NCDA&CS

2023 Annual Progress Report (Crop Year 2022) on the Tar-Pamlico Agricultural Rule (15A NCAC 02B .0732)

A Report to the Division of Water Resources from the Tar-Pamlico Basin Oversight Committee: Crop Year 2022

Date approved by Tar-Pamlico Basin Oversight Committee: 11/21/2023
Date submitted to NC Division of Water Resources: 11/21/2023


Tar-Pamlico River Basin
PERSON
VANCE
WARREN
GRANVILLE
HALIFAX
NORTHAMPTON
GATES
CURRITUCK
HERTFORD
CAMDEN
PASQUOTANK
PERQUIMANS
CHOWAN
ORANGE
DURHAM
FRANKLIN
NASH
EDGECOMBE
BERTIE
TYRRELL
WASHINGTON
MARTIN
WAKE
JOHNSTON
WILSON
PITT
DARE
LEE
GREENE
BEAUFORT
HYDE
HARNETT
WAYNE
LENOIR
CRAVEN
JONES
DUPLIN
CARTERET
ONSLOW
PENDER
Legend
Water Bodies
Major Rivers
Tar-Pamlico River Basin
Roads
Municipalities
County Boundaries
N
W
E
S
0 5 10 20 30 40 50 60
Miles

Summary

The Tar-Pamlico Basin Oversight Committee (BOC) received and approved crop year[1] (CY) 2022 annual reports from the fourteen Local Advisory Committees (LACs) operating under the Tar-Pamlico Agriculture Rule as part of the Tar-Pamlico Basin Nutrient Management Strategy. The report demonstrates agriculture's ongoing collective compliance with the Tar-Pamlico Agriculture Rule and estimates further progress in decreasing nutrient losses. In CY2022, agriculture collectively achieved an estimated 57% reduction in nitrogen loss compared to the 1991 baseline, continuing to exceed the rule-mandated 30% reduction. Twelve of fourteen LACs exceeded the 30% reduction goal established by the BOC. Phosphorus tracking in the basin indicates less risk of phosphorus loss during CY2022 than in the baseline year for 6 of the 9 qualitative indicators.

Rule Requirements and Compliance History

Tar-Pamlico NSW Strategy

The Environmental Management Commission (EMC) adopted the Tar-Pamlico nutrient strategy in 2000. The management strategy built upon the precedent-setting Neuse River Basin effort established three years earlier, which for the first time set regulatory reduction measures for nutrients on cropland acres in the state. The NSW strategy goal is to reduce the average annual load of nitrogen to the Pamlico estuary by 30% from 1991 levels and to limit phosphorus loading to 1991 levels. Mandatory controls were applied to address non-point source pollution in agriculture, urban stormwater, nutrient management, and riparian buffer protection. As of 2020, the Pamlico estuary is still classified as impaired and is not meeting its 30 percent nitrogen loading reduction goals.

Effective September 2001, the Tar-Pamlico Nutrient Sensitive Waters Management Strategy (NSW) provides for a collective strategy for farmers to meet the 30% nitrogen loss reduction and no-increase phosphorus goals within five years. A BOC and fourteen Local Advisory Committees (LACs) were established to implement the rule and to assist farmers with complying with the rule.

All fourteen LACs submitted their first annual report to the BOC in November 2003, which collectively estimated a 39% nitrogen loss reduction, and 10 of 14 individual LACs exceeded the 30% goal. Collective reductions gradually increased in succeeding years, and by CY2007 only one LAC did not meet the 30% goal. All LACs except two are currently exceeding the 30% reduction target.

All fourteen LACs submitted county data reports in 2023 to Division of Soil and Water Conservation staff. Annual reductions were calculated using the Nitrogen Loss Estimation Worksheet (NLEW). Based on submitted data, the agricultural community in the Tar-Pamlico basin achieved a collective 57% nitrogen loss reduction in CY2022 from the 1991 baseline.

[1] The 2022 crop year began October 1st, 2021, and ended September 30th, 2022.

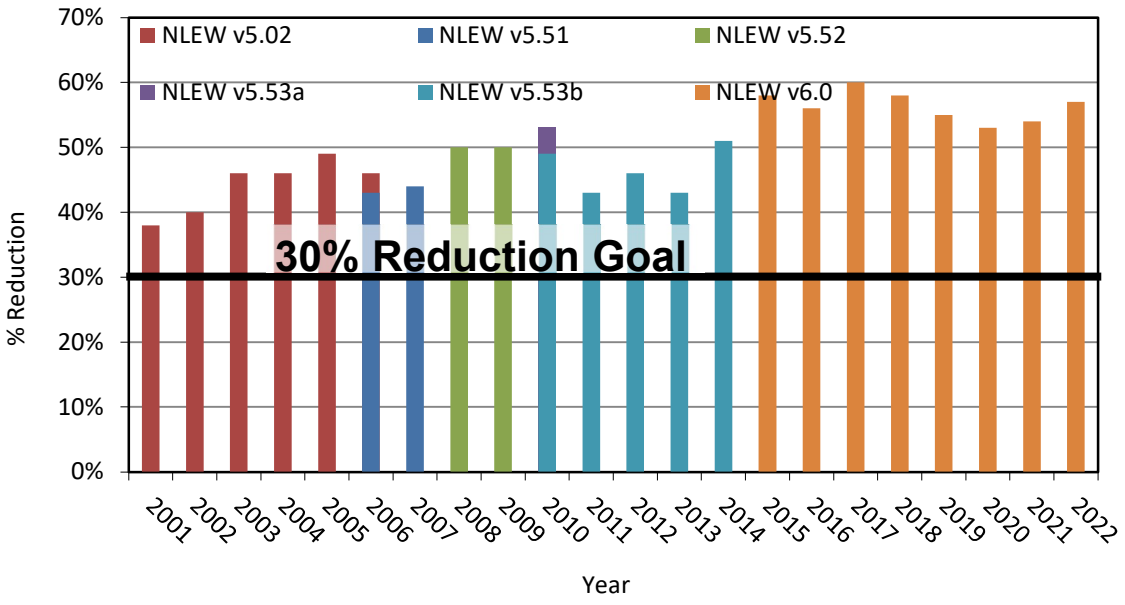
Scope of Report and Methodology

The estimates provided in this report represent whole-county scale calculations of nitrogen loss from cropland agriculture, adjusted for acreage in the basin. These estimates were made by Division of Soil and Water Conservation staff using the 'aggregate' version of NLEW, an accounting tool developed to meet the specifications of the Neuse Rule and approved by the EMC for use in the Tar-Pamlico Basin. The development team included interagency technical representatives of the NC Division of Water Resources (DWR), NC Division of Soil and Water Conservation (DSWC), USDA-NRCS and was led by NC State University Soil Science Department faculty. NLEW captures application of both inorganic and animal waste sources of fertilizer to cropland. It is an "edge-of-management unit" accounting tool that estimates changes in nitrogen loss from croplands but does not estimate changes in nitrogen loading to surface waters. An assessment method was developed for phosphorus, approved by the EMC, and is described later in the report.

Annual Estimates of N Loss and the Effect of NLEW Refinements

The NLEW software is periodically revised to incorporate new knowledge gained through research and improvements to data. These changes have incorporated the best available data, but changes to NLEW must be considered when comparing nitrogen loss reduction in different versions of NLEW. Further updates in soil management units are expected as NRCS produces updated electronic soils data. The small changes in soil management units are unlikely to produce significant effects on nitrogen loss reductions. Figure 1 represents the annual percent nitrogen loss reduction from the baseline for 2001 to 2022.

Figure 1: Collective Cropland Nitrogen Loss Reduction Percent 2001 to 2022, Tar Pamlico River Basin.



The first NLEW reports were run in 2001, and agriculture has continued to exceed its collective 30% nitrogen reduction goal since that time. The first NLEW revision (v5.51) updated soil management units and marked a significant change in the nitrogen reduction efficiencies of buffers, so both the baseline and CY2005 were re-calculated based on the best available information. The second (v5.52) and third (v5.53a) revisions were administrative and included minor updates to soil mapping units and realistic yields. In April of 2011 the NLEW Committee established further reductions (v5.53b) in nitrogen removal efficiencies for buffers based on additional research. In 2016 NLEW software was updated (v6.0) from outdated software and transferred to a web-based platform on NCDA&CS servers. Revised realistic yield and nitrogen use efficiency data from NCSU was incorporated, and some minor calculation errors were corrected for corn and sweet potatoes. Table 1 lists the changes in buffer nitrogen reduction efficiencies over time.

Table 1: Changes in Buffer Width Options and Nitrogen Reduction Efficiencies in NLEW

Buffer Width	NLEW v5.02* % N Reduction 2001-2005	NLEW v5.51, v5.52, v5.53a % N Reduction 2006-2010	NLEW v5.53b, v6.0 % N Reduction 2011-Current
20'	40% (grass) 75% (trees & shrubs)	30%	20%
30'	65%	40%	25%
50'	85%	50%	30%
70'	85%	55%	30%
100'	85%	60%	35%

**NLEW v5.02 - the vegetation type (i.e. trees, shrubs, grass) within 20' and 50' buffers determined reduction values. Based on research results, this distinction was dropped from subsequent NLEW versions.*

Current Status

Nitrogen Reduction from Baseline for CY2022

All fourteen LACs submitted their twenty-second annual reports to the BOC in September 2023. For the entire basin, in CY2022 agriculture achieved a 57% reduction in nitrogen loss compared to the 1991 baseline. This percentage is 3% higher than the reduction reported for CY2021. This year, twelve LACs achieved the target 30% nitrogen loss reduction goal set by the BOC. Table 2 lists each county's baseline, CY2021 and CY2022 nitrogen (lbs per year) loss values, and nitrogen loss percent reductions from the baseline in CY2021 and CY2022.

*Table 2: Estimated Reductions in Agricultural Nitrogen Loss from Baseline (1991) for CY2021 and CY2022, Tar-Pamlico River Basin**

County	Baseline N Loss (lb)*	CY2021 N Loss (lb)*	CY2021 N Reduction (%)	CY2022 N Loss (lb)*	CY2022 N Reduction (%)
Beaufort	9,178,262	4,715,659	49%	4,362,739	52%
Edgecombe	5,037,742	2,756,016	45%	2,596,710	48%
Franklin	2,183,680	628,375	71%	600,125	73%
Granville	890,371	150,186	83%	127,055	86%
Halifax	2,902,105	1,389,640	52%	1,430,062	51%
Hyde	5,501,161	2,330,827	58%	2,373,708	57%
Martin	782,152	609,490	22%	625,645	20%
Nash	4,693,868	1,730,035	63%	1,583,238	66%
Person	153,228	65,667	57%	111,783	27%
Pitt	6,229,921	2,757,497	56%	2,450,894	61%
Vance	419,485	107,008	74%	100,525	76%
Warren	535,517	236,471	56%	220,956	59%
Washington	939,912	566,308	40%	547,274	42%
Wilson	890,691	470,662	47%	414,778	53%
Total	40,338,095	18,513,841	54%	17,545,492	57%

**Nitrogen loss values are for comparative purposes. They represent nitrogen that was applied to agricultural lands in the basin and neither used by crops nor intercepted by BMPs in a Soil Management Unit, based on NLEW calculations. This is not an in-stream loading value.*

Nitrogen loss reductions were achieved through a combination of fertilization rate decreases, cropping shifts, BMP implementation, and cropland acreage fluctuation. Some of this cropping shift is due to the need for regular rotations on agricultural operations. For example, in order to minimize the threat of disease, a double-crop planting of wheat and soybeans may be followed by a corn crop. This means that fluctuations within rotations are to be expected from year to year even in the face of similar weather conditions. In CY2022, overall corn totals decreased by 22,700 acres and cotton totals increased by 19,827 acres from CY2021 values. Other major commodity crops experienced moderate changes. Wheat increased by 1,610 acres and soybean, tobacco and hay acres decreased by 2,607 acres, 537 acres, and 192 acres respectively. Fluctuating weather conditions markedly impact annual cropping shifts by affecting farmers' ability to prepare fields for harvest and planting as well as overall crop health

and yield. The winter of 2021-2022 was generally warm and dry (December, February), although the month of January was notably cool and wet.[2] Overall, 2022 concluded as a slightly drier year than normal and was among the state's top 20 warmest years on record.[3] Nevertheless, across the state precipitation varied substantially (the north and west were slightly wetter than normal, the east considerably drier) and there were frequent rapid changes from wet to dry conditions (and back again).[3] Factors that influence agricultural nitrogen reductions are shown in Table 3.

Martin County is currently reporting a 20% nitrogen loss reduction from baseline (1991), which is a 2% decrease in reduction from CY2021. In CY2022 Martin County reported 21,162 acres of crops, a 1,744 acre decrease from baseline reported crop acres. The county's overall nitrogen application rate on cropland (total nitrogen applied divided by total reported cropland) in Martin County for CY2022 is 27% lower from the county's overall nitrogen application rate in baseline. Corn, cotton, peanut, and soybean fertilization rates in CY22 have not fluctuated from baseline rates for those commodities. Tobacco, oat, and wheat fertilization rates in CY22 are lower than baseline rates. Most significantly, Martin County has experienced a 12% decrease in nitrogen uptake by crops in CY2022 from baseline. The overall crop nitrogen uptake estimated in baseline was 57% of the total estimated crop nitrogen needs. In CY2022, overall crop nitrogen uptake was 46% of the total estimated crop nitrogen needs. This decrease is most likely attributable to the increase in reported row crop acreage in CY2022 (all reported acres were row crops) in comparison to baseline (in which 87% of reported crop acres were row crops). The nitrogen use efficiency of agronomic crops is generally 40 to 65% in comparison to 75% for sod crops (hay).[4] Significant BMP installation has occurred in Martin County since baseline. In CY2022 there was over a 700% increase in pounds of nitrogen intercepted by annual BMPs (cover crops) and cumulative BMPs (riparian buffers and water control structures) from the amount of nitrogen intercepted by BMPs in baseline. Martin County will continue to work toward reducing nitrogen loss from agricultural land to meet the 30% reduction target.

Person County is currently reporting a 27% nitrogen loss reduction from baseline (1991), which is a 30% decrease in reduction from CY2021. This decrease is most likely attributable to the increase in reported row crop acreage (specifically for wheat and tobacco) in CY2022. Approximately 8% of Person County lies within the Tar-Pamlico basin. Given the small amount of agricultural acreage in the Tar-Pamlico basin portion of the county, year-to-year crop shifts can result in a magnified effect on the county's annual aggregate nitrogen loss reduction. In CY2022 Person County reported 887 more cropland acres than the previous year. Wheat acreage reported by the county in CY2022 more than doubled from CY2021 totals and tobacco

[2] Davis, C. 2022. Winter Recap 2021-22: Warm Weather Prevails, Even with a Snowy Surprise. Prepared by North Carolina State Climate Office for the Climate Blog, Climate Summary. https://climate.ncsu.edu/blog/2022/03/winter-recap-2021-22-warm-weather-prevails/

[3] Davis C, and K. Dello. 2023. The Weather Year in Review: Familiar Patterns with New Twists in 2022. https://climate.ncsu.edu/blog/2023/01/the-weather-year-in-review-familiar-patterns-with-new-twists-in-2022/

[4] Gatiboni, L. & Osmond, D. 2019. Nitrogen Management and Water Quality. AG-439-02. https://content.ces.ncsu.edu/nitrogen-management-and-water-quality

acreage nearly doubled. Fertilization rates for reported crops largely remained stable between CY2021 and CY2022, with the exception of fescue, the rate of which increased by 19 lbs N per acre. Person County also reported approximately 100 acres of manured soybeans (50 lbs N per acre) in CY2022. The county's overall nitrogen application rate on cropland (total nitrogen applied divided by total reported cropland) in Person County for CY2022 is 35% lower than the county's overall nitrogen application rate in baseline. Furthermore, in CY2022, total nitrogen applied to reported crops was below the calculated total crop nitrogen needs, indicating some cropland in the county was under-fertilized. The Person LAC will continue to work to report best available estimates for county agricultural activity each crop year and the County will continue to work toward reducing nitrogen loss from agricultural land to meet the 30% reduction target.

The most significant factors affecting nitrogen loss reductions across the whole Tar-Pamlico basin are cropping shifts and improved fertilization management. Table 3 shows the NLEW outputs and staff calculations that estimate factor importance (by percentage) in achieving total collective nitrogen loss reduction in the basin (57%).

*Table 3: Factors that Influence Nitrogen Reduction by Percentage on Agricultural Lands, Tar-Pamlico River Basin Since Baseline**

Factor	CY2019	CY2020	CY2021	CY2022
BMP implementation	7%	6%	6%	6%
Fertilization Management	22%	20%	20%	20%
Cropping shift	13%	13%	15%	18%
Cropland converted to grass/trees	5%	5%	5%	5%
Cropland lost to idle land	7%	8%	7%	7%
Cropland lost to development**	1%	1%	1%	1%
TOTAL	55%	53%	54%	57%

**Percentages are based on a total of the reduction, not a year-to-year comparison.*
***Acreage of cropland lost to development has not been tracked since CY2015.*

BMP Implementation

BMP implementation is one of the factors that influence nitrogen reduction on agricultural land. In low elevation coastal counties (Washington, Hyde, Beaufort, and Pitt) near and around the Tar-Pamlico estuary the predominant BMPs implemented by agricultural producers are water control structures. Since baseline, Beaufort and Hyde have cumulatively implemented water control structures that affect roughly 46,000 and 27,000 acres respectively. These practices are normally implemented to control salinity and soil moisture, but with appropriate management, they can also increase denitrification of agricultural drainage water as an added benefit. Many water control structures in use in the Tar-Pamlico Basin were implemented more than a decade ago and are no longer under active cost-share contracts with operation and maintenance agreements. Every effort is made to ensure that BMPs reported continue to function as designed and are maintained appropriately for water quality benefits. Verification of functionality and appropriate management requires site visits to individual farm owners who may or may not have this BMP under an active cost-share contract. Coastal counties have reported that despite contract expirations for practices installed more than 10 years ago, some water control structures no longer covered by an operation and maintenance agreement are still functional and actively managed by producers for water quality benefits.

All acres affected by water control structures reported in CY2012 were manually removed from each county's total in this report to ensure that all affected acres currently being reported are for active contracts only with operation and maintenance agreements. This has resulted in a decrease of 3,375 water control structure affected acres in CY2022 from CY2021, as shown in Figure 2. The water control structure reporting change from cumulative affected acres to active contract affected acres, approximated by a 10-year rolling window, began in CY2019. Members of each LAC in coastal counties were notified in Fall 2019 that inactive contract acres, starting in CY2019 and moving forward, would no longer be included in BMP totals until older structures were inspected and determined to be appropriately operational and managed for water quality benefits, or until the producer signed a new cost share contract. Several Soil and Water Conservation Districts indicated an interest and willingness in re-engaging with cooperators with older structures. Staff worked diligently in 2022 and 2023 to set up a clear pathway for performing necessary structure function and management checks in the field for re-adding older structures back into county BMP totals for nitrogen reduction credit. A pilot project in the Neuse River Basin, which assessed older water control structures and tested the established field inspection procedure and GIS tools developed to organize the assessment process and collected data, was completed in the 2022-2023 winter. The pilot was largely successful. The overall process and tools were found to be easy to follow and use. Actionable data was captured as part of the pilot to add some older structures back into county totals with confidence. In future reporting years coastal districts in the Tar-Pamlico basin may choose to engage with the newly established structure field inspection process and GIS tools to add functional and managed water control structures with expired contracts back into county BMP totals.

The removal of inactive contract BMP acres from annual reports has resulted in smaller nitrogen loss reductions in coastal counties, particularly Beaufort, Edgecombe, Hyde, Pitt, and

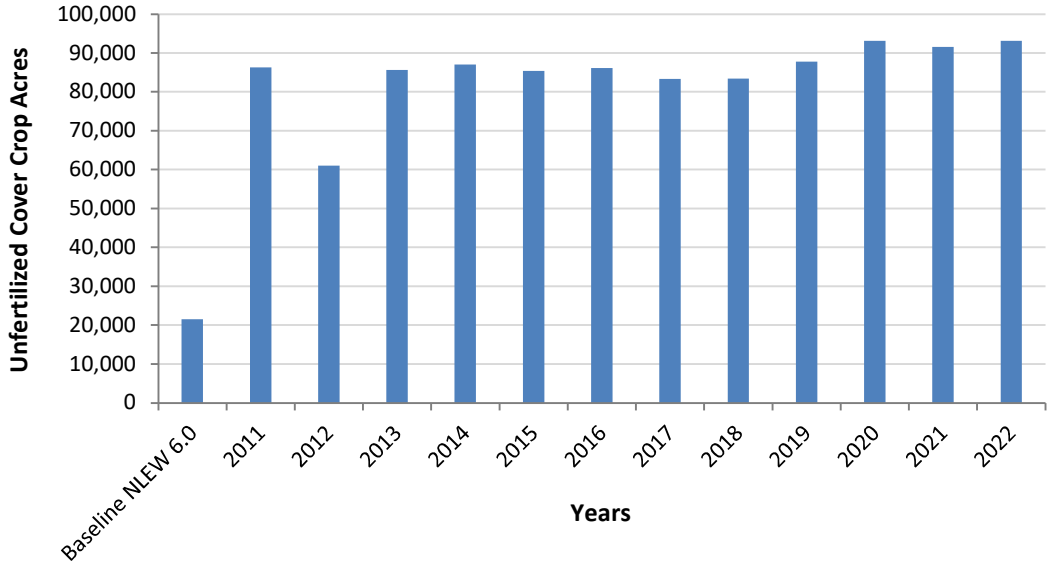
Washington. It is important to note that this abrupt reduction, first seen in the CY2019 report, is primarily based on a methodological change and not on farmer behavior or BMP functionality. The BOC expects that there remains acreage not captured in this report that is impacted by functioning, controlled drainage practices that are managed for water quality benefits. The methodology change and the newly established pathway to re-add acreage affected by structures no longer under state/federal contract to county BMP totals ensures counties continue ongoing engagement with cooperators on structure management for water quality benefits. Due to ever-present demand and increased prioritization, implementation of water control structure contracts is still evident in many of these counties. The BOC expects this trend to continue as precipitation and sea level patterns change. Figure 2 shows the cumulative total of all acres affected by water control structures since baseline from CY2011 to CY2022, as well as the adjusted totals showing only acres affected by water control structures under active cost share contract from CY2019 to CY2022.

Figure 2: Acres Affected by Water Control Structures for Baseline (1991) and Installed from CY2011 to CY2022, Tar-Pamlico River Basin

The Division of Soil and Water Conservation, Soil and Water Conservation Districts and Natural Resources Conservation Service staff continue to make refinements to the NLEW accounting process as opportunities arise. LAC members estimate annual unfertilized cover crop acres based on crop rotations, producer cropping history, state and federal incentive programs, weather patterns, and seed prices. Buffer and water control structure BMP data is collected from state and federal cost share program active contracts, and in some cases (especially for unfertilized cover crops) BMPs that were installed without cost share funding. While there is some potential for variability in the data reported, LACs are including data that is the best information currently available. As additional reliable data sources become available, the LACs will review them and update methodology for reporting, if warranted. Unfertilized cover crop

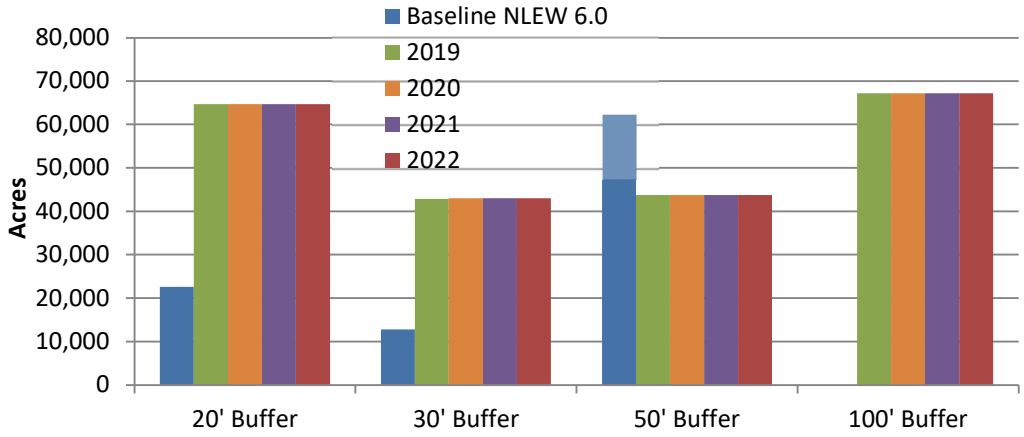
acres are documented on an annual basis because their implementation depends on crop rotations. As illustrated in Figure 3, CY2022 yielded an increase of 1,564 acres of unfertilized cover crops.

Figure 3: Unfertilized Cover Crop Acres Planted Annually on Agricultural Lands for Baseline (1991) and Installed from CY2011 through CY2022, Tar-Pamlico River Basin



From 2001 through 2006, the NLEW program captured buffers 50 feet and wider as one category. After the 2007 update, categories for 70- and 100-foot buffers were added. In CY2006 the buffers larger than 50 feet were redistributed into these new categories. From CY2011 to present, 50- and 70-foot buffers were combined into a single category for everything larger than 50 feet but less than 100 feet. There was an increase of 40 acres of 30-foot buffers implemented in CY2022 (Figure 4).

*Figure 4: Buffer Acres Present on Agricultural Lands for Baseline (1991) and Installed from CY2019 through CY2022, Tar-Pamlico River Basin**



**The acres of buffers listed represent actual acres. Acres affected by the buffer could be 5 to 10 times larger in the Piedmont than the acreage shown above.[4]*

Overall, the total acres of implementation of BMPs have increased since baseline as illustrated in Figures 2, 3, and 4. When cumulative acres of BMPs installed through federal, state and local cost share programs are compared to total reported cropland (598,184 acres), more than half of all reported cropland receives some kind of BMP treatment. This does not include farmer installed BMPs that are not funded by cost share programs, except in some cases where LACs are made aware of work that has been completed. Additionally, the treatment estimate is likely greater because it does not account for the entire drainage area treated by buffers in the Piedmont, which is generally 5 to 10 times higher than the actual footprint acres of the buffer shown in Figure 4.[5]

[5] Bruton, Jeffrey Griffin. 2004. Headwater Catchments: Estimating Surface Drainage Extent Across North Carolina and Correlations Between Landuse, Near Stream, and Water Quality Indicators in the Piedmont Physiographic Region. Ph.D. Dissertation. Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC 27606.http://www.lib.ncsu.edu/theses/available/etd-03282004-174056/

Additional Nutrient BMPs

At the field level, many BMPs contribute to nutrient reduction and subsequent water quality improvement; however, not all nutrient-reducing BMPs are tracked by NLEW. These include livestock-related nitrogen and phosphorus reducing BMPs, BMPs that reduce soil and phosphorus loss, and BMPs that do not have enough scientific research to support estimating a nitrogen reduction benefit credit. The BOC believes it is worthwhile to recognize these practices. Table 4 identifies BMPs not accounted for in NLEW and tracks their implementation in the basin since CY2001. Table 5 indicates the total number of BMPs not accounted for in NLEW, which are under active contract (implemented from CY2012 to CY2022).

Since baseline, increased implementation is evident across all BMP types. In CY2022, implementation of most of the additional nutrient-reducing BMPs increased (Tables 4 and 5). Some of these BMPs will yield reductions in nitrogen loss that are not reflected in the NLEW accounting in this report, but that will benefit the estuary.

*Table 4: Nutrient-Reducing Best Management Practices Not Accounted for in NLEW, CY2001 to CY2022, Tar-Pamlico River Basin**

BMP	Units	2001 – 2020**	2021**	2022
Diversion	Feet	441,962	441,962	441,962
Fencing (USDA Programs)	Feet	267,540	267,540	270,251
Field Border	Acres	1,322	1,325	1,325
Grassed Waterway	Acres	2,633	2,639	2,641
Livestock Exclusion	Feet	247,748	250,348	255,203
Sod Based Rotation	Acres	140,073	142,644	143,669
Tillage Management	Acres	87,693	89,271	89,823
Terraces	Feet	371,936	371,936	371,936

** Cumulative data quantified by adding BMPs implemented with State and Federal cost share program funding each Crop Year to cumulative totals reported the previous Crop Year. Additional BMPs may exist in the basin as practices may be installed by farmers without cost share assistance.*

***Updated values are provided to correct for propagating errors in spreadsheets found to date.*

*Table 5: Nutrient-Reducing Best Management Practices installed from CY2012 to CY2022, Not Accounted for in NLEW**

BMP	Units	BMPs Installed (CY2012 – CY2022)
Diversion	Feet	43,671
Fencing (USDA Programs)	Feet	28,519
Field Border	Acres	61
Grassed Waterway	Acres	166
Livestock Exclusion	Feet	22,142
Sod Based Rotation	Acres	80,102
Tillage Management	Acres	43,015

** Values represent only active contracts in State and Federal cost share programs approximated by a 10-year rolling window. Additional BMPs may exist in the basin as producers may maintain practices after the life of a cost share contract. Practices installed by producers without cost share assistance are not included in BMP totals.*

Fertilization Management

Better nutrient management in the Tar-Pamlico River Basin has resulted in a reduction of fertilizer application rates from baseline levels. Figure 5 indicates that nitrogen rates for the major crops in the basin have reduced from the baseline period.

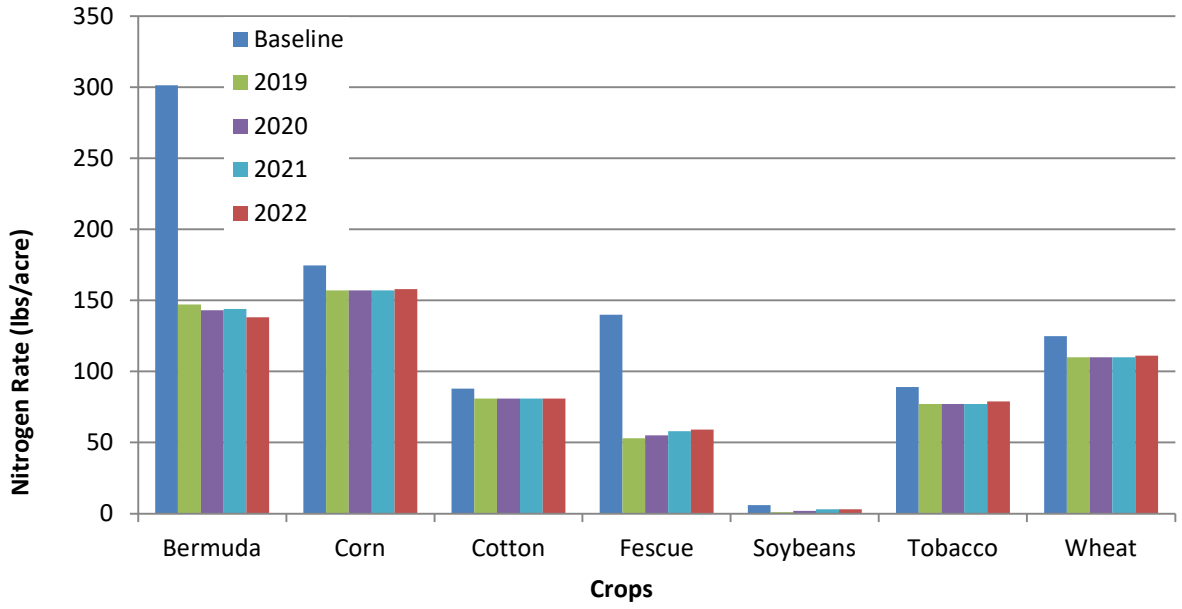
Between CY2021 and CY2022 nitrogen rates remained relatively stable (less than 5 lbs N per acre fluctuations) for corn, cotton, fescue, soybeans, tobacco, and wheat. Bermuda fertilization rates decreased by 6 lbs N per acre between CY2021 and CY2022. Most pastures are under-fertilized throughout the Tar-Pamlico basin and pasture and hayland is typically not supplemented with inorganic fertilizers. Figure 5 shows nitrogen application rates from CY2019 to CY2022.

Factors Identified by LACs Contributing to Reduced Nitrogen Rates since the Baseline Year

- Economic decisions and fluctuating farm incomes.
- Increased education and outreach on nutrient management.
- Mandatory waste management plans.
- The federal government tobacco quota buy-out reducing tobacco acreage.
- Neuse and Tar-Pamlico Nutrient Strategies.

Over time there has been an economic incentive for producers to improve nitrogen management. Fertilizer rates and standard application practices are revisited annually by LACs using data from farmers, commercial applicators and state and federal agencies' professional estimates.

Figure 5: Average Annual Nitrogen Fertilization Rate (lb/ac) for the Major Agricultural Crops for the Baseline (1991) and 2019-2022, Tar-Pamlico River Basin

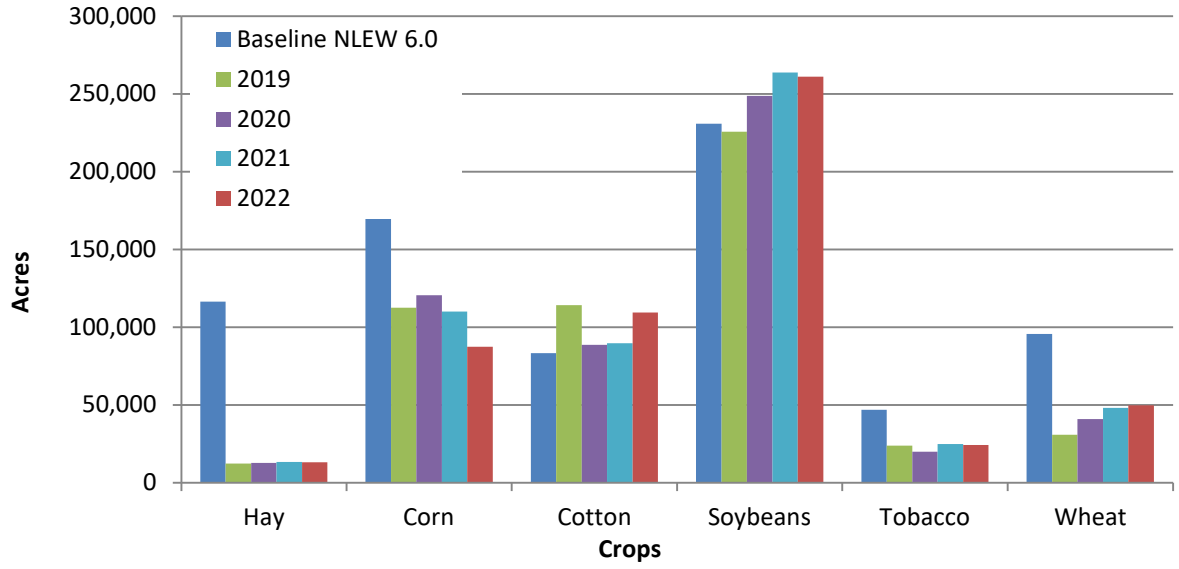


Cropping Shifts

Local Advisory Committees use data reported by farmers to the USDA-Farm Service Agency to annually estimate NLEW-reportable cropland within their counties lying within the Tar-Pamlico basin. Each crop requires different amounts of nitrogen and assimilates applied nitrogen with different efficiency rates. Changes in the mix of crops grown annually can have a significant impact on the cumulative yearly nitrogen loss reduction. The BOC anticipates that the basin will see additional crop shifts in the upcoming year based on changing commodity prices and weather patterns.

Figure 6 shows crop acres and shifts for the last four years compared to the baseline. Some crops have remained relatively stable, while others show more yearly variation. From CY2021 to CY2022, corn acreage decreased by 22,700 acres. Corn typically requires higher nitrogen application rates than other crops and generally follows the double-crop planting of wheat and soybeans to minimize disease pressures. Cotton acreage increased by 19,827 acres from CY2021. Hay (bermuda and fescue), soybean, and tobacco acreage slightly decreased in the basin between crop years. Hay decreased by 192 acres, soybeans by 2,607 acres, and tobacco by 537 acres. Wheat acreage in the basin increased by a moderate 1,610 acres. Cropping shift changes contributed to the overall collective nitrogen loss decrease seen between CY2021 and CY2022 in Table 2 (approximately 968,000 less lbs of total nitrogen lost). A host of factors from individual choice to global markets determine crop selection.

Figure 6: Acreage of Major Crops for the Baseline (1991) and 2019-2022, Tar-Pamlico River Basin



Land Use Change to Development, Idle Land and Cropland Conversion

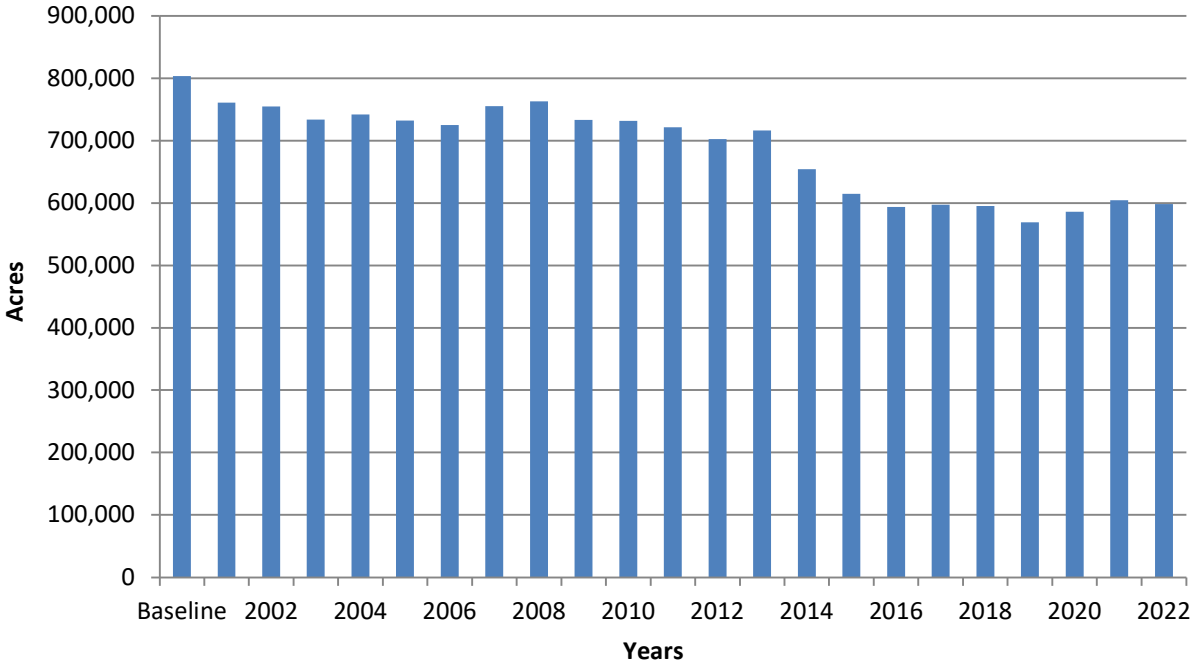
The number of cropland acres fluctuates every year in the Tar-Pamlico River Basin. Each year, some cropland is permanently lost to development. Annually, some cropland is converted to grass or trees and is likely to be ultimately lost from agricultural production. Idle land is agricultural land that is currently out of production but could be brought back into production at any time. Currently, it is estimated that almost 13,000 acres have been permanently lost to development in the basin since baseline, although this metric has not been updated since CY2015 due to incomplete data and reporting inconsistencies among local governments in the basin. Cropland conversion totals supported by state or federal cost-share funds are tracked and updated annually. Currently, 47,903 acres are estimated to have been converted to grass or trees in the Tar-Pamlico Basin since the 1991 baseline. In CY2022, there were 64,925 idle acres reported and a total of 598,184 NLEW-accountable acres of cropland (Figure 7). All the above estimates come from the LAC members' best professional judgment, USDA-FSA records and county planning department data. The total crop acres are estimated from USDA-FSA annual reports. Cropland acres have continued to decrease from the baseline period. Reported crop acres decreased by 6,377 acres between CY2021 and CY2022 (Figure 7).

In the last decade, LACs have noted increased conversion of agricultural land to leased and constructed solar facilities in the Tar-Pamlico basin. Although solar land use conversion data in the Tar-Pamlico Basin is not available for this report, the NC Sustainable Energy Association (NCSEA) has been monitoring and collecting data, including land use conversion information, on solar installations since 2009.[6] In 2017, a joint study conducted by NCSEA and NCDA&CS found that statewide 0.19% (9,074 acres) of the total 4.7 million acres of cropland in North Carolina had been repurposed for utility-scale solar development.[7] An updated report in 2022 from NCSEA using data through 2022 found that utility-scale solar photovoltaics (PV) occupied 0.28% of NC agricultural land (defined in the 2022 report as the combination of cultivated cropland, evergreen forest, and pasture/hay National Land Cover Database (NLCD) land use categories from the 2008 dataset). As of the 2022 report, utility-scale solar PV systems statewide occupy 38,081 total acres of land of which 31,125 acres were formerly agricultural land.[6]

[6] Brookshire, D., Carey, J., & Parker, D. 2022. North Carolina Solar Land Use and Agriculture 2022 Update. North Carolina Sustainable Energy Association. https://energync.app.neoncrm.com/np/viewDocument?orgId=energync&id=402887968151eed40181a722ef040100

[7] Aldina, R., Parker, D., Seo, B., Masatsugu, L., Childress, S., & Odera, M. 2017. April 2017 North Carolina Solar and Agriculture. North Carolina Sustainable Energy Association. https://energync.z2systems.com/np/viewDocument?orgId=energync&id=4028888b76b813ac0176e2e248c20152

*Figure 7. NLEW-Accounted Cropland Acres in the Tar-Pamlico River Basin, Baseline (1991) and 2001 – 2022**



**Some of the acres represented here are acres counted twice due to double-cropping on the same field. Some acreage reduction represents double-cropped wheat-soybeans converted to a full-season soybean crop.*

Phosphorus

Phosphorus Indicators for CY2022: The qualitative indicators included in Table 6 show the relative changes in land use and management parameters and their relative effect on phosphorus loss risk in the basin. This approach was recommended by the Phosphorus Technical Advisory Committee (PTAC) in 2005 due to the difficulty of developing an aggregate phosphorus tool to parallel the nitrogen NLEW tool and was approved by the EMC. Table 6 builds upon the data provided in the 2005 PTAC report, which included all available data at the time ending with data from 2003. This report adds phosphorus indicator data for CY2019 through CY2022. Except for animal waste P and soil test P, the other parameters indicate less risk of phosphorus loss than in the baseline year. Water Control Structures are reported as both cumulative and active contract acres, which makes determining a positive or negative risk change difficult without additional data. The BOC notes consistent and ongoing implementation of water control structure cost share contracts in coastal counties, and Soil and Water Conservation Districts will complete field verifications of older structures as capacity allows.

Phosphorous Technical Advisory Committee (PTAC)

The PTAC's overall purpose was to establish a phosphorus accounting method for agriculture in the basin. It determined that a defensible, aggregated, county-scale accounting method for estimating phosphorus losses from agricultural lands is not currently feasible due to "the complexity of phosphorus behavior and transport within a watershed, the lack of suitable data required to adequately quantify the various mechanisms of phosphorus loss and retention within watersheds of the basin, and the problem with not being able to capture agricultural conditions as they existed in 1991." The PTAC instead developed recommendations for qualitatively tracking relative changes in practices in land use and management related to agricultural activity that either increase or decrease the risk of phosphorus loss from agricultural lands in the basin on an annual basis.

The increase of nutrient-reducing BMPs in the basin contributes to the reduced risk of phosphorus loss. The soil test phosphorus median number reported for the basin fluctuates each year due to the way the data is collected and compiled. The soil test phosphorus median numbers shown in Table 6 are generated by using North Carolina Department of Agriculture and Consumer Services (NCDA&CS) soil test laboratory results from voluntary soil testing on agriculture land and the data is reported by the NCDA&CS. The number of samples collected each year varies. The data only includes samples submitted for cropland. It does not include soil tests that were submitted to private laboratories. The soil test results from the NCDA&CS database represent data from entire counties in the basin and have not been adjusted to include only those samples collected in the river basin area.

Based on these findings, the BOC recommends that no additional management actions be required of agricultural operations in the basin at this time to comply with the "no net increase above the 1991 levels" phosphorus goal of the agriculture rule. The BOC will continue to track and report the identified set of qualitative phosphorus indicators to DWR annually, and to bring any concerns raised by the results of this effort to DWR's attention as they arise, along with recommendations for any appropriate action. The BOC expects that BMP implementation will continue to increase throughout the basin in future years, and notes that BMPs installed for nitrogen, pathogen and sediment control often provide significant phosphorus benefits as well.

Table 6: Relative Changes in Land Use and Management Parameters and their Relative Effect on Phosphorus Loss Risk in the Tar-Pamlico

Parameter	Units	Source	1991 Baseline	CY2019	CY2020	CY2021	CY2022	1991 – 2022 Change	CY2022 P Loss Risk +/-
Agricultural land (annual)	Acres	FSA	803,451ϕ	569,061	585,994	604,561	598,184	-26%	-
Cropland conversion (to grass & trees) (cumulative)	Acres	USDA-NRCS & NCACSP	660	47,462	47,516	47,681	47,903	7,158%	-
CRP / WRP (cumulative)	Acres	USDA-NRCS	19,241	41,833	41,833	41,833	41,833	117%	-
Conservation Tillage* (cumulative)	Acres	USDA-NRCS & NCACSP	41,415	84,346**	87,693**	89,271**	89,823	117%	-
Vegetated buffers (cumulative)	Acres	USDA-NRCS & NCACSP	97,810 ϕ	218,461	218,584	218,603	218,643	124%	-
Water control structures (cumulative/ active contract)	Acres Affected	USDA-NRCS & NCACSP	52,966 ϕ	(93,576)/ 12,228**	(94,819)/ 11,975	(95,457)/11,015	(96,395)/7,640	-86%***	+/-***
Unfertilized cover crop (annual)	Acres	LAC, USDA-NRCS & NCACSP	21,522 ϕ	87,787	93,085	91,569	93,133	333%	-
Animal waste P (annual)	lbs of P per yr	NC Ag Statistics	13,374,238 ϕ	15,054,325	16,601,897	16,769,915	15,979,432	19%	+
Soil test P median (annual)	P Index	NCDA&CS	83	93	91	84	84	1%	+

** Conservation tillage is likely being practiced on additional acres, but this number only reflects cumulative cost share contract acres since baseline, not acres where farmers have implemented conservation tillage without cost share assistance. According to the 2017 Ag Census, conservation tillage (including no-till) was practiced on 451,018 crop acres in the Tar-Pamlico River Basin.*[8]

***Numbers were adjusted since reported to correct spreadsheet errors or to include updated data.*

****Cumulative water control structure acres are reported along with acres currently under active contract. An unknown portion of inactive acres are likely still affected by water control structures, as a result, the BOC believes the P loss risk in this category is difficult to describe as clearly positive or negative.*

Φ Values were corrected from previous years reports. At certain times in annual reporting (NLEW updates, etc.) baseline was updated. Baseline updates were not always carried over to this table. Corrected values are those currently in NLEW version 6.0.

[8] USDA NASS, 2017 Census of Agriculture, Census by Watershed (HUC 030201). Available at: www.agcensus.usda.gov/ Publications/2017/Online_Resources/Watersheds/sag03.pdf

Looking Forward

The Tar-Pamlico BOC will continue to report on rule implementation, relying heavily on Soil and Water Conservation District staff to compile county data reports. The BOC continues to encourage counties to implement additional BMPs to further reduce nutrient losses.

Because cropping shifts are susceptible to various pressures, the BOC is working with LACs in all counties to continue BMP implementation that provides lasting reduction in nitrogen loss in the basin.

Basin Oversight Committee recognizes the dynamic nature of agricultural business.

- Changes in the world economies, energy or trade policies.
- Changes in government programs (e.g. commodity support or environmental regulations)
- Weather and climate (e.g. long periods of drought or rain)
- Scientific advances in agronomics (e.g. production of new types of crops or improvements in crop sustainability)
- Plant disease or pest problems (e.g. viruses or foreign pests)
- Urban encroachment (e.g. crop selection shifts as fields become smaller)
- Age of farmer (e.g. as retirement approaches farmers may move from row crops to cattle)

The BOC has noted and is monitoring an increase in poultry in some areas of the state. According to Agricultural Statistics data, in CY2022 there was an approximately 8% increase in annual broiler production in the Tar-Pamlico Basin from 1993/1994. CY2022 broiler production totals remain below peak broiler production in the Tar-Pamlico Basin from 1995 to 1997. A significant increase in layer hen inventory from 1993/1994 was seen in the Tar-Pamlico basin with establishment of the Rose Acre Farms facility in Hyde County in the mid-2000s. After establishment of this facility, layer hen inventory in the basin has remained stable, with slight decreases in total inventory seen since 2008. Increases in layer hen inventory since CY2019 are predominantly attributable to inventory changes at the Rose Acre Farms facility. There does not appear to be a significant upward trend of total poultry (produced and inventoried) in the Tar-Pamlico Basin compared to baseline, despite notable poultry increase trends in other parts of the state. In the last thirty years since baseline, cattle and swine inventory totals are trending downward with evident decreases from peak production in the late-1990s (1995 to 1999). The BOC will continue to monitor poultry production and inventory changes in the Tar-Pamlico basin as well as the increase in soil test phosphorus since baseline.

Funding

Ongoing agriculture rule reporting has incorporated data processing efficiencies and improvements since reporting began. NLEW upgrades have allowed LAC members to more actively participate in the compilation of data and analysis of nitrogen loss trends, and the Division of Soil and Water Conservation's digital contracting system has helped optimize BMP documentation efforts.

In CY2022 Soil and Water Conservation Districts spent almost $340,000 through the Agriculture Cost Share Program in the Tar-Pamlico River Basin, and the Natural Resources Conservation

Service spent over $1,777,000 through the Environmental Quality Incentives Program in the counties with land in the Tar-Pamlico River Basin. These programs have all helped fund erosion and nutrient reducing BMPs in the Tar-Pamlico basin.

Sufficient funding for technical assistance and BMP implementation incentivization is indispensable for continued achievement and maintenance of agricultural nitrogen reduction and no additional phosphorus loss goals. Local demand for funding, to support experienced staff versed in conservation planning and cost-share program implementation in addition to supporting adoption of water-quality improving BMPs, far outstrips existing resources. In FY2023, Soil and Water Conservation Districts lying within the Tar-Pamlico Basin requested nearly three times more Agriculture Cost Share Program funding than was available for the fiscal year's allocation. Funding of state and federal cost share programs is essential for continued progress in reducing nutrient losses from agricultural land.

Over 150 farmers, local staff, and agency personnel with other responsibilities serve on the Neuse and Tar-Pamlico LACs in a voluntary capacity. Basin Oversight Committee members meet at least once per year to review and approve this annual progress report, which includes time spent outside of that annual meeting to review draft documents and approve methodology changes. Participation by so many members of the local agricultural community demonstrates a commitment toward achieving the nutrient strategy's long-term goals.

Funding is necessary for continued agricultural data collection and annual reporting. In the early years of Tar-Pamlico Agriculture Rule reporting, grant funding supported technicians and basin coordinators at Soil and Water Conservation Districts to assist with reporting requirements. At present, there is no funding for full-time Tar-Pamlico basin coordinators or technicians. The Division of Soil and Water Conservation expends approximately $90,000 on agricultural reporting staff support annually, using funds received through an EPA 319(h) grant administered by the Department of Environmental Quality. Currently, in addition to other duties, the NCDA&CS Division of Soil and Water Conservation's Nonpoint Source Planning Coordinator completes data collection, compilation and reporting duties for the Tar-Pamlico Agriculture Rule and for all other basins and watersheds subject to existing NSW Management Strategies with Agriculture Rules.

With less funding available for reporting support at the state level, responsibility for compilation of annual local progress reports falls on LACs and Soil and Water Conservation District staff. Few currently serving LAC members were active during the initial stakeholder process for the Tar-Pamlico Agriculture Rule, so some institutional knowledge about annual reporting requirements has been lost. As a result, training of new Soil and Water Conservation District staff and LAC members regarding rule requirements and reporting is necessary and ongoing.

Reductions in funding and staffing necessitate implementing a more centralized approach to agricultural data collection and verification for annual progress reports. This evolving approach may involve developing additional GIS analysis tools, streamlining FSA acreage documentation, and training LACs on how to handle changing methods. While necessary with existing funding

and staffing limitations, centralizing and automating data collection and verification may come at the expense of local knowledge. Annual agricultural reporting is required by the rules; therefore, continued funding for the Division's remaining Nonpoint Source Planning Coordinator position is essential for compliance.

The BOC will continue to review data from recent studies that may be relevant to annual progress reporting, particularly findings providing new information on nutrient loadings from land-based sources and uses. Previously, funding was available to support North Carolina-specific research on conservation practice effectiveness, realistic yields, and nitrogen use efficiencies. Due to grant eligibility changes and other funding constraints, it is unlikely that new data will be developed. Prior funding sources for such research, which provided much of the scientific information on which NLEW was based, are no longer available. Should new funding be made available, additional North Carolina-specific research information should be incorporated into future NLEW updates.

Conclusion

Significant progress has been made in agricultural nutrient loss reduction, and the agricultural community consistently reaches its collective 30% nitrogen reduction goal and no net increase in phosphorus loss goal. However, the measurable effects of these BMPs on overall in-stream nutrient reduction may take years to develop due to the nature of non-point source pollution. The BOC supports new funding for research and implementation to further improve reductions and enhance agricultural nutrient reporting, including identification of additional sources. Nitrogen reduction values presented in this annual summary of agricultural reductions reflect "edge-of-management unit" calculations that contribute to achieving the overall 30% nitrogen loss reduction goal. Significant quantities of agricultural BMPs have been installed since the adoption and implementation of the Tar-Pamlico NSW Management Strategy, and agriculture continues to fulfill its obligations toward achieving the collective goals of a 30% reduction of nitrogen and no net increase of phosphorus delivered to the Pamlico estuary.