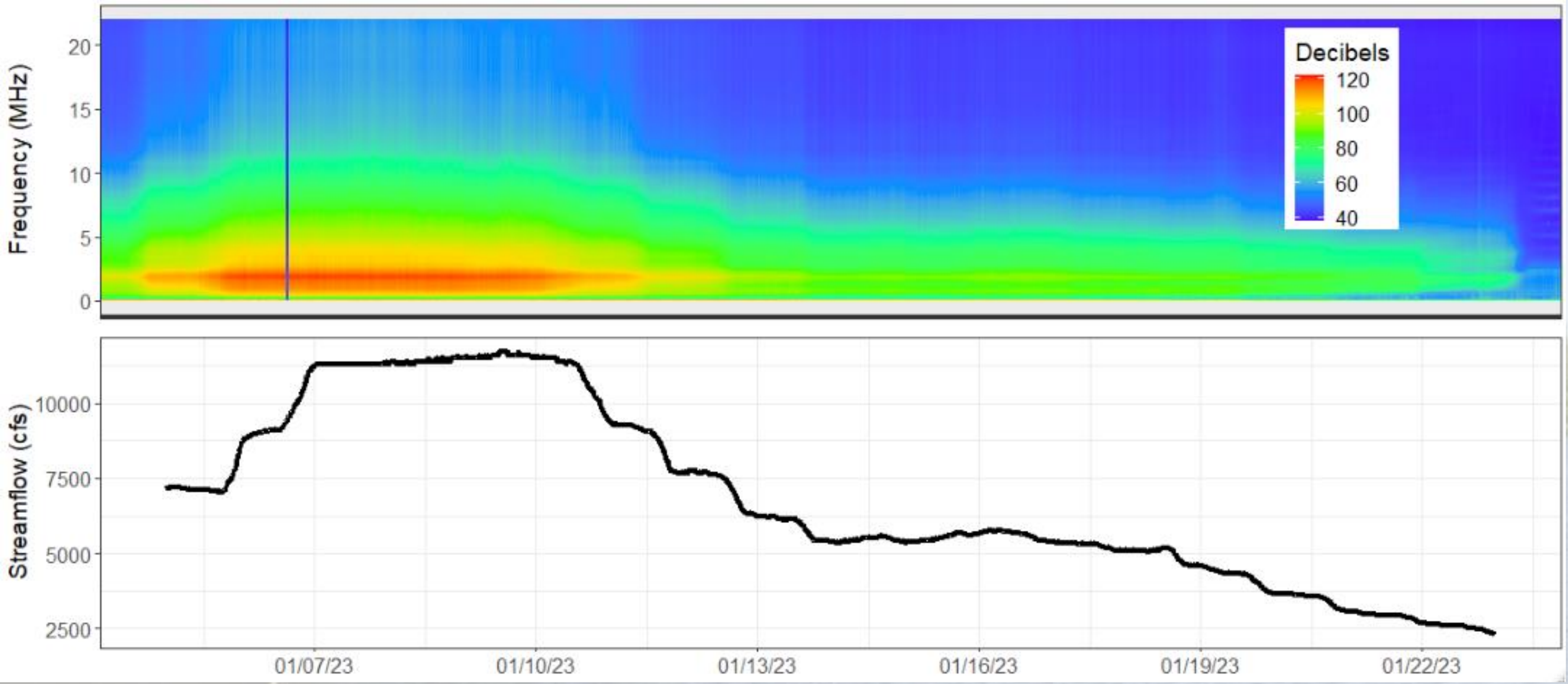
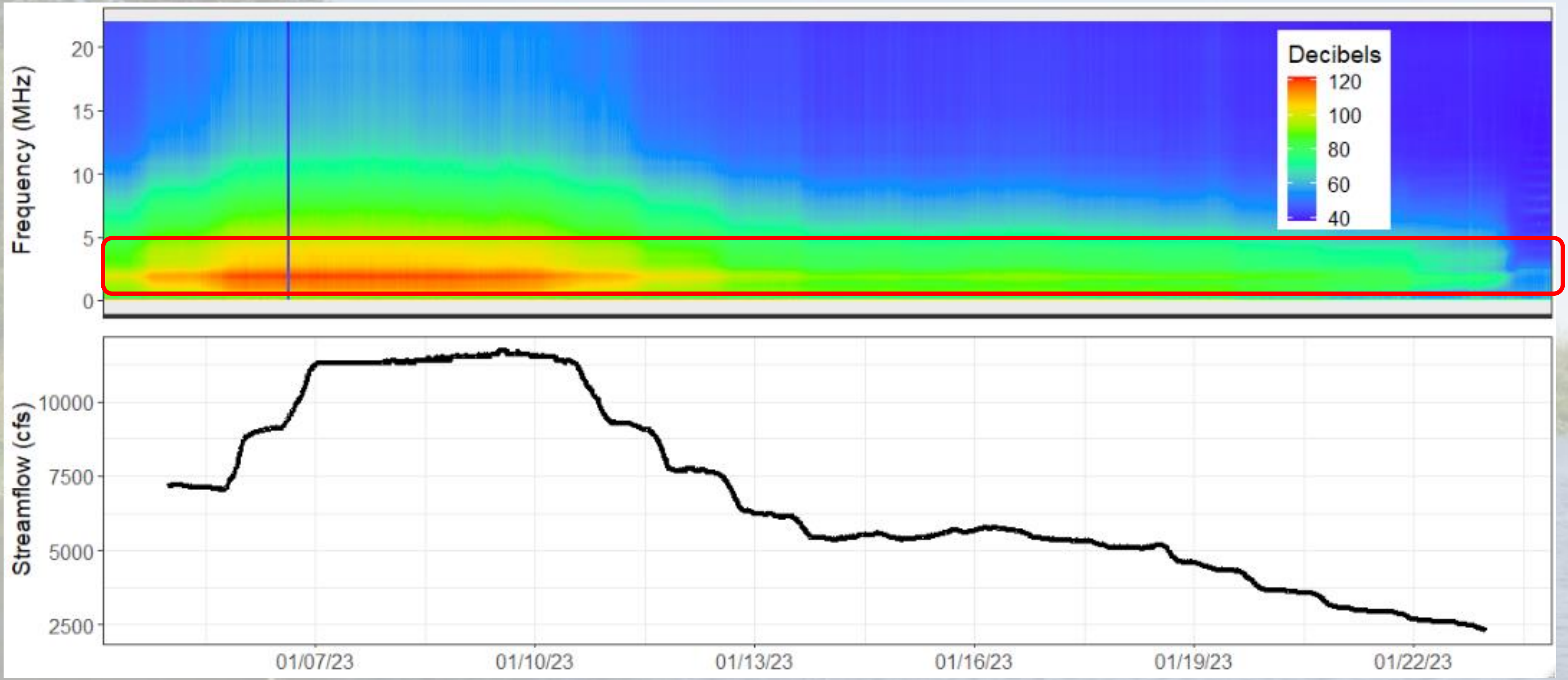
Monitoring bedload transport



Preliminary results. Do not cite

Monitoring bedload transport



Sediment generated noise thought to be in the 0.5-7 KHz range (Belleudy et al., 2017, Belleudy et al., 2010)

USGS

Preliminary results. Do not cite

Monitoring bedload transport

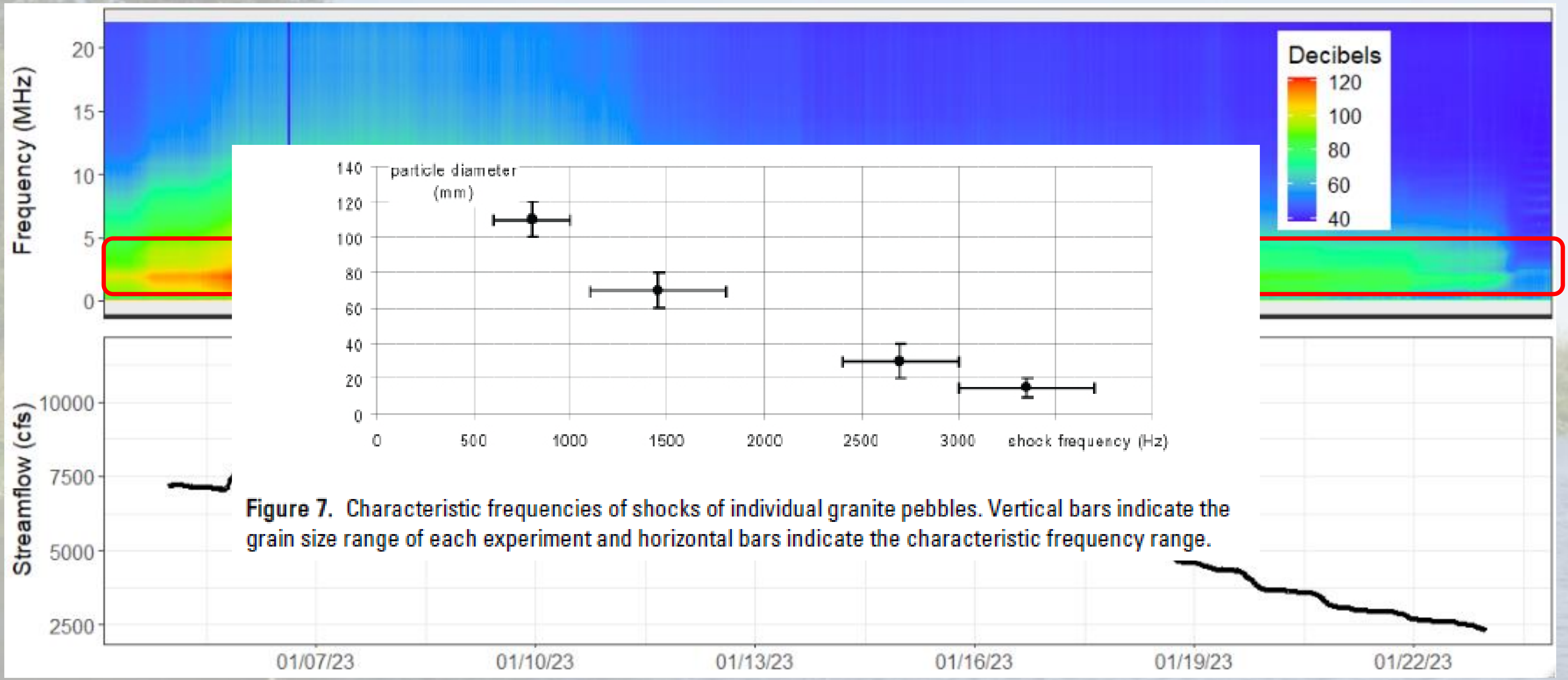


Figure 7. Characteristic frequencies of shocks of individual granite pebbles. Vertical bars indicate the grain size range of each experiment and horizontal bars indicate the characteristic frequency range.

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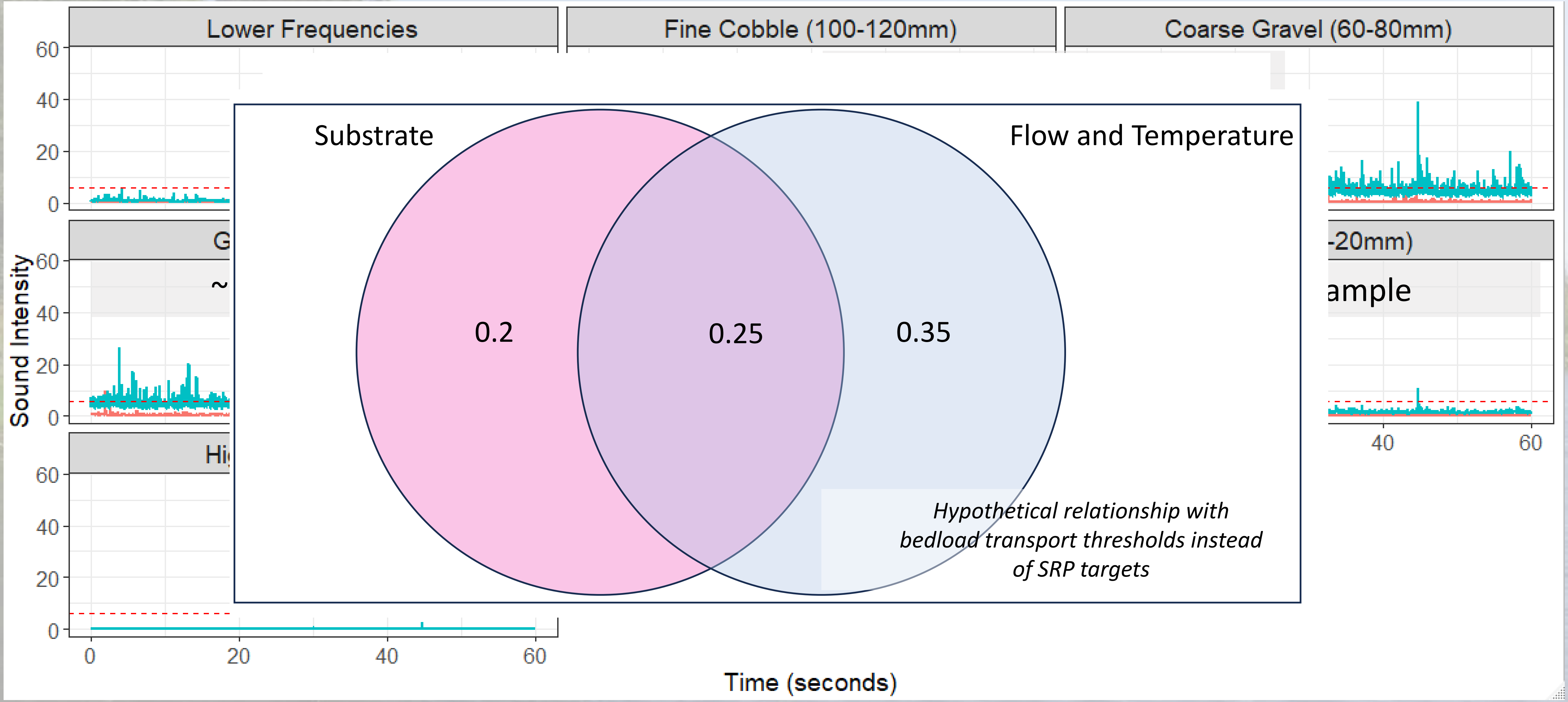
Preliminary results. Do not cite

Monitoring bedload transport

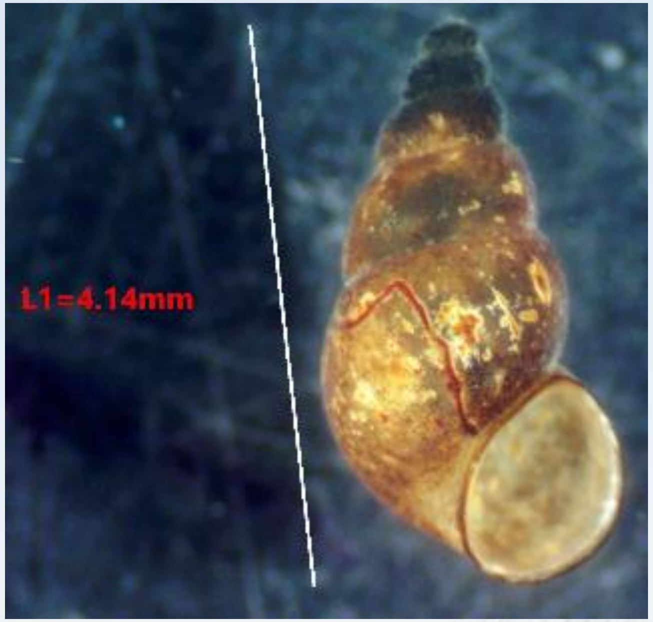
Monitoring bedload transport



USGS

Preliminary results. Do not cite

Frustrating shifting baselines



- New Zealand mudsnails, first found in 2022
  - Middle Fork Willamette River - Jasper State Recreation Area
  - Found in 2023 in greater numbers and downstream

- Ringed crayfish, found in 2023
  - Coast Fork of the Willamette - Mount Pisgah Arboretum
  - Previously only documented above Dorena Reservoir

Added to the Nonindigenous Aquatic Species database

Clean your gear!!

Next steps

2024 macro sampling

- Integration of sediment mobilization thresholds with data to examine impacts on composition, biomass, and trajectories

- Refinement of bedload transport/frequency relationships

Juga

Mayfly

E

Stonefly

P

Caddisfly

T

NZ Mudsnail

Many thanks to
USACE: Chris Budai, Keith Duffy
USGS: Rose Wallick, Jay Spillum, Greg Lind, Brandon Overstreet
Portland State University: David Burnett, Quinn Morgan

Questions