Conservation Innovation Center

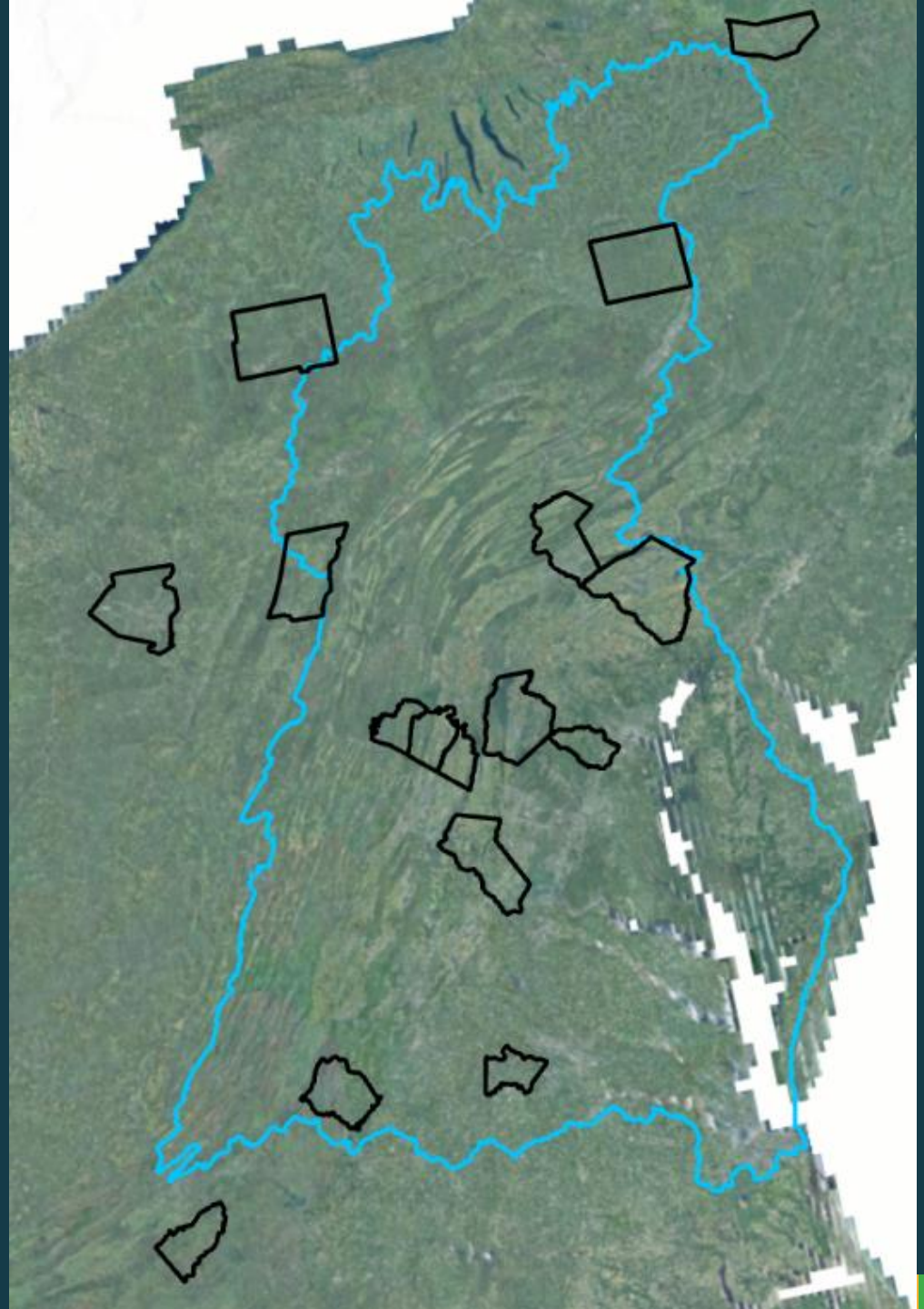
Non-Tidal Wetland Mapping

Dr. Michael Evans, Deputy Director
David Saavedra, Geospatial Technical Lead
Charlotte Weinstein, Geospatial Data Analyst

Chesapeake Conservancy

1/30/2025

Photo by Nicholas A. Tonelli



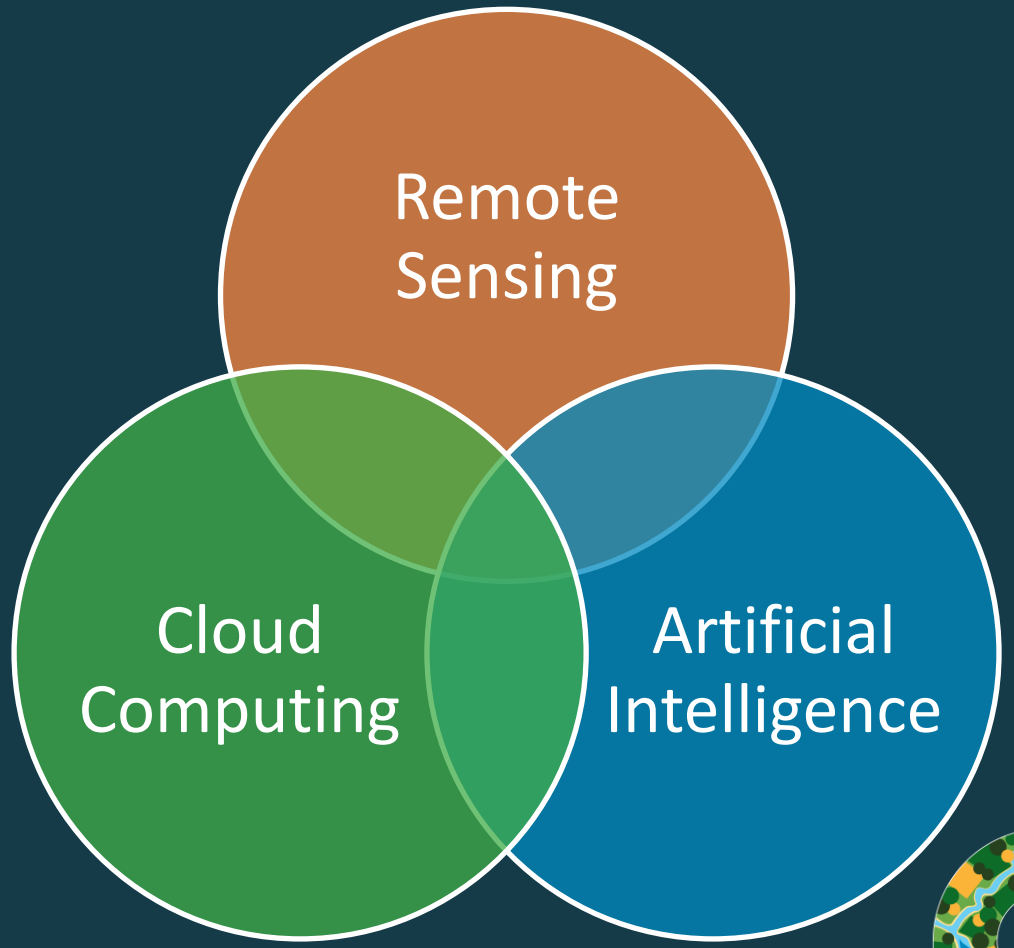
Goal

Refine a deep-learning model for mapping wetland presence in non-tidal geographies within the Chesapeake Bay watershed

Objectives

- Produce geospatial wetland data for a subset of CBW
- Create data dictionary of existing geospatial wetland data
- Research potential for production of NWI data

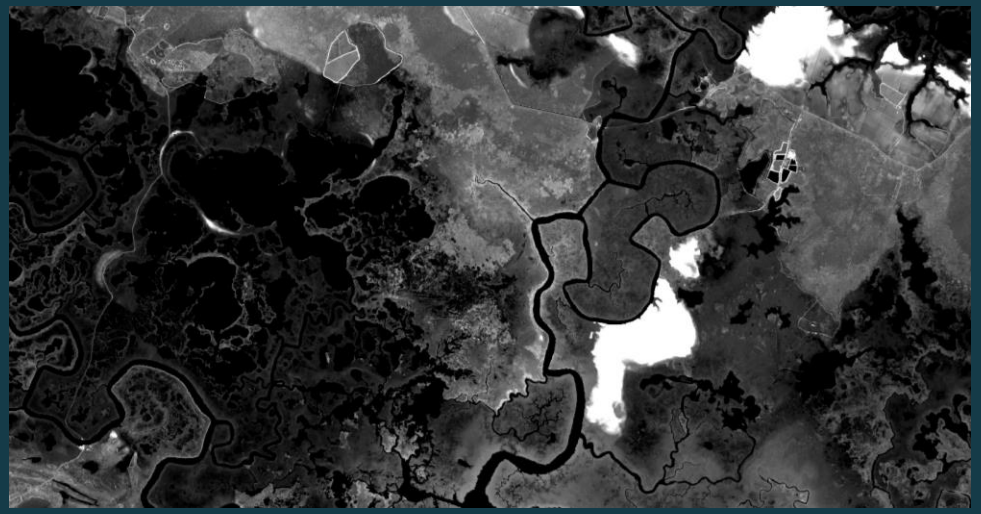
Approach



Input Data: NAIP

- Four Variables: Red, Green, Blue, Near Infrared Reflectance
- Resampled to 1 m resolution
- Collected from nearest year to NWI imagery

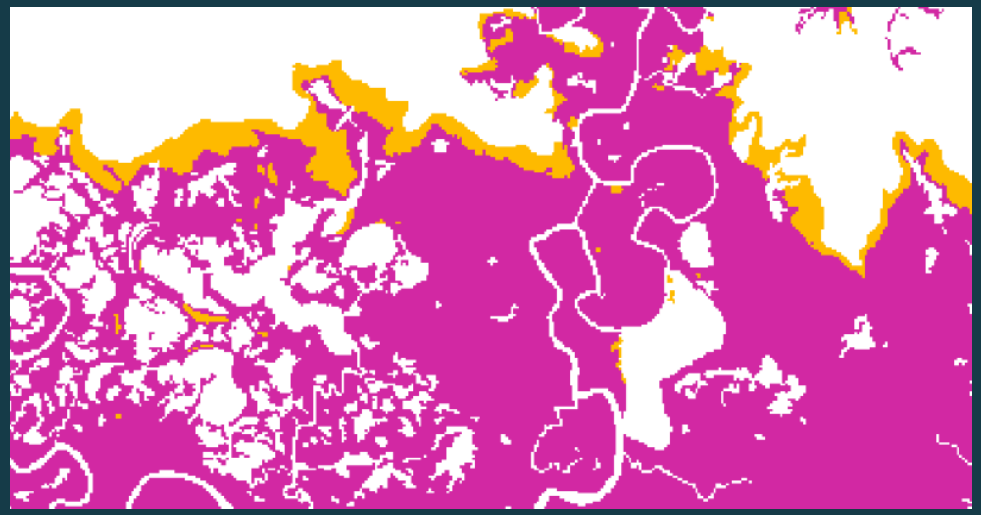
Input Data : Elevation

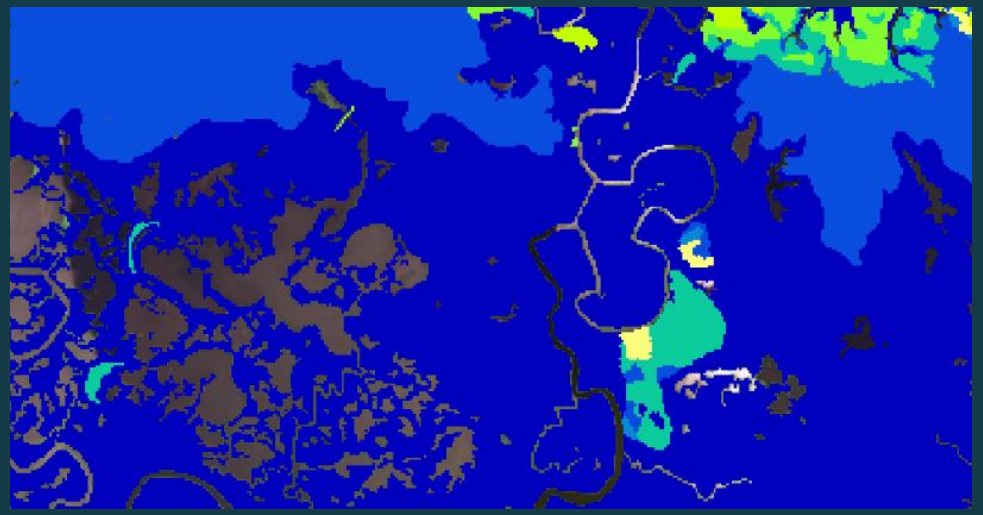


- LiDAR-derived digital elevation model
- 1 m Resolution
- Produced for CBW and select counties

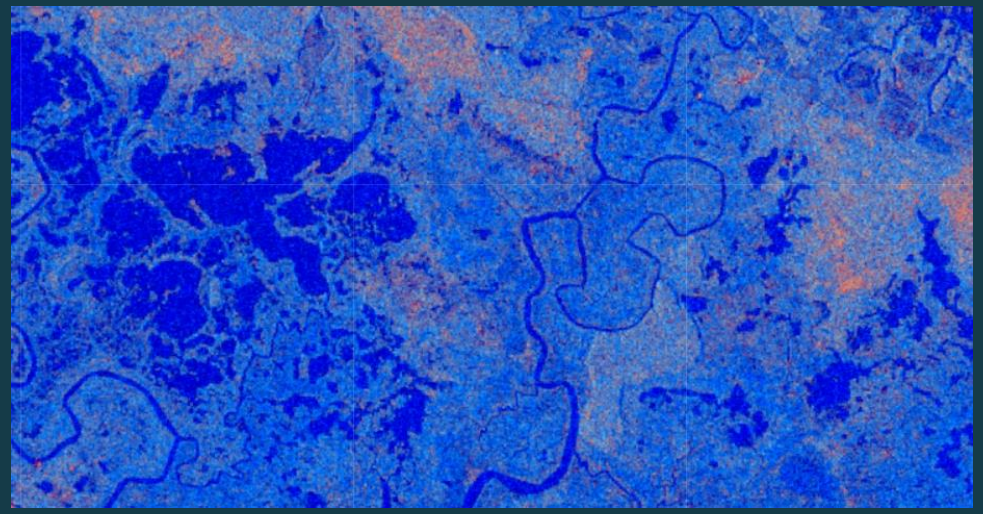
Input data: SSURGO soil characteristics

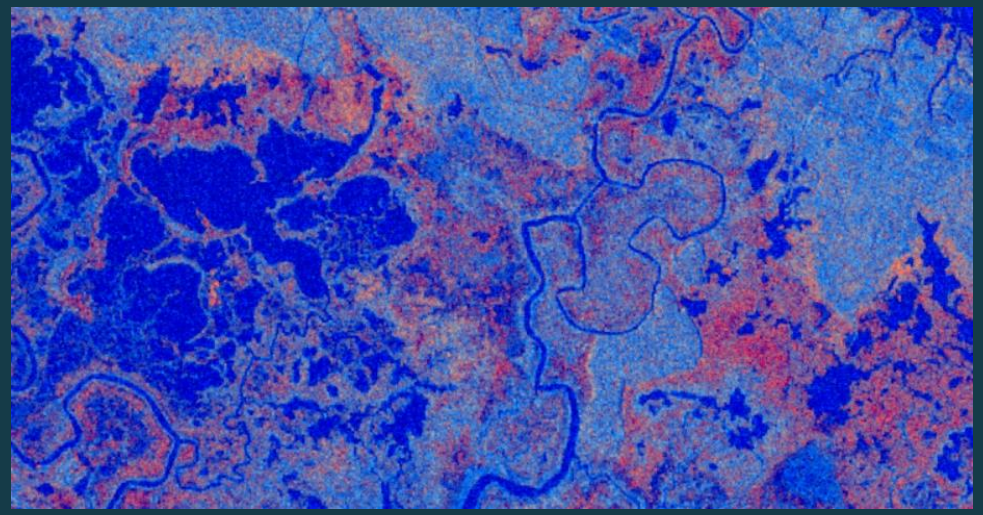
- Four Variables: Wetness depth, Drainage class, Flood frequency, Hydric class
- 10 m resolution
- Rescaled categorical variables driest = 0 to wettest = 1



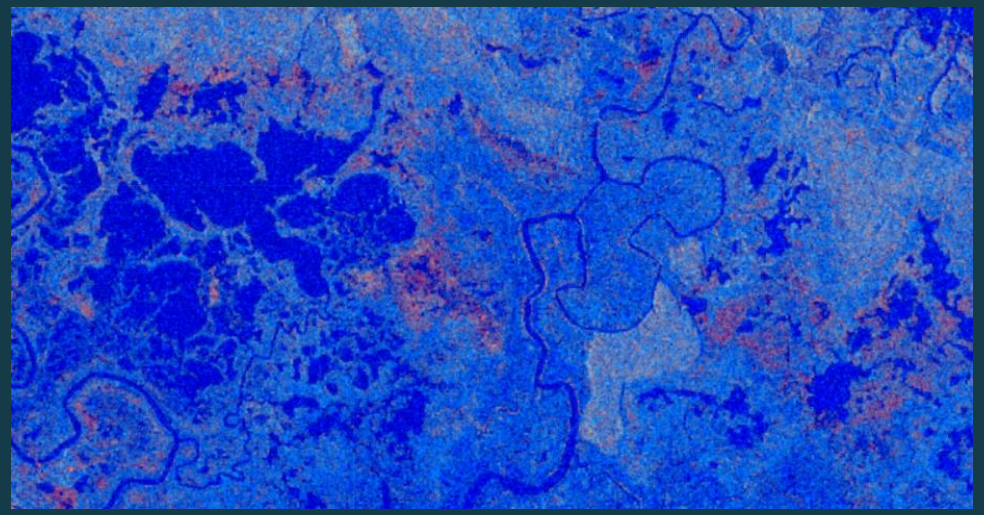


Input Data: Sentinel-1



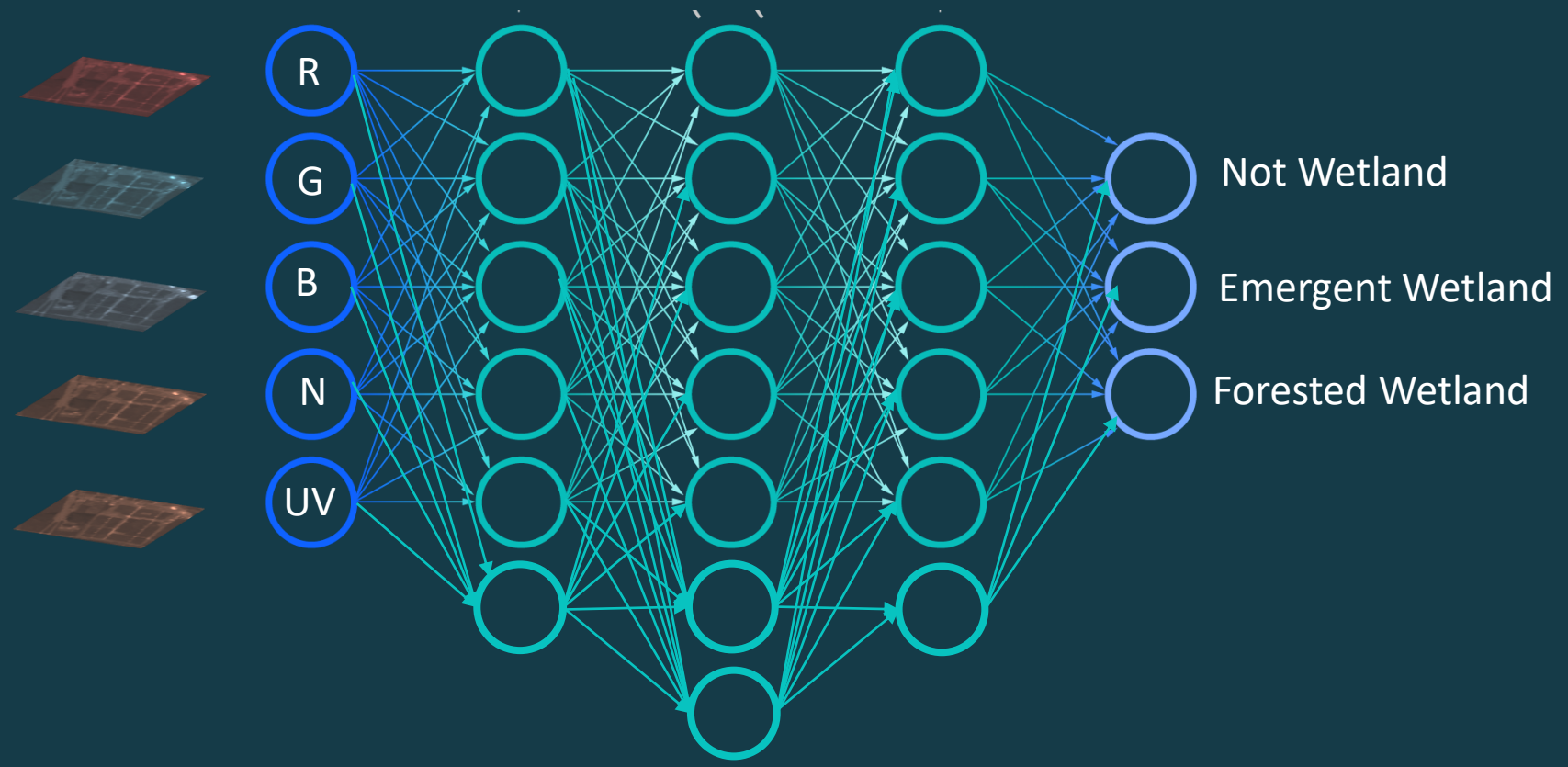


- Two Variables: VV, VH C-band radar returns
- 10 m Resolution
- Ascending Pass, Wide-swath (IW)
- Six bi-monthly median composite timeseries



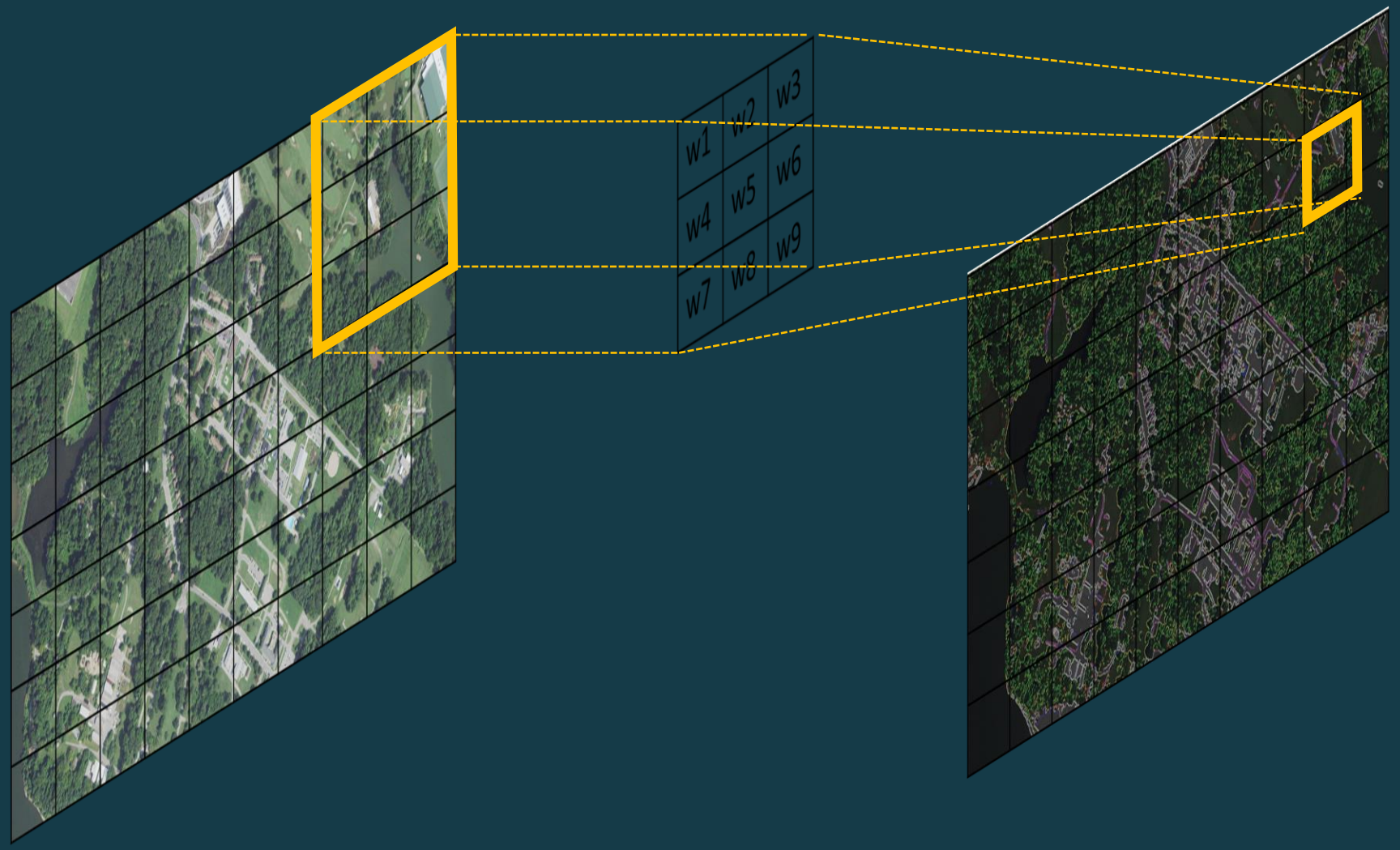
Deep Learning (AI)

Neural network – learn non-linearities, conditionalities, & interactions

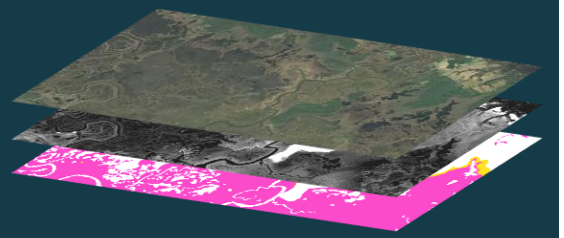


Deep Learning: Convolution

learn the shape and context of objects in images



Model Architecture #1: U-Net



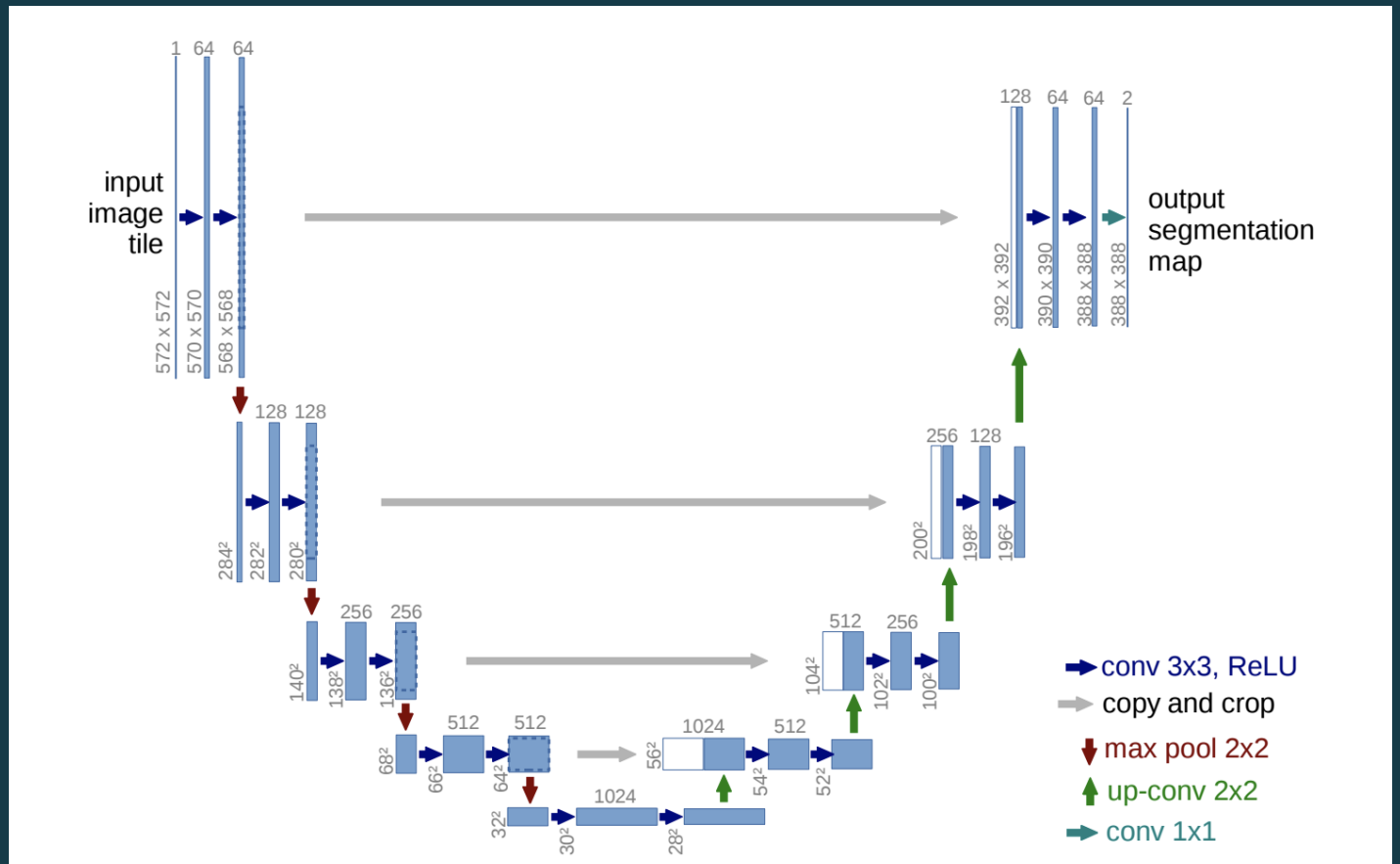
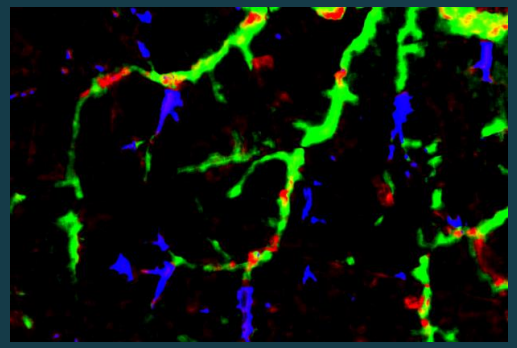


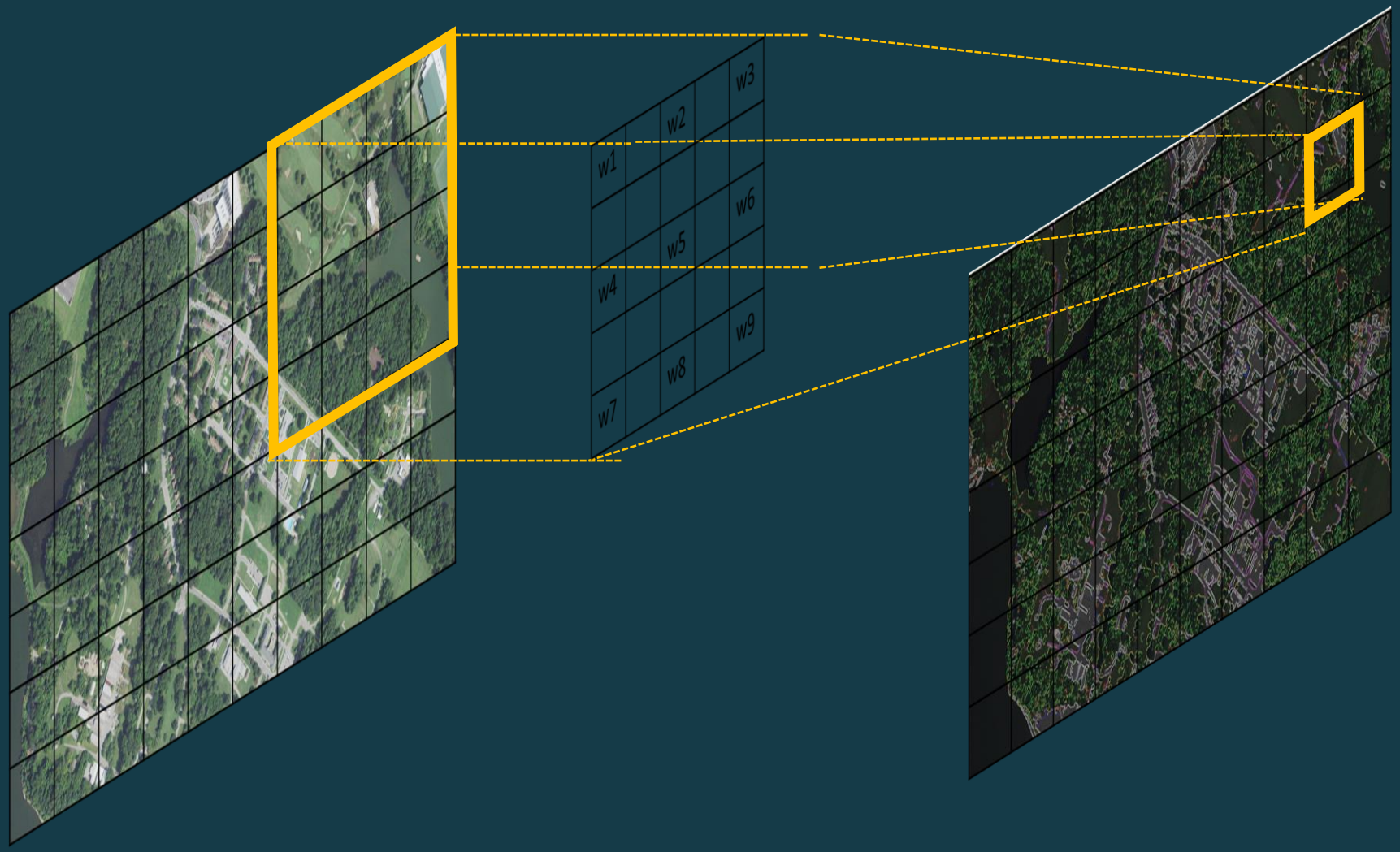
Fig. 1. U-net architecture (example for 32x32 pixels in the lowest resolution). Each blue box corresponds to a multi-channel feature map. The number of channels is denoted on top of the box. The x-y-size is provided at the lower left edge of the box. White boxes represent copied feature maps. The arrows denote the different operations.

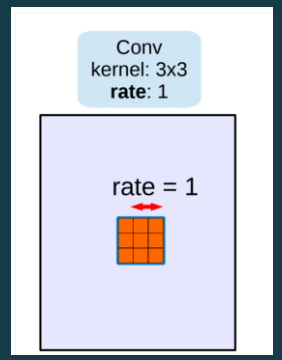


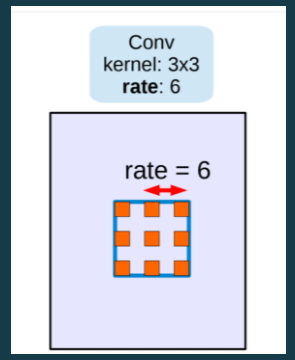
Ronneberger et al. 2015

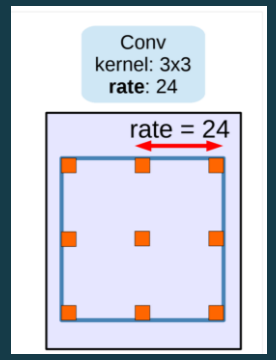
Deep Learning: Atrous convolution

Increase field of view

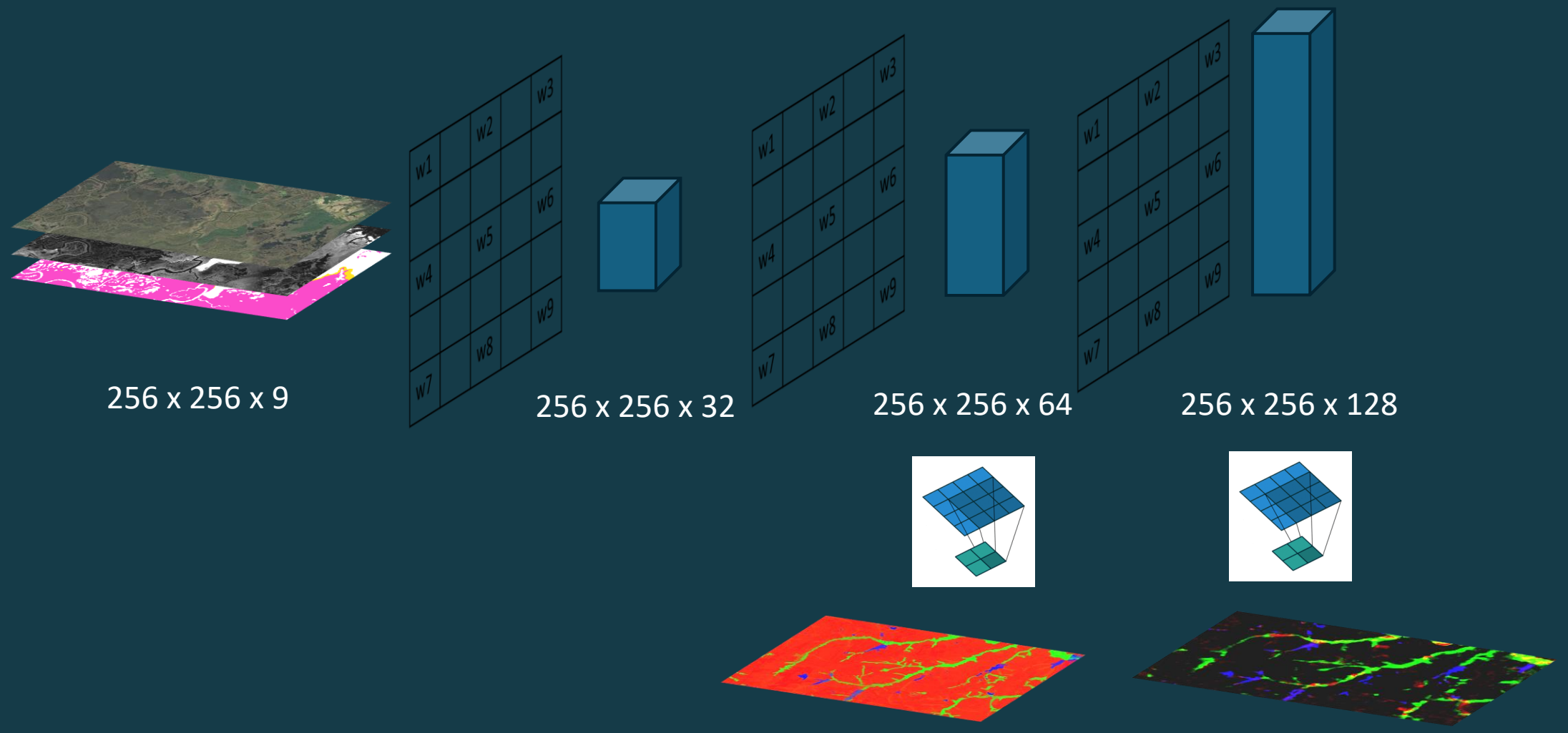






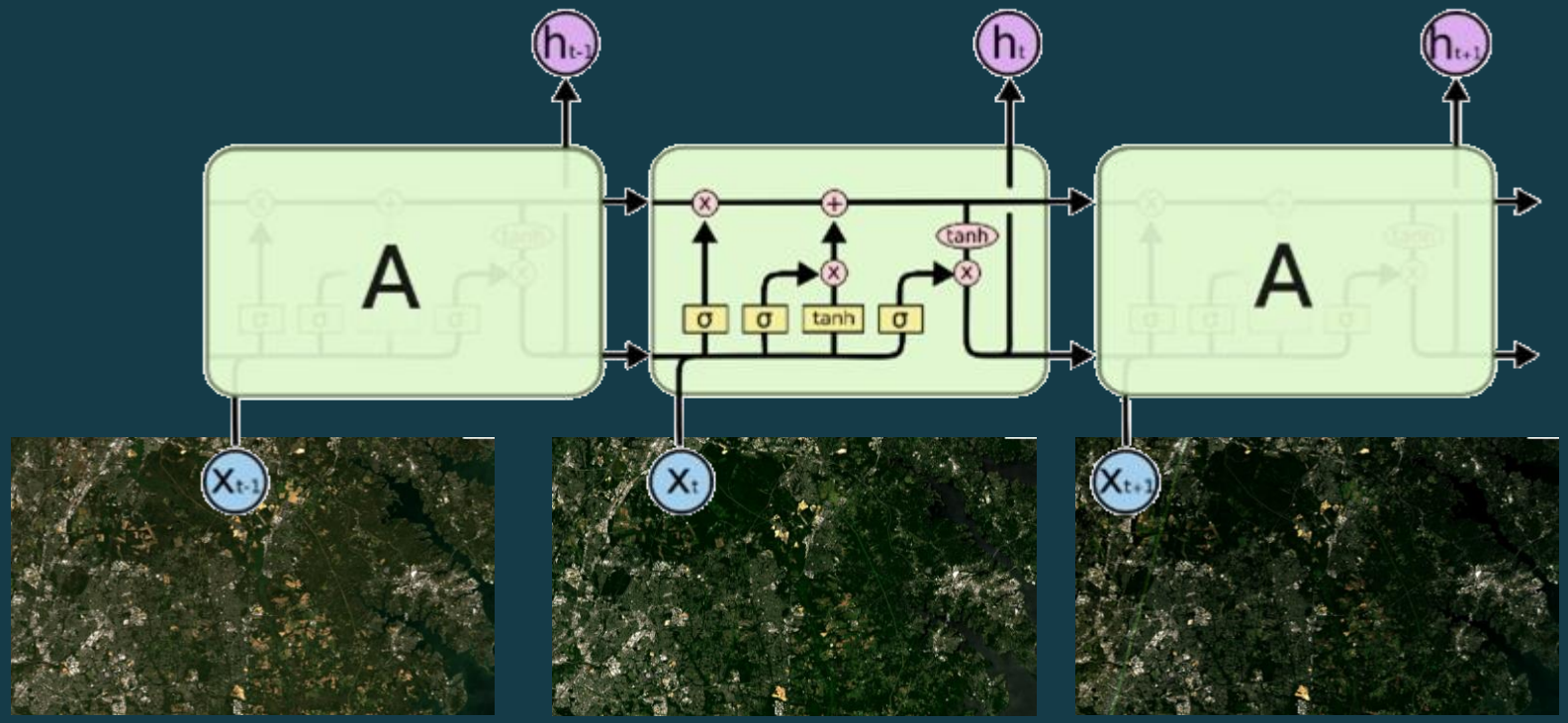


Deep Learning: ACNN



Ronneberger et al. 2015

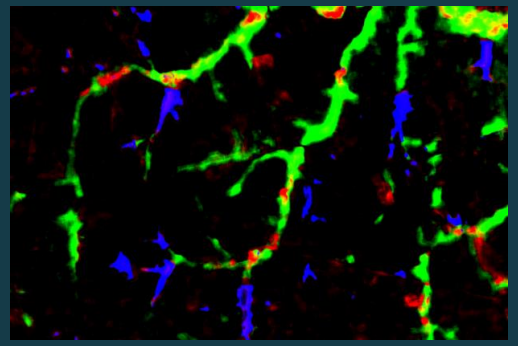
Deep Learning : Long Short-Term Memory



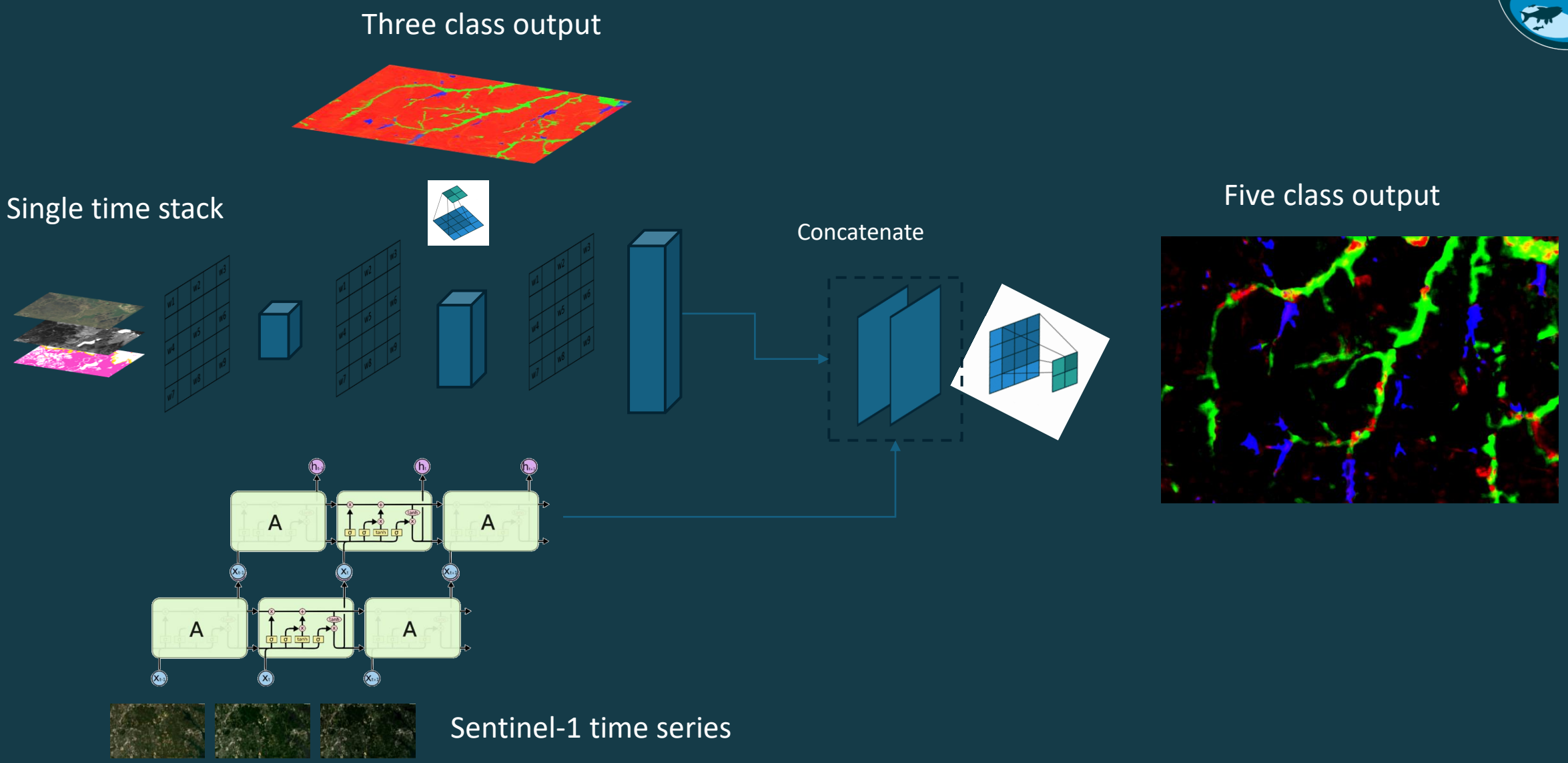
April/May

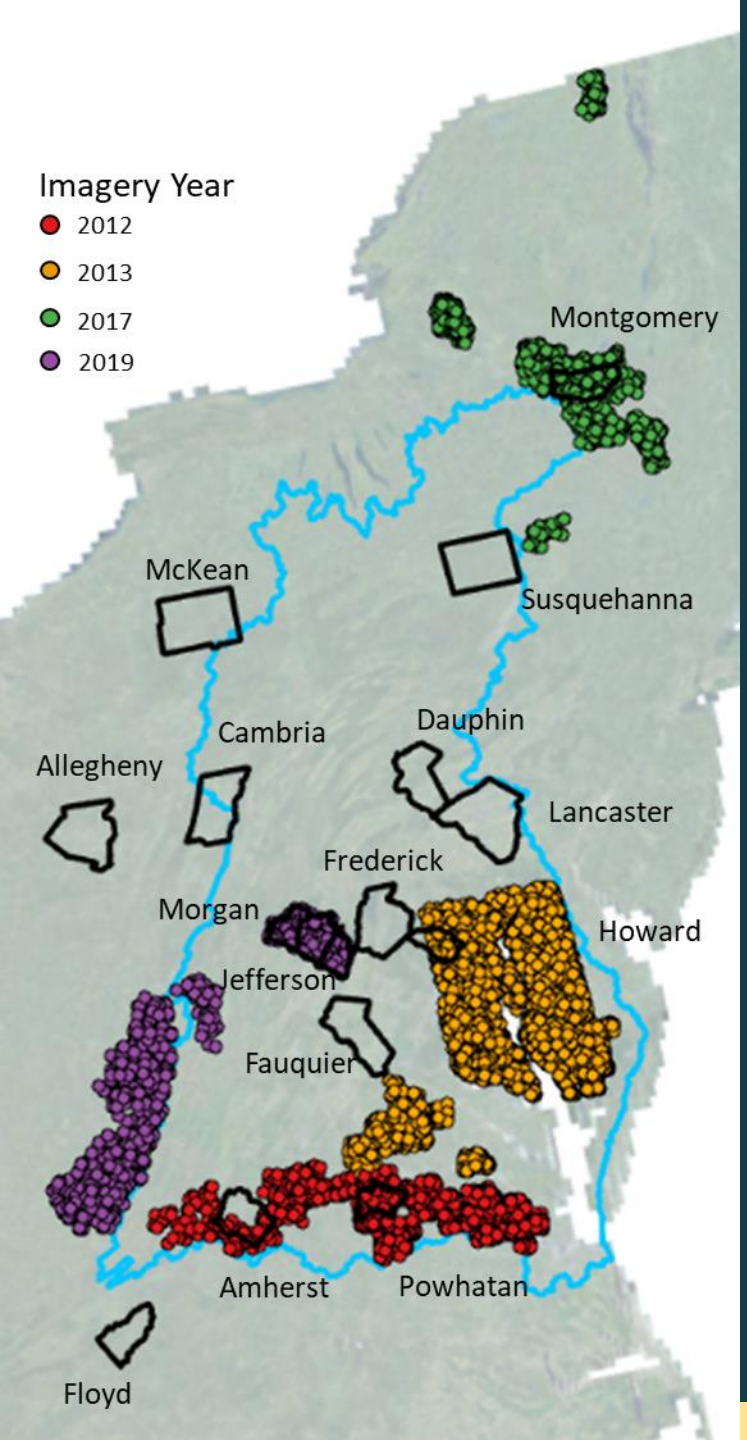
June/July

Aug/Sep



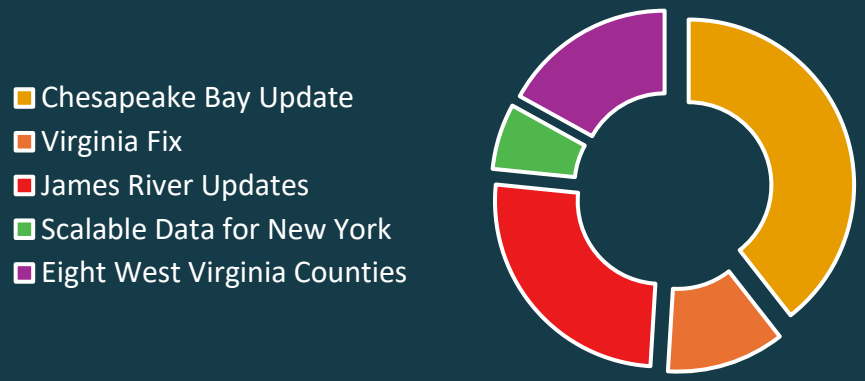
Model Architecture #2: Hierarchical





Data Sampling

NWI Project ID	NWI Project Name	Source Imagery Year	# of Samples
R05Y11P02	Chesapeake Bay Update	2013	5,916
R09Y16P04	Virginia Fix	2013	1,729
R05Y13P07	James River Updates	2012	3,845
R06Y18P03	Mapping for Scalable Data Areas of New York	2014 - 2017	963
R05Y19P02	NWI Update for Eight West Virginia Counties	2019	2,547



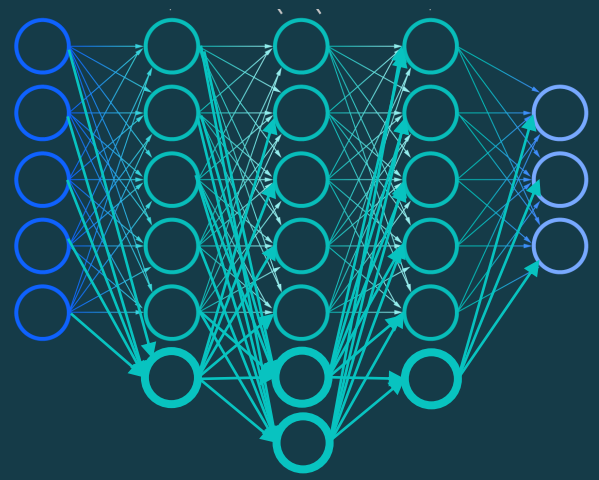
Data Sampling

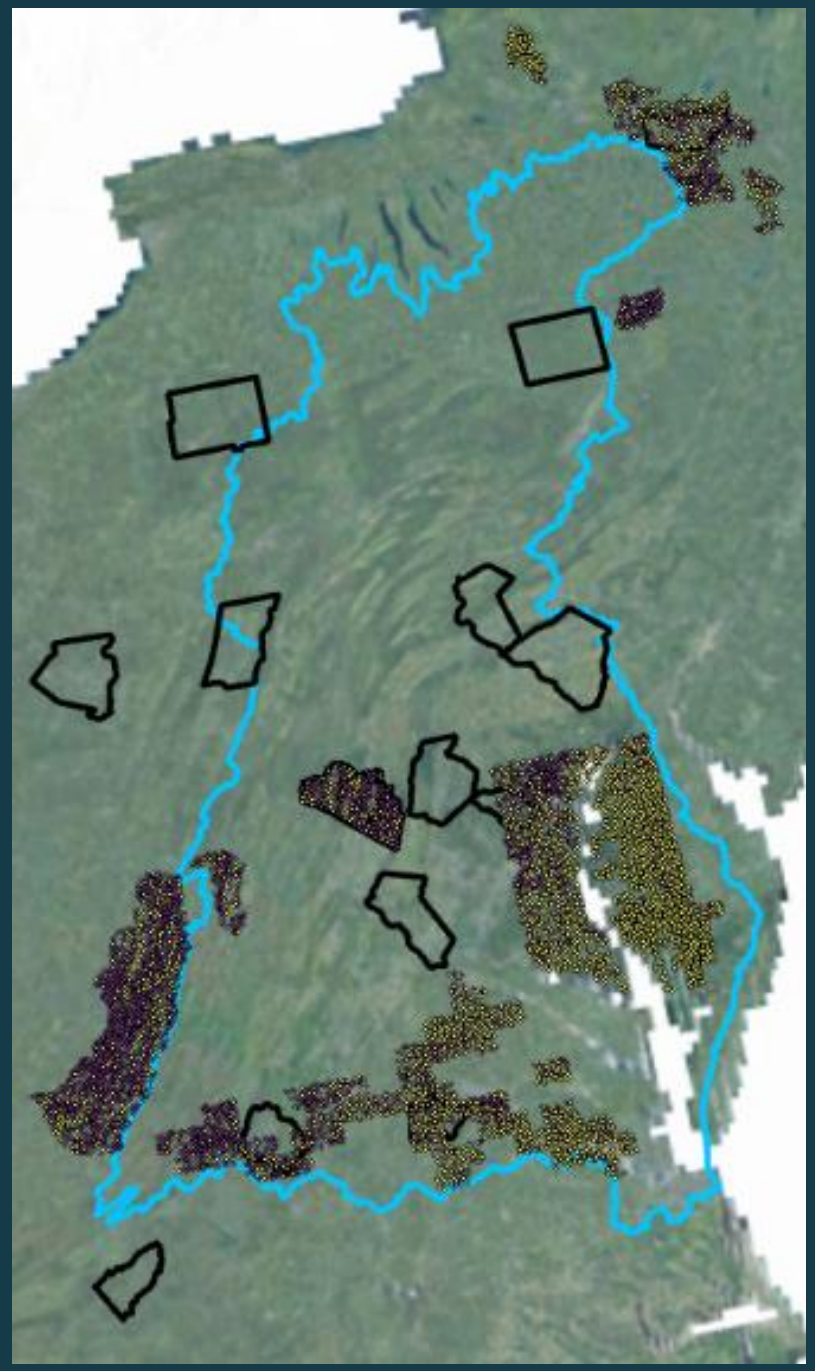
NWI Wetland Type	Reclassification	Output Band	Samples
Non-Wetland	Non-Wetland	1	10,170
		Total Non-Wetland	**10,170**
Estuarine and Marine Wetland	Emergent Wetlands	2	1,628
Freshwater Emergent Wetland	Emergent Wetlands	2	903
		Total Emergent	**2,531**
Freshwater Forested/Shrub Wetland	Forested Wetlands	3	10,311
		Total Forested	**10,311**
Freshwater Pond	Open Water	5	564
Lake	Open Water	5	288
Estuarine and Marine Deepwater	Open Water	5	215
Riverine	Open Water	5	936
		Total Open Water	**2,003**
Other	Farmed Wetlands	4	155
		Total Farmed	**155**
TOTAL		**TOTAL**	**25,170**

Model Training: Data

25,000 sample points

600 x 600 pixel ‘chips’





- Inside wetlands
- Outside wetlands

Model Training: Image Augmentation

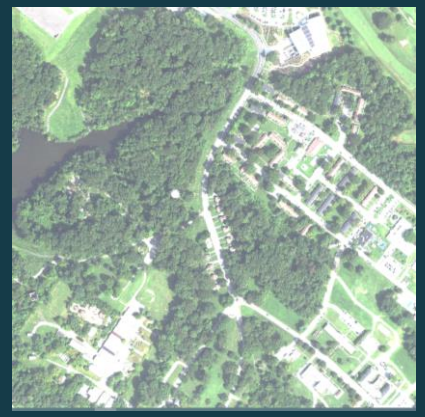
Original

Rotate 90°

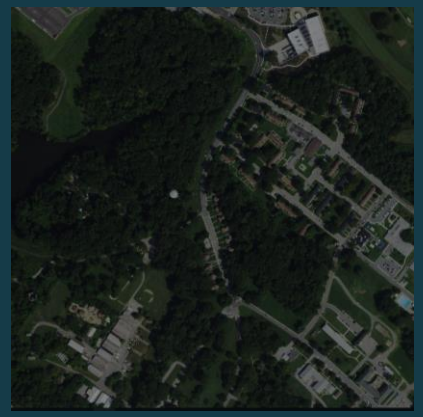
Rotate 180°

Rotate 270°

Brightness -5%
Contrast -5%



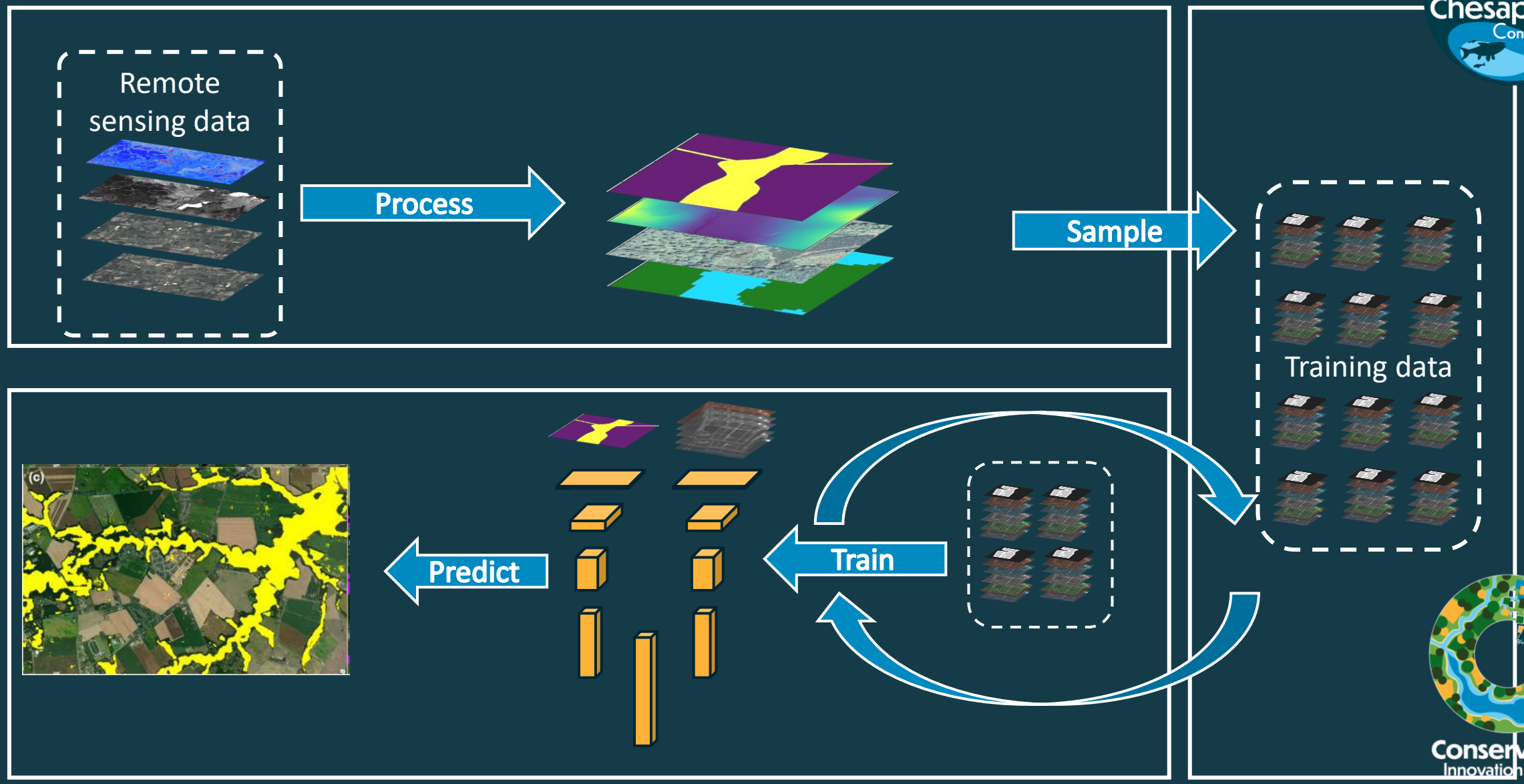
Brightness +5%
Contrast -5%



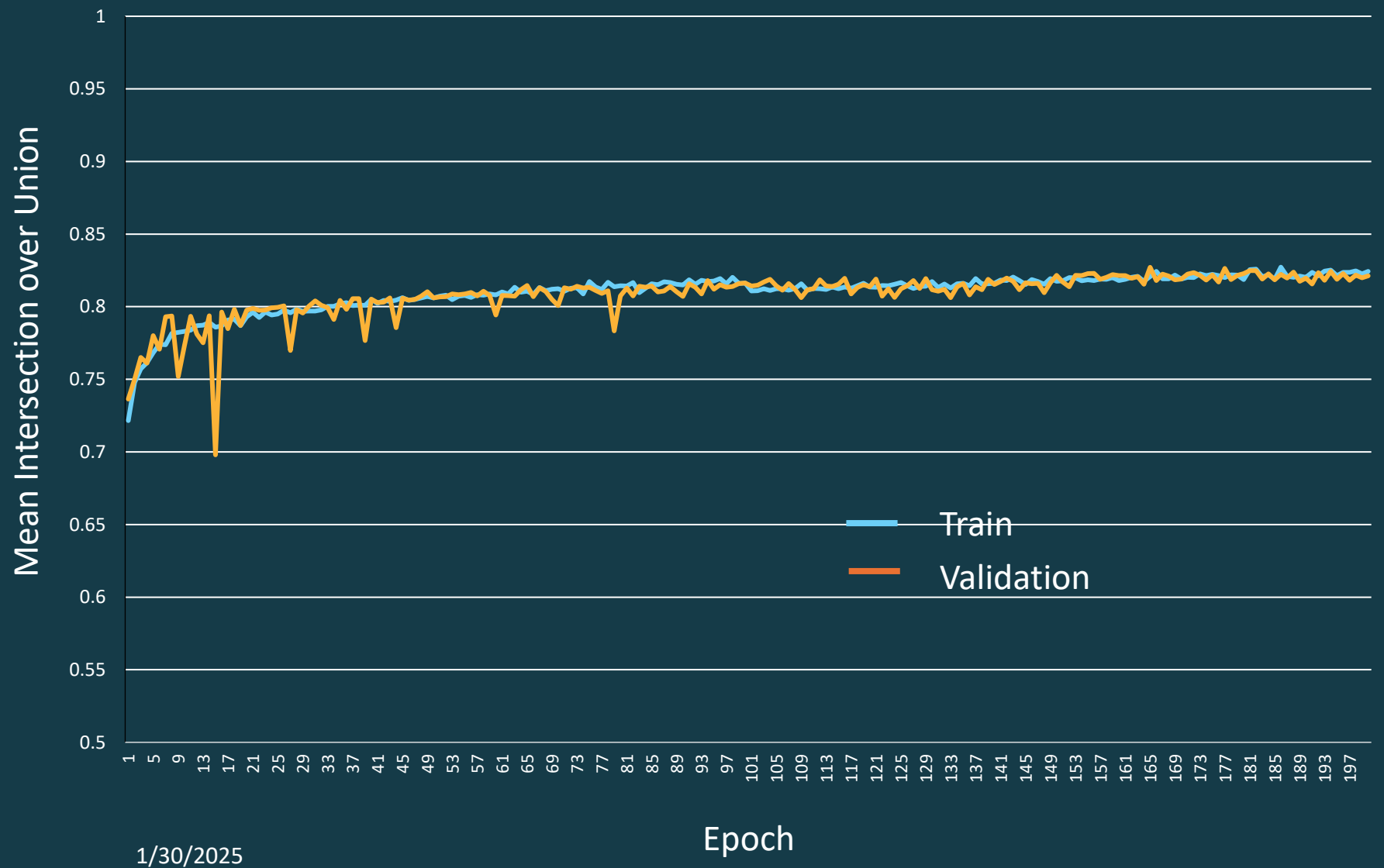
Brightness -5%
Contrast +5%

Brightness +5%
Contrast +5%

Model Training: Workflow

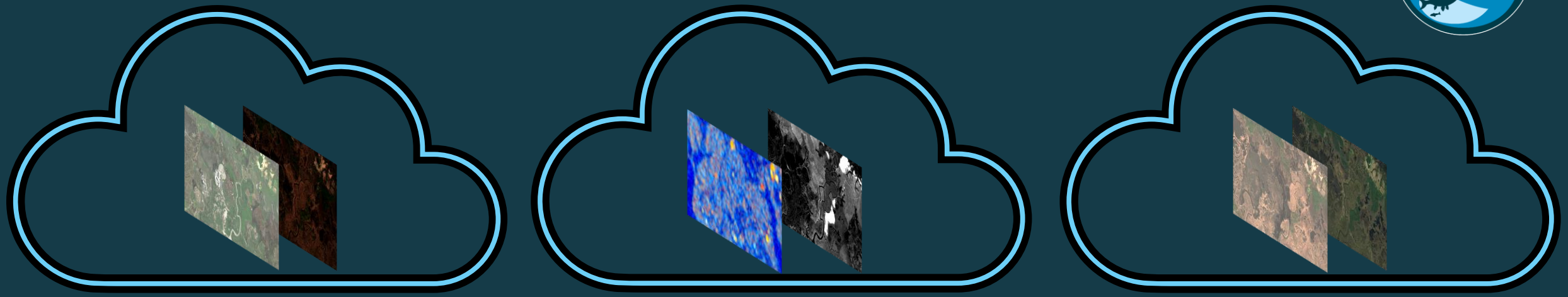


Model Training: Performance

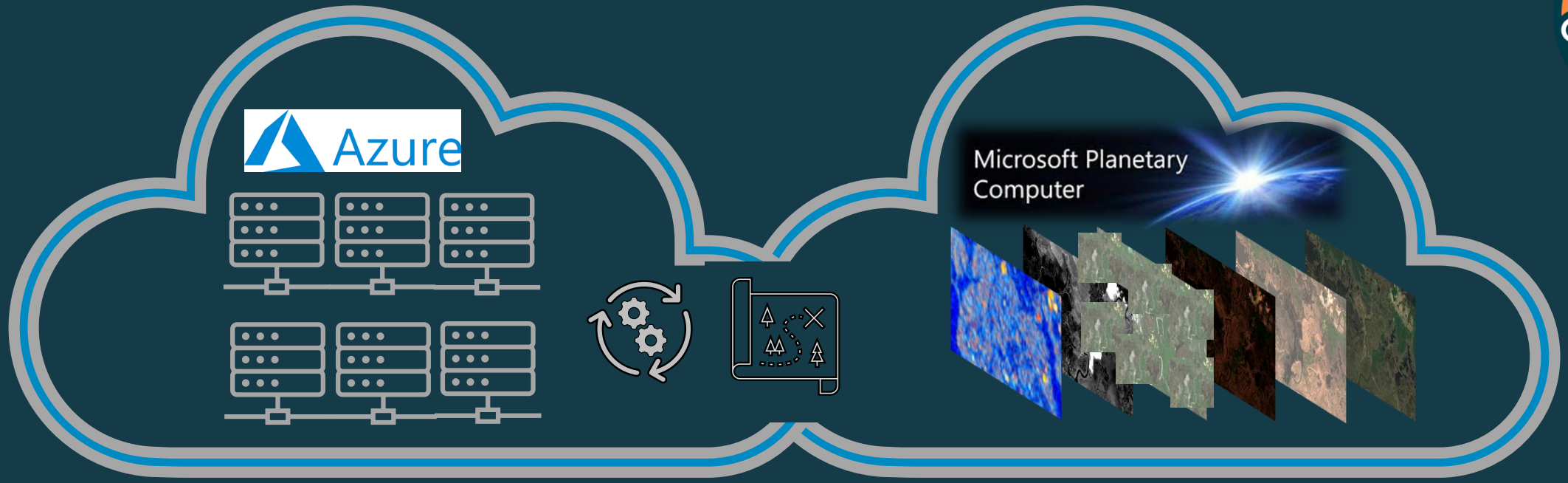


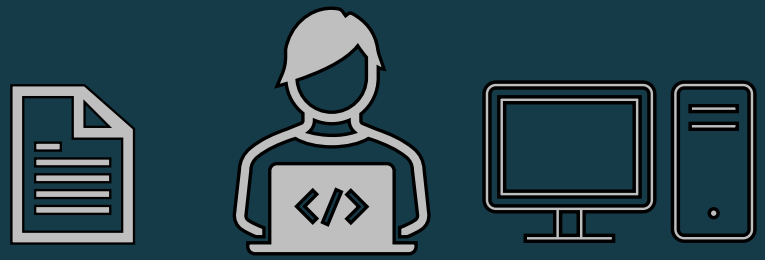
Model	Precision	Recall	IoU
Hierarchical	0.887	0.892	0.745
U-Net	0.901	0.911	0.792

Cloud Computing



Cloud Computing

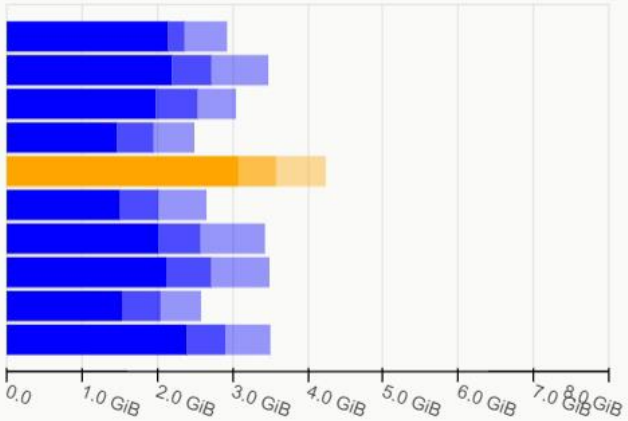




Status Workers Tasks System Profile Graph Groups Info More...

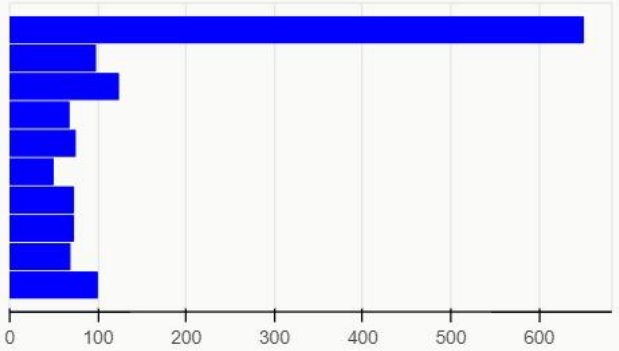
Bytes stored: 31.92 GiB

Bytes stored per worker

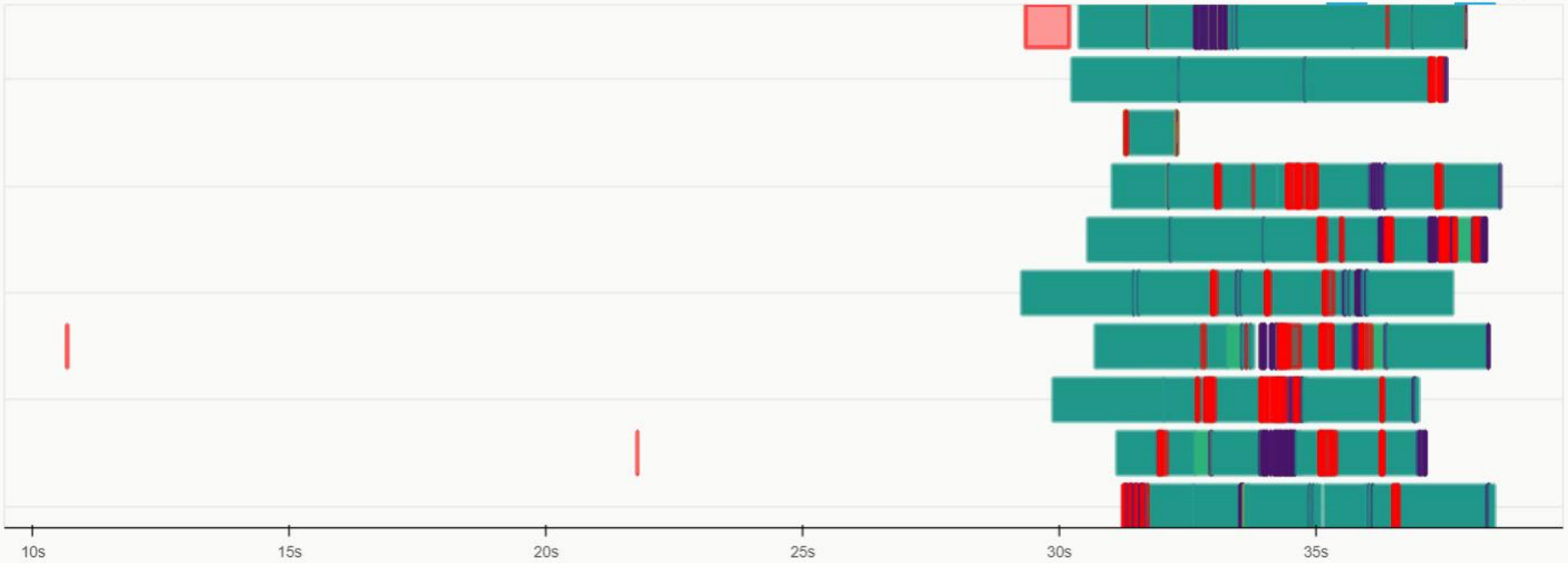


Processing CPU Occupancy

Tasks Processing



Task Stream



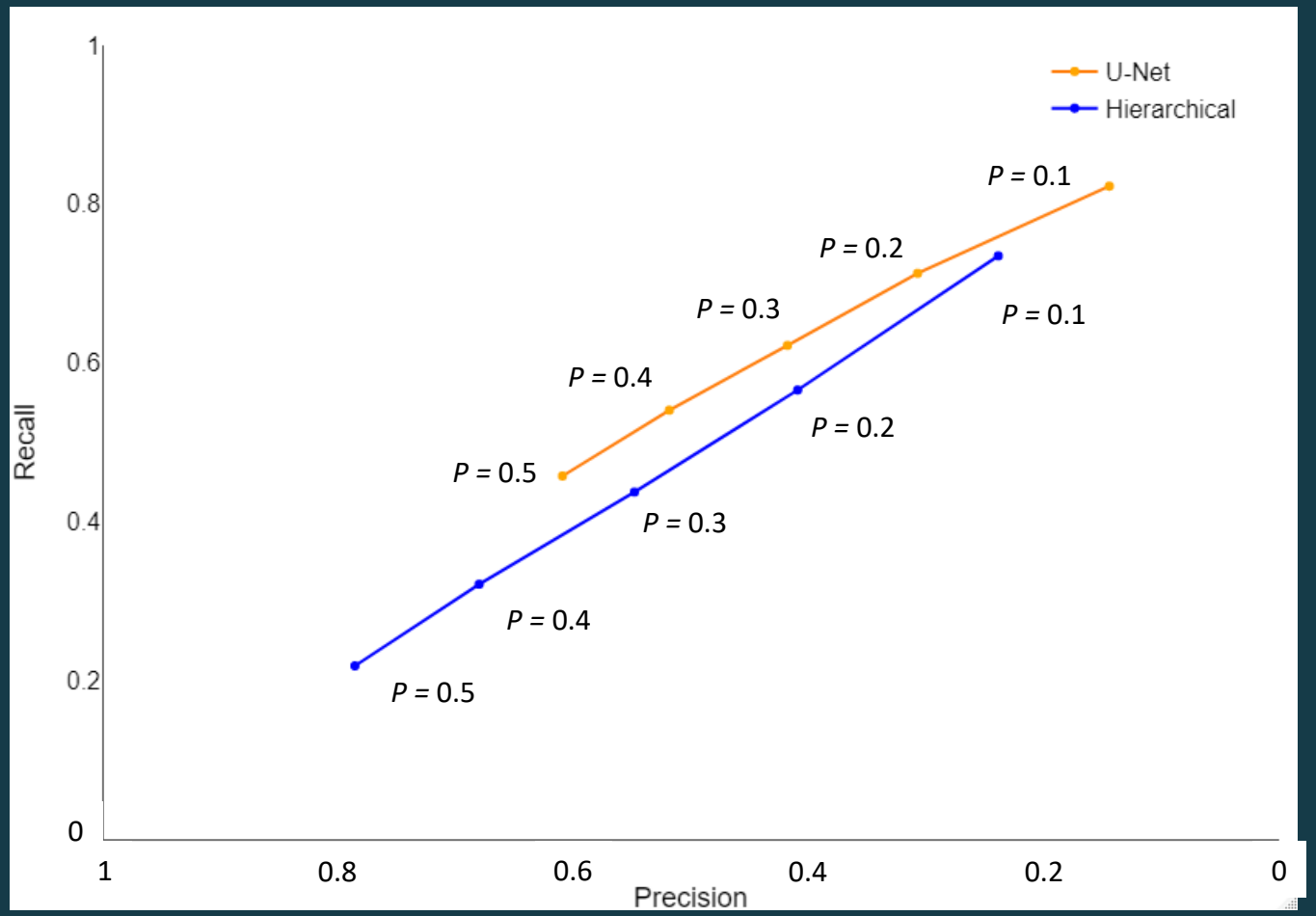
Progress -- total: 19324, in-memory: 1122, processing: 1371, waiting: 15266, erred: 0

rechunk-split	1524 / 6254	rechunk-merg...	30 / 624	moment_combi...	8 / 208
getitem	107 / 4606	mean_chunk	29 / 624	mean_combine...	8 / 208
where	324 / 792	concatenate	48 / 428	asset_table	132 / 132
rechunk-merge	130 / 676	_trim	0 / 350	asset-table	132 / 132
truediv-getitem	24 / 624	block-info	32 / 350	add	4 / 104
moment_chunk	30 / 624	predict_chunk	0 / 350	rechunk-spli...	30 / 104
where-getitem	30 / 624	getitem-overlap	0 / 350	mean_agg-agg...	4 / 104
nanmedian	30 / 624	rechunk-merg...	4 / 259	rechunk-merg...	2 / 91

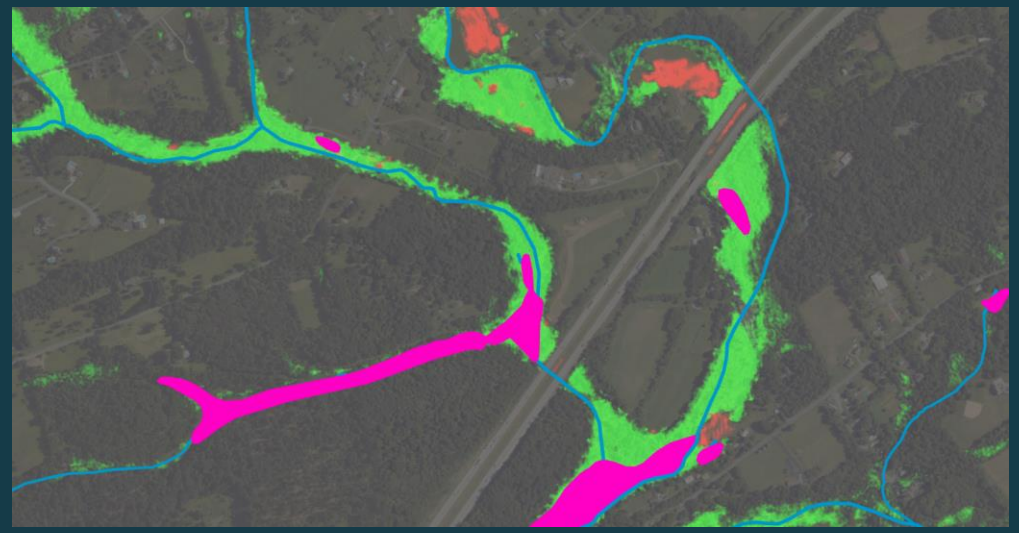
Chesapeake Conservancy

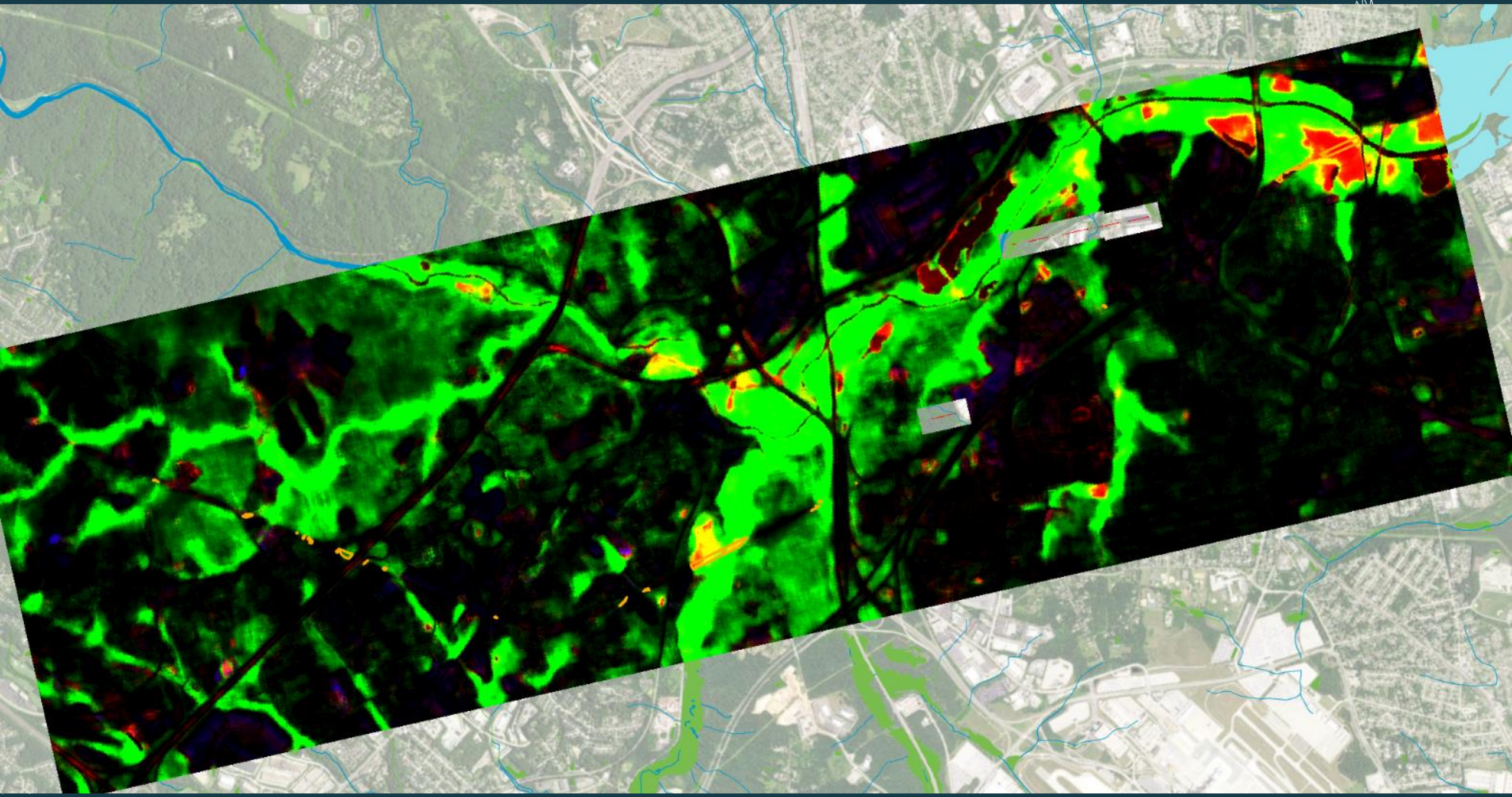
Conservation Innovation Center

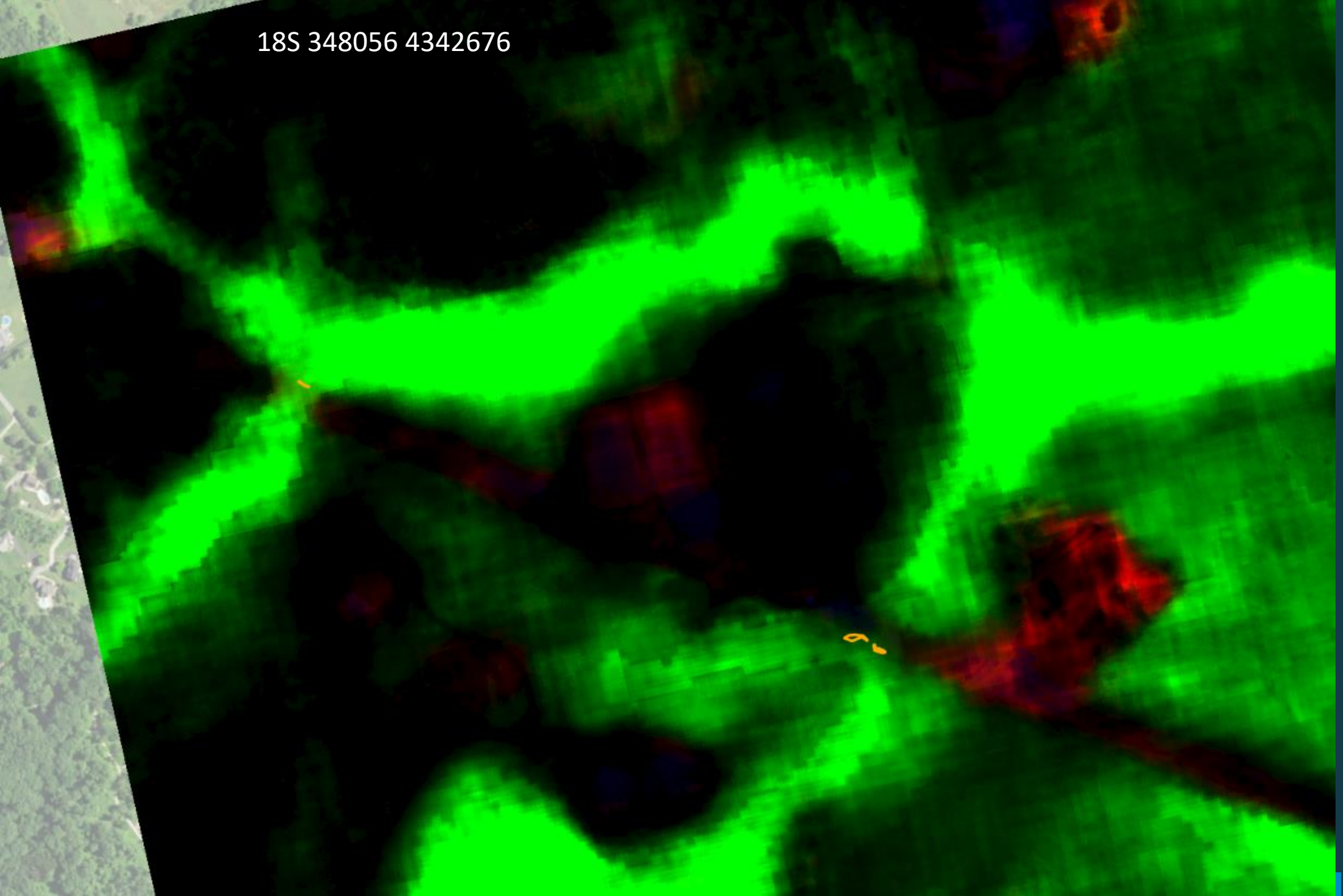
Model Training: Performance vs. NWI



Model	Precision	Recall	IoU
Hierarchical	0.51	0.53	0.38
U-Net	0.62	0.54	0.40







NWI

Wetland

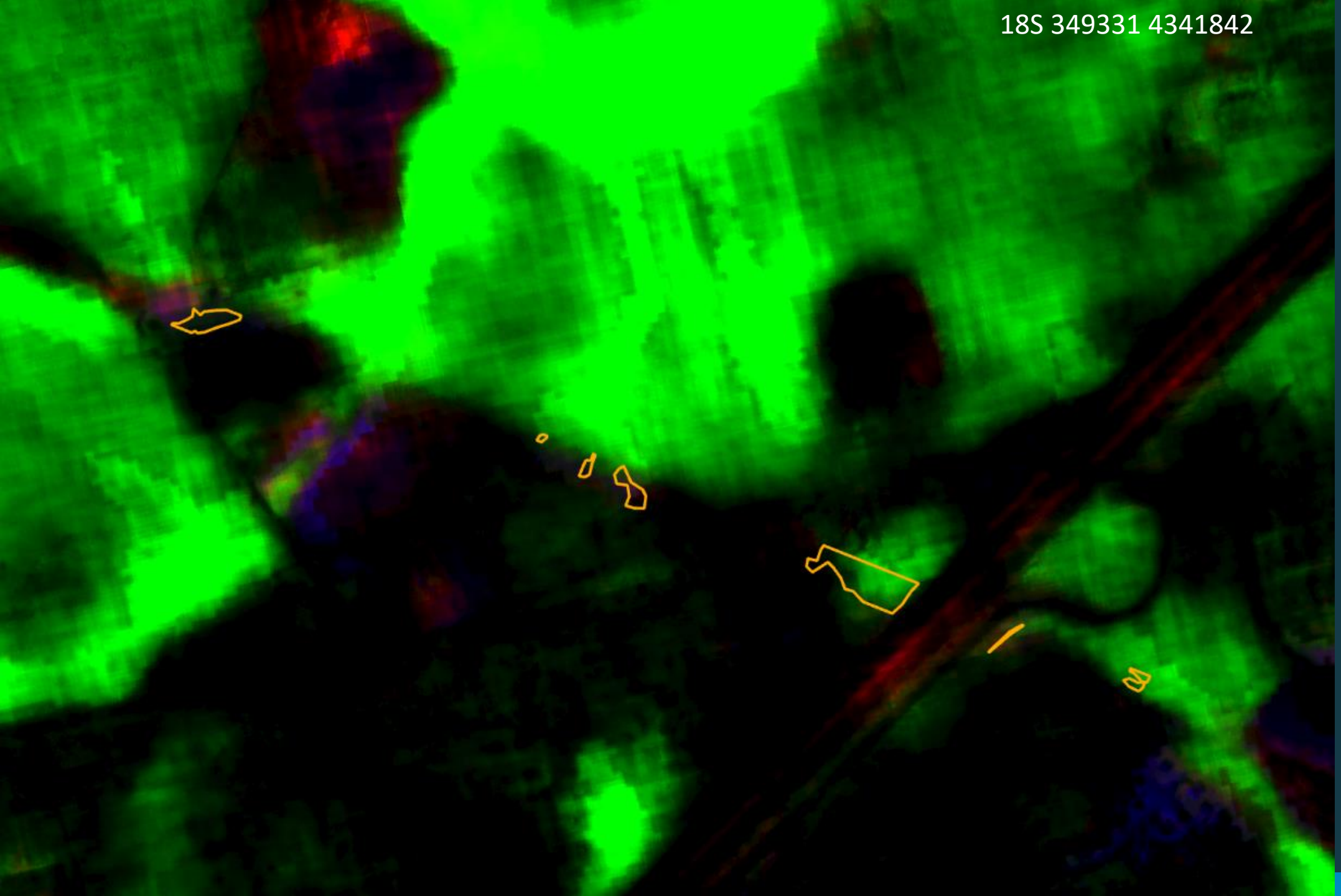
Water

AI Wetland Probability

Emergent

Wooded

Farmed



Wetland

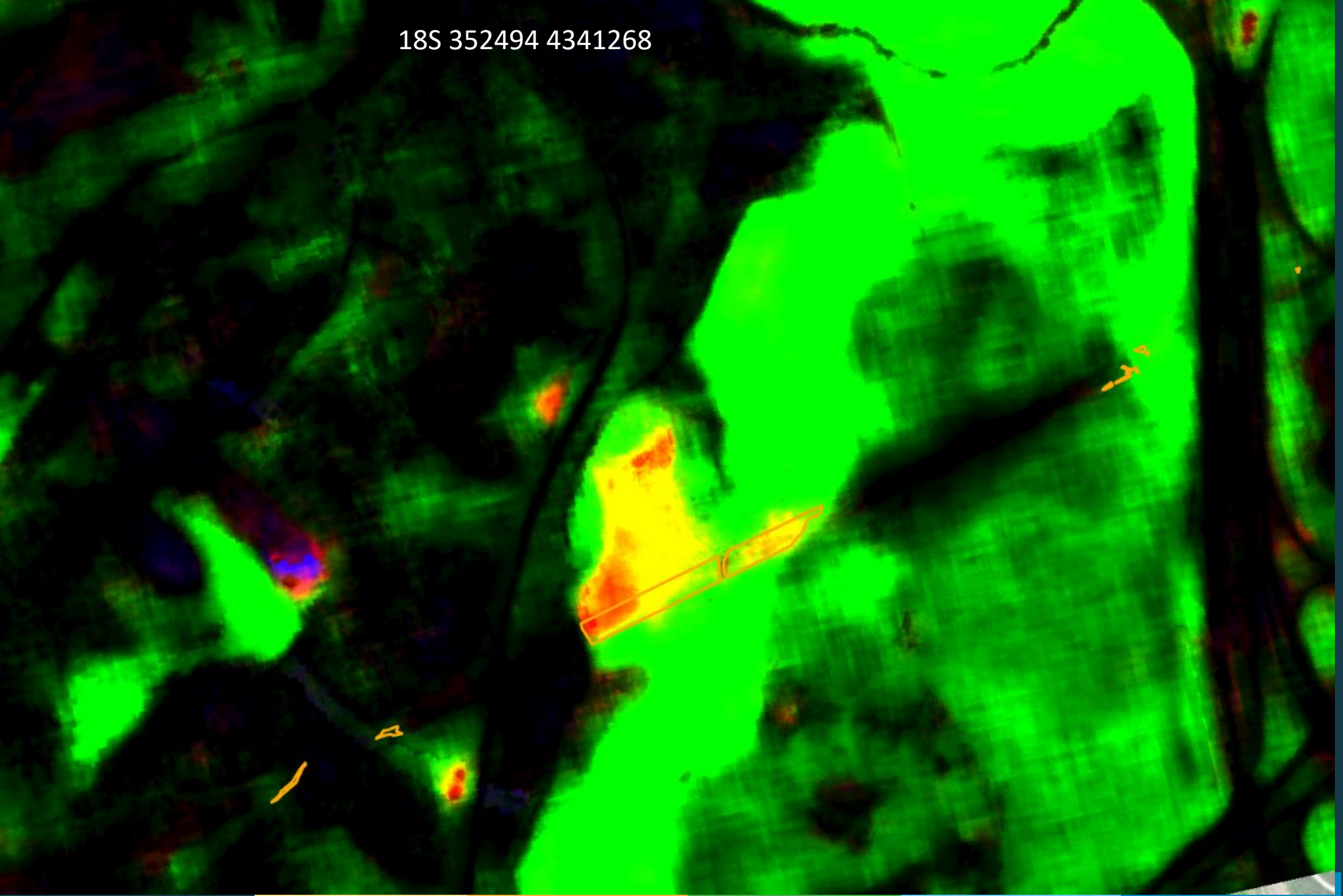
Water

AI Wetland Probability

Emergent

Wooded

Farmed



Wetland

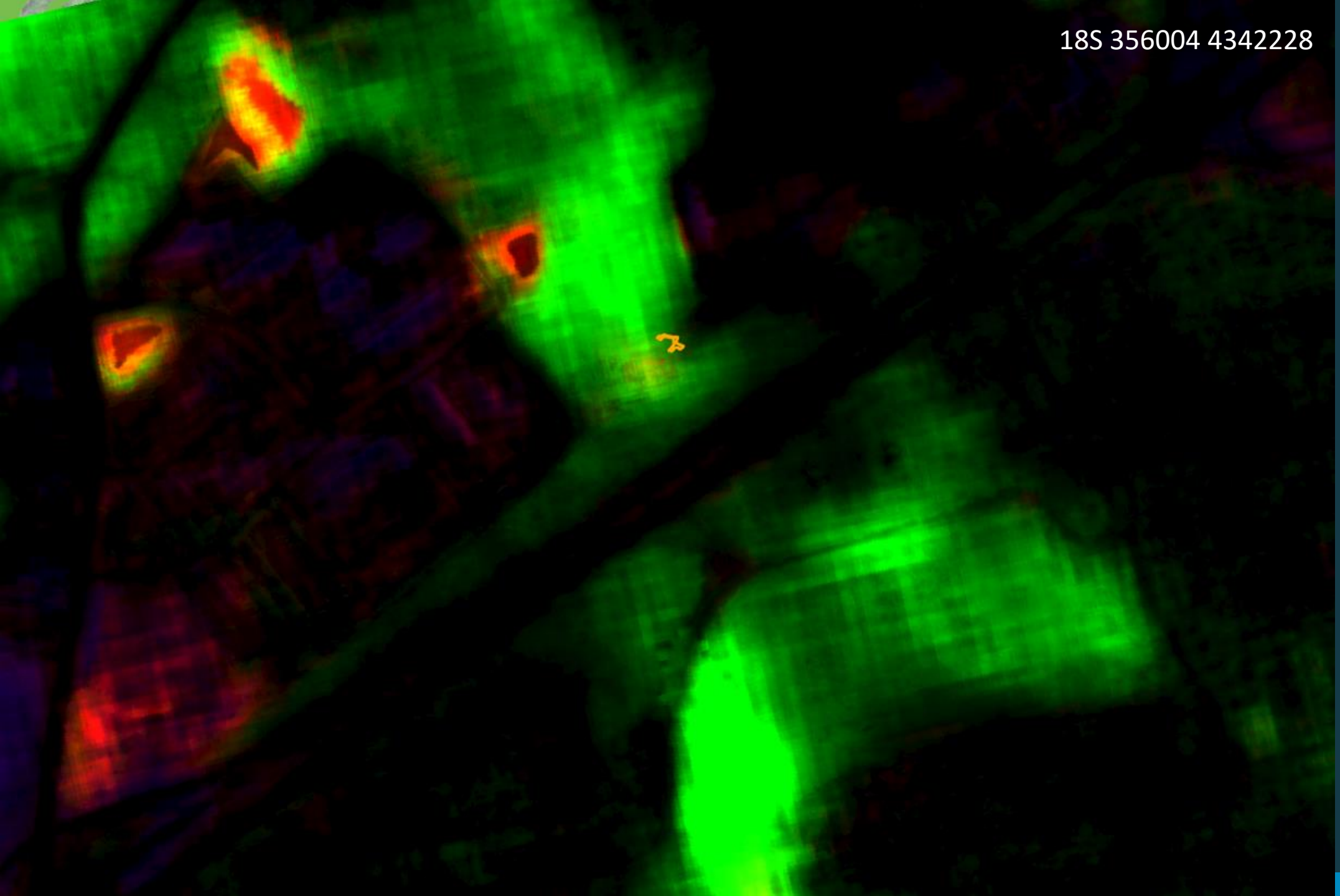
Water

AI Wetland Probability

Emergent

Wooded

Farmed



Wetland

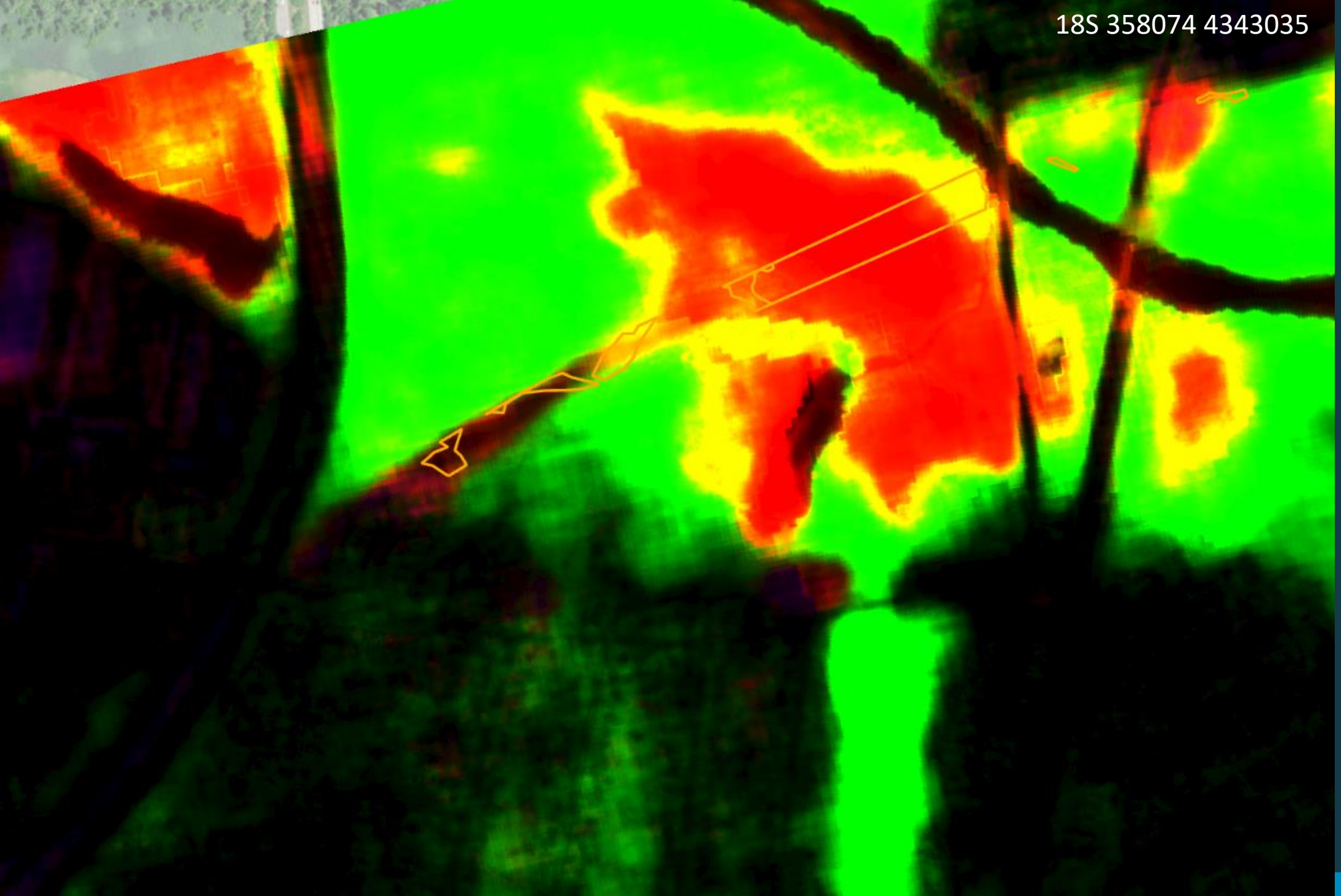
Water

AI Wetland Probability

Emergent

Wooded

Farmed



Wetland

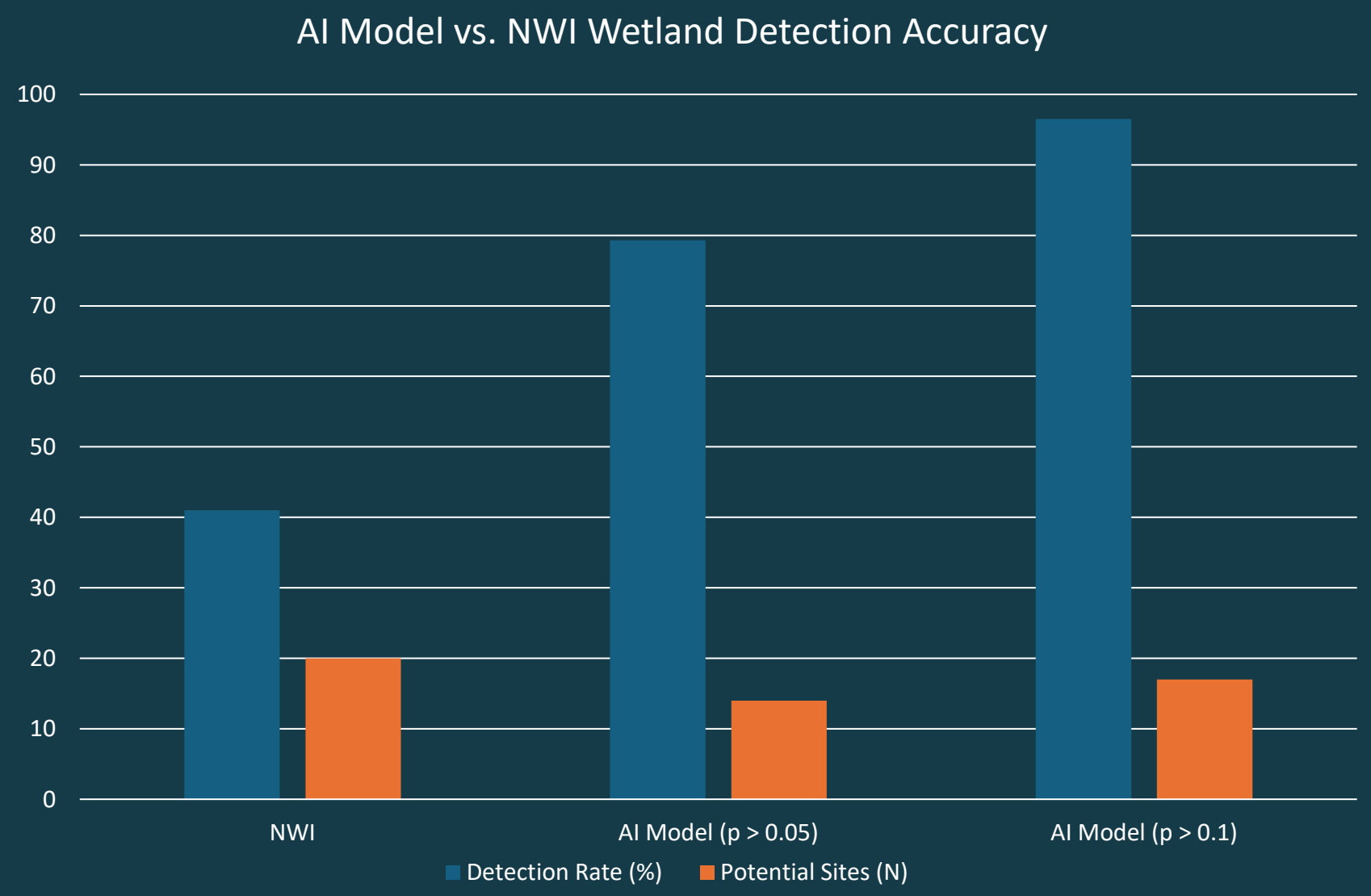
Water

AI Wetland Probability

Emergent

Wooded

Farmed

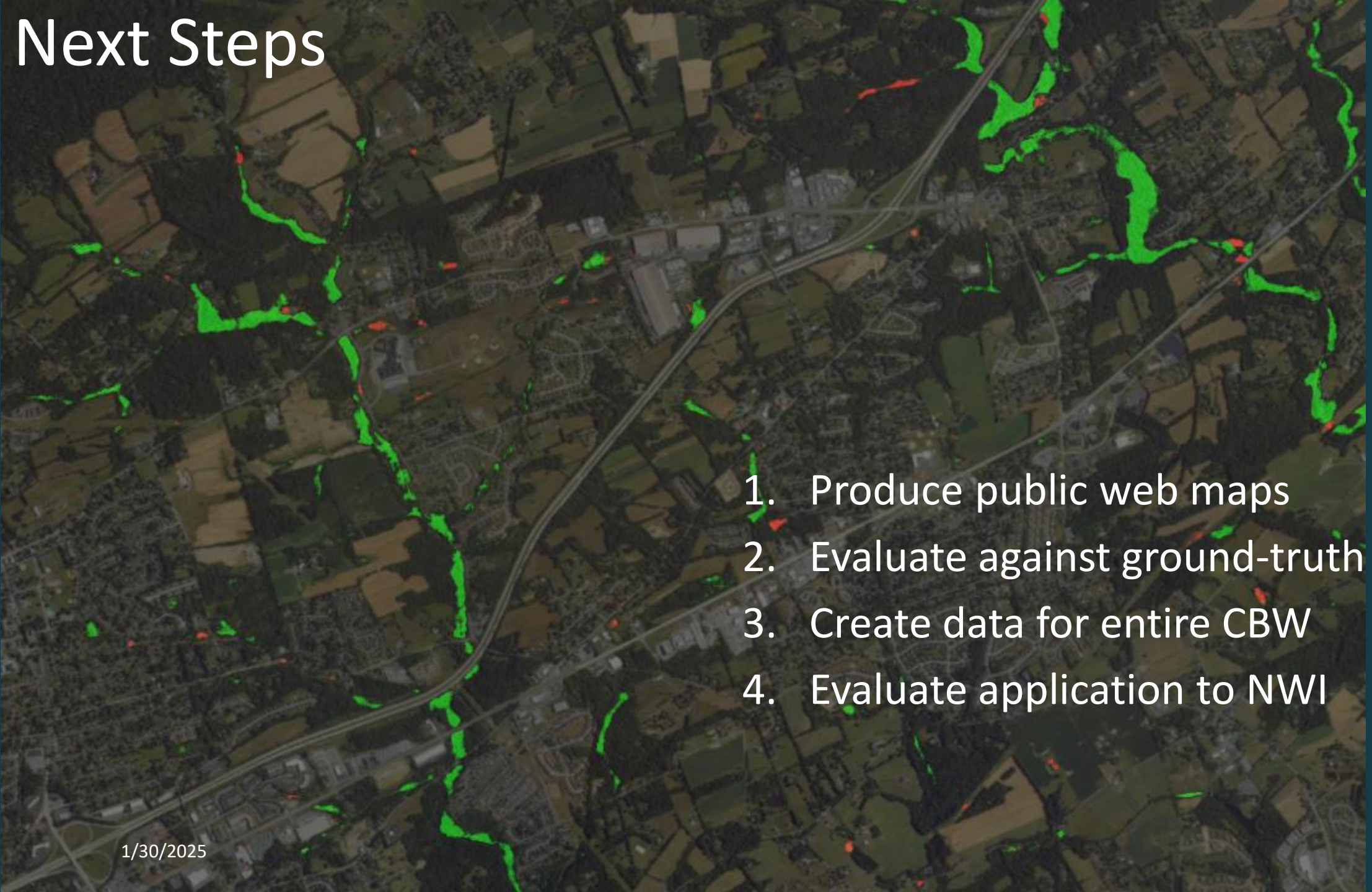


We evaluated AI model accuracy using two probability thresholds for identifying wetlands – 0.05 and 0.10.

Detection rate is the % of BGE delineated wetland polygons intersected by a given dataset (NWI vs. AI Model)

Potential Sites are the number of places where a wetland dataset intersected the ROW, identifying a location where a survey might be necessary

Next Steps



1. Produce public web maps
2. Evaluate against ground-truth
3. Create data for entire CBW
4. Evaluate application to NWI