Evaluating the Potential of Lidar to Improve the Stream Typing Model

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Natural Resource Spatial Informatics Group
Precision Forestry Cooperative
University of Washington

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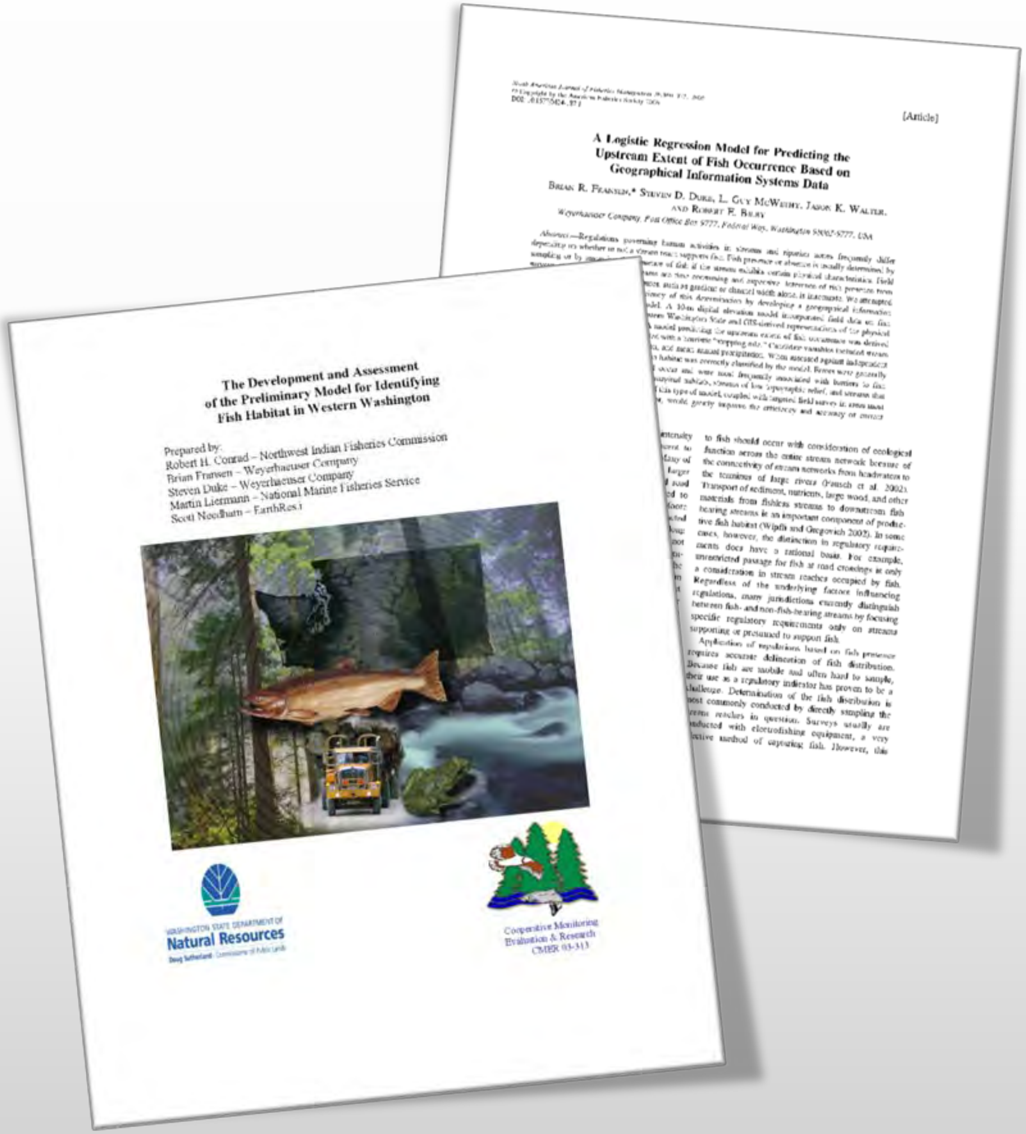
Background


[Article]

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

The Development and Assessment of the Preliminary Model for Identifying Fish Habitat in Western Washington

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Robert H. Conrad – Northwest Indian Fisheries Commission
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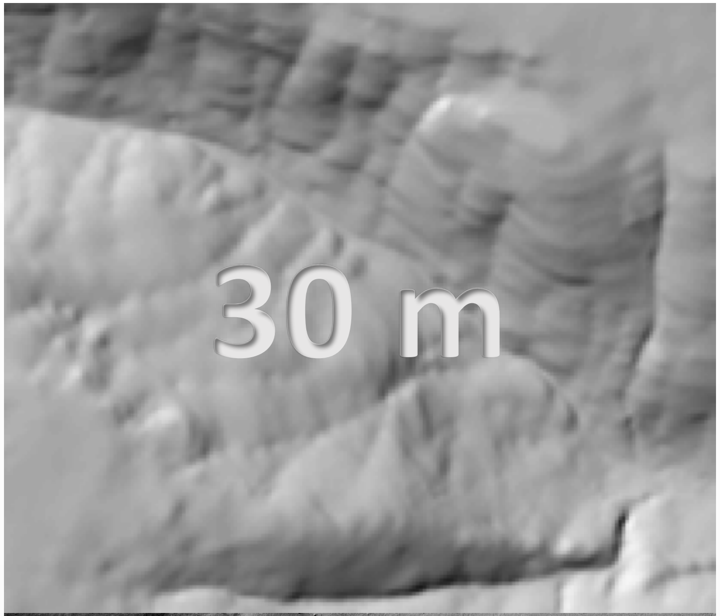
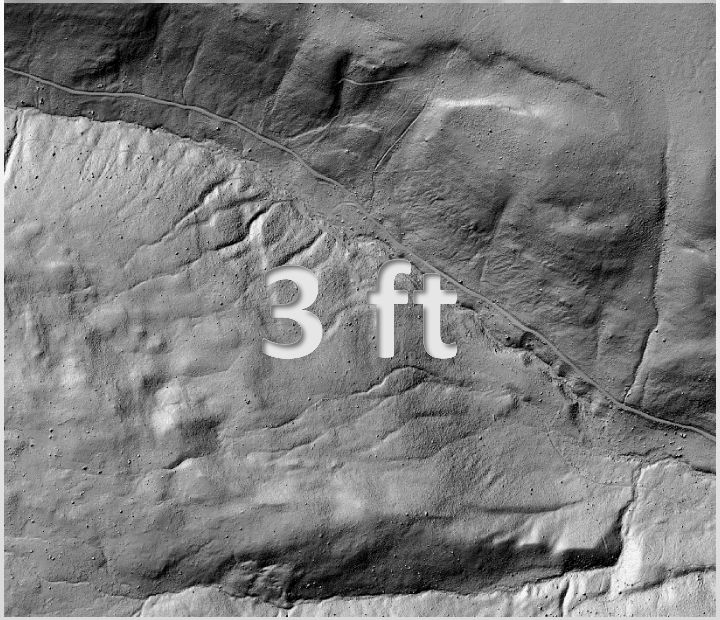
Steven Duke – Weyerhaeuser Company
Martin Liermann – National Marine Fisheries Service
Scott Needham – EarthRes.

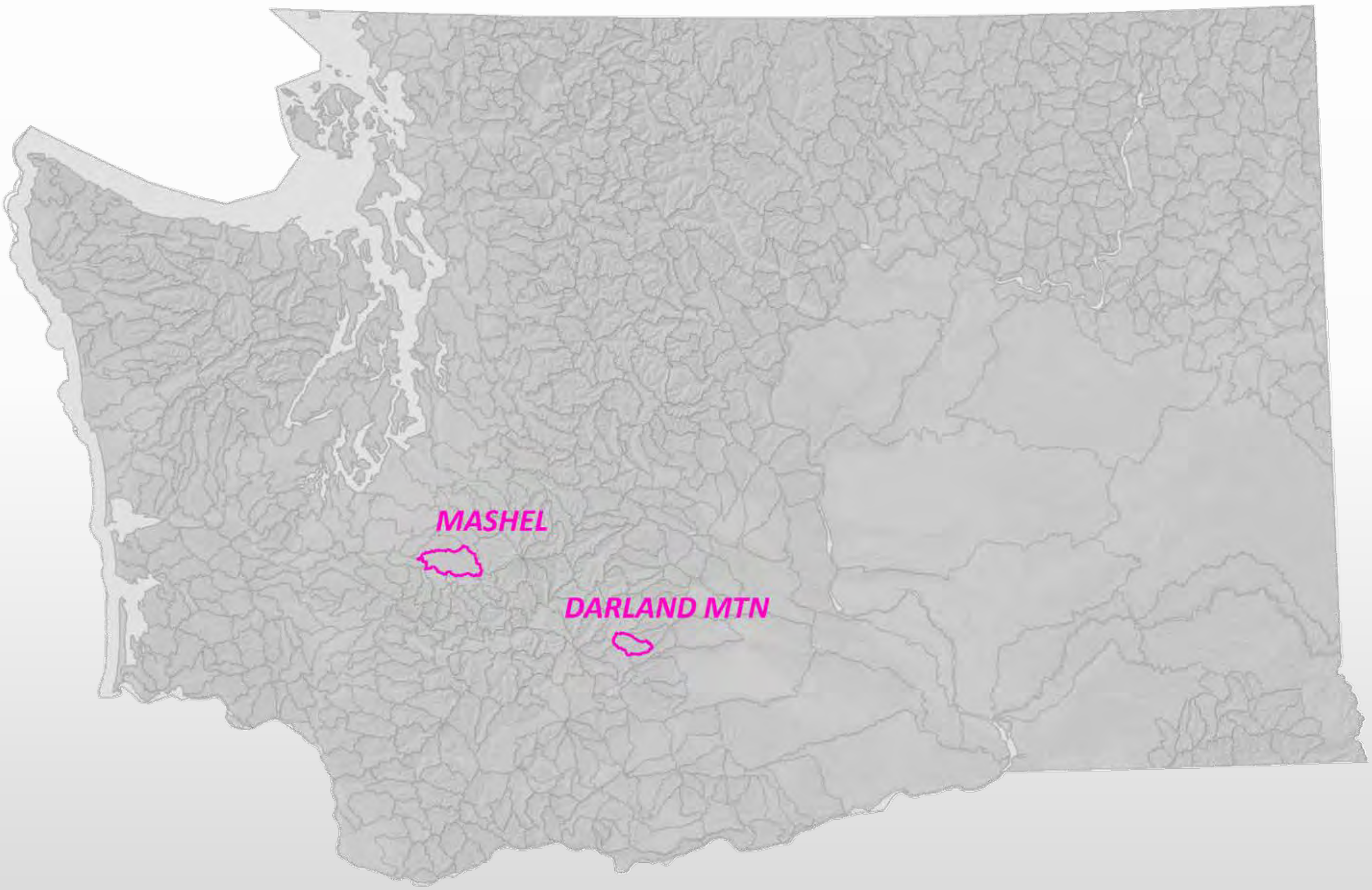
Washington State Department of Natural Resources

Cooperative Monitoring Evaluation & Research
CMER 03-313





Geography & Data



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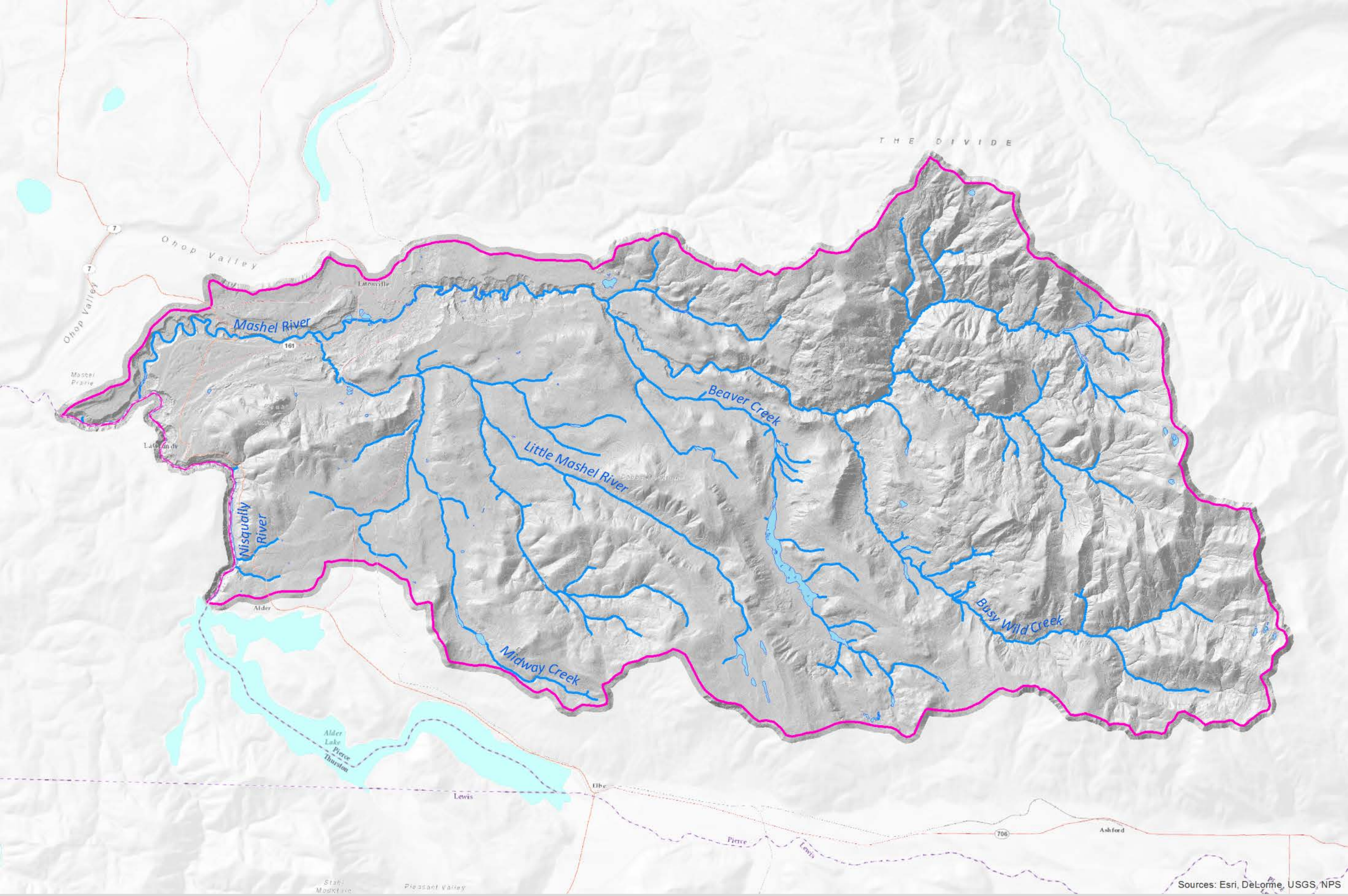
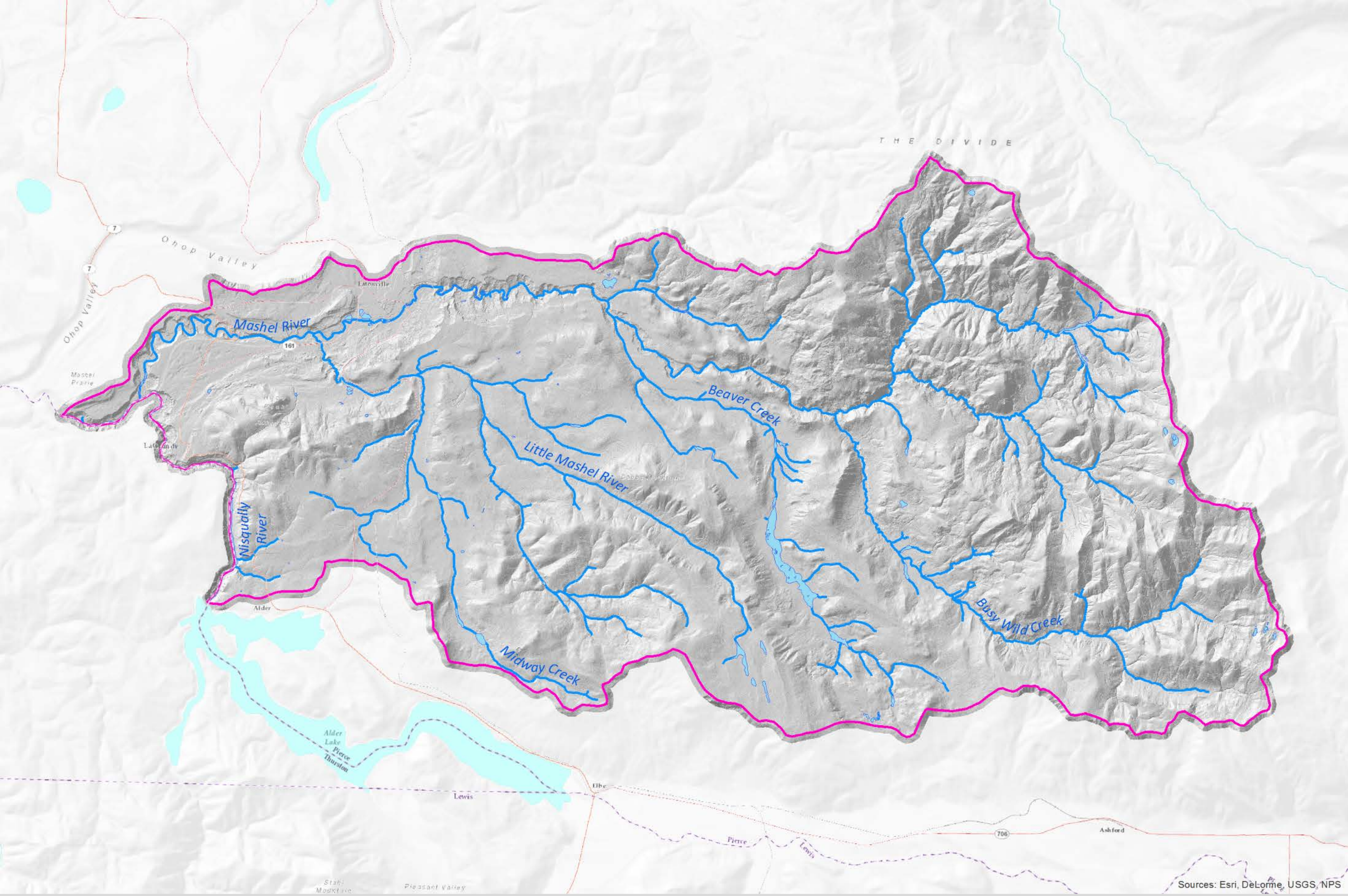

THE DIVIDE
Ohop Valley
Mashel River
Beaver Creek
Little Mashel River
Nisqually River
Midway Creek
Busy Wild Creek
Eatonville
Alder
Alder Lake
Pierce
Thurston
Lewis
Elbe
Ashford
Pleasant Valley
Sources: Esri, DeLorme, USGS, NPS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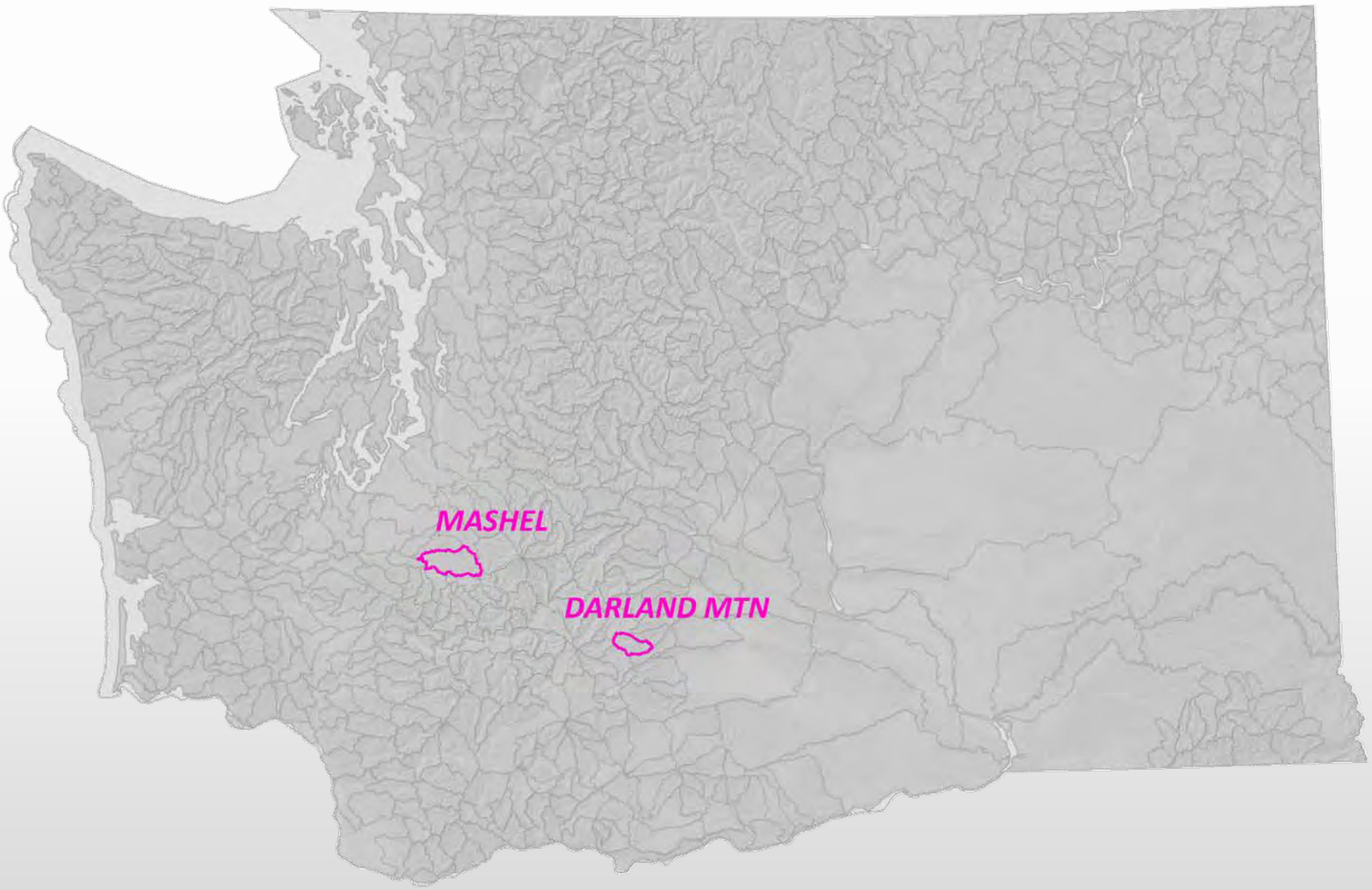

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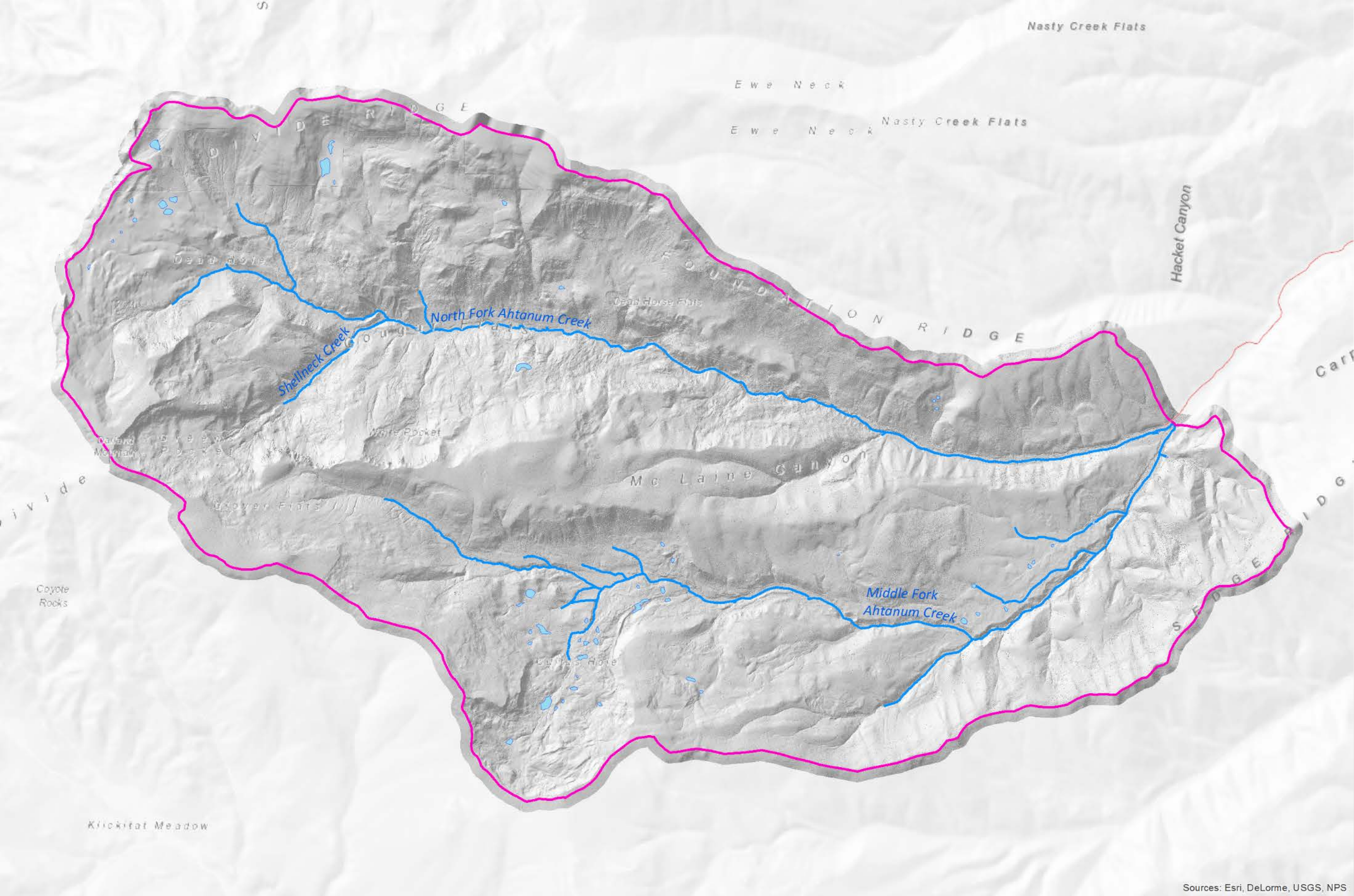
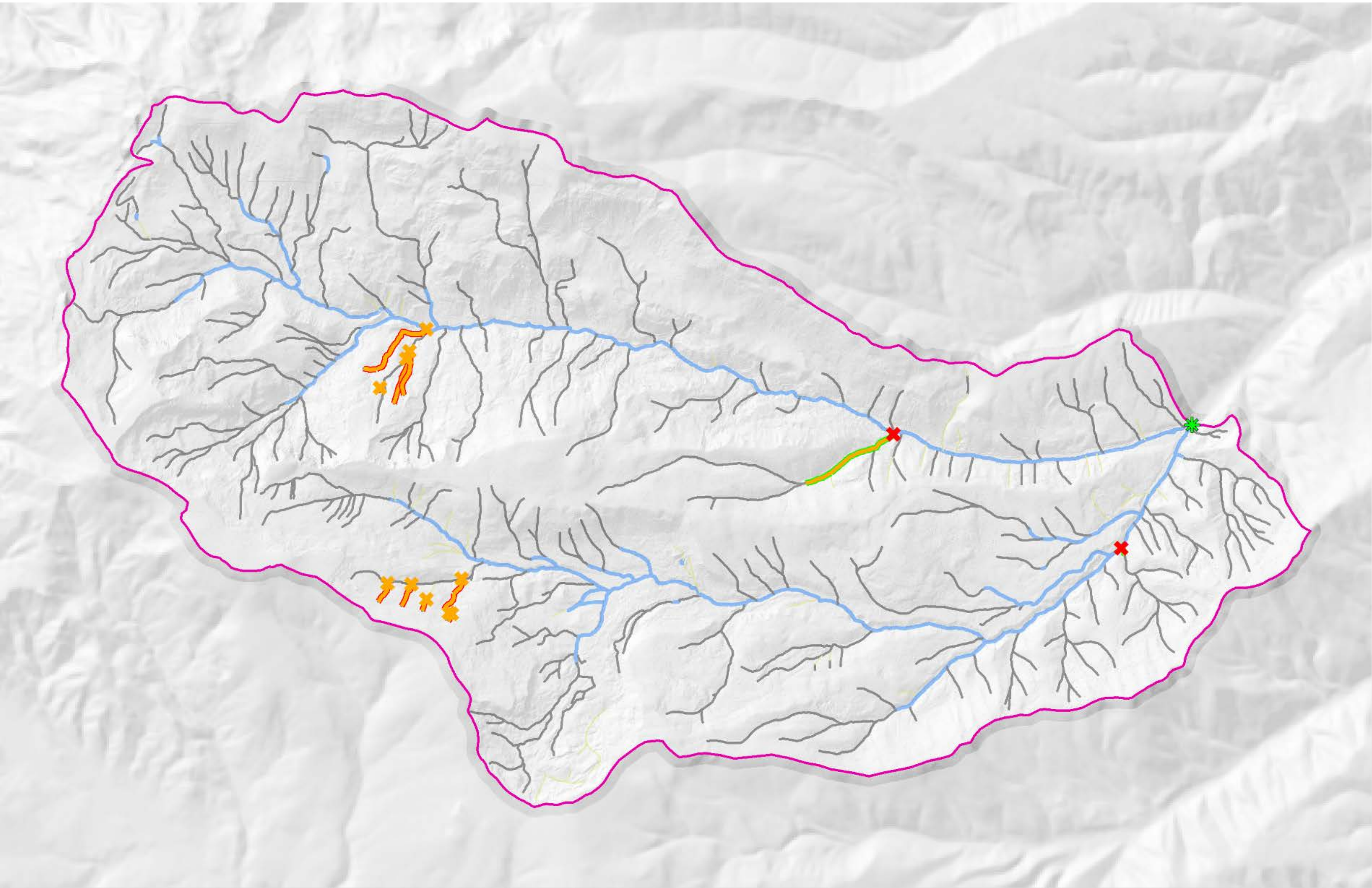

Nasty Creek Flats
Ewe Neck
Ewe Neck
Nasty Creek Flats
Hacket Canyon
DIVIDE RIDGE
FOUNDATION RIDGE
North Fork Ahtanum Creek
Shellneck Creek
Dead Horse Flats
White Pocket
Mc Laine Canyon
Middle Fork
Ahtanum Creek
Coyote
Rocks
Klickitat Meadow
Sources: Esri, DeLorme, USGS, NPS

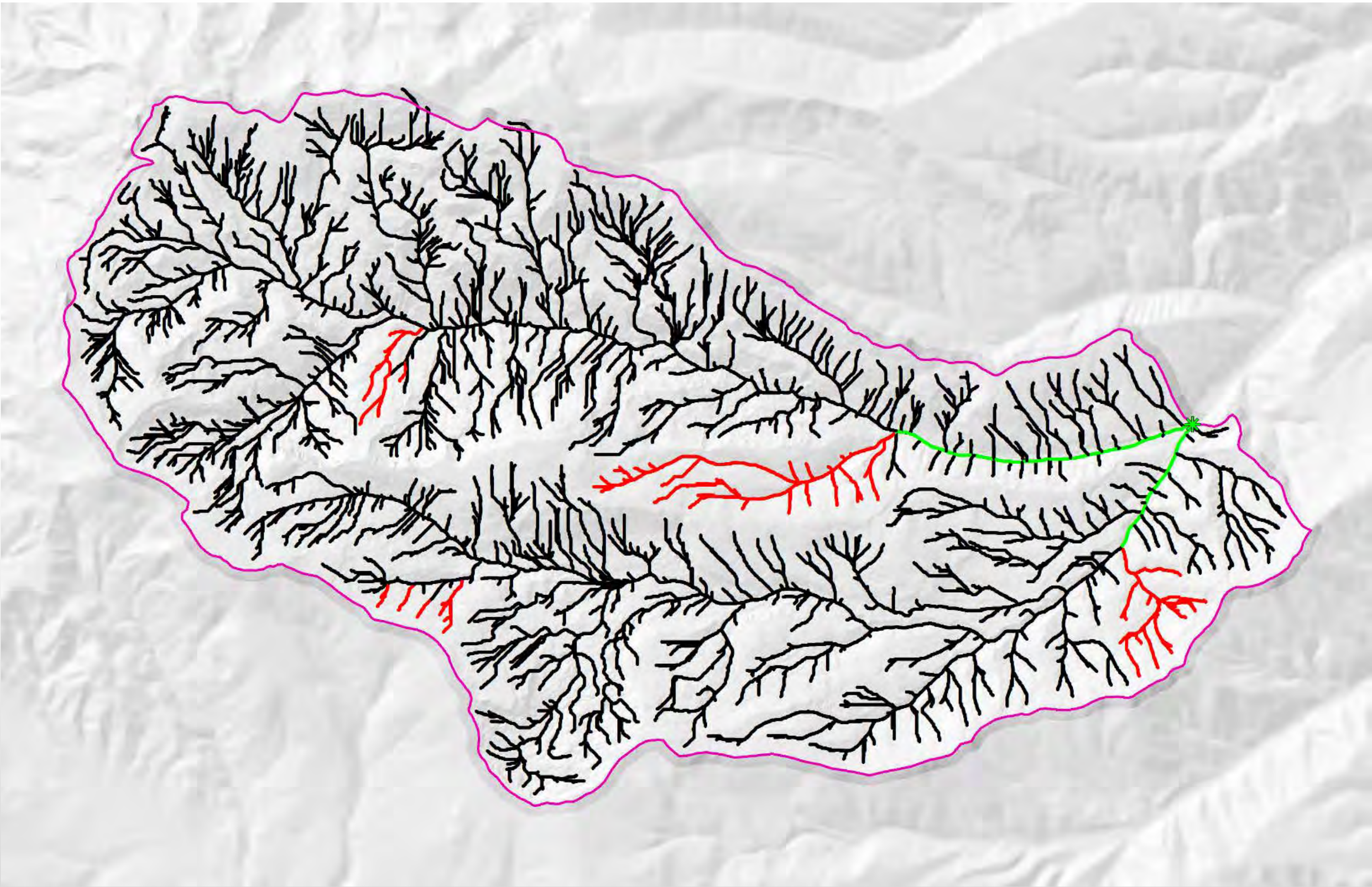
Methodology

- Task 1: Build Digital Elevation Models (DEM)
- Task 2: Generate streams
- Task 3: Create points at 10 meter spacing along streams
- Task 4: Attribute stream points with independent variables
  - basin area, basin weighted precipitation, upstream and downstream gradients, elevation and measurement and processing variables (stream mile, stream order)
- Task 5: Digitize end-of-fish points from DNR Water Type Modification forms
- Task 6: Run logistic regression model to predict fish presence probability
- Task 7: Run stopping rule using a “cut point” and “block size” to predict fish presence/absence
- Task 8: Generate maps and descriptive statistics

Darland Mtn Field Data



Darland Mtn Validation Data



Darland Mtn Results

Logistic Model

DEM	Correct	Over	Under
LIDAR			
3	99.80%	0.00%	0.20%
10	98.99%	0.84%	0.18%
30	98.92%	0.93%	0.15%
USGS			
30	98.26%	1.74%	0.00%

Stopping Rule

DEM	Correct	Over	Under
LIDAR			
3	99.83%	0.00%	0.17%
10	99.83%	0.00%	0.17%
30	99.90%	0.10%	0.00%
USGS			
30	96.46%	3.54%	0.00%

Stream Type	Field Verification Method	# WTMF
Non-Fish	Biological	2
Non-Fish	Physical	10

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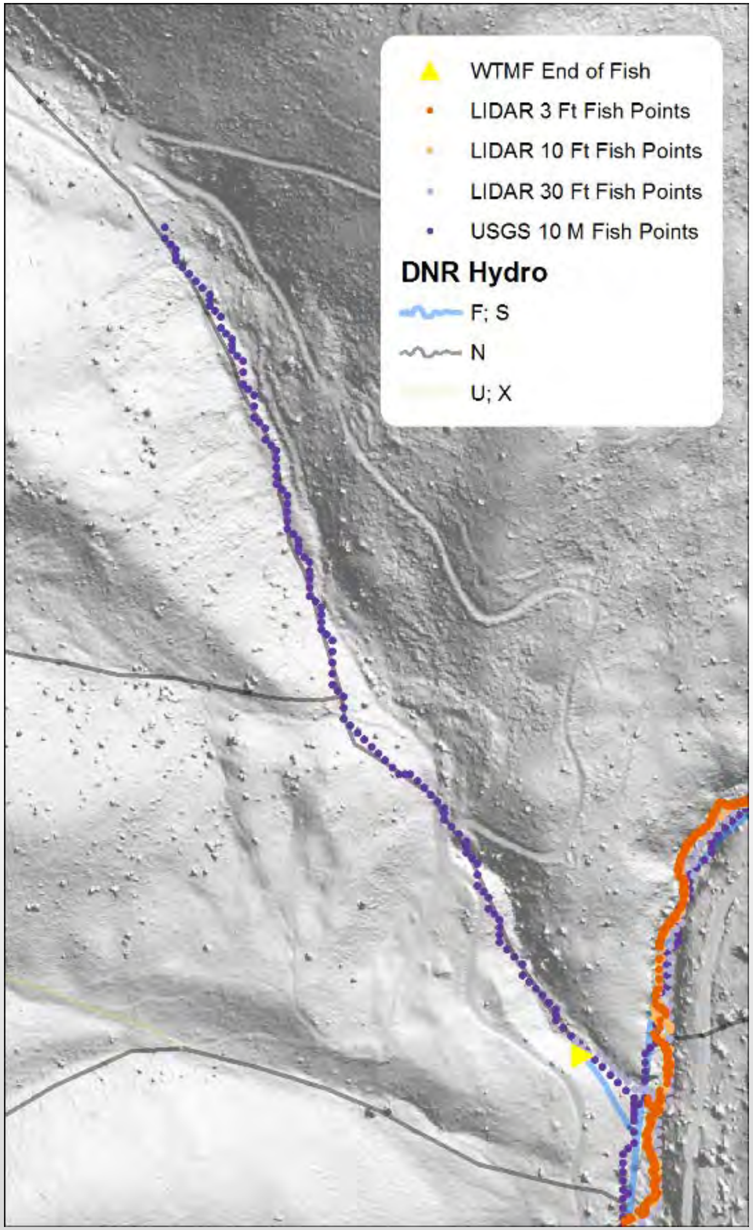
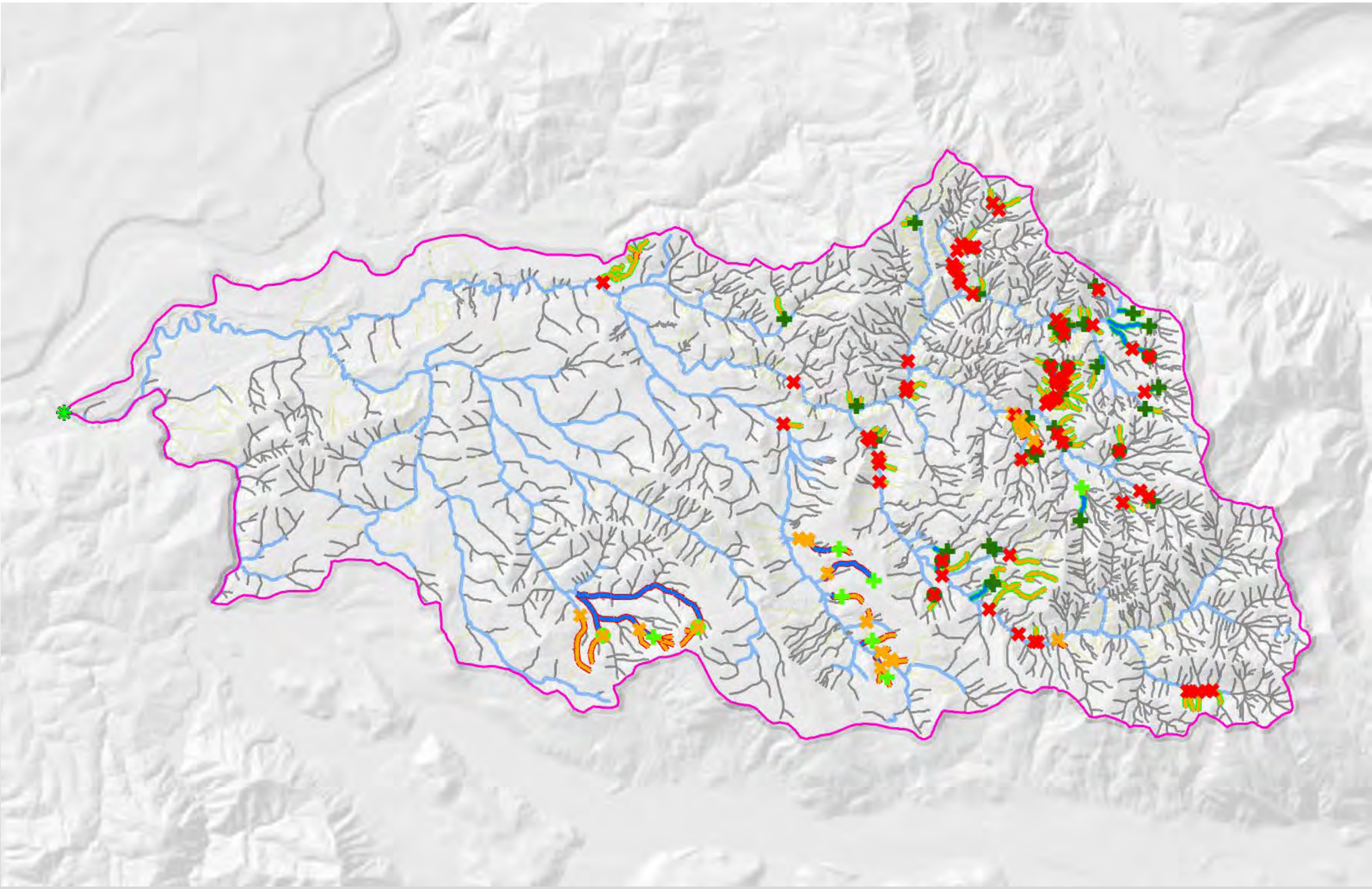
Darland Mtn Results

Error Distances

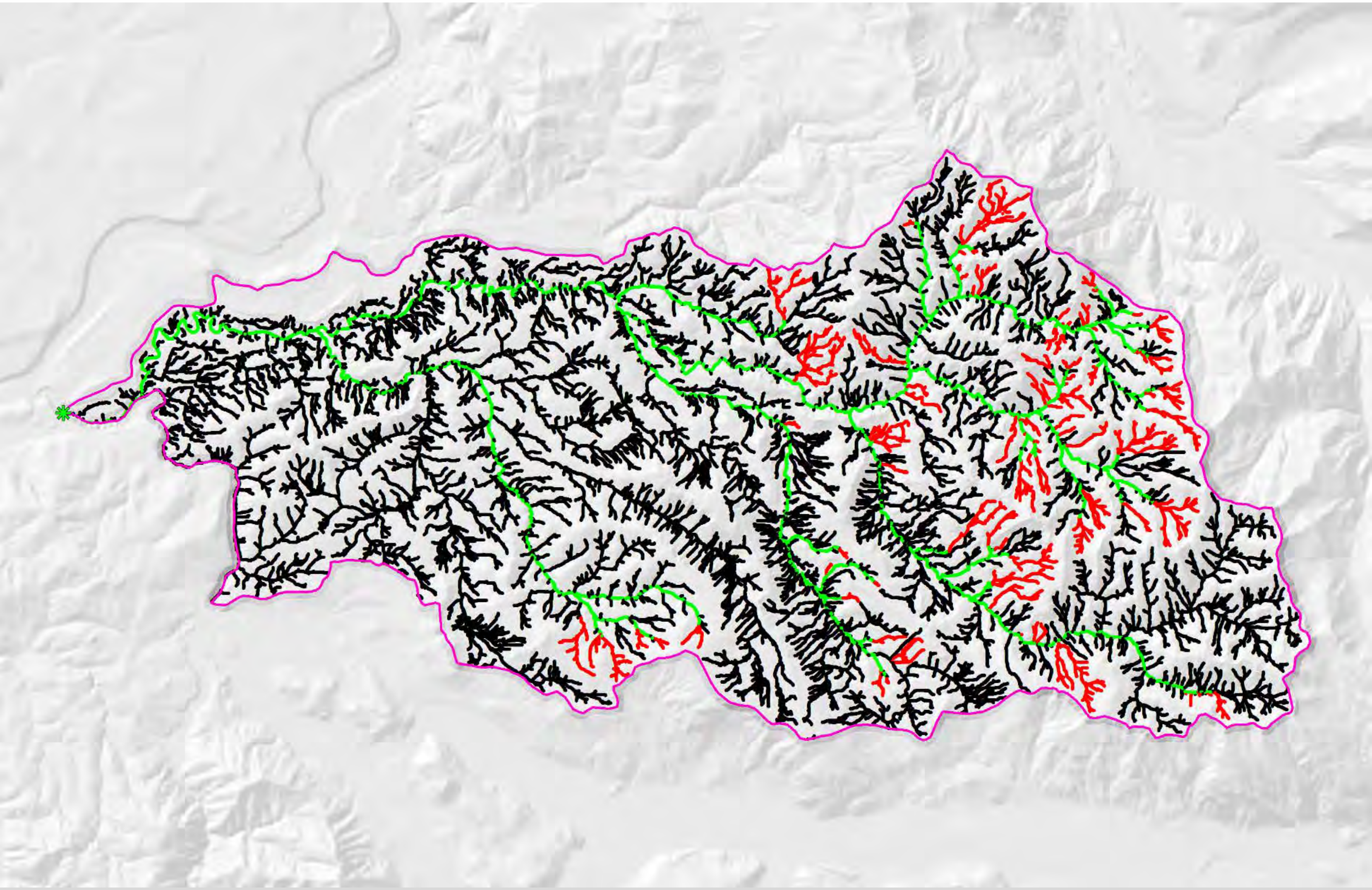
DEM	Error Distance	Absolute Error Distance	Average Error Distance
LIDAR			
3	253	253	127
10	240	240	120
30	-93	93	-47
USGS			
30	-2,868	2,868	-1,434



Mashel Field Data



Mashel Validation Data



Mashel Results

Logistic Model

DEM	Correct	Over	Under
LIDAR			
3	87.96%	0.85%	11.18%
10	86.22%	0.02%	13.76%
30	81.95%	0.04%	18.01%
USGS			
30	85.25%	0.11%	14.64%

Stopping Rule

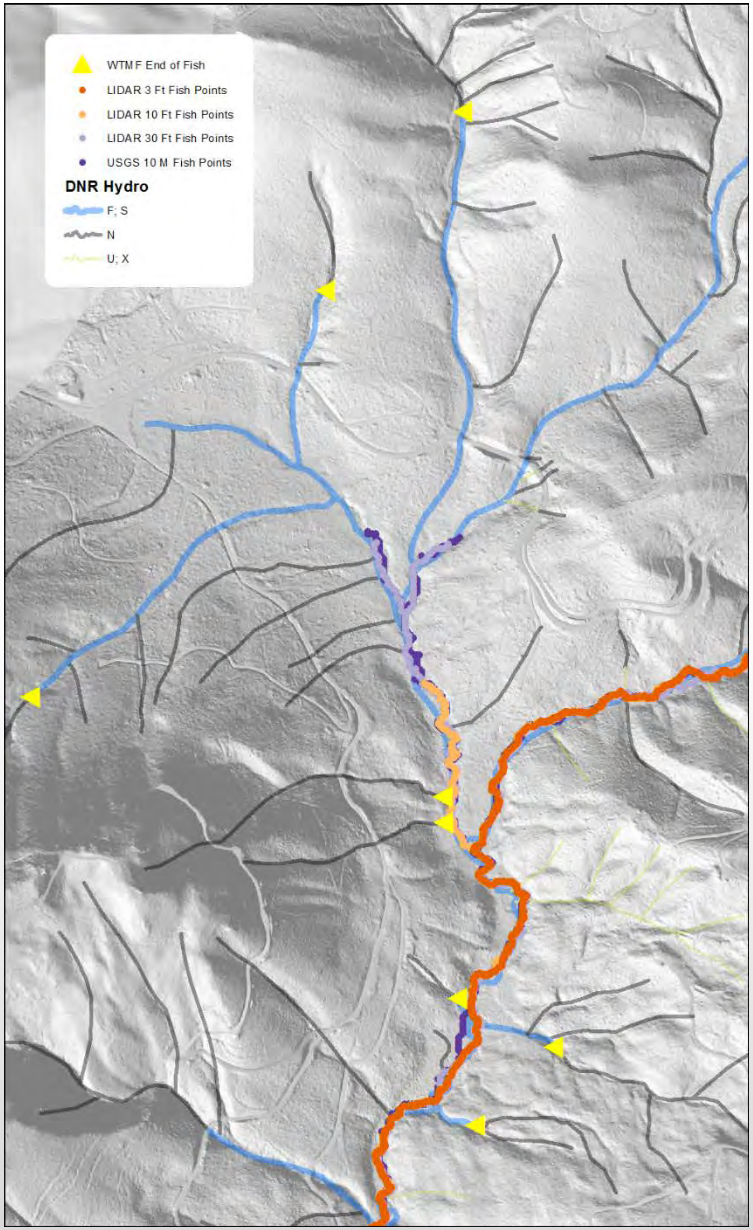
DEM	Correct	Over	Under
LIDAR			
3	88.80%	1.47%	9.73%
10	88.18%	0.10%	11.73%
30	83.56%	0.06%	16.38%
USGS			
30	87.67%	0.12%	12.21%

Stream Type	Field Verification Method	# WTMF
Fish	Biological	36
Non-Fish	Biological	66
Fish	Physical	9
Non-Fish	Physical	20

Mashel Results

Error Distances

DEM	Error Distance	Absolute Error Distance	Average Error Distance
LIDAR			
3	60,938	64,944	984
10	82,944	84,044	1,184
30	86,580	87,274	1,015
USGS			
30	81,508	83,112	966



Challenges

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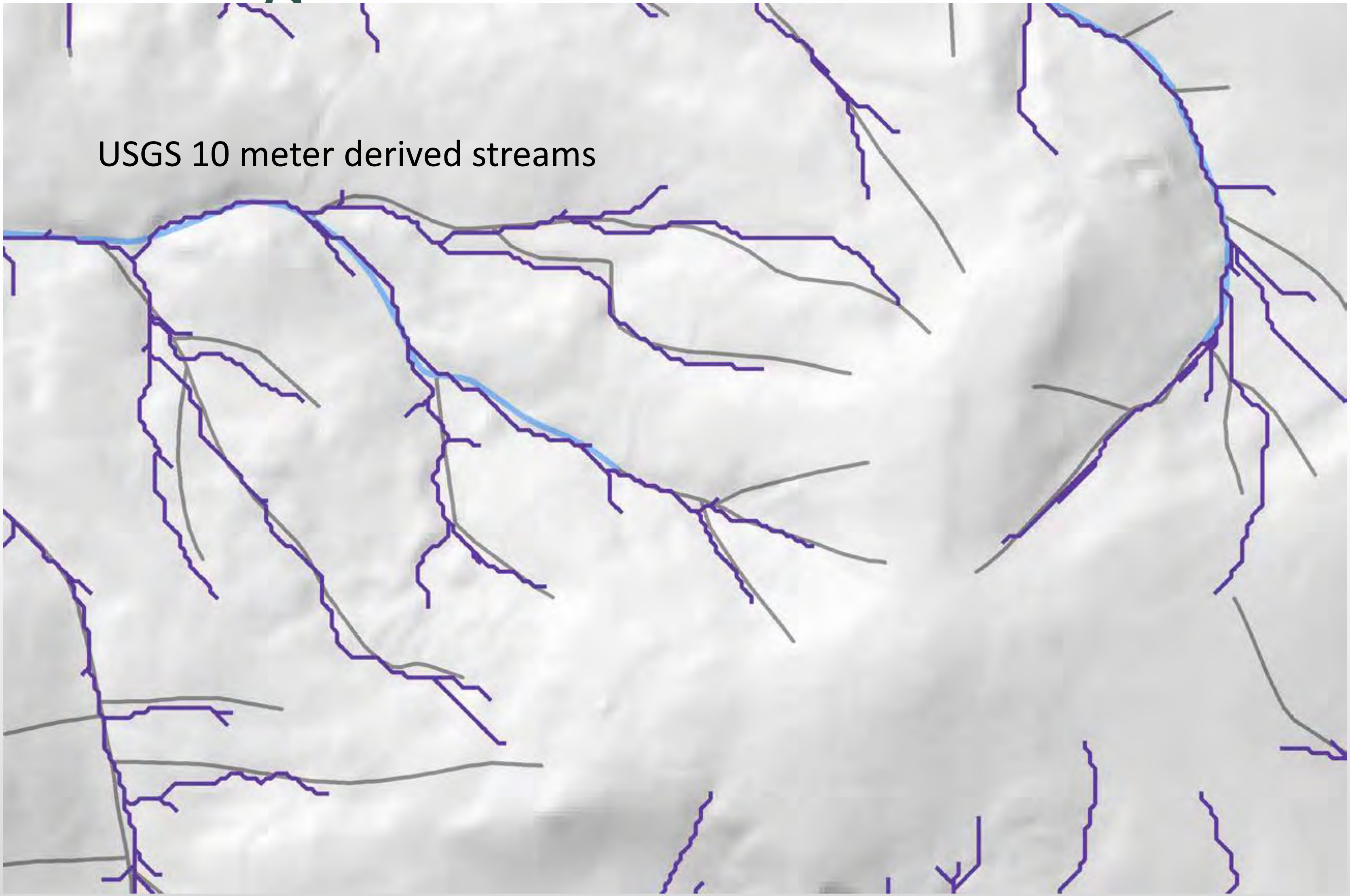

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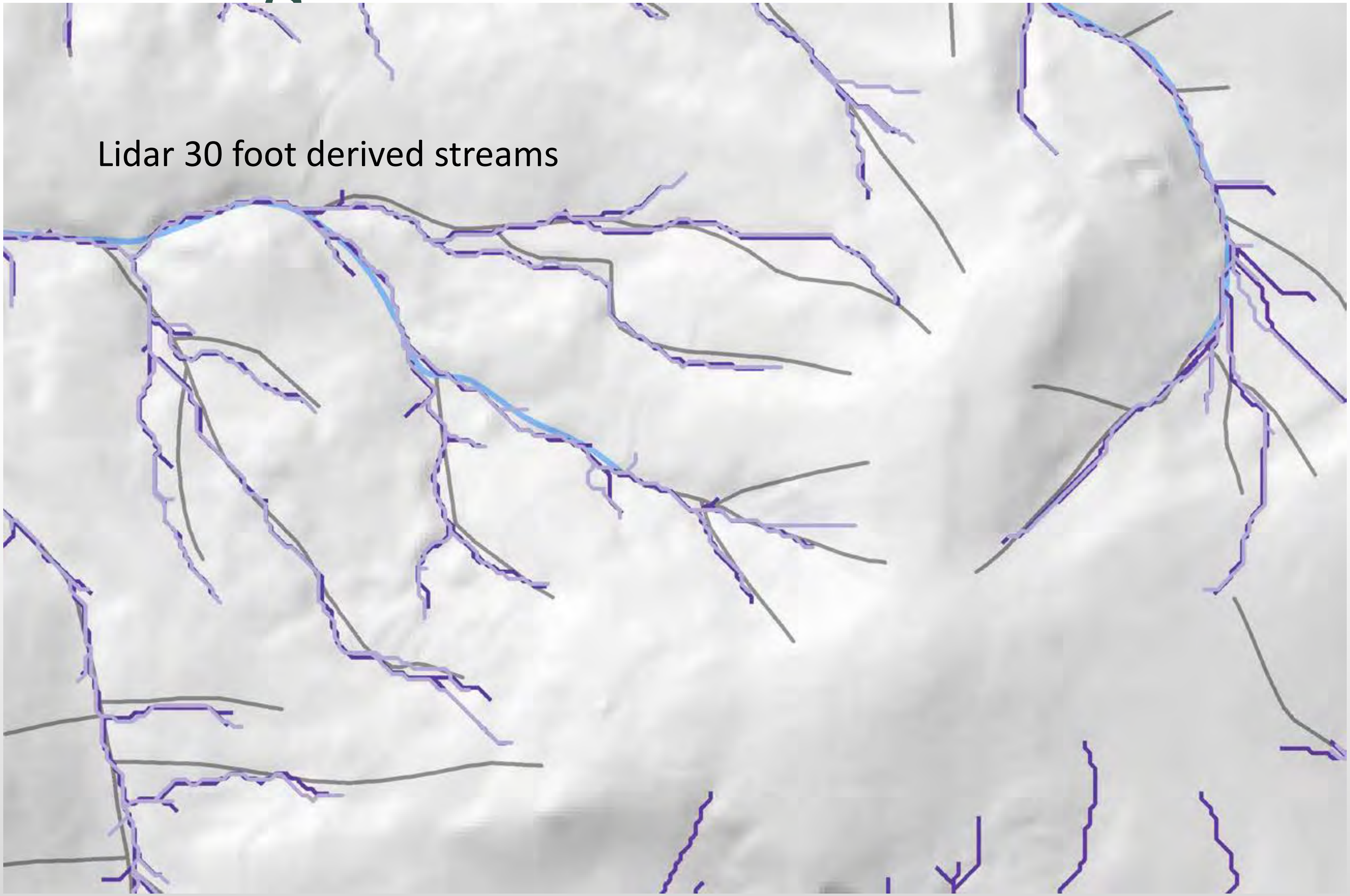

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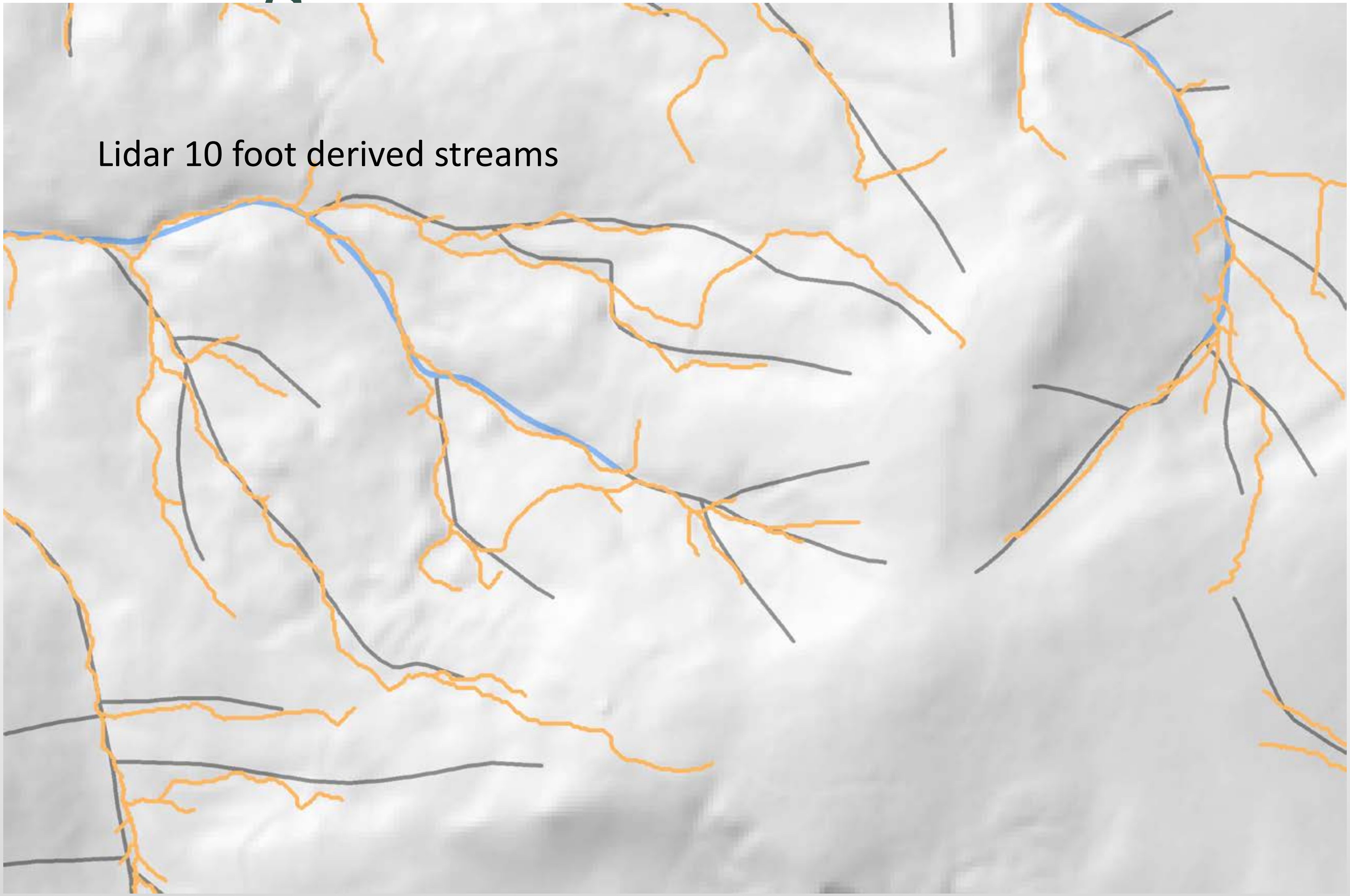
Challenges



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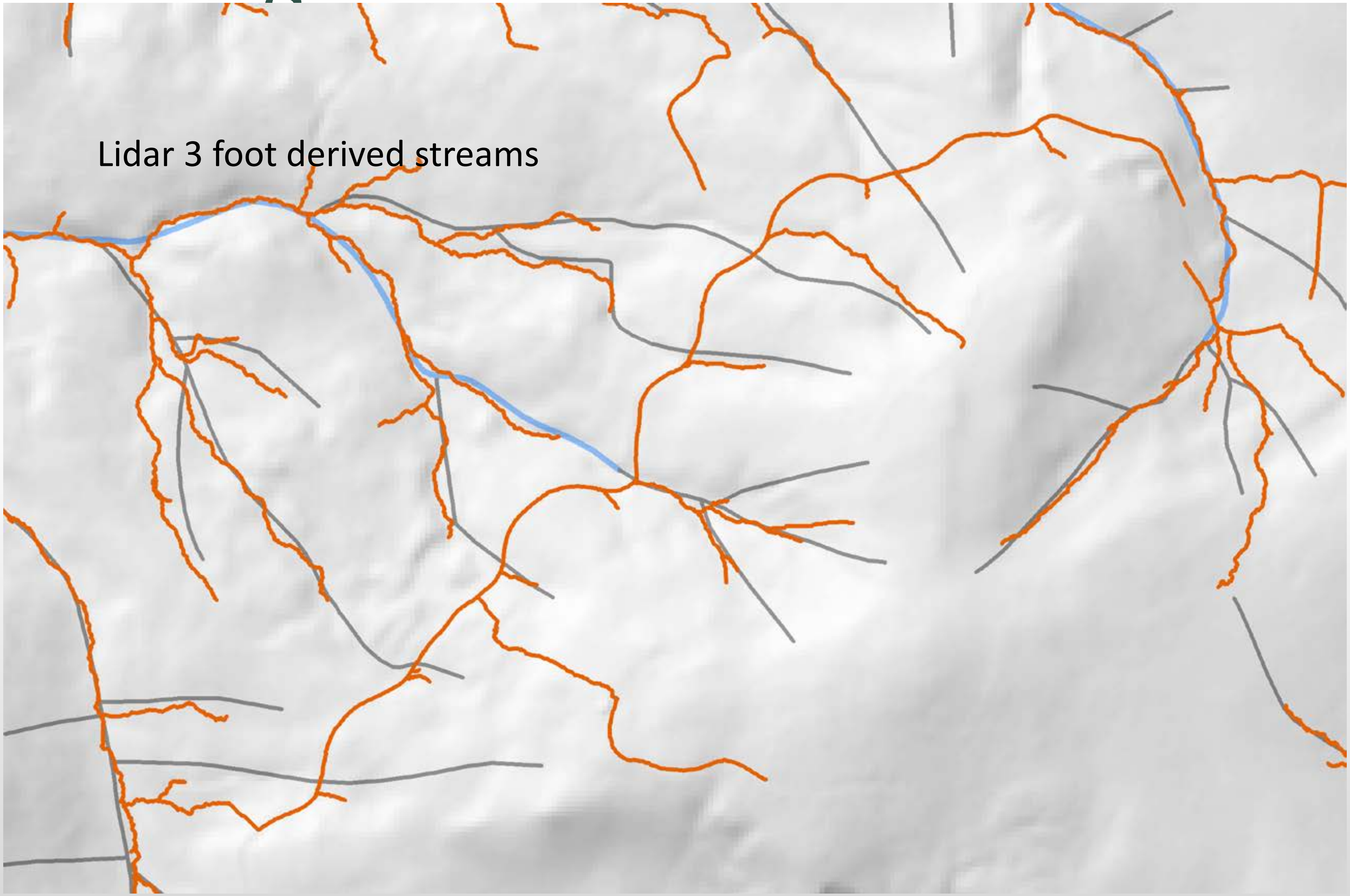
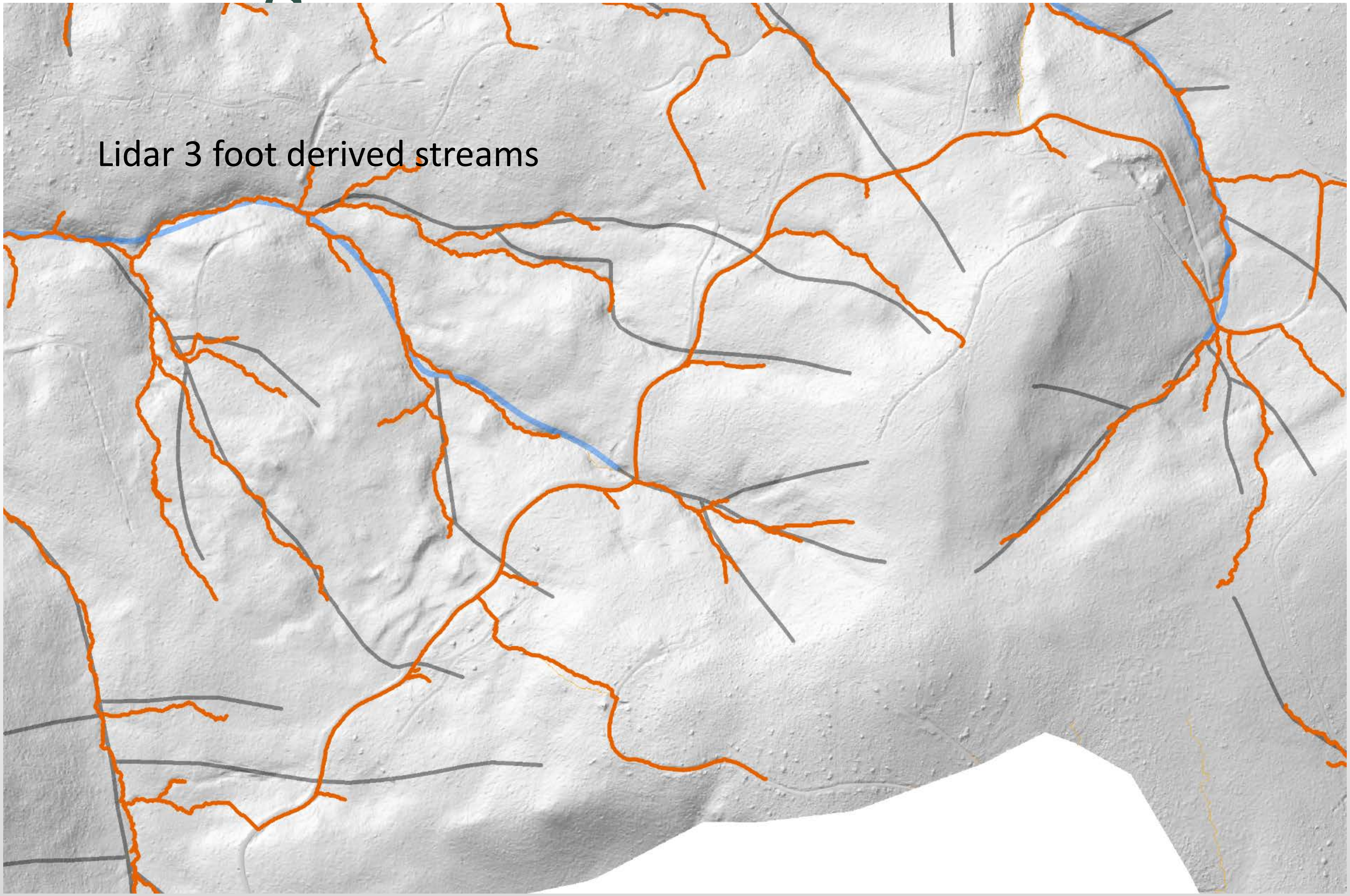


Challenges – Roads



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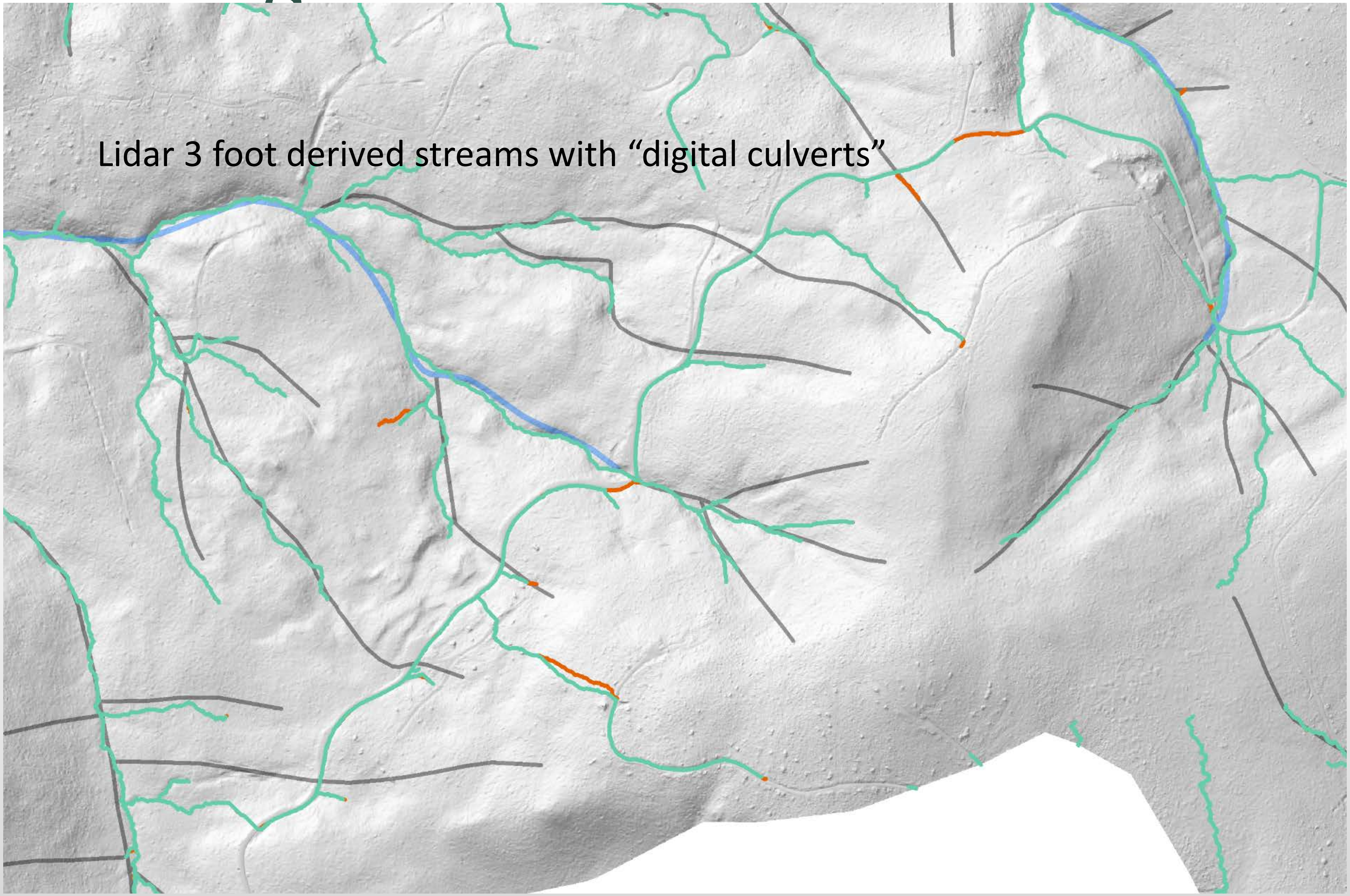
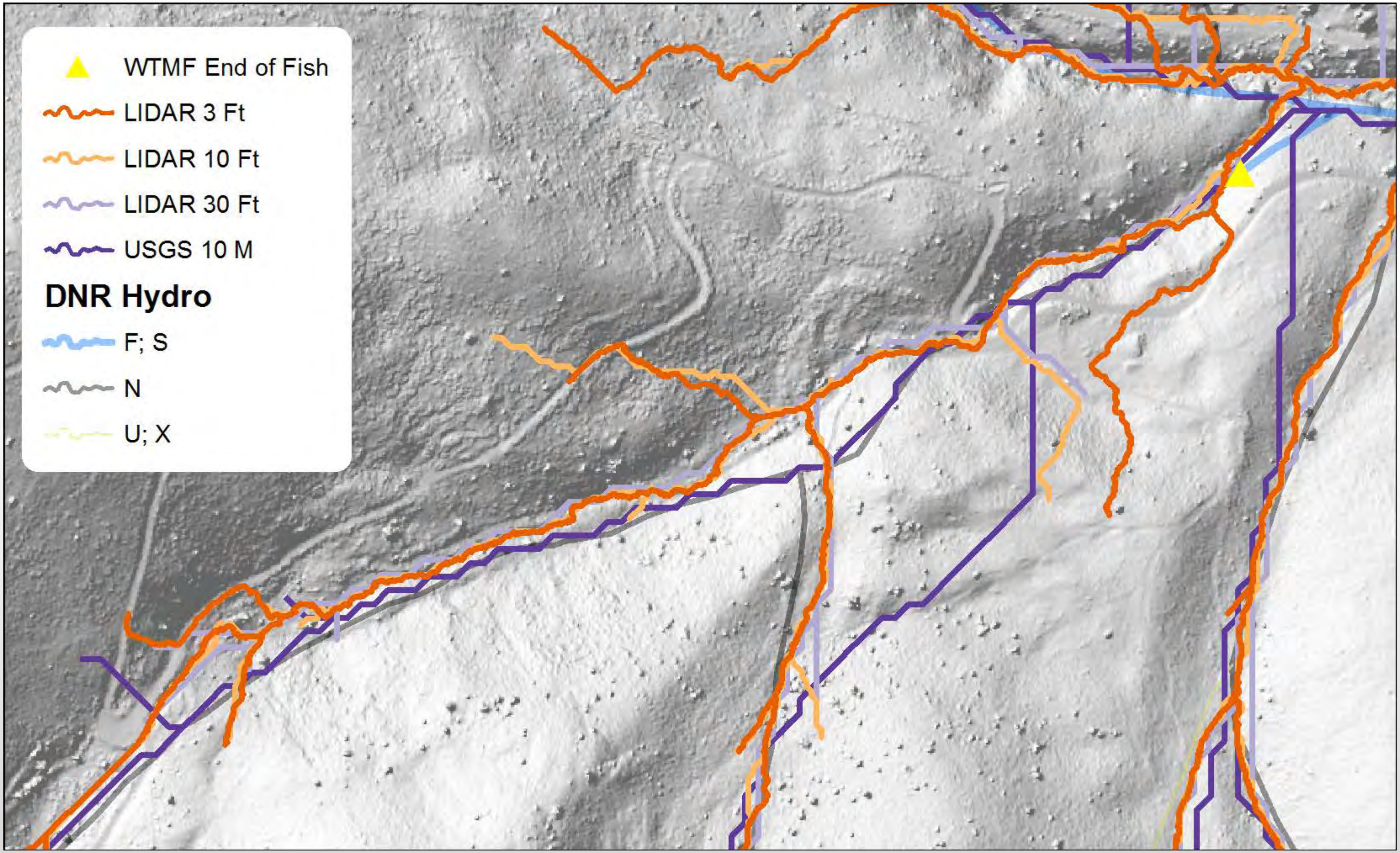


Challenges – Stream Gradient



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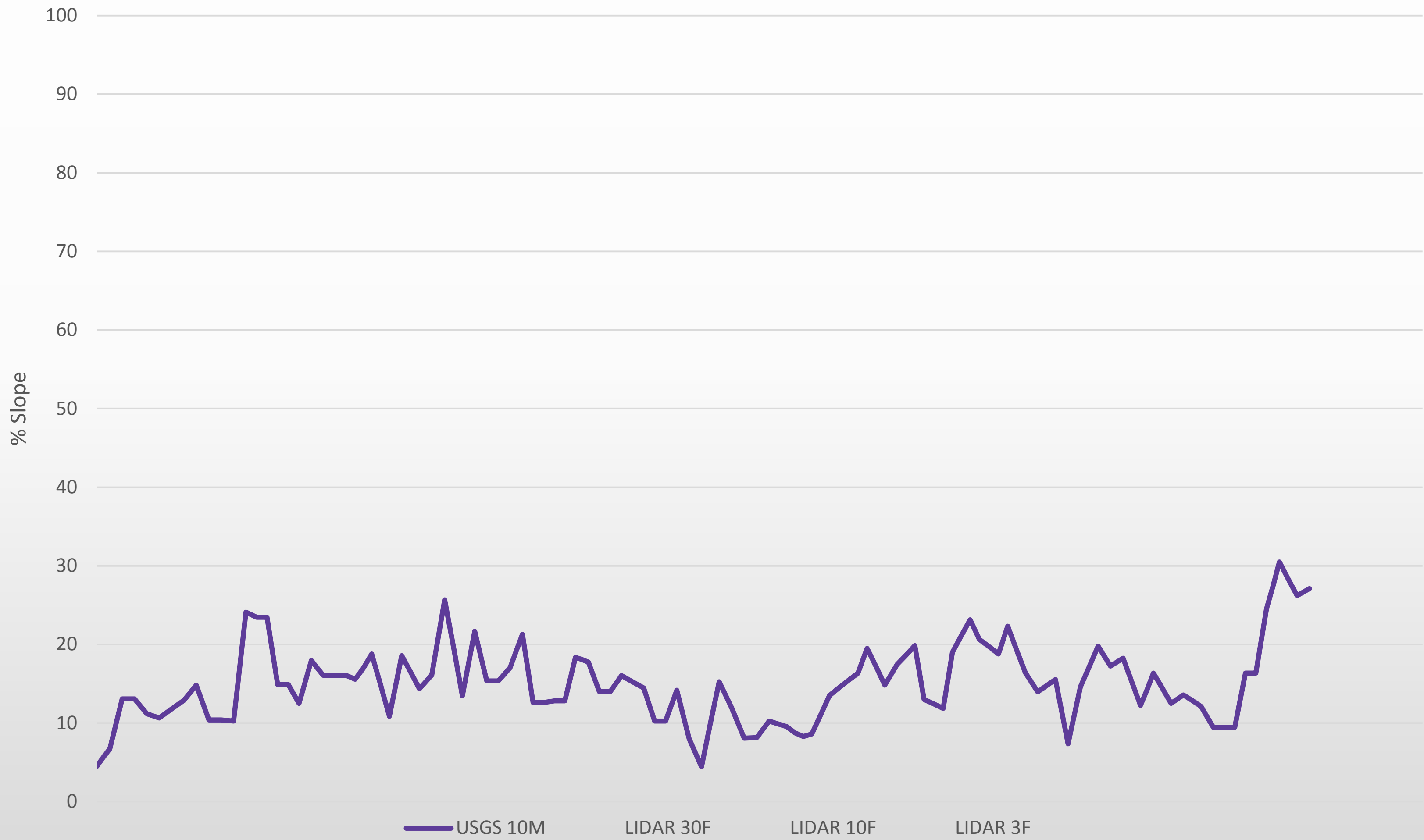

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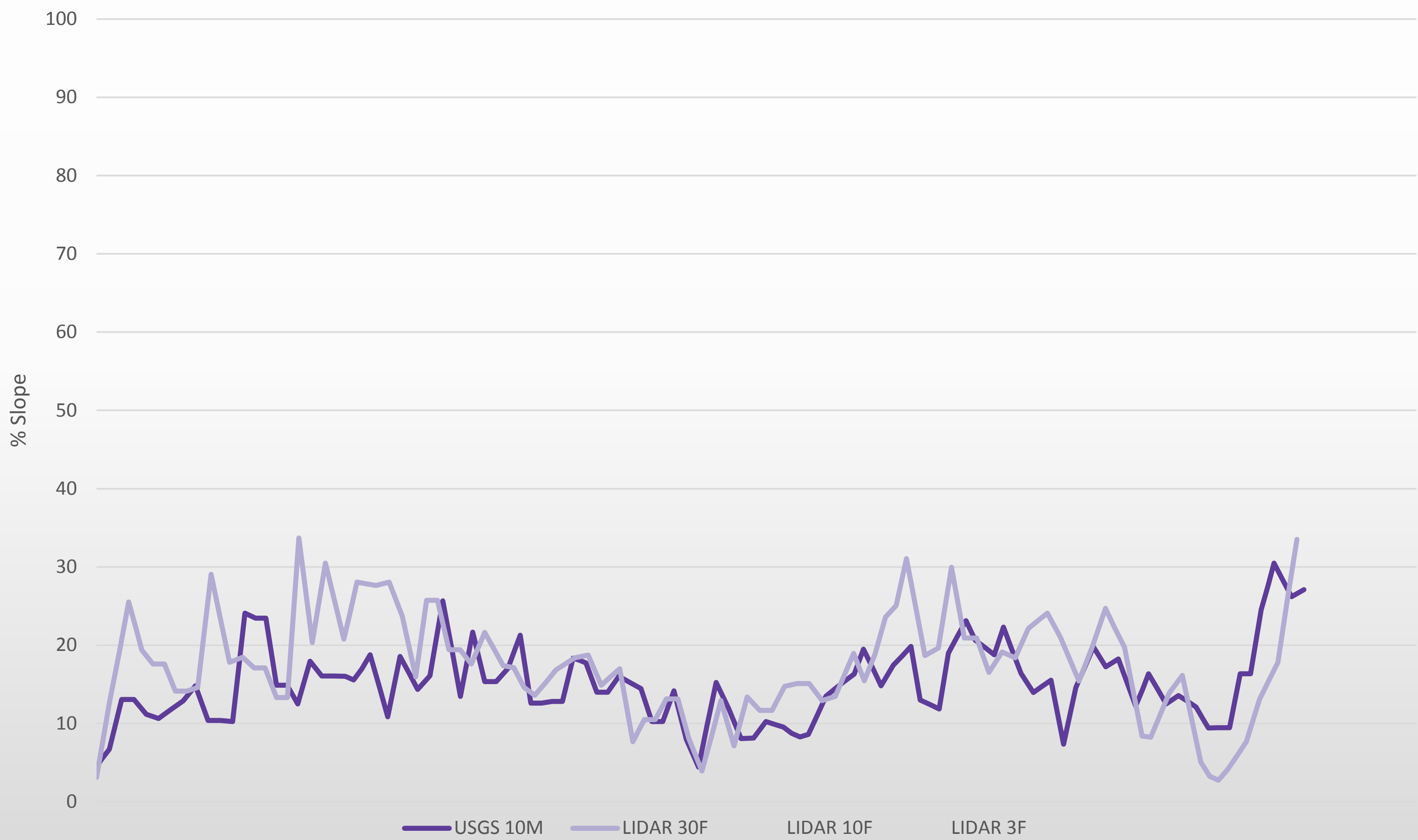

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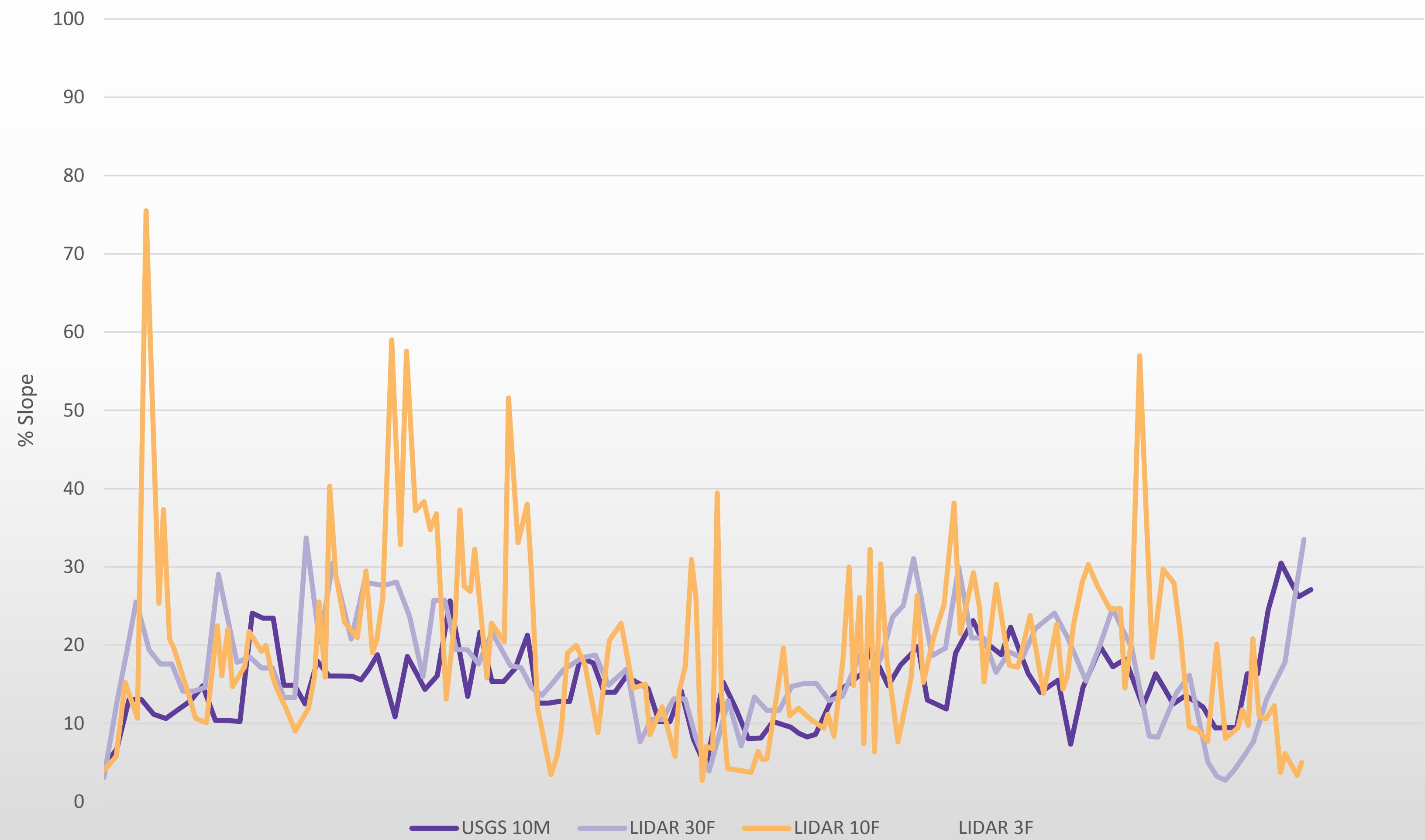

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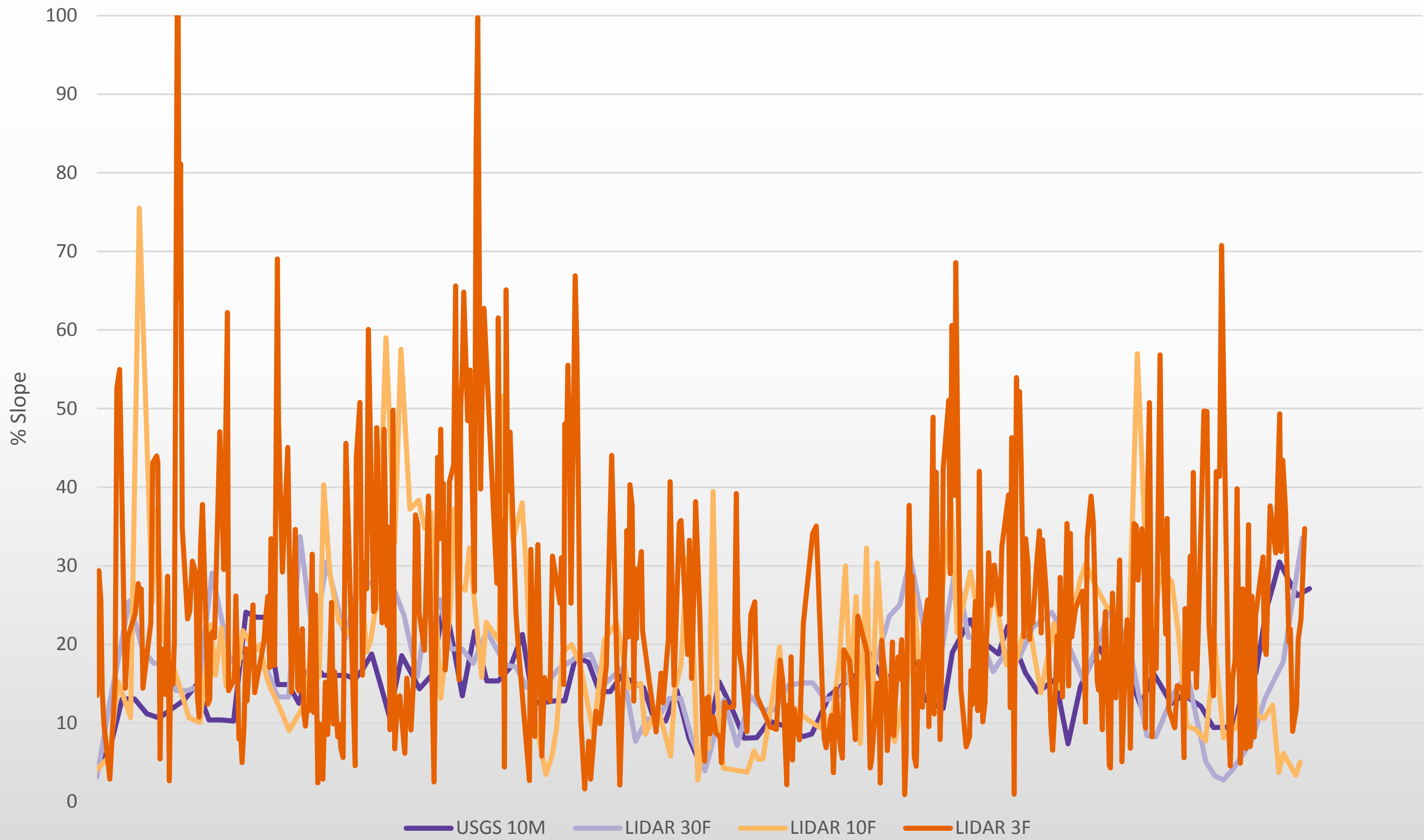

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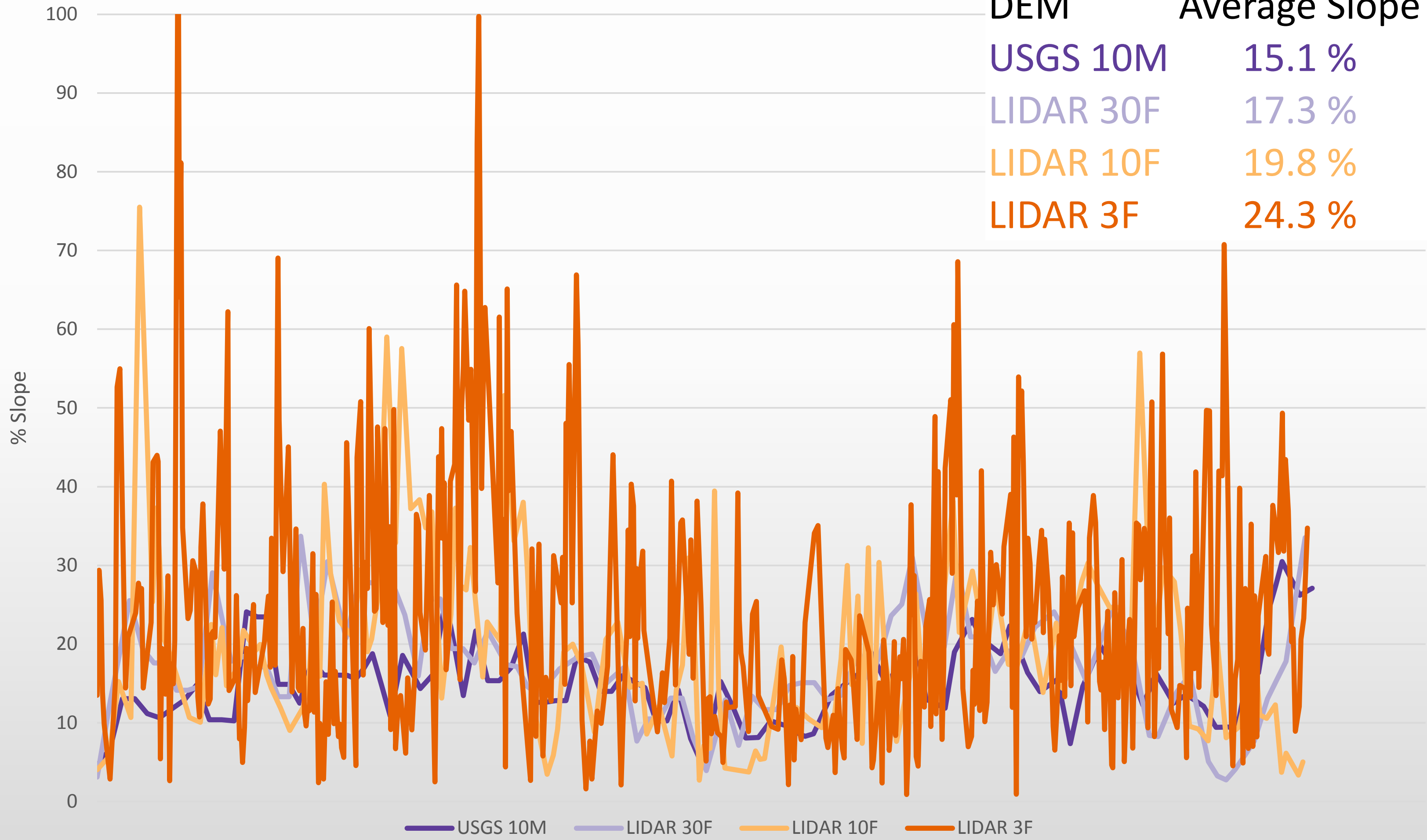

DEM	Average Slope
USGS 10M	15.1 %
LIDAR 30F	17.3 %
LIDAR 10F	19.8 %
LIDAR 3F	24.3 %

Conclusions

- Lidar derived Digital Elevation Models and derived stream networks *appear* to improve both the East and Westside models for predicting fish presence.
- High-resolution lidar creates some challenges:
  - The methodology and models were built to run at ~10 meters. Refining the methodology used to create the independent variables would *likely* improve model results;
  - The detail in high-resolution lidar creates unrealistic stream networks, making model predictions worse;
  - Large datasets make model runs slow (2-3 days per WAU);
  - Lidar data does not exist everywhere;
  - Lots more streams, depending on Perennial Initiation Point locations and contributing area.
- Not all Water Type Modification Forms are created equal. Some are more appropriate for model formulation and validation than others.
- The entire process has been coded in a modern programming language making model runs and comparisons relatively quick.

Recommendations

- Investigate independent variable creation to determine if altered methodology more appropriate for higher-resolution DEMs could improve model predictions. ($)
- Research producing modified hydrologically correct DEMs by creating "digital culverts" to more realistically model stream flows. ($)
- Expand pilot to include additional watersheds, and if needed, collect additional field verified end-of-fish data with protocol surveys to support more robust model validation. ($$)
- Leverage existing investment in coded process to rapidly investigate additional resolutions and alternative flow accumulation models. ($$)
- Consider a pilot to reformulate the models using high-resolution DEMs natively. ($$$)

Thank You

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