

TABLE 1: Summary characteristics of monitoring stations on the Patuxent River estuary. Chlorophyll-*a* and salinity values are based on averages from 1986 to 2014. Stations used for the analysis are in bold. Segments are salinity regions in the Patuxent for the larger Chesapeake Bay area (TF = tidal fresh, OH = oligohaline, MH = mesohaline).

Station	Lat	Long	Segment	Distance (km)	Depth (m)	ln-Chl ($\mu\text{g/L}$)	Sal (ppt)
TF1.3	38.81	-76.71	TF	74.90	2.9	1.52	0.00
TF1.4	38.77	-76.71	TF	69.50	2.0	2.31	0.02
TF1.5	38.71	-76.70	TF	60.30	10.6	2.88	0.27
TF1.6	38.66	-76.68	OH	52.20	6.2	2.44	0.90
TF1.7	38.58	-76.68	OH	42.50	3.0	2.09	4.09
RET1.1	38.49	-76.66	MH	32.20	11.2	2.47	10.25
LE1.1	38.43	-76.60	MH	22.90	12.1	2.31	12.04
LE1.2	38.38	-76.51	MH	13.40	17.1	2.16	12.73
LE1.3	38.34	-76.48	MH	8.30	23.4	2.12	12.89
LE1.4	38.31	-76.42	MH	0.00	15.4	2.21	13.46

TABLE 2: Summaries of model performance using **RMSE!** (deviance in parentheses) of observed to predicted **ln-chla!** for each station (LE1.2 and TF1.6). Overall performance for the entire time series is shown at the top with groupings by different time periods below. Time periods are annual groupings every seven years (top), seasonal groupings (middle), and flow periods based on quantile distributions of discharge.

Period	LE1.2		TF1.6	
	GAM	WRTDS	GAM	WRTDS
All	0.51 (139.5)	0.51 (135.1)	0.50 (128.4)	0.52 (138.6)
Annual				
1986-1993	0.50 (41.1)	0.50 (40.9)	0.48 (37.2)	0.49 (39.1)
1994-2000	0.51 (34.7)	0.50 (33.2)	0.55 (39.3)	0.58 (44.9)
2001-2007	0.61 (51.5)	0.60 (49.6)	0.50 (33.7)	0.53 (37.5)
2008-2014	0.37 (12.1)	0.36 (11.4)	0.45 (18.2)	0.44 (17.1)
Seasonal				
JFM	0.60 (38.1)	0.58 (35.3)	0.49 (24.4)	0.49 (23.8)
AMJ	0.64 (65.2)	0.64 (65.3)	0.54 (45.7)	0.58 (51.9)
JAS	0.35 (19.3)	0.35 (18.6)	0.45 (30.4)	0.46 (32.2)
OND	0.39 (16.8)	0.38 (15.9)	0.52 (27.9)	0.54 (30.7)
Flow				
1 (Low)	0.36 (17.4)	0.36 (16.7)	0.45 (26.5)	0.46 (27.7)
2	0.43 (24.4)	0.42 (23.5)	0.53 (36.6)	0.54 (37.8)
3	0.58 (43.8)	0.57 (42.9)	0.49 (31.3)	0.52 (35.4)
4 (High)	0.64 (53.9)	0.63 (52.0)	0.51 (34.0)	0.54 (37.7)

TABLE 3: Summaries of flow-normalized trends from each model at LE1.2 for different time periods. Summaries are averages and percentage changes of $\ln\text{-chl}a$ ($\mu\text{g/L}$) based on annual means within each category. Percentage changes are the differences between the last and first years in the periods. Time periods are annual groupings every seven years (top), seasonal groupings (middle), and flow periods based on quantile distributions of discharge.

Period	GAM		WRTDS	
	Ave.	% Change	Ave.	% Change
All	2.17	24.28	2.18	18.85
Annual				
1986-1993	1.99	9.60	2.03	1.75
1994-2000	2.12	5.49	2.12	5.50
2001-2007	2.24	5.50	2.24	5.35
2008-2014	2.37	3.20	2.37	6.07
Seasonal				
JFM	2.57	20.06	2.58	14.04
AMJ	2.32	31.20	2.33	22.47
JAS	2.01	18.48	2.01	19.91
OND	1.82	25.29	1.83	15.14
Flow				
1 (Low)	1.90	20.86	1.93	16.77
2	2.10	13.71	2.11	7.73
3	2.28	15.66	2.29	9.24
4 (High)	2.34	25.09	2.33	22.29

TABLE 4: Summaries of flow-normalized trends from each model at TF1.6 for different time periods. Summaries are averages and percentage changes of $\ln\text{-chl}a$ ($\mu\text{g/L}$) based on annual means within each category. Percentage changes are the differences between the last and first years in the periods. Time periods are annual groupings every seven years (top), seasonal groupings (middle), and flow periods based on quantile distributions of discharge.

Period	GAM		WRTDS	
	Ave.	% Change	Ave.	% Change
All	2.43	-4.81	2.44	-2.28
Annual				
1986-1993	2.62	-4.93	2.60	-3.06
1994-2000	2.69	-5.05	2.65	-3.55
2001-2007	2.15	-22.42	2.19	-21.51
2008-2014	2.24	47.10	2.30	38.35
Seasonal				
JFM	1.52	9.03	1.48	32.72
AMJ	2.63	5.47	2.62	5.14
JAS	3.06	0.04	3.08	0.79
OND	2.17	-18.16	2.20	-17.55
Flow				
1 (Low)	2.89	-4.78	2.93	-0.42
2	2.41	16.71	2.43	20.31
3	2.28	6.53	2.27	15.20
4 (High)	2.22	-11.58	2.21	-11.27

TABLE 5: Comparison of predicted results between **WRTDS!** and **GAM!**s using average differences (%) and **RMSE!**. Overall comparisons for the entire time series are shown at the top with groupings by different time periods below. Time periods are annual groupings every seven years (top), seasonal groupings (middle), and flow periods based on quantile distributions of discharge. Negative percentages indicate **WRTDS!** predictions were lower than **GAM!** predictions (??).

Period	LE1.2		TF1.6	
	Ave. diff.	RMSE!	Ave. diff.	RMSE!
All	-0.11	0.09	0.01	0.13
Annual				
1986-1993	0.20	0.10	-0.75	0.11
1994-2000	0.34	0.09	-1.29	0.15
2001-2007	-0.55	0.07	0.68	0.13
2008-2014	-0.53	0.08	3.06	0.14
Seasonal				
JFM	0.39	0.12	-2.02	0.14
AMJ	0.22	0.10	-0.66	0.14
JAS	-0.71	0.06	0.76	0.10
OND	-0.46	0.05	1.03	0.15
Flow				
1 (Low)	-0.27	0.07	-0.15	0.10
2	-0.14	0.09	0.70	0.13
3	0.48	0.11	1.06	0.14
4 (High)	-0.53	0.09	-1.77	0.15

TABLE 6: Regression fits comparing predicted (*pred*) and flow-normalized (*norm*) results for **WRTDS!** and **GAM!**s. Values in bold-italic are those where the intercept (β_0) estimate was significantly different from zero or the slope (β_1) estimate was significantly different from one. Fits for the entire time series are shown at the top. Time periods are annual groupings every seven years (top), seasonal groupings (middle), and flow periods based on quantile distributions of discharge.

Period	LE1.2		TF1.6		LE1.2		TF1.6	
	$\beta_{0,pred}$	$\beta_{1,pred}$	$\beta_{0,pred}$	$\beta_{1,pred}$	$\beta_{0,norm}$	$\beta_{1,norm}$	$\beta_{0,norm}$	$\beta_{1,norm}$
All	<i>0.05</i>	<i>0.97</i>	<i>0.08</i>	<i>0.97</i>	<i>0.15</i>	<i>0.94</i>	0.02	0.99
Annual								
1986-1993	0.02	0.99	-0.02	1.00	<i>0.20</i>	<i>0.92</i>	<i>-0.12</i>	<i>1.03</i>
1994-2000	<i>0.16</i>	<i>0.93</i>	-0.03	0.99	<i>0.17</i>	<i>0.92</i>	<i>-0.12</i>	<i>1.02</i>
2001-2007	0.02	0.99	<i>0.13</i>	<i>0.95</i>	<i>0.06</i>	<i>0.98</i>	<i>0.11</i>	<i>0.97</i>
2008-2014	0.00	1.00	<i>0.12</i>	0.97	0.01	0.99	<i>0.08</i>	0.99
Seasonal								
JFM	-0.01	1.01	0.09	<i>0.92</i>	0.01	1.00	<i>0.20</i>	<i>0.84</i>
AMJ	<i>0.28</i>	<i>0.88</i>	<i>0.27</i>	<i>0.89</i>	<i>0.38</i>	<i>0.84</i>	<i>0.34</i>	<i>0.87</i>
JAS	-0.08	1.03	<i>0.34</i>	<i>0.89</i>	<i>0.30</i>	<i>0.85</i>	<i>0.39</i>	<i>0.88</i>
OND	0.02	0.98	<i>0.13</i>	<i>0.95</i>	<i>0.38</i>	<i>0.80</i>	0.03	1.00
Flow								
1 (Low)	<i>0.14</i>	<i>0.92</i>	-0.03	1.01	<i>0.46</i>	<i>0.77</i>	<i>0.16</i>	<i>0.95</i>
2	0.00	1.00	<i>0.12</i>	<i>0.96</i>	<i>0.14</i>	<i>0.94</i>	0.01	1.00
3	0.09	0.96	<i>0.21</i>	<i>0.91</i>	<i>0.12</i>	<i>0.96</i>	-0.02	1.00
4 (High)	0.09	<i>0.96</i>	0.03	<i>0.97</i>	<i>0.09</i>	<i>0.96</i>	<i>0.09</i>	<i>0.95</i>

TABLE 7: Summaries of model performance comparing observed **chla!** with predicted values ($Chl_{obs} \sim \widehat{Chl}_{obs}$) and biological **chla!** with flow-normalized values ($Chl_{bio} \sim \widehat{Chl}_{bio}$) for the three simulated time series (no flow, constant flow, and increasing flow effect). Summaries are **RMSE!** values (deviance in parentheses) comparing results from each model (**GAM!**, **WRTDS!**).

Simulations	$Chl_{obs} \sim \widehat{Chl}_{obs}$	$Chl_{bio} \sim \widehat{Chl}_{bio}$
No flow		
GAM	0.51 (31.2)	0.53 (33.2)
WRTDS	0.50 (29.4)	0.52 (31.7)
Constant flow		
GAM	0.51 (31.2)	0.58 (39.8)
WRTDS	0.53 (32.8)	0.57 (38.9)
Increasing flow		
GAM	0.51 (31.2)	0.54 (35.0)
WRTDS	0.50 (29.7)	0.52 (31.9)

TABLE 8: Qualitative comparisons of generalized additive models and **WRTDS!**. Qualities are grouped by ease of use and statistical considerations. Ease of use qualities are described as good, moderate, or poor and statistical qualities as yes/no.

Quality	GAM!	WRTDS!
ease of use		
computational requirements	good	poor
interpretation ¹	poor	moderate
software and documentation ²	moderate	good
visualization	moderate	good
statistical		
additional variables	y	n
censored data	n	y
confidence intervals	y	y
quantile fits	n	y

¹Relates to statistical foundation, not results

²In reference to analysis of water quality trends