Updating the National Wetland Inventory in Pennsylvania

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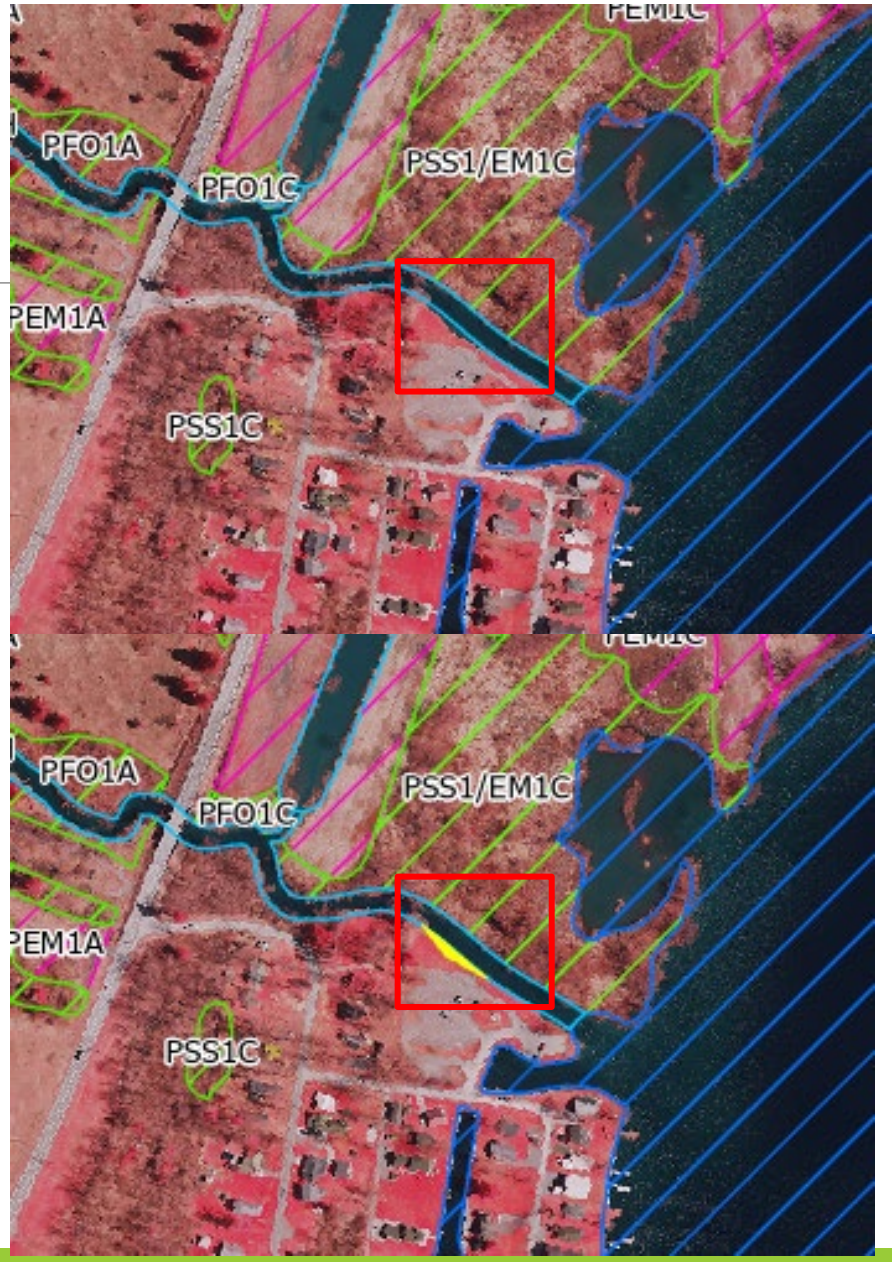
Agenda

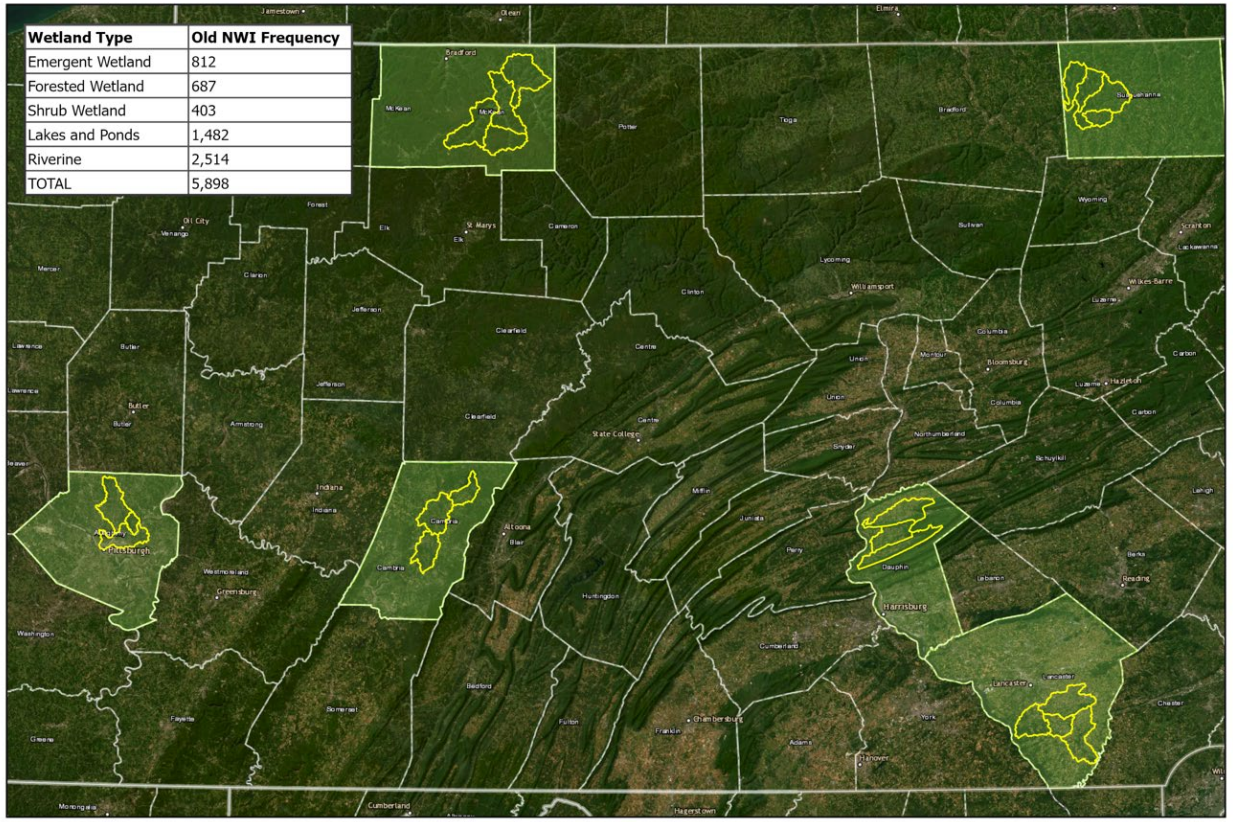
- NWI Project overview
- Overview of automation in NWI
- Chesapeake model and methodology
- Results


Puget Sound
CCAP
Chesapeake
Conservancy Model
Coastal Texas
NHD Rivers
Tampa
Bay CCAP

NWI Standards

- NWI standards were developed based on human photo-interpreters
- Cowardin classification system is very complex.
- Makes it very difficult to fully automate – DU has attempted hybrid approaches
- Horizontal accuracy of +/- 5 meters



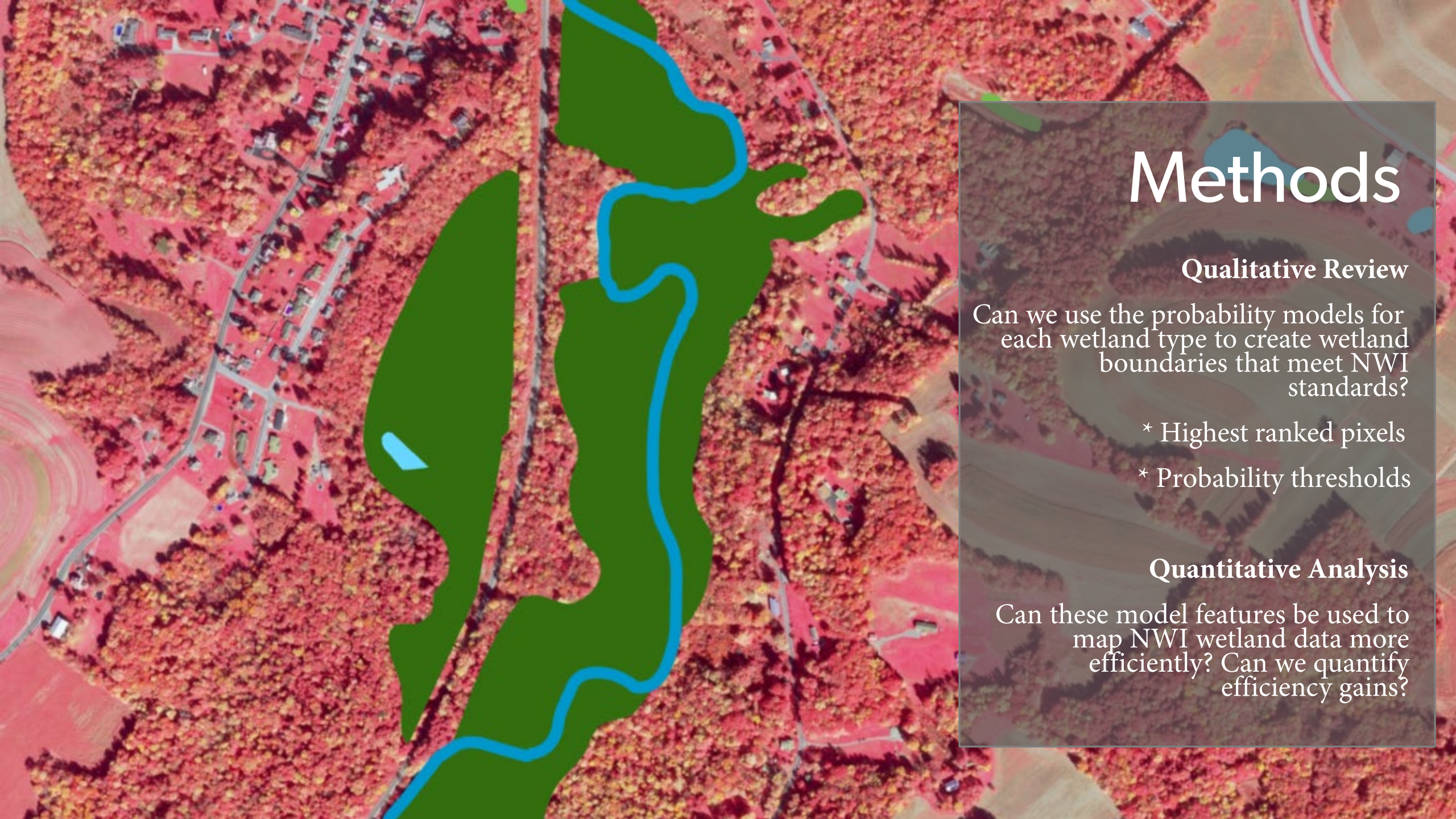


Project Goals

1) Update the National Wetland Inventory

   21 HUC12 watersheds within 6 Pennsylvania Counties
   - Allegheny County
   - Cambria County
   - Dauphin County
   - Lancaster County
   - McKean County
   - Susquehanna County

2) Assess the viability of using or incorporating similar automated wetland products in future NWI projects



Methods

Qualitative Review

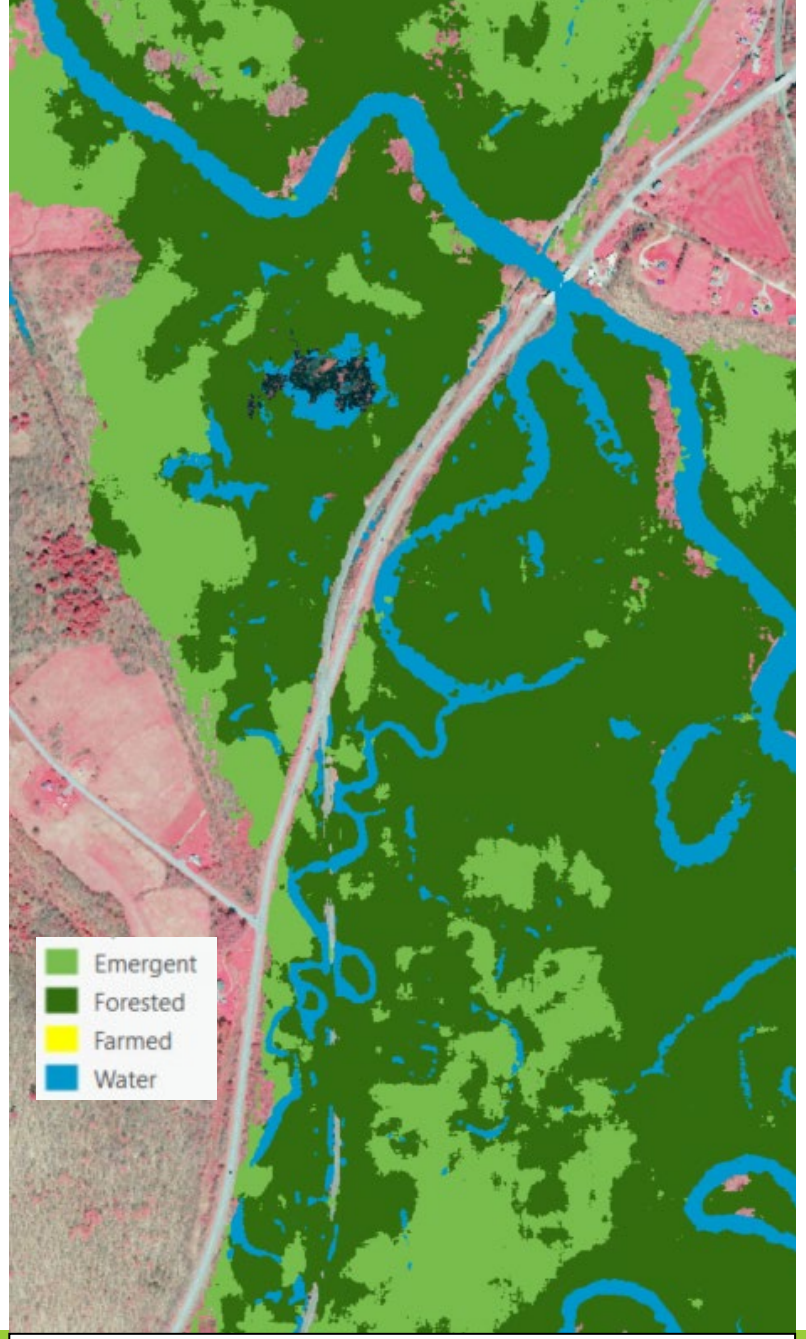
Can we use the probability models for each wetland type to create wetland boundaries that meet NWI standards?

* Highest ranked pixels

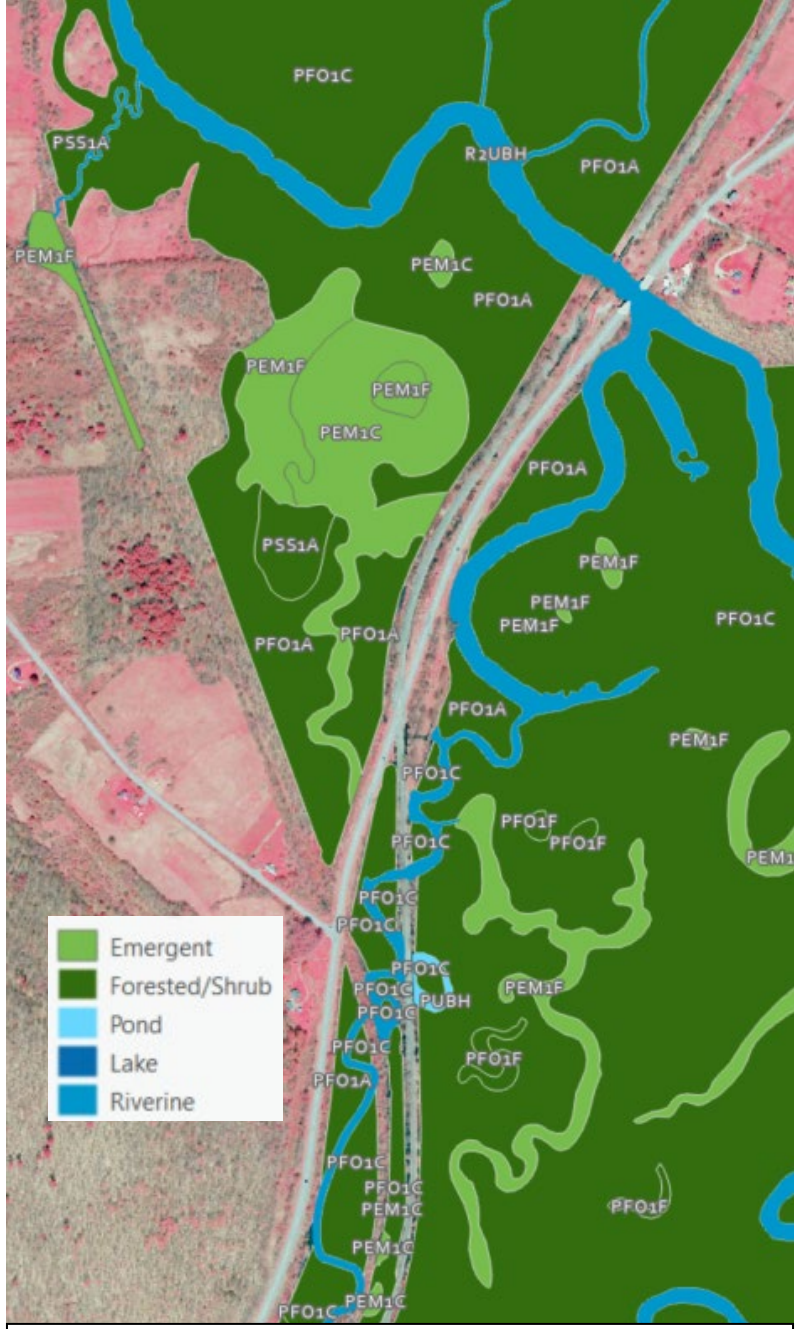
* Probability thresholds

Quantitative Analysis

Can these model features be used to map NWI wetland data more efficiently? Can we quantify efficiency gains?



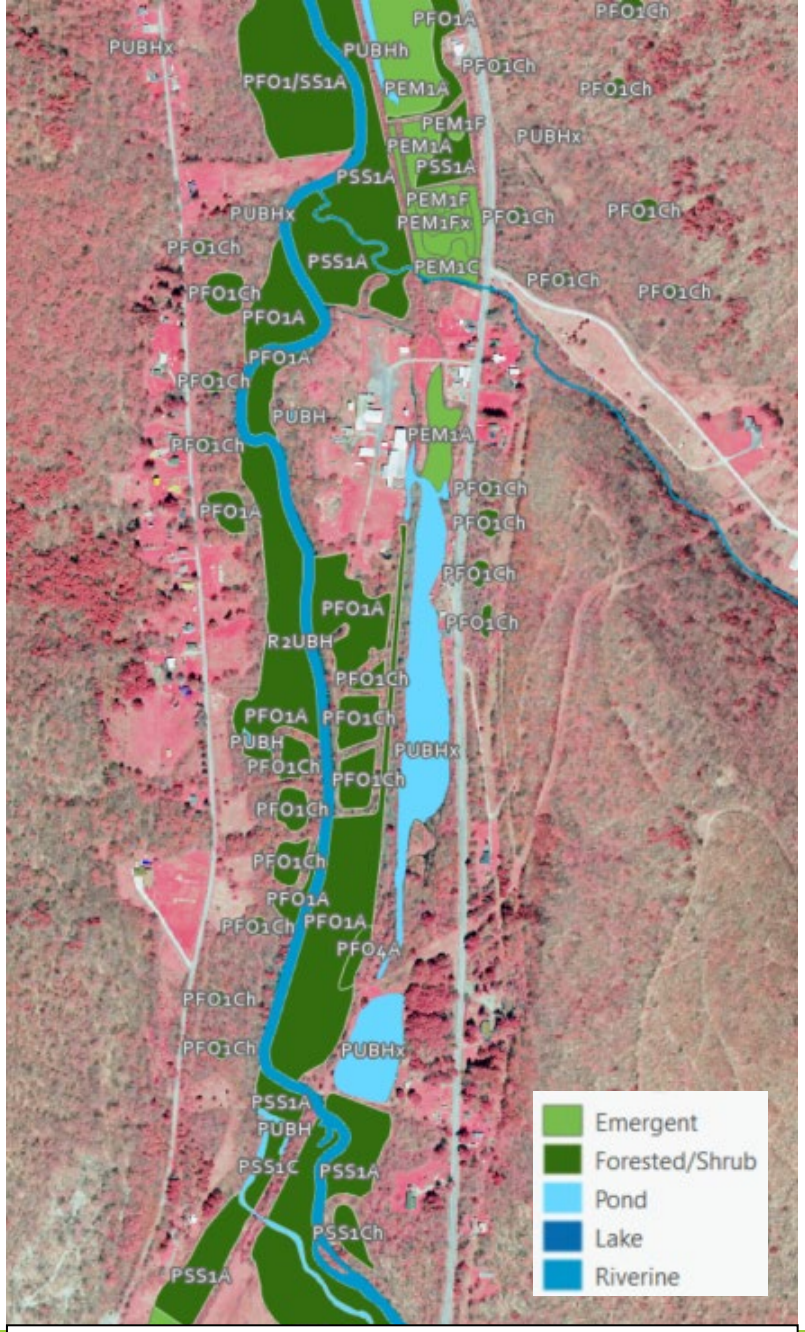
Chesapeake Bay Model – Highest Ranked Pixels



Traditional NWI Photo Interpretation

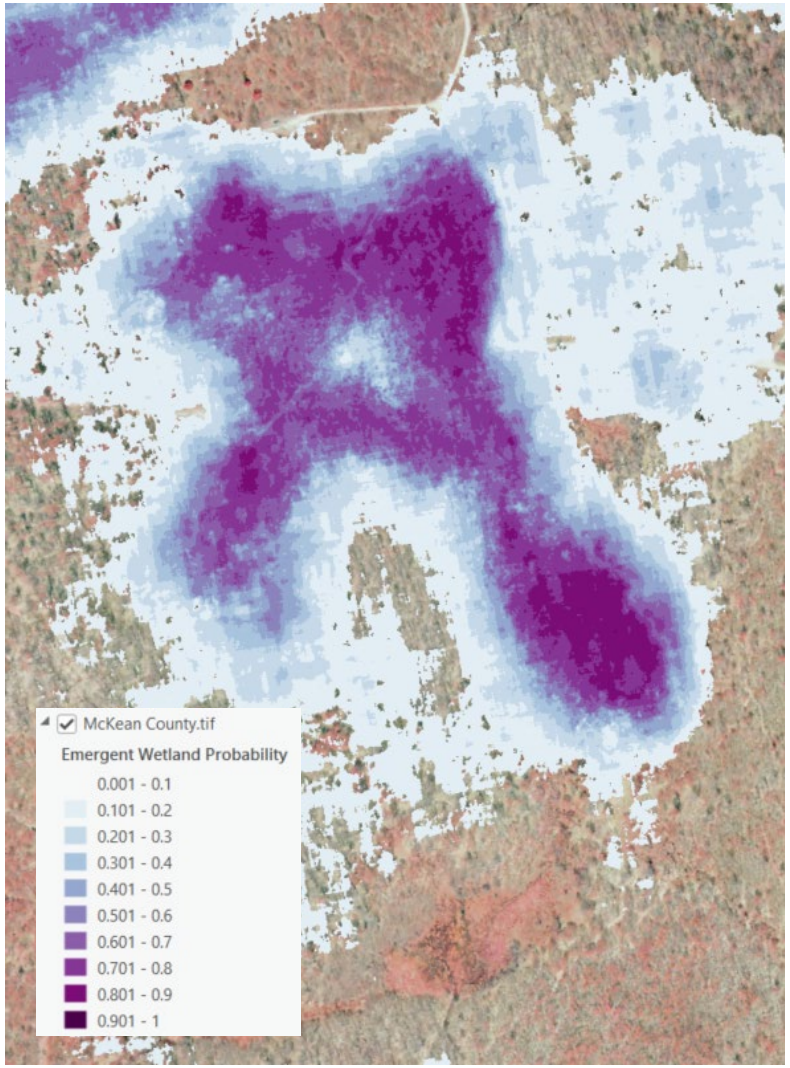
CIR NAIP 2022

Chesapeake Bay Model – Highest Ranked Pixels



Traditional NWI Photo Interpretation

CIR NAIP 2022


McKean County.tif
Emergent Wetland Probability
0.001 - 0.1
0.101 - 0.2
0.201 - 0.3
0.301 - 0.4
0.401 - 0.5
0.501 - 0.6
0.601 - 0.7
0.701 - 0.8
0.801 - 0.9
0.901 - 1


McKean County
78.5846320°W 41.7411271°N
1:5000

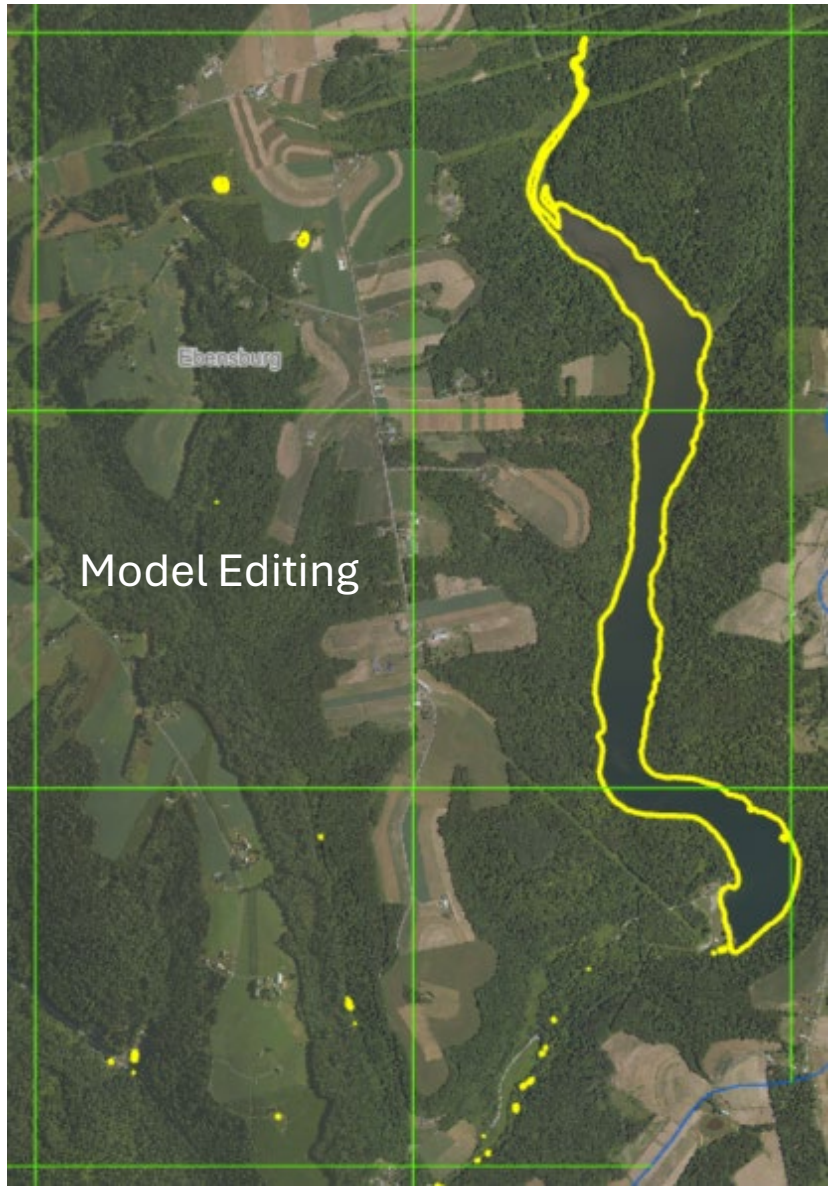
Qualitative Review

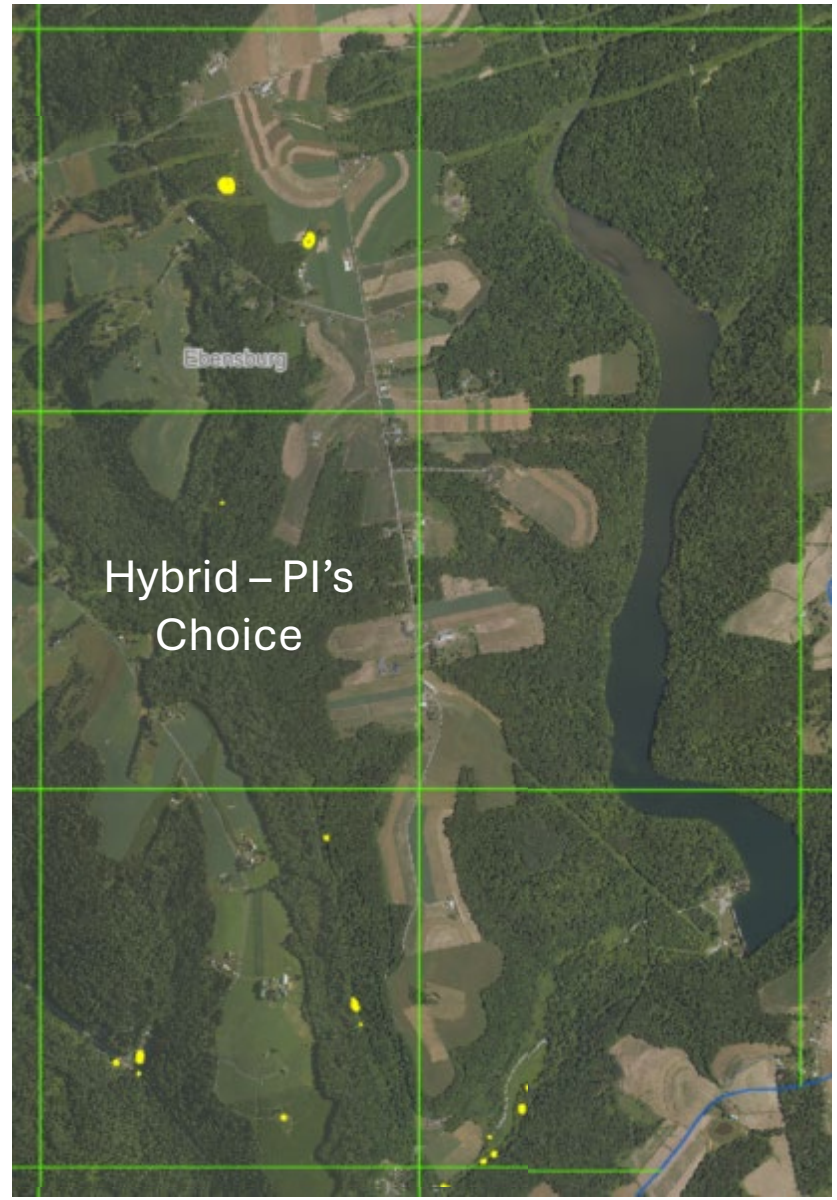
1. Model good at detecting wetland complex presence.
   - Boundaries don't consistently align with NWI standards *but*
   - Model as an ancillary dataset could improve efficiency for new photo-interpreters by reducing decision-fatigue (not quantitatively tested).
2. Highest Ranked Pixels didn't consistently map wetland types accurately for most wetland types except water bodies.
3. No threshold value consistently aligned with NWI standards.
   - Lower probability thresholds:
     - Show small wetlands
     - Over-map larger wetland complexes (commission errors)
   - Higher probability thresholds:
     - Perform better at mapping larger wetland complexes
     - Miss small wetlands (omission errors)

Quantitative Analysis: Efficiency of using model-derived features during the photo interpretation process?


Converted the highest-ranked pixels for open water to polygon features.
Focus: water bodies (lake and ponds only)

Comparing Digitization Speed Among Three Methods



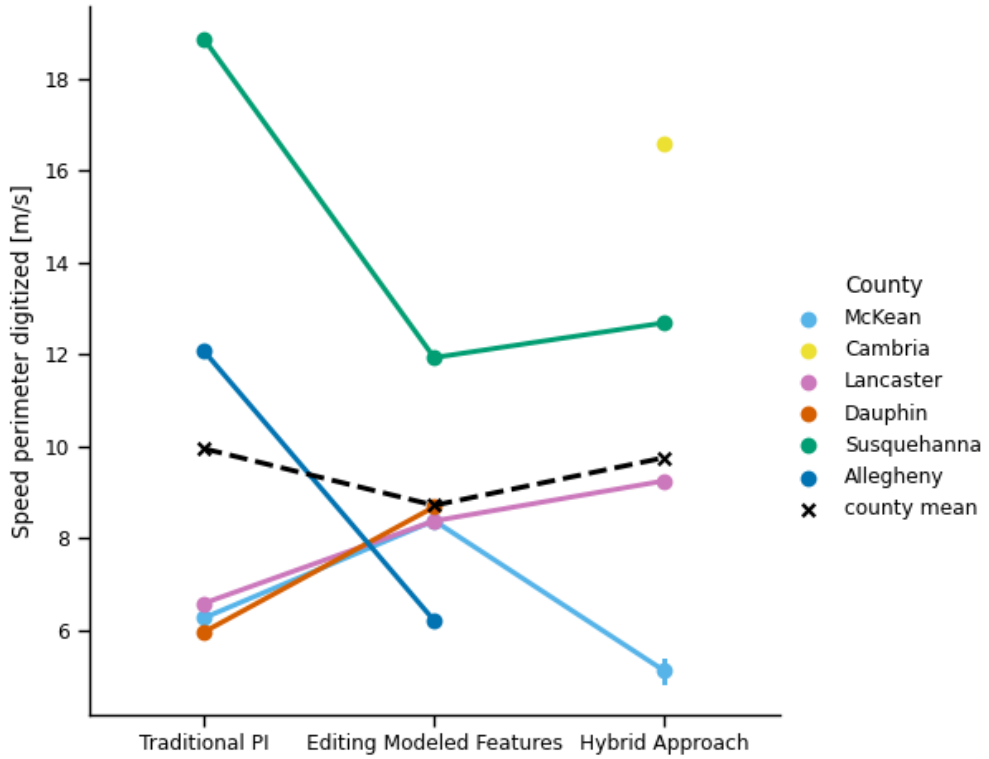


Summary of Timed Sprints

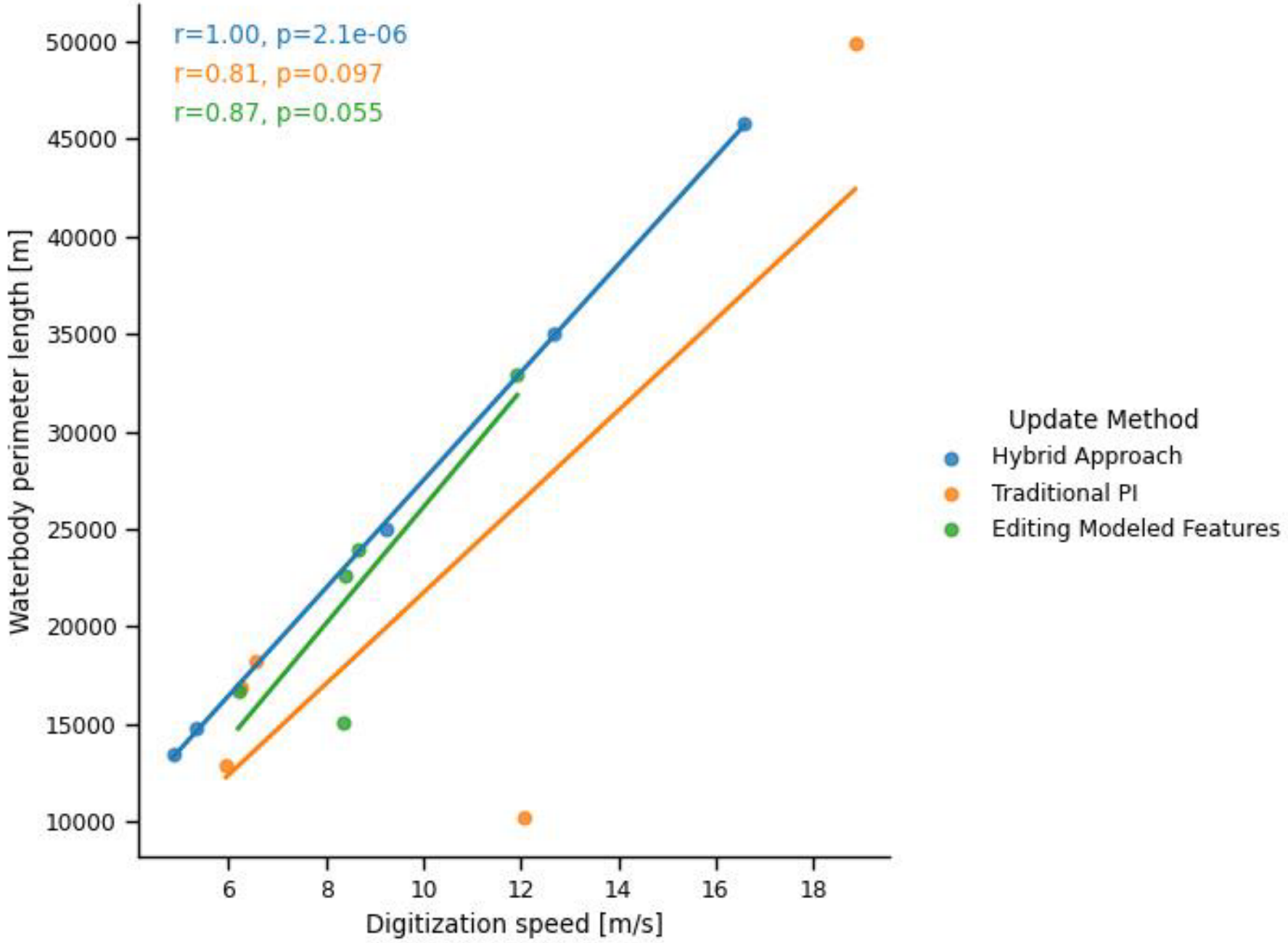
Method	Number of Timed Trials	Number of Counties	Average Completion Time (sec)	Average Feature Count	Average Length of Waterbody Perimeter (m)	Average Waterbody Area (ac)
Traditional	5	5	2,224	112	21,603.08	94.45
Model Editing	5	5	2,546	115	22,270.52	78.50
Hybrid	5	4	2,750	113	26,801.15	245.76

Table 1. Summary of timed sprints performed using different PI methods: A) Traditional PI, B) Editing Modeled Features, and C) the Hybrid Approach.

ANOVA and Levene tests showed no statistically significant difference between the three methods.



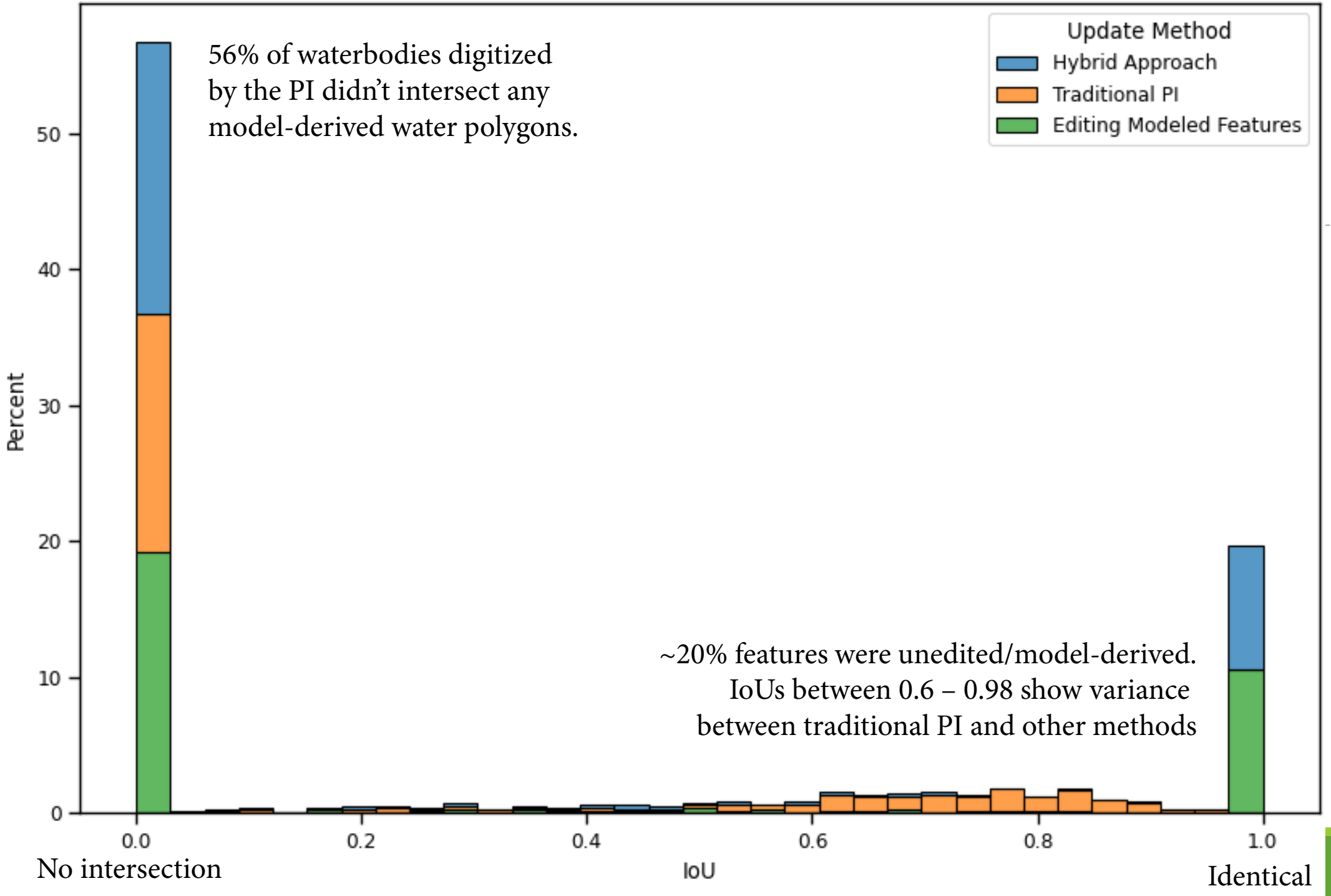
Method	Average Digitization Speed			Per-Feature Averages	
	Perimeter (m/s)	Area (ac/s)	Polygon/ second	Area (ac)	Perimeter length (m)
Traditional PI	9.94	0.05	0.048	1.29	222.36
Model Editing	8.71	0.03	0.046	0.67	195.57
Hybrid Approach	9.75	0.09	0.040	1.91	234.04



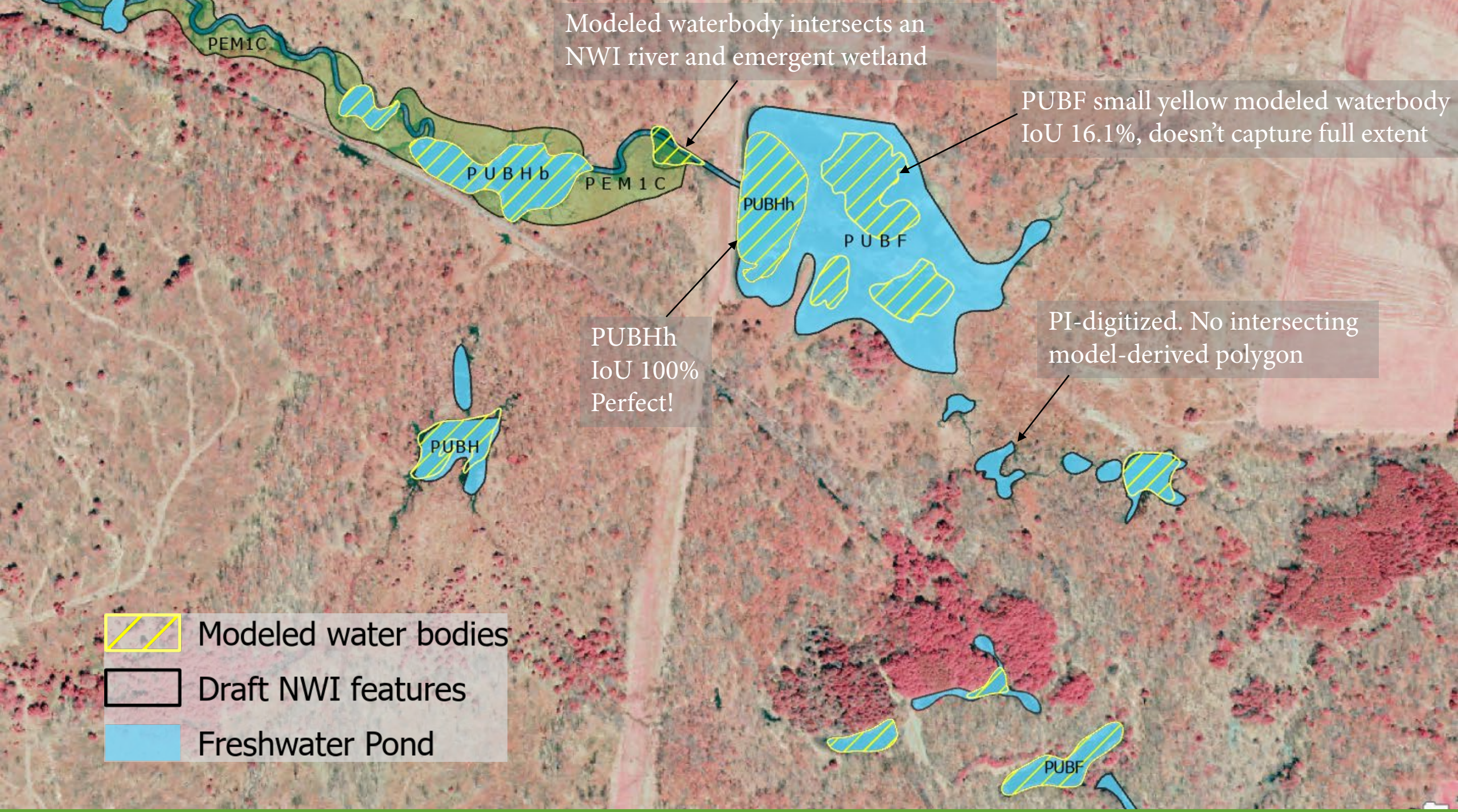
The linear relationship between total waterbody perimeter and digitization speed across three methods.

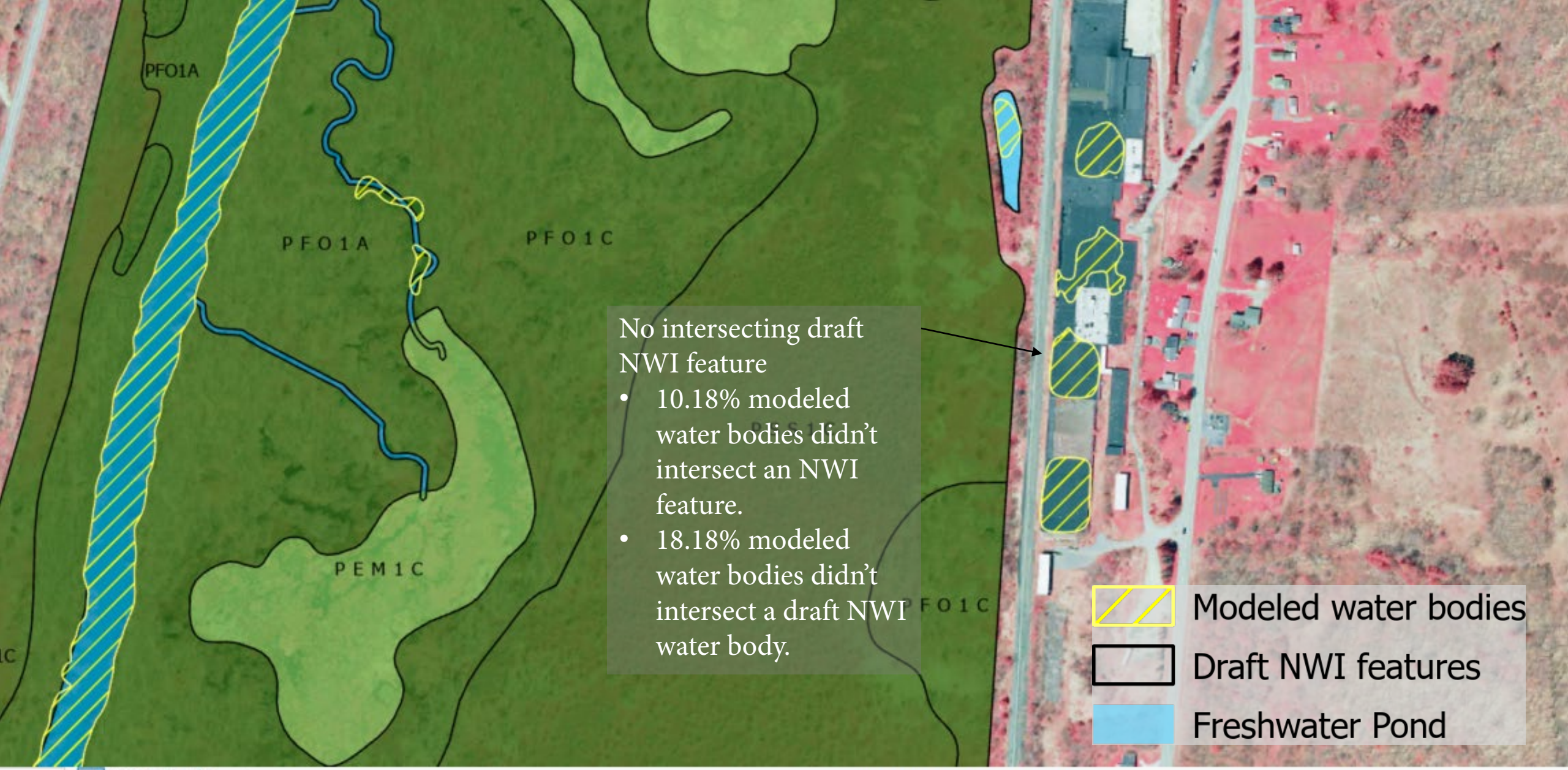
How similar is the output for modeled waterbodies to the final NWI product?

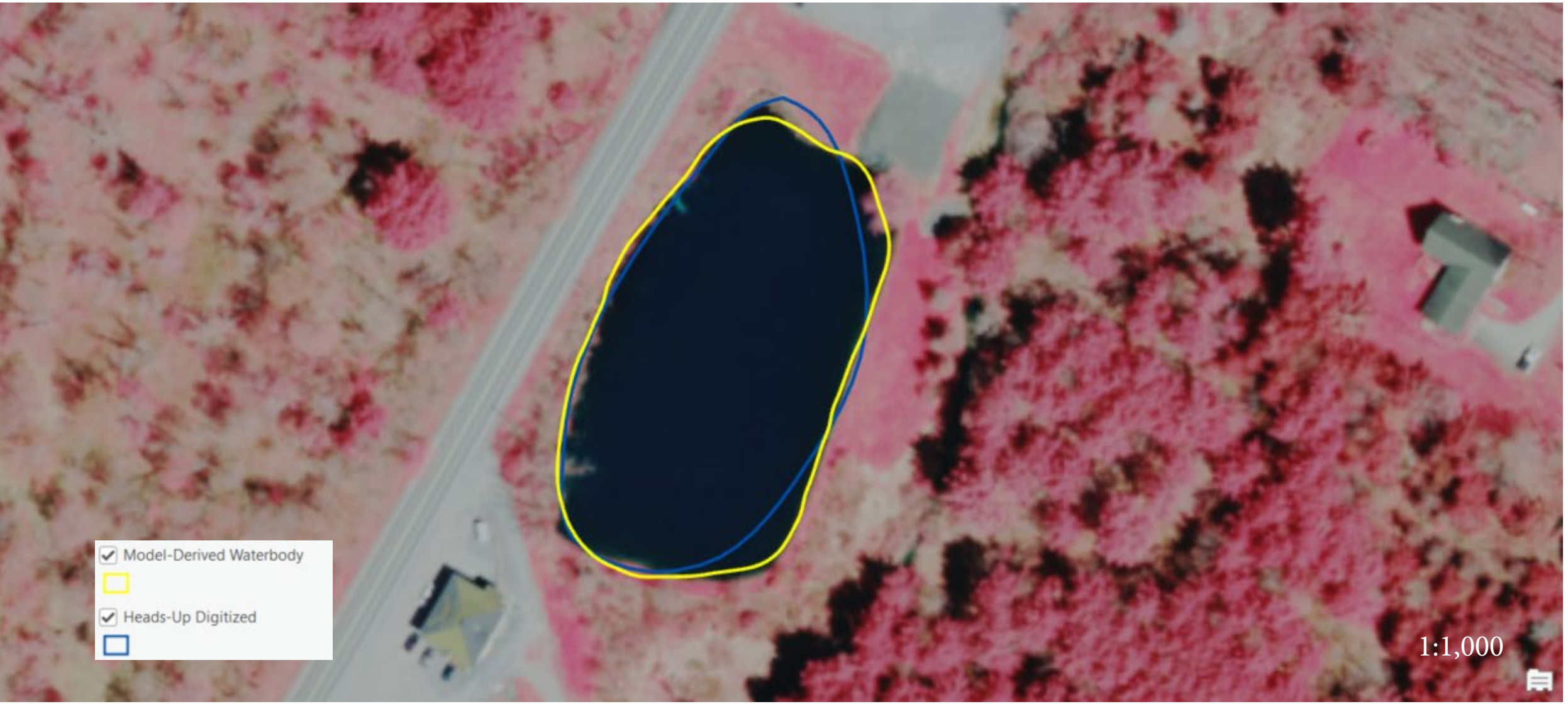
$$IoU = \frac{\text{Area of Overlap}}{\text{Area of Union}}$$


56% of waterbodies digitized by the PI didn't intersect any model-derived water polygons.
Update Method
Hybrid Approach
Traditional PI
Editing Modeled Features
Percent
50
40
30
20
10
0
~20% features were unedited/model-derived.
IoUs between 0.6 – 0.98 show variance
between traditional PI and other methods
0.0
0.2
0.4
0.6
0.8
1.0
IoU
No intersection
Identical


PUBHh
IoU 100%
Perfect!
PI-digitized ponds. No intersecting model-derived polygon.
1:12,000


Modeled waterbody intersects an NWI river and emergent wetland
PUBF small yellow modeled waterbody IoU 16.1%, doesn't capture full extent
PUBHh IoU 100% Perfect!
PI-digitized. No intersecting model-derived polygon
PEM1C
PUBHb
PEM1C
PUBHh
PUBF
PUBH
PUBF
Modeled water bodies
Draft NWI features
Freshwater Pond


PFO1A
PFO1A
PFO1C
PEM1C
PFO1C
No intersecting draft NWI feature
• 10.18% modeled water bodies didn't intersect an NWI feature.
• 18.18% modeled water bodies didn't intersect a draft NWI water body.
Modeled water bodies
Draft NWI features
Freshwater Pond
78.3727557°W 41.9270899°N


Model-Derived Waterbody
Heads-Up Digitized
1:1,000

Similarity metrics between modeled waterbodies (MWBs) and final NWI data

11.31% of MWB have an IoU >0.95 with final NWI waterbodies.

10.79% of MWBs have an IoU > 0.95 with final NWI features.

58% of NWI waterbodies don't intersect any MWBs

10.18% of MWBs don't intersect any NWI features

Conclusions

No statistically significant difference between methods that incorporate model-derived features and traditional photo-interpretation methods.

Many small waterbodies were not captured by the model.

Some commission errors with the waterbody model (shadows and buildings).

But:

Some of modeled water polygons are more accurately mapped than the PI polygons (pers. Obs.)

Model-derived polygons are great for reducing decision-fatigue and do support the photointerpretation process.


Thank you!