ASSESSING HYDRAULICALLY SUITABLE HABITAT WITH 2D HYDRAULIC MODELS

RRNW 2025: Tools of the Trade

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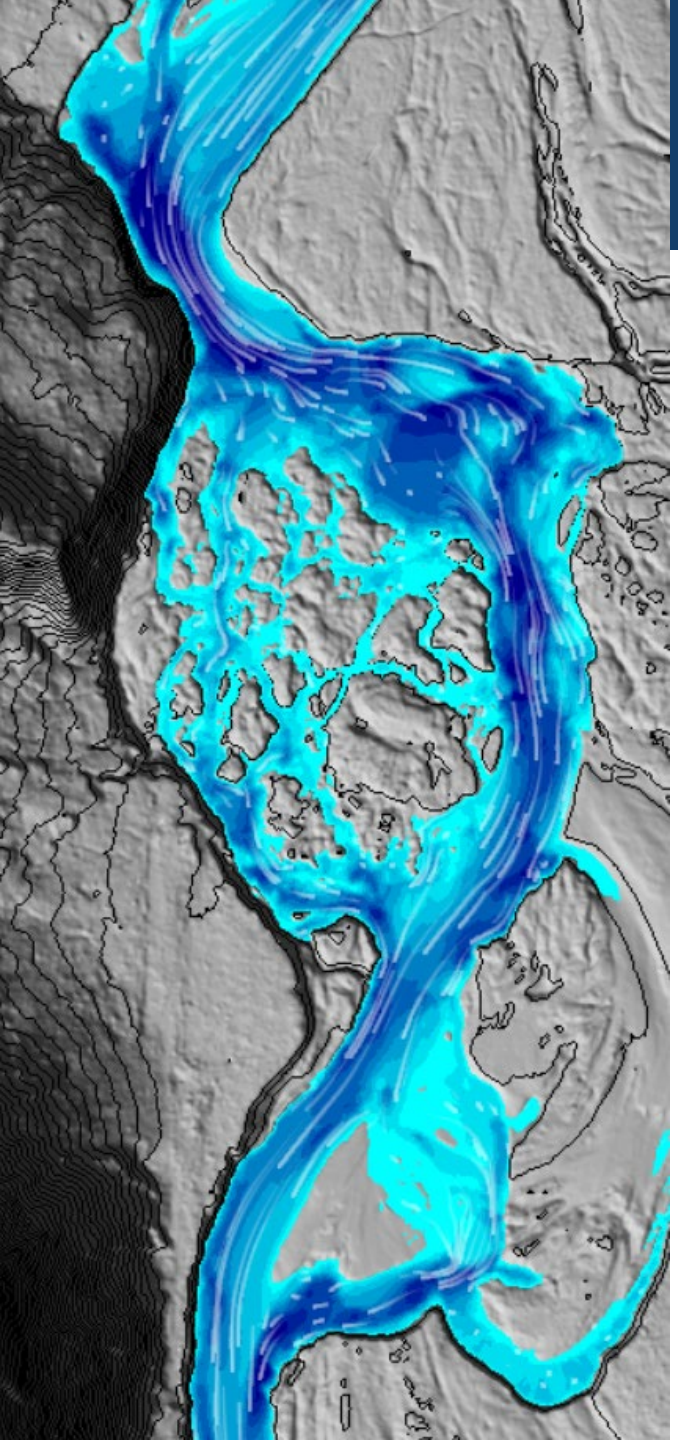
ASSESSING HABITAT

Quantitative metrics of habitat quality and/or quantity are useful for:

- Prioritizing project locations
- Designing restoration projects
- Evaluation and monitoring



BENEFITS OF MODELING HABITAT

- Field observations can be time, labor, and equipment intensive
  - Limited spatial/temporal scales
- Models can test a range of conditions
  - e.g., velocities in flood flows
- Ability to simulate hypothetical conditions

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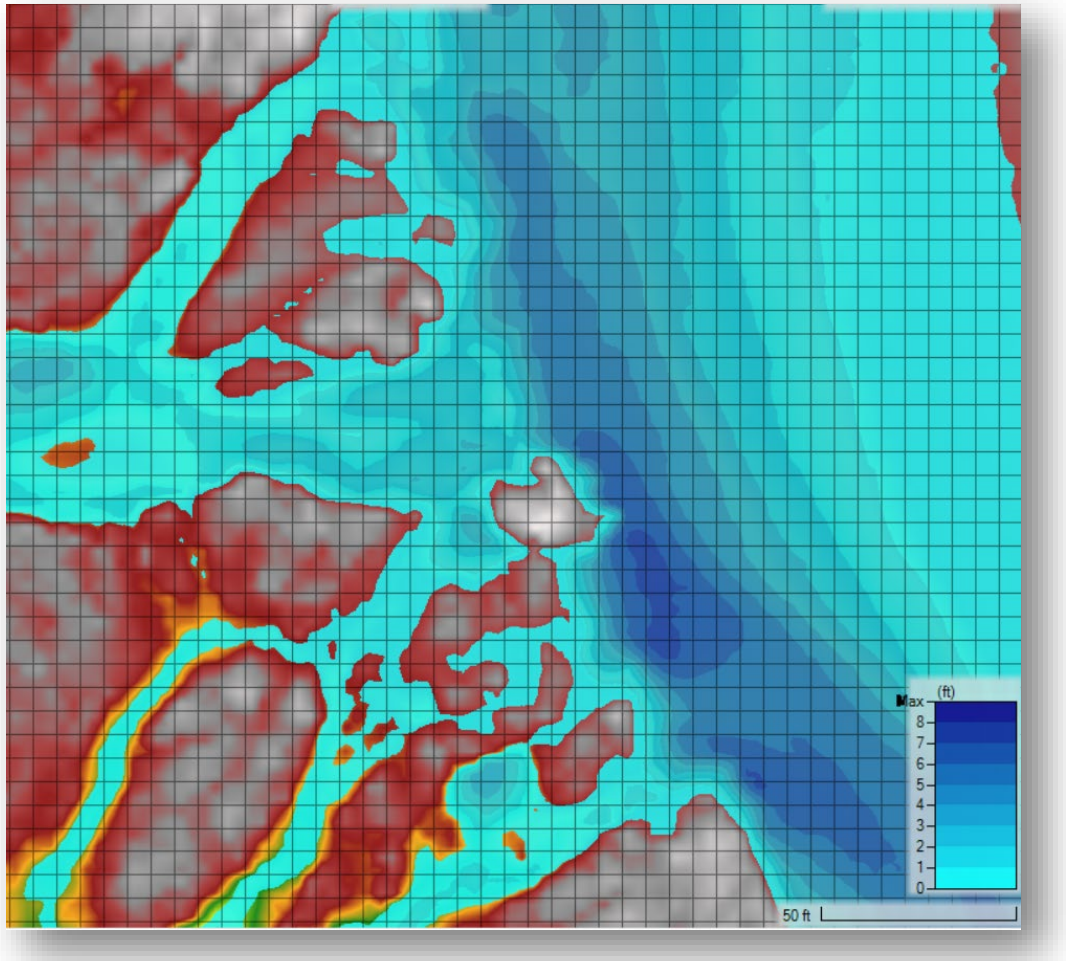
2D MODELING IS IMPROVING

- Constantly updating 2D modeling programs
  - User friendly post-processing
- More & cheaper computing power
- LiDAR, including topobathymetric
- High resolution aerial imagery
- UAV collected imagery and topography

We can make 2D models with much finer spatial resolutions, covering larger extents, with more accurate representations of the land surface and roughness.

MODELING: SPATIAL SCALES

- Interested in large river reaches
- Small scales are relevant for fish and habitat
- One approach: 2D model computational mesh at or near the terrain resolution
  - Captures small scale velocity gradients



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WOOD IN 2D MODELS

- Representing hydraulic effects of wood in models is a key challenge
  - **As terrain:** overrepresents obstruction to flow for many jams
  - **As porous plate:** computationally intensive, limits scale
  - **As roughness:** adjustable, but not a measurable parameter
- Wood jams have a wide range of hydraulic effects!

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POROSITY-BASED WOOD ROUGHNESS

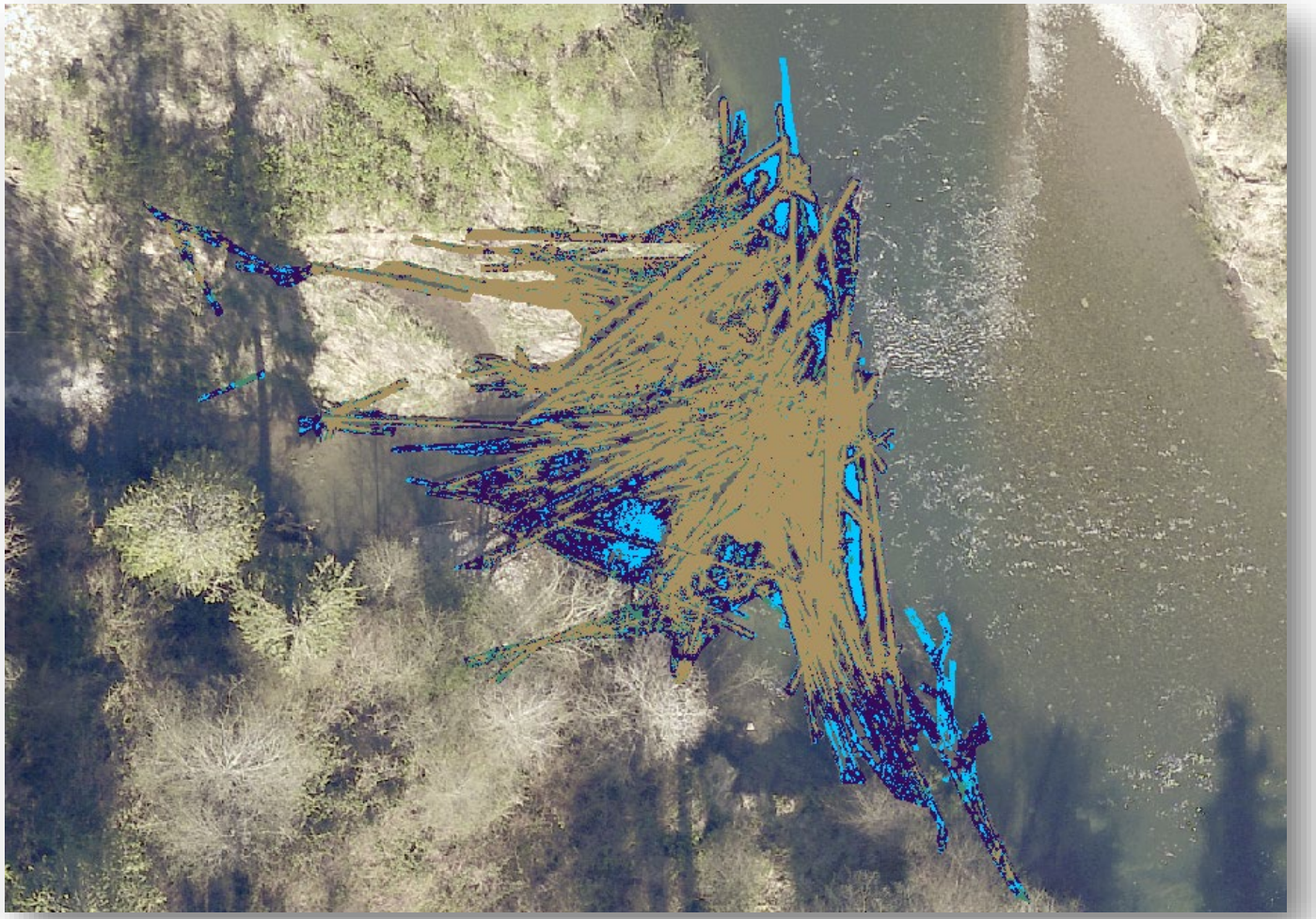
- Incorporate jam porosity into the representation of wood in a 2D model
- Use wood jam planform density as a proxy for jam porosity
    - Verified this proxy by comparing to field observations

POROSITY-BASED WOOD ROUGHNESS

1. Delineate wood jams in high-resolution aerial imagery

POROSITY-BASED WOOD ROUGHNESS

2. Use automated image classification to sort wood vs. not wood



- exposed wood
- shadowed wood
- submerged wood
- nonwood water
- nonwood shadow

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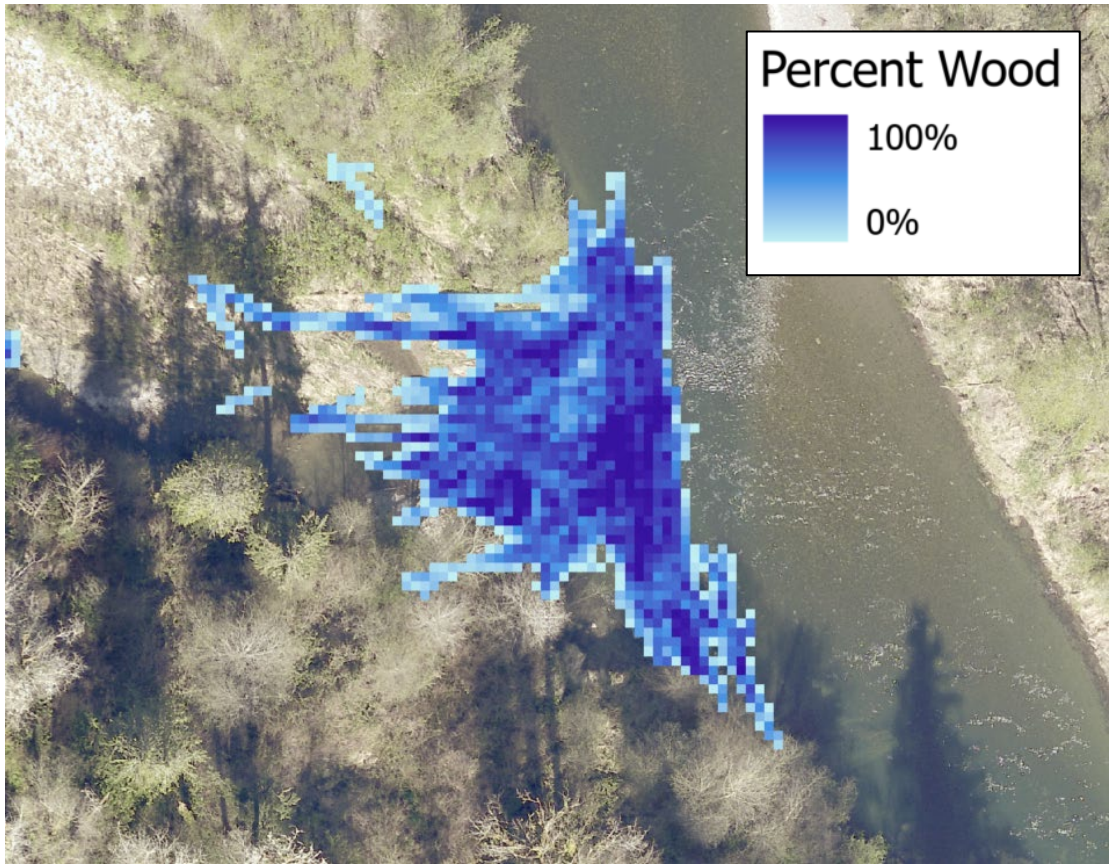
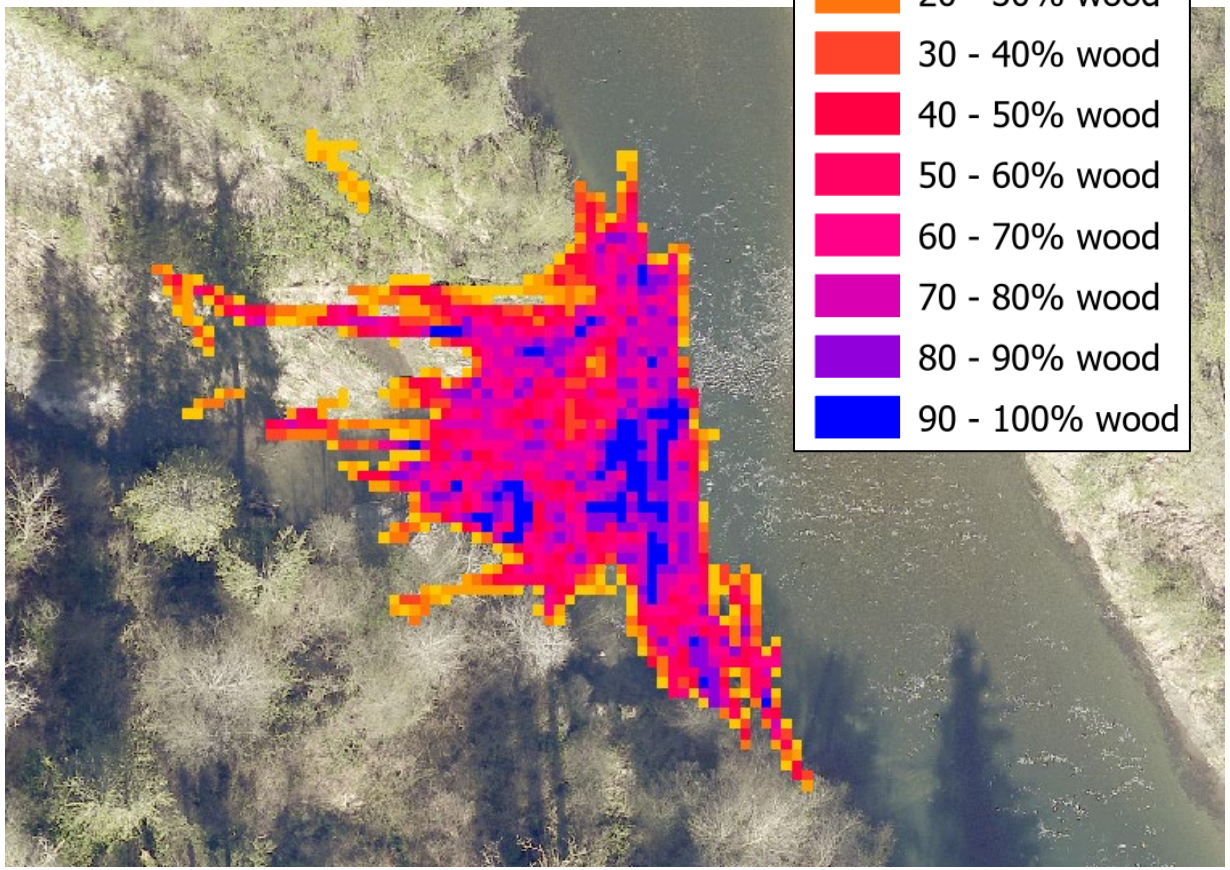
POROSITY-BASED WOOD ROUGHNESS

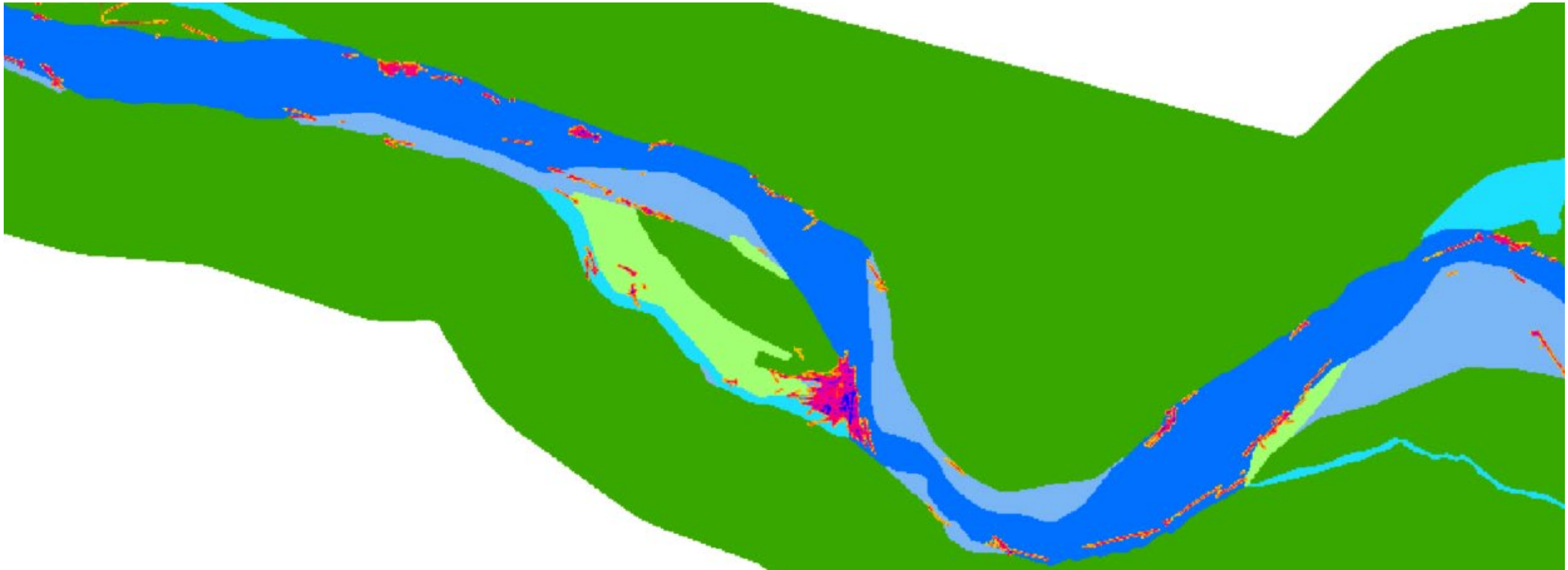
3. Aggregate as percent wood to model or terrain resolution
4. Classify into a manageable number of wood density classes





POROSITY-BASED WOOD ROUGHNESS

5. Assign a Manning's n roughness value for each wood density class
6. Add to Manning's n land cover layer

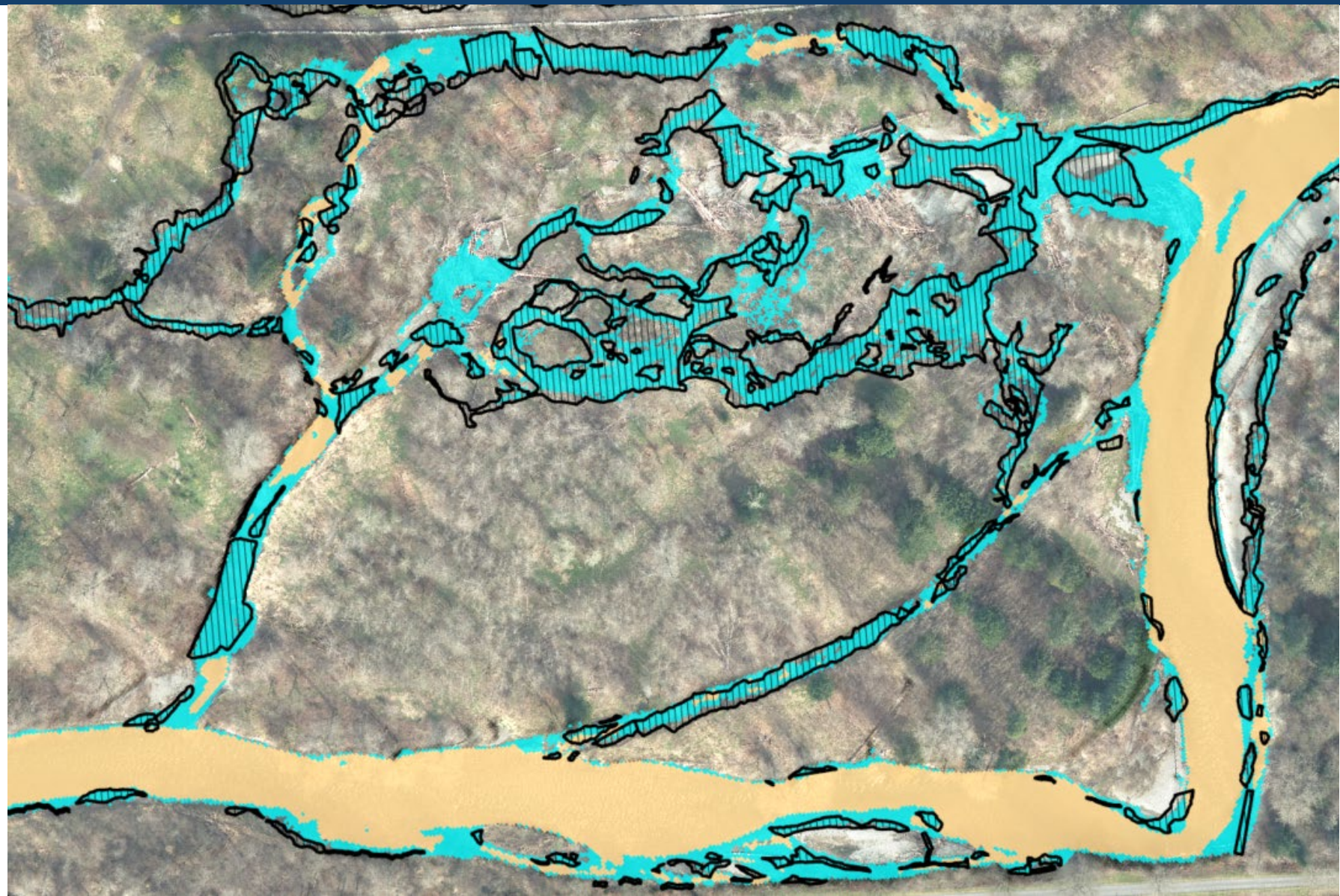


MODEL VERIFICATION

Slow water habitat (< 1.5 ft/s) mapped in field with GPS.

Model has good agreement with field mapping.

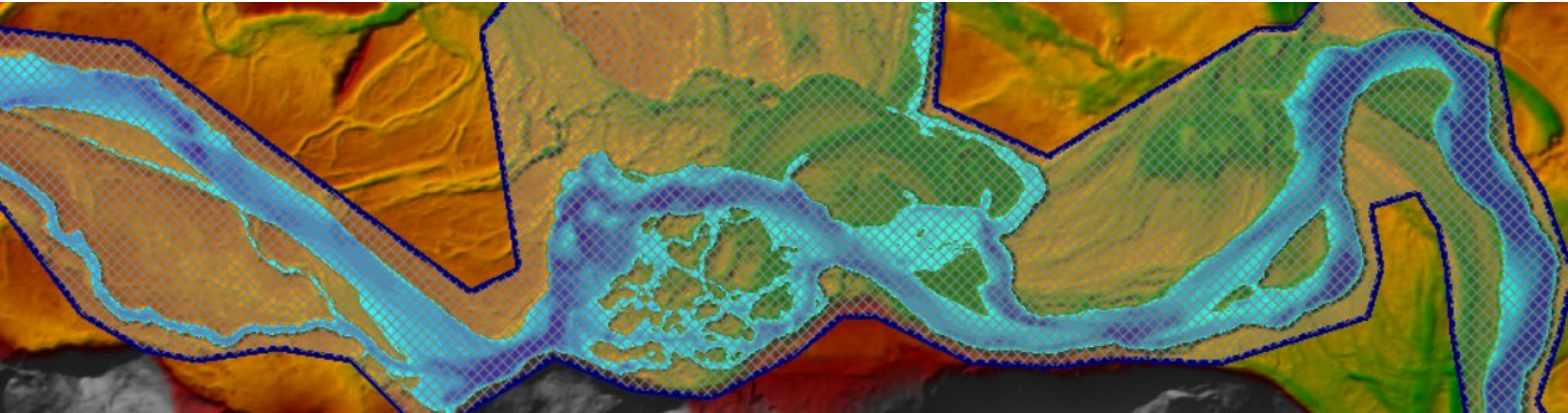
Model includes area under the jams in slow water area.



TESTING THE THEORETICAL

How does the slow water habitat in a river change with flow?

- Relevant for regulated rivers
- Slow water habitat defined as velocity < 1.5 ft/s and depth > 1 ft



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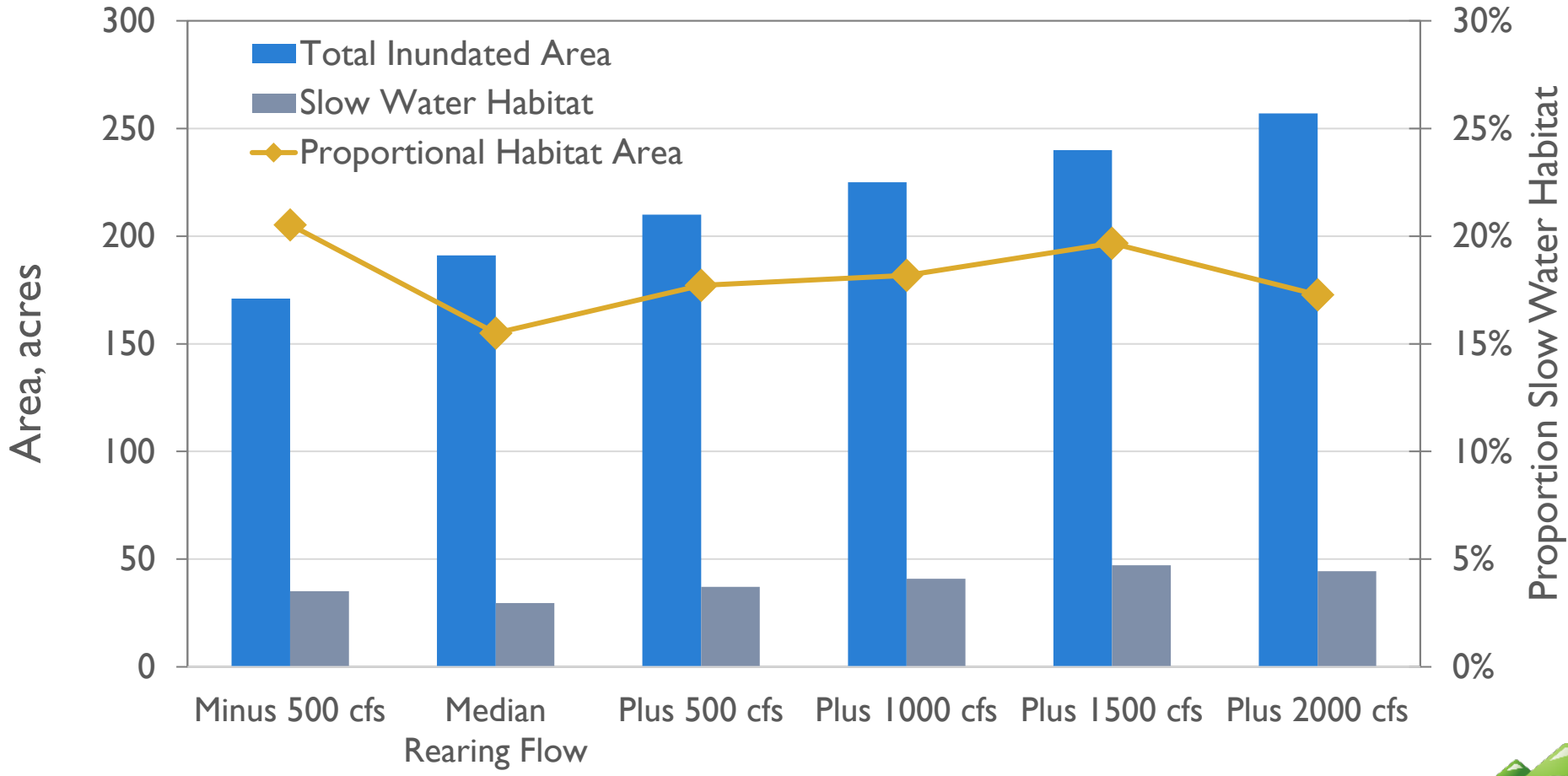

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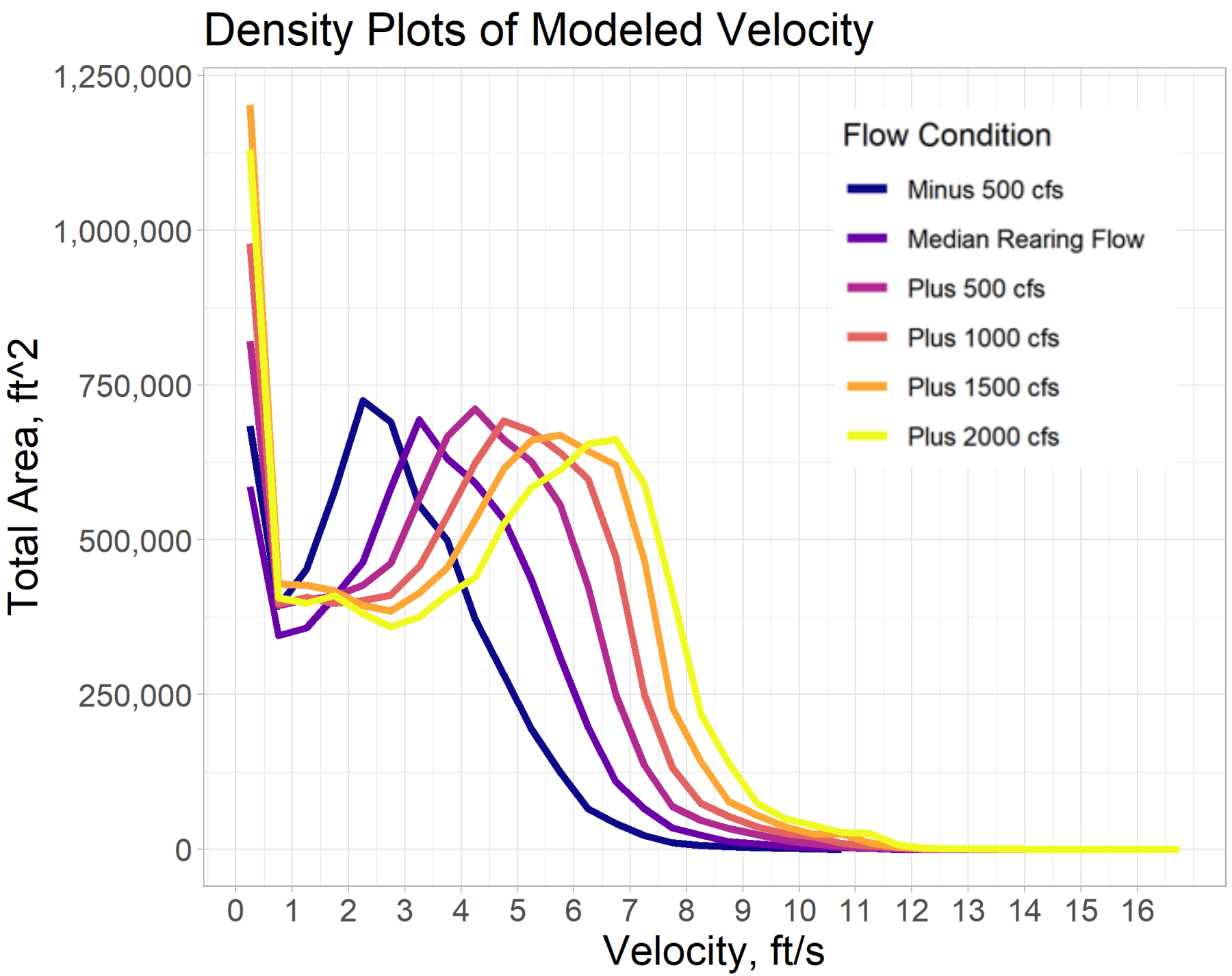

Model results are easy to query for multiple different hydraulic criteria and can inform sensitivity.

Visualizations of 2D model results can help identify patterns and/or thresholds.

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LIMITATIONS AND CONSIDERATIONS

- 2D models are still 2D
  - Plunging flows and vertical flow variations not represented
- Most reach scale models will not include minor tributaries, groundwater, or hyporheic flow
- Considerable uncertainty in Manning's n values, especially for wood
- Better calibration (groundtruthing) data makes better results
- Each model is developed with a specific purpose
  - Consider the assumptions

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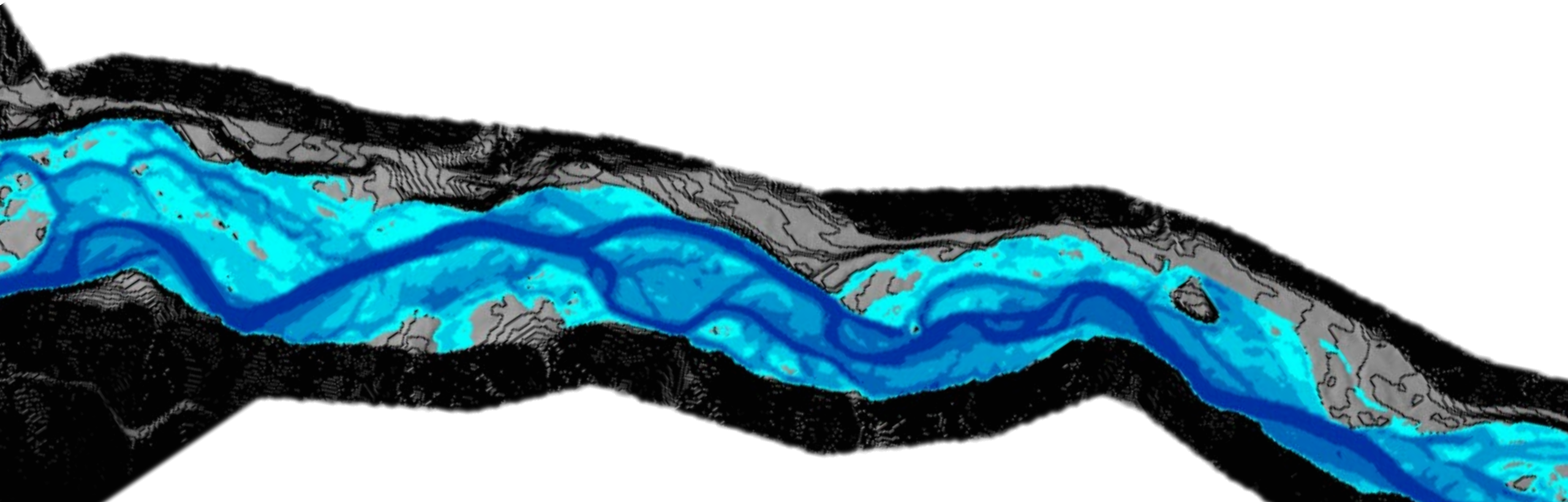
Advances in computing power, 2D modeling programs, and remotely sensed data

1. Larger models domains
2. Finer spatial resolutions
3. Better representations of wood

2D modeling as a more powerful tool for aquatic habitat assessment

All models are wrong,
but some are (getting more) useful.



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QUESTIONS?

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