Predicting the Freshwater Range of Occurrence for Salmonids to Guide Restoration Efforts in the Chehalis River Basin, WA

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Chehalis Science Symposium January 7, 2020

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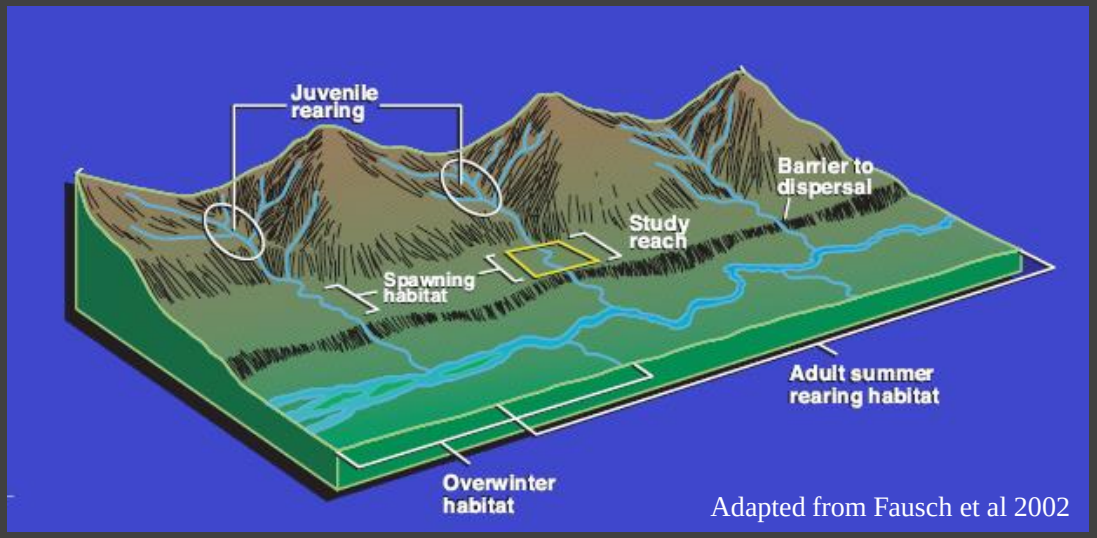
Distribution and fundamental knowledge gaps



Adapted from Fausch et al 2002

- Range of occurrence:→all habitat exploited across freshwater life stages
- Connectivity crucial for species viability

Verh. Internat. Verein. Limnol. 29 123–136 Stuttgart, March 2005

Plenary lecture

The shifting habitat mosaic of river ecosystems

J. A. Stanford, M. S. Lorang, and F. R. Hauer

Restoration connects habitat

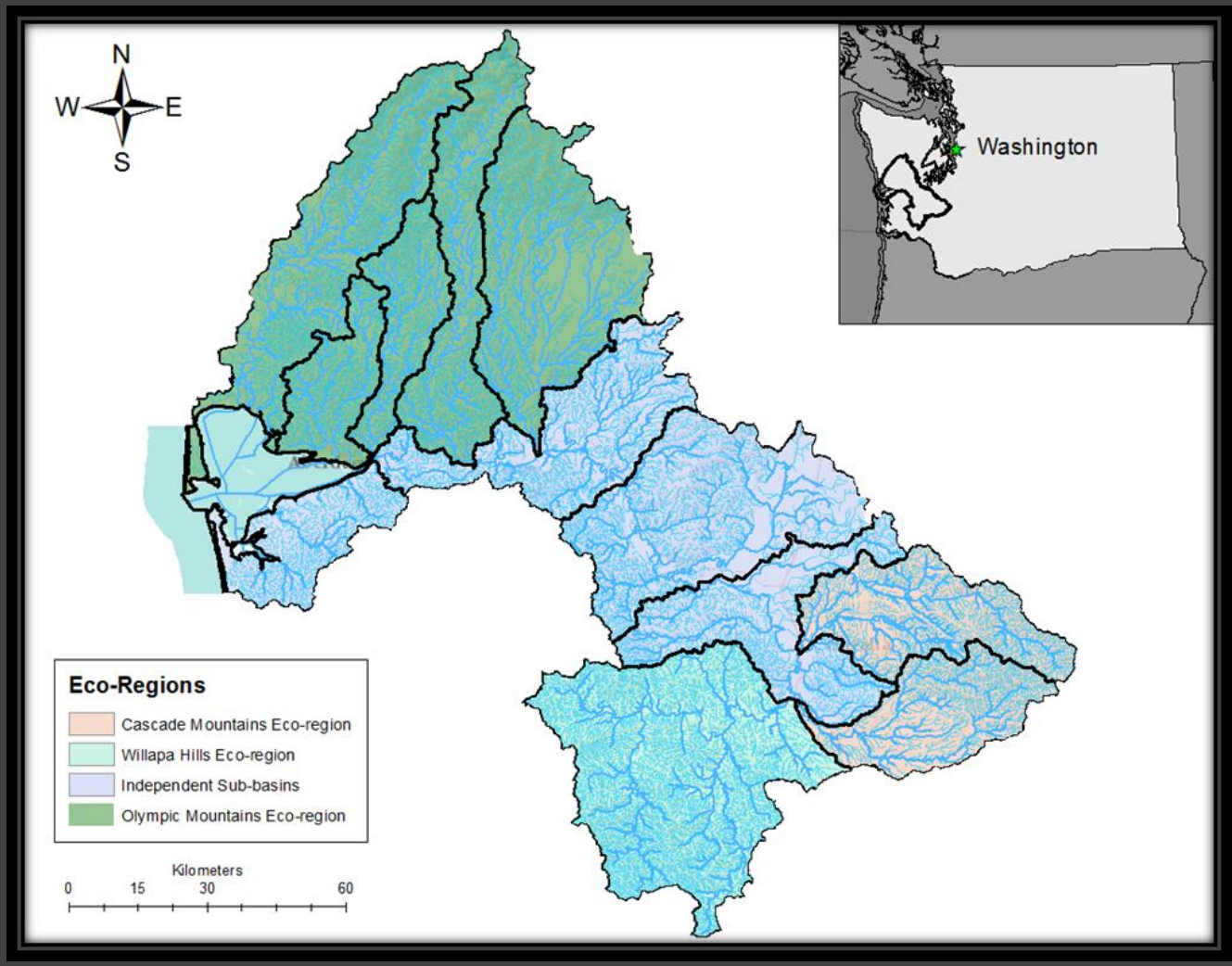
How much habitat are we providing?

Application towards restoration

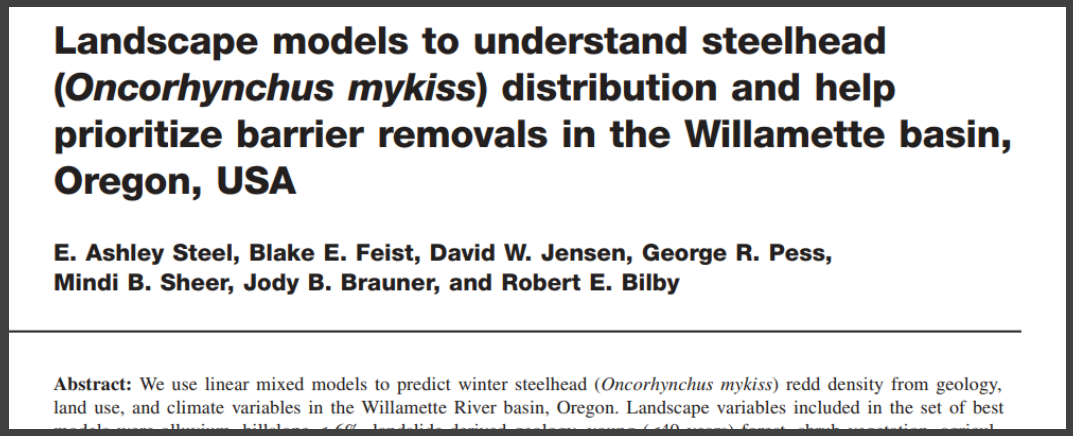
- ASRP modeling to guide large scale restoration efforts
- Output of modeling is highly sensitive to quantity of available habitat
- Current distribution information is from Statewide Washington Integrated Fish Distribution (SWIFD) database

The Chehalis River Basin is a large and diverse watershed

- 6,889 km^2
- 3 dominant eco-regions
- ca. 18,500 linear river kilometers
- Rain dominant hydrology
- Low gradient



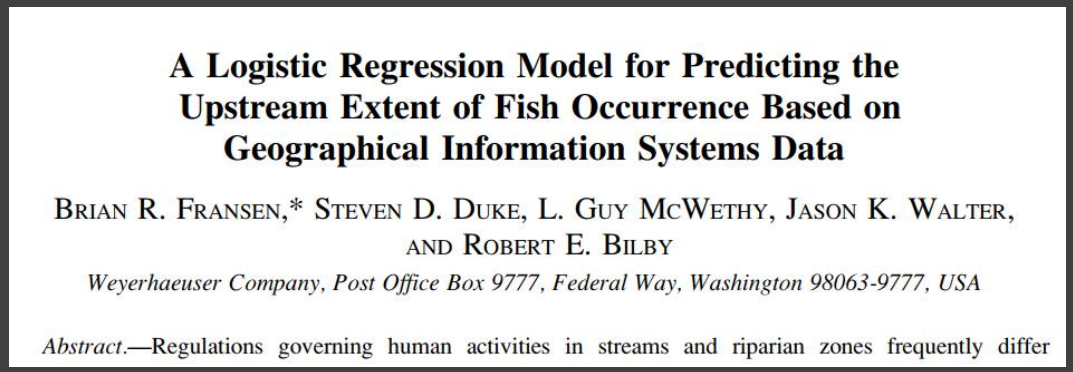
Landscape features associated with local stream characteristics



Landscape models to understand steelhead (*Oncorhynchus mykiss*) distribution and help prioritize barrier removals in the Willamette basin, Oregon, USA

E. Ashley Steel, Blake E. Feist, David W. Jensen, George R. Pess, Mindi B. Sheer, Jody B. Brauner, and Robert E. Bilby

Abstract: We use linear mixed models to predict winter steelhead (*Oncorhynchus mykiss*) redd density from geology, land use, and climate variables in the Willamette River basin, Oregon. Landscape variables included in the set of best



A Logistic Regression Model for Predicting the Upstream Extent of Fish Occurrence Based on Geographical Information Systems Data

BRIAN R. FRANSEN,* STEVEN D. DUKE, L. GUY MCWETHY, JASON K. WALTER, AND ROBERT E. BILBY

Weyerhaeuser Company, Post Office Box 9777, Federal Way, Washington 98063-9777, USA

Abstract.—Regulations governing human activities in streams and riparian zones frequently differ

- Can't survey all habitat
- Relationship varies among watersheds → need watershed specific models
- Empirically based

We expect there to be a relationship between **landscape characteristics** and the **range of occurrence**

Predicted relationships: range of occurrence and landscape

Landscape characteristic	Expected biological response
Drainage Area (km^2) 	↑
Mean Annual Precipitation (cm/yr) 	↑
Stream channel slope (%) 	↓
Elevation (m) 	↓
Geology type 	↓ ↑
Wetland presence 	↓

Project Objectives

1) Document the upper limit of occurrence (ULO)

Coho

Steelhead

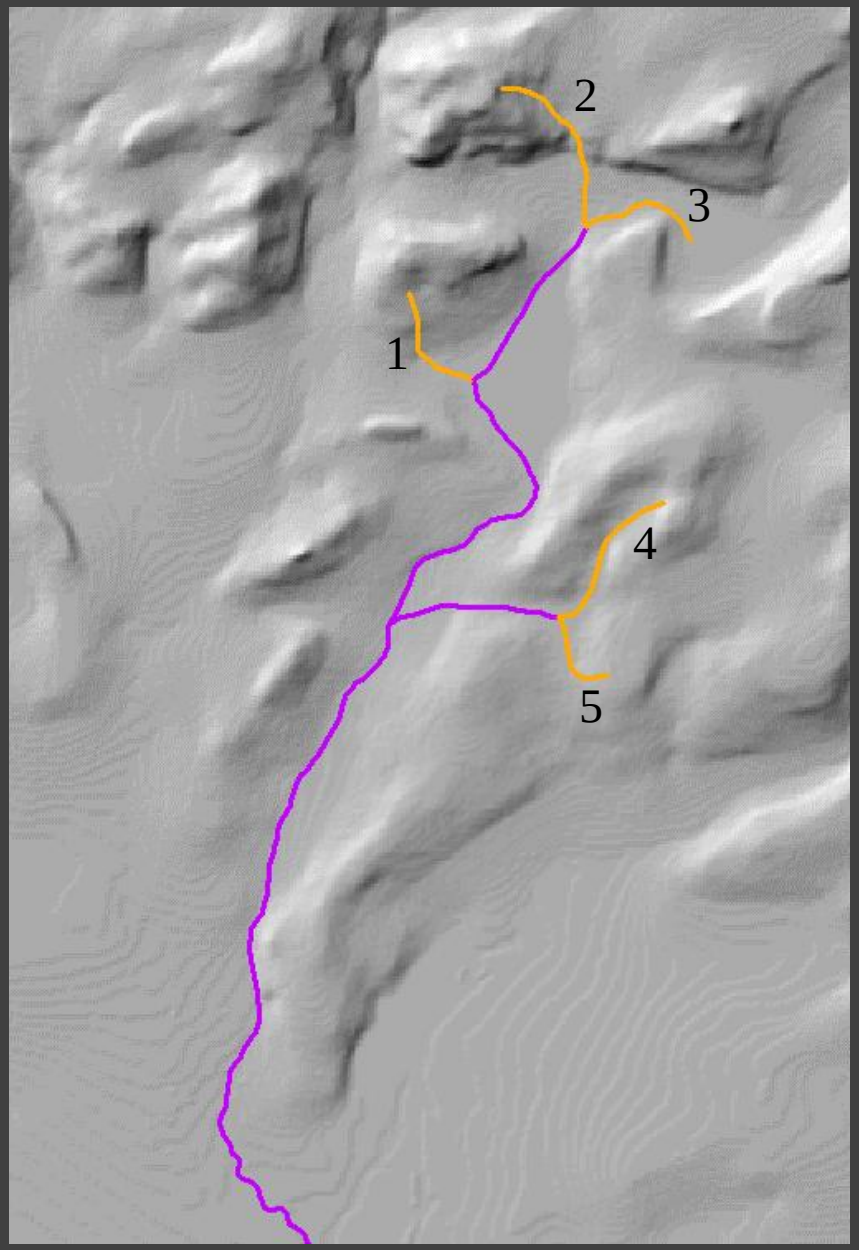
Chum

2) Link range of occurrence to landscape characteristics

3) Predict range of occurrence across basin

4) Compare to current assumed range

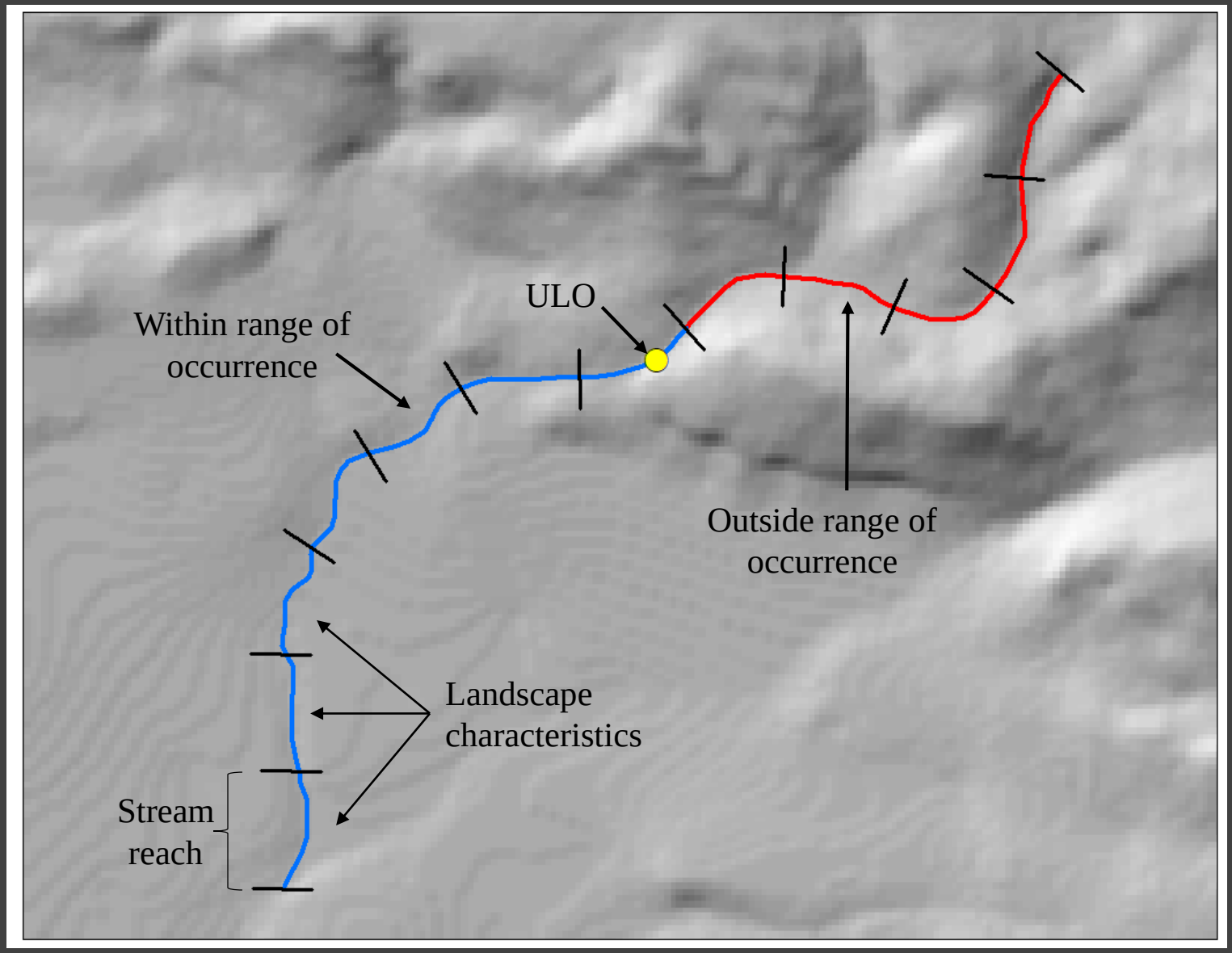
Documenting the ULO in the field



- Surveyed terminal streams
- Random selected and spatially balanced

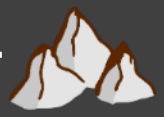
Documenting the ULO in the field

- Redd surveys
- Consistent criteria


ULO
Within range of occurrence
Outside range of occurrence
Landscape characteristics
Stream reach

$$log\left(\frac{\pi_{ik}}{1-\pi_{ik}}\right) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + Geo_j + Wet_w + a_k$$







Fixed effects

Random

Drainage Area (km^2)

Elevation (m)

Slope (%)

Mean Annual Precipitation (cm/yr)

Geology type

Wetland presence

Sub-basin

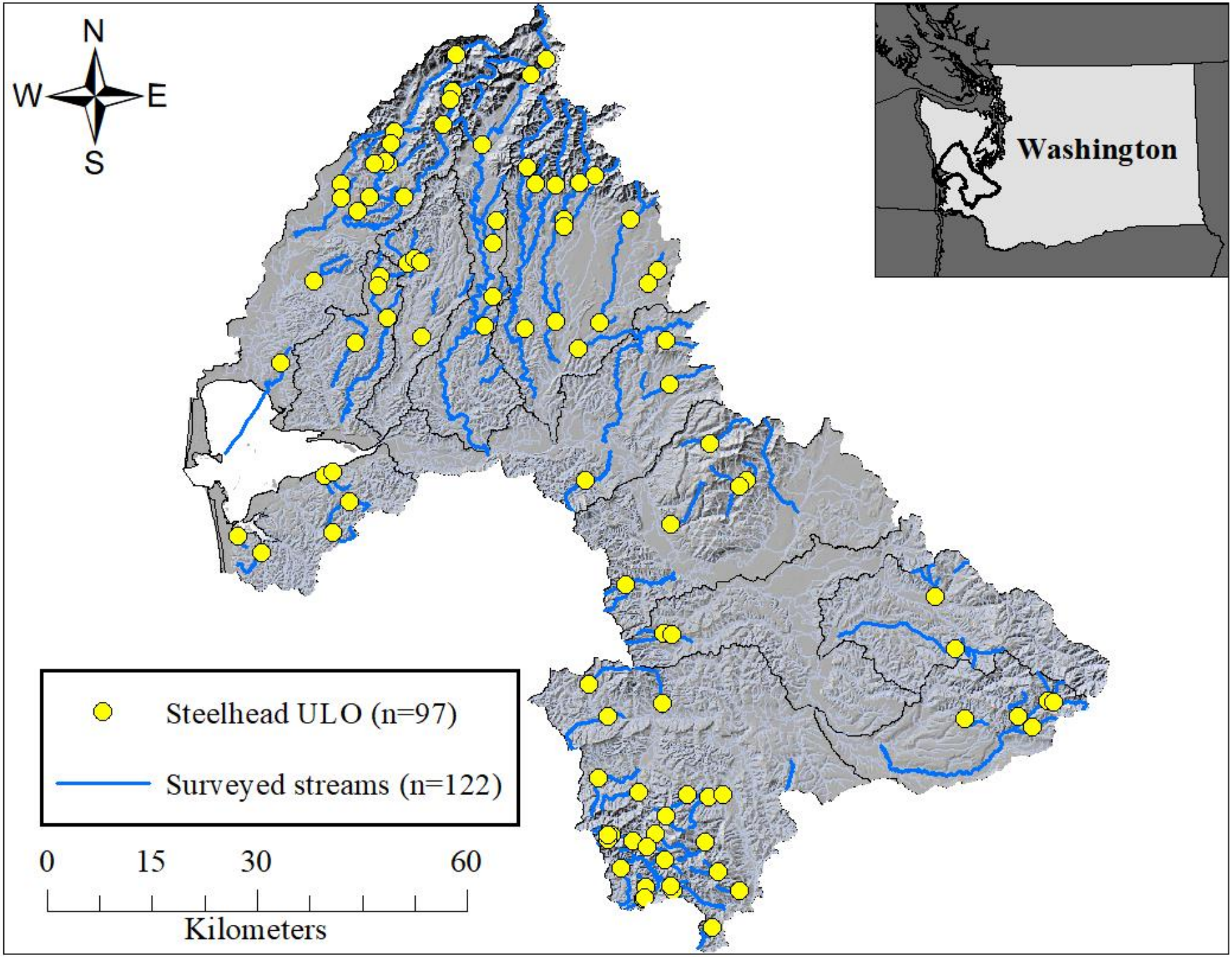
Cross validation for model selection

Specificity 

Sensitivity 

Percent Correct Classification 

Area under the receiver operating characteristic curve (AUC)

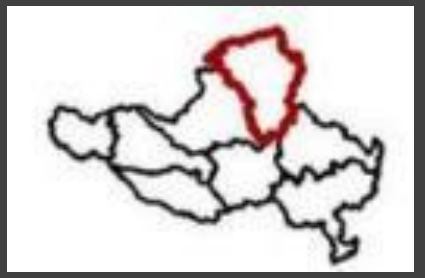

N
W
E
S
Washington
Steelhead ULO (n=97)
Surveyed streams (n=122)
0
15
30
60
Kilometers

Best performing model included drainage area and elevation

=

+

+



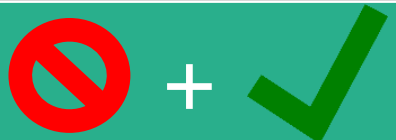
Fixed effects

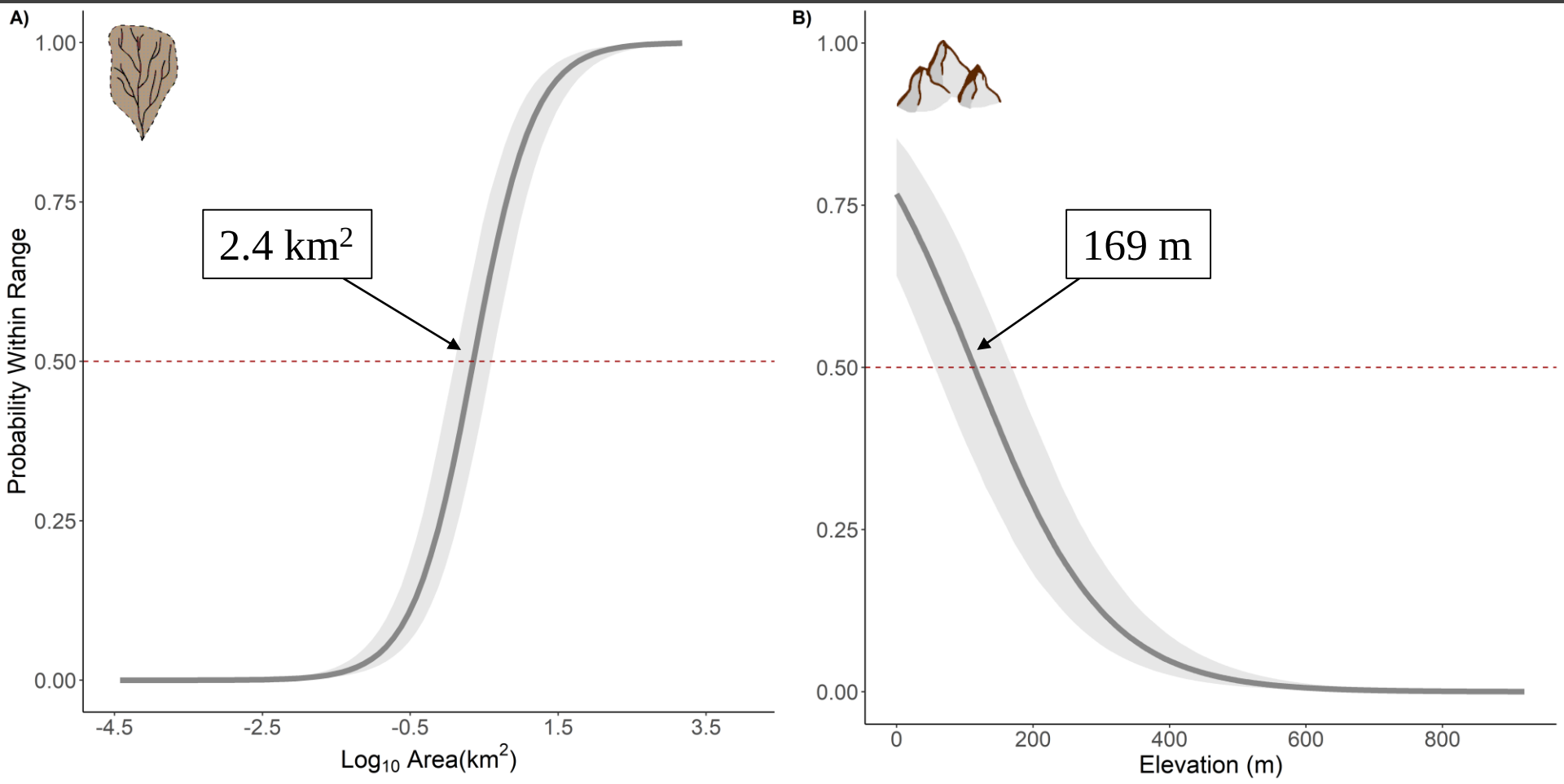
Random

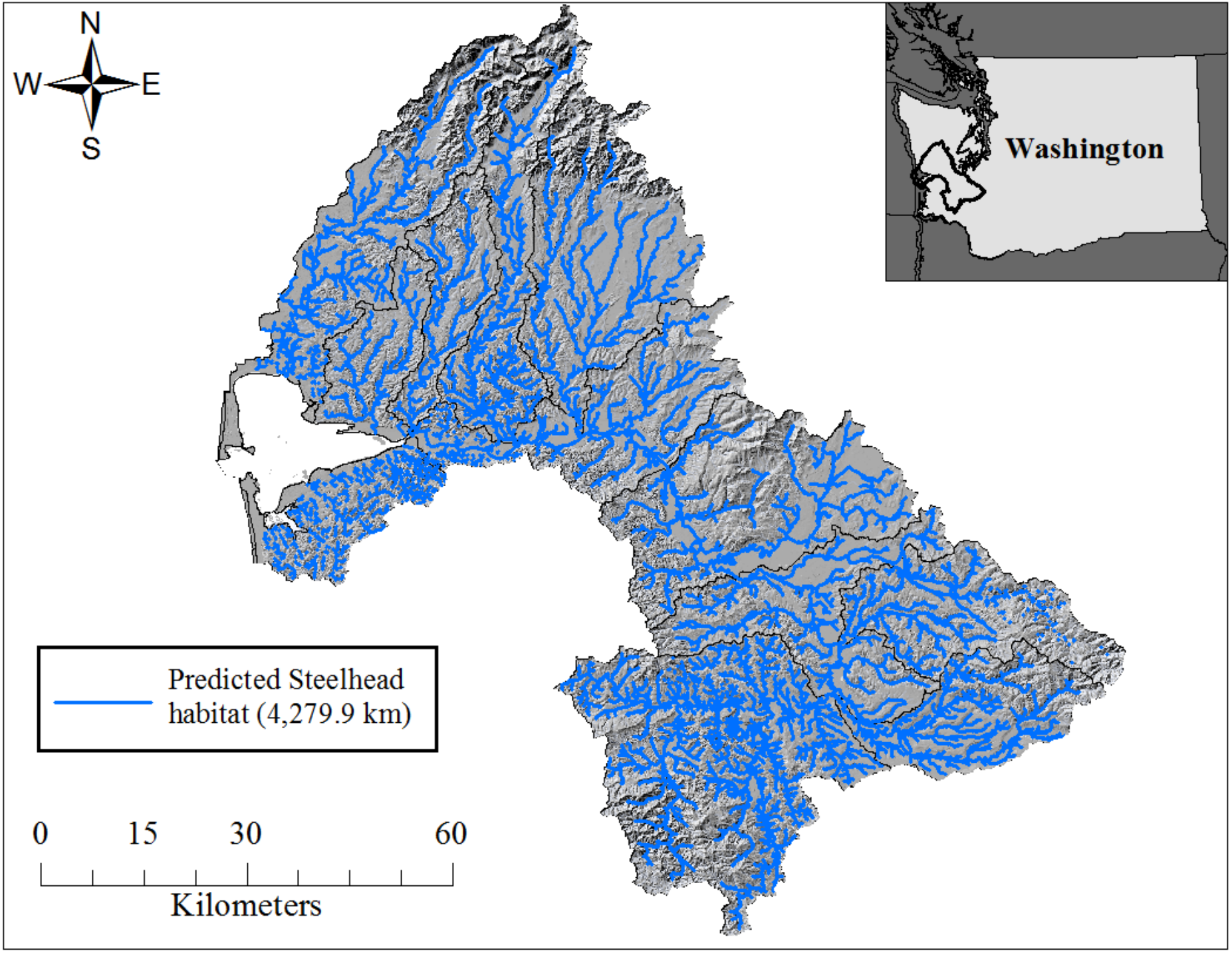
Drainage Area (km^2)

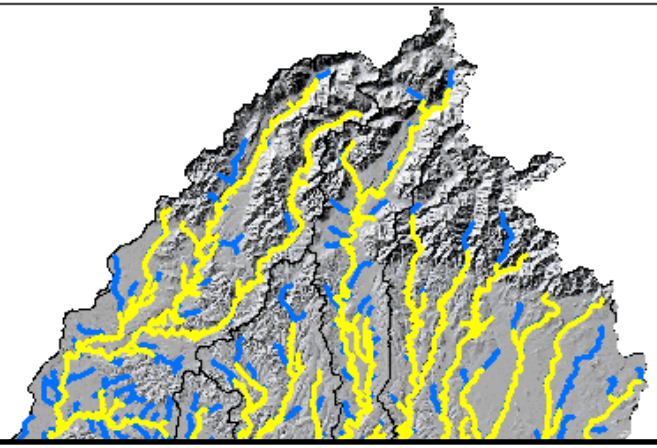
Elevation (m)

Sub-basin

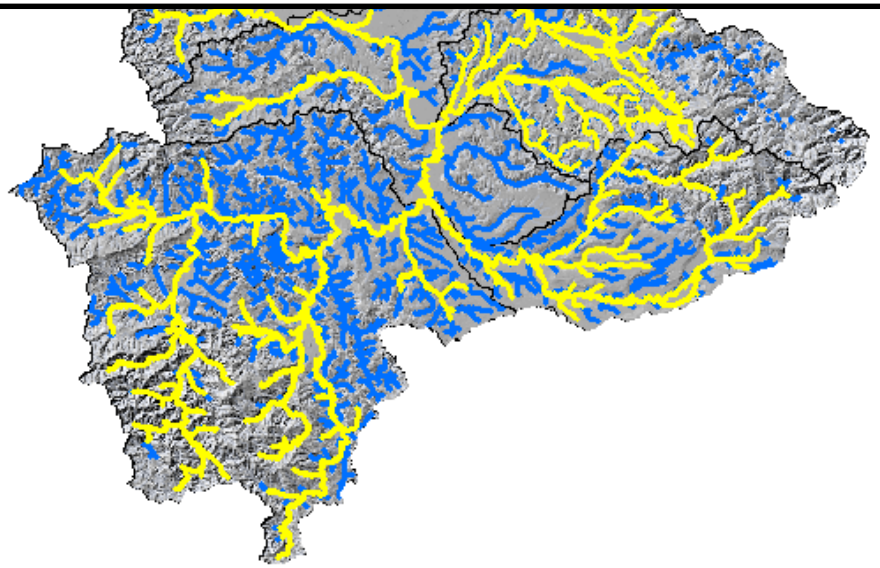
			**AUC**
83.8% ± 1.3%	88.0% ± 1.3%	86.1% ± 0.8%	92.4% ± 0.6%


A)
1.00
0.75
0.50
0.25
0.00
Probability Within Range
2.4 km2
-4.5
-2.5
-0.5
1.5
3.5
Log10 Area(km2)
B)
1.00
0.75
0.50
0.25
0.00
169 m
0
200
400
600
800
Elevation (m)


N
W
E
S
Washington
Predicted Steelhead habitat (4,279.9 km)
0
15
30
60
Kilometers



Twice as much potential steelhead habitat than currently being considered for restoration



Predicted Steelhead habitat (4,279.9 km)

SWIFD Steelhead distribution (2117.8 km)

0 15 30 60

Kilometers

? Distribution identified as data gap in Chehalis

2x amount of potential steelhead habitat

Pairing updated distribution information with identified core habitat and abundance data can improve effective prioritization of restoration projects

Take Home

- Necessary first step
- Species and basin specific response to landscape
- Modeling effective approach

Next Steps

- Refine models
- Quantify habitat gained from culvert correction
- Compare among species

Acknowledgments

WDFW:

Marisa Litz

Arleta Agun

Thomas Buehrens

Amy Edwards

Curt Holt

Jenny Kordosky

Dan Rawding

Nick Vanbuskirk

John Winkowski

Marie Winkowski

ELC unit

Fish Passage team

UAF:

Donnie Arthur

Jeff Falke

Julia McMahon

SEEC Lab

NOAA:

Tim Beechie

Gus Seixas

Funding: Washington State legislature

Field technicians: Jarrod Box, Keith Brady, Brady Green, Sebastian Ford, Joe Kalish, Kate McLaughlin, Callie Miller, Justin Miller-Nelson, Jonathan Ofiara, Brent Trim, Nick Wegener, Jocelyn Wensloff, Megan Wusterbarth

Land access: Weyerhaeuser, Rayonier, Green Diamond, Port Blakely, Campbell Global, Anderson Middleton, Grays Harbor County, DNR, Sierra Pacific, Hancock, and many private landowners

Questions

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