

The Delaware River Watershed Initiative (DRWI):

4states1source.org

Carol R. Collier, FAICP, FAWRA

Academy of Natural Sciences
Of Drexel University

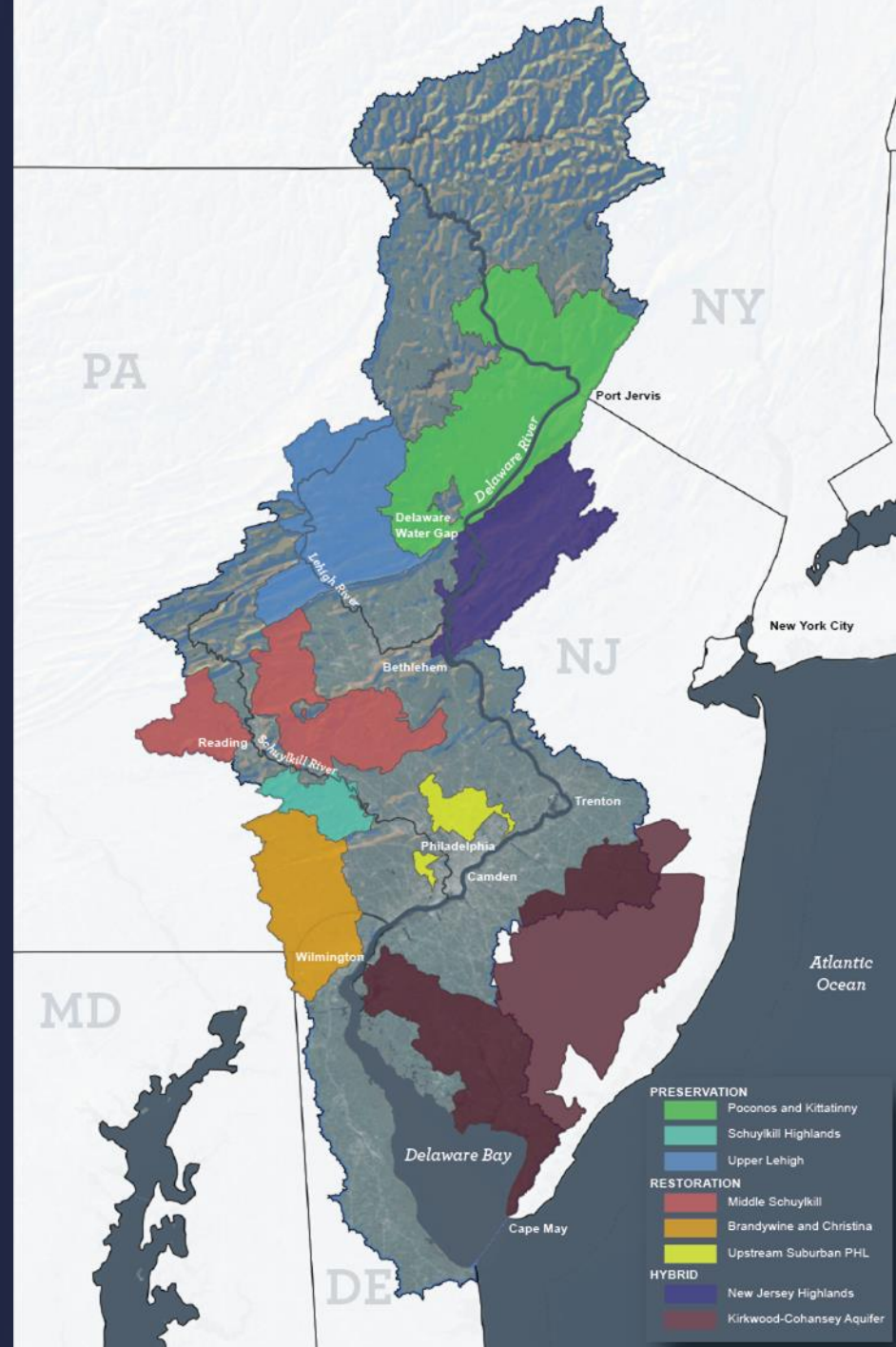


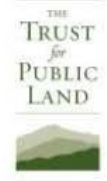
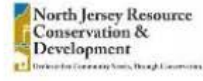
**GOAL: “Watersheds That Provide
High Quality Water in Sufficient Quantity
To Support
Healthy Natural and Human Communities”**



Delaware River Watershed Initiative

- Identified stressors: forest fragmentation and loss, agriculture run-off, stormwater, aquifer depletion
- Evaluated impact of stressors on 400 HUC-12 watersheds
- Prioritized watersheds for conservation or restoration
- Designated 8 sub-watershed areas where high-priority areas were “clustered”





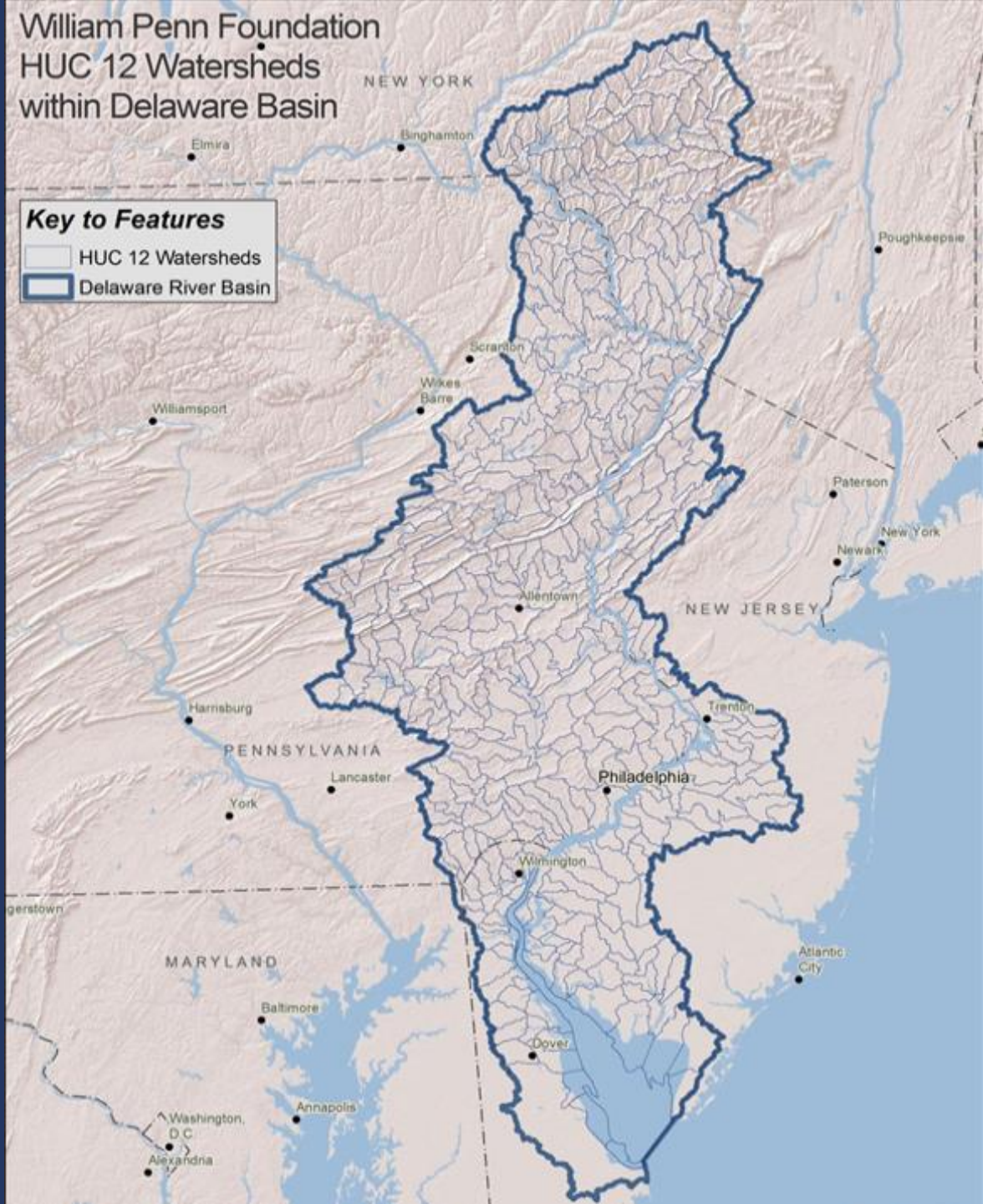
Unique Features

- Strong Scientific Backbone
- Working Through “Grasstops” Organizations
 - Not top down, 60+ organizations
- Targeted Programs and Funding
 - Restoration and Preservation
- Continual Evaluation of Program Value and Transferability (lessons learned)
- Phase 2 ('18 – '20)– Even better program

William Penn Foundation HUC 12 Watersheds within Delaware Basin

Key to Features

- HUC 12 Watersheds
- Delaware River Basin



The DRWI

Specific Stressors

- Forest fragmentation and loss in headwaters
- Agricultural run-off
- Stormwater run-off
- Aquifer depletion

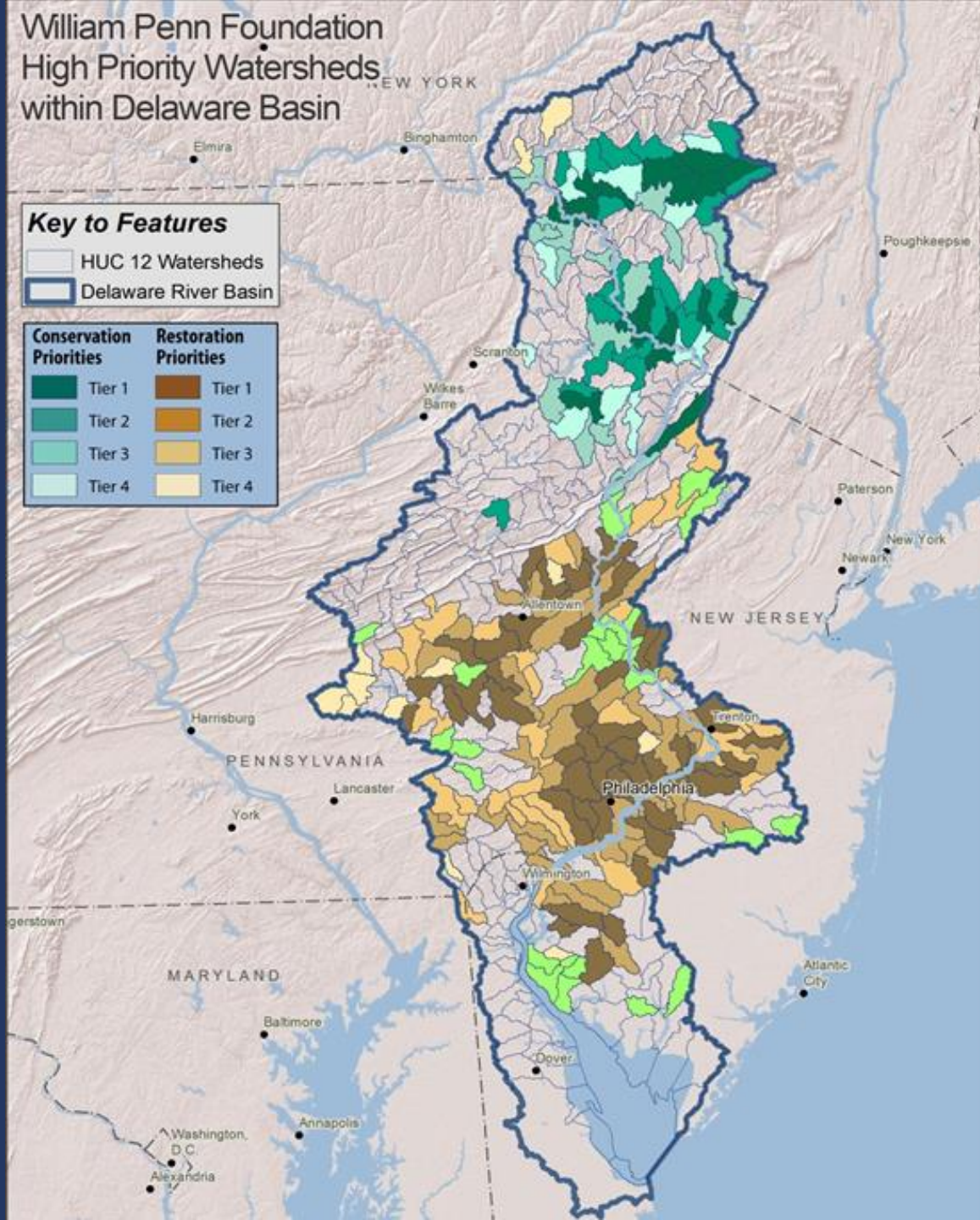


William Penn Foundation High Priority Watersheds within Delaware Basin

Key to Features

- HUC 12 Watersheds
- Delaware River Basin

Conservation Priorities	Restoration Priorities
Tier 1	Tier 1
Tier 2	Tier 2
Tier 3	Tier 3
Tier 4	Tier 4

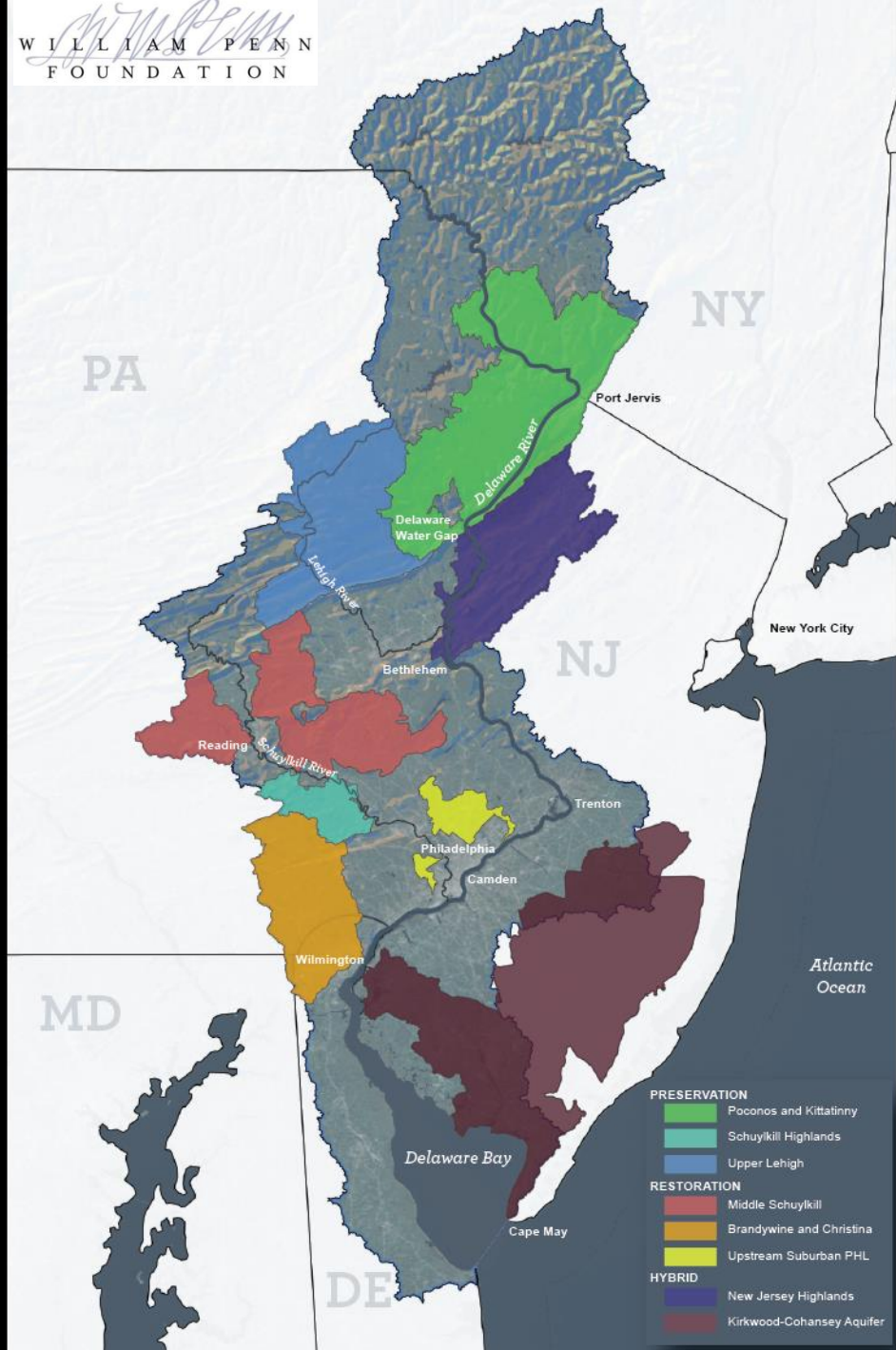


Feasibility for Investment in Watersheds

- Potential for Significant Impact
- Urgency to Act
- Organization Capacity
- Cost Efficiency
- Ability to Measure Impact



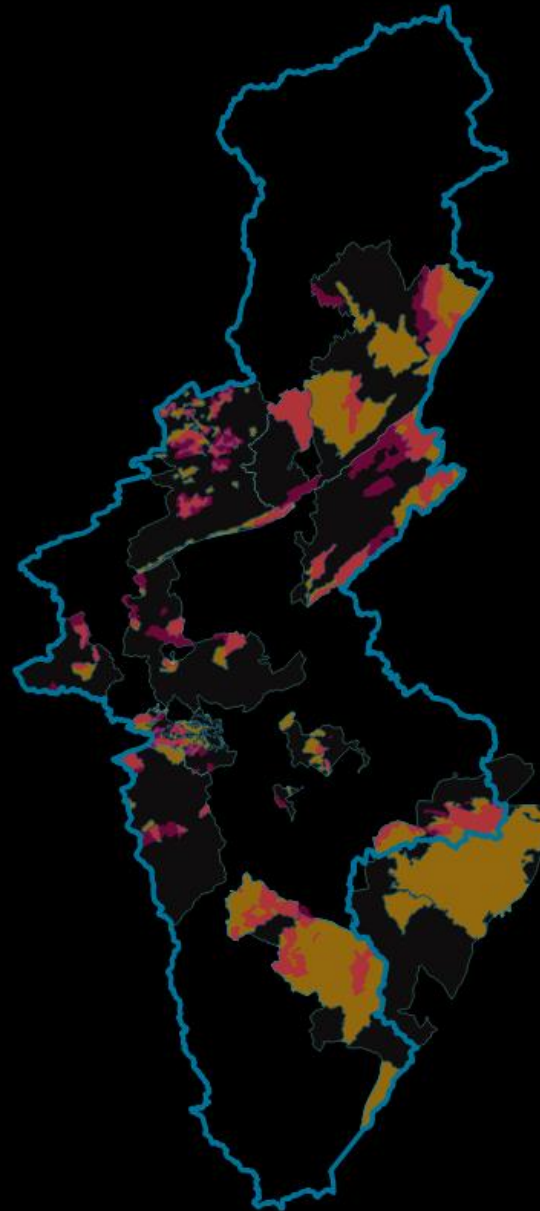
Delaware Water Gap National Recreation Area



- PRESERVATION**
- Poconos and Kittatinny
 - Schuylkill Highlands
 - Upper Lehigh
- RESTORATION**
- Middle Schuylkill
 - Brandywine and Christina
 - Upstream Suburban PHL
- HYBRID**
- New Jersey Highlands
 - Kirkwood-Cohansey Aquifer

DRWI Phase 1 \implies Phase 2

- Phase 1 – average area 97 km²
- Phase 2 – average area 41.8 km²
- Phase 2 focus areas designed around strict watershed boundaries
- Average reduction of 69%



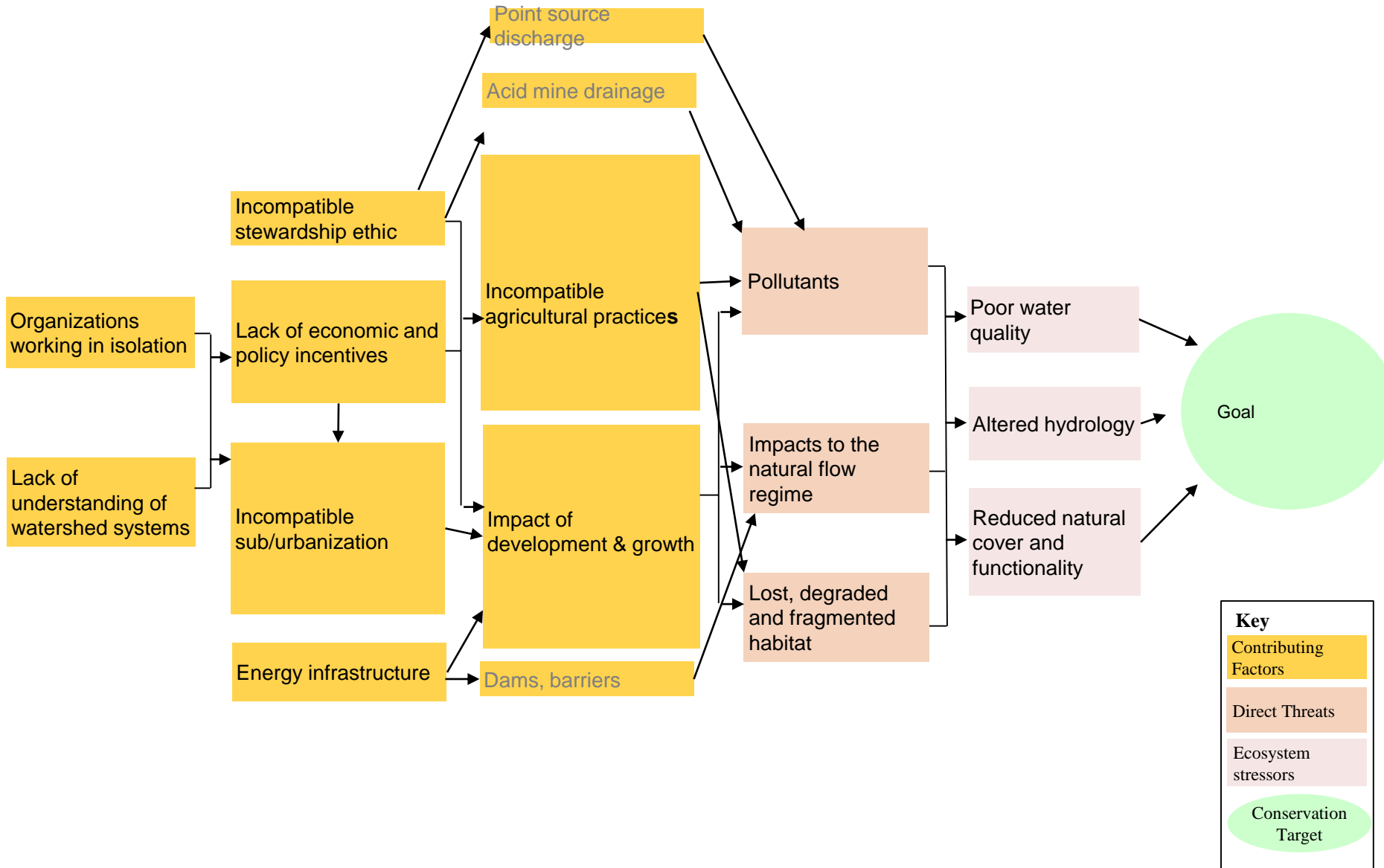
BUILDING DRWI PHASE 2

- **Lessons Learned from Phase 1**
- **Moving from Opportunistic to More Data-derived Decisions**

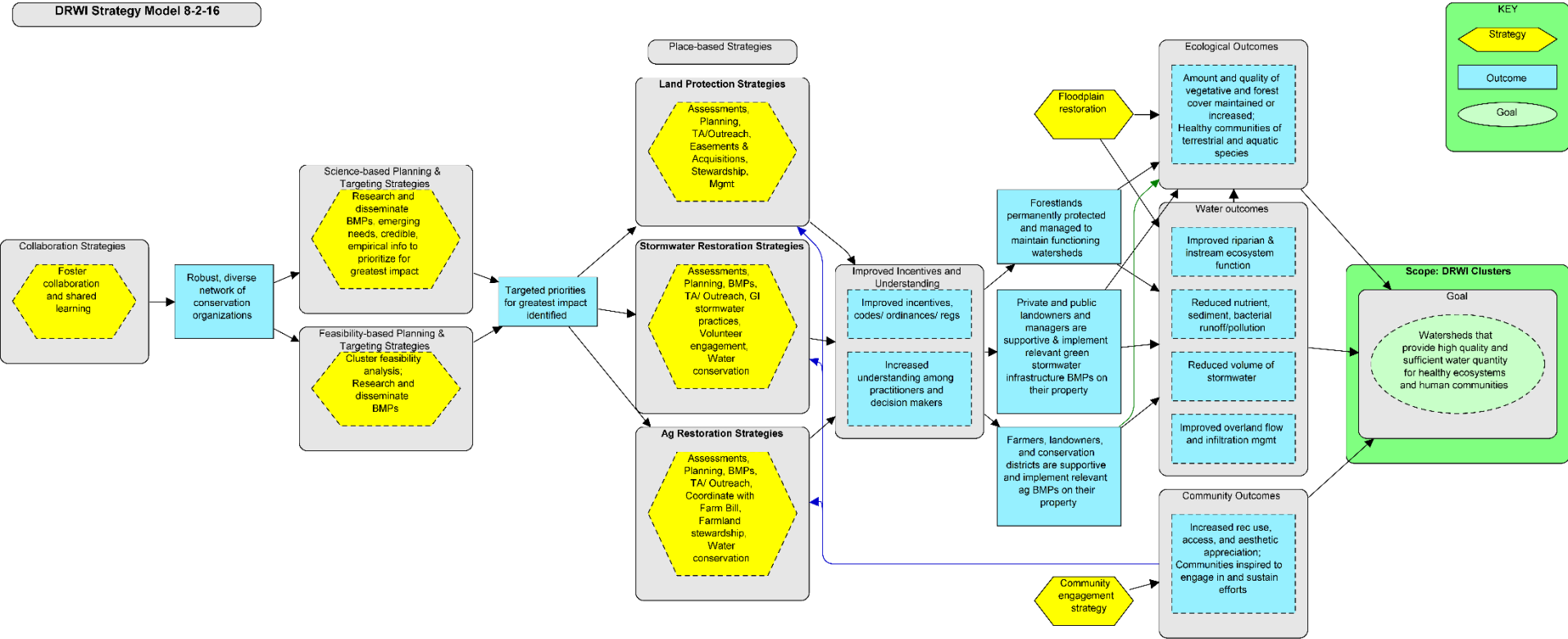
BUILDING DRWI PHASE 2

- **Stronger Scientific Basis for Focus Area and Site Selection**
- **Added Accountability – Progress toward Goal**
- **Metrics –**
 - Performance and Outcome
- **Team Building – Outreach**
- **Working with watershed-wide advocacy orgs.**
- **Hopefully 6 year effort (2018-2024)**

Threats Model



DRWI Strategy Model 8-2-16



ON-THE GROUND PROJECTS

- **Over \$40M/ 3 yrs – for DRWI Phase I**
- **Preservation/Protection**
 - ~20,000 acres of forested lands protected
 - ~90 miles of forested riparian buffer
 - 3:1 match; \$9MM invested, \$56MM match leverage
- Open Space Institute
- **Restoration**
 - ~9000 acres of Ag & Suburban lands restored
 - ~ 60 miles of forested stream banks restored
 - 1:1 match; \$8MM leveraged \$16MM
- Nat'l Fish and Wildlife Foundation (NFWF)

COMPLEMENTARY STRATEGIES

Municipal Ordinances

Tech Assist to Municipalities

County Open Space Bond Issues

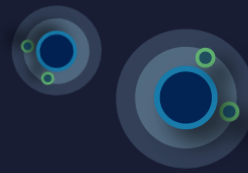
Building local support for environmental actions

Educational Programs – students, adults, teachers

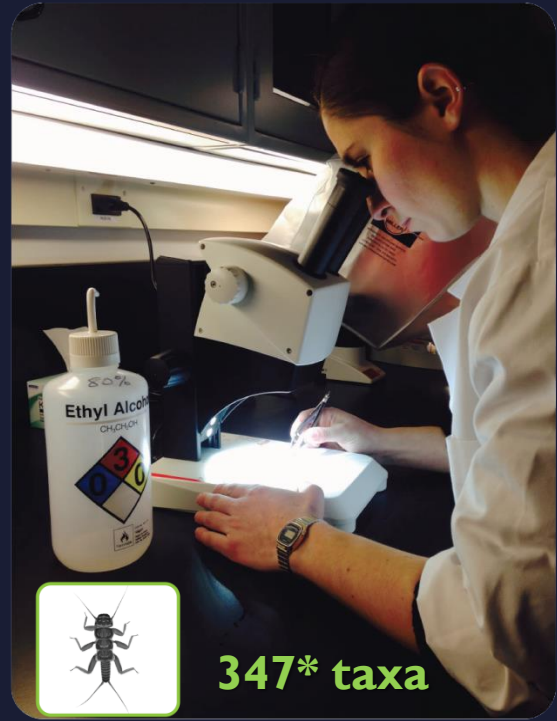
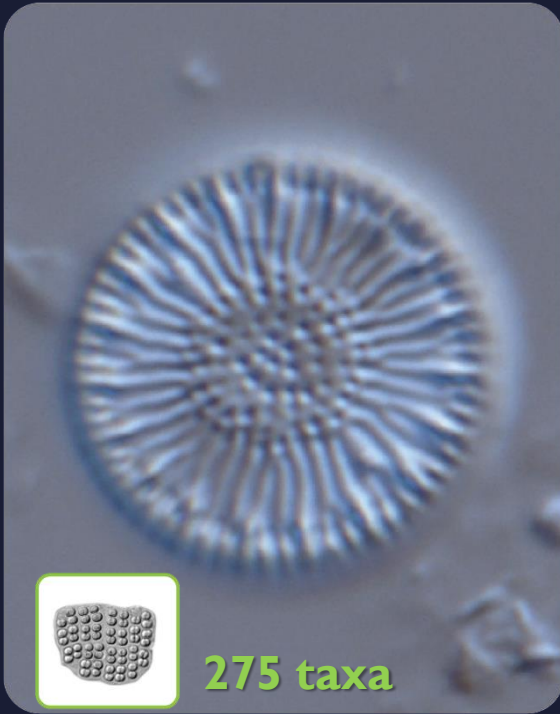
Using champions to influence their neighbors

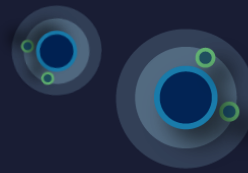
RESEARCH AGENDA TO FILL THE GAPS

- Research Re-Granting Program
 - \$5M – Delaware Watershed Research Fund – 17 research teams
 - Nov. 29 – Del. Watershed Research Conf. ANS
- Addressing Critical Questions
 - Ecological Targets for Conservation Workgroup
 - Forested Headwater Workgroup
- Connecting Scientists with Practitioners



Monitoring Overview





UNDERLYING QUESTIONS

How are in-stream ecosystems responding to on-the-ground actions?

Which indicators best respond to current stressors and conditions, as well as changes in water (and ecosystem) quality over time?

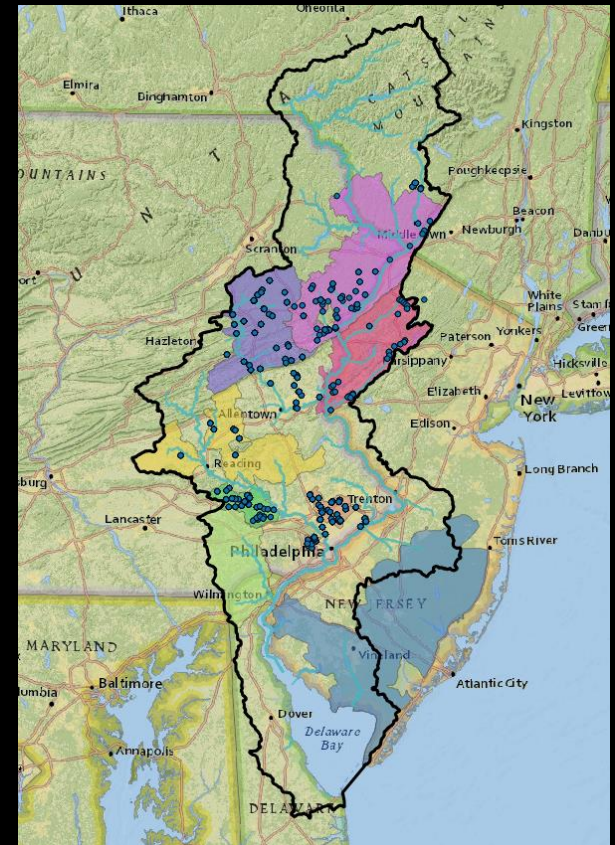
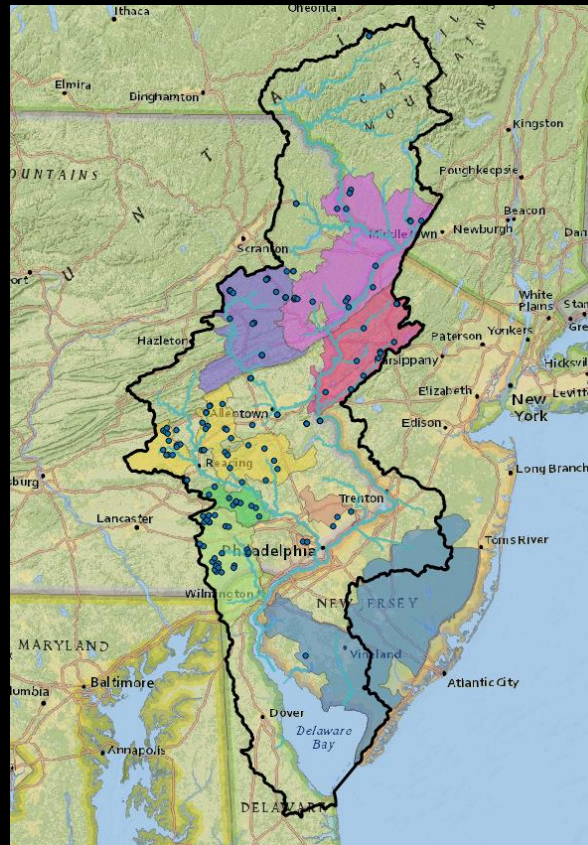
How can monitoring results inform the DRWI and similar work in the future?

DRWI Data Collected

Academy of Nat. Sci.

Partnering Organizations

- Fish
- Macroinvertebrate
- Diatom
- Chemistry
- Habitat
- Stormwater



500 Monitoring Sites

IMPROVEMENTS IN PHASE 2 MONITORING

More citizen monitoring with Tier 2 Methodology

- Tier 1 – species, Peer –review articles
- Tier 2 – ANS/Stroud training, QCed data
- Tier 3 – Instream monitoring for outreach, “red flags”

Mostly chemistry and macroinvertebrates

- Some organizations doing bacteria and algae

More targeted – project sites and focus areas

Outcome Monitoring Committee – each Cluster

LOCATION OF DATA

CUAHSI – Hydroshare

Raw data reserved for 3 years, but assessed data available sooner upon request.

MODELING TOOLS FOR SELECTION OF SITES

- **SRAT – one sq. mile watersheds, land use impacts /direct runoff/ upstream influence. Used to prioritize watersheds for action**
- **WikiWatersheds – User friendly, focus on specific watershed, input different alternatives for site restoration. (e.g. - Difference in a 30 or 100 ft. forested buffer)**

MAPPING & TOOLS FOR DRB

UVM – NLCD (USGS Nat'l Land Cover Dataset) plus LIDAR

- 1 meter resolution
- 7 land use categories

Shippensburg University & USGS

- Sleuth Model and local input
- Land Use Change Forecasts

Delaware River Watershed Initiative // Phase II Planning

STREAM REACH ASSESSMENT TOOL

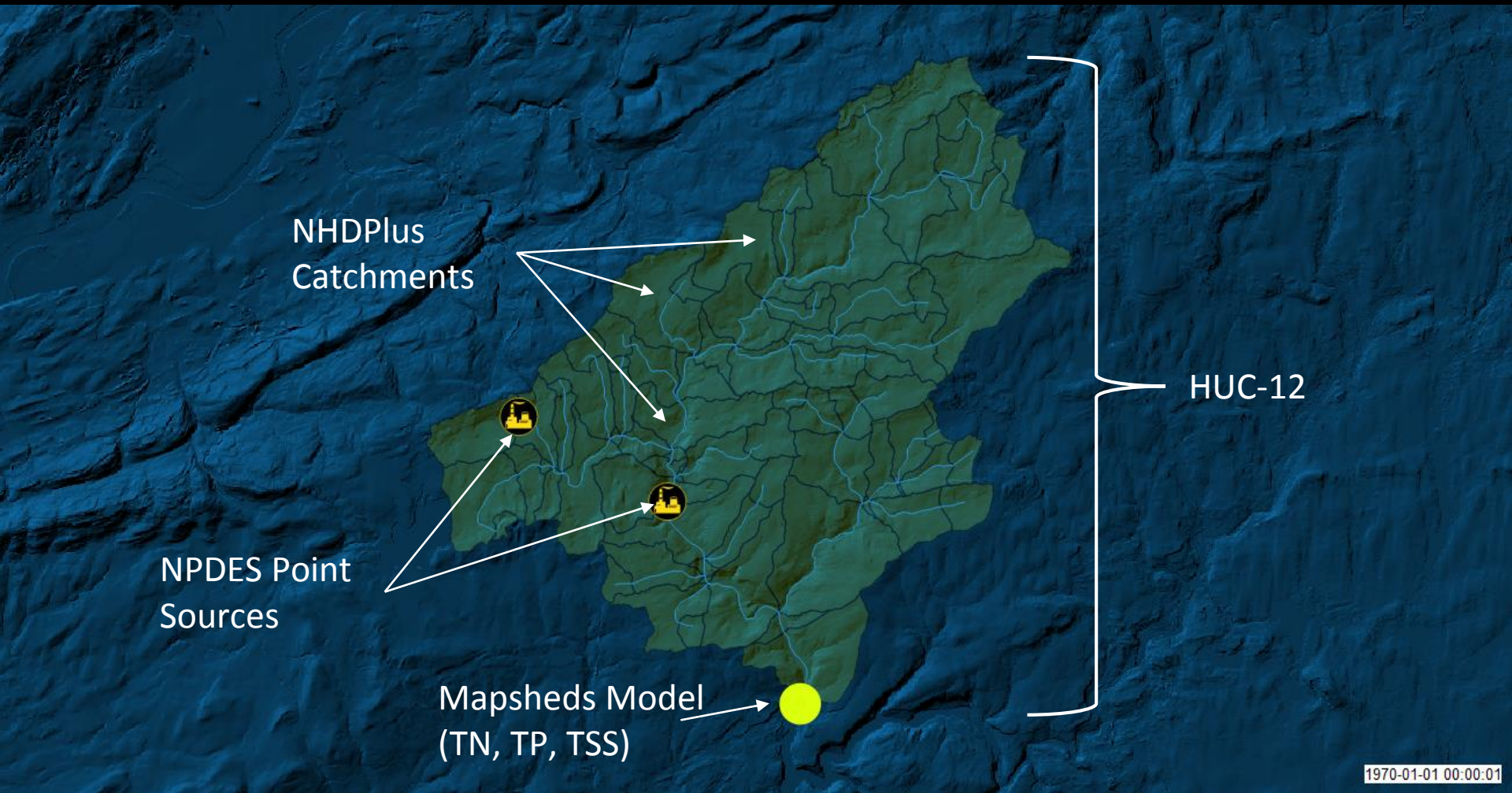
- Models nutrient yields and concentrations through out the DRB
- Created with data from multiple sources
 - Mapshed developed by Dr. Barry Evans
 - NHDPlus
 - National Land Cover Database
 - NPDES point sources
- Models at reach-scale:
 - Mean annual loads & in-stream concentrations - TN, TP & TSS
 - Ability to Produce Clean and Abundant Water – score aggregating local landscape features

External Data

- Located in PASDA

The screenshot shows the homepage of the Pennsylvania Spatial Data Access (PASDA) website. At the top, there is a navigation bar with the PASDA logo and the text "PENNSYLVANIA SPATIAL DATA ACCESS The Pennsylvania Geospatial Data Clearinghouse". Below the navigation bar are links for HOME, ABOUT, ADVANCED SEARCH, APPS & TOOLS, SHARE DATA, TUTORIALS & HELP, and CONTACT US. The main content area features a large banner image of a green field with trees. Below the banner, there is a section titled "Open GIS Data Access for the Commonwealth of Pennsylvania" with a brief description and a "Learn More >>" link. The page is divided into two main columns. The left column has a section titled "Access Data" with two search boxes: "SEARCH BY KEYWORD(S)" and "SEARCH BY DATA PROVIDER", each with a "Submit" button. Below these is a "BROWSE FTP SITE:" link with a folder icon. The right column has a section titled "Data Shortcuts" with a grid of icons and labels: Imagery (airplane icon), LIDAR & Elevation (mountain icon), Hydrology (water drop icon), Transportation (bus icon), Boundaries (globe icon), Recreation (person on a boat icon), Biota (plant icon), Energy (lightning bolt icon), Local (capitol building icon), and NGOs & Academic (handshake icon). At the bottom of the left column, there is a "New Additions" section with two entries: "PA FISH & BOAT COMMISSION" and "PA DCNR", each with a small icon and a brief description of the data.

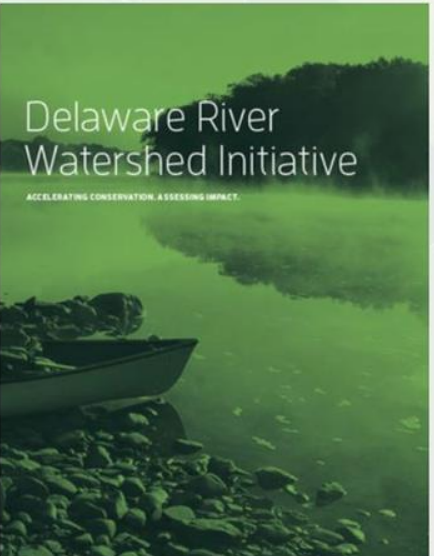
Stream Reach Assessment Tool



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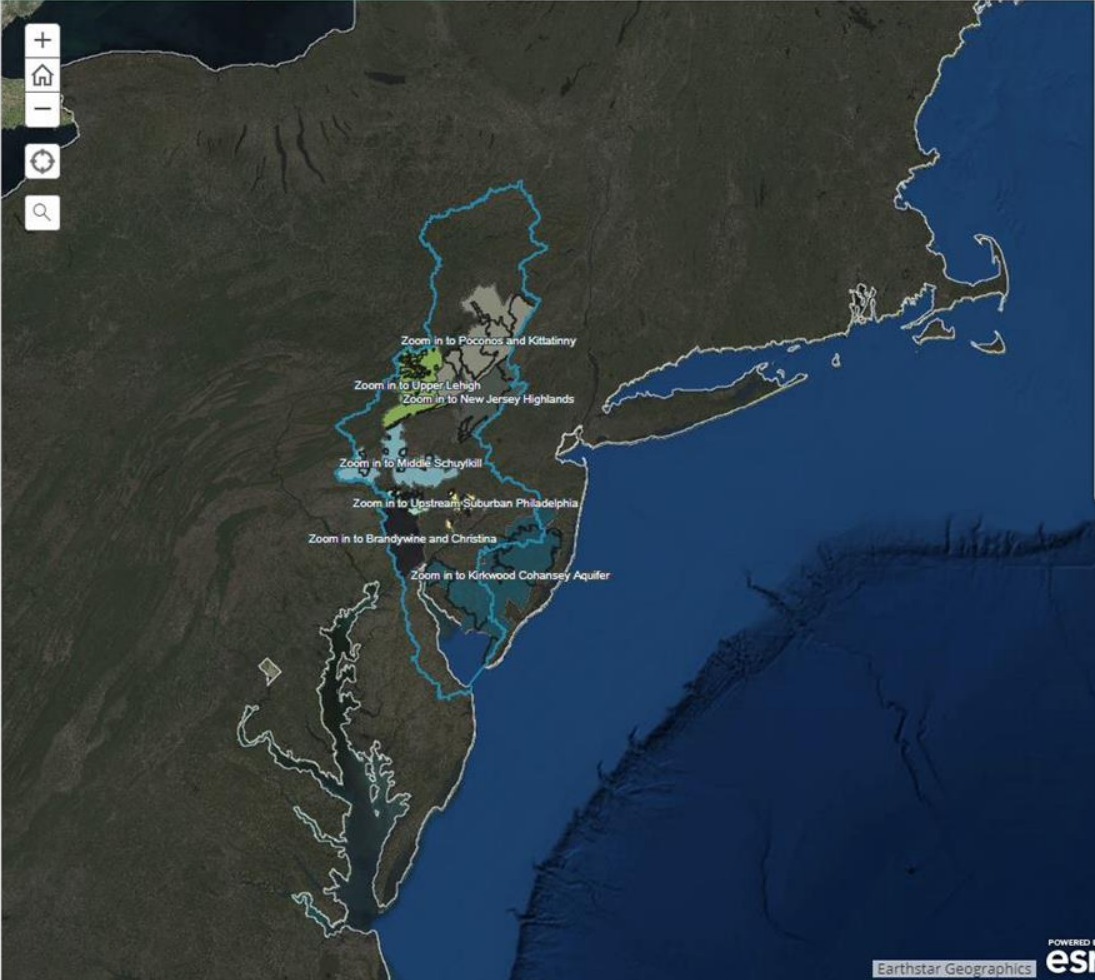
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- Land Cover & Land Use



In an unprecedented collaboration to protect and restore water quality, more than 50 leading nonprofits have joined together to accelerate conservation in eight regions of the Delaware River watershed. Informed by science, the Initiative aligns priorities for land protection and restoration projects in these ecologically significant areas. Scientists assess water quality impacts at select sites throughout the basin to evaluate progress towards the goal: Watersheds that provide high quality and sufficient water quantity for healthy ecosystems and human communities.

Stream Reach Assessment Tool Overview

Land use decisions upstream affect water quality downstream. A small headwaters stream might be influenced by land use on as little as a few thousand acres; for a larger tributary, as many as two million acres may affect the river's chemical and biological traits. Understanding impacts at different scales is challenging. In order to accurately assess pollutant loads in streams and evaluate the quality of natural resources that are supporting clean water, the Stream Reach Assessment Tool (SRAT) was designed to integrate dozens of datasets to provide the following information:



LEGEND

Subwatershed Clusters - Copy

- Brandywine and Christina
- Kirkwood Cohansey Aquifer
- Middle Schuylkill
- New Jersey Highlands
- Poconos and Kittatinny
- Schuylkill Highlands
- Upper Lehigh
- Upstream Suburban Philadelphia



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Nitrogen

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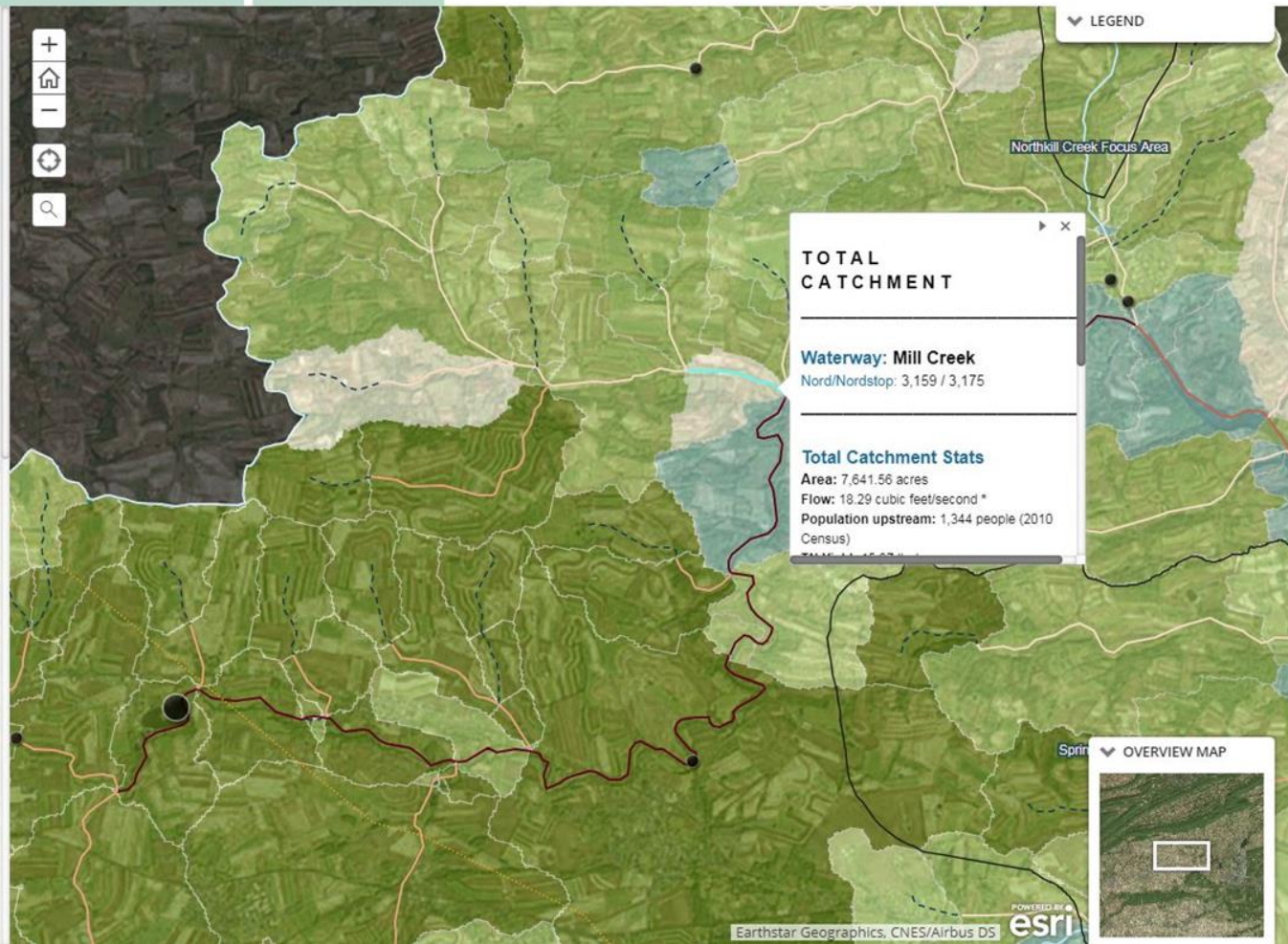
In most fresh water bodies, phosphorus is the limiting nutrient for aquatic growth. Conversely, in most estuarine systems, nitrogen is the limiting nutrient. In some cases, however, the determination of which nutrient is the most limiting is difficult. For this reason, the ratio of the amount of N to the amount of P is often used to make this determination (Thomann and Mueller, 1987). If the N/P ratio is less than 10, nitrogen is limiting. If the N/P ratio is greater than 10, phosphorus is the limiting nutrient.

If the nutrient load to a water body can be reduced, the available pool of nutrients that can be utilized by plants and other organisms will be reduced and, in general, the total biomass can subsequently be decreased as well (Novotny and Olem, 1994). In most efforts to control eutrophication processes in water bodies, emphasis is placed on the limiting nutrient. This is not always the case, however. For example, if nitrogen is the limiting nutrient, it still may be more efficient to control phosphorus loads if the nitrogen originates from difficult to control sources such as nitrates in ground water.

Nutrient (i.e., nitrogen and phosphorus) loads primarily originate from wastewater treatment plants and agricultural land. Watersheds with high farm animal populations also tend to have higher nutrient loads. In this case, much of the animal waste is used as an organic fertilizer on surrounding cropland, which contributes to the nutrient loads emanating from these areas.

Pollutant Thresholds:

Provided below is a table that presents some "threshold" values for nutrients and sediment that are intended to help determine whether a given watershed or stream segment might be impaired with respect to water quality. It must be understood, however, that these values are provided for guidance purposes only, and that actual impairments may vary based on many factors that interact at any given location. In the case of the values from Sheeder and Evans, both loading rate and in-stream concentration values are given. These latter values are to be interpreted as approximate "breakpoints" between impaired and unimpaired watersheds that were based on an analysis of observed stream data for 29 watersheds in Pennsylvania. The in-stream concentration values developed by USEPA and NJDEP, on the other hand, represent "targets" that each agency believes should be met to ensure unimpaired conditions within the general region of the Delaware River Basin. In the case of the USEPA values, a range is given for TN and TP due to that fact that values were developed for different ecoregions across the U.S. and the



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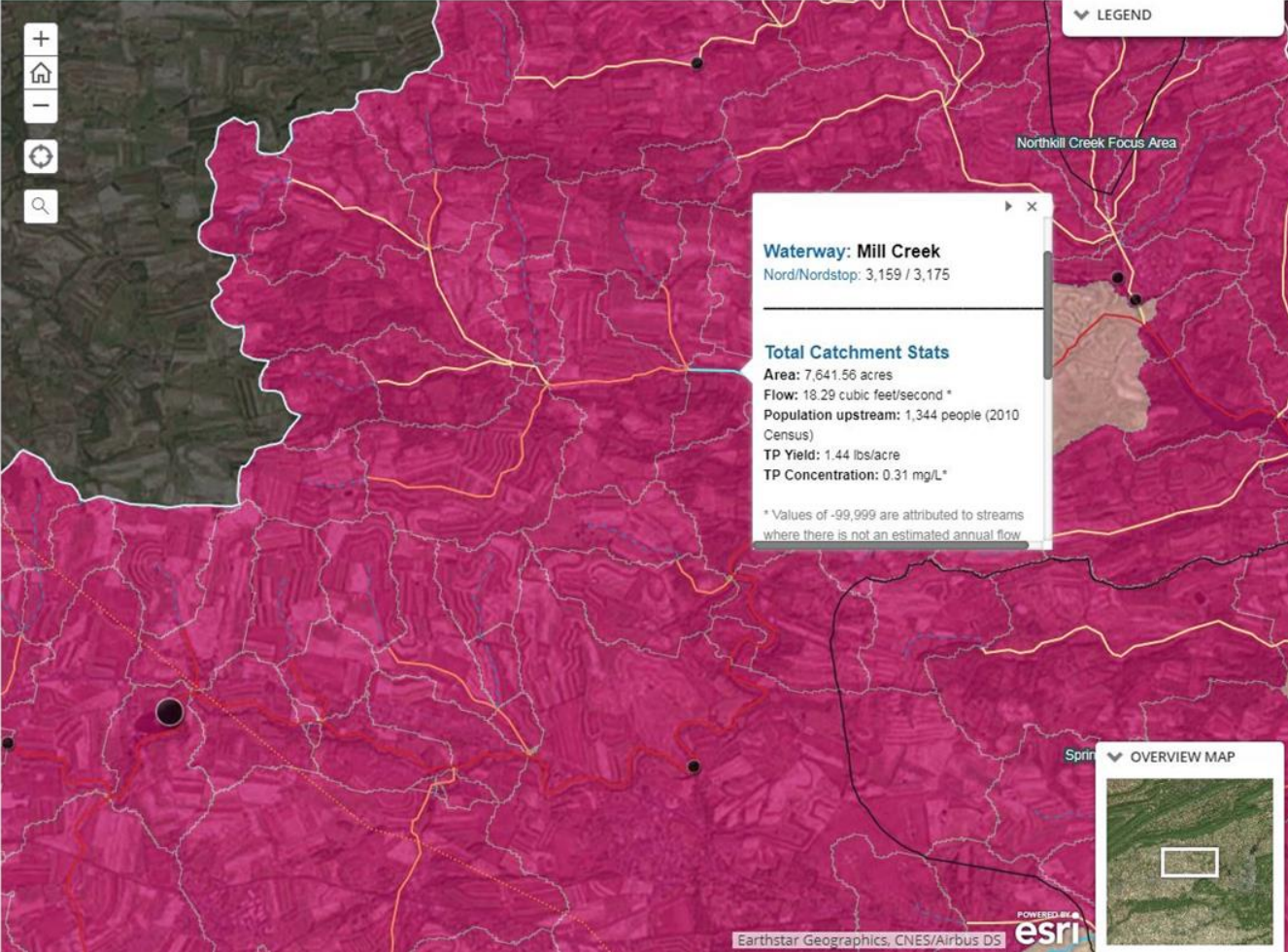
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From the table, it can be seen that a threshold value of 0.1 mg/l seems appropriate for TP. Although the values range considerably for TN, it should be noted, as described earlier, that the value for TP is usually more important due to the fact that it is the limiting nutrient for most streams in the Delaware River Basin. In the case of TSS, NJDEP has set different threshold values for TSS depending upon whether the streams do or do not support trout.

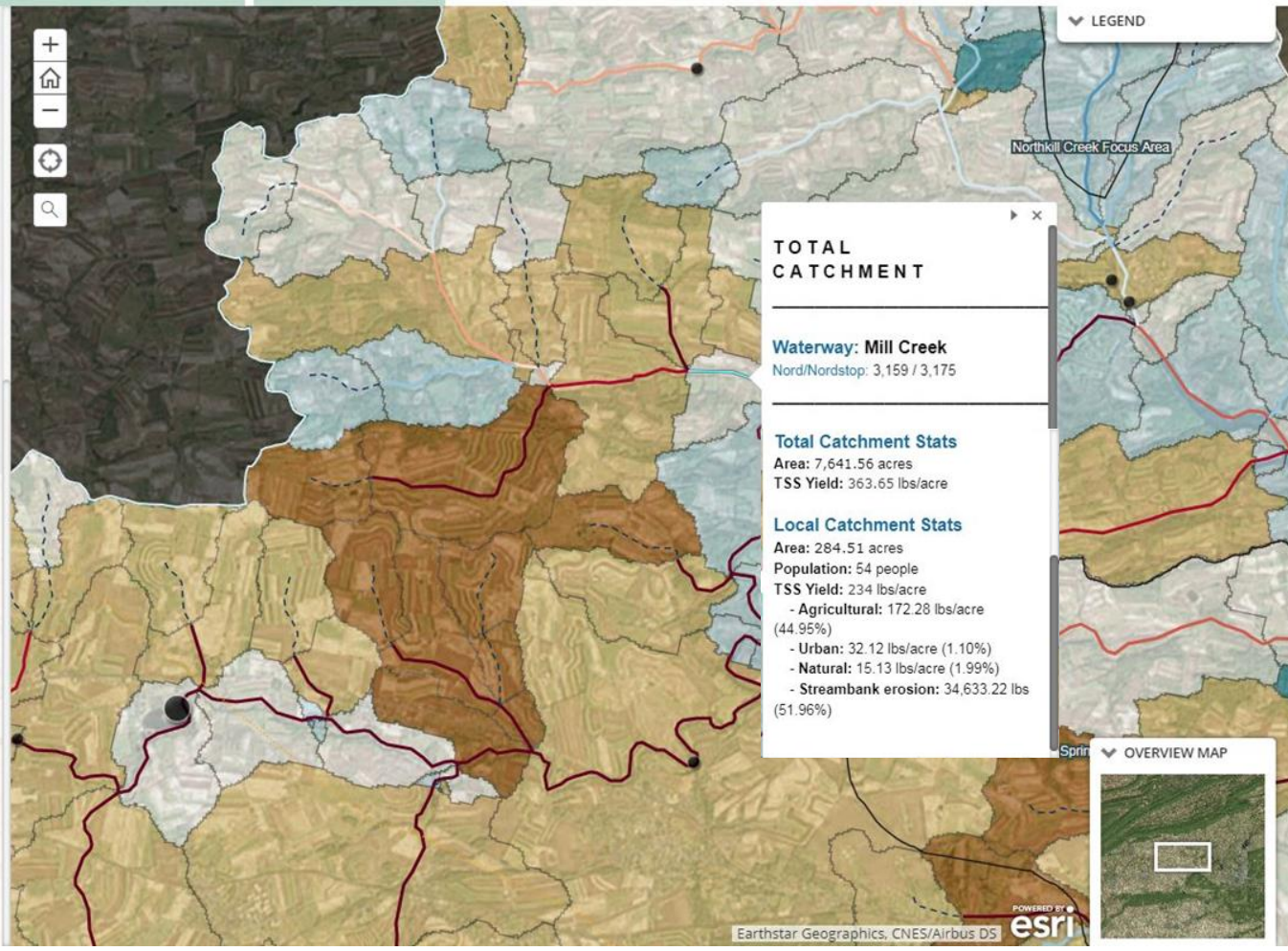
Yields and Concentration Thresholds:

	TN	TP	TSS
Sheeder and Evans	13.0 kg/ha (14.6 lb/ac)	0.30 kg/ha (0.34 lb/ac)	785 kg/ha (882 lb/ac)
Sheeder and Evans	3.0 mg/L	0.07 mg/L	197 mg/L
USEPA	0.07-1.0 mg/L	0.006 - 0.1 mg/L	---
NJDEP	10.0 mg/L	0.1 mg/L	25 - 40 mg/L (trout vs. non trout)

*Note the actual nitrogen values given in Sheeder and Evans are for inorganic N only, and are lower than those shown in the table above. The ones shown above have been adjusted upwards to account for organic N as well. Also note that the TN values for NJDEP are for nitrate-N only. In this case, the value appears to be based on the national 10 mg/l drinking water standard rather than ecological or nutrient enrichment factors.

Sources:

Sheeder, S.A., Evans, B.M., 2004. Estimating nutrient and sediment threshold criteria for biological impairment in Pennsylvania watersheds. J. Am. Water Res. Assoc. 40, 881-888.



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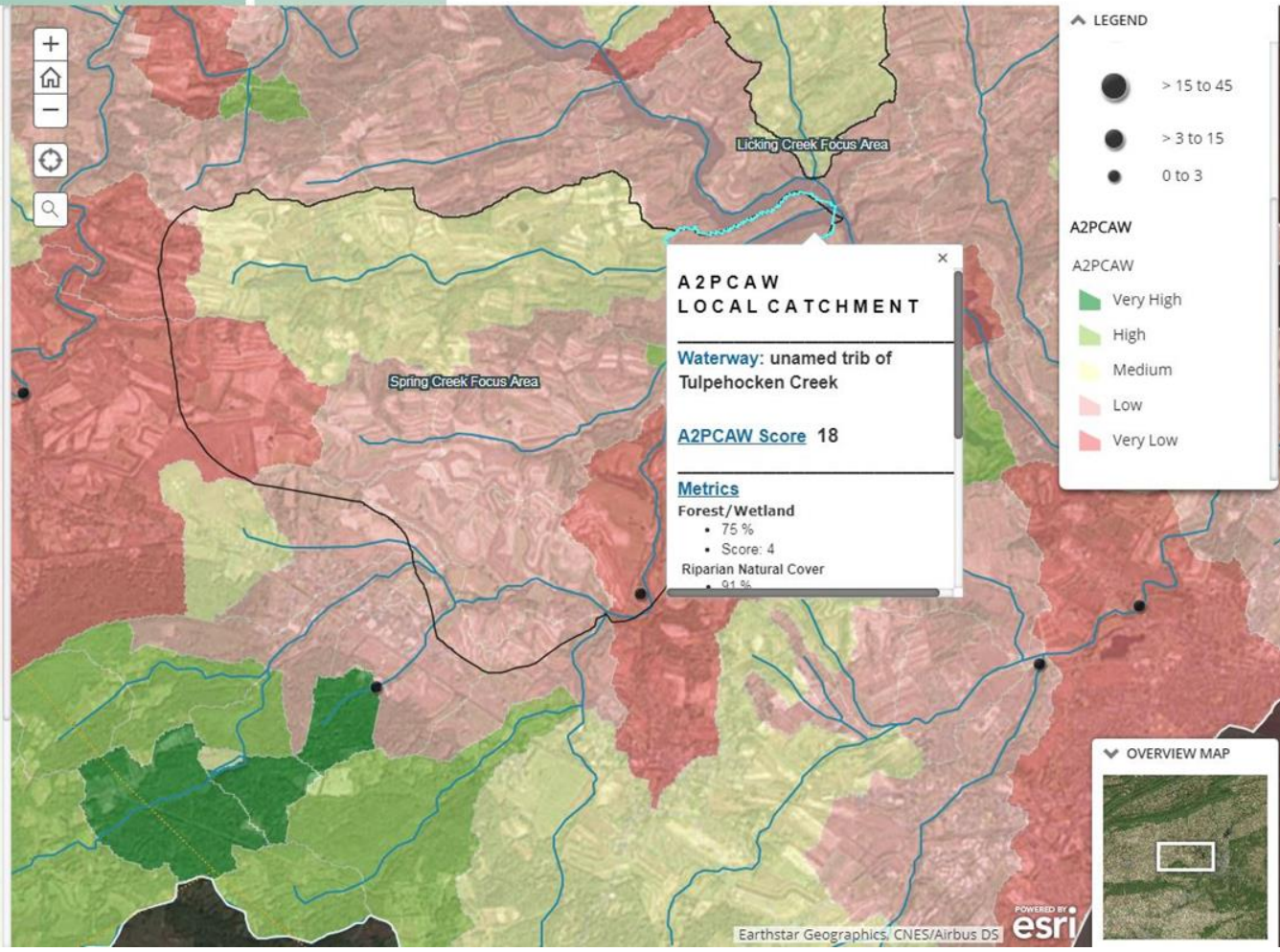
Ability to Produce Clean Abundant Water

As part of Phase I of the Delaware River Watershed Initiative, the Open Space Institute (OSI) developed a metric to measure the relative capacity of small-scale (HUC12) watersheds to produce clean surface and ground water. The metric directly considers watershed conditions including land cover, terrain and hydrology that affect both the abundance and quality of surface and ground water within a reasonably-sized watershed (i.e., HUC12 boundary).

The new indexing scheme used to derive this metric (still called the "Ability to Produce Clean Abundant Water") is summarized in the table below. This metric retains many of the analytical components of other previously-developed watershed-rating approaches such as "Forest-to-Faucet" (Barnes et al., 2008), the "Conservation Priority Index" (WRI, 2013), and the "SmartConservation" initiative in southeast Pennsylvania (<http://www.natlands.org/services/formunicipalities/smartconservation/>) upon which the earlier metrics were based. For use within SRAT, this metric was re-calculated down to the local catchment of each of the 15,000 stream reaches in the Basin to provide a finer-scale version of this metric.

Ability to Produce Clean Abundant Water Metric

	Very High	High	Medium	Low	Very Low
	(5)	(4)	(3)	(2)	(1)
% Forest/Wetland*	> 88	68 - 88	47 - 68	24 - 47	< 24
% Riparian Natural Cover	> 89	71 - 89	50 - 71	28 - 50	< 28
Erosion Potential	< 82	82 - 128	128 - 186	186 - 277	> 277
Ground Water Recharge (inches/year)	> 16.4	15.6 - 16.4	14.2 - 15.6	10.7 - 14.2	< 10.7
Stream Order	1	---	2	---	3
% Base Flow	> 60	53 - 60	47 - 53	39 - 47	< 39



LEGEND

- > 15 to 45
- > 3 to 15
- 0 to 3

A2PCAW

A2PCAW

- Very High
- High
- Medium
- Low
- Very Low



Stream Reach Assessment Tool



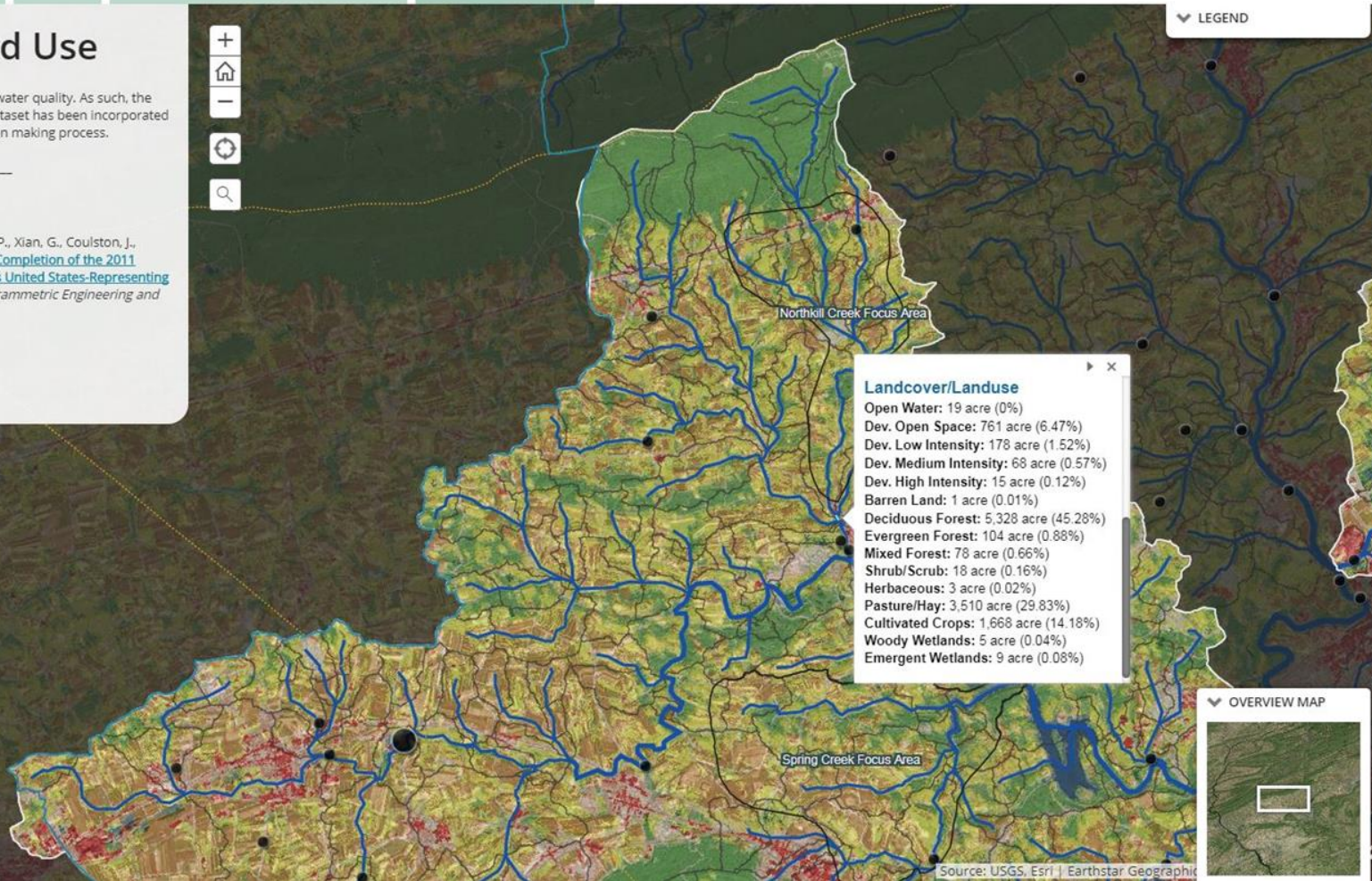
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Land Cover & Land Use

Land cover and land use are highly correlated with water quality. As such, the National Land Cover Database 2011 (NLCD 2011) dataset has been incorporated into the SRAT outputs to further inform your decision making process.

Sources:

NLCD 2011 citation:
 Homer, C.G., Dewitz, J.A., Yang, L., Jin, S., Danielson, P., Xian, G., Coulston, J., Herold, N.D., Wickham, J.D., and Megown, K., 2015. [Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information](#). *Photogrammetric Engineering and Remote*



DRWI METRIC DASHBOARD

Endpoint Integration



FIELDDOC

Project site scale



DRWI METRIC DASHBOARD

Organization, Focus Area, Cluster and DRB scale

Scope

- *Track progress and impact* in the project sites, focus areas, clusters, and DRB
- *Integrate tool components and datasets* across DRWI platforms to facilitate end-user success
- *Leverage existing data* (monitoring and modelling) generated by DRWI partners
- Port metric and project data to CUAHSI Cloud Hydroshare

New Jersey Highlands Cluster

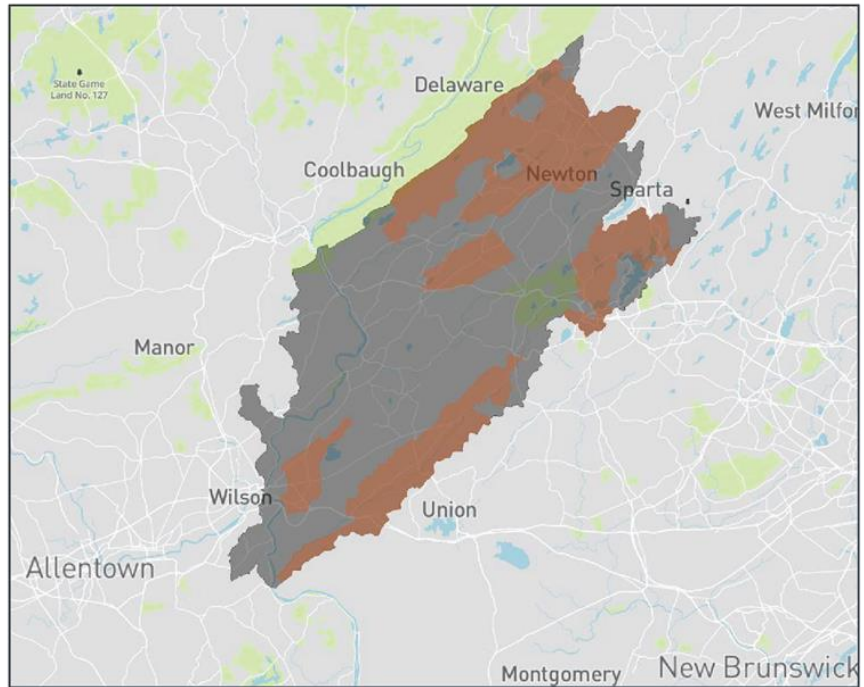
Your Organization: The Nature Conservancy

Partners:

- Association of New Jersey Environmental Commissions
- Hunterdon Land Trust, Musconetcong Watershed Association
- New Jersey Audubon
- New Jersey Conservation Foundation
- New Jersey Highlands Coalition
- North Jersey Resource Conservation & Development
- Wallkill River Watershed Management Group
- The Land Conservancy of New Jersey
- Trout Unlimited

PHASE 2 FOCUS AREAS

PAULINSKILL	BEAVER BROOK
LOPATCONG	L.M. MUSCONETCONG
UPPER MUSCONETCONG	ALL FOCUS AREAS



PERFORMANCE METRIC SUMMARY / CLUSTER

AG. LAND TREATED with BMPs



50.0%
Installed To-Date

WETLANDS RESTORED



100.0%
Installed To-Date

LANDOWNERS REACHED



73.3%
Reached To-Date

FORESTED BUFFER



100.0%
Installed To-Date

NON DRWI FUNDING



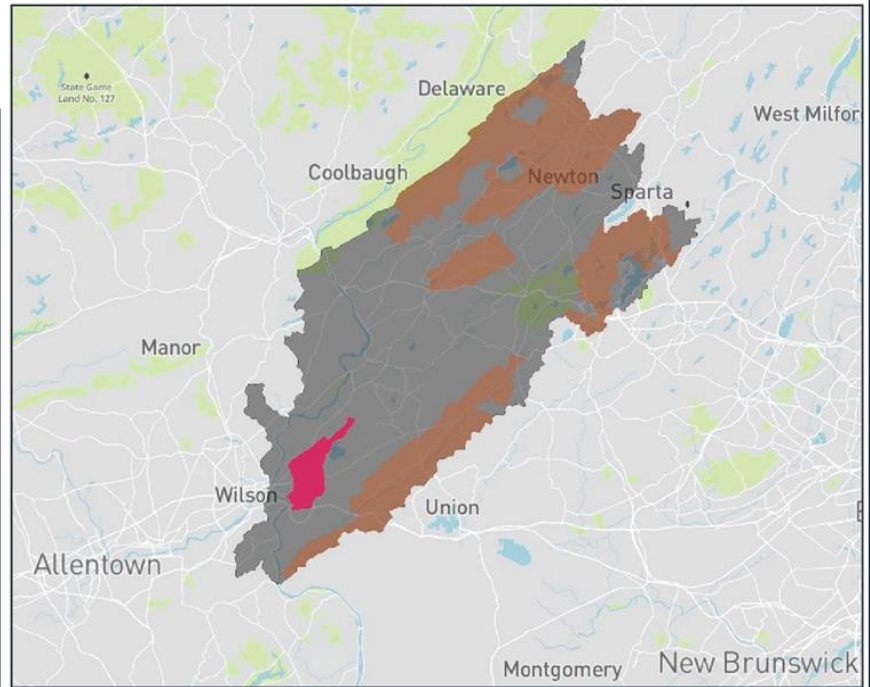
50.0%
Leveraged To-Date

New Jersey Highlands Cluster

Your Organization: The Nature Conservancy

Partners:

- New Jersey Audubon
- New Jersey Conservation Foundation
- New Jersey Highlands Coalition
- The Land Conservancy of New Jersey
- Trout Unlimited



PHASE 2 FOCUS AREAS

- PAULINSKILL
- BEAVER BROOK
- LOPATCONG**
- L.M. MUSCONETCONG
- UPPER MUSCONETCONG
- ALL FOCUS AREAS

PERFORMANCE METRIC SUMMARY / LOPATCONG

AG. LAND TREATED with BMPs



75.0%
Installed To-Date

WETLANDS RESTORED



0.0%
Installed To-Date

LANDOWNERS REACHED



50.0%
Reached To-Date

FORESTED BUFFER



100.0%
Installed To-Date

NON DRWI FUNDING



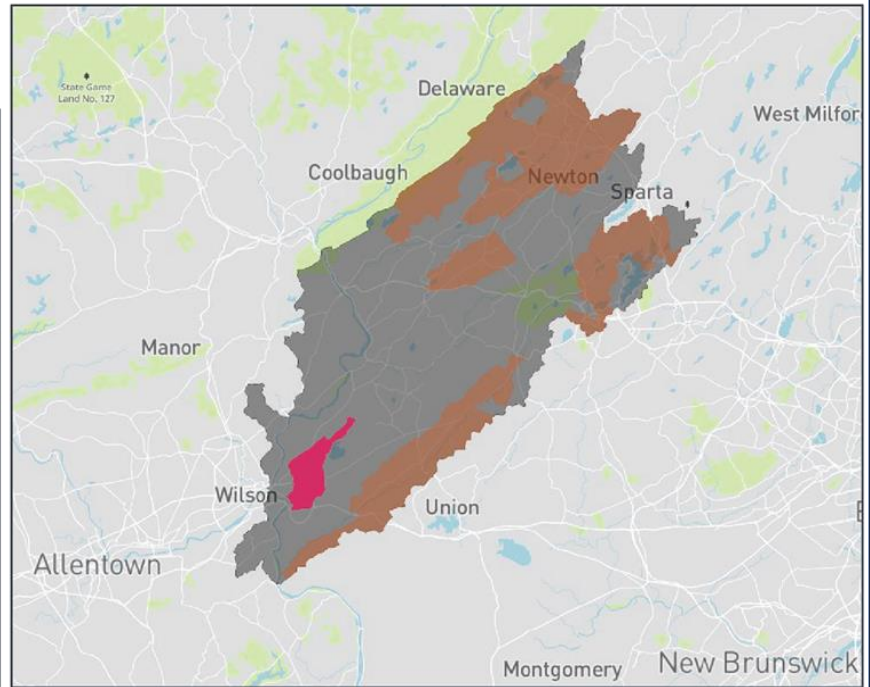
25.0%
leveraged To-Date

New Jersey Highlands Cluster

Your Organization: The Nature Conservancy

Partners:

- New Jersey Audubon
- New Jersey Conservation Foundation
- New Jersey Highlands Coalition
- The Land Conservancy of New Jersey
- Trout Unlimited



PHASE 2 FOCUS AREAS

- PAULINSKILL
- BEAVER BROOK
- LOPATCONG
- L.M. MUSCONETCONG
- UPPER MUSCONETCONG
- ALL FOCUS AREAS

PERFORMANCE METRIC SUMMARY / LOPATCONG

AG. LAND TREATED
with BMPs



75.0%
Installed To-Date
Update Metric
(FieldDoc)

WETLANDS
RESTORED



0.0%
Installed To-Date

LANDOWNERS
REACHED



50.0%
Reached To-Date
Update Metric

FORESTED BUFFER



100.0%
Installed To-Date
Update Metric
(FieldDoc)

NON DRWI
FUNDING



25.0%
leveraged To-Date
Update Metric

Poconos and Kittatinny Cluster

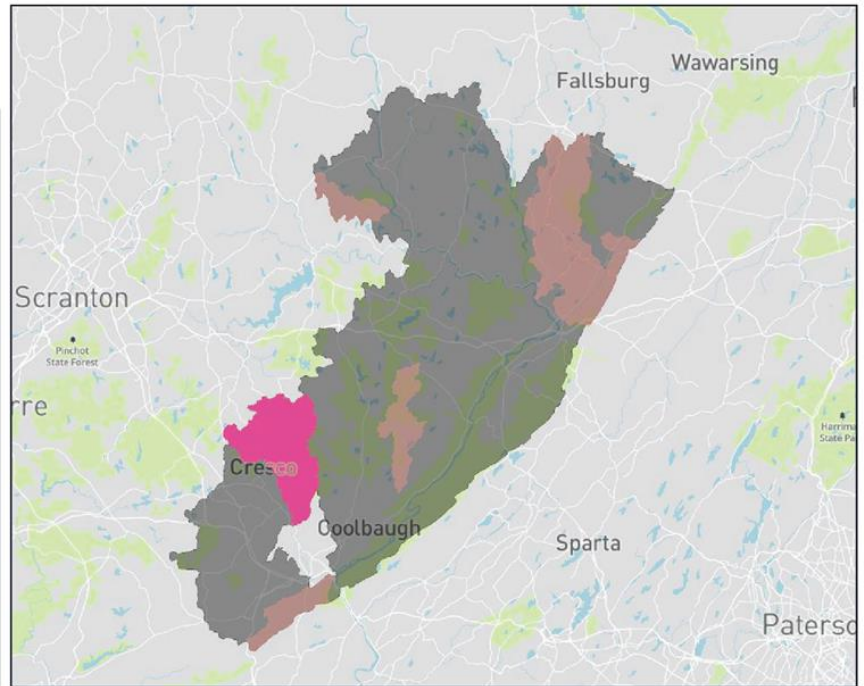
Your Organization: Brodhead Watershed Association

Partners:

- Delaware Highlands Conservancy
- East Stroudsburg University
- Natural Lands
- Orange County Land Trust
- Pinchot Institute for Conservation
- Pocono Heritage Land Trust
- The Nature Conservancy–Pennsylvania.

PHASE 2 FOCUS AREAS

KITTATINNY RIDGE EAST	BRODHEAD	UPPER NEVERSINK
CHERRY VALLEY	RATTLESNAKE CREEK	LOWER NEVERSINK
LITTLE BUSHKILL	EASTERN MONGAUP	LOWER BASHAKILL



PERFORMANCE METRIC SUMMARY / BRODHEAD

PROTECTED LAND



LANDOWNERS REACHED






FORESTED BUFFER



NON DRWI FUNDING



SUMMARY.....

- **Using local groups to address land-based problems**
- **Focus on local, backyard creek**
- **Targeted stressors and geographic areas**
- **Backbone of science**
- **Lucky to have input of , but also brings more  into watershed**
- **Avoidance or alternative to TMDL**
- **Building  for local creeks and rivers**