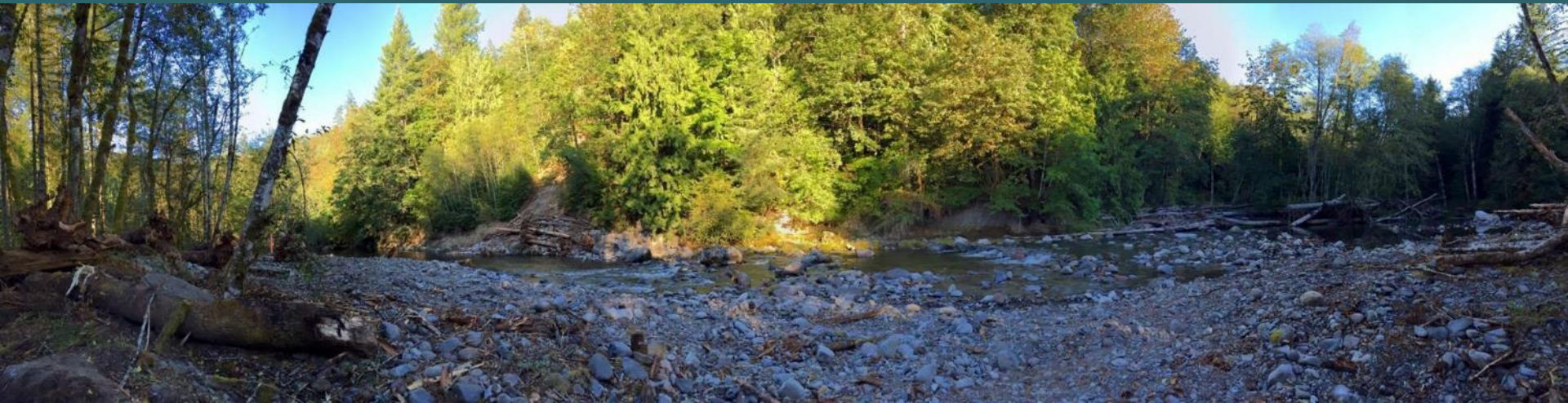


Using remote sensing techniques to extract bathymetry from gravel bed streams in a mountain drainage basin



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Bathymetric data: why is it important?

- Basic descriptor of channel morphology
- Adjusts in response to fluctuations and disturbances
- Controls location of channel units

Current surveying techniques

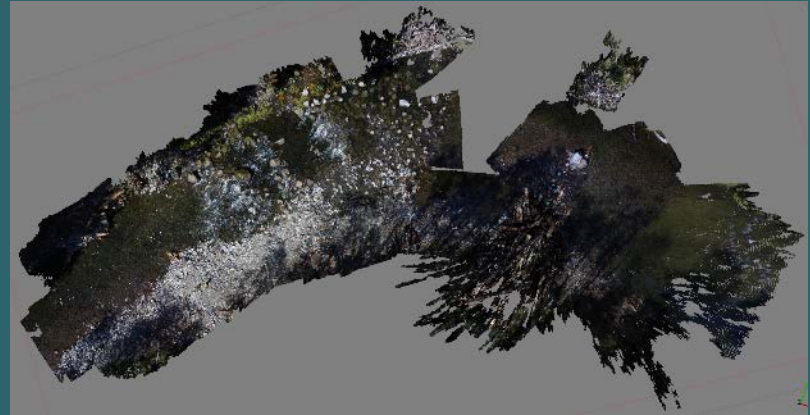
- Lower spatial resolution



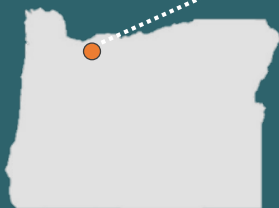
- New applications demand higher resolution data
 - Geomorphic change detection
 - Physical habitat modeling
 - 2D hydraulic modeling
 - Sediment budgeting
 - Restoration monitoring

Remote sensing & bathymetric data

- Structure-from-Motion (SfM)
- Equipment
 - Camera
 - GPS



Salmon River, Oregon



Field Work: Photo acquisition

- DJI Phantom Pro III
 - 12 megapixel
 - 3-axis gimbal
- Camera angle off-nadir
(James and Robson, 2014)



Field Work: RTK-GPS

- 30 Ground control points placed, 24 used in processing
- Cross sections (175 in channel points)



Results

SfM processing

- 0.4 cm orthophoto
- 1.5 cm DEM
(digital elevation model)

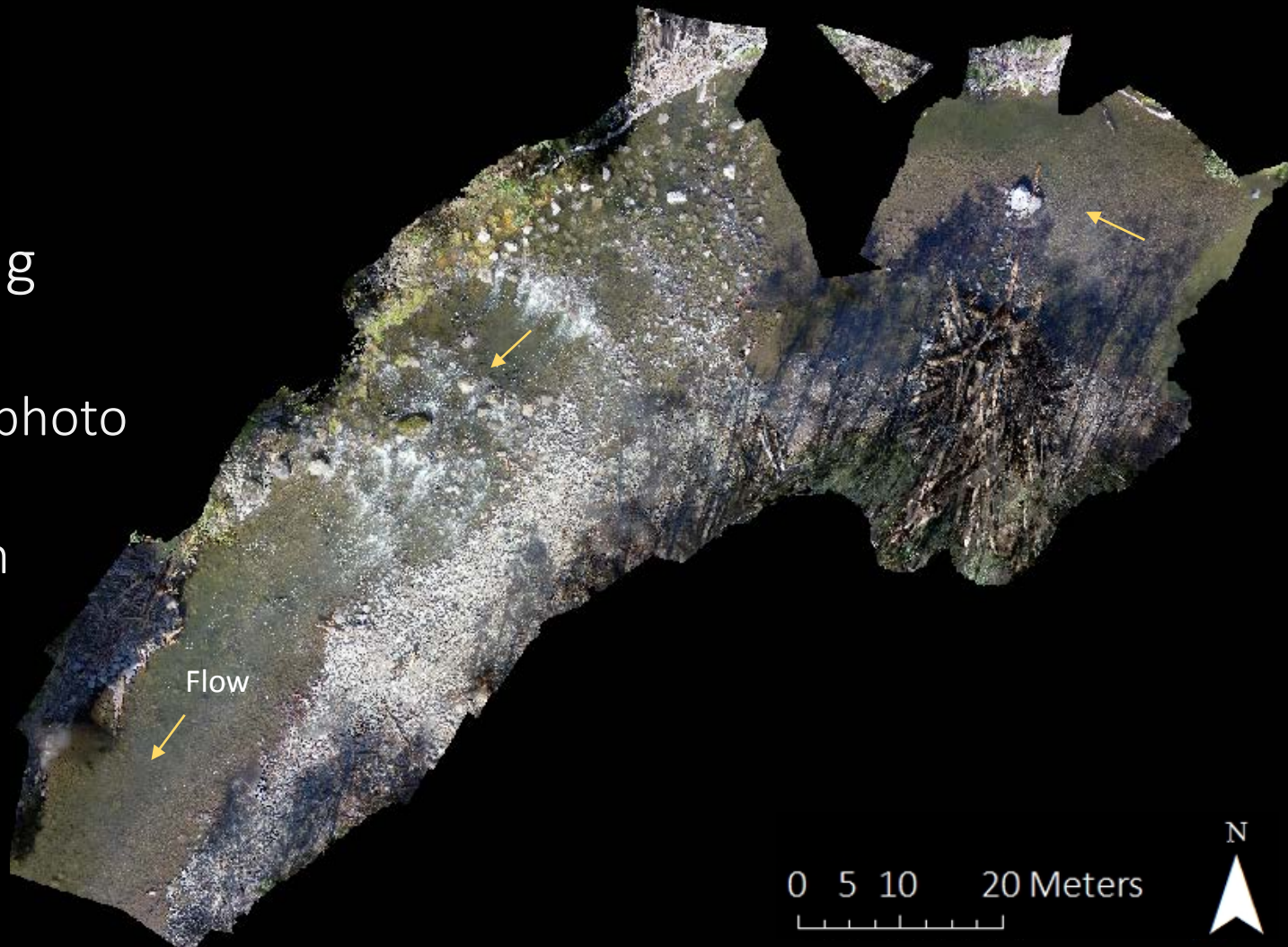


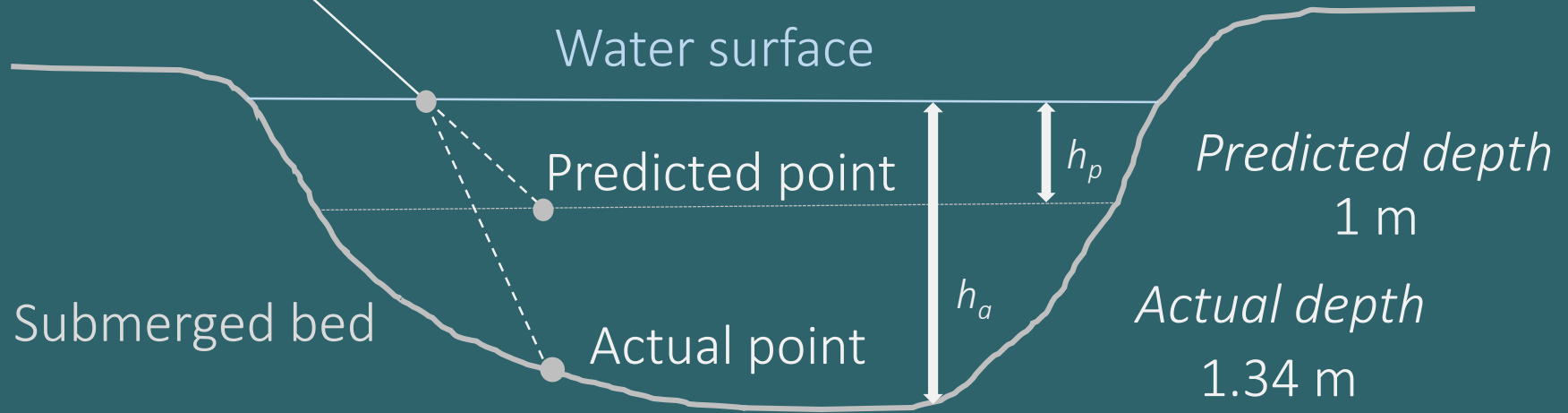
Diagram of light refraction in water



$$h_a = n \times h_p$$

where 'n' is a refraction coefficient

$$1.34 = 1.34 \times 1$$



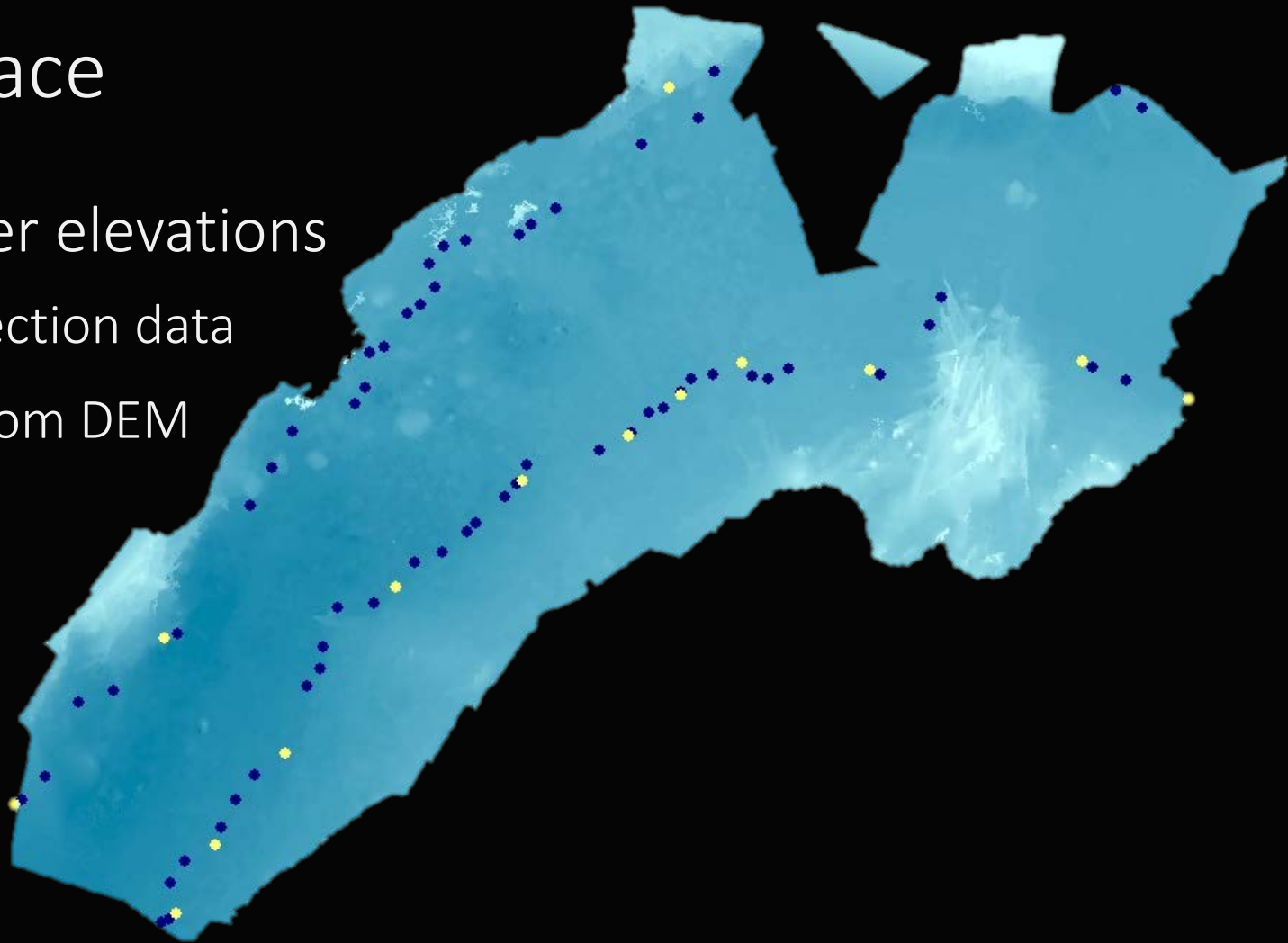
Water surface

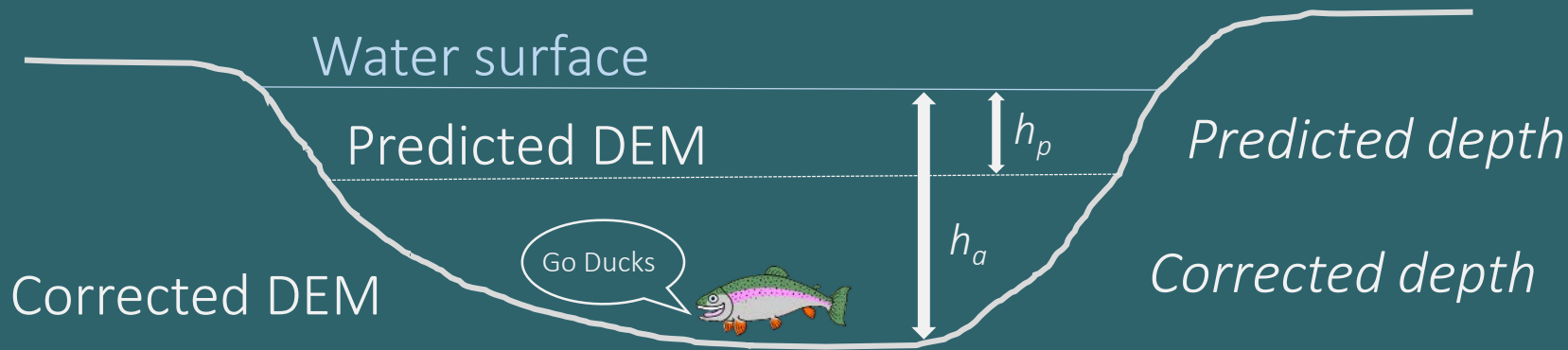
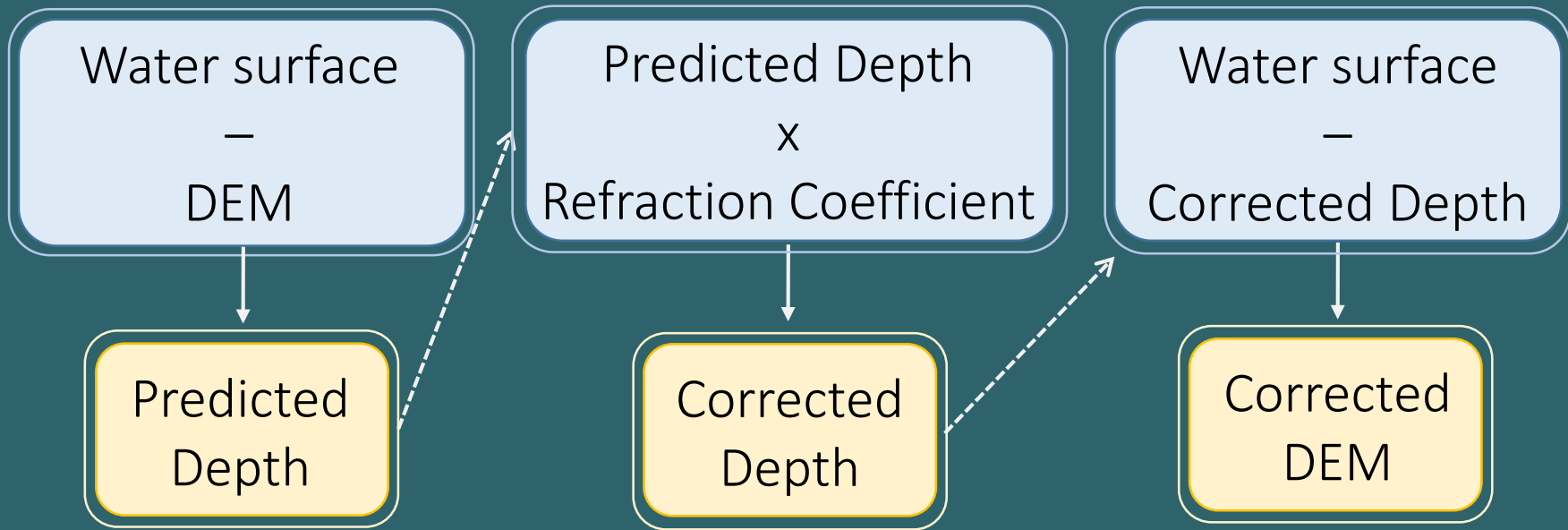
Edge-of-water elevations

● GPS cross section data

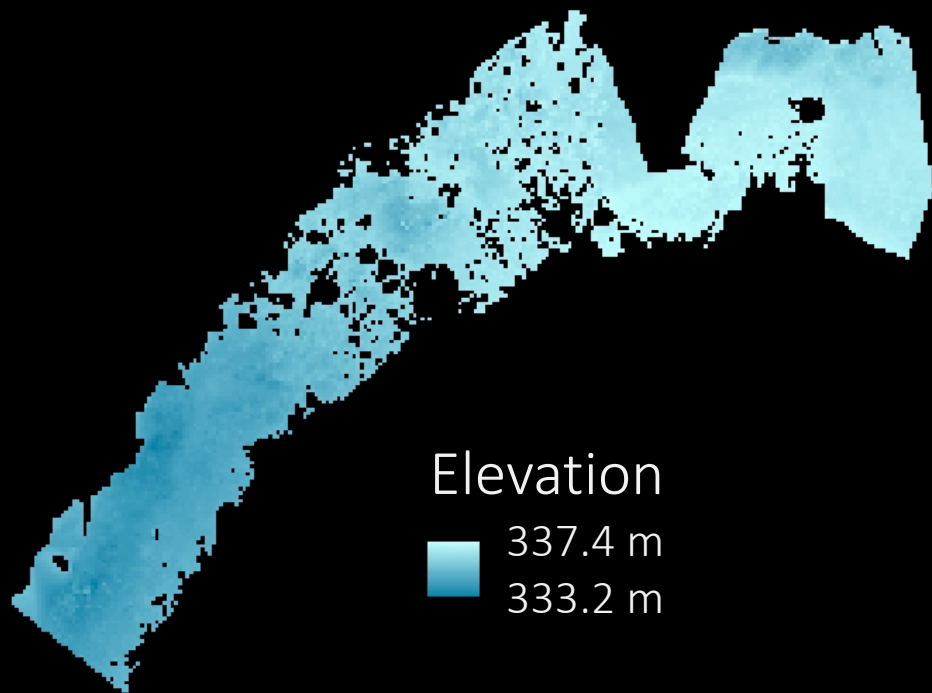
● Extracted from DEM

1.5 cm DEM

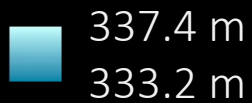




Corrected Bathymetry

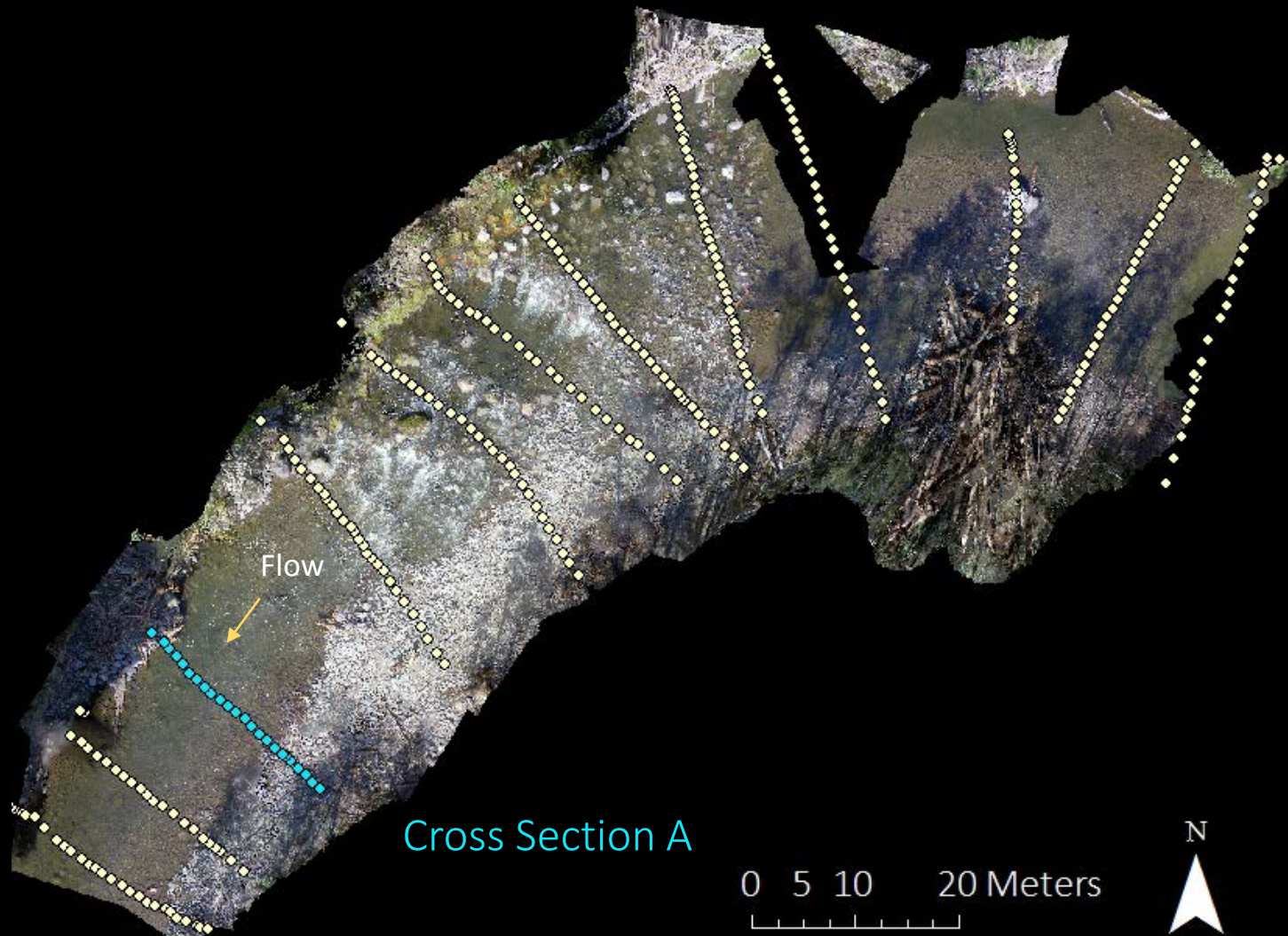


Elevation



0 5 10 20 Meters





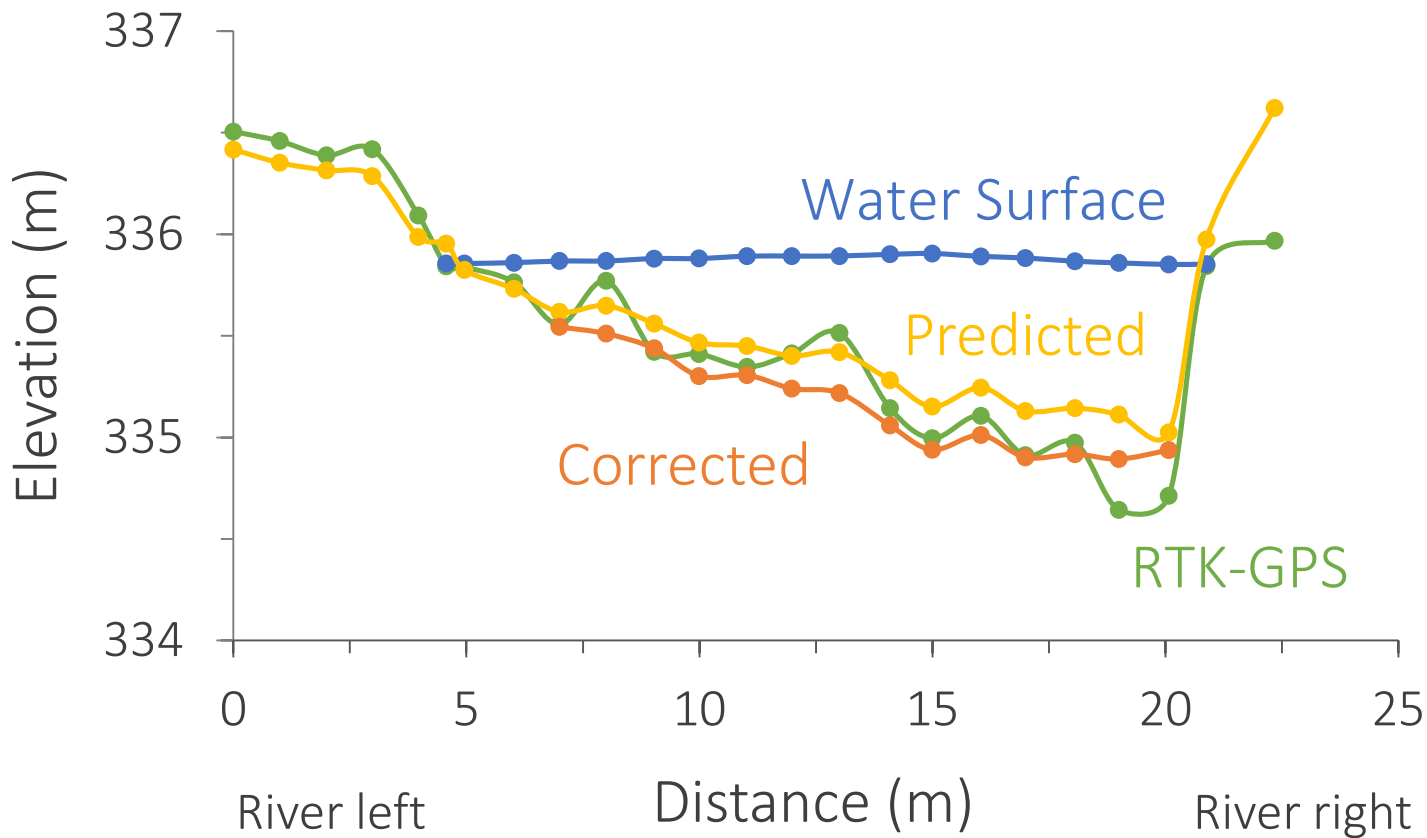
Flow

Cross Section A

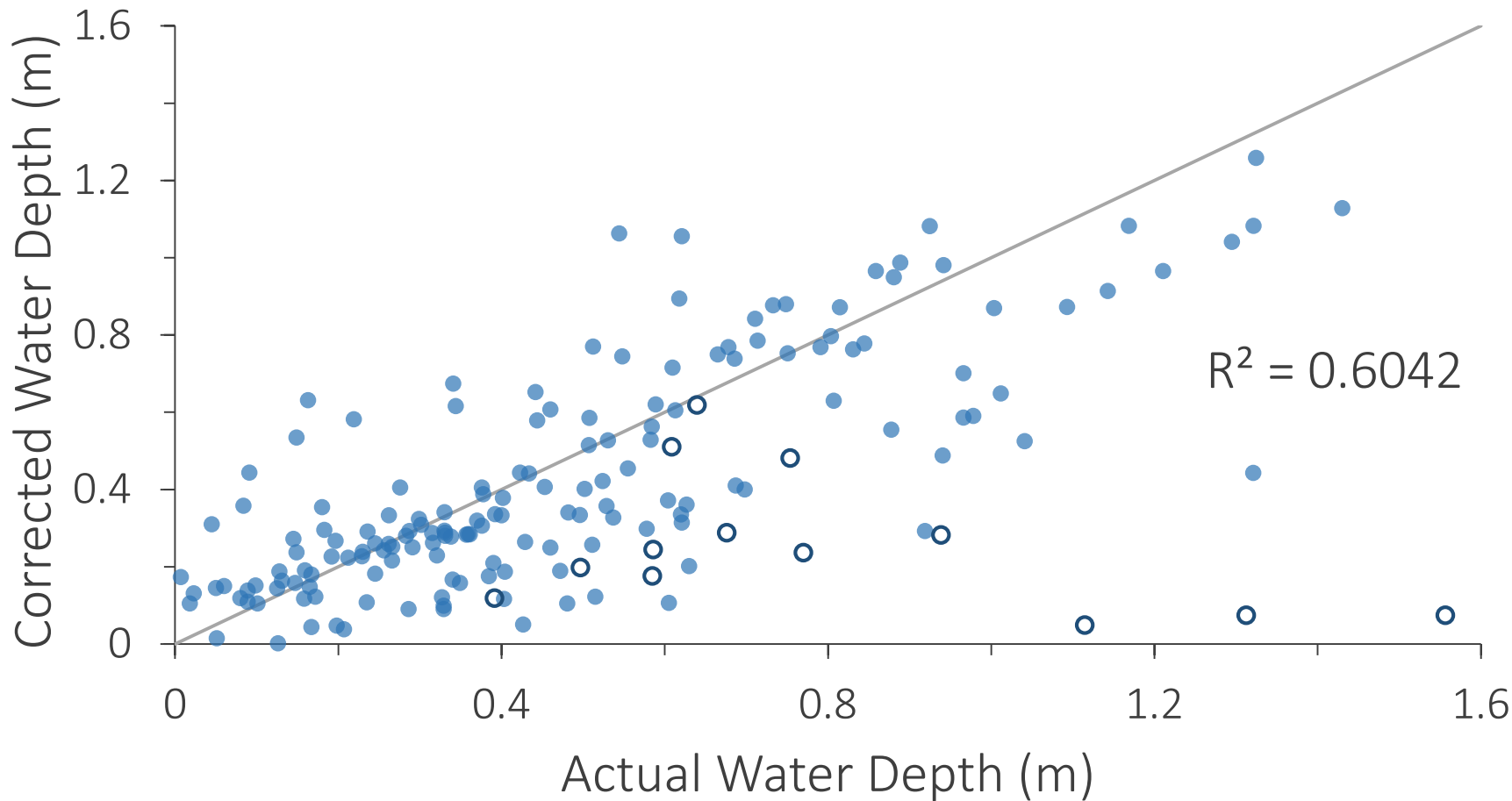
0 5 10 20 Meters

N

Comparison of Channel Bathymetry along Cross Section A



Actual vs. Corrected Water Depths



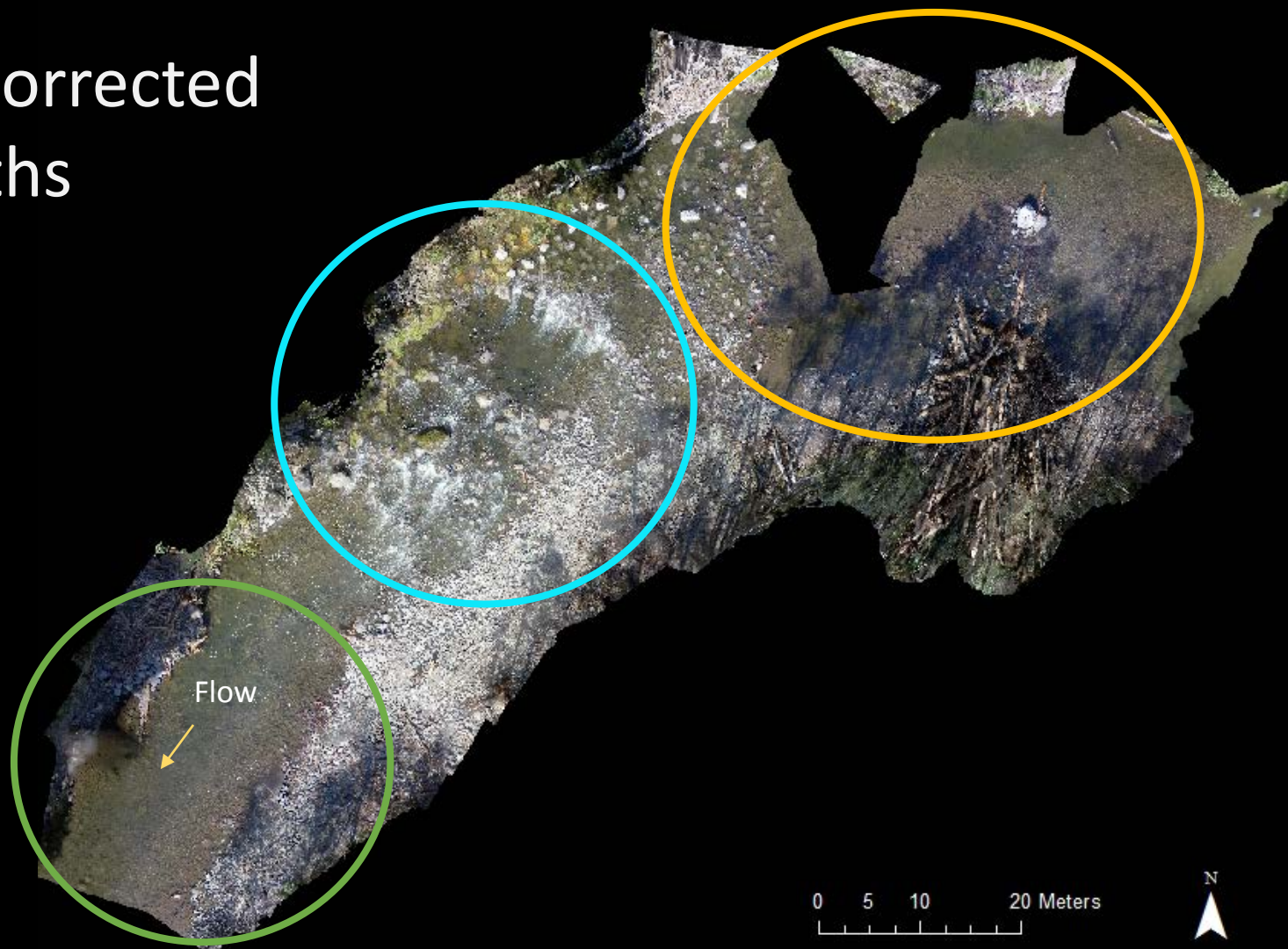
Actual vs. Corrected Water Depths

R^2

0.76 - glide

0.48 - riffle

0.56 - pool



Limitations and Considerations

- White water or turbid water
- Depth limit
- Light and shadow
- What is the appropriate refraction coefficient?
- Number of validation points necessary?

Time and Cost comparison

- 500 meter reach
- Field work: ~ 2 – 3 days
- Post processing: ~5 – 7 days

- Might take longer, but results include:
 - High resolution orthophoto and DEM
 - Spatially continuous data set

Summary

- Remote sensing techniques have great potential to extract bathymetry
- SfM can produce accurate bathymetric data sets in shallow, clear streams
- Develop guidelines for application



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