

Nanticoke River Watershed Restoration Plan



Developed by:
The Nanticoke Restoration Work Group

May 19, 2009

Acknowledgements

This plan was developed by the dedicated effort of the Nanticoke Restoration Work Group which includes a diverse array of partners who perform or support restoration projects in Delaware. Members represent a wide variety of expertise including restoration, wetlands, early successional habitats, soils, forestry, wildlife, plants and agriculture (see Table 1 for list of participants and organizations). Work group members dedicated time and expertise to identifying conservation targets and priorities as well as public outreach to begin implementing the plan and identifying landowners in target areas.

Rick McCorkle (USFWS) and Tom Saldyga (DE DNREC) provided exceptional expertise for the intensive GIS analyses that were used to identify conservation opportunities for restoration and to prioritize restoration efforts.

This plan was funded by the Delaware Department of Natural Resources and Environmental Control, U.S. Environmental Protection Agency Wetland Program Development Grant assistance # WL-97329901-0 and the in-kind services of all the organizations listed in Table 1.

Table 1. Nanticoke River watershed restoration plan work group members

Participant	Organization	Expertise
Tom Barthelmeh	DE DNREC/ Division of Soil and Water	Wetland Restoration
Chris Bason	Center for the Inland Bays	Wetlands
Karen Bennett	DE DNREC/ Division of Fish and Wildlife	Wildlife/ Habitat
Jack Conner	Nanticoke Tributary Action Team	Watershed Issues
Ken Dunne	DE Department of Transportation	Restoration
Deb Fillis	DE DNREC/ Division of Water Resources	Wetlands
Rob Gano	DE DNREC/ Division of Fish and Wildlife	Habitat
Tim Garrihan	NRCS	Agriculture/ Conservation Practices
Kate Hackett	The Nature Conservancy	Conservation/ Protection
Laura Herr	DE DNREC/ Division of Water Resources	Wetlands/ Subaqueous lands
Amy Jacobs	DE DNREC/ Division of Water Resources	Wetlands
EB James	Nanticoke Watershed Alliance	Watershed Issues
Lyle Jones	DE DNREC/ Division of Water Resources	Soils, Nutrients
Sally Kepfer	NRCS	Restoration
Rob Line	DE DNREC/ Division of Parks and Recreation	Restoration/ Uplands
Anne Love	DE DNREC/ Division of Water Resources	Wetlands
Andy Manus	The Nature Conservancy	Conservation/ Protection
Bill McAvoy	DE DNREC/ Division of Fish and Wildlife/ Natural Heritage Program	Plants/ Habitat
Rick McCorkle	U.S. Fish and Wildlife Service	Wildlife
Erin McLaughlin	MD Department of Natural Resources	Wetlands
Bill Meredith	DE DNREC/ Division of Fish and Wildlife	Wetlands
Marlene Mervine	DE DNREC/ Division of Fish and Wildlife	Landowner Contact
Bill Moyer	Duffield Associates, Inc	Wetlands
Evan Rehm	DE DNREC/ Division of Water Resources	Wetlands
Al Rizzo	U.S. Fish and Wildlife Service	Restoration/ Wetlands
Tom Saladyga	DE DNREC/ Division of Water Resources	GIS Analysis
Austin Short	DE Department of Agriculture/ Forestry	Forestry
Shelly Tovell	DE DNREC/ Division of Fish and Wildlife/ Landowner Incentive Program	Restoration
Melanie Tymes	DE DNREC/ Division of Water Resources	Wetlands
Tommy Wiltbanks	NRCS	Agriculture/ Conservation Practices

Table of Contents

Acknowledgements	i
Table of Contents	ii
Introduction	4
Watershed Characterization	4
Process	6
Watershed Plan Goal	6
Identification of Conservation Targets	6
Opportunities for Enhancement and Re-establishment	9
Of Conservation Targets	9
Prioritizing Conservation Targets	10
Based on Program Goals	10
Stream Habitat and Biology Program Goal Results	12
Water Quality Program Goal Results	16
Wildlife Habitat Program Goal Results	23
Multiple Program Goal Results	30
Implementation Plan	31
Assessment	31
References	33
Appendix A. GIS Layers used to develop the Nanticoke Restoration Plan	34
Appendix B. Analysis details used to identify conservation target opportunities	36
Appendix C. Stream Biology and Habitat Program Goal Rankings	39
Appendix D. Water Quality Program Goal Rankings	41
Appendix E. Wildlife Habitat Program Goal Rankings	44

List of Figures

Figure 1. Restoration of channelized stream rankings to improve stream segments that are not meeting water quality standards for biology and/or habitat in the Nanticoke River watershed, DE.....	12
Figure 2. Riparian and tidal wetland buffer re-establishment rankings to improve stream segments that are not meeting water quality standards for biology and/or habitat in the Nanticoke River watershed, DE.....	13
Figure 3. High priority areas for restoration of channelized streams and re-establishment of riparian and tidal wetland buffers to improve stream segments that are not meeting water quality standards for biology and/or habitat in the Nanticoke River watershed, DE.....	14
Figure 4. Restoration of channelized stream rankings to improve water quality in the Nanticoke River watershed, DE.....	16
Figure 5. Riparian and tidal wetland buffer re-establishment rankings to improve water quality in the Nanticoke River watershed, DE.....	17
Figure 6. High priority areas for restoration of channelized streams and re-establishment of riparian and tidal wetland buffers to improve water quality in the Nanticoke River watershed, DE.....	18
Figure 7. Headwater/ large forest block enhancement and re-establishment rankings to improve water quality in the Nanticoke River watershed, DE.....	20
Figure 8. High priority areas for headwater/ large forest block enhancement and re-establishment to improve water quality in the Nanticoke River watershed, DE.....	21
Figure 9. Restoration of channelized stream rankings to improve wildlife habitat in the Nanticoke River watershed, DE.....	23
Figure 10. Riparian and tidal wetland buffer re-establishment rankings to improve wildlife habitat in the Nanticoke River watershed, DE.....	24
Figure 11. High priority areas for restoration of channelized streams and re-establishment of riparian and tidal wetland buffers to improve wildlife habitat in the Nanticoke River watershed, DE	25
Figure 12. Headwater/ large forest block enhancement and re-establishment rankings to improve wildlife habitat in the Nanticoke River watershed, DE.....	27
Figure 13. High priority areas for headwater/ large forest block enhancement and re-establishment to improve wildlife habitat in the Nanticoke River watershed, DE.....	28
Figure 14. Highest priority areas for conservation targets that were in the top ranking percentiles for both water quality and wildlife habitat program goals. There are 41ha of high priority forest enhancement, 4ha of high priority forest re-establishment, 8ha of high priority buffer restoration, and 9km of stream restoration.....	30
Figure 15 Forest block categories and potential reestablishment areas with parcel overlay.....	37

Introduction

In June 2008, State of Delaware, State of Maryland, the Friends of the John Smith Chesapeake Trail, and The National Park Service signed an agreement which included the goal to “Identify and implement the best management practices for the protection, restoration and enhancement of the Nanticoke watershed’s natural, historic and cultural resources” (Nanticoke Partnership Agreement 2008). Additionally, other concurrent efforts in the State of Delaware by The Nature Conservancy, Natural Resource Conservation Service, Nanticoke Watershed Alliance and the Delaware Department of Natural Resources and Environmental Control have identified the Nanticoke Watershed as a focus area for conservation efforts. Each of these and other groups are performing restoration and enhancement in the watershed to improve natural resources, but the majority of projects are being performed as opportunities present themselves from interested landowners. There is a need to develop a science-based process to identify priority areas for restoration that could be used by all groups working in the watershed to maximize the collective efforts.

Watershed restoration plans identify priorities, establishing a transparent process for locating areas to restore, and allow local communities to make decisions to best protect and restore natural lands. Watershed plans can also be used to inform permit decisions and locate mitigation sites. In April 2008, the U.S. Army Corps of Engineers with the U.S. Environmental Protection Agency published a Compensatory Mitigation Rule which calls for all wetland mitigation to be incorporated into local watershed plans. Restoration plans direct projects to locations where they have the greatest ecological impact and bring together the multiple organizations undertaking restoration projects to help maximize the efforts of each respective group.

The Nanticoke Restoration Work Group was formed to develop a restoration plan for the watershed by identifying priority areas and to implement the plan by facilitating coordination among members. The work group used the best available science and the diverse expertise of participants to identify conservation targets and locate these targets on the ground. Priority areas were then identified for each conservation target based on different program goals: habitat restoration, water quality improvement, and stream biology/ habitat improvement.

The intent of this plan is to document the process used to develop the restoration strategy. New and improved data are continually being collected; we envision that this plan will be updated and refined on a regular basis to incorporate new information and identify optimal areas for restoration. This plan will be used to perform outreach, market restoration opportunities, and secure funding resources. We acknowledge that this plan does not cover every species and habitat that needs to be restored in the Nanticoke watershed, and as such, should by no means be used to exclude projects that are otherwise deemed a priority.

Watershed Characterization

The Nanticoke River is a major tributary of the Chesapeake Bay, draining approximately 2,072 square kilometers (800 square miles) in the states of Maryland and Delaware (CBF 1996). The watershed is over 88.5 miles long and the total rise in elevation is only 19.8 feet, giving the river a

very low gradient (Tiner et al. 2000). The river is tidal along the major channels, up to dams located on Broad Creek in Laurel, Delaware and on Deep Creek in Concord, Delaware.

The Nanticoke River watershed has been a focus for protection because of its abundance of rare fauna and flora and unique biological communities. The Nature Conservancy listed the Nanticoke River watershed as one of their “Last Great Places” and has targeted significant conservation efforts in this region (TNC 1998). In Maryland and Delaware there are approximately 200 plant species and 70 animal species that are state rare, threatened or endangered, including over 20 plant and 5 animal species that are globally rare (TNC 1998). Many of these species are found in rare natural communities in the watershed including coastal plain ponds, xeric dunes, and Atlantic white cedar swamps. The Nanticoke is also important for waterfowl and fisheries, is a focus area of the North American Waterfowl Management Plan, and is a reintroduction site for American shad (*Alosa sapidissima*).

Due to land use practices in the watershed, many of the natural systems have been degraded. This has impacted natural populations of fish and wildlife, and decreased the ecological services that these systems provide such as water quality improvement and flood protection. At the time of European settlement, the land was predominately forested, and has been estimated to have had as much as 95% old growth mixed species forest (Tiner and Bergquist 2003). Large blocks of forest remain, but many of these forest stands have been highly fragmented and/ or converted from the original mix of hardwood species to extensive pine plantations, and there are no known remaining old growth forest stands. In the Delaware portion of the watershed, Tiner (2004) estimated that 41% of the land area remain in natural vegetation (Tiner 2004). The remaining 60% is dominated by agriculture (not including forestry). In recent years, however, development has been increasing in the watershed.

Another stressor impacting natural communities in the watershed is channelization of streams and expansion of ditch networks into the headwaters of the watershed to increase drainage. Tiner et al. (2001) estimated that 80% of the natural streams have been channelized and there are 2.3 miles of ditches per square mile of land in the Delaware portion of the watershed. Channelization impacts adjacent wetlands by reducing the residence time in these wetlands. Channelization typically results in depositing spoils along stream channels, further isolating floodplain wetlands by preventing overbank flooding.

The combination of land use practices and alteration of natural hydrology has led to degraded water quality in the watershed. According to the Nanticoke watershed total maximum daily load (TMDL), several designated uses including fish and aquatic life, exceptional recreational and ecological significance, and primary contact, have not been met because of reduced water quality from eutrophication, low dissolved oxygen, high bacteria, and high water temperature. A TMDL was developed in 1998, and requires several pollutant reduction measures, including a 30% reduction of total nitrogen and a 50% reduction of total phosphorus from nonpoint sources (DE DNREC 1998).

Process

The Nanticoke River Watershed Restoration Plan consists of 6 steps:

1. Establish watershed plan Goal
2. Identify conservation targets
3. Locate opportunities to enhance or re-establish conservation targets in the watershed
4. Prioritize areas for restoration and/or re-establishment
5. Implement plan through community outreach to generate participation in conservation programs and direct restoration efforts to high priority areas
6. Assess improvement in the ecological integrity at the site and watershed level

This document details steps 1-4 and provides a framework for implementing steps 5 and 6.

Watershed Plan Goal

The Nanticoke River and its 2,000 square-kilometer watershed is an exceptional resource. Rare species and natural communities, rich cultural heritage and working lands are integrated throughout the watershed which influence the quality of life of the citizens from Greenwood, DE south to the mouth where it enters the Chesapeake Bay in Maryland. To maintain the character and quality of the Nanticoke River and the lands that encompass its watershed, a network of natural high quality lands are needed to provide habitat for plants and animals and to provide essential ecosystem services such as clean air and water, and flood and storm protection.

The Nanticoke Restoration Plan was developed by a multi-disciplinary working group to identify priority areas for restoration in the watershed. The working group established the goal of the plan as: to focus restoration activities in the watershed to improve and maintain the ecological integrity of species and habitats, and the functions and services they provide.

Nanticoke Restoration Plan Goal

Focus restoration activities in the watershed to improve and maintain the ecological integrity of species and habitats and the functions and services they provide.

Identification of Conservation Targets

Work Group members identified thirteen potential conservation targets for restoration in the Nanticoke Watershed, including

- Large forested tracts
- Headwater forested wetlands areas
 - Atlantic White Cedar Swamps
 - Bald Cypress
- Xeric Dunes/Sand ridges
- Coastal plain ponds
- Corridor and riparian buffers
- High quality groundwater recharge areas
- Mature forest interiors with buffers (250 ac)

- Firm substrate of the Nanticoke River, SAV
 - Freshwater mussel beds
- Tidal wetland buffers
- Freshwater tidal/intertidal shorelines
- Scrub/shrub swamps riparian areas
- Channelized streams
- Isolated wetlands

Each participant was given three votes to allocate to one or more of the proposed targets with the charge to identify the conservation targets that would be most effective (or important) in achieving the stated goal. The highest ranking priorities were:

1. Headwater forests
2. Large forest tracts
3. Channelized streams
4. Corridor and riparian buffers
5. Tidal Wetland Buffers

After further discussion the group refined the conservation targets as defined in Table 2.

Table 2. Nanticoke River watershed high priority conservation targets

Conservation Target	Definition	Importance to maintaining ecological integrity of Nanticoke Watershed
Expand and enhance headwater forests/ large forest blocks	Forested areas that are or have the potential to be expanded to 250 acres in size by reforestation of adjacent lands. 250 acres was based on the definition of forest blocks from the Delaware Wildlife Action Plan (DE NHP 2006). Because the Delaware portion of the Nanticoke River watershed includes the headwaters of the river and major tributaries and extends only where tidal influence begins we considered all portions of the watershed in Delaware to be headwaters.	Headwater forests in Delaware are typically a mosaic of wetland and upland systems. Large blocks of forests provide habitat to sustain wildlife populations, store carbon from being released to the atmosphere, improve air quality and intercept runoff and atmospheric deposition of nitrogen.
Restore channelized streams	Channelized streams are waterways that were historically natural streams and have been deepened and straightened to increase drainage primarily for agricultural lands.	Restoration of channelized streams to natural flowing streams will re-connect the stream with the floodplain and adjacent wetlands. An intact stream/ wetland system will improve habitat for wildlife, reduce flooding downstream by providing greater storage during storms and reducing the flow of flood waters, improve water quality by waters interacting with the adjacent wetlands to remove sediment and transform nitrogen and phosphorus.
Expand riparian and tidal wetland buffers	Buffers are defined as lands within 50m of streams, rivers and tidal wetlands supporting native vegetation.	Expanding buffers will benefit wildlife through improved habitat, providing shade to streams, and serving as corridors to connect large forest blocks. Buffers also improve water quality by retaining sediment and intercepting nutrients.

Opportunities for Enhancement and Re-establishment Of Conservation Targets

Analysis of GIS data using Environmental Systems Research Institute’s (ESRI) ArcGIS 9.2, yielded maps of potential areas for restoration based on the three conservation targets: expand and enhance headwater forests/ large forest blocks, restore channelized streams, and expand riparian and tidal wetland buffers. A brief description of how each conservation target was identified using GIS data is provided below. Detailed analysis procedures and data layer sources are provided in Appendix A. The total area/ length existing for each conservation target is listed in Table 3.

Large forest blocks with potential for enhancement and or expansion were identified based the Delaware Wildlife Action Plan (DE NHP 2006) that defines a large forest block as 250 acres. Forested areas that were either 250 acres or had the potential to become 250 acres were considered optimal for enhancement. A site was considered to have potential to become 250 acres if it was a minimum of 100 acres of forest and there was suitable adjacent land that was available to expand the forest block to 250 acres. Un-forested areas that met the criteria to expand an existing forest to 250 acres were considered optimal for re-establishment of large forest blocks. Areas that were considered not suitable for enhancement or re-establishment included developed areas (residential and urban) and planned developments (submitted development plan to the state as of 2006).

Channelized streams were identified by a tax ditch layer (2007) developed by DNREC, Division of Soil and Water, Drainage Program. This layer was used to represent mostly channelized streams, though some of the ditches may not historically have been streams.

Buffer re-establishment areas were identified as non-forested areas within 50 meters of surface water (i.e. river, stream, ditch, millpond) or tidal wetland with the potential for re-establishment of forest or native vegetation. Areas that were considered not suitable included developed areas (residential and urban) and future developments (those that had a submitted development plan to the state as of 2006).

Table 3. Total Areas/ Length of Potential Restoration Opportunities by Conservation Target

Conservation Target	Identified for potential restoration
Headwater forests/ large forest blocks – enhancement	35,739 acres (14,463 ha) Wetland
	30,087 acres (12,176 ha) Upland
Headwater forests/ large forest blocks – re-establishment	40,489 acres (16,385 ha) Wetland
	51,998 acres (21,042 ha) Upland
Restoration of channelized streams	1,015 miles (1, 634 km)
Riparian and tidal wetland buffers	45,106 acres (18,254 ha) Riparian buffers
	736 acres (298 ha) tidal wetland buffers

Prioritizing Conservation Targets Based on Program Goals

There were many opportunities identified in the watershed to restore and enhance headwater forests/ large forest blocks, channelized streams, and riparian and tidal wetland buffers (Table 3). However, these opportunities encompass very large areas of land and streams. To focus the multiple activities of the groups performing restoration, a process was developed to further prioritize areas that should be targeted for restoration in the next few years.

The Nanticoke Restoration Work Group prioritized areas for restoration within each conservation target by weighting scientific data layers, that were then summed to provide a total score for each 5x5m grid cell included in the opportunity layer.

$$\text{Total Cell Score} = \sum W_i$$

Where W_i = the weight for variable i that was assigned by the work group. Variable included scientific data such as inclusion of rare species or proximity to stream.

The work group assigned variable weights based on 3 different program goals: water quality, wildlife habitat, and stream habitat/ biology. This allowed groups to identify priorities that would meet the Nanticoke Restoration Plan goal as well as specific program goals of their agency.

Program Goals used to Prioritize Areas for Restoration in the Nanticoke River Watershed

Water Quality –focus on restoring areas within each conservation target that will improve water quality in the Nanticoke River and its tributaries.

Wildlife Habitat – focus on restoring areas within each conservation target that will improve habitat for wetland and upland fauna and flora.

Stream Habitat/ Biology - focus on restoring areas within each conservation target* that will improve the condition of, and ultimately de-list, stream segments on the State Impaired Waters list (303(d)) for habitat and biology.

*Because of the need to improve the condition of specific sections of streams only the Channelized Stream and Buffer targets were prioritized to meet this goal.

Nanticoke Restoration Work Group members were divided into two groups based on their expertise (water quality or wildlife habitat). Each group was provided a list of variables that could be used to prioritize areas within each conservation target (i.e. part of Delaware Ecological Network, within 100m of a natural stream, etc.). Variables that would not contribute scientifically-based analysis of best locations for restoration projects were not included (Appendix F). As a group, team members assigned each variable a weight 0 – 5 with 0 meaning that the variable should not be used to prioritize that conservation target and 5 meaning the variable is highly important to prioritizing restoration. Each group performed the exercise for each conservation target. Groups then worked

together to assign weights for the stream habitat/ biology goal. Variables and weights for each program goal are listed in Appendix C-E.

Raster analysis in ESRI ArcView and ArcGIS was used to assign the weight for each variable to 5m x 5m grid cells for each conservation target and program goal. Weights of all variables were then summed for each cell to create a composite score for each cell. The top 25% of scores were selected as highest priority. Summary data were compiled for each priority by program goal and conservation target including the total area of high priority opportunity, number of parcels greater than 2 acres that contain the high priority areas, number of landowners with high priority areas, and hectares or kilometers of high priority areas on protected lands. Results are summarized by program goal and conservation target below. Additionally, areas that were ranked as high priority areas for both wildlife habitat and water quality are identified as multiple program priorities and should be given the highest priority for restoration.

Stream Habitat and Biology Program Goal Results

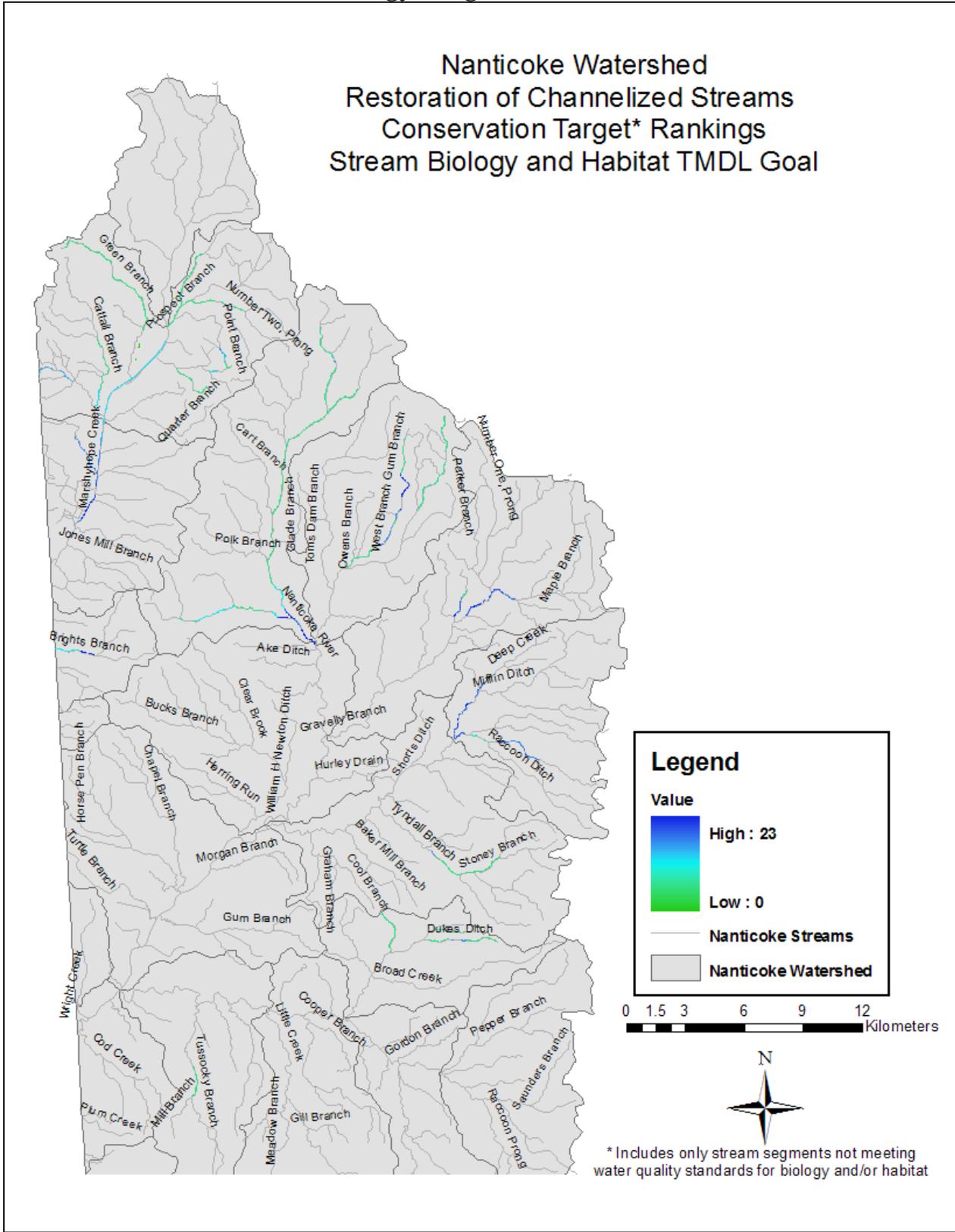


Figure 1. Restoration of channelized stream rankings to improve stream segments that are not meeting water quality standards for biology and/or habitat in the Nanticoke River watershed, DE.

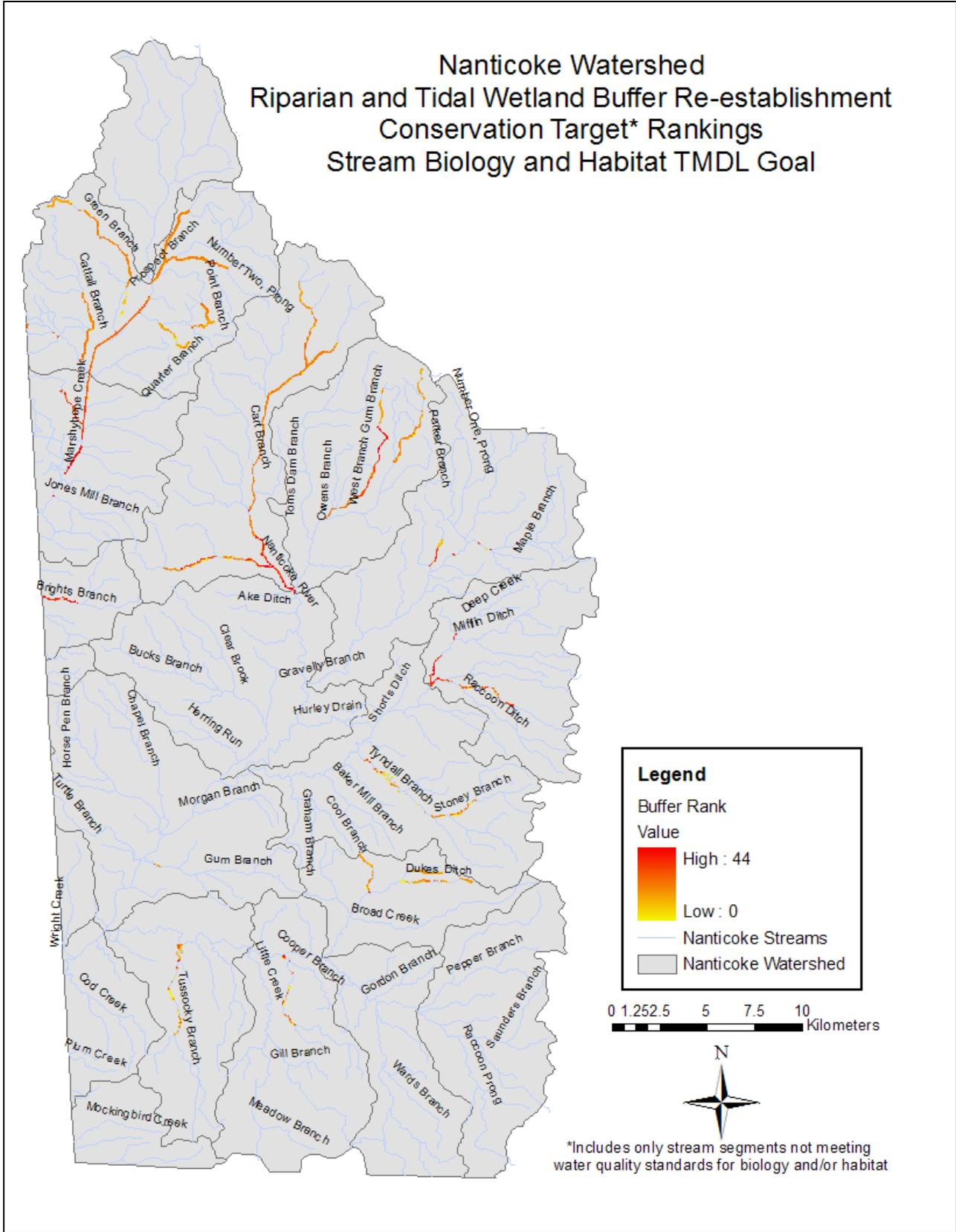


Figure 2. Riparian and tidal wetland buffer re-establishment rankings to improve stream segments that are not meeting water quality standards for biology and/or habitat in the Nanticoke River watershed, DE.

Nanticoke Watershed
Top 25% Ranking Areas
Restoration of Channelized Streams and
Riparian and Tidal Wetland Buffer
Re-establishment Conservation Targets*
Stream Biology and Habitat TMDL Goal

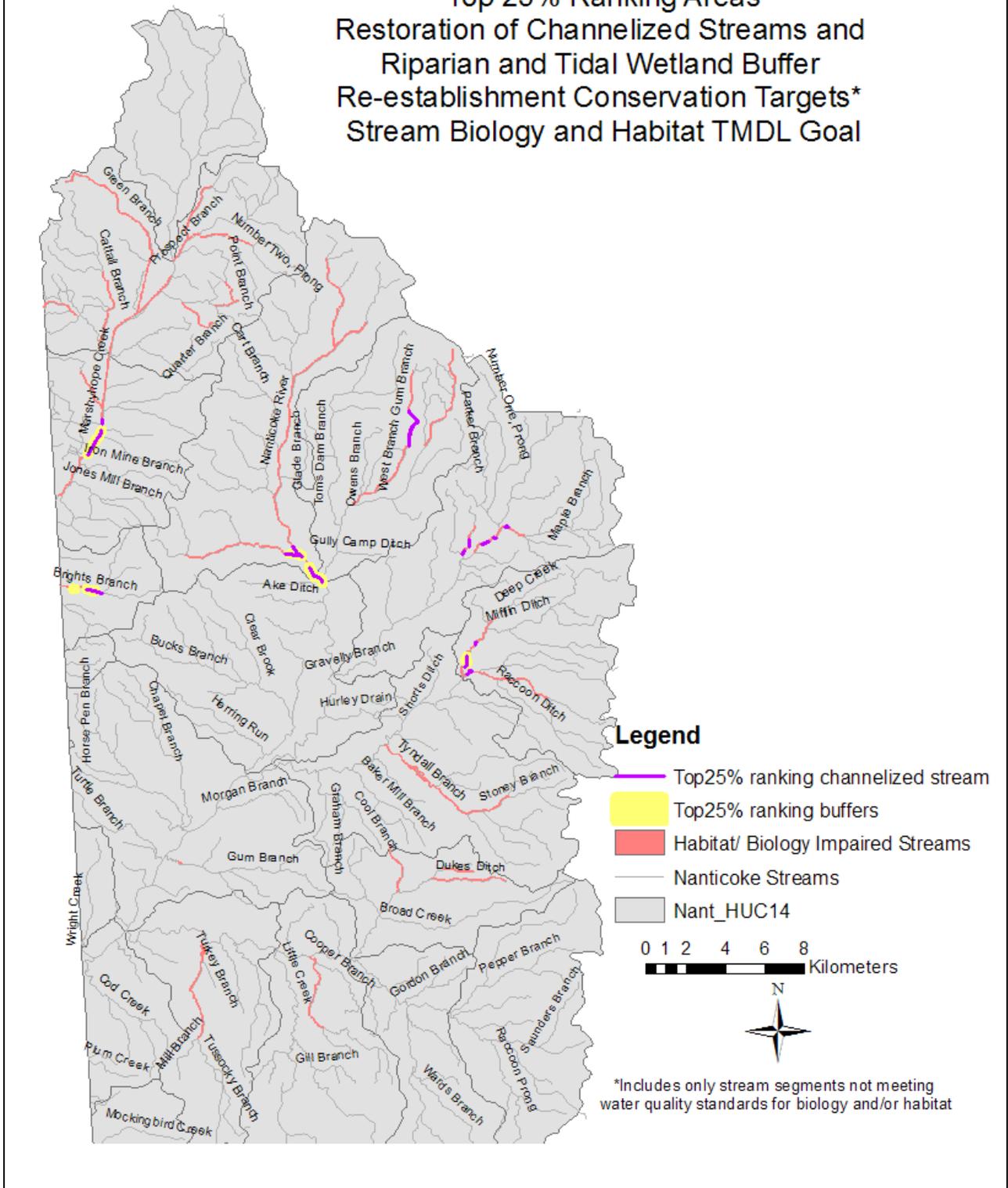


Figure 3. High priority areas for restoration of channelized streams and re-establishment of riparian and tidal wetland buffers to improve stream segments that are not meeting water quality standards for biology and/or habitat in the Nanticoke River watershed, DE.

Table 4. High priority channelized stream restoration opportunities for stream habitat and biology program goal. (Scores ranged from 0 – 23)

Total length of channelized streams impaired for biology and/or habitat in Nanticoke Watershed: 155 km	Top 25% (Score ≥ 17)
Channelized stream length	10.7 km; 68 segments
# Landowners	42
# Landowners with >100m of priority stream	19 landowners with 31 parcels (9 State Owned)
Length on protected lands	4.1 km

Table 5. High priority riparian and tidal wetland buffer re-establishment opportunities for stream habitat and biology program goal. (Scores ranged from 0 – 44)

Total areas of potential buffer re-establishment in Nanticoke Watershed: 18,552 ha	Top 25% Score ≥ 33
Buffer re-establishment area	14 ha
# Parcels >2 acres	28 (2 State Owned)
# Landowners	19
# Parcels with existing restoration project	0
Area on protected lands	<1 ha

Water Quality Program Goal Results

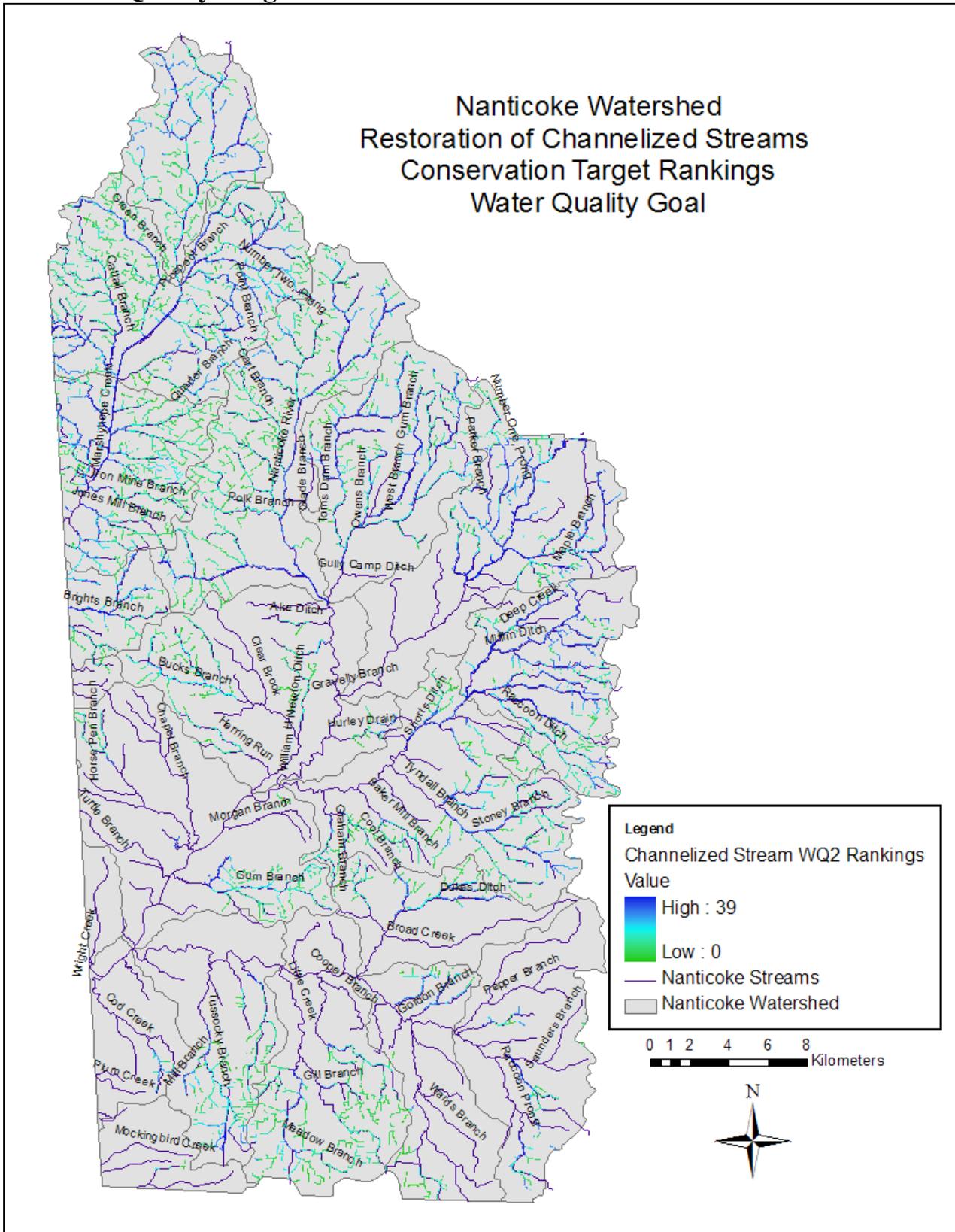


Figure 4. Restoration of channelized stream rankings to improve water quality in the Nanticoke River watershed, DE

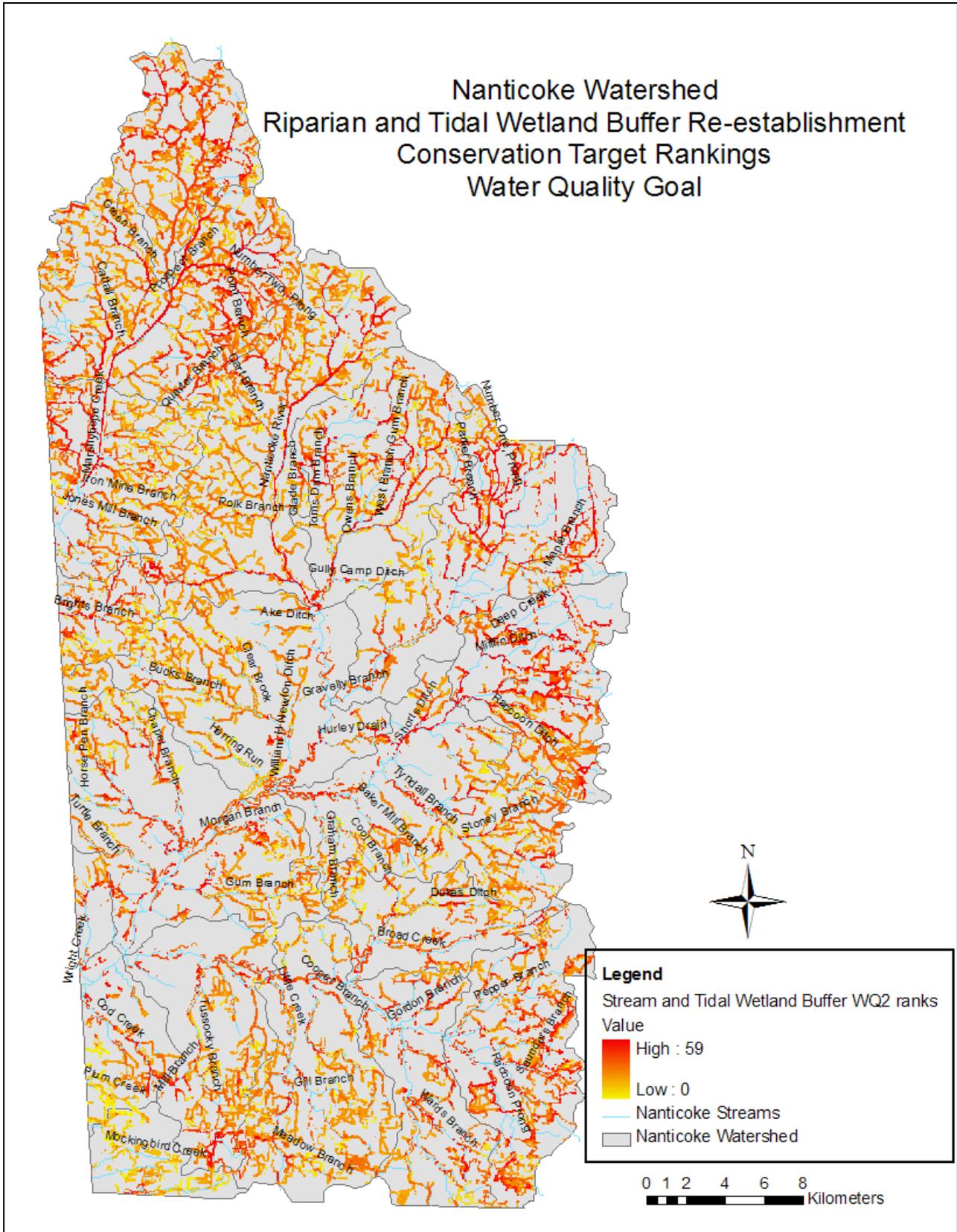


Figure 5. Riparian and tidal wetland buffer re-establishment rankings to improve water quality in the Nanticoke River watershed, DE.

Nanticoke Watershed
Top 25% Ranking Areas
Restoration of Channelized Streams and
Riparian and Tidal Wetland Buffer Re-establishment
Conservation Targets
Water Quality Goal

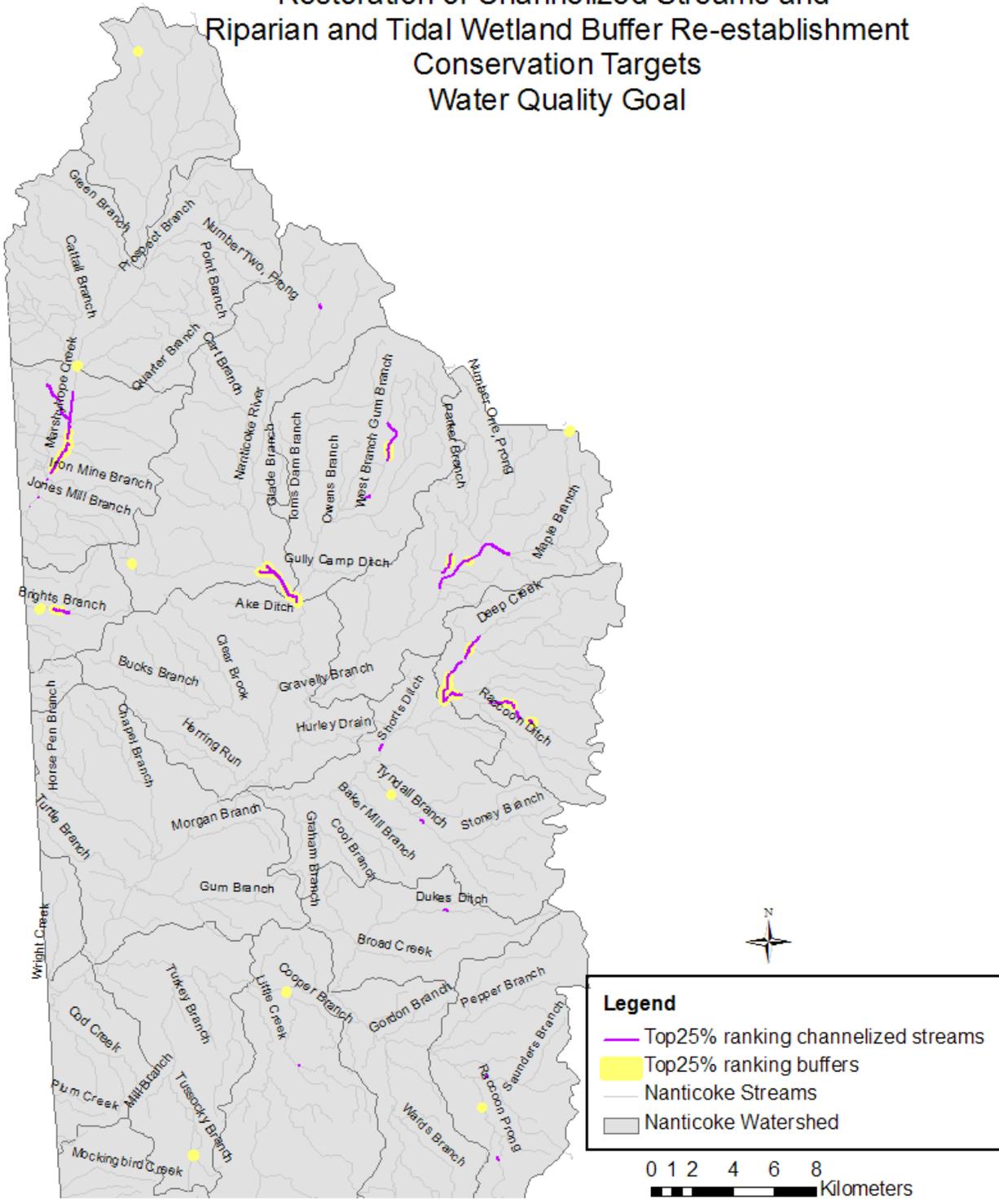


Figure 6. High priority areas for restoration of channelized streams and re-establishment of riparian and tidal wetland buffers to improve water quality in the Nanticoke River watershed, DE.

Table 6. High priority channelized stream restoration opportunities for water quality program goal. (Scores ranged from 0-39)

Total length of channelized streams in Nanticoke Watershed: 1,634 km	Top 25% (Score ≥ 29)
Channelized stream length	32 km; 31 segments >200m
# Landowners	90
# Parcels with >100m of priority stream	89 parcels (22 State Owned); 47 landowners
Length on protected lands	12km

Table 7. High priority riparian and tidal wetland buffer re-establishment opportunities for water quality program goal. (Scores ranged from 0-59)

Total areas of potential buffer re-establishment in Nanticoke Watershed: 18,552 ha	Top 25% (Score ≥ 44)
Buffer re-establishment area	33 ha
# Parcels >2 acres	83 (11 State Owned)
# Landowners	57
# Parcels with existing restoration sites	0
Area on protected lands	3.9 ha

Nanticoke Watershed
 Headwater/ Large Forest Block
 Enhancement and Re-establishment
 Conservation Target Rankings
 Water Quality Goal

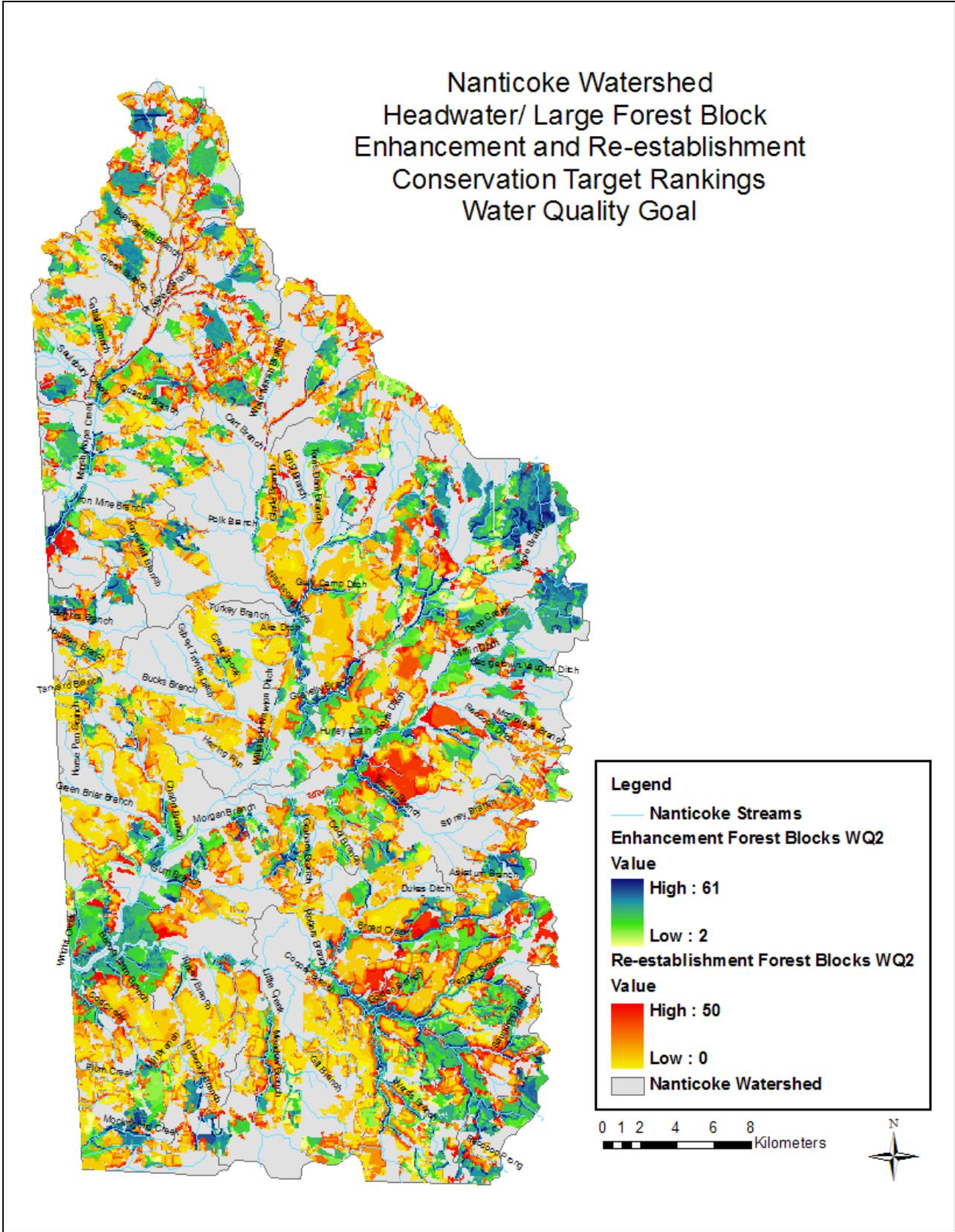


Figure 7. Headwater/ large forest block enhancement and re-establishment rankings to improve water quality in the Nanticoke River watershed, DE.

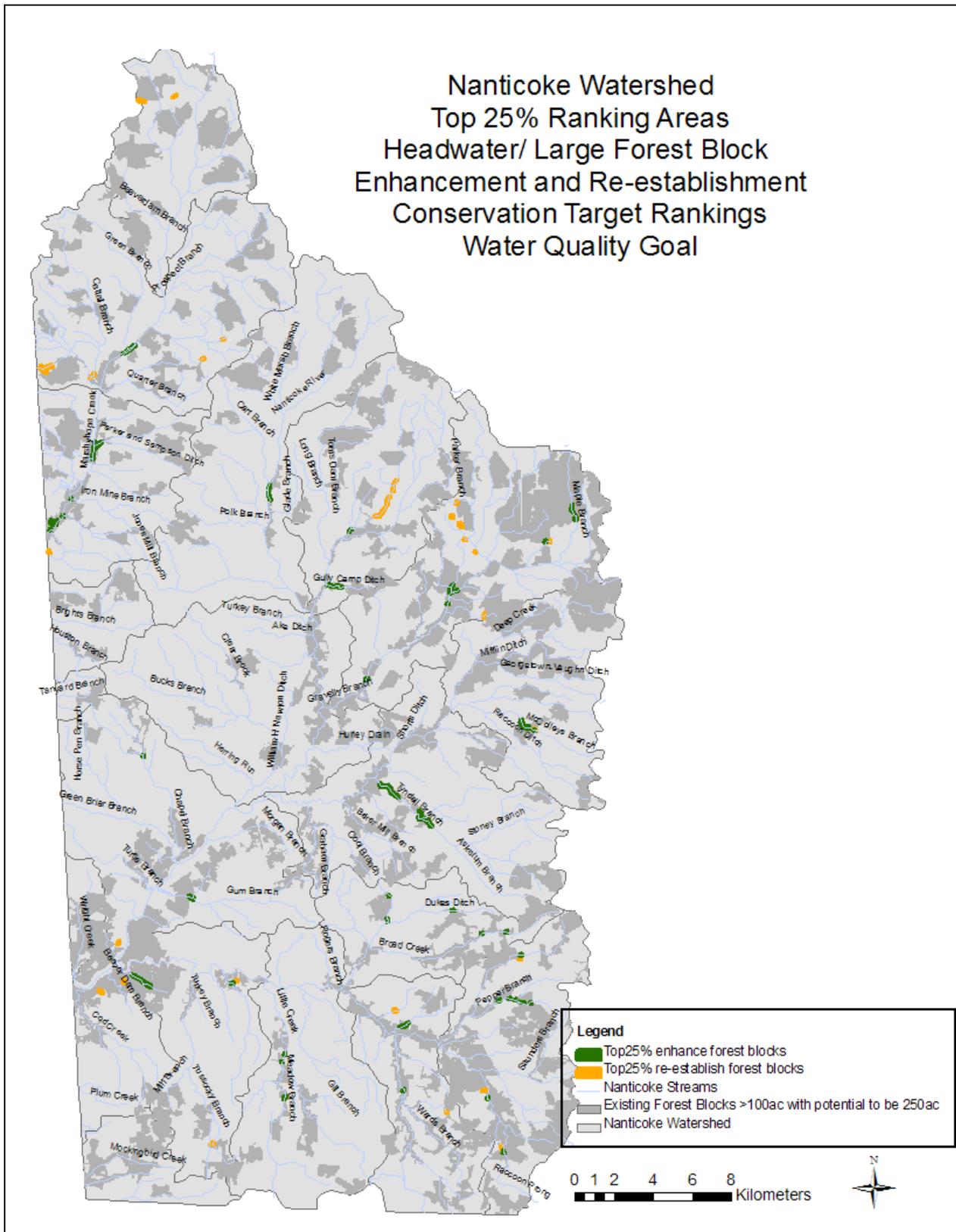


Figure 8. High priority areas for headwater/ large forest block enhancement and re-establishment to improve water quality in the Nanticoke River watershed, DE.

Table 8. High priority headwater forests/ large forest blocks enhancement opportunities for water quality goal. (Scores ranged from 2 – 61)

Total area of potential enhancement opportunities in Nanticoke Watershed: 14,463ha (35,739 acres) Wetland 12,176ha (30,087 acres) Upland	Top 25% (Score ≥ 45)
Enhancement area >0.5ha	79 ha (46 areas)
# Parcels >2 acres	103 (12 State Owned)
# Landowners	74
Priority area on protected lands	40 ha

Table 9. High priority headwater forests/ large forest blocks r-establishment opportunities for water quality goal. (Scores ranged from 0-50)

Total area of potential restoration opportunities in Nanticoke Watershed: 16,385ha (Wetland) 21,042ha (Upland)	Top 25% (Score ≥ 37)
Re-establishment area >0.5ha	40 ha (29 areas)
# Parcels >2 acres	63 (9 State Owned)
# Landowners	39
Priority area on protected lands	14 ha

Wildlife Habitat Program Goal Results

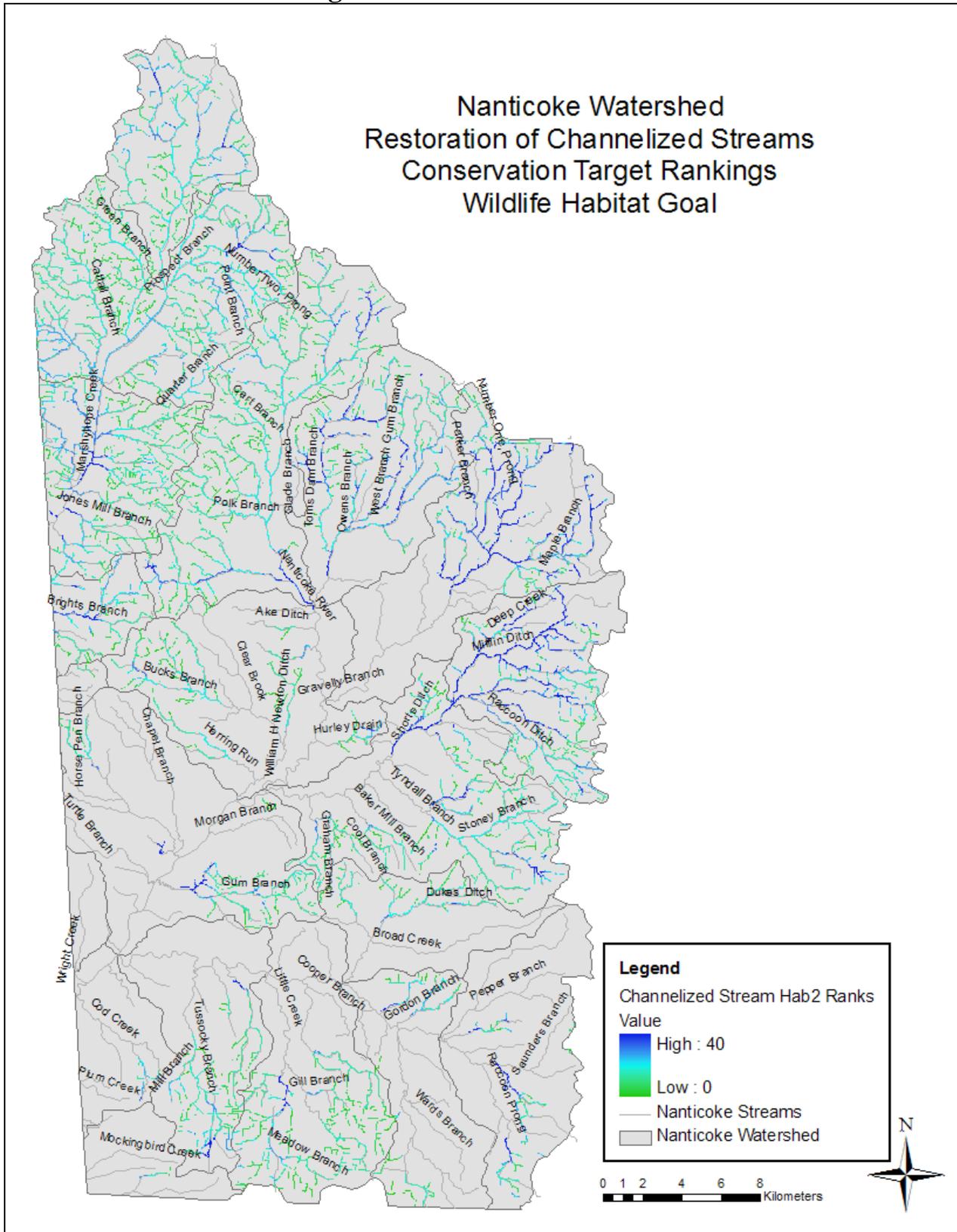


Figure 9. Restoration of channelized stream rankings to improve wildlife habitat in the Nanticoke River watershed, DE

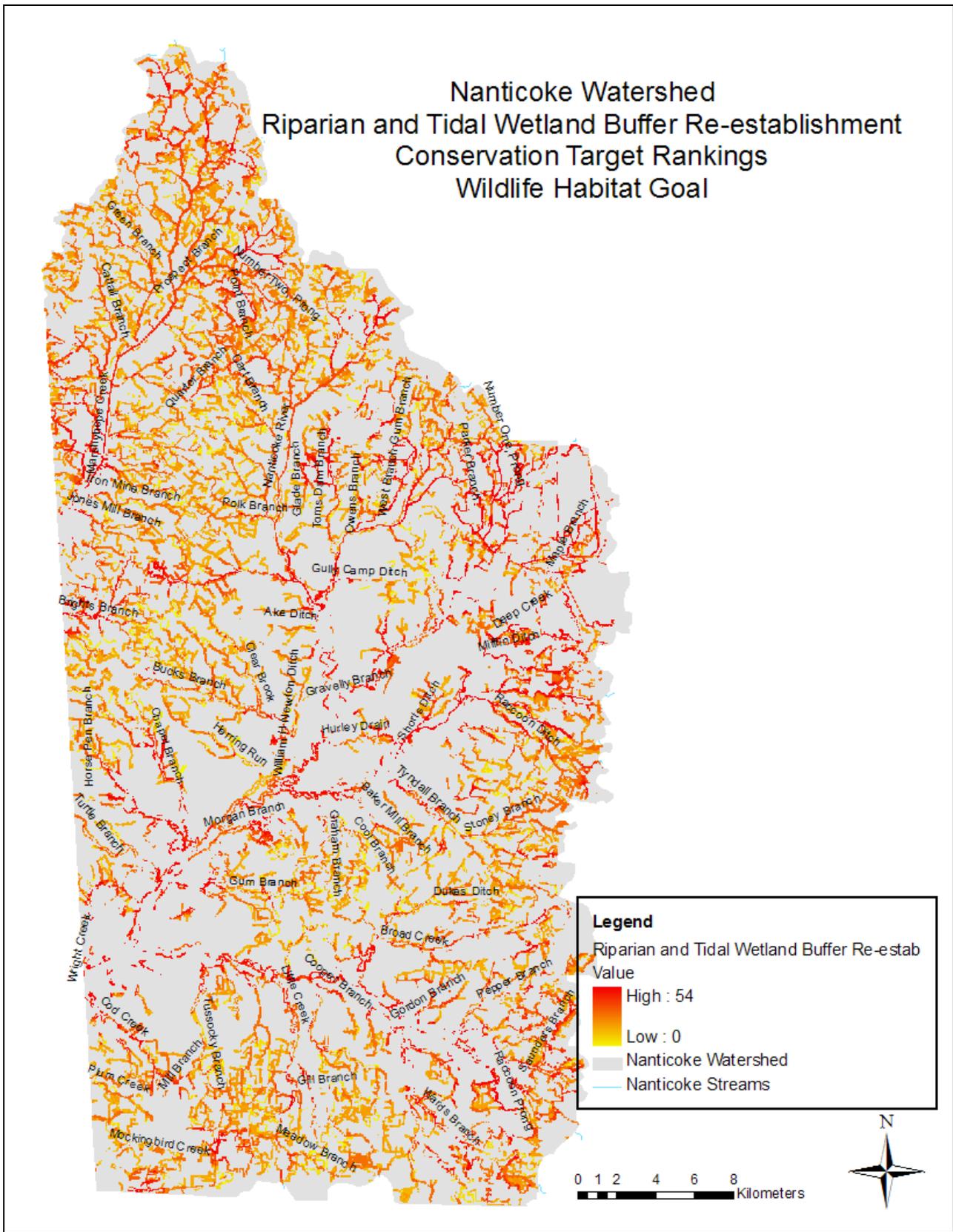


Figure 10. Riparian and tidal wetland buffer re-establishment rankings to improve wildlife habitat in the Nanticoke River watershed, DE

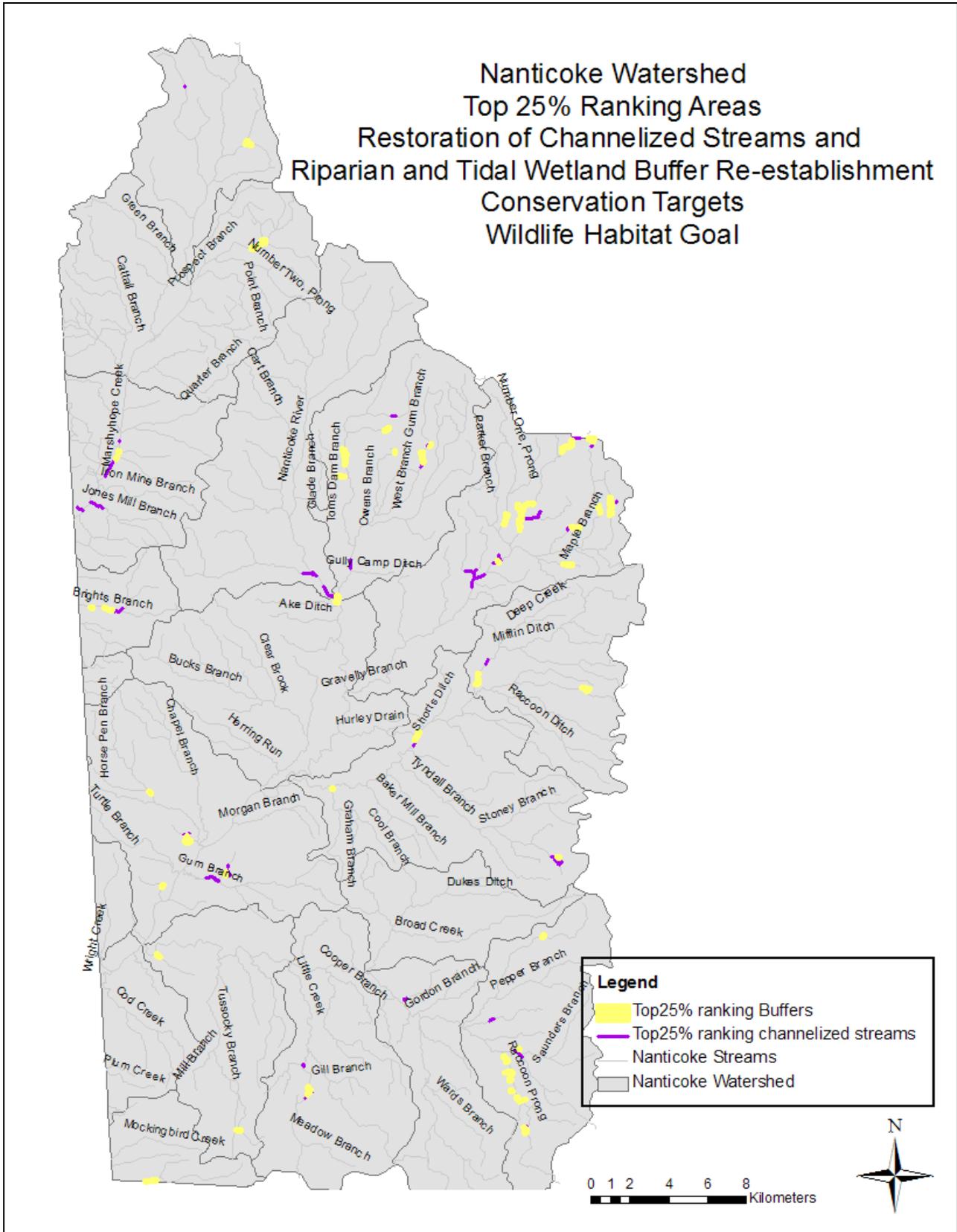


Figure 11. High priority areas for restoration of channelized streams and re-establishment of riparian and tidal wetland buffers to improve wildlife habitat in the Nanticoke River watershed, DE

Table 10. High priority channelized stream restoration opportunities for Habitat Goal. (Scores ranged from 0 to 40)

Total length of channelized streams in Nanticoke Watershed: 1,634 km	Top 25% (Scores ≥ 30)
Channelized stream length	34 km
# Parcels >2 acres	175 (26 State Owned)
# Landowners	116
# Parcels with >100m of priority stream	98 (57 >200)
Length on protected lands	16 km

Table 11. High priority riparian and tidal wetland buffer re-establishment opportunities for Habitat Goal. (Scores ranged from 0-54)

Total areas of potential buffer re-establishment in Nanticoke Watershed: 18,552 ha	Top 25% (Scores ≥ 40)
Buffer re-establishment area >0.25 ha	57 ha (70 areas)
# Parcels >2 acres	139 (20 State Owned)
# Landowners	98
Priority area on protected lands	22 ha

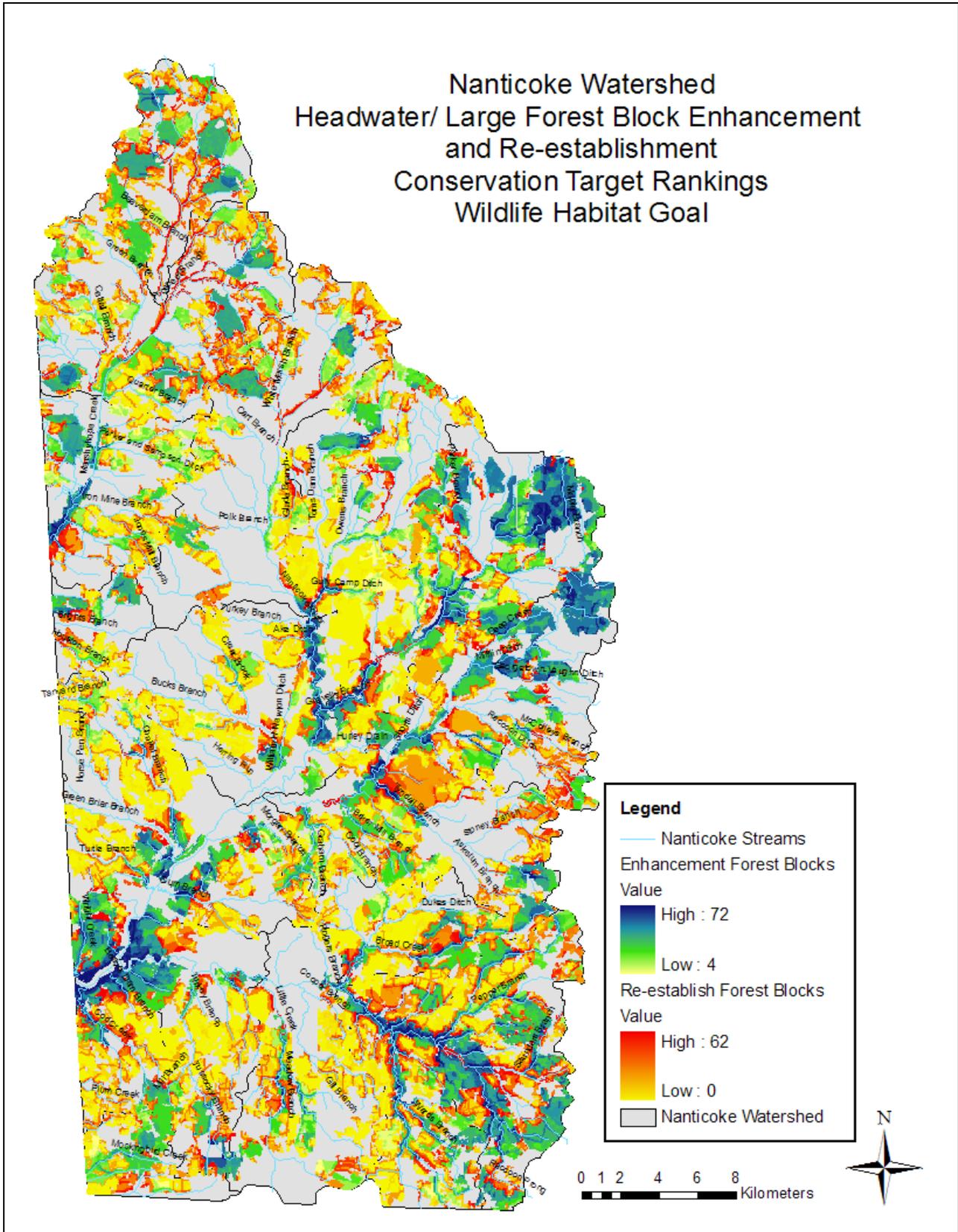


Figure 12. Headwater/ large forest block enhancement and re-establishment rankings to improve wildlife habitat in the Nanticoke River watershed, DE

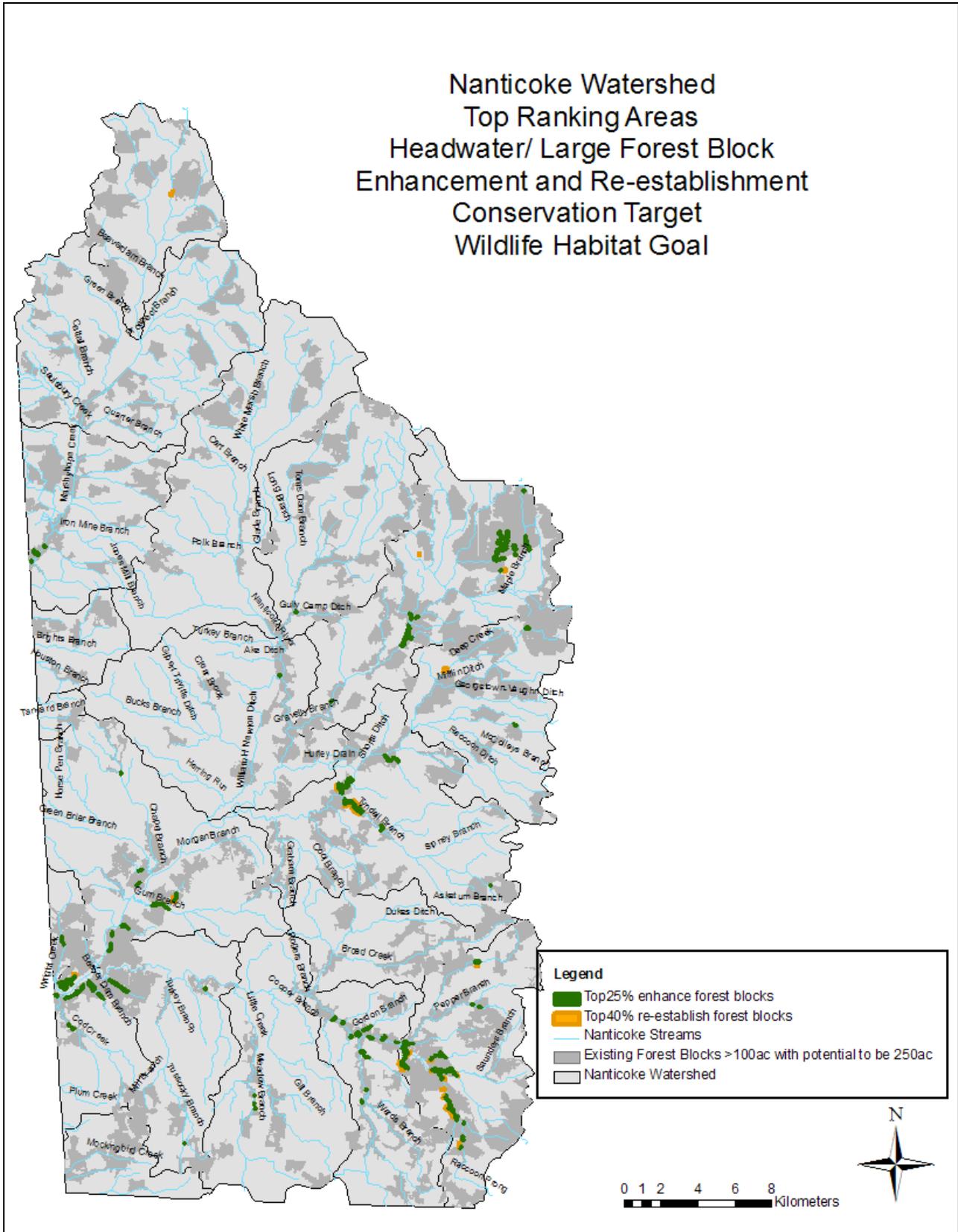


Figure 13. High priority areas for headwater/ large forest block enhancement and re-establishment to improve wildlife habitat in the Nanticoke River watershed, DE

Table 12. High priority headwater forests/ large forest blocks enhancement opportunities for Habitat Goal. (Scores ranged from 4 – 72)

Total area of potential enhancement opportunities in Nanticoke Watershed: 14,463ha (35,739 acres) Wetland 12,176ha (30,087 acres) Upland	Top 25% (Score >54)
Enhancement area >0.5 ha	285 ha (85 areas)
# Parcels >2 acres	159 (40 State Owned)
# Landowners	112
Priority area on protected lands	266 ha

Table 13. High priority headwater forests/ large forest blocks re-establishment opportunities for Habitat Goal. (Scores ranged from 0 – 62)

Total area of potential restoration opportunities in Nanticoke Watershed: 16,385ha (Wetland) 21,042ha (Upland)	Top 40%* (Scores \geq 37)
Re-establishment area >0.5ha	32 ha (28 areas)
# Parcels >2 acres	42 (15 State Owned)
# Landowners	22
Priority area on protected lands	11 ha

*40% used because the top 25% only comprised 4ha of high priority restoration area

Multiple Program Goal Results

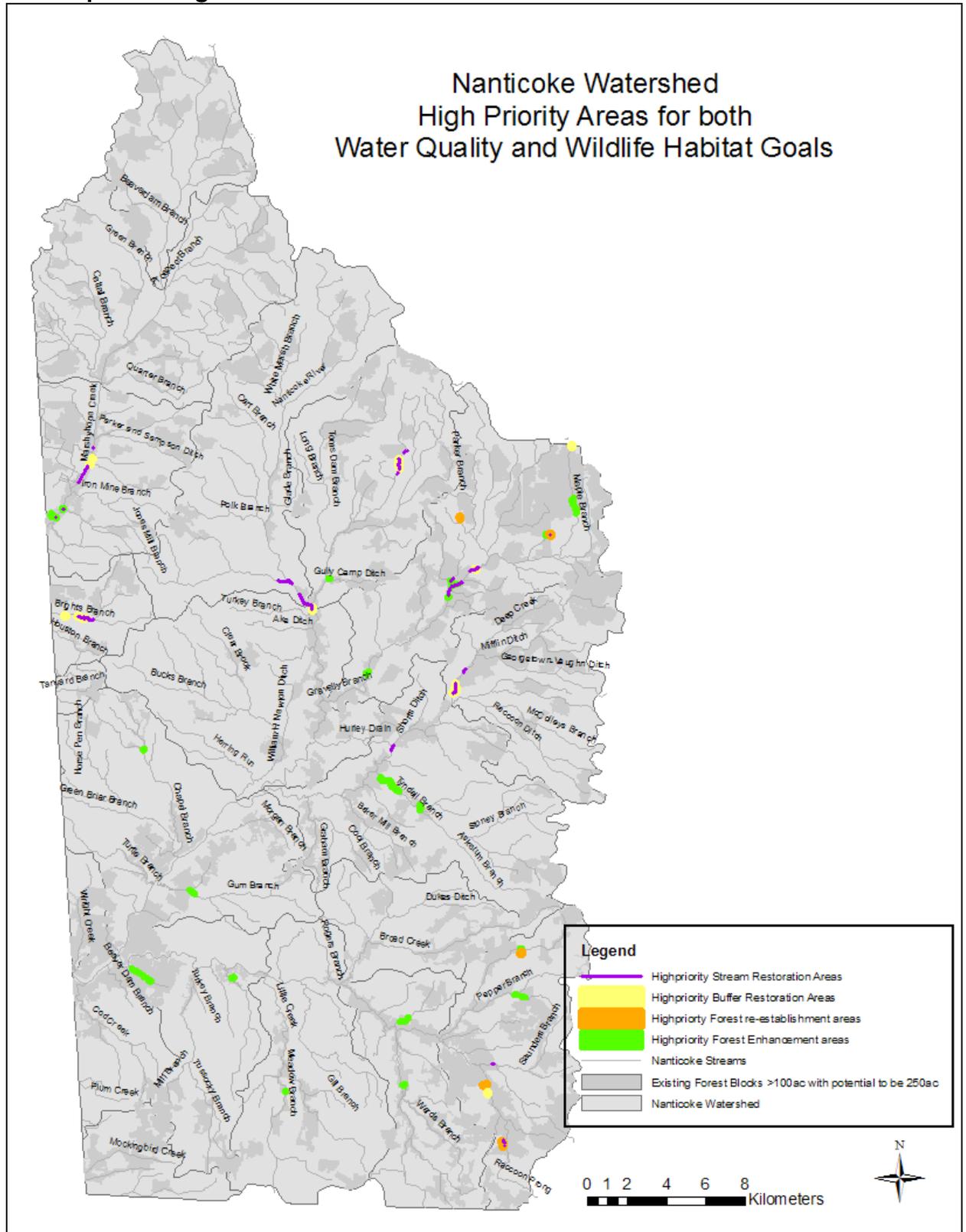


Figure 14. Highest priority areas for conservation targets that were in the top ranking percentiles for both water quality and wildlife habitat program goals. There are 41ha of high priority forest enhancement, 4ha of high priority forest re-establishment, 8ha of high priority buffer restoration, and 9km of stream restoration.

Implementation Plan

The Nanticoke Restoration Work Group will collaborate to engage landowners of priority conservation targets. Separate outreach plans will be developed to work with private landowners, and public and conservation landowners. This plan identified significant opportunities on public and private lands for restoration and enhancement. We will work with the owners and managers of these properties to identify the best restoration alternatives on their properties, to secure funding and to implement projects.

The Nanticoke watershed coordinator will perform targeted outreach to landowners in high priority areas to generate a list of projects by interested landowners. Landowner contact and coordination among work group members will be tracked using the National Biological Information Infrastructure (NBII) website to provide work group members access to restoration opportunities in high priority areas for each conservation target. The watershed coordinator will maintain the site to provide up to date information to provide easy access to projects as funds or grant opportunities arise.

Work group members will search for additional funding opportunities in addition to that provided by their specific programs to leverage funds and increase the number of projects that can be performed. Figure 15 provides a list of potential funding sources for wetland projects.

Federal Funding Sources for Wetland Projects

- *Five-Star Restoration Program*: provides funds to support community-based wetland and riparian restoration projects
- *National Coastal Wetlands Conservation Grant Program*: provides matching grants for conservation and restoration of coastal wetlands
- *NOAA Community-Based Restoration Program*: provides financial assistance for community based restoration of coastal wetlands
- *Partners for Fish and Wildlife Program*: provides financial assistance to private landowners to restore wetlands and habitat on their land
- *Coastal Wetlands Planning, Protection, and Restoration Act*: provides matching grants to coastal states to acquire, manage, restore and enhance wetlands
- *North American Wetlands Conservation Act Grant Program*: makes grants available to states and private organizations for wetland conservation
- *Wetlands Reserve Program*: provides financial incentives to private landowners for wetland conservation and restoration
- *Watershed Protection and Flood Protection Program*: provides technical and financial assistance to local governments for wetland restoration projects

Figure 15. Federal funding sources for restoration (From Capiella et al. 2006; Source: Kusler, 2003)

Assessment

The ecological improvement of implementing the Nanticoke Restoration Plan will be assessed by tracking the progress of work group members, assessing functions and services provided by individual restoration projects, and developing ecological integrity indicators for the watershed and

Nanticoke River including both habitat and water quality metrics. The watershed coordinator will track the progress of implementing projects that were identified in this plan by keeping updated records of the acreage and number of projects completed for each conservation target and posting this on the NBII website.

Individual sites will be assessed by the lead group performing the restoration if they have an established protocol. Additionally, work group members will develop standard protocols to assess the functions and services that restoration projects are providing and to track their change over time. The watershed coordinator will assess a subset of sites every year. This information will be used to evaluate specific construction techniques that were used to restore a site, to document the natural succession of sites in different landscapes, and to improve and inform future projects.

Work group members will develop indicators to track changes in the ecological integrity of the Nanticoke River and its watershed. Existing indicators for the watershed and other Chesapeake Bay tributaries will be compiled and evaluated to determine if they will provide the needed information to assess progress towards meeting the goal of the restoration plan. The watershed coordinator will provide an annual update on progress using information on the projects completed, site assessment results, and the watershed indicators.

References

- Cappiella, K., A. Kitchell. 2006. Using Local Watershed Plans to Protect Wetlands
Wetlands & Watersheds Article #2, Center for Watershed Protection **2**: 67.
- Chesapeake Bay Foundation (CBF). 1996. Nanticoke River Watershed: Natural and Cultural Resources
Atlas. Chesapeake Bay Foundation, Annapolis, MD.
- Compensatory Mitigation Rule. 2008.
http://www.epa.gov/owow/wetlands/pdf/wetlands_mitigation_final_rule_4_10_08.pdf
- Cappiella, K., T. Schueler, J. Tasillor, T. Wright. 2005. Adapting Watershed Tools to Protect Wetlands.
Article 3 of the Wetlands & Watersheds Article Series. Center for Watershed Protection. Ellicott
City, MD 21043. www.cwp.org
- DE DNREC. 1998. Total Maximum Daily Load (TMDL) Analysis for Nanticoke River and Broad Creek,
Delaware. Delaware Department of Natural Resources and Environmental Control, Dover, DE.
- Delaware Natural Heritage Program (DE NHP). 2006. Delaware Wildlife Action Plan 2007-2017. Delaware
Natural Heritage and Endangered Species Program, Delaware Division of Fish and Wildlife
Delaware Department of Natural Resources and Environmental Control, 89 Kings Highway Dover
DE 19901
- Kusler, J. 2003. Wetlands and Watershed Management – Wetlands, Riparian Areas, Floodplains: A Guide
for Local Governments. Publication No. 28. Association of State Wetland Managers. Berne, NY.
- Nanticoke Partnership Agreement. 2008.
<http://www.dnrec.delaware.gov/Info/Documents/NanticokeAgreement.pdf>
- Tiner, R., M. Starr, H. Bergquist and J. Swords. 2000. Watershed-based wetland characterization for
Maryland's Nanticoke River and Coastal Bays watersheds: a preliminary assessment report.
National Wetlands Inventory report. U.S. Fish and Wildlife Service, Northeast Region, Hadley, MA,
USA.
- Tiner, R., H. C. Bergquist, J. Q. Swords and B. J. McClain. 2001. Watershed-based wetland characterization
for Delaware's Nanticoke River watershed: a preliminary assessment report. National Wetlands
Inventory Report. U.S. Fish and Wildlife Service, Northeast Region, Hadley, MA, USA.
- Tiner, R. W. and Bergquist, J. Q. 2003. Historical Analysis of Wetlands and their Functions for the
Nanticoke River Watershed. A Comparison between Pre-settlement and 1998 Conditions. U.S. Fish
& Wildlife Service, National Wetlands Inventory, Hadley, MA.
([www.mde.state.md.us/Programs/WaterPrograms/Wetlands _Waterways/](http://www.mde.state.md.us/Programs/WaterPrograms/Wetlands_Waterways/)).
- Tiner, R. W. 2004. Remotely-sensed indicators for monitoring the general condition of “natural habitat” in
watersheds: an application for Delaware’s Nanticoke River watershed. *Ecological Indicators* 4:227-
243.
- TNC. 1998. Nanticoke River bioserve strategic plan. The Nature Conservancy, Bethesda, MD, USA.

Appendix A. GIS Layers used to develop the Nanticoke Restoration Plan

Shapefile	Source
Agricultural Preservation Program lands (lands enrolled in this program will remain in some form of agriculture (but can include natural habitats) and will not be developed	Delaware Department of Agriculture
Delaware Ecological Network (“Core” habitat areas, “hubs” and “corridors”)	The Conservation Fund
Element Occurrence Records (i.e., State Rare and Endangered species documented locations; birds buffered by 500 m, fish/shellfish and odonates buffered by 300 m with extension of buffer 1000 m up and down-stream, and all other species buffered by 300 m)	Element Occurrence Records provided as points shapefile by Delaware Division of Fish and Wildlife, Endangered Species and Natural Heritage Program.
Existing wetlands	Tiner, R. 2004. Remotely sensed indicators for monitoring the general condition of “natural habitat” in watersheds: an application for Delaware’s Nanticoke River watershed. Ecological Indicators 4: 227-243. Updated wetland layer based on 1998 photography.
Farmed wetlands	Delaware State Wetlands Mapping Program (SWMP) data developed by PhotoScience, Inc., through a contract with Delaware Dept. of Nat. Resources and Environmental Control
Forest blocks (including forest blocks \geq 250 ac; forest blocks \geq 100 ac with potential to become 250 ac through reforestation; and forest blocks \geq 100 ac with no potential to become 250 ac)	DE DNREC, Division of Parks and Recreation. 2004. Forest Blocks derived from 1997 and 2002 Aerial Photography.
Flood zones	FEMA flood zones labeled as Kent (May 5, 2003) and Sussex (January 6, 2005)
Groundwater Recharge Areas	Delaware Dept. of Natural Resources and Environmental Control
Impaired Streams (CWA, 303-D identified impaired streams; impaired for habitat, biology, nutrients, pathogens, dissolved oxygen, or temperature. Two layers used 1) impaired for habitat/biology; 2) impaired for water quality)	Delaware Department of Natural Resources and Environmental Control
Key wildlife habitat	DE DNREC, Division of Fish and Wildlife. 2006. Delaware Wildlife Action Plan. Dover, DE.
Parcels (parcel size derived from this layer; also parcels with existing restoration projects)	Kent and Sussex County Planning Office (June 2006), Kent and Sussex County Planning Office (2007)
Pine Plantations	Delaware Department of Natural Resources and Environmental Control
(Merged) Protected Lands	Delaware Department of Natural Resources and Environmental Control

Rare Bird Hotspots (areas predicted, through modeling, to support 21-27 species of Delaware State-listed/ranked endangered or rare (S1, S2, S3) birds)	U.S. Fish & Wildlife Service, Delaware Bay Estuary Project: Maryland-Delaware-New Jersey Gap Analysis Project
Soils (reclassified by degree of drainage, from hydric to non-hydric)	Natural Resource Conservation Service 2007 SURGGO, Kent and Sussex County, DE
SRA (State Resource Areas)	DE DNREC, Division of Parks and Recreation. 2006
Streams/ditches (including channelized streams and ditches, and natural streams)	Tiner, R. 2004. Remotely sensed indicators for monitoring the general condition of “natural habitat” in watersheds: an application for Delaware’s Nanticoke River watershed. Ecological Indicators 4: 227-243.
Tax Ditches	Delaware Department of Natural Resources, Division of Soil and Water
Undeveloped land	Derived from the DNREC DPR “developed land” layer (i.e. land within the state that isn’t developed) 2006.
Uplands (non-wetland/non-floodplain)	Derived from Existing Wetland and Flood Zone layers and includes all areas that aren’t classified as either wetlands or flood zones.
Unforested land	Derived from the forest block layer (i.e. land within the state that isn’t forested)
Wetlands lost	Tiner, R. 2005. Assessing cumulative loss of wetland functions in the Nanticoke River watershed using enhanced national Wetland Inventory data. Wetlands 25:405-419.
50 meter buffers of various stream layers listed above, within which restoration priorities were identified	Tom Saldyga (DE DNREC), Amy Jacobs (DE DNREC), Rick McCorkle (USFWS); GIS process
100 meter buffers of various layers listed above (e.g., Key Wildlife Habitats, Delaware Ecological Network, Forest Blocks, SRA, Rare Bird Hotspots); within which restoration priorities were identified to expand on and benefit these important habitat areas	Rick McCorkle (USFWS); GIS process

Appendix B. Analysis details used to identify conservation target opportunities

Analysis Target 1 – Headwater Forests/ Large Forest Blocks

1. *Union* - Wetlands lost with Uplands = Wetlands lost/Uplands
2. *Intersect* – Wetlands lost/Uplands with Undeveloped land = Wetlands lost/Uplands/Undeveloped
3. *Intersect* – Wetlands lost/Uplands/Undeveloped with Unforested land
4. Select polygons with a perimeter/area ratio ≤ 0.4 and delete to remove “slivers” = Wetlands lost/Uplands/Undeveloped/Unforested
5. *Intersect* – Wetlands lost/Uplands/Undeveloped/Unforested with Soils
6. Select polygons with a perimeter/area ratio ≤ 0.4 and delete
7. Select polygons ≥ 0.5 acres and adjacent and connecting to forest blocks greater than 100 acres = Potential reestablishment
8. Identified polygons within Potential reestablishment as either
 - a. Wetland – hydric/partially hydric soils
 - b. Upland – non-hydric soils
9. To determine forest blocks with potential to be 250 acres (area sufficient for quality wildlife habitat with minimum edge effects) - *Dissolve* – ‘Potential reestablishment
10. Start editing – explode features in newly dissolved layer; save edits, stop editing; calculate acres
11. Add text field ‘POT_250’ to forest block layer; *select by location* in forest block layer:
 - Forest polygons 100-125 acres that share a line segment with potential reestablishment (new dissolved/exploded layer) polygons ≥ 150 acres; calculate “Y” for POT_250 field
 - Forest polygons 125-150 acres that share a line segment with potential reestablishment (new dissolved/exploded layer) polygons ≥ 125 acres; calculate “Y” for POT_250 field
 - Forest polygons 150-175 acres that share a line segment with potential reestablishment (new dissolved/exploded layer) polygons ≥ 100 acres; calculate “Y” for POT_250 field
 - Forest polygons 175-200 acres that share a line segment with potential reestablishment (new dissolved/exploded layer) polygons ≥ 75 acres; calculate “Y” for POT_250 field
 - Forest polygons 200-225 acres that share a line segment with potential reestablishment (new dissolved/exploded layer) polygons ≥ 50 acres; calculate “Y” for POT_250 field
 - Forest polygons 225-250 acres that share a line segment with potential reestablishment (new dissolved/exploded layer) polygons ≥ 25 acres; calculate “Y” for POT_250 field
12. All forest block polygons with “Y” in the POT_250 field have the potential to expand to 250 acres of contiguous forest. Delete areas contiguous to blocks that DO NOT have the potential to become 250ac.

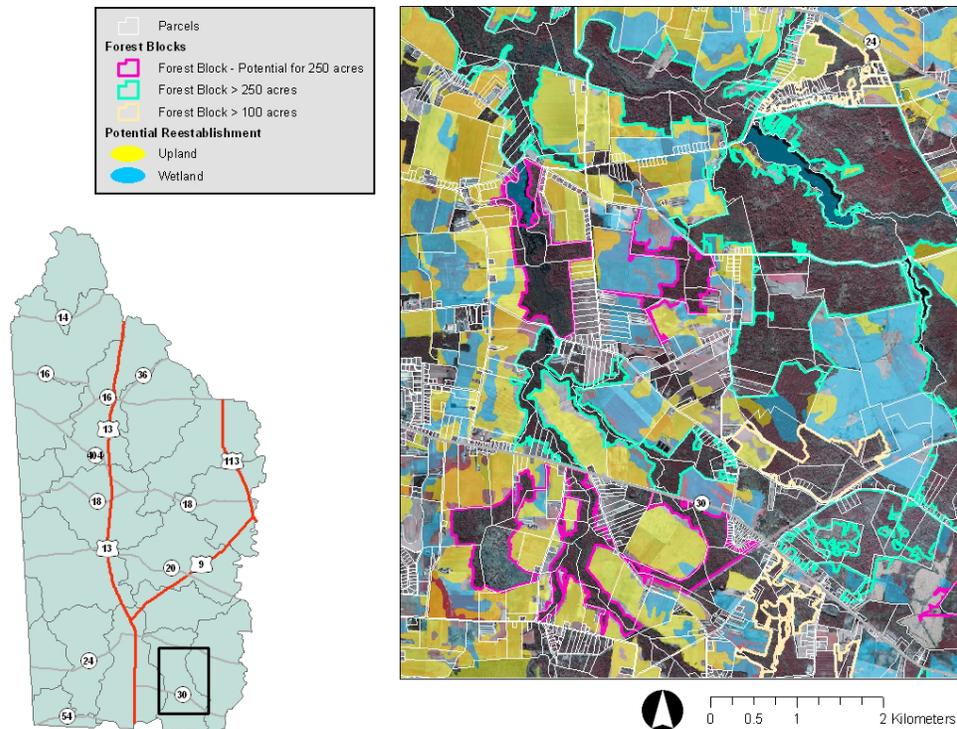


Figure 15 Forest block categories and potential reestablishment areas with parcel overlay

Analysis Target 2 – Restoration of Channelized Streams

1. Includes all segments from tax ditch layer (DE DNREC/ Division of Soil and Water/ Drainage Program)

Analysis Target 3 – Riparian and Tidal Wetland Buffers

1. *Buffer* Tiner streams/ ditches with 50m on each side
2. Select tidal wetlands and water (Riverine Tidal (R1) and vegetated tidal wetlands containing the modifier code "T"(semipermanent tidal), and lacustrine and palustrine (impounded) portions of the river and tributaries from SWMP data (seasonal and temporary tidal ("R" and "S") were not included)
3. *Buffer* tidal wetlands with 50m
4. All LULC polys, except for 410, 420, 430, 610 and 630 (deciduous forest, evergreen forest, mixed forest, non-tidal forested wetland and tidal forested wetland) selected from 2007 LULC, and converted to a raster grid, <non_forest>, with value = 0 representing non-forest, and "nodata" representing forest.
5. <non_forest> added to <wtr_tidl_buf>, the result being that "nodata" areas (representing forest) in <non_forest> clipped these [forested areas] out of <wtr_tidl_buf>, to produce <tidal_buf_nf>.
6. <wet_st_dt_buf> (from wetland_stream_ditch_50m_buffers(final-dissolve).shp) includes "buffer" areas that fall within tidal wetlands (i.e., the tidal river was buffered instead of the tidal wetlands adjacent to it), so original tidal wetlands merged with this grid, and the overlap from this merge was reclassified to remove those “buffer” areas that overlapped tidal wetlands.

7. Resulting grid from step 6 merged with <tidal_buf_nf> to produce final 50-m buffer grid, which includes buffers of streams and ditches, and buffers of other water and tidal wetlands (value = 0), with all other areas outside of buffers = nodata (this will allow for clipping of priority-setting results to only these non-forested buffer areas). The name of this final base layer/clip grid is <wtr_wet_buf>.

Appendix C. Stream Biology and Habitat Program Goal Rankings

Analysis Names: Chan_strbiohab Buf_strbiohab	Target: Restoration of Channelized Streams ("Chan" = channelized streams)	Target: Riparian and tidal wetland buffer establishment ("BUF" = Buffer re-establishment polygon)
Variable	Weight*	Weight*
Soils - hydric soils NRCS	0	4 ^a
Farmed Wetlands (from SWMP) within BUF polygon	NR	0
Flood Zones (CHAN or BUF in FEMA floodzone)	0	0 = outside floodzone, 1=0.2% chance of flood; 2 = 1% chance of flood
Conservation Planning		
The Conservation Fund DE Ecological Network (CHAN or BUF within or adjacent to)	corridors=1; non-core hub areas=3; core areas=5	corridors=2; non-core hub areas=4; core areas=6
Natural Heritage Information		
NHP Element Occurrence in CHAN or BUF ((buffered actual EO points by 500m for birds, 300 m for all other species, and extending 1000 m up and down stream for aquatic species - recommended by DE NHP)	10	8
GAP Rare Species Hotspots (areas with 21-27 species) (CHAN or BUF within or adjacent to)	10	10
Key wildlife habitat (CHAN or BUF within or adjacent to)	10	4
Streams/Ditches (Tiner) (<i>Natural, Excavated</i>)		
- ditches/ chanelized streams (within or adjacent to BUF and upstream of impaired segments)	Base layer	10
- natural streams (unchannelized) (within or adjacent to BUF)	NR	10
Surface Water Quality in Streams (TMDL data) specify criteria		
impaired for habitat or biology (adjacent to BUF)	Base layer	10
Groundwater Source Areas (CHAN or BUF in high groundwater source area)	0	0

*weight - weight from "10" (highest priority) to "1"(lowest priority), if a layer should not be included weight as "0"; (original group rankings from 1-5 were doubled when performing raster analysis to avoid any decimals).
NR = variable was not weighted for this conservation target

^aSoil weights: Soil information from Natural Resource Conservation Service 2007 SURGGO, Kent and Sussex County, DE

Drainage	Hydric	Weight
Poorly Drained	all hydric	4
Very poorly drained	all hydric	4
Very poorly drained	partially hydric	4
Well drained	unknown	0
Well drained	not hydric	0
Moderately well drained	not hydric	0
Excessively drained	not hydric	0
Somewhat excess. drained	not hydric	0
Somewhat excess. drained	unknown	0
Excessively drained	partially hydric	1
Moderately well drained	partially hydric	1
Well drained	partially hydric	1
Poorly drained	partially hydric	3
somewhat poorly drained	partially hydric	2
somewhat poorly drained	unknown	2

Appendix D. Water Quality Program Goal Rankings

Analysis Names: Chan_WQ Buf_WQ Enhance_WQ Reestab_WQ	Target: Restoration of Channelized Streams ("Chan" = channelized streams)	Target: Riparian and tidal wetland buffer establishment ("BUF" = Buffer re- establishment polygon)	Target: Enhancement of headwater large forests ("FBE" = Forest block enhancement polygon)	Target: Re- establishment of headwater large forests ("PRE" = potential re- establishment polygon)
Variable	Weight*	Weight*	Weight*	Weight*
Forest Blocks (criteria of forest blocks for FBE and adjacent forest blocks for PRE)				
>250ac	NR	NR	6	6
>100 with potential to become 250 with re-establishment	NR	NR	10	10
>100 with no potential to become 250	NR	NR	2	2
Forest cover type - pine plantations	NR	NR	0	8
Soils - hydric soils NRCS	6 ^a	5 ^b	6 ^a	0
Farmed Wetlands (from SWMP) within CHAN, BUF, or PRE polygon	NR	10	NR	10
Flood Zones (CHAN, BUF, FBR, or PRE in FEMA floodzone)	0	0 = outside floodzone, 1=0.2% chance of flood; 2 = 1% chance of flood	0	0
Conservation Planning				
The Conservation Fund DE Ecological Network (CHAN, BUF, FBR, or PRE within or adjacent to)	corridors=6; non-core hub areas=8; core areas=10	corridors=6; non-core hub areas=8; core areas=10	corridors=6; non-core hub areas=8; core areas=10	corridors=6; non-core hub areas=8; core areas=10
Natural Heritage Information				
NHP Element Occurrence in CHAN, BUF, FBR, or PRE ((buffered actual EO points by 500m for birds, 300 m for all other species, and extending 1000 m up and down stream for aquatic species - recommended by DE NHP)	5	5	5	5
GAP Rare Species Hotspots (areas with 21-27 species) (CHAN, BUF, FBR, or PRE within or adjacent to)	5	5	5	5

Analysis Names: Chan_WQ Buf_WQ Enhance_WQ Reestab_WQ	Target: Restoration of Channelized Streams ("Chan" = channelized streams)	Target: Riparian and tidal wetland buffer establishment ("BUF" = Buffer re- establishment polygon)	Target: Enhancement of headwater large forests ("FBE" = Forest block enhancement polygon)	Target: Re- establishment of headwater large forests ("PRE" = potential re- establishment polygon)
Key wildlife habitat (CHAN, BUF, FBR, or PRE within or adjacent to)	5	5	5	5
Streams/Ditches (Tiner) (Natural, Excavated)				
- ditches (historically not a stream) within or adjacent to CHAN, BUF, FBR, or PRE	NR	10	10	10
- channelized streams within or adjacent to CHAN, BUF, FBR, or PRE	Base Layer	10	10	10
- natural streams (unchannelized) CHAN, BUF, FBR, or PRE	NR	10	10	10
Surface Water Quality in Streams (TMDL data)				
- Impaired for O2, Temp, Bacteria or Nutrients (impaired segment within or adjacent to CHAN, BUF, FBR, or PRE)	2	2	2	2
- impaired for habitat or biology (impaired segment within or adjacent to CHAN, BUF, FBR, or PRE)	10	10	10	10
Groundwater Source Areas (CHAN, BUF, FBR, or PRE in high groundwater source area)	0	0	water area = 0; poor = 0; fair = 2; good = 4; excellent = 6	water area = 0; poor = 0; fair = 2; good = 4; excellent = 6
Wetland Condition in subwatershed of FBE or PRE				
- good condition	NR	NR	4	4
- fair condition	NR	NR	8	8
- poor condition	NR	NR	10	10

*weight - weight from "10" (highest priority) to "1"(lowest priority), if a layer should not be included weight as "0"; (original group rankings from 1-5 were doubled when performing raster analysis to avoid any decimals).

NR = variable was not weighted for this conservation target

^aSoil weights for Channelized Stream Target

Soil information from Natural Resource Conservation Service 2007 SURGGO, Kent and Sussex County, DE

Drainage	Hydric	Weight
Poorly Drained	all hydric	6
Very poorly drained	all hydric	6
Very poorly drained	partially hydric	6
Well drained	unknown	0
Well drained	not hydric	0
Moderately well drained	not hydric	0
Excessively drained	not hydric	0
Somewhat excess. drained	not hydric	0

Somewhat excess. drained	unknown	0
Excessively drained	partially hydric	1
Moderately well drained	partially hydric	1
Well drained	partially hydric	1
Poorly drained	partially hydric	4
somewhat poorly drained	partially hydric	2
somewhat poorly drained	unknown	2

^bSoil Weights for Buffer and Forest Block Enhancement Target

Soil information from Natural Resource Conservation Service 2007 SURGGO, Kent and Sussex County, DE

Drainage	Hydric	Weight
Poorly Drained	all hydric	5
Very poorly drained	all hydric	5
Very poorly drained	partially hydric	5
Well drained	unknown	0
Well drained	not hydric	0
Moderately well drained	not hydric	0
Excessively drained	not hydric	0
Somewhat excess. drained	not hydric	0
Somewhat excess. drained	unknown	0
Excessively drained	partially hydric	1
Moderately well drained	partially hydric	1
Well drained	partially hydric	1
Poorly drained	partially hydric	3
somewhat poorly drained	partially hydric	2
somewhat poorly drained	unknown	2

Appendix E. Wildlife Habitat Program Goal Rankings

Analysis Names: Chan_HAB Buf_HAB Enhance_HAB Reestab_HAB	Target: Restoration of Channelized Streams ("Chan" = channelized streams)	Target: Riparian and tidal wetland buffer establishment ("BUF" = Buffer re- establishment polygon)	Target: Enhancement of headwater large forests ("FBE" = Forest block enhancement polygon)	Target: Re- establishment of headwater large forests ("PRE" = potential re- establishment polygon)
Variable**	Weight*	Weight*	Weight*	Weight*
Forest Blocks (criteria of forest blocks for FBE and adjacent forest blocks for PRE)				
>250ac	NR	NR	10	0
>100 with potential to become 250 with re-establishment	NR	NR	8	0
>100 with no potential to become 250	NR	NR	4	0
Forest cover type - pine plantations	NR	NR	0 (note: not included in base layer)	0
Top 25% ranking areas for FBE target	NR	NR	NR	10
Soils - hydric soils NRCS	6 ^a	4 ^c	6 ^a	4 ^c
Farmed Wetlands (from SWMP) within CHAN, BUF, or PRE polygon	NR	0	NR	0
Flood Zones (CHAN, BUF, FBR, or PRE in FEMA floodzone)	0 = outside floodzone, 1=0.2% chance of flood; 2 = 1% chance of flood	0 = outside floodzone, 2=0.2% chance of flood; 4 = 1% chance of flood	0 = outside floodzone, 2=0.2% chance of flood; 4 = 1% chance of flood	0 = outside floodzone, 2=0.2% chance of flood; 4 = 1% chance of flood
Conservation Planning				
The Conservation Fund DE Ecological Network (CHAN, BUF, FBR, or PRE within or adjacent to)	corridors=4; non-core hub areas=6; core areas=8	corridors=4; non-core hub areas=6; core areas=8	corridors=4; non-core hub areas=6; core areas=8	corridors=4; non-core hub areas=6; core areas=8
Natural Heritage Information				
NHP Element Occurrence in CHAN, BUF, FBR, or PRE ((buffered actual EO points by 500m for birds, 300 m for all other species, and extending 1000 m up and down stream for aquatic species - recommended by DE NHP)	10	10	10	10

Analysis Names: Chan_HAB Buf_HAB Enhance_HAB Reestab_HAB	Target: Restoration of Channelized Streams ("Chan" = channelized streams)	Target: Riparian and tidal wetland buffer establishment ("BUF" = Buffer re- establishment polygon)	Target: Enhancement of headwater large forests ("FBE" = Forest block enhancement polygon)	Target: Re- establishment of heardwater large forests ("PRE" = potential re- establishment polygon)
GAP Rare Species Hotspots (areas with 21-27 species) (CHAN, BUF, FBR, or PRE within or adjacent to)	8	8	8	8
Key wildlife habitat (CHAN, BUF, FBR, or PRE within or adjacent to)	6	6	6	6
Streams/Ditches (Tiner) (Natural, Excavated)				
- ditches (historically not a stream) within or adjacent to CHAN, BUF, FBR, or PRE	NR	8	6	8
- channelized streams (tax ditches) within or adjacent to CHAN, BUF, FBR, or PRE	Base Layer	8	6	8
- natural streams (unchannelized) CHAN, BUF, FBR, or PRE	NR	10	10	10
Surface Water Quality in Streams (TMDL data)				
- Impaired for O2, Temp, Bacteria or Nutrients (impaired segment within or adjacent to CHAN, BUF, FBR, or PRE)	0	0	0	0
- impaired for habitat or biology (impaired segment within or adjacent to CHAN, BUF, FBR, or PRE)	0	0	0	0
Groundwater Source Areas (CHAN, BUF, FBR, or PRE in high groundwater source area)	0	0	0	0
Wetland Condition in subwatershed of FBE or PRE				
- good condition	NR	NR	2	0
- fair condition	NR	NR	4	0
- poor condition	NR	NR	6	0
Additional layer suggestions:				

*weight - weight from "10" (highest priority) to "1"(lowest priority), if a layer should not be included weight as "0"; (original group rankings from 1-5 were doubled when performing raster analysis to avoid any decimals).

NR = variable was not weighted for this conservation target

** Adjacent defined as 100m

*Soil Weights for Channelized Stream Target

Soil information from Natural Resource Conservation Service 2007 SURGGO, Kent and Sussex County, DE

Drainage	Hydric	Weight
Poorly Drained	all hydric	6
Very poorly drained	all hydric	6
Very poorly drained	partially hydric	6

Well drained	unknown	0
Well drained	not hydric	0
Moderately well drained	not hydric	0
Excessively drained	not hydric	0
Somewhat excess. drained	not hydric	0
Somewhat excess. drained	unknown	0
Excessively drained	partially hydric	1
Moderately well drained	partially hydric	1
Well drained	partially hydric	1
Poorly drained	partially hydric	4
somewhat poorly drained	partially hydric	2
somewhat poorly drained	unknown	2

*Soil Weights for Channelized Stream Target

Soil information from Natural Resource Conservation Service 2007 SURGGO, Kent and Sussex County, DE

Drainage	Hydric	Weight
Poorly Drained	all hydric	4
Very poorly drained	all hydric	4
Very poorly drained	partially hydric	4
Well drained	unknown	0
Well drained	not hydric	0
Moderately well drained	not hydric	0
Excessively drained	not hydric	0
Somewhat excess. drained	not hydric	0
Somewhat excess. drained	unknown	0
Excessively drained	partially hydric	1
Moderately well drained	partially hydric	1
Well drained	partially hydric	1
Poorly drained	partially hydric	3
somewhat poorly drained	partially hydric	2
somewhat poorly drained	unknown	2

Appendix F. Other Data Layers

These data layers were not used in the analysis to prioritize areas for restoration but could be used to evaluate opportunity in high ranking sites to meet certain program needs.

- Location of existing restoration projects
- Tax parcel size
- State Resource Areas
- Properties enrolled in agriculture preservation program
- Public owned land