Streambed Scour and Redeposition in Streambed Simulated Culverts over an Annual Cycle

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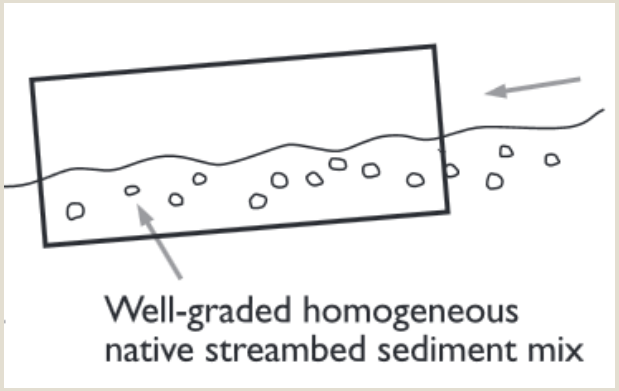
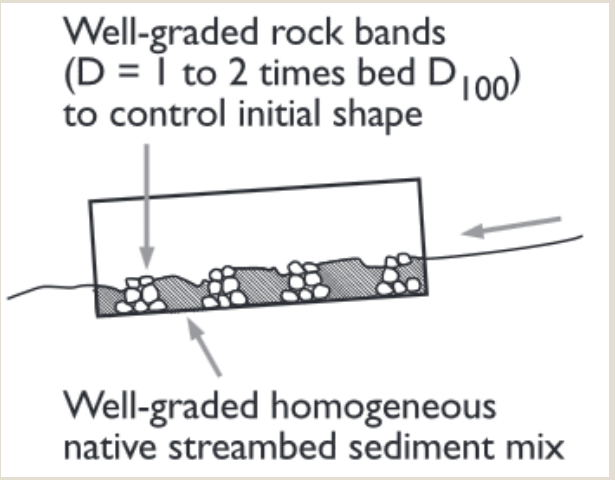
Background: Streambed Simulation Culverts

- Purpose: provide an efficient stream crossing while ensuring discharge capacity, natural stream characteristics, and fish passage
- Focus is placed on the width and slope of the structure
  - Width= 1.2 * $W_{channel}$ +2 ft
  - Slope < 1.25 * $S_{channel}$
- Additionally bed material should be similar to surround native bed material, and be between 20-50% of the structure's rise

Slope >4%



Slope <4%



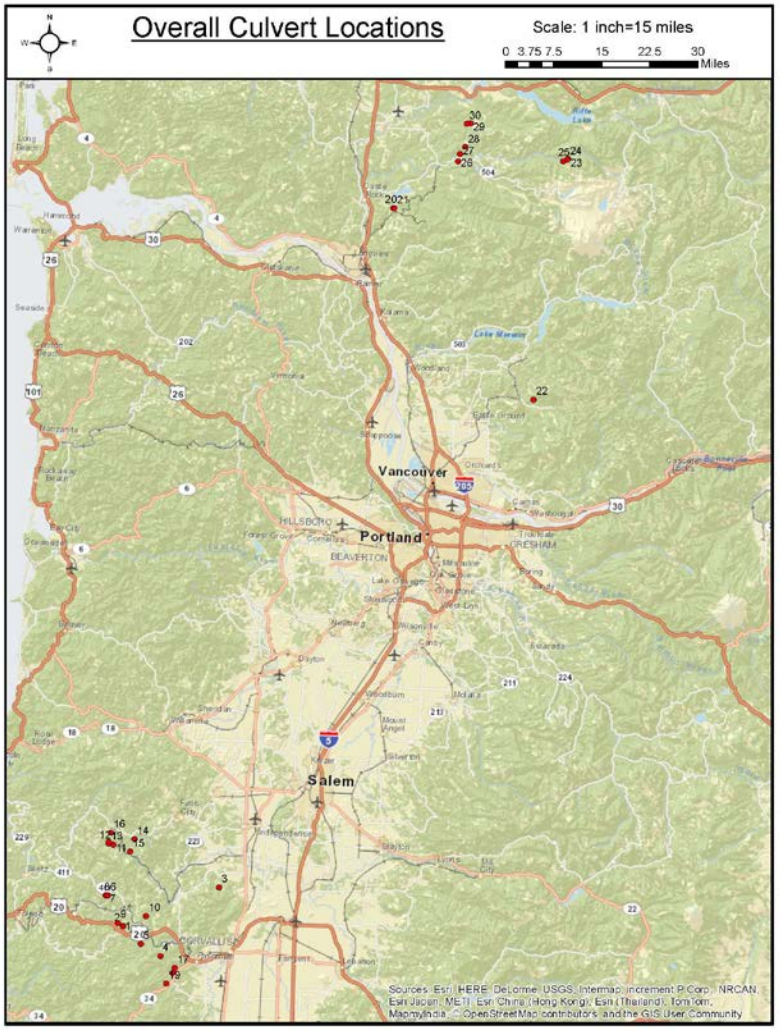
Background

Background

Objective & Purpose

- 1: First order observations on scour and redeposition behavior within closed bottom streambed simulation designs throughout the year
- 2: Consider the potential to gather information on bed level changes for management and monitoring applications
- 3: Evaluate the scour and net bed level change results against site characteristic for potential trends and relate to other bedload transport relationships.

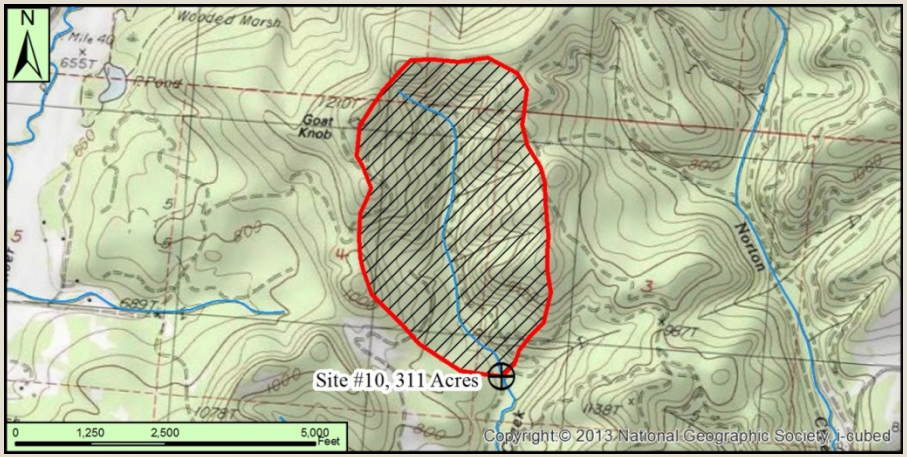
Project Scope



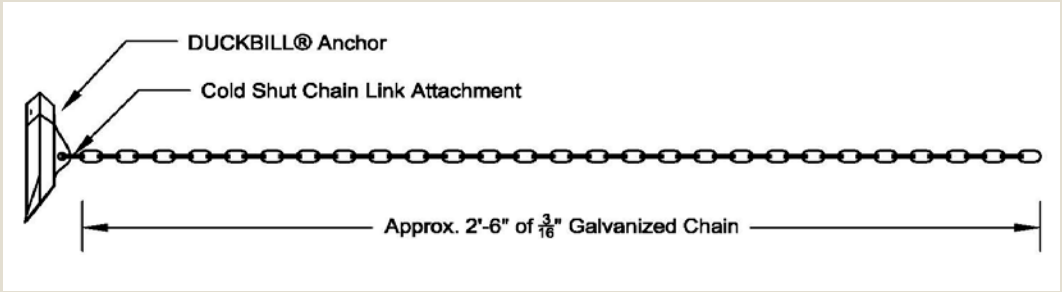
- 30 sites were selected across OR and WA from a initial pool of streambed simulations culverts provided by local forest engineers
- 5 sites had data gathered over 3 years while the other 25 had 2 years of data collected.
- Site were not randomly selected but were instead chosen based on their location, and potential to produce bed level changes
- Emphasis was placed on gathering a variety of site characteristics and sites posing potential management issues

Site Information Gathered/Calculated

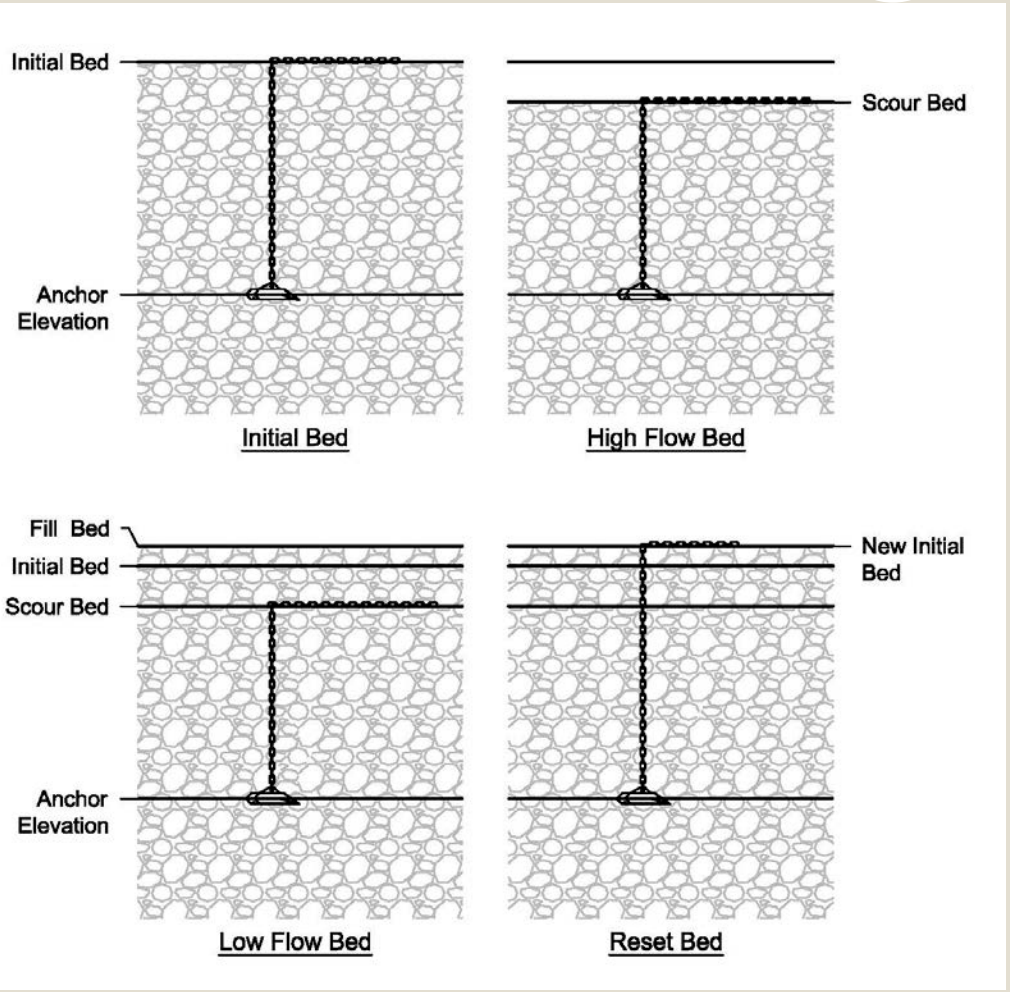
- Culvert Size
- Installation Year
- D_{84} Size
- Bed Material Description
- Culvert Gradient
- Thalweg Location
- Watershed Size
- Peak Instantaneous Discharge
- Discharge for:
  - 2 year event
  - 5 year event
  - 10 year event
  - 25 year event



Scour Chains

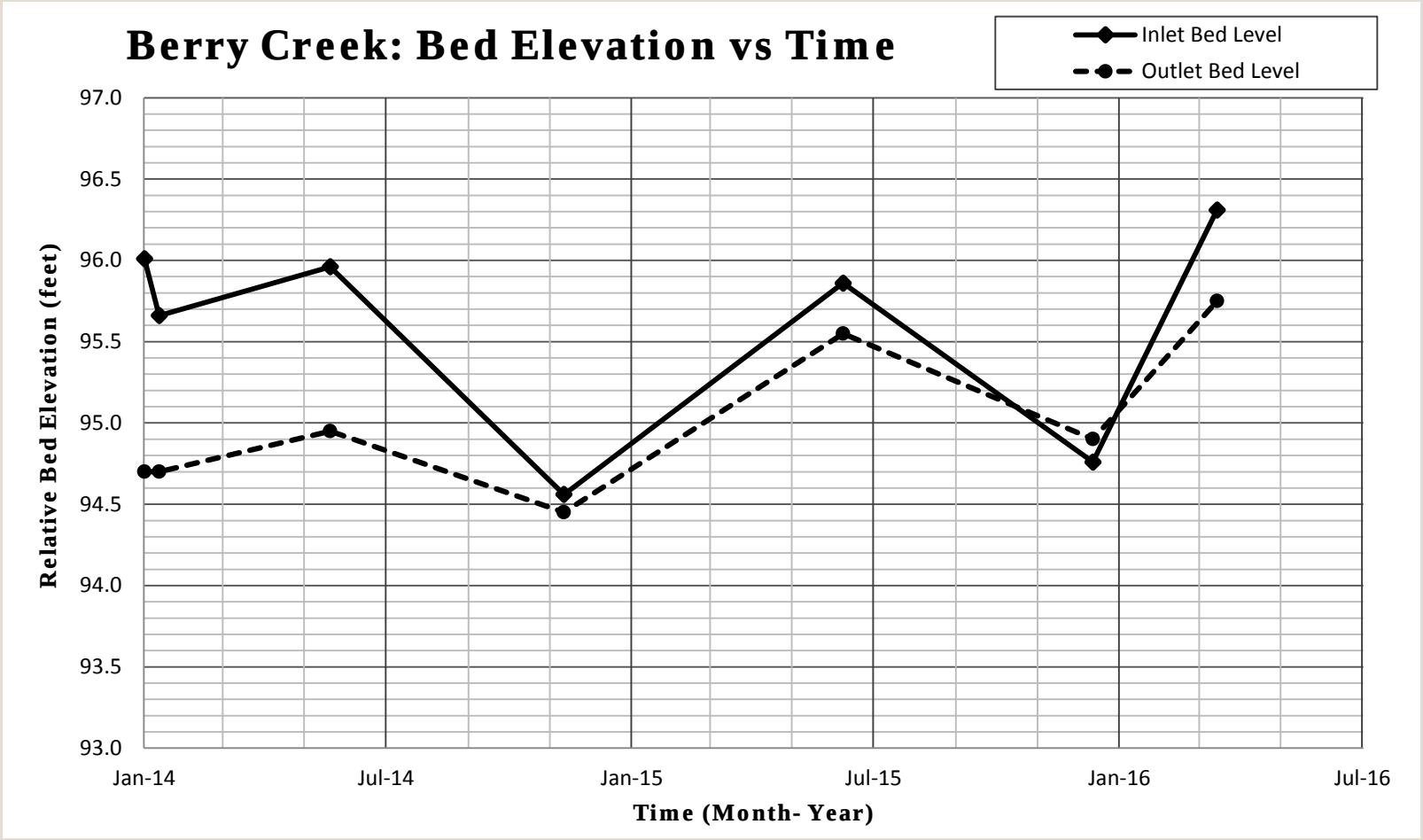


Scour Chains

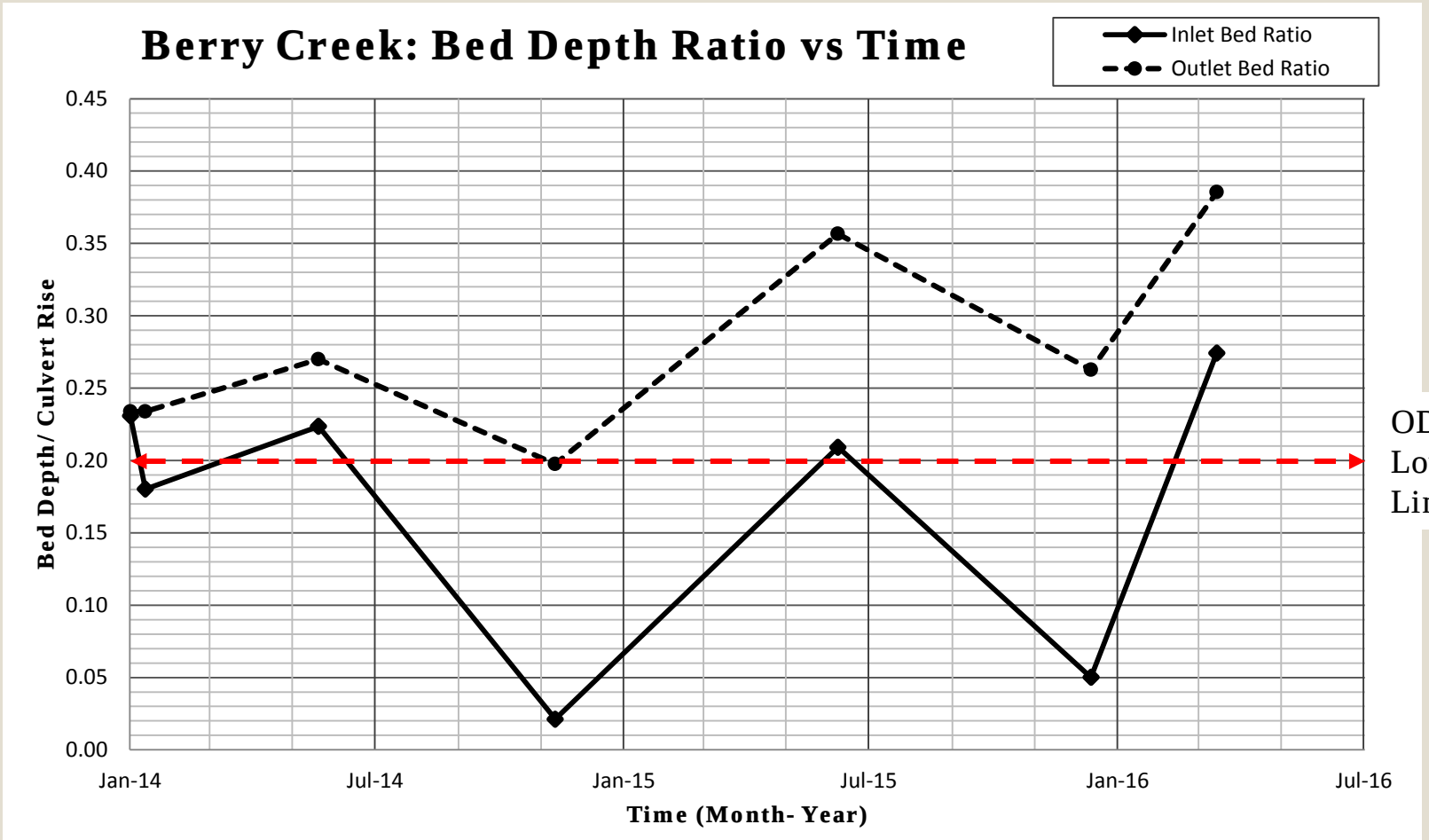


Methods: Scour Chains

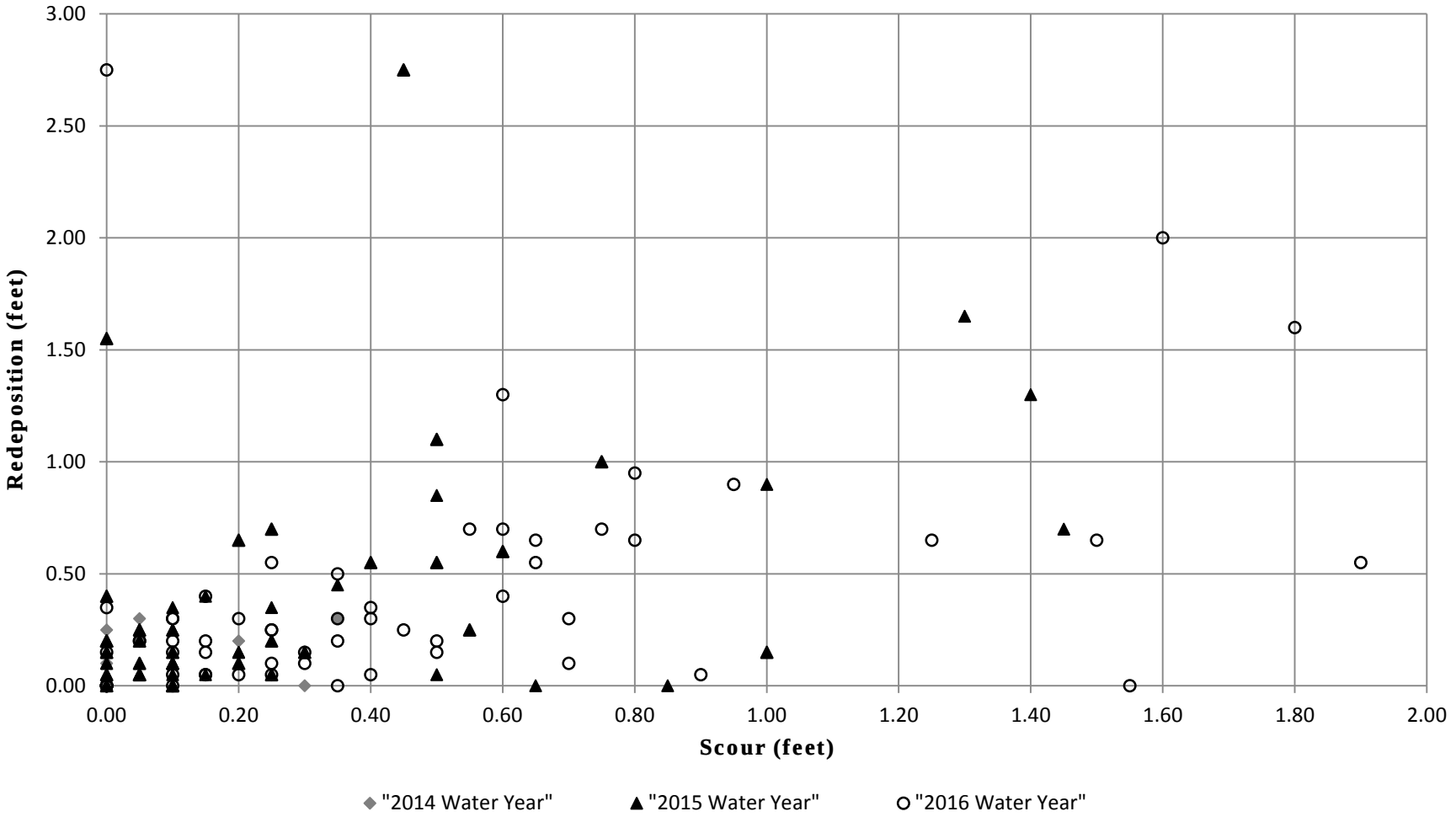
Results: Individual Culverts



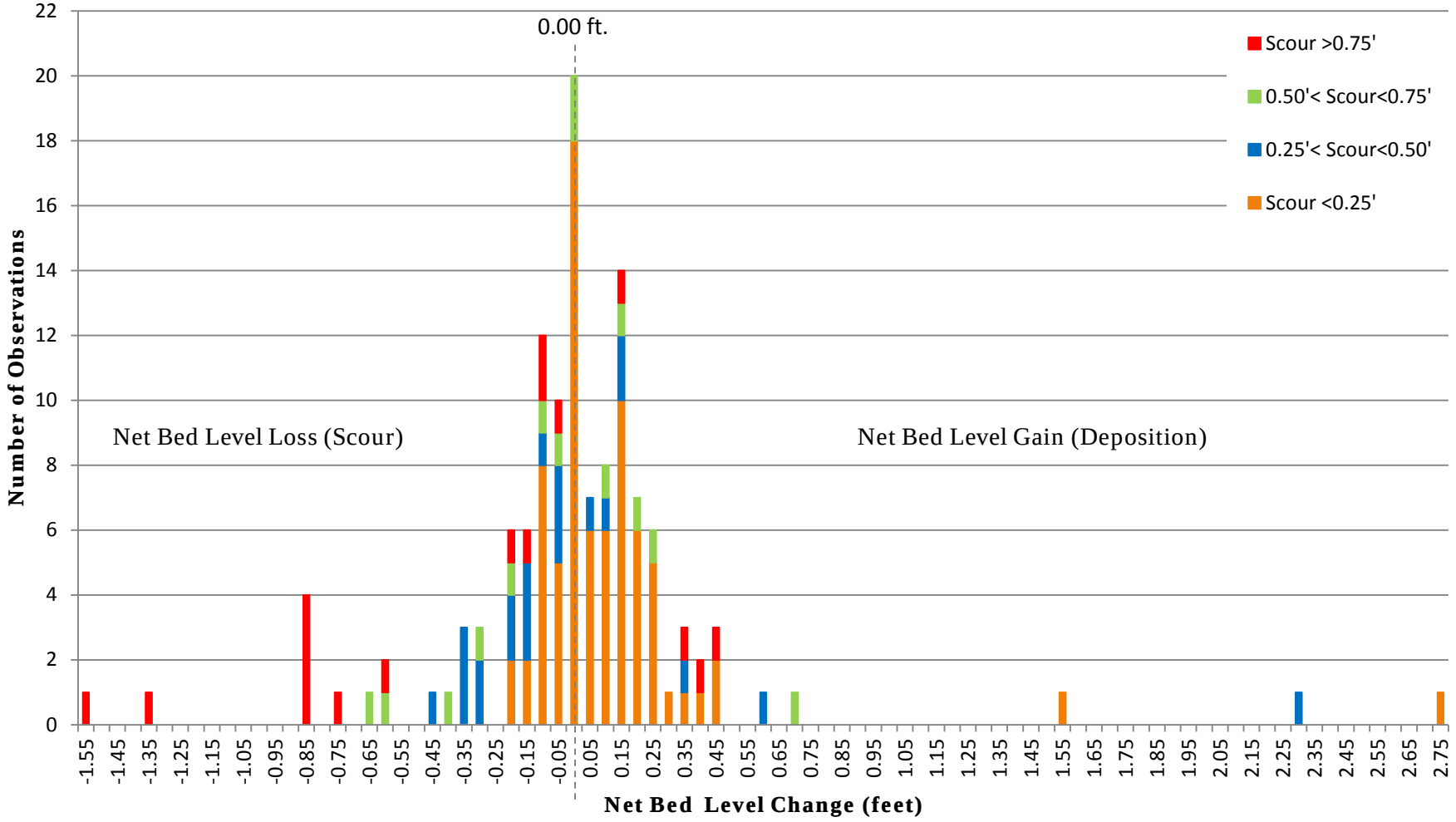
Results: Individual Culverts



Results: Entire Study

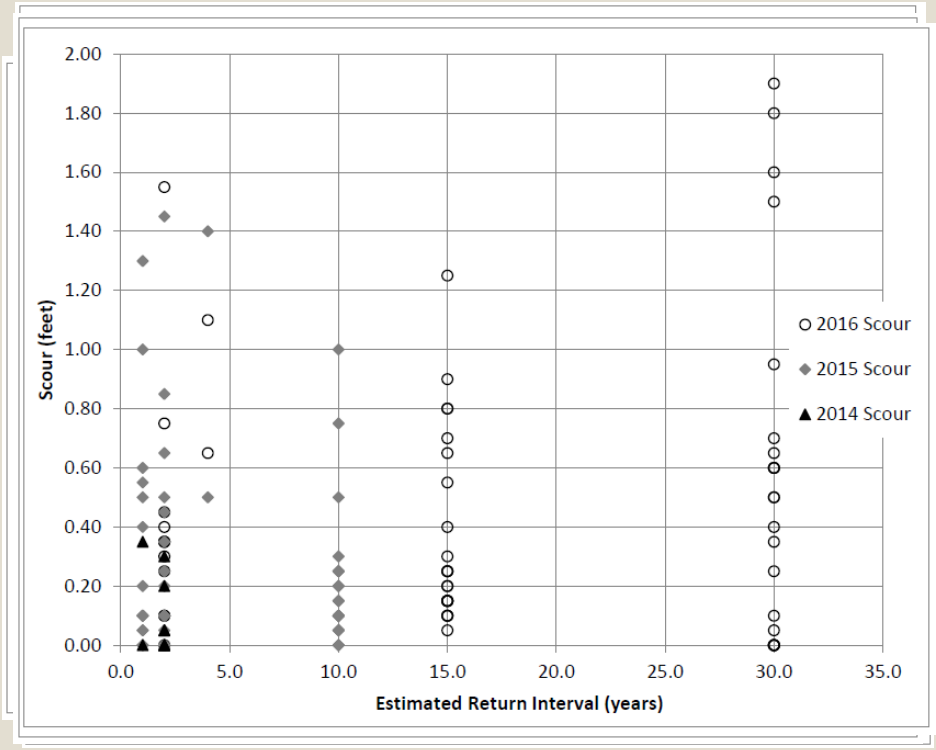


Results: Net Bed Level Change



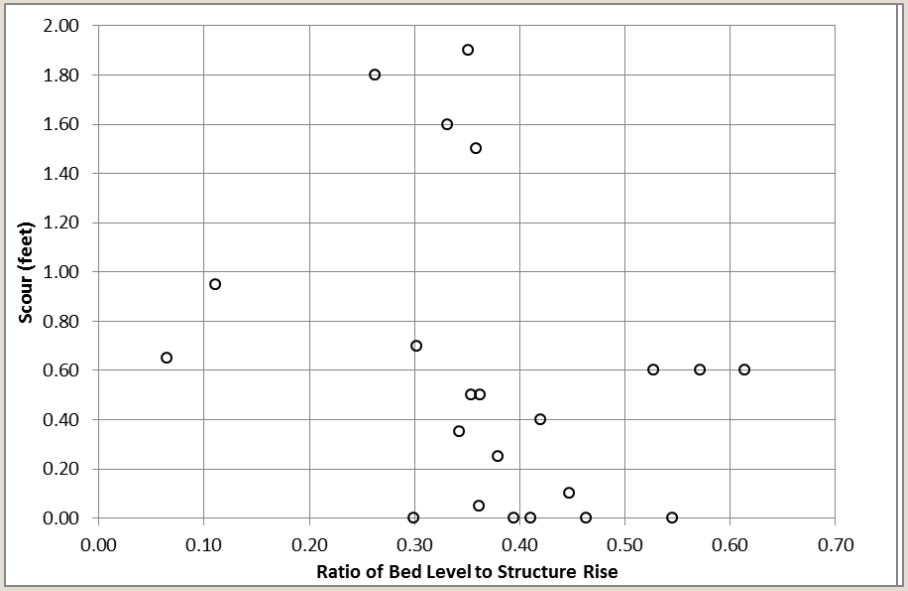
Bivariate Correlations

Comparison Variable		Scour	Net Change
Slope	Pearson Corr.	**0.262**	-0.182
	Significance	**0.035**	0.148
Installation Year	Pearson Corr.	**0.372**	-0.159
	Significance	**0.002**	0.206
Equivalent Round Diameter	Pearson Corr.	**0.281**	-0.107
	Significance	**0.023**	0.395
D84	Pearson Corr.	**0.262**	-0.049
	Significance	**0.035**	0.696
Bed Level to Culvert Rise Ratio	Pearson Corr.	0.216	0.009
	Significance	0.084	0.944
Hydraulic Radius	Pearson Corr.	-0.181	0.012
	Significance	0.148	0.922
Peak Flow	Pearson Corr.	0.114	-0.126
	Significance	0.365	0.316
Flow Recurrence Interval	Pearson Corr.	**0.375**	-0.038
	Significance	**0.002**	0.764

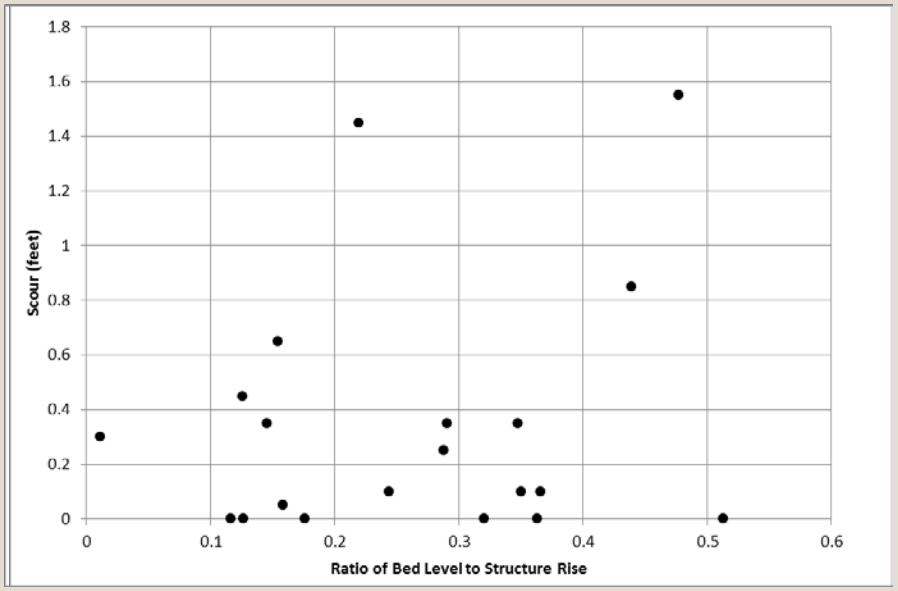


Scour v. Recurrence Interval

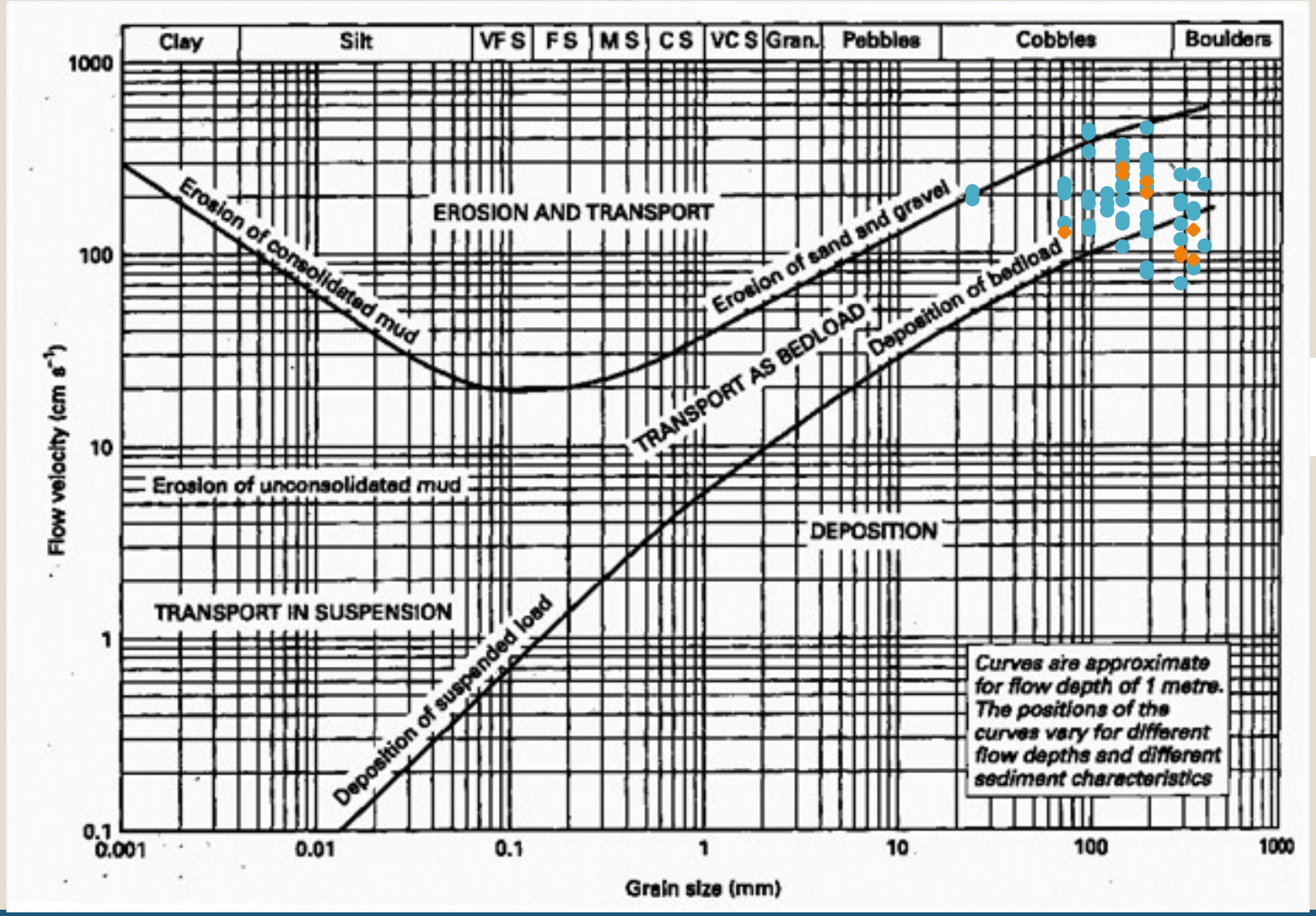
25+ Year Event



2 Year Event



Hjulström Diagram Analysis



Hjulström Diagram Analysis

- Manning's Equation:

$$V = 1.486 / n * R_h^{2/3} * S^{1/2}$$

$$V = Q / A$$

- Incorporated site variables without requiring significant assumptions.

- Overall correctly predicted 75% of scour events observed, 80% if the 5 sites installed in 2015 were excluded for their first winter.

Conclusions

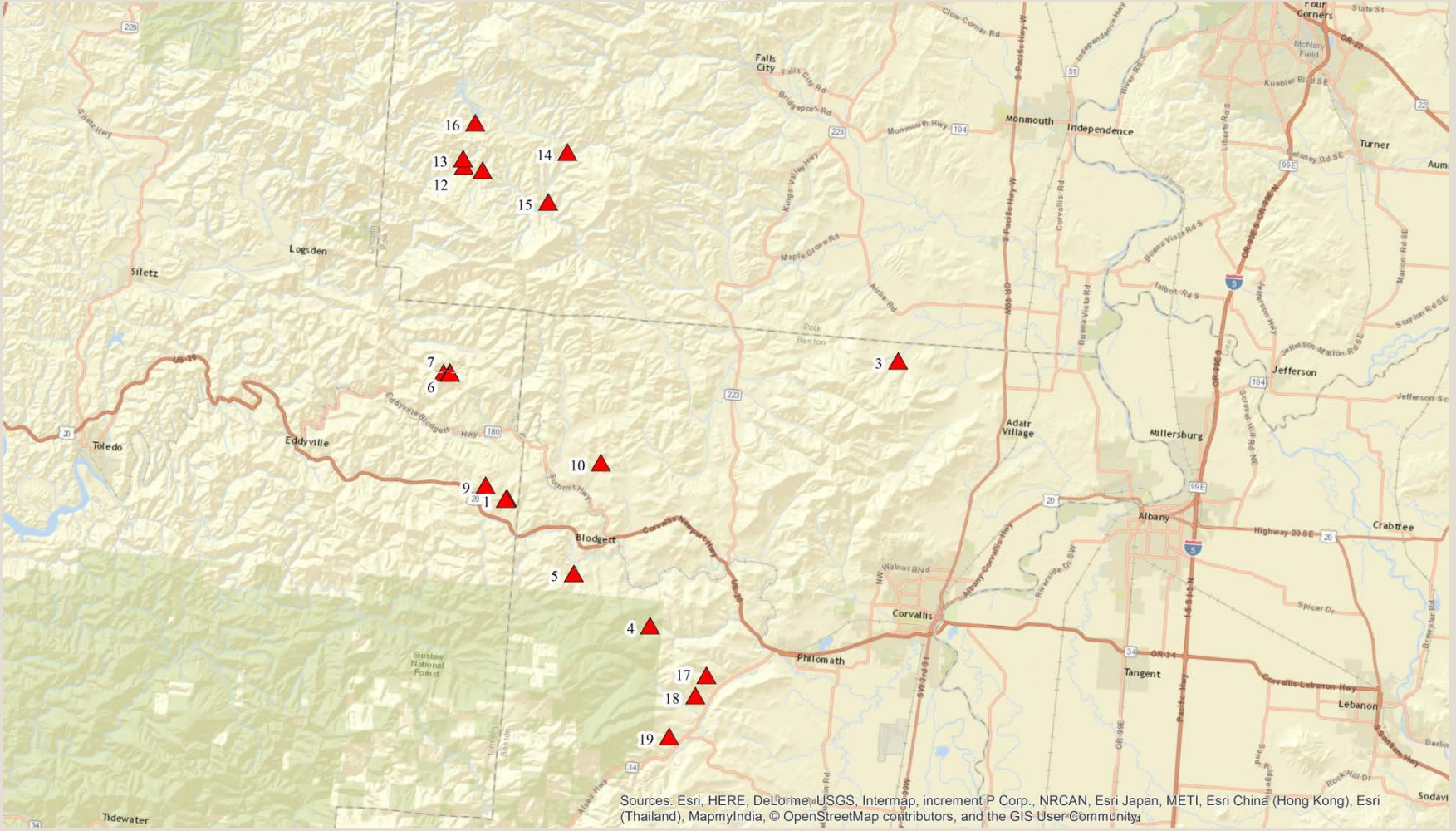
- Bed levels often DO change
  - Similar summertime bed levels are not necessarily indicative of wintertime bed levels
- There is no clear site characteristic related to scour or redeposition
  - Hjulström's Diagram, however, was semi-successful despite required assumptions
- These are very complex systems
  - Affected by measurable and immeasurable variables
- Scour chains hold significant potential for management applications
- Overall, this study brings into question the tools that are currently in use for determining the success of these streambed simulation crossings, and suggests that further efforts be allocated to understand these systems for management and regulatory purposes.


Questions?

Results: Individual Culverts

Background

Site Locations: Oregon



Site Locations: Washington