Analyzing and applying cost information in restoration planning

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Overview of Talk

1. Some theory: What are costs and why do we care
2. Measuring costs: Fish passage case study
3. Early thoughts: Cost information in a 6PPD context

Why is cost information necessary?

Goals of conservation planning:

Provide the **most environmental benefit** for the **least cost**

or…

Achieve **environmental targets** at the **least cost**

or…

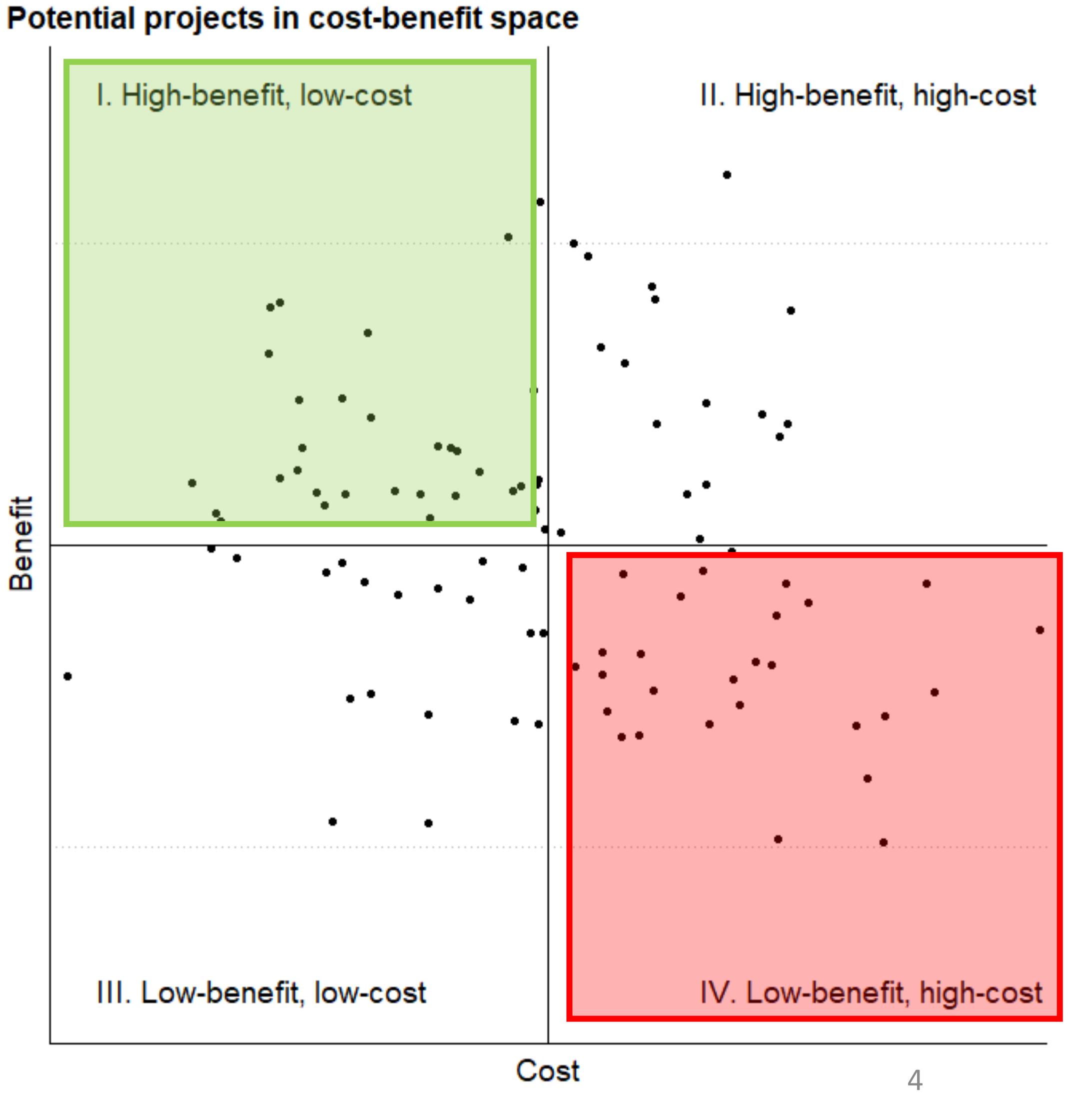
Provide the **most environmental benefit** within **the budget**

*Regardless of formulation, requires knowledge of **costs** and **benefits** of any alternative course of action*

Motivation: When is cost info important?

Goal: **Most benefit** within **budget**

Based on [Babcock et al., 1998, *Land Econ.*]



Recreation of figures from of Babcock et al. (1997)

Motivation:

Systems that favor…

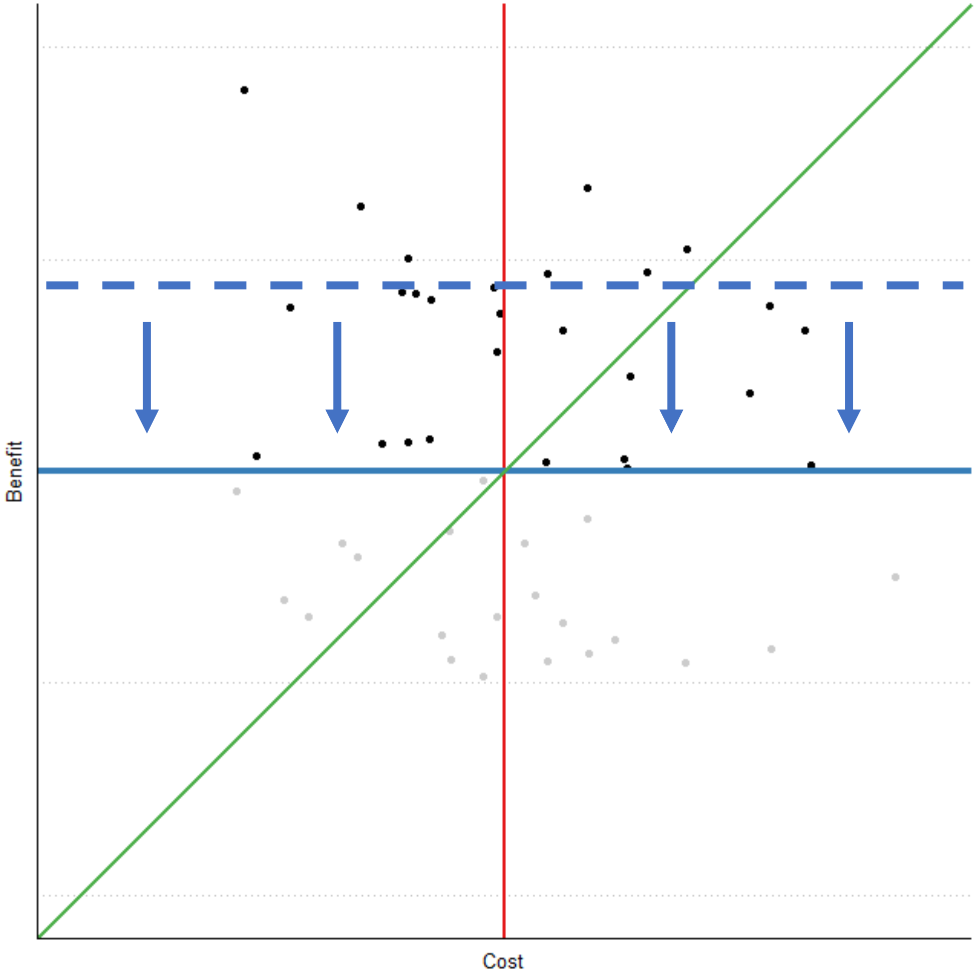
benefits (most habitat first)

vs.

costs (least expensive first)

…will select different projects

Potential projects in cost-benefit space: Benefit (B) targeting



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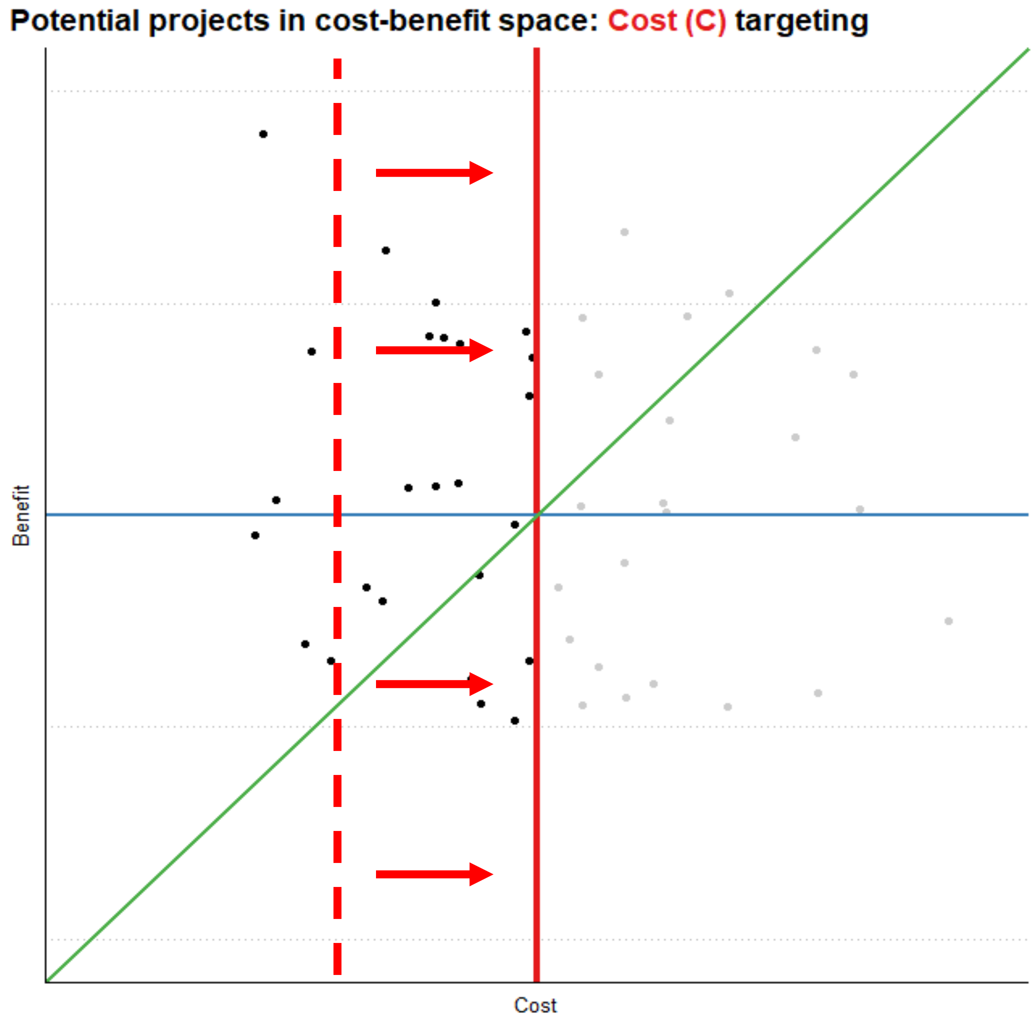

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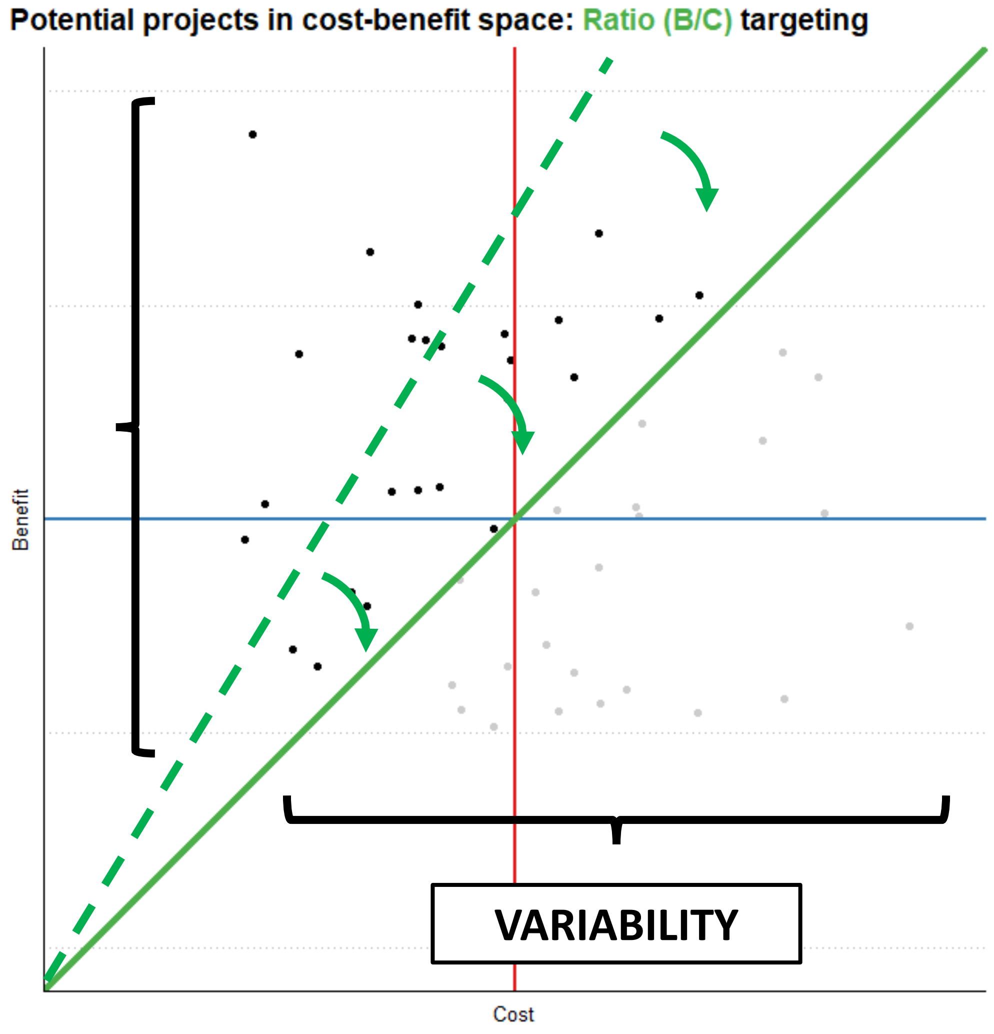
Which is closer to **optimal** (full information) depends on relative **variability**

- High variability means identifying outliers is more important
- Ideally would implement cost screening in areas where costs are highly variable



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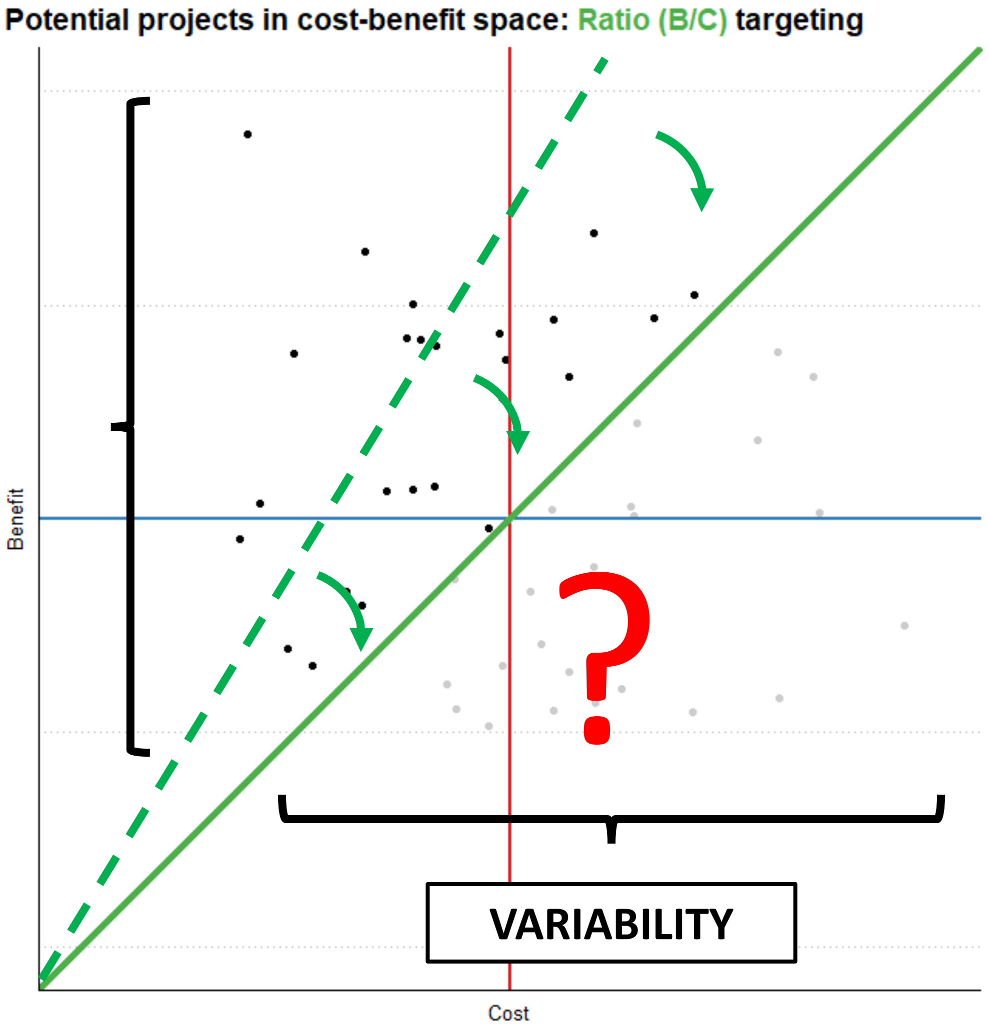

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What are costs?

Types of costs

Planning costs
- Permitting, design, site access

Construction costs 🡐
- Labor, materials, equipment

Opportunity costs
- Other potential uses of space during and following construction

How costs scale

Fixed costs
- Costs that can be shared across multiple sites
- Costs that are the same regardless of project size

Variable costs
- Costs that must be incurred at every site
- Costs that scale with project size

How do costs enter the planning process?

Integrated vs. Parallel Ranking

Integrated:

Directly weighted in priority scoring alongside benefit metrics

Parallel:

Separate analysis compared to benefits in a subsequent process

Early vs. Late

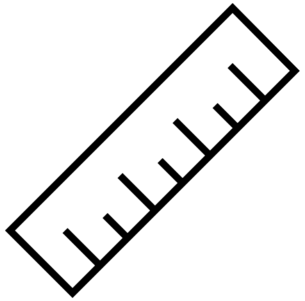
Earlier:

Can give a better idea of long-term budget needs, but data intensive

Later:

Get better picture of costs for fewer projects

Measuring costs



Goal: How much will this project cost? (Loaded question!)

Approaches:

Budgeting vs. Empirical

Are estimates based on input prices or are they based on historical data?

Conditional vs. Unconditional

Do estimates capture environmental variability?

Planning vs. Engineering

How important is precision? Are preliminary designs and field surveys viable for all alternatives?

Key Message: Methods require tradeoffs, match method to needs

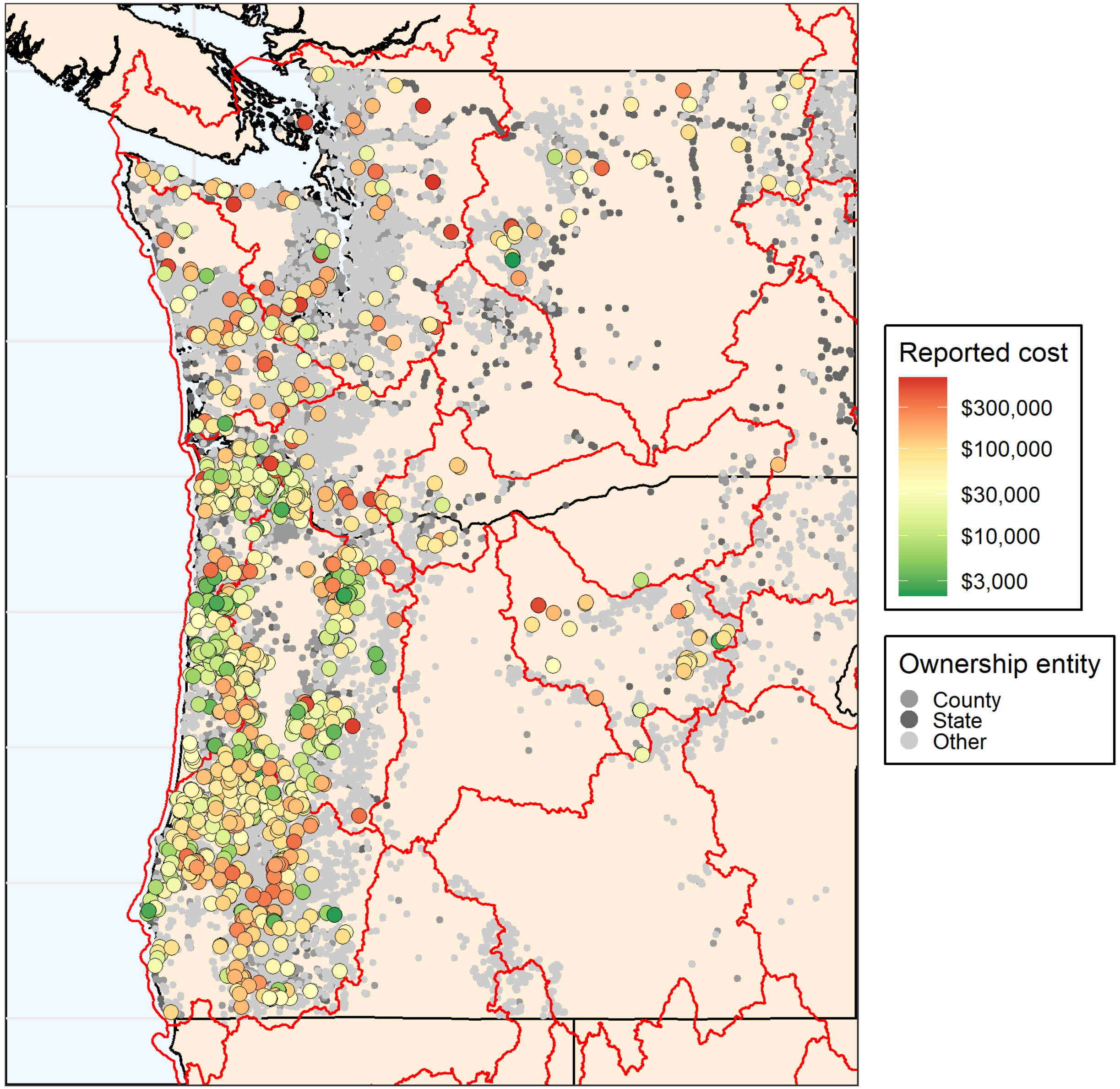
Case Study: Culvert Correction Costs

Data from PNSHP

- NWFSC-maintained clearinghouse for salmon habitat restoration projects
- 15 years of data (`01-`15)
- Lots of data (N = 1,236)

Two modeling approaches

1. ***Drivers:*** multiple linear regression
   - Easily interpretable
   - Good for hypothesis testing
2. ***Predictions:*** boosted regression trees
   - Improved accuracy
   - Incorporates information from 243 explanatory variables



Data Source: PNSHP culvert worksites; costs are in 2019 CPI-adjusted dollars

Based on work by Van Deynze, Fonner, Feist, Jardine, & Holland under revision

Additional Data: What drives culvert costs?

Stream variables: channel slope, bankfull width

Road variables: road material, speed limit class

Terrain variables: terrain slope, elevation, land cover

Property ownership: housing density, distance to urban area, ownership of surrounding property (public/private/industrial)

Nearby suppliers: construction/forestry employment, distance to material/equipment suppliers

Project variables: # of worksites, distance between worksites

Geospatial Data Matching Methods

Streams & Roads: “snap” to nearest line

Terrain: land cover/elevation raster cover

Property: 500m-radius buffer

Suppliers: custom density layer of firms

Cost Drivers:

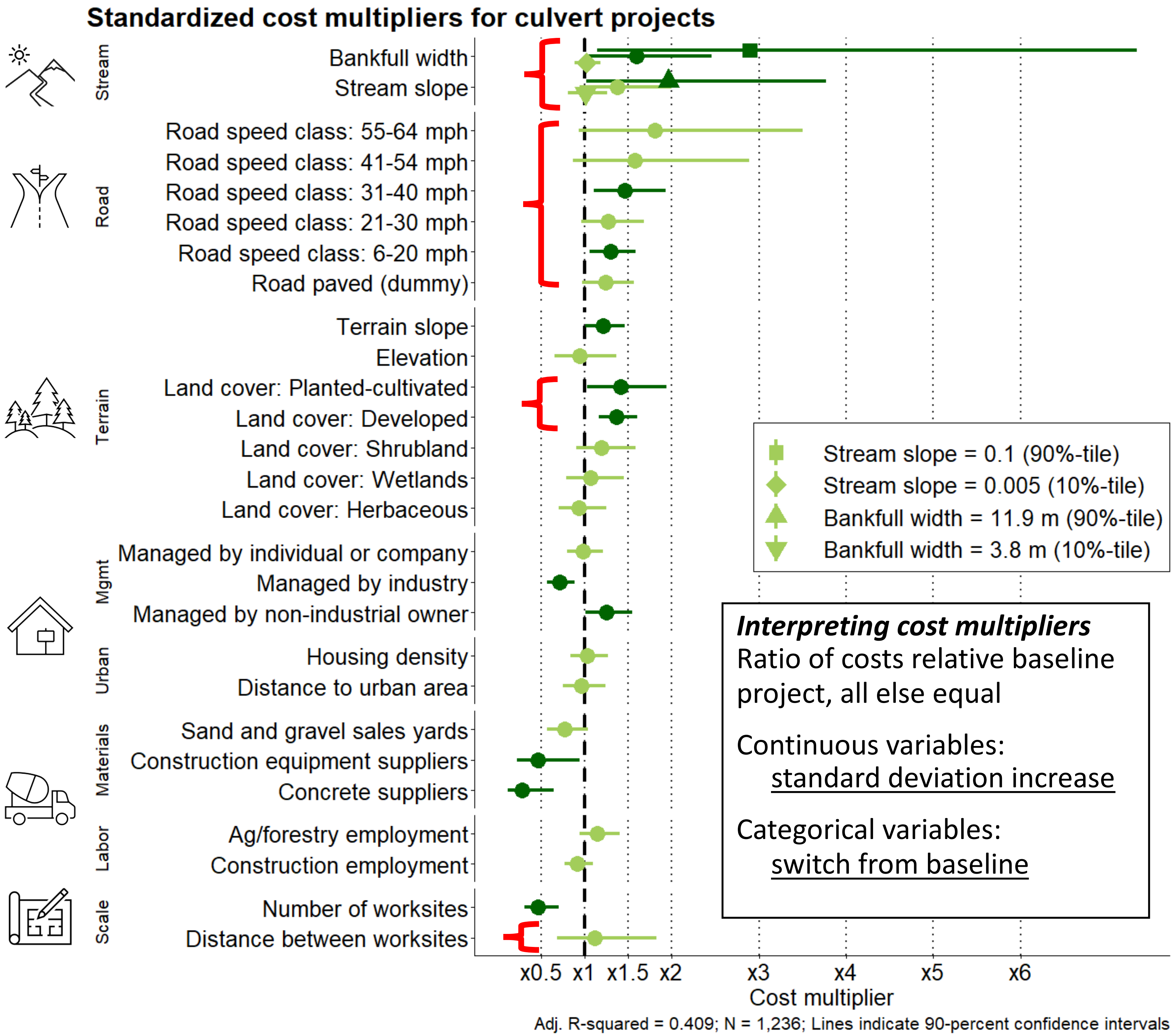
Linear model structure

$$\log(cost_i) = \alpha + \boldsymbol{x_i \beta} + \mu_{year(i)} + \mu_{basin(i)} + \mu_{source(i)} + \varepsilon_i$$

- Fixed effects for:
  - Year
  - Basin (HUC6)
  - Reporting source

Expensive projects

- Steeper & wider streams
- Larger, paved roads
- Surrounded by development, cropland
- Worksites further apart (complexity)



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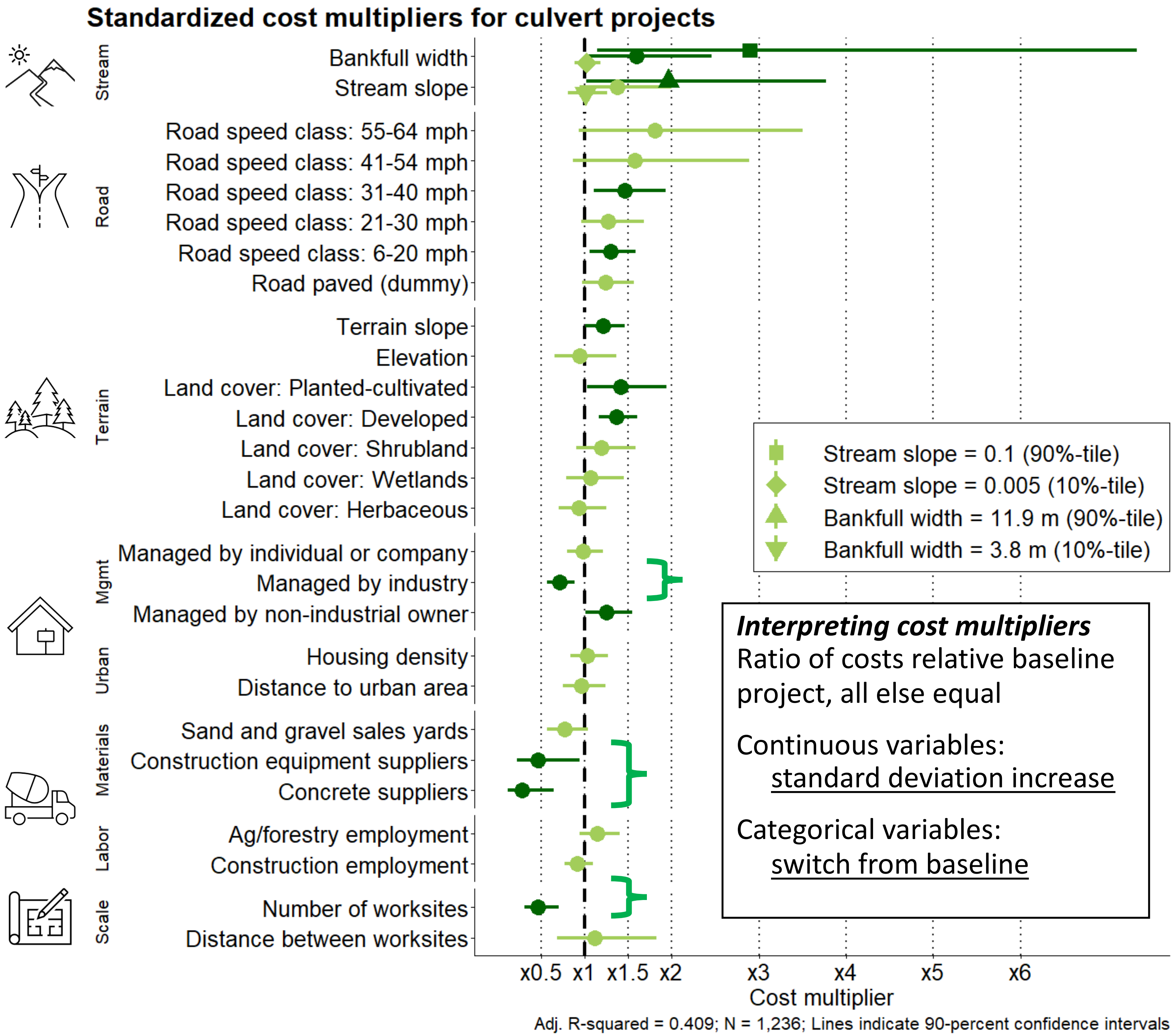
Cheap projects

- Surrounded by private forest
- Close to construction equipment & concrete suppliers
- More worksites (scale economies)



Interpreting cost multipliers
Ratio of costs relative baseline project, all else equal

Continuous variables:
standard deviation increase

Categorical variables:
switch from baseline

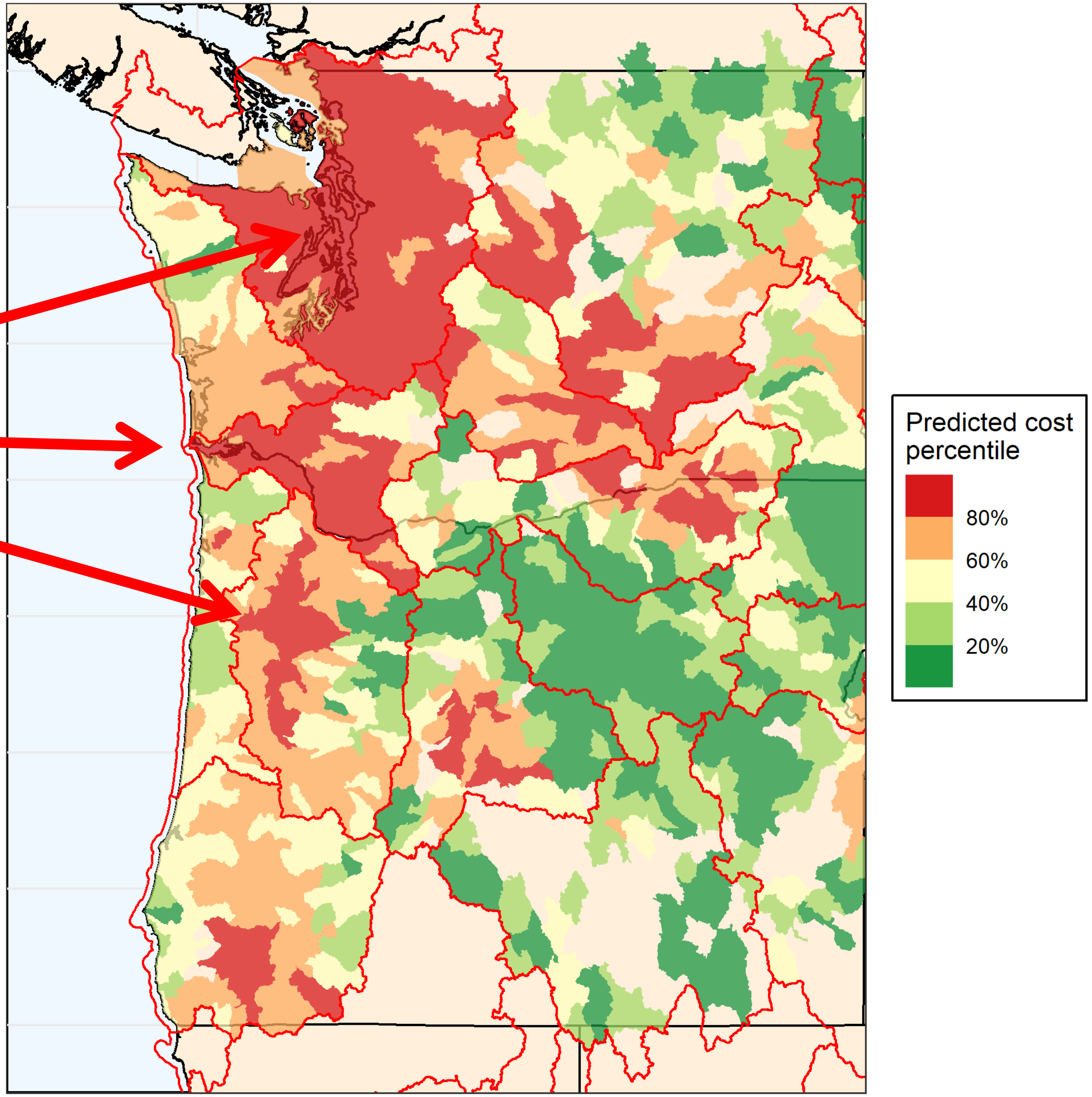
Prediction Results:
Where are culvert improvements more expensive?

Puget Sound, Lower Columbia, Upper Willamette expensive

- Relatively high development
- Larger roads along major interstate corridor

Washington Coastal, Northern Oregon Costal and Eastern Oregon cheaper

- Forest land cover more frequent
- Barriers tend to be on smaller, private roads



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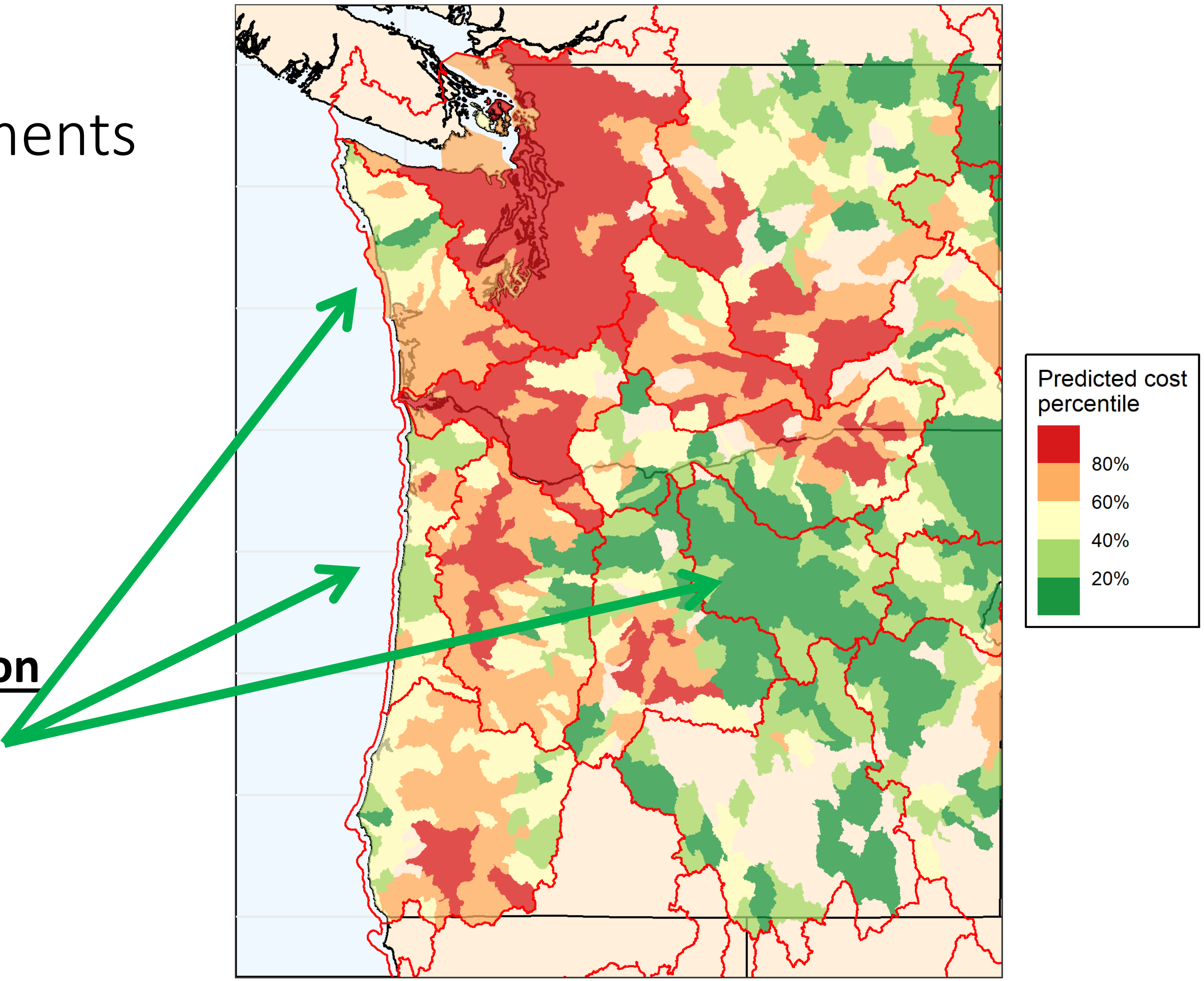

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Costs in a 6PPD Prioritization Context

Challenge: *Still early on in learning about effectiveness of interventions*

→ Not a lot of data from historical projects

→ Best practices may not be universal (costs, benefits, and ratio might vary across practices and environment)

Initial Thoughts:

1. Identify potential cost drivers from other contexts (culverts, road construction)
2. Consider ballpark estimates (relative, ranges) for selected practices in representative context(s)
3. Issue call to track costs consistently and transparently across the state (Iacona et al., 2018, *Cons. Bio.*)

Thank you!

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