Stream Ecological Health Assessment for the Chowan River Basin, Virginia and North Carolina

Watershed-based Ecological Health Conservation Plan for Raccoon Creek

Report to the Virginia Department of Conservation and Recreation and the Virginia Department of Environmental Quality

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Executive Summary

Through Section 319 funding support from the Nonpoint Source Program at EPA Region III, the Chowan River Basin Healthy Waters Conservation Implementation Plan will help advance interstate watershed management efforts between North Carolina and Virginia. This project will expand and leverage existing activities underway within the Albemarle-Pamlico National Estuary Partnership, Virginia's Healthy Waters Program and entities such as The Nature Conservancy. It will result in a plan that sets ambitious goals to conserve and help restore the health of rivers and streams throughout the basin. In addition, this plan will provide recommended modifications to the guidance and objectives of the nine key elements of a Watershed Implementation Plan to be used for the purpose of protection as opposed to restoration of water quality. This plan and suggested recommendations will be provided to EPA, for consideration.

Overall, the project develops a Ecologically Healthy Watershed Conservation Plan that will be used to identify critical areas for protection and be used as the basis for the healthy watershed protection goals of the Albemarle-Pamlico National Estuary Partnership's Comprehensive Conservation and Management Plan. It assures these ecologically healthy streams are incorporated into the Department of Conservation and Recreation's Natural Heritage Biotics Database and integrated into land conservation and land planning projects in Virginia. It expands Virginia's Healthy Waters Program by expanding into a basin that has limited data and will include an assessment of stream ecological health using the existing protocol that integrates fish, aquatic life as well as habitat indicators to determine condition. To facilitate the success of this project, the Virginia partnership will include the Virginia Department of Conservation and Recreation, the Virginia Department of Environmental Quality, Virginia Commonwealth University North Carolina Department of Environment and Natural Resources, the Albemarle-Pamlico National Estuary Partnership, US Environmental Protection Agency, The Nature Conservancy, local governments and other interested stakeholders.

Background

The role of Virginia's Department of Conservation and Recreation (VDCR), Division of Natural Heritage (DNH) is the identification and protection of aquatic and terrestrial communities and rare plant and animal species that contribute important ecosystem services or represent significant ecological resources. Virginia is a member of the NatureServe Natural Heritage Network and draws upon resources throughout the Western Hemisphere to advance biodiversity conservation and shares Virginia conservation information and successes throughout the Hemisphere. Virginia has a well established record of identifying and achieving protection for rare species and terrestrial communities; the Healthy Waters Program, in strong collaboration with Virginia Commonwealth University (VCU), is finally able to identify the most biologically diverse streams in the state. In Virginia, the challenges associated with these important efforts, specifically as they relate to aquatic communities, include: 1) development and application of objective, quantitative, and diagnostic stream assessment protocols and 2) defining a set of measurable and appropriate stream conditions, based on empirical data, as goals for protection efforts. Both of these challenges are dependent on an understanding of, and comparison to, relevant reference conditions that describe accurately and quantitatively the ecological potential of streams and rivers within a specific region. In Virginia, the scarcity of relatively undisturbed streams to serve as reference systems is problematic in many ecoregions. In early 2000, in response to national US Environmental Protection Agency (US EPA) Region III initiatives, Virginia created the *Healthy Waters Program*, with the goal of identifying and protecting ecologically intact streams, riparian habitats, and stream-dependent living resources. Identification of healthy streams is a prerequisite for any resource protection program; however, current state agency-based stream monitoring and assessment activities focus primarily on water quality impairments and target degraded streams for rehabilitation.

Traditionally, water quality based programs have emphasized the assessment of streams to determine if water bodies meet water quality standards with a subsequent restoration plan to improve degraded surface waters. While this is a critical activity to provide the Commonwealth a healthy ecosystem it is equally as important to seek viable opportunities for best management practices to protect streams that are already considered healthy/biologically diverse. It is economically and ecologically preferable to conserve and protect healthy ecosystems than to restore them after they have been damaged. Agricultural BMPs may serve as a key role in the protection of healthy waters and healthy watersheds. The integrity (health) of aquatic ecosystems (streams) is tightly linked to the watersheds of which they are a part. There is a direct relationship between land cover, key watershed processes and the ecological health of streams.

As stated, in early 2000, in response to the problems outlined above, Virginia Commonwealth University, the Virginia Department of Conservation and Recreation, and the Virginia Coastal Zone Management Program (VCZM) initiated a multi-phase project to develop an integrative, objective, and statistically valid stream ecological health assessment application. The project uses high quality archival data, combined with extensive, new data collected by the VCU stream assessment team, to develop a broad suite of georeferenced databases of aquatic resources, including fish and macroinvertebrate communities, instream and riparian habitat, and geomorphological data. These databases are the foundation for the ***IN***teractive ***ST***ream ***A***ssessment ***R***esource (***INSTAR;***http://gis.vcu.edu/instar/) application: an online, interactive mapping and database application designed to quantitatively assess stream conditions based on comparisons among a suite of integrative, multimetric indices and models of regional reference conditions. An ecologically-based approach to water quality assessment has been adopted by most state and federal natural resources agencies because it effectively integrates water quality and instream habitat conditions across spatial and temporal scales. Such an approach also provides a direct evaluation of stream biological and ecological integrity (i.e., stream 'health') and an inventory of economically and ecologically important living resources. Due to this assessment approach, Virginia has identified more than 300 ecologically healthy streams, creeks and rivers throughout the state, and there are more to be identified. Healthy streams are identified by factors that include: high numbers of native species and a broad diversity of species, few or no nonnative species, few generalist species that are tolerant of degraded water quality, high numbers of native predators, migratory species whose presence indicates that river or stream systems are not blocked by dams or other impediments, and low incidence of disease or parasites.

INSTAR, and the extensive aquatic resource database on which it runs, were developed to support a variety of stream assessment, management and planning activities aimed at restoring and protecting water quality and aquatic living resources throughout the Commonwealth. The project is currently focused on developing an aquatic resources (blue infrastructure) database and stream health assessment protocols for Virginia's portion of the Chesapeake Bay and Chowan watersheds. In addition, regional reference stream models (i.e., *virtual* streams) for both non-tidal and small to medium-sized tidal tributaries are developed as criteria for prioritization of candidate streams and watersheds for protection and restoration, objective and quantitative performance measures, and as a decision support tool for environmental planning and implementation. The *INSTAR* program (http://gis.vcu.edu/instar/) and related applications developed by VCU leverage cutting-edge, information technologies and an expanding database of high-quality, geospatial information to conduct both watershed (sixth-order hydrologic units) and reach-specific assessments of stream and river health throughout the Commonwealth. Currently, *INSTAR* has compiled information on approximately 2,300 Virginia and North Carolina streams and representing over 265,000 records. The INSTAR application is currently the only tool available to identify ecologically healthy, freshwater streams and rivers in the Commonwealth.

Some actions that typically support healthy waters protection:

- Create, maintain, or expand riparian buffers: Vegetative corridors of at least 35' in width buffer streams from activities in the watershed by intercepting runoff that would otherwise transport sediment and other pollutants to the stream. This is one of the most effective measures for protecting streams. However, to achieve protection of steam corridors to maintain and ensure aquatic and terrestrial communities, we recommend forested riparian buffers along the river and any streams on the property. These buffers should be at least 100 feet wide on both sides of the waterways. If slopes are 11-25 % the buffers should be 150 feet wide and if slopes are greater than 25% buffers should be at least 200 feet wide. These buffers should be kept free of livestock and soil disturbances. Timber harvesting of 50% cover of the landward 50 feet these buffers may be acceptable.
- Protect headwater streams: Often intermittent, and therefore not recognized as a "blue line stream" and underserved by regulation, these streams are extremely important to the natural function of downstream waters and habitat for aquatic communities. Exclusion such as fencing livestock out of these areas can prevent downstream degradation of high quality perennial streams.
- Maintain natural stream flow to ensure aquatic habitat consistent with healthy ecosystems: The natural, seasonal pattern of stream flow, the stream's response to storm events, and maintaining minimum flow levels may be as critical to a stream's health as water quality.

- Protect natural stream channels: Stream channels naturally adjust across their floodplain and are continually changing. By protecting riparian corridors, through easements or by excluding livestock from unlimited access to stream channels, direct introduction of some pollution (bacteria) may be minimized as well as reducing the direct impacts to aquatic habitat and the creation of erosion problems.

<u>Basin Description</u>

The Chowan River Basin is a shared resource in the southeastern region of the Commonwealth of Virginia and the northeastern region of the State of North Carolina. The basin is approximately 130 miles long, drains an area of nearly 5,000 square miles (3.2M ac), contains nearly 10,000 miles of streams and lies 75 percent within Virginia and 25 percent within North Carolina (Figure 1). In Virginia, the basin covers all, or a portion of, Brunswick, Dinwiddie, Isle of Wight, Lunenburg, Mecklenburg, Nottoway, Prince George, Surry, Southampton, and Sussex counties. In North Carolina, all or a portion, of Chowan, Gates, Bertie, Hertford, and Northampton are located in the basin. The Blackwater, Meherrin and Nottoway rivers are the major tributaries to the mainstem Chowan, which is located entirely in North Carolina. The Chowan Basin flows through the piedmont and coastal plain physiological provinces and is primarily in forestry or agricultural use with pine and peanuts being the primary crops. One of the driving factors for initiating the Chowan Project is that it is mostly rural - approximately 64 percent of its land covered by forest. Cropland and pasture make up another 28 percent, while only about 6 percent is classified as urban.

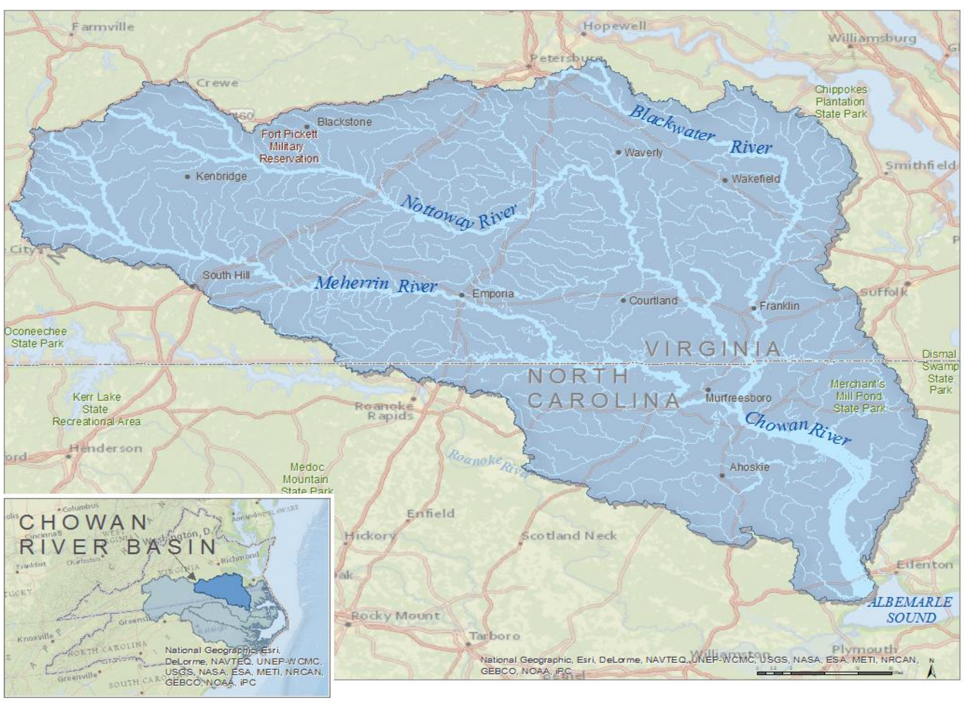

Figure 1 Chowan Basin

The piedmont physiographic province within the Chowan Basin is home to important warm water fisheries including habit and significant populations of the endangered Roanoke Logperch *(Percina rex)*. It also has good water quality and important habitat for freshwater mussel assemblages. The coastal plain physiological province includes low gradient black water swamps and bottomland hardwood forests.

<u>Planning Process</u>

The planning process for the Chowan Project was driven by a number of distinctive factors. The first is the planning effort was designed to identify streams with high ecological integrity and to develop a conservation strategy rather than one based on restoration, as is typical for many watershed planning activities. Second, the assessment process involved both a landscape scale screening and a probabilistic in-stream assessment guided by the landscape scale screening. The landscape scale assessment used remotely-sensed indicators for monitoring the general condition of "natural habitat" in basin. Another unique aspect of the basin is that it is largely forested and is comparatively less populated than other regions of the State, especially compared to other basins of this scale. As described below, this factor was significant because it shaped the efforts of the planning team and the approach to stakeholder engagement. The plan was intended to take an interstate approach and to involve two Environmental Protection Agency regions, other federal agencies, two state agencies and local nongovernmental partners to develop a comprehensive planning process. The in-stream and landscape scale assessments drove the final element of the planning process: identifying watersheds to develop specific protection-based implementation plans. The Section 319 Scope of Work for the project committed to developing three discreet watershed implementation plans. As the project advanced, the opportunity to target additional areas arose. Therefore, the final project deliverable includes four watershed implementation plans that include watershed implementation plan elements adapted to a conservation based planning framework.

<u>Planning Team</u>

The initial development of the Chowan assessment was the formation of the project planning team. As noted above, the Virginia Healthy Waters Program has been developed through a collaborative multi-agency effort between VDCR, VDEQ and VCU. The Chowan Project has also benefited from this multi-agency involvement and was expanded with the addition of the North Carolina Agencies. The Project Team, lead by the VDCR, Division of Natural Heritage, in collaboration with VCU staff, engaged numerous cooperating state agencies including VDEQ, the Virginia Department of Forestry (DOF) and The Nature Conservancy, throughout the planning process. As a demonstration of continuing cooperation on conservation initiatives, the Project Manager engaged the North Carolina Department of Environment and Natural Resources, NC Natural Heritage staff, along with staff from the Albemarle-Pamlico National Estuary Partnership. These relationships have benefited the planning process immeasurably and have further demonstrated the benefits of interstate cooperation and conservation planning. The VDCR Natural Heritage Division led the overall planning process and plays a lead role in Virginia with management and dissemination of biodiversity conservation information, with VCU staff being the primary science investigators for the project. The VCU staff served as the lead for field data acquisition, field study design, and data development and analysis. VCU staff designed and developed the landscape scale assessment and stream ecological health assessment for the targeted watersheds. VCU has continued to be an important partner is the state of Virginia's Healthy Waters Program. Specifically, VCU leads the stream assessment design, data collection, analysis and hosts the Healthy Waters data and geographic information system (GIS).

On January 30, 2012, the Project Manager organized a kickoff meeting hosted by the APNEP to develop the Chowan Project Team and to establish an ongoing collaborative and cooperative effort. The APNEP has shared the funding of a conservation field staff, Watershed Field Coordinator, which was housed in Virginia but worked in both states for several years. This relationship proved extremely beneficial since the Watershed Field Coordinator identified the potential role for APNEP and the connection to the Comprehensive Conservation and Management Plan (CCMP) for the Basin and identified additional initial partners. The CCMP outlines several targeted strategies to address resource protection in watersheds draining into the Albemarle and Pamlico Sounds. The shared management and funding of the Watershed Field Coordinator is based on an identified Memorandum of Agreement (MOA) between both the Commonwealth of Virginia and the State of North Carolina for this watershed and staff. An intended outcome of this project was the expansion of the MOA between the two states to develop an overall, comprehensive, interstate, inter-basin, watershed coordination MOA between the States. The purpose was to encompass all watershed activities between the two states to improve efficiencies, capacity and share resources. Management of the VA DCR, Division of Soil and Water at that time deemed the concept was to be removed from consideration and would no longer be an outcome of the project or process.

Through the newly developed relationship with the state of North Carolina and the staff of the Department of Environment and Natural Resources, this project was embraced as an opportunity to connect land conservation activities throughout the basin and as a mechanism to inform future land conservation activities. The NCDENR recognized additionally the opportunity to develop a North Carolina Healthy Waters Program, based on the outcome of this process using the Commonwealth of Virginia as a model for their Program. The NCDENR also recognized the opportunity that the data to be developed from the assessments would inform their long range plans to expand and protect those areas near to significant and protected natural features, such as Merchants Mill Pond.

The Nature Conservancy staffs have long been an important partner in conservation efforts in the Chowan Basin and in the Commonwealth of Virginia. With regard to this project, The Nature Conservancy Southern Rivers staff helped coordinate and guide watershed prioritization, stakeholder identification and community engagement. In particular, TNC identified unique opportunities for focusing the work and recognized significant stakeholders such as the City of Norfolk, Department of Utilities, and Enviva Pellets Southampton LLC (Enviva). The City is an important watershed stakeholder because they have a water intake in the Nottoway River that is used to supply the reservoirs serving their communities. Currently, the City implements protective measures around reservoirs to minimize impacts to water quality. An opportunity sought to be realized was the protection of those riparian adjacent to the sites common for water withdrawal in river systems that supplied those reservoirs.

Much of the watershed is forested and has significant forestry operations throughout the basin. The VA Department of Forestry became another important partner in the project identifying opportunities and challenges. The DOF informed the planning process and assisted in bringing important forest industry partners, such as Enviva into the dialog. With a strong sustainability commitment, Enviva is an important partner in helping to ensure sustainability at the point of forest extraction. Point of extraction sustainability is vital to conserving the health of streams throughout the basin because the protection of bottomland hardwoods coincides with the protection of healthy aquatic ecosystems. The DOF also identified the opportunity to introduce the VA Sustainable Forestry Initiative (SFI) Board to the Healthy Waters Program and to inform them of the available data and resource protection goals. The prospect of sharing the resources of the VDCR DNH Healthy Waters Program is one to be capitalized upon since the reach would benefit not simply the region of the Chowan study area, but statewide. During discussions with both the TNC Southern Rivers Manager and the VDOF, Healthy Waters staff ascertained that two new forest product facilities were planned to be developed to support the growing pellet industry. The DOF and TNC confirmed the general locations of Franklin, VA and Roanoke Rapids, NC as the sites for the receiving of timber serving the pellet production process. Both DOF and TNC confirmed that theses two locations had a “fiber basket” radius of 75mi for each location. Geographically, this poses a significant challenge to the protection of resources. The two 75mi radii overlap and when shown in a Venn diagram-like manner demonstrates those areas most likely to be the focus of the majority of the extraction. Those overlapping radii can be seen in Figure 2.

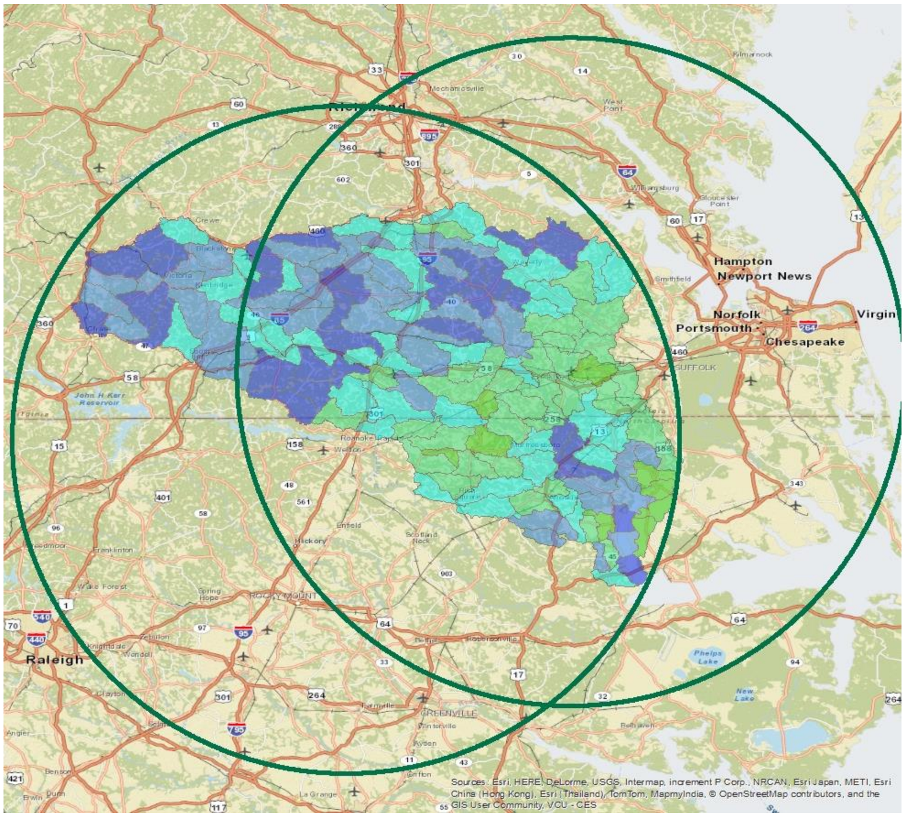

Figure 2. 75mi overlapping radii “fiber baskets” serving Roanoke Rapids, NC and Franklin, VA as centers.

The US Department of Defense, Fort Pickett staff also became an important cooperator with this project. In addition to hosting site visits and coordinating team meetings, such as a recent meeting between VDCR, North Carolina DENR and APNEP staff, Fort Pickett staff agreed to incorporate healthy waters conservation elements into the Integrated Base Management Plan. The Ft Pickett Base Natural Resources Manager offered the opportunity to broker a stronger relationship with the neighboring localities and landholders to permit an improved tie to resource protection benefiting the Healthy Waters Program and their own resource protection goals.

The Virginia Department of Environmental Quality provided grant administration and was engaged as an active participant in the modification of the watershed restoration planning elements to create conservation-based plan criteria. The outcome of that process was the development of the A-I Criteria for Ecologically Healthy Watershed Conservation. The VDEQ remains an active participant in the integration of the planning elements into the TMDL and restoration process. The VA DEQ had recently taken a step to allow the VDCR Division of Natural Heritage to outline strategies, share data for the identification and protection of critical resources and help with TMDL prioritization based on Healthy Waters data.

The Project Team focused the input of the Project Partners to identify those areas to direct the acquisition of field based data to inform the development of the INSTAR and

Healthy Waters sites. Based on the outcome of the Index of Terrestrial Integrity assessment, or coarse-scale remote analysis, the areas of the Meherrin, Assamoosic, Nottaway and Chowan would be the areas assessed by field personnel. Illustrations of those areas can be found in the following section articulating those areas most likely to contain healthy resources. While not the typical probabilistic-based approach, the limited project budget necessitated the direct field assessment to these areas. A probabilistic approach was used in those watersheds to guide the acquisition of field data.

Adapting Watershed Planning Elements to a Conservation Plan

A deliverable of this project is the adaptation of EPA's Nine Key Elements of Watershed Planning to a create Healthy Watersheds Implementation Plan. The Project Team used an iterative and cooperative approach to adapt the planning elements with a focus on protection. As the lead nonpoint source agency, VDEQ was directly engaged in the development of these planning elements.

In 2004, EPA issued Federal Guidelines for the Award of Section 319 Nonpoint Source Grants to States and Territories. This guidance identified nine key elements that are critical for achieving improvements in water quality. EPA requires that these nine elements be addressed in watershed plans funded with incremental Clean Water Act section 319 funds and strongly recommends that they be included in all other watershed plans intended to address water quality impairments. For purposes of this project, the nine key elements are not directly applicable because the project is designed to proactively protect aquatic integrity rather than restore impaired waters. The deliverable of this project was to recommend conservation based planning elements that would be applicable to future conservation based watershed plans.

The planning team developed these conservation-based watershed planning elements considering how each element could be adapted to a Healthy Watershed Plan. To guide this effort the team identified fundamental differences between conservation based planning and restoration based planning. One consistent difference was the need to integrate ecosystem-based principles into the elements. This approach moves beyond physical and chemical water quality parameters and considers a holistic systems-based approach.

The team also considered differences between monitoring, resource assessment and that the actions typically taken to conserve natural resources may differ from corrective actions taken to restore degraded water quality. Protection measures such as land conservation and land use plan and ordinance development are strong factors for consideration. While code and ordinance conservation provisions were not the highest priority for conserving Healthy Waters in the Chowan Basin, they may be the most important components for other watersheds. Typically, the *A-I Criteria* is used as part of a watershed restoration strategy identifying the following points:

A. Identify and quantify causes and sources of impairments

B. Estimate expected load reductions

C. Identify BMPs and critical areas to achieve load reductions

D. Estimate needed technical and financial resources

E. Provide information, education and public participation component

F. Include schedule for implementing NPS management measures

G. Identify interim measurable milestones for implementation

H. Establish criteria to determine if load reductions are achieved

I. Provide a monitoring component to evaluate effectiveness

This iterative approach resulted in the following A-I Elements that where applied in developing the watershed based plans in the Chowan Basin, referred to as the A-I *Criteria for Ecologically Healthy Watershed Conservation*:

A. Quantify and verify the empirical basis for aquatic communities identified with high ecological integrity

   The watershed plan should include detailed description of assessments and those data that characterize an ecological basis for conservation, accompanied by a detailed map identifying those specific features and conditions. The plan should identify those aquatic community assessments, terrestrial assessments; National Land Cover Data; VA Department of Forestry Forest Conservation Values; catalogue of existing ownership and other relevant information quantify ecological health and aquatic integrity and inform prioritization. The conclusions are based on aquatic and terrestrial data and assessments that clearly identify ecological health. For Virginia, initial assessments utilize a remote assessment to identify prioritizations based on a modified Index of Terrestrial Integrity (mITI), to classify all 12-digit HUCs and to identify a prioritized subset of HUCs with high terrestrial integrity *prior to* on-the-ground stream and site assessment. By focusing on HUCs with relatively high terrestrial integrity, the ability to more effectively leverage the limited resources available for fieldwork improves the ability identify new Healthy Waters locations for conservation and protection activities. A field-based VA Department of Conservation and Recreation, Natural Heritage Division INSTAR assessment is the basis for identifying aquatic integrity to inform the development of Healthy Waters sites. This element will include an accounting of the significant terrestrial and aquatic natural resources within the basin.

B. Identify conditions needed to maintain existing ecological

   On the basis of the assessed existing ecological condition and characterization the plan will identify the area that would most likely be recommended for protection.

Those areas will be variable bas based on the previous assessments but will be informed by National Land Cover Data, VA Natural Heritage Division data relevant to maintaining the ecological condition, existing conservation easements, and INSTAR data. An assessment that concludes with an indication of ecological aquatic health is based on the existing baseline conditions, therefore it is implied that those current conditions, if maintained, will ensure that classification.

C. Identify best management practices, preventative and protective actions to achieve and maintain the system with high ecological integrity

The plan should identify those specific actions required to ensure the assessed ecological condition is maintained. These might include such practices as direct acquisition of land, conservation easements with specific language relevant to the protection of aquatic integrity or the application of increased standards for water quality protection or improvement such as those identified in the Sustainable Forestry Initiative.

D. Estimate needed technical and financial resources

The plan should estimate the financial and technical assistance needed to implement the entire plan. This includes implementation and long-term operation and maintenance of management measures, I/E activities, monitoring, and evaluation activities. The plan should also document which relevant authorities might play a role in implementing the plan. Plan sponsors should consider the use of federal, state, local, and private funds or resources that might be available to assist in implementing the plan. Shortfalls between needs and available resources should be identified and addressed in the plan.

E. Provide information, education and public participation component

The plan should include an I/E component that identifies the education and outreach activities or actions that will be used to implement the plan. These I/E activities may support the adoption and long-term operation and maintenance of management practices and support stakeholder involvement efforts.

F. Include schedule for implementing best management measures

You should include a schedule for implementing the management measures outlined in your watershed plan. The schedule should reflect the milestones you develop in section G.

G. Identify interim measurable milestones for implementation

The plan will include interim, measurable milestones to measure progress in implementing the management measures for your watershed plan. These milestones will measure the implementation of the management measures, such as whether they are being implemented on schedule, whereas element h (see below) will measure the effectiveness of the management measures, for example, by documenting those actions to protect aquatic integrity.

H. Establish criteria to determine high ecological integrity is maintained at baseline conditions

   As projects are implemented in the watershed the plan should include specific benchmarks to track progress. The criteria in element h (not to be confused with water quality criteria in state regulations) are the benchmarks or waypoints to measure against through monitoring. These interim targets can be direct measurements or indirect indicators of resource protection. The plan should also indicate how to determine whether the watershed plan needs to be revised if interim targets are not met. These revisions could involve changing management practices, updating the loading analyses, and reassessing the time it takes for pollution concentrations to respond to treatment.

I. Provide a monitoring component to evaluate effectiveness

   The watershed plan should include a monitoring component to determine whether progress is being made toward attaining or maintaining the applicable characterization based on the outcome of the assessments. The monitoring program should be fully integrated with the established schedule and interim milestone criteria identified above. The monitoring component should be designed to track the progress of protecting those critical resources and maintaining the existing conditions as assessed. Watershed-scale monitoring can be used to measure the effects of multiple programs, projects, and trends over time. Instream monitoring does not have to be conducted for individual BMPs unless that type of monitoring is particularly relevant to the project.

GIS Prioritization

The Virginia Watershed Integrity Model (VWIM) was developed and published in 2007 by a team that included the Virginia Department of Forestry, Virginia Division of Natural Heritage, and Virginia Commonwealth University to show the relative value of land as it contributes to watershed integrity, water quality, or stream ecological health. As development pressure continues across the state, critical resources are being irretrievably lost to development. A large number of published and unpublished studies have demonstrated strong relationships between land use and the integrity of water resources (Hughes, 1999; Karr, 1981; Tiner, 2004, Garman, 2010). Hence, valid models of high quality green infrastructure like the VWIM should be useful in predicting—with remotely sensed data—which watersheds are most likely to support streams with high ecological integrity (i.e., Healthy and Outstanding Waters). For the Virginia Watershed Integrity Model, input parameters focused on important terrestrial features that contribute specifically to water and aquatic resources, and, therefore watershed integrity. Given the limited resources available for on-the-ground activities, the use of models like the VWIM to prioritize watersheds prior to direct stream assessment may be an effective approach.

Prioritizing watershed integrity on a large spatial scale (i.e., the Chowan River Basin of Virginia and North Carolina) should apply terrestrial ecological indictors or indices that "include site-specific, field-derived metrics and landscape-level properties" in an effort to get at finer scale information (Tiner 2004). The focus of the current project was to employ a GIS-based classification of terrestrial integrity for 12-digit watersheds (HUCs) in the Chowan Basin (Figure 3) to identify those HUCs that are most likely to harbor healthy streams.

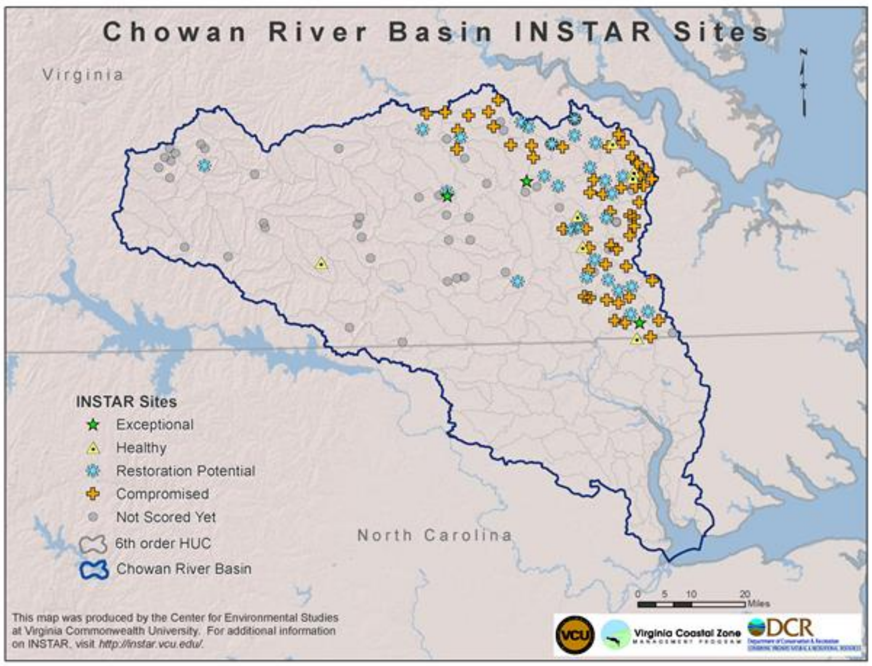

Figure 3. The Chowan River Basin of Virginia and North Carolina, showing Hydrologic Unit (HUC) boundaries and locations of **archival** (i.e., pre-project, *ca*. 2010) INSTAR collections (primarily in the Blackwater system). Per 2014 discussions between DCR and DEQ, the term, "Exceptional" as shown in the Figure, has been changed to, "Outstanding".

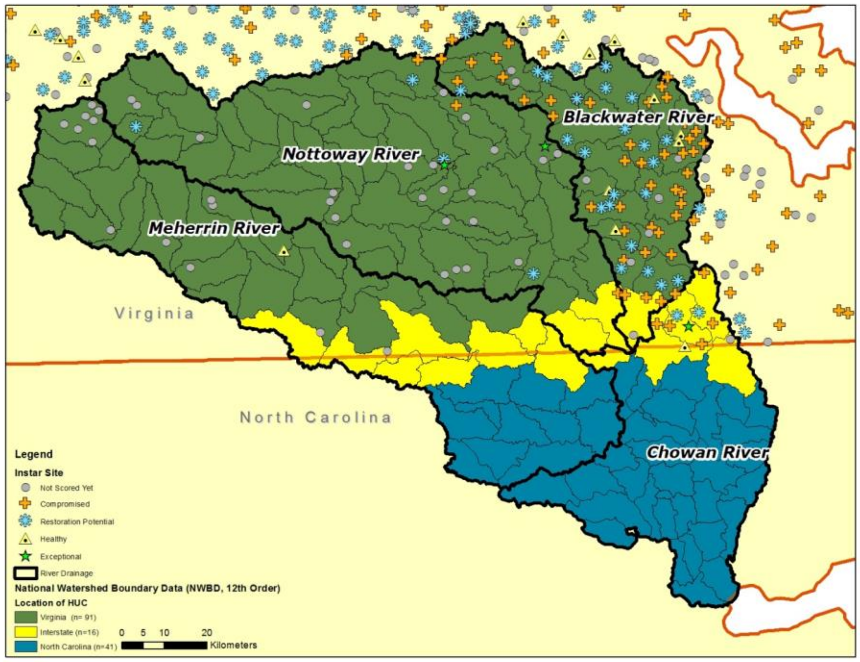

Figure 4. Division of the Chowan Basin between the Commonwealth of Virginia and the State of North Carolina, showing archival (pre-study) stream data. Per 2014 discussions between DCR and DEQ, the term, "Exceptional" as shown in the Figure, has been changed to, "Outstanding".

Accessibility to GIS and remotely sensed information makes these processes easier to run and can provide an important monitoring tool for watershed integrity. These indices may also provide important information on aquatic ecosystem integrity (i.e., health) which can be used to develop indicators of overall stream health (Garman 2010). The Index of Terrestrial Integrity (ITI, Tiner 2004) is a component of the Virginia Watershed Integrity Model and was modified and applied to a GIS-based analysis of green infrastructure throughout the Chowan Basin. Results were used to classify HUCs (Figure 4) and to prioritize field activities that sought to identify ecologically healthy waters throughout the Chowan Basin. Specific input variables/metrics used for this application of a modified ITI in the Chowan Basin included:

a. The Natural Cover Index (INC) of Tiner (2004) based on the proportion of a watershed that is represented by natural vegetation (i.e., undeveloped landscapes);
b. The River-Stream Corridor Integrity Index (IRSCI) of Tiner (2004) that provides information on the status of vegetated riparian corridors;
c. The Habitat Fragmentation/Road Index (IHF) of Tiner (2004), which attempts to address habitat fragmentation by roads and reflects degradation of water quality, and terrestrial and aquatic ecosystems from associated development;
d. The Imperviousness Index (IP) was *not* used by Tiner (2004) but was added by VCU to this analysis to indicate degree of human development. It is based upon the proportion of a watershed that is identified as impervious cover and used the NLCD 2001 impervious dataset. While strongly correlated with the road density (and thereby IHF), it should add information where high density development is pervasive.

These four metrics, along with relevant and published geospatial coverages from Virginia and North Carolina sources, were used to compute a composite Index of Terrestrial Integrity (ITI) based on the formula: ITI = (0.75 * INC) + (0.25 * IRSCI) – (0.25 * IHF) – (0.25 * IP) (J. Scrivani, Virginia Department of Forestry, unpublished report). The model was used to classify all Chowan Basin 12-digit HUCs and then identify a prioritized subset of HUCs with high terrestrial integrity (Figure 5) *prior to* on-the-ground stream and site assessment by VCU biologists in 2012 and 2013. By focusing on HUCs with relatively high terrestrial integrity, VCU was able to more effectively leverage the limited resources available for fieldwork to identify new Healthy Waters locations for conservation and protection activities. In the Chowan Basin, the modified ITI was a good predictor of HUCs that harbored one or more new Healthy Waters Locations (Figure 5). Following the analysis, the Project Team determined those areas most likely to contain resources that may score a ranking of Healthy or higher would be located in the lower Meherrin, Assamoosic, or mainstem Chowan (eastern portion) (Figure 6).

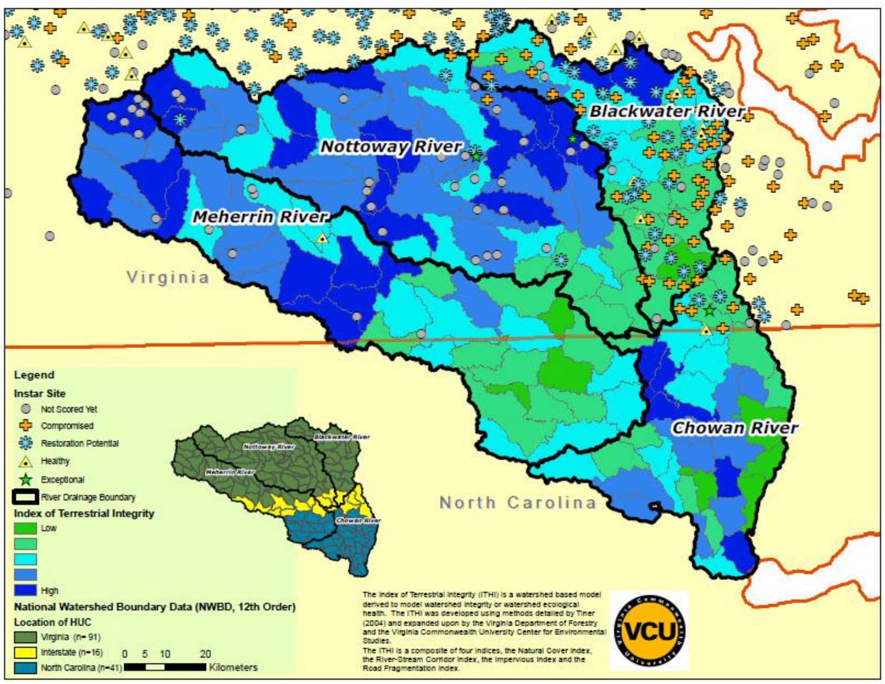

Figure 5. Application of the Index of Terrestrial Integrity to 12-digit HUCs of the Chowan Basin prior to field activities. Watersheds with high ITI scores were prioritized for field activities. A detailed explanation of the ITI and its application for this study is provided in the text. Per 2014 discussions between DCR and DEQ, the term, “Exceptional” as shown in the Figure, has been changed to, “Outstanding”.

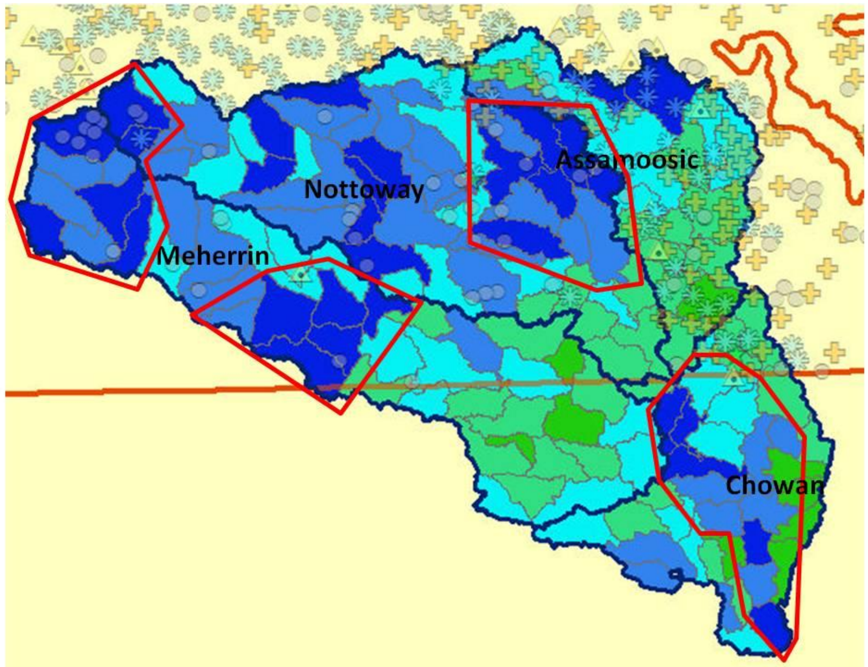

Figure 6. Focal areas of field-based INSTAR assessment (dark blue HUCs), overlaid on the Index of Terrestrial Integrity, illustrating the areas to achieve one watershed plan for Virginia, one for North Carolina and one shared watershed

<u>Field Activities and Preliminary Data Analysis</u>

Within prioritized HUCs of the Chowan, probabilistic study reaches (a minimum of 100 new stream reaches) for INSTAR sampling were selected for potential fieldwork through a statistically powerful, stratified (by stream order) randomizing protocol. Within geo-referenced reaches (150-500 m) and following methods outlined in the Quality Assurance Performance Plan (QAPP), fishes were sampled quantitatively using electrofishing equipment (Smith-Root backpacks, tote barge units, boats) and standard methods. Backpack and tote barge sampling was performed throughout the entire reach in a single pass. Boat electrofishing included additional sampling effort depending on stream width and habitat variability. Electrofisher settings (e.g. output voltage, waveform, etc.) for each sampling event were set to optimize sampling efficiency and minimize fish mortality based on ambient conditions and operator experience. Electrofishing settings and total effort (seconds of generator output) were recorded for each sampling event, along with any other relevant information. All fishes were identified to species in the field, checked for anomalies, and released. A synoptic assessment for instream habitat quality (EPA Rapid Habitat Assessment, RHA) was also performed at each site with the appropriate metrics for high *versus* low gradient. A total of 109 streams in Virginia and North Carolina were visited for this project during 2012 and 2013. A total of 24 sites had insufficient water to justify sampling and were neither sampled nor assessed. An additional 14 sites—primarily lower Chowan River locations—were not wadeable and were sampled by boat electrofishing. However, we had insufficient data to develop reference condition models for 'big water' sites in the Chowan and these 14 sites were not classified. Data from these locations were incorporated into INSTAR. A total of 71 stream reaches were sampled during 2012 and 2013 and classified for this project. Additional archival collections from various sources (VDGIF, NCDENR, VCU) met the criteria for database inclusion and/or stream ecological health.

Following data entry and QA procedures, biological and habitat data were compiled in SQL databases and application macros within INSTAR were used to calculate 47 separate metrics and ecological variables, including those typically generated for the Index of Biotic Integrity (IBI), Rapid Bioassessment Protocol (RBP), and Rapid Habitat Assessment (RHA). Variables and metrics were subjected to ordination and cluster analysis using uni-modal models (e.g. correspondence analysis (CA), de-trended correspondence analysis (DCA), and canonical correspondence analysis (CCA)) and linear response models (e.g. principal components analysis (PCA), multiple regression techniques). These multivariate analyses were used to develop regional reference condition models for comparison to empirical data for specific stream collections. We used Gower's similarity index to compare empirical scores obtained from each sampled stream reaches to the appropriate virtual reference stream, generating an index of stream health as a measure of percent comparability to the appropriate (virtual) reference condition model. High percent comparability scores (> 70%) were used as thresholds to classify streams as "healthy" and "outstanding" (> 80% comparability). Percent comparability scores below 70% were associated with streams that were "compromised" or represented "restoration potential." A more detailed explanation of field, laboratory, and data analysis methods is provided in an approved quality assurance (EPA-QAPP) document, provided in the Appendices. VCU held all necessary collection permits from State and Federal agencies to conduct fisheries fieldwork in Virginia and North Carolina.

Data Interpretation

Biotic metrics to evaluate stream health are increasingly utilized because of their ability to represent attributes or processes of the biological communities that respond to a gradient of anthropogenic influences (Karr 1981). Multmetric indices are commonly used as a mechanism to assess freshwater ecosystem quality (Hughes and Oberdorff, 1999) and are considered an efficient tool for evaluating the quality of running waters (Barbour et al. 1996). Often these indices are confined to a single taxonomic group (fishes, macroinvertebrates, diatoms, etc.) and are scored against some form of reference stream or hypothetical condition. This project's approach used data collected by uniform, statistically acceptable (probabilistic) methods to assess how the communities (primarily fish assemblages) under consideration are structured. Following the initial exploratory analyses, we evaluated variation among sites. We integrated the results from fish community analyses along with synoptic instream habitat data to strengthen our capacity to correctly assess impacts and stream condition.

Empirical data and derived metrics were compiled from the original data base and analyzed with multivariate techniques (e.g. detrended correspondence analysis (DCA), canonical correspondence analysis (CCA), principal components analysis (PCA), nonmetric multidimensional scaling (NMS) and linear regression). The goal for the first set of ordination analyses was to probe for underlying gradients or structure in the species data (NMS). We then used CCA and/or DCCA to assess community structure as it relates to the watershed metrics. Additional exploratory ordinations (PCA) examined the structure of the biotic communities based on functional attributes of the community members. A complete listing of candidate metrics, including those metrics selected by the analysis for model development, is provided in Table 1.

Fish Community Metrics	**Watershed Metrics**
Total species richness	Stream Order
Native species richness	Link Magnitude
Proportion Native species	Colonizing Link
Darter species	Distance to colonizing Link
Sucker species	Distance to mainstem
Sucker individuals	Distance to headwater
Sunfish species	Elevation
Introduced sunfish species	**Ecological Metrics**
Proportion of native sunfish species	Omnivorous species
Total sunfish individuals	Omnivorous individuals
Proportion of native sunfishes	Water Column Insectivore species
Sensitivity Metrics	Water Column Insectivorous individuals
Intolerant species	Benthic insectivore species
Intolerant individuals	Benthic Insectivore individuals
Intolerant of Biological Impairment	Apex predator species
Intolerant of Chemical Impairment	Apex predator individuals
Intolerant of Sedimentation	General carnivores species
Tolerant of Biological Impairment	General carnivores individuals
Tolerant of Chemical Impairment	General Invertivore species
Tolerant of Sedimentation	General Invertivore individuals
Tolerant species	**Fish Position Metrics**
Tolerant individuals	Benthic species
	Benthic Hiding species
Coastal Plain specialist	Water column species
Shannon's diversity	Water column hiding species
Evenness	
Proportion with anomalies	
	Significant metric from regression analysis

Table 1. Candidate metrics generated by INSTAR and used for reference condition model development and stream assessment, Chowan River Basin (Virginia and North Carolina). A substantial number of the candidate metrics were based on previously published protocols (e.g. Index of Biotic Integrity, Rapid Habitat Assessment, Rapid Biomonitoring Protocols; Garman et al. 2010). Highlighted cells indicate metrics selected by initial ordination analyses and metrics included as variables in the final reference condition models.

Some metrics were of limited use for further analysis because of their lack of variability among sites sampled. Other metrics were highly correlated and as such do not add information to the analyses. These metrics were systematically removed from the data sets prior to further analysis. The refined (or 'cleaned') datasets were again analyzed using the appropriate ordination technique using species data, metrics, and habitat data. The resultant ordination diagrams (final response) plot similar sites together (or of close proximity to one another) and as such can be further examined for community structure and gradients among the stream sites. Often highly impacted streams and those of high quality are far removed from one another in these diagrams. Examination of the site scores and position of variables on the diagram indicate the relative importance of any given variable to the overall structure. Variables that exhibit a uniform or central distribution would not contribute to a more rigorous model and are thus not included in the final statistical analyses. Those variables and metrics that are important are included in the final stepwise linear regression analysis.

The site scores (i.e., coefficients from the final response model) are entered as the response variable and significant ($P<0.05$) biotic and abiotic variables and metrics are entered as explanatory variables. Finally, a series of reference stream condition models (i.e., virtual reference streams) are created for appropriate ecoregions and stream orders. The stream models use the resultant significant variables from the regression analysis and are scored depending on divisive categories (i.e., stream order). We used Gower's similarity index to compare empirical scores obtained from sampled stream sites and reaches to the appropriate reference stream, generating an index of stream health (i.e., Virtual Stream Assessment, VSA, score; range 0-100%) as a measure of percent comparability to the appropriate (virtual) reference condition model.

Results of initial ordinations (exploratory data analysis) revealed significant separation among samples based on the biota present (Figure 7). Strong clustering of some fish species on the plot suggests the presence of persistent habitat-based guilds, based on co-occurrence. The strongest gradient observed was along the 1st (X) axis and represents an elevational gradient. Those species on the left side of gradient are more affiliated with streams of higher elevation and those to the right lowland streams. The 2nd (Y) axis represents a strong stream size gradient with upper species associated more with larger streams. When examined by quadrants, the lowland species such as mudminnows, and many of the native sunfishes represent a low-gradient, low elevation guild (lower right), while redhorse suckers and some of the cyprinid insectivores comprise a moderate stream order and higher elevation guild (upper left). (Figure 7). Further data analysis was divided into two groups of sites representing those below (131 sites) and above (104 sites) 150 feet in elevation. In addition, sites representing streams of 4th or higher stream order were removed from further analysis. Aside from stream size and elevation, only Colonizing Link (representing the size of the next largest stream downstream of the sampled site) exhibited notable influence on the species composition ordination. The remaining watershed metrics were not considered further.

The first run of the Principal Components Analysis (PCA) included all fish community and categorized habitat metrics (Table 1) and resulted in significant correlation among many of the metrics. For example, the metric of overall tolerance to degradation (Tolerant) showed similar direction and gradient influence as metrics of sedimentation tolerance and chemical tolerance (Sed-T, Chem-Tl Figures 7 & 8). We retained only one (Tolerance) in further analyses. A second PCA was performed after correlated variables were removed. Metrics exhibiting little descriptive potential were then removed from further analyses to reduce variables further. The series of ordination resulted in a final set of variables and a clustering/ordination of sites produced from the raw data (Figure 7).

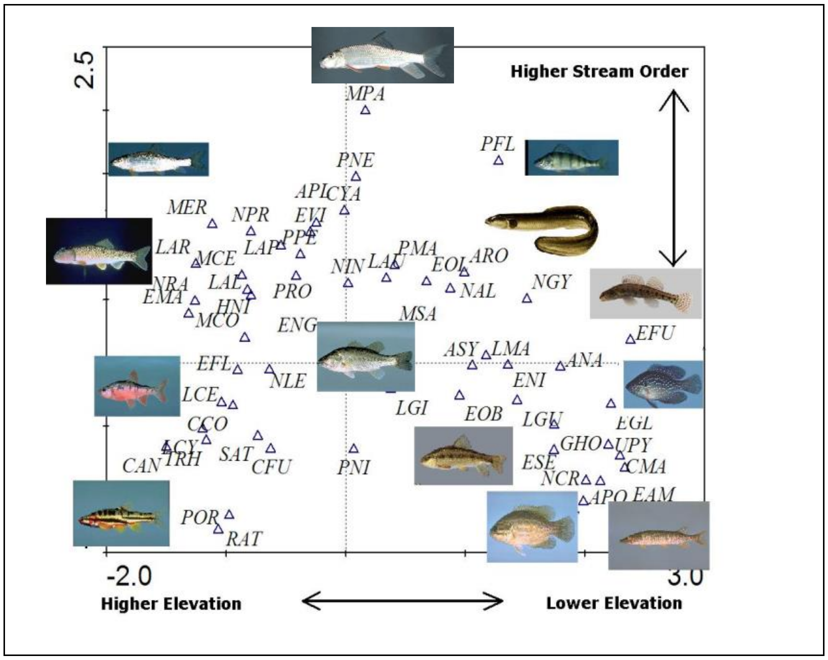

Figure 7. Ordination of fish metric associations for Chowan River basin streams based on INSTAR assessment. Arrow length represents the relative importance of the metric; metrics that are closely associated spatially on the plot are highly correlated A complete list of metrics analyzed is presented in Table 1. Taxonomic codes are explained in Appendix II.

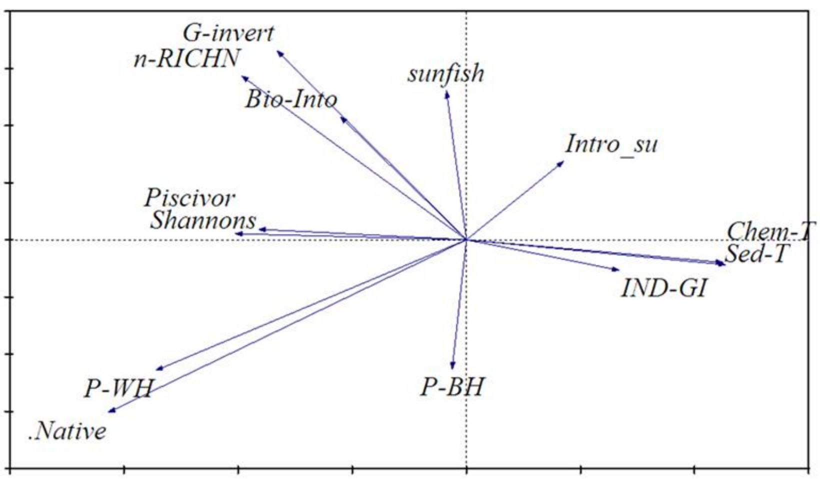

Figure 8. Ordination plot of stream habitat and landscape metrics generated by INSTAR data collection for sampled stream reaches in the Chowan River Basin. Arrow length represents the relative importance of the metric; metrics that are closely associated spatially on the plot are highly correlated. The axis scores (1st axis) of species data ordination were used as the dependent variable.

In the final iteration we utilized both species data and fish metric data (separately) and ordinate with watershed position metrics (link metrics) while partially out known variation due to stream order and elevation. The resulting ordination did not show a strong gradient associated with any of watershed parameters. There was a moderate gradient associated with Colonizing link, indicating a probably influence of the downstream colonizing pool on community structure.

The eight metrics exhibiting the most variation in the final PCA were used as explanatory variables in a multiple linear regression to further assess the ability to assess stream placement on a gradient. The first axis scores from the final species data ordination were used as the dependent variable. Two stepwise linear regression models (one for each elevational group) resulted in the final three variables listed below in the order that the model accepted them. These represent the variables that have the highest probability of setting a condition gradient based on the extant biota. As represented in Figure 7, 150 ft. or greater Elevation: Native species Richness, Proportion of native sunfishes, number of darters. Whereas, <150 ft Elevation = Native species Richness, Proportion of native sunfishes, and Number of Coastal Plain specialist species. Other variables included in the analysis were not found to significantly benefit the model.

We implemented different scoring criteria (i.e., submodels) based on stream order for all metrics included in the final model. Variable scores from the sampled sites were compared with expected/referenced scores based on their stream orders. The three variable scores were then averaged (nonweighted) and percent similarity reported as the stream health (ecological integrity) index for each stream evaluated.

Provisional ecological integrity scores, represented as percent comparability (range: 91-23%) to the appropriate regional reference condition model (described above) and applied both new (2012 & 2013) and scrubbed archival data for Chowan streams, were used to place streams into one of four categories, including ‘outstanding’ and ‘healthy’ (Figure 9). The distribution of stream ecological health categories between Chowan basin (this study) and Chesapeake basin (Garman et al. 2010) streams also assessed by INSTAR protocols in 2011 are presented in Figure 10. A greater percentage of Chowan streams were Healthy or Outstanding (49% combined) compared to Chesapeake streams (29% combined). Conversely, almost twice as many Chowan streams were ecologically compromised (33%) compared to Chesapeake streams (18%).

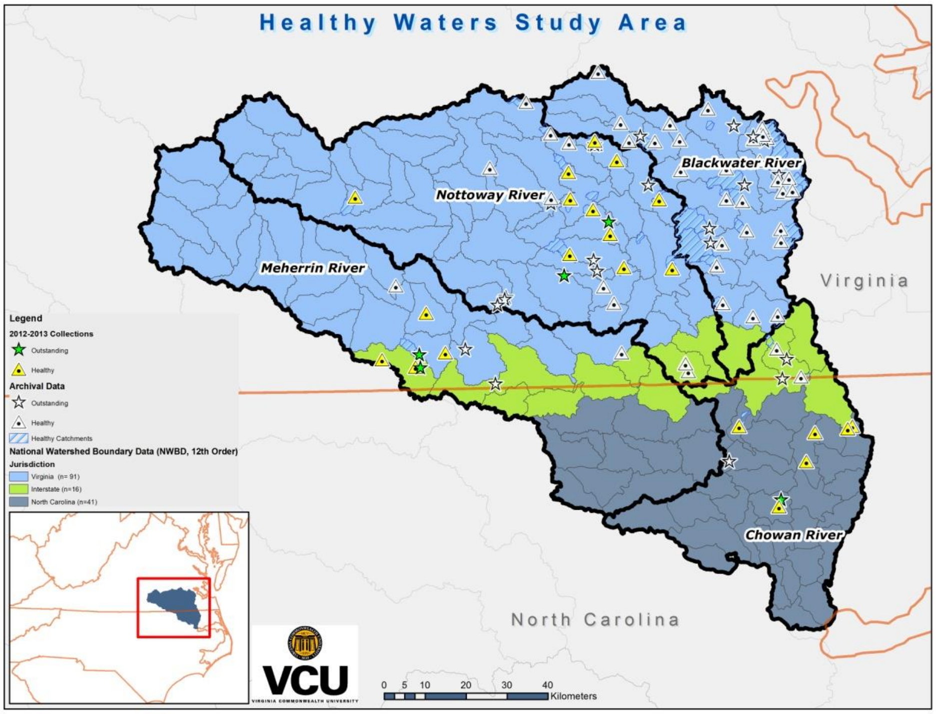

Figure 9. Final identification of new and archival Healthy and Outstanding stream sites in the Chowan River Basin, North Carolina.

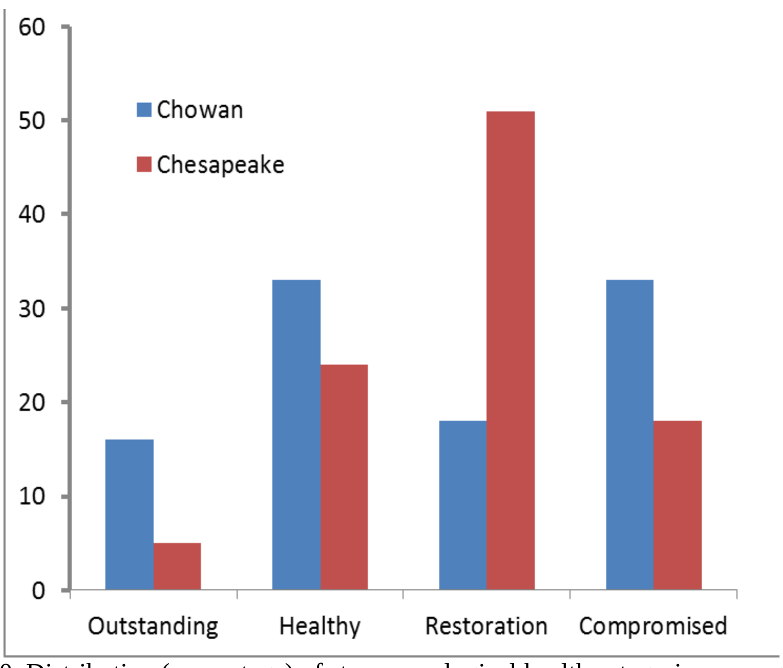

Figure 10. Distribution (percentage) of stream ecological health categories among Chowan (this study) and Chesapeake basin (Garman et al. 2010) streams assessed by INSTAR protocols. Chowan streams in this study had a distinct bi-modal distribution.

Conserving the Chowan Basin

The Section 319 Scope of Work for the project committed to developing three discreet watershed implementation plans. As the project advanced, the opportunity to target additional areas arose, however, the final project deliverable focused on a detailed Conservation Plan for the Raccoon Creek and includes four watersheds where conservation plans could be developed utilizing plan elements adapted to conservation based planning framework. The focus of the planning activities are in the Upper Nottoway River, Raccoon Creek but also identified, the Upper Nottaway River, Lower Nottaway River, Meherrin River and mainstem Chowan River. The opportunity to partner with the US Department of Defense and affect the Integrated Base Management Plan was one that needed to be capitalized upon. Significant terrestrial Natural Heritage Resources have been identified on Ft Pickett due to the unique land management strategy that replicates a consistent pattern of applying a burn strategy to the landscape. Additionally, Ft Pickett has encouraged the development of native plants and forest cover. Supplementing the terrestrial data with additional aquatic resources for their purposes of landscape scale conservation was a high priority. Specifically, the four additional locations are: Upper Nottaway: Wildcat Creek, Blackstone, VA; Lower Nottaway River: Joseph Swamp, near Waverly, VA; Meherrin River: White Oak and Rattlesnake Creeks, Valentines, VA; Chowan River: Beasley Branch and Bennett's Creek, Gatesville, NC. The example watershed plan is focused on the Upper Nottoway, Raccoon Creek.

As previously indicated, an outcome of the Project was the development of a suggested criterion for the protection of resources based on aquatic health. The VA DCR led meetings between the VDCR, VDEQ and VCU, to develop the following suggested approach to create criteria for protection of natural resources based on aquatic conditions, habitat and species. The process utilized the USEPA Criteria for Watershed Restoration consistent with the VA DEQ watershed restoration planning process to create protection criteria that could be combined with restoration. The typical, the *A-I Criteria* is used as part of a watershed restoration strategy identifying the following points:

A. Identify and quantify causes and sources of impairments

B. Estimate expected load reductions

C. Identify BMPs and critical areas to achieve load reductions

D. Estimate needed technical and financial resources

E. Provide information, education and public participation component

F. Include schedule for implementing NPS management measures

G. Identify interim measurable milestones for implementation

H. Establish criteria to determine if load reductions are achieved

I. Provide a monitoring component to evaluate effectiveness

This iterative approach resulted in the following A-I Elements that where applied in developing the watershed based plans in the Chowan Basin, referred to as the A-I Criteria for Ecologically Healthy Watershed Conservation:

A. Quantify and verify the empirical basis for aquatic communities identified with high ecological integrity

B. Identify conditions needed to maintain existing ecological integrity

C. Identify best management practices and other preventative actions to achieve and maintain the system with high ecological integrity

D. Estimate needed technical and financial resources

E. Provide information, education and public participation component

F. Include schedule for implementing best management measures

G. Identify interim measurable milestones for implementation

H. Establish criteria to determine high ecological integrity is maintained at baseline assessments

I. Provide a monitoring component to evaluate effectiveness

The following section outlines the protection strategies for Nottoway watershed in the Chowan Basin.

Watershed-Based
Ecological Health Conservation Plan
for
Raccoon Creek
Nottoway River
Chowan Basin

Nottaway River: Raccoon Creek Source Water Protection

Overall, the project develops a Ecologically Healthy Watershed Conservation Plan that will be used to identify critical areas for protection and be used as the basis for the healthy watershed protection goals of the Albemarle-Pamlico National Estuary Partnership's Comprehensive Conservation and Management Plan and local planning efforts. It assures these ecologically healthy streams are incorporated into the Department of Conservation and Recreation's Natural Heritage Biotics Database and integrated into land conservation and land planning projects in Virginia. It expands Virginia's Healthy Waters Program by expanding into a basin that has limited data and will include an assessment of stream ecological health using the existing protocol that integrates fish, aquatic life as well as habitat indicators to determine condition. To facilitate the success of this project, the Virginia partnership will include the Virginia Department of Conservation and Recreation, the Virginia Department of Environmental Quality, Virginia Commonwealth University North Carolina Department of Environment and Natural Resources, the Albemarle-Pamlico National Estuary Partnership, US Environmental Protection Agency, The Nature Conservancy, local governments and other interested stakeholders.

The role of Virginia's Department of Conservation and Recreation, Division of Natural Heritage is the identification and protection of aquatic and terrestrial communities and rare plant and animal species that contribute important ecosystem services or represent significant ecological resources. Virginia is a member of the NatureServe Natural Heritage Network and draws upon resources throughout the Western Hemisphere to advance biodiversity conservation and shares Virginia conservation information and successes throughout the Hemisphere. Virginia has a well established record of identifying and achieving protection for rare species and terrestrial communities; the Healthy Waters Program, in strong collaboration with Virginia Commonwealth University (VCU), is finally able to identify the most biologically diverse streams in the state. In Virginia, the challenges associated with these important efforts, specifically as they relate to aquatic communities, include: 1) development and application of objective, quantitative, and diagnostic stream assessment protocols and 2) defining a set of measurable and appropriate stream conditions, based on empirical data, as goals for protection efforts. Both of these challenges are dependent on an understanding of, and comparison to, relevant reference conditions that describe accurately and quantitatively the ecological potential of streams and rivers within a specific region. In Virginia, the scarcity of relatively undisturbed streams to serve as reference systems is problematic in many ecoregions. In early 2000, in response to national US Environmental Protection Agency (US EPA) Region III initiatives, Virginia created the *Healthy Waters Program*, with the goal of identifying and protecting ecologically intact streams, riparian habitats, and stream-dependent living resources. Identification of healthy streams is a prerequisite for any resource protection program; however, current state agency-based stream monitoring and assessment activities focus primarily on water quality impairments and target degraded streams for rehabilitation.

Traditionally, water quality based programs have emphasized the assessment of streams to determine if water bodies meet water quality standards with a subsequent restoration plan to improve degraded surface waters. While this is a critical activity to provide the Commonwealth a healthy ecosystem it is equally as important to seek viable opportunities for best management practices to protect streams that are already considered healthy/biologically diverse. It is economically and ecologically preferable to conserve and protect healthy ecosystems than to restore them after they have been damaged. Agricultural BMPs may serve as a key role in the protection of healthy waters and healthy watersheds. The integrity (health) of aquatic ecosystems (streams) is tightly linked to the watersheds of which they are a part. There is a direct relationship between land cover, key watershed processes and the ecological health of streams.

Based on the assessments and outlined in the previous sections, the lower Nottaway River, Raccoon Creek area has been identified as containing several sites characterized as having *Outstanding* and *Healthy* ecological health. The Raccoon Creek drains into the lower Nottoway directly above a source water intake location for regional water districts and wellhead protection areas. Additionally, the site is relative to several VDCR Division of Natural Heritage Conservation Sites that contains rare vascular plants, and vertebrate animal species and is associated with High or Very High Ecological Health as identified by the VDCR DNH Natural Landscape Assessment. The drainage encompasses 126,984 acres that is dominated by evergreen and hardwood forests. Half of the area identified as hardwood is bottomland hardwood swamp, areas critical to maintaining high aquatic integrity.

Relevance: In addition to the rating of Outstanding based on the INSTAR assessment, the site lies within the overlapping Venn diagram of 75mi concentric fiber baskets. The site is in the upper headwaters of surface and groundwater withdrawal sites. Regional drinking water reservoirs have maintained buffers but extraction sites do not, therefore there are significant economic incentives to protect the adjacent resources as opposed to an increased treatment prior to distribution to the public. This site resides in the county of Sussex where opportunities to integrate the protection of significant Heritage data may be incorporated into local planning and land conservation efforts. Significant relationships were developed with the Nature Conservancy to advance the protection in this area including working through the Conservancy to assist with local drinking water organizations.

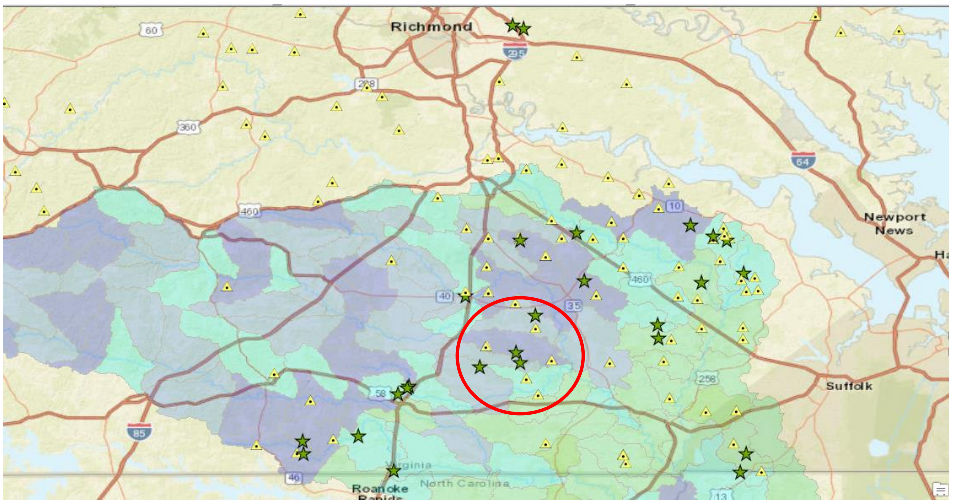

Figure 11. Raccoon Creek, Nottoway River

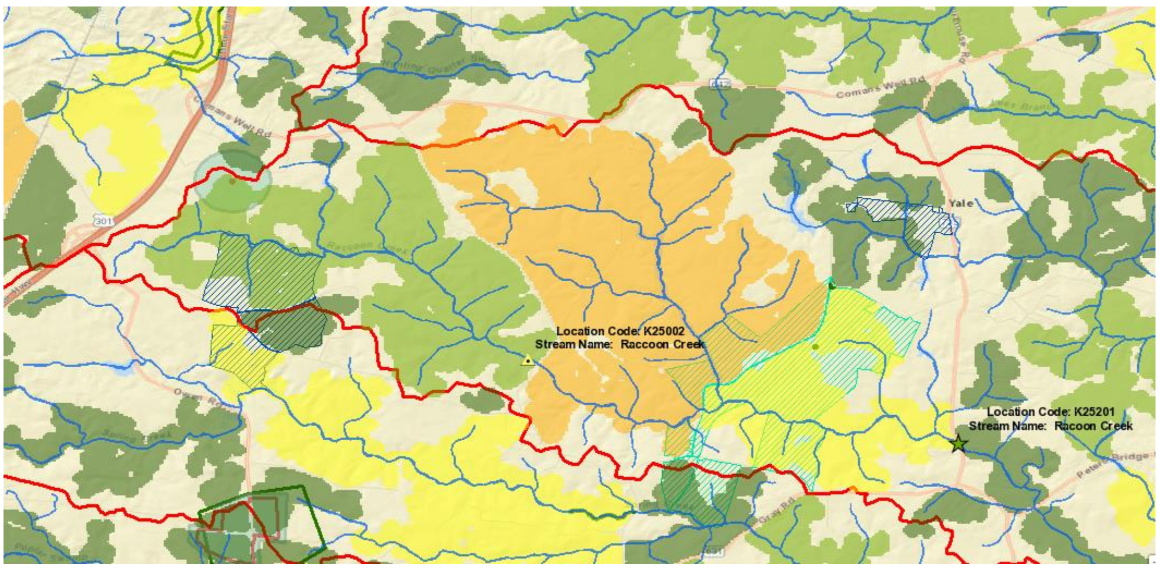

Figure 12. Nottaway River, Raccoon Creek near Sussex, VA, illustrating VDCR DNH natural features and VA Department of Health Drinking Water Intakes

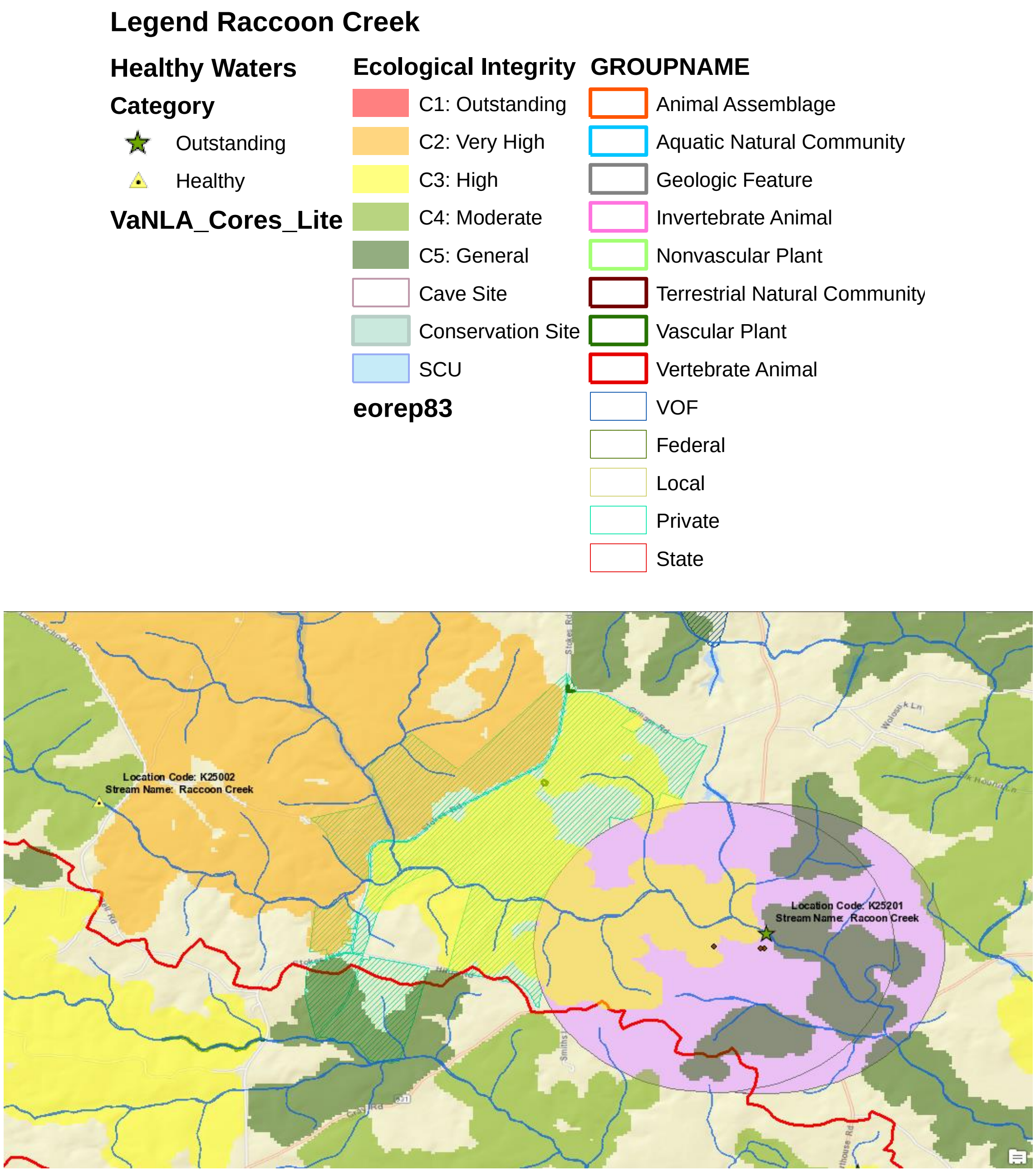

Figure 13. Purple areas designated at Well-head Protection areas

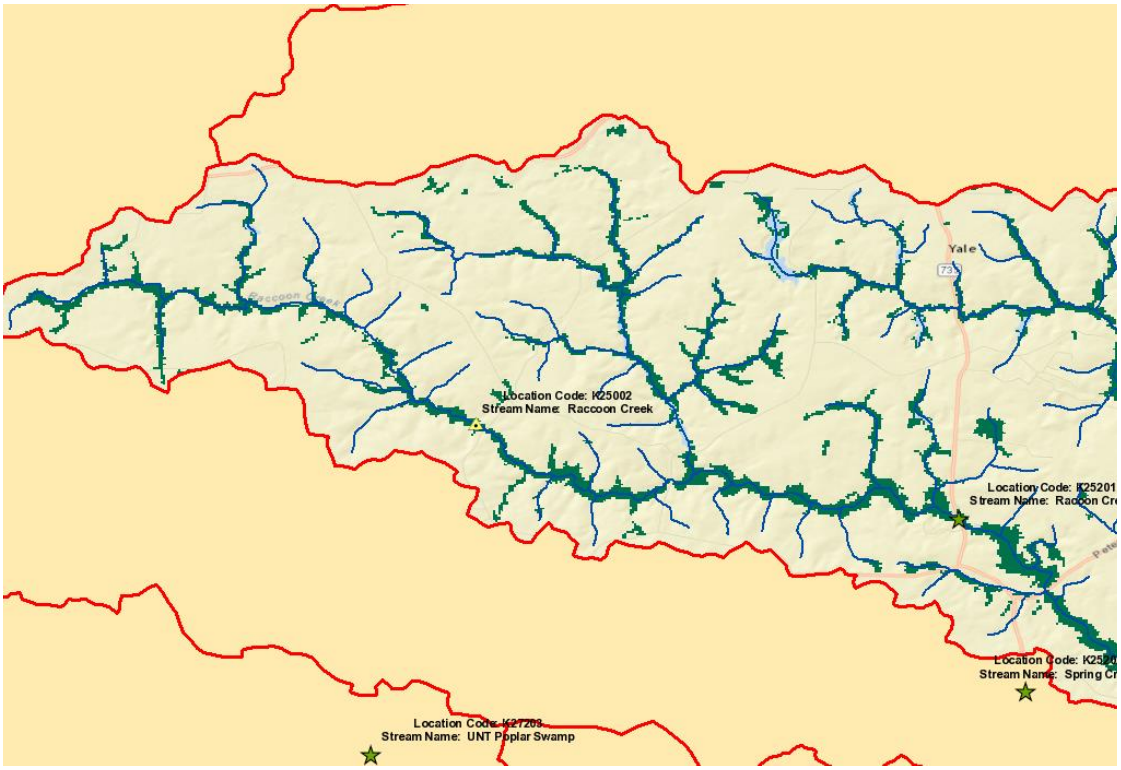

Figure 14. National Land Cover Dataset displaying Forested Wetlands in Raccoon Crk

A-I Criteria for Lower Nottoway, Raccoon Creek Conservation

A. Quantify and verify the empirical basis for aquatic communities identified with high ecological integrity. The following outline conditions at time of survey that serves as a baseline to ensure the site remains in the current designation ecological condition.

    1. Site 25201 Raccoon Creek is identified as an Ecologically *Exceptional* Healthy Water, the highest characterization of the VA Healthy Waters Program
    2. These catchments epitomize historical conditions in low-gradient stream systems of Virginia's lower Coastal Plain physiography, particularly within the James and Chowan river basins. Water quality is dominated by high concentrations of natural organic acids (i.e., 'blackwater systems'), which are diagnostic for relatively undisturbed watersheds characterized by braided and undefined channels, low pH (4-6 units), seasonal hypoxia, unstable sand substrates, and heavily vegetated riparian zones. These natural but unusual physico-chemical stream conditions are increasingly rare in our region, as a consequence of agricultural conditioning, ditching, and other land-use practices that change the natural structure and function of Coastal Plain 'blackwater' streams. Unique aquatic communities that are adapted to the challenges of low dissolved oxygen and high natural acidity are characteristic of the highlighted streams. Fish assemblages in both systems support populations of rare or uncommon 'acid-endemic'

species, including Swampfish, Mud Sunfish, Blackbanded Sunfish, and Sawcheek Darter, with limited (and declining) distributions in their native ranges. Most other fishes here are native habitat generalists (e.g. Pirate Perch, Bluespotted Sunfish) that are able to tolerate the unique physio-chemical conditions. Only a single nonindigenous fish species-Bluegill Sunfish-was represented in fish community collections at these sites, and it was not numerically dominant. All collections were characterized by high species richness and diversity values for the region. In summary, in comparison to data for other streams in the INSTAR database, both locations are characteristic of relatively undisturbed streams that exhibit high ecological integrity (i.e., are 'healthy') and should be protected by appropriate tools for land conservation.

3. The Raccoon Creek site has a total of three individual Natural Heritage Element Occurrences with both Global and State Rankings, specific to two vascular plant occurrences). Identified are two G4 S1 Vascular Plants and one G3 T3 S2 Vertebrate Animal. Where **S1** - Critically imperiled in the state because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the state. Typically 5 or fewer populations or occurrences, or very few remaining individuals (<1000). **S2** - Imperiled in the state because of rarity or because of some factor(s) making it very vulnerable to extirpation from the state. Typically 6 to 20 populations or occurrences or few remaining individuals (1,000 to 3,000). **Natural Heritage Global Ranks** are similar, but refer to a species' rarity throughout its total range. Global ranks are denoted with a "G" followed by a character. Note GX means the element is presumed extinct throughout its range. A "Q" in a rank indicates that a taxonomic question concerning that species exists. Ranks for subspecies are denoted with a "**T**". The global and state ranks combined (e.g. G2/S1) give an instant grasp of a species' known rarity.
4. The sites contain two core areas identified by the Virginia Natural Landscape Assessment as **B3**-High and **B2**-Very High Values, at approximately 1408ac and 4322ac, respectively. C-rank is a rating of the significance of the conservation site based on presence and number of natural heritage resources; on a scale of 1-5, 1 being most significant. Sites are also coded to reflect the presence/absence of federally/state listed species
5. The site contains a Nature Conservancy conservation easement of 1406ac that encompasses much of the B3-High Value Core
6. Upper reaches of Nottoway providing source water protection for groundwater serving the Tidewater Christian Service Area, including three identified well-heads and a source water drinking locations
7. Headwaters for regional drinking water intake from surface and ground water
8. A National Land Cover Database landuse and land cover analysis shows the current active categories, acreage and percentages for Raccoon Creek can be seen as:

Raccoon Creek			
Land Use		**Acres**	**Percentage**
Open Water		18.45	0.15
Open Space		373.24	2.94
Developed- Low Intensity		18.23	0.14
Developed- Medium Intensity		1.32	0.01
Barren Land		19.11	0.15
Deciduous Forest		1047.66	8.25
Evergreen Forest		3622.53	28.54
Mixed Forest		387.08	3.05
Shrub/Scrub		2167.37	17.07
Grassland/Herbaceous		1835.65	14.46
Pasture/Hay		574.68	4.53
Cultivated Crops		1178.37	9.28
Forested Wetlands		1365.53	10.76
Emergent Herbaceous Wetlands		84.80	0.67
Total		**12694.03**	**100.00**

B. Identify conditions needed to maintain existing ecological integrity.
    1. A maintained forested riparian habitat (31.4mi), hydrology and instream habitat and protection of High Ecological Value areas and forested wetlands to ensure the baseline ecological health remains in the current Exceptional condition

C. Identify best management practices, preventative and protective actions to achieve and maintain the system with high ecological integrity
    1. Ensure protection of 1365ac of Forested Wetlands per NLCD, 31.4 miles of stream corridor
        i. Direct acquisition of those areas to include the 1365ac (10% of total area)
        ii. Create conservation easements that include language and criteria to protect aquatic integrity ensuring Ecologically Healthy Waters to be held by TNC, VOF, SWCDs or water districts
        iii. Apply 100% of SFI Water Quality standards and practices, for forestry operations standards at point of extraction
        iv. Prioritization will be given to those areas directly associated with the protection of lands in the 1408ac B3-High Value Core, inclusive of the Nature Conservancy conservation easement and 4322ac B2-Very High Value Core
    2. Create conservation easements to protect areas associated with the VA Department of Natural Heritage Element Occurrences for two Vascular Plants and one Vertebrate Animal

3. Coordinate with regional water districts to encourage application of riparian protection measures that would minimize impacts to source-water and headwater areas
4. Maintained forested buffers with minimal impacts
5. Implementation of DCR DNH recommendations to protect critical habitats and resources utilizing Stream Conservation Unit protection language
6. Integration with other regional planning efforts

D. Estimate needed technical and financial resources (includes effort allocation)
    1. Technical assistance to be rendered by DCR, DEQ, DOF, TNC, SWCD
        i. The DCR DNH overseeing both conservation actions and the Healthy Waters Program would incur the following expenses:
            1. The average time for developing protective actions for a parcel of land to vary depending on local interests, local value of resources, value of property, etc. Therefore, the following is an estimate of time required for to apply those identified actions to conserve those areas in the Raccoon Creek. For this purpose, it will be assumed 18mo to implement protective actions on each parcel of property at a rate of $125,000/annually (including overhead) for a 20 year period totaling $2.5M, for protection.
            2. The DCR DNH Healthy Waters Program Manager would oversee all aspects of project coordination and development of strategies and implementation at an annual rate of $125,000 (including overhead) at 50% time allocated for 20 yrs totaling $1.25M
        ii. The VDOF would oversee the implementation of forestry-based conservation actions including the delivery of technical assistance for implementing SFI actions. Annually, an average cost may be $90,000 (including overhead) for a 20 year period at $1.8M
        iii. The VDEQ Nonpoint Source Protection field personnel implementing conservation actions and nonpoint source actions over a 20yr period in the watershed might incur $90,000 annually (including overhead), totaling $1.8M
        iv. The Nature Conservancy oversees the development of conservation actions and strategies at a similar estimated rate as the DCR DNH with average time for developing protective actions for a parcel of land to vary depending on local interests, local value of resources, value of property, etc. Therefore, the following is an estimate of time required for to apply those identified actions to conserve those areas in the Raccoon Creek. For this purpose, it will be assumed 18mo to implement protective actions on each parcel of property at a rate of $125,000/annually (including overhead) for a 20 year period totaling $2.5M, for protection.
    2. An assessment and valuation of those lands identified for protection should be conducted to develop a clear funding plan

3. Source water protection should consider an evaluation of the ecosystems services provided by headwater area protection Easements that include language for habitat and aquatic community protection
4. Evaluate funding options
    i. State
        1. VA Agricultural BMP Practices Cost-Share
        2. VA Agricultural BMP Tax Credit Program
        3. VA Agricultural BMP Loan
        4. VA Water Quality Improvement Fund
    ii. Federal
        1. Conservation Reserve Program
        2. Conservation Reserve Enhancement Program
        3. Environmental Quality Incentives Program
        4. Army Compatible Use Buffer (ACUB)—corridors for low level flights to protect stream buffers, acquisition of adjacent lands
        5. Forestry Reserve Act funding to meet multiple conservation goals within the watershed and adjacent areas
    iii. Other
        1. South East Rural Community Assistance Project
        2. National Fish and Wildlife Foundation
        3. Clean Water State Revolving Fund

E. Provide info, education and public participation component
    1. The role of the Virginia Department of Conservation and Recreation is to provide tangible and lasting improvements to the quality of Virginia's resource lands and waters; serving as a trusted steward of the outdoor recreational and natural resources placed under its care; promoting the conservation and enjoyment of Virginia's diverse and unique environment; protecting public safety through regulatory programs and conservation law enforcement. The VDCR includes the Division of Natural Heritage on science-based conservation to protect Virginia's native plant and animal life and the ecosystems upon which they depend to assess and prioritize those natural features for the Commonwealth of Virginia. As part of the VDCR DNH, the Healthy Waters Program identifies those areas with high aquatic integrity for the purpose of long-term protection. The HWP will:
        i. Establish a Project Team to implement those protection measures identified within this plan.
        ii. Coordinate all aspects of education, coordination and outreach to promote the area and protection of valuable resources
        iii. Work in conjunction with partners (DEQ, DOF, TNC, SWCDs, etc, to create and deliver pertinent training on HWP priorities, applicability and goals.
        iv. Coordinate with the DEQ, DOF, TNC and SWCDs on their local planning efforts to integrate HWP goals and priorities

v. Coordinate with the DOF to ensure Sustainable Forestry Initiative (SFI) standards are applied at timber extraction sites to minimize impacts to the aquatic integrity and develop presentation materials and training to SFI Board
vi. Coordinate with DOF, VOF, and TNC to develop incentive-based program for landowners in source water protection areas to ensure water quality protection aspects of the SFI standards are applied to protect aquatic integrity
vii. Coordinate with regional water districts to ensure the source water protection goals are achieved by developing outreach and education materials in coordination with Nature Conservancy to deliver information on aquatic health and ecological integrity

2. The role of the Virginia Department of Forestry is to work with local landowners that intend to implement forest management activities. This includes technical assistance to protect natural features and water quality. The DOF will be a critical partner in the protection of valuable habitats associated with maintaining the baseline aquatic integrity. The DOF will
   i. Coordinate with the VDCR HWP to work with timber lot owners to implement additional measures to ensure the water quality protection standards are applied for SFI and to apply the fullest SFI standards possible
   ii. Apply HWP recommendations to have SFI certification applied at point of extraction
3. The role of the VA Department of Environmental Quality is that of the lead agency on water quality regulations, specifically for point and nonpoint source. Applicable to this, are the planning efforts to develop and implement Watershed Implementation Plans for the purpose of restoring water bodies not meeting water quality standards. The VDEQ will:
   i. Coordinate with the HWP to integrate nonpoint source restoration best management practices to eliminate sources of pollutants associated with those waters not meeting water quality standards and implement Watershed Implementation Plans associated with TMDLs in the Chowan basin. Coordinated watershed planning will ensure community support and long-term success
4. The role of the Nature Conservancy in Virginia is to work regionally and locally to identify and protect valuable natural areas and features in the Commonwealth. For this region, the regional manager is specifically focused on the area that includes the Chowan basin. The Nature Conservancy has a long history of successful partnerships to implement long-term protection measures. The TNC will:
   i. Coordinate with the HWP to work with regional water districts to implement protection measures that include buffering riparian areas, protecting bottom-land hardwood areas and forested wetlands to ensure baseline aquatic integrity is maintained

5. The SWCDs work locally with respective landowners to apply conservation measures to restore and protect water quality and aquatic integrity. The SWCDs will
    i. Coordinate with the HWP to implement collaborative education and outreach materials tailored for their region and end users.
    ii. Integrate HWP protection measures into their local strategies to protect water quality and ensure aquatic integrity
6. The role of the VA Department of Health is to maintain safe drinking water, measured by standards set by the EPA. The VDH will:
    i. Coordinate with the HWP to ensure standards and enforceable actions to correct or eliminate impacts from OSDS and threats to drinking water systems

F. Include schedule for implementing best management measures
1. Year 1 will include the major activities to ensure overall coordination and educational development, these include
    a. Development of Raccoon Creek Strategic Plan following Milestones and overall approach identified in this plan
    b. Coordination of Project Team by DCR DNH
    c. Development of educational programs and initiatives targeting VDEQ, VDOF, SWCDs and TNC
2. Year 2 will include the implementation of those actions identified under the strategic planning efforts in year 1 and include:
    a. Delivery of education for DOF SFI Board
    b. Delivery of technical assistance by VDEQ, VDOF, SWCDs and TNC to possible landowners with the expected outcome of implemented conservation actions
        i. VDEQ to target nutrient and nps actions
        ii. VDOF to target forestry based actions to address WQ and SFI including forest buffers, improved stream crossings and SFI standards applied at point of extraction
        iii. SWCDs to provide direct technical assistance in the implementation of conservation actions
        iv. TNC to target those actions to directly conserve areas identified under section C.
3. Years 3-5, conservation actions will be applied for conservation including land protection focused on those areas identified with bottomland hardwood wetlands, or forested wetlands
4. Years 6-10, conservation actions will be applied for conservation including land protection focused on those areas identified with bottomland hardwood wetlands, or forested wetlands
5. Years 11-15, conservation actions will be applied for conservation including land protection focused on those areas identified with bottomland hardwood wetlands, or forested wetlands

6. Years 16-20, conservation actions will be applied for conservation including land protection focused on those areas identified with bottomland hardwood wetlands, or forested wetlands

G. ID interim measurable milestones for implementation
   1. Protection of 1365ac of NLCD "woody wetlands"
      i. In year 1, outreach will be initiated to implement programs and objectives identified above
      ii. Year 1 will include the development of language for conservation easements that include specific mention of, "protection of aquatic integrity" as a maintained criteria
      iii. At year 5, 100 acres of the 1365ac will be under conservation easement or other natural area protections that include the specifics for maintaining aquatic integrity
      iv. At year 10, 700 acres of the 1365ac will be under conservation easement or other natural area protections
      v. At year 15, all 1000ac will be under conservation actions that ensure aquatic integrity is maintained at the baseline condition
      vi. At year 20, all 1365ac will be under conservation actions that ensure aquatic integrity is maintained at the baseline condition

H. Establish criteria which define conditions necessary to ensure high ecological integrity is maintained at initial baseline assessments
   1. 1365ac of Forested Wetlands conserved to ensure those lands are left in a natural condition
      i. Direct acquisition of those areas to include the 1365ac (10% of total area) and;
      ii. Conservation easements that include language and criteria to protect aquatic integrity ensuring Ecologically Healthy Waters to be held by TNC, VOF, SWCDs or water districts and;
      iii. 100% of SFI Water Quality standards and practices, for forestry operations standards at point of extraction
   2. Streamside Management Zones are established and maintained to a minimum of 100' with preference toward 150' per side, based on slope increasing and;
   3. VDCR DNH Vascular Plant and Vertebrate Animals are protected and maintained and;
   4. VDCR DNH Healthy Waters Program characterization of Exceptional Ecological Health is maintained and;

I. Provide an assessment component to evaluate effectiveness
   1. Conduct a re-assessment of the Chowan basin to ensure ITI accuracy as a means to validate criteria as identified in B, above at 5, 7 and 10 yr intervals

2. Conduct a re-assessment of the focal area (Raccoon Creek) to quantify aquatic conditions meet baseline conditions ensuring aquatic habitat and integrity maintained 1, 2, 3, 5, 7 and 10 yr intervals
3. Conduct a Land Use, Land Cover Analysis to determine if assessed conditions remain in baseline status 1, 2, 3, 5, 7 and 10 yr intervals

J. Other Considerations
    1. Integration of other plans or planning processes
        i. The Chowan Basin resides in the Albemarle-Pamlico National Estuary Partnership (APNEP) region and is applicable to guidance and implementation projects under the Comprehensive Conservation Management Plan (CCMP) for the region
    2. Coordination, identification of roles and responsibilities of stakeholders and other entities
        i. Federal Government
        ii. State
            1. DC's role is to provide tangible and lasting improvements to the quality of Virginia's resource lands and waters; serving as a trusted steward of the outdoor recreational and natural resources placed under its care; promoting the conservation and enjoyment of Virginia's diverse and unique environment and rich cultural legacy for future generations; protecting public safety through regulatory programs and conservation law enforcement
            2. DEQ's role is to protect and enhance Virginia's environment, and promotes the health and well-being of the citizens of the Commonwealth; and is the lead agency for Water Quality (NPS and PS) regulations
            3. DOF role is Protecting Virginia's Forests from Wildfire; Managing the Forest Resource; Protecting Virginia's Waters; Conservation of Virginia's Forests; Manage the State Lands and Nurseries; Regulated Incentive Programs for Forest Landowners
            4. VDH's role is to promote and protect the health of all Virginians
        iii. Regional and Local Government
            1. Sussex County Government
            2. SWCDs
        iv. Businesses and Community Groups
            1. Timber and Forest Products Industry
            2. Nature Conservancy
            3. APNEP
    3. Explore new partnerships
        i. Local nongovernmental organizations