NCDA&CS

2024 Annual Progress Report (Crop Year 2023) 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 2023

Date approved by Tar-Pamlico Basin Oversight Committee: 10/29/24
Date submitted to NC Division of Water Resources: 10/29/24


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) 2023 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 CY2023, agriculture collectively achieved an estimated 49% 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 CY2023 than in the baseline year for 6 of the 9 qualitative indicators.

Rule Requirements and Compliance History

Tar-Pamlico Nutrient Sensitive Waters (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. The Pamlico estuary is still classified as an impaired water and water quality monitoring data show the overall strategy for all regulated sectors has not yet reduced total nitrogen loading to the estuary by 30%.

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 2024 to Division of Soil and Water Conservation staff. Annual reductions were calculated using the aggregate Nitrogen Loss Estimation Worksheet (NLEW). Based on submitted data, the agricultural community in the Tar-Pamlico basin achieved a collective 49% nitrogen loss reduction in CY2023 from the 1991 baseline.

[1] The 2023 crop year began October 1st, 2022, and ended September 30th, 2023.

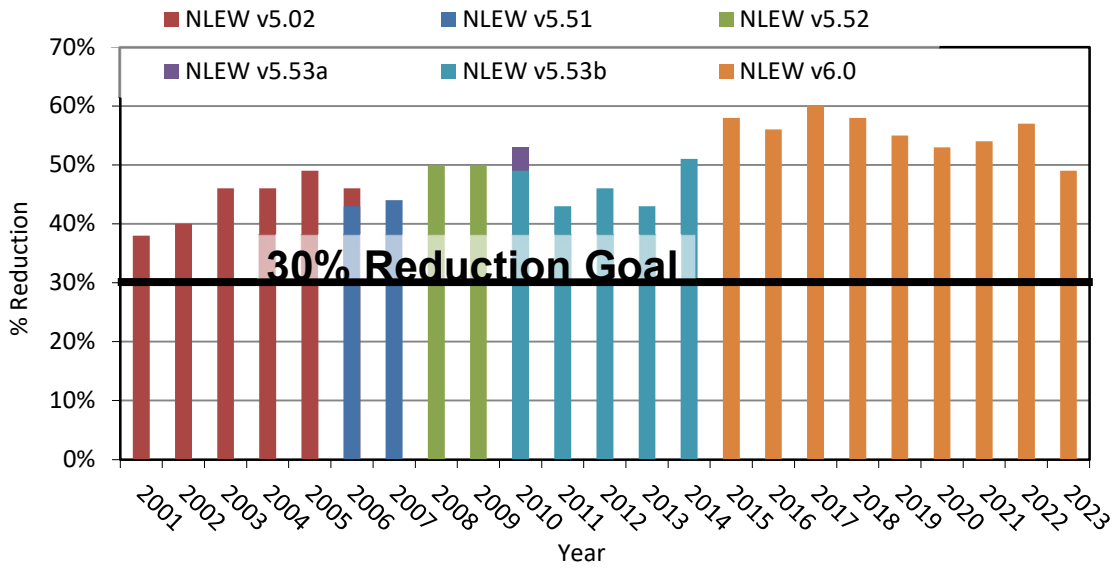
Scope of Report and Methodology

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 2023.

Figure 1: Collective Cropland Nitrogen Loss Reduction Percent 2001 to 2023, Tar Pamlico River Basin.



The first NLEW reports were run in 2001, and agriculture has continued to exceed the collective 30% nitrogen reduction goal set for the sector 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 were incorporated, and some minor calculation errors were corrected for corn and sweet potatoes. The modernized web-based NLEW software (v6.0) was updated to pull revised realistic yield and nitrogen use efficiency data from the North Carolina Realistic Yield Database[2]. 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.*

[2] The North Carolina Realistic Yield Database is the product of an extensive data gathering and review process conducted by many state and federal partners. The North Carolina Realistic Yield Database is maintained and updated by North Carolina State University.

North Carolina Interagency Nutrient Management Committee. 2014. Realistic yields and nitrogen application factors for North Carolina crops. realisticyields.ces.ncsu.edu
North Carolina State University, North Carolina Department of Agriculture and Consumer Services, North Carolina Department of Environment and Natural Resources, Natural Resources Conservation Service. Raleigh NC.

Current Status

Nitrogen Reduction from Baseline for CY2023

All fourteen LACs submitted their twenty-third annual reports to the BOC in August 2024. For the entire basin, in CY2023 agriculture achieved a 49% reduction in nitrogen loss compared to the 1991 baseline. This percentage is 8% lower than the reduction reported for CY2022. This year, twelve LACs achieved the target 30% nitrogen loss reduction goal set by the BOC. Table 2 lists each county's baseline, CY2022 and CY2023 nitrogen (lbs per year) loss values, and nitrogen loss percent reductions from the baseline in CY2022 and CY2023.

In 2024, the Division of Soil and Water Conservation was successful in requesting georeferenced Farm Service Agency cropland data for the first time in the history of annual reporting for the Tar-Pamlico Basin. Prior to receiving this new dataset, cropland data in the Tar-Pamlico Basin was approximated by multiplying publicly released FSA county-aggregated cropland data by the percentage of land in the county lying within the Tar-Pamlico Basin. Each year Local Advisory Committees, through member knowledge of farm, operator, and crop planting locations, helped to further refine and adjust county cropland acreage totals in the basin estimated according to this methodology. The new georeferenced FSA cropland dataset provides the most accurate assessment of cropland acreage in the Tar-Pamlico Basin since reporting began. The Basin Oversight Committee commends the enhanced collaboration and partnership between USDA-FSA and the NCDA&CS DSWC that made this new stage of data-sharing possible and allows for a more accurate delineation of cropland in the Tar-Pamlico Basin.

Comparing georeferenced CY2023 data to baseline totals estimated using the previous, best-available methodology at the time presents some challenges. As shown in Table 2 below, while most counties (9) in the Tar-Pamlico Basin experienced only moderate nitrogen-loss reduction changes between CY2022 and CY2023 (less than +/- 10%), a subset of counties (5) experienced more significant swings. Steep drops in county nitrogen-loss reductions were precipitated by significantly more cropland acreage reported in the Tar-Pamlico basin portions of each county than was estimated in baseline. Sharp rises in county nitrogen-loss reductions were caused by reductions of county cropland acreage reported in the Tar-Pamlico Basin. The significant nitrogen reduction shifts seen in Table 2 are not due to major agricultural management changes or new crop cultivation trends in the basin or within specific counties.

*Table 2: Estimated Reductions in Agricultural Nitrogen Loss from Baseline (1991) for CY2022 and CY2023, Tar-Pamlico River Basin**

County	Baseline N Loss (lb)*	CY2022 N Loss (lb)*	CY2022 N Reduction (%)	CY2023 N Loss (lb)*ϕ	CY2023 N Reduction (%) ϕ
Beaufort	9,178,262	4,362,739	52%	4,786,706	48%
Edgecombe	5,037,742	2,596,710	48%	2,689,834	47%
Franklin	2,183,680	600,125	73%	621,581	72%
Granville	890,371	127,055	86%	270,392	70%
Halifax	2,902,105	1,430,062	51%	1,645,045	43%
Hyde	5,501,161	2,373,708	57%	3,731,734	32%
Martin	782,152	625,645	20%	932,337	-19%
Nash	4,693,868	1,583,238	66%	1,414,272	70%
Person	153,228	111,783	27%	72,960	52%
Pitt	6,229,921	2,450,894	61%	2,170,730	65%
Vance	419,485	100,525	76%	101,499	76%
Warren	535,517	220,956	59%	260,282	51%
Washington	939,912	547,274	42%	1,295,681	-38%
Wilson	890,691	414,778	53%	428,435	52%
Total	40,338,097	17,545,492	57%	20,421,489	49%

**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.*

Φ Nitrogen loss reduction values are calculated using more accurate georeferenced cropland information from FSA that was obtained for the first time in summer 2024.

In CY2023, 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 CY2023, overall corn totals increased by 29,861 acres, soybean totals increased by 9,434 acres, and cotton totals decreased by 9,286 acres from CY2022 values. Other major commodity crops experienced moderate changes. Tobacco acres decreased by 232 acres and wheat and hay acres increased by 5,155 acres and 1,911 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 2022-2023 was generally warm (January, February) and dry (December, February); however, the month of December was distinctly cool, and January had higher than typical precipitation.[3] Overall, 2023 concluded as a year characterized by oscillations from the norm. Cooler seasons were atypically warm and warmer seasons began uncharacteristically cool. Late April precipitation brought localized

[3] Davis, C. 2023. Winter Recap 2022-23: Snow is Scarce, Blooms Come Early. Prepared by North Carolina State Climate Office for the Climate Blog, Climate Summary. https://climate.ncsu.edu/blog/2023/03/winter-recap-2022-23-snow-is-scarce-blooms-come-early/

flooding in eastern counties and a significant, extended period of drought followed in the fall (September to November). The year is among the state's top ten warmest years on record[3] and record corn yields were reported throughout the state. Factors that influence agricultural nitrogen reductions are shown in Table 3.

As is seen in Table 2, due to newly available georeferenced cropland data utilized in CY2023 reporting, Martin and Washington Counties are reporting negative nitrogen loss reductions from baseline (1991). In CY2023 Martin County reported 26,344 acres of crops, an over 5,000 acre increase from CY2022 reported crop totals and a nearly 3,500 acre increase from baseline reported crop acres. The county's overall nitrogen application rate on cropland (total nitrogen applied divided by total reported cropland – lbs N/ac) for CY2023 is 19% lower from the county's overall nitrogen application rate (lbs N/ac) in baseline. Corn and cotton fertilization rates in CY23 have not fluctuated from baseline rates. Tobacco, peanut, and soybean fertilization rates in CY23 are higher than baseline rates whereas wheat and sorghum fertilization rates decreased. Most significantly, Martin County experienced an 11% decrease in nitrogen uptake by crops in CY2023 from baseline. The overall crop nitrogen uptake estimated in baseline was 57% of the total estimated crop nitrogen needs. In CY2023, 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 CY2023 (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 CY2023 there was over an 800% 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.

In CY2023, Washington County reported 27,323 acres of crops, an 8,630 acre increase from baseline reported crop acres and a nearly 12,000 acre increase from crop acres reported in CY2022. The county's overall nitrogen application rate on cropland (total nitrogen applied divided by total reported cropland) for CY2023 is 6% lower than the county's overall nitrogen application rate in baseline. All fertilization rates for commodities in CY2023 are equal or lower than baseline rates for comparable crops. Over 3,700 acres of implemented buffer of varying widths have been recorded by Washington County since baseline. However, given reporting methodology changes for water control structures, there are over 5,000 fewer acres of agricultural drainage water management reported by Washington County in CY2023 in comparison to baseline. Consequently, Washington County is reporting less subsurface N capturing by BMPs in CY2023 than in the baseline year. Commodity increases resulting from newly utilized georeferenced cropland data without a corresponding increase in nitrogen capture by BMPs, in part due to limitations with reporting methodology and local field data on the functionality and maintenance of older water control structures, is likely the primary reason for higher total N losses in CY2023 than in baseline for Washington County. More work is

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

needed to identify reportable acres of buffer and maintained water control structures in Washington County to truly represent current field conditions and nitrogen losses from agricultural land in the county. Washington County will continue to work toward reducing nitrogen loss from agricultural land.

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 (49%).

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

Factor	CY2020	CY2021	CY2022	CY2023
BMP implementation	6%	6%	6%	4%
Fertilization Management	20%	20%	20%	17%
Cropping shift	13%	15%	18%	15%
Cropland converted to grass/trees	5%	5%	5%	5%
Cropland lost to idle land	8%	7%	7%	7%
Cropland lost to development**	1%	1%	1%	1%
TOTAL	53%	54%	57%	49%

**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 increase denitrification of agricultural drainage water and reduce surface phosphorus losses as an added benefit, but they can also control salinity and soil moisture with appropriate management. 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. Currently, funding for water control structures through federal programs is prioritized to projects also alleviating salt water intrusion concerns. Beaufort and Hyde Counties as a result are seeing more implementation of federally funded water control structure and drainage water management practices. 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 CY2013 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 843 water control structure affected acres in CY2023 from CY2022, 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 largely successful 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 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.

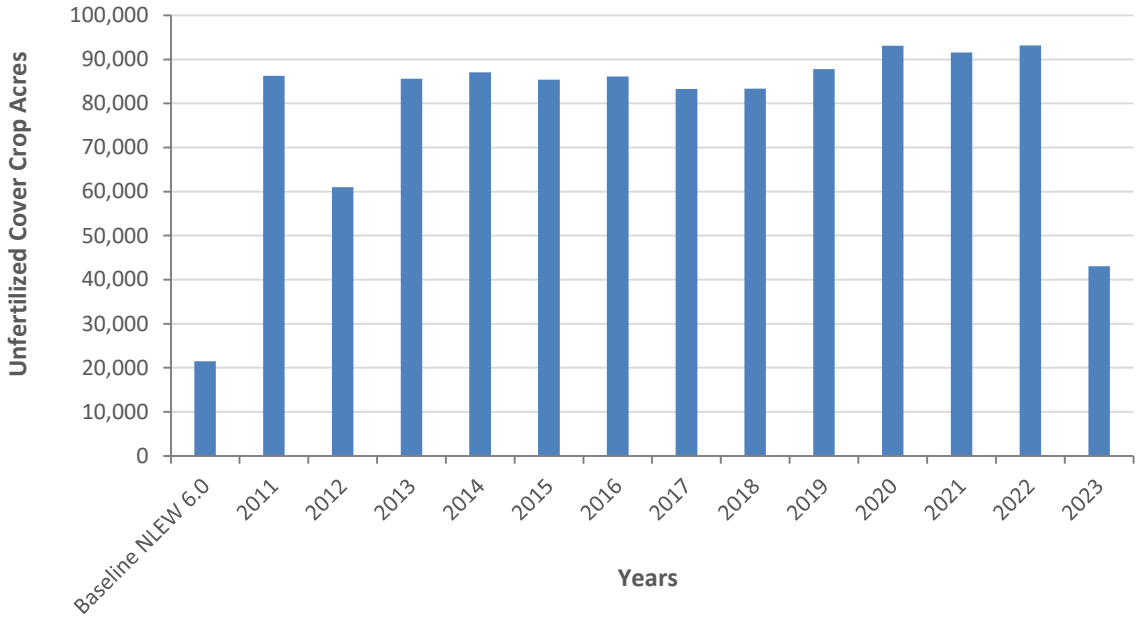
The removal of inactive contract BMP acres from annual reports has resulted in smaller nitrogen loss reductions in coastal counties, particularly Beaufort, Edgecombe, Hyde, Pitt, and Washington. It is important to note that this abrupt reduction, first seen in the CY2019 report, is primarily based on 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 CY2023, as well as the adjusted totals showing only acres affected by water control structures under active cost share contract from CY2019 to CY2023.

Figure 2: Acres Affected by Water Control Structures for Baseline (1991) and Installed from CY2011 to CY2023, 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 county data reporting 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

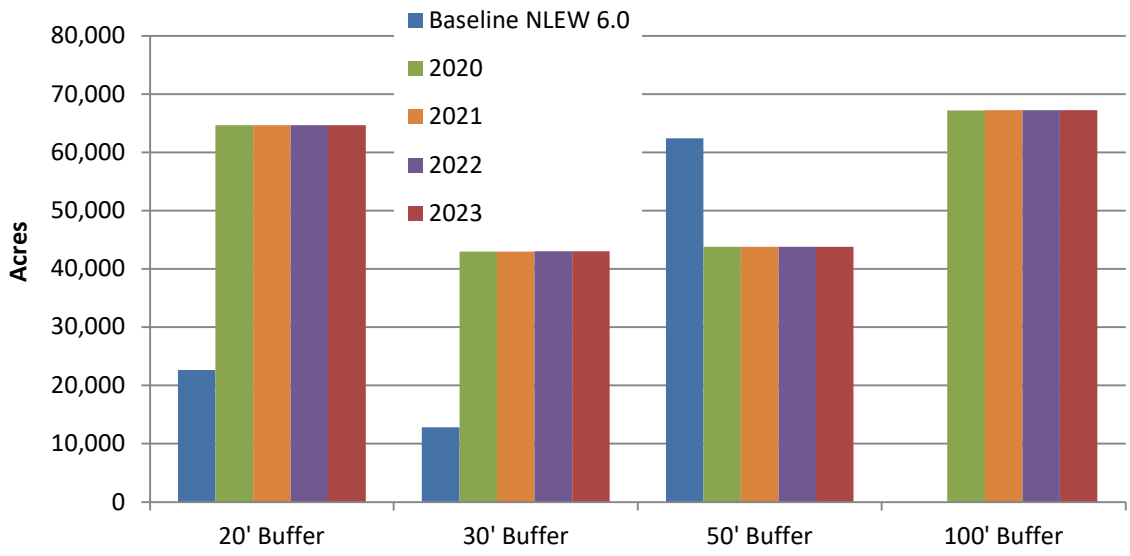
unfertilized cover crops) BMPs that were installed without cost share funding. While there is some potential for variability in the data reported, LACs include data based on local professional expertise and the best information currently available. As additional reliable data sources become available, 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, a little over 43,000 acres of unfertilized cover crops were estimated to be grown in CY2023. The drop in reported unfertilized cover crops between CY22 and CY23 was due to a cover crop reporting change for one county in the basin and is not indicative of a significant change in farmer behavior and interest in unfertilized cover crops in the basin. Unfertilized cover crop acreage reported in the Tar-Pamlico basin in CY2023 remains high and is approximately double the acreage reported in baseline (1991).

Figure 3: Unfertilized Cover Crop Acres Planted Annually on Agricultural Lands for Baseline (1991) and Installed from CY2011 through CY2023, 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 4 acres of 20-foot buffers implemented in CY2023 (Figure 4).

*Figure 4: Buffer Acres Present on Agricultural Lands for Baseline (1991) and Installed from CY2020 through CY2023, 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 (641,700 acres), more than half of all reported cropland receives some kind of NLEW reportable BMP treatment. This total largely excludes 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 CY2013 to CY2023).

Since baseline, increased implementation is evident across all BMP types. In CY2023, 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 CY2023, Tar-Pamlico River Basin**

BMP	Units	2001 – 2021	2022	2023
Diversion	Feet	441,962	441,962	442,813
Fencing (USDA Programs)	Feet	267,540	270,251	271,531
Field Border	Acres	1,325	1,325	1,330
Grassed Waterway	Acres	2,639	2,641	2,641
Livestock Exclusion	Feet	250,348	255,203	255,203
Sod Based Rotation	Acres	142,644	143,669	147,890
Tillage Management	Acres	89,271	89,823	95,550
Terraces	Feet	371,936	371,936	378,381

** 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.*

*Table 5: Nutrient-Reducing Best Management Practices installed from CY2013 to CY2023, Not Accounted for in NLEW**

BMP	Units	BMPs Installed (CY2013 – CY2023)
Diversion	Feet	17,217
Fencing (USDA Programs)	Feet	15,147
Field Border	Acres	46
Grassed Waterway	Acres	123
Livestock Exclusion	Feet	16,527
Sod Based Rotation	Acres	66,370
Tillage Management	Acres	43,365

** 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.

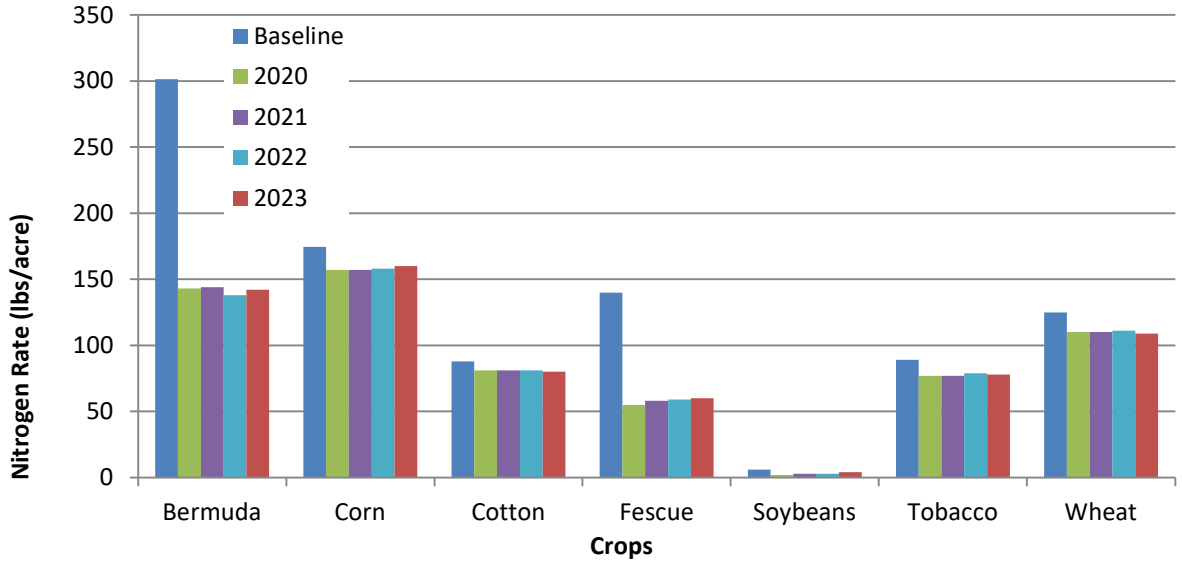
Between CY2022 and CY2023 nitrogen rates remained relatively stable (less than 5 lbs N per acre fluctuations) for all major commodity crops (bermuda, corn, cotton, fescue, soybeans, tobacco, and wheat). Most pastures are under-fertilized throughout the Tar-Pamlico basin and pasture and hayland is typically not supplemented with inorganic fertilizers. Figure 5 shows nitrogen application rates from CY2020 to CY2023.

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 2020-2023, Tar-Pamlico River Basin



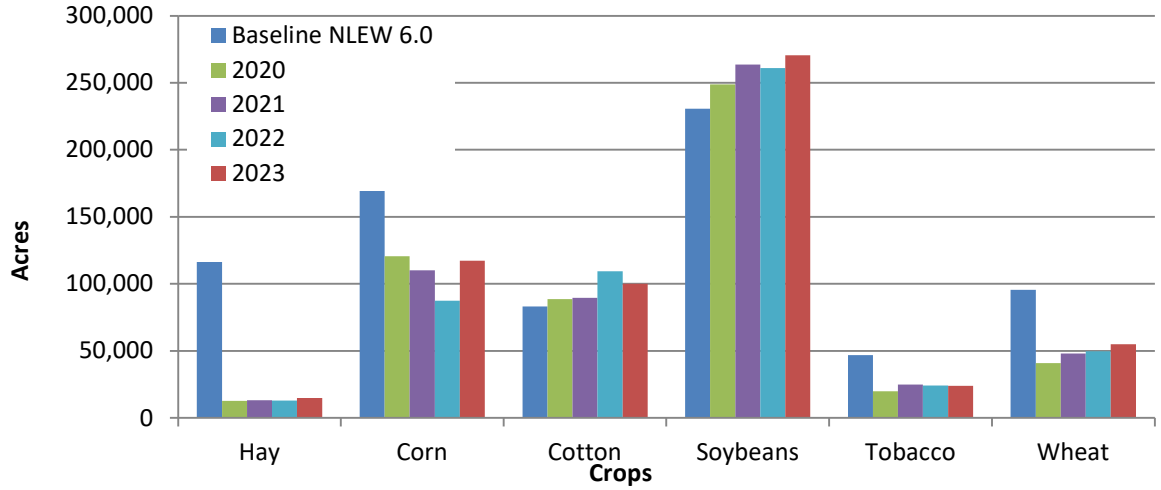
Cropping Shifts

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. In 2024, the Division of Soil and Water Conservation was successful in requesting georeferenced Farm Service Agency cropland data for the first time in the history of annual reporting for the Tar-Pamlico Basin. Georeferenced cropland data provides better field estimations of commodities grown in individual counties and within the entire Tar-Pamlico basin.

All crops require different amounts of nitrogen and assimilate 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. Beyond cropping shifts expected due to possession of better geospatial commodity data in the basin, 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 CY2022 to CY2023, corn acreage increased by 29,861 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 decreased by 9,286 acres from CY2022. Tobacco acreage slightly decreased (by 232 acres) and soybean, wheat, and hay acreage increased by 9,434 acres, 5,155 acres, and 1,911 acres respectively. Cropping shift changes contributed to the overall collective nitrogen loss increase seen between CY2022 and CY2023 in Table 2 (approximately 2.9 million lbs more of total nitrogen lost). Over 19.9 million fewer total pounds of nitrogen were lost in the Tar-Pamlico Basin in CY2023 than in baseline (1991). A host of factors from individual choice to global markets determine crop selection.

Figure 6: Acreage of Major Crops for the Baseline (1991) and 2020-2023, Tar-Pamlico River Basin



Land Use Change to Development, Idle Land and Cropland Conversion

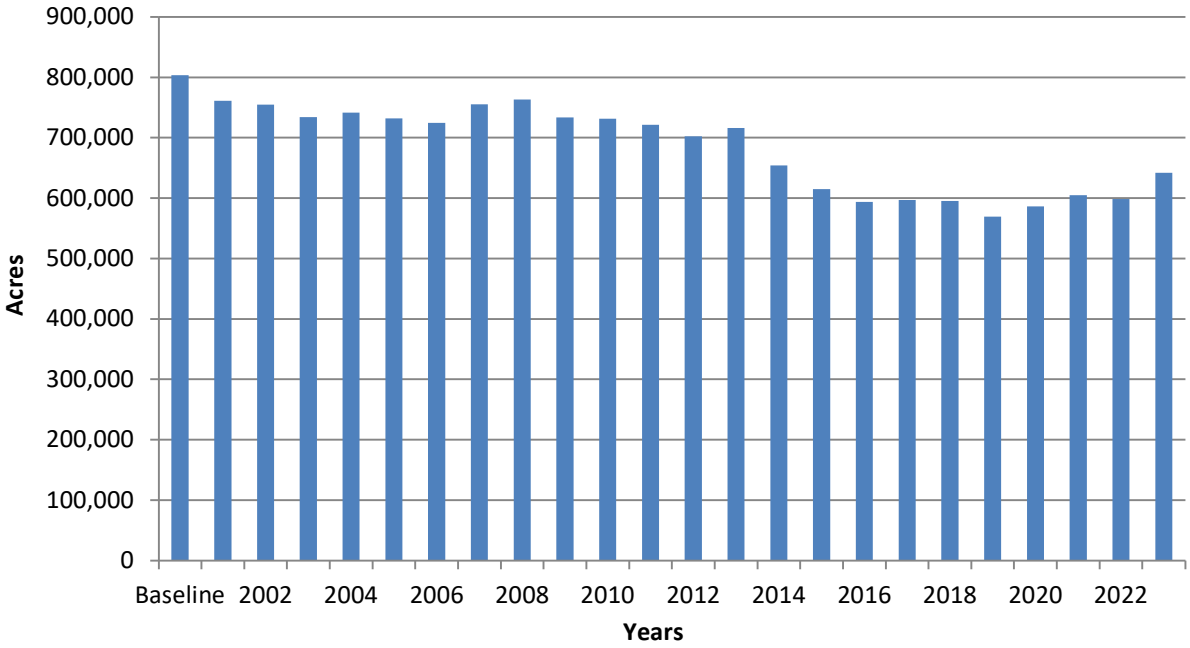
The number of cropland acres fluctuates every year in the Tar-Pamlico River Basin. Each year, some cropland is permanently lost to development. Annually, some cropland is converted to grass or trees and is likely to be ultimately lost from agricultural production. Idle land is agricultural land that 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, 47,986 acres are estimated to have been converted to grass or trees in the Tar-Pamlico Basin since the 1991 baseline. In CY2023, there were 65,147 idle acres reported and a total of 641,700 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 georeferenced annual report data. Cropland acres have continued to decrease from the baseline period. Reported crop acres increased by 43,516 acres between CY2022 and CY2023 (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 collected by LACs for inclusion in 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 NCSEA 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 – 2023**



**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 CY2023: 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 tool, aggregate NLEW, 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 CY2020 through CY2023. 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. The Committee 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 land use and management practices 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. From a fertility perspective, the CY2023 soil test phosphorus median number is considered high.

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	CY2020	CY2021	CY2022	CY2023	1991 – 2023 Change	CY2023 P Loss Risk +/-
Agricultural land (annual)	Acres	FSA	803,451ϕ	585,994	604,561	598,184	641,700	-20%	-
Cropland conversion (to grass & trees) (cumulative)	Acres	USDA-NRCS & NCACSP	660	47,516	47,681	47,903	47,986	7,171%	-
CRP / WRP (cumulative)	Acres	USDA-NRCS	19,241	41,833	41,833	41,833	42,092	119%	-
Conservation Tillage* (cumulative)	Acres	USDA-NRCS & NCACSP	41,415	87,693**	89,271**	89,823	95,550	131%	-
Vegetated buffers (cumulative)	Acres	USDA-NRCS & NCACSP	97,810 ϕ	218,584	218,603	218,643	218,647	124%	-
Water control structures (cumulative/ active contract)	Acres Affected	USDA-NRCS & NCACSP	52,966 ϕ	(94,819)/ 11,975	(95,457)/11,015	(96,395)/7,640	(97,153)/6,797	-87%	+/-***
Unfertilized cover crop (annual)	Acres	LAC, USDA-NRCS & NCACSP	21,522 ϕ	93,085	91,569	93,133	43,090	100%	-
Animal waste P (annual)	lbs of P per yr	NC Ag Statistics	13,374,238 ϕ	16,709,882**	16,876,130**	16,083,876**	15,908,438	19%	+
Soil test P median (annual)	P Index	NCDA&CS	83	91	84	84	88	6%	+

** 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 2022 Ag Census, conservation tillage (including no-till) was practiced on 425,138 crop acres in the Tar-Pamlico Basin (HUC 030201), which is approximately 60% of the total cropland reported in the Tar-Pamlico Basin in the 2022 census.*[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, 2022 Census of Agriculture, Census by Watershed Region 03 (HUC 030201). Available at: https://www.nass.usda.gov/Publications/AgCensus/2022/Online_Resources/Watersheds/watershed_Region03.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 CY2023 there was an approximately 9% increase in annual broiler production in the Tar-Pamlico Basin from 1993/1994. CY2023 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 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. Total number of layers in CY23 is approximately 20% less than the average layer totals between 2008 – 2012. 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 CY2023 Soil and Water Conservation Districts spent almost $423,000 through the Agriculture Cost Share Program in the Tar-Pamlico River Basin, and the Natural Resources Conservation Service spent over $1,686,000 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 FY2025, 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. Due to grant eligibility changes and other funding constraints, new data can only be developed intermittently. Prior funding sources for such research, which provided much of the scientific information on which NLEW was based, are no longer available. As new funding is made available, additional North Carolina-specific research information will be considered for incorporation into future NLEW updates. The NLEW software (v6.0) is currently configured to pull revised realistic yield and nitrogen use efficiency data from the North Carolina Realistic Yield Database, which is intermittently updated when new research comes available.

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.