

Flow path based spatial analysis to prioritize riparian buffer placement in the Catskills

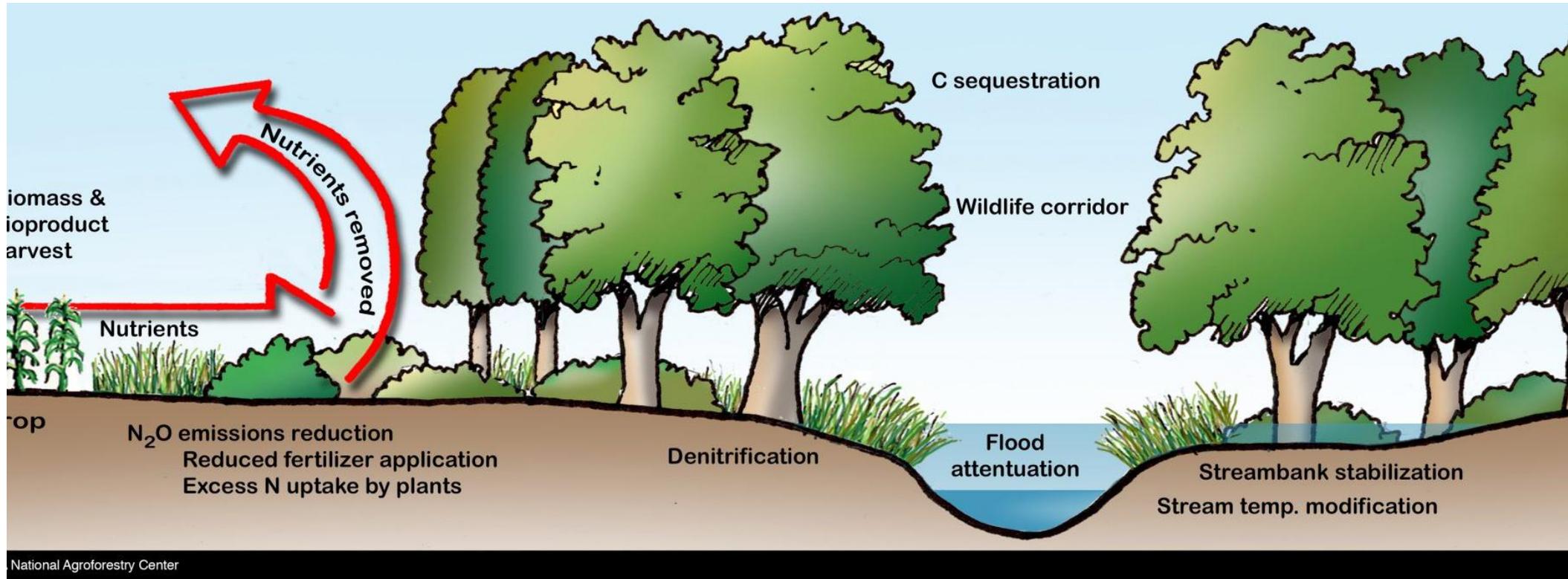
Ashok Jacob, Cibin Raj, Rajith Mukundan, Rakesh Gelda, Sijal Dangol

Water Quality in Catskills

- Catskills/ Delaware Supply remains of very high quality (NYCDEP, 2024)
- Stream management programs help limit sediment and nutrient runoff
- Recent Hudson Estuary blooms stress ongoing monitoring



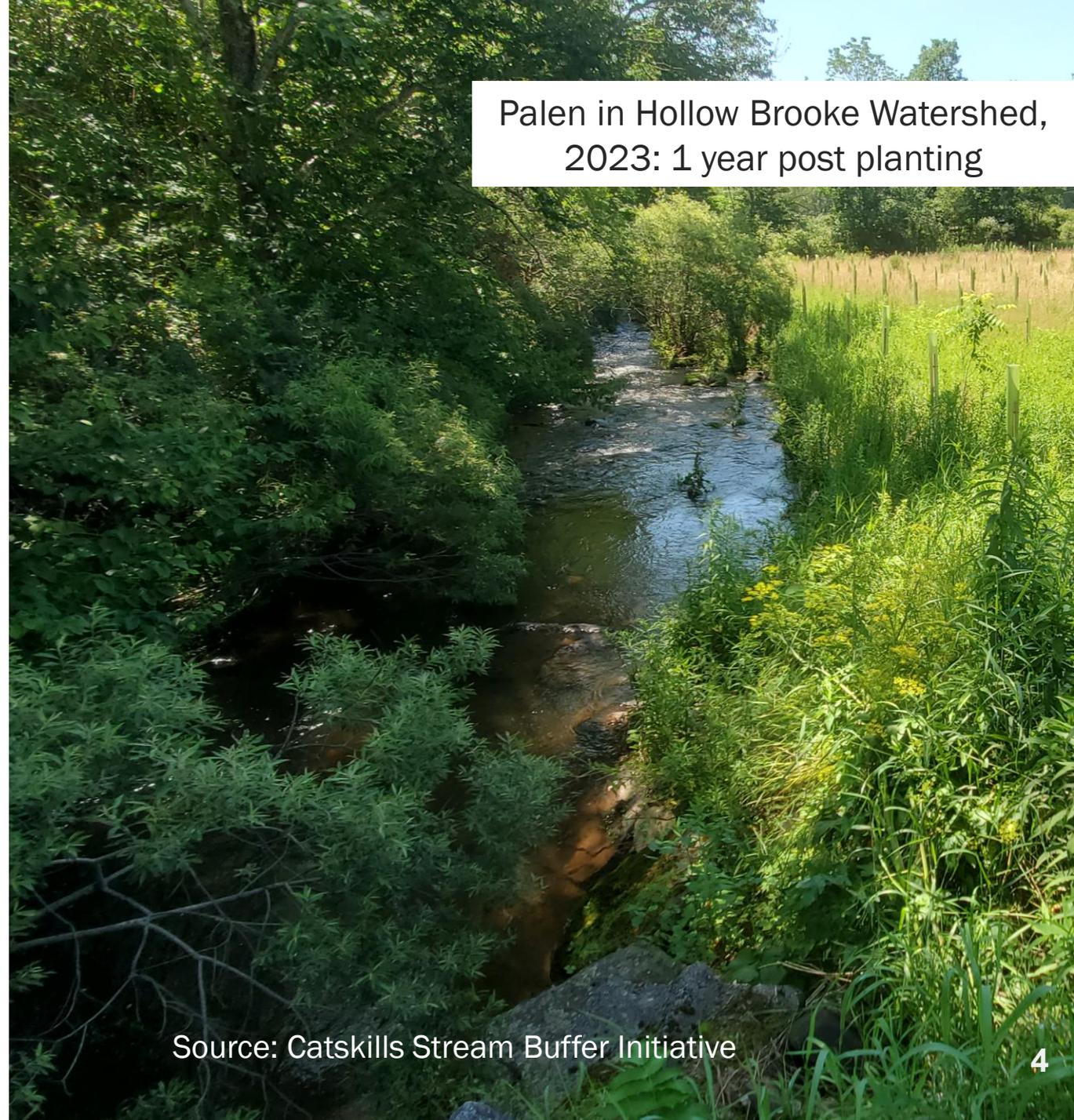
Applications of Riparian Buffers



Source: USDA Climate Hubs (2024)

Riparian Buffers in Catskills

- CSBI & Stream Management Programs partner with landowners
- Plant site-adapted vegetation along streams
- 61% of NY stream programs (National Academic Press 2020)
- Lowest cost (~\$0.4 M / mile; Reichheld 2018)



Palen in Hollow Brooke Watershed,
2023: 1 year post planting

Key Questions



Are riparian buffers effectively covering critical contaminant zones?



How effective are existing buffers in reducing pollutant loading?

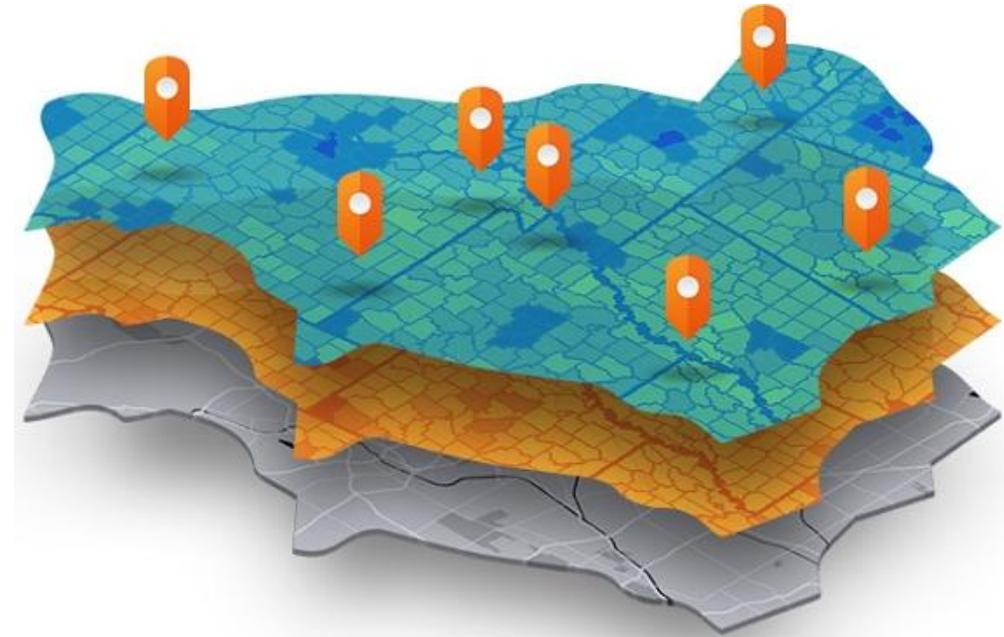


Which areas still need buffer implementation?

Flow path based spatial analysis

Planning tool for riparian buffer optimization

- Computationally efficient
- Does not require extensive calibration
- Reproducible across regions

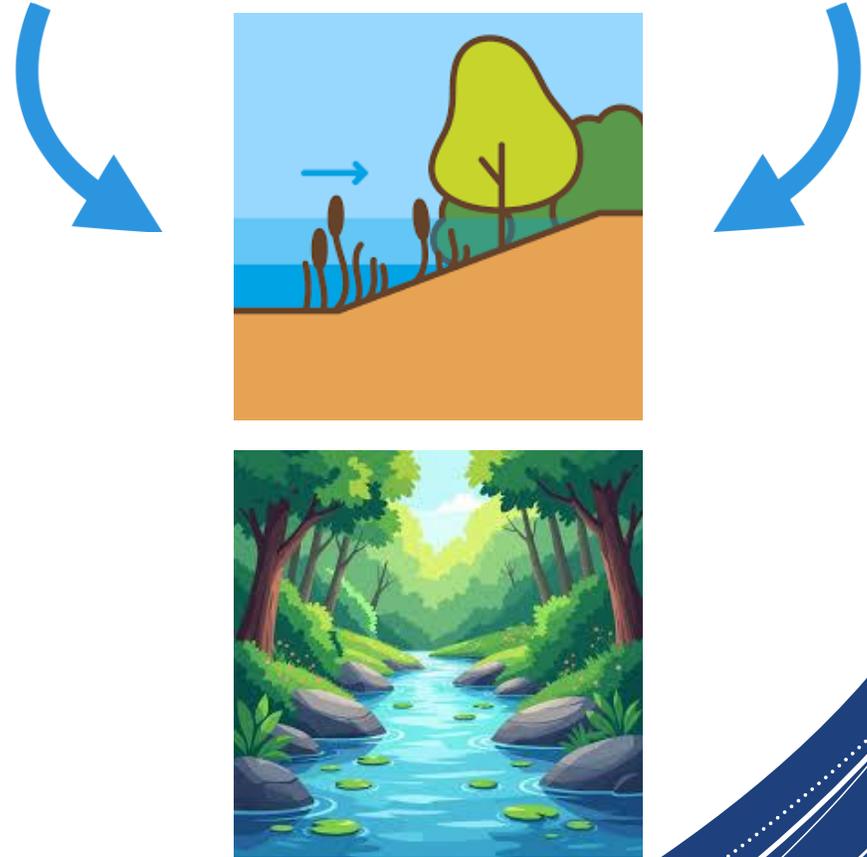


Source: ESRI (2015)

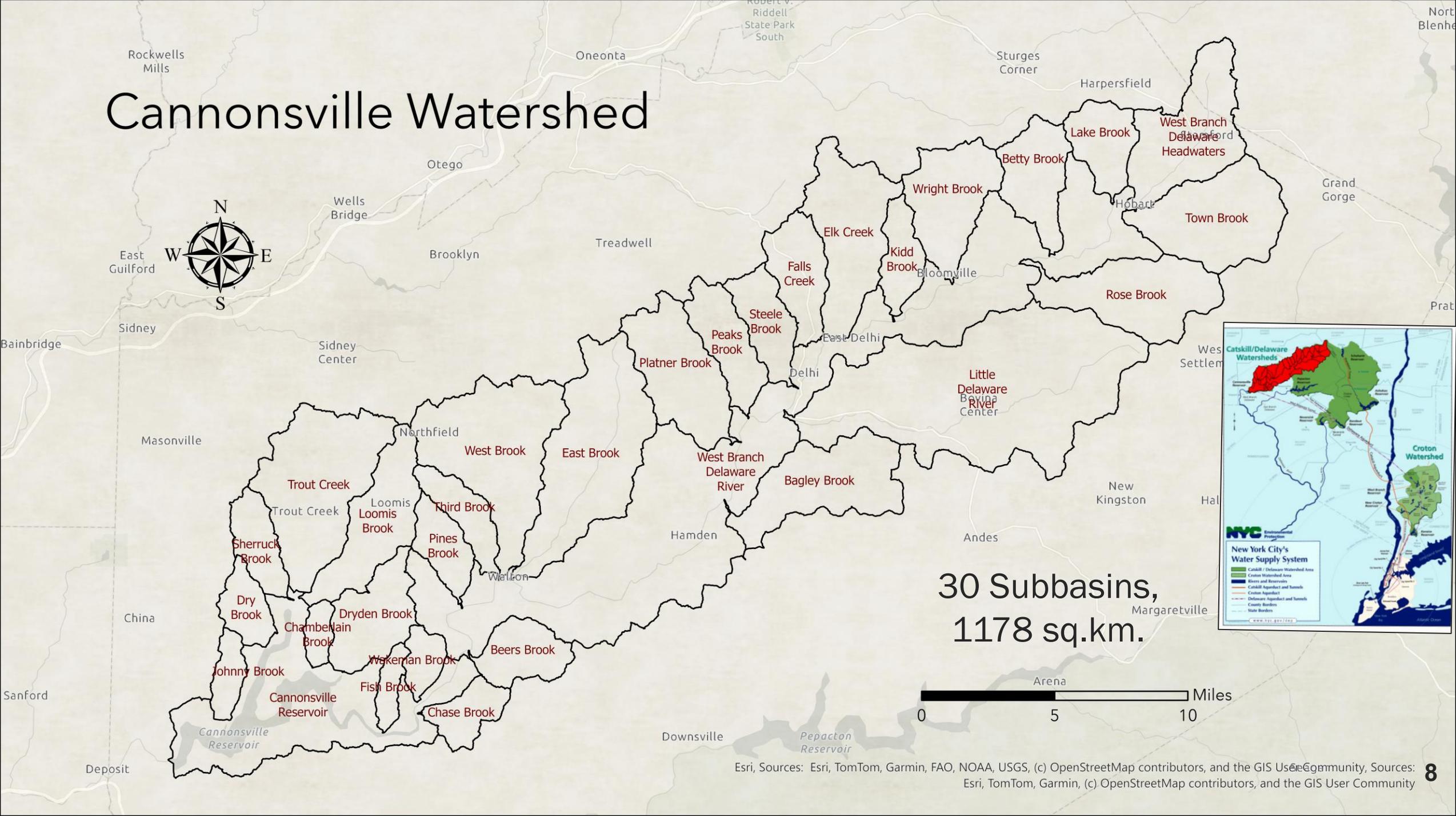
Traversability Algorithm



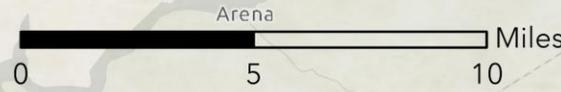
- Introduced by Billmire and Koziol (2018)
- Integrates pollutant source, flow path and filtering along the route
- Stronger predictor than traditional metrics; simpler than process-based modelling



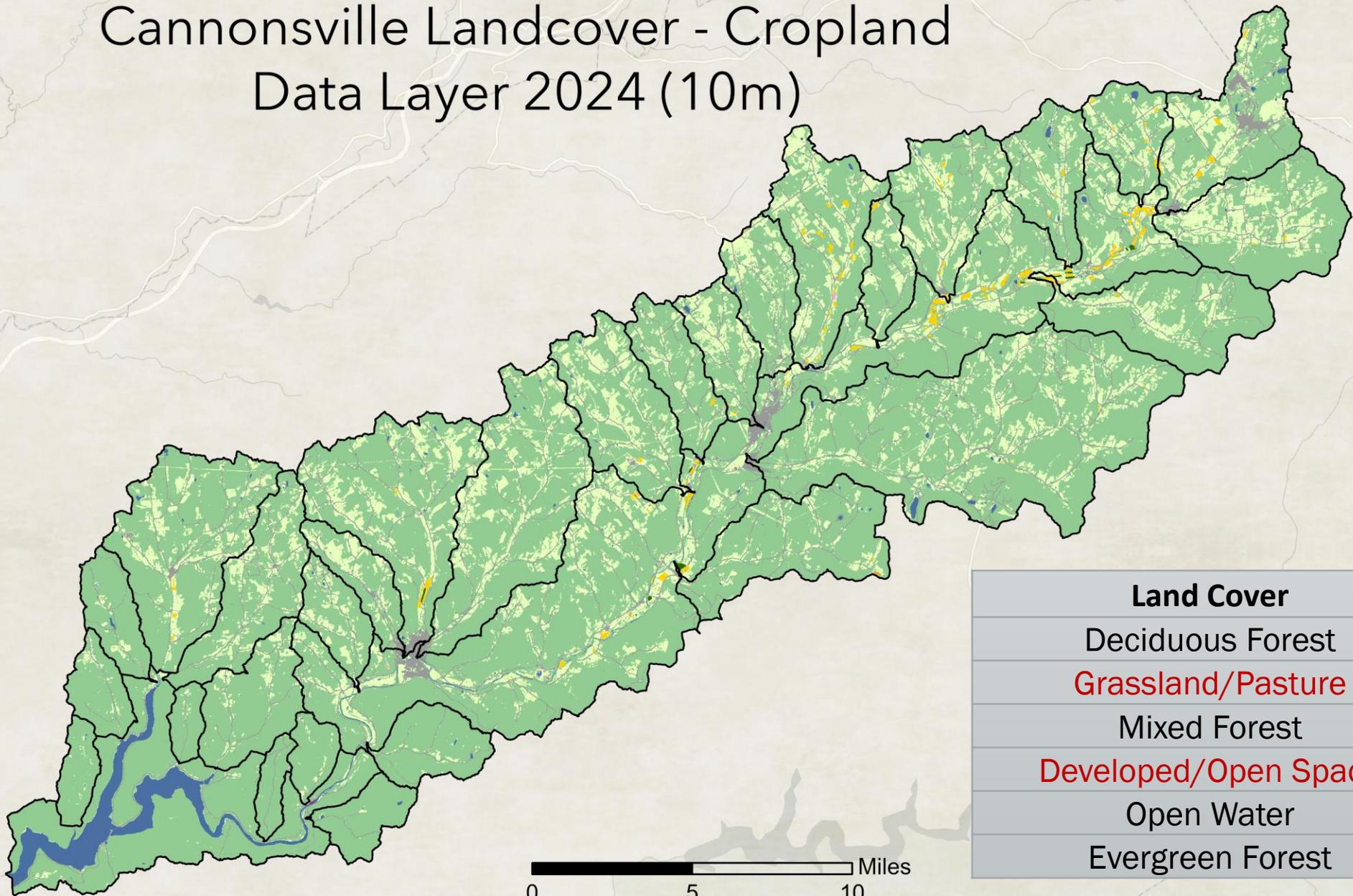
Cannonsville Watershed



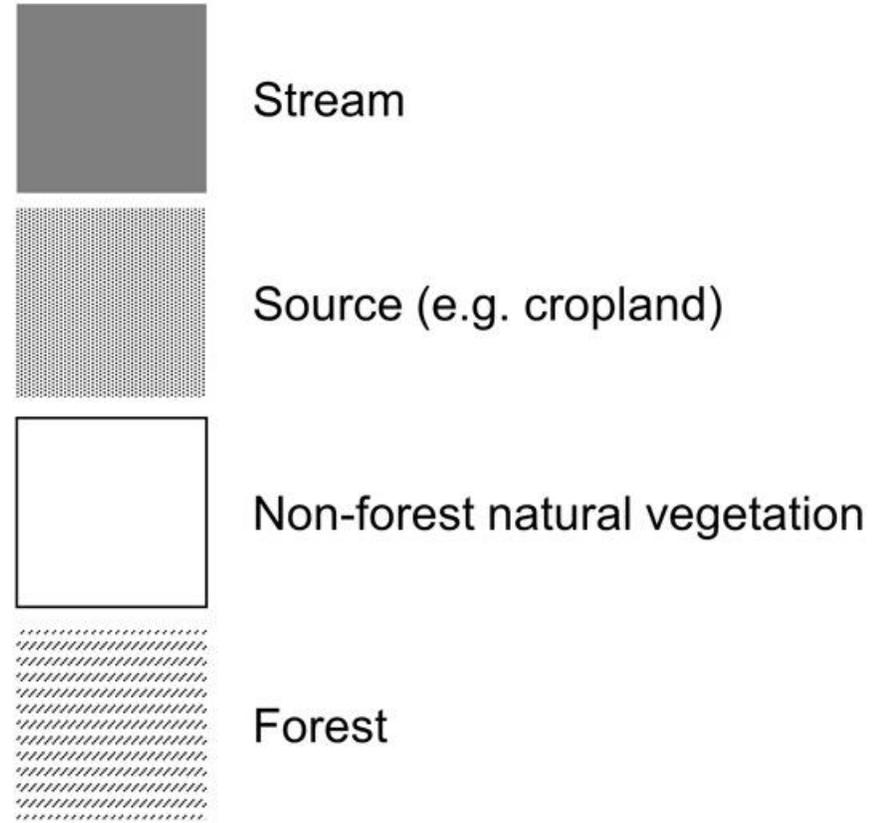
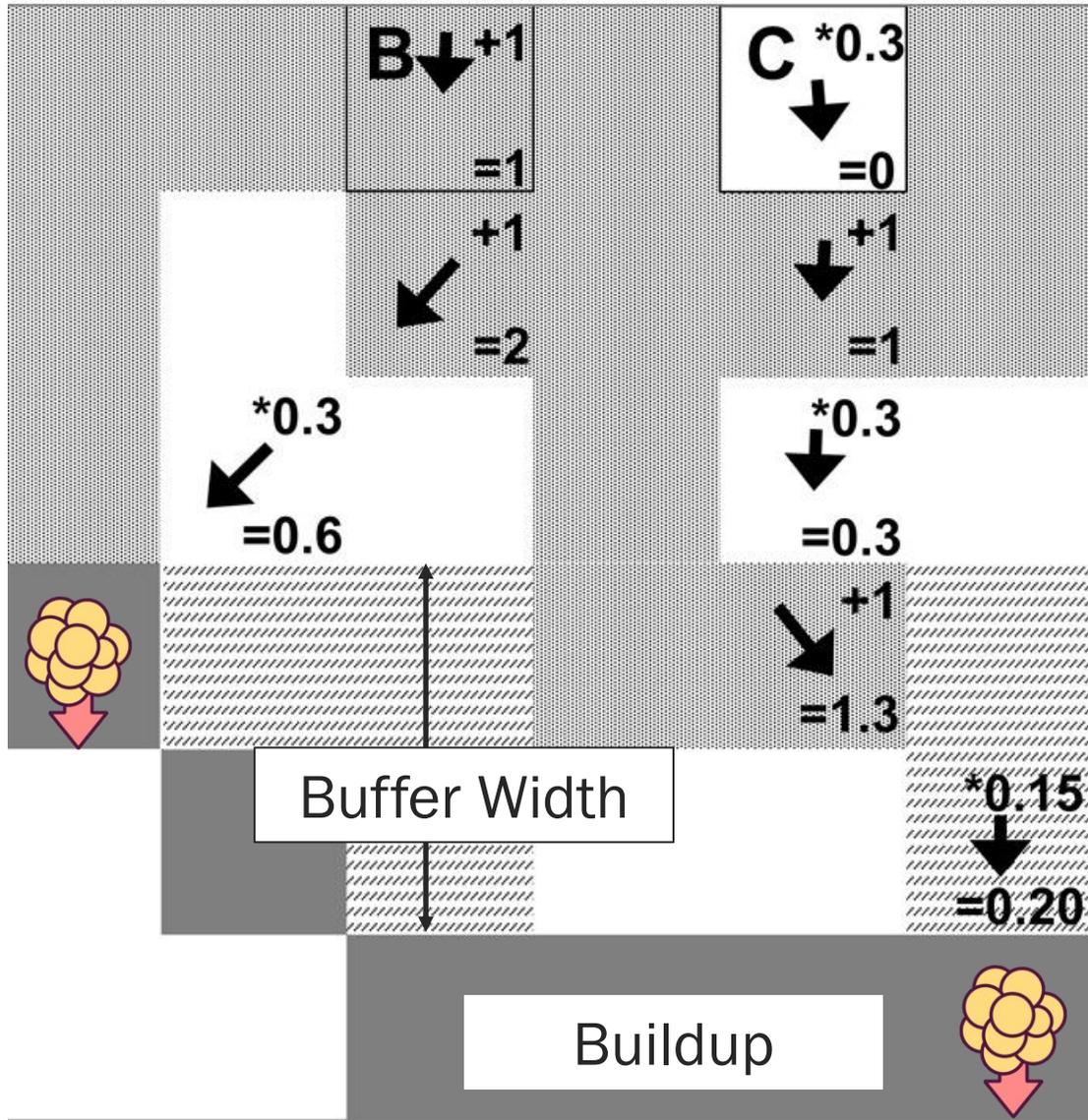
30 Subbasins,
1178 sq.km.

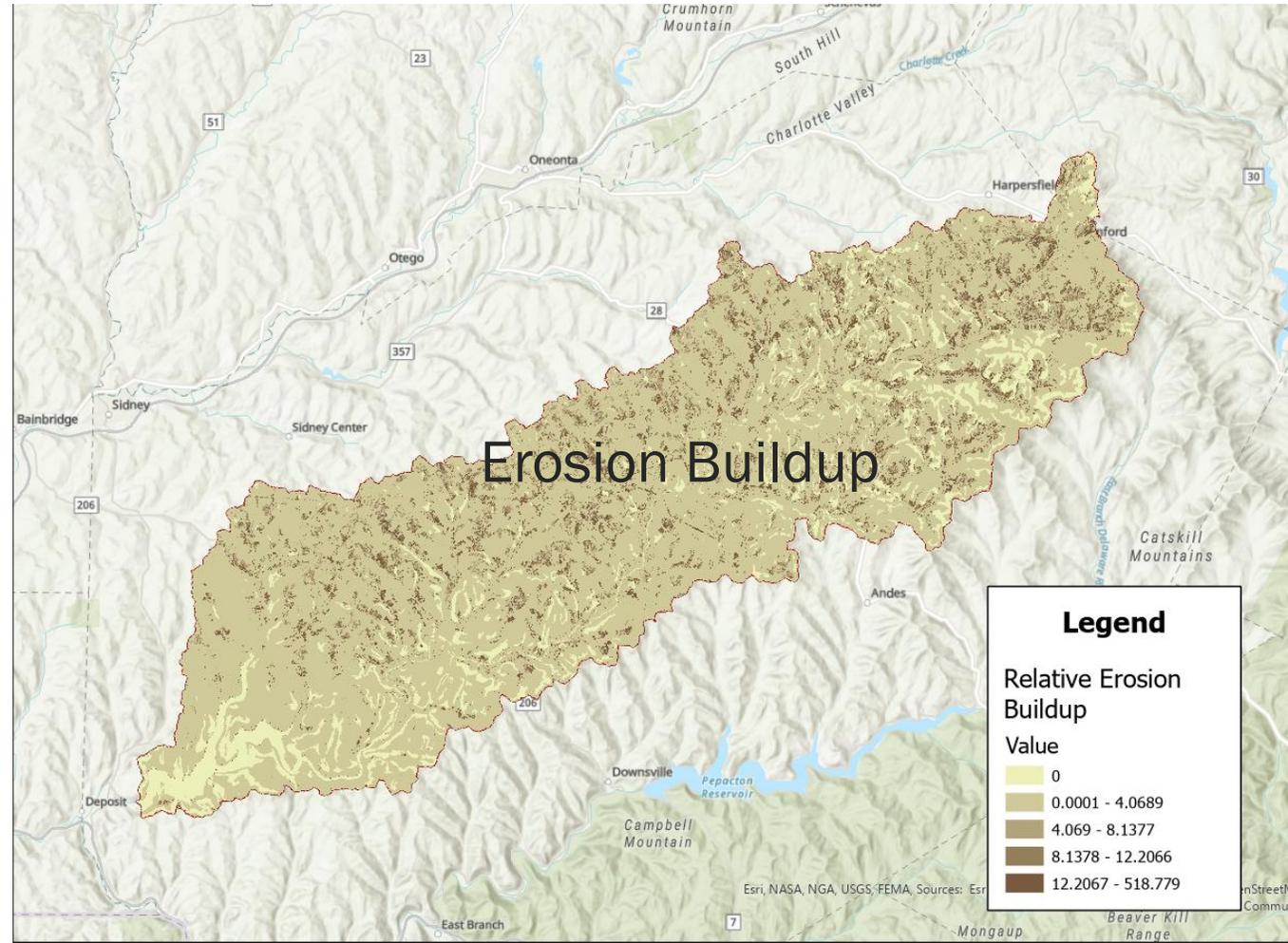
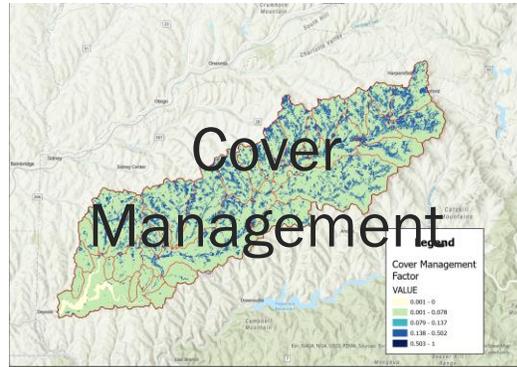
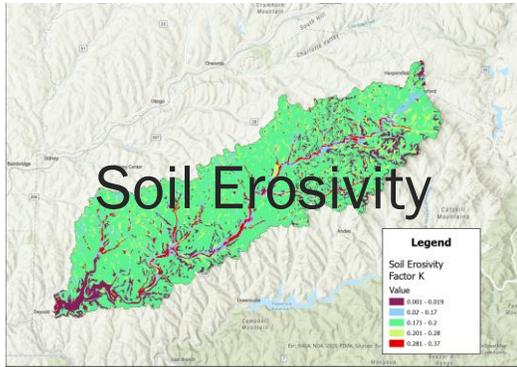
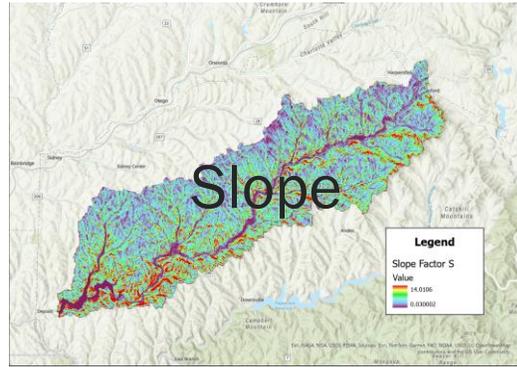
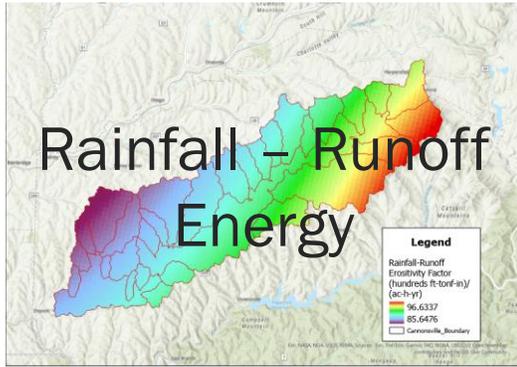


Cannonsville Landcover - Cropland Data Layer 2024 (10m)



Land Cover	Percentage (%)
Deciduous Forest	63.24
Grassland/Pasture	17.87
Mixed Forest	9.83
Developed/Open Space	4.20
Open Water	1.79
Evergreen Forest	1.22





Revised Universal Soil Loss Equation

$$A = RKLS\overline{C}P$$

Inputs to Traversability Algorithm

Input	Source	Processing
Land Cover	Cropland Data Layer (CDL) 2024 (10 m)	NHDPlus flowlines & waterbody polygons burned in
Relative Erosion raster	10 m raster	Developed using RUSLE
Flow Direction (D8)	USGS 1/3" 3DEP (~10 m)	Derived in ArcGIS Pro's Fill → Flow Direction
100 m Mask	NHDPlus flowlines (HR)	Euclidean Distance → binary ≤ 100 m

Buffer Efficiency

- Based on meta-study on riparian buffer efficiency by Zhang et al.(2010)
- Forest : Buffer Efficiency = 0.9
- Non-forest Natural Vegetation: Buffer Efficiency = 0.7
- Refinement planned with Concentrated Flow Pathway approach

Critical zones and restoration points

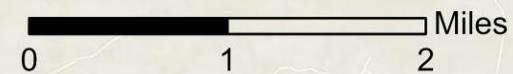
- TA outputs: Buffer width & buildup rasters
- Threshold: 75th percentile of non-zero buildup values = high-buildup zones
- Restoration targets: $\text{buildup} > \text{threshold} \ \& \ \text{buffer} = 0$

West Branch Delaware Headwaters

Subbasin Area: 4068.85 ha



Watershed Boundary
Streamline

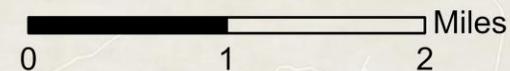


West Branch Delaware Headwaters

Subbasin Area: 4068.85 ha
Buffer Length: 35.36 mi

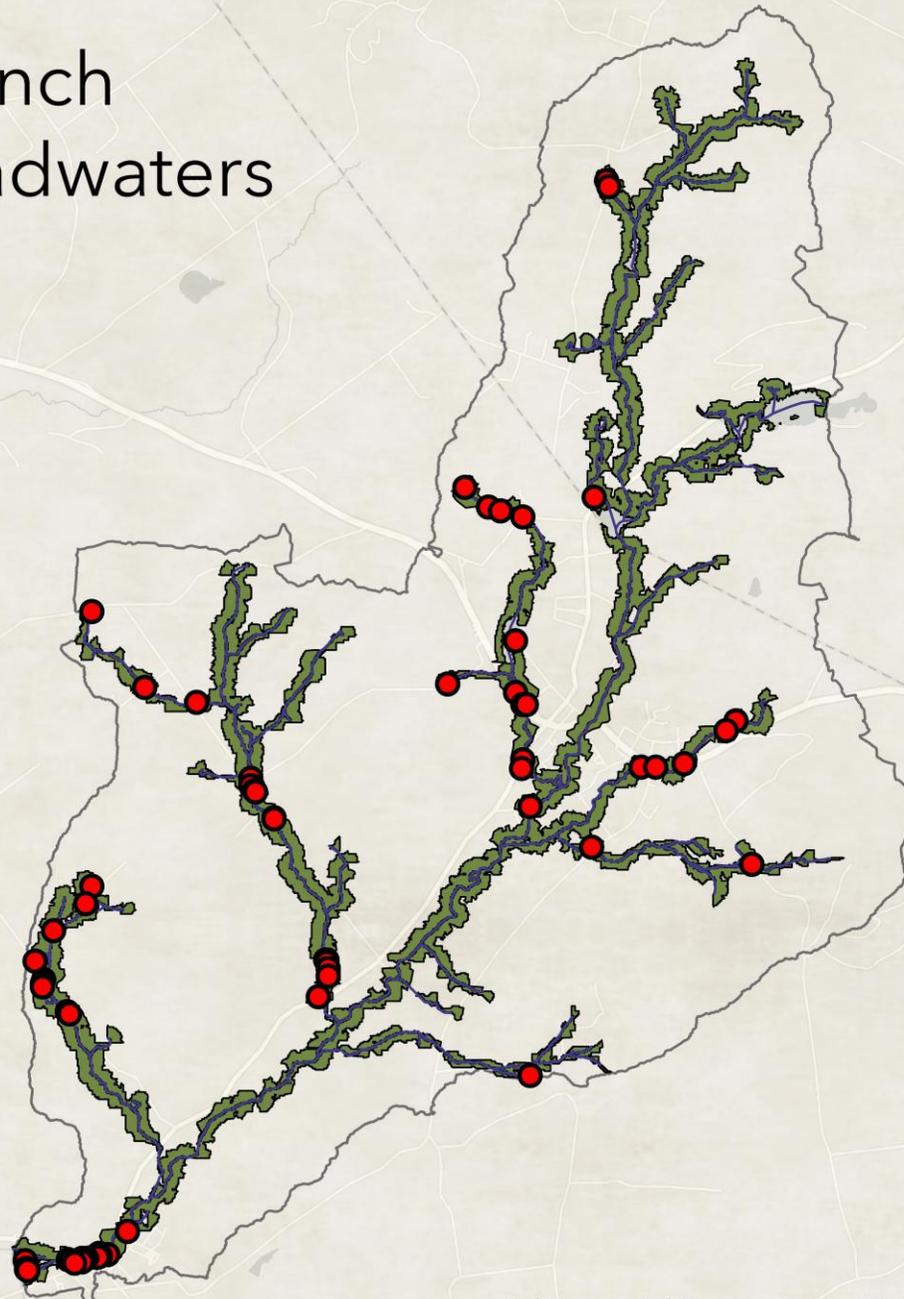


- Watershed Boundary
- Riparian Buffer
- Streamline

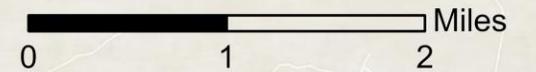


West Branch Delaware Headwaters

Subbasin Area: 4068.85 ha
Buffer Length: 35.36 mi
Potential Contamination
Length: 0.41 mi

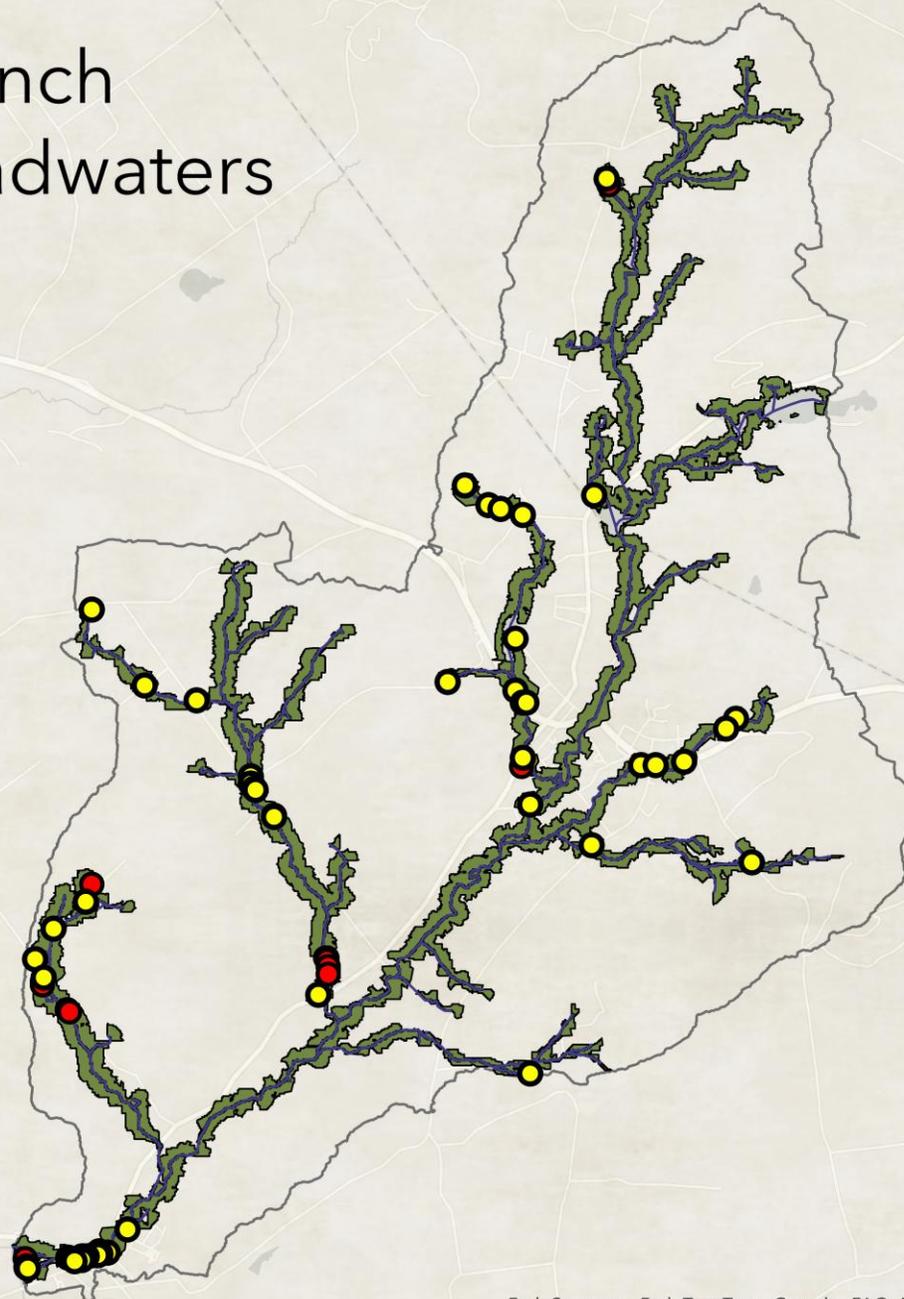


- Watershed Boundary
- Riparian Buffer
- Maximum Buildup Points
- Streamline

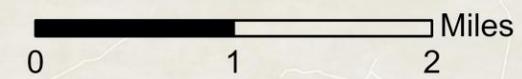


West Branch Delaware Headwaters

Subbasin Area: 4068.85 ha
Buffer Length: 35.36 mi
Potential Contamination
Length: 0.41 mi
Potential Restoration Length:
0.32 mi



- Watershed Boundary
- Riparian Buffer
- Restoration Points
- Maximum Buildup Points
- Streamline



Restoration Length

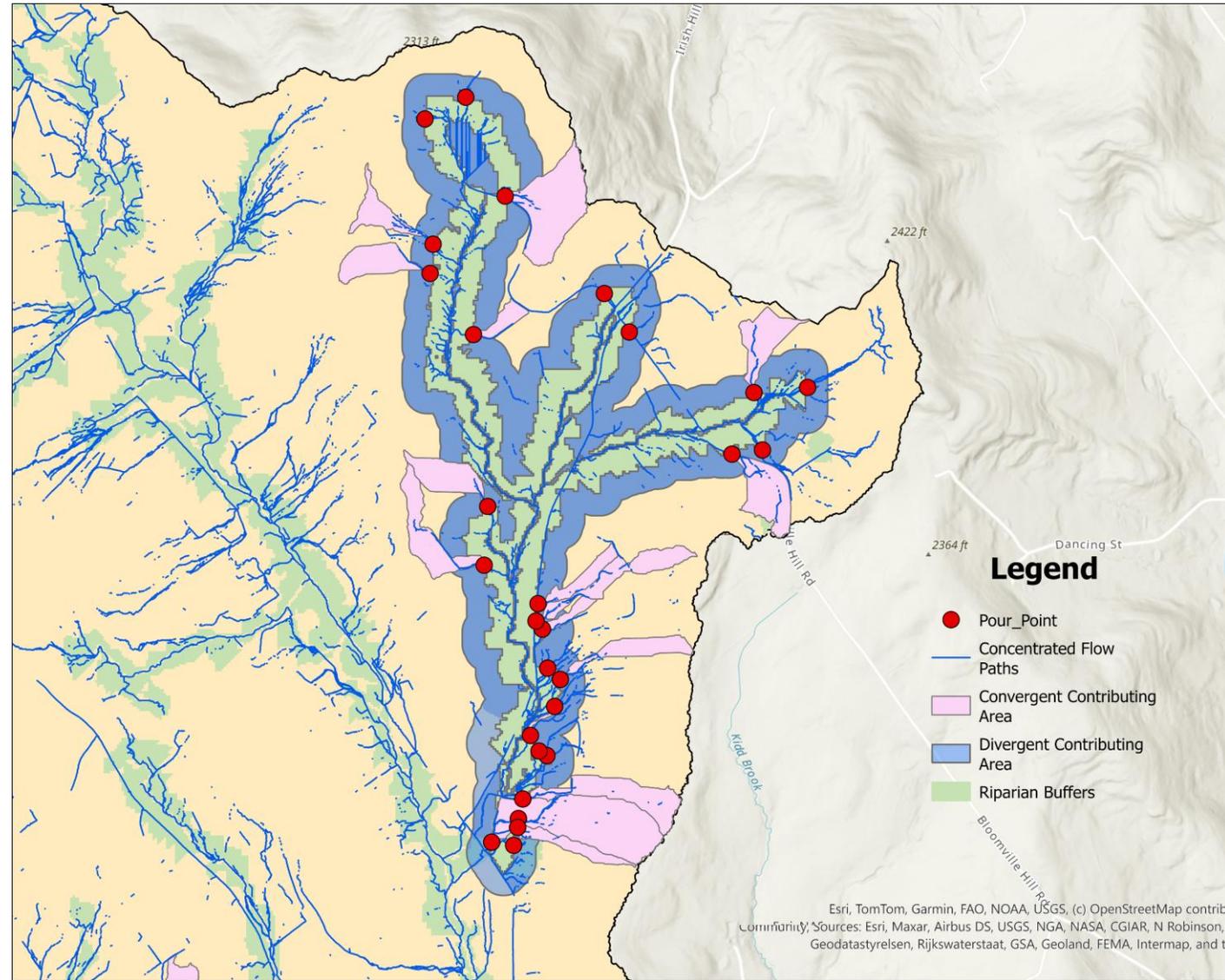
Subbasin	Length (mi)	Subbasin	Length (mi)
West Branch Delaware River	3.32	Bagley Brook	0.30
Little Delaware River	1.34	Falls Creek	0.29
West Brook	1.02	Third Brook	0.28
East Brook	0.99	Loomis Brook	0.25
Platner Brook	0.66	Rose Brook	0.19
Elk Creek	0.54	Wright Brook	0.19
Trout Creek	0.54	Sherruck Brook	0.17
Peaks Brook	0.51	Cannonsville Reservoir	0.14
Dryden Brook	0.43	Chamberlain Brook	0.09
Beers Brook	0.41	Kidd Brook	0.09
Pines Brook	0.39	Lake Brook	0.08
Dry Brook	0.35	Fish Brook	0.07
Steele Brook	0.34	Wakeman Brook	0.07
West Branch Delaware Headwaters	0.32	Betty Brook	0.06
Town Brook	0.31	Chase Brook	0.06

Project outputs

- Automated scripts that require land cover, watershed boundary, DEM and soil data as input
- Identification of existing buffer locations and widths
- Identification of critical contaminant loading zones
- Recommendations of potential restoration points

Future Directions

- Concentrated Flow Pathway (CFP) analysis
- CFPs bring contaminants from farther upstream
- CFPs bypass riparian buffers, reducing efficiency



Thank you!

Funding : Catskills Science Collaborative

Collaborators: Penn State | NYC DEP | Cary Institute of Ecosystem Studies

Contact: Ashok Jacob
(abj5710@psu.edu)



Source: Catskills Stream Buffer Initiative