ALBEMARLE RESOURCE CONSERVATION AND DEVELOPMENT COUNCIL, INC

# Little River Watershed

## Nine-Element Restoration Plan

**2/18/2015**

The Little River Watershed Nine-Element Restoration Plan was developed by the Albemarle Resource Conservation and Development Council through a grant from the NC Division of Water Quality to the Albemarle Commission. The U.S. Environmental Protection Agency provided the grant funds under Sections 604(b) and 205(j) of the Clean Water Act.

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## INTRODUCTION

The Albemarle Commission (AC), Albemarle Resource Conservation and Development Council (ARCD), Perquimans and Pasquotank Counties, Soil and Water Conservation Districts (SWCD), Elizabeth City State University (ECSU), Elizabeth City Bass Masters (ECBM), and local community groups are working together to restore the Little River watershed (HU-10), which includes about eight miles of Impaired river (NCDWQ, 2012). The 86,000 acre watershed was once rich in biodiversity with key anadromous fish and shellfish areas, and swamp forests critical to support native fish and wildlife, mitigate flooding, and protect water quality. To help restore the Little River's biodiversity, the partnership is developing a number of activities including construction of in-stream wetlands on main drainage canals flowing into the Little River, restoration of natural hydrology in riparian buffers, conservation of riparian buffers, construction of fish habitat, improved public access, public outreach and environmental education, and monitoring and research.

The goals of the project are:

- Develop a dynamic public-private partnership of local governments, local, state and federal agencies, non-profit groups, community groups, universities and high schools working to conserve and restore the Little River.
- Construct in-stream wetlands on drainage canals throughout the watershed, which will be the key Best Management Practice (BMP) for improving water quality.
- Develop an effective water quality and fisheries monitoring program to measure project impacts.
- Create active public participation in conservation and restoration activities.
- Develop practical and useful communication tools for public outreach and education.
- Create a practical framework for restoring similar watersheds in eastern North Carolina.

This nine-element restoration plan will help guide efforts to restore the Little River watershed. The plan's implementation will address the causes of Impairment by working directly with farmers, homeowners and businesses in the watershed to reduce sediment and nutrient loading from agricultural operations and stormwater. An outreach and education program will increase public awareness of and participation in conservation and restoration of riparian buffers. A water quality and fisheries monitoring program will help strengthen state and federal monitoring programs in the watershed.

## ELEMENT 1.

An **identification of the causes and sources** or groups of similar sources that will need to be controlled to achieve the load reductions estimated in the watershed.

A number of stakeholder meetings were held in 2013 and 2014 to identify problems, solutions and key partners for improving water quality in the watershed.

***Stakeholder Meetings***

- Two stakeholder meetings were held in 2013 in Elizabeth City with representatives from ARCD, Perquimans and Pasquotank Counties, SWCD, ECSU, ECBM, NC Division of Marine Fisheries (DMF), DWQ, and Northeast High School. These meetings led to the development of an outline for restoration activities in the Little River watershed including a strategy for applying for grant funding. The grant application for the nine-element restoration plan was a product of these meetings.
- A stakeholder meeting was held in March, 2014 with local farmers and representatives from ARCD and Pasquotank S&W. Best Management Practices (BMPs) were discussed for managing stormwater from agricultural lands that drain directly into the Little River. The BMP options have been developed and incorporated into the nine-element restoration plan in Element 2.
- A stakeholder meeting was held May 27$^{th}$, 2014 in Elizabeth City to discuss water quality monitoring and improvements to fisheries on the Little River. Participants included Michael Loeffler, Biologist with NCDMF, Kevin Dockendorf, Coastal Research Coordinator with NCWRC, Heather Jennings, NCDWQ, Jeffrey Rousch, Professor at ECSU, Dwane Hinson, Pasquotank SWCD, Scott Alons, Perquimans SWCD, Rodney Johnson, Chairman, ARCD, and Mark Powell, Natural Resources Management Consultant. Discussions focused on monitoring river herring, which moves in coastal, joint and inland waters. The water quality monitoring program would measure improvements from BMPs, in particular Chlorophyll *a*. The fisheries monitoring program would determine the correlation between water quality and stocks of herring. A related study would be to determine the correlation between stocks of herring and stocks of other fish species. Focusing the monitoring on herring also would increase grant opportunities from both state and federal sources.
- Future stakeholder meetings will include ARCD, Soil and Water, ECMB, ECSU, DWQ, DMF, and Wildlife Resources to develop and coordinate water quality and fisheries habitat improvement, and monitoring activities.
- Landowners will be contacted in early 2015 to inform them of opportunities to enroll their riparian buffers in a voluntary conservation agreement in exchange for grant incentives.

***Watershed Function*.** Beneficial watershed characteristics and watershed function.

The Little River watershed covers the boundary of Pasquotank and Perquimans counties, from remnants of the Great Dismal Swamp in the north to the Albemarle Sound in the south. The watershed was once rich in biodiversity with key anadromous fish and shellfish areas, and swamp forests critical to support native fish and wildlife, mitigate flooding, and protect water quality (Figures 1-4). The river is used for recreational fishing, commercial crabbing and watersports. However, according to fisherman in the ECBM and local residents, water quality and fisheries have declined significantly over the past 10 years or so.

Unique characteristics of the watershed as defined by the *NC Biodiversity Wildlife Habitat Assessment* and other sources include:

- Approximately 5,300 acres of Strategic Habitat Area.

- Approximately 2,500 acres and 17,000 acres of Exceptional and Substantial wetlands, respectively.
- Approximately 7.5 square miles of Critical anadromous fish spawning areas.
- Submerged Aquatic Vegetation along the Albemarle Sound (433 acres Patchy and 107 acres Dense)
- Nine animal, plant and natural communities identified by the NC Natural Heritage Program.
- Shortnose and Atlantic Sturgeon on the Endangered Species list, Grassleaf Arrowhead on the Federal Species of Concern list, and Bald Eagles under the Bald and Golden Eagle Protection Act.

Nature Tourism

- The Little River and Big Flatty Creek are included in the Albemarle Regional Paddle Trail System (Figures 5-7). The restoration plan will include a strategy for removing trash and debris from the Little River and creeks, and improving paddler access and recreational opportunities throughout the watershed. Information on the Albemarle Regional Paddle Trail System may be found on the Albemarle RC&D Council's website: www.albemarlercd.org

***Stressors*** (causes of impairment). Physical, chemical and/or biological sources degrading the watershed function.

Agricultural operations and residential and commercial development have significantly impacted water quality and fisheries in the watershed. Agricultural operations have opened drainage canals that directly carry sediments and nutrients to the river, and residential and commercial developments have increased pollution from stormwater runoff. Swamp forests, especially in the headwaters of a watershed can function to reduce erosion, flooding, sedimentation, algal blooms, and fish kills downstream (NCCHPP, 2010). Swamp forest buffers throughout the watershed have been eliminated or severely degraded in many locations along the river. As a result, the upper and lower sections of the Little River have been included at different times on the 303(d) list of Impaired waters, beginning in 1998 with the upper section of the river from its source to Halls Creek (12 mi.) for low DO. A TMDL does not exist for the watershed.

In 2012, a section of the Little River from SR 1225 to Halls Creek (8 miles), was listed Impaired in the aquatic life category (NCDWQ, 2012). Over the course of the five-year assessment period, nearly 11 percent of samples were above the water quality standard for Chlorophyll *a* indicating nutrient enrichment in this segment of the river. The lower Little River, from Halls Creek to the Albemarle Sound (6,264 acres), was not sampled during this assessment period.

In 2002, DWQ developed four broad restoration goals for the Pasquotank River Basin (NCDWQ, 2002). Each goal reflected the DWQ's watershed restoration strategy to focus restoration projects within local watersheds in order to address water quality impacts from nonpoint source pollution. The goals also reflected the DWQ's focus on restoring wetland and riparian areas, enhancing water quality, increasing storage of floodwaters, and improving fish and wildlife habitat. The restoration goals for the Pasquotank River Basin include:

- Restore ditched wetlands to improve the habitat, fishery and flood control functions of these wetlands.
- Reduce sediment loading and other pollutants from surface runoff by increasing the soil retention, filtration, and nutrient uptake functions of wetland and riparian areas.
- Contribute to the re-opening of closed (posted) shellfish waters within certain tidal creeks.
- Restore and protect wildlife corridors and other key links to high-value habitat areas.
- Restore and protect natural breeding, nesting and feeding habitat to promote species richness and diversity.

In 2007, DWQ recommended that the upper 2.8 miles of the Little River be removed from the 2008 303(d) list of Impaired waters as a result of a benthic bioclassification (NCDWQ, 2007). However, Little River [AU# 30-5-(1)b], from SR 1225 (one mile downstream of SR 1221) to Halls Creek was listed on the 2008 303(d) list for a water quality standards violation. Lower Little River [AU# 30-5-(2)] remained on the 2008 303(d) list of Impaired waters of Chlorophyll *a* for further assessment of DO and swamp drainage affects. DWQ noted that expanded residential and commercial development had significantly changed the Little River watershed. DWQ provided the following recommendations for the watershed:

- Develop stormwater management programs for new development and to retrofit existing development.
- Establish riparian buffers, as needed throughout the basin, both in residential and agricultural land use areas.
- Reestablish natural drainage and associated wetlands to reduce stormwater runoff, assist with flood control and improve water quality.
- Support the development and implementation of best management practices (BMPs) to help reduce nonpoint source pollution. Monitoring of these BMPs should also be required to improve maintenance, design and functionality. BMPs applicable in residential areas need to be encouraged through public education campaigns.
- Watershed education programs should be implemented and continued by local governments with the goal of reducing current stream damage and preventing further degradation.

In 2012, Pasquotank County adopted a Coastal Area Management Act (CAMA) Advanced Core Land Use Plan, which includes the following water quality policies:

- Ensure that water quality in coastal wetlands, rivers, streams, and estuaries is maintained if not impaired and improved if impaired.
- Establish land use categories that maximize the protection of open shell fishing waters and that assist with the restoration of any closed shell fishing waters.
- Encourage the use of Best Management Practices for agriculture and land development.

The landuse in the upper and middle watershed along the Impaired section of river is summarized in the following table.

| | | | | | | |
|---|---|---|---|---|---|---|
| **Little River Watershed** | **HUC10** | | | | | |
| | 301020505 | | | | | |
| **Subwatershed Name** | **HUC12** | **Watershed Total Area (acre)** | | | | |
| Upper Little River | 30102050501 | 12,235 | | | | |
| Rabbit Corner-Middle Little River | 30102050502 | 29,983 | | | | |
| | | **42,218** | | | | |
| | | | | | | |
| **Landuse area (acres)** | | | | | | |
| **Subwatershed Name** | **Urban** | **Cropland** | **Pastureland** | **Forest** | **Water** | **Others** |
| Upper Little River | 635 | 9,150 | 729 | 150 | - | 1,571 |
| Rabbit Corner-Middle Little River | 1,452 | 17,052 | 2,701 | 2,258 | 107 | 6,411 |
| | **2,088** | **26,203** | **3,430** | **2,408** | **107** | **7,982** |
| | | | | | | |
| **Agricultural Animals** | | | | | | |
| **Subwatershed Name** | **Beef Cattle** | **Dairy Cattle** | **Swine** | **Sheep** | **Horse** | **Chicken** |
| Upper Little River | 21 | 0 | 200 | 14 | 7 | 7 |
| Rabbit Corner-Middle Little River | 75 | 0 | 683 | 54 | 27 | 27 |
| | **96** | | **883** | **68** | **34** | **34** |
| | | | | | | |
| **Septic System data** | | | | | | |
| **Subwatershed Name** | **Septic Systems** | **Pop per System** | **% Septic Failure Rate** | | | |
| Upper Little River | 472 | 2 | 0.59 | | | |
| Rabbit Corner-Middle Little River | 561 | 2 | 0.59 | | | |
| | **1,033** | | | | | |

## Watershed Forest Loss and Gain

Forest riparian buffers have been degraded or eliminated in the Little River watershed over many years and a wood pellet mill in Ahoskie is increasing demand for wood from wetland forests within a 75 mile radius of the plant:
http://www.nrdc.org/energy/forestnotfuel/files/enviva-wood-pellets-FS.pdf
A new on-line mapping tool is available from *Earth Engine Partners* to track forest cover loss and gain going forward (Hansen et al. 2013). Figure 8 shows forest loss and gain in the watershed for the period 2000 to 2012. Data is available on-line from: http://earthenginepartners.appspot.com/science-2013-global-forest.

Another tool for tracking forest change is *ForWarn*, a satellite-based forest disturbance monitoring system for the conterminous United States. It delivers new forest change products every eight days and provides tools for attributing abnormalities to insects, disease, wildfire, storms, human development or unusual weather. Archived data provide disturbance tracking across all lands since 2000. Interactive maps are accessible via the Forest Change Assessment Viewer. Figures 9, 10, and 11 show forest change and biomass in the Little River watershed.

***Indicators***. The measures of impact associated with stressors. (ex. Water quality measurements, waterbody advisories)

- The upper and lower sections of the Little River have been included at different times on the 303(d) list of Impaired waters, beginning in 1998 with the upper section of the river from its source to Halls Creek (11.8 mi.) for low DO.

- In 2012, a section of the Little River from SR 1225 to Halls Creek was listed Impaired in the aquatic life category. Over the course of the five-year assessment period, nearly 11 percent of samples were above the water quality standard for Chlorophyll *a* indicating nutrient enrichment in this segment of the river. The lower Little River, from Halls Creek to the Albemarle Sound was not sampled during this assessment period.
- A TMDL does not exist for the watershed.

**ELEMENT 2.**

A **description of the NPS management measures** that will need to be implemented to achieve load reductions as well as to achieve other watershed goals identified in the watershed based plan.

The NPS management measures will focus initially on two strategies:

1. Construct the first in-stream wetland in the upper watershed and then replicate this key BMP in other parts of the watershed.
2. Work with Pasquotank and Perquimans Counties to develop grant incentives for landowners to enroll riparian lands in conservation agreements.

**NPS Issue or Problem**

Agricultural operations and residential and commercial development have significantly impacted water quality and fisheries in the Little River watershed. Agricultural operations have opened drainage canals that directly carry sediments and nutrients to the river, and residential and commercial developments have increased pollution from stormwater runoff. Swamp forest buffers have been eliminated or severely degraded in many locations along the river. As a result, the upper and lower sections of the Little River have been included at different times on the 303(d) list of Impaired waters, beginning in 1998 with the upper section of the river from its source to Halls Creek (12 mi.) for low DO. In 2012, a section of the Little River from SR 1225 to Halls Creek was listed Impaired in the aquatic life category. Over the course of the five-year assessment period, nearly 11 percent of samples were above the water quality standard for Chlorophyll *a* indicating nutrient enrichment in this segment of the river. The lower Little River, from Halls Creek to the Albemarle Sound was not sampled during this assessment period.

**In-Stream Wetland Pilot Projects**

North Carolina State University, Soil and Water Conservation Districts, Albemarle RC&D Council and other partners conducted a number of pilot projects in eastern NC over the past 20 years to demonstrate and evaluate alternative management strategies and channel design that enhance water quality and ecological functions while maintaining the necessary drainage function. Channel alternatives included establishment of in-stream and riparian wetlands, lowering of the floodplain to reconnect the channel with the floodplain, redesign of channels using natural channel design principles to reconnect the channel with the natural floodplain, and establishment of conservation easements to eliminate traditional ditch bank mowing and facilitate establishment of perennial riparian vegetation.

In-stream wetlands were constructed at different locations. Results indicate that these alternatives can be used to address drainage, water quality and ecological functions more effectively than have been achieved in the past with conventional drainage canals (Evans et al, 2007). The in-stream wetlands in general reduced nitrogen (N), phosphorus (P) and sediment. The cost of establishing the in-stream wetlands is greater than the cost of establishing traditional drainage ditches. However, the water quality benefits are significant in most cases.

**In-stream Wetlands**

Restoration activities will focus on constructing in-stream wetlands on key drainage canals throughout the watershed. Most of the canals that flow into the Little River are on private lands, and constructing in-stream wetlands along these privately owned canals is critical for effectively managing stormwater in the watershed. The first in-stream wetlands will be constructed along a privately-owned canal that drains approximately 6,000 acres of agricultural land in the headwaters of the watershed (Figure 12). This project will show how in-stream wetlands may be constructed along a main drainage canal on private land to effectively manage stormwater. The project will also show how the same stormwater system may be used on privately-owned canals throughout the watershed that flow into the Little River. Potential locations of in-stream wetlands along ditches and canals in the watershed are shown in Figure 13. The impact of agriculture on water quality of the Little River watershed is typical to watersheds in eastern NC, and the proposed innovative stormwater management system on private lands could be replicated throughout the region.

**Purpose, goals, and objectives**

The purpose of in-stream wetlands is to help restore the health and integrity of the Little River watershed.

The goals of constructing in-stream wetlands are:

- Replicate at a watershed scale a practical and effective stormwater BMP for improving water quality.
- Develop an effective water quality monitoring program to measure project impacts.
- Develop practical and useful communication tools for public outreach and education.
- Create a practical framework for restoring similar watersheds in eastern North Carolina.

The objectives of the project are:

- Construct in-stream wetlands on main drainage canals in agricultural lands.
- Implement an effective water quality monitoring program in collaboration with researchers at NCSU and ECSU.
- Communicate the impacts and broad application of the project through field days, publications, project partners, and web sites.

**Strategy and approach**

The strategy and approach described here is for the first in-stream wetland project. However, the same strategy and approach will be used to construct in-stream wetlands on key canals throughout the watershed.

The first in-stream wetland construction project and monitoring program will be designed during the first three months of the project. Easement agreements with farmers will also be signed during this phase. The agreements will stipulate that farmers will be responsible for the Operation and Maintenance of the in-stream wetlands, and that access will be allowed for monitoring, evaluation and demonstration activities. The Pasquotank Soil and Water Conservation District will hold and monitor the easement agreements. The Albemarle RC&D Council will provide technical and administrative support throughout the project. The In-stream wetlands will be constructed in the fourth to sixth months of the project. Baseline data will be collected in drainage canals before the construction of in-stream wetlands. Data collection and evaluation will continue after the construction of in-stream wetlands through the second year of the project. Field days will be held in the second year of the project for farmers and conservation professionals within and outside of the watershed to demonstrate the function and benefits of the in-stream wetlands for effectively managing stormwater and protecting water quality at a watershed scale. A final project report documenting the findings, results and outputs will be produced at the end of the second year of the project.

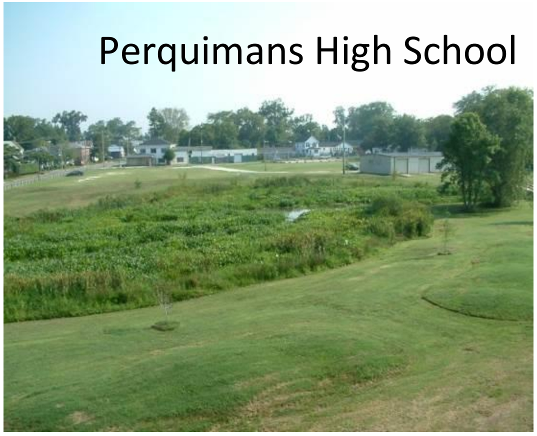
**Results**

The project will achieve the following outcomes, results and products:

- In-stream wetlands constructed along a main agricultural drainage canals to demonstrate practical and effective stormwater management.
- A monitoring and evaluation program to demonstrate the efficacy of in-stream wetlands for reducing Chlorophyll *a* and removing nitrogen, phosphorus and sediment from stormwater.
- Farmers and conservation professionals within and outside of the watershed informed about how the innovative system may be used to manage stormwater and protect water quality.
- Extension materials and research publications that document design, costs and benefits of using in-stream wetlands on agricultural drainage canals.

**In-Stream Wetlands for Drainage Systems Definition and Purpose:**

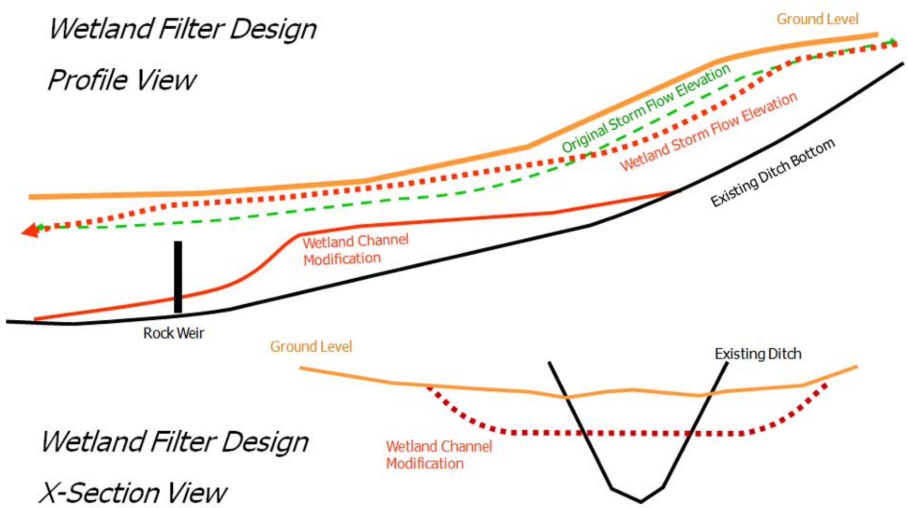
A wetland constructed within an existing drainage system to reduce the concentration of targeted pollutants (Chlorophyll *a*, N, P, sediment) in drainage waters from runoff or subsurface flows before reaching creeks or streams in an effort to address watershed and regional water quality issues.



**Guidelines:**

1. In-stream wetlands within existing drainage systems are intended to address the water quality issues associated with uncontrolled and unfiltered drainage systems that carry water borne pollutants (N, P, and sediment) directly to creeks, streams, and rivers.
2. In-stream wetlands will be planted with four or more species of trees and emergent vegetation (refer to wetland plant list below). These species must emulate the indigenous wetland vegetation within the watershed. Initial planting will be at a spacing of one plant per 10 square feet. Wetland plants can be transferred from sources within the watershed (dug and replanted), or purchased from a nursery source.
3. For future maintenance, the concentration and type of wetland plants found is expected to change with seasonal and environmental conditions. Any natural occurring density, variance, or spatial distribution of population is acceptable for wetland specifications.
4. In-stream wetland design. Considerations:
    - Watershed scale modeling (utilizing HEC-RAS, etc) will be performed to determine weir configurations that reflect upstream drainage considerations.
    - Maintain stagnant water levels 0.5 to 1.5 feet deep in the wetland area.




5. In-stream wetlands must include water control structures (usually Rock Weirs).


**<u>Wetland Plants List - In-stream wetlands for Drainage Systems</u>**
**<u>Suggested Plantings*</u>**

- Arrow arum — *Peltandra virginica*
- Broad leaf arrowhead — *Sagittaria* spp.
- Southern blue flag, — *Iris virginica*
- Cattail — *Typha latifolia*
- Lizard's tail — *Saururus cernuus*
- Pickerelweed — *Pontederia cordata*
- Spatterdock — *Nuphar advena*
- Bulrush — *Scirpus* spp.
- Sawgrass — *Cladium mariscus jamaicense*
- Sedge — *Carex Carex* spp.
- Spike Rush — *Eleocharis* spp.
- Black needle rush — *Juncus roemerianus*

| | |
|---|---|
| • Rush | *Juncus* spp. |
| • Giant Cane | *Arundinaria gigantean* |
| • Giant Cordgrass | *Spartina cynosuroides* |
| • Salt Meadow Cordgrass | *Spartina patens* |
| • Smooth Cordgrass | *Spartina alterniflora* |
| • Rice Cutgrass | *Leersia oryzoides* |
| • Black gum | *Nyssa sylvatica* |
| • Swamp black gum | *Nyssa biflora* |
| • Water tupelo | *Nyssa aquatica* |
| • Bald Cypress | *Taxodium distichum* |

*(Recommended species for in-stream wetlands for drainage systems. Plantings should reflect the indigenous plants within the watershed).

**Application and dissemination**

The impact of agriculture on water quality of the Little River watershed is typical to watersheds in eastern North Carolina, and the in-stream wetlands along agricultural drainage canals in the Little River watershed could be replicated throughout the region to demonstrate an effective way to manage stormwater and protect water quality. The results will be shared through field days with farmers and conservation professionals from across the region. Extension materials and research results will be shared and disseminated through local, regional and state Soil and Water Conservation offices, and university networks including NCSU and ECSU.

**Riparian Conservation Easements**

Pasquotank and Perquimans SWCD are working with county managers to develop a grant incentive for landowners who protect their riparian buffers with conservation agreements. The example in Figure 14 shows seven acres of riparian forest within a 300 foot buffer from the center line of the river. This landowner would qualify for a grant incentive based on the assessed value of the seven acres within the buffer. The county would record the grant incentive in the next cycle of property adjustments.  The Albemarle RC&D Council is contacting landowners on both sides of the Little River to inform them of the voluntary conservation program and a number of landowners have expressed interest. A copy of the voluntary conservation agreement is included below.

**Little River Voluntary Conservation Agreement ____________ County**
As a riparian landowner, I/we would like to help improve water quality in Little River by establishing a voluntary no-cut, no-disturbance vegetative buffer 300 feet from the centerline of Little River. I/we accept the approximate wetland forest delineations and acreage shown on the attached map(s). I understand that the enrolled acreage may qualify for a grant incentive as long as I participate in the program. A grant incentive is defined as the county's assessed value of the riparian acreage as shown on the attached map(s). The county shall record the grant incentive for each property in January during the official period of adjustments.

The following property(s) is/are hereby enrolled in the Little River Voluntary Conservation Program:

| Tax Parcel Number(s) | Wetland Forest Acreage |
|---|---|
| | |
| | |
| | |
| | |

This agreement is in place for perpetuity from the date of its execution, and may be revoked by Owner(s) at any time, with written notice to the ____________ County Soil and Water Conservation District (SWCD). The SWCD may revoke this Agreement if the Owner(s) is/are noncompliant with this Agreement.

Landowner Name:
___________________________Signature:_______________________Date:_________
(Printed)
Landowner Name:

__________________________Signature:________________________Date:__________
(Printed)

North Carolina, ______________ County

I, _____________________________, Technician for ____________County Soil and Water Conservation District, North Carolina, do hereby certify that the landowner(s) and property(s) listed above qualify for the voluntary conservation program.

## ELEMENT 3.

An **estimate of the load reductions** expected for the management measures.

The NC BMP Manual lists nutrient removal rates for in-stream wetlands of 40% for Total N and 35% for Total P. For the first 6 acres of in-stream wetlands to be constructed in the upper watershed (catchment area 6,000 acres), the BMP removal calculation worksheet for the Coastal Plain of the Tar-Pamlico River Basin shows pre-BMP TN load of 4,351 lb/yr and pre-BMP TP load of 857 lb/yr. The worksheet shows post-BMP TN Load of 2,610 lb/yr and post-BMP TP Load of 567 lb/yr. The STEPL model estimates lower N and P removal as shown in the table below. However, the model does not allow the selection of an in-stream wetland BMP. A streambank BMP was the closest option for the calculation. The project will compare actual nutrient and sediment removal rates from in-stream wetlands to the Tar-Pamlico and STEPL models and adjust the models as needed for local use.

| N Reduction | P Reduction | BOD Reduction | Sediment Reduction |
|---|---|---|---|
| lb/year | lb/year | lb/year | t/year |
| 550.7 | 103.9 | 149.1 | 23.3 |
| 0.0 | 0.0 | 0.0 | 0.0 |
| 550.7 | 103.9 | 149.1 | 23.3 |

NC DWQ’s water quality “Redbook” (Revised 2007) provides standards for the Little River Watershed. Load reduction targets will be estimated from baseline data collected at six YSI monitoring stations along the upper, middle and lower sections of the Little River.

- Chlorophyll *a* (corrected): not greater than 40 ug/l for lakes, reservoirs, and other waters subject to growths of macroscopic or microscopic vegetation not designated as trout waters.
- DO for swamp waters: not less than a daily average of 5.0 mg/l with a minimum instantaneous value of not less than 4.0 mg/l.
- pH for swamp waters: as low as 4.3 if it is the result of natural conditions.
- Temperature: not to exceed 2.8 degrees C (5.04 degrees F) above the natural water temperature, and in no case to exceed 32 degrees C (89.6 degrees F) for lower piedmont and coastal plain waters.
- Turbidity: the turbidity in the receiving water shall not exceed 50 Nephelometric Turbidity Units (NTU) in streams not designated as trout waters.

## ELEMENT 4.

An **estimate of the amount of technical and financial assistance needed** associated costs and or sources and authorities that will be relied upon, to implement the plan.

The following budget summarizes costs to establish six acres of demonstration in-stream wetlands on a main drainage canal in the upper watershed. Approximately 6,000 acres of farmland would drain through the new wetlands (Figure 12). The costs to construct in-stream wetlands at other sites in the watershed (Figure 13) will depend on the size of ditches and canals and the areas to be treated for stormwater. The nine-element plan will be updated with costs for technical assistance and construction as new in-stream wetlands are completed.

| **Work Task** | **Total Project Funds** | **Amount of Grant Funds** | **Other (Matching) Funds** | | |
|---|---|---|---|---|---|
| | | | **Amount** | **Source(s)** | **Status** |
| Develop a detailed work schedule for completing project activities. | $4,000 | $3,000 | $1,000 | Pasquotank and Perquimans Soil and Water staff time. | In-kind professional services. |
| Finalize the design of in-stream wetlands and monitoring and evaluation program. | $4,000 | $3,000 | $1,000 | Pasquotank and Perquimans Soil and Water staff time. | In-kind professional services. |
| Secure easement agreements with participating landowners. | $7,000 | $1,000 | $6,000 | Pasquotank Soil and Water staff time.<br><br>Farmers | In-kind professional services.<br><br>Value of farm land under easement. |
| Construct approximately six acres of in-stream wetlands with weirs. | $118,000 | $100,000 | $3,000<br><br>$15,000 | Farmer Equipment and Services.<br><br>Clear debris and control Alligator Weed above and below wetlands to help restore natural hydrology. | In-kind services.<br><br>Pasquotank S&W has applied for state funds. Applications pending. |

| | | | | | |
|---|---|---|---|---|---|
| Collect water quality data before and after in-stream wetland construction. | $4,000 | $3,000 | $1,000 | ECSU, NCSU and Pasquotank Soil and Water. | In-kind prof. services, professors and student graduate assistants. |
| Measure effectiveness of in-stream wetlands for reducing N, P and sediment. | $16,000 | $15,000 | $1,000 | ECSU, NCSU and Pasquotank Soil and Water. | In-kind prof. services, professors and student graduate assistants. |
| Summarize and disseminate the project goals, objectives, results and outputs. | $21,000 | $15,000 | $1,000 | ECSU, NCSU and Pasquotank Soil and Water. | In-kind prof. services, professors and student graduate assistants. |
| | | | | | |
| **Totals** | **$174,000** | **$140,000** | **$29,000** | | |

The following budget summarizes costs for a two-year water quality monitoring program with 6 YSI stations to cover the upper, middle and lower sections of the Little River as shown in Figure 15. The budget also includes estimated costs to develop a public education and awareness program. The nine-element plan will be updated with costs for monitoring water quality as stations are put in use.

| **Little River Restoration Project** | | | | |
|---|---|---|---|---|
| **July 1, 2015 to July 1, 2017** | **Year 1** | | **Year 2** | |
| | **No. FTE*** | **Cost ($)** | **No. FTE*** | **Cost ($)** |
| **EXPENSE** | | | | |
| Personnel by position title | | | | |
| Linda Peterson, Project Administrator | 0.25 | $ 3,744 | 0.25 | $ 3,952 |
| Consultant GIS, Public Awareness | 0.15 | $ 12,000 | 0.15 | $ 12,000 |
| ECSU Graduate Student One | 0.25 | $ 4,000 | 0.25 | $ 4,100 |
| ECSU Graduate Student Two | 0.25 | $ 4,000 | 0.25 | $ 4,100 |
| Fringe (social security, retirement, health) | | | | |
| Linda Peterson, Project Administrator (15%) | 0.25 | $ 562 | 0.25 | $ 593 |
| ECSU Graduate Student One (23%) | 0.25 | $ 920 | 0.25 | $ 943 |
| ECSU Graduate Student Two (23%) | 0.25 | $ 920 | 0.25 | $ 943 |
| Travel (mileage, meals, lodging) | | | | |
| Project-related travel (2500 miles/yr@.565/mile) | | $ 1,413 | | $ 1,413 |
| State conference travel (M&L @$101.5/day x 3 days x 2 persons) | | | | $ 609 |
| State conference travel (Mileage RT 600 @$ .565/mile x 2 persons) | | | | $ 678 |
| YSI 666XLMV2 (2 probes) WQ monitoring stations ($6,000 x 6) | | $ 36,000 | | $ - |
| Gas (for boats) | | $ 500 | | $ 500 |
| Safety Items (for installing monitoring equipment) | | $ 300 | | $ 300 |
| Postage | | $ 500 | | $ 500 |
| Printing/photocopying | | $ 1,000 | | $ 1,000 |
| Web site set up and hosting | | $ 1,000 | | $ 200 |
| Office Supplies | | $ 700 | | $ 700 |
| Public Meetings | | $ 2,000 | | $ 2,000 |
| Educational workshops for local high school students (2) | | $ 1,000 | | $ 1,000 |
| Office Equipment (photocopier, fax, etc.) | | $ 500 | | $ 500 |
| Information Kiosks (6 @ $1,000 each)) | | $ 4,000 | | $ 2,000 |
| **TOTAL DIRECT COST** | | **$ 75,058** | | **$ 38,030** |
| **INDIRECT COST (Rate = 10% of TDC)** | | **$ 7,506** | | **$ 3,803** |
| **GRANT REQUEST** | | | **$ 124,397** | |
| **MATCH** | | | **$ 17,000** | |
| **TOTAL COST** | | | **$ 141,397** | |

Grant sources for watershed and community development projects are listed below.

**USEPA 319**

Announcement in late February or Early March.
Proposals due late May
http://portal.ncdenr.org/web/wq/ps/nps/319program

**USEPA Wetland Development Grants**

Announcement usually in Summer
http://water.epa.gov/grants_funding/wetlands/grantguidelines/index.cfm

**CWMTF**
Announcement in November
Proposals due February 1 and July 1.
http://www.cwmtf.net/

**DMF Coastal Recreational Fishing License Program**
Announcement in early June
Proposals due end of July. http://portal.ncdenr.org/web/mf/crfl-program

**CAMA Planning and Public Access**
Announcement usually in late February
Proposals due mid-April
http://portal.ncdenr.org/web/cm/grants

**Z Smith Reynolds**
Proposals due February 1.
http://www.zsr.org/

**NCDENR Water Resources**
Proposals due July 1 and January 1.
http://www.ncwater.org/?page=7

**NC Rec Trails**
Pre-application due November 1
Application due January 31.
http://www.ncparks.gov/About/trails_RTP.php

**Adopt-A-Trail**
Announcement in October
Proposals due January 31.
http://www.ncparks.gov/About/trails_AAT.php

**Environmental Enhancement Grants (EEG)**
Letter of Intent August 10
Proposals September 14.
http://www.ncdoj.gov/EEG.aspx

**APNEP:**
Usually Spring announcement.
http://portal.ncdenr.org/web/apnep/grants#APNEP

**USEPA and NCDWQ 205(j) Grants**
Usually May announcement.
Proposals through regional council of government (Albemarle Commission)
http://portal.ncdenr.org/web/wq/ps/bpu/205j

## ELEMENT 5.

An **information/education component** that will be used to enhance public understanding of the project.

Public education and outreach will be a major component throughout the watershed planning process. Key stakeholders will be identified and included in the development and implementation of the watershed plan. Local, state, and federal programs will also be included in the planning process to tie in financial and technical assistance. Examples of information and education activities include:

- Develop a project web site for public access to information and activities for conservation and restoration. Also access to monitoring data.
- Develop informational brochures and materials for public meetings and educational events.
- Conduct public meetings for landowners in Pasquotank and Perquimans Counties.
- Implement BMPs in areas visible to the public
- Conduct educational workshops for local high school students.
- Install information kiosks and signage at river access sites, along the river and at BMPs to highlight project activities in watershed conservation and restoration.

The stakeholder meetings in 2013 identified the importance of environmental education with local high schools. The proposed workshops “Fishing Little River: Fish, Habitat, Restoration" are described below.

<u>Environmental Education with Local High Schools</u>

Educational workshops will be a collaborative effort between ECSU, Northeastern High School (NHS), ECBM and project personnel. These half-day weekend workshops will be for students and their parents/guardians on “Fishing Little River: Fish, Habitat, and Restoration". These free workshops will educate students and their families on how to catch fish in the Little River, the species of fish, the importance of habitats (e.g. swamp forests, submerged aquatic vegetation), and how to help enhance fishing in the Little River for the long term. Elizabeth Brinker (Coastal Ecologist, Marine Biologist and Science Teacher at NHS in Elizabeth City) will help develop, coordinate, implement and assess both workshops. ECSU faculty and graduate students will engage and inform the students on the University’s efforts in studying the ecology of the river, as well as mentor them on college and career opportunities in science. Project personnel will contribute information on the success of Little River restoration efforts. ECBM volunteers, with their outstanding fishing expertise and knowledge, would participate as well.

**ELEMENT 6.**
A **schedule for implementing the NPS management measures** identified in this plan that is reasonably expeditious.

The following sections describe the schedule for constructing the first six acres of in-stream wetlands in the upper watershed. However, the same schedule and steps will be used to construct in-stream wetlands in other areas of the watershed. The project is developing a list of farmers interested in constructing in-stream wetlands in order to move quickly on grant opportunities.

**Task Schedule for In-stream Wetlands:**

| TASK | July 1, 2015 to July 1, 2017 | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J |
| Develop a detailed work schedule for completing project activities. | | | | | | | | | | | | | | | | | | | | | | | | |
| Finalize the design of in-stream wetlands and monitoring and evaluation program. | | | | | | | | | | | | | | | | | | | | | | | | |
| Secure easement agreements with landowners. | | | | | | | | | | | | | | | | | | | | | | | | |
| Construct in-stream wetlands. | | | | | | | | | | | | | | | | | | | | | | | | |
| Collect water quality data before and after in-stream wetland construction. | | | | | | | | | | | | | | | | | | | | | | | | |
| Measure effectiveness of in-stream wetlands for reducing N, P and sediment. | | | | | | | | | | | | | | | | | | | | | | | | |
| Conduct field days. | | | | | | | | | | | | | | | | | | | | | | | | |
| Summarize & disseminate the project goals, objectives, results and outputs. | | | | | | | | | | | | | | | | | | | | | | | | |

**Strategy and approach**

The in-stream wetlands and monitoring program will be designed during the first three months of the project. Easement agreements with farmers will also be signed during this phase. The agreements will stipulate that farmers will be responsible for the O&M of the in-stream wetlands, and that access will be allowed for monitoring, evaluation and demonstration activities. The Pasquotank Soil and Water Conservation District will hold and monitor the easement agreements. The Albemarle RC&D Council will provide technical and administrative support throughout the project. The in-stream wetlands will be constructed in the fourth to sixth months of the project. Baseline data will be collected in drainage canals before the construction of in-stream wetlands. Data collection and evaluation will continue monthly after the construction in-stream wetlands through the second year of the project. Field days will be held in the second year of the project for farmers and conservation professionals within and outside of the watershed to demonstrate the function and benefits of the in-stream wetlands for effectively managing stormwater and protecting water quality. A final project report documenting the findings, results and outputs will be produced at the end of the second year of the project.

**Detailed Work Plan**

**Access/easement acquisition**

<u>Purpose and objectives</u>.

- Secure easement agreements with participating landowners in the first three months of the project.

<u>Activities to be conducted</u>.

- Develop easement agreements for in-stream wetlands along drainage canals.
- Sign easement agreements between Pasquotank Soil and Water Conservation District and participating landowners.

<u>Outcomes, results, and products</u>.

- Signed easement agreements within first three months of project.
- Agreements will stipulate that farmers will be responsible for the Operation and Maintenance (O&M) of the in-stream wetlands, and that access will be allowed for monitoring, evaluation and demonstration activities. The Pasquotank Soil and Water Conservation District will hold and monitor the easement agreements.

**Construction**

<u>Purpose and objectives.</u>

- Construct approximately six acres of in-stream wetlands in month four to six.

<u>Activities to be conducted.</u>

- Develop and issue construction bid packets by the second month of the project.
- Select qualified contractor in the third month of the project.
- Coordinate construction activities with landowners.

<u>Outcomes, results, and products</u>.

- The in-stream wetlands will be designed to require minimum O&M. However, participating farmers will be responsible for O&M, and will allow access for monitoring, evaluation and demonstration activities.

- Soil excavated from drainage canals to create wetlands will be deposited and spread on adjacent agricultural lands by participating farmers.
- The wetlands will be constructed in drainage canals along a public gravel road, which will facilitate access for monitoring and demonstration activities.
- The Pasquotank Soil and Water Conservation District will monitor wetland plant survival during and after the project and will replant if needed.

**Data collection**

Purpose and objectives.

- Collect water quality data before and after in-stream wetland construction.

Activities to be conducted.

- NCSU, ECSU, Pasquotank Soil and Water coordinate purchase and installation of monitoring equipment.
- Collect pre-construction baseline samples in months two to three
- After construction, collect water flow, Chlorophyll *a*, N, P, and sediment samples bi-weekly.

Outcomes, results, and products.

- **General approach for monitoring and evaluation program.** Baseline water samples will be taken along the drainage canal prior to construction of the in-stream wetland. The in-stream wetlands will be instrumented to continuously measure inflow and outflow. Flow measurements will be made at the main inlet and at the wetland outlet using continuous water level recorders. Weirs (V-notch, rectangular etc.) will be installed at the inlet and outlet of the wetland. Stage measurements at each location will be used as inputs to standard weir discharge equations to calculate wetland inflows and outflows. Automatic water samplers will be utilized at the main inlet and at the outlet.
- Data will be summarized and presented on the Albemarle RC&D Council's web site and through NCSU, ECSU and local, regional, state and national Soil and Water networks.

**Data evaluation**

Purpose and objectives.

- Measure effectiveness of in-stream wetlands for reducing Chlorophyll *a*, N, P and sediment, while maintaining drainage.

Activities to be conducted.

- Compare predicted drainage and runoff from the watershed and measured wetland outflow volumes.
- Take water quality samples over time and at various flow stages to measure Chlorophyll *a*, N, P and sediment.
- After planting, take grab samples on bi-weekly intervals.
- In the second year, conduct two field days for farmers and conservation professionals in eastern NC.

<u>Outcomes, results, and products</u>.

- Network of farmers and conservation professionals both within and outside the Little River watershed who are familiar with the design, costs and benefits of the innovative stormwater system.
- Data summarized and presented in practical formats for the public on the Albemarle RC&D Council's web site and through NCSU, ECSU and local, regional, state and national Soil and Water networks.

**Report preparation**

<u>Purpose and objectives.</u>

- Summarize and disseminate the project goals, objectives, results and outputs.

<u>Activities to be conducted.</u>

- Evaluate project data for reductions in Chlorophyll *a*, N, P and sediment.
- Evaluate costs of establishing the stormwater system.
- Identify and quantify canals where the stormwater system may be replicated within the watershed.

<u>Outcomes, results, and products</u>.

- Farmers and locations identified within the watershed where the innovative stormwater system may be replicated.
- Watersheds and locations identified in eastern NC where the innovative stormwater system may be replicated.
- Project results shared through Albemarle RC&D Council publications and website, NCSU and ECSU university networks, and Soil and Water networks at the local, regional, state and national level.

**Task Schedule for Water Quality Monitoring and Public Awareness and Education:**

| TASK | Year 1, July 1, 2015 to July 1, 2016 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
| Design water quality and fisheries monitoring program. | | | | | | | | | | | | |
| Install 6 YSI water quality monitoring stations. | | | | | | | | | | | | |
| Collect baseline fisheries data. | | | | | | | | | | | | |
| Develop and maintain project web site. | | | | | | | | | | | | |
| Develop conservation tax structure. | | | | | | | | | | | | |
| Develop informational brochures and materials. | | | | | | | | | | | | |
| Conduct public meetings. | | | | | | | | | | | | |
| Collect water quality data. | | | | | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conduct educational workshop for local high school students. | | | | | | | | | | | | |
| | **Year 1, July 1, 2016 to July 1, 2017** | | | | | | | | | | | |
| **TASK** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** |
| Collect water quality data. | | | | | | | | | | | | |
| Collect fisheries data. | | | | | | | | | | | | |
| Update project web site. | | | | | | | | | | | | |
| Conduct public meetings. | | | | | | | | | | | | |
| Install six information kiosks. | | | | | | | | | | | | |
| Conduct educational workshop for local high school students. | | | | | | | | | | | | |
| Prepare final report. | | | | | | | | | | | | |

**ELEMENT 7.**

A description of interim, **measurable milestones for determining whether NPS management measures** or other control actions are being implemented.

Milestones will measure watershed improvement by setting:

- Short-term goals (1 – 2 years)
    - Completing the watershed restoration plan and beginning implementation activities including in-stream wetlands demonstration, public education and baseline monitoring of water quality and fisheries.
- Mid-term goals (2 – 5 years)
    - Establishing at least six in-stream wetlands throughout the watershed, and a long-term water quality and fisheries monitoring program.
    - Obtaining commitments from local governments and state and federal agencies to provide technical and financial assistance.
- Long-term goals (5 – 10 years)
    - Measuring reductions in Chlorophyll *a*, N, P, and sediment, and improvements in water quality and fisheries stocks.

**ELEMENT 8.**

A set of **criteria that can be used to determine whether loading reductions are being achieved** over time and substantial progress is being made towards attaining water quality standards.

The restoration plan will provide a time estimate and criteria by which the pollutant controls will result in water quality standard attainment for Chlorophyll a (µg liter$^{-1}$).

Criteria include
- Reducing N and P (lbs/yr)
- Increasing DO (mg/L)
- Reducing TSS and Turbidity

For stormwater wetlands, the NC BMP Manual lists nutrient removal rates of 40% for Total N and 35% for Total P. For the first 6 acres of in-stream wetlands to be constructed in the upper watershed draining 6,000 acres, the BMP removal calculation worksheet for the Coastal Plain of the Tar-Pamlico River Basin shows pre-BMP TN load of 4,351 lb/yr and pre-BMP TP load of 857 lb/yr. The worksheet shows post-BMP TN Load of 2,610 lb/yr and post-BMP TP Load of 567 lb/yr. The STEPL model estimates lower N and P removal, however, the model does not allow the selection of a stormwater wetland BMP. The project will compare actual nutrient and sediment removal rates from in-stream wetlands to the Tar-Pamlico and STEPL models and adjust the models as needed for local use.

The EPA's recommended narrative for chlorophyll *a* in the Chesapeake Bay (2003) may be a good guide for the Little River watershed: *Concentrations of chlorophyll a in free-floating microscopic aquatic plants (algae) shall not exceed levels that result in ecologically undesirable consequences—such as reduced water clarity, low dissolved oxygen, food supply imbalances, proliferation of species deemed potentially harmful to aquatic life or humans or aesthetically objectionable conditions—or otherwise render tidal waters unsuitable for designated uses.*

The following water quality standards are summarized from the NC DENR – Division of Water Quality "Redbook" Surface Waters and Wetlands Standards (NC ADMINISTRATIVE CODE 15A NCAC 02B .0100 & .0200) AMENDED EFFECTIVE: APR 1, 2003. REVISED 2007.

- Chlorophyll *a* (corrected): not greater than 40 $\mu$g/l for lakes, reservoirs, and other waters subject to growths of macroscopic or microscopic vegetation not designated as trout waters.
- Dissolved oxygen for swamp waters: not less than a daily average of 5.0 mg/l with a minimum instantaneous value of not less than 4.0 mg/l.
- pH for swamp waters: as low as 4.3 if it is the result of natural conditions.
- Temperature: not to exceed 2.8 degrees C (5.04 degrees F) above the natural water temperature, and in no case to exceed 32 degrees C (89.6 degrees F) for lower piedmont and coastal plain waters.
- Turbidity: the turbidity in the receiving water shall not exceed 50 Nephelometric Turbidity Units (NTU) in streams not designated as trout waters.

**ELEMENT 9.**

A **monitoring component** to evaluate the effectiveness of the implementation efforts over time measured against the criteria established under ELEMENT 8.

The final project monitoring plan will address the following:
- Identify purpose of monitoring, including all valuable indicators.

- Consider data quality needed to meet the goals and objectives in the management plan.
- Define who and how the data will be used.
- Collect background information in the watershed that can be used to refine the goals and objectives if needed.
- Provide the identity and experience of the monitoring plan preparer.
- Description of the monitoring plan.
- Parameters to be monitored.
- Method of analysis.
- Monitoring frequency.
- Monitoring site locations (mapped in GIS).

**In-stream Wetlands**

For the first six acres of in-stream wetlands in the upper watershed, water samples will be collected along the drainage canal prior to construction. The in-stream wetlands will be instrumented to continuously measure inflow and outflow. Flow measurements will be made at the main inlet and at the wetland outlet using continuous water level recorders. Weirs (V-notch, rectangular etc.) will be installed at the inlet and outlet of the wetland. Stage measurements at each location will be used as inputs to standard weir discharge equations to calculate wetland inflows and outflows. Automatic water samplers will be utilized at the main inlet and at the outlet. This same monitoring approach will be used for key in-stream wetlands constructed in other areas of the watershed.

**Watershed Scale**

The stakeholder meetings in 2013 identified a framework for a water quality and fisheries monitoring program for the entire watershed, which is described below.

<u>Develop Water Quality and Fisheries Monitoring Program</u>

- ECSU staff and students work with ARCD, Soil and Water, DWQ and DMF to design and implement a water quality and fisheries monitoring program.
- Install six water quality monitoring stations in the upper, middle and lower sections of the watershed.
- Provide public access to monitoring data on a new project website.
- Develop a Quality Assurance Project Plan (QAPP).

<u>Water Quality Monitoring and Analysis</u>

Professors in the ECSU Department of Natural Sciences and graduate and undergraduate students will help design and implement a water quality monitoring program using both autonomous monitoring stations (Yellow Springs Instruments[YSI], Sonde 6600 Series) and discreet sampling (fluorometrically determined nitrogen and phosphorus, Turner Designs, Trilogy model). Data will be submitted following the DMF Data Dictionary format. Six autonomous water quality monitoring stations of YSI Sondes will be deployed along the Little River at locations on the upper, middle and lower sections of the watershed (Figure 14). Deploying the stations all along the Little River will allow the project to compare changes in water quality by section of river. The station closest to the Albemarle Sound will be monitored for influence from wind tides.

Each YSI water quality station will be equipped with sensors to continuously measure the following water quality parameters: temperature, conductivity/salinity, pH/ORP, DO, Chlorophyll *a*, and turbidity. These stations will be serviced monthly. Chlorophyll is especially important to measure since this chemical indicator of algal abundance is closely associated with stream nutrient and sediment loading issues.

Additionally, water samples will be collected at each station monthly and as soon as practicable after major named storm events for the specific purpose of analyzing N and P levels. It is important to measure these specific elements since they are associated with stream eutrophication largely by their contribution to excess algal growth The effectiveness of changes in land owner behavior in regard to riparian protections should become apparent notably as reductions in nitrogen, phosphorus and chlorophyll levels. Total N and total and dissolved P will be determined using fluorometric instrumentation (Turner Designs, Trilogy Model). Samples for N and P will be collected and preserved streamside according to Section 2.22.2 of the Intensive Survey Branch Standard Operating Procedures Manual: Physical and Chemical Monitoring, version 2.1 (ISB SOP)(December 2013). Additionally, samples to determine dissolved N and P will be filtered at the time of collection according to section 2.22.3 and Appendix 6 of the ISB SOP (December 2013).

Additionally, when water is collected for N and P analyses, hand-held meters (YSI) will be used to measure: pH, salinity, temperature, DO and conductivity. The project will purchase for ECSU a Turner Designs Trilogy Model fluorometer with accessory modules to confirm Chlorophyll *a* and determine at least total and soluble N and P.

The following DWR water quality standards are targets for measuring improvements from watershed restoration activities (in-stream wetlands, conservation and restoration of swamp buffers, public education, etc).

- Chlorophyll *a* (corrected): not greater than 40 $\mu$g/l.
- Dissolved oxygen for swamp waters: not less than a daily average of 5.0 mg/l with a minimum instantaneous value of not less than 4.0 mg/l.
- pH for swamp waters: as low as 4.3 if it is the result of natural conditions.
- Temperature: not to exceed 2.8 degrees C (5.04 degrees F) above the natural water temperature, and in no case to exceed 32 degrees C (89.6 degrees F).
- Turbidity: the turbidity in the receiving water shall not exceed 50 Nephelometric Turbidity Units (NTU).

The following tasks will be conducted during monthly service: sensors cleaning, battery replacement, data down load, on-site measurement, and water sample collection. Project volunteers from the ARCD will work with ECSU staff and students on collecting monthly samples and data from water quality monitoring stations.

<u>Develop Fisheries Monitoring Program</u>
The fisheries monitoring program will focus on herring because it travels in coastal, joint and inland waters, and it may be an indicator species for other joint and inland species. The initiative will work with staff of DMF and WRC to establish a baseline for stocks, mainly from existing

data and some sampling to confirm the data. The location of sampling stations is shown in Figure 15. Removing the Impaired designation for Little River through reductions in Chlorophyll *a*, N, and P and increasing DO should in theory lead to improvement in stocks of herring and other species. Long-term water quality and fisheries monitoring should help answer this important research question. The model for this analysis may be applicable to similar watersheds in eastern N.C.

The program to monitor water quality and herring would address specific research needs identified by the N.C. Division of Marine Fisheries (DMF), which lists river herring as Depleted, and since 2007 has implemented a no-harvest provision for commercial and recreational fisheries in joint and coastal waters. DMF research needs include:

- Evaluate spawning and nursery habitat areas by expanding independent sampling programs.
- Identify and evaluate all potential blockages to historical spawning areas and develop strategies to minimize the impacts of these blockages.

The monitoring program would also address two important research topics identified in the *2010 NC Coastal Habitat Protection Plan* for Depleted wetland-enhanced species such as river herring.

- An assessment of acidification risk should be conducted in Anadromous Fish Spawning Areas in North Carolina.
- More fishery-independent information and habitat change analysis are needed to determine the effect of wetland-coverage on the abundance of fish and invertebrates.

The following information with a focus on herring is taken directly from the *2010 Coastal Habitat Protection Plan*.

- In low-salinity areas of coastal North Carolina, the fish community is dominated by freshwater and anadromous species. In late winter, river herring (blueback herring and alewife), striped bass, Atlantic sturgeon, American shad, and other anadromous species migrate from the ocean and lower estuary to spawn upstream in freshwater areas. After spawning, the adults migrate back to the lower estuary or oceans, while the juveniles spawned in spring begin their seaward migration in late fall. Residents of the low-salinity zone include estuarine species like bay anchovy but are dominated by freshwater species, such as white perch, yellow perch, catfishes, sunfishes, and minnows. (Page 31.)
- Anadromous fish species can generally tolerate fresh water with lower pH. For example, alewife eggs and larvae require pH between 5.0-8.5 pH and blueback herring eggs and larvae require pH levels between 5.7 and 8.5. This pattern of pH requirements between systems also illustrates the adaptation of freshwater and estuarine organisms to their environment. Acidification in headwater streams harboring spawning river herring was attributed to rain storms in poorly buffered streams. Several coastal streams in the Chesapeake Bay watershed were monitored for pH and correlated with base-flow conditions, buffering capacity, and precipitation. These factors explained 74% of the variation in stream pH. The resulting risk assessment for the Chesapeake Bay predicted greater than 50% of streams would experience harmful pH levels during wet years. *A*

*similar assessment of acidification risk should be conducted in Anadromous Fish Spawning Areas in North Carolina.* (Page 34.)

- In riverine systems, water temperature increases downstream from river headwaters to the estuary. The gradual increase in temperature is determined naturally by elevation, air temperature, shading, and water velocity. Temperature in riverine systems is one of the primary cues for anadromous fish spawning. For example, spawning of striped bass in coastal rivers is triggered by increasing water temperatures in early spring. Page 34.
- Growth of actively swimming fish is reduced at DO concentrations below about 6 mg/l, metabolism is reduced at 4.5 mg/l, and most fish cannot tolerate DO less than 2 mg/l. Other species and life stages requiring DO levels greater than 3-4 mg/l include juvenile river herring. (Page 35.)
- Species and life stages requiring high DO levels (>4 mg/l) include larval alewife, yellow perch and blueback herring, and adult American shad, striped bass, white perch, and yellow perch. (Page 36.)
- Algal production and microbial decomposition are enhanced in warm, nutrient-rich waters. Excessive algal production can deplete the water column of DO through nighttime plant respiration. Excessive algal production creates labile organic biomass that dies and is consumed by microbial decomposition, creating a biochemical oxygen demand (BOD). Chlorophyll *a* concentrations and BOD have been strongly correlated in a variety of North Carolina coastal creeks, estuaries, lakes and rivers. (Page 36.)
- Alewife spawn in lakes, slow-moving oxbows and small streams where the species co-occurs with blueback herring. Alewives spawn in water that is between 15cm and 3m deep, while blueback herring prefer deeper waters. Blueback herring will use lentic (standing) water or lotic (moving) water as spawning habitat, while alewives will only use lentic. Species also differ in whether they prefer the mainstem river, or small tributary creeks for spawning. Mainstem spawners include American shad and striped bass. Blueback herring and alewife spawn in tributary creeks. For hickory shad, there is evidence of spawning in flooded tributaries in North Carolina and Virginia. In terms of water quality, adequate DO levels in slow-moving backwaters are critical to spawning river herring because the eggs require >5 mg/l DO. During their spawning migration, anadromous fish actively avoid waters with low DO and extremely high turbidity. (Page 41.)
- Of the fishery stocks with higher relative abundance in wetlands, six are Depleted, five are Concern, two are Recovering, and five are Viable. There are an approximately equal number of Viable and Concern stocks showing some preference for wetland habitat. The wetland-enhanced stocks listed as Depleted were river herring (alewife and blueback herring in Albemarle Sound), sturgeon species, CSMA striped bass, southern flounder, spotted seatrout and black seabass (South of Hatteras). Wetland-enhanced species of Concern included yellow perch, blue crab, Atlantic croaker, spot, and black seabass (North of Hatteras). While most of the concern over declining fish stocks has focused on overfishing, habitat loss and degradation can also prevent recovery or make a stock more susceptible to overfishing. Therefore, protection or enhancement of wetland habitat can be especially beneficial to wetland-enhanced species classified as Depleted or Concern, by maximizing recruitment and productivity. *More fishery-independent information and*

*habitat change analysis are needed to determine the effect of wetland-coverage on the abundance of fish and invertebrates.* (Page 298.)

- Physical spawning (adult) and egg development requirements for resident freshwater and anadromous fishes inhabiting coastal North Carolina are shown in Figure 16.

**Data Delivery Plan for Research Projects:** ECSU staff and graduate students will design and implement a water quality and fisheries monitoring program in the watershed. They will collect data once per month and after major storm events, and process the data per DWQ data format requirements. They will also summarize the data for presentation on the project's web site and in communication media including flyers and electronic newsletters.

**Resources for Watershed Planning**

EPA's ***Healthy Watersheds*** web site provides information on Healthy Watersheds, including:

**Concept, Approach and Benefits:** Approaches and benefits of conserving and protecting healthy watersheds.
**Assessment Framework:** A systems approach to watershed assessment.
**Examples of Assessments:** Current assessment approaches being used by regions, states, and communities.
**Conservation Approaches & Tools:** Conservation and protection approaches used by states and communities for ensuring healthy watersheds remain intact.
**Outreach Tools:** Strategies and resources for watershed managers to encourage stakeholder engagement in conservation and protection of healthy watersheds.

http://water.epa.gov/polwaste/nps/watershed/index.cfm

***EnviroAtlas*** combines hundreds of data layers developed through collaboration between EPA; US Geological Survey; US Forest Service; other federal, state, and non-profit organizations; and several universities. Using powerful web application tools, it lets users generate customized maps and images that show the condition of their local community's air, water, and landscape; as well as population density and other demographic data. Users can investigate land cover patterns, see how ecosystem services reduce pollution, and view closer-to-true-scale data to compare them across selected communities. http://enviroatlas.epa.gov/enviroatlas/

EPA ***How's My Waterway***: http://watersgeo.epa.gov/mywaterway/

EPA ***Watershed Education and Training Resources***: http://water.epa.gov/learn/

**High-Resolution Global Maps of 21st-Century Forest Cover Change**. Data available on-line from: http://earthenginepartners.appspot.com/science-2013-global-forest.

NC Coastal Federation ***Watershed Restoration Planning Guidebook***
http://www.nccoast.org/content.aspx?key=a7f021ae-cb38-49d7-9862-d2b9c1793ebb&title=Introduction

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Figure 1. Watershed Overview Map

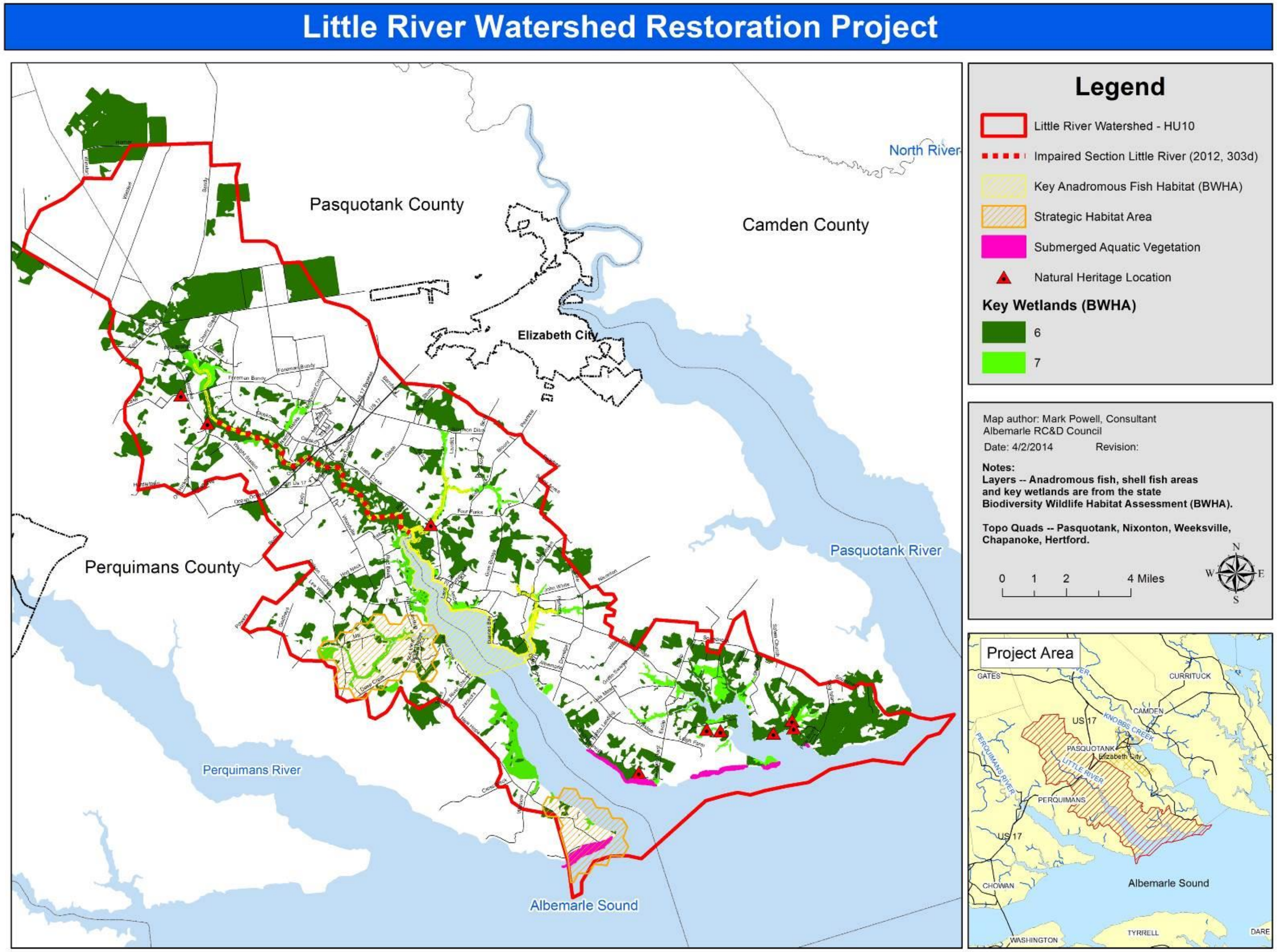

Figure 2. North Watershed with Aerial Imagery

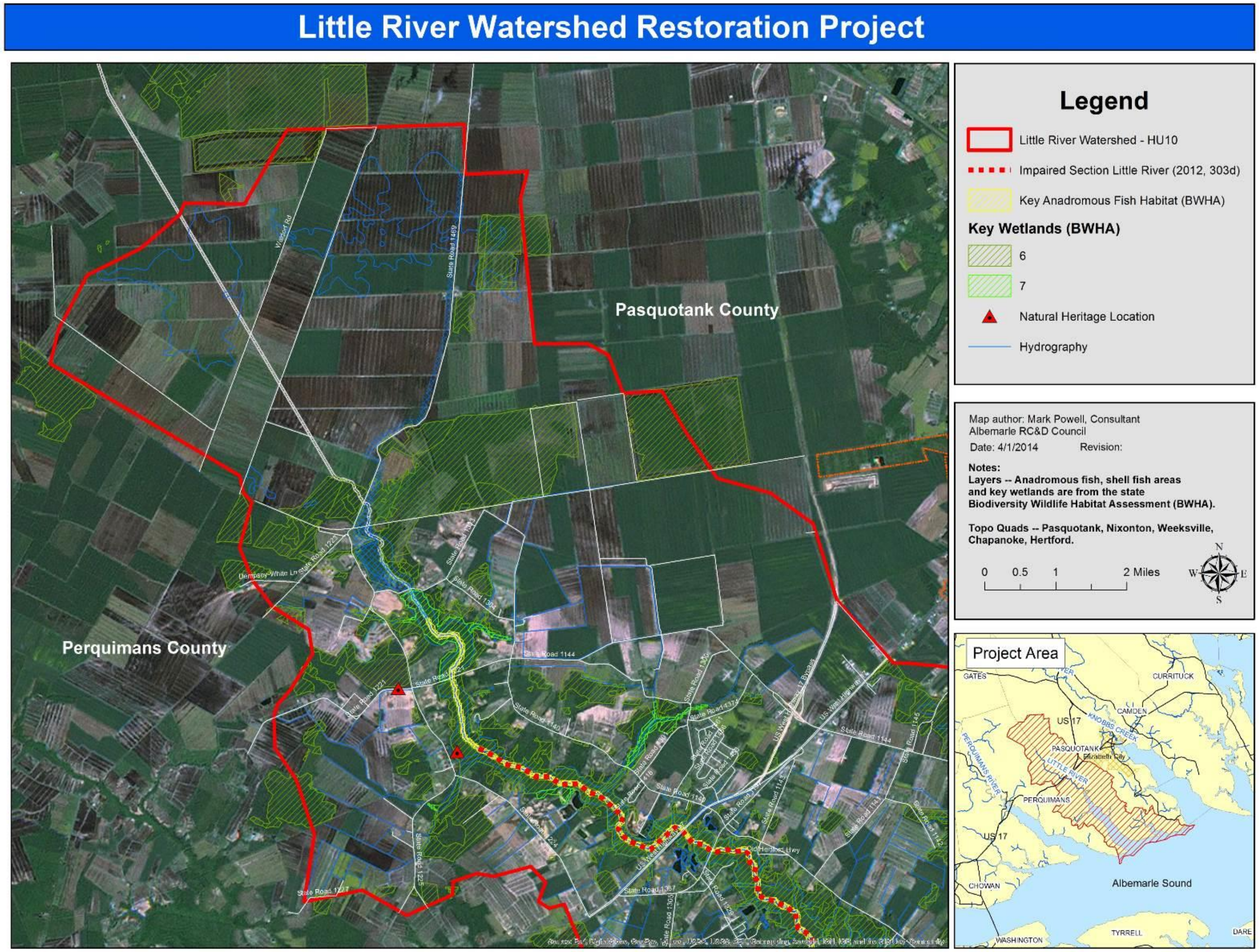

Figure 3. Central Watershed with Aerial Imagery.

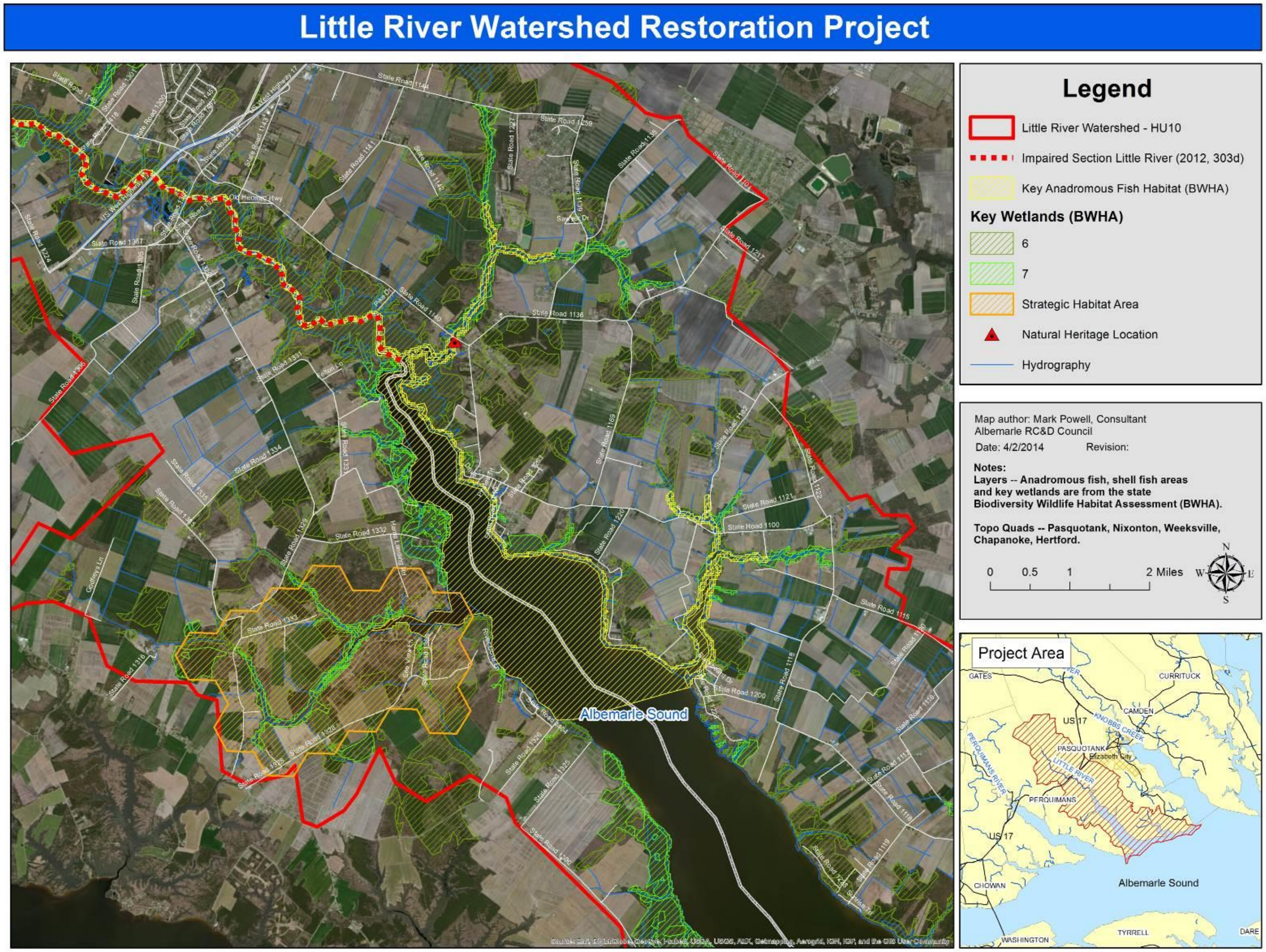

Figure 4. South Watershed with Aerial Imagery.

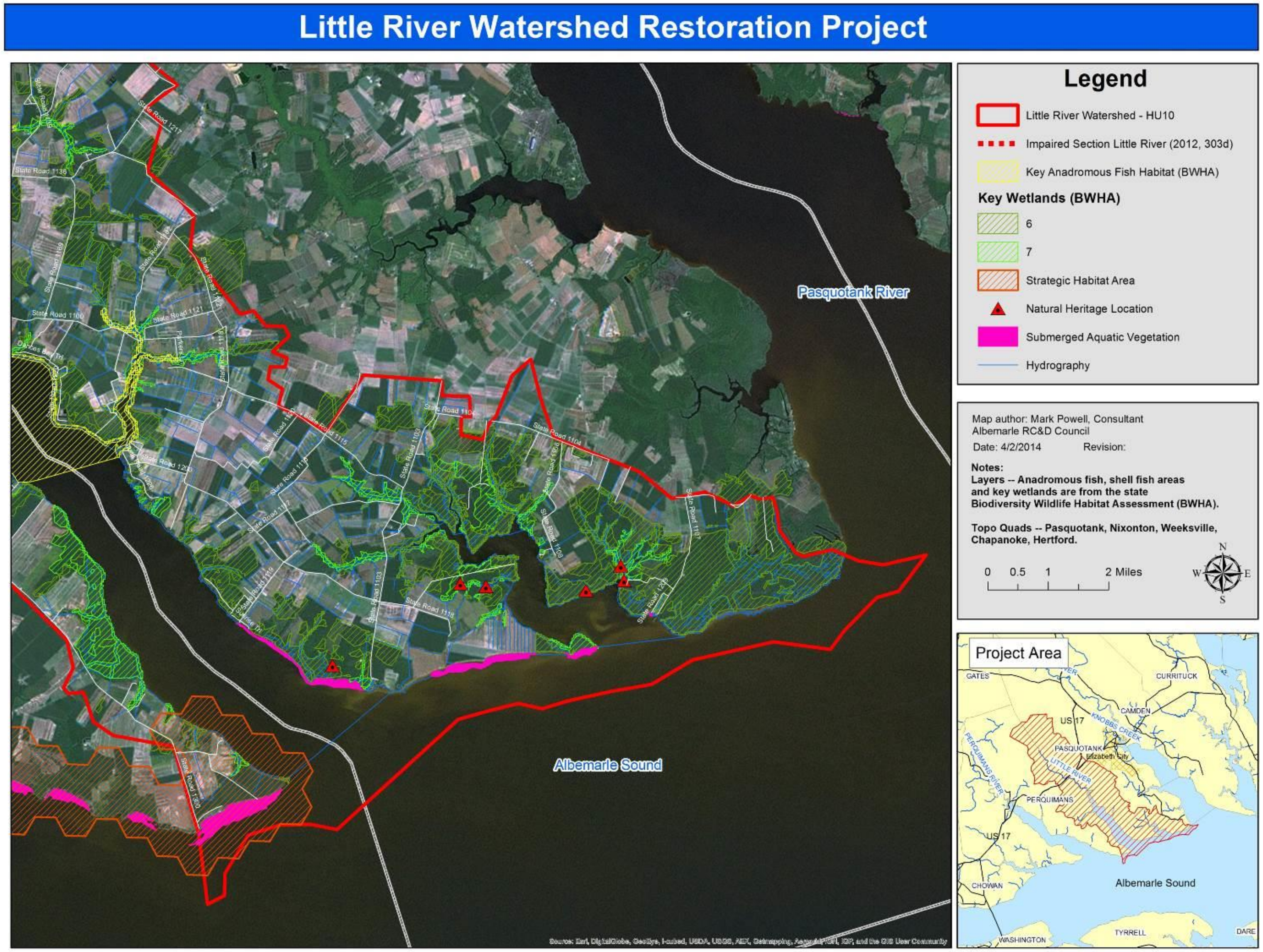

Figure 5. Albemarle Regional Paddle Trail System

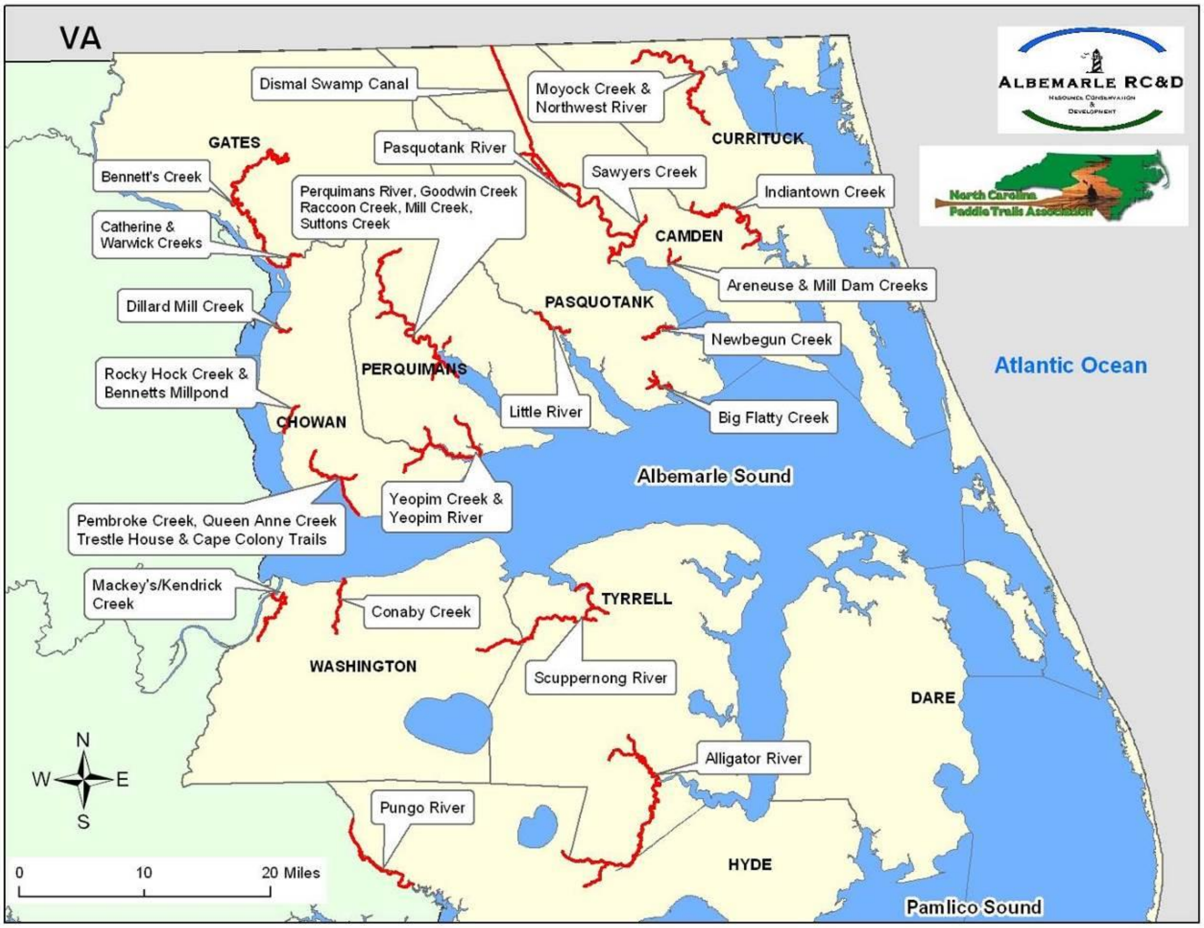

Figure 6. Little River Paddle Trail


Figure 7. Big Flatty Creek Paddle Trail

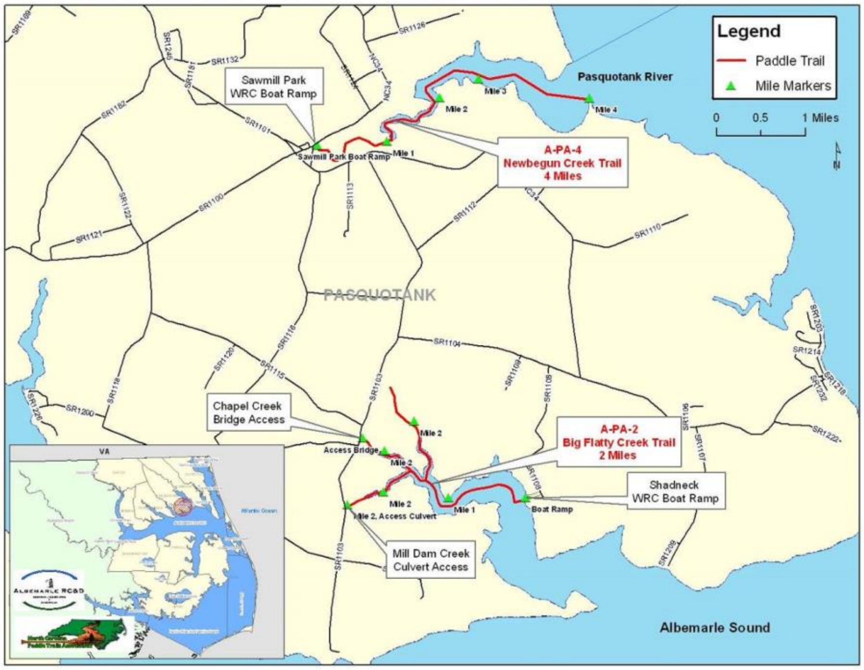

Figure 8. Forest Loss and Gain 2000-2012. Source: Hansen/UMD/Google/USGS/NASA

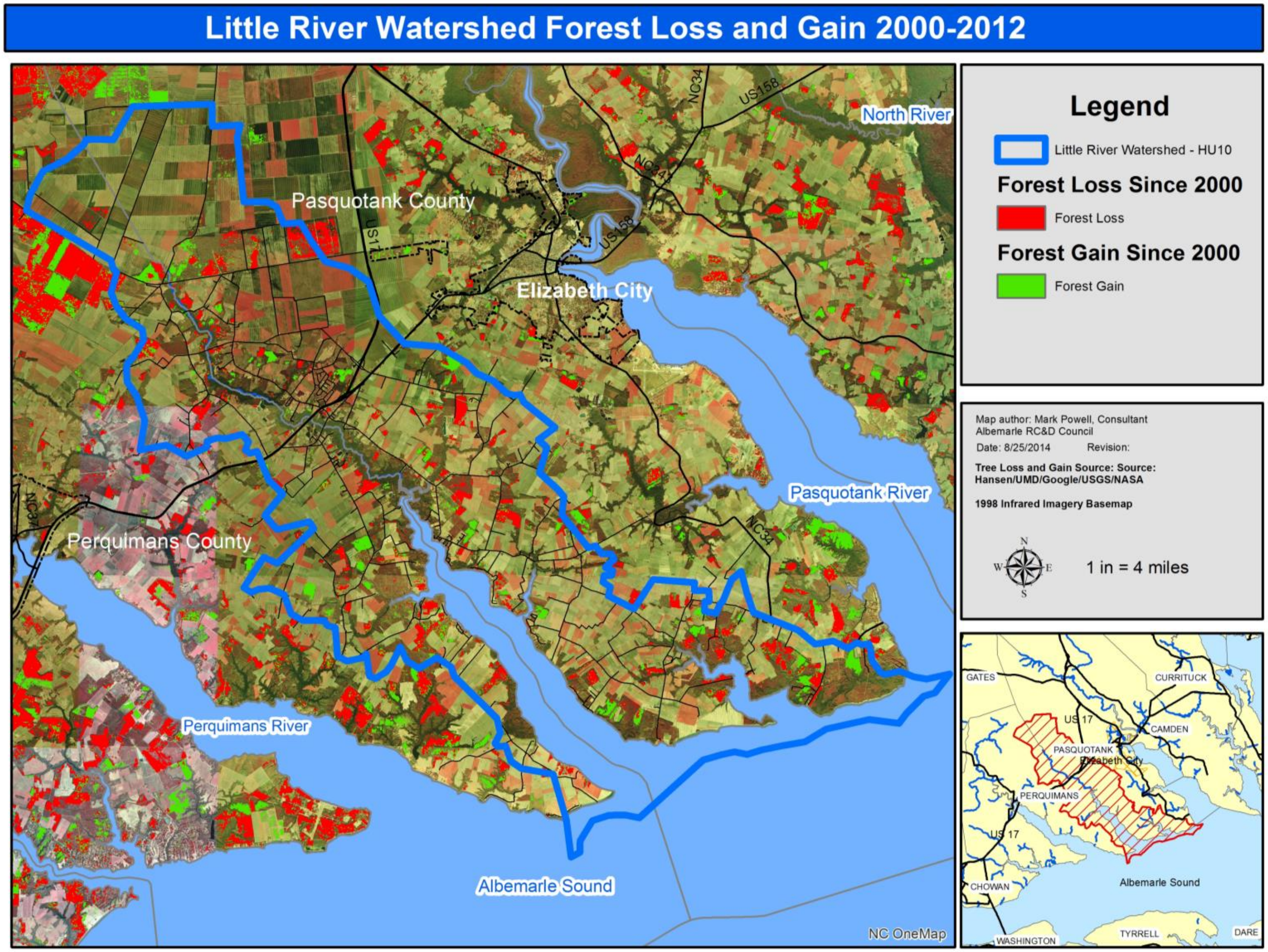

Figure 9. ForWarn Forest Loss 2004-2014 Little River Watershed (approximate boundary).

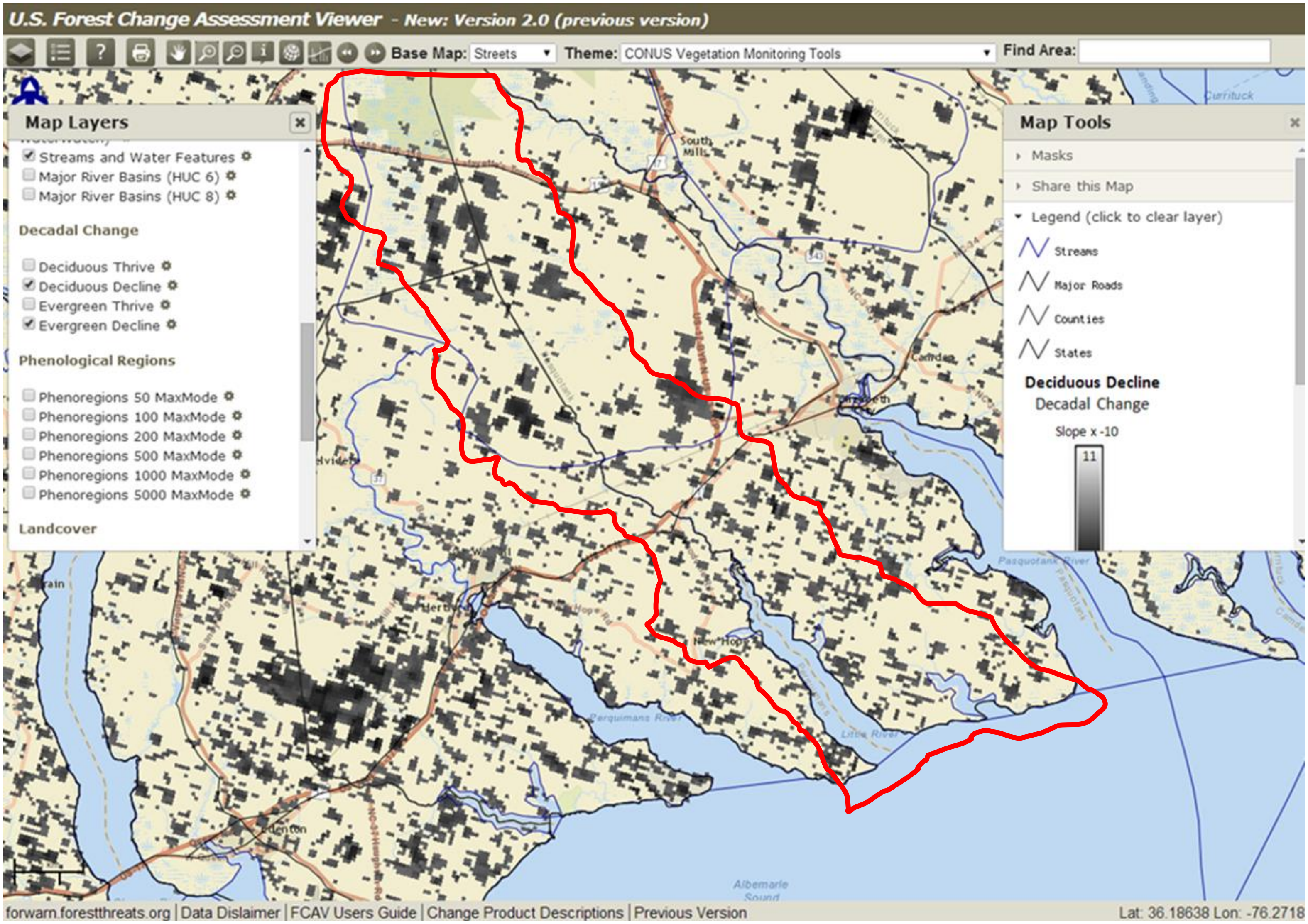

Figure 10. ForWarn Forest Gain 2004-2014 Little River Watershed (approximate boundary).

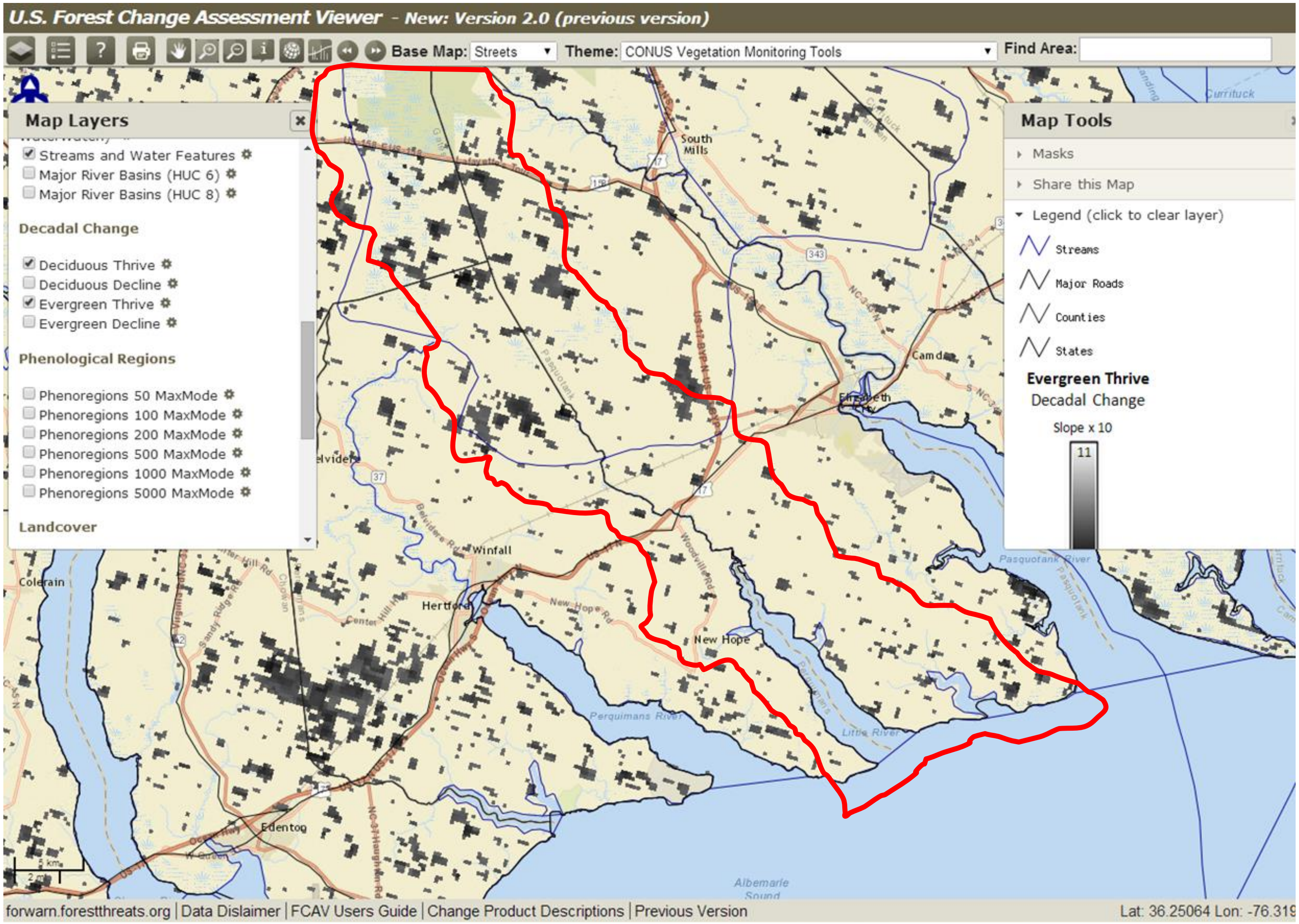

Figure 11. ForWarn Forest Biomass Little River Watershed (Approximate Boundary).

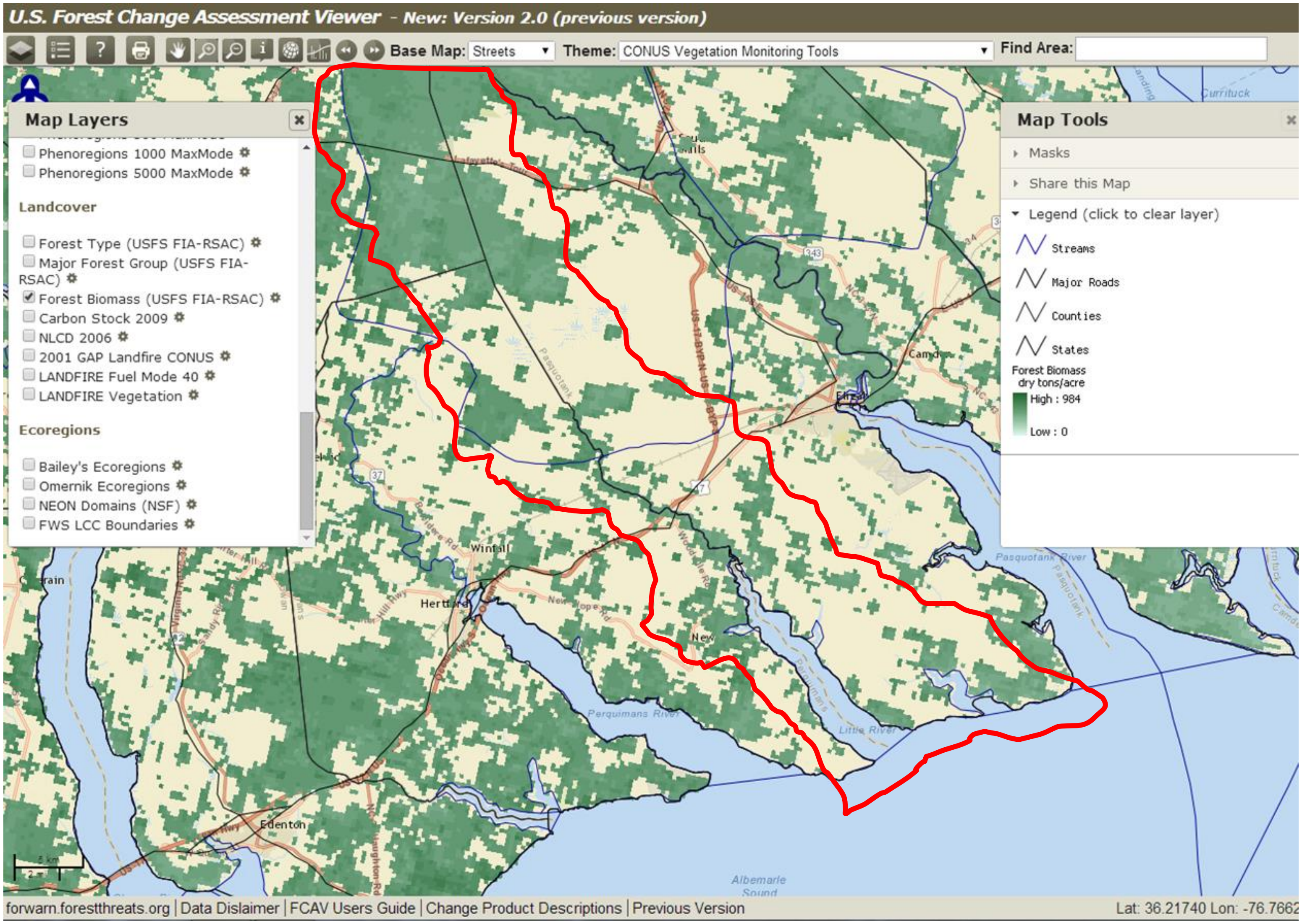

Figure 12. Demonstration In-Stream Wetland

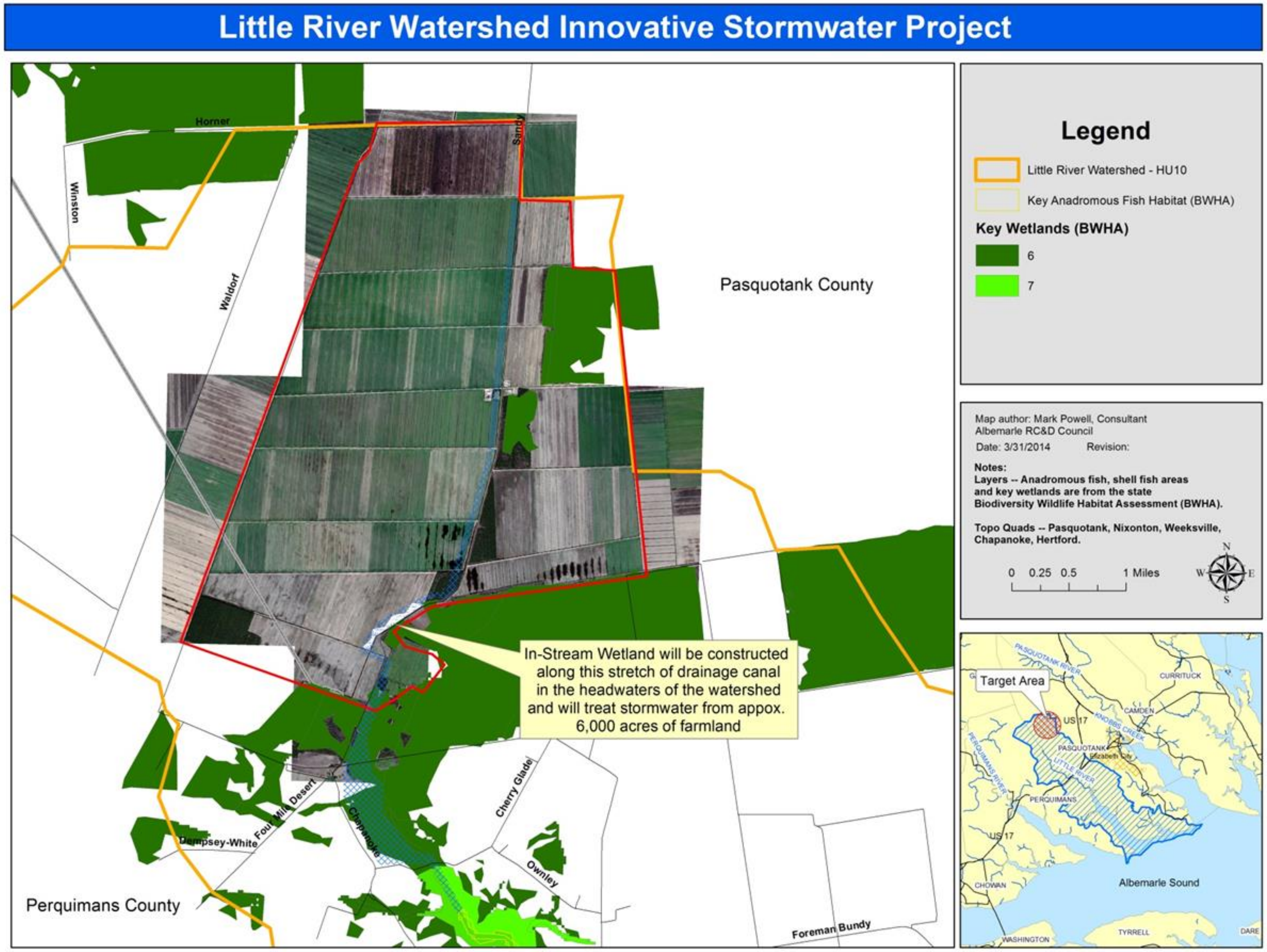

Figure 13. Locations of Potential In-Stream Wetlands on Ditches and Canals in the Watershed.

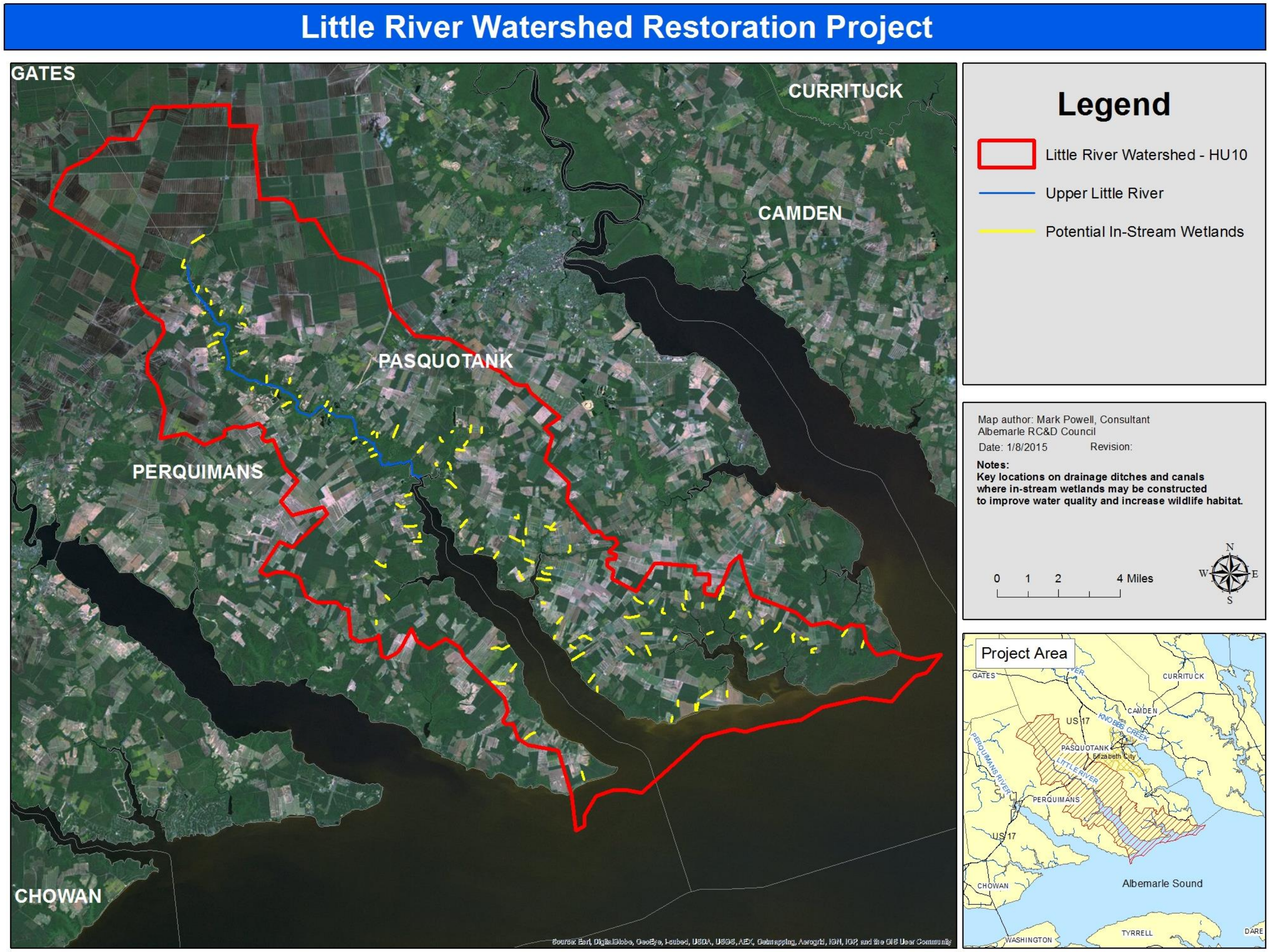

Figure 14. Example Riparian Buffer.

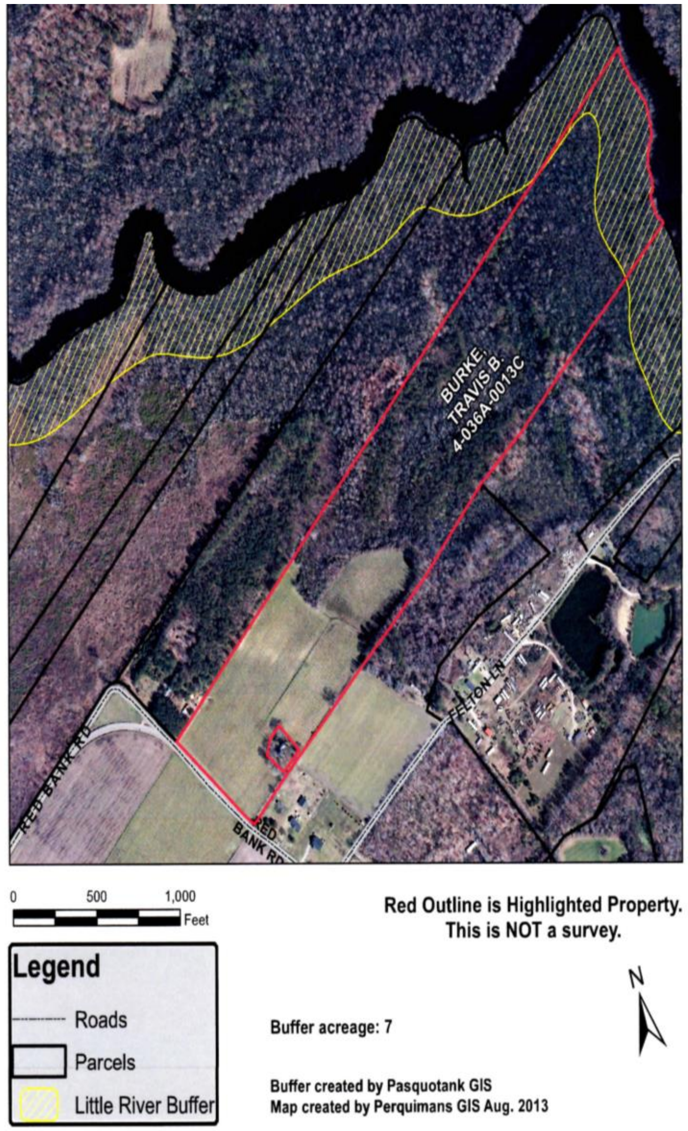

Figure 15. Location of Water Quality Sampling Stations.

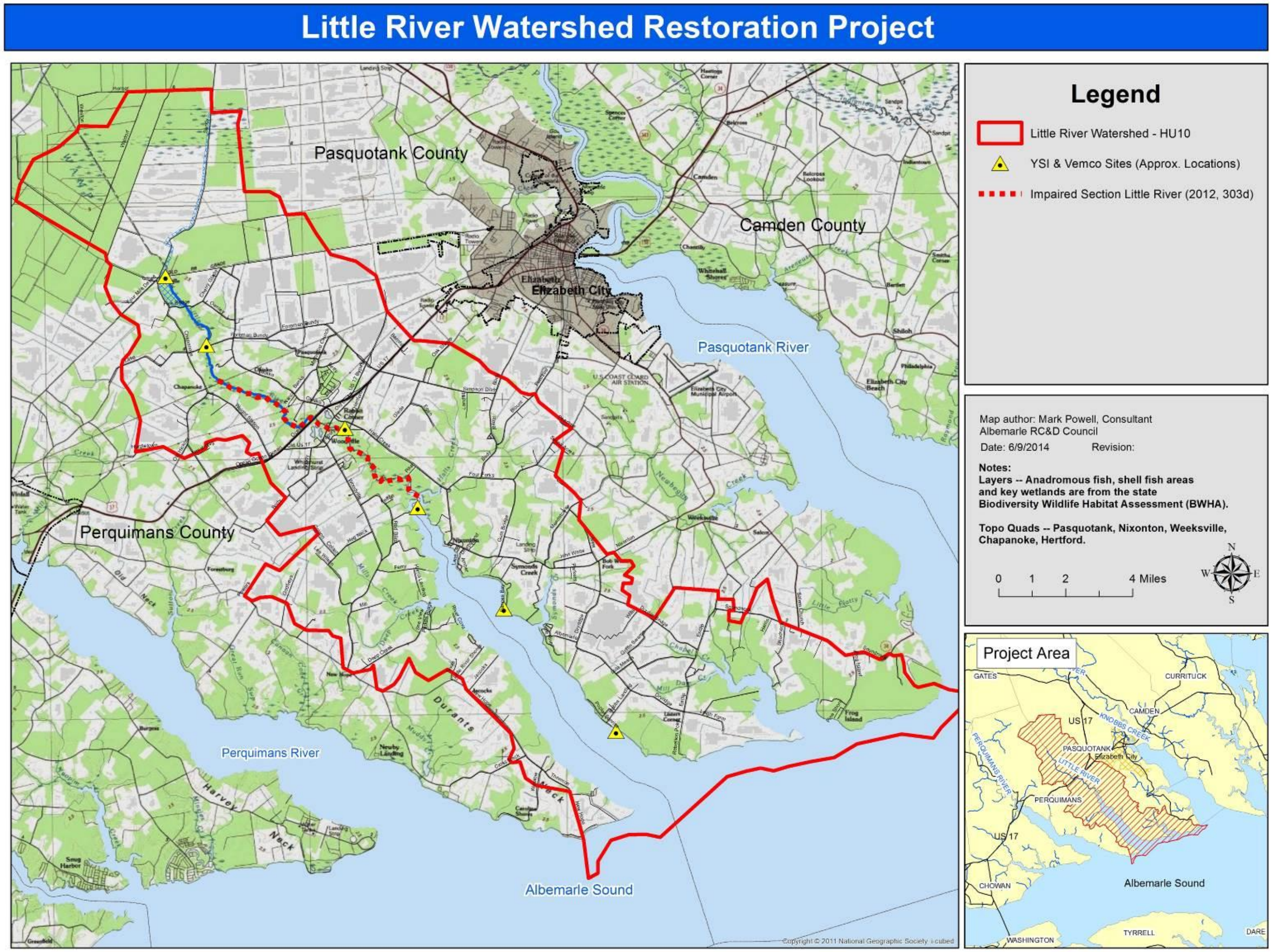

Figure 16. Physical spawning (adult) and egg development requirements for resident freshwater and anadromous fishes inhabiting coastal North Carolina (Deaton et al. 2010).

| | Salinity (ppt) | | Temperature (C) | | Dissolved oxygen (mg/l) | | Flow (cm/s) | Other parameters |
|---|---|---|---|---|---|---|---|---|
| **Species** | **Adult** | **Spawn/ Egg** | **Adult** | **Spawn/ Egg** | **Adult** | **Spawn/ Egg** | **Spawning** | **Spawn/ Egg** |
| Alewife | [S] 0-5 | [S] 0-5 [O] 0-2 | | [S] 11-28 [O] 17-21 | [S] >3.6 | [S] >4 | [O] slow current | [S] Suspended solids <1000 mg/l |
| American shad | [S] 0-18 | [S] 0-18 | [S] 10-30 | [S] 13.0-26.0 | [S] >5 | | [S] 30-90 | |
| Blueback herring | [S] 0-5 | [S] 0-22 [O] 0-2 | | [S] 14-26 [O] 20-24 | [S] >5 | | [O] strong current | [S] Suspended solids <1000 mg/l |
| Striped bass | [S] 0-5 | [S] 0.5-10 | [S] 20-22 | [S] 12-24, [O] ~18-22 | [S] >5 | | [S] 30.5-500, [O] 100-200 | |
| Yellow perch | [S] 0-13 | [S] 0-2 | [S] 6-30 | | [S] >5 | | | [S] Suspended solids <1000 mg/l |
| White perch | [S] 5-18 | [S] 0-2 | [S] 10-30 | [S] 12-20 | [S] >5 | | | [S] Suspended solids <100 mg/l |
| Sturgeon, Atlantic | [S] 0 to >30 | [S] 0-5 | [S] 0 to >30 | [S] 11-20 | | | | |
| Sturgeon, Shortnose | [S] 0 to >30 | [S] 0-5 | [S] 0 to >30 | [S] 5-15 | | | | |

[S] = Suitable, and [O] = Optimum