StreamSweepers Completion of Rapidan River Cleaning and Assessment 2015

DRAFT REPORT – November 20, 2015

Report to Riverside Landowners and Watershed Supporters

By The Center for Natural Capital, Orange, VA

Acknowledgments

November 20, 2015

This draft report has been prepared by the Center for Natural Capital for Rapidan and Robinson River riverside landowners and watershed supporters. More results from the StreamSweepers years of work will be added to the FINAL REPORT, expected January 1, 2016.

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Arrowpoint Farm
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Beggars Banquet Rentals
Blue Ridge Embroidery
Jim Darnell
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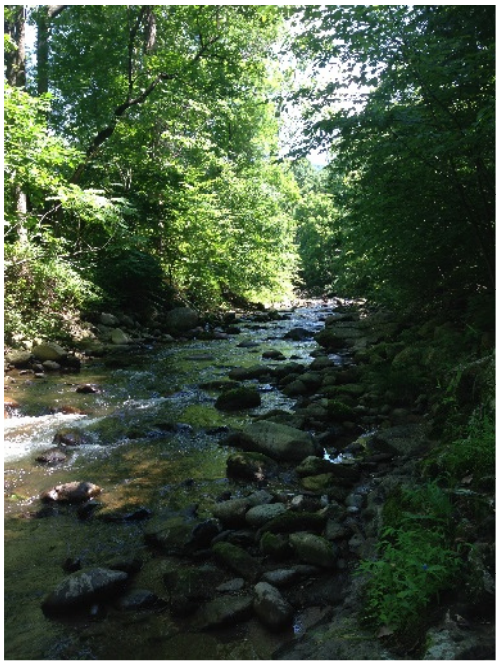
Denton Dixon
Ben Hale
John Harkness
Todd and Lisa Harris
Karen and Paul Heatwole
Andy Hutchison
The Light Well
Mike and Betty Long
Randy and Sis Merrick
Mason Insurance
Mountain Cove Vineyard
Oakencroft Winery
Ruth Penn
Rapidan Mill LLC
Peggy and Peter Rice
Alan and Adele Shotwell
Marcus Taylor
Virginia Outdoor Center
Paul and Molly Visosky
Woodberry Forest School

Finish the Rapidan!



StreamSweepers 2015 goal was to ***Finish The Rapidan!*** In 2013, the program completed 20 miles in the middle section of the river near the Town of Orange. In 2014, another 20 miles of the Rapidan was completed along with 20 miles of the Robinson River (a tributary of the Rapidan).

The work of the previous two summers left us in a great place to complete the Rapidan do this but we knew there would be some challenges that we hadn't previously encountered. We would have to work our way back from the program's original starting point in 2013 at Liberty Mills in Somerset, VA, to the shallow head waters beyond Graves Mill at Shenandoah National Park – roughly 20 miles of river. We would then pick-up where we left off last year just past Woodberry Forest School and head down to the confluence with the Rappahannock River in Spotsylvania County – roughly another 20 miles of river. The upper reaches were navigable only on foot. The lower portion of the river widens greatly as it passes Ely's Ford and heads towards the Rappahannock. In this section, due to its width, more boats and Sweepers per river mile were needed to span the width of the river. StreamSweeper donors, after learning of our need for more boats to cover the lower section, provided thousands of dollars as well as used boats to expand our fleet. Building on relationships created over the last two summers, StreamSweepers was able to coordinate access in these two distant sections of the river and to secure the financial resources and commitments from key contributors and long-time Supporters and Program Founders.

As last year, we were fortunate to have on staff a third year program participant working as a "River Analyst" to compile and review the assessment data we collected and compare it with

the Rapidan River Riparian Assessment study completed by the Virginia Institute of Marine Science (VIMS) and Friends of the Rappahannock (FOR) in 2000. Based on findings in previous years, we decided to add the identification of invasive species to the Sweeper training education.

The field crew size was 10 Sweepers this year and 1 Analyst in the office. In addition, the Macroinvertebrate assessment detailed in this report was completed by Senior Sweeper, Cole Reeves. Most of the watershed analyses work was completed by the Analyst, Griffin Rice, with technical oversight by Center for Natural Capital Executive Director, Michael Collins.

Sweepers continued water quality testing throughout the remainder of the Rapidan. In Partnership with the National Institute of Health, National Cancer Institute, a new sampling protocol was created for screening of endocrine mimicking compounds. We have received preliminary testing results which will be reviewed and findings will be distributed at a later date once analysis is complete.

StreamSweeper Business Model

StreamSweepers attempts to serve two categories of "Customers". The first category is riverside landowners, the heart of the business model. The assessment and cleaning is considered a service to enhance health and appearance of river real estate frontage. The cost of the Sweeping and Assessments is monetized on a unit basis for each side of the river. The unit rate for 2015 was 50 cents per linear foot for both sides of the river, or 25 cents per foot per side.

The second customer is watershed supporters or persons that can live anywhere that care about a particular river ecosystem. This second category is important, because only a portion of riverside landowners pay for the service. StreamSweepers blends revenue from riverside landowners with donations from watershed supporters to cover costs of the service. The long term financial goal is to have 100% of the costs of the service covered by riverside landowners, however we have found that thus far, and depending upon the river stretch, no more than 50% of the cost has been covered by riverside landowner support. We are looking to increase funding from watershed supporters and those individuals and organizations who are interested in supporting the program.

About This Report

This report is prepared primarily for participating riverside landowners and watershed supporters. It contains generalized or non-parcel specific information about the 2015 assessment and cleaning of the Rapidan river valley. StreamSweepers collects and stores a large amount of location specific information not published in this report, available to participating riverside landowners and watershed supporters. Water quality data collected for 2015, at the time this report was prepared, was still being analyzed.

Program Deliverables 2015

- Riverside Landowner Outreach
- Sweeper Hiring
- Training Curriculum Development
- Sweeper Training
- Assessment Protocol Revision
- Trash Removal Protocol Update
- Methodology to Compare 2015 and 2000 River Health Assessment Data
- Water Quality Testing Protocol Revision and Training
- Water Sample Collection
- River Assessment
- Comparison River Health 2015 vs. 2000
- River Cleaning
- Report Preparation
- Publication on website at www.streamsweepers.org

2015 River Segments

StreamSweepers work for the 2015 season once again focused on a portion of the Rappahannock River drainage area, or watershed, located in Central Virginia (see yellow are in image below). A watershed or drainage basin is an area of land where surface water from rain converges to a single point at a lower elevation, usually the exit of the basin, where a river joins another. The Rappahannock watershed spreads

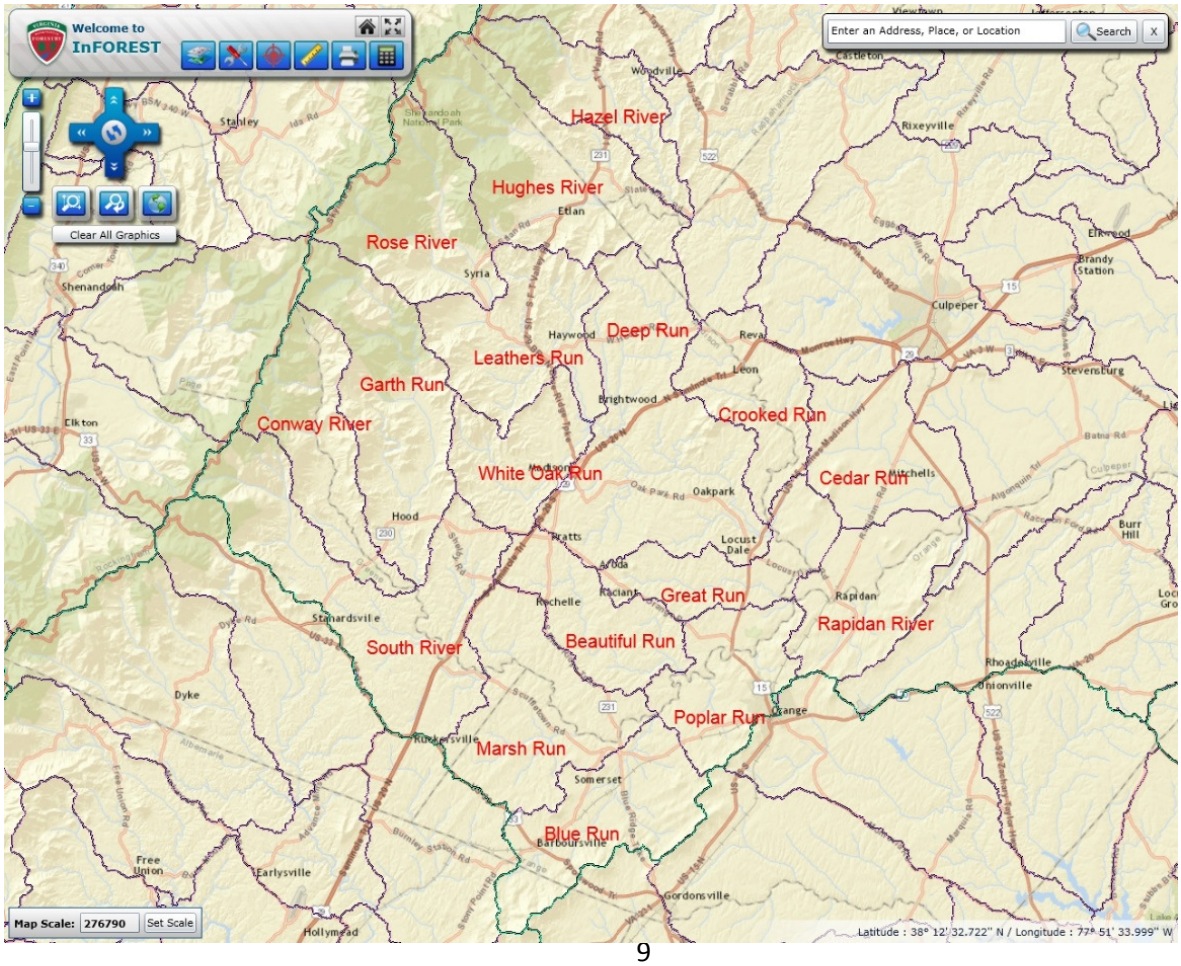
across 2,175 square miles and drains all or portions of 18 counties, taking up 6.8 percent of Virginia's total land area. Drainage basins adjacent to the Rappahannock are the Potomac-Shenandoah to the north and the York and James to the south. The origin of the river is located in Shenandoah National Park, at a mountain spring in Rappahannock County, just below Chester Gap. From there it flows southeasterly for 184 miles before opening into the Chesapeake Bay. The river's mouth is more than 3.5 miles wide and is located 60 miles east of Richmond. Major tributaries (river that flow into another river) of the Rappahannock are the Hazel, Thornton, Rapidan, Robinson, and Corotoman rivers, as well as Mountain Run and Cat Point Creek. StreamSweepers 2015 work took place in the upper portion and the lower portion of the basin, within the Rapidan River Valley.

The portion of the Rapidan selected for 2015 work spans from Graves Mill Parking Access of Shenandoah National Park (Route 662) to Stegara Road (Route 676) (first image below) and from Raccoon Ford (Route 522) to the confluence with the Rappahannock (second image below), a total of 40 river miles.

Rapidan River Watershed Description

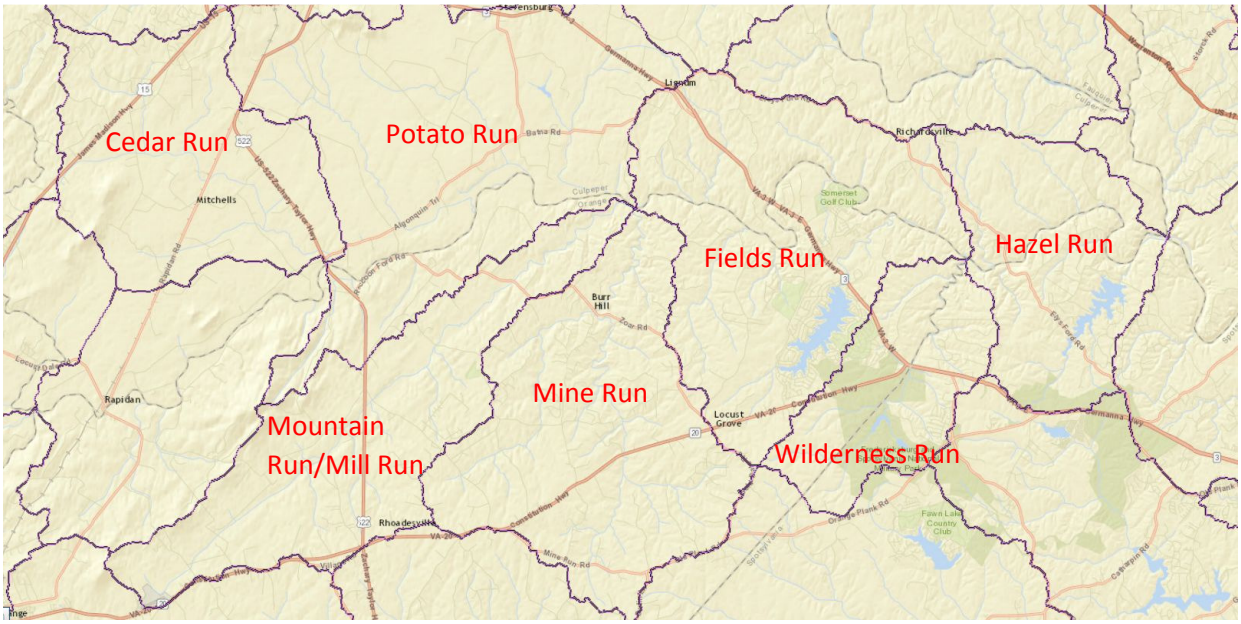
There are 21 areas (called subwatersheds or catchments or drainage basins) that flow into the Rapidan River watershed. These are listed below and shown in the following images. Knowledge of the land cover in a river's drainage basins helps understanding about river health. We worked in two distinct areas in 2015 starting at the headwaters of the Rapidan and those subwatersheds are marked with an asterisk. We then moved to the lower portion of the Rapidan which encompass the remaining subwatersheds.

- Beautiful Run
- Blue Run
- Conway River*
- Crooked Run
- Deep Run
- Garth Run*
- Great Run
- Hazel River
- Hughes River
- Leathers Run
- Marsh Run*
- Poplar Run
- Rapidan River
- Rose River
- South River*
- White Oak Run



Lower Rapidan Subwatersheds from Route 522 to Confluence with Rapphannock River

- Cedar Run
- Fields Run
- Hazel Run
- Mine Run
- Mountain Run/Mill Run
- Potato Run
- Wilderness Run

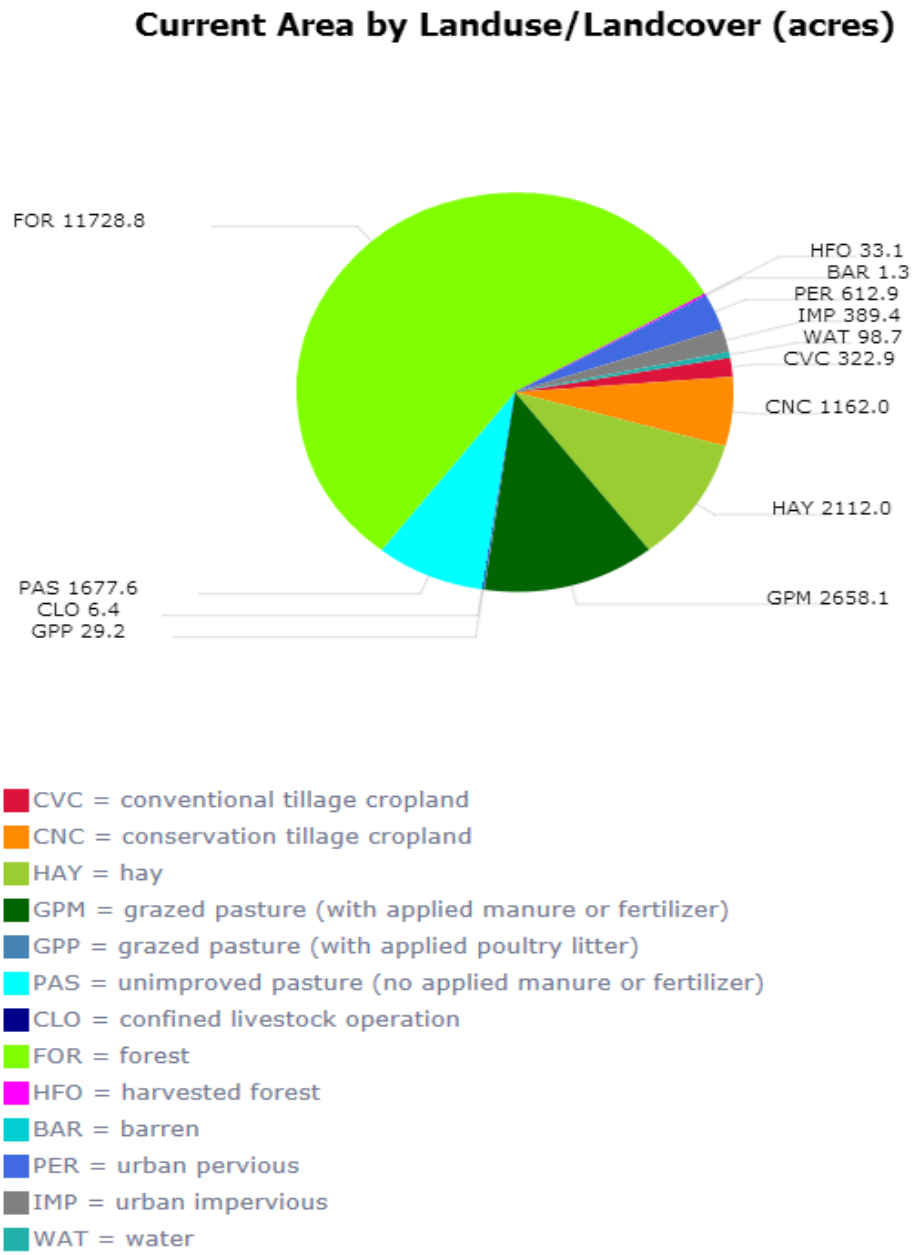


Land Cover in Rapidan River Subwatersheds

The following charts show the proportion of types of land cover for each of these subwatersheds. Note that those subwatersheds marked with an asterisk correspond to the upper portion of Rapidan River assessed in 2015.

Blue Run

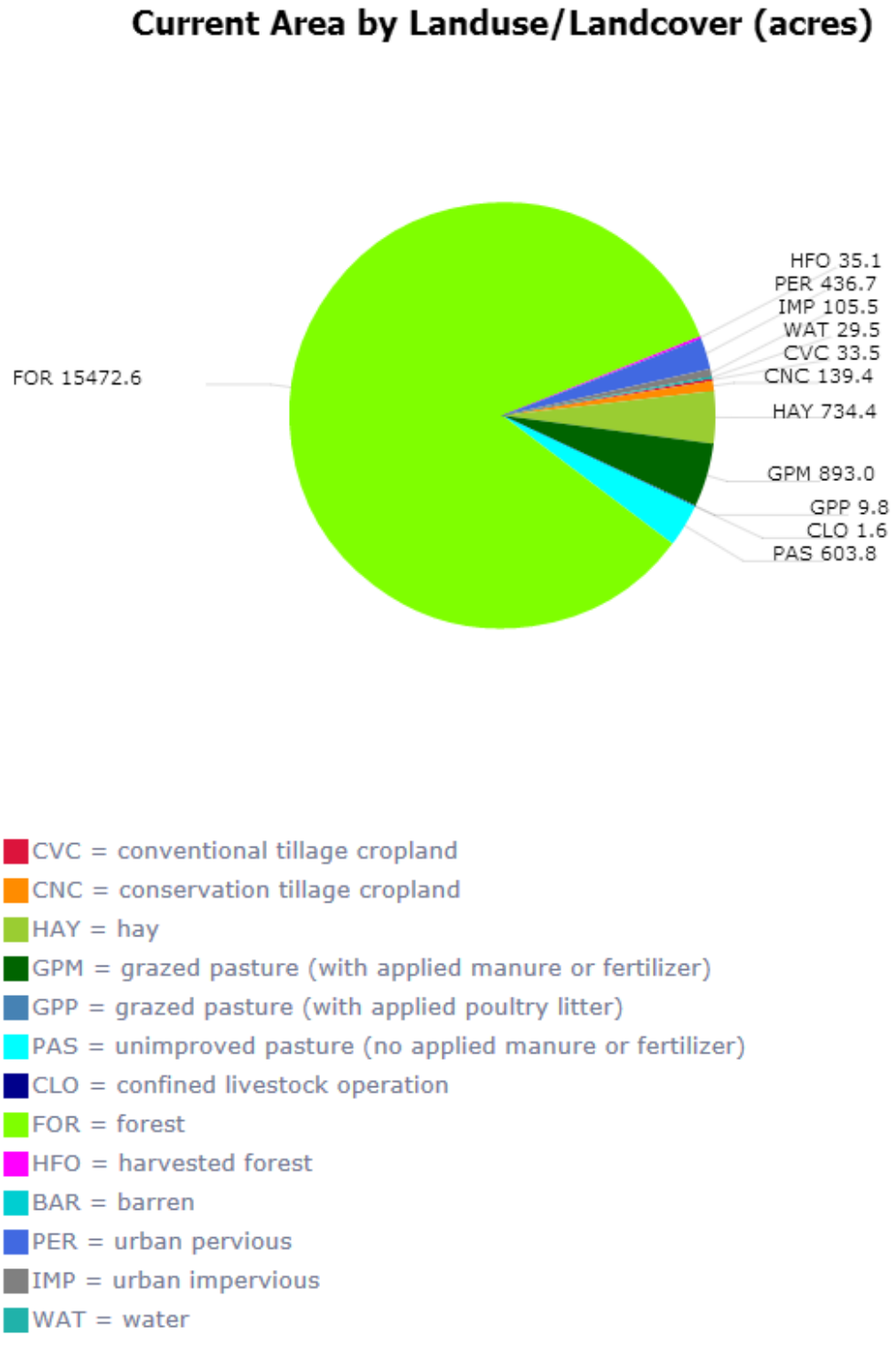
Note the majority of landcover in Blue Run is forest, hay, and pasture.



Blue Run Land Cover

Conway River*

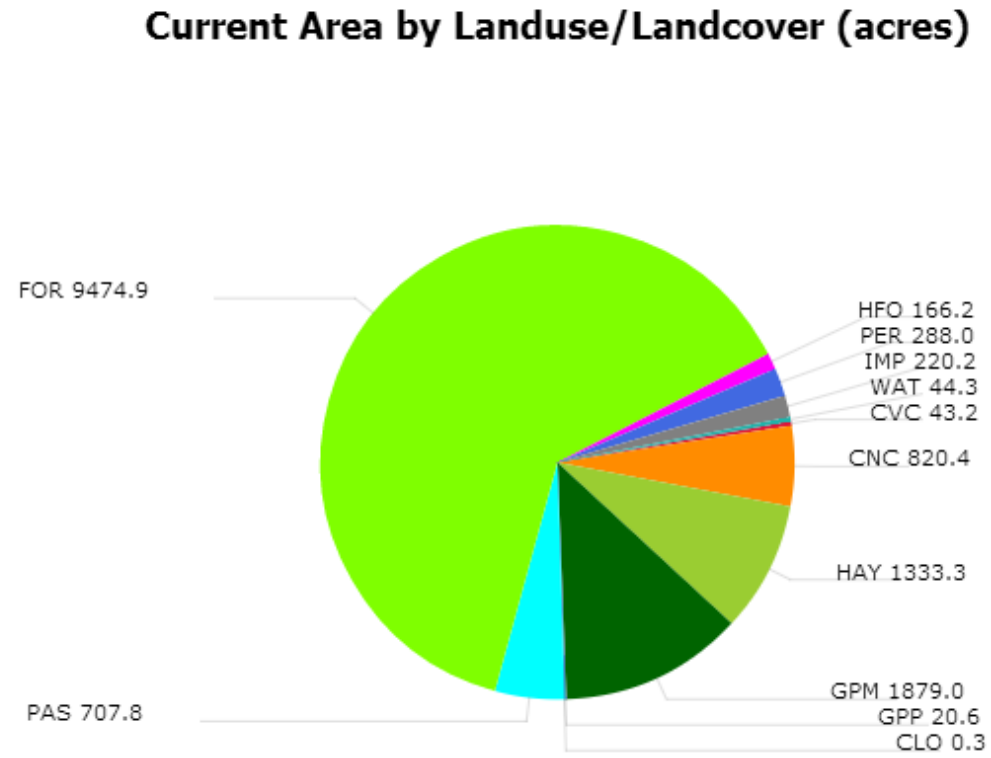
Note the very high percentage of the watershed in forest cover.



Conway River Land Cover

Crooked Run

Again, note the high percentage of watershed in forest cover.

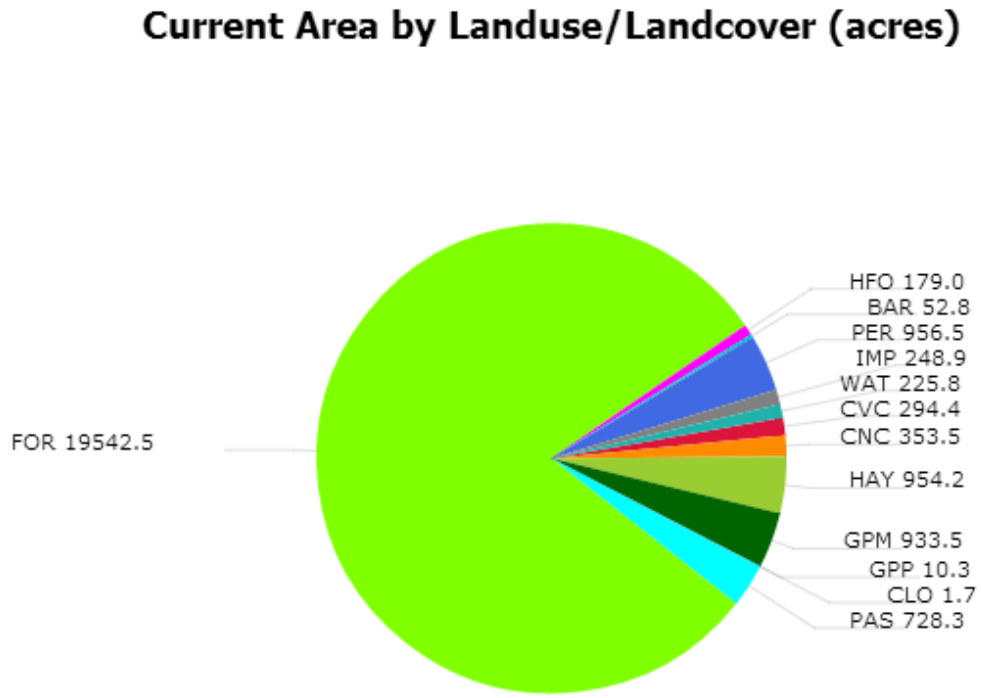


CVC = conventional tillage cropland
CNC = conservation tillage cropland
HAY = hay
GPM = grazed pasture (with applied manure or fertilizer)
GPP = grazed pasture (with applied poultry litter)
PAS = unimproved pasture (no applied manure or fertilizer)
CLO = confined livestock operation
FOR = forest
HFO = harvested forest
BAR = barren
PER = urban pervious
IMP = urban impervious
WAT = water

Crooked Run Land Cover

Deep Run

Again, this watershed has a high percentage of forest cover.



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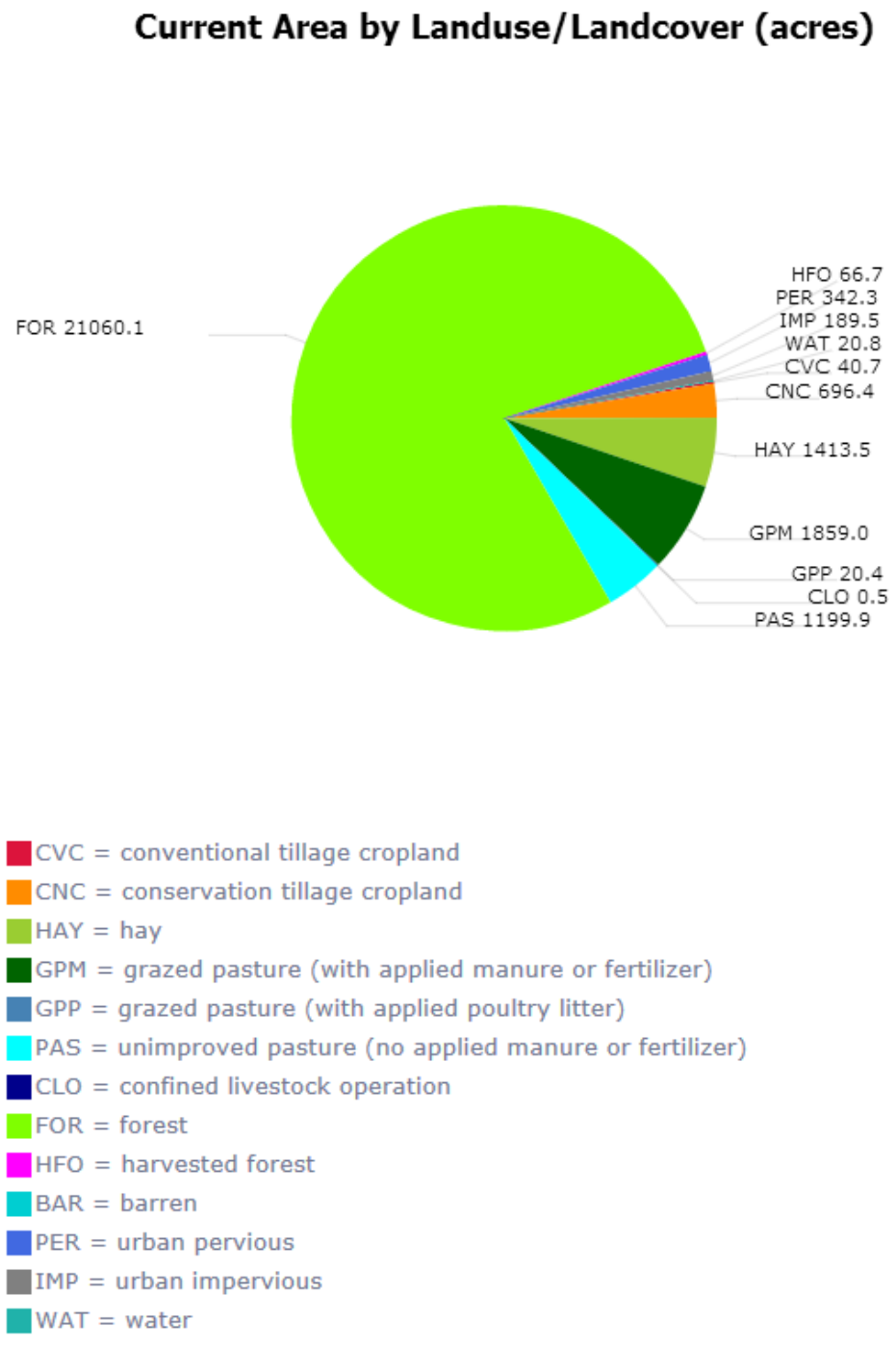
Deep Run Land Cover

Garth Run*

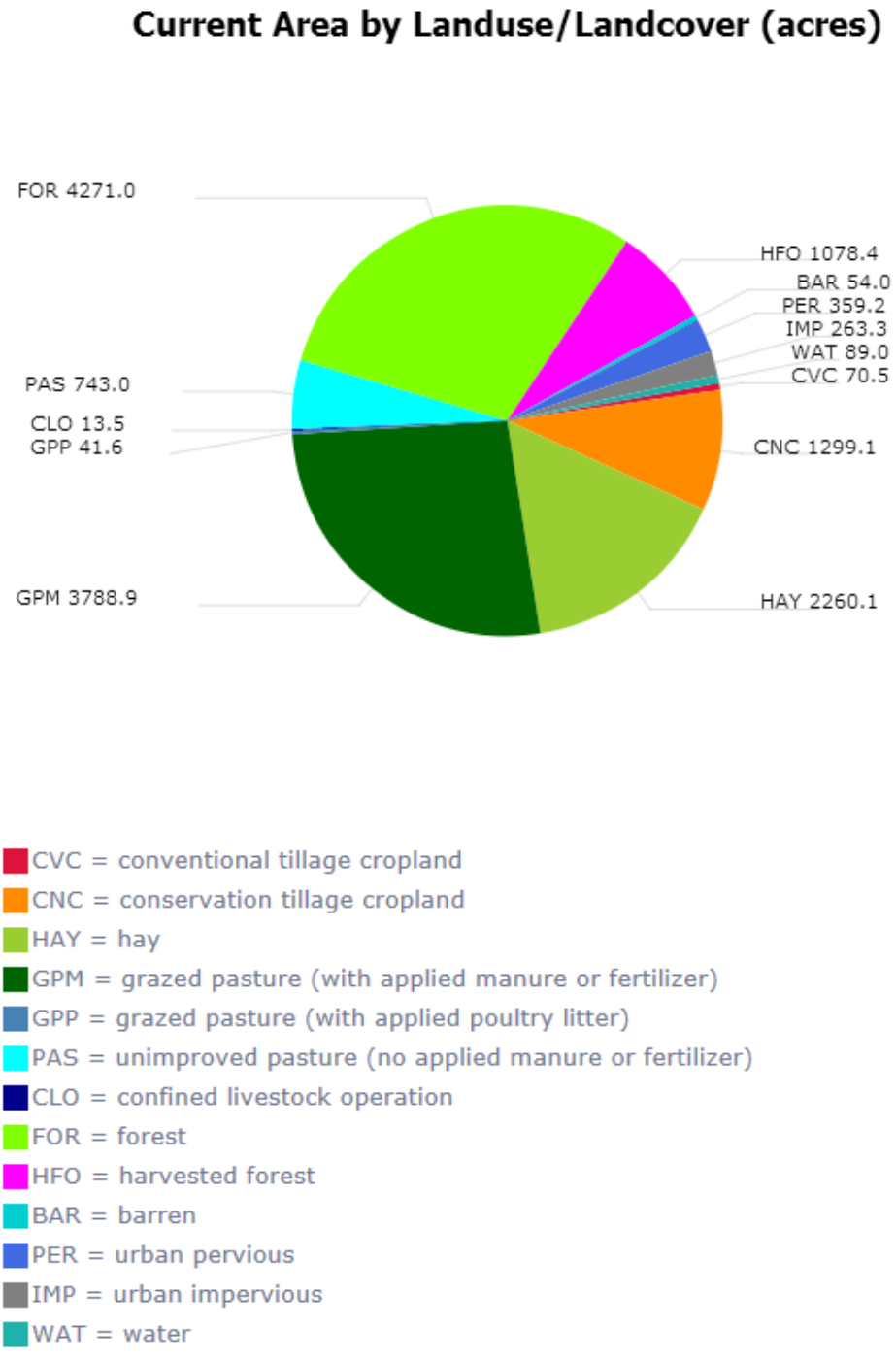
Note the significant proportion of forest cover and lesser though consequential grazed pasture with manure, hay, and conservation tillage.



Garth Run Land Cover

Great Run

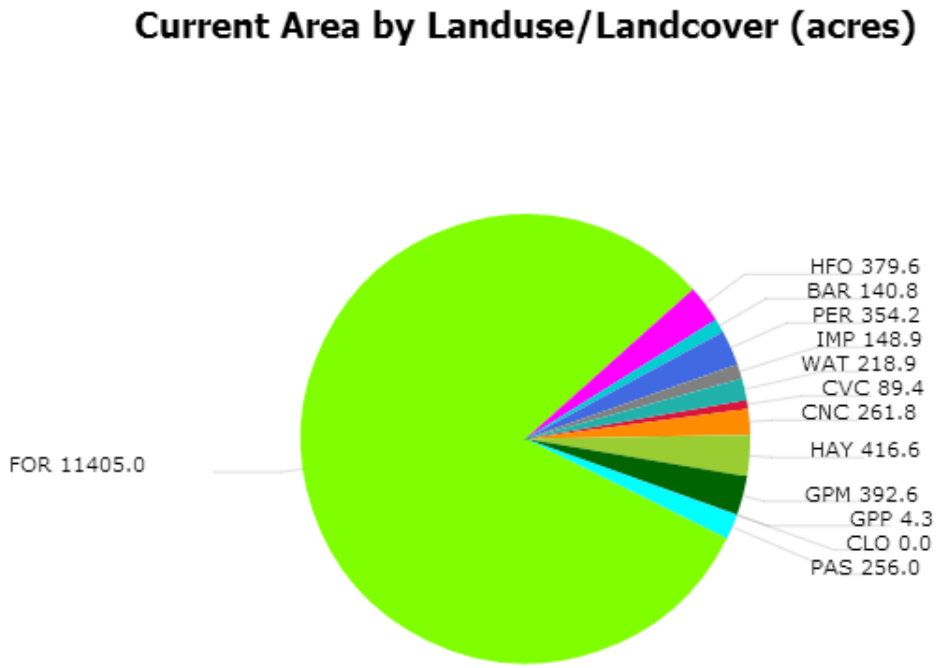
Note the greatest types of land cover are forest, grazed pasture, and hay, respectively. Also note the significant proportion of conservation tillage.



Great Run Land Cover

Hazel River

Again, as found in Garth Run, note the high proportion of forest cover, and consequential grazed pasture with fertilizer, hay, and conservation tillage.



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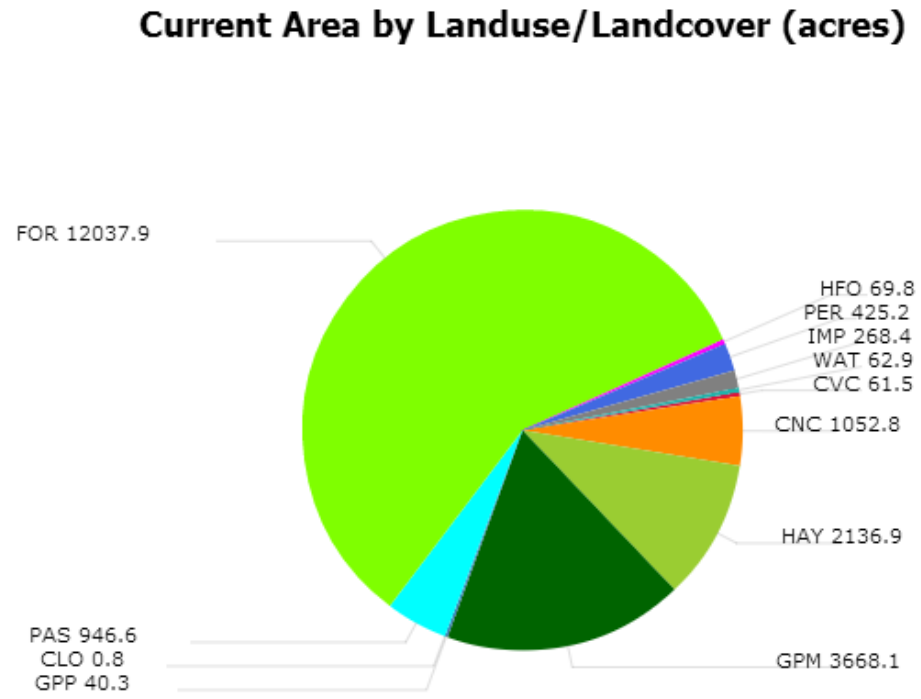
Hazel River Land Cover

Leathers Run

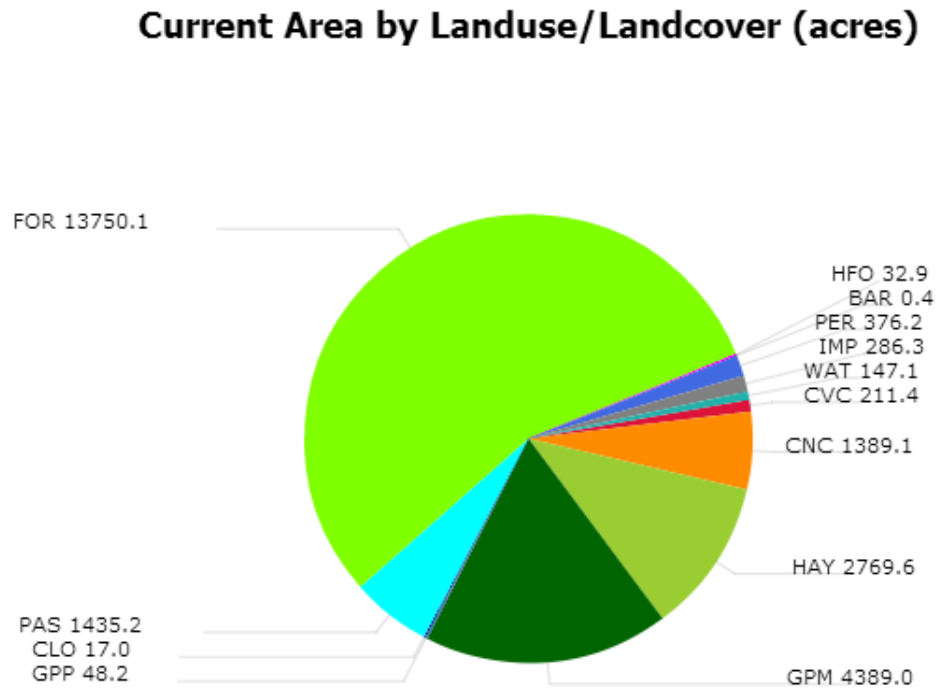
Note the significant proportions of forest cover and grazed pasture with applied manure in this subwatershed.



Leathers Run Land Cover

Marsh Run*

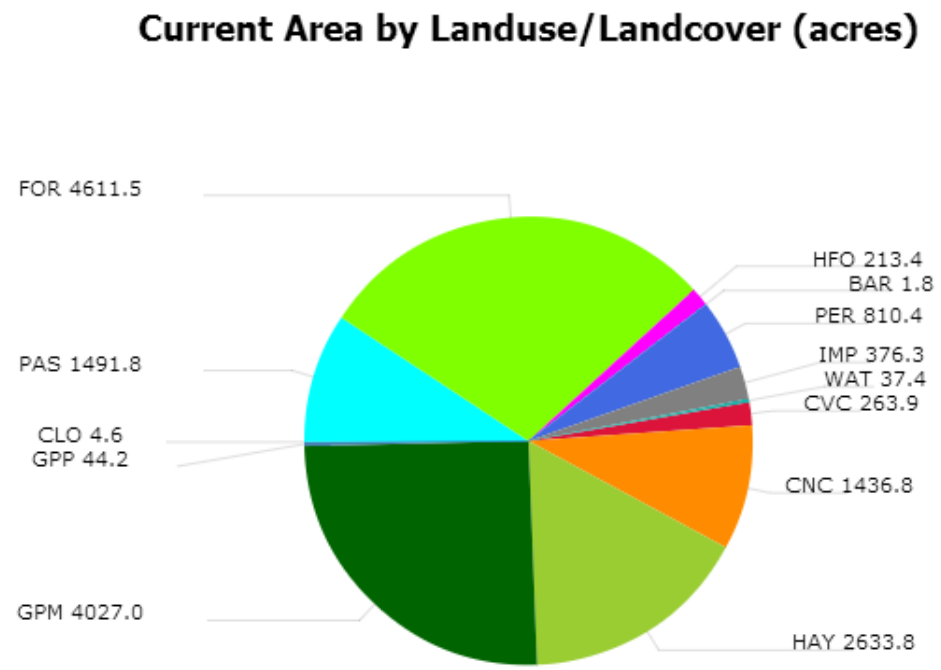
Note the significant proportion of forest cover, grazed pasture with fertilizer, hay, and conservation tillage.



Marsh Run Land Cover

Poplar Run

Note the exceptionally high proportion of forest cover in the Poplar Run subwatershed.



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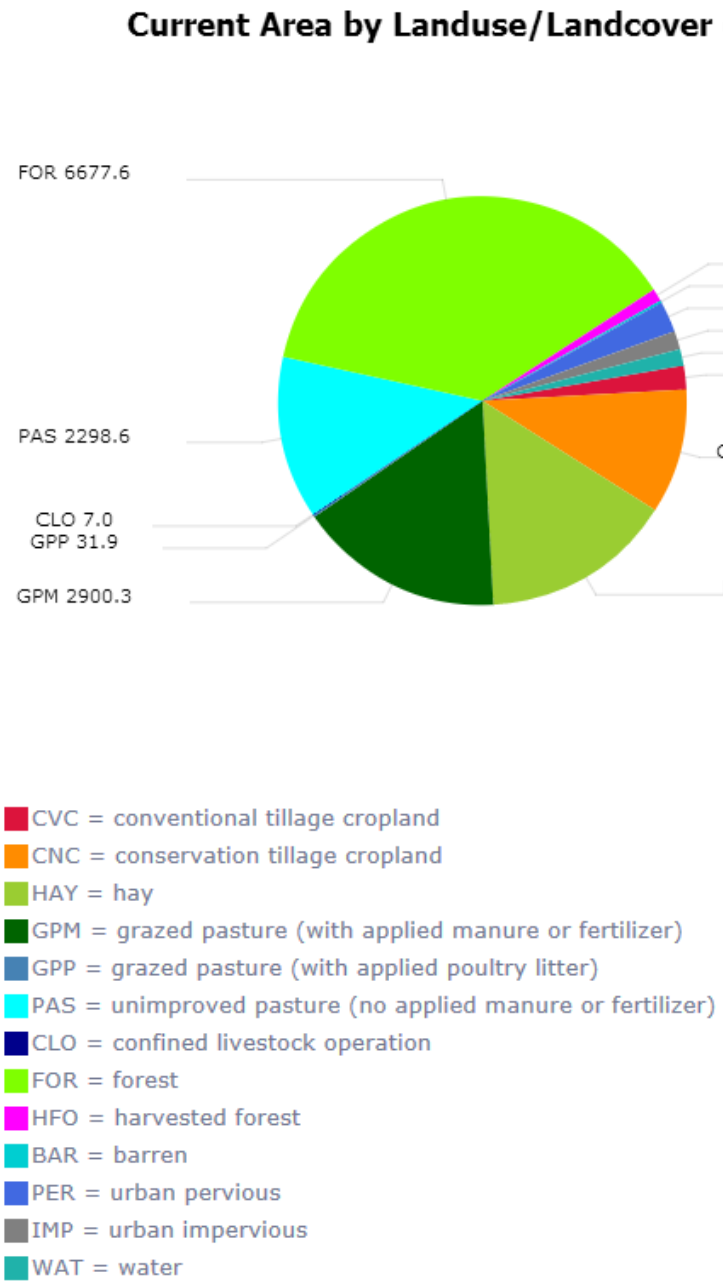
Poplar Run Land Cover

Rapidan River Land Cover

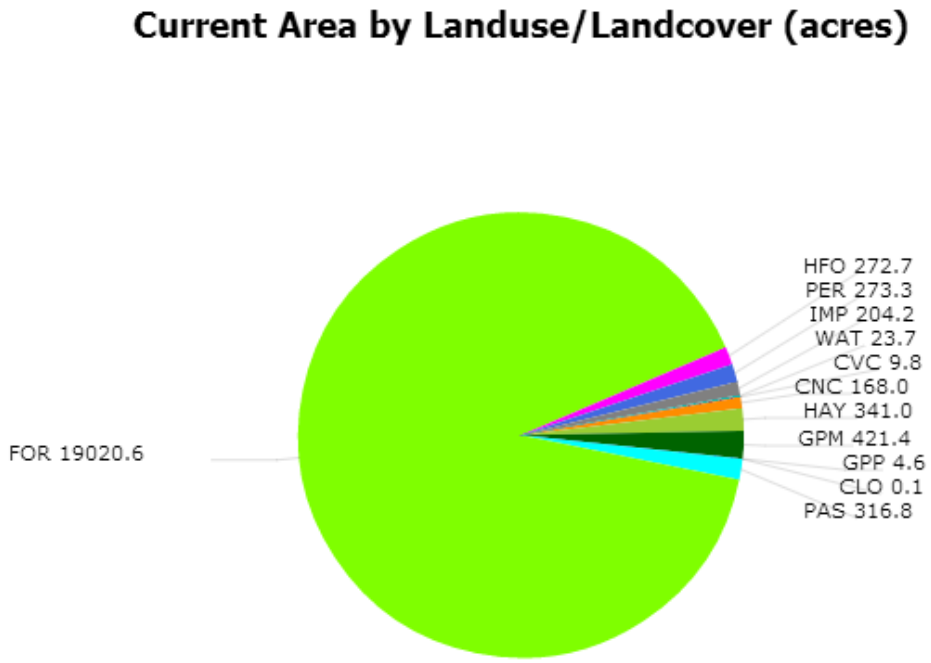
Note that this area drains lands directly adjacent to river around the village of Rapidan (thus the name of this subwatershed within the larger Rapidan drainage basin). Other subwatersheds that also drain lands directly into the main stem of the river are Poplar Run and Marsh Run. Note the significant proportions of forest cover, unimproved pasture, grazed pasture with fertilizer, hay, and conservation tillage.



Rapidan River Land Cover

Rose River

Note the exceptionally high proportion of forest cover in the Rose River subwatershed.



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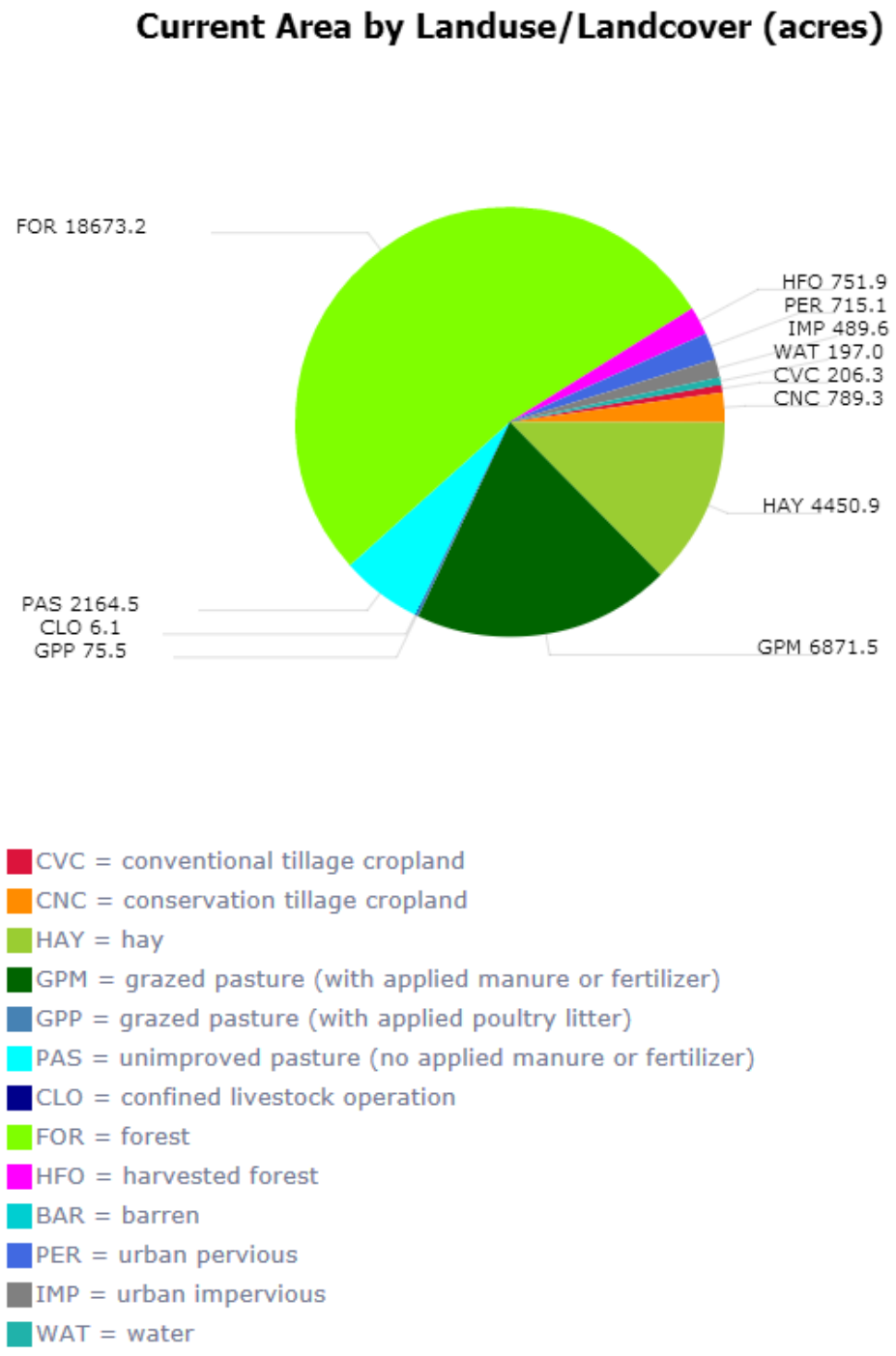
Rose River Land Cover

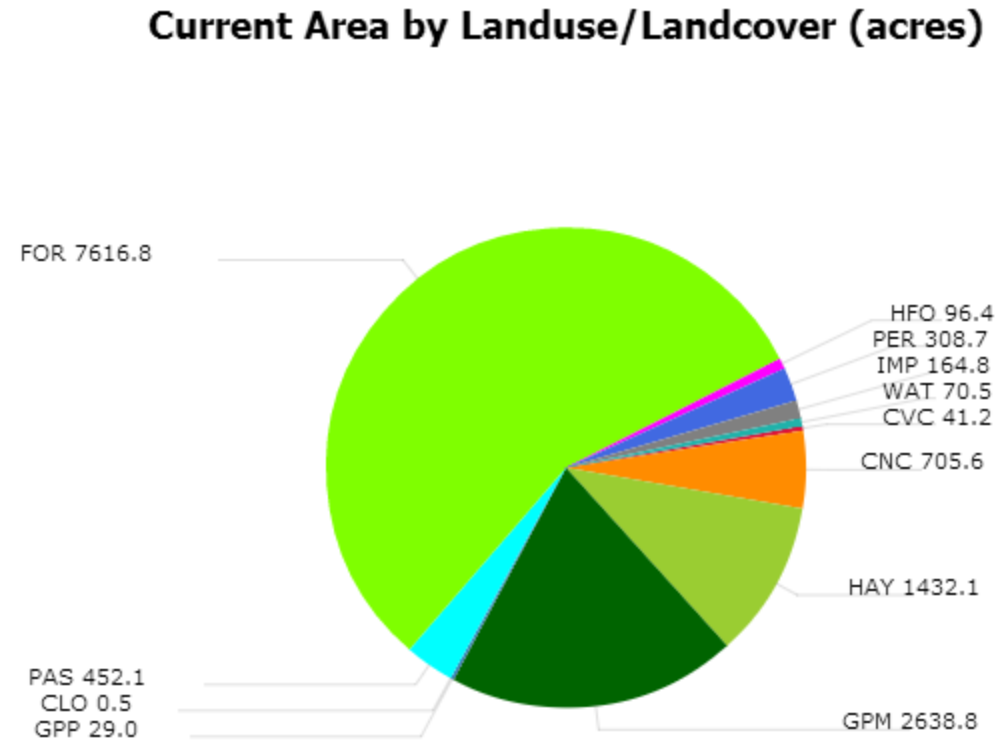
South River*

The South River subwatershed is predominately forested, with significant proportions of grazed pasture with fertilizer and hay.



South River Land Cover

White Oak Run



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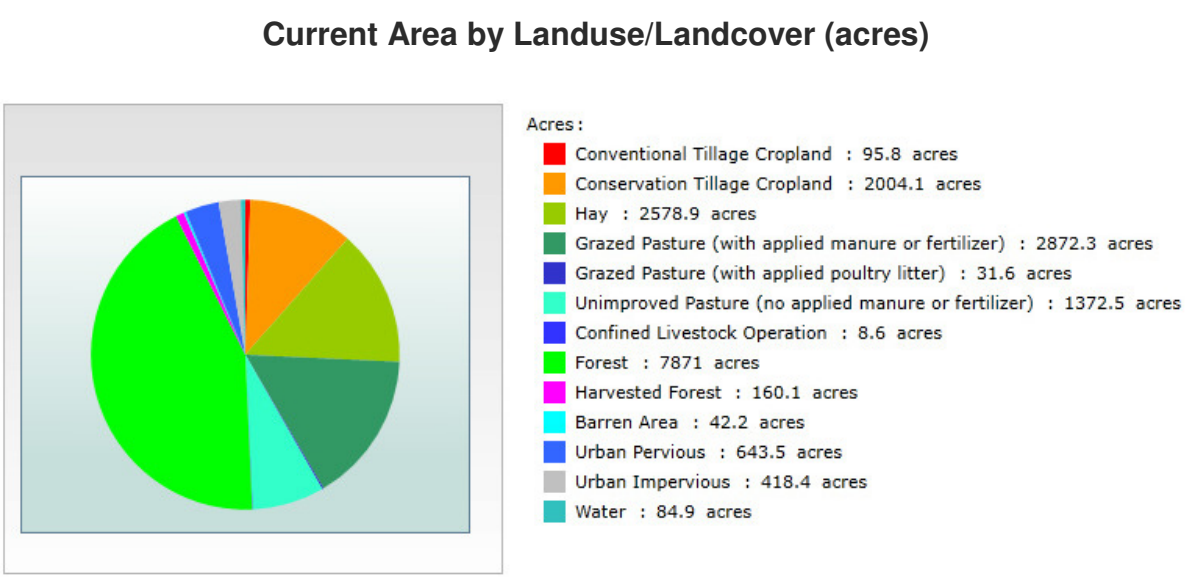
Cedar Run

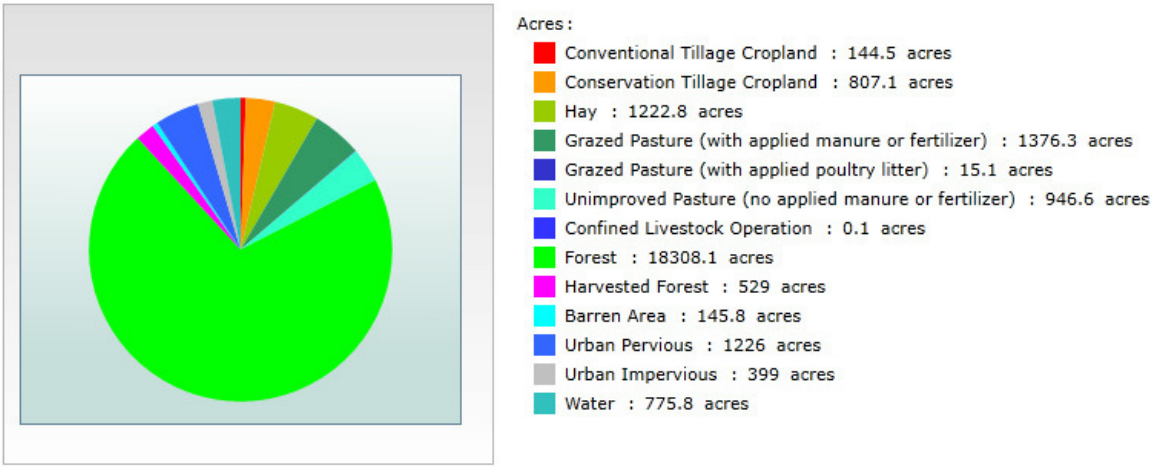
Nearly half of this subwatershed is in forest cover.



Cedar Run Land Cover

Fields Run

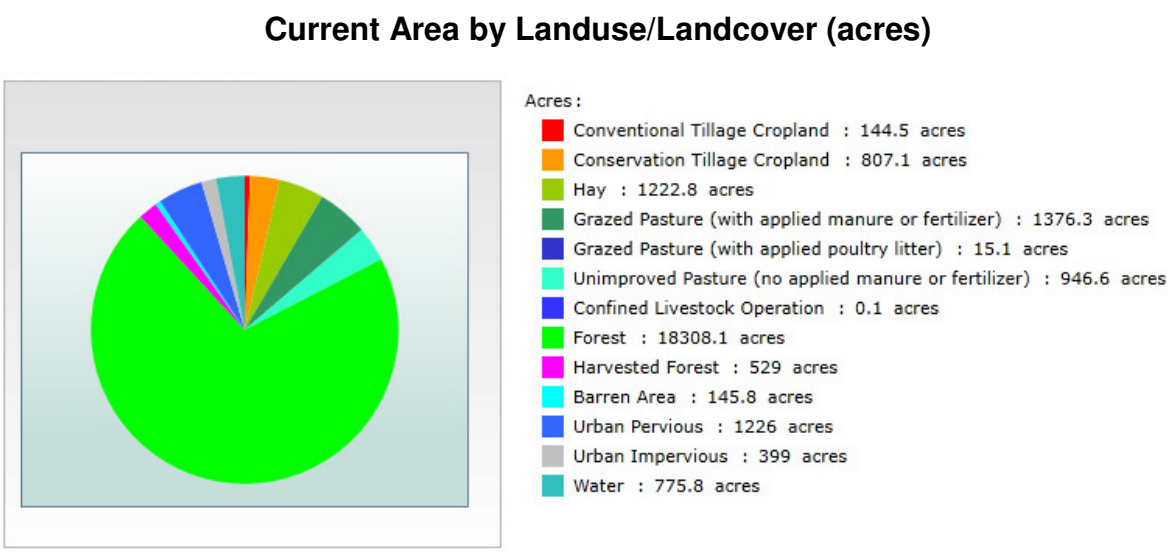
Almost three fourths of this subwatershed is in forest cover.



Fields Run Land Cover

Hazel Run

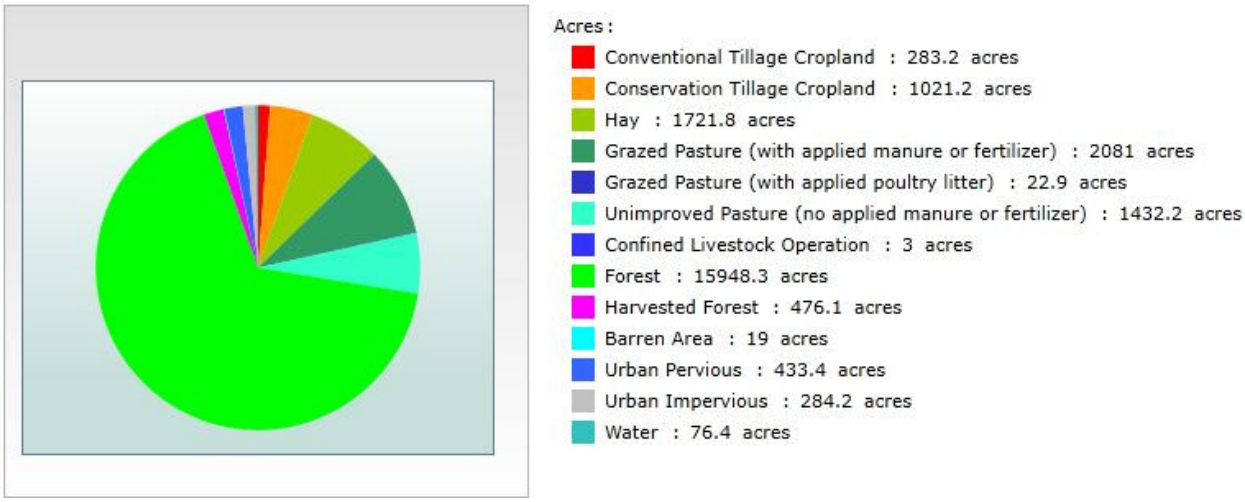
Almost three fourths of this subwatershed is in forest cover.



Hazel Run Land Cover

Mine Run

About two thirds of this subwatershed is in forest cover.

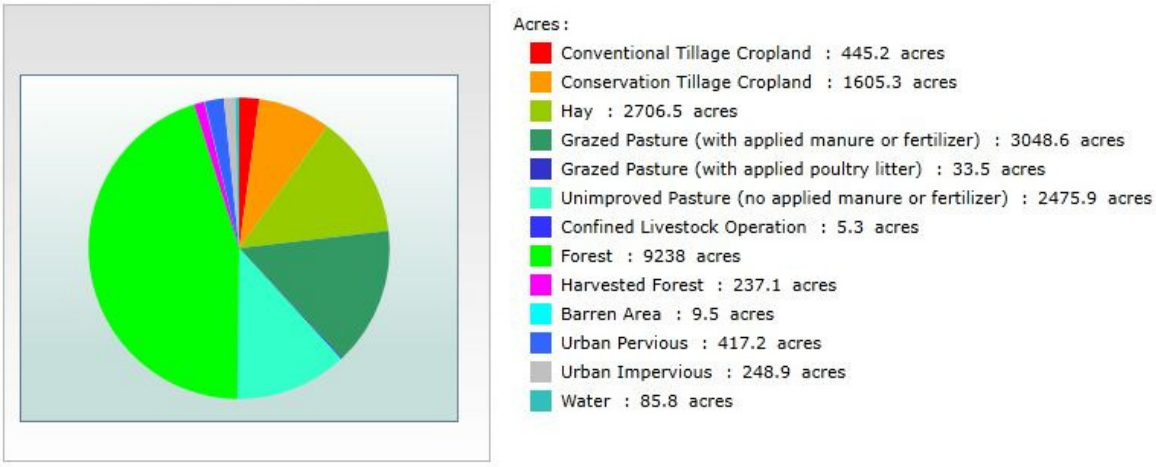


Mine Run Land Cover

Mountain Run/Mill Run

Nearly half of this subwatershed is in hay, grazed pasture and unimproved pasture and about one half of this subwatershed is in forest cover.

Current Area by Landuse/Landcover (acres)

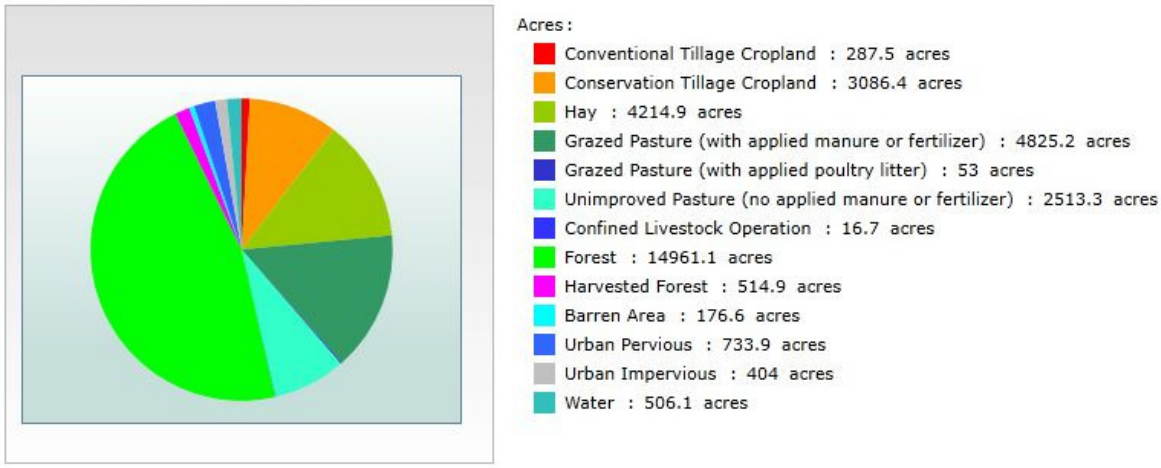


Mountain Run/Mill Run Land Cover

Potato Run

Nearly half of this subwatershed is in hay, grazed pasture and unimproved pasture and about one half of this subwatershed is in forest cover.

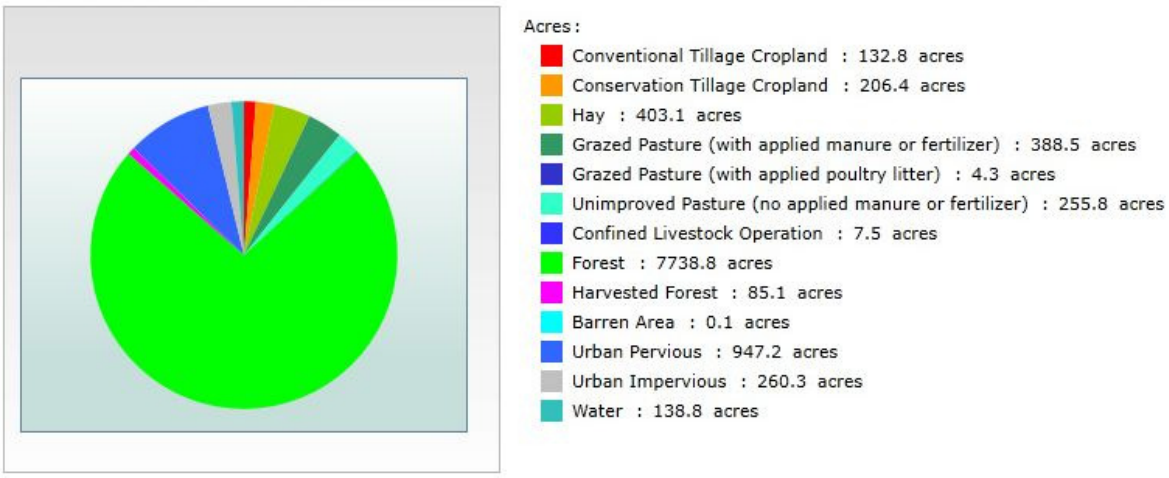
Current Area by Landuse/Landcover (acres)



Potato Run Land Cover

Wilderness Run

About two thirds of this subwatershed is in forest cover.



Wilderness Run Land Cover

Training

11 young adults from Central Virginia were hired as Sweepers for the summer of 2015. As employees of the Center for Natural Capital, they were trained over a week long period and tested on the information presented at the completion of their training. We believe that the success of this program relies heavily on the ability of these young adults to form a strong and cohesive team. The foundation for any successful team is in the formative or training stage. In addition, the nature of the work performed by the Sweepers in remote settings heightens the need for thorough training. General job skills like punctuality, responsibility along with expanded concepts of environmental science and risk management were covered during training week.

We began the week speaking in broad terms and moved toward specificity including water sampling protocols, safety protocols and ecological assessment protocols. We have found that Sweepers gain a lasting work experience and we believe that the training to perform the work effectively is part of this success.

Topics covered during the training week:

- Geologic History of the Mid-Atlantic Region and Triassic Basins
- Introduction to Ecological History of North America
- Introduction To Business
- Introduction To Hydrogeology and River Science for Non-Engineers
- Introduction To Fluvial Geomorphology
- Introduction To Economics and Ecosystem Services and Regenerative Entrepreneurship

- Introduction To Empathic Relationships
- Introduction To Impact of Land Cover on Watershed Health
- Assessment Methodology
- On-water Risk Reduction
- First Aid
- Canoe Skills
- Logistics Planning
- GPS Instruction

Assessment Protocol

Sweepers conduct a river health assessment of the river bed and banks. Sweepers worked as a team in a canoe, with one person observing and calling out assessment ratings, while the other person recorded the information on handheld Garmin Global Positioning System (GPS) Units. The purpose of the assessment included the following objectives:

- Identification of emergency access points - the latitude/longitude was recorded on the GPS units.
- Identification of trash clusters - also recorded on GPS units.
- River health assessment - see below for protocol and methods.

*Note: the word *"health"* is used to indicate functionality of the riparian ecosystem.

Assessment data for the 2015 season of StreamSweepers was collected in a similar manner to 2014. Like last year, two GPS units were used to mark locations of change in any of the rating categories. One team was assigned to mark only the quality of the left hand side of the river, with the other team assuming responsibility for the right side. The categories and their rating scales are as follows:

Criteria	Rating Scale	Highest Attribute Attainable
Canopy (C)	**0-4**	**100% coverage over water**
Buffer (B)	**0-2**	**Woody vegetation as far as eye can see**
Bank Erosion (BE)	**0-2**	**None**
Bed (BED)	**0-2**	**100% cobbles/boulders/woody plant substrate**
Bank Cover (BC)	**0-4**	**Woody Over & Under Story**
Bank Geometry (BG)	**0-2**	**45 degrees or less**
Bank Height (BH)	**0-3**	**0-5 feet**
Invasive Species (IS)	**0-1**	**Absence**

These categories are explained further below.

Canopy (C) – Rating Scale (0 - 4): An assessment of the amount of shade over either the left or ride side of the river. Each half of the river was given an independent canopy rating of 0%, 25%, 50%, 75%, or 100%. A 0 indicates no canopy, a 4 indicates 100% canopy coverage over the particular side of the river. To determine the canopy rating, the StreamSweepers assessed the amount of river surface area covered by vegetation.

Buffer (B) - Rating Scale (0 - 2): An assessment of the amount of the tree buffer on the riverbank. 0 indicates no buffer, 1 generally represents a buffer of a few trees, and 2 indicates dense forest, extending away from the river at least 50 feet.

Bank Erosion (BE) – Rating Scale (0 - 2): An assessment of the quality of the bank, representing how much erosion has occurred there. A 0 represents no erosion, a 1 represents moderate erosion, and a 2 represents severe erosion.

Bed (BED) – Rating Scale (0 - 2): Indicates the quality of the riverbed. A 0 indicates roughly 100% sand or silt, 1 indicates a mix of sand and cobbles, and 2 represents a mostly cobblestone bed.

Bank Cover (BC) – Rating Scale (0 - 4) : Indicates the type of plant matter covering the bank of the river. A 1 refers to only grass, a 2 represents only understory (small trees and shrubs), a 3 represents only overstory (large trees), and a 4 refers to the presence of understory and overstory.

- The StreamSweepers analyzed the river right and left banks for forest stages of succession. Lower ratings were allotted for barren or grass covered areas, while higher ratings were given to areas that had both an understory and an overstory. The majority of the time, the bank cover contained both an understory and overstory. Rarely was the bank completely barren or grassy. The invasive species contributed to greater bank coverage but negatively affected the overall health of the bank vegetation. The most commonly identified invasive species include Kudzu, Alanthus (Tree of Heaven), Autumn Olive, Japanese Stilt Grass and Oriental Bittersweet.

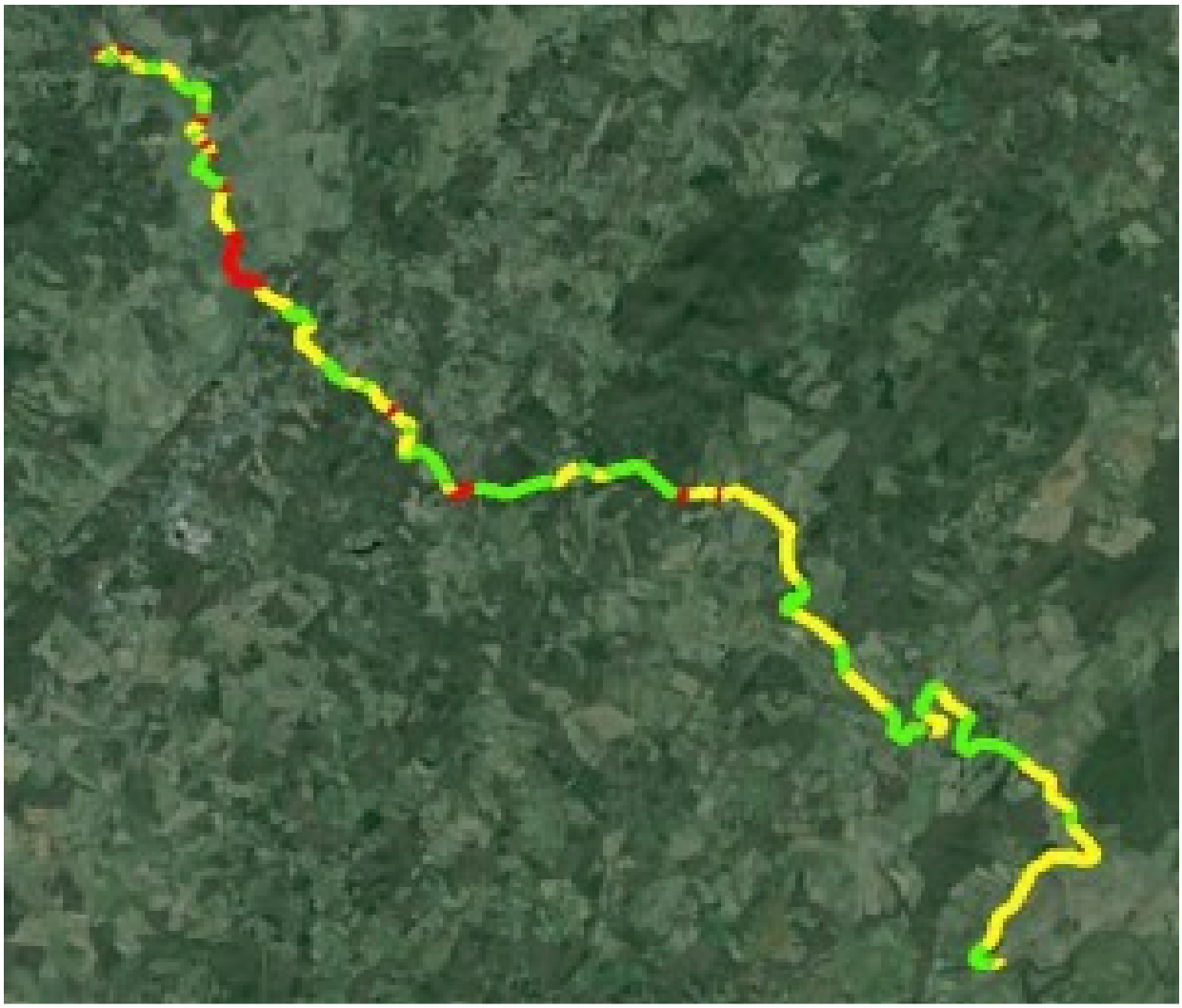
Bank Geometry (BG) – Rating Scale (0 – 2): An assessment of the geometry of the bank, measured by observing the angle of the bank's ascent from the river. A 2 represents a 0 to 45 degree angle, 1 represents between a 45 and 90 degree angle, and a 0 refers to a bank that is 90 degrees to the river or undercut.

Bank Height (BH) – Rating Scale (0 - 3): A measure of the bank's height. In determining the height of the bank, the StreamSweepers approximated the different heights into four categories: 0-5ft, 6-10ft, 11-15ft, and >15ft. A 3 refers to a bank that generally does not go much higher than the water and a 0 means about a bank taller than 15 ft.

Invasive Species (IS) – Rating Scale (0 – 1): Refers to the presence of invasive species alongside the river. A 0 indicates the presence of invasive species, and a 1 indicates absence. Sweepers were taught to identify the following 15 invasive species: Alanthus, Autumn Olive, Burning Bush (Euyonymous), Canadian Thistle, Centoria, Chinese Privet, Chinese Wisteria, Crown Vetch, Garlic Mustard, Japanese Barberry, Japanese Honeysuckle, Japanese Stilt Grass, Kudzu, Linden Viburnum, Mile A Minute Vine, Mimosa Tree, Multiflora rose, Oriental Bittersweet, Perilla, Privet, Vinca Major and Wild Potato Vine. The aquatic species noted were: Eurasian Watermilfoil, Giant Salvinia, Hydrilla, Parrot Feather Watermilfoil and Water Chestnut.

New assessment data points were recorded each time just one of the variables along the river changed. This means that in visually representing the assessment data on a map, colored lines representing the variables' score stretch from each data point to the next, changing when the rating changes. As an example, the following map contains the assessment data for the river left (side of river as one floats downstream) side buffer of the river. Red represents a 0, yellow represents a 1, and green represents a 2. Once all of the assessments were carried out, the data was transferred from points on the GPS unit to color-coded maps made through use of Google Earth.

As an example, the image below shows assessment data for a river segment ; Red represents a 0, yellow represents a 1, and green represents a 2.



The culmination of 3 years of river health assessments is shown below for the entire Rapidan River Valley from Shenandoah National Park to Fredericksburg. This image shows total river health averaged for both sides of the river. Portions of the river valley in green are the most healthy while portions in red are the least healthy. Yellow portions have a composite rating between these two extremes. The results show that the Rapidan is most healthy near Shenandoah National Park, in a stretch near Rt. 610 (Wilhoits Mill Road), a stretch east of Rt. 15, and the portion of the river near the confluence with the Rappahannock.

In the weeks ahead we will be publishing many more findings from the Sweepers years of work on the Rapidan and Robinson Rivers of Virginia.