

Appendix C - Long-term Trends in Phytoplankton Bioindicators

Appendix C - Section A. Long-term trends in phytoplankton index of biotic integrity (IBI) primary productivity and selected indicators in the James River, for the period of 1985 through 2008. See the method section of the report for definitions of Seasons. "N.E." in the Percent Change column indicates "No Estimate" was made for the percent change due to a zero value for the parameter baseline. Note: Primary productivity trends are for the period of 1990 through 2008.

Station	Season	Parameter	P value	Slope	Baseline	Percent Change	Direction	Homogeneity test P value
TF5.5	ANNUAL	Phytoplankton IBI	0.4666	0.00	1.60	0.00	No Trend	0.5037
TF5.5	ANNUAL	Total Abundance	0.0223	519646	21243084	56.26	No Trend	0.0247
TF5.5	ANNUAL	Total Biomass	0.0000	44153954	509107199	199.47	Increasing	0.5893
TF5.5	ANNUAL	Margalef Diversity Index	0.8179	0.00	2.39	0.80	No Trend	0.8775
TF5.5	ANNUAL	C14 Productivity	0.0001	3.16	32.33	195.73	Degrading	0.7061
TF5.5	ANNUAL	Diatom Biomass	0.1463	5802893	343870864	38.81	No Trend	0.3687
TF5.5	ANNUAL	Dinoflagellate Biomass	0.1263	0	700211	0.00	No Trend	0.5885
TF5.5	ANNUAL	Cyanobacteria Biomass	0.0000	924047	16209464	131.12	Degrading	0.7077
TF5.5	ANNUAL	Chlorophyte Biomass	0.0000	16298972	13674242	2741.48	Improving	0.9559
TF5.5	ANNUAL	Picoplankton Biomass	0.0005	-1387500	76800000	-36.13	Improving	0.1359
TF5.5	ANNUAL	Cryptophyte Biomass	0.5887	59029	10266340	13.22	No Trend	0.1869
TF5.5	ANNUAL	Cyanobacteria Abundance	0.0000	125991	4511922	64.23	Degrading	0.5297
RET5.2	ANNUAL	Phytoplankton IBI	0.2932	0.00	2.50	0.00	No Trend	0.2757
RET5.2	ANNUAL	Total Abundance	0.8302	-34609	7429901	-10.71	No Trend	0.0815
RET5.2	ANNUAL	Total Biomass	0.0158	11505676	168028570	157.49	No Trend	0.0809
RET5.2	ANNUAL	Margalef Diversity Index	0.0001	-0.02	1.65	-31.35	Degrading	0.4904
RET5.2	ANNUAL	C14 Productivity	0.0361	-1.29	125.14	-20.56	Improving	0.0830
RET5.2	ANNUAL	Diatom Biomass	0.4110	2573875	117653325	50.32	No Trend	0.0790
RET5.2	ANNUAL	Dinoflagellate Biomass	0.5972	0	478731	0.00	No Trend	0.4674
RET5.2	ANNUAL	Cyanobacteria Biomass	0.5919	74776	3577520	48.07	No Trend	0.3679
RET5.2	ANNUAL	Chlorophyte Biomass	0.0002	1936266	1762185	2527.21	Improving	0.0571
RET5.2	ANNUAL	Picoplankton Biomass	0.0002	-1952200	113625000	-34.36	Improving	0.1713
RET5.2	ANNUAL	Cryptophyte Biomass	0.3125	214480	14385423	34.29	No Trend	0.9115
RET5.2	ANNUAL	Cyanobacteria Abundance	0.6294	-9966	714837	-32.07	No Trend	0.2871
LE5.5	ANNUAL	Phytoplankton IBI	0.8517	0.00	2.49	0.00	No Trend	0.6599
LE5.5	ANNUAL	Total Abundance	0.0327	62399	5066591	29.56	No Trend	0.1439
LE5.5	ANNUAL	Total Biomass	0.3556	2195533	235110748	22.41	No Trend	0.0197
LE5.5	ANNUAL	Margalef Diversity Index	0.1019	-0.01	2.50	-8.39	No Trend	0.3636
LE5.5	ANNUAL	C14 Productivity	0.0985	0.84	62.05	27.20	No Trend	0.2721
LE5.5	ANNUAL	Diatom Biomass	0.1980	1834119	161454403	27.26	No Trend	0.0132
LE5.5	ANNUAL	Dinoflagellate Biomass	0.1590	347840	20753674	40.22	No Trend	0.7422
LE5.5	ANNUAL	Cyanobacteria Biomass	0.0000	14213	508	67213.29	Degrading	0.1358
LE5.5	ANNUAL	Chlorophyte Biomass	0.4449	0	5826	0.00	No Trend	0.7607
LE5.5	ANNUAL	Picoplankton Biomass	0.1530	-184286	68925000	-5.35	No Trend	0.7826
LE5.5	ANNUAL	Cryptophyte Biomass	0.0008	-391524	20197572	-46.52	Decreasing	0.4009
LE5.5	ANNUAL	Cyanobacteria Abundance	0.0000	4057	14288	681.48	Degrading	0.3528

Appendix C - Section B. Long term trends in phytoplankton index of biotic integrity (IBI) primary productivity and selected indicators in the Elizabeth River, for the period of 1985 through 2008. See the method section of the report for definitions of Seasons. "N.E." in the Percent Change column indicates "No Estimate" was made for the percent change due to a zero value for the parameter baseline. Note: Primary productivity trends are for the period of 1990 through 2008.

Station	Season	Parameter	P value	Slope	Baseline	Percent Change	Direction	Homogeneity test P value
SBE5	ANNUAL	Phytoplankton IBI	0.2720	0.00	1.40	0.00	No Trend	0.2504
SBE5	ANNUAL	Total Abundance	0.6024	14639	2554411	11.46	No Trend	0.2996
SBE5	ANNUAL	Total Biomass	0.1370	-1596637	76329377	-41.84	No Trend	0.3625
SBE5	ANNUAL	Margalef Diversity Index	0.3293	-0.01	2.40	-4.96	No Trend	0.3629
SBE5	ANNUAL	C14 Productivity	0.3313	0.35	57.37	10.89	No Trend	0.5705
SBE5	ANNUAL	Diatom Biomass	0.0499	-1491515	44433057	-67.14	No Trend	0.1436
SBE5	ANNUAL	Dinoflagellate Biomass	0.5634	-45281	8659873	-10.46	No Trend	0.4842
SBE5	ANNUAL	Cyanobacteria Biomass	0.0002	39264	103136	761.40	Degrading	0.8788
SBE5	ANNUAL	Chlorophyte Biomass	0.2217	-961	276008	-6.97	No Trend	0.5666
SBE5	ANNUAL	Picoplankton Biomass	0.1354	107183	26850000	7.98	No Trend	0.0474
SBE5	ANNUAL	Cryptophyte Biomass	0.0830	-218993	13747694	-31.86	No Trend	0.8146
SBE5	ANNUAL	Cyanobacteria Abundance	0.0030	4280	7868	1087.98	Degrading	0.2071

Appendix C - Section C. Long term trends in phytoplankton index of biotic integrity (IBI) primary productivity and selected indicators in the York River, for the period of 1985 through 2008. See the method section of the report for definitions of Seasons. "N.E." in the Percent Change column indicates "No Estimate" was made for the percent change due to a zero value for the parameter baseline. Note: Primary productivity trends are for the period of 1990 through 2008.

Station	Season	Parameter	P value	Slope	Baseline	Percent Change	Direction	Homogeneity test P value
TF4.2	ANNUAL	Phytoplankton IBI	0.6216	0.00	3.00	0.00	No Trend	0.0166
TF4.2	ANNUAL	Total Abundance	0.0095	83050	3316370	55.09	Increasing	0.9982
TF4.2	ANNUAL	Total Biomass	0.0704	2688999	100121180	59.09	No Trend	0.8805
TF4.2	ANNUAL	Margalef Diversity Index	0.6254	0.00	1.85	-2.84	No Trend	0.1677
TF4.2	ANNUAL	C14 Productivity	0.0065	0.38	10.29	73.39	Degrading	0.2681
TF4.2	ANNUAL	Diatom Biomass	0.4967	688659	86661160	17.48	No Trend	0.9991
TF4.2	ANNUAL	Dinoflagellate Biomass	0.9843	0	155268	0.00	No Trend	0.5534
TF4.2	ANNUAL	Cyanobacteria Biomass	0.0001	85454	364833	515.30	Degrading	0.1117
TF4.2	ANNUAL	Chlorophyte Biomass	0.0000	308066	871272	777.88	Improving	0.7679
TF4.2	ANNUAL	Picoplankton Biomass	0.5498	-94520	38400000	-4.92	No Trend	0.9407
TF4.2	ANNUAL	Cryptophyte Biomass	0.2879	149500	8547560	38.48	No Trend	0.5034
TF4.2	ANNUAL	Cyanobacteria Abundance	0.0092	10479	58370	394.95	Degrading	0.0772
RET4.3	ANNUAL	Phytoplankton IBI	0.6697	0.00	1.50	0.00	No Trend	0.2074
RET4.3	ANNUAL	Total Abundance	0.0323	163174	7856296	47.77	No Trend	0.4548
RET4.3	ANNUAL	Total Biomass	0.0130	6464785	329829759	45.08	No Trend	0.7215
RET4.3	ANNUAL	Margalef Diversity Index	0.8922	0.00	1.61	-0.49	No Trend	0.2813
RET4.3	ANNUAL	C14 Productivity	0.0007	1.61	34.81	92.27	Degrading	0.7536
RET4.3	ANNUAL	Diatom Biomass	0.0913	3356348	185043140	41.72	No Trend	0.2770
RET4.3	ANNUAL	Dinoflagellate Biomass	0.2904	137738	19948221	15.88	No Trend	0.8218
RET4.3	ANNUAL	Cyanobacteria Biomass	0.0003	136397	901456	348.01	Degrading	0.8725
RET4.3	ANNUAL	Chlorophyte Biomass	0.0000	216340	1404	354363.54	Improving	0.3854
RET4.3	ANNUAL	Picoplankton Biomass	0.4784	-182944	42525000	-8.60	No Trend	0.3417
RET4.3	ANNUAL	Cryptophyte Biomass	0.7795	-86356	19348050	-10.27	No Trend	0.0490
RET4.3	ANNUAL	Cyanobacteria Abundance	0.0001	18196	194361	215.32	Degrading	0.9616
WE4.2	ANNUAL	Phytoplankton IBI	0.0201	0.02	2.39	21.34	No Trend	0.0752
WE4.2	ANNUAL	Total Abundance	0.2753	32875	6089918	12.96	No Trend	0.6708
WE4.2	ANNUAL	Total Biomass	0.8417	-532914	358999358	-3.56	No Trend	0.5954
WE4.2	ANNUAL	Margalef Diversity Index	0.0005	-0.02	2.61	-19.26	Degrading	0.2777
WE4.2	ANNUAL	C14 Productivity	0.0157	1.09	50.54	43.23	Degrading	0.4133
WE4.2	ANNUAL	Diatom Biomass	0.5697	943594	183248326	12.36	No Trend	0.2968
WE4.2	ANNUAL	Dinoflagellate Biomass	0.1487	569987	51821394	26.40	No Trend	0.1841
WE4.2	ANNUAL	Cyanobacteria Biomass	0.0000	29340	0		Degrading	0.2426
WE4.2	ANNUAL	Chlorophyte Biomass	0.4372	0	71432	0.00	No Trend	0.6662
WE4.2	ANNUAL	Picoplankton Biomass	0.4061	-191167	56850000	-6.73	No Trend	0.3104
WE4.2	ANNUAL	Cryptophyte Biomass	0.0000	-729890	23280456	-75.24	Decreasing	0.2686
WE4.2	ANNUAL	Cyanobacteria Abundance	0.0000	5376	1536	8399.59	Degrading	0.5508

Appendix C - Section D. Long term trends in phytoplankton index of biotic integrity (IBI) primary productivity and selected indicators in the Rappahannock River, for the period of 1985 through 2008. See the method section of the report for definitions of Seasons. "N.E." in the Percent Change column indicates "No Estimate" was made for the percent change due to a zero value for the parameter baseline. Note: Primary productivity trends are for the period of 1990 through 2008.

Station	Season	Parameter	P value	Slope	Baseline	Percent Change	Direction	Homogeneity test P value
TF3.3	ANNUAL	Phytoplankton IBI	0.1018	0.00	2.00	0.00	No Trend	0.0003
TF3.3	ANNUAL	Total Abundance	0.0000	1058181	4890501	497.66	Increasing	0.7241
TF3.3	ANNUAL	Total Biomass	0.0000	33571723	94304280	818.79	Increasing	0.6781
TF3.3	ANNUAL	Margalef Diversity Index	0.3581	0.00	1.54	6.65	No Trend	0.9615
TF3.3	ANNUAL	C14 Productivity	0.0000	4.62	51.88	178.25	Degrading	0.6408
TF3.3	ANNUAL	Diatom Biomass	0.0000	19478208	72419559	618.62	Improving	0.6813
TF3.3	ANNUAL	Dinoflagellate Biomass	0.0075	22961	881362	59.92	Degrading	0.6850
TF3.3	ANNUAL	Cyanobacteria Biomass	0.0000	1356462	1358370	2296.77	Degrading	0.5484
TF3.3	ANNUAL	Chlorophyte Biomass	0.0000	3934498	1749939	5171.23	Improving	0.8959
TF3.3	ANNUAL	Picoplankton Biomass	0.7689	114503	71700000	3.19	No Trend	0.6884
TF3.3	ANNUAL	Cryptophyte Biomass	0.7455	-53348	12445860	-9.86	No Trend	0.4083
TF3.3	ANNUAL	Cyanobacteria Abundance	0.0000	300781	171100	4043.24	Degrading	0.8910
RET3.1	ANNUAL	Phytoplankton IBI	1.0000	0.00	2.25	0.00	No Trend	0.4884
RET3.1	ANNUAL	Total Abundance	0.0000	623223	6640168	215.87	Increasing	0.4423
RET3.1	ANNUAL	Total Biomass	0.0000	17968180	201242741	205.36	Increasing	0.5698
RET3.1	ANNUAL	Margalef Diversity Index	0.1899	-0.01	1.77	-7.54	No Trend	0.4308
RET3.1	ANNUAL	C14 Productivity	0.0000	4.11	65.84	124.97	Degrading	0.3669
RET3.1	ANNUAL	Diatom Biomass	0.0023	6084739	117569989	119.03	Improving	0.6495
RET3.1	ANNUAL	Dinoflagellate Biomass	0.4572	-35213	20778928	-3.90	No Trend	0.8753
RET3.1	ANNUAL	Cyanobacteria Biomass	0.0000	957823	1936906	1137.38	Degrading	0.1391
RET3.1	ANNUAL	Chlorophyte Biomass	0.0000	1012328	1492127	1560.43	Improving	0.5330
RET3.1	ANNUAL	Picoplankton Biomass	0.5012	-227127	119700000	-3.79	No Trend	0.8768
RET3.1	ANNUAL	Cryptophyte Biomass	0.9208	-19350	21408468	-2.08	No Trend	0.3543
RET3.1	ANNUAL	Cyanobacteria Abundance	0.0000	122552	169424	1663.69	Degrading	0.7335
LE3.6	ANNUAL	Phytoplankton IBI	0.0136	0.03	2.88	22.96	No Trend	0.9784
LE3.6	ANNUAL	Total Abundance	0.0118	108096	5063581	51.23	No Trend	0.9086
LE3.6	ANNUAL	Total Biomass	0.4282	-2125064	377739520	-13.50	No Trend	0.7127
LE3.6	ANNUAL	Margalef Diversity Index	0.0472	-0.01	2.23	-9.89	No Trend	0.3666
LE3.6	ANNUAL	C14 Productivity	0.0171	0.86	34.88	49.33	Degrading	0.8597
LE3.6	ANNUAL	Diatom Biomass	0.3269	-1607198	225079575	-17.14	No Trend	0.7512
LE3.6	ANNUAL	Dinoflagellate Biomass	0.0207	911260	23164503	94.41	No Trend	0.0610
LE3.6	ANNUAL	Cyanobacteria Biomass	0.0000	80229	643	299362.54	Degrading	0.8378
LE3.6	ANNUAL	Chlorophyte Biomass	0.2995	0	186621	0.00	No Trend	0.6751
LE3.6	ANNUAL	Picoplankton Biomass	0.0000	-1243040	106500000	-23.34	Improving	0.5440
LE3.6	ANNUAL	Cryptophyte Biomass	0.0000	-522830	27224033	-46.09	Decreasing	0.1726
LE3.6	ANNUAL	Cyanobacteria Abundance	0.0000	17975	256	168514.90	Degrading	0.7693

Appendix C - Section E. Long term trends in phytoplankton index of biotic integrity (IBI) primary productivity and selected indicators in the Mainstem, for the period of 1985 through 2008. See the method section of the report for definitions of Seasons. "N.E." in the Percent Change column indicates "No Estimate" was made for the percent change due to a zero value for the parameter baseline. Note: Primary productivity trends are for the period of 1990 through 2008.

Station	Season	Parameter	P value	Slope	Baseline	Percent Change	Direction	Homogeneity test P value
CB6.1	ANNUAL	Phytoplankton IBI	0.1695	0.01	3.25	5.77	No Trend	0.5777
CB6.1	ANNUAL	Total Abundance	0.0254	60100	5316407	27.13	No Trend	0.5904
CB6.1	ANNUAL	Total Biomass	0.1850	-3383292	422147678	-19.23	No Trend	0.0322
CB6.1	ANNUAL	Margalef Diversity Index	0.3042	-0.01	2.33	-5.36	No Trend	0.5526
CB6.1	ANNUAL	C14 Productivity	0.2942	0.32	23.89	27.18	No Trend	0.9069
CB6.1	ANNUAL	Diatom Biomass	0.4013	-1073741	228810663	-11.26	No Trend	0.1433
CB6.1	ANNUAL	Dinoflagellate Biomass	0.4950	317355	32128541	23.71	No Trend	0.0229
CB6.1	ANNUAL	Cyanobacteria Biomass	0.0000	50340	653	185075.02	Degrading	0.2650
CB6.1	ANNUAL	Chlorophyte Biomass	0.3276	0	140324	0.00	No Trend	0.6407
CB6.1	ANNUAL	Picoplankton Biomass	0.0000	-1574944	81975000	-38.42	Improving	0.5890
CB6.1	ANNUAL	Cryptophyte Biomass	0.0000	-734648	25735449	-68.51	Decreasing	0.8761
CB6.1	ANNUAL	Cyanobacteria Abundance	0.0000	10537	9978	2534.49	Degrading	0.4604
CB6.4	ANNUAL	Phytoplankton IBI	0.1039	0.01	2.74	12.85	No Trend	0.8728
CB6.4	ANNUAL	Total Abundance	0.0041	90964	3712028	58.81	Increasing	0.8840
CB6.4	ANNUAL	Total Biomass	0.8038	410151	221864754	4.44	No Trend	0.7925
CB6.4	ANNUAL	Margalef Diversity Index	0.0020	-0.01	2.19	-15.54	Degrading	0.1508
CB6.4	ANNUAL	C14 Productivity	0.0091	0.92	30.47	60.45	Degrading	0.8394
CB6.4	ANNUAL	Diatom Biomass	0.8038	-373778	161577654	-5.55	No Trend	0.8825
CB6.4	ANNUAL	Dinoflagellate Biomass	0.0047	1307229	31861194	98.47	Degrading	0.5345
CB6.4	ANNUAL	Cyanobacteria Biomass	0.0000	22821	0		Degrading	0.9987
CB6.4	ANNUAL	Chlorophyte Biomass	0.3883	0	82373	0.00	No Trend	0.6852
CB6.4	ANNUAL	Picoplankton Biomass	0.0000	-996931	92512500	-21.55	Improving	0.8943
CB6.4	ANNUAL	Cryptophyte Biomass	0.0027	-423794	16798536	-60.55	Decreasing	0.0234
CB6.4	ANNUAL	Cyanobacteria Abundance	0.0000	6589	0		Degrading	0.9876
CB7.3E	ANNUAL	Phytoplankton IBI	0.2905	0.01	2.67	8.25	No Trend	0.9745
CB7.3E	ANNUAL	Total Abundance	0.0291	59272	3428481	41.49	No Trend	0.2471
CB7.3E	ANNUAL	Total Biomass	0.7519	-531926	297662958	-4.29	No Trend	0.2765
CB7.3E	ANNUAL	Margalef Diversity Index	0.0008	-0.02	2.46	-17.99	Degrading	0.7276
CB7.3E	ANNUAL	C14 Productivity	0.0772	0.40	20.48	39.46	No Trend	0.9523
CB7.3E	ANNUAL	Diatom Biomass	0.8592	-254461	193693507	-3.15	No Trend	0.7107
CB7.3E	ANNUAL	Dinoflagellate Biomass	0.4360	229709	31423533	17.54	No Trend	0.2365
CB7.3E	ANNUAL	Cyanobacteria Biomass	0.0000	28730	9326	7393.53	Degrading	0.9518
CB7.3E	ANNUAL	Chlorophyte Biomass	0.0808	0	1569	0.00	No Trend	0.8003
CB7.3E	ANNUAL	Picoplankton Biomass	0.0993	-417516	83062500	-10.05	No Trend	0.9663
CB7.3E	ANNUAL	Cryptophyte Biomass	0.0008	-371787	18016468	-49.53	Decreasing	0.1763
CB7.3E	ANNUAL	Cyanobacteria Abundance	0.0000	5956	8294	1723.49	Degrading	0.9228
CB7.4	ANNUAL	Phytoplankton IBI	0.0977	0.02	3.15	12.40	No Trend	0.3438
CB7.4	ANNUAL	Total Abundance	0.0004	84976	2535640	80.43	Increasing	0.7567
CB7.4	ANNUAL	Total Biomass	0.0561	3923705	163322672	57.66	No Trend	0.8387
CB7.4	ANNUAL	Margalef Diversity Index	0.0000	-0.04	2.85	-31.62	Degrading	0.9332
CB7.4	ANNUAL	C14 Productivity	0.0021	0.56	15.95	70.50	Degrading	0.6604
CB7.4	ANNUAL	Diatom Biomass	0.0601	2261431	135076476	40.18	No Trend	0.7685
CB7.4	ANNUAL	Dinoflagellate Biomass	0.0363	509710	18234240	67.09	No Trend	0.4947
CB7.4	ANNUAL	Cyanobacteria Biomass	0.0000	3566	0		Degrading	0.7390
CB7.4	ANNUAL	Chlorophyte Biomass	0.4433	0	29864	0.00	No Trend	0.0351
CB7.4	ANNUAL	Picoplankton Biomass	0.1794	-277103	97800000	-5.67	No Trend	0.5149
CB7.4	ANNUAL	Cryptophyte Biomass	0.0436	-173091	7805429	-53.22	No Trend	0.4219
CB7.4	ANNUAL	Cyanobacteria Abundance	0.0000	3700	240	36998.48	Degrading	0.3365