



Stagnant Waters

Despite Two Decades of Bay Cleanup Efforts, No Improvement
for Phosphorus Pollution on MD Eastern Shore



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ACKNOWLEDGEMENTS

This report was researched and written by Keene Kelderman of the Environmental Integrity Project with maps by Louisa Markow and editing from Courtney Bernhardt, Ari Phillips, and Tom Pelton.

THE ENVIRONMENTAL INTEGRITY PROJECT

The Environmental Integrity Project (<http://www.environmentalintegrity.org>) is a nonpartisan, nonprofit organization established in March of 2002 by former EPA enforcement attorneys to advocate for effective enforcement of environmental laws. EIP has three goals: 1) to provide objective analyses of how the failure to enforce or implement environmental laws increases pollution and affects public health; 2) to hold federal and state agencies, as well as individual corporations, accountable for failing to enforce or comply with environmental laws; and 3) to help local communities obtain the protection of environmental laws.

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PHOTO CREDITS:

Images: Cover photo of the Pocomoke River by Tom Pelton of the Environmental Integrity Project. Choptank River, Tom Pelton. Pocomoke River, Tom Pelton. Pocomoke with Chicken House, Tom Pelton. Poultry farm, Shutterstock.

Stagnant Waters:

Despite Two Decades of Bay Cleanup Efforts, No Improvement for Phosphorus on Maryland's Eastern Shore

In 2010, following the failure of two previous Chesapeake Bay cleanup agreements, the U.S. Environmental Protection Agency and the Bay region states agreed to a new cleanup plan that was supposed to be a game-changer. This new plan, called the Chesapeake Bay Total Maximum Daily Load, or Bay TMDL, for the first time imposed numeric limits on the amount of nutrient pollution allowed into the Bay from each state and threatened penalties for states that did not achieve the targets.¹ The states were required, by 2025, to implement plans that would result in reductions in phosphorus and nitrogen pollution by about 25 percent compared to 2009.

On the Eastern Shore of Maryland, an analysis of state water quality monitoring data shows that levels of phosphorus and algae fed by this pollutant remained stuck at high levels with no improvement between 2010 and 2020, and some backsliding.²³ A similar lack of improvement in phosphorus and algae levels can be seen over a longer period, 2003 to 2020, while nitrogen pollution declined slightly, according to data from 18 water quality monitoring stations in Bay tributaries.⁴

Concentrations of nitrogen, phosphorus, and summertime algae on the Eastern Shore continue to fail “healthy waters” benchmarks established by the University of Maryland Center for Environmental Sciences. Average summer concentrations of algae exceeded benchmark levels by 298 percent from 2018 to 2020, for phosphorus by 135 percent over this period, and for nitrogen by 127 percent.

The Delmarva Peninsula’s soil continues to contain high concentrations of phosphorus, a byproduct of the region’s poultry industry, which runs off into Eastern Shore rivers and creeks. The runoff of both phosphorus and nitrogen into the surrounding waterways fertilizes excessive growth of algae, which in turn can smother underwater grasses and cause low-oxygen “dead zones.” Scientists estimate the prevalence of these algal blooms by measuring concentrations of a pigment called chlorophyll-a that is produced by algae and plants.



Most Eastern Shore rivers, including the Choptank (shown here) have seen no improvements in phosphorus pollution levels or algal blooms over the last two decades.

The long-term trends for nitrogen on the Eastern Shore have been somewhat different than those for phosphorus. While all 18 monitoring stations showed concentrations of nitrogen well above benchmarks for healthy rivers, two stations showed decreasing levels of nitrogen from 2010 to 2020, and 10 showed decreases in nitrogen from 2003 to 2020. These declines might suggest an improvement in controlling nitrogen runoff pollution from farms, some of which have been planting cover crops and incorporating other best management practices to reduce runoff. However, a 2016 study by a University of Maryland Center for Environmental Sciences professor concluded that the overall reduction in nitrogen pollution into the Bay is not because of changes in agricultural practices, but because of steep national declines in nitrogen oxide air pollution from coal-fired power plants and vehicles, which drifts down into the Bay.⁵ This reduction in nitrogen is good news. But it was likely driven not by the Bay TMDL but instead by 1990 amendments to the Clean Air Act signed by President George H.W. Bush, as well as by a national shift from coal to cheaper natural gas, wind, and solar power.⁶ The reduction in nitrogen air pollution was also helped by the Obama Administration's tightening of fuel-efficiency and emissions standards for cars and trucks.



The Pocomoke River, shown here, has experienced reductions in nitrogen pollution over the last two decades, but not in phosphorus or that algae that is fed by nutrients.

The results of EIP's analysis of trends in Eastern Shore water quality monitoring data echo the findings of the University of Maryland Center for Environmental Science (UMCES). According to UMCES annual report cards of the health of the Bay region, the overall health of the Eastern Shore's rivers has declined over the last two decades, falling from an average of 42 out of 100 in the years 1998-2000 to 36 out of 100 in the years 2018-2020.⁷ More broadly, the Chesapeake Bay's overall health has not improved from an average of 46 out of 100 in 1998-2000 to 45 out of 100 in 2018-2020, according to

the UMCES data. Nitrogen pollution levels in both the Bay and in Eastern Shore waterways improved over these two decades, according to UMCES, but progress on phosphorus lagged and algal blooms worsened in both the Bay and on the Eastern Shore.⁸ A recent assessment by scientists working with the EPA-led Chesapeake Bay Program concluded that there has been a slight improvement in the Bay over the last four decades – mostly during the 1980s and 1990s, when many sewage plants were upgraded – but that the improvement has been much slower than expected.⁹ At the current pace, it will take 180 years for the Bay to meet water quality standards, according to the scientists, Peter Tango of the U.S. Geological Survey and Qian Zhang of UMCES.

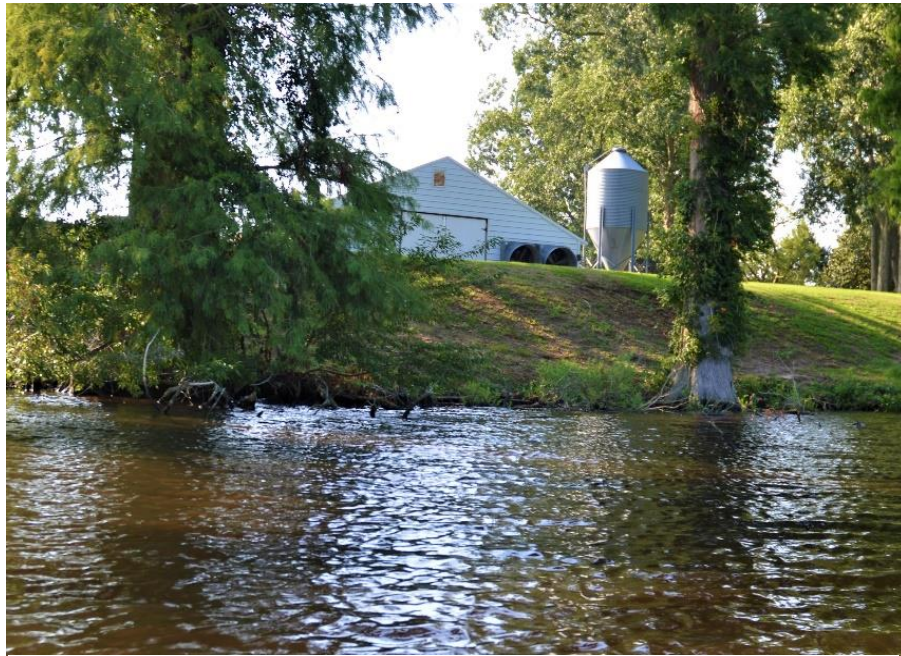
Managing farm runoff is critically important because agriculture is the largest single source of pollution in the estuary.¹⁰ The agricultural sector contributes about 42 percent of nitrogen and 55 percent of phosphorus entering the Bay, according to the EPA's Chesapeake Bay Program.¹¹ For the Eastern Shore, it is likely higher, as farms dominate the landscape and there are comparatively few and smaller wastewater treatment plants. Practices like the over-application of poultry manure to cropland lead to runoff pollution that feeds algal blooms and low-oxygen "dead zones." Historical over-application of manure and fertilizer have created a buildup of nutrients in the soil that will take years or decades to remediate. These problems include nitrate contamination of groundwater that is used as a drinking water supply on the Eastern Shore.

New regulations restricting the overapplication of poultry manure to farm fields in Maryland – called the Phosphorus Management Tool or PMT – took full effect on July 1, 2021. These rules could potentially drive down phosphorus pollution runoff into the Eastern Shore Rivers over time, if farmers comply with them.¹² To make sure that the state's phosphorus regulations are effective, the Maryland Department of Agriculture (MDA) and Maryland Department of the Environment (MDE) will need to step up their oversight of farms to reduce overapplication of poultry litter and other fertilizers. (See EIP's report, "[Blind Eye to Big Chicken](#): Frequent Violations but Few Penalties for Maryland's Poultry Industry.")¹³ While these phosphorus regulations are a step in the right direction, they do little to reduce the overwhelming amount of poultry manure still generated every year on the Eastern Shore. And the state's regulations are not enough to shift farmers toward more sustainable agricultural practices.

This report, which is based on an analysis of Maryland Department of Natural Resources water quality monitoring data and other reports and public records, makes the following recommendations:

- 1) Both the Bay region states and EPA need to more vigorously implement the Bay TMDL and more strongly enforce environmental laws that are designed to reduce phosphorus and nitrogen pollution. The emphasis should be on real results in the water, not merely plans on paper.
- 2) More monitoring, including of phosphorus and dissolved oxygen in Eastern Shore waterways, is needed to act as a reality check against claims of progress often made by the farm lobby.
- 3) The excessive amounts of poultry manure, laden with phosphorus, being produced by the broiler industry should not just be trucked from one part of the Eastern Shore to another, as is often promoted as a solution today. The poultry companies – not the farmers -- should take responsibility for responsibly disposing of excess manure or exporting it outside of the Bay watershed.
- 4) Both the federal government and states need to increase public funding and support for farmers on the Eastern Shore to help them transition to more sustainable agriculture. Maryland should use a combination of financial incentives and regulations to encourage a shift away from the large-scale, monoculture agriculture and toward smaller family farms that incorporate more trees and best management practices to reduce runoff pollution.

Although the waters of Maryland's Eastern Shore have been stagnant for decades, there is no reason that vigorous implementation of the state's new manure management regulations and the incorporation of more forested lands and other best management practices on our farms can't make our rivers run clear once again.



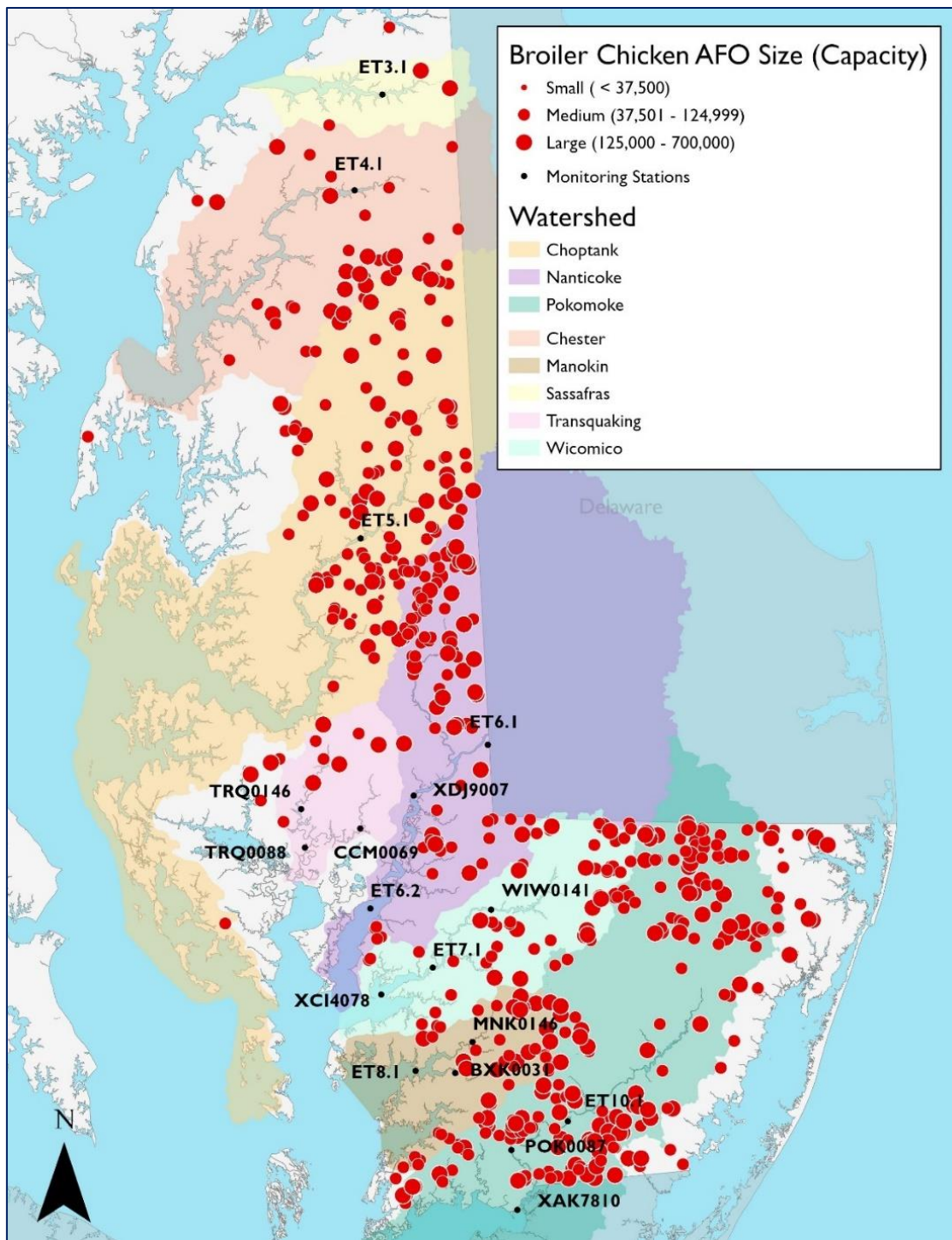
The location of industrial-scale poultry operations near waterways, like this one on the banks of the Pocomoke River, contributes to runoff pollution on the Eastern Shore.

Scope and Methods

This report examines water quality at 18 upstream locations monitored by the Maryland Department of Natural Resources in eight Eastern Shore waterways (See Map 1 on the next page). The Environmental Integrity Project (EIP) sought to determine whether concentrations of nitrogen, phosphorus, and algae (as measured by chlorophyll-a) exceeded healthy river benchmarks, and whether concentrations had improved, degraded, or stayed about the same over the past 18 years.¹⁴

The locations of the water monitoring stations in relationship to the poultry operations on Maryland's Eastern Shore can be seen in map on the following page:

Map 1: Water Monitoring Stations in Relation to Poultry Operations



EIP relied on monitoring data collected by the Maryland Department of Natural Resources (DNR), which the department makes available through the U.S. Environmental Protection Agency Chesapeake Bay Program's online Water Quality Database.¹⁵ We removed any sample results with error codes¹⁶ and averaged duplicate measurements. We compared three-year average concentrations of total phosphorus, total nitrogen, and chlorophyll-a, from 2018 to 2020, to relevant benchmark values for healthy waterways identified by the University of Maryland Center for Environmental Science (UMCES).¹⁷ These benchmark values indicate when concentrations of phosphorus, nitrogen, and chlorophyll-a are low enough to indicate "healthy waters" and vary by season and salinity. Using three-year average concentrations helps smooth annual variations from year to year. We focused on concentrations during the spring and summer because our review of the data suggested that these months had the highest concentrations and were the most consequential for algae blooms and low-oxygen areas. Seasonal averages for total phosphorus and total nitrogen include samples collected from March through September. Spring chlorophyll-a concentrations include samples from March through May, and summer concentrations were collected from July through September.

We also examined trends in seasonal concentrations of phosphorus, nitrogen, and chlorophyll-a to determine whether conditions had improved, worsened, or remained the same between 2003 and 2020, and over a shorter time-period between 2010 and 2020. We employed what is called the Mann-Kendall trend test for this analysis.¹⁸ We chose to examine trends over a longer period of time, rather than year-to-year comparisons, because year-to-year comparisons may not reflect true trends due to changes in flow, sources, and other factors. The start of our trend analysis began in 2003 because that was the year when monitoring began in upstream portions of several Eastern Shore waterways.¹⁹ Trends in this report are not flow-adjusted or flow-normalized to adjust for years with heavy or light rainfall, and they represent actual concentrations at the time of sampling.

DNR stopped monitoring at nine of the 18 stations between 2013 and 2019 and did not monitor any stations in the spring of 2020 due to the coronavirus pandemic and related shutdowns. Of the nine monitoring stations with significant data gaps, three are located on the Transquaking River (a body of water just south of the Blackwater National Wildlife Refuge), three are on the Lower Pocomoke River, and one each is on the Manokin, Nanticoke, and Wicomico rivers. Out of all five of these rivers with gaps in water monitoring, only the Transquaking River, which receives wastewater from a poultry processing plant called the Valley Proteins rendering facility in Linkwood, Md., was not sampled at all by DNR between 2014 and 2019. DNR sampled in at least one monitoring location in the other four rivers since 2003. These data gaps affect seasonal trends and benchmark comparisons for all parameters, but especially chlorophyll-a, as the most recent spring measurements of chlorophyll-a at half the stations were taken in 2013 or 2014, due to a lack of sampling by DNR in March through May of 2020 because of COVID. While this report provides a first look at what the new monitoring data from the nine stations indicate, additional data would strengthen an analysis of trends and recent conditions.

Nutrients and Algae Still Exceeding Benchmarks

EIP compared average spring and summer concentrations of total nitrogen, total phosphorus, and chlorophyll-a from 2018 to 2020 to relevant UMCES benchmarks to get a sense of current quality of water on these tributaries. For total nitrogen, the average concentrations exceeded the UMCES benchmark at all 18 of the monitoring stations. The benchmark was exceeded by an average of 41 percent along the Lower Pocomoke, 112 percent on the Manokin, 151 percent on the Nanticoke, 120 percent on the Sassafras, 217 percent on the Transquaking, 153 percent on the Upper Chester, 170 percent on the Upper Choptank, and by 114 percent on the Wicomico River. The highest exceedance, of 402 percent, occurred on the Transquaking River, at monitoring station TRQ0146. (See Table 2 on next page.)



The excessive amounts of poultry manure, laden with phosphorus, being produced by the broiler industry should not just be trucked from one part of the Eastern Shore to another, as is often promoted as a solution today.

The average concentrations of phosphorus exceeded the UMCES benchmark at all but one of the 18 monitoring stations. The benchmark was exceeded by an average of 109 percent along the Lower Pocomoke, 225 percent on the Manokin, 64 percent on the Nanticoke, 71 on the Sassafras, 287 percent on the Transquaking, 100 percent on the Upper Chester, 114 percent on the Upper Choptank, and by 67 percent on the Wicomico River. The highest exceedance rate, of 600 percent, occurred on the Transquaking, at monitoring station TRQ0146.

Summer concentrations of chlorophyll-a exceeded the benchmark at all but three of the 18 monitoring stations. At locations with elevated levels of chlorophyll-a, concentrations exceeded the benchmark by at least 48 percent, and as high as 1,793 percent. For the three stations that fell below the benchmark, concentrations were between ten and 81 percent lower. Just like with total nitrogen and total phosphorus, the highest exceedance of the benchmark occurred on the Transquaking, at monitoring station TRQ0146, with average concentrations exceeding by 1,793 percent.

As for spring concentrations of chlorophyll-a, due to the data gaps at nine of the stations explained earlier, we were only able to calculate average concentrations for the remaining nine stations without data gaps. For these nine stations, the three-year average concentrations were calculated using data from 2017 to 2019, since COVID prevented any spring monitoring in 2020, also mentioned earlier. One-third of these locations had chlorophyll-a levels below the benchmark, while the other two-thirds had levels above it. For the two-thirds with elevated levels, the benchmark was exceeded by at least 56 percent,

with the max exceedance of 744 percent calculated for the WIW0141 station on the Wicomico.

Table 1: Percent Above or Below Benchmark Values for Healthy Waters, 2018-2020

River	Station	Total Nitrogen	Total Phosphorus	Algae, Summer**	Algae, Spring (2017-2019)**
Lower Pocomoke	BXK0031*	43%	143%	102%	N/A
	ET10.1	49%	150%	-81%	-91%
	POK0087*	42%	100%	-45%	N/A
	XAK7810*	31%	43%	118%	N/A
Manokin	ET8.1	50%	25%	48%	83%
	MNK0146*	173%	425%	217%	N/A
Nanticoke	ET6.1	206%	50%	363%	91%
	ET6.2	175%	100%	165%	92%
	XDJ9007*	73%	43%	276%	N/A
Sassafras	ET3.1	120%	71%	983%	56%
Transquaking	CCM0069*	117%	186%	508%	N/A
	TRQ0088*	132%	75%	193%	N/A
	TRQ0146*	402%	600%	1,793%	N/A
Upper Chester	ET4.1	153%	100%	-10%	-78%
Upper Choptank	ET5.1	170%	114%	65%	-55%
Wicomico	ET7.1	108%	75%	110%	78%
	WIW0141	213%	125%	479%	744%
	XCI4078*	20%	0%	73%	N/A

*The figures above are for seasonal averages from 2018 to 2020. Note: *These stations stopped monitoring in 2013 or 2014 and did not start back up again till 2020. For that reason, the average concentrations are only based on the three samples collected during the 2020 summer months. **We are using the term algae here to represent concentrations of chlorophyll-a.*

Trends from 2003 to 2020 indicate that concentrations of total phosphorus and chlorophyll-a at most Eastern Shore monitoring stations have largely remained the same. This was a very similar result to what EIP discovered back in a 2014 report on Eastern Shore water monitoring, titled “Poultry’s Phosphorus Problem.”²⁰ It worth reminding here that these trends are not comparing levels of pollutants in a pair of years -- 2003 and 2020 -- but instead are looking at trends in concentrations over the entire 18-year timeframe.

Overall, we found that spring and summer concentrations of phosphorus did not improve at 15 stations over the 18-year monitoring period, while two stations worsened, and only one station improved. The levels of chlorophyll-a during the summer months experienced no change at more than 50 percent of the water monitoring stations from 2003 to 2020. Four stations showed an increase in chlorophyll-a in the summer, with only two stations showing improvement. For total nitrogen, a fair number of water monitoring stations (seven) had

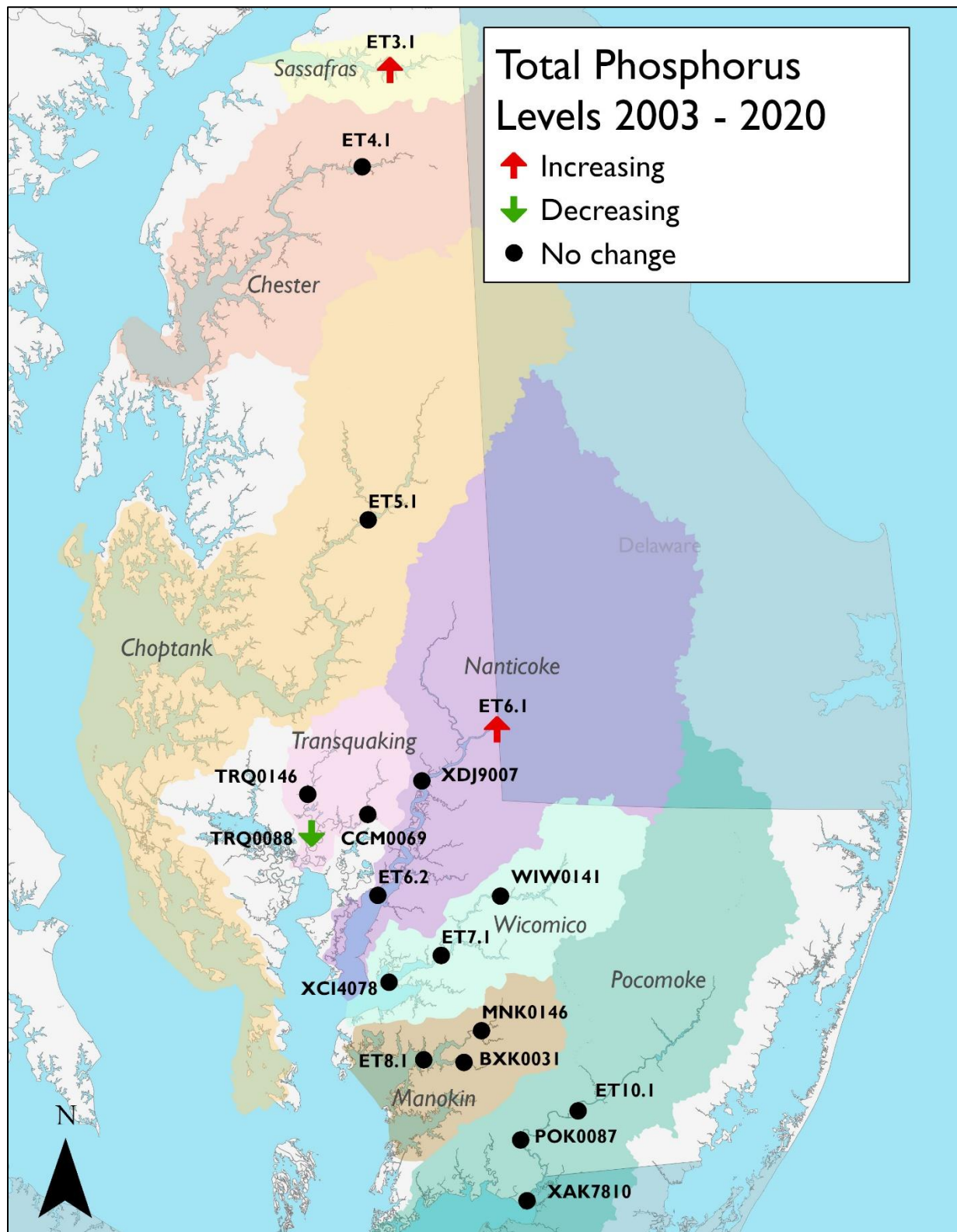
concentrations remain the same from 2003 to 2020 and one got worse. But 10 of 18 stations registered a decrease in total nitrogen concentration over this period. See the maps on the following pages trends in phosphorus, chlorophyll-a, and nitrogen on the Eastern Shore.

Table 2: Trends in Nitrogen, Phosphorus and Algae for Spring and Summer, 2003-2020

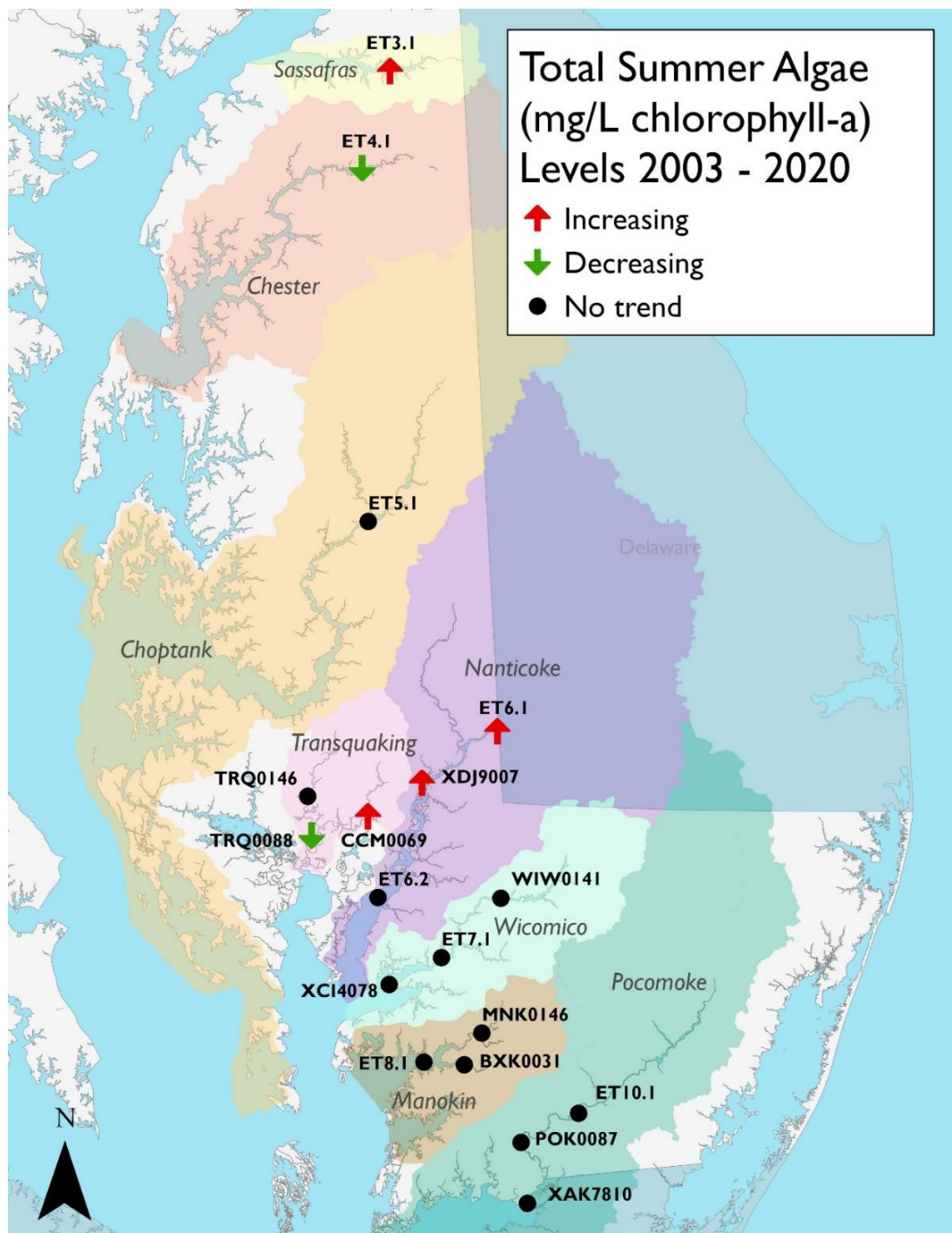
River	Station	Total Nitrogen	Total Phosphorus	Algae (Chlorophyll-a) Summer
Lower Pocomoke	BXK0031*	Better	No Change	No Change
	ET10.1	Better	No Change	No Change
	POK0087*	Better	No Change	No Change
	XAK7810*	Better	No Change	No Change
Manokin	ET8.1	Better	No Change	No Change
	MNK0146*	No Change	No Change	No Change
Nanticoke	ET6.1	Better	Worse	Worse
	ET6.2	No Change	No Change	No Change
	XDJ9007*	Better	No Change	Worse
Sassafras	ET3.1	No Change	Worse	Worse
Transquaking	CCM0069*	Worse	No Change	Worse
	TRQ0088*	Better	Better	Better
	TRQ0146*	No Change	No Change	No Change
Upper Chester	ET4.1	No Change	No Change	Better
Upper Choptank	ET5.1	No Change	No Change	No Change
Wicomico	ET7.1	No Change	No Change	No Change
	WIW0141	Better	No Change	No Change
	XCI4078*	Better	No Change	No Change

*Note: The term “algae” here means concentrations of chlorophyll-a, a pigment found in plants that is used as an indicator of algal blooms. *These stations stopped monitoring in 2013 or 2014 and did not start back up again till 2020.*

Map 2: Trends in Total Phosphorus on Eastern Shore, 2003-2020

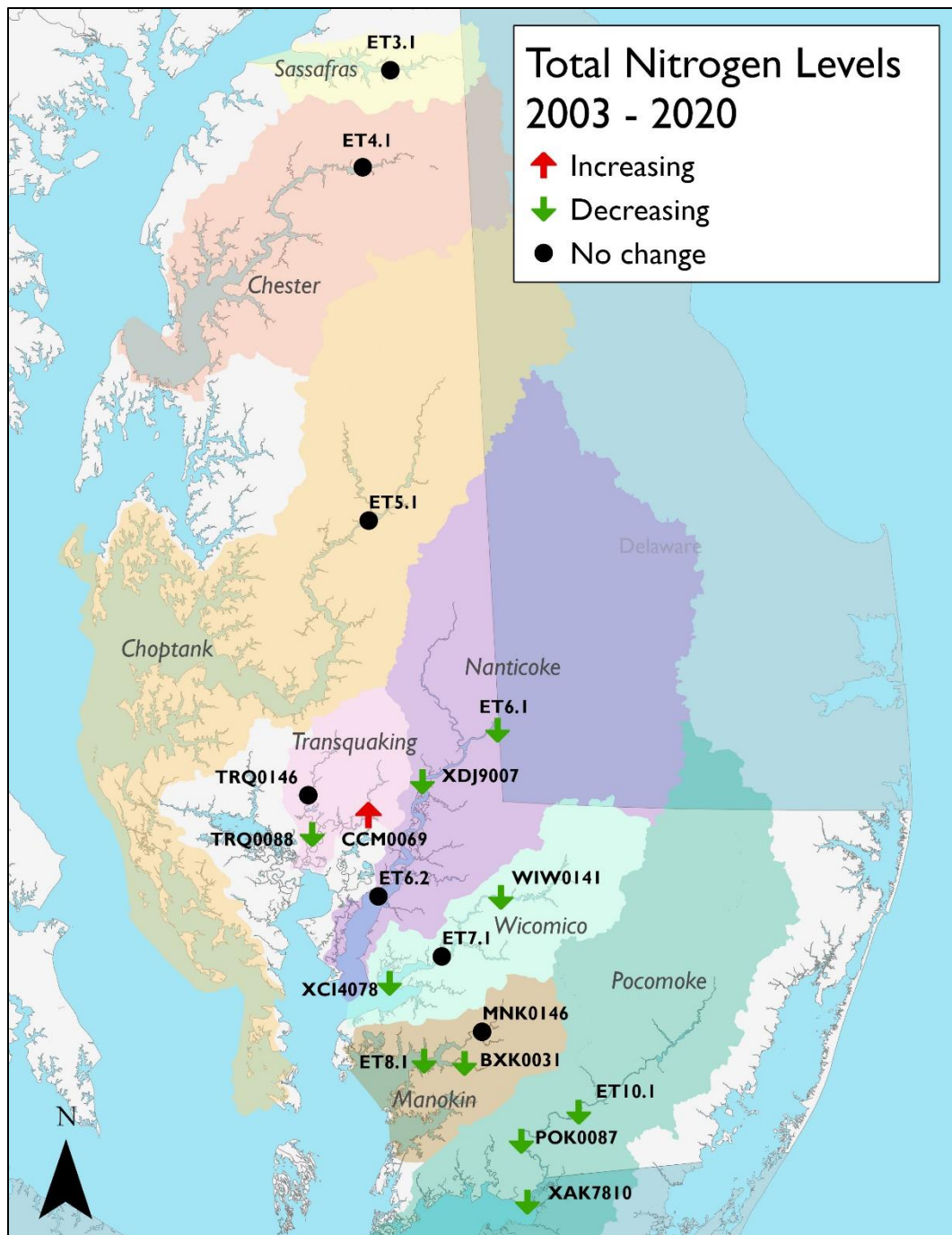


Map 3: Trends in Summer Algae Levels in Eastern Shore Waterways



(For a map showing trends in summer algae trends from 2003 to 2020, see Appendix A)

Map 4: Trends in Nitrogen in Eastern Shore Waterways



Historical Comparisons of Nitrogen Levels

Nitrogen levels declined (improved) between 2003 and 2020 at more monitoring locations on the Eastern Shore than increased. For the 10 locations that experienced a net improvement over this period, concentrations declined (improved) on average by 28 percent.²¹ However, none of the stations that experienced improvements had average concentrations that dropped below the benchmark for healthy waters. As mentioned earlier in this report, some research has suggested that declining nitrogen in the Bay over the last two decades has happened in large part because of federal regulation of air pollution from coal-fired power plants and vehicles and shifts away from coal in the energy sector.²²

Meanwhile, the average increases for phosphorus and chlorophyll-a concentrations at sites that experienced worsening trends in these areas from 2003 to 2020 were larger: 35 percent and 253 percent, respectively.²³ In other words, the sites that got worse for phosphorus and algae got much worse, while the sites that got better for nitrogen improved less. Even when we remove the stations where data was missing between 2013/2014 and 2020, the average drop in nitrogen levels was 23 percent while the average increase in phosphorus was 35 percent.

Nitrogen and phosphorus trends also vary by waterway. The areas on the Eastern Shore that have experienced worsening concentrations of nutrients over the last 20 years include the Transquaking, Nanticoke, and Sassafras rivers. The Transquaking had one station that experienced increasing concentrations for nitrogen, phosphorus, and chlorophyll-a from 2003 to 2020. The Nanticoke went from having average levels of chlorophyll-a below the benchmark for healthy waterways in 2003 to 2005 to almost five times the benchmark between 2018 and 2020.

Below is a breakdown of how many Eastern Shore waterway monitoring locations experienced improvements, worsening conditions, or no change over the last two decades.

Table 3: Water Quality Monitoring Trends for all 18 Monitoring Stations, 2003 to 2020

Parameter	Number of Stations with Decreasing Concentrations	Number of Stations with Increasing Concentrations	Number of Stations with No Observable Change in Concentrations
Algae, Spring (mg/L chlorophyll-a)*	3	6	9
Algae, Summer (mg/L chlorophyll-a)*	2	4	12
Total Nitrogen	10	1	7
Total Phosphorus	1	2	15

* We are using the term *algae* here to represent concentrations of chlorophyll-a, as chlorophyll-a is used to estimate algae levels.

Two monitoring stations, located on the Nanticoke (ET6.1) and Sassafras (ET3.1) rivers, exhibited increasing concentrations of total phosphorus during the spring and summer

months. Both of these stations have been monitored monthly by DNR since 2003. Nitrogen concentrations only increased at one location on the Transquaking River (CCM0069) during the spring and summer months.

More stations registered worsening chlorophyll-a levels during the spring months than in the summer months. The six stations with increasing trends during the spring are located on the Nanticoke (ET6.1), Sassafra (ET3.1), Transquaking (CCM0069, TRQ0088, TRQ0146), and Wicomico (WIW0141) rivers. The state stopped monitoring at all three of the locations on the Transquaking in 2013 before resuming in 2020. DNR monitored the other three locations annually from 2003 to 2020.

Only one station, CCM0069, on the Transquaking, experienced increasing concentrations for algae, phosphorus and nitrogen. There were two stations, one on the Nanticoke and the other on the Sassafra, that experienced increasing concentrations for both phosphorus and chlorophyll-a, but not nitrogen.

Trends Before and After the 2010 Bay TMDL

When looking at trends in nutrient concentrations before and after 2010, when the current Bay cleanup plan (the Bay TMDL) started, we saw more stations with worsening pollution trends from 2010 to 2020 than we saw from 2003 to 2009. Eight stations with either no trend or decreasing trends from 2003 to 2009 showed increasing (worsening) trends from 2010 to 2020 for phosphorus. For nitrogen, there were ten stations that exhibited decreasing trends from 2003 to 2009 but then showed no observable trends from 2010 to 2020.

While these trends on the Eastern Shore may give the impression that the Bay TMDL is not producing results, there are a lot of other factors to consider. For example, concentrations of phosphorus in waterways tend to track with rainfall totals, since one of the main sources of phosphorus pollution is runoff. The more rain, the more runoff of nutrients into surrounding waters.²⁴ When looking at average rainfall across the Eastern Shore, the first three years after the TMDL were years of average or less than average rainfall, 43 inches per year. In contrast, 2003, 2018, and 2020 were the three highest years of average rainfall over the last two decades, with 61, 57, and 56 inches respectively.²⁵ The reality is that that increases in runoff pollution could be due to climate change. There is also a lag time to consider with the implementation of various pollution reduction practices, with young trees planted along streams on farms, for example, not absorbing much pollution until years or decades later. It also takes time for legacy nutrients in soil or groundwater to slowly work their way out of the system.

Also important to remember is that, whether nitrogen, phosphorus or algae concentrations increased or decreased slightly over the last two decades, their overall levels on the Eastern Shore remain well above thresholds for healthy waters. As mentioned earlier, all 18 Eastern Shore monitoring stations had three-year annual average nitrogen concentrations (from 2018 to 2020) over the benchmark for healthy rivers, with an average of 126 percent over healthy levels. As for phosphorus, 17 of 18 stations had three-year annual average concentrations above the benchmark, with an average of 142 percent over.

Oxygen Levels in Rivers and Streams

EIP also examined dissolved oxygen concentrations at these same monitoring stations. Low levels of dissolved oxygen in the water can kill fish, crabs, and other forms of aquatic life. Hypoxic (low oxygen) or anoxic (no oxygen) conditions in the water are often caused by decomposing algal blooms fueled by nitrogen and phosphorous pollution. When looking at seasonal concentrations of dissolved oxygen over time, EIP found that two-thirds of monitoring stations registered no change in average dissolved oxygen levels during the summer months from 2003 to 2020. Annual Bay health reports by UMCES²⁶ support these results, as they show mostly steady levels of dissolved oxygen in the Upper and Lower Eastern Shore waterways over this period, as well as in the Choptank. However, the results are somewhat different when we examine a different metric: the percentage of samples that exceed standards for dissolved oxygen in healthy waterways²⁷ in the 2003-2005 time period, compared to 2018-2020.

Table 2: Dissolved Oxygen Concentrations Below Water Quality Standards 2003-2005 Compared to 2018-2020

Season	2003-2005 Sample Count	2003-2005 Percentage of Samples Below Standard	2018-2020 Sample Count	2018-2020 Percentage of Samples Below Standard
Spring	192	2.6%	53	0.0%
Summer	211	26.5%	107	5.6%
Fall	190	8.4%	103	3.9%
Winter	131	0.0%	104	0.0%

These results seem encouraging, because it looks like dissolved oxygen levels in these waterways have improved, especially in the summer. But the numbers don't tell the full story. All of the dissolved oxygen samples collected at these monitoring stations were gathered during the day, when oxygen concentrations tend to be at their highest. Algae and other aquatic plants photosynthesize during the day, releasing oxygen into the surrounding water. But dissolved oxygen concentrations tend to drop at night, when plants can't photosynthesize. This daily fluctuation in dissolved oxygen concentrations is revealed at continuous monitoring stations, which measure dissolved oxygen every 15 minutes, day and night. DNR operates these continuous monitors in close proximity to five of the 18 stations with daytime-only oxygen monitoring whose results are shown in the table above.²⁸ Not surprisingly, dissolved oxygen concentrations at night were far more likely to drop below the water quality standards than during the day. For that reason, the daytime-only results shown above are likely not capturing most of the worst problems with dissolved oxygen in Eastern Shore rivers.

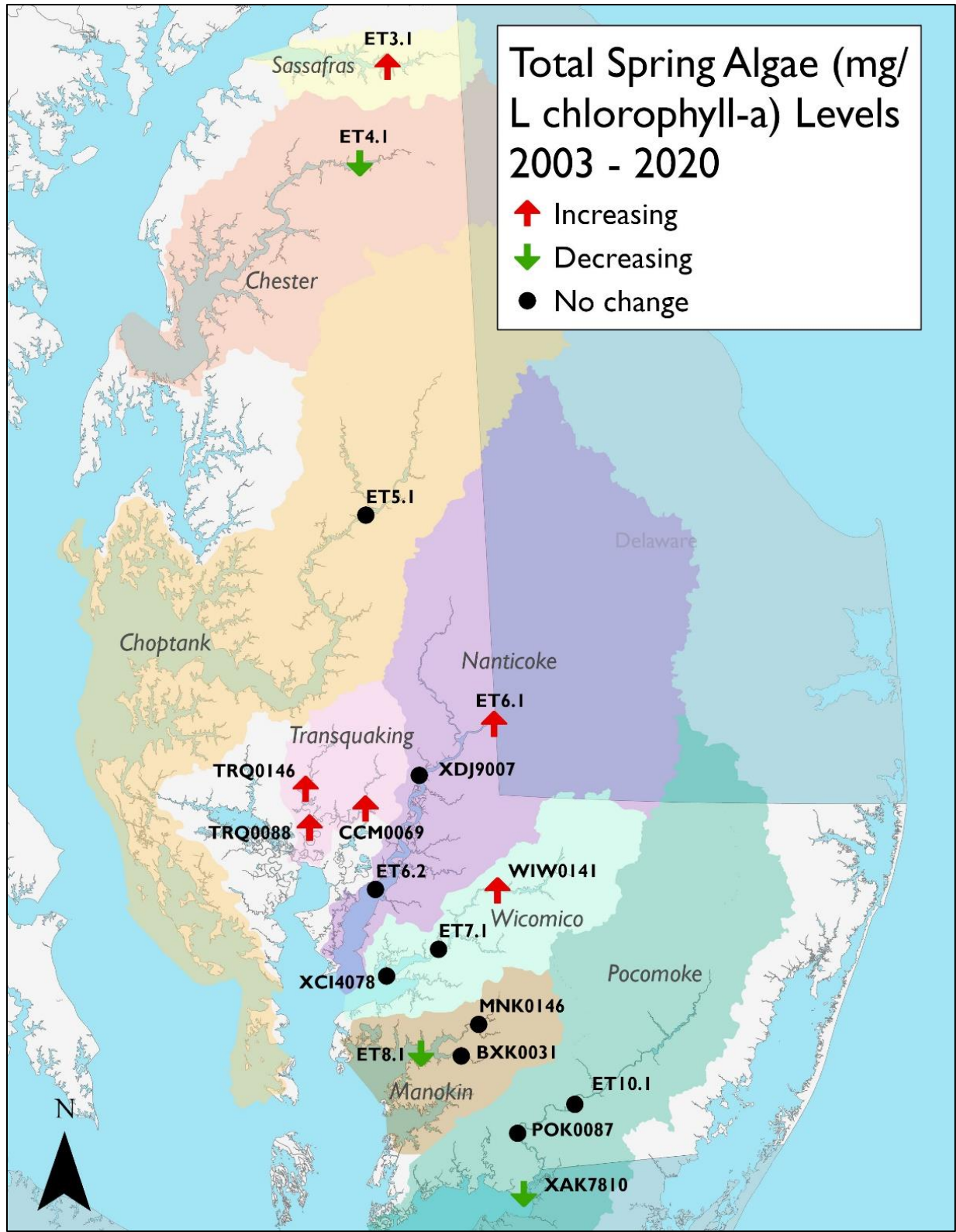
Conclusion and Recommendations

Although the Chesapeake Bay cleanup plan imposed by the EPA in 2010 was supposed to dramatically accelerate pollution reductions, water quality monitoring data on the Eastern Shore of Maryland do not show any progress in the decade since then for phosphorus pollution. This is likely because farms, which dominate the landscape and economy of the Eastern Shore, continue to over apply poultry manure, which is loaded with phosphorus, to their fields, as they have for decades. The continued runoff of this phosphorus into streams is fueling algal blooms in the Eastern Shore's rivers, which have not seen much improvement over the last two decades. One encouraging note is that nitrogen pollution levels have declined at monitoring stations in some waterways. This is an improvement that is being driven across the Chesapeake Bay watershed in part by reduced nitrogen oxygen air pollution from coal-fired power plants and vehicle emissions, according to a UMCES study.²⁹ Clearly, Maryland needs to do more to make sure that the predominant industry on the Eastern Shore – agriculture – steps up its efforts to reduce the runoff of nutrients from farm fields into local streams and rivers. This report recommends the following steps to achieve those water quality improvements:

- 1) Both the Bay region states and EPA need to more vigorously implement the Bay TMDL and more strongly enforce environmental laws that are designed to reduce phosphorus and nitrogen pollution. The emphasis should be on real results in the water, not merely plans on paper.
- 2) More monitoring, including of phosphorus and dissolved oxygen in Eastern Shore waterways, is needed to act as a reality check against claims of progress often made by the farm lobby.
- 3) The excessive amounts of poultry manure, laden with phosphorus, being produced by the broiler industry should not just be trucked from one part of the Eastern Shore to another, as is often promoted as a solution today. The poultry companies – not the farmers -- should take responsibility for responsibly disposing of excess manure or exporting it outside of the Bay watershed.
- 4) Both the federal government and states need to increase public funding and support for farmers on the Eastern Shore to help them transition to more sustainable agriculture. Maryland should use a combination of financial incentives and regulations to encourage a shift away from the large-scale, monoculture agriculture and toward smaller family farms that incorporate more trees and best management practices to reduce runoff pollution.

Although water quality in the rivers and streams of the Eastern Shore have been stagnant for a long time, Marylanders should not tolerate the status quo any longer, with a Bay cleanup deadline approaching in 2025 and the survival of the nation's largest estuary at stake.

Appendix: Trends in Spring Algae Levels, 2003-2020



End Notes:

¹ EPA, “Chesapeake Bay Total Maximum Daily Load”, available on EPA website: <https://www.epa.gov/chesapeake-bay-tmdl/chesapeake-bay-tmdl-document>

² Water quality monitoring performed by the Maryland Department of Natural Resources and compiled by the U.S. EPA Chesapeake Bay Program.

⁴ Water quality monitoring performed by the Maryland Department of Natural Resources and compiled by the U.S. EPA Chesapeake Bay Program.

⁵ Eshleman, Keith N. and Robert D. Sabo. “Declining nitrate-N yields in the Upper Potomac River Basin: What is really driving progress under the Chesapeake Bay restoration?” *Atmospheric Environment* 146, (December 2016): 280-289.

http://www.umces.edu/sites/default/files/Eshleman%20study_Atmospheric%20Environment.pdf

⁶ Ibid.

⁷ “Eco Health Report Cards”, University of Maryland Center for Environmental Science, available at: <https://ecoreportcard.org/report-cards/chesapeake-bay/bay-health/>

⁸ Ibid.

⁹ Peter Tango and Aian Zhang, “Progress toward attainment of Chesapeake Bay water-quality standards,” Chesapeake Bay Program power point presentation, October 12, 2021. Link: https://www.chesapeakebay.net/channel_files/43867/2021_wqs_attainment_20211012.pdf

¹⁰ “Agriculture,” Chesapeake Bay Program, available at:

<https://www.chesapeakebay.net/issues/agriculture#inline>

¹¹ Ibid.

¹² Jeremy Cox, “Brown Water? Dead fish? Odd smell? Blame mahogany tide,” *Bay Journal*, June 2, 2020, available at: https://www.bayjournal.com/news/fisheries/brown-water-dead-fish-odd-smell-blame-mahogany-tide/article_99eb4fd8-a11f-11ea-bc21-33df6d113174.html

¹³ Environmental Integrity Project report, “*Blind Eye to Big Chicken: Frequent Violations but Few Penalties for Maryland’s Poultry Industry*,” released October 28, 2021. Link: <https://environmentalintegrity.org/wp-content/uploads/2021/10/MD-Poultry-Enforcement-report-EMBARGOED-for-10-28-21-.pdf>

¹⁴ The methods used by the Environmental Integrity Project (EIP) in the creation of this report were similar to those used in our 2014 report “[Poultry’s Phosphorus Problem](#).”

¹⁵ CBP Water Quality Database (1984-present). Available at: <http://data.chesapeakebay.net/WaterQuality>

¹⁶ The sample results with the following problem codes were removed from the analysis: V – “Sample results rejected due to QC criteria”, A – “Laboratory accident”, X – “Sample not preserved properly.” All other problem codes were kept.

¹⁷ UMCES benchmark levels for healthy water quality.

¹⁸ For more information about this method, see D.R. Helsel and R.M. Hirsch, US Geological Survey, *Techniques of Water-Resources Investigations*, Book 4, Statistical Methods in Water Resources, Chapter 12, Trend Analysis. Available online at: <http://pubs.usgs.gov/twri/twri4a3/>. Trend calculations were carried out in Python, a free, open-source general purpose programming language.

¹⁹ See: USGS (2013) Summary of Trends and Yields Measures at the Chesapeake Bay Nontidal Network Sites: Water Year 2012 Update, available from: <http://cbrim.er.usgs.gov/trendandyieldhighlights.html>

²⁰ “Poultry’s Phosphorus Problem: Phosphorus and Algae in Eastern Shore Waterways: High Concentrations, No Improvement in Past Decade,” Environmental Integrity Project, July 14, 2014. Available at: https://environmentalintegrity.org/wp-content/uploads/2016/11/2014-07_Poultrys_Phosphorus_Problem.pdf

²¹ The smallest decrease in nitrogen levels occurred at station ET8.1, on the Manokin, where there was a nine percent decrease, resulting in a 0.09 mg/l drop in average concentrations over 18 years. The largest decrease in

nitrogen levels occurred at station XDJ9007, on the Nanticoke, where there was a 45 percent decrease, resulting in a 1.26 mg/l drop in average concentrations over 18 years.

²² Eshleman, Keith N. and Robert D. Sabo. “Declining nitrate-N yields in the Upper Potomac River Basin: What is really driving progress under the Chesapeake Bay restoration?” *Atmospheric Environment* 146, (December 2016): 280-289.

http://www.umces.edu/sites/default/files/Eshleman%20study_Atmospheric%20Environment.pdf

²³ Across all the 18 monitoring sites over this time period, phosphorus concentrations rose 8.2 percent and chlorophyll-a rose 65 percent.

²⁴ We should also consider the data gap experienced by half the stations. There was a large amount of data from 2003-2009, but far less data available for many sites from 2010-2020. Trends were found at sites with and without data gaps, so we are confident in the analysis.

²⁵ Using NOAA’s Climate at a Glance tool (<https://www.ncdc.noaa.gov/cag/>), annual rainfall was collected for each county on the Eastern Shore where the monitoring stations are located and then averaged them together.

²⁶ “Eco Health Report Cards”, University of Maryland Center for Environmental Science, available at:

<https://ecoreportcard.org/report-cards/chesapeake-bay/bay-health/>

²⁷ Maryland Department of Environment (MDE) has several [dissolved oxygen standards](#) depending on the class and use of a particular body of water. For this particular project, the stations examined were either Class I or Class II: Open-water Fish and Shellfish, so the relevant dissolved oxygen criteria were used.

²⁸ Maryland’s Department of Natural Resources (DNR) operates a continuous monitoring station located on the Wicomico River that reports on water quality conditions, like pH, dissolved oxygen, temperature, and chlorophyll-a every 15 minutes. Similar stations can be found here:

<http://eyesonthebay.dnr.maryland.gov/contmon/ContMon.cfm>

²⁹ Keith N. Eshleman and Robert D. Sabo, “Declining nitrate-N yields in the Upper Potomac River Basin: What is

really driving progress under the Chesapeake Bay restoration?” *Atmospheric Environment*, 2016. Link:

http://www.umces.edu/sites/default/files/Eshleman%20study_Atmospheric%20Environment.pdf