

## Appendix C - Long-term Trends in Phytoplankton Bioindicators

Appendix C - Long term annual trends in the P-IBI and associated bioindicators for the period of 1985 through 2015.

Section I. James River

Station	Parameter	P value	Slope	Baseline	Absolute Change	% Change	Direction	Homogeneity Test P value
TF5.5	Phytoplankton IBI	0.2960	0.00	1.33	0.00	0.00	No Trend	0.3172
TF5.5	Total Abundance	0.5637	77316	21151551	2319470	10.97	No Trend	0.0364
TF5.5	Total Biomass	<0.0001	0.0253	0.3088	0.7603	246.20	Increasing	0.7983
TF5.5	Margalef Diversity Index	0.1765	0.00	2.22	0.14	6.27	No Trend	0.9212
TF5.5	Diatom Biomass	0.0002	0.0067	0.1224	0.1999	163.26	Improving	0.6827
TF5.5	Dinoflagellate Biomass	0.4182	0.0000	0.0007	0.0000	0.00	No Trend	0.5264
TF5.5	Cyanobacteria Biomass	0.0023	0.0005	0.0162	0.0150	92.41	Degrading	0.1412
TF5.5	Chlorophyte Biomass	<0.0001	0.0080	0.0137	0.2410	1762.37	Improving	0.5519
TF5.5	Picoplankton Biomass	<0.0001	-0.0014	0.0768	-0.0371	-48.30	Improving	0.0040
TF5.5	Cryptophyte Biomass	0.0103	-0.0003	0.0103	-0.0087	-84.50	No Trend	0.0016
TF5.5	Cyanobacteria Abundance	<0.0001	72894	4511922	2186810	48.47	Degrading	0.5629
RET5.2	Phytoplankton IBI	0.6837	0.00	3.50	0.00	0.00	No Trend	0.6789
RET5.2	Total Abundance	0.0020	-262509	7317548	-7875263	-107.62	Decreasing	0.0027
RET5.2	Total Biomass	0.5548	0.0013	0.1272	0.0377	29.64	No Trend	0.0019
RET5.2	Margalef Diversity Index	0.2808	0.00	1.60	-0.12	-7.29	No Trend	0.1210
RET5.2	Diatom Biomass	0.9182	0.0001	0.0685	0.0028	4.13	No Trend	0.0046
RET5.2	Dinoflagellate Biomass	0.7262	0.0000	0.0005	0.0000	0.00	No Trend	0.2243
RET5.2	Cyanobacteria Biomass	0.0144	-0.0002	0.0036	-0.0061	-170.16	No Trend	0.1947
RET5.2	Chlorophyte Biomass	0.4039	0.0001	0.0018	0.0026	148.75	No Trend	0.0047
RET5.2	Picoplankton Biomass	<0.0001	-0.0018	0.1136	-0.0479	-42.13	Improving	0.6755
RET5.2	Cryptophyte Biomass	0.0002	-0.0004	0.0144	-0.0120	-83.52	Decreasing	0.0760
RET5.2	Cyanobacteria Abundance	0.0775	-27883	714837	-836490	-117.02	No Trend	0.1032
LE5.5	Phytoplankton IBI	0.0136	0.01	2.32	0.45	19.50	No Trend	0.6946
LE5.5	Total Abundance	0.7322	-6865	4899463	-212822	-4.34	No Trend	0.6979
LE5.5	Total Biomass	0.0662	-0.0017	0.2052	-0.0538	-26.23	No Trend	0.6224
LE5.5	Margalef Diversity Index	0.0710	-0.01	2.44	-0.17	-7.18	No Trend	0.5846
LE5.5	Diatom Biomass	0.2666	-0.0007	0.1416	-0.0230	-16.27	No Trend	0.2218
LE5.5	Dinoflagellate Biomass	0.7802	0.0000	0.0208	0.0014	6.71	No Trend	0.6348
LE5.5	Cyanobacteria Biomass	0.0012	0.0000	0.0000	0.0001	13842.01	Degrading	0.0901
LE5.5	Chlorophyte Biomass	0.0102	0.0000	0.0000	0.0000	0.00	No Trend	0.5680
LE5.5	Picoplankton Biomass	0.1669	-0.0001	0.0689	-0.0032	-4.66	No Trend	0.0944
LE5.5	Cryptophyte Biomass	<0.0001	-0.0005	0.0202	-0.0143	-71.01	Decreasing	0.0850
LE5.5	Cyanobacteria Abundance	<0.0001	6065	14288	188021	1315.91	Degrading	0.2921

Appendix C - Long term annual trends in the P-IBI and associated bioindicators for the period of 1985 through 2015.

Section II. Elizabeth River

Station	Parameter	P value	Slope	Baseline	Absolute Change	% Change	Direction	Homogeneity Test P value
SBE5	Phytoplankton IBI	0.0037	-0.02	1.50	-0.58	-38.57	Degrading	0.2513
SBE5	Total Abundance	0.0008	-67303	2101342	-1817181	-86.48	Decreasing	0.3737
SBE5	Total Biomass	0.0115	-0.0014	0.0617	-0.0385	-62.33	No Trend	0.1874
SBE5	Margalef Diversity Index	0.9302	0.00	2.22	0.01	0.37	No Trend	0.9938
SBE5	Diatom Biomass	0.0005	-0.0009	0.0292	-0.0251	-85.82	Degrading	0.0160
SBE5	Dinoflagellate Biomass	0.8928	0.0000	0.0087	0.0001	1.67	No Trend	0.4126
SBE5	Cyanobacteria Biomass	0.5614	0.0000	0.0001	0.0000	6.37	No Trend	0.5371
SBE5	Chlorophyte Biomass	0.0037	0.0000	0.0003	-0.0001	-38.89	Degrading	0.3688
SBE5	Picoplankton Biomass	0.0435	0.0001	0.0269	0.0035	13.19	No Trend	0.0278
SBE5	Cryptophyte Biomass	<0.0001	-0.0004	0.0137	-0.0115	-83.75	Decreasing	0.6381
SBE5	Cyanobacteria Abundance	0.0277	2688	7868	72576	922.48	No Trend	0.1508

Appendix C - Long term annual trends in the P-IBI and associated bioindicators for the period of 1985 through 2015.

Section III. York River

Station	Parameter	P value	Slope	Baseline	Absolute Change	% Change	Direction	Homogeneity Test P value
TF4.2	Phytoplankton IBI	0.2737	0.00	3.00	0.00	0.00	No Trend	0.2294
TF4.2	Total Abundance	0.1543	30672	1972396	889484	45.10	No Trend	0.8283
TF4.2	Total Biomass	<0.0001	0.0029	0.0274	0.0839	305.88	Increasing	0.9431
TF4.2	Margalef Diversity Index	<0.0001	0.02	1.70	0.51	30.09	Improving	0.3770
TF4.2	Diatom Biomass	<0.0001	0.0016	0.0148	0.0471	319.10	Improving	0.7099
TF4.2	Dinoflagellate Biomass	0.2007	0.0000	0.0002	0.0000	0.00	No Trend	0.8755
TF4.2	Cyanobacteria Biomass	0.0029	0.0000	0.0004	0.0011	297.03	Degrading	0.0355
TF4.2	Chlorophyte Biomass	0.0004	0.0001	0.0009	0.0037	425.82	Improving	0.6784
TF4.2	Picoplankton Biomass	0.4652	0.0001	0.0384	0.0030	7.68	No Trend	0.7127
TF4.2	Cryptophyte Biomass	0.0016	-0.0002	0.0085	-0.0052	-60.36	Decreasing	0.0160
TF4.2	Cyanobacteria Abundance	0.0010	11659	58370	338120	579.27	Degrading	0.0311
RET4.3	Phytoplankton IBI	0.0007	-0.01	2.20	-0.41	-18.82	Degrading	0.7283
RET4.3	Total Abundance	0.6318	-18857	7855528	-565706	-7.20	No Trend	0.0438
RET4.3	Total Biomass	0.6411	0.0006	0.2613	0.0176	6.72	No Trend	0.3418
RET4.3	Margalef Diversity Index	0.2138	0.00	1.53	0.10	6.66	No Trend	0.4336
RET4.3	Diatom Biomass	0.2599	0.0007	0.1276	0.0216	16.94	No Trend	0.0119
RET4.3	Dinoflagellate Biomass	0.4332	0.0001	0.0199	0.0018	9.14	No Trend	0.8822
RET4.3	Cyanobacteria Biomass	0.9020	0.0000	0.0009	0.0000	-1.50	No Trend	0.0308
RET4.3	Chlorophyte Biomass	0.1047	0.0000	0.0000	0.0003	18738.38	No Trend	0.0585
RET4.3	Picoplankton Biomass	0.0898	-0.0003	0.0425	-0.0093	-21.94	No Trend	0.0705
RET4.3	Cryptophyte Biomass	0.0002	-0.0005	0.0193	-0.0145	-75.02	Decreasing	0.0004
RET4.3	Cyanobacteria Abundance	<0.0001	19228	194361	576837	296.79	Degrading	0.2242
WE4.2	Phytoplankton IBI	0.0172	-0.02	2.88	-0.62	-21.57	No Trend	0.8133
WE4.2	Total Abundance	0.1352	-30273	5796962	-938452	-16.19	No Trend	0.2830
WE4.2	Total Biomass	<0.0001	-0.0046	0.3460	-0.1440	-41.63	Decreasing	0.4431
WE4.2	Margalef Diversity Index	0.0004	-0.01	2.55	-0.42	-16.36	Degrading	0.5176
WE4.2	Diatom Biomass	0.0155	-0.0012	0.1414	-0.0372	-26.32	No Trend	0.1337
WE4.2	Dinoflagellate Biomass	0.0336	-0.0005	0.0518	-0.0152	-29.39	No Trend	0.2646
WE4.2	Cyanobacteria Biomass	<0.0001	0.0000	0.0000	0.0003		Degrading	0.2560
WE4.2	Chlorophyte Biomass	0.5039	0.0000	0.0001	0.0000	0.00	No Trend	0.2917
WE4.2	Picoplankton Biomass	0.2804	-0.0002	0.0569	-0.0043	-7.65	No Trend	0.0086
WE4.2	Cryptophyte Biomass	<0.0001	-0.0007	0.0233	-0.0209	-89.66	Decreasing	0.6780
WE4.2	Cyanobacteria Abundance	<0.0001	11679	1536	362046	23570.71	Degrading	0.1367

Appendix C - Long term annual trends in the P-IBI and associated bioindicators for the period of 1985 through 2015.

Section IV. Rappahannock River

Station	Parameter	P value	Slope	Baseline	Absolute Change	% Change	Direction	Homogeneity Test P value
TF3.3	Phytoplankton IBI	0.0094	0.00	3.00	0.00	0.00	No Change	0.4685
TF3.3	Total Abundance	<0.0001	579816	4516659	17394480	385.12	Increasing	0.7867
TF3.3	Total Biomass	<0.0001	0.0151	0.0559	0.4542	812.56	Increasing	0.3431
TF3.3	Margalef Diversity Index	0.2987	0.00	1.46	0.11	7.64	No Trend	0.2758
TF3.3	Diatom Biomass	<0.0001	0.0071	0.0242	0.2128	879.47	Improving	0.4227
TF3.3	Dinoflagellate Biomass	0.1333	0.0000	0.0009	0.0000	3.06	No Trend	0.6332
TF3.3	Cyanobacteria Biomass	<0.0001	0.0009	0.0014	0.0270	1984.10	Degrading	0.6973
TF3.3	Chlorophyte Biomass	<0.0001	0.0022	0.0017	0.0649	3708.28	Improving	0.8813
TF3.3	Picoplankton Biomass	0.4662	-0.0002	0.0717	-0.0064	-8.97	No Trend	0.2099
TF3.3	Cryptophyte Biomass	0.0010	-0.0004	0.0124	-0.0107	-86.34	Decreasing	0.0135
TF3.3	Cyanobacteria Abundance	<0.0001	307285	171100	9218560	5387.84	Degrading	0.4911
RET3.1	Phytoplankton IBI	0.0008	-0.03	3.00	-0.95	-31.82	Degrading	0.0948
RET3.1	Total Abundance	0.0046	202583	6178668	6077487	98.36	Increasing	0.8567
RET3.1	Total Biomass	0.0048	0.0053	0.1596	0.1586	99.38	Increasing	0.8879
RET3.1	Margalef Diversity Index	0.6572	0.00	1.70	0.04	2.30	No Trend	0.0675
RET3.1	Diatom Biomass	0.0224	0.0018	0.0682	0.0533	78.11	No Trend	0.8732
RET3.1	Dinoflagellate Biomass	0.8366	0.0000	0.0208	0.0000	0.00	No Trend	0.7970
RET3.1	Cyanobacteria Biomass	<0.0001	0.0004	0.0019	0.0122	629.15	Degrading	0.5417
RET3.1	Chlorophyte Biomass	<0.0001	0.0004	0.0015	0.0106	711.43	Improving	0.9441
RET3.1	Picoplankton Biomass	0.0050	-0.0009	0.1197	-0.0245	-20.43	Improving	0.2205
RET3.1	Cryptophyte Biomass	0.0015	-0.0004	0.0214	-0.0119	-55.35	Decreasing	0.1725
RET3.1	Cyanobacteria Abundance	<0.0001	118694	169424	3560828	2101.73	Degrading	0.3293
LE3.6	Phytoplankton IBI	0.7918	0.00	2.75	0.00	0.00	No Trend	0.6357
LE3.6	Total Abundance	0.5017	-19657	4596799	-609379	-13.26	No Trend	0.0759
LE3.6	Total Biomass	0.0012	-0.0041	0.3540	-0.1264	-35.71	Decreasing	0.7351
LE3.6	Margalef Diversity Index	0.0072	-0.01	2.13	-0.22	-10.40	Degrading	0.5479
LE3.6	Diatom Biomass	0.0487	-0.0013	0.2020	-0.0407	-20.16	No Trend	0.3687
LE3.6	Dinoflagellate Biomass	0.9473	0.0000	0.0232	-0.0008	-3.40	No Trend	0.0232
LE3.6	Cyanobacteria Biomass	<0.0001	0.0000	0.0000	0.0011	171973.81	Degrading	0.7672
LE3.6	Chlorophyte Biomass	0.3919	0.0000	0.0002	0.0000	0.00	No Trend	0.5749
LE3.6	Picoplankton Biomass	<0.0001	-0.0008	0.1065	-0.0222	-20.81	Improving	0.2512
LE3.6	Cryptophyte Biomass	<0.0001	-0.0006	0.0272	-0.0198	-72.55	Decreasing	0.1916
LE3.6	Cyanobacteria Abundance	<0.0001	25514	256	790928	308956.10	Degrading	0.6544

Appendix C - Long term annual trends in the P-IBI and associated bioindicators for the period of 1985 through 2015.

Section V. Virginia Chesapeake Bay Mainstem

Station	Parameter	P value	Slope	Baseline	Absolute Change	% Change	Direction	Homogeneity Test P value
CB6.1	Phytoplankton IBI	0.7436	0.00	3.18	0.00	0.00	No Trend	0.6022
CB6.1	Total Abundance	0.8000	-4464	4748803	-138377	-2.91	No Trend	0.4548
CB6.1	Total Biomass	<0.0001	-0.0050	0.4139	-0.1561	-37.71	Decreasing	0.0070
CB6.1	Margalef Diversity Index	0.0136	-0.01	2.26	-0.23	-10.13	No Trend	0.4965
CB6.1	Diatom Biomass	0.0354	-0.0011	0.2199	-0.0352	-16.02	No Trend	0.1324
CB6.1	Dinoflagellate Biomass	0.4473	-0.0002	0.0321	-0.0069	-21.39	No Trend	0.0149
CB6.1	Cyanobacteria Biomass	<0.0001	0.0000	0.0000	0.0010	156352.65	Degrading	0.8078
CB6.1	Chlorophyte Biomass	0.9682	0.0000	0.0001	0.0000	0.00	No Trend	0.4671
CB6.1	Picoplankton Biomass	<0.0001	-0.0009	0.0820	-0.0237	-28.97	Improving	0.1588
CB6.1	Cryptophyte Biomass	<0.0001	-0.0007	0.0257	-0.0213	-82.74	Decreasing	0.6459
CB6.1	Cyanobacteria Abundance	<0.0001	22744	9978	705079	7066.16	Degrading	0.5788
CB6.4	Phytoplankton IBI	0.4788	0.00	2.83	0.00	0.00	No Trend	0.4607
CB6.4	Total Abundance	0.2027	28223	3469502	874916	25.22	No Trend	0.3691
CB6.4	Total Biomass	0.0038	-0.0030	0.2170	-0.0945	-43.53	Decreasing	0.0638
CB6.4	Margalef Diversity Index	<0.0001	-0.01	2.14	-0.44	-20.49	Degrading	0.0905
CB6.4	Diatom Biomass	0.0153	-0.0013	0.1559	-0.0390	-25.04	No Trend	0.0233
CB6.4	Dinoflagellate Biomass	0.4985	-0.0001	0.0319	-0.0039	-12.21	No Trend	0.3028
CB6.4	Cyanobacteria Biomass	<0.0001	0.0000	0.0000	0.0005		Degrading	0.9890
CB6.4	Chlorophyte Biomass	0.5383	0.0000	0.0001	0.0000	0.00	No Trend	0.0730
CB6.4	Picoplankton Biomass	0.0011	-0.0005	0.0925	-0.0138	-14.88	Improving	0.6587
CB6.4	Cryptophyte Biomass	<0.0001	-0.0005	0.0168	-0.0159	-94.78	Decreasing	0.1761
CB6.4	Cyanobacteria Abundance	<0.0001	14826	0	459598		Degrading	0.6911
CB7.3E	Phytoplankton IBI	0.3900	0.00	3.07	0.03	1.02	No Trend	0.1549
CB7.3E	Total Abundance	0.9319	-1522	3139422	-47185	-1.50	No Trend	0.7082
CB7.3E	Total Biomass	0.0012	-0.0033	0.2891	-0.1026	-35.49	Decreasing	0.1664
CB7.3E	Margalef Diversity Index	<0.0001	-0.01	2.36	-0.42	-17.63	Degrading	0.9928
CB7.3E	Diatom Biomass	0.0136	-0.0013	0.1861	-0.0398	-21.37	No Trend	0.4814
CB7.3E	Dinoflagellate Biomass	0.1749	-0.0003	0.0314	-0.0089	-28.31	No Trend	0.1909
CB7.3E	Cyanobacteria Biomass	<0.0001	0.0000	0.0000	0.0002	2264.84	Degrading	0.9749
CB7.3E	Chlorophyte Biomass	0.7037	0.0000	0.0000	0.0000	0.00	No Trend	0.3220
CB7.3E	Picoplankton Biomass	0.0477	-0.0003	0.0831	-0.0088	-10.57	No Trend	0.2797
CB7.3E	Cryptophyte Biomass	<0.0001	-0.0005	0.0180	-0.0143	-79.55	Decreasing	0.7867
CB7.3E	Cyanobacteria Abundance	<0.0001	9138	8294	283271	3415.27	Degrading	0.9595
CB7.4	Phytoplankton IBI	0.3647	0.00	3.01	0.03	1.14	No Trend	0.2062
CB7.4	Total Abundance	0.3501	13510	2415823	418812	17.34	No Trend	0.6595
CB7.4	Total Biomass	0.2255	-0.0011	0.1411	-0.0344	-24.38	No Trend	0.2477
CB7.4	Margalef Diversity Index	<0.0001	-0.02	2.77	-0.76	-27.61	Degrading	0.7044
CB7.4	Diatom Biomass	0.9023	-0.0001	0.1103	-0.0019	-1.73	No Trend	0.2424
CB7.4	Dinoflagellate Biomass	0.4388	-0.0001	0.0182	-0.0032	-17.33	No Trend	0.3064
CB7.4	Cyanobacteria Biomass	<0.0001	0.0000	0.0000	0.0001		Degrading	0.9952
CB7.4	Chlorophyte Biomass	0.7160	0.0000	0.0000	0.0000	0.00	No Trend	0.1574
CB7.4	Picoplankton Biomass	0.7129	-0.0001	0.0978	-0.0016	-1.62	No Trend	0.5654
CB7.4	Cryptophyte Biomass	<0.0001	-0.0003	0.0078	-0.0089	-113.68	Decreasing	0.3907
CB7.4	Cyanobacteria Abundance	<0.0001	8552	240	265097	110456.88	Degrading	0.9077

