Non-tidal long-term monitoring program trends results through 2023

The Maryland Department of Natural Resources regularly monitors non-tidal waters at 51 long-term stations (https://eyesonthebay.dnr.maryland.gov/eyesonthebay/documents/MDNR106draftQAPP_2020_2021.pdf). Hi storically, 53 sites have been sampled; however, station POT1472 was not sampled in 2021 or 2022 because of a land dispute that shut down the ferry and was discontinued officially in 2022. Likewise, bridge construction made station MON0020 unsafe to sample in 2022 and this station was also discontinued. Monitoring data provide information on the past and present concentrations of pollutants in our waterways. Monitoring data cannot, however, identify the sources of the pollutants nor predict future pollutant loads resulting from planned pollutant reduction efforts, the impacts of climate change, growth, etc.; for that information, we must depend on models and additional information.

This document consists only of a description of temporal trend analysis results from long-term non-tidal monitoring program concentration data. It does not employ other models or incorporate other information or data to interpret results. However, knowledge of trends in water quality conditions is useful for understanding and reporting on the water quality condition of Maryland's waters.

Water quality trends are calculated according to a generalized additive model (GAM), applied using the Baytrends R package which was developed by the Chesapeake Bay Program (Murphy et al. 2019). Each station and parameter is analyzed separately, and a GAM is derived from all the data for that station from 1986-2023. The trend significance and amount of change is determined using the two-year means for the start and end of the trend period of interest, 1999/2000 and 2022/2023. Each mean is calculated from the 24 values predicted by the GAM for the 15th of each month within each two-year time period. This method ensures that 24 values are always available for the calculation, as data are drawn from the predictive model rather than from the raw dataset that may be impacted by missing samples or irregular sampling intervals. Although data from 1986 to the present are included in the analysis, trends are summarized here for the 1999 to the present time period to remain consistent with tidal trends reporting for public audiences, including the Joint Chairman's Report and the Integrated Assessment (reporting by Maryland Dept of the Environment) and funding is not available for further analysis.

Trends are determined using a flow-adjustment method. The flow-adjusted method uses daily flow data from the closest USGS gage with a measurement for the entire 1986-2023 period for each station to include the impact of changes in river flow on the nutrients and sediment levels; higher nutrients and sediments are associated with high river flows. Changes in the levels of nutrients and sediments are flow-adjusted by using flow as one of the factors that determine the differences in concentrations between years. The flow-adjusted method is much more robust for determining the changes in water quality concentrations over a long-time period. A more detailed analysis method description is available on the Eyes on the Bay website (https://eyesonthebay.dnr.maryland.gov/eyesonthebay/documents/MDNR106draftQAPP_1920.pdf).

Statistical analysis of monitoring data collected at long-term non-tidal stations from 1999 through 2023 demonstrated significant reductions in nitrogen concentrations at 75% of non-tidal stations (Figure 1), phosphorus concentrations at 49% of non-tidal stations (Figure 2), sediment concentrations at 24% of non-tidal stations (Figure 3), dissolved inorganic nitrogen concentrations at 53% of non-tidal stations (Figure 4), orthophosphate concentrations at 49% of non-tidal stations (Figure 5), water temperature at 0% of non-tidal stations (Figure 6), conductivity at 29% of non-tidal stations (Figure 7), and dissolved oxygen concentration at 53% of non-tidal stations (Figure 8).

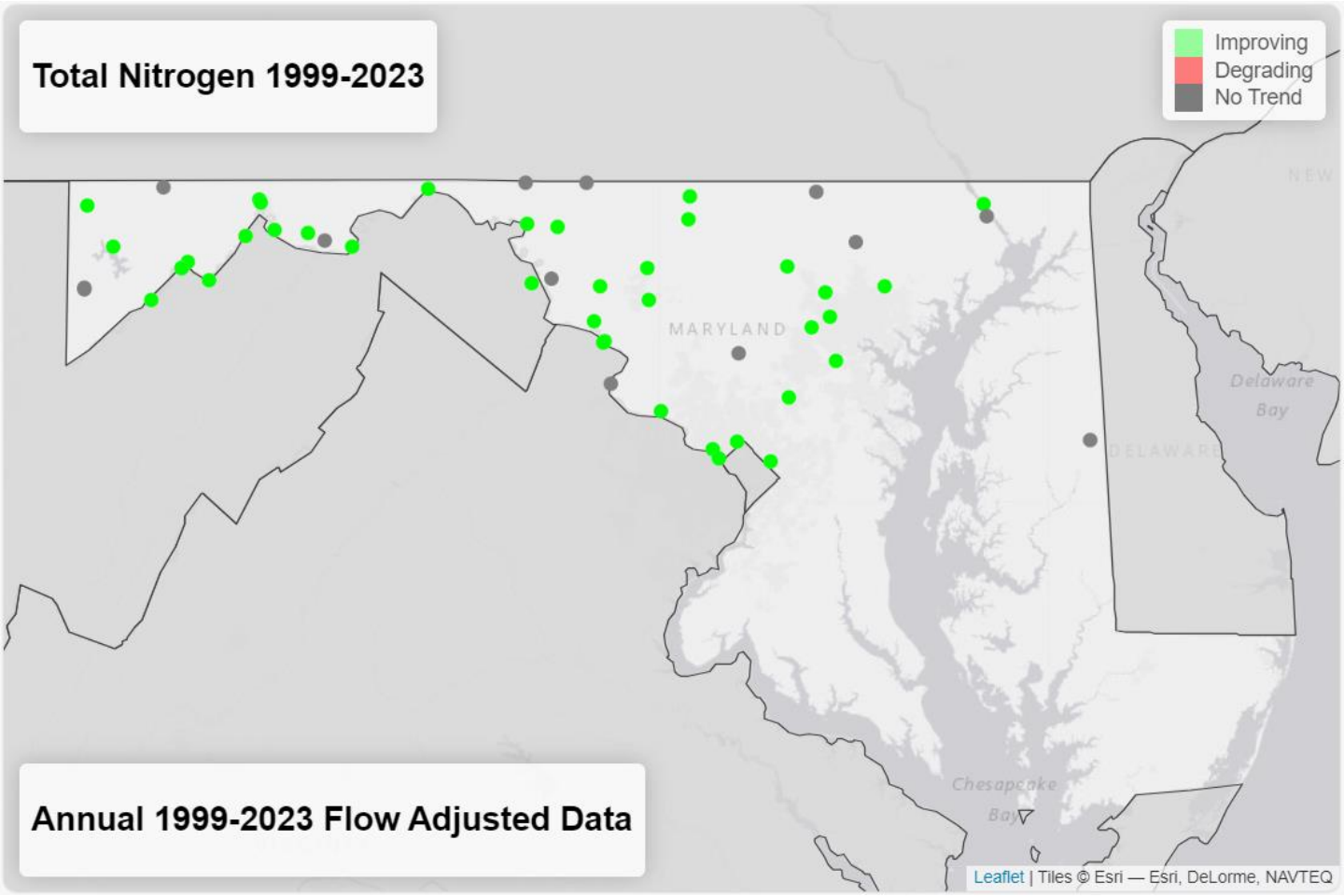

Figure 1. Trends in flow-adjusted total nitrogen concentrations 1999–2023

- 75% of stations (38 of 51) have improved total nitrogen levels compared to 1999
- 0% of stations (0 of 51) have degraded total nitrogen levels compared to 1999
- 25% of stations (13 of 51) do not have total nitrogen levels that are significantly different from 1999

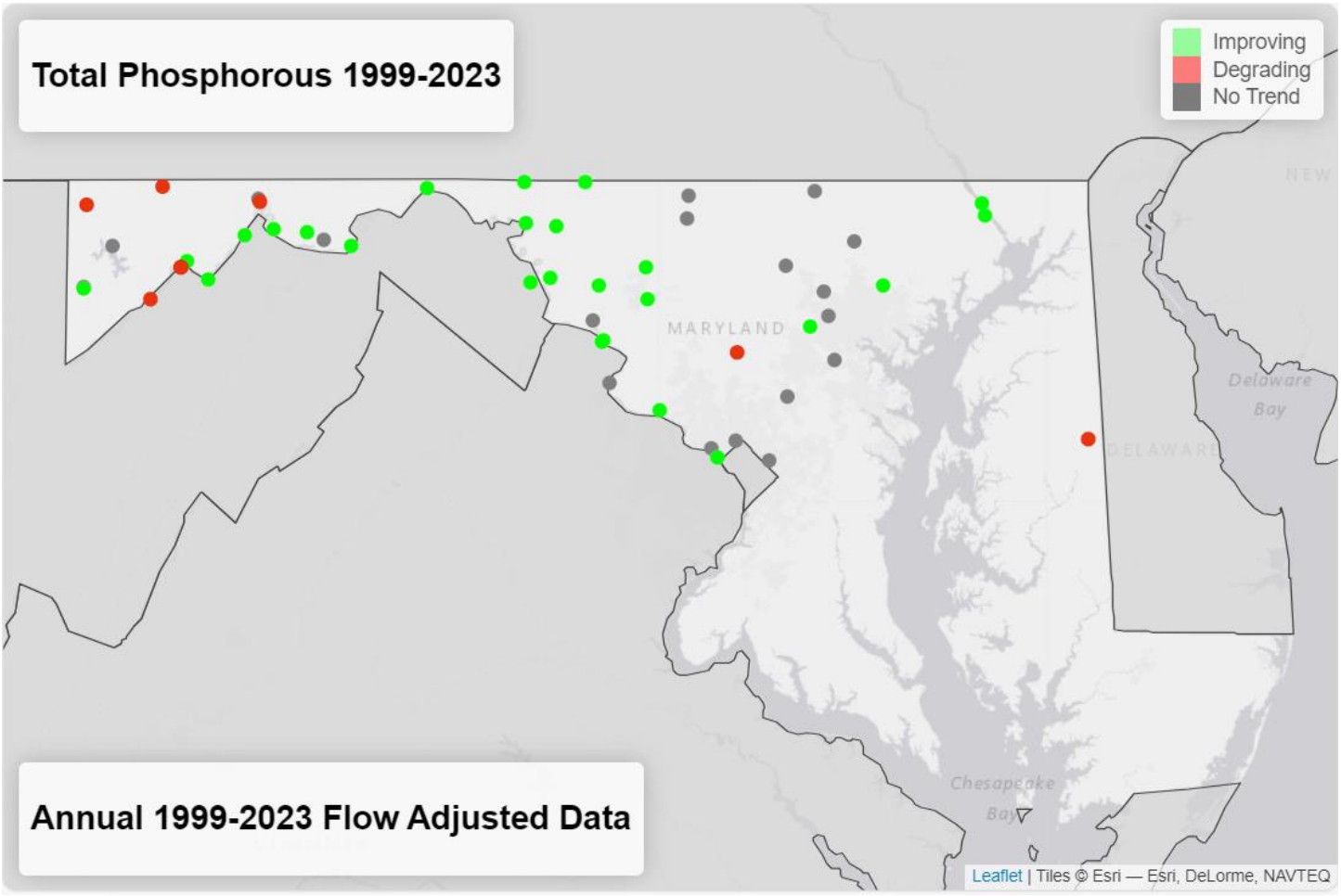

Figure 2. Trends in flow-adjusted total phosphorus concentrations 1999–2023

- 49% of stations (25 of 51) have improved total phosphorus levels compared to 1999
- 16% of stations (8 of 51) have degraded total phosphorus levels compared to 1999
- 35% of stations (18 of 51) do not have total phosphorus levels that are significantly different from 1999

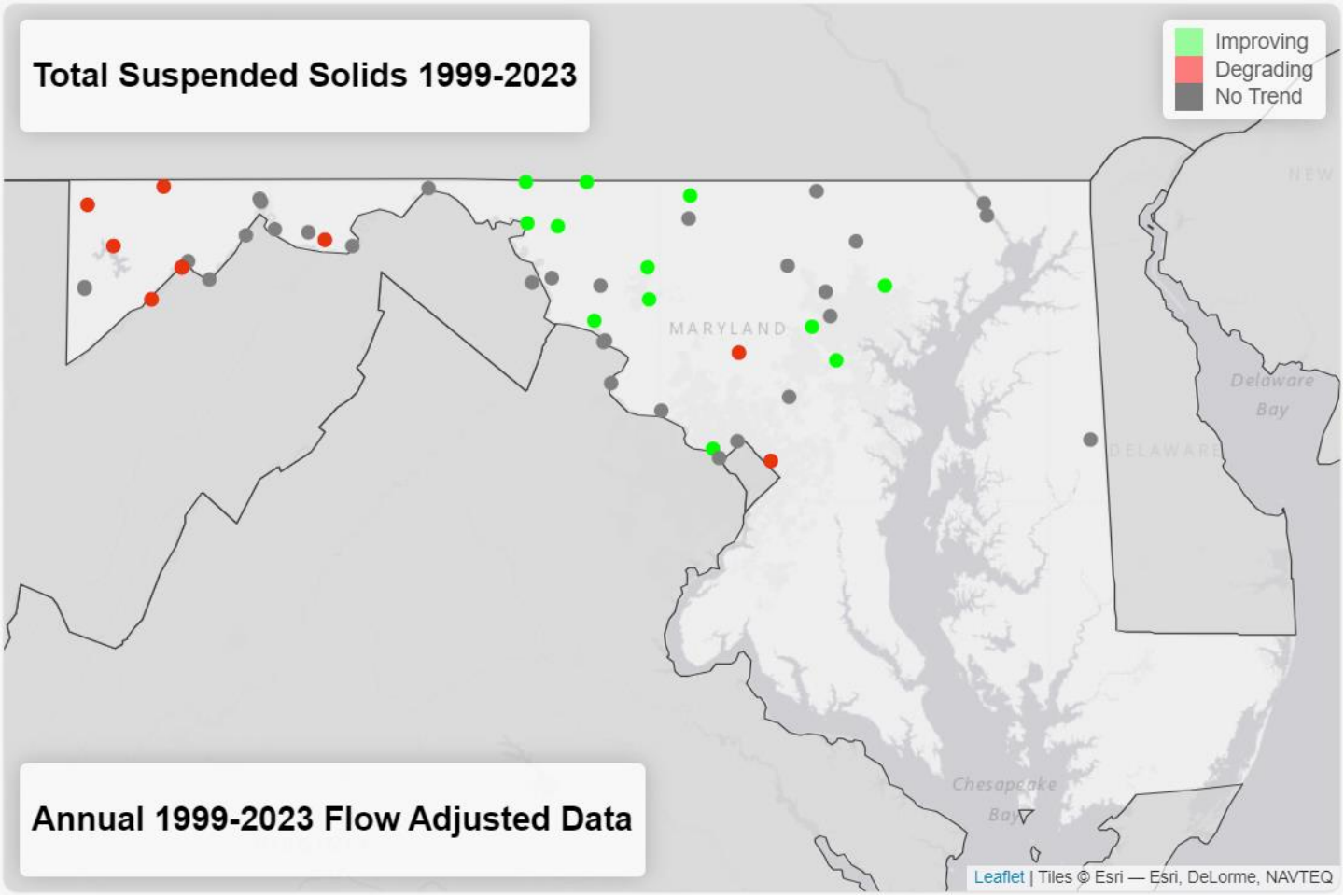

Figure 3. Trends in flow-adjusted total suspended solids concentrations 1999–2023

- 24% of stations (12 of 51) have improved total suspended solids levels compared to 1999
- 17% of stations (9 of 51) have degraded total suspended solids levels compared to 1999
- 59% of stations (30 of 51) do not have total suspended solids levels that are significantly different from 1999

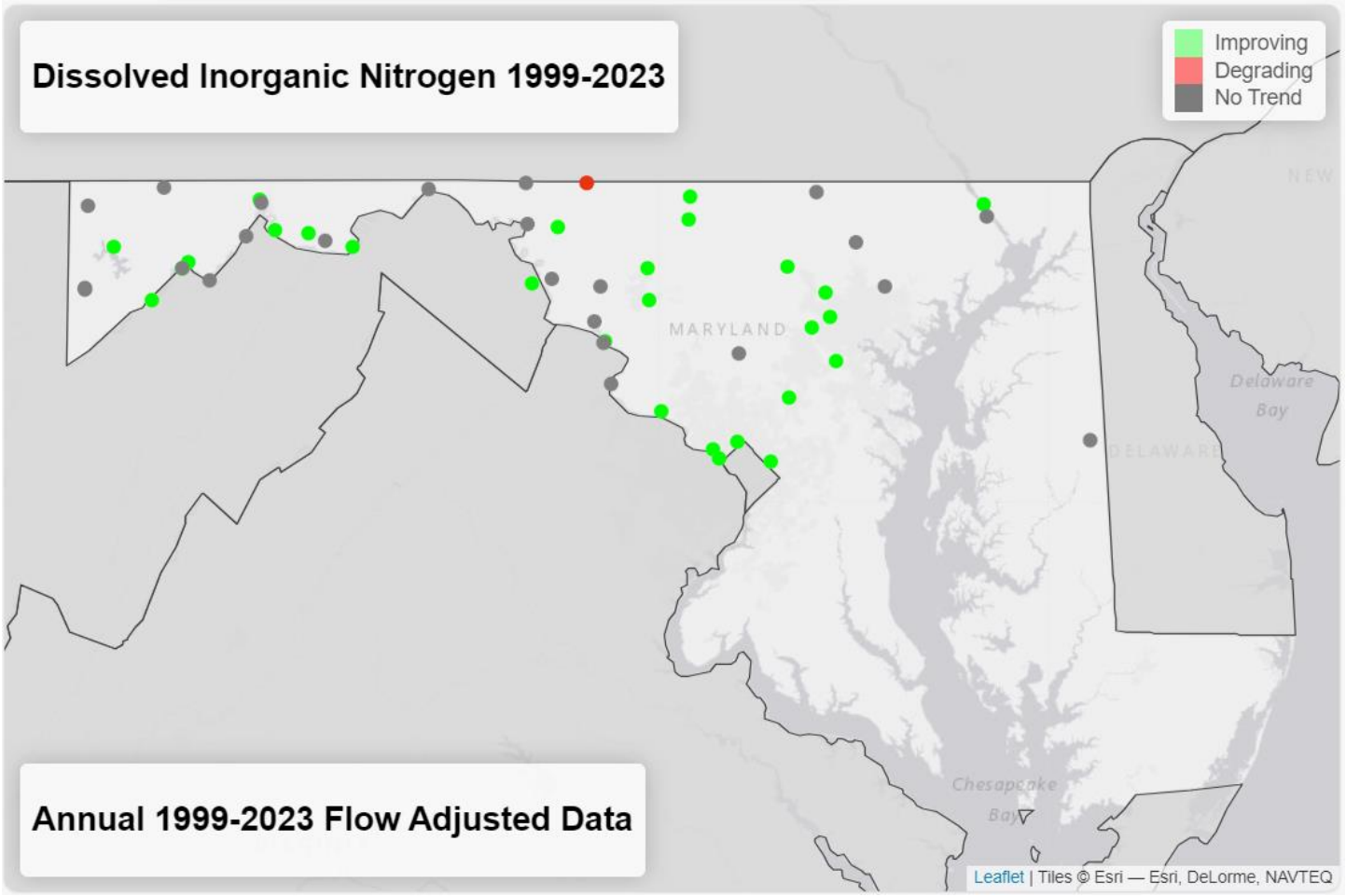

Figure 4. Trends in flow-adjusted dissolved inorganic nitrogen concentrations 1999–2023

- 53% of stations (27 of 51) have improved dissolved inorganic nitrogen levels compared to 1999
- 2% of stations (1 of 51) have degraded dissolved inorganic nitrogen levels compared to 1999
- 45% of stations (23 of 51) do not have dissolved inorganic nitrogen levels that are significantly different from 1999

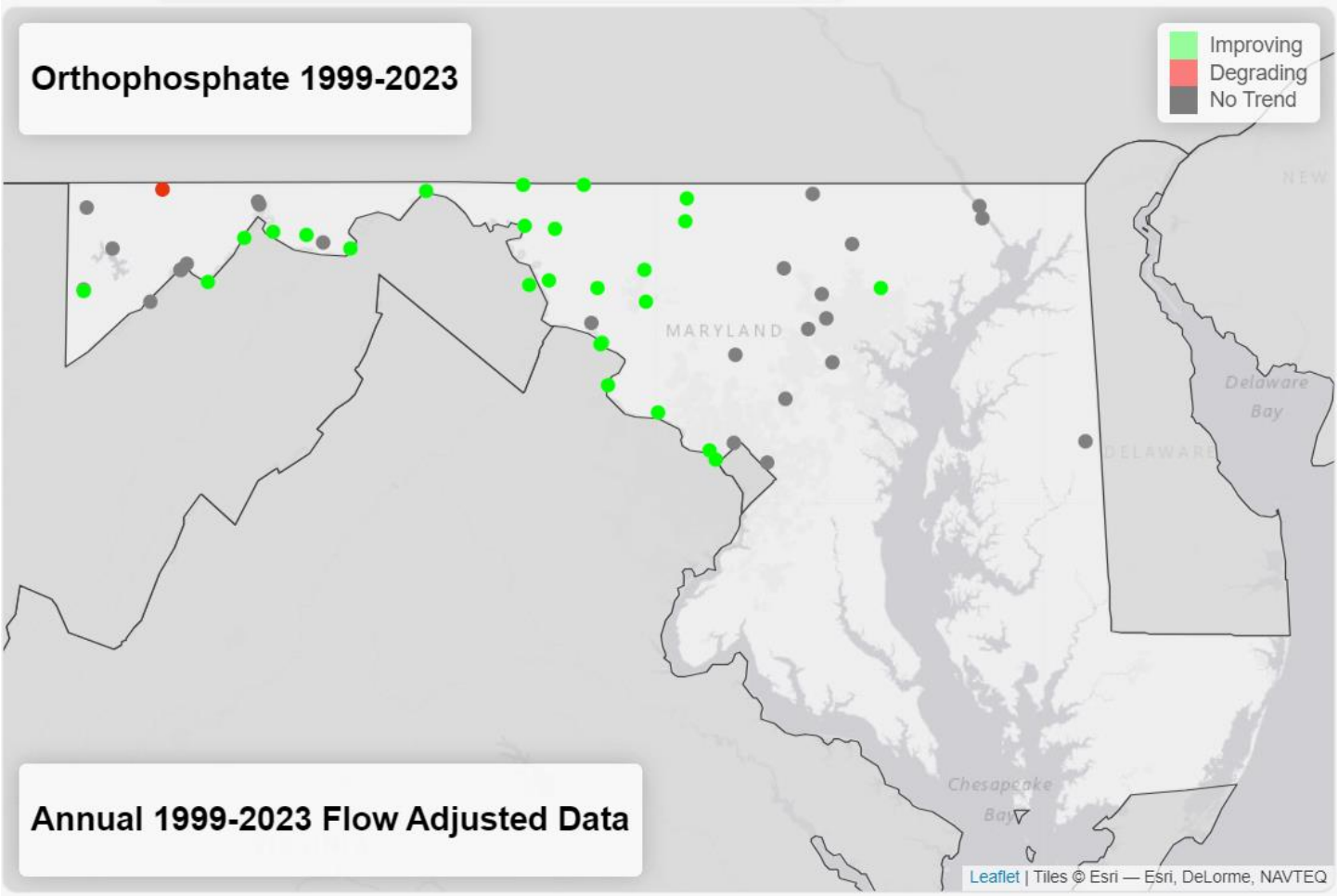

Figure 5. Trends in flow-adjusted orthophosphate concentrations 1999–2023

- 49% of stations (25 of 51) have improved orthophosphate levels compared to 1999
- 2% of stations (1 of 51) have degraded orthophosphate levels compared to 1999
- 49% of stations (25 of 51) do not have orthophosphate levels that are significantly different from 1999

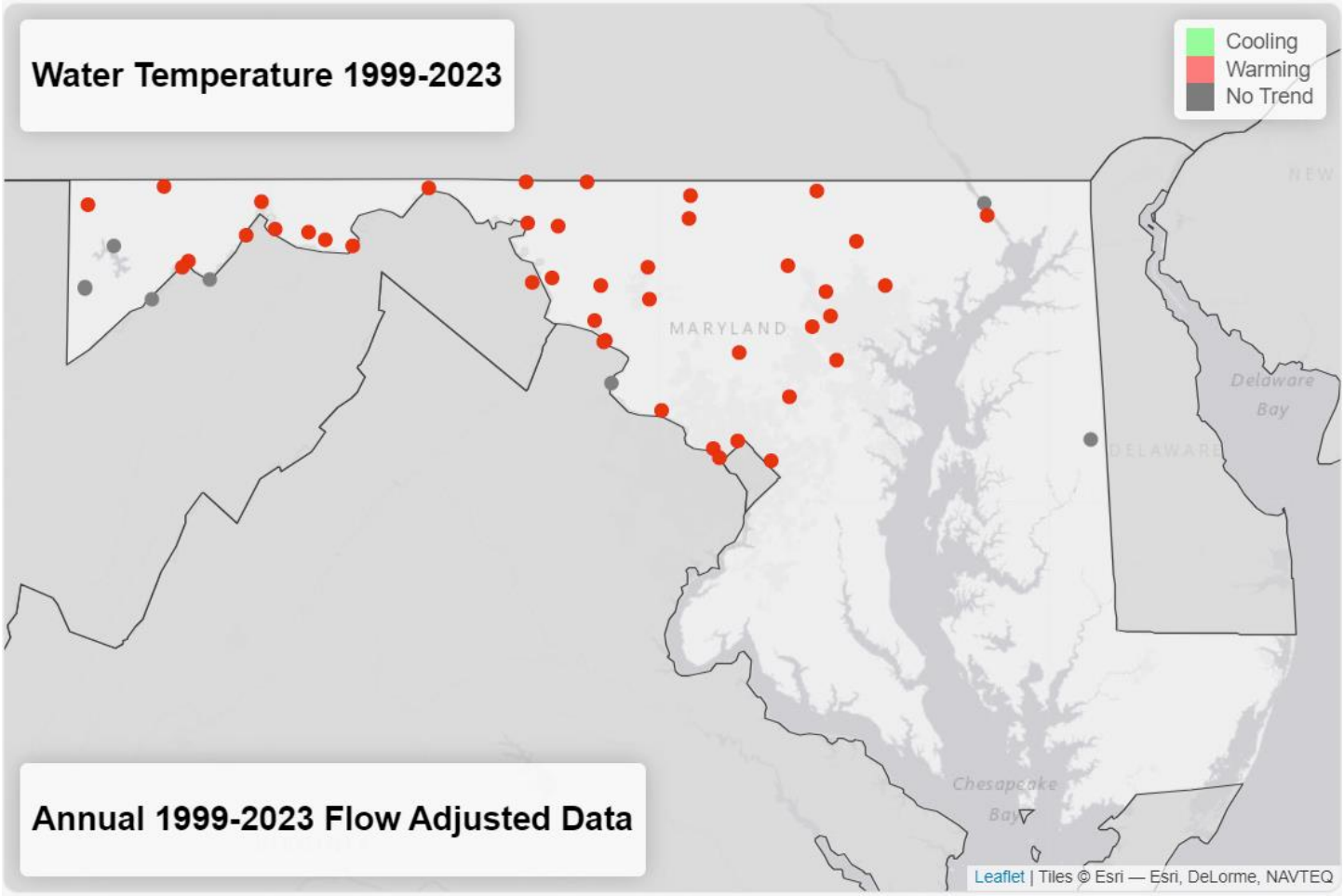

Figure 6. Trends in flow-adjusted water temperature concentrations 1999–2023

- 0% of stations (0 of 51) have cooling water temperature levels compared to 1999
- 84% of stations (43 of 51) have warming water temperature levels compared to 1999
- 16% of stations (8 of 51) do not have water temperature levels that are significantly different from 1999

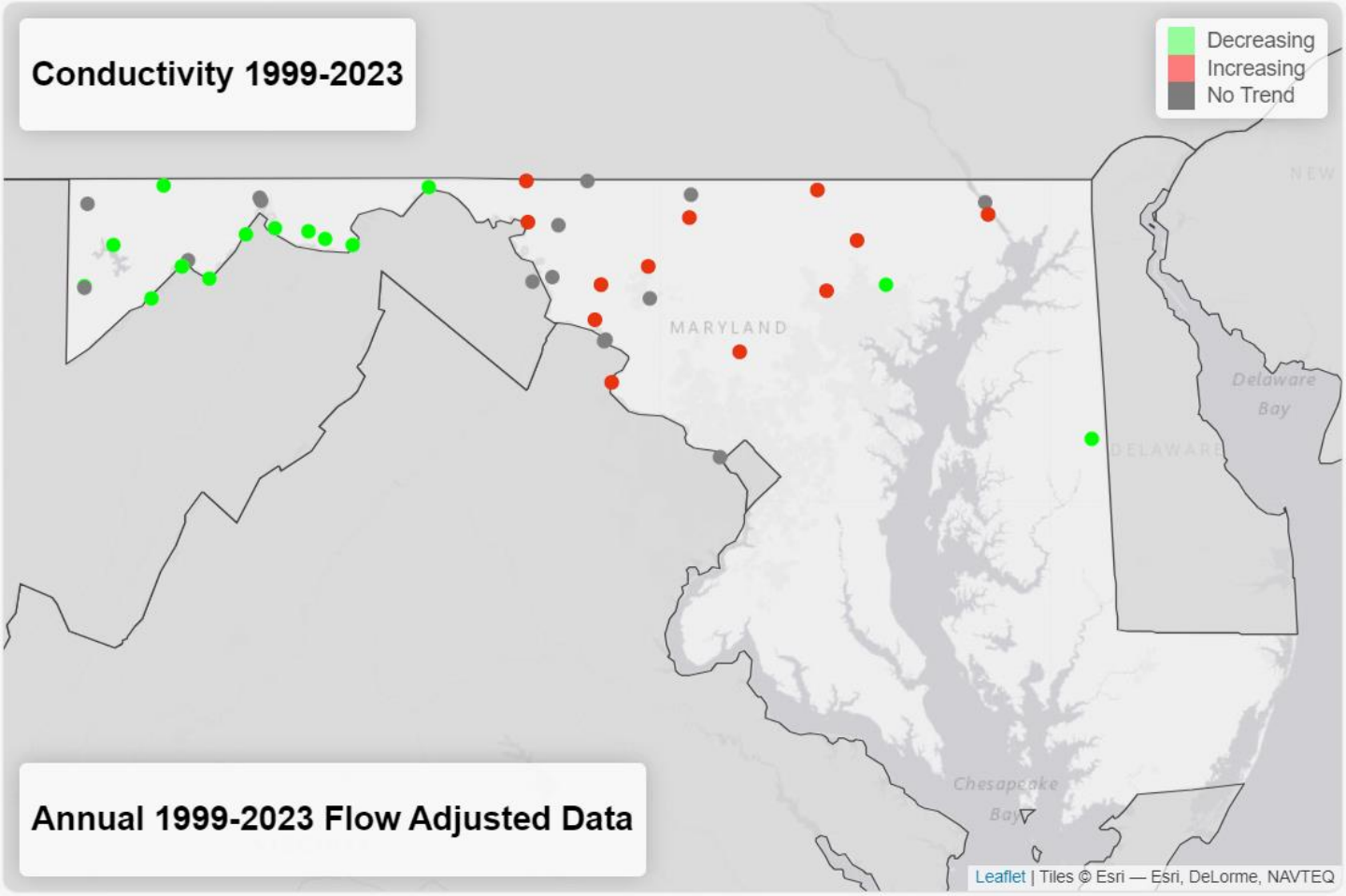

Figure 7. Trends in flow-adjusted conductivity concentrations 1999–2023

- 29% of stations (15 of 51) have decreased conductivity levels compared to 1999
- 42% of stations (21 of 51) have increased conductivity levels compared to 1999
- 29% of stations (15 of 51) do not have conductivity levels that are significantly different from 1999

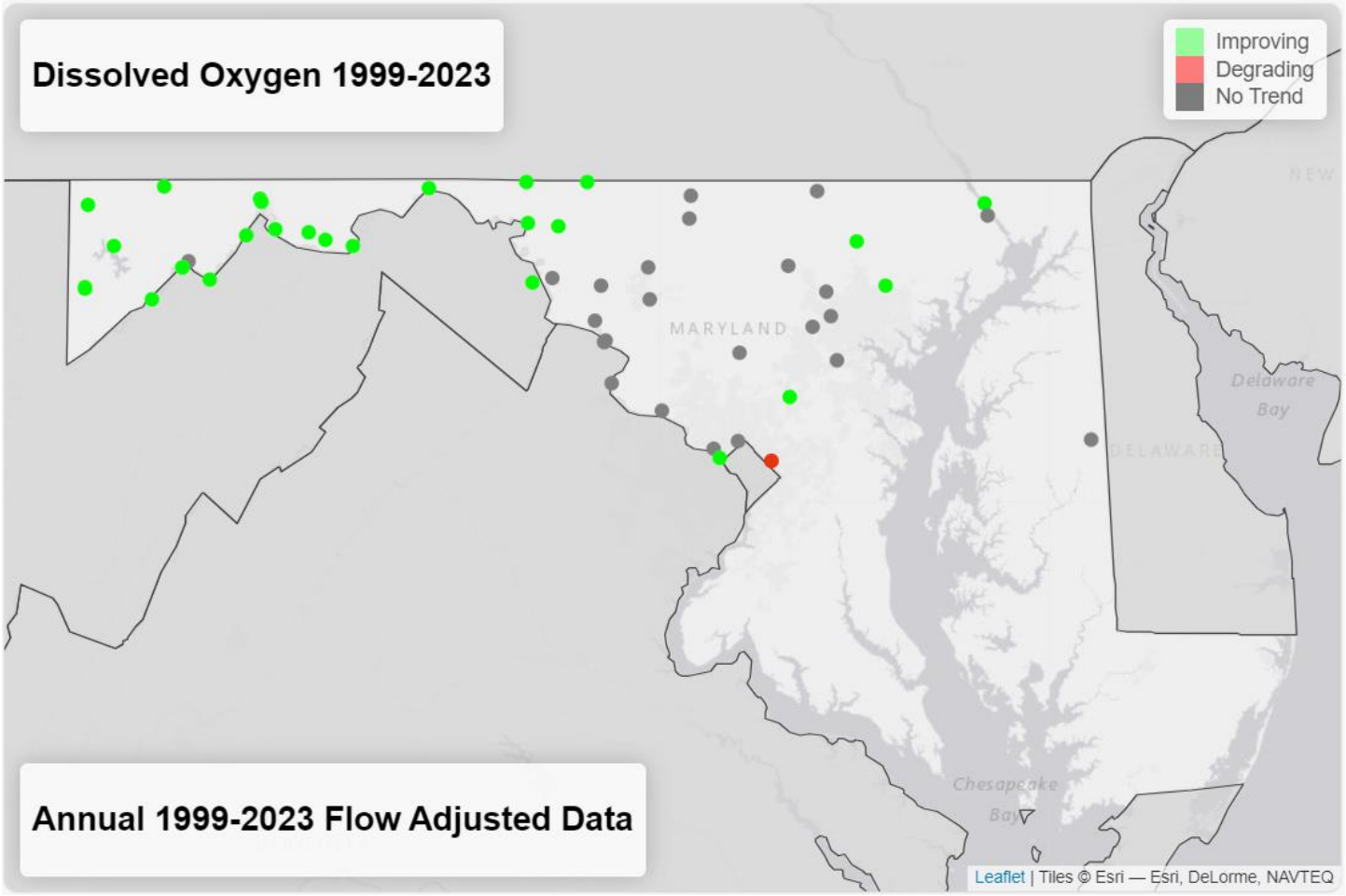

Figure 8. Trends in flow-adjusted dissolved oxygen concentrations 1999–2023

- 53% of stations (27 of 51) have improved dissolved oxygen levels compared to 1999
- 2% of stations (1 of 51) have degraded dissolved oxygen levels compared to 1999
- 45% of stations (23 of 51) do not have dissolved oxygen levels that are significantly different from 1999

Table 1. Trends in nutrients and total suspended solids at long-term non-tidal stations for the period 1999-2023. Highlighted values change by more than 50%, bolded values change by more than 20%, red indicates degrading (increasing) trends, green indicates improving (decreasing) trends, and empty cells indicate a not significant trend. Trends are significant at p <= 0.05.

Order	System	Station	Total Nitrogen	Total Phosphorus	Total Suspended Solids	Dissolved Inorganic Nitrogen	Orthophosphate
1	Western Maryland	LYO0004		imp >20%			imp >20%
2	Western Maryland	YOU1139					
3	Western Maryland	YOU0925	imp.	deg >20%	deg >50%		
4	Western Maryland	CCR0001	imp >20%		deg >50%	imp >50%	
5	Western Maryland	CAS0479		deg >20%	deg >50%		deg >50%
6	West. Upp. Potomac	NBP0689	imp >20%	deg >50%	deg >50%	imp >20%	
7	West. Upp. Potomac	NBP0534	imp >20%	deg >50%	deg >50%	imp >20%	
8	West. Upp. Potomac	SAV0000	imp.	deg >20%	deg >50%		
9	West. Upp. Potomac	GEO0009	imp >20%	imp >20%		imp >50%	
10	West. Upp. Potomac	NBP0461	imp >20%	imp >50%			imp >50%
11	West. Upp. Potomac	NBP0326	imp >20%	imp >50%			imp >50%
12	West. Upp. Potomac	BDK0000	imp >20%			imp.	
13	West. Upp. Potomac	WIL0013	imp >20%	deg >50%			
14	West. Upp. Potomac	NBP0103	imp >20%	imp >50%		imp >20%	imp >50%
15	West. Upp. Potomac	NBP0023	imp >20%	imp >50%		imp.	imp >50%
16	West. Upp. Potomac	TOW0030			deg >50%		

Order	System	Station	Total Nitrogen	Total Phosphorus	Total Suspended Solids	Dissolved Inorganic Nitrogen	Orthophosphate
17	West. Upp. Potomac	POT2766	imp >20%	imp >20%		imp >20%	imp >50%
18	West. Upp. Potomac	POT2386	imp >20%	imp >20%			imp >50%
19	East. Upp. Potomac	CON0180		imp >20%	imp >20%		imp >50%
20	East. Upp. Potomac	CON0005	imp.	imp >20%	imp >20%		imp >50%
21	East. Upp. Potomac	POT1830	imp >20%	imp >20%		imp.	imp >50%
22	East. Upp. Potomac	ANT0366		imp >20%	imp >50%	deg	imp >20%
23	East. Upp. Potomac	ANT0203	imp.	imp >50%	imp >50%	imp.	imp >50%
24	East. Upp. Potomac	ANT0044		imp >50%			imp >50%
25	East. Upp. Potomac	CAC0148	imp.	imp >20%			imp >50%
26	East. Upp. Potomac	CAC0031	imp.		imp >20%		
27	East. Upp. Potomac	POT1596	imp >20%	imp >20%			imp >50%
28	East. Upp. Potomac	POT1595	imp >20%	imp >20%		imp.	imp >50%
29	Monocacy	MON0528	imp >20%		imp >20%	imp >20%	imp >20%
30	Monocacy	BPC0035	imp.			imp.	imp >20%
31	Monocacy	MON0269	imp >20%	imp >20%	imp >20%	imp >20%	imp >50%
32	Monocacy	MON0155	imp >20%	imp >50%	imp >20%	imp >20%	imp >50%
33	Middle Potomac	POT1471					imp >20%
34	Middle Potomac	SEN0008	imp >20%	imp >50%		imp >20%	imp >50%
35	Middle Potomac	CJB0005	imp.		imp >20%	imp >20%	imp >20%

Order	System	Station	Total Nitrogen	Total Phosphorus	Total Suspended Solids	Dissolved Inorganic Nitrogen	Orthophosphate
36	Middle Potomac	RCM0111	imp >20%			imp >20%	
37	Middle Potomac	POT1184	imp >20%	imp >20%		imp >20%	imp >50%
38	Middle Potomac	ANA0082	imp >20%		deg >20%	imp >20%	
39	Gunpowder	GUN0476					imp >20%
40	Gunpowder	GUN0258					
41	Gunpowder	GUN0125	imp.	imp >20%	imp >50%		imp >20%
42	Susquehanna	DER0015		imp >20%			
43	Susquehanna	CB1.0	imp.	imp.		imp.	
44	Patapsco	NPA0165	imp.			imp.	
45	Patapsco	PAT0285	imp >20%	imp >20%	imp >50%	imp >20%	
46	Patapsco	PAT0176	imp.		imp >20%	imp >20%	
47	Patapsco	JON0184	imp.			imp.	
48	Patapsco	GWN0115	imp >20%			imp >20%	
49	Patuxent	PXT0972		deg >20%	deg >50%		
50	Patuxent	PXT0809	imp.			imp.	
51	Choptank	ET5.0		deg >20%			

Table 2. Mean start, end, and difference in mean parameter value for period 1999-2023. Highlighted values change by more than 50%, bolded values change by more than 20%, red indicates degrading (increasing) flow-adjusted trends, green indicates improving (decreasing) flow-adjusted trends, and black text indicates a not significant flow-adjusted trend (see Table 1).

		Total Nitrogen (mg/L)			Total Phosphorus (mg/L)			Total Suspended Solids (mg/L)			Dissolved Inorganic Nitrogen (mg/L)			Orthophosphate (mg/L)		
Order	Station	1999/ 2000 Mean Value	2022/ 2023 Mean Value	Change	1999/ 2000 Mean Value	2022/ 2023 Mean Value	Change	1999/ 2000 Mean Value	2022/ 2023 Mean Value	Change	1999/ 2000 Mean Value	2022/ 2023 Mean Value	Change	1999/ 2000 Mean Value	2022/ 2023 Mean Value	Change
1	LYO0004	1.55	1.40	-0.15	0.071	0.053	-0.018	8.38	7.47	-0.91	0.99	0.89	-0.10	0.021	0.013	-0.008
2	YOU1139	1.14	1.04	-0.10	0.043	0.039	-0.004	5.40	7.03	1.63	0.79	0.81	0.02	0.005	0.005	0.000
3	YOU0925	0.76	0.67	-0.10	0.018	0.025	0.007	2.21	4.34	2.12	0.48	0.46	-0.03	0.003	0.003	0.000
4	CCR0001	0.57	0.40	-0.17	0.013	0.017	0.004	1.65	2.78	1.13	0.20	0.09	-0.11	0.003	0.003	0.000
5	CAS0479	0.84	0.80	-0.05	0.025	0.037	0.012	2.10	3.96	1.86	0.54	0.56	0.02	0.005	0.014	0.009
6	NBP0689	1.19	0.80	-0.39	0.009	0.014	0.005	1.52	3.38	1.85	0.99	0.69	-0.30	0.003	0.002	0.000
7	NBP0534	1.07	0.80	-0.27	0.009	0.016	0.007	1.05	2.61	1.56	0.87	0.66	-0.20	0.002	0.002	0.000
8	SAV0000	0.84	0.72	-0.13	0.010	0.014	0.004	0.61	2.52	1.90	0.62	0.55	-0.07	0.003	0.003	0.001
9	GEO0009	1.27	0.65	-0.62	0.033	0.019	-0.014	6.11	6.13	0.02	0.94	0.46	-0.47	0.004	0.003	-0.001
10	NBP0461	1.10	0.79	-0.31	0.047	0.016	-0.031	4.65	2.91	-1.74	0.73	0.66	-0.07	0.006	0.002	-0.004
11	NBP0326	1.11	0.77	-0.34	0.045	0.020	-0.025	4.91	3.16	-1.75	0.66	0.64	-0.03	0.007	0.003	-0.004
12	BDK0000	0.69	0.50	-0.19	0.018	0.026	0.007	6.32	4.69	-1.62	0.47	0.39	-0.08	0.003	0.004	0.001
13	WIL0013	0.83	0.66	-0.18	0.015	0.022	0.008	2.22	2.71	0.49	0.54	0.46	-0.08	0.003	0.004	0.000
14	NBP0103	1.28	0.79	-0.49	0.060	0.026	-0.034	3.25	3.14	-0.11	0.85	0.66	-0.18	0.014	0.006	-0.009
15	NBP0023	1.16	0.80	-0.36	0.062	0.030	-0.032	4.16	3.57	-0.58	0.76	0.63	-0.13	0.012	0.006	-0.006

		Total Nitrogen (mg/L)			Total Phosphorus (mg/L)			Total Suspended Solids (mg/L)			Dissolved Inorganic Nitrogen (mg/L)			Orthophosphate (mg/L)		
Order	Station	1999/2000 Mean Value	2022/2023 Mean Value	Change	1999/2000 Mean Value	2022/2023 Mean Value	Change	1999/2000 Mean Value	2022/2023 Mean Value	Change	1999/2000 Mean Value	2022/2023 Mean Value	Change	1999/2000 Mean Value	2022/2023 Mean Value	Change
16	TOW0030	0.57	0.51	-0.06	0.015	0.015	0.000	1.27	2.34	1.07	0.21	0.26	0.04	0.003	0.003	0.000
17	POT2766	0.94	0.64	-0.30	0.031	0.024	-0.008	2.90	3.83	0.93	0.62	0.38	-0.23	0.009	0.004	-0.005
18	POT2386	0.90	0.71	-0.19	0.031	0.023	-0.008	5.45	4.24	-1.21	0.48	0.43	-0.05	0.015	0.007	-0.008
19	CON0180	3.96	3.80	-0.16	0.095	0.066	-0.029	9.17	5.55	-3.62	3.42	3.46	0.04	0.057	0.026	-0.031
20	CON0005	3.87	3.57	-0.30	0.086	0.054	-0.032	11.13	6.28	-4.85	3.35	3.25	-0.10	0.044	0.022	-0.022
21	POT1830	1.58	1.22	-0.36	0.041	0.026	-0.015	4.63	4.53	-0.10	1.10	0.97	-0.14	0.023	0.007	-0.016
22	ANT0366	4.01	4.13	0.12	0.144	0.078	-0.066	13.61	6.16	-7.45	3.39	3.79	0.40	0.083	0.045	-0.038
23	ANT0203	4.78	4.18	-0.60	0.235	0.077	-0.158	15.22	7.13	-8.08	4.16	3.82	-0.35	0.153	0.042	-0.111
24	ANT0044	4.41	4.18	-0.23	0.160	0.069	-0.091	9.02	9.77	0.75	3.91	3.77	-0.14	0.097	0.034	-0.062
25	CAC0148	1.53	1.32	-0.20	0.079	0.046	-0.033	4.36	4.57	0.21	1.02	0.95	-0.06	0.050	0.025	-0.026
26	CAC0031	1.95	1.72	-0.23	0.087	0.101	0.014	6.18	4.58	-1.60	1.43	1.31	-0.11	0.055	0.056	0.001
27	POT1596	1.47	1.13	-0.33	0.067	0.048	-0.019	7.18	6.21	-0.97	0.82	0.73	-0.09	0.039	0.015	-0.025
28	POT1595	1.77	1.38	-0.39	0.051	0.039	-0.012	7.73	6.82	-0.91	1.27	1.06	-0.21	0.026	0.013	-0.013
29	MON0528	1.96	1.35	-0.60	0.101	0.093	-0.009	6.68	4.40	-2.28	0.98	0.69	-0.29	0.063	0.046	-0.017
30	BPC0035	3.68	3.13	-0.55	0.047	0.039	-0.008	6.27	7.15	0.87	3.15	2.71	-0.45	0.027	0.019	-0.008
31	MON0269	2.78	2.05	-0.73	0.093	0.072	-0.021	7.58	4.47	-3.12	2.14	1.69	-0.45	0.053	0.025	-0.027
32	MON0155	3.41	2.01	-1.40	0.181	0.062	-0.120	10.21	6.64	-3.58	2.69	1.59	-1.10	0.129	0.025	-0.103
33	POT1471	2.02	1.83	-0.20	0.075	0.063	-0.012	8.41	6.72	-1.69	1.48	1.42	-0.06	0.042	0.021	-0.020

		Total Nitrogen (mg/L)			Total Phosphorus (mg/L)			Total Suspended Solids (mg/L)			Dissolved Inorganic Nitrogen (mg/L)			Orthophosphate (mg/L)		
Order	Station	1999/2000 Mean Value	2022/2023 Mean Value	Change	1999/2000 Mean Value	2022/2023 Mean Value	Change	1999/2000 Mean Value	2022/2023 Mean Value	Change	1999/2000 Mean Value	2022/2023 Mean Value	Change	1999/2000 Mean Value	2022/2023 Mean Value	Change
34	SEN0008	2.86	1.70	-1.16	0.123	0.049	-0.074	5.54	4.88	-0.66	2.37	1.28	-1.09	0.085	0.013	-0.072
35	CJB0005	1.36	1.11	-0.25	0.027	0.027	0.001	3.05	2.08	-0.97	0.90	0.71	-0.19	0.014	0.009	-0.005
36	RCM0111	1.58	1.20	-0.38	0.053	0.058	0.005	6.96	6.01	-0.96	0.95	0.73	-0.22	0.013	0.012	-0.001
37	POT1184	1.73	1.28	-0.45	0.073	0.040	-0.033	9.49	8.32	-1.17	1.13	0.76	-0.37	0.035	0.008	-0.026
38	ANA0082	1.49	1.14	-0.34	0.044	0.055	0.010	5.60	7.93	2.33	0.85	0.58	-0.27	0.009	0.007	-0.002
39	GUN0476	3.23	3.41	0.18	0.031	0.036	0.005	5.78	6.50	0.72	2.83	2.94	0.11	0.011	0.008	-0.003
40	GUN0258	2.43	2.30	-0.12	0.020	0.023	0.002	5.24	4.41	-0.83	2.07	2.03	-0.04	0.007	0.005	-0.002
41	GUN0125	1.45	1.30	-0.15	0.037	0.021	-0.016	12.52	2.76	-9.76	0.99	0.96	-0.03	0.007	0.004	-0.003
42	DER0015	3.42	3.47	0.05	0.037	0.026	-0.011	4.61	3.54	-1.07	2.93	3.11	0.18	0.016	0.010	-0.005
43	CB1.0	1.52	1.31	-0.22	0.042	0.037	-0.005	8.05	8.13	0.08	1.12	0.95	-0.17	0.006	0.008	0.002
44	NPA0165	4.19	3.66	-0.53	0.019	0.020	0.000	3.78	3.52	-0.25	3.82	3.38	-0.44	0.005	0.005	0.001
45	PAT0285	2.57	1.83	-0.74	0.049	0.030	-0.020	5.79	2.69	-3.11	2.13	1.59	-0.54	0.010	0.009	-0.002
46	PAT0176	2.22	1.79	-0.43	0.048	0.037	-0.011	5.63	3.31	-2.32	1.73	1.32	-0.42	0.012	0.010	-0.003
47	JON0184	1.92	1.70	-0.22	0.021	0.020	-0.001	3.99	3.77	-0.22	1.61	1.41	-0.20	0.007	0.009	0.002
48	GWN0115	1.78	1.35	-0.43	0.030	0.032	0.002	4.05	2.34	-1.72	1.35	0.97	-0.38	0.007	0.008	0.002
49	PXT0972	2.81	2.66	-0.16	0.024	0.032	0.009	5.79	11.39	5.60	2.48	2.35	-0.13	0.007	0.007	0.000
50	PXT0809	1.62	1.38	-0.24	0.029	0.033	0.004	5.98	5.69	-0.28	1.19	1.00	-0.20	0.004	0.004	0.000
51	ET5.0	1.86	1.82	-0.04	0.067	0.088	0.020	3.18	3.31	0.13	1.33	1.37	0.04	0.026	0.029	0.003

Table 3. Trends in water temperature, conductivity and dissolved oxygen at long-term non-tidal stations for the period 1999-2023. Grey cells indicate stations not sampled for that parameter. Highlighted values change by more than 50%, bolded values change by more than 20%, red indicates degrading or increasing trends, green indicates improving or decreasing trends, and empty cells indicate a not significant trend except in the case of dissolved oxygen, where an increasing trend is improving and colored green, and a decreasing trend is degrading and colored red. Trends are significant at p <= 0.05.

Order	System	Station	Water Temperature	Conductivity	Dissolved Oxygen
1	Western Maryland	LYO0004			imp.
2	Western Maryland	YOU1139		imp.	imp.
3	Western Maryland	YOU0925	deg		imp.
4	Western Maryland	CCR0001		**imp >20%**	imp.
5	Western Maryland	CAS0479	deg	imp.	imp.
6	West. Upp. Potomac	NBP0689		**imp >20%**	imp.
7	West. Upp. Potomac	NBP0534	deg	imp.	imp.
8	West. Upp. Potomac	SAV0000	**deg >20%**	imp.	imp.
9	West. Upp. Potomac	GEO0009	deg		
10	West. Upp. Potomac	NBP0461		**imp >20%**	imp.
11	West. Upp. Potomac	NBP0326	deg	**imp >20%**	**imp >20%**
12	West. Upp. Potomac	BDK0000	**deg >20%**		imp.
13	West. Upp. Potomac	WIL0013	deg		imp.
14	West. Upp. Potomac	NBP0103	deg	**imp >20%**	imp.
15	West. Upp. Potomac	NBP0023	deg	**imp >20%**	imp.

Order	System	Station	Water Temperature	Conductivity	Dissolved Oxygen
16	West. Upp. Potomac	TOW0030	deg	imp.	imp.
17	West. Upp. Potomac	POT2766	deg	**imp >20%**	imp.
18	West. Upp. Potomac	POT2386	deg	imp.	imp.
19	East. Upp. Potomac	CON0180	deg	deg	**imp >20%**
20	East. Upp. Potomac	CON0005	deg	deg	imp.
21	East. Upp. Potomac	POT1830	deg		imp.
22	East. Upp. Potomac	ANT0366	deg		imp.
23	East. Upp. Potomac	ANT0203	deg		imp.
24	East. Upp. Potomac	ANT0044	deg		
25	East. Upp. Potomac	CAC0148	deg	deg	
26	East. Upp. Potomac	CAC0031	deg	deg	
27	East. Upp. Potomac	POT1596	deg		
28	East. Upp. Potomac	POT1595	deg		
29	Monocacy	MON0528	deg		
30	Monocacy	BPC0035	deg	deg	
31	Monocacy	MON0269	deg	deg	
32	Monocacy	MON0155	deg		
33	Middle Potomac	POT1471		deg	
34	Middle Potomac	SEN0008	deg	**deg >50%**	
35	Middle Potomac	CJB0005	deg	**deg >20%**	

Order	System	Station	Water Temperature	Conductivity	Dissolved Oxygen
36	Middle Potomac	RCM0111	deg	**deg >20%**	
37	Middle Potomac	POT1184	deg		imp.
38	Middle Potomac	ANA0082	deg	**deg >20%**	deg.
39	Gunpowder	GUN0476	deg	deg	
40	Gunpowder	GUN0258	deg	deg	imp.
41	Gunpowder	GUN0125	deg	**imp >20%**	**imp >20%**
42	Susquehanna	DER0015	deg	deg	
43	Susquehanna	CB1.0			imp.
44	Patapsco	NPA0165	deg	**deg >20%**	
45	Patapsco	PAT0285	deg	**deg >20%**	
46	Patapsco	PAT0176	deg	**deg >20%**	
47	Patapsco	JON0184	deg	deg	
48	Patapsco	GWN0115	deg	**deg >50%**	
49	Patuxent	PXT0972	deg	deg	
50	Patuxent	PXT0809	deg	**deg >20%**	imp.
51	Choptank	ET5.0		imp.	

Table 4. Mean start, end, and difference in mean parameter value for period 1999-2023. Grey cells indicate stations not sampled for that parameter. Highlighted values change by more than 50%, bolded values change by more than 20%, red indicates degrading or increasing flow-adjusted trends, green indicates improving

or decreasing flow-adjusted trends, and black text indicates a not significant flow-adjusted trend (see Table 3) except in the case of dissolved oxygen, where an increasing trend is improving and colored green, and a decreasing trend is degrading and colored red.

		Water Temperature (°C)			Conductivity (µmhos/cm at 25°C)			Dissolved Oxygen (mg/L)		
Order	Station	1999/ 2000 Mean Value	2021/ 2023 Mean Value	Change	1999/ 2000 Mean Value	2021/ 2023 Mean Value	Change	1999/ 2000 Mean Value	2021/ 2023 Mean Value	Change
1	LYO0004	10.0	10.6	0.6	174	185	11	9.1	9.8	0.7
2	YOU1139	10.1	10.7	0.7	126	110	-15	9.3	10.1	0.8
3	YOU0925	9.9	11.0	1.1	101	95	-6	10.2	11.0	0.8
4	CCR0001	8.6	9.5	0.9	**123**	**73**	**-51**	9.9	10.6	0.8
5	CAS0479	8.8	10.2	1.3	189	152	-36	10.0	11.2	1.2
6	NBP0689	10.4	11.6	1.2	**485**	**373**	**-112**	10.1	10.7	0.7
7	NBP0534	9.7	11.1	1.4	384	319	-64	10.4	11.0	0.6
8	SAV0000	**9.0**	**10.9**	**1.9**	129	105	-24	10.7	11.3	0.6
9	GEO0009	10.6	12.4	1.8	840	877	37	10.6	10.8	0.2
10	NBP0461	11.4	11.6	0.2	**485**	**319**	**-166**	9.6	11.4	1.8
11	NBP0326	11.8	12.9	1.2	**450**	**321**	**-129**	**9.3**	**11.2**	**1.9**
12	BDK0000	**9.1**	**11.6**	**2.5**	945	1,019	73	10.5	10.9	0.4
13	WIL0013	10.0	11.9	1.9	285	286	1	10.2	11.2	1.1
14	NBP0103	12.2	13.2	1.1	**423**	**316**	**-107**	9.5	11.0	1.5
15	NBP0023	12.4	13.4	0.9	**410**	**307**	**-103**	9.4	10.7	1.3
16	TOW0030	11.9	14.1	2.1	187	165	-22	10.2	11.2	1.0
17	POT2766	13.3	14.5	1.2	**300**	**235**	**-65**	9.7	10.7	1.1

		Water Temperature (°C)			Conductivity (µmhos/cm at 25°C)			Dissolved Oxygen (mg/L)		
Order	Station	1999/ 2000 Mean Value	2021/ 2023 Mean Value	Change	1999/ 2000 Mean Value	2021/ 2023 Mean Value	Change	1999/ 2000 Mean Value	2021/ 2023 Mean Value	Change
18	POT2386	13.9	14.4	0.4	300	279	-21	9.8	10.4	0.6
19	CON0180	12.4	14.7	2.4	386	420	34	**9.5**	**11.6**	**2.1**
20	CON0005	13.2	15.4	2.3	387	429	42	9.8	11.6	1.8
21	POT1830	14.4	15.4	1.0	311	308	-4	9.7	10.4	0.7
22	ANT0366	11.5	13.1	1.5	375	400	25	9.9	11.3	1.4
23	ANT0203	12.8	14.0	1.2	508	524	16	9.4	10.2	0.8
24	ANT0044	12.8	14.3	1.5	520	539	19	10.2	10.2	0.1
25	CAC0148	12.1	13.3	1.2	218	250	32	10.6	10.6	0.0
26	CAC0031	12.1	13.5	1.4	243	286	43	10.0	10.0	0.0
27	POT1596	14.0	14.6	0.7	285	268	-18	9.7	9.5	-0.1
28	POT1595	13.8	14.6	0.8	321	299	-22	9.7	9.7	0.0
29	MON0528	12.6	14.1	1.5	284	305	21	9.0	9.4	0.4
30	BPC0035	12.0	13.1	1.1	241	254	14	9.9	9.9	0.0
31	MON0269	13.0	14.2	1.2	271	305	34	9.4	9.7	0.3
32	MON0155	13.0	14.0	1.0	302	287	-15	9.1	9.2	0.1
33	POT1471	15.6	15.2	-0.4	311	335	25	9.5	9.2	-0.2
34	SEN0008	13.0	15.2	2.2	**252**	**415**	**162**	10.6	10.7	0.1
35	CJB0005	13.1	14.2	1.1	**382**	**554**	**172**	10.8	10.8	0.0

		Water Temperature (°C)			Conductivity (µmhos/cm at 25°C)			Dissolved Oxygen (mg/L)		
Order	Station	1999/ 2000 Mean Value	2021/ 2023 Mean Value	Change	1999/ 2000 Mean Value	2021/ 2023 Mean Value	Change	1999/ 2000 Mean Value	2021/ 2023 Mean Value	Change
36	RCM0111	13.4	15.1	1.7	**330**	**466**	**136**	9.1	9.7	0.5
37	POT1184	15.5	16.2	0.7	281	307	26	9.6	10.1	0.5
38	ANA0082	15.2	16.5	1.4	**302**	**425**	**124**	10.5	9.4	-1.1
39	GUN0476	11.5	12.7	1.2	163	195	32	10.9	11.0	0.1
40	GUN0258	11.5	12.2	0.8	171	205	34	10.7	11.4	0.7
41	GUN0125	13.6	15.3	1.7	**422**	**331**	**-91**	**9.1**	**11.1**	**2.0**
42	DER0015	12.1	13.3	1.1	169	194	25	10.4	10.5	0.1
43	CB1.0	15.3	15.9	0.6	239	245	6	9.7	10.5	0.9
44	NPA0165	10.9	13.0	2.0	**223**	**274**	**51**	10.5	10.5	0.0
45	PAT0285	12.3	13.9	1.7	**231**	**288**	**56**	10.0	10.0	-0.1
46	PAT0176	12.5	13.8	1.3	**270**	**324**	**54**	10.0	9.9	-0.1
47	JON0184	11.5	13.7	2.1	391	460	70	10.7	10.9	0.2
48	GWN0115	11.6	13.7	2.1	**321**	**500**	**179**	10.4	10.5	0.1
49	PXT0972	11.5	12.7	1.2	136	156	20	10.3	10.3	0.0
50	PXT0809	13.6	14.6	1.0	**149**	**194**	**46**	9.2	9.7	0.4
51	ET5.0	14.0	14.6	0.6	147	137	-9	8.8	8.8	0.1

Works Cited

Murphy, R. R., E. Perry, J. Harcum, and J. Keisman. 2019. A Generalized Additive Model approach to evaluating water quality: Chesapeake Bay case study. Environmental Modeling & Software 118:1-13.