

NCDA&CS

2025 Annual Progress Report (Crop Year 2024) 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 2024

Date approved by Tar-Pamlico Basin Oversight Committee: 10/31/25
Date submitted to NC Division of Water Resources: 10/31/25

Tar-Pamlico River Basin



Summary

The Tar-Pamlico Basin Oversight Committee (BOC) received and approved crop year¹ (CY) 2024 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 CY2024, agriculture collectively achieved an estimated 52% 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 CY2024 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 (NSW) Management Strategy 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. 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 52% nitrogen loss reduction in CY2024 from the 1991 baseline.

¹ The 2024 crop year began October 1st, 2023, and ended September 30th, 2024.

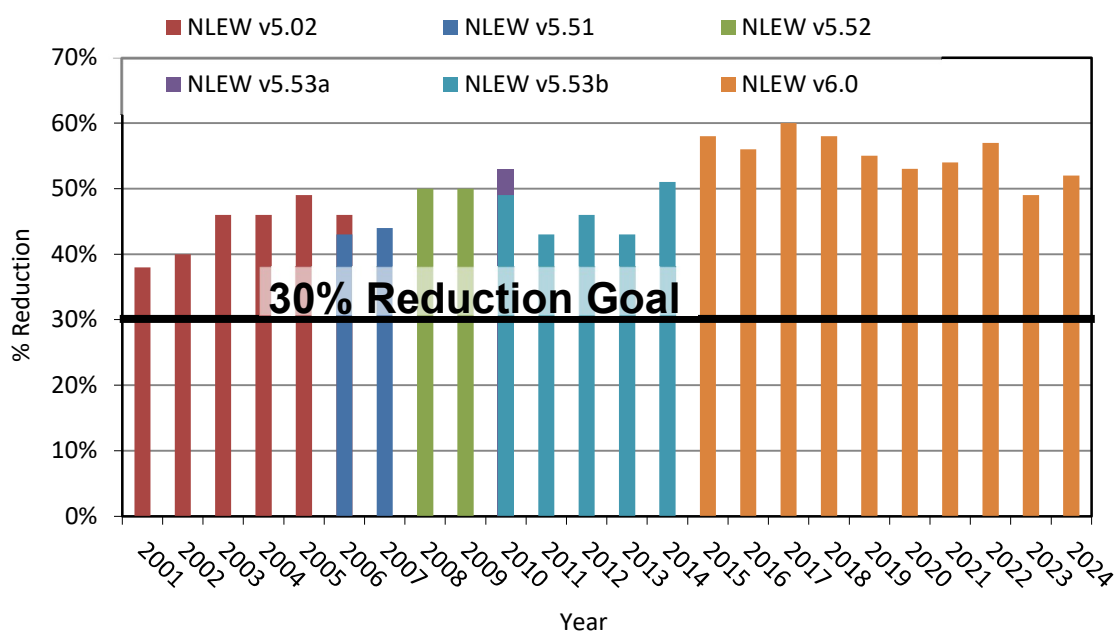
Scope of Report and Methodology

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. The 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 Nitrogen 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 2024.

Figure 1: Collective Cropland Nitrogen Loss Reduction Percent 2001 to 2024, 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 Database². 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)	30%	20%
	75% (trees & shrubs)		
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.

Current Status

Nitrogen Reduction from Baseline for CY2024

All fourteen LACs submitted their twenty-fourth annual reports to the BOC in August 2025. For the entire basin, in CY2024 agriculture achieved a 52% reduction in nitrogen loss compared to the 1991 baseline. This percentage is 3% higher than the reduction reported for CY2023. This year, twelve LACs achieved the target 30% nitrogen loss reduction goal set by the BOC. Table 2 lists each county's baseline, CY2023 and CY2024 nitrogen (lbs per year) loss values, and nitrogen loss percent reductions from the baseline in CY2023 and CY2024.

*Table 2: Estimated Reductions in Agricultural Nitrogen Loss from Baseline (1991) for CY2023 and CY2024, Tar-Pamlico River Basin**

County	Baseline N Loss (lb) *	CY2023 N Loss (lb)* Φ	CY2023 N Reduction (%) Φ	CY2024 N Loss (lb)* Φ	CY2024 N Reduction (%) Φ
Beaufort	9,178,262	4,786,706	48%	4,474,281	51%
Edgecombe	5,037,742	2,689,834	47%	2,482,224	51%
Franklin†	2,183,680	621,581	72%	628,797	71%
Granville	890,371	270,392	70%	213,955	76%
Halifax	2,902,105	1,645,045	43%	1,667,723	43%
Hyde	5,501,161	3,731,734	32%	3,583,733	35%
Martin	782,152	932,337	-19%	958,938	-23%
Nash	4,693,868	1,414,272	70%	1,335,621	72%
Person	153,228	72,960	52%	60,811	60%
Pitt	6,229,921	2,170,730	65%	2,192,248	65%
Vance†	419,485	101,499	76%	82,308	80%
Warren†	535,517	260,282	51%	245,199	54%
Washington	939,912	1,295,681	-38%	1,146,885	-22%
Wilson	890,691	428,435	52%	458,198	49%
Total	40,338,097	20,421,489	49%	19,530,920	52%

* 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 started to be incorporated in annual reporting in CY2023. Georeferenced cropland information was not available in the baseline period.

† Buffer acreage was recalculated in CY2024 piloting a new spatial analysis tool to improve nitrogen loss reduction estimation.

The Division of Soil and Water Conservation continues to use georeferenced Farm Service Agency cropland data. Georeferenced FSA cropland data was first incorporated into annual reporting for the CY2023 report and provides the most accurate assessment of cropland acreage in the Tar-Pamlico Basin. However, comparing georeferenced CY2023 and CY2024 data to baseline totals estimated using the previous best-available methodology is not

straightforward, as differences in methodology and underlying assumptions can complicate the evaluation. As shown in Table 2, all counties in the Tar-Pamlico Basin experienced only moderate nitrogen-loss reduction changes between CY2023 and CY2024 (less than +/- 10%) apart from Washington County. Washington County experienced a larger swing, likely due to a different mix of crops and additional BMP acres reported in CY2024 in comparison to CY2023.

For CY2024, a new spatial analysis tool was piloted to recalculate riparian buffers at 20-, 30-, 50-, and 100-foot or greater widths for georeferenced Farm Service Agency (FSA) cropland data in three counties—Franklin, Vance, and Warren. The buffer recalculation was conducted in CY2024 as an initial step toward addressing cumulative inaccuracies that arose from cropland loss and other land use changes over time. These three Upper Tar-Pamlico counties collectively reported approximately 50% fewer NLEW-reportable cropland acres in CY2024 compared to baseline conditions. The Basin Oversight Committee (BOC) and technical experts will need to further evaluate the tool’s performance to determine its technical strengths and limitations, as well as its applicability to other portions of the Tar-Pamlico Basin with different hydrological regimes.

In CY2024, nitrogen loss reductions were achieved through a combination of fertilization rate decreases, cropping shifts, BMP implementation, and cropland acreage fluctuation. Factors that influence agricultural nitrogen reductions are shown in Table 3. 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 (52%).

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

Factor	CY2021	CY2022	CY2023	CY2024
BMP implementation †	6%	6%	4%	3%
Fertilization Management	20%	20%	17%	20%
Cropping shift	15%	18%	15%	16%
Cropland converted to grass/trees	5%	5%	5%	5%
Cropland lost to idle land	7%	7%	7%	7%
Cropland lost to development**	1%	1%	1%	1%
TOTAL	54%	57%	49%	52%

*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.

† Buffer acreage was recalculated in three counties in CY2024 piloting a new spatial analysis tool to improve nitrogen loss reduction estimation.

Some of the cropping shift impacts shown in Table 3 can be attributed to the need for regular rotations on agricultural operations. The double-crop planting of wheat and soybeans is usually followed by a corn crop, to minimize the threat of disease. Fluctuations within the corn,

soybean, and wheat rotation are to be expected annually even in the face of similar weather conditions. In CY2024, corn and wheat experienced the largest acreage reductions from CY2023 levels, decreasing by 7,865 and 14,091 acres, respectively. Cotton and tobacco saw moderate increases of 5,896 and 1,404 acres, while soybean acreage declined by 4,774 acres. Hay (fescue and bermuda) showed the smallest change, with fluctuations of less than 1,000 acres.

Fluctuating weather conditions strongly influence annual cropping patterns by affecting farmers' ability to prepare fields for planting and harvest as well as overall crop health and yield. North Carolina entered CY2024 under abnormally dry to moderate drought conditions; however, the onset of the El Niño pattern brought a shift to warm and wet conditions from December to February.³ Warm weather prevailed through the rest of CY2024, which included the first freeze-free March for Wilson since 1945. By June, sustained hot and dry conditions catalyzed drought conditions that devastated corn production in much of eastern North Carolina. In the fall, Tropical Storm Debby brought heavy rainfall and flooding to many counties in the Tar-Pamlico Basin. Two highly destructive storms followed —Tropical Cyclone Eight and Hurricane Helene— which caused severe, unprecedented damage to regions of North Carolina outside the Tar-Pamlico Basin.⁴ Overall, 2024 concluded as a year marked by weather extremes – intense periods of dryness and wetness that deviated significantly from the norm – and has been described by many as the worst crop year in North Carolina's history.

The Tar-Pamlico Agriculture Rule (15A NCAC 02B .0732) sets a basinwide collective target of reducing nitrogen losses from agricultural land by 30% relative to baseline conditions. To support progress toward achieving this basinwide mandate, the BOC has set corresponding 30% nitrogen reduction goals for each LAC, encouraging all counties to contribute toward the collective reduction effort. However, BOC-set targets are aspirational, and the Committee acknowledges that some LACs may not be able to meet a 30% nitrogen loss reduction in a given crop year. As is seen in Table 2, due to incorporation of georeferenced cropland data for CY2024 reporting, Martin and Washington Counties are reporting negative nitrogen loss reductions from baseline (1991). In CY2024 Martin County reported 25,647 acres of crops, a 2,741 acre increase from baseline crop acres. The county's overall nitrogen application rate on cropland (total nitrogen applied divided by total reported cropland – lbs N/ac) for CY2024 is 17% lower from the county's overall nitrogen application rate (lbs N/ac) in baseline. Since baseline, wheat fertilization rates have dropped by 30 lbs N/ac and corn, cotton, and tobacco fertilization rates have remained stable. However, changes in the fertilization rates for soybeans and peanuts in the county over the past few years are a significant factor contributing to the county's lowered N reduction achievements in CY2023 and CY2024. Martin is currently reporting full season soybean fertilization at 25 lbs N/ac and peanut fertilization at 30 lbs N/ac,

³ Davis, C. (2024, March 18). *Winter recap 2023–24: Rain returns, but snow stays away*. North Carolina State Climate Office. <https://climate.ncsu.edu/blog/2024/03/winter-recap-2023-24-rain-returns-but-snow-stays-away/>

⁴ Davis, C., & Dello, K. (2025, January 21). *The weather year in review: Heat, Helene, and weather whiplash in 2024*. North Carolina State Climate Office. <https://climate.ncsu.edu/blog/2025/01/the-weather-year-in-review-heat-helene-and-weather-whiplash-in-2024/>

which is applied at planting to boost early growth. Both crops did not receive any fertilization in baseline. Additionally, it is important to recognize that due to the crop mix grown, Martin County has not experienced a significant difference in nitrogen uptake by crops in CY2024 from baseline. Crucially, significant BMP installation has occurred in Martin County since baseline. In CY2024 there was an over 900% 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 continues to work toward reducing nitrogen loss from agricultural land.

In CY2024, Washington County reported 26,434 acres of crops, a 7,741 acre increase from baseline reported crop acres. The county's overall nitrogen application rate on cropland (total nitrogen applied divided by total reported cropland) for CY2024 is 15% lower than the county's overall nitrogen application rate in baseline. All fertilization rates for commodities in CY2024 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 4,500 fewer acres of agricultural drainage water management reported by Washington County in CY2024 in comparison to baseline. Consequently, Washington County is reporting less subsurface nitrogen captured by BMPs in CY2024 than in the baseline year. The NLEW-reportable crop increase resulting from newly utilized georeferenced cropland data, without a corresponding increase in nitrogen capture by BMPs, significantly contributes to higher total nitrogen losses in CY2024 compared to baseline in Washington County. This discrepancy is partly due to limitations with reporting methodology and local field data on the functionality and maintenance of older water control structures. More work is 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 continues to work toward reducing nitrogen loss from agricultural land.

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 28,000 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 saltwater 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, which includes District staff performing

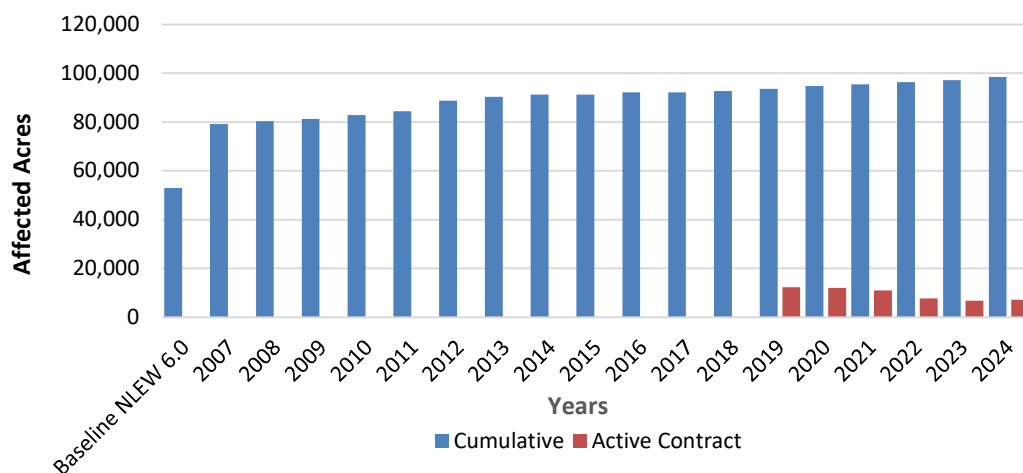
spot checks annually on active state contracts according to program policy (at least 5% of all contracts in addition to certain BMPs requiring yearly checks). Verification of functionality and appropriate management requires site visits to individual farm owners who may or may not have this BMP under 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 and quantity benefits.

All acres affected by water control structures reported in CY2014 were manually removed from each county's total in this report to ensure that all affected acres currently being reported are for only active contracts with operation and maintenance agreements. There was a 379 affected-acre increase in "active contract" water control structures between CY2023 and CY2024, 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 a smaller nitrogen loss reduction in coastal counties (primarily Beaufort, Edgecombe, Hyde, Pitt, and Washington) since the change in water control structure accounting methodology. 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

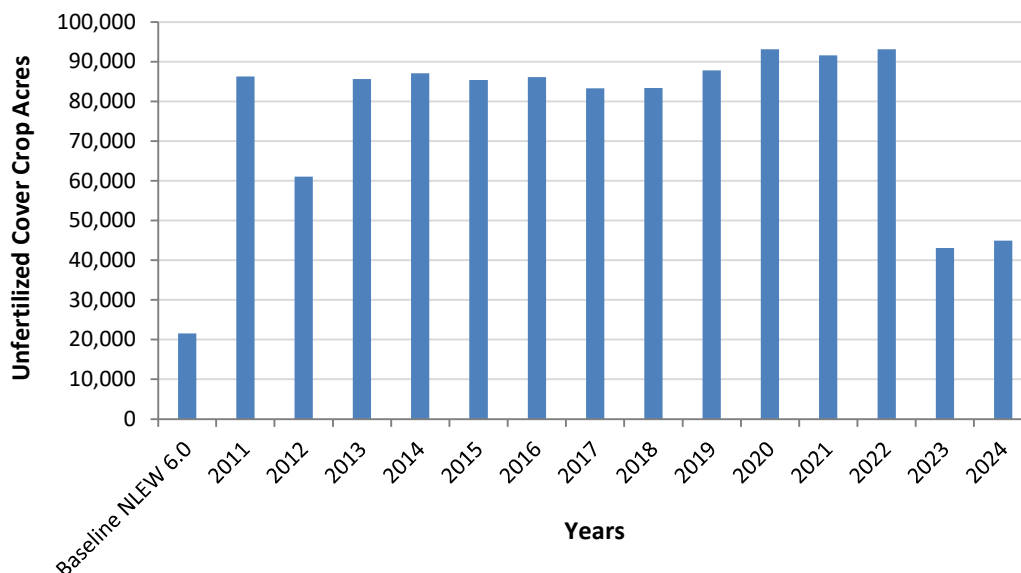
affected by water control structures since baseline from CY2011 to CY2024, as well as the adjusted totals showing only acres affected by water control structures under active cost share contract from CY2019 to CY2024.

Figure 2: Acres Affected by Water Control Structures for Baseline (1991) and Installed from CY2011 to CY2024, 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, almost 45,000 acres of unfertilized cover crops were estimated to be grown in CY2024. Unfertilized cover crop acreage reported in the Tar-Pamlico basin in CY2024 is approximately double the acreage reported in baseline (1991). The drop in reported unfertilized cover crops between CY2022 and CY2023 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.

Figure 3: Unfertilized Cover Crop Acres Planted Annually on Agricultural Lands for Baseline (1991) and Installed from CY2011 through CY2024, 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.

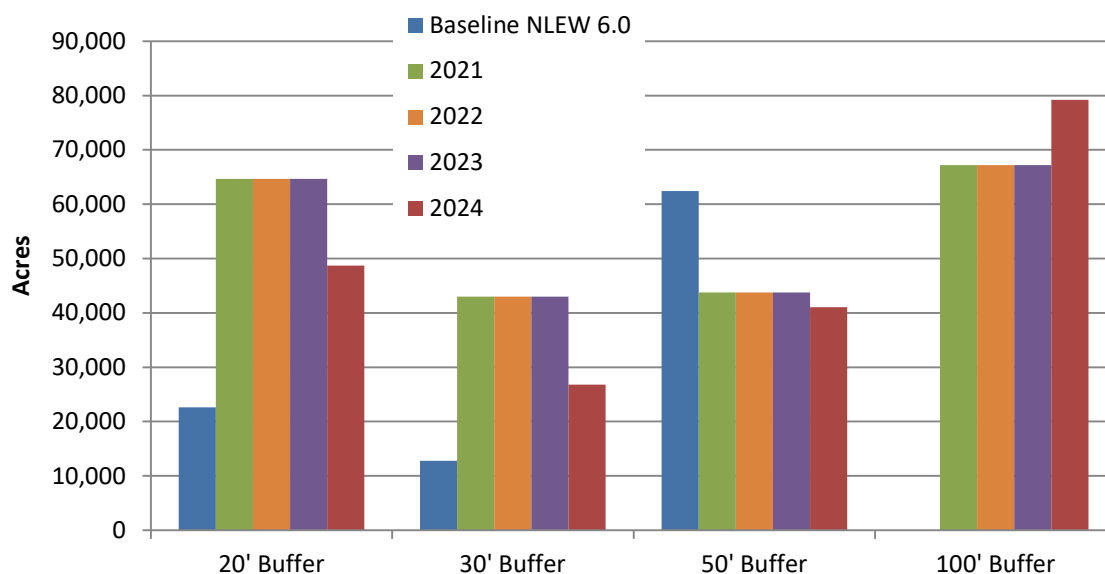
For CY2024, a new spatial analysis tool was piloted to recalculate riparian buffers at 20-, 30-, 50-, and 100-foot or greater widths for georeferenced Farm Service Agency (FSA) cropland data in three counties—Franklin, Vance, and Warren. This pilot aimed to begin addressing cumulative discrepancies in buffer data resulting from cropland loss and land use changes over time. The three counties where buffer recalculation was conducted in CY2024 collectively reported approximately 50% fewer NLEW-reportable cropland acres in CY2024 compared to baseline. Moving forward, the BOC and technical experts will further review the accuracy and practicality of the new buffer-calculation spatial tool to determine its advantages, limitations, and potential suitability for application in other regions of the Tar-Pamlico Basin with different watershed and surface water flow dynamics.

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 (623,717 acres), more than half of all reported cropland receives some kind of nitrogen-reducing BMP treatment that is reportable through NLEW. 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 acres of buffer shown in Figure 4.⁵

The changes in buffer acres seen in Figure 4 between CY2023 and CY2024 are due to buffer recalculation activities that were piloted in three counties in the Upper Tar-Pamlico Basin. Decreases in buffer acreage between CY2023 and CY2024 do not reflect the physical removal of buffers, but rather indicate that previously buffered agricultural land has transitioned to other land uses. It is important to emphasize that these reductions result from a methodological update and do not represent changes in farmer behavior or losses of BMPs on active agricultural land.

Figure 4: Buffer Acres Present on Agricultural Lands for Baseline (1991) and Installed from CY2021 through CY2024, 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

† Buffer acreage was recalculated in CY2024 piloting a new spatial analysis tool to improve nitrogen loss reduction estimation in three counties in the Upper Tar-Pamlico Basin.

⁵ Bruton, J. G. (2005). Headwater catchments: Estimating surface drainage extent across North Carolina and correlations between landuse, near stream, and water quality indicators in the Piedmont physiographic region (Doctoral dissertation). North Carolina State University. <https://repository.lib.ncsu.edu/items/05a5b48e-2d1a-4736-80a1-6a78351123d2>

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 CY2014 to CY2024).

Since baseline, increased implementation is evident across all BMP types. In CY2024, 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 CY2024, Tar-Pamlico River Basin**

BMP	Units	2001 – 2022	2023	2024
Diversion	Feet	441,962	442,813	445,613
Fencing (USDA Programs)	Feet	270,251	271,531	271,531
Field Border	Acres	1,325	1,330	1,331
Grassed Waterway	Acres	2,641	2,641	2,649
Livestock Exclusion	Feet	255,203	255,203	260,264
Sod Based Rotation	Acres	143,669	147,890	150,974
Tillage Management	Acres	89,823	95,550	97,109
Terraces	Feet	371,936	378,381	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 CY2014 to CY2024, Not Accounted for in NLEW**

BMP	Units	BMPs Installed (CY2014 – CY2024)
Diversion	Feet	16,917
Fencing (USDA Programs)	Feet	15,147
Field Border	Acres	43
Grassed Waterway	Acres	125
Livestock Exclusion	Feet	21,588
Sod Based Rotation	Acres	69,314
Tillage Management	Acres	44,681

* 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.

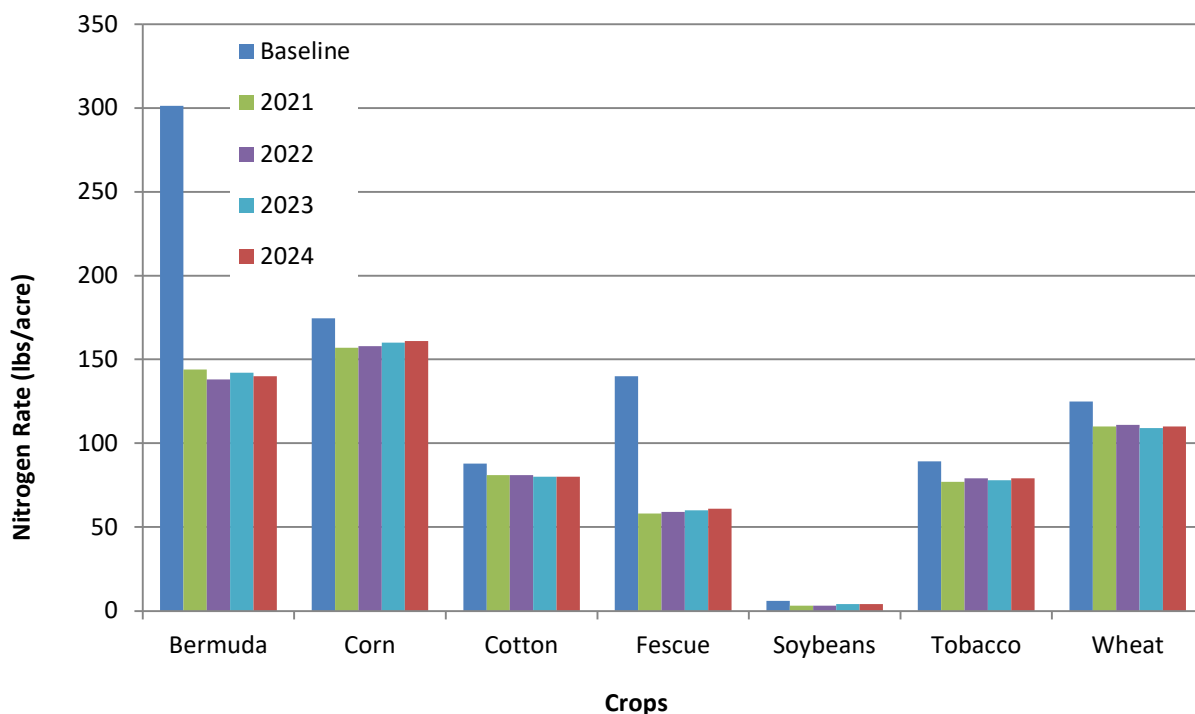
Between CY2023 and CY2024 nitrogen rates remained relatively stable (less than 5 lbs N per acre fluctuations) for all major commodity crops (bermuda, corn, cotton, fescue, soybeans, tobacco, and wheat). Most pastures are under-fertilized throughout the Tar-Pamlico basin and pasture and hayland is typically not supplemented with inorganic fertilizers. Figure 5 shows nitrogen application rates from CY2021 to CY2024.

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 2021-2024, Tar-Pamlico River Basin



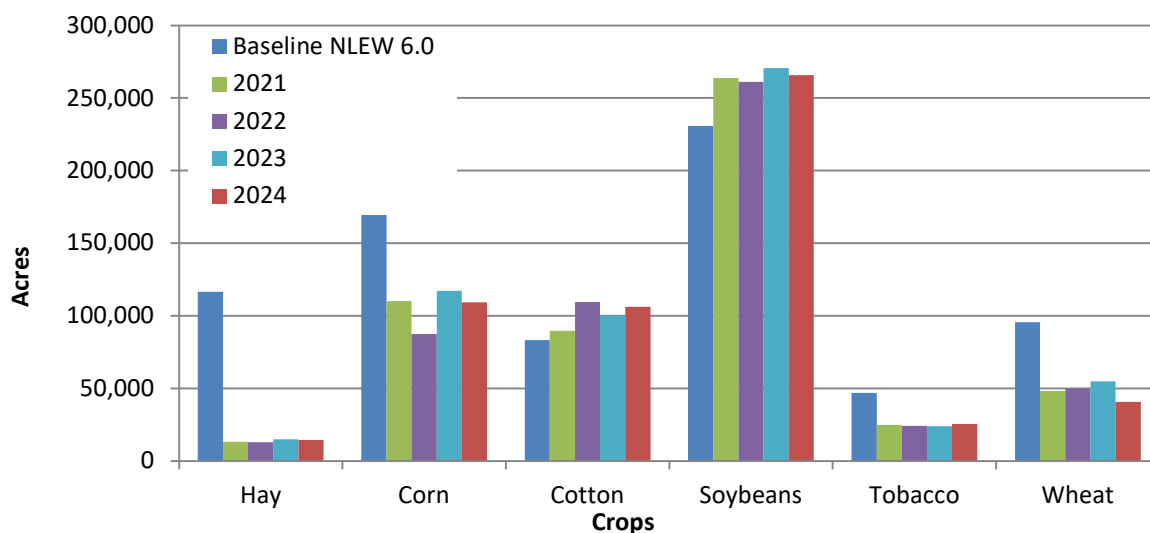
Cropping Shifts

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. For CY2023 reporting, 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 and has continued to be used for CY2024 reporting.

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 utilization 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. A host of factors from individual choice to global markets determine crop selection.

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 CY2023 to CY2024, corn acreage decreased by 7,865 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. Wheat acres decreased by over 14,000 acres from CY2023. Hay acreage in the basin experienced slight changes (+727 acres for fescue and -283 acres for bermuda) and soybean, cotton, and tobacco commodities experienced moderate changes by -4,774 acres, +5,896 acres, and +1,404 acres respectively. Cropping shift changes contributed to the overall collective nitrogen loss decrease seen between CY2023 and CY2024 in Table 2 (approximately 900,000 fewer pounds of total nitrogen lost). Over 20.8 million fewer pounds of nitrogen were lost in the Tar-Pamlico Basin in CY2024 than in baseline (1991).

Figure 6: Acreage of Major Crops for the Baseline (1991) and 2021-2024, Tar-Pamlico River Basin



Land Use Change to Development, Idle Land and Cropland Conversion

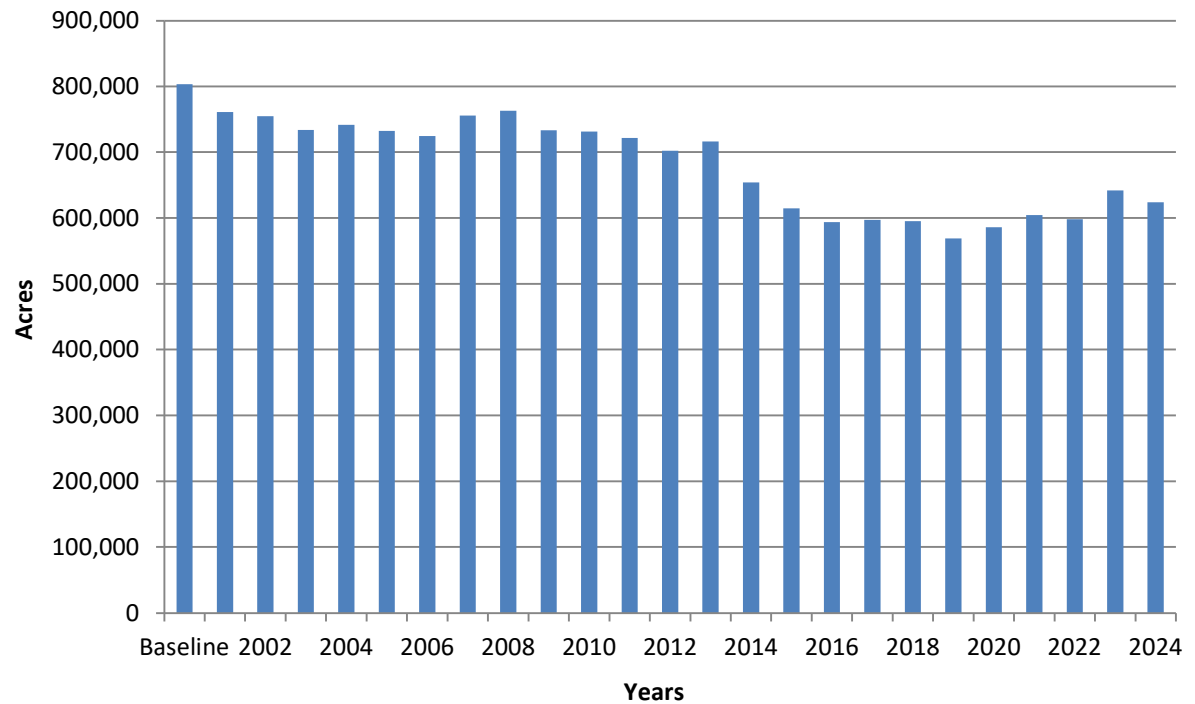
The number of cropland acres fluctuates every year in the Tar-Pamlico River Basin. Each year, some cropland is permanently lost to development. Annually, some cropland is converted to grass or trees and is likely to be ultimately lost from agricultural production. Idle land is agricultural land that is currently out of production but could be brought back into production at any time. As of CY2015, it is estimated that almost 13,000 acres have been permanently lost to development in the basin since baseline. 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, 47,998 acres are estimated to have been converted to grass or trees in the Tar-Pamlico Basin since the 1991 baseline. In CY2024, there were 68,932 idle acres reported and a total of 623,717 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 decreased by 17,983 acres between CY2023 and CY2024 (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 monitored and collected 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). *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 – 2024*



**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 CY2024: 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 CY2021 through CY2024. 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 about continued management of structures after contract termination. 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 CY2024 soil test phosphorus median number is considered high. A soil test phosphorus designation of high indicates that no additional phosphorus needs to be added by some farmers.

Based on reduced phosphorus loss risk for 6 out of 9 qualitative indicators, 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	CY2021	CY2022	CY2023	CY2024	1991 – 2024 Change	CY2024 P Loss Risk +/-
Agricultural land (annual)	Acres	FSA	803,451φ	604,561	598,184	641,700	623,717	-22%	-
Cropland conversion (to grass & trees) (cumulative)	Acres	USDA-NRCS & NCACSP	660	47,681	47,903	47,986	47,998	7,172%	-
CRP / WRP (cumulative)	Acres	USDA-NRCS	19,241	41,833	41,833	42,092	42,230	119%	-
Conservation Tillage* (cumulative)	Acres	USDA-NRCS & NCACSP	41,415	89,271**	89,823	95,550	97,109	134%	-
Vegetated buffers (cumulative)	Acres	USDA-NRCS & NCACSP	97,810 φ	218,603	218,643	218,647	218,654	124%	-
Water control structures (cumulative/ active contract)	Acres Affected	USDA-NRCS & NCACSP	52,966 φ	(95,457)/11,015	(96,395)/7,640	(97,153)/6,797	(98,416)/7,176	-86%	+/-***
Unfertilized cover crop (annual)	Acres	LAC, USDA-NRCS & NCACSP	21,522 φ	91,569	93,133	43,090	44,884	109%	-
Animal waste P (annual)	lbs of P per yr	NC Ag Statistics	13,374,238 φ	16,876,130**	16,083,876**	15,908,438	15,691,854	17%	+
Soil test P median (annual)	P Index	NCDA&CS	83	84	84	88	89	7%	+

* 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 U.S. Department of Agriculture, National Agricultural Statistics Service. (2024, July 24). 2022 Census of Agriculture: Watershed Region 03 (South Atlantic-Gulf). 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 and maintenance that provides lasting reduction in nitrogen loss in the basin.

The BOC has noted and is monitoring an increase in poultry in some areas of the state. According to Agricultural Statistics data, in CY2024 there was an approximately 7% increase in annual broiler production in the Tar-Pamlico Basin from 1993/1994. The CY2024 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 relatively stable, with decreases in total inventory seen since 2008. Recent increases in layer hen inventory since CY2019 are predominantly attributable to inventory changes at the Rose Acre Farms facility. Total number of layers in the basin in CY2024 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.

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)

Funding

Ongoing agriculture 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 CY2024 Soil and Water Conservation Districts spent over \$442,000 through the Agriculture Cost Share Program in the Tar-Pamlico River Basin, and the Natural Resources Conservation Service spent over \$3.1 million 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 FY2026, 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 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 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 comes 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 periodically 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.