Rapidan StreamSweepers 2013

Orange County Line to Madison Mills

Report to Landowners
and
Friends of Rapidan StreamSweepers

By
The Center for Natural Capital

October, 2013

About this Report

This report has been prepared by Center for Natural Capital staff and consultants especially for Rapidan StreamSweeper 2013 river landowners and Friends.

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Background & Acknowledgements

In the winter of 2012, a small group of Orange residents got together to discuss garbage they had seen while fishing in the rivers and streams of the Rapidan watershed. A concept was hatched to create a river cleaning service that would be paid for by landowners with water frontage and others that understand their connection with the area's rivers and streams.

The concept expanded to encompass the need for meaningful young adult career training and summer jobs. A vision began to emerge that our community could hire and train a small group to screen the health of a river stretch of 10 miles or more and using canoes and jonboats remove most of the garbage through private property using access points identified during the screening exercise. Rapidan StreamSweepers was born.

In an effort to provide some of the funding necessary to get the effort off the ground, a proposal was submitted to the Environmental Protection Agency – Chesapeake Bay Trust – and was denied due to the staff's perspective that there would be no way that the proposed concept could work. Steadfast in belief for the concept, the Center for Natural Capital, a charitable corporation begun in 2006, focused on the use of economic development to solve modern environmental conservation challenges, agreed to proceed with implementation of the pilot project with nothing more than the vision that a business model could be created to adequately fund the effort.

By spring, the concept of a team of yearly paid StreamSweepers doing good works throughout the Rapidan watershed had taken on a life of its own. David Perdue, Teddy Grennan, Buzz VanSantvoord, Phil Audibert, and Beth Seale began doing some serious strategizing – developing a simple business plan, budget, and timeline. Others soon joined in the effort – Orange and Madison County, Virginia residents John Jeanes, John Wright, Andy Hutchison, Peter Rice, Ed Stelter, Julie Connelly, American Canoe Association, Virginia Outdoor Center, and Shack Shackelford – all in various ways contributing time and talents. From there the vision mushroomed.

For the summer 2013 solstice, an "Argentinian Asado" was held in Somerset, Virginia with all walks of life enjoying music, good food, information, a few laughs, and fellowship. Thanks to Reese Altman, Phil Audibert and Alex Caton, Peter LaBau. Many were very, very generous that evening and thereafter. Word got out through Orange and Madison County High School (OCHS) staff, especially with the help of Dwight Paschall, Becky Gore, and John Wright. From a pool of candidates, four young men were chosen as Sweepers. JMU rising junior, Spencer Jarrell signed up first, followed by local high school upper classmen, Franklin Marrs, Jordan Lee and Griffin Rice. Beth Seale of the Rapidan River Kayak Company was hired as the on-water risk manager. The 17-mile stretch of river from roughly the Greene County line to Rt. 15 was selected based on interest from river frontage landowners. With donation of canoes and trailer from Bill Micks with the Virginia Outdoor Center, and the generosity of river farmers providing emergency and garbage removal access, the project morphed from a dream to a real project. Doug Duncan and Eugene Williams secured the OCHS library for training, and librarian Faith Olen Mills and central office staff member Don Stafford helped get the computers ready. Mason Insurance Agent Bryan Hargett spent countless hours helping us navigate insurance issues at the 11th hour and by Friday, August 26th, the project was ready for launch.

The Sweepers were trained to read a river through understanding the eco-history of the watershed from the Jurassic to the Present, through its macroinvertebrates (mayflies, stoneflies, etc.), through the physics of its bends, through its canopy, geometry of its banks, and structure of its beds. Local physician Randy Merrick trained them about common sense first aid and provided what proved to be essential Betadine solution and other supplies. Ed Furlow and Eric Filep provided forest quality training. John Hermsmeier provided decades of experience and wisdom about in-stream biology. Beth Seale trained the Sweepers in everything about paddling piedmont rivers. They made maps of the river stretch using the latest computer software and information from online GIS, Google Earth, Department of Forestry, and Virginia Natural Heritage. By the end of day Friday, July 26 they were trained and ready for the field.

With the Tinder family, Diana Dodge, the Perdue Family, the Seales, and the Merricks providing access for put in and take out, the Sweepers set about to diagnose the condition of the stretch, identifying major garbage along the way for the following week's sweeping. Using dual Garmin GPS units, the team conducted rapid assessments of the Madison and Orange sides of the river, using a simple rating system for river bed, bank, riparian forest, and canopy. By Friday, August 2 they knew where the trash was and had a plan for how they were going to get it out.

The sweeping yielded more garbage than anyone thought possible. Several dozen car, truck, and tractor tires, an oil drum, plastic urinal, plastic pots, landscape cloth, old rafts, beer cans and bottles, multiple cars and large culverts were included in items found. Large items were extracted with shovels and digging bar. Some (the rusting culverts above the town of Orange intake) were simply too big to get out without winches. The Sweepers were lucky that week - there was the occasional slip down a bank and near miss with a copperhead, but everyone made it through the week safely. It took a day to dispose of all the booty. Local tire retailers Tucker Altman, Grant McDaniel, and the Orange County Landfill helped with disposal. The adventure ended as quickly as it began with a couple of days of report preparation and team debriefing.

The StreamSweepers 2013 Steering Committee acknowledges the following Friends of Rapidan StreamSweepers for their belief in this eco-entrepreneurial dream.

Bald Eagle
Anonymous
Teddy Grennan
Randy Hudgins
Mark and Ann Kington
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American Shad
Stephen Brooks

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Betsy Brantley
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Andy Hutchison
Schatzie McClean
Randy Merrick
Mike Miller
Jeff and Sarah Poole
Peter Rice
Monique and Russell Riley
Page Sullenberger
Frank and Bernice Walker
Vlad Wojcik

StreamSweeper Business Model

StreamSweepers was conceived as a blended fee for service and philanthropic enterprise. StreamSweepers sells identification and removal of river trash and assessment of river health. Landowners buy this service along with concerned residents of the river watershed, or "Friends of Rapidan StreamSweepers". Participating landowners and Friends receive a generic report of Sweeper findings. Additional landowner specific assessment and recommended restoration information is also available as an additional cost determined on a case by case basis.

Project Deliverables 2013

- Concentrations of Interested Landowners Identification
- River Segment Selection
- 2013 Budget Preparation
- Financial and Administrative Resource Procurement
- Watershed Fundraiser
- Sweeper Hiring
- Training Curriculum Development
- Sweeper Training
- Eco-Screening Protocol Development
- Trash Removal Protocol Development
- Eco-Screening Completion
- Trash Removal Completion
- Report Preparation
- Presentation of Findings

Landowner Identification and River Segment Selection

Project team members discussed river cleaning with Rapidan and Robinson River landowners. A concentration of interested landowners on a 17 mile stretch of the Rapidan River roughly from the Greene County line to Rt. 15 emerged. Tax parcel maps of landowners with river frontage were created. Members of the Steering Committee attempted to personally contact each landowner.

2013 Plan and Budget Preparation

A project implementation plan and budget was prepared for 2013. The budget contained the following line items:

- Fundraising expenses
- River risk manager
- Project manager
- Logistics manager
- 4 Sweeper staff
- Transportation
- First Aid
- Liability insurance
- Workers Comp.
- GPS unit(s)
- Trash removal fees

It was estimated that $15,000 + substantial in-kind resources from the Center and Project Team Members would be needed to meet all project costs.

Financial and Administrative Resource Procurement

Prior to completion of this report, $13,000 had been raised for the project. Liability insurance was purchased through the American Canoe Association. Workers Comp. was purchased through Mason Insurance. Classroom space for training was provided free of charge by Orange County Public Schools. A project operations center was provided free of charge by Rapidan River Kayak Company. Boats were provided free of charge by the Virginia Outdoor Center.

Description of Watershed

The majority of the headwaters of the segment is found in Greene and Madison Counties. This area is comprised of five subwatersheds (Figure 1); Rapidan River Garth Run,

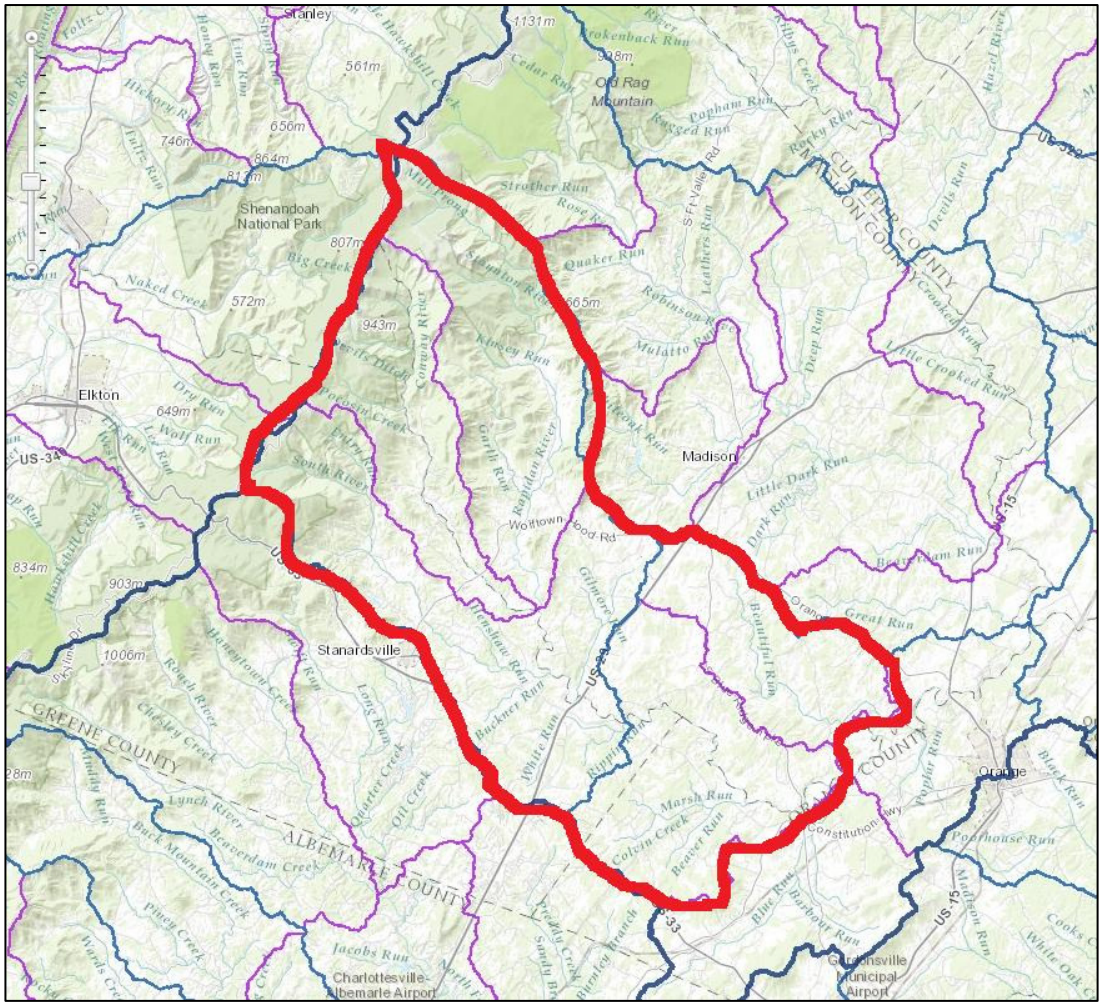


Figure 1 – Rapidan Segment Headwaters

Rapidan River Marsh Run, Conway River, Beautiful Run, and Rapidan River South River. Note that the Robinson River watershed drains below this segment and thus is not a contributing sub-watershed.

Watershed Landcover

The current landcover for each subwatershed is shown below (Figures 2, 3, 4, 5, and 6) (www.inforest.com). The Conway River watershed has the largest proportion of forest cover. Rapidan River Beautiful Run has the largest proportion of Grazed Pasture with applied manure or fertilizer. Rapidan River Marsh Run has the most tillage. Rapidan River South River has the largest proportion of urban pervious land cover.

Table 1 shows the total acreages for the major land cover classifications. 63% of the area is forest, with 10% hay, 15% improved pasture, and 5% unimproved pasture.

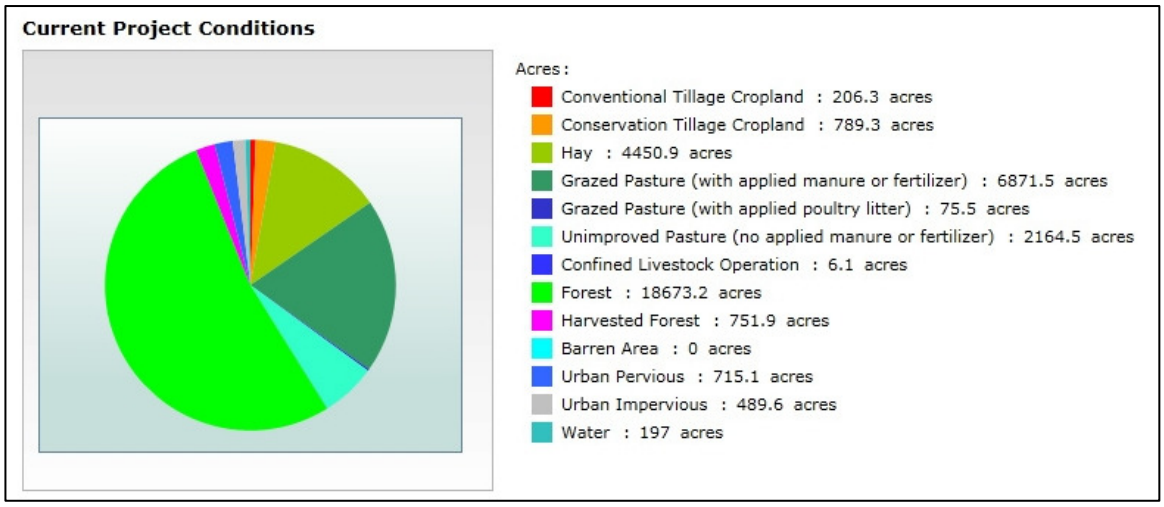


Figure 2 – Rapidan River South River

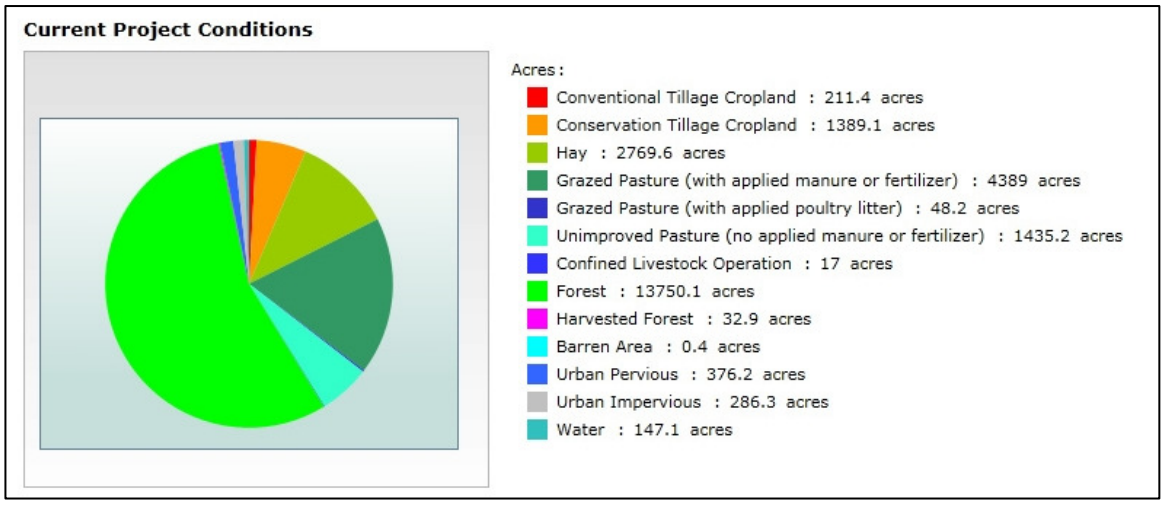


Figure 3 – Rapidan River Marsh Run

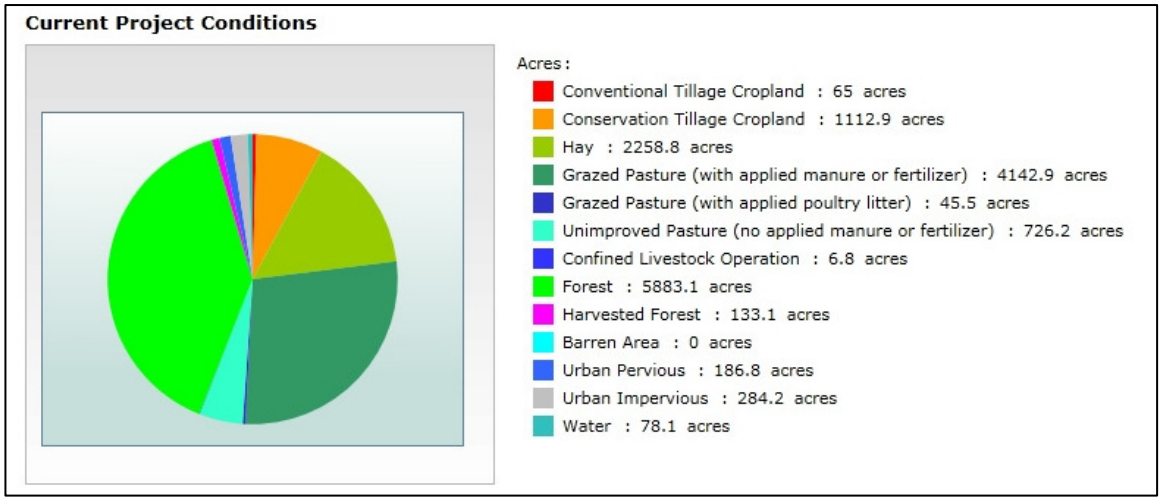


Figure 4 – Rapidan River Beautiful Run

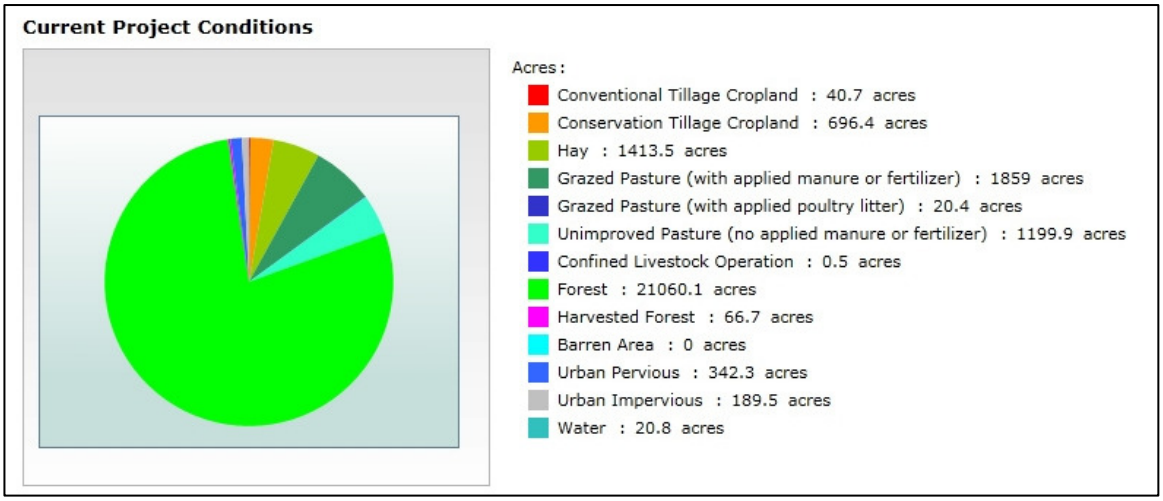


Figure 5 – Rapidan River Garth Run

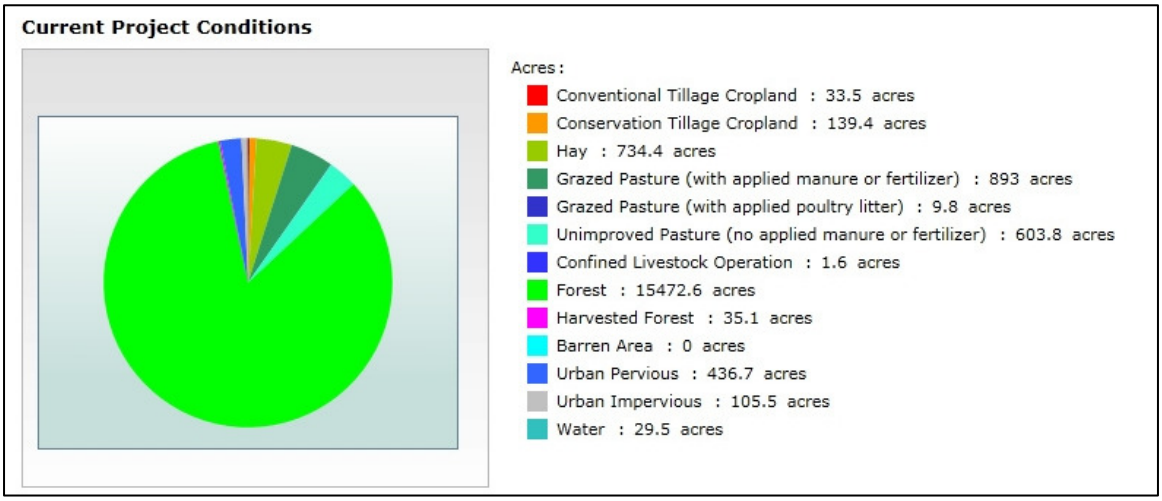


Figure 6 – Conway River

Land Cover	Acres	%
Total	120569	100
Forest	75860	63
Tillage	4684	4
Hay	11627	10
Improved Pasture	18356	15
Unimproved Pasture	6128	5
Urban	2769	2
Other	1145	1

Table 1 – Headwaters Land Cover

River Forest Conservation Value

The Virginia Department of Forestry has established a relative Forest Conservation Value (FCV) for all forestland in the state. This value is based on the level of benefits provided by a particular area of forest in combination with the level of threat the area faces from conservation to another land use, primarily development. Figure 7 shows four portions of the segment (circled in red) with high forest value; Stegara Road area on both sides of the river, Ridge Road intersection with Scuffletown Road on both sides of the river, an area slightly downstream of this on the Madison side of the river, and an area just east of Rt. 231 on both sides of the river.

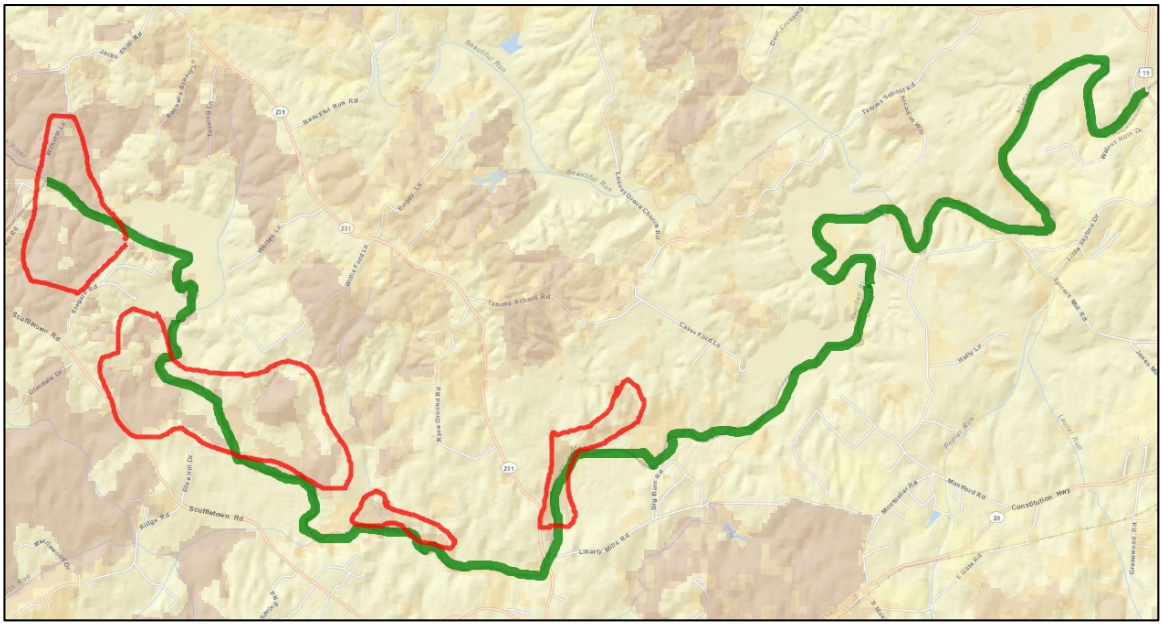


Figure 7 – River Segment Forest Conservation Value

River Land Cover - Forest

Figure 8 shows land cover along the river segment. Portions circled in red have significant forest cover along one or both sides of the river.

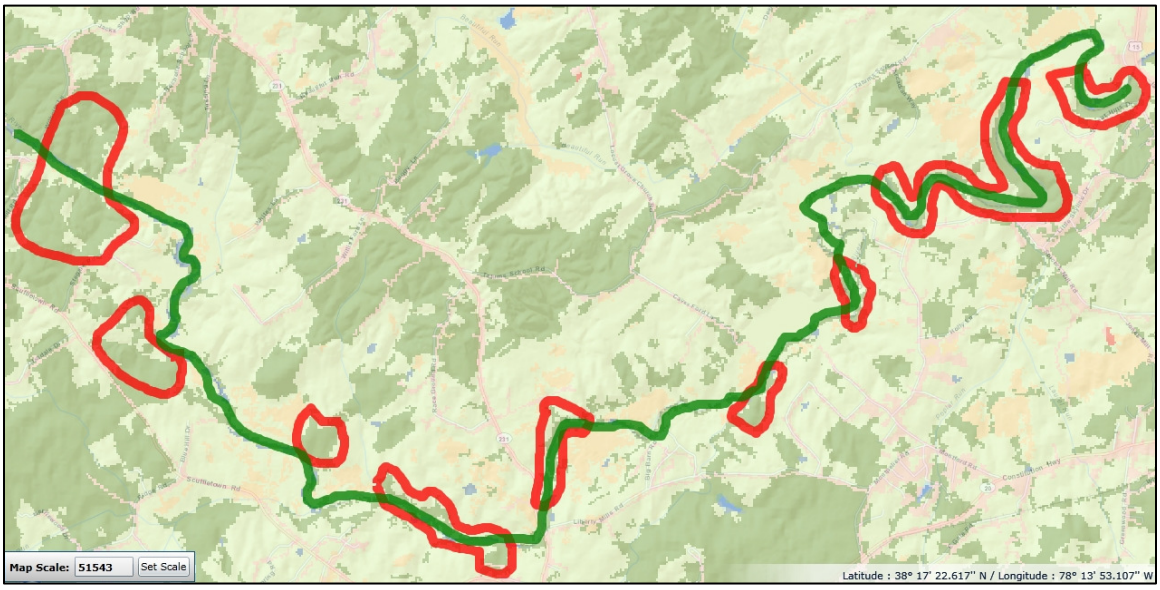


Figure 8 – Areas along the river segment with significant forest cover

River Land Cover – Pasture and Cultivated Land

Figure 9 shows areas circled in red with extensive cultivation up to the river bank.

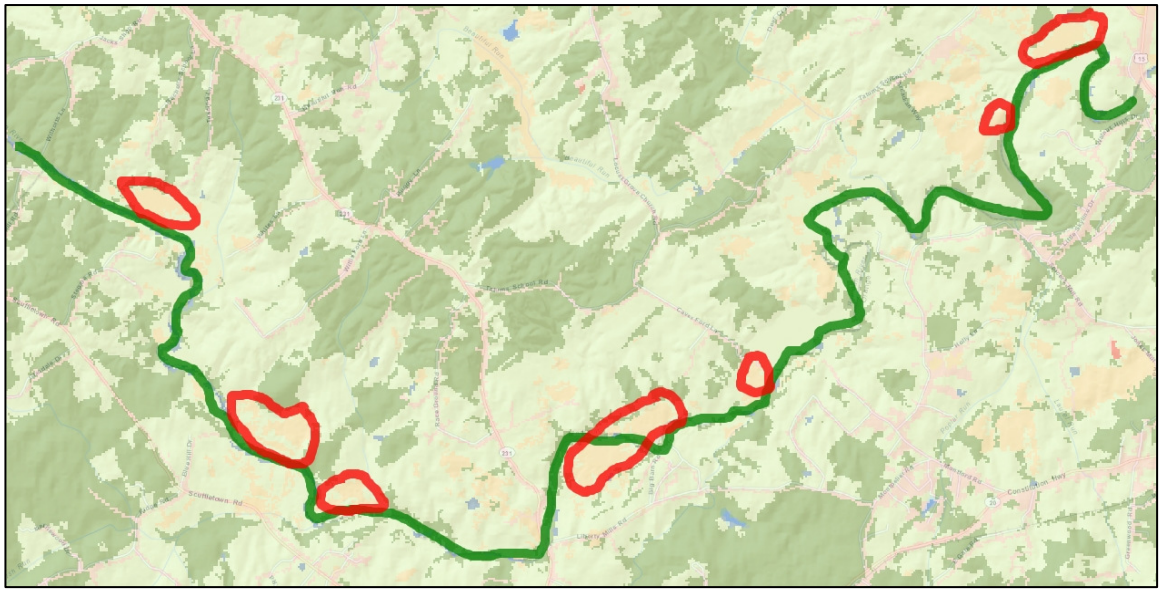


Figure 9 – Areas along the river with significant cultivation

Figures 10-16 show the appearance of river bank in areas with difference degrees of forest and cultivated land cover. Note that soil loss occurs to some degree on any river bank surface, and much sediment in the river is from land use activity that occurred decades and centuries ago.

Figure 10 – Deep forest cover both sides river

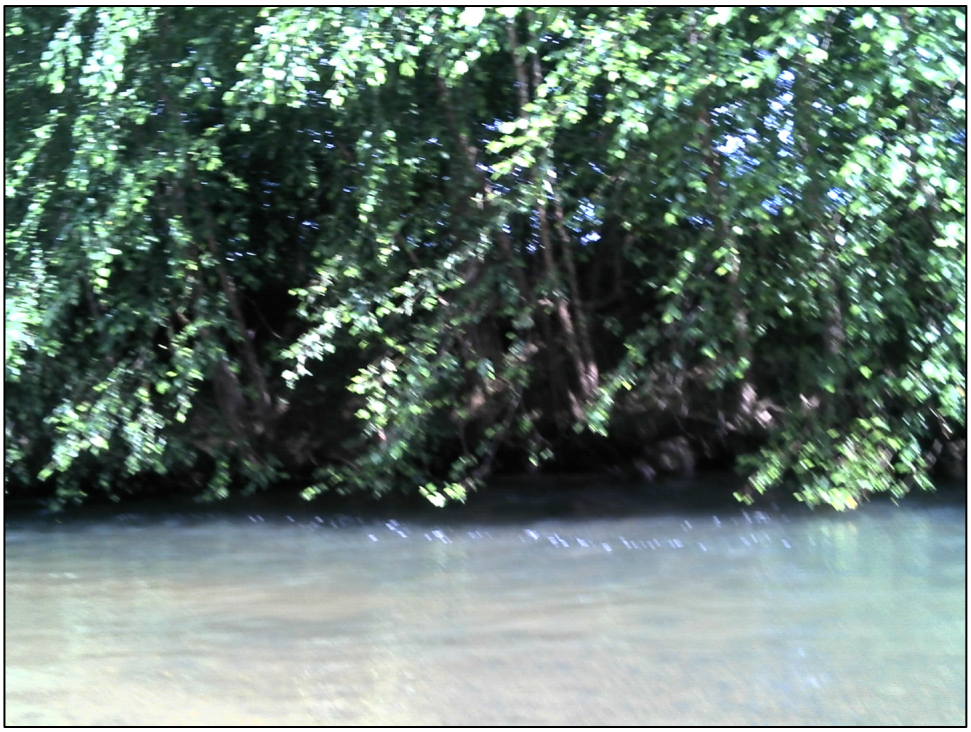


Figure 11 – Native river birch on bank

Figure 12 – Transition from forest to cultivated

Figure 13 – Birch roots holding bank

Figure 14 – Bamboo on bank

Figure 15 – Cultivated cover on bank

River Easements

Figure 10 shows the location of permanently conserved lands along the river.

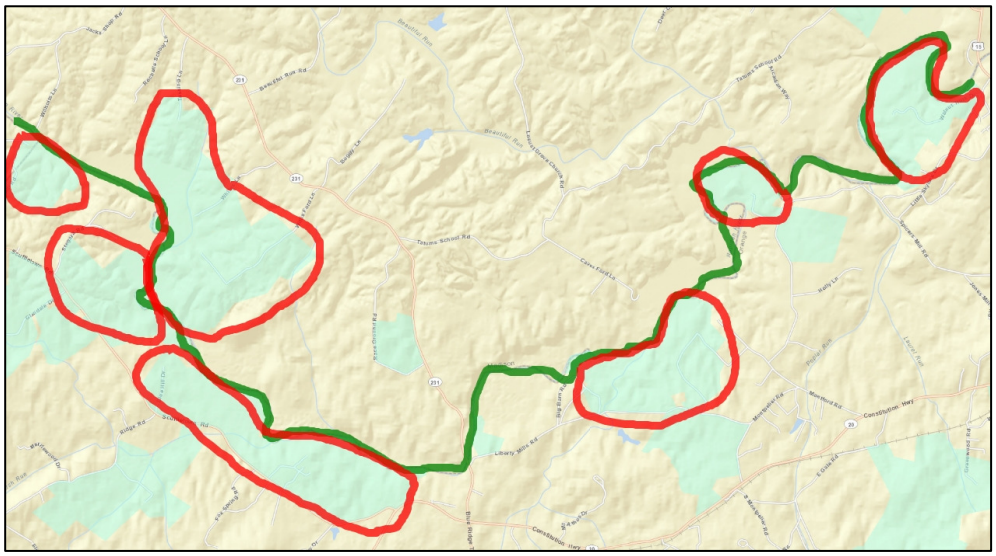


Figure 16 – Eased Lands along the River

Sweeper Training

Four young adults were hired as Sweepers for the summer of 2013. As employees of the Center for Natural Capital they were trained and tested to have the following skill sets:

- Eco-history of Central Virginia
- Geographic Information Systems Mapping and Analysis
- Health Screening Methodology
    - Stream Bed Screening Methodology
    - Stream Bank Vegetation Screening Methodology
    - Stream Bank Geometry Screening Methodology
    - Stream Canopy Screening Methodology
- Health Diagnostic Methodology
    - Macroinvertebrate Sampling
    - Width-Depth Ratio Sampling
    - Bank Forest Cover Sampling
    - Morphology Assessment
- First Aid
- Risk Reduction
- Canoe Skills
- Logistics Planning
- Business Development
- Report Writing

Figures 17, 18, 19 – Boating, macroinvertebrate, and forestry skills

River Health Screening Method

Sweepers conducted a "screening" of the 17 mile river stretch. Two 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 the handheld Garmin GPS (Figure 14). The purposes of the screening included the following objectives:

- GPS identification of emergency and trash removal access points
- GPS identification of trash clusters
- GPS-based river health screening

Figure 20 – Sweepers working as a team to screen River Health

The river health screening focused on four main categories: canopy cover, bank geometry, bank vegetation, and bed composition. Scoring the canopy cover follows a fairly simple protocol. Sweepers studied and estimated how much of the surface of the river was shaded by the overhead tree cover. If there are no trees in an area, then that area receives the lowest score of zero. If there are a few trees in the area providing partial shade to the water, the area receives a moderate score of one. If the area has many trees providing full shade to the water, the area receives a high score of two. Canopy cover is important because trees are necessary to shade the surface of the river, and shade helps keep the water temperature cool to make that area a more suitable environment for the many species of organisms that live in the river.

The second category, bank geometry, follows the same grading scale. If the bank in any given area is steep, close to vertical, with signs of erosion or head cutting, the area receives a low score of zero. If the banks form between a 90 and 45 degree angle, where there is a possibility of erosion, the area receives a moderate score of one. If the angle formed by the bank is 45 degrees or less, with no erosion or head cutting, the area receives a high score of two. This scoring is based on the possibility or occurrence of erosion. When banks fail and large slices of earth fall into the river, sediment is deposited on the bottom and over time a bottom that was entirely rock can turn to entirely sand. This causes the loss of many organisms that live on the bottom among the rocks, and also the loss of valuable topsoil that is rich in minerals and nutrients.

Bank vegetation refers to the area 100' from the edge of the water. If there is no buffer zone, such as places where the land is being used for agriculture right up to the edge of the bank, the area receives a low score of zero. If there is a buffer zone, but the vegetation ends close to the river, or if it is thin or partially cleared, the area receives a moderate score of one. If there is a thick, 100 foot wide buffer zone that consists of woody growth, the area receives a high score of two. A woody buffer zone provides trees to hold the earth together on the banks with their roots. If the bank vegetation is removed, a long-term chain reaction occurs, leading to reduced function of the river ecosystem.

The final category, bed composition, is also a simple factor to grade. If the bed is all or mostly sand, with no rock or wood, the area receives a low score of zero. If the bed is an even mixture of sand and rocks, with a small amount of wood, the area receives a moderate score of one. If the bed is mostly rock, with a decent amount of wood, the area receives a high score of two. The reason for this scoring is that a woody and rocky bed provides the best habitat for the organisms that live in the river. Fish and mammals live on these organisms.

The four categories mentioned above are all added together for each side of the river to create an overall score for each area. Each time the river bank changes with respect to one of these variables, a new score is recorded with coordinates using the GPS unit. The scores go from zero to eight, with eight being the highest possible score. Over several days, Sweepers rated the river bank on both sides of the river from the beginning to the end of the 17 mile stretch. Two representative cross-sections were chosen to represent the highest and lowest scores, and these areas were revisited by the Stream Sweepers to do more in-depth evaluations or diagnostics.

Screening Results

The river screening was carried out in three different sections, on three different days. Section 1 is from Stegara Road to Rt. 231. Section 2 is from Rt. 231 to Spicewood Road. Section 3 is from Spicewood Road to Rt. 15. Two teams, one examining the Madison side and the other the Orange side, rated the conditions of the river, marking distinct areas and scoring them from 0 to 2 for each of the four categories described above. Ratings are shown on the maps below using colored pushpins, with red having an overall score of 0 to

3, light green 4 and 5, and dark green 6 to 8. Section 1, Madison results are shown in Figure 15.

Figure 21 – Section 1 Madison Side

Note that much of this section is rated as low or moderate, with the exception of an area about 1/3 of the way down. The Orange side of this same section is shown below.

Figure 22 – Section 1 Orange Side

Note that with the exception of the area around 231 rated as high, most of this section is also rated as low or moderate. Section 2 Madison results are shown in Figure 17 below. Note that with the exception of an area ¼ of the way down the stretch, most of this area is rated low.

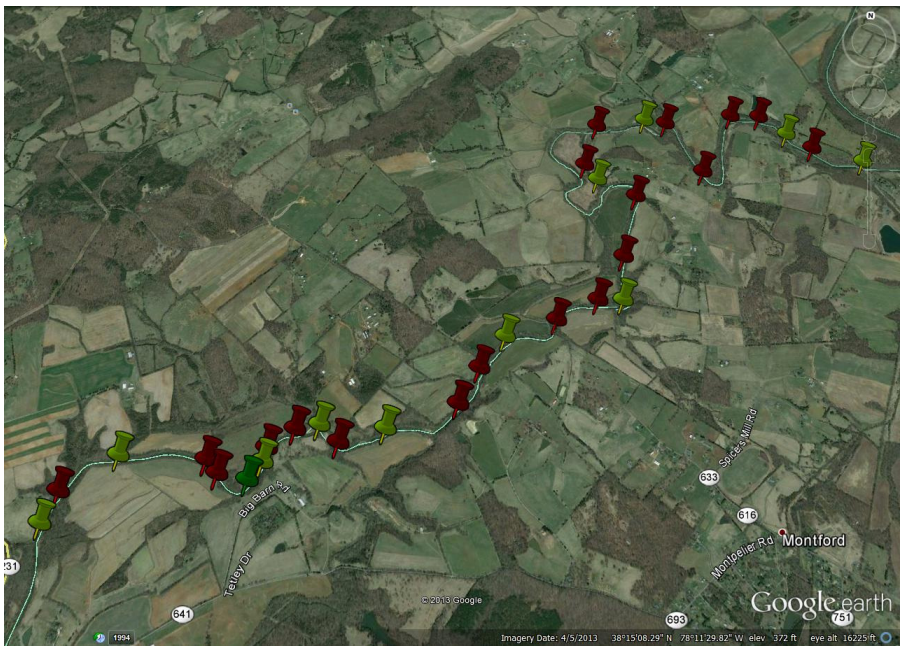


Figure 23 – Section 2 Madison Side

Section 2, Orange side of the river screening results, are shown in Figure 18 below. With the exception of the three areas rated moderate, each a third of the way down the river, all of this section is rated as low.

Figure 24 – Section 2 Orange Side

Section 3, Madison results are shown below in Figure 19. Note the moderate and high results at the beginning of the stretch and the lower results toward the end.

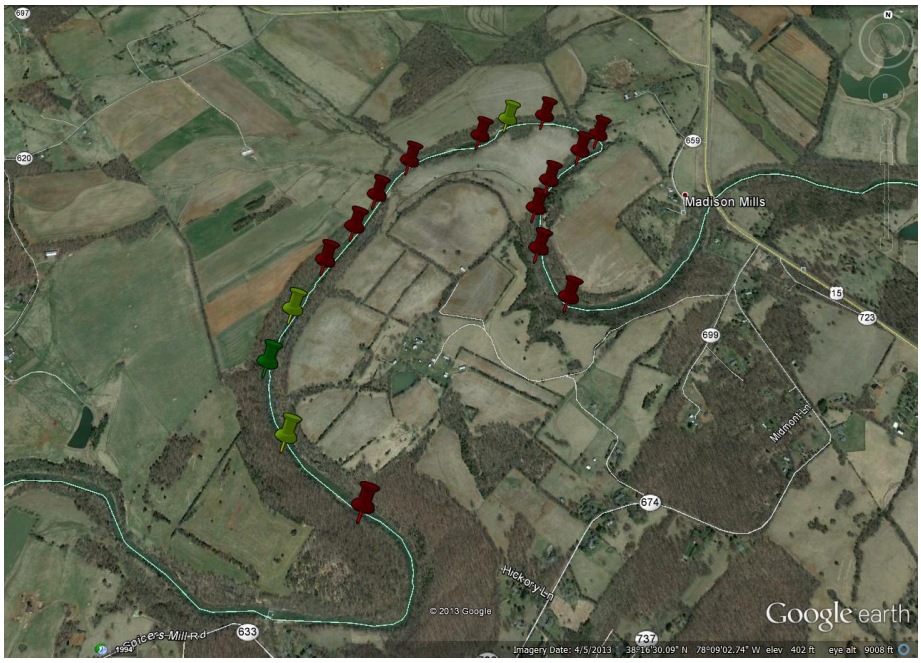


Figure 25 – Section 3 Madison Side

Finally, the Section 3, Orange side is shown below in Figure 20. Note the moderate to high quality of the beginning and end of this section of river.

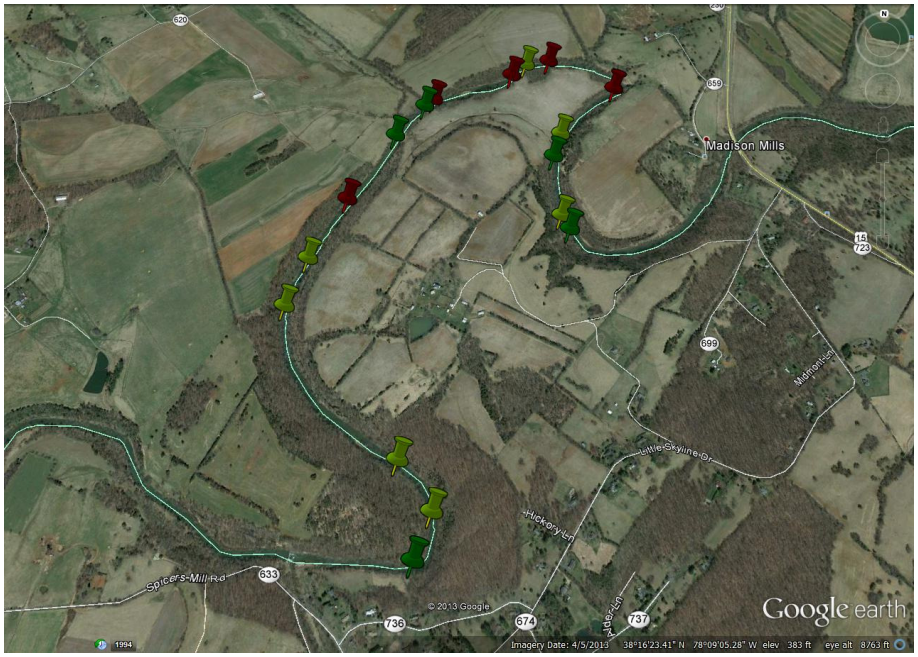


Figure 26 – Section 3 Orange Side

Diagnostic Method

The screening is a rapid, qualitative assessment of river condition based on a USDA Stream Assessment Protocol (Figure 21).

For quantitative evaluation, the Team also conducted river diagnostics. A diagnostic measures river health on representative cross sections (from one side to the other) selected. Three cross sections were identified that would provide information on moderate and high assessment areas. Due to time constraints, no diagnostic was conducted on a low assessment area. The diagnostic consists of the following factors:

- Bank height and river width
- Floodplain forest quality
- Bed and bank condition
- Channel condition
- Macroinvertebrate condition

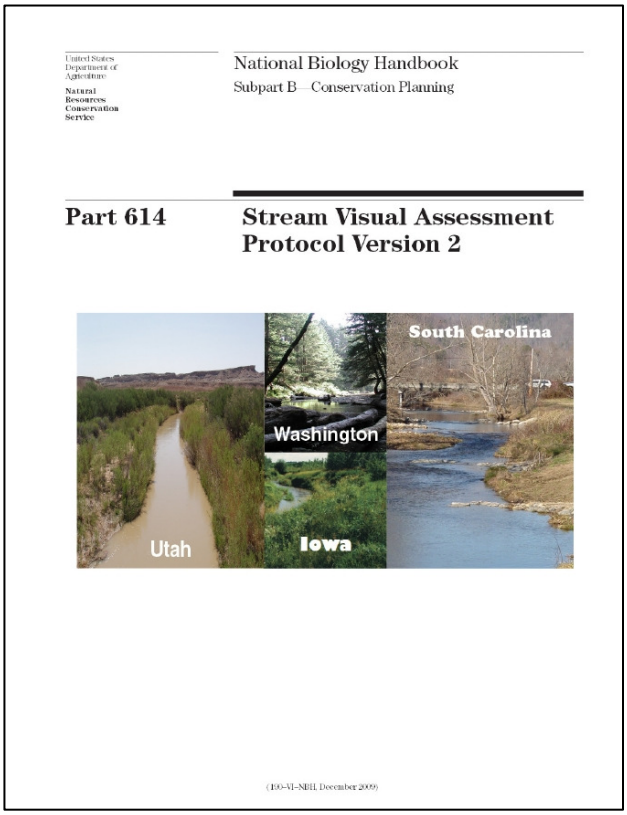
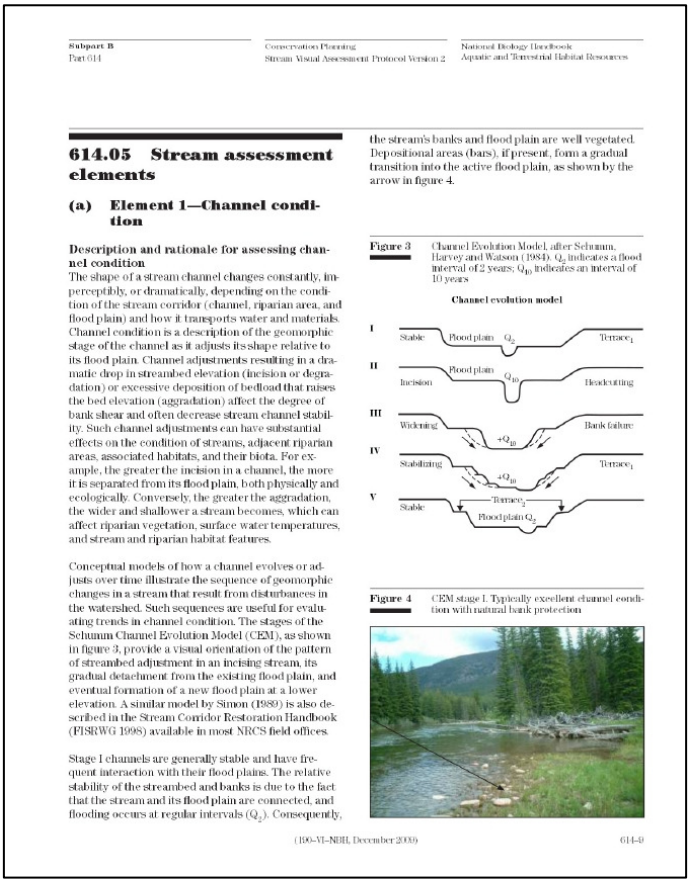


Figure 27 – USDA Protocol

Bank height was measured from the bank full elevation to the top of the bank. Width was measured from bank full on one side to bank full on the other side. The bank and bed

assessments were ratings of the structure and stability of the banks and the composition of the river channel. Bank condition was scored on scale of 1 to 10 based on the structure and stability of the bank. If the bank is gently sloping, with no erosion or incising, and a good amount of vegetation to hold the soil in place, then it receives a higher score. If the bank is straight up and down, with obvious signs of erosion and incising, and little or no vegetation to hold the soil in place, it receives a lower score. To determine Forest Quality, Sweepers estimated the percent of the forest floor on the river bank and floodplain that was covered by the tree crown or canopy. Sweepers also chose a random plot that was three feet square and estimated the amount of vegetation that covered this small plot. In addition, they measured 100' from the edge of water and at this point estimated the percent of this area that was covered by forest. The Channel Condition was based on the maturity and stability of the cross section (see Figure 22 below). If there was gently sloping banks with a clear and relatively deep channel, the section received a higher score. If the channel was wide and steep with no discernable channel (rather shallow from one side to the other), the section received a lower score.



Subpart B
Part 614

Conservation Planning
Stream Visual Assessment Protocol Version 2

National Biology Handbook
Aquatic and Terrestrial Habitat Resources

614.05 Stream assessment elements

(a) Element 1—Channel condition

Description and rationale for assessing channel condition

The shape of a stream channel changes constantly, imperceptibly, or dramatically, depending on the condition of the stream corridor (channel, riparian area, and flood plain) and how it transports water and materials. Channel condition is a description of the geomorphic stage of the channel as it adjusts its shape relative to its flood plain. Channel adjustments resulting in a dramatic drop in streambed elevation (incision or degradation) or excessive deposition of bedload that raises the bed elevation (aggradation) affect the degree of bank shear and often decrease stream channel stability. Such channel adjustments can have substantial effects on the condition of streams, adjacent riparian areas, associated habitats, and their biota. For example, the greater the incision in a channel, the more it is separated from its flood plain, both physically and ecologically. Conversely, the greater the aggradation, the wider and shallower a stream becomes, which can affect riparian vegetation, surface water temperatures, and stream and riparian habitat features.

Conceptual models of how a channel evolves or adjusts over time illustrate the sequence of geomorphic changes in a stream that result from disturbances in the watershed. Such sequences are useful for evaluating trends in channel condition. The stages of the Schumm Channel Evolution Model (CEM), as shown in figure 3, provide a visual orientation of the pattern of streambed adjustment in an incising stream, its gradual detachment from the existing flood plain, and eventual formation of a new flood plain at a lower elevation. A similar model by Simon (1989) is also described in the Stream Corridor Restoration Handbook (FISRWG 1998) available in most NRCS field offices.

Stage I channels are generally stable and have frequent interaction with their flood plains. The relative stability of the streambed and banks is due to the fact that the stream and its flood plain are connected, and flooding occurs at regular intervals (Q_2). Consequently, the stream's banks and flood plain are well vegetated. Depositional areas (bars), if present, form a gradual transition into the active flood plain, as shown by the arrow in figure 4.

Figure 3 Channel Evolution Model, after Schumm, Harvey and Watson (1984). Q_2 indicates a flood interval of 2 years; Q_{10} indicates an interval of 10 years

Figure 4 CEM stage I. Typically excellent channel condition with natural bank protection

Figure 28- Channel Assessment

The Macroinvertebrate sampling was the most involved portion of the diagnostic. In each of the three areas the Team collected three samples by holding a net against the bottom of the river and churning up the rocks upstream so that any organisms that were dislodged

from the rocks would be caught in a net. Sweepers identified all the different types of organisms (such as hellgrammites and mayflies) and added them up to produce a score for the sample.

Diagnostic Results

Diagnostic 1 and 2 results are shown below in Table 2.

	Moderate 1	Moderate 2	High
Width (@ Bank Full Height)	67 Ft.	110 Ft.	105 Ft.
Depth (top of bank to Bank Full)	Orange: 30 Ft. Madison: 15 Ft.	Orange: 30 Ft. Madison: 19 Ft.	Orange: 19 Ft. Madison: 16 Ft.
Forest Analysis (Orange Side Only)	Canopy:50% Understory: 85% 3X3 Plot: 100% Floodplain: 50%	Canopy:50% Understory:15% 3X3 Plot: 100% Floodplain: 30%	Canopy: 100% Understory: 80% 3X3 Plot: 10% Floodplain: 100%
Bank Condition	Orange: 9/10 Madison: 4/10	Orange: 4/10 Madison: 4/10	Orange: 8/10 Madison: 8/10
Channel Condition	4/10	4/10	4/10
Bed Composition	Cobbles: 20% Sand: 80% Wood: 0%	Cobbles: 10% Sand: 85% Wood: 5%	Cobbles: 50% Sand: 30% Wood: 20%
Macro Invertebrates	16 18 19	19 18 18	19 19 16

Table 2: Diagnostic Results

Diagnostic Results

No difference in river width and depth was able to be determined between high and low cross sections. Differences in forest composition on the bank and floodplain were observed as more mature canopy and understory was found in the high quality cross section. The floodplain plots reflected this – as less grass was found where there the forest was more

mature. No discernable difference in Channel Condition was found between high and low areas. Bed composition was somewhat different in the high area – with a higher percentage of cobbles and woody debris in the water. No discernable difference was found between the areas in the context of the macroinvertebrates.

Trash Removal Method

During the assessment and diagnostic stage of the project described above, Sweepers took GPS coordinates of concentrations of tires and other large debris. Landowners were contacted to secure trash removal access points and boat put in/take out at several locations throughout the 17 mile stretch. Based upon observation, the Team divided the stretch into four segments. Each Sweeper used a canoe as a garbage barge (Figure 23). For one section, a jonboat was also used due to the large quantity of debris (Figure 24).

Figure 29 – Canoes used as garbage barge

Figure 30 – Jonboat garbage barge

Every Sweeper 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. Many times a tire needed to be dug out of the river bank or bed. This required a few members of the crew 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 (Figure 25) . Canoes, paddles, etc. would be hauled up well away from the water ready for the next day's put in.

Figure 31 – Trash removal at access point

Trash Removal Results

The 17 mile stretch of river contained many different types of trash. The material found most often was plastic. The majority of weight came from the numerous tires found.

Figure 32 – Access Point 2 Trash

Figures 33/34 – Access Points 1 and 4 Trash

The total tally for trash removed is shown in Table 3 below.

Type of trash	Section 1: Stegara Road to Liberty Mills	Section 2: Liberty Mills to Blue Run	Section 3: Blue Run to Spicer's Mill	Section 4: Spicer's Mills to Madison Mills	Total
Tires	8	7	6	7	28
Flower pot	2	2	0	1	5
Misc. Plastic	8	14	10	7	39
Can	3	5	8	4	20
Glass	3	1	2	2	8
Carpet	1	0	0	0	1
Metal	5	4	1	5	15
Landscape Cloth	0	1	1	0	2

Table 3 – Trash Tally

Conclusions

Business Model

- River frontage landowners were 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.
- Community watershed supporters were entirely motivated by job corps benefits and stewardship.
- Not all landowners participated financially in the project (some allowed access but declined to provide funds). Other landowners were difficult to contact due to absentee ownership or poor contact information (physical address but no phone number or email). These holes in landowner financial support has to be filled through community watershed support for adequate financial support.
- Including pre-project marketing and planning, labor to get trash to the landfill and tire shops, and post project report writing, the actual cost of 20 miles of sweeping is ~ 20k. This roughly equates to 1k per river mile or 10 cents per linear foot for each side.
- Young adults hired as Sweepers should be limited to college students. This is primarily due to the need for self-transportation and added maturity.

- It seems reasonable to believe that local governments and water/wastewater utilities using the river would have an interest in supporting this effort. This should be explored in the future.

River Health Assessment

- Macroinvertebrate sampling shows that throughout this stretch of river, water quality is average to good, but not excellent. Likely reasons for this include:
    - The contributing subwatersheds average 63% forest cover. Most water quality studies show that a minimum of 80% forest cover in a watershed is necessary for a highly functional river ecosystem.
    - Significant areas along this stretch have cultivated lands up to the edge of bank. During high water, large slices of topsoil and subsoil are calved off of steep riverbank smothering bed cobbles.
    - River canopy is spotty – in some places it covers 50% or more of the channel, in most places it is much less.
    - Forest quality in the bed and floodplain is also spotty – in some place excellent but in many areas narrow or non-existent.
    - The stream morphology in most areas shows that in most areas, the river is transitioning from incision and widening to more stable channel formation. Using the NBH rating system, the Sweepers diagnostic assessments found the river to be "stage 4" – meaning that the channel is just beginning to stabilize. Channel formation is critical for fish and mammal habitat.
- It is noteworthy that the highest macroinvertebrate scores were just below the Orange intake dam. This is likely due to the dam acting as a sediment trap and reflects positively on the quality of discharge from the town's new sewage treatment system.

Trash Removal

- The ability of Sweepers to identify and remove debris is closely correlated with water level. Just a few inches drop reveals trash that otherwise is generally invisible.
- Casual observation of trash dramatically underestimates actual quantity. Sweepers repeatedly hauled more trash than they had identified during the River Health Assessment.
- Removal of tires, oil drums, etc. is time consuming due to digging required.
- Removal of trash is also time consuming due to human health risks. For example, a cottonmouth was found in one tire and a Sweeper fell down a bank scraping his side; these illustrate the need for Sweepers to work very slowly and very carefully.

Impact of Tires on Aquatic Ecosystems

- 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).
- While common sense would dictate that the impact from a few dozen tires in a 17 mile reach of river is likely negligible, the point is that there could be more than just an aesthetic impact to the river from concentrations of submerged tires.

River Recommendations

- A kitchen table discussion could be convened by a landowner or two that would like to see if river health can be improved. Using the database developed for this project, a significant percentage of landowners on the Orange and Madison sides of the river could be invited to a non-judgmental gathering focused on opportunities to enhance river functionality. What might be discussed?
    - From a strictly river health perspective, 17% more forest cover is needed in the contributing watersheds. This is probably impossible to achieve, however, with 5% unimproved pasture, perhaps there is opportunity for conversion of a significant portion of this to forestland. Would landowners along this stretch of river be willing to entertain financial arrangements to pay upstream landowners to increase forest cover?
    - Figure 8 shows the areas with substantial forest cover along the river. A significant proportion of areas adjacent to the river has little to no forest cover. Absent any regulatory influence, how could landowners somehow work together to create conditions that might favor growth of a higher % of forest buffer along the river?
- Large rusting culverts just upstream of the Town of Orange intake need to be removed. A winch with cable will be needed to complete this task. It seems reasonable that the Town of Orange and the Rapidan Water and Sewer Authority would have an interest in helping to spearhead this effort.
- The paradox of few folks recreating on the river and therefore caring about it; and greater traffic perhaps leading to more trash and encroachment problems should be discussed by Rapidan community watershed supporters and landowners.
- To facilitate completion of some or all of this work described above, a Friends of the Rapidan non-profit entity could be created under the auspices of the Center for Natural Capital or other group such as the Friends of the Rappahannock.
- StreamSweepers has landowner – specific information not published in this report. Landowners interested in improving their frontage can contact Center staff to learn more about how to obtain this information and recommendations for frontage improvements.

Program Recommendations

This report provides evidence that StreamSweepers demonstrated proof of concept. The question now is - what's next? With completion of this stretch, there remains 71 miles (81%) of main stem of the river left to sweep. Then there are the major tributaries; the Robinson, Conway, and South Rivers in the upper section, and Mine Run, Black Run, Summerduck Run, and others in the lower portion of the watershed (Figures 35 and 36). It is noteworthy that StreamSweepers was successful as a first year pilot project, but can the business model meet the need for a comprehensive, systematic program to regularly sweep the entire watershed according to need? The Steering Committee is currently the only entity that can answer this question. That group will meet October 16th, 2013 at a celebration of the 2013 season and will begin to discuss this question.

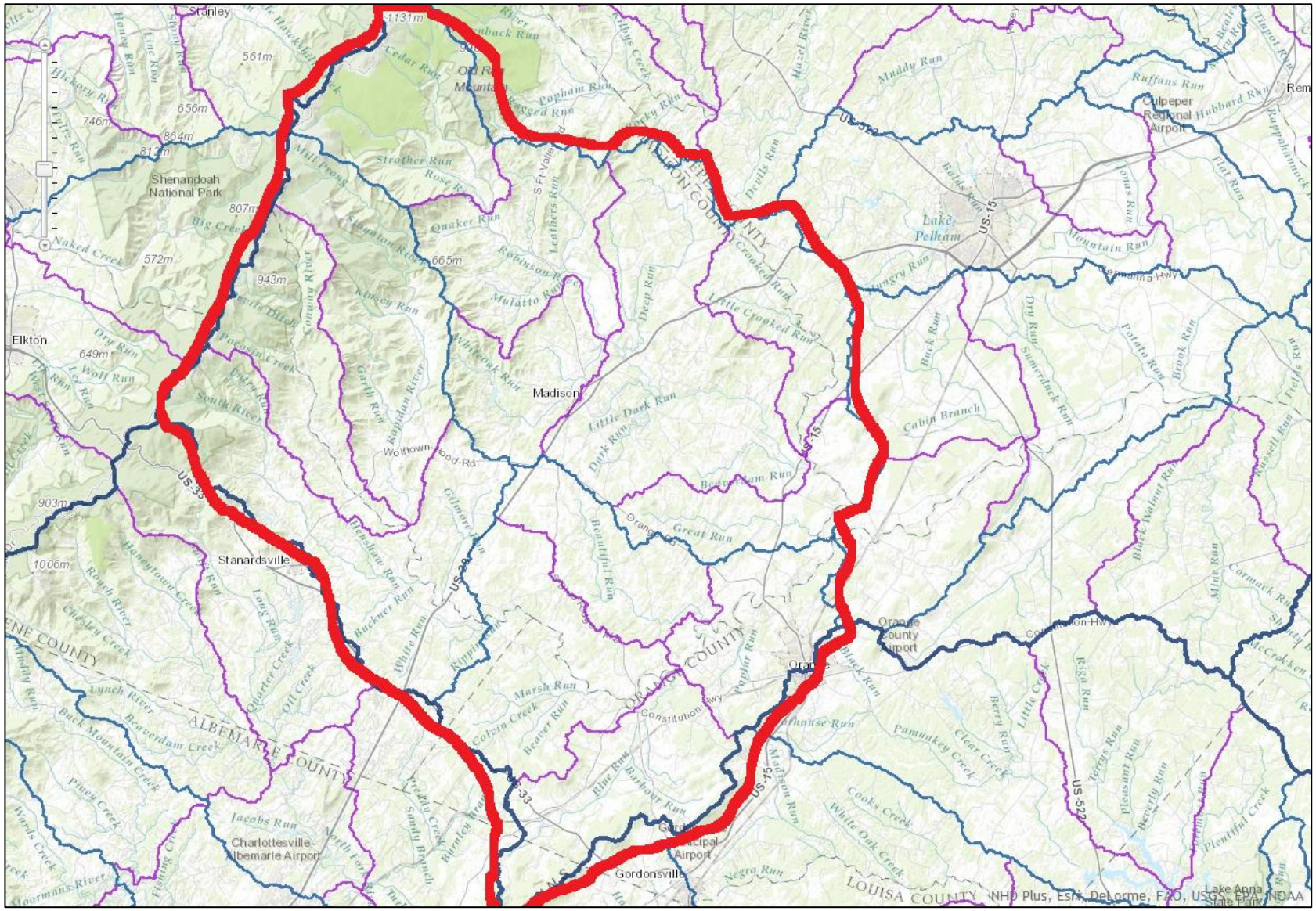


Figure 35 – Upper Rapidan Watershed

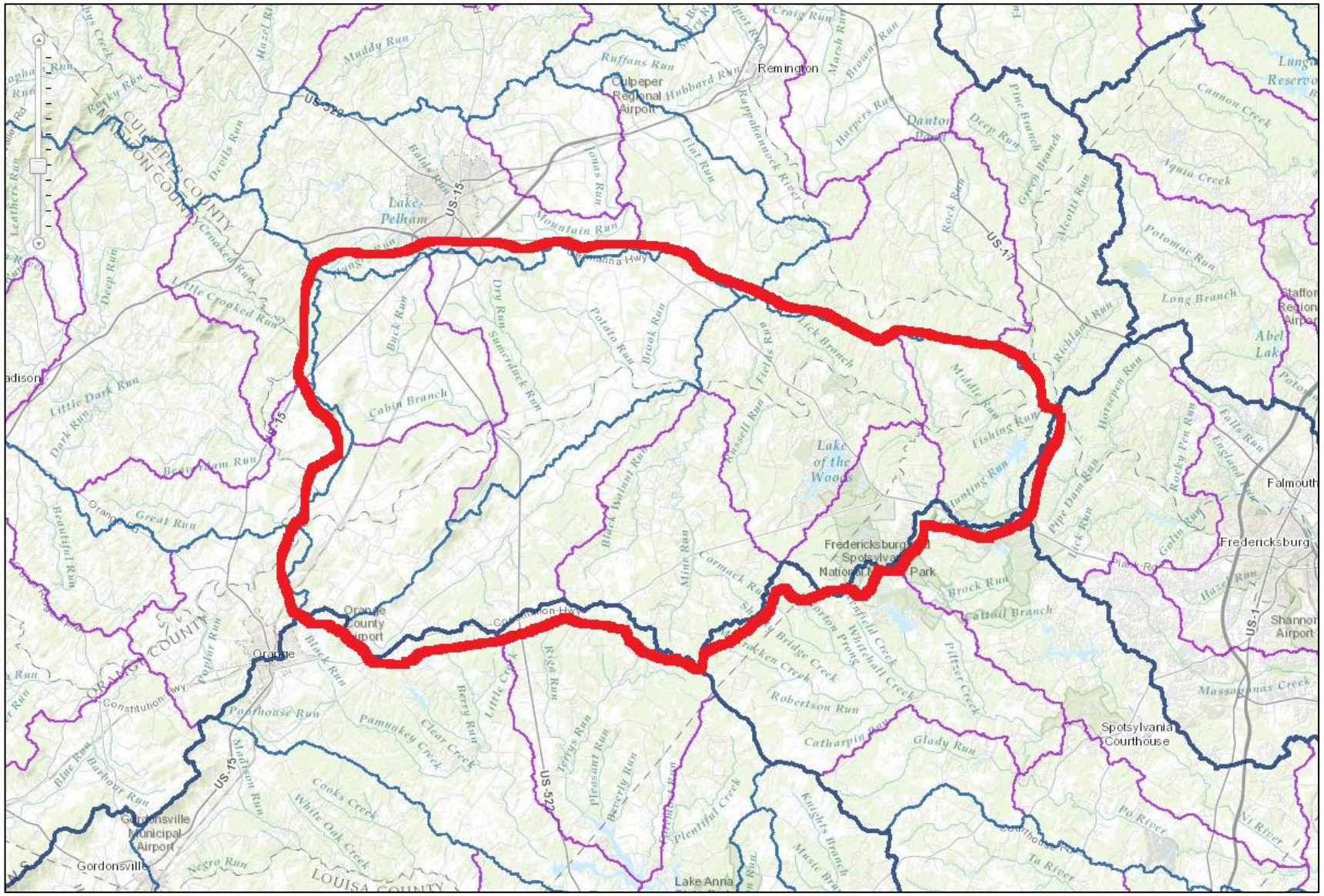


Figure 36 – Lower Rapidan Watershed

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