



Acknowledgments

This report has been prepared by the Center for Natural Capital for Rapidan and Robinson River riverside landowners and watershed supporters.

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Karen and Paul Heatwole
Andy Hutchison
The Light Well
Mike and Betty Long
Randy and Sis Merrick
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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

StreamSweepers 2014 was a bodacious concept. Center for Natural Capital Board of Directors felt there was no question that work on the Rapidan River would continue, from Madison Mills downstream, perhaps as far as Lake of the Woods in the eastern part of Orange County. During this discussion, CNC Board Member and StreamSweeper Founder David Perdue advocated for inclusion of the Robinson River, noting it's location close to the CNC office in Orange and his sense that the portion along River Road may have a lot of garbage in it. More discussion with key StreamSweeper Supporters lead to a decision to start at Banco in Madison County and go all the way to confluence with the Rapidan. As for the Rapidan, it was decided to go to Rt. 522 in Culpeper. This would be roughly 40 miles of rivers, doubling last year's mileage. Undertaking something like this would require landowner outreach and project planning that exceeded the Center's offseason resources. Fortunately, some "early adopter" Rapidan and Robinson River landowners and watershed supporters, particularly including Mark Kington and the Dominion Foundation, stepped in with resources to turn the dream into reality.



With use of a new riparian landowner fee, the ball got rolling, with many more riverside landowners agreeing to pay for cleanup and assessment of their frontage. One landowner, Woodberry Forest School, was a game changer for 2014, bringing on their own graduating students as paid Sweepers to handle the Rapidan, providing classroom space for training, along with a shuttle for team pick up and drop off. This effort was spearheaded by two Woodberry staff; Ben Hale with support from Randy Hudgins. The Woodberry Rapidan Team overhauled assessment protocols and developed new methods to render assessment findings for customers and supporters.



This year's strategy was notable for another new development. Thanks to Friends of the Rappahannock, a 2000 riparian assessment of the entire Rapidan River watershed conducted in cooperation with the Virginia Institute of Marine Science (VIMS), was provided to the

Sweepers, in the hope that a way could be found to compare 2014 results with project findings from this earlier study. A method was devised and the findings have been published as a portion of this report.



Also, this year was notable for the Sweepers themselves.

Crew size increased from 4 in 2013 to 13 this year. In addition, a new position was created, River Analyst, filled by two Sweepers from 2013. Most of the watershed analyses work was completed by these Analysts.



Finally, for the first time, Sweepers completed water quality testing throughout the stretches of both rivers. In Partnership with the National Institute of Health, National Cancer Institute, a sampling protocol was created for screening of endocrine mimicking compounds.

- *Michael Collins*

StreamSweeper Business Model

StreamSweepers attempts to serve two categories of “Supporters”. The first category is riverside supporters, the heart of the business model. The assessment and cleaning is considered a landscaping service to enhance 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 2014 was .25 cents per linear foot. The second category 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.

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 2014 assessment and cleaning of the Rapidan and Robinson river valleys. 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 2014, at the time this report was prepared, was still being analyzed. Once analysis is complete, participating landowners and watershed supporters will be contacted to review findings. Whether some form of the results is published in a future version of this report has yet to be decided by the Center for Natural Capital Board of Directors.

Also please note that the report has been formatted expressly for the web, with chapter set up as pages on this site. The "Table of Contents" is the menu found when clicking on the StreamSweepers 2014 Report Tab, found on the left side or top of the homepage.

Program Deliverables 2014

- River Reach Selection
- Riverside Landowner Outreach
- Sweeper Hiring
- Training Curriculum Development
- Sweeper Training
- Assessment Protocol
- Trash Removal Protocol
- Methodology to Compare 2014 and 2000 Data
- Water Quality Testing Protocol
- Water Sample Collection
- River Assessment
- Comparison River Health 2014 vs. 2000
- River Cleaning
- Landowner Economic Opportunities to Restore Floodplain
- Report Preparation
- Publication @ www.streamsweepers.org
- StreamSweepers 2014 Celebration at Historic Rapidan Mill

2014 River Segments

StreamSweepers work for the 2014 season once again focused on the Rappahannock River drainage area, or watershed, located in Central Virginia (see 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 of the Rappahannock are the Hazel, Thornton, Rapidan, Robinson, and Corotoman rivers, as well as Mountain Run and Cat Point Creek. StreamSweepers 2014 work took place in the upper portion of the basin, within the Rapidan and Robinson River Valleys.



Rappahannock River Watershed - from the Blue Ridge Mountains to the Bay (in yellow)

The portion of the Rapidan selected for 2014 work spans from Rt. 15 (Madison Mills to just beyond Rt. 522 (Raccoon Ford) (see image below), a total of 20 river miles.



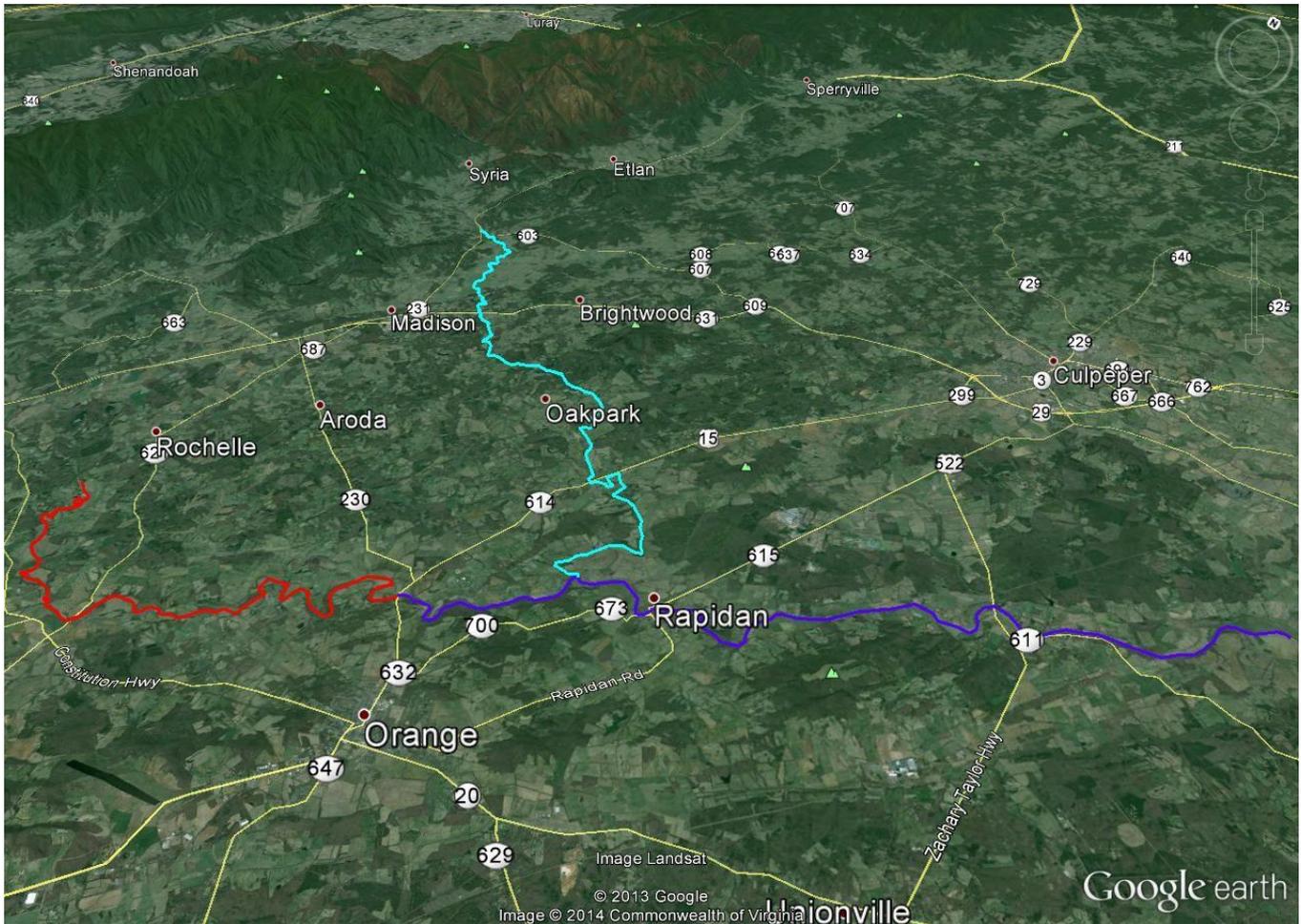
2014 Section or Stretch of the Rapidan River

The portion selected for the Robinson spans from the village of Banco in Madison County to the river's confluence with the Rapidan west of the Village of Rapidan (see image below – looking to the west), a total of 17 river miles.



2014 Robinson River Stretch

To date, 2013 and 2014 StreamSweepers have assessed and cleaned roughly 60 miles of rivers, as shown in the image below (2013 Rapidan stretch shown in red, 2014 Rapidan stretch shown in purple, and 2014 Robinson stretch shown in light blue).

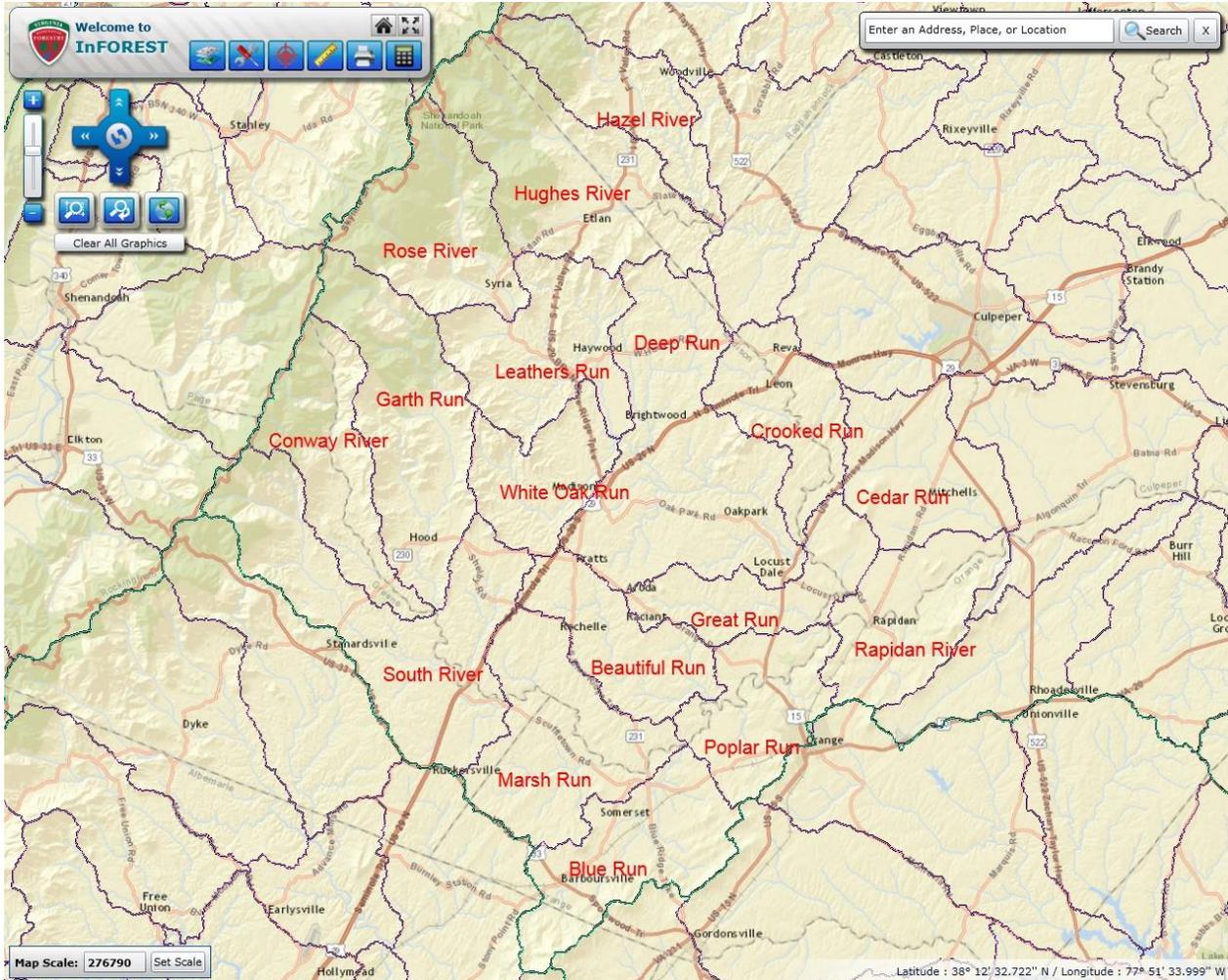


2013 and 2014 StreamSweeper Maintained River Segments

Rapidan and Robinson Rivers Watershed Description

There are 16 areas (called subwatersheds or catchments or drainage basins) that flow into the 2014 portions of the Rapidan and Robinson River watersheds. These are listed below (from west to east) and shown in the following image. Knowledge of the land cover in a river's drainage basins helps understanding about river health.

- 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



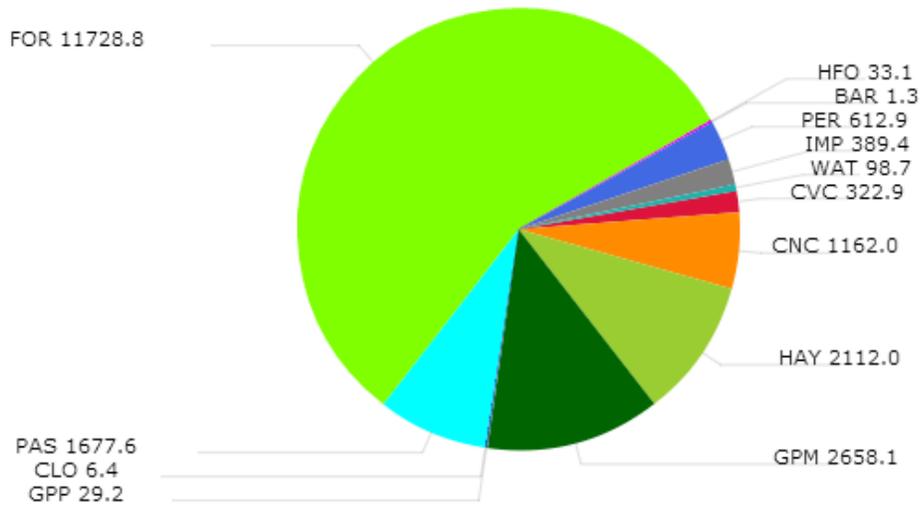
Rapidan and Robinson River 2014 Subwatersheds

The following charts show the proportion of types of land cover for each of these subwatersheds.

Blue Run

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

Current Area by Landuse/Landcover (acres)

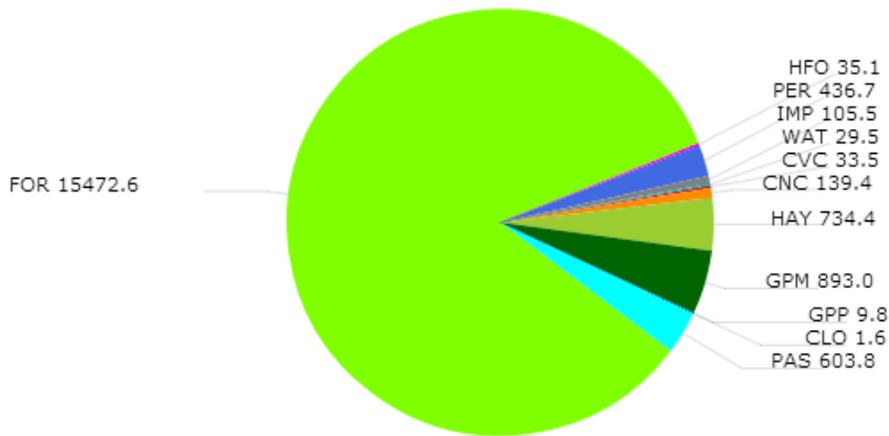


- CVC = conventional tillage cropland
- CNC = conservation tillage cropland
- HAY = hay
- GPM = grazed pasture (with applied manure or fertilizer)
- GPP = grazed pasture (with applied poultry litter)
- PAS = unimproved pasture (no applied manure or fertilizer)
- CLO = confined livestock operation
- FOR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

Conway River

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

Current Area by Landuse/Landcover (acres)

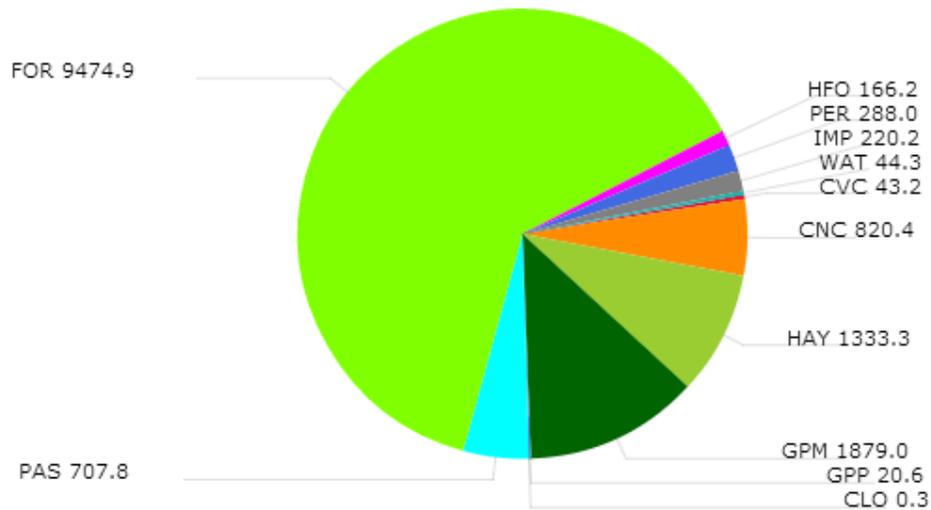


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Crooked Run

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

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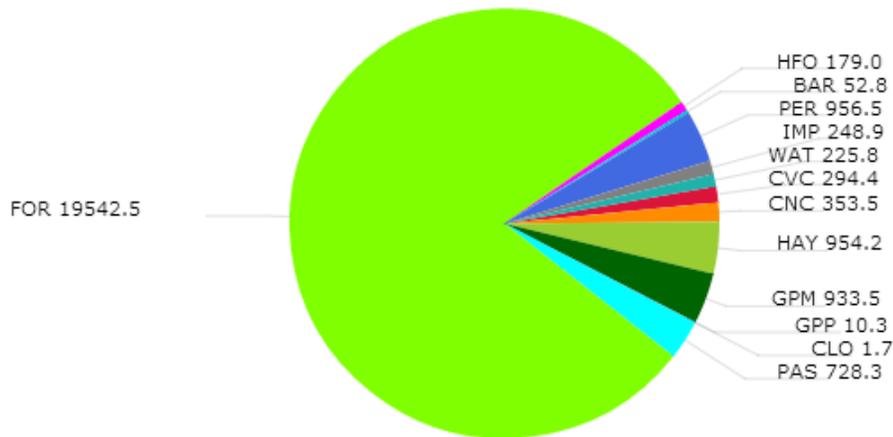


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Deep Run

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

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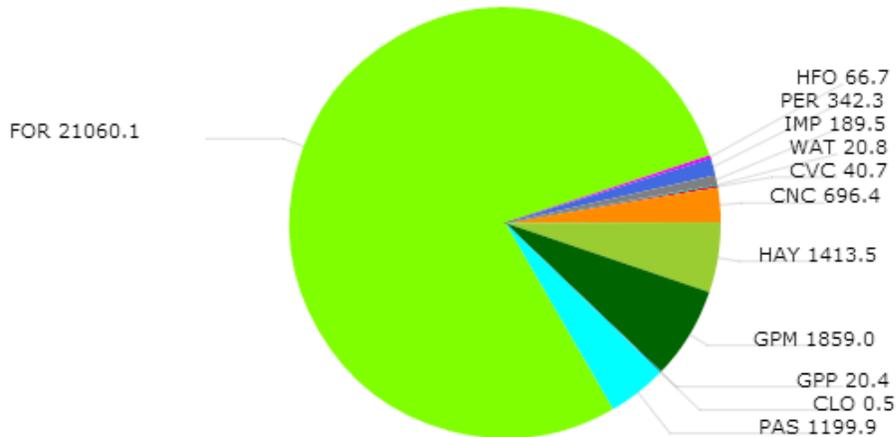


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Garth Run

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

Current Area by Landuse/Landcover (acres)

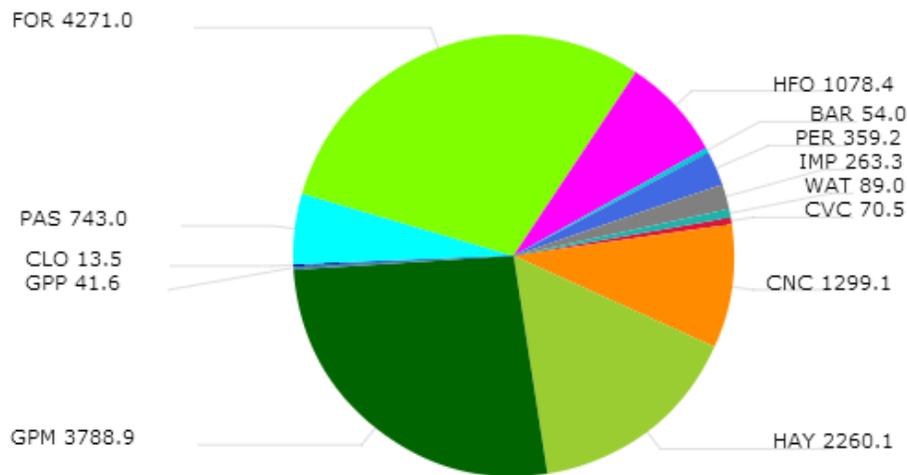


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Great Run

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

Current Area by Landuse/Landcover (acres)

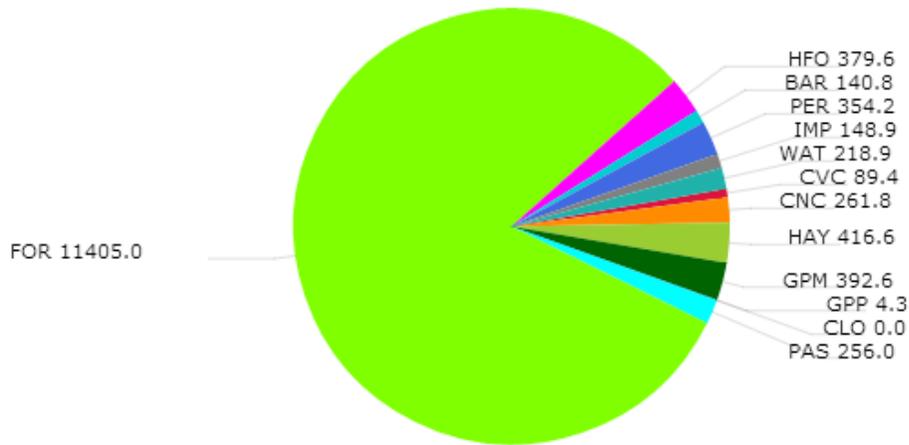


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Hazel River

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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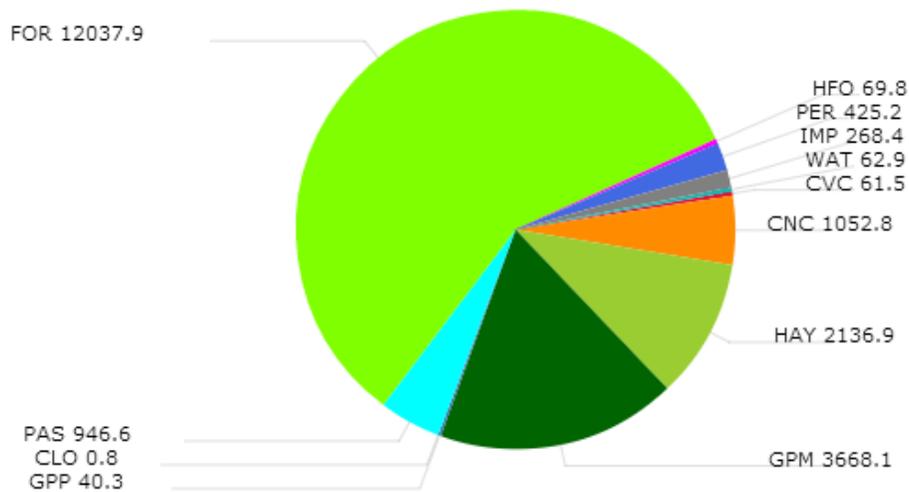


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Leathers Run

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

Current Area by Landuse/Landcover (acres)

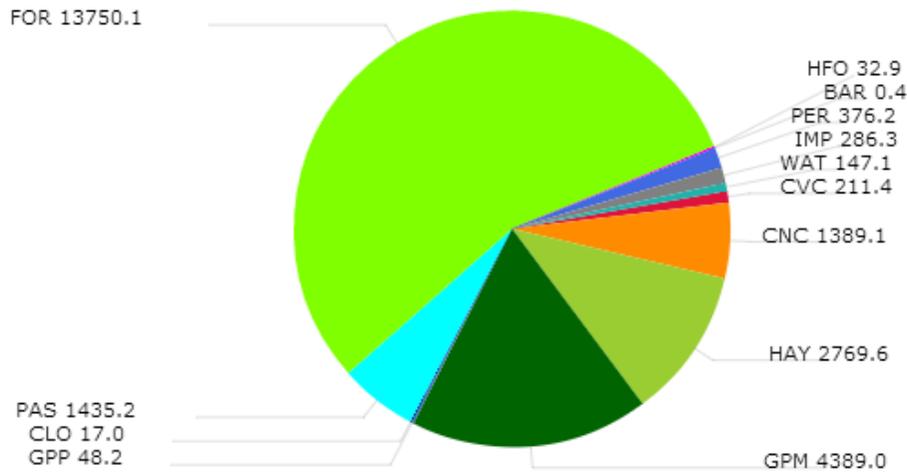


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Marsh Run

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

Current Area by Landuse/Landcover (acres)

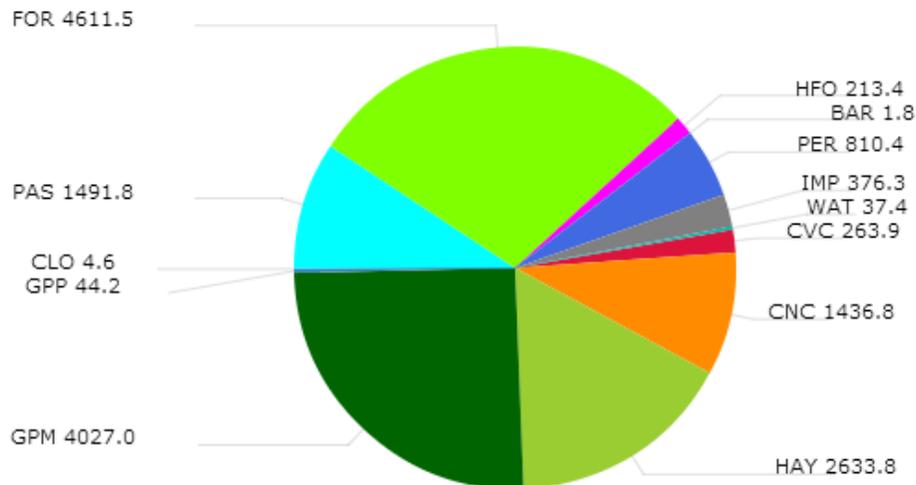


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Poplar Run

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

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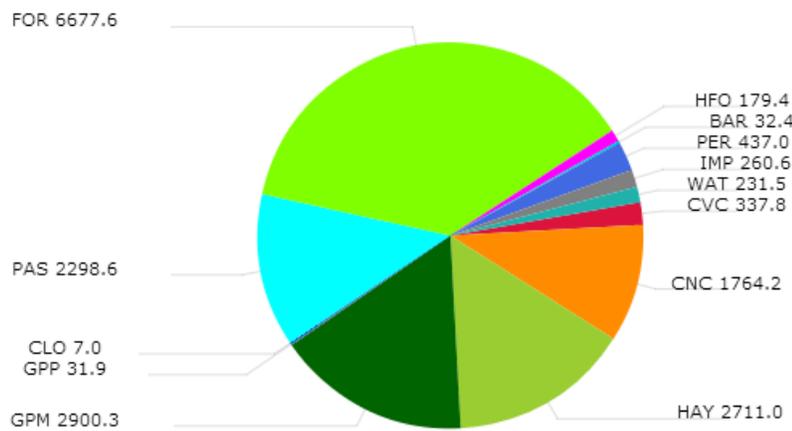


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Rapidan River Land Cover

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.

Current Area by Landuse/Landcover (acres)

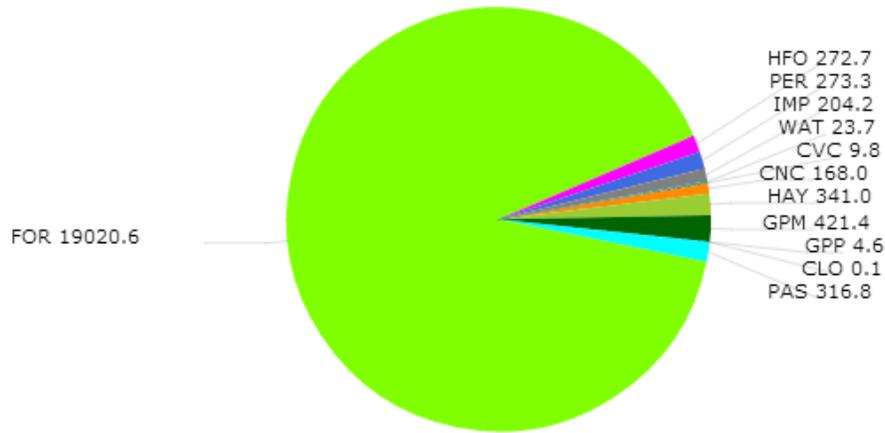


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Rose River

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

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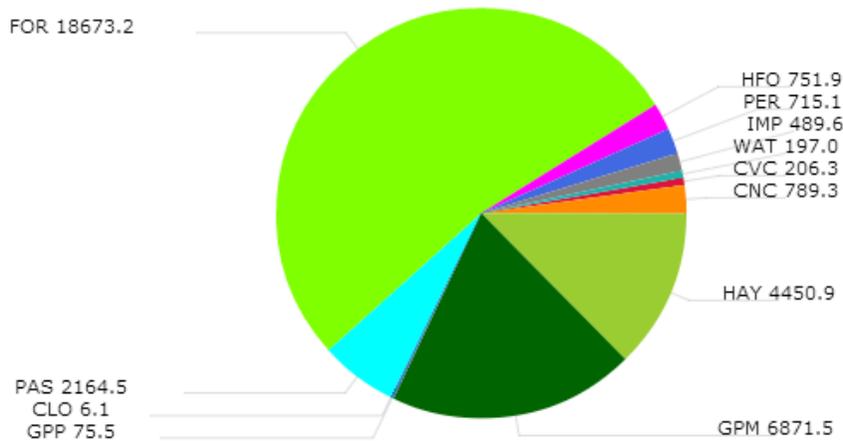


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South River

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

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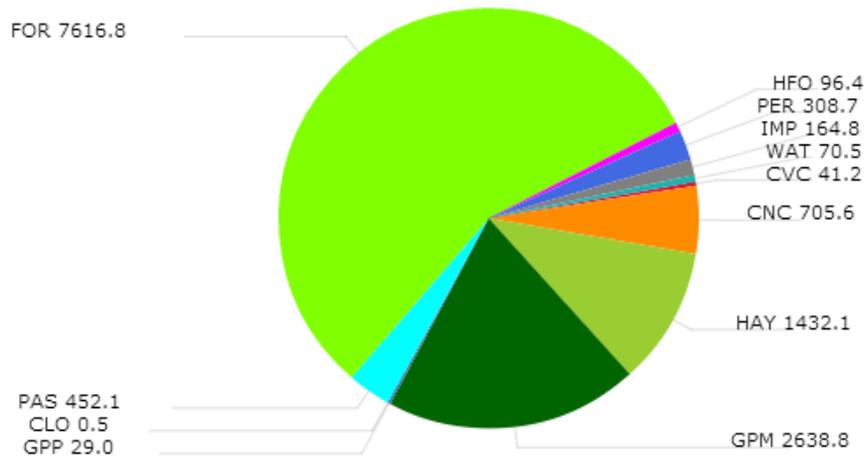


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South River Land Cover

White Oak Run

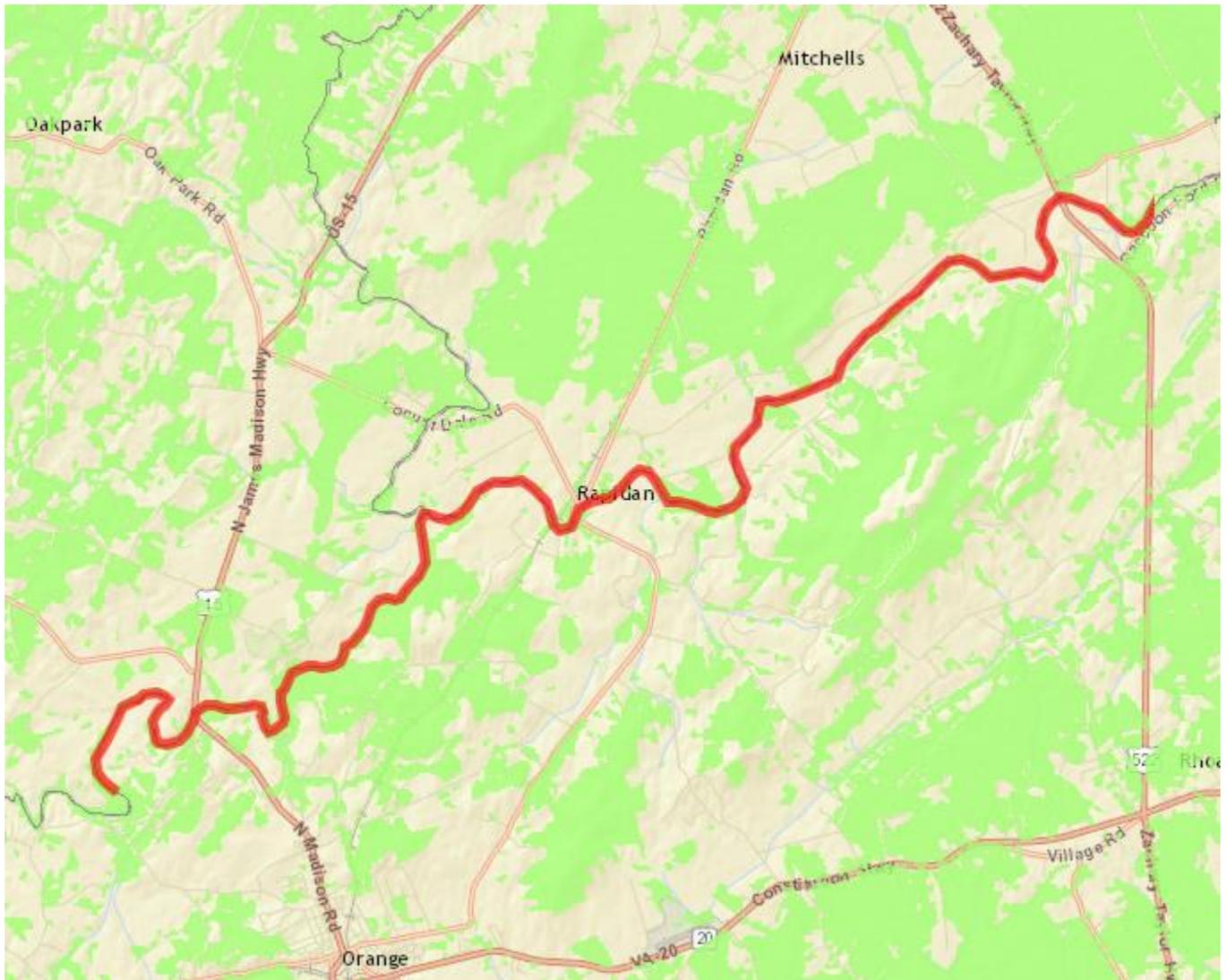
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Rapidan and Robinson River Valleys Landscape Characteristics

Forest cover is universally understood to be the best type of landcover for healthy rivers and streams. The images below show forest cover (in light green) for the 2014 Rapidan and Robinson River segments, and of particular importance is the landcover immediately adjacent to the river on both sides.



Rapidan River Valley Forest Cover

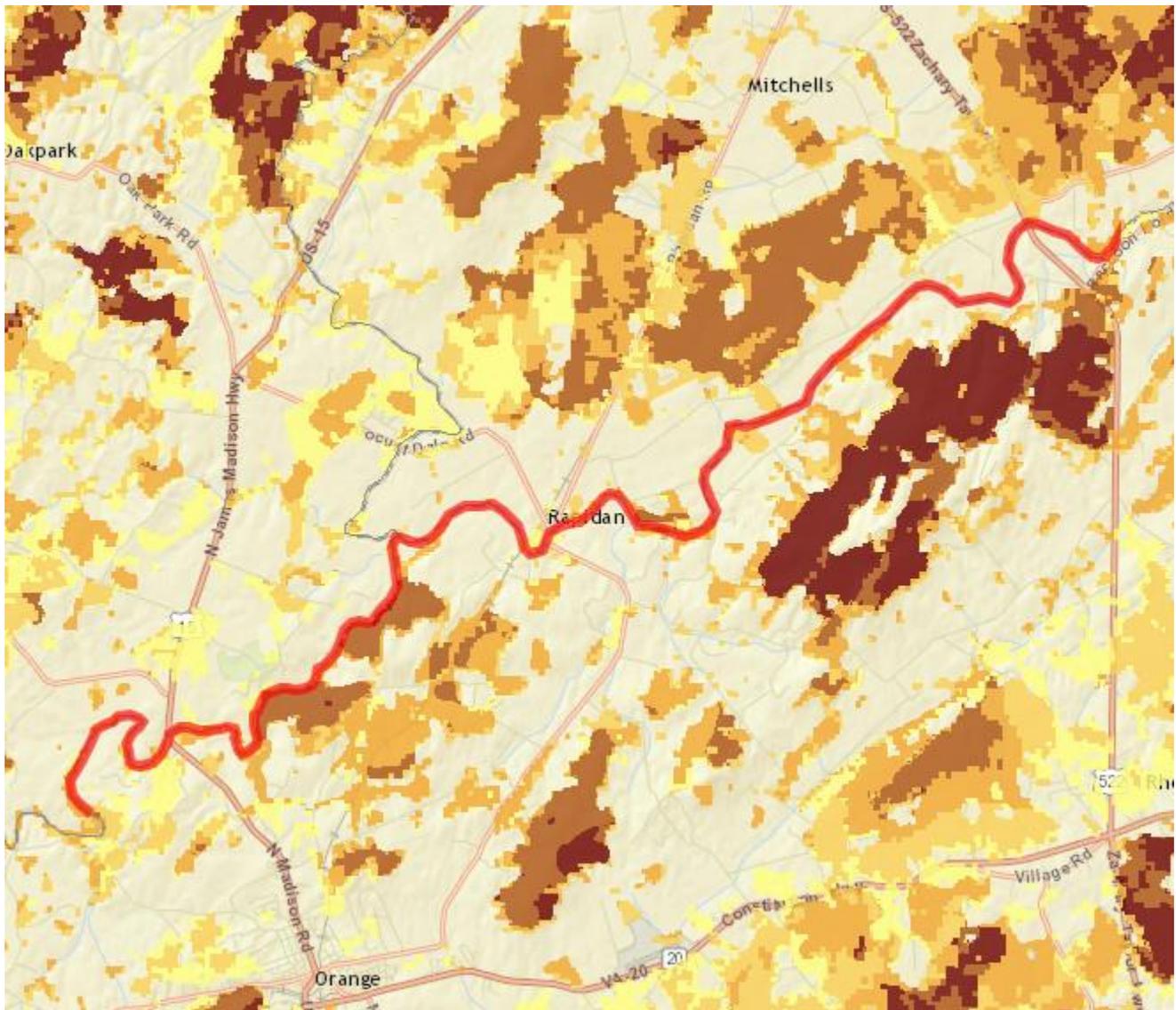
Note the preponderance of forest cover (green coloring) on the south side of the river east of Rt. 15 in the image above.



Robinson River Valley Forest Cover

Note the generally greater amount of forest cover spread along the Robinson River (shown above), as compared to the Rapidan.

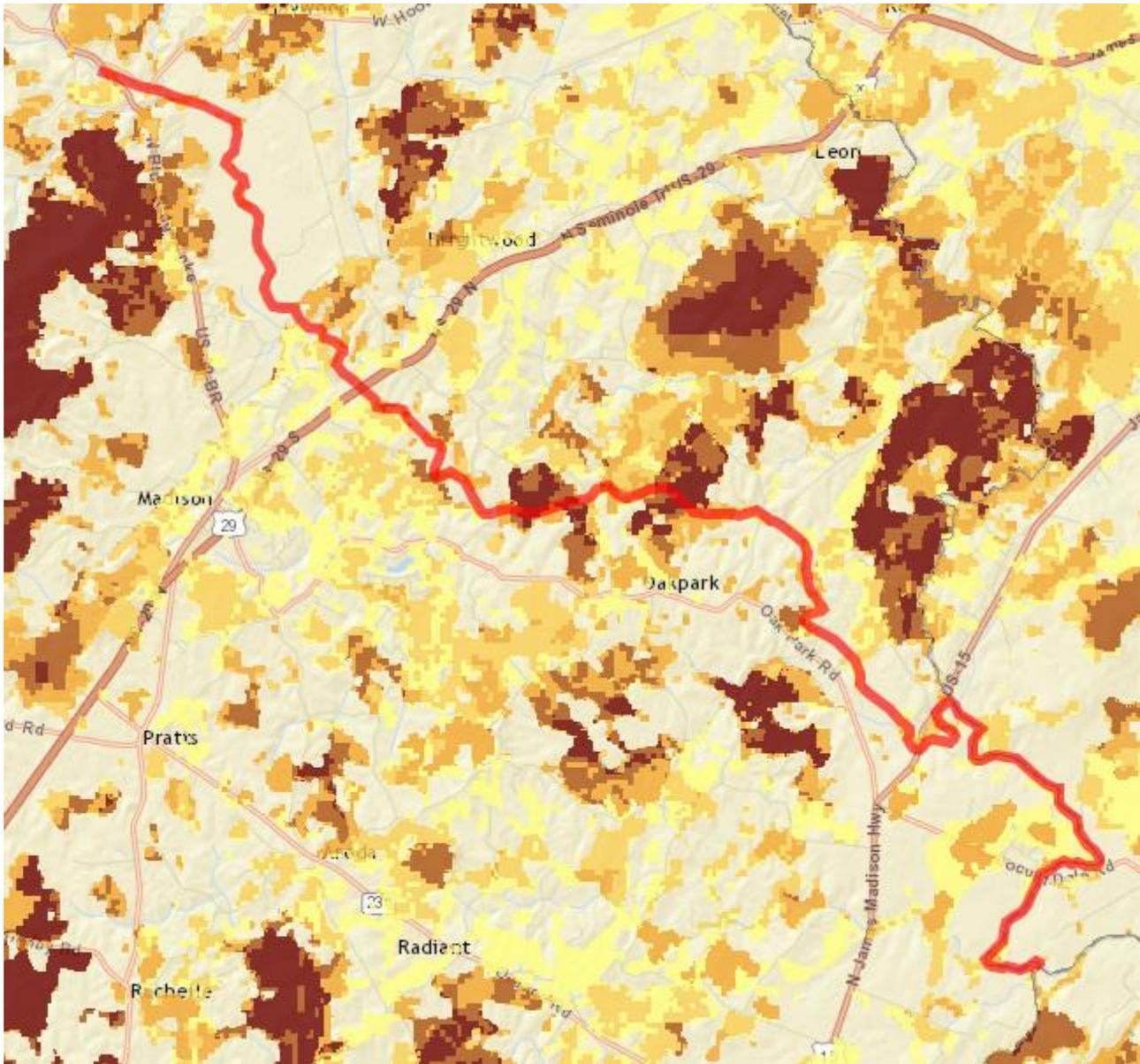
The Virginia Department of Forestry identifies *Forest Conservation Value (FCV)* for all forestland in the state. This ranking is based on the level of benefits provided by a particular area of forest combined with the threat of conversion to non-forest land use. Areas shown in the figures below in dark brown have the greatest priority for conservation programs.



Rapidan River Valley Area Forest Conservation Value

Note the priority areas on the south side of the river east (right side) of Rt. 15 in Orange County, shown in brown, adjacent to the river.

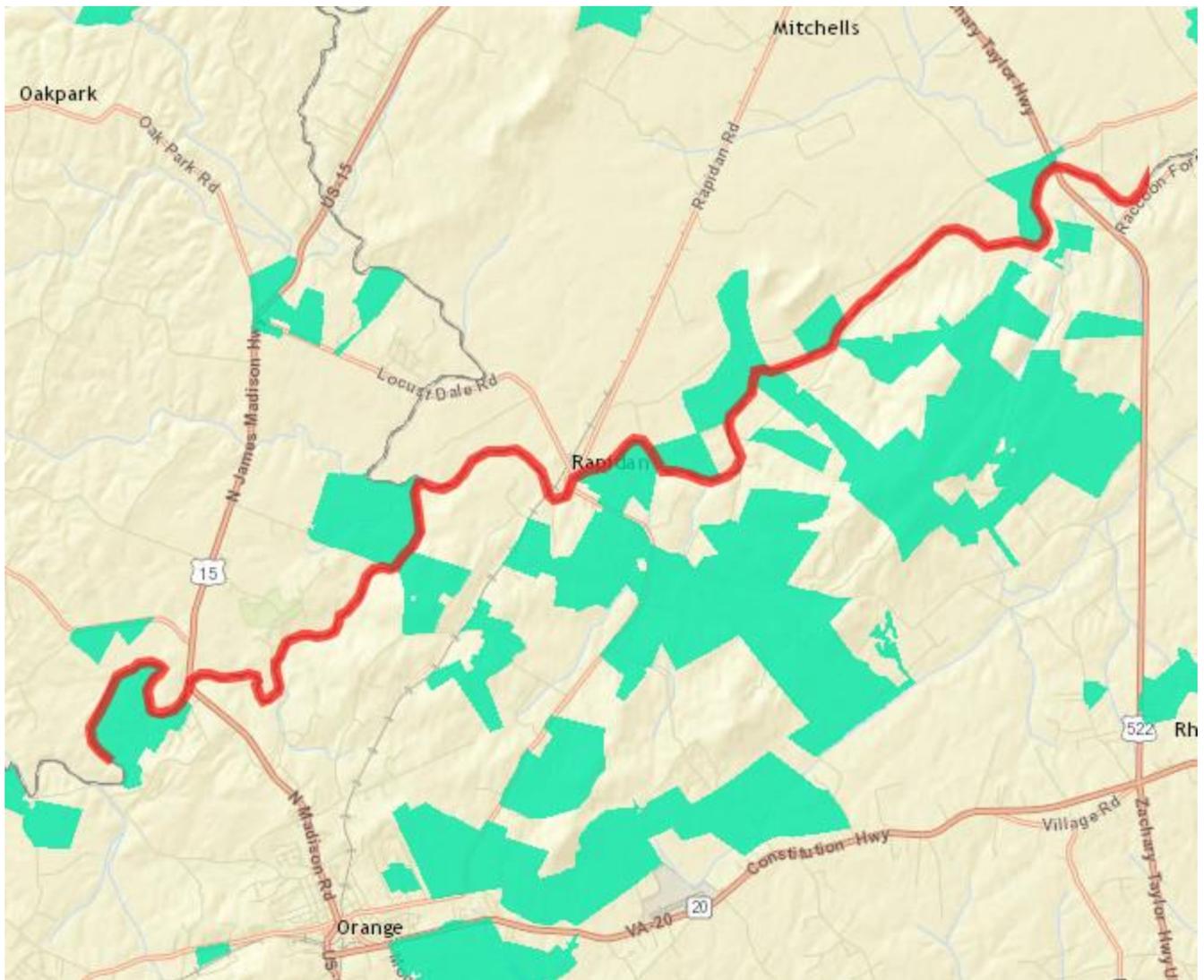
The image below shows Forest Conservation Value for the Robinson River Valley.



Robinson River Valley Area Forest Conservation Value

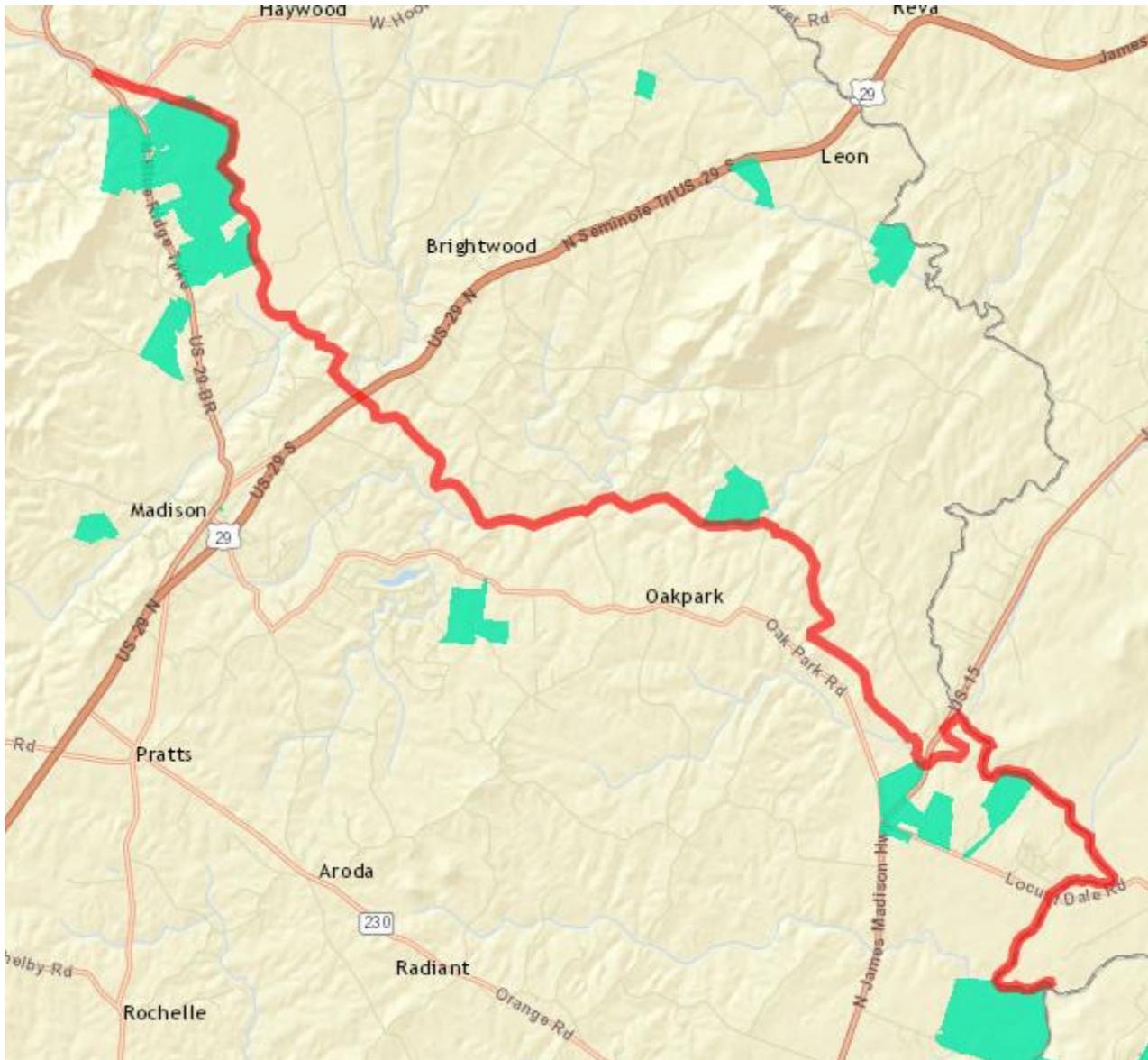
Note the concentration of high forest conservation value area around Oak Park, towards the middle of this stretch.

Conservation easements are one tool that can help to maintain rural landscapes. The image below shows conservation easements along both sides of the Rapidan River. Though spotty, significant areas along both sides of the river are held in easement.



Rapidan River Valley Area Conservation Easements

Conservation easements for the StreamSweeper 2014 Robinson River stretch are shown below. Note the lower proportion of area near the river in easement as compared to the Rapidan.



Robinson River Valley Area Conservation Easements

Rapidan and Robinson River Valleys Floodplain Analysis

A floodplain is an area of land adjacent to a stream or river that stretches from the banks of its channel to the base of the enclosing valley walls and experiences flooding during periods of high discharge. Over centuries, rivers move laterally within their floodplains, as flood events occur. This back and forth movement, throughout the width of a floodplain, is a natural process. A healthy river ecosystem, including its plants and animals, is accustomed to pulses of nutrients and sediment as this process occurs. Too little or too much nutrients and sediment over time can impair the health of the ecosystem. The type of land cover in a river's floodplain can greatly affect the rate of nutrient and sediment loss.

The best land cover from an ecosystem health perspective is forest or forest combined with native grasses. This type of land cover has a sediment and nutrient loss rate that is optimum for river ecosystem processes.

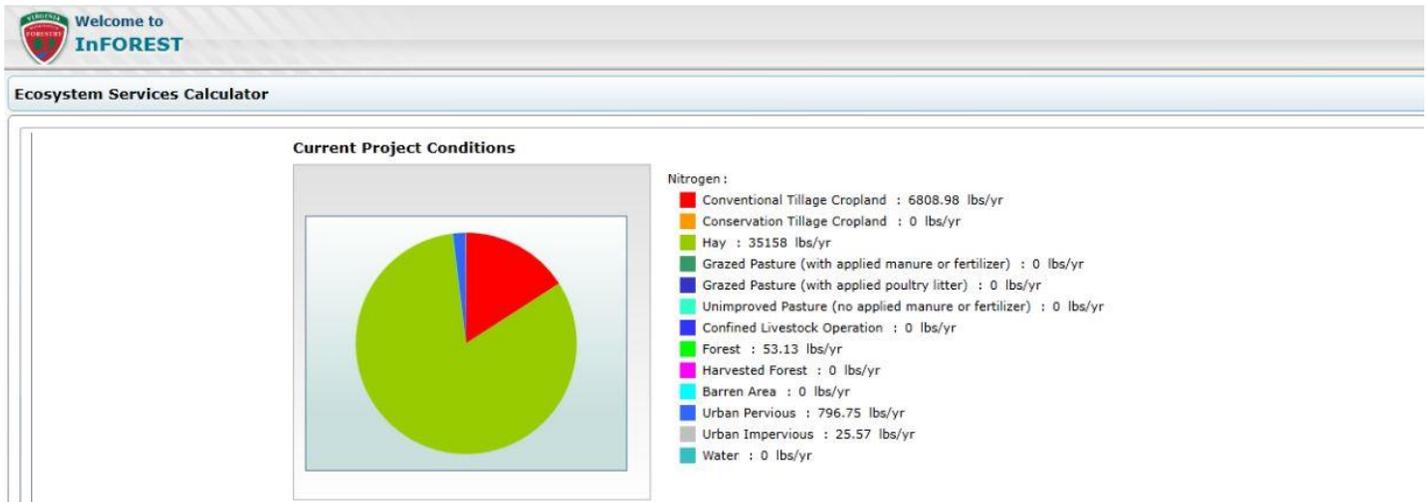
As part of StreamSweepers' 2014 data collection, land cover information has been generated for the Rapidan, Robinson and other tributary rivers of the Rappahannock River watershed. Floodplains were delineated and land cover data was generated through use of the Virginia Department of Forestry's online software, InFOREST. The following table contains land cover percentages for each of the major tributaries of the Rappahannock western portion of the Rappahannock River.

| River | Forest | Cropland | Water | Urban | Hay | Pasture |
|---------------------|--------|----------|-------|-------|-------|---------|
| <u>Rapidan</u> | 29.9% | 16.1% | 5.5% | 3.4% | 15.3% | 29.9% |
| Conway | 22.4% | 29.3% | 0.6% | 8.5% | 12.9% | 26.4% |
| Hazel | 37.9% | 14.4% | 1.6% | 2.0% | 17.2% | 26.9% |
| Hughes | 30.4% | 9.5% | 0.0% | 8.9% | 14.5% | 36.7% |
| Jordan | 41.0% | 0.5% | 0.3% | 3.8% | 22.7% | 31.8% |
| Robinson | 16.0% | 12.8% | 1.8% | 9.5% | 20.7% | 39.2% |
| Rose | 13.7% | 1.3% | 0.0% | 18.0% | 21.1% | 45.9% |
| Rush | 42.7% | 0.5% | 2.0% | 4.4% | 15.9% | 34.6% |
| South | 16.3% | 9.9% | 2.6% | 7.0% | 21.1% | 43.1% |
| Thornton | 30.9% | 0.9% | 2.6% | 7.7% | 25.5% | 32.5% |
| <u>Rappahannock</u> | 47.9% | 14.9% | 26.2% | 0.9% | 15.4% | 17.7% |

Note the low percentages of the Rapidan and Robinson River floodplain in forest land cover.

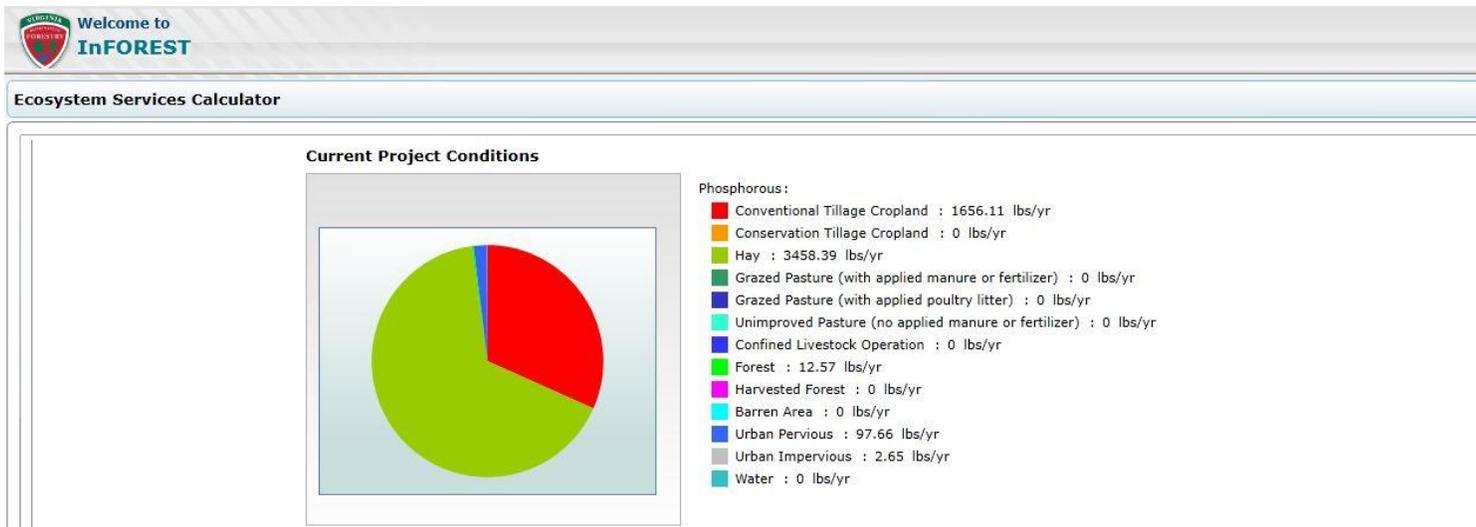
Land Cover Nutrient and Sediment Contributions from Floodplains

Again using the InFOREST online, StreamSweepers estimated nutrient (nitrogen and phosphorus) and sediment (soil) loss in the major Rappahannock River tributary floodplains. Results were generally similar to Robinson River findings. The land cover classification currently contributing the most nitrogen is hay (see image below).



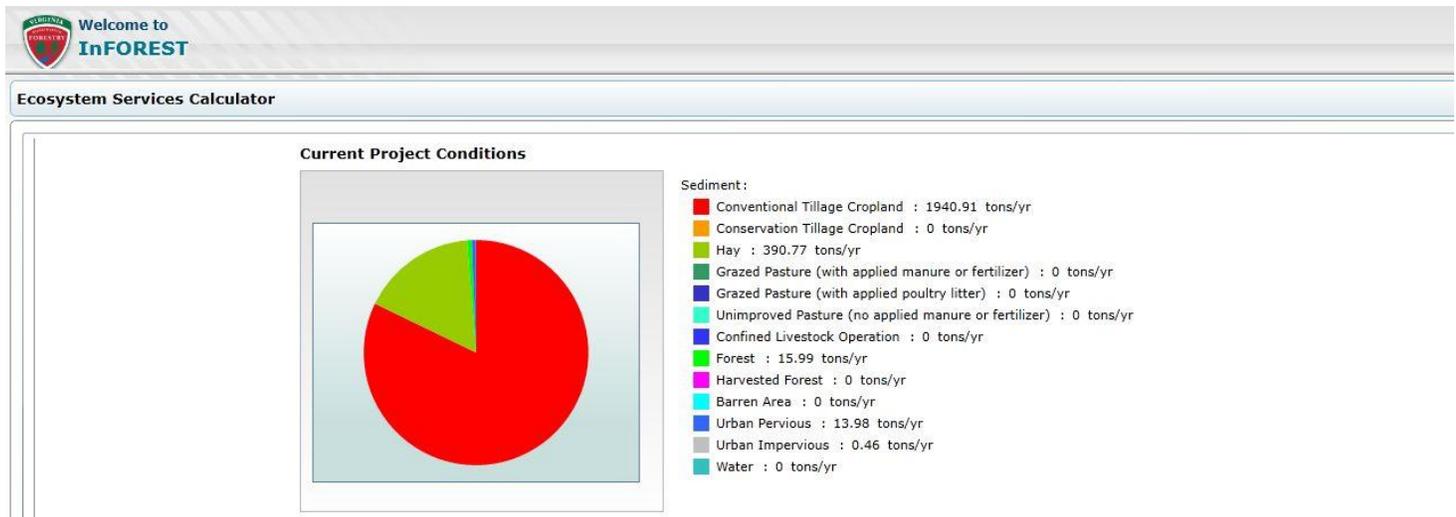
Nutrient (Nitrogen) Loss from Robinson River Floodplain Land Cover

The type of land cover currently contributing the most phosphorus in the Robinson River valley is also hay (see image below).



Nutrient (Phosphorus) Loss from Robinson River Floodplain Land Cover

Finally, the type of land cover currently contributing the most sediment in the Robinson River floodplain is conventional tillage cropland (see image below).



Sediment (Soil) Loss from Robinson River Floodplain Land Cover

StreamSweeper Training

13 young adults from Central Virginia were hired as Sweepers for the summer of 2014. As employees of the Center for Natural Capital, they were trained and tested to have the following skill sets:

- Geologic History of the Mid-Atlantic Region
- Geologic History of Triassic Basins
- Intro. To Ecological History of North America
- Intro. To Business
- Intro. To Hydrogeology
- Intro. To Fluvial Geomorphology
- Intro. To Economics and Ecosystem Services
- Intro. To Empathic Relationships
- Intro. To Impact of Land Cover on Watershed Health
- Assessment Methodology



Detailed inspection is required for biological monitoring

- On-water Risk Reduction
- First Aid
- Canoe Skills
- Logistics Planning
- GPS Instruction

Assessment Protocol and Methodology

Sweepers conducted an assessment of the Rapidan and Robinson River Valleys. 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 2014 season of StreamSweepers was collected in a similar manner to 2013. 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. One difference in this year’s assessments was the addition of several rating categories. Last year the categories included canopy, bed, bank and bank vegetation. For 2014, the categories and scoring range (low scores indicate lower levels of functionality, high scores indicate higher functionality) are as follows:

Canopy (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.

- For the Rapidan River, the majority of the time, the canopy coverage was 25% (37%, river left; 52%, river right), while the canopy coverage was 100% only 1% of the time (river right). Lower canopy ratings correlated strongly with those of buffer, bank erosion, and bank cover. Many species of non-invasive hardwoods were present - primarily Sycamores, Poplars, Hickory, River Birch, Oak and Maple. Invasive Species tended not to affect the canopy but did affect the understory of the bank coverage.

Buffer (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 (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 (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.

- Ratings for river bed assessment fell into three categories: cobbled, mixed, and silted (indicators of good, moderate, and poor river health). For the Rapidan River, assessing the bed was perhaps the most subjective measurement because the majority of the time, silt and depth prevented accurate observations of the river bottom.

Bank Cover (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, Tree of Heaven, Bamboo, Garlic Mustard, and Oriental Bittersweet.

Bank Geometry (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.

- Most of the river had moderate bank geometry (around 80% of the time). Good and poor bank geometry sections were few and far between. Steep or undercut banks typically

translated into areas with severe erosion. Gently-sloping banks provided great substrate for greater canopy and bank cover ratings.

Bank Height (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.

- For the Rapidan, despite relatively few changes in bank height (about 70% of the time, the bank was 6-10 ft high), there were greater tendencies toward 0-5ft banks on river right (28% of the time) and toward 11-15ft banks on river left (20% of the time). As the river widened, the banks tended to reach greater heights and vice versa.

Invasive Species (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.

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 Robinson. 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 the GPS unit to color-coded maps made through use of Google Earth.

As an example, the image below shows the buffer assessment data for the river left side buffer of the Robinson. Red represents a 0, yellow represents a 1, and green represents a 2.



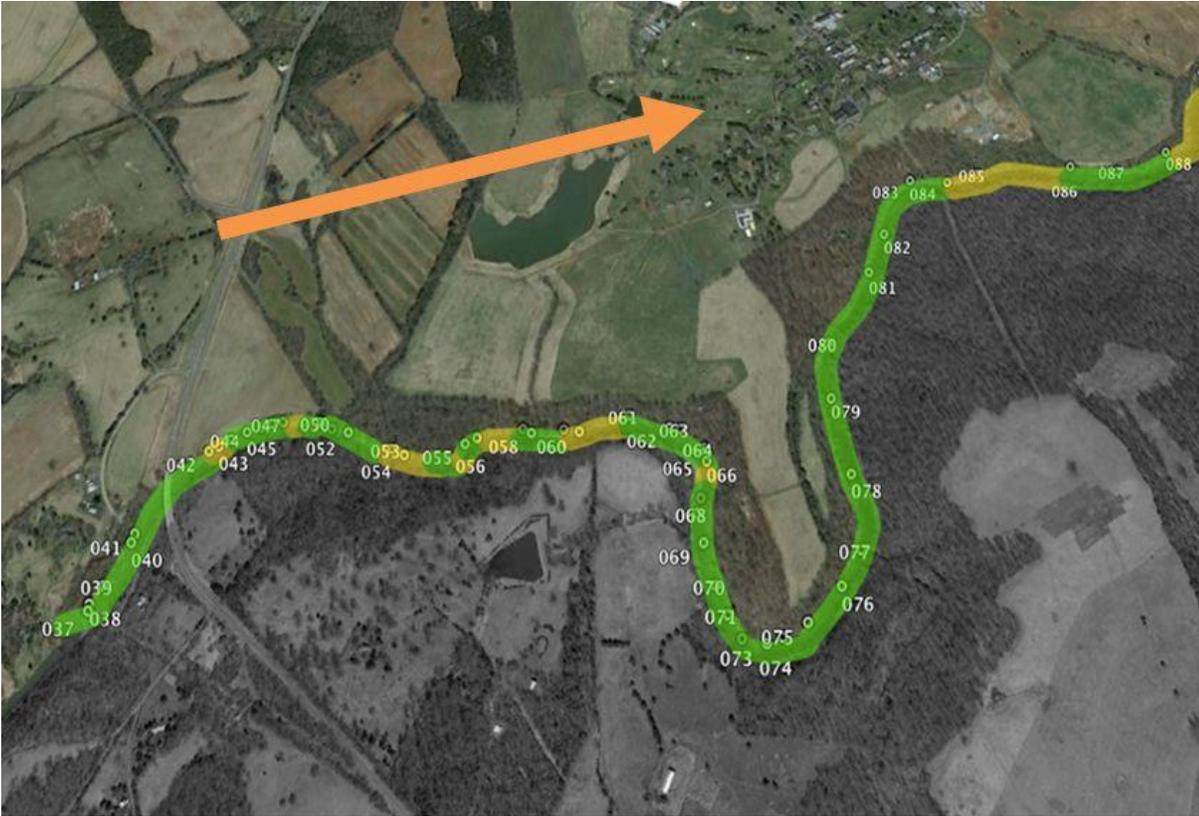
Rapidan River Assessments

The following images show the overall health of the Rapidan River. Each side of the river was analyzed independently by assessing the seven different variables described above. After Sweepers finished the assessment, the total numerical value of the variables was added together for each position, and using graphical analysis the points were grouped into areas of good health (green) fair health (yellow) and poor health (red) (see portion of table shown in image below).

| | A | B | C | D | E | F | G | H | I |
|-----|----------|--------|--------|--------------|-----|------------|---------------|-------------|-------|
| 1 | Waypoint | Canopy | Buffer | Bank Erosion | Bed | Bank Cover | Bank Geometry | Bank Height | Total |
| 137 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 8 |
| 138 | 178 | 1 | 1 | 1 | 1 | 3 | 1 | 2 | 10 |
| 139 | 183 | 2 | 1 | 2 | 1 | 2 | 1 | 3 | 12 |
| 140 | 181 | 1 | 0 | 2 | 1 | 2 | 1 | 2 | 9 |
| 141 | 182 | 2 | 2 | 1 | 1 | 3 | 1 | 2 | 12 |
| 142 | 183 | 0 | 0 | 1 | 2 | 2 | 1 | 1 | 7 |
| 143 | 184 | 1 | 1 | 1 | 1 | 3 | 2 | 3 | 12 |
| 144 | 185 | 2 | 1 | 1 | 1 | 3 | 1 | 3 | 12 |
| 145 | 187 | 1 | 1 | 1 | 1 | 3 | 1 | 2 | 10 |
| 146 | 188 | 2 | 0 | 1 | 1 | 3 | 1 | 1 | 9 |
| 147 | 189 | 1 | 1 | 1 | 1 | 4 | 1 | 2 | 11 |
| 148 | 190 | 0 | 2 | 1 | 1 | 3 | 1 | 2 | 10 |
| 149 | 191 | 1 | 1 | 0 | 1 | 3 | 1 | 2 | 9 |
| 150 | 192 | 1 | 1 | 0 | 1 | 2 | 0 | 2 | 7 |
| 151 | 193 | 1 | 1 | 1 | 1 | 3 | 1 | 2 | 10 |
| 152 | 194 | 1 | 1 | 0 | 1 | 3 | 1 | 2 | 9 |
| 153 | 195 | 1 | 1 | 1 | 1 | 3 | 1 | 2 | 10 |
| 154 | 196 | 1 | 0 | 0 | 1 | 1 | 1 | 2 | 6 |
| 155 | 197 | 1 | 1 | 1 | 1 | 3 | 0 | 2 | 9 |
| 156 | 198 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 9 |
| 157 | 189 | 1 | 2 | 1 | 1 | 4 | 1 | 2 | 12 |
| 158 | 200 | 2 | 2 | 1 | 1 | 4 | 1 | 1 | 12 |
| 159 | 201 | 1 | 2 | 1 | 1 | 3 | 1 | 2 | 11 |
| 160 | 202 | 2 | 2 | 1 | 1 | 4 | 1 | 1 | 14 |
| 161 | 203 | 1 | 2 | 2 | 1 | 4 | 2 | 3 | 15 |
| 162 | 204 | 1 | 1 | 1 | 0 | 3 | 1 | 3 | 10 |

Portion of Rapidan Assessment Spreadsheet

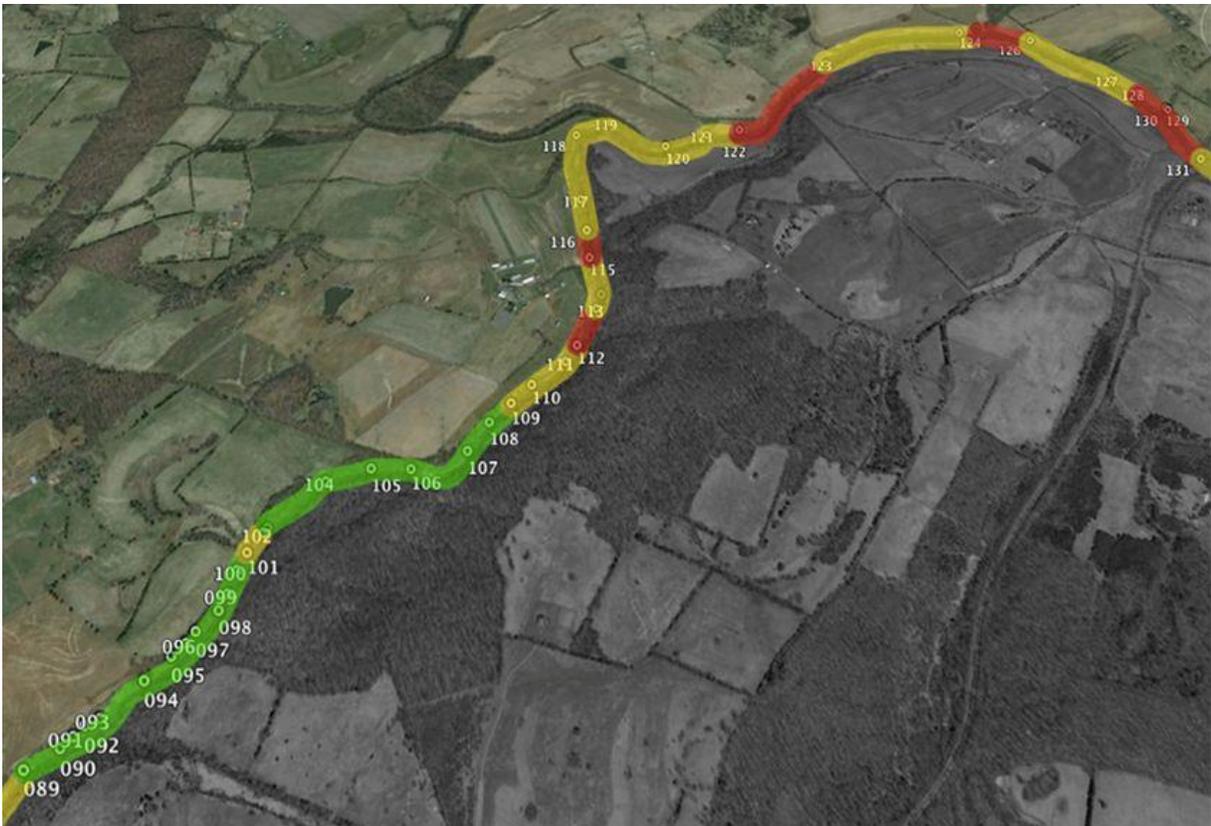
The following images show total assessment scores for river left and river right. To portray the entire section at an understandable scale, 5 sets of river left/river right images were created.



Rapidan River total assessment score portion 1 of 5 (river left) – Arrow indicates flow of river



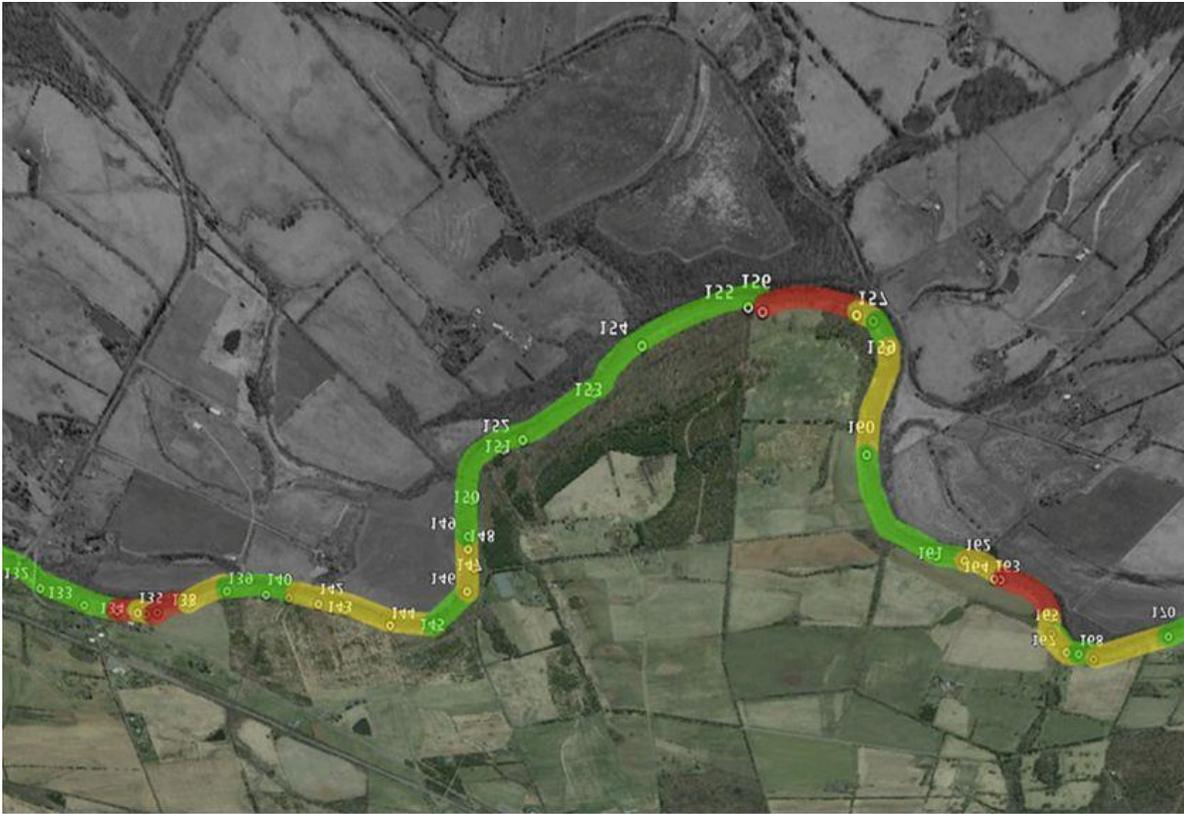
Rapidan River total assessment score section 1 of 5 (river right)



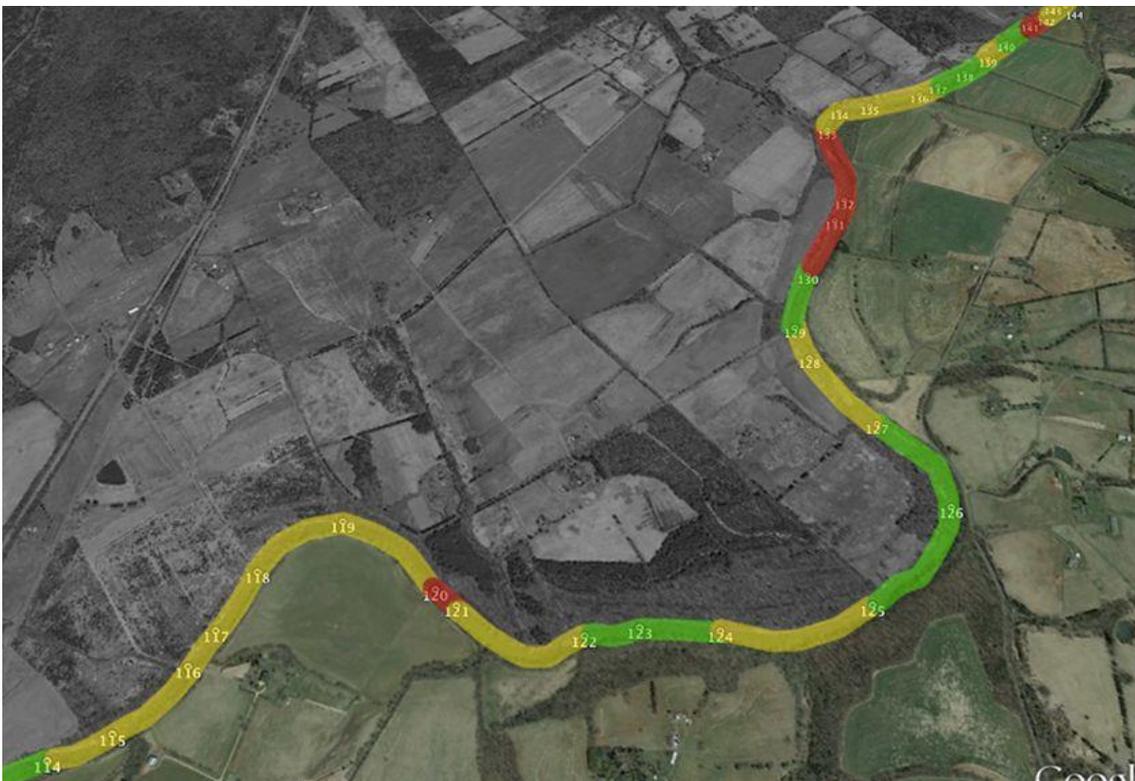
Rapidan River total assessment score section 2 of 5 (river left)



Rapidan River total assessment score section 2 of 5 (river right)



Rapidan River total assessment score section 3 of 5 (river left)



Rapidan River total assessment score section 3 of 5 (river right)



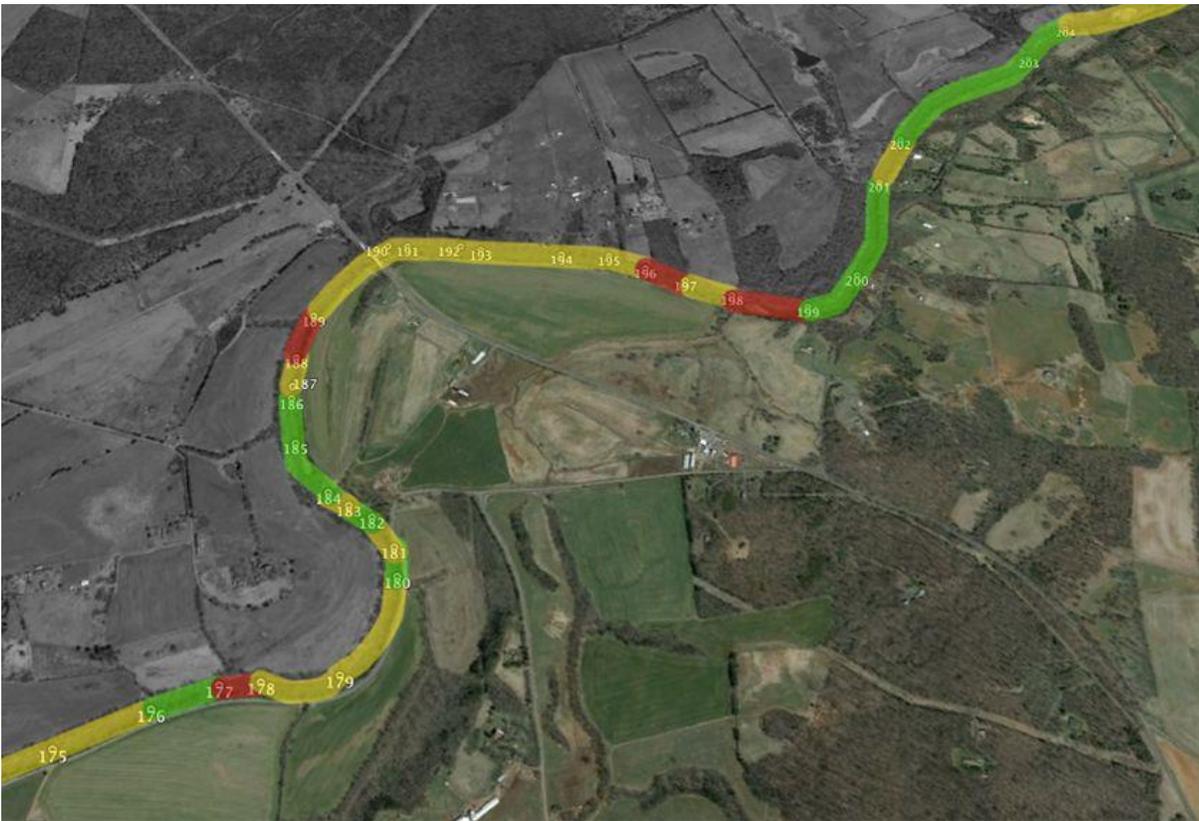
Rapidan River total assessment score section 4 of 5 (river left)



Rapidan River total assessment score section 4 of 5 (river right)



Rapidan River total assessment score section 5 of 5 (river left)

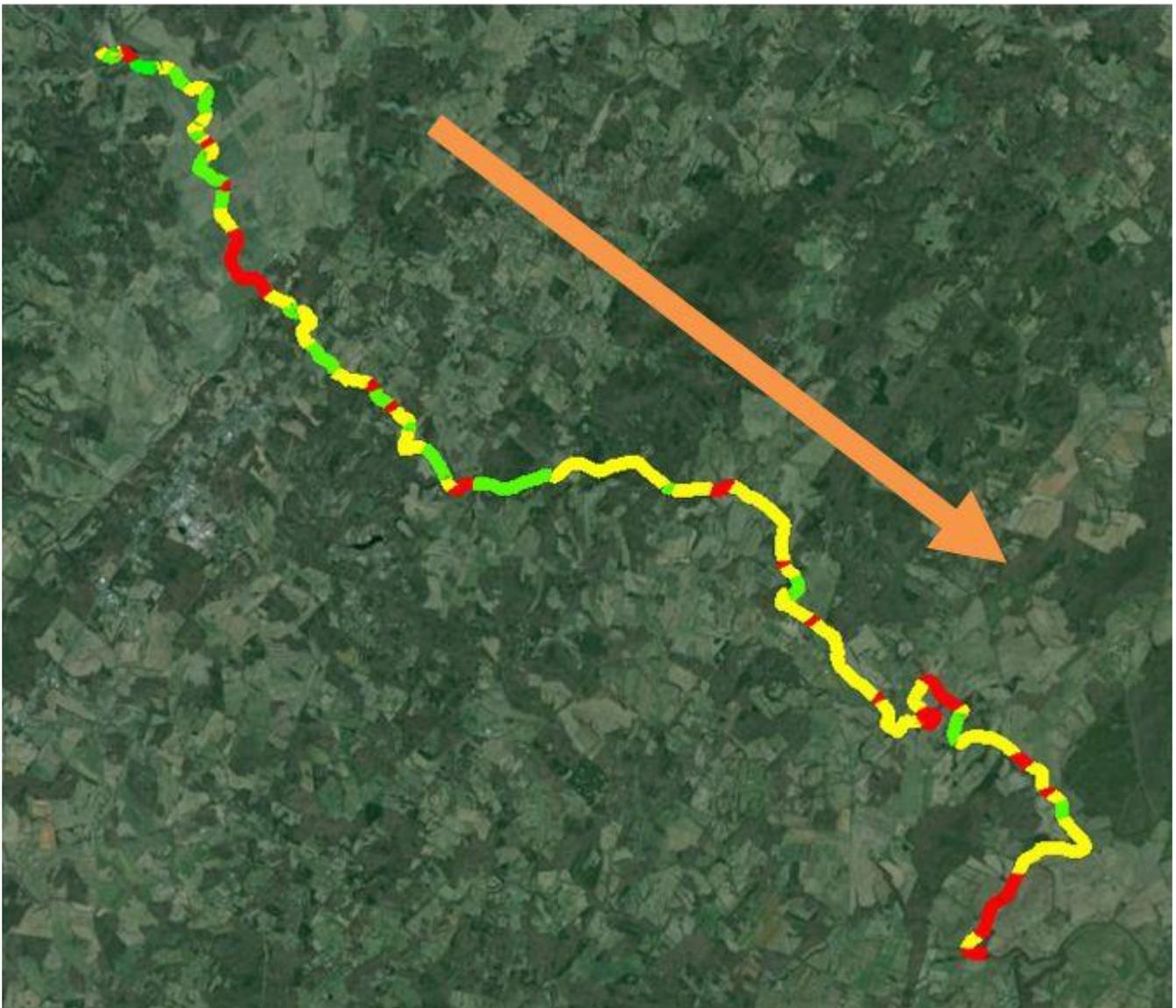


Rapidan River total assessment score section 5 of 5 (river right)

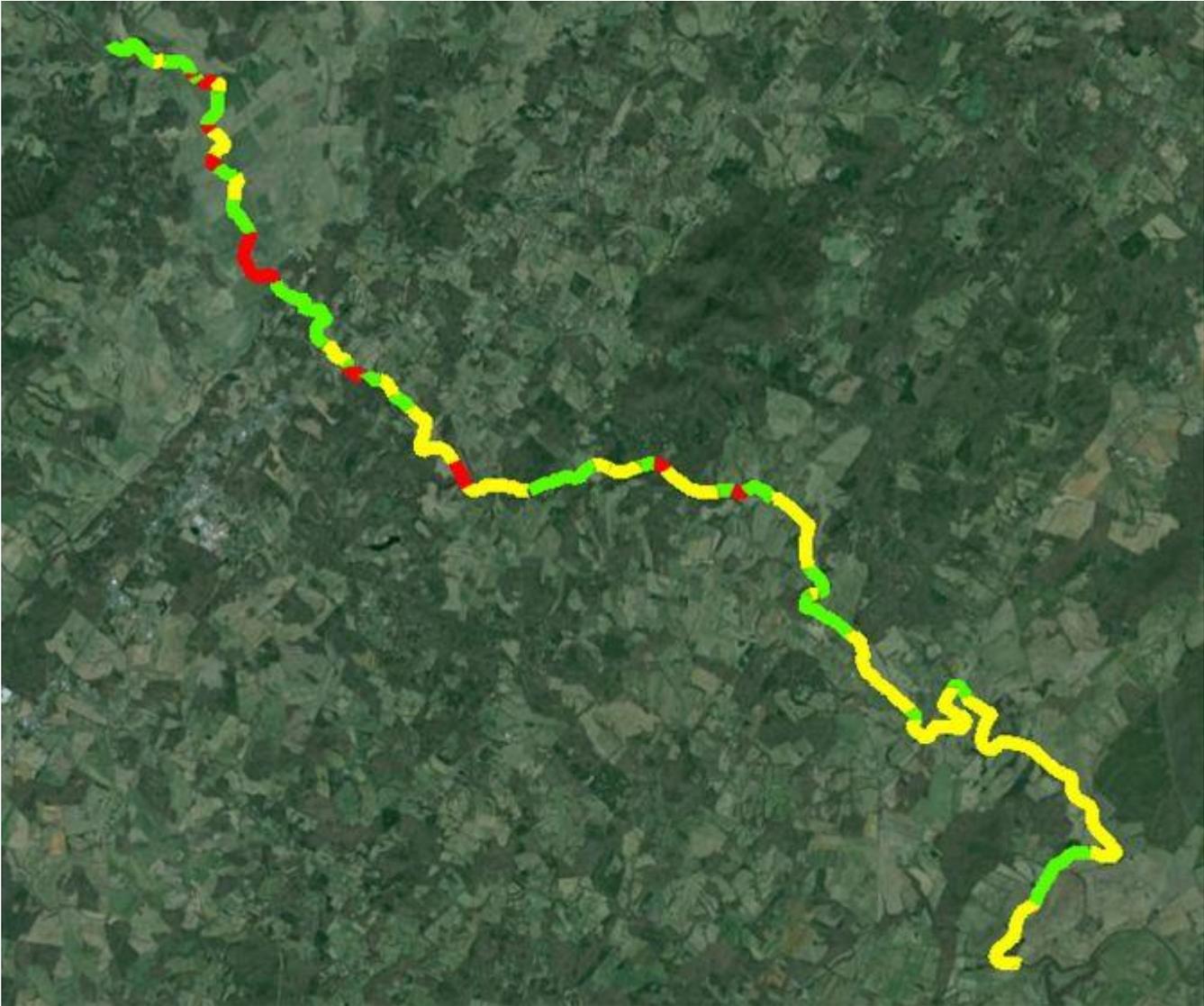
Robinson River Assessment Results

The following images show the overall health of the Robinson River. Each side of the river was analyzed independently by assessing seven different variables according to a set protocol. Sweepers analyzed canopy, buffer, bank erosion, river bed, bank cover, and bank geometry. Each variable was assigned a numerical value based on its quality, and every time there was a change in one of the variables along the river, all seven variables were reassessed and recorded. After Sweepers finished the assessment, the total numerical value of the variables was added together for each position, and using graphical analysis the points were grouped into areas of good health (green) fair health (yellow) and poor health (red).

Note: Arrow indicates direction of river flow.



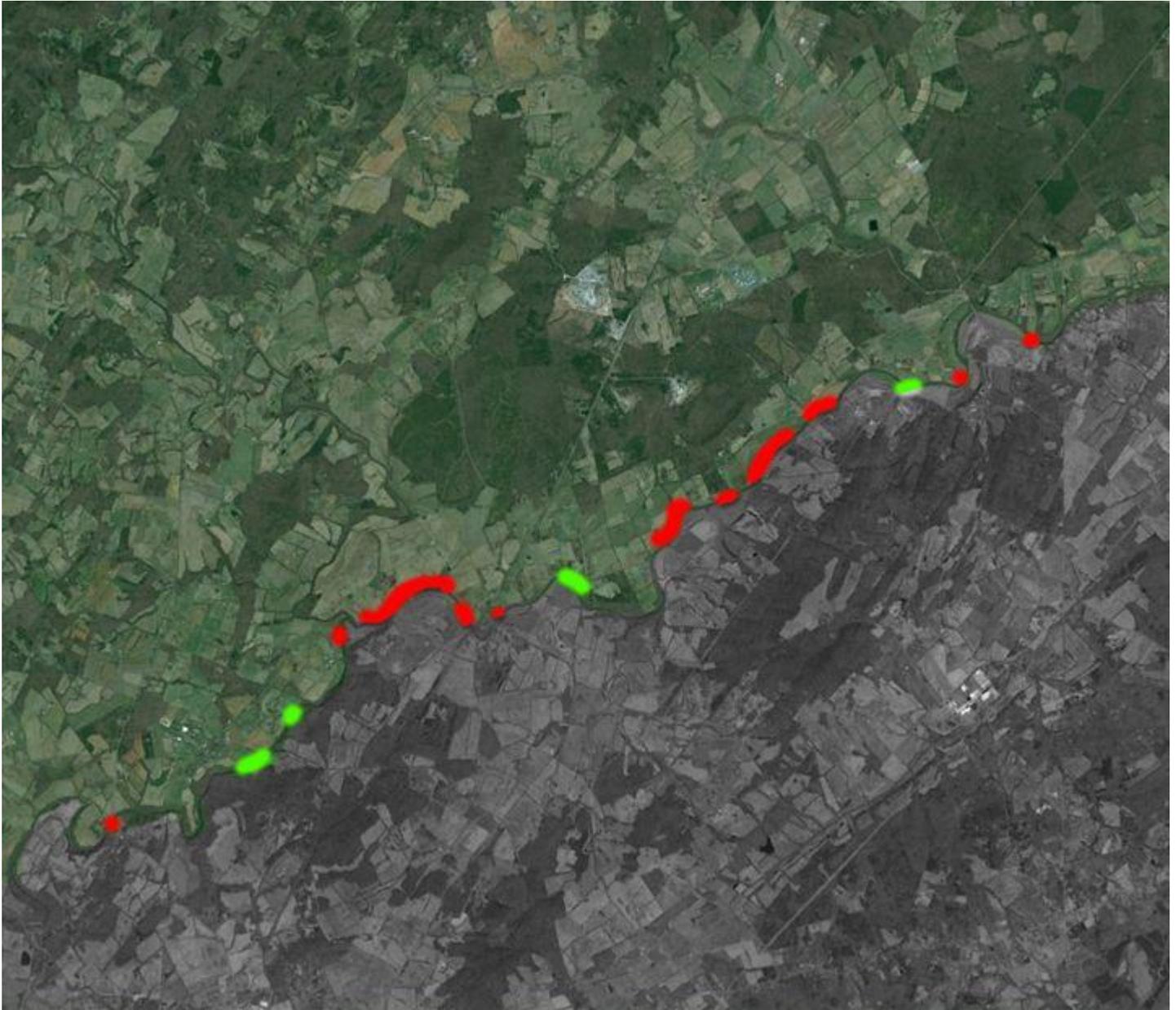
Robinson River total assessment score (river left)



Robinson River total assessment score (river right)

Comparison of Rapidan River 2014 and 2000 Assessment Results

Using a study conducted by the Virginia Institute of Marine Science and the Friends of the Rappahannock in 2000, Sweeper Riparian Analysts were able to estimate change in river health over the course of 14 years. The swaths of river marked in red below are the areas of change where health has declined. The health of areas marked in green have improved. Areas with no color have no change.



Rapidan River 2000-2014 Assessment Comparison – River Left



Rapidan River 2000-2014 Assessment Comparison – River Right

Comparison of Robinson River 2014 and 2000 Assessment Results

Using the same information described above, Sweeper Riparian Analysts were able to estimate the change in river health over the course of 14 years. The swaths of river marked in red below are the areas of change where health has declined. The health of areas marked in green have improved. Areas with no color have no change.



Robinson River 2000-2014 Assessment Comparison – River Left



Robinson River 2000-2014 Assessment Comparison – River Right

Sweeping Results

Removal of trash from the streambed and bank is one of the major services StreamSweepers provide riverside landowners and watershed supporters. This proved to be a monumental effort for 2014 due to the quantity of waste found in the Robinson River.

During the river assessments, StreamSweepers took GPS coordinates of concentrations of tires and other large debris. Landowners were contacted to secure trash removal access and canoe put in/take out points at several locations along the roughly 40 miles of 2014 river stretches.

Every StreamSweeper was responsible for scanning the river bed and bank for trash. Whenever trash was spotted, a team member would secure his boat and pick up the trash and place it in the canoe. Most trash removal required team members to leave their canoes and enter the river. Most times when a tire needed to be dug out of the river bank or bed, a few members of the crew were needed to work together shoveling sediment from around the item in order to free it from the river. Upon arriving at each access point, Sweepers would remove trash from the boats and pile it up on the bank.

Trash Removal Results

Trash removed for the Rapidan and Robinson Rivers for 2014 is shown in the images below.

Waterway Information

| | | | |
|---|---|--------------------------------------|-----------------------|
| <u>Start Location</u> (<u>address, city,</u> <u>state, zip or GPS</u> <u>location</u>) | Rapidan River - Madison Mills, VA, Robinson River - Banco, VA. | | |
| <u>End Location</u> (<u>address, city,</u> <u>state, zip or GPS</u> <u>location</u>) | Rapidan R. - Raccoon Ford, VA, Robinson River - confluence w/ Rapidan River | | |
| <u>Waterway Name</u> | Rapidan River and Robinson River | | |
| <u>Waterway Type</u> | River | <u>Nearest</u> <u>Tributaries</u> | Rappahannock River |

Large & Small Items

| | |
|--|---|
| <u>Plastic/s (Number</u> <u>& Type)</u> | <p>*Rapidan River = tarps - 32 child's slide child's wading pool plastic bottles - 42 frisbee large trash can pvc pipe - 1 pvc pipe joint - 1 plastic chairs - 4 inflatable raft plastic bags - 13 plastic tub pieces - 3 plastic fertilizer drum plastic buckets - 5 child inner tubes - 2 plastic window blind styrofoam cups - 7 plastic pieces - 250 lbs.</p> <p>*Robinson River = black plastic pipe - 10' plastic child's play car - 1 garden hose - 3' bottles - 94 plastic sandbag - 1 plastic ball - 5 plastic netting - approx. 8' plastic rope - 25' plastic bucket lid - 4</p> |
|--|---|

tarps - 10
 250' black plastic sheeting material (probably silage cover)
 plastic bag - 13
 styrofoam cooler w/top
 trash can - 4
 plastic bucket - 8
 plastic child's float - 3
 plastic landscape pot - 9
 plastic feeding trough - 3
 nylon strap - 6'
 pvc pipe - 19'
 plastic chair - 4
 orange plastic mesh fencing - 2'x4'
 piece of fiberglass - 3'x4'
 large plastic cylinder - 1
 misc. plastic pieces - 20
 landscaping tree tubes - 7
 VDOT barrels - 9
 child's plastic tricycle - 1
 CD - 1
 fiberglass - 2'x5'
 styrofoam cups - 3
 black ribbed drainage pipe - 7'
 plastic sand barrel
 fiberglass tube
 fishing reel
 welcome mat
 6' rubber belt
 hairbrush
 borken mesh lawn chair

**Metal/s (Number
 & Type)**

*Rapidan River =
 aluminum cans - 233
 metal milk can
 air conditioner case
 metal fence posts - 3
 oil drums - 3
 grill top - 1
 metal pipe - 40 lbs.
 metal rods - 3
 metal filter - 1
 2' culvert shell piece
 aluminum siding - 3 pieces (7' each), 1'x2'5"
 grill grates - 4
 logging chain - 20'
 metal scrap - 525 lbs.

*Robinson River =
 hub cap - 4
 sm. metal can - 1
 mailbox - 1
 metal wheel rim - 5
 car transmission - 1
 bar - 3'
 wire mesh - 4'x6'
 aluminum bar - 3'
 aluminum cans - 265
 barrel - 2
 sm. metal canister - 1
 can lid - 2
 barbed wire - approx 20'
 wire mesh cylinder - 1
 fence post - 2
 metal cart - 250 lbs.
 window frame

metal screen - 1
sheet metal & assorted metal pieces - 1'x2', 1'x4', 2'x4', 2'x2', 2'x6', 3'x5', 3'x3', 2'x4', 1'x3', 17', 2'x3',
3'x5', 2', 2', 8', 6", 4", 16"
tea kettle - 4.5
1/2 metal canoe paddle
10' metal coil
braided wire - 3', 7', 6', 25'
20' strip metal
locker door
metal siding - 9'
metal - 5lb.
gas grill frame - 2
oven door
chair frame - 2
metal ring 1'x1'
metal grill bottom
1/2 lock box
oven ring
bicycle seat
sm. metal cylinder
dipper
metal hook
deer stand
fish fryer for grill

**Glass/s (Number
& Type)**

*Rapidan River =
glass bottles - 10
glass pieces - 55

*Robinson River =
bottles - 451
pieces - 47

**Rubber/s
(Number & Type)**

*Rapidan River =
tires - 26
inner tubes - 3
garden hose - 47'
black rubber tubing - 105'

*Robinson River =
balloon
rubber belt 6'
inner tubes - 5
tires - 274

**Lumber (Number
& Type)**

treated wood - 38 pieces (6-10' long)

**Cloth & Fabric
(Number & Type)**

*Rapidan River =
shoes - 9
shirt - 2
shorts - 1
towel - 1
cushion - 3
canvas - 1 (large piece)

*Robinson River =
shirts - 5
curtain
pillow
fabric
large piece of foam
cushion
blanket
shoes - 14

| | | |
|---------------------------|--|------------------------|
| | dog toy | |
| | hat | |
| | tablecloth | |
| | 2'x3' rug | |
| <u>Unclassifiable</u> | *Rapidan River = | |
| <u>Items</u> | ceramic drain pipe - 5 | |
| | hammock | |
| | rope - 50' | |
| | brick - 2 | |
| | 3/4 fiberglass canoe | |
| | large cardboard box | |
| | *Robinson River = | |
| | electric wire - approx. 12' | |
| | 4 pieces of a kayak | |
| | front quarter panel of an auto | |
| | refrigerator door | |
| | sofa | |
| | child's ride-on 4-wheeler | |
| | car battery | |
| | microwave | |
| | vacuum | |
| | ceramic shard - 3lb. | |
| | padded toilet seat | |
| | child car seat | |
| | Total | |
| <u>Total Weight (lbs)</u> | Rapidan River = approx. 3,000 lbs. | <u>Or Total Volume</u> |
| | Robinson River = 12,930 lbs. | |
| <u>Additional Notes</u> | Using 2 teams of a total of 12 paid employees (high school & college students), and one on-water-Manager (Beth Seale), the StreamSweepers removed a combined total of almost 16,000 lbs. of trash from the Rapidan and Robinson Rivers. | |
| | Overall the largest amount of debris was by far the number of tires. A total of 300 tires was removed from along 40 miles of these two small rivers, 26 from the Rapidan River and 274 from the Robinson River. The number is staggering, and there were many very large tires that had to be left behind because of their size and weight. There was also a large amount of huge metal objects that had to be left in or along the river because it was beyond what we were able to remove simply using shovels, man-power, and canoes. | |

As significant as the amount of trash removed by the 2014 StreamSweepers was, the teams were unable to remove 100% of the trash in the river valleys. A few dump sites remain where the items are too large to be removed by boat.

2014 Conclusions

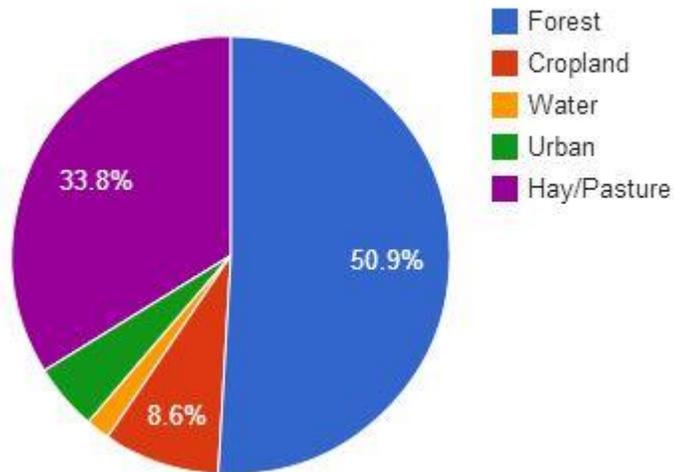
Business Model

- As in 2013, riverside landowners seemed willing to purchase river clean-up services based on two types of value proposition; private property enhancement via improvement of river frontage, and public service via support for job training for young adults and general environmental stewardship. Watershed supporters seemed to be motivated by job corps benefits for young adults and environmental stewardship.
- As in 2013, not all riverside landowners participated financially in the project (some allowed access but declined to provide funds). Other riverside landowners were difficult to contact due to absentee ownership or poor contact information (physical address but no phone number or email).
- Even with a much more robust early spring marketing effort, less than half of the riverside landowners participated financially in the project.
- Due principally to the high cost of riverside landowner outreach and logistics, the cost per year of the program for 2014 for 40 river miles is estimated to be ~\$80,000.00, or ~\$2000.00 per river mile.

River Health Assessment

- Comparing 2014 assessments to the Friends of the Rappahannock/Virginia Institute of Marine Science assessments, the health of the Rapidan and Robinson Rivers has declined in many areas, with only a few areas showing improvement.
- Forest cover is thin along the Rapidan River, with the exception of a large forested area to the east of Rt. 15 on the Orange County side of the river.
- Forest cover is notably absent along the Robinson River in the Hebron Valley and along both sides of the river west of Rt. 15.
- Forest conservation values are high in the same area of the Rapidan across from Woodberry School where there is good forest cover. Forest conservation values are also high in the Oak Park area of the Robinson River.
- Forest cover in the contributing subwatersheds varies, with some having 70% forest cover or higher, while others have significantly less. For the Rappahannock River Basin as a whole, the percent forest cover is roughly 51% (see image below). This is significantly less than the forest cover proportion of a healthy river ecosystem in the mid-atlantic region.

Rappahannock River Basin (InFOREST)



Rappahannock River Basin Land Cover - note the percentage of Forest Cover @ 51%

- Floodplain forest cover is low in both river valleys and particularly so in the Robinson River valley, with only 16%.
- Hay and conventional tillage cropland are the largest contributors of excess nutrients and sediment.

River Sweeping

- A tremendous amount of trash, and in particular tires, was removed from the Rapidan and Robinson rivers. Tires obviously last decades if not centuries in fresh water. Tires contain lead, chromium, copper, nickel, cadmium, zinc, styrene butadiene, and other organic compounds. There is evidence that these compounds are leached and have negative effects on fish, or not inert. Inorganic materials and organic additives can leach from tires into aqueous environments (Sullivan, 2006, Vukanti, 2009). Some of these leached compounds are water soluble and toxic to fish (Wik, 2007).
- Several dump sites remain on both rivers that require overland removal. Some of these contain old rusting oil type drums.

2014 Recommendations

- Trash at the remaining dump sites (see images below), requiring overland removal, needs to be completed. Plans for private cleanup, in cooperation with riverside landowners, are now being developed.

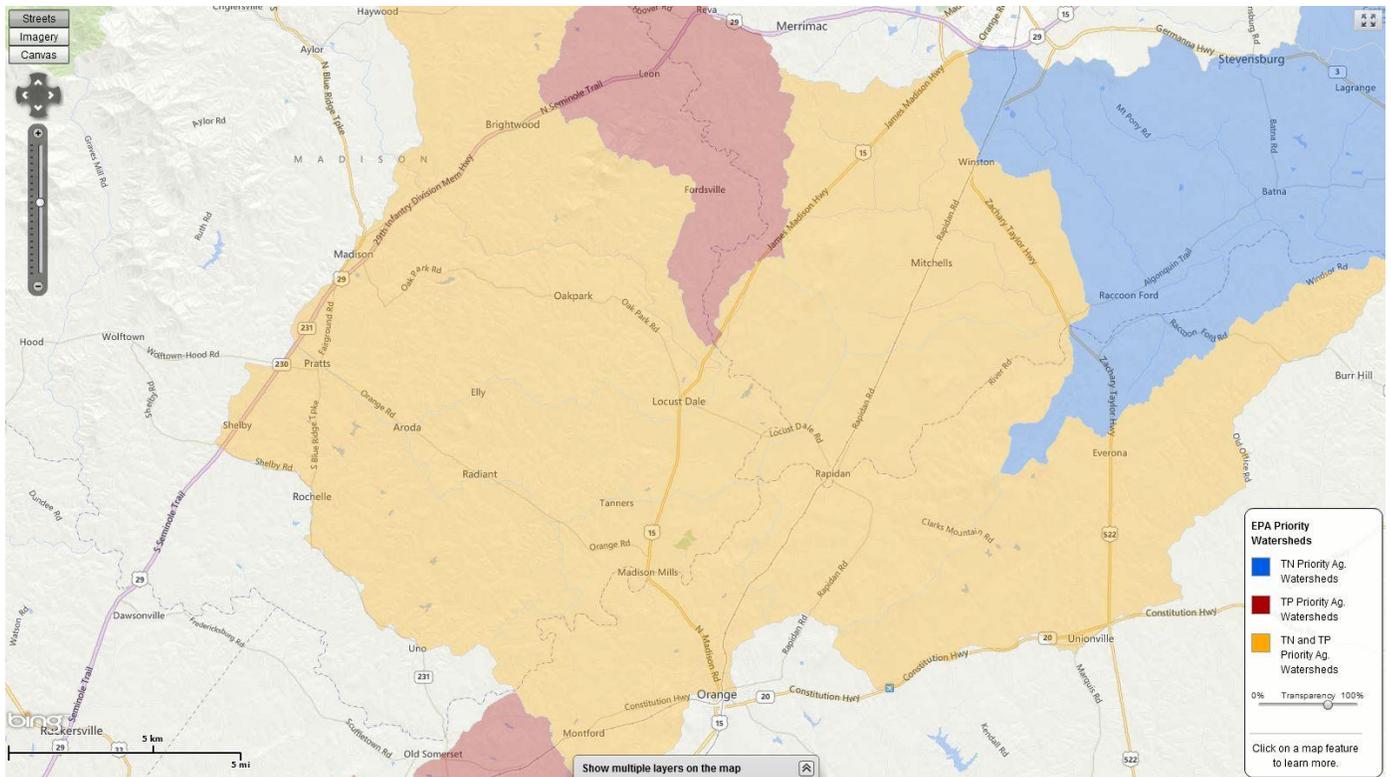


Trash Sites Remaining in the Rapidan River Valley unable to be removed with canoes



Trash Sites remaining in the Robinson River Valley unable to be removed with canoes

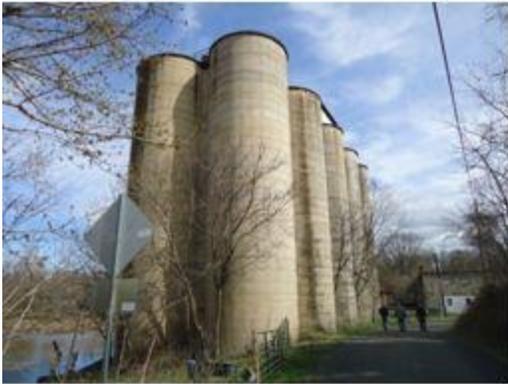
- To increase the % of riverside landowner financial support, a more focused enrollment of landowners should be considered, perhaps only undertaking a few river miles at a time, where high concentrations of supportive landowners are found. In other words, rather than the (2) 20 mile sections completed in 2014, perhaps StreamSweepers take on (10) 4 mile stretches for 2015, with each stretch having a significantly higher proportion of riverside landowner financial support.
- Communication with the Virginia Department of Conservation and Recreation (DCR) and the Virginia Department of Transportation (VDOT) should be considered, in the contexts of state park river maintenance and removal of rusting former road culverts, respectively.
- Incentive programs to pay riverside landowners to grow trees or some type of agroforestry in the Rapidan and Robinson River floodplains need to be created. As shown in the image below, nearly all of the portions of the Rapidan and Robinson Rivers completed by StreamSweepers in 2014 are a priority for the Chesapeake Bay program. This is not surprising, considering StreamSweepers own data showing a decline from 2000 to 2014 in areas of both rivers.



EPA Chesapeake Bay Cleanup Priorities in the Western Piedmont of Virginia

• One way to help create markets to pay landowners for ecosystem friendly land cover, is through the use of bioenergy. Hundreds of boilers, fueled with heating oil, are currently used by schools, hospitals, and local government complexes in this region. Conversion of a few of these to woody and/or native perennial grass bioenergy technologies (as shown below) could help drive demand for ecosystem friendly land cover in local watersheds. Use of existing grain infrastructure for storage and processing, would help increase the potential for job creation.

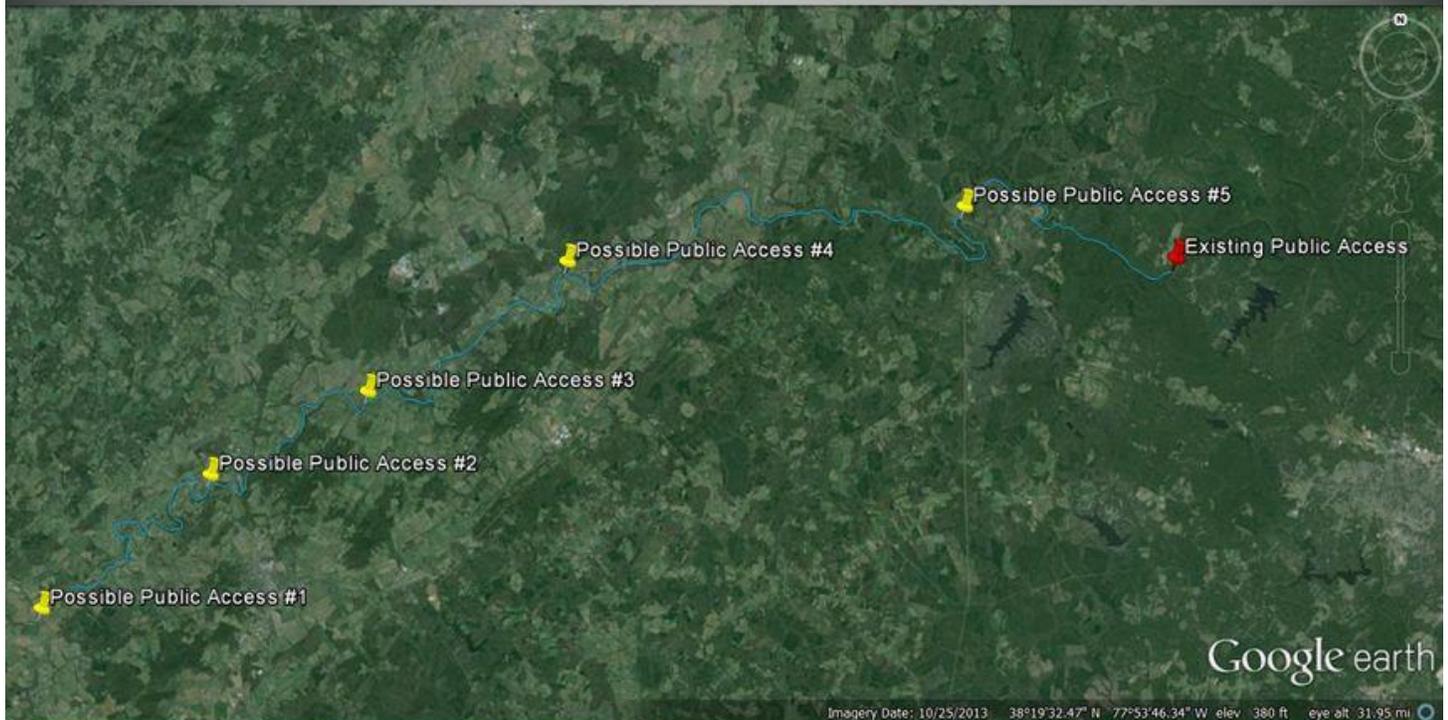
Use Energy to Improve River Health



Boilers for the Bay

- Increasing use of the Rapidan and Robinson Rivers for ecosystem friendly forms of economic development could help bring greater collective energies to the goal of enhancement of river valley health. A way to do this could be a **landowner led** “Blueway” pilot project with the following elements:
 - o Identify a stretch of the Rapidan or Robinson Rivers with riverside landowners supportive of greater use of the river (see image below showing possible access sites on Rapidan and Robinson Rivers).

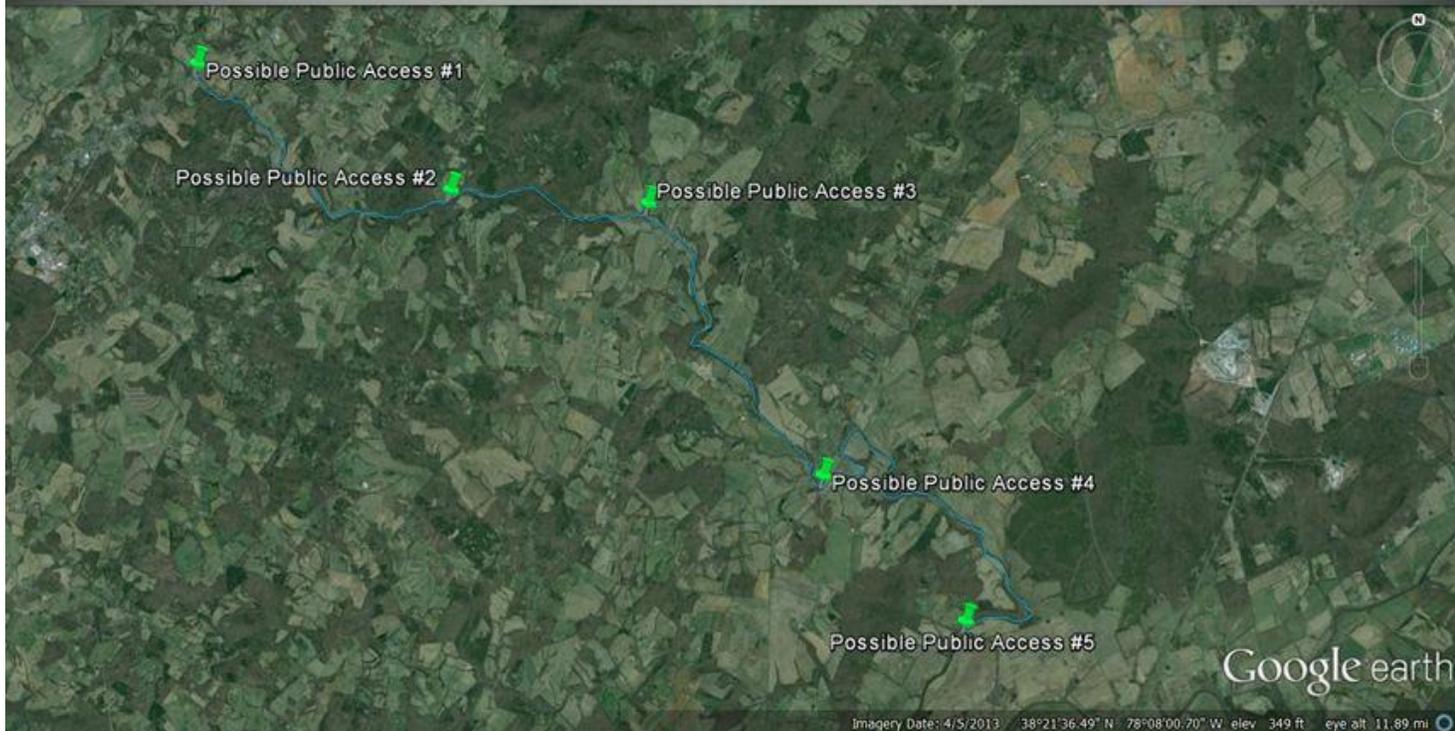
Possible Public Access Points on the Rapidan River



1. Liberty Mills Bridge
2. Madison Mills Bridge
3. Rapidan Bridge
4. Route 522 Bridge
5. Route 3 Bridge @ Germanna Foundation
6. Existing Public Access @ Ely's Ford

Rapidan River Possible Access Points

Possible Public Access Points on the Robinson River

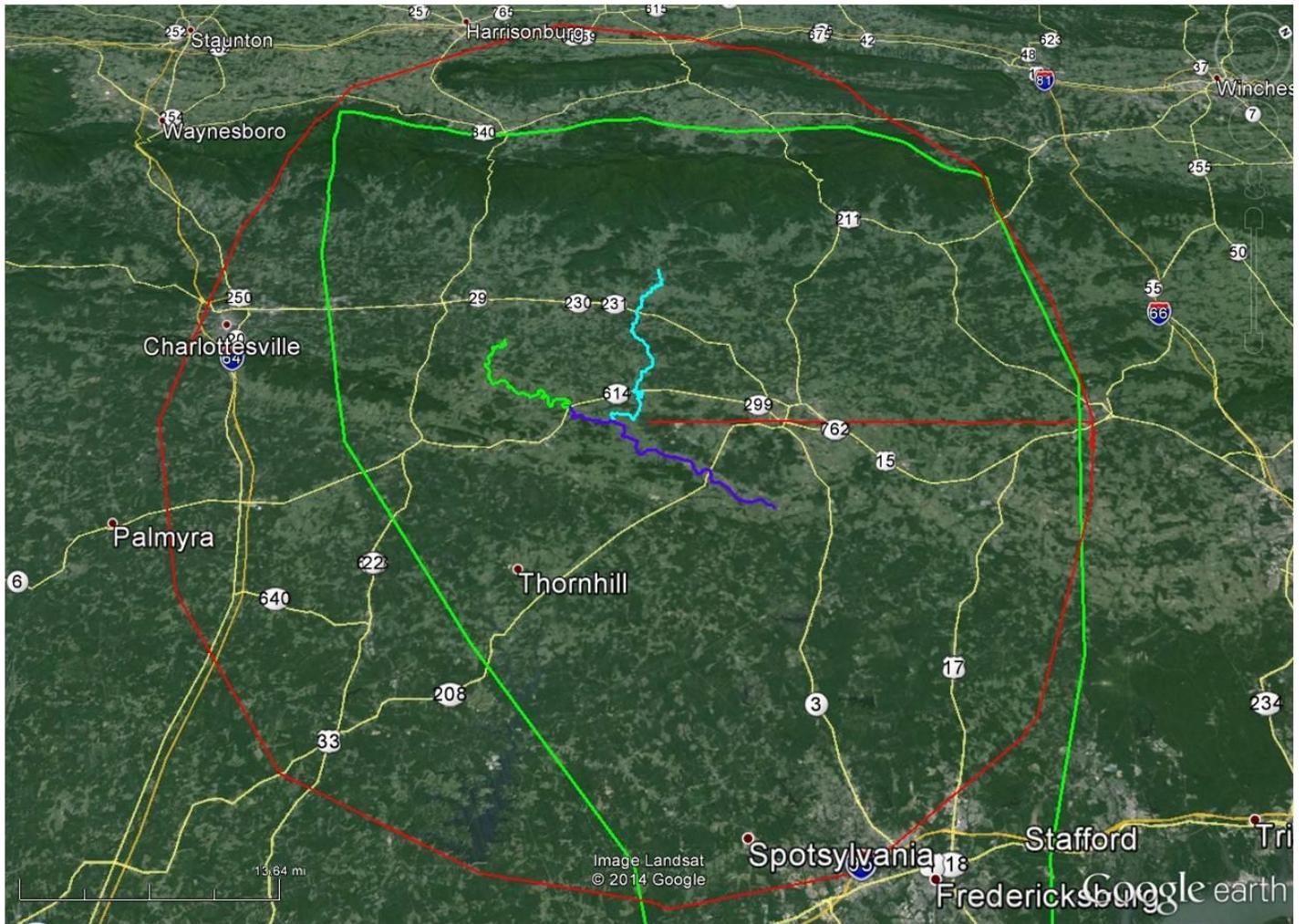


1. Route 29 Bridge
2. Lillard's Ford Road Bridge
3. Beahm Town Rd. & Ford's Shop Rd. Bridge
4. Route 15 Bridge
5. Locust Dale Rd. Bridge

Robinson River Public Access Points

- o Create a riverside landowner led business plan to maintain a “put in” and “take out” as well as monitoring for appropriate use of the stretch for a summer season.
- o Shop the plan to public and private entities with an interest in river health.
- o Implement one year pilot project.

The economic potential of a Blueways project, assuming 30 miles of travel time, might be significant considering the population centers found around these rivers (see image below).



30 mile Blueways capture market extending south to Charlottesville, north to Warrenton west to Harrisonburg, and east to I-95