

Integrated Report for North Carolina's Wetlands Program

July 2012

Introduction

North Carolina's wetlands program is centered around the EPA's Core Elements Framework (CEF): (1) Monitoring and Assessment, (2) Regulation, (3) Voluntary Restoration and Protection, and (4) Water Quality Standards for Wetlands. Over the last decade the North Carolina Division of Water Quality (DWQ) has conducted research, implemented rules and policies, developed regulatory tools, and performed training to support the wetlands regulatory program largely through resources provided from multiple EPA Wetlands Program Development Grants. To further these efforts, work is scheduled to begin on development of North Carolina's Wetlands Program Plan (WPP) in the second half of 2012. This document discusses previous and ongoing wetlands activities within the context of the CEF.

(1) Monitoring and Assessment

Overview of Wetlands Monitoring In North Carolina

The wetlands monitoring program in NC began in 2004, and since that time has been supported primarily by EPA Wetland Program Development Grants. Each grant put emphasis on specific wetland types to be monitored for up to two years. Recent participation by North Carolina in the EPA's National Wetland Condition Assessment (NWCA) during 2011 increased the types and number of wetlands monitored. Monitoring sites are primarily located in the Piedmont (Ecoregion 45) and in the Coastal Plain (Ecoregions 63 and 65). Types of wetlands that have been monitored thus far (consistent with the North Carolina Wetland Assessment Method – NCWAM) are:

- Headwater Forest (Headwater Wetland)
- Riverine Swamp Forests
- Basin Wetlands
- Bottomland Hardwood Forests
- Brackish/Salt Marsh
- Estuarine Woody
- Hardwood Flat
- Pine Flat
- Pocosin

The wetland classifications listed above include isolated wetlands in some cases. Data collected have included both biotic and abiotic parameters. Data has been collected at all three levels of analysis (Levels I, II, and III). The data level types are described in Table 1 below:

Table 1: Data collected as part of Level I, Level II, and Level III analysis.

	<u>Level I</u>	<u>Level II</u>	<u>Level III</u>
GIS Analysis	Created land use density index and two LDIs		
Rapid Assessment Methods		NCWAM ORAM USA-RAM	
Water Quality Sampling			Physical Chemical Biological
Soil Sampling			Nutrients/Macronutrients Sodium pH, acidity, sum cation % base saturation, humic matter Cation exchange capacity Weight to volume ratio
Biological Surveys (IBIs developed)			Vegetation Amphibians Macroinvertebrates
Hydrologic Sampling			Continual depth readings (every 30 minutes or every hour)

Note: Due to varying site conditions and study designs, not all of the data shown in Table 1 was collected on every site. For example, the NWCA study did not include amphibian, macroinvertebrate, or hydrologic data collection.

The wetlands monitoring work performed in North Carolina over the last eight years has established a consistent scientific methodology for monitoring wetlands throughout the southeastern United States. While establishing the methodology for the NWCA, EPA incorporated portions of North Carolina’s monitoring methodology into the Field Operations Manual that was used on a national level. This methodology for monitoring wetlands has also been used in 401 Water Quality Certification activities where the impact to the wetland needed to be monitored on a long term basis.

Another important aspect of the North Carolina wetland monitoring program is that a profile of wetland types are being created in terms of the vegetation, amphibians, macroinvertebrates, soil characteristics, and hydrologic characteristics that make up a particular wetland type. This wetland profile data ~~for~~ can serve as reference sites for other wetland studies, can be used for regulatory decision making in the 401 regulatory program, or can be used as guidelines for determining success criteria for mitigation/restoration of wetlands.

Early Grants: Wetland Monitoring and Assessment

The first EPA Wetlands Program Development Grant that focused on monitoring and assessment activities awarded to North Carolina was focused on headwater wetlands (CD 974260-01). Twelve headwater wetlands were randomly selected in the Piedmont and 11 sites were randomly selected in the Coastal Plain. Headwater Wetlands were chosen because of their unique position in the landscape and because they had not yet been studied to any extent at that time. One important question proposed by this monitoring of headwater wetlands was: Given that streams emerge from the wetlands, does water quality improve downstream of the wetland? The results of this study showed that levels of metals and nutrients were reduced downstream from the wetland center. The data from this monitoring study also developed a profile of headwater wetlands in terms of their vegetation, amphibian and macroinvertebrate populations, hydrology and soils.

The second EPA Wetland Program Development Grant (CD 96422105-0) dealt with monitoring wetlands in specific watersheds. NC DWQ worked with the NC Ecosystem Enhancement Program (NC EEP), North Carolina's in-lieu fee program for compensatory mitigation, to identify watersheds where monitoring data could be used to aid in the development of EEP's long term watershed plans. The two watersheds chosen were the Fishing Creek Watershed in Granville County (Piedmont Ecoregion) and the Lockwood Folly Watershed in Brunswick County (Inner Coastal Plain Ecoregion). After surveying the wetlands in the two watersheds, six Basin Wetlands and six Bottomland Hardwood Forests were selected in the Fishing Creek Watershed and six Basin Wetlands and seven Riverine Swamp Forests were selected in the Lockwood Folly Watershed. This monitoring study provided data that could be used at the watershed level, and also expanded NC DWQ's wetland profile data to add new wetland types. The study discovered that the Basin Wetlands in the Piedmont were different from Basin Wetlands in the Inner Coastal Plain. We also learned that water quality could improve in Riverine Swamp Forest as levels of nutrients and metals were often reduced from upstream samples to downstream samples. Finally, while the sample size was small, NC DWQ was able to begin development of wetland profiles for Basin Wetlands, Bottomland Hardwood Forests, and Riverine Swamp Forests in terms of their vegetation, amphibian and macroinvertebrate populations, hydrology and soils.

As a result of these first two grants, NC DWQ decided to continue monitoring some of the wetlands on a long term basis. From the first grant, six Headwater Wetlands (three Piedmont and three Coastal Plain) were selected for long term monitoring. Eight wetlands were chosen from the second grant to be monitored long term (four Basin wetlands, two Bottomland Hardwood Forests, and two Riverine Swamp Forests). The objective of this long term monitoring activity was to provide data that could be analyzed to show changes over time, and therefore lead to better management decisions. Furthermore, these sites could serve as reference sites for other wetland monitoring activities such as wetland mitigation/restoration projects. Continuing to monitor these wetland sites on a long term basis has strengthened the wetlands monitoring program in NC.

Use of Probabilistic Random Sampling for Wetlands Monitoring

Several other studies have used probabilistic sampling (specifically the Generalized Random Tessellation Stratified (GRTS) used by the EPA) to choose sites for wetlands monitoring activities. These include two related studies on Coastal Plain isolated wetlands, a pilot study on NC mitigation sites, the National Wetland Condition Assessment, and the follow-up Southeast Wetlands Monitoring Intensification Grant.

The Southeast Isolated Wetland Assessment (SEIWA) was a Regional Environmental Monitoring and Assessment Program Grant in which RTI International partnered with NC DWQ and the University of South Carolina (USC) to complete the study. North Carolina again partnered with USC for the follow-up grant, "Hydrologic Connectivity, Water Quality Function, and Biocriteria of Coastal Plain Geographically Isolated Wetlands" (CD-95415809). The SEIWA study applied a three level approach to accessing the quantity, location, and functional condition of isolated wetlands in an eight county study area in the Coastal Plain of North and South Carolina. The Level 1 SEIWA study developed a "GIS Isolated Predictive Mapping Tool" with GIS layers and LiDAR that was used to map potential or "candidate" isolated wetlands (IWs) located in the study area. The Level 2 SEIWA study used the Level 1 results to generate a target population of 170 candidate polygons through a two stage cluster stratification process based on county and 14-digit hydrologic unit code (HUC). The candidate polygons were ground-truthed for accuracy, volume, ecosystem type, and functional condition with NCWAM and the Ohio Rapid Assessment Method (ORAM) in 2008. The Level 2 portion of the SEIWA study found that of the candidate IWs mapped during the Level 1 analysis, 69% were jurisdictional wetlands and only 22% were in fact IWs. The Level 3 SEIWA study was conducted on two clusters of isolated wetlands located during the Level 2 study. The goal of the Level 3 survey was to characterize the biocriteria (amphibians, macroinvertebrates, and vegetation), soils, hydrology and pollution absorption capacity through water quality sampling. The small size of the Level 3 sampling size was due to funding constraints and was the reason a follow-up grant was applied for and awarded through the EPA Wetlands Program Development Grant program.

The goal of the ongoing follow-up grant "Hydrologic Connectivity, Water Quality Function, and Biocriteria of Coastal Plain Geographically Isolated Wetlands" (CD-95415809) was to further characterize the biocriteria of isolated wetlands, their pollution absorption capacity, and hydrologic connectivity to downstream waters via groundwater. In addition, the biocriteria results will be used to further verify and validate NCWAM and to conduct a review of the NC DWQ database of impacts versus mitigation to determine if there has been a net loss or gain of these wetland systems. Two sets of eleven sites were chosen for this study: biocriteria and hydrology. The biocriteria sites were selected from the SEIWA Level 2 study sites through a probability based sampling design related to the SEIWA Level 2 NCWAM rating results. The hydrology sites were selected from the SEIWA Level 1 polygons through map review and reconnaissance. The hydrology sites could not be randomly chosen because the study required accessible sites that were preferably located on public or conservation lands to would allow the installation of wells. The field work for this grant was completed in May 2012 and data is currently being analyzed.

The NC DWQ and North Carolina State University (NCSU) are currently being contracted by the Environmental Law Institute (ELI) with EPA Wetland Program Development Grant funds to conduct the North Carolina Wetland Mitigation Evaluation Pilot Survey. The purpose of this survey is to evaluate the ecological integrity of wetland compensatory mitigation projects overall and compare each of the three mitigation methods available in North Carolina: Permittee responsible, mitigation banks, and in-lieu fee programs. The survey design was developed by the EPA with assistance from ELI, the NC DWQ, and NCSU. The survey will be conducted by the NC DWQ and NCSU at 30 wetland mitigation sites. The NC DWQ mitigation database was used to develop a target population of mitigation sites that met the following criteria: (1) Riparian/Riverine wetland, (2) permitted at restoration sites between 2002 and 2006, (3) greater than 0.1 Ha in size, (4) deemed successful by state regulators during the most recent monitoring year, and (5) good accessibility. A Generalized Random Tessellation Stratified (GRTS) survey design for a finite (discrete) resource was used to order selected sites of each type of mitigation. The top 10 selected sites of each of the three types of mitigation that meet the design criteria will be used for the survey. NWCA methods with minor revisions will be used for this pilot study on mitigation sites in North Carolina.

The EPA's National Wetland Condition Assessment (NCWA) was conducted during the growing season of 2011. The EPA invited NC DWQ to help test the Field Operations Manual (FOM) in September of 2010. NC DWQ served as trainers for EPA Region 4 in Pensacola, Florida. Specifically, Ginny Baker was a trainer for the vegetation protocol and Rick Savage was a trainer for water quality, algae sampling, and chlorophyll sampling. EPA used a probabilistic random sample to select 900 sites across the lower 48 states. North Carolina received 47 wetlands to survey. All of the 47 sites occurred in the Coastal Plain. The wetland types were (by NC WAM definitions): Salt Marsh, Pocosin, Estuarine Woody, Riverine Swamp Forest, Pine Flat, Hardwood Flat, and Bottomland Hardwood Forest. The one-day intensive surveys included a comprehensive survey of the vegetation, soils, water quality, buffer analysis, hydrology analysis, and the site preparation/determination. Many of the salt marshes had to be accessed by boat. Access to some sites had to be delayed due to fires or hurricanes. After a very long field season, North Carolina completed the 47 sites and delivered all data and samples to the EPA. North Carolina hopes to use some of the regional data in conjunction with the Southeast Wetlands Monitoring Intensification Grant (see below) to draw some conclusions about the overall condition of wetlands in the Southeast Region.

The last wetland monitoring effort that used a probabilistic sampling method is the ongoing Southeast Wetlands Monitoring Intensification Grant (CD 9944910). This grant is a partnership with Alabama and South Carolina, with North Carolina serving as the project lead. The EPA encouraged North Carolina to apply for this grant to mentor Alabama and South Carolina in establishing their wetland monitoring programs. Georgia is also participating, but on a separate grant. All four states are using the same monitoring protocol so that regional analysis can be done in order to draw conclusions about the overall condition of wetlands in the Southeast Region. The wetland sites are made up of 10 Riverine Swamp Forests in the Coastal Plain (Ecoregion 65) and 10 Bottomland Hardwood Forests in the Piedmont (Ecoregion 45). The sites were chosen by the EPA using their probabilistic sampling method

from the sample population of wetland sites for the NWCA, so that EPA can add the resulting data to the NWCA database. The NWCA sampling protocol is being used with some modifications to the water sampling parameters and the soil sampling parameters. North Carolina's methods for sampling macroinvertebrates and amphibians will be used as well as the hydrology monitoring method. The EPA has expressed interest in some of the additional procedures as possible additions to the NWCA protocol in future assessments. Furthermore, the EPA is encouraging the states in this grant to use the NWCA data to help with the assessment of wetland condition in the Southeast Region. Another eventual product that could result from this regional work is a regional rapid assessment. To enhance that effort, three rapid assessment methods are being used by all four states: ORAM, NCWAM, and USA-RAM. To develop a truly comprehensive regional rapid assessment method, more data will be needed.

Development of NC WAM

One of the most popular tools for wetland assessment is the rapid assessment. The Ohio Rapid Assessment Method (ORAM) was an early method that has spawned rapid assessments for several states. North Carolina developed the North Carolina Rapid Assessment Method (NCWAM) with a team of state and federal agencies including the NC DWQ, US Army Corps of Engineers (USACE), North Carolina Department of Transportation (NC DOT), the EPA, and the US Fish and Wildlife Service (USFWS). NCWAM is a rapid wetland functional assessment consisting of three primary functions: hydrology, water quality, and habitat. The NCWAM results in a score of High, Medium, or Low for the entire wetland, along with separate scores for each of the three functions. Each function consists of multiple sub functions which also result in a score. NCWAM is based on a model of the 16 wetland types that are found in North Carolina. One primary purpose of NCWAM is to assess wetlands based on their functional value so that compensatory mitigation can be based on function rather than acreage. The USACE Wilmington District and the NC DWQ is currently considering how to implement NCWAM for in the 401/404 permitting process. Some of the Level III data collected during the various wetlands monitoring projects discussed in this document was utilized to validate the NCWAM model during the tool's development. Analysis is currently underway to determine how NCWAM performs when assessing headwater wetlands.

(2) Overview of Regulatory Programs for Protection of Wetlands

North Carolina's General Assembly has appointed the Environmental Management Commission (EMC) responsible for adopting rules to protect, preserve and enhance the state's air and water resources. The EMC has tasked the North Carolina Department of Environment and Natural Resources (NCDENR) with implementing these rules. The North Carolina Division of Water Quality (DWQ), a Division of DENR, protects wetlands via permitting programs as outlined below.

National Pollutant Discharge Elimination System (NPDES):

In 1975, the EPA delegated NPDES permitting authority to the state of North Carolina. This means that all wastewater discharged to surface waters (including wetlands) must be authorized by a state-issued NPDES Permit. NPDES permits include limitations on flow volumes and pollutant constituents to ensure not only compliance with the Section 402 of Clean Water Act, but also with state water quality requirements pursuant to North Carolina Administrative Code (NCAC) 15A NCAC 02B .0100 - .0500 and 02H .0100 - .1200.

Wastes Not Discharged to Surface Waters:

Systems that apply wastewater, biological solids, or reclaimed water to the land surface are subject to regulation under NCAC 15A NCAC 02T and 02U. While the primary purpose of these rules has historically been to protect North Carolina's groundwater resources from pollution, more emphasis is being placed on the interaction between groundwater and surface waters; and wetlands are an obvious example of this interaction. Non-discharge permits prohibit these systems from discharging directly to surface waters, provide flow and pollutant limitations, and contain required setback distances that must be maintained between land application activities and surface waters (perennial streams, intermittent streams, and wetlands).

401 Water Quality Certifications and Isolated Wetlands Permitting:

Development impacts to wetlands in North Carolina are regulated under three different categories. **404 Wetlands:** The U.S. Army Corps of Engineers (USACE) is the federal agency responsible for issuing permits pursuant to Section 404 of the Clean Water Act. These permits are required for the discharge of fill material into streams, wetlands and open waters. **Coastal (CAMA) Wetlands:** CAMA permits are required under the Coastal Area Management Act and are issued by the NC Division of Coastal Management (DCM) for development projects within one of NC's twenty coastal counties in or affecting an Area of Environmental Concern. **Isolated/non-404 Wetlands:** According to the Environmental Protection Agency's (EPA's) June 2007 Guidance, as a result of recent U.S. Supreme Court decisions, a wetland that does not have a significant nexus to a Traditionally Navigable Waterway (i.e., isolated wetland) is not protected under Section 404 of the Clean Water Act and therefore is not under USACE jurisdiction. Since isolated wetlands perform many of the same functions as other wetlands, impacts to isolated wetlands in North Carolina are subject to state permitting and compensatory mitigation requirements under 15A NCAC 02H .1300.

Section 401 of the Clean Water Act stipulates that no Federal permit, including 404 permits, will be issued unless a 401 Water Quality Certification has been issued or waived. 401 Water Quality Certifications (Clean Water Act) correspond with the permits issued by the USACE and DCM. 401 Certifications are required for any federally permitted or licensed activity that may result in a discharge to or filling of streams, wetlands or open waters. DWQ requires applicants to document measures taken to avoid and minimize impacts to wetlands during design of their projects and to perform compensatory

mitigation in accordance with the 401 Water Quality Certification requirements in 15A NCAC 02H .0506. The “401” process essentially provides verification by DWQ that a given project authorized by a federal permit will not contravene the water quality standards provided in 15A NCAC 2B .0200.

(3) Compensatory Mitigation for Wetlands and Voluntary Restoration and Protection

As discussed in the regulatory section above, entities that propose to impact wetlands as a result of activities such as land development or road construction are subject to both federal (USACE) and state (NC DWQ) requirements to avoid and minimize impacts to the greatest extent possible. Projects causing unavoidable impacts require both federal (404) permitting and state (401) certification, and must provide compensatory mitigation to offset impacts in accordance with both federal and state regulations. DWQ requires applicants to perform compensatory mitigation in accordance with the 401 Water Quality Certification requirements in 15A NCAC 02H .0506(h)(6). This rule requires that “all mitigation proposals shall provide for the replacement of wetland acres lost due to the proposed activity at a minimum of a 1:1 ratio through restoration or creation prior to utilizing enhancement or preservation to satisfy the mitigation requirements...”. Impacts to isolated wetlands are subject to a 2:1 mitigation ratio for impacts greater than 1 acre in size pursuant to 15A NCAC 02H .1305(g)(6). Compensatory mitigation may be accomplished through one of three options: (1) purchase from a privately owned mitigation bank, (2) purchase from the State’s in-lieu fee program (NC EEP), or (3) applicant-supplied (project specific) mitigation.

In April 2008, the Department of Defense and the Environmental Protection Agency jointly released “Compensatory Mitigation for Losses of Aquatic Resources; Final Rule (33 CFR 325 and 332; 40 CFR 230). This rule requires review and evaluation of mitigation banks and in-lieu fee programs by an Interagency Review Team (IRT) made up of federal and state regulatory and non-regulatory agencies. NC DWQ is one of the member agencies of North Carolina’s Interagency Review Team (IRT). As such, NC DWQ is responsible for reviewing stream restoration plans and assessing mitigation sites for the purpose of evaluating the success of mitigation projects, and approving ultimate closeout of projects.

Voluntary restoration and protection initiatives in North Carolina currently function independently of NC DWQ regulatory programs. Voluntary activities include participation in the NRCS Wetlands Reserve Program, establishment of conservation easements, restoration projects funded through federal 319 grants, and a patchwork of other projects funded through various non-profit organizations and conservation-oriented foundations. During upcoming development of North Carolina’s Wetlands Program Plan, NC DWQ will evaluate options for strengthening partnerships with these organizations as well as to seek opportunities for community involvement to increase incentives for voluntary wetlands restoration and protection activities.

(4) Water Quality Standards for Wetlands

Wetland Standards

North Carolina's water quality standards for wetlands were implemented in 1996. The water quality standards contained in 15A NCAC 02B .0231 are narrative in nature (non-numeric) and were designed to protect, preserve, restore and enhance the quality and uses of wetlands and other waters of the state that are influenced by wetlands. Wetland uses protected in the rule are as follows:

- Storm and flood water storage/retention;
- Hydrologic functions such as groundwater discharge and groundwater recharge;
- Filtration/storage of pollutants;
- Shoreline protection; and
- Habitat for the propagation of wetland-dependent aquatic organisms and other wildlife species.

The uses outlined above are maintained and/or enhanced through standards that prohibit liquids, fill, debris, oil or other materials that would produce aesthetic effects that would adversely impact existing uses. Substances which are toxic or harmful to human, animal, or plant life may not be present in amounts sufficient to adversely impact wetland uses. In addition to prohibitions on harmful materials or substances, hydrologic conditions must be maintained as necessary to support natural biological and physical characteristics. Wetland flora and fauna is required to be maintained in order to protect biological integrity.

These narrative standards have provided DWQ with the basic regulatory structure needed to protect wetlands from various detrimental activities outside of USACE jurisdiction such as ditching and draining. However, numeric standards for water quality assessment and determining impairment have not been developed at this time. During upcoming development of North Carolina's Wetlands Program Plan, NC DWQ will evaluate the need and potentially determine a process for updating existing standards and/or developing numeric wetland standards related to water quality.

Unique Wetlands Classification

Classifications for surface waters in North Carolina are outlined in 15A NCAC 02B .0101. Certain classifications are subject to more stringent levels of protection depending upon their use, uniqueness, and/or sensitivity to pollutants. Unique wetlands (UWL) are wetlands of exceptional ecological significance which require special protection to maintain existing uses. Data collected as part of North Carolina's monitoring and assessment program was instrumental in securing this level of protection for UWLs.

Future Directions in Wetland Monitoring

The Wetlands Monitoring program in North Carolina has progressed beyond its infancy stage and is maturing with added experience. One of the primary future goals is to better utilize the wetlands monitoring data and methodology. For example, several recent 401 Water Quality Certifications issued in North Carolina have required monitoring of wetland impacts. In these cases, the monitoring methodology established by the North Carolina wetlands monitoring program was used by the Permittees to establish baseline data for the impacted wetlands.

Another example for use of the wetland monitoring data would be establishing guidelines for success criteria for wetland mitigation projects. Currently, these success criteria are determined on a case by case basis. There is a need to develop scientifically-based guidance that would provide consistency in the project planning stages. Data collected thus far will be important in establishing guidelines for vegetation composition, soil characteristics, macroinvertebrate and amphibian populations, and hydrologic regimes for wetlands mitigation projects. North Carolina's wetland monitoring data could also be used to identify reference conditions for establishing monitoring plans for wetlands that may be impacted by development projects or wastewater disposal activities. Data is also needed to evaluate the performance of North Carolina's rapid assessment method, NCWAM. The level three data collected for specific wetland types can be used to validate NCWAM's results. This analysis is currently in progress with the Headwater Wetland (Headwater Forest) monitoring data. Finally, the water quality data collected by the wetland monitoring program could be used as a basis for establishing water quality standards for wetlands which is one of the four core elements included in EPA's framework for state wetlands programs.

A second major area of growth for North Carolina's wetlands monitoring program would be the analysis of the long term monitoring data. Up to seven years of monitoring data has been collected for some long term sites, and efforts are being made to continue monitoring at the long term sites in order to eventually produce a data set that can be used to determine trends in wetland condition. This type of trend analysis could be used to develop a model for the detection of wetland change for both specific wetland types or for particular regions of the state. Understanding trends and changes in wetland condition will lead to more informed decision making within North Carolina's regulatory program.

A third growth opportunity for North Carolina's wetlands monitoring program would be to establish a permanent wetland monitoring network in North Carolina. Fourteen wetlands are currently being monitored long term. However, this number would need to at least double in order to have a viable wetland monitoring network. The value of a wetland monitoring network would be: (1) to strengthen the application of wetland monitoring data mentioned above, (2) to provide more data for trend analysis or model development to detect changes over time and hence provide better management decisions, (3) to begin to understand effects of climate change on wetlands, (4) to provide a better statewide assessment of wetland condition; and (5) to eventually establish a regional wetland monitoring network in the Southeast, which would contribute to all of the potential uses of wetland monitoring data previously mentioned.

As the wetland monitoring program in North Carolina continues to evolve, future Integrated Reports will provide more data and results to accompany narrative descriptions of monitoring initiatives. North Carolina's Wetlands Program Plan is currently under development and will be used as a vehicle to outline specific goals, schedules and outcomes for the future direction of North Carolina's wetlands monitoring program and to identify sustainable fiscal resources to support implementation of the monitoring activities that have been developed to date.

References

- Baker, V., R. Savage, C. Reddy, and M. Turner. 2008. Development of a wetland monitoring program for headwater wetlands in North Carolina. Final Report. EPA Grant CD 974260-01. North Carolina Department of Environment and Natural Resources (NC DENR), North Carolina Division of Water Quality (NC DWQ). Raleigh, NC. 372 pp.
- Mack, J.J. 2001. *Ohio Rapid Assessment Method for Wetlands. Manual for Using Version 5.0*. Ohio EPA Technical Bulletin Wetland/2001-1-1. Ohio Environmental Protection Agency, Division of Surface Water, 41 Wetland Ecology Units, Columbus, Ohio.
http://www.epa.state.oh.us/dsw/401/oram50sf_s.pdf
- NC Wetland Functional Assessment Team. 2008. *NC Wetland Assessment Method – Users Manual*. Version 4.1. Raleigh, NC. Available:
<http://portal.ncdenr.org/web/wq/swp/ws/pdu/ncwam>
- RTI International, NC Department of Environment and Natural Resources, South Carolina Department of Health and Environmental Control, University of South Carolina. 2011. Assessing Geographically Isolated Wetlands in North and South Carolina – the Southeast Isolated Wetlands Assessment (SEIWA). Final Report for U.S. Environmental Protection Agency ORD NHEERL, Corvallis, OR. EPA Cooperative Agreement No. COA RM-83340001.
- Savage, R., V. Baker, M. Turner, and S. Schwarzer. 2010. Field verification of wetland functional assessment methods within local watershed planning areas draft report. Report to the U.S. Environmental Protection Agency in fulfillment of EPA Wetlands Program Development Grant CD 96422105-0. 358pp.