D R A F T

A Model for Simulating Phosphorus Concentrations in Waters and Soils Downstream of Everglades Stormwater Treatment Areas

prepared for

U.S. Department of Interior

by

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A P P E N D I X

Simulation Results

System	Depth cm	Summary	Graphs	Output Matrix
STA-2	10	1	2	3
STA-34	10	4	5	6
STA-5	10	7	8	9
STA-6	10	10	11	12
STA-2	20	13	14	15
STA-34	20	16	17	18
STA-5	20	19	20	21
STA-6	20	22	23	24
STA-2 GDR	10	25	26	27
STA-2 GDR	20	28	29	30
S10s	10	31	32	33
S10s	20	34	35	36

E P G M **STA-2** **Depth:** **10 cm** **Page:** **1**
Receiving Area: **NW 2A** **Start:** **1999**

Input Variables

Variable	Units	Values	Input Variable	Units	Values
Rainfall P Conc.	ppb	30	Soil Depth	cm	10
Rainfall	m/yr	1.23	Initial Bulk Density	g/cm3	0.080
ET	m/yr	1.38	Initial P Content	mg/kg	442
STA Outflow Conc.	ppb	50	Initial Gradient	mg/cm3/cm	-0.0018
STA Outflow Volume	hm3/yr	254.0	Final Bulk Density	g/cm3	0.080
Flow Path Width	km	12.1	P Settling Rate, Yr 1	m/yr	30.0
Hydroperiod	-	92%	P Settling Rate, Yr 2	m/yr	20.0
Logisitic Coef - Spread	-	144.1	P Settling Rate, Yr >=3	m/yr	10.2
Logistic Coef - MidPoint	-	1034.4	Spatial Resolution	ha	121

Profile at Beginning of Year 2007

Distance	km	0.0	0.5	1.0	2.0	4.0	8.0
Soil Accretion Rate	cm/yr	0.51	0.47	0.43	0.35	0.22	0.11
P Accretion Rate	mg/m2-yr	469	384	315	216	110	49
Bulk Density	g/cm3	0.080	0.080	0.080	0.080	0.080	0.080
Soil TP Conc.	mg/kg	928	764	664	559	482	458
Volumetric TP Conc.	mg/cm3	0.074	0.061	0.053	0.045	0.039	0.037
Cattail Density	%	32%	13%	7%	4%	2%	2%
Water Column TP	ppb	50	41	34	23	12	5

Water-Column P Impacts

		Threshold Criterion		
Variable	Units	Low	Medium	High
Water Column Conc.	ppb	10	20	30
Distance Exceeded	km	4.55	2.35	1.25
Area Exceeded	ha	5506	2844	1513

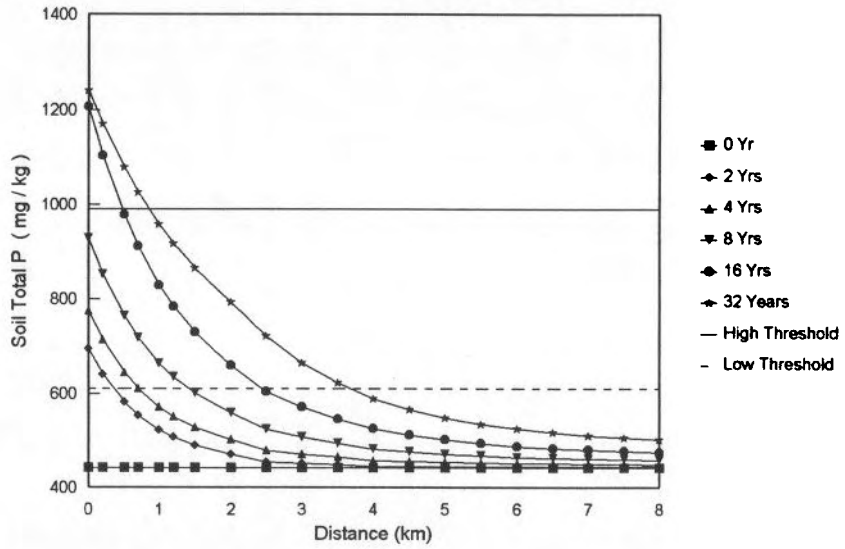
Soil P Impacts

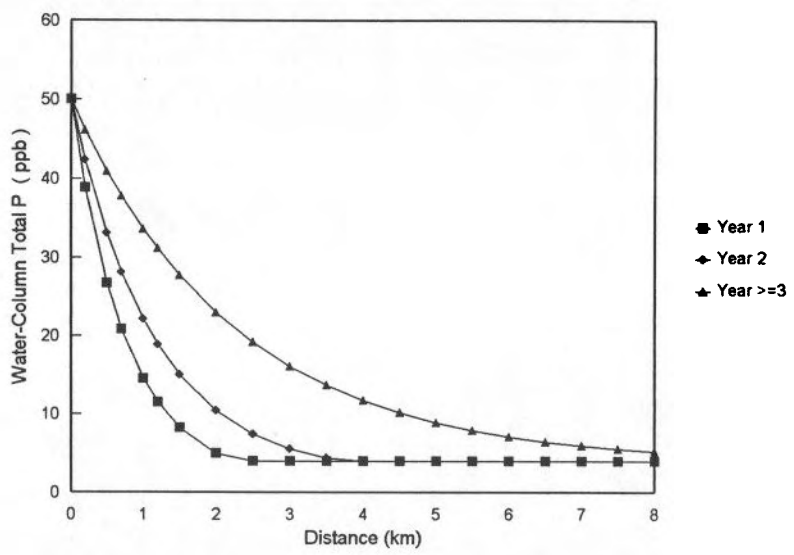
		Threshold Criterion		
Variable	Units	Low	Medium	High
Threshold Soil P	mg/kg	610	870	990
Equivalent Threshold Conc	ppb	11	30	38
Time to Steady State				
At C = 50 ppb	years	20	20	20
At C = Threshold	years	49	25	22
Exceedance of Soil P Criteria				
Initial Time	years	2	7	10
Calendar Year		2000	2005	2008
Maximum Time	years	38	27	17
Calendar Year		2036	2025	2015
Maximum Distance	km	4.0	1.6	1.0
Maximum Area	ha	4780	1876	1150
Exceedance of Soil P Criteria at End of Year 2006				
Distance Exceeded	km	1.5	0.2	0.0
Area Exceeded	ha	1755	182	0

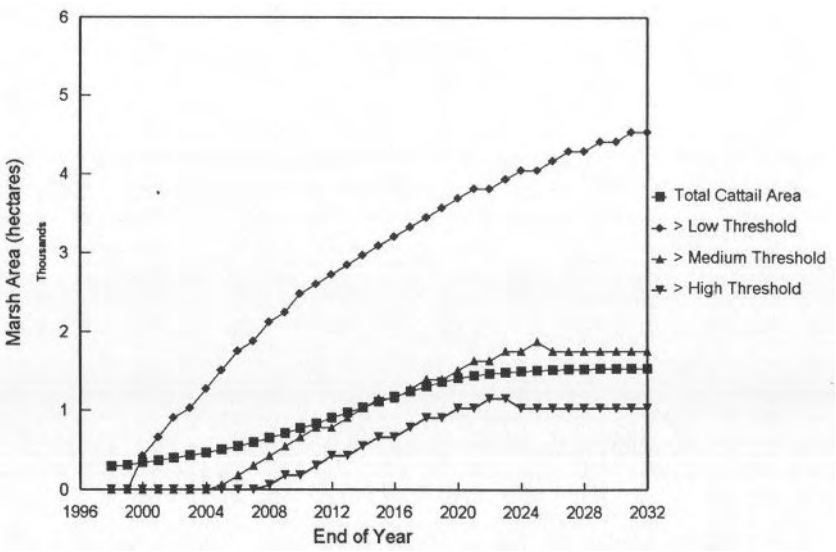
Soil P & Cattail Time Series

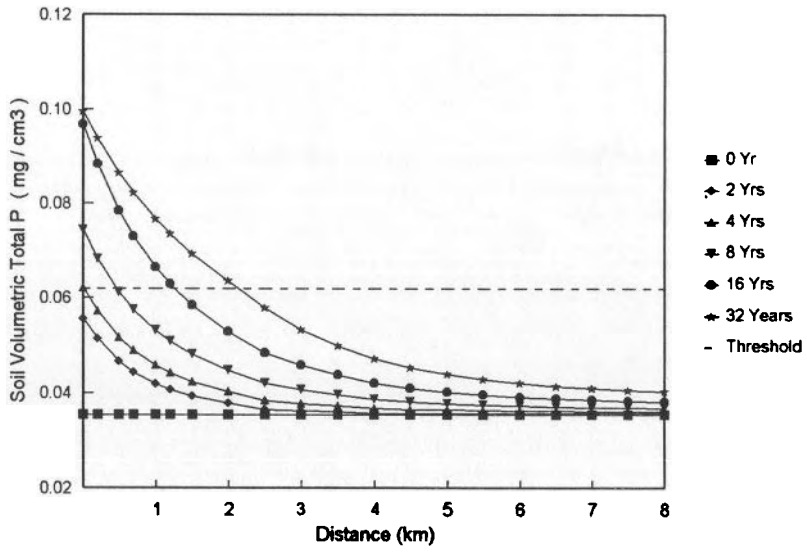
End of Year	1998	2000	2002	2004	2006	2008	2010
Soil P @ 0 km (mg/kg)	442	694	775	852	928	1001	1072
Cattail Density @ 0 km	2%	9%	14%	22%	32%	44%	57%
Cattail Density @ 1 km	2%	3%	4%	5%	7%	9%	12%
Cattail Density @ 2 km	2%	2%	2%	3%	4%	4%	5%
Total Cattail Area (ha)	291	344	397	465	550	653	772
Area Increase (ha)	0	53	106	173	259	362	481
Area with Density > 5%	0	424	908	1271	1755	2118	2481
Area with Density > 10%	0	0	182	545	908	1150	1392
Area with Density > 50%	0	0	0	0	0	0	61
Area with Density > 90%	0	0	0	0	0	0	0

E P G M **STA-2** **Depth = 10 cm** **Startup Date =** **1999**









Soil P Concentrations (mg / kg) at End of Year

Distance	Wtr-Col Total P	Time in Years																		
		0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2010	2013	2018	2023	2028	2033	2038	SS
0.0	50	442	597	694	735	775	814	852	891	928	965	1001	1072	1174	1318	1280	1250	1227	1210	1151
0.1	48	442	577	666	704	742	779	816	852	888	923	958	1025	1121	1271	1238	1212	1192	1177	1124
0.2	46	442	560	641	677	713	749	784	818	852	885	918	982	1074	1215	1200	1177	1159	1146	1098
0.3	44	442	545	619	654	688	722	755	788	820	851	882	943	1030	1164	1164	1144	1128	1116	1073
0.4	43	442	532	599	632	665	697	729	760	790	821	850	908	990	1117	1130	1113	1099	1088	1049
0.5	41	442	521	582	614	645	675	705	735	764	793	821	875	953	1074	1099	1084	1071	1062	1026
0.7	38	442	502	554	582	610	638	665	692	718	744	769	818	889	997	1042	1030	1020	1013	983
1.0	34	442	483	522	547	571	595	618	641	664	686	708	750	810	902	969	960	953	948	925
1.5	28	442	464	489	509	528	546	565	583	600	618	635	668	714	786	848	867	863	860	844
2.0	23	442	454	471	487	502	516	531	545	559	572	586	611	648	704	753	795	792	790	779
2.5	19	442	443	455	467	479	491	502	513	524	535	545	566	595	639	677	710	730	730	727
3.0	16	442	443	452	461	471	480	489	498	507	516	524	540	564	599	630	656	678	687	685
3.5	14	442	443	449	457	465	472	480	487	494	501	508	521	540	569	594	615	634	648	651
4.0	12	442	443	445	451	458	464	470	476	482	487	493	504	519	543	564	582	597	610	624
4.5	10	442	443	445	450	455	461	466	471	475	480	485	494	507	527	545	560	573	584	603
5.0	9	442	443	445	449	454	458	462	467	471	475	479	487	498	515	530	543	555	565	585
6.0	7	442	443	445	448	452	455	458	461	464	468	471	476	485	498	510	521	530	538	561
7.0	6	442	443	445	448	450	453	456	458	461	463	466	470	477	488	498	507	515	522	545
8.0	5	442	443	445	447	450	452	454	456	458	461	463	467	473	482	491	499	506	512	535
10.0	4	442	443	445	447	449	451	452	454	456	458	460	463	468	476	483	490	496	502	525
12.0	4	442	443	445	447	448	450	452	454	455	457	459	462	466	474	481	487	493	498	521

Cattail Density (%) at End of Calendar Year

Distance	Wtr-Col Total P	Time in Years																		
		0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2010	2013	2018	2023	2028	2033	2038	SS
0.0	50	2%	5%	9%	11%	14%	18%	22%	27%	32%	38%	44%	57%	72%	88%	85%	82%	79%	77%	78%
0.1	48	2%	4%	7%	9%	12%	15%	18%	22%	27%	32%	37%	48%	65%	84%	80%	77%	75%	73%	73%
0.2	46	2%	4%	6%	8%	10%	12%	15%	18%	22%	26%	31%	41%	57%	78%	76%	73%	70%	68%	69%
0.3	44	2%	3%	5%	7%	8%	10%	13%	15%	18%	22%	26%	35%	49%	71%	71%	68%	66%	64%	64%
0.4	43	2%	3%	5%	6%	7%	9%	11%	13%	16%	18%	22%	29%	42%	64%	66%	63%	61%	59%	60%
0.5	41	2%	3%	4%	5%	6%	8%	9%	11%	13%	16%	18%	25%	36%	57%	61%	58%	56%	55%	55%
0.7	38	2%	2%	3%	4%	5%	6%	7%	8%	10%	12%	14%	18%	27%	44%	51%	49%	48%	46%	46%
1.0	34	2%	2%	3%	3%	4%	5%	5%	6%	7%	8%	9%	12%	17%	29%	39%	37%	36%	35%	36%
1.5	28	2%	2%	2%	3%	3%	3%	4%	4%	5%	5%	6%	7%	10%	15%	22%	24%	23%	23%	23%
2.0	23	2%	2%	2%	2%	2%	3%	3%	3%	4%	4%	4%	5%	6%	9%	12%	16%	16%	16%	16%
2.5	19	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	4%	5%	6%	8%	10%	11%	11%	11%
3.0	16	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	4%	5%	6%	7%	8%	8%	8%
3.5	14	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	4%	4%	5%	6%	6%	7%
4.0	12	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	4%	4%	5%	5%	5%
4.5	10	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	4%	4%	4%	5%
5.0	9	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	4%	4%
6.0	7	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	4%
7.0	6	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%
8.0	5	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%
10.0	4	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%
12.0	4	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%
Total Cattail Area (ha)		291	314	344	369	397	429	465	505	550	599	653	772	970	1307	1486	1528	1535	1534	1596

SS = Steady State

Input Variables

Variable	Units	Values	Input Variable	Units	Values
Rainfall P Conc.	ppb	30	Soil Depth	cm	10
Rainfall	m/yr	1.23	Initial Bulk Density	g/cm3	0.179
ET	m/yr	1.38	Initial P Content	mg/kg	463
STA Outflow Conc.	ppb	50	Initial Gradient	mg/cm3/cm	-0.0039
STA Outflow Volume	hm3/yr	520.9	Final Bulk Density	g/cm3	0.080
Flow Path Width	km	14.2	P Settling Rate, Yr 1	m/yr	30.0
Hydroperiod	-	88%	P Settling Rate, Yr 2	m/yr	20.0
Logisitic Coef - Spread	-	144.1	P Settling Rate, Yr >=3	m/yr	10.2
Logistic Coef - MidPoint	-	1034.4	Spatial Resolution	ha	142

Profile at Beginning of Year 2007

Distance	km	0.0	0.5	1.0	2.0	4.0	8.0
Soil Accretion Rate	cm/yr	0.50	0.48	0.45	0.41	0.32	0.20
P Accretion Rate	mg/m2-yr	449	402	361	291	193	96
Bulk Density	g/cm3	0.159	0.161	0.163	0.166	0.170	0.173
Soil TP Conc.	mg/kg	630	590	561	524	490	472
Volumetric TP Conc.	mg/cm3	0.100	0.095	0.091	0.087	0.083	0.082
Cattail Density	%	6%	4%	4%	3%	2%	2%
Water Column TP	ppb	50	45	40	32	22	11

Water-Column P Impacts

		Threshold Criterion		
Variable	Units	Low	Medium	High
Water Column Conc.	ppb	10	20	30
Distance Exceeded	km	8.45	4.35	2.35
Area Exceeded	ha	11999	6177	3337

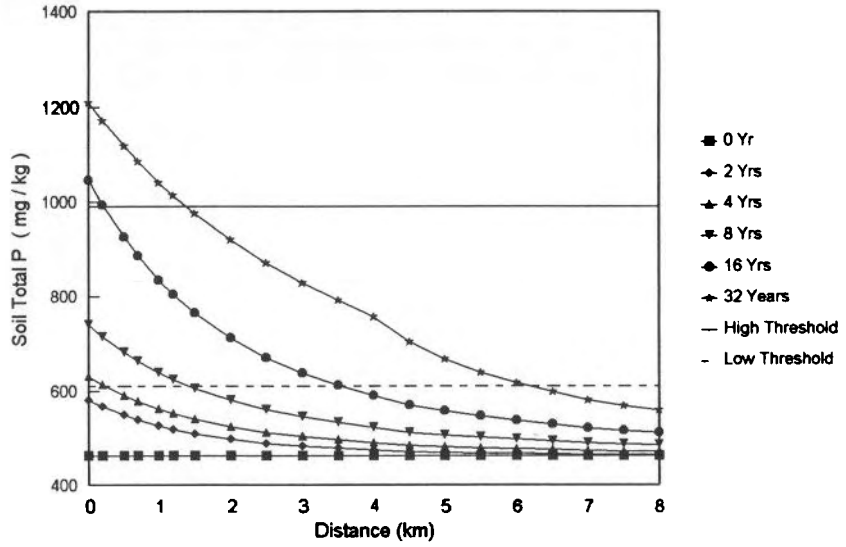
Soil P Impacts

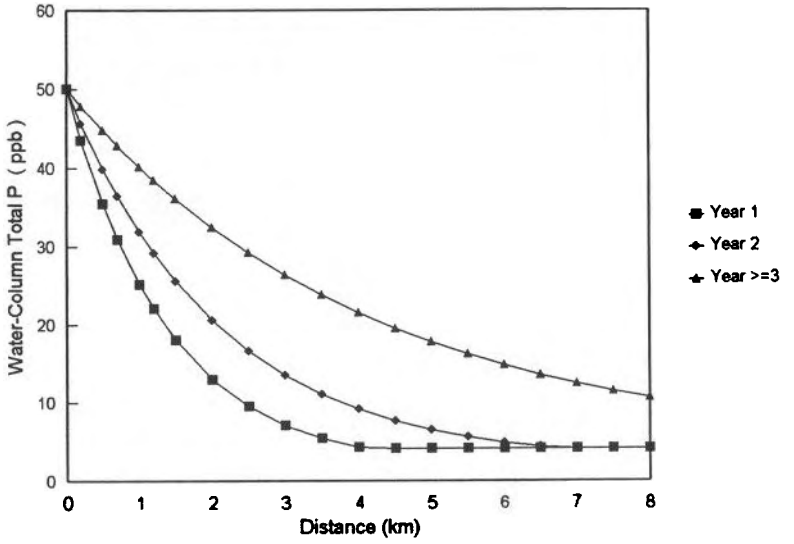
		Threshold Criterion		
Variable	Units	Low	Medium	High
Threshold Soil P	mg/kg	610	870	990
Equivalent Threshold Conc	ppb	11	31	40
Time to Steady State				
At C = 50 ppb	years	20	20	20
At C = Threshold	years	49	25	22
Exceedance of Soil P Criteria				
Initial Time	years	4	12	15
Calendar Year		2006	2014	2017
Maximum Time	years	40	27	20
Calendar Year		2042	2029	2022
Maximum Distance	km	7.0	2.6	1.6
Maximum Area	ha	9869	3621	2201
Exceedance of Soil P Criteria at End of Year 2006				
Distance Exceeded	km	0.3	0.0	0.0
Area Exceeded	ha	355	0	0

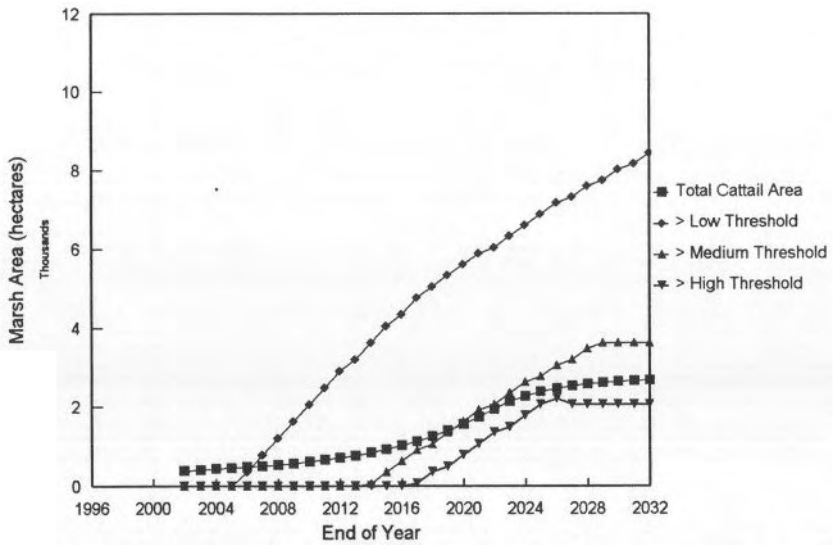
Soil P & Cattail Time Series

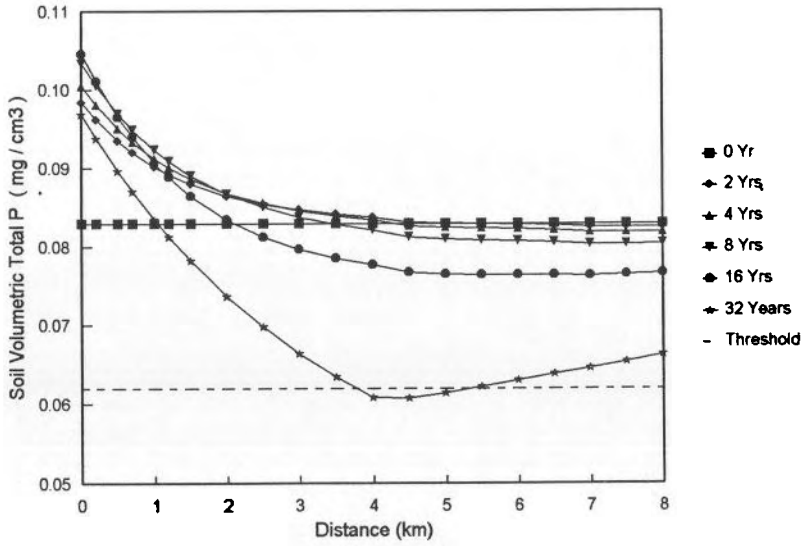
End of Year	2002	2000	2002	2004	2006	2008	2010
Soil P @ 0 km (mg/kg)	463	463	463	581	630	683	741
Cattail Density @ 0 km	2%	2%	2%	4%	6%	8%	12%
Cattail Density @ 1 km	2%	2%	2%	3%	4%	5%	6%
Cattail Density @ 2 km	2%	2%	2%	2%	3%	3%	4%
Total Cattail Area (ha)	395	ERR	395	441	488	546	620
Area Increase (ha)	0	ERR	0	46	93	151	225
Area with Density > 5%	0	ERR	0	0	355	1207	2059
Area with Density > 10%	0	ERR	0	0	0	0	213
Area with Density > 50%	0	ERR	0	0	0	0	0
Area with Density > 90%	0	ERR	0	0	0	0	0

EPGM **STA-34** **Depth = 10 cm** **Startup Date = 2003**









Soil P Concentrations (mg / kg) at End of Year

Distance	Wtr-Col Total P	Time in Years																		
		0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2014	2017	2022	2027	2032	2037	2042	SS
0.0	50	463	533	581	605	630	656	683	711	741	772	804	875	999	1283	1247	1219	1197	1180	1121
0.1	49	463	528	574	597	621	646	672	699	728	757	789	856	974	1242	1225	1198	1178	1162	1107
0.2	48	463	523	567	589	613	637	662	688	715	744	774	838	951	1204	1204	1179	1160	1145	1093
0.3	47	463	519	560	582	605	628	652	677	704	731	760	822	929	1168	1183	1160	1143	1129	1079
0.4	46	463	515	554	575	597	620	643	667	693	719	747	806	908	1134	1164	1142	1126	1113	1066
0.5	45	463	512	549	569	590	612	635	658	682	708	734	791	889	1102	1145	1125	1109	1097	1053
0.7	43	463	505	538	558	577	598	619	641	663	687	711	764	853	1044	1109	1092	1078	1067	1028
1.0	40	463	497	526	543	561	579	599	618	638	659	681	728	806	969	1060	1046	1035	1026	992
1.5	36	463	487	509	524	540	555	572	588	605	623	641	679	742	869	989	979	971	965	938
2.0	32	463	480	497	510	524	537	551	565	580	595	610	642	693	794	925	922	916	911	890
2.5	29	463	475	489	500	512	524	536	548	560	573	586	613	655	736	836	873	868	865	848
3.0	26	463	472	483	493	503	513	524	534	545	556	567	590	625	691	769	830	827	824	810
3.5	24	463	469	478	487	496	505	514	523	533	542	552	571	601	656	717	790	790	788	776
4.0	22	463	467	474	482	490	498	506	514	522	530	539	555	581	627	676	732	757	756	747
4.5	20	463	464	470	477	484	491	498	505	512	519	526	541	563	601	641	685	724	723	720
5.0	18	463	464	469	475	481	487	494	500	506	513	519	532	551	583	617	653	690	700	697
6.0	15	463	464	467	472	477	482	487	492	497	502	507	517	532	557	582	607	631	656	658
7.0	12	463	464	465	469	473	477	481	485	489	493	497	505	517	537	556	574	591	608	627
8.0	11	463	464	465	468	472	475	479	482	485	489	492	498	508	524	539	554	567	580	603
10.0	8	463	464	465	468	470	473	475	477	480	482	485	489	496	508	519	529	538	547	570
12.0	7	463	464	465	467	469	471	473	475	477	479	481	484	490	499	507	515	523	530	549

Cattail Density (%) at End of Calendar Year

Distance	Wtr-Col Total P	Time in Years																		
		0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2014	2017	2022	2027	2032	2037	2042	SS
0.0	50	2%	3%	4%	5%	6%	7%	8%	10%	12%	14%	17%	25%	44%	85%	81%	78%	76%	73%	74%
0.1	49	2%	3%	4%	5%	5%	6%	7%	9%	11%	13%	15%	22%	40%	81%	79%	76%	73%	71%	71%
0.2	48	2%	3%	4%	4%	5%	6%	7%	8%	10%	12%	14%	20%	36%	76%	76%	73%	71%	68%	69%
0.3	47	2%	3%	4%	4%	5%	6%	7%	8%	9%	11%	13%	19%	32%	72%	74%	71%	68%	66%	66%
0.4	46	2%	3%	3%	4%	5%	5%	6%	7%	9%	10%	12%	17%	29%	67%	71%	68%	65%	63%	64%
0.5	45	2%	3%	3%	4%	4%	5%	6%	7%	8%	9%	11%	16%	27%	62%	68%	65%	63%	61%	61%
0.7	43	2%	2%	3%	4%	4%	5%	5%	6%	7%	8%	10%	13%	22%	52%	63%	60%	58%	56%	56%
1.0	40	2%	2%	3%	3%	4%	4%	5%	5%	6%	7%	8%	11%	17%	39%	54%	52%	50%	49%	49%
1.5	36	2%	2%	3%	3%	3%	3%	4%	4%	5%	5%	6%	8%	12%	24%	42%	41%	39%	38%	38%
2.0	32	2%	2%	2%	3%	3%	3%	3%	4%	4%	5%	5%	6%	9%	16%	32%	31%	31%	30%	30%
2.5	29	2%	2%	2%	2%	3%	3%	3%	3%	4%	4%	4%	5%	7%	11%	20%	25%	24%	24%	24%
3.0	26	2%	2%	2%	2%	2%	3%	3%	3%	3%	3%	4%	4%	6%	8%	14%	20%	19%	19%	19%
3.5	24	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	3%	4%	5%	7%	10%	16%	16%	15%	15%
4.0	22	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	3%	4%	6%	8%	11%	13%	13%	13%
4.5	20	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	4%	5%	6%	8%	10%	10%	10%
5.0	18	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	4%	5%	7%	8%	9%	9%
6.0	15	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	4%	4%	5%	6%	7%	7%
7.0	12	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	4%	4%	5%	6%
8.0	11	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	4%	4%	5%
10.0	8	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	3%	4%
12.0	7	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	3%
Total Cattail Area (ha)		395	416	441	464	488	516	546	581	620	665	717	846	1132	1948	2531	2666	2688	2681	2749

SS = Steady State

Input Variables

Variable	Units	Values	Input Variable	Units	Values
Rainfall P Conc.	ppb	30	Soil Depth	cm	10
Rainfall	m/yr	1.23	Initial Bulk Density	g/cm3	0.197
ET	m/yr	1.38	Initial P Content	mg/kg	508
STA Outflow Conc.	ppb	50	Initial Gradient	mg/cm3/cm	-0.0052
STA Outflow Volume	hm3/yr	37.9	Final Bulk Density	g/cm3	0.080
Flow Path Width	km	3.0	P Settling Rate, Yr 1	m/yr	30.0
Hydroperiod	-	69%	P Settling Rate, Yr 2	m/yr	20.0
Logisitic Coef - Spread	-	144.1	P Settling Rate, Yr >=3	m/yr	10.2
Logistic Coef - MidPoint	-	1034.4	Spatial Resolution	ha	30

Profile at Beginning of Year 2007

Distance	km	0.0	0.5	1.0	2.0	4.0	8.0
Soil Accretion Rate	cm/yr	0.45	0.40	0.35	0.26	0.16	0.10
P Accretion Rate	mg/m2-yr	352	277	219	142	71	41
Bulk Density	g/cm3	0.155	0.162	0.168	0.176	0.185	0.189
Soil TP Conc.	mg/kg	700	624	584	547	525	519
Volumetric TP Conc.	mg/cm3	0.109	0.101	0.098	0.097	0.097	0.098
Cattail Density	%	9%	5%	4%	3%	3%	3%
Water Column TP	ppb	50	39	31	20	10	6

Water-Column P Impacts

		Threshold Criterion		
Variable	Units	Low	Medium	High
Water Column Conc.	ppb	10	20	30
Distance Exceeded	km	4.05	2.05	1.05
Area Exceeded	ha	1215	615	315

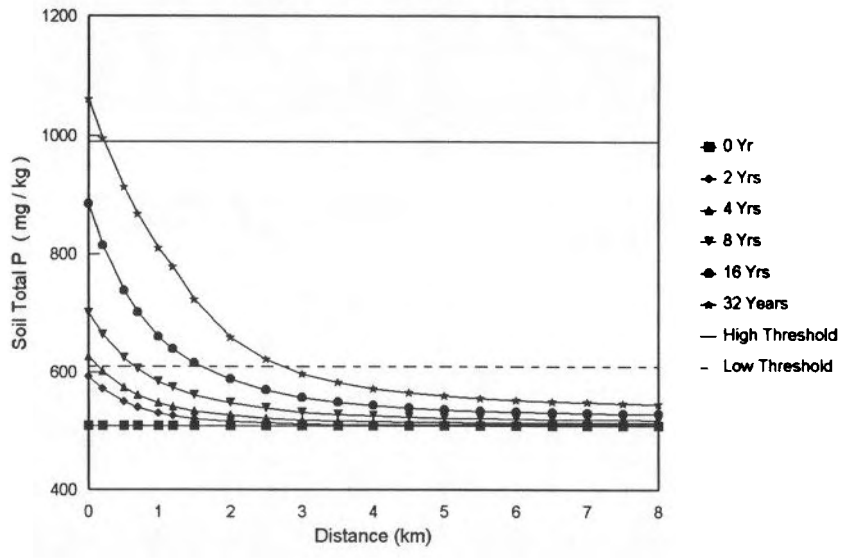
Soil P Impacts

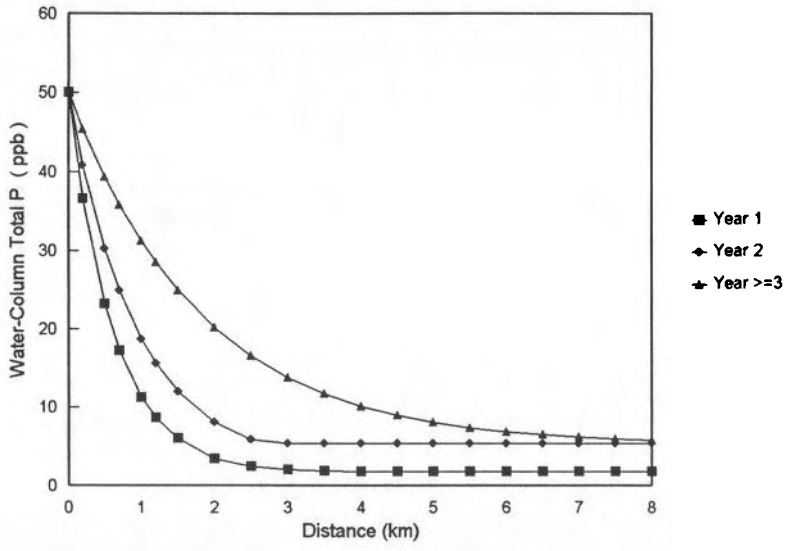
		Threshold Criterion		
Variable	Units	Low	Medium	High
Threshold Soil P	mg/kg	610	870	990
Equivalent Threshold Conc	ppb	14	39	51
Time to Steady State				
At C = 50 ppb	years	22	22	22
At C = Threshold	years	49	25	22
Exceedance of Soil P Criteria				
Initial Time	years	4	16	20
Calendar Year		2002	2014	2018
Maximum Time	years	38	27	19
Calendar Year		2036	2025	2017
Maximum Distance	km	3.0	0.8	0.3
Maximum Area	ha	885	225	75
Exceedance of Soil P Criteria at End of Year 2006				
Distance Exceeded	km	0.7	0.0	0.0
Area Exceeded	ha	195	0	0

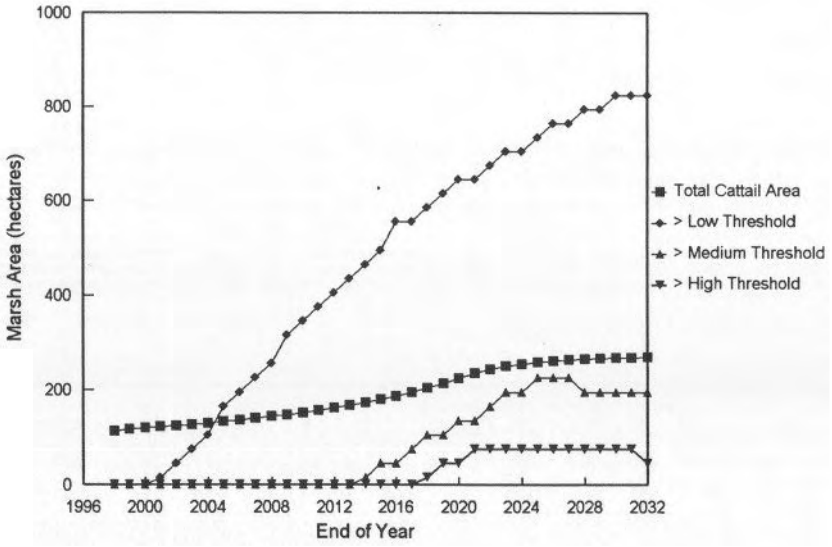
Soil P & Cattail Time Series

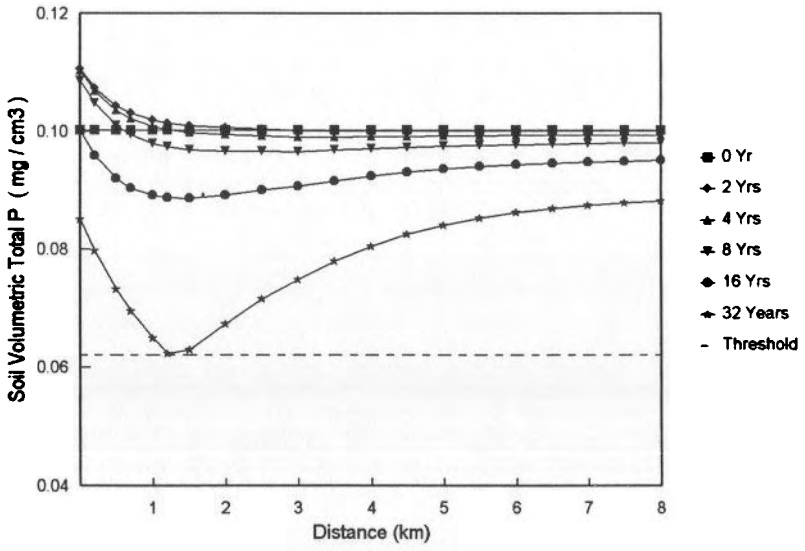
End of Year	1998	2000	2002	2004	2006	2008	2010
Soil P @ 0 km (mg/kg)	508	592	626	662	700	740	784
Cattail Density @ 0 km	3%	4%	6%	7%	9%	11%	15%
Cattail Density @ 1 km	3%	3%	3%	4%	4%	5%	5%
Cattail Density @ 2 km	3%	3%	3%	3%	3%	4%	4%
Total Cattail Area (ha)	114	119	124	130	136	143	152
Area Increase (ha)	0	6	11	16	23	30	38
Area with Density > 5%	0	0	45	105	195	255	345
Area with Density > 10%	0	0	0	0	0	15	75
Area with Density > 50%	0	0	0	0	0	0	0
Area with Density > 90%	0	0	0	0	0	0	0

E P G M **STA-5** **Depth = 10 cm** **Startup Date =** **1999**









Soil P Concentrations (mg / kg) at End of Year

Distance	Wtr-Col Total P	Time in Years																		
		0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2010	2013	2018	2023	2028	2033	2038	SS
0.0	50	508	558	592	609	626	644	662	681	700	720	740	784	857	1013	1092	1069	1050	1036	979
0.1	48	508	551	581	597	612	629	645	663	680	698	717	757	822	958	1053	1033	1017	1005	955
0.2	45	508	544	571	586	601	616	631	647	663	680	697	733	792	912	1017	1000	987	976	931
0.3	43	508	539	563	577	590	604	619	633	648	664	679	712	766	871	984	970	958	949	909
0.4	41	508	534	556	569	582	595	608	622	635	650	664	694	742	836	954	942	932	924	889
0.5	39	508	530	550	562	574	586	598	611	624	637	650	678	722	806	911	916	907	900	869
0.7	36	508	525	540	551	561	572	583	594	605	616	628	651	688	755	836	870	863	858	832
1.0	31	508	519	530	539	548	557	566	575	584	593	602	621	650	700	756	812	807	804	785
1.5	25	508	513	521	527	534	541	547	554	561	568	574	588	608	642	675	709	735	733	720
2.0	20	508	511	516	521	527	532	537	542	547	553	558	568	583	607	630	651	669	681	671
2.5	17	508	510	514	518	522	526	530	534	538	543	547	554	566	584	601	616	629	638	634
3.0	14	508	510	511	515	518	521	525	528	531	535	538	544	553	568	581	593	602	609	605
3.5	12	508	510	511	514	517	520	522	525	528	531	533	538	546	558	569	579	587	593	584
4.0	10	508	510	511	514	516	518	521	523	525	528	530	534	541	551	561	569	576	582	568
4.5	9	508	510	511	513	515	517	519	521	524	526	528	531	537	546	554	562	568	574	555
5.0	8	508	510	511	513	515	517	519	520	522	524	526	529	534	542	550	557	563	568	546
6.0	7	508	510	511	513	514	516	517	519	520	522	523	526	531	538	544	550	555	560	534
7.0	6	508	510	511	512	514	515	517	518	519	521	522	525	529	535	541	546	551	556	527
8.0	6	508	510	511	512	514	515	516	518	519	520	521	524	528	533	539	544	549	553	523
10.0	5	508	510	511	512	514	515	516	517	518	520	521	523	527	532	537	542	547	551	520
12.0	5	508	510	511	512	513	515	516	517	518	519	521	523	526	532	537	542	546	550	519

Cattail Density (%) at End of Calendar Year

Distance	Wtr-Col Total P	Time in Years																		
		0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2010	2013	2018	2023	2028	2033	2038	SS
0.0	50	3%	4%	4%	5%	6%	6%	7%	8%	9%	10%	11%	15%	23%	46%	60%	56%	53%	50%	51%
0.1	48	3%	3%	4%	5%	5%	6%	6%	7%	8%	9%	10%	13%	19%	37%	53%	50%	47%	45%	45%
0.2	45	3%	3%	4%	4%	5%	5%	6%	6%	7%	8%	9%	11%	16%	30%	47%	44%	42%	40%	40%
0.3	43	3%	3%	4%	4%	4%	5%	5%	6%	6%	7%	8%	10%	13%	24%	41%	39%	37%	36%	36%
0.4	41	3%	3%	3%	4%	4%	5%	5%	5%	6%	6%	7%	9%	12%	20%	36%	34%	33%	32%	32%
0.5	39	3%	3%	3%	4%	4%	4%	5%	5%	5%	6%	6%	8%	10%	17%	30%	31%	29%	28%	28%
0.7	36	3%	3%	3%	3%	4%	4%	4%	4%	5%	5%	6%	7%	8%	13%	20%	24%	23%	23%	23%
1.0	31	3%	3%	3%	3%	3%	4%	4%	4%	4%	4%	5%	5%	6%	9%	13%	18%	17%	17%	17%
1.5	25	3%	3%	3%	3%	3%	3%	3%	3%	4%	4%	4%	4%	5%	6%	8%	9%	11%	11%	11%
2.0	20	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	4%	4%	4%	5%	6%	7%	7%	8%	8%
2.5	17	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	4%	4%	5%	5%	6%	6%	6%
3.0	14	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	4%	4%	4%	5%	5%	5%
3.5	12	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	4%	4%	4%	4%	4%	4%
4.0	10	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	4%	4%	4%	4%	4%
4.5	9	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	4%	4%	4%	4%
5.0	8	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	4%	4%	4%	3%
6.0	7	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	4%	3%
7.0	6	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
8.0	6	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
10.0	5	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
12.0	5	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Total Cattail Area (ha)		114	117	119	122	124	127	130	133	136	140	143	152	167	204	250	265	269	271	256

SS = Steady State

Input Variables

Variable	Units	Values	Input Variable	Units	Values
Rainfall P Conc.	ppb	30	Soil Depth	cm	10
Rainfall	m/yr	1.23	Initial Bulk Density	g/cm3	0.222
ET	m/yr	1.38	Initial P Content	mg/kg	467
STA Outflow Conc.	ppb	50	Initial Gradient	mg/cm3/cm	-0.0054
STA Outflow Volume	hm3/yr	79.5	Final Bulk Density	g/cm3	0.080
Flow Path Width	km	6.0	P Settling Rate, Yr 1	m/yr	30.0
Hydroperiod	-	61%	P Settling Rate, Yr 2	m/yr	20.0
Logisitic Coef - Spread	-	144.1	P Settling Rate, Yr >=3	m/yr	10.2
Logistic Coef - MidPoint	-	1034.4	Spatial Resolution	ha	60

Profile at Beginning of Year 2007

Distance	km	0.0	0.5	1.0	2.0	4.0	8.0
Soil Accretion Rate	cm/yr	0.42	0.38	0.34	0.27	0.17	0.10
P Accretion Rate	mg/m2-yr	311	255	210	146	80	44
Bulk Density	g/cm3	0.174	0.181	0.187	0.196	0.206	0.212
Soil TP Conc.	mg/kg	624	570	539	511	486	478
Volumetric TP Conc.	mg/cm3	0.109	0.103	0.101	0.100	0.100	0.101
Cattail Density	%	5%	4%	3%	3%	2%	2%
Water Column TP	ppb	50	41	34	23	13	7

Water-Column P Impacts

		Threshold Criterion		
Variable	Units	Low	Medium	High
Water Column Conc.	ppb	10	20	30
Distance Exceeded	km	5.15	2.45	1.35
Area Exceeded	ha	3090	1470	810

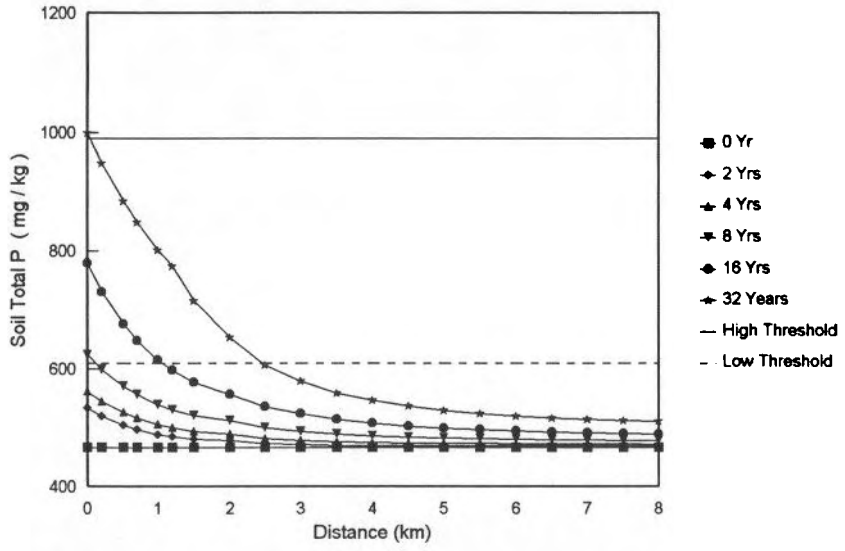
Soil P Impacts

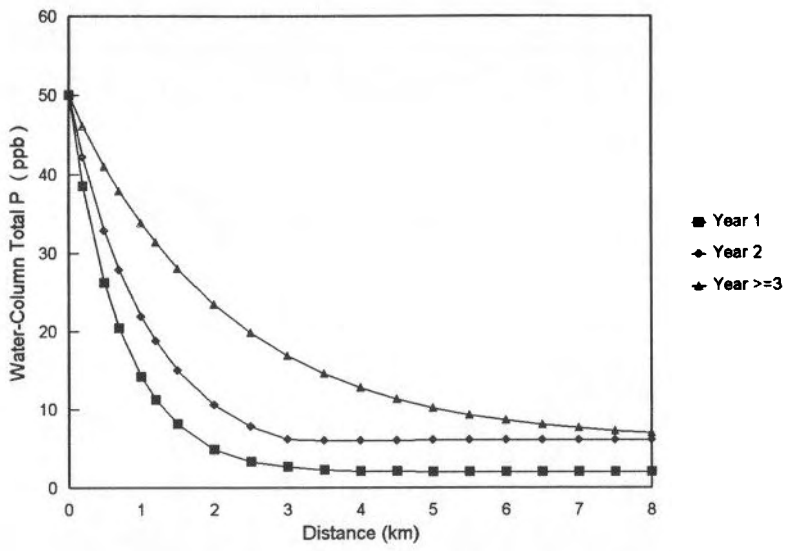
		Threshold Criterion		
Variable	Units	Low	Medium	High
Threshold Soil P	mg/kg	610	870	990
Equivalent Threshold Conc	ppb	16	45	58
Time to Steady State				
At C = 50 ppb	years	24	24	24
At C = Threshold	years	49	25	22
Exceedance of Soil P Criteria				
Initial Time	years	8	20	29
Calendar Year		2006	2018	2027
Maximum Time	years	39	28	21
Calendar Year		2037	2026	2019
Maximum Distance	km	2.9	0.7	0.2
Maximum Area	ha	1710	390	90
Exceedance of Soil P Criteria at End of Year 2006				
Distance Exceeded	km	0.2	0.0	0.0
Area Exceeded	ha	90	0	0

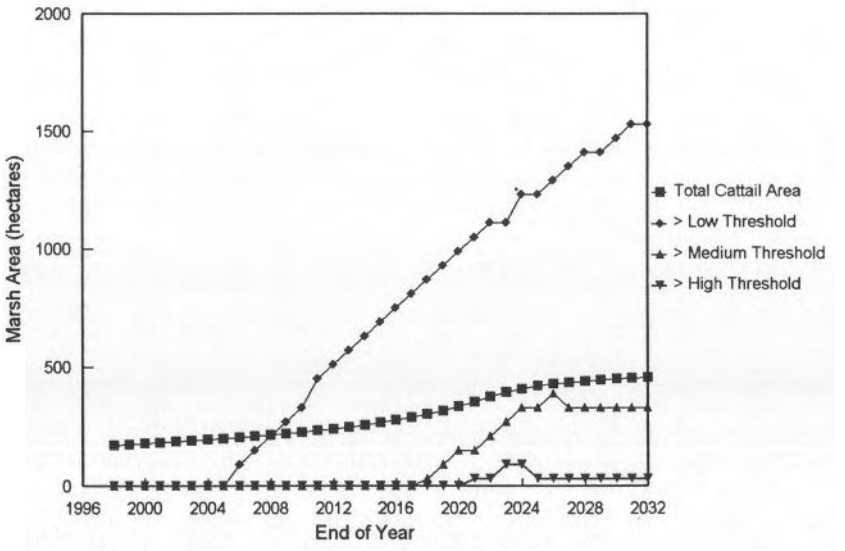
Soil P & Cattail Time Series

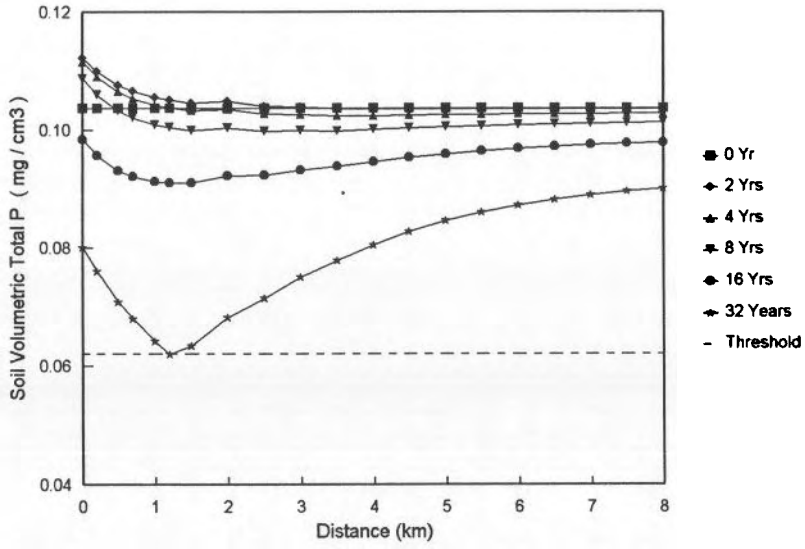
End of Year	1998	2000	2002	2004	2006	2008	2010
Soil P @ 0 km (mg/kg)	467	534	562	592	624	657	694
Cattail Density @ 0 km	2%	3%	4%	4%	5%	7%	9%
Cattail Density @ 1 km	2%	2%	2%	3%	3%	4%	4%
Cattail Density @ 2 km	2%	2%	2%	2%	3%	3%	3%
Total Cattail Area (ha)	171	179	187	195	205	215	227
Area Increase (ha)	0	8	16	24	33	44	55
Area with Density > 5%	0	0	0	0	90	210	330
Area with Density > 10%	0	0	0	0	0	0	0
Area with Density > 50%	0	0	0	0	0	0	0
Area with Density > 90%	0	0	0	0	0	0	0

E P G M **STA-6** **Depth = 10 cm** **Startup Date =** **1999**









Soil P Concentrations (mg / kg) at End of Year

Distance	Wtr-Col Total P	Time in Years																		
		0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2010	2013	2018	2023	2028	2033	2038	SS
0.0	50	467	507	534	548	562	577	592	607	624	640	657	694	756	890	1026	1005	988	975	919
0.1	48	467	501	526	539	553	567	581	595	610	626	642	676	733	852	996	978	963	952	901
0.2	46	467	497	520	532	545	558	571	585	599	613	628	659	712	819	969	953	940	930	884
0.3	44	467	493	514	526	538	550	562	575	588	602	616	645	693	790	928	930	918	909	868
0.4	43	467	490	509	520	531	543	554	567	579	592	605	632	676	764	886	908	898	890	852
0.5	41	467	487	504	515	525	536	548	559	570	582	595	620	661	741	848	887	878	871	837
0.7	38	467	482	497	506	516	526	536	546	556	567	577	600	635	702	787	850	843	837	809
1.0	34	467	477	488	497	505	514	522	531	539	548	557	576	605	658	720	801	798	793	771
1.5	28	467	473	480	487	493	500	507	514	520	527	534	548	570	607	648	694	737	734	719
2.0	23	467	473	478	484	489	495	500	506	511	517	523	534	551	579	609	640	673	697	677
2.5	20	467	469	473	477	482	486	491	495	500	504	509	518	531	553	575	597	619	640	644
3.0	17	467	469	471	475	479	482	486	490	494	497	501	509	520	538	555	572	588	603	617
3.5	15	467	468	470	473	476	479	482	486	489	492	495	501	510	525	540	554	567	578	596
4.0	13	467	468	469	472	475	478	481	483	486	489	491	497	505	518	530	542	553	563	580
4.5	11	467	468	469	472	474	477	479	482	484	486	489	493	500	512	523	533	542	551	567
5.0	10	467	468	469	472	474	476	478	480	482	485	487	491	497	507	517	526	535	543	556
6.0	9	467	468	469	471	473	475	477	478	480	482	484	487	493	501	509	517	524	531	542
7.0	8	467	468	469	471	473	474	476	477	479	480	482	485	490	497	504	511	518	524	533
8.0	7	467	468	469	471	472	474	475	477	478	480	481	484	488	495	502	508	514	520	527
10.0	6	467	468	469	471	472	473	475	476	477	479	480	483	486	493	499	505	510	515	522
12.0	6	467	468	469	471	472	473	475	476	477	478	480	482	486	492	498	503	509	514	520

Cattail Density (%) at End of Calendar Year

Distance	Wtr-Col Total P	Time in Years																		
		0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2010	2013	2018	2023	2028	2033	2038	SS
0.0	50	2%	2%	3%	3%	4%	4%	4%	5%	5%	6%	7%	9%	13%	27%	48%	45%	42%	40%	40%
0.1	48	2%	2%	3%	3%	3%	4%	4%	5%	5%	6%	6%	8%	11%	22%	43%	40%	38%	36%	36%
0.2	46	2%	2%	3%	3%	3%	4%	4%	4%	5%	5%	6%	7%	10%	18%	39%	36%	34%	33%	33%
0.3	44	2%	2%	3%	3%	3%	3%	4%	4%	4%	5%	5%	6%	9%	16%	32%	33%	31%	30%	30%
0.4	43	2%	2%	3%	3%	3%	3%	3%	4%	4%	4%	5%	6%	8%	13%	26%	29%	28%	27%	27%
0.5	41	2%	2%	2%	3%	3%	3%	3%	4%	4%	4%	5%	5%	7%	12%	22%	26%	25%	24%	25%
0.7	38	2%	2%	2%	2%	3%	3%	3%	3%	3%	4%	4%	5%	6%	9%	15%	22%	21%	20%	20%
1.0	34	2%	2%	2%	2%	2%	3%	3%	3%	3%	3%	4%	4%	5%	7%	10%	16%	16%	16%	16%
1.5	28	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	3%	3%	4%	5%	6%	9%	11%	11%	11%
2.0	23	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	3%	4%	5%	6%	8%	9%	9%
2.5	20	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	4%	5%	5%	6%	7%
3.0	17	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	4%	4%	5%	6%
3.5	15	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	4%	4%	5%
4.0	13	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	4%	4%
4.5	11	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	3%	4%
5.0	10	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	3%	4%
6.0	9	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	3%
7.0	8	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%
8.0	7	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%
10.0	6	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%
12.0	6	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%
Total Cattail Area (ha)		171	175	179	183	187	191	195	200	205	210	215	227	248	301	395	442	459	467	495

SS = Steady State

Input Variables

Variable	Units	Values	Input Variable	Units	Values
Rainfall P Conc.	ppb	30	Soil Depth	cm	20
Rainfall	m/yr	1.23	Initial Bulk Density	g/cm3	0.071
ET	m/yr	1.38	Initial P Content	mg/kg	366
STA Outflow Conc.	ppb	50	Initial Gradient	mg/cm3/cm	-0.0018
STA Outflow Volume	hm3/yr	254.0	Final Bulk Density	g/cm3	0.080
Flow Path Width	km	12.1	P Settling Rate, Yr 1	m/yr	30.0
Hydroperiod	-	92%	P Settling Rate, Yr 2	m/yr	20.0
Logisitic Coef - Spread	-	71.2	P Settling Rate, Yr >=3	m/yr	10.2
Logistic Coef - MidPoint	-	727.7	Spatial Resolution	ha	121

Profile at Beginning of Year 2007

Distance	km	0.0	0.5	1.0	2.0	4.0	8.0
Soil Accretion Rate	cm/yr	0.51	0.47	0.43	0.35	0.22	0.11
P Accretion Rate	mg/m2-yr	469	384	315	216	110	49
Bulk Density	g/cm3	0.073	0.073	0.073	0.072	0.072	0.072
Soil TP Conc.	mg/kg	675	581	522	456	405	385
Volumetric TP Conc.	mg/cm3	0.049	0.042	0.038	0.033	0.029	0.028
Cattail Density	%	32%	11%	5%	2%	1%	1%
Water Column TP	ppb	50	41	34	23	12	5

Water-Column P Impacts

		Threshold Criterion		
Variable	Units	Low	Medium	High
Water Column Conc.	ppb	10	20	30
Distance Exceeded	km	4.55	2.35	1.25
Area Exceeded	ha	5506	2844	1513

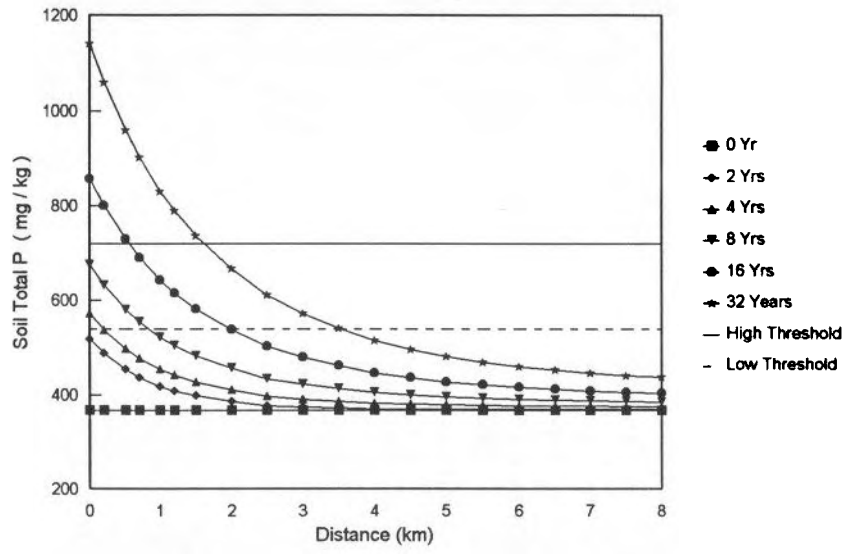
Soil P Impacts

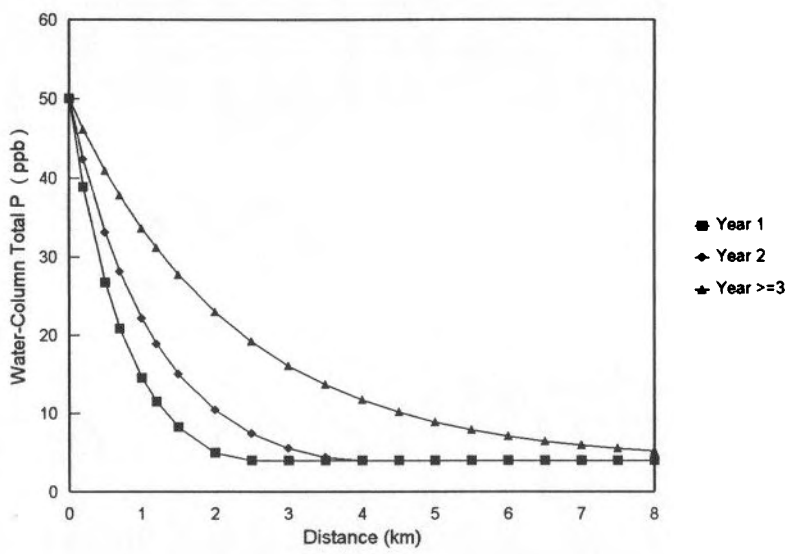
		Threshold Criterion		
Variable	Units	Low	Medium	High
Threshold Soil P	mg/kg	540	610	720
Equivalent Threshold Conc	ppb	6	11	19
Time to Steady State				
At C = 50 ppb	years	39	39	39
At C = Threshold	years	165	97	66
Exceedance of Soil P Criteria				
Initial Time	years	3	6	10
Calendar Year		2001	2004	2008
Maximum Time	years	40	39	23
Calendar Year		2038	2037	2021
Maximum Distance	km	4.1	3.0	2.0
Maximum Area	ha	4901	3570	2360
Exceedance of Soil P Criteria at End of Year 2006				
Distance Exceeded	km	0.9	0.4	0.0
Area Exceeded	ha	1029	424	0

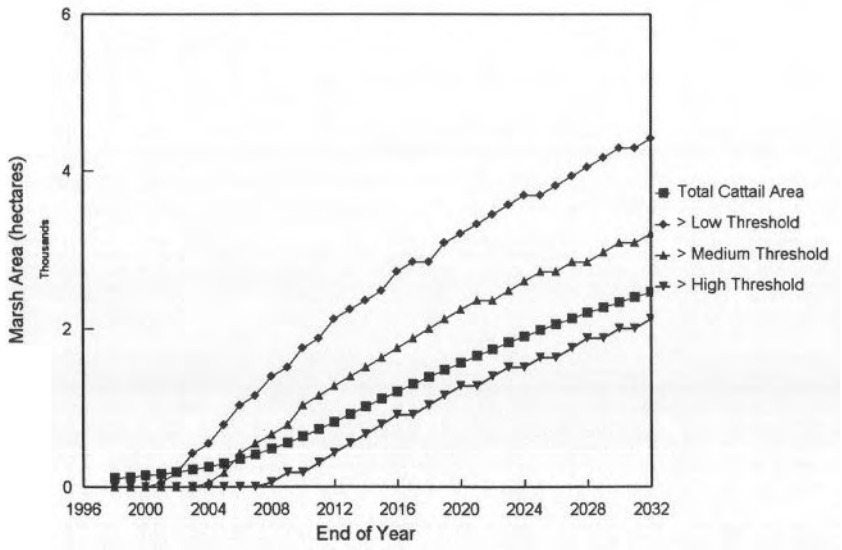
Soil P & Cattail Time Series

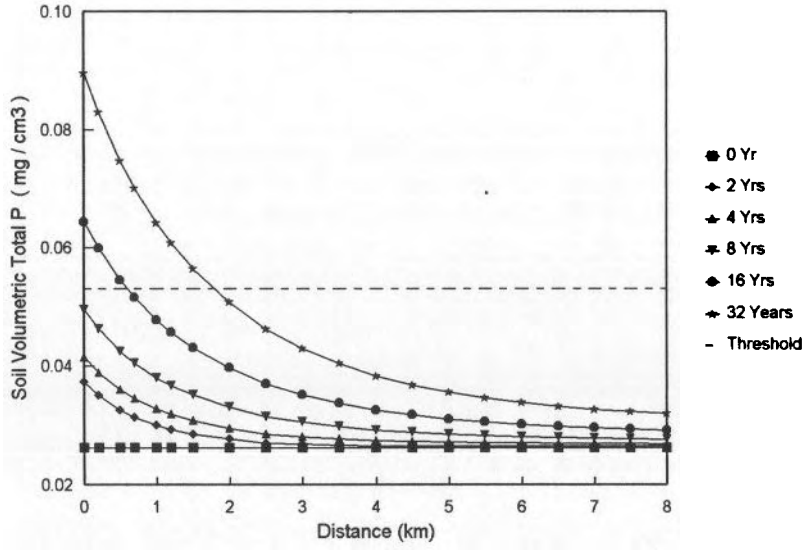
End of Year	1998	2000	2002	2004	2006	2008	2010
Soil P @ 0 km (mg/kg)	366	518	572	624	675	723	770
Cattail Density @ 0 km	1%	5%	10%	19%	32%	48%	64%
Cattail Density @ 1 km	1%	1%	2%	3%	5%	8%	12%
Cattail Density @ 2 km	1%	1%	1%	2%	2%	3%	4%
Total Cattail Area (ha)	113	146	189	254	349	479	639
Area Increase (ha)	0	33	76	141	236	366	526
Area with Density > 5%	0	61	424	787	1271	1634	2118
Area with Density > 10%	0	0	61	303	666	1029	1392
Area with Density > 50%	0	0	0	0	0	0	182
Area with Density > 90%	0	0	0	0	0	0	0

E P G M **STA-2** **Depth = 20 cm** **Startup Date =** **1999**









Soil P Concentrations (mg / kg) at End of Year

Distance	Wtr-Col Total P	Time in Years																		
		0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2010	2013	2018	2023	2028	2033	2038	SS
0.0	50	366	459	518	545	572	599	624	650	675	699	723	770	836	938	1030	1111	1182	1235	1151
0.1	48	366	447	502	528	554	579	604	628	652	676	699	743	807	905	992	1070	1138	1198	1124
0.2	46	366	437	487	513	537	562	585	609	632	654	676	719	780	874	958	1032	1098	1154	1098
0.3	44	366	429	475	499	523	546	569	591	613	635	656	697	756	846	926	997	1060	1114	1073
0.4	43	366	421	463	487	509	532	554	575	596	617	637	677	733	819	896	965	1025	1077	1049
0.5	41	366	415	453	476	497	519	540	561	581	601	620	658	712	795	869	934	992	1042	1026
0.7	38	366	404	437	457	477	497	516	535	554	572	590	625	675	751	819	880	933	978	983
1.0	34	366	392	418	436	454	471	488	505	522	538	554	584	629	696	756	810	857	898	925
1.5	28	366	381	398	413	427	441	455	469	483	496	509	534	570	626	676	720	759	793	844
2.0	23	366	375	386	399	410	422	434	445	456	467	478	499	529	575	616	653	686	714	779
2.5	19	366	368	377	387	396	406	416	425	434	443	452	470	494	533	568	599	627	652	727
3.0	16	366	368	374	383	391	399	407	415	422	430	437	452	473	505	535	562	586	607	685
3.5	14	366	368	373	380	387	393	400	407	413	419	426	438	456	483	509	532	553	572	651
4.0	12	366	368	370	376	382	388	393	399	405	410	415	426	441	465	487	507	526	543	624
4.5	10	366	368	370	375	380	385	390	395	400	404	409	418	431	452	471	489	506	521	603
5.0	9	366	368	370	375	379	383	388	392	396	400	404	412	424	442	459	475	490	504	585
6.0	7	366	368	370	374	377	381	384	387	391	394	397	403	413	427	441	455	467	478	561
7.0	6	366	368	370	373	376	379	382	384	387	390	393	398	406	418	430	441	452	462	545
8.0	5	366	368	370	373	375	378	380	383	385	387	390	394	401	412	423	433	443	452	535
10.0	4	366	368	370	372	375	377	379	381	383	385	387	391	397	406	416	424	433	441	525
12.0	4	366	368	370	372	374	376	378	380	382	384	386	390	395	404	413	421	429	437	521

Cattail Density (%) at End of Calendar Year

Distance	Wtr-Col Total P	Time in Years																		
		0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2010	2013	2018	2023	2028	2033	2038	SS
0.0	50	1%	2%	5%	7%	10%	14%	19%	25%	32%	40%	48%	64%	82%	95%	99%	100%	100%	100%	100%
0.1	48	1%	2%	4%	6%	8%	11%	15%	20%	26%	32%	40%	55%	75%	92%	98%	99%	100%	100%	100%
0.2	46	1%	2%	3%	5%	6%	9%	12%	16%	21%	26%	33%	47%	68%	89%	96%	99%	99%	100%	100%
0.3	44	1%	1%	3%	4%	5%	7%	10%	13%	17%	21%	27%	39%	60%	84%	94%	98%	99%	100%	100%
0.4	43	1%	1%	2%	3%	4%	6%	8%	10%	14%	17%	22%	33%	52%	78%	91%	97%	98%	99%	99%
0.5	41	1%	1%	2%	3%	4%	5%	7%	9%	11%	14%	18%	27%	45%	72%	88%	95%	98%	99%	99%
0.7	38	1%	1%	2%	2%	3%	4%	5%	6%	8%	10%	13%	19%	32%	58%	78%	89%	95%	97%	98%
1.0	34	1%	1%	1%	2%	2%	3%	3%	4%	5%	6%	8%	12%	20%	39%	60%	76%	86%	92%	96%
1.5	28	1%	1%	1%	1%	1%	2%	2%	3%	3%	4%	4%	6%	10%	19%	33%	47%	61%	71%	87%
2.0	23	1%	1%	1%	1%	1%	1%	2%	2%	2%	3%	3%	4%	6%	10%	17%	26%	36%	45%	71%
2.5	19	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	3%	4%	6%	10%	14%	20%	26%	51%
3.0	16	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	3%	4%	6%	9%	12%	16%	36%
3.5	14	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	3%	4%	6%	8%	10%	26%
4.0	12	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	3%	4%	6%	7%	18%
4.5	10	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	3%	3%	4%	5%	14%
5.0	9	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	3%	3%	4%	12%
6.0	7	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	3%	3%	9%
7.0	6	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	2%	7%
8.0	5	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	6%
10.0	4	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	5%
12.0	4	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	5%
Total Cattail Area (ha)		113	126	146	165	189	218	254	298	349	410	479	639	914	1390	1822	2198	2522	2802	4103

SS = Steady State

Input Variables

Variable	Units	Values	Input Variable	Units	Values
Rainfall P Conc.	ppb	30	Soil Depth	cm	20
Rainfall	m/yr	1.23	Initial Bulk Density	g/cm3	0.176
ET	m/yr	1.38	Initial P Content	mg/kg	358
STA Outflow Conc.	ppb	50	Initial Gradient	mg/cm3/cm	-0.0039
STA Outflow Volume	hm3/yr	520.9	Final Bulk Density	g/cm3	0.080
Flow Path Width	km	14.2	P Settling Rate, Yr 1	m/yr	30.0
Hydroperiod	-	88%	P Settling Rate, Yr 2	m/yr	20.0
Logisitic Coef - Spread	-	71.2	P Settling Rate, Yr >=3	m/yr	10.2
Logistic Coef - MidPoint	-	727.7	Spatial Resolution	ha	142

Profile at Beginning of Year 2007

Distance	km	0.0	0.5	1.0	2.0	4.0	8.0
Soil Accretion Rate	cm/yr	0.50	0.48	0.45	0.41	0.32	0.20
P Accretion Rate	mg/m2-yr	449	402	361	291	193	96
Bulk Density	g/cm3	0.167	0.168	0.168	0.170	0.172	0.174
Soil TP Conc.	mg/kg	455	435	420	399	379	367
Volumetric TP Conc.	mg/cm3	0.076	0.073	0.071	0.068	0.065	0.064
Cattail Density	%	2%	2%	1%	1%	1%	1%
Water Column TP	ppb	50	45	40	32	22	11

Water-Column P Impacts

		Threshold Criterion		
Variable	Units	Low	Medium	High
Water Column Conc.	ppb	10	20	30
Distance Exceeded	km	8.45	4.35	2.35
Area Exceeded	ha	11999	6177	3337

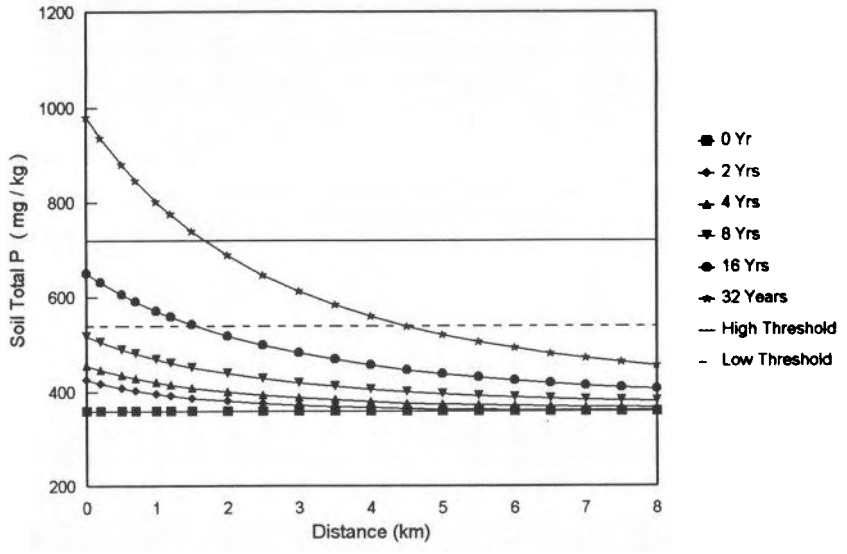
Soil P Impacts

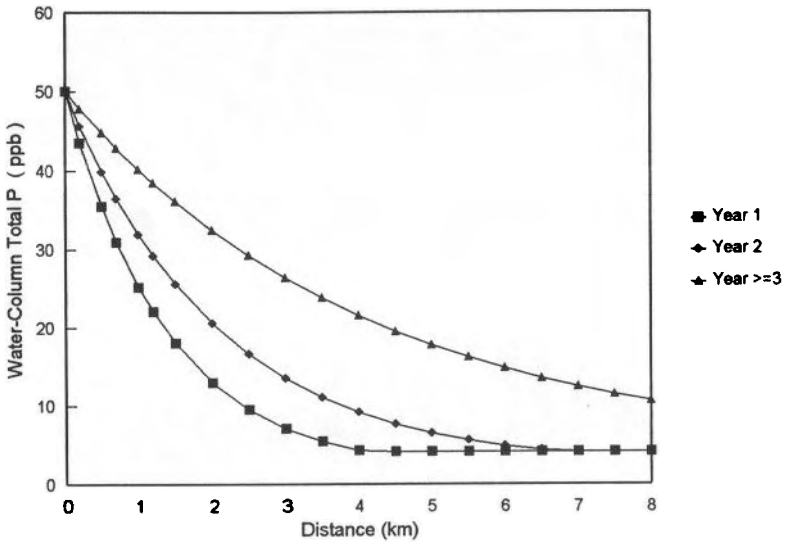
		Threshold Criterion		
Variable	Units	Low	Medium	High
Threshold Soil P	mg/kg	540	610	720
Equivalent Threshold Conc	ppb	6	11	20
Time to Steady State				
At C = 50 ppb	years	40	40	40
At C = Threshold	years	165	97	66
Exceedance of Soil P Criteria				
Initial Time	years	10	14	20
Calendar Year		2012	2016	2022
Maximum Time	years	40	40	28
Calendar Year		2042	2042	2030
Maximum Distance	km	5.6	4.1	2.6
Maximum Area	ha	7881	5751	3621
Exceedance of Soil P Criteria at End of Year 2006				
Distance Exceeded	km	0.0	0.0	0.0
Area Exceeded	ha	0	0	0

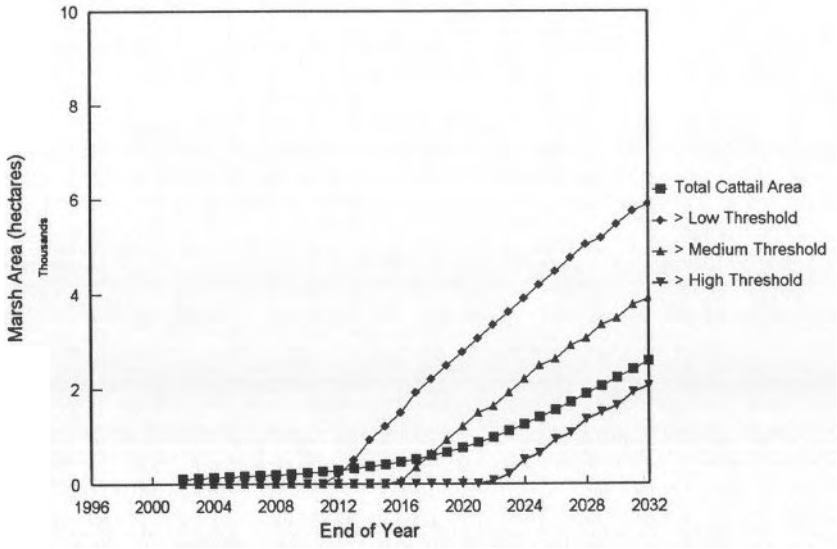
Soil P & Cattail Time Series

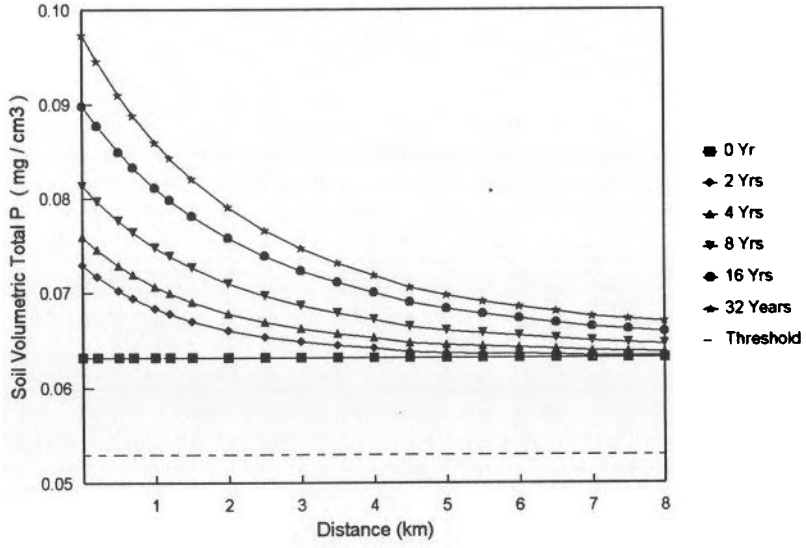
End of Year	2002	2000	2002	2004	2006	2008	2010
Soil P @ 0 km (mg/kg)	358	358	358	425	455	486	517
Cattail Density @ 0 km	1%	1%	1%	1%	2%	3%	5%
Cattail Density @ 1 km	1%	1%	1%	1%	1%	2%	3%
Cattail Density @ 2 km	1%	1%	1%	1%	1%	1%	2%
Total Cattail Area (ha)	118	ERR	118	138	162	194	235
Area Increase (ha)	0	ERR	0	19	44	76	117
Area with Density > 5%	0	ERR	0	0	0	0	0
Area with Density > 10%	0	ERR	0	0	0	0	0
Area with Density > 50%	0	ERR	0	0	0	0	0
Area with Density > 90%	0	ERR	0	0	0	0	0

E P G M **STA-34** **Depth = 20 cm** **Startup Date = 2003**









Soil P Concentrations (mg / kg) at End of Year

Distance	Wtr-Col Total P	Time in Years																		
		0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2014	2017	2022	2027	2032	2037	2042	SS
0.0	50	358	397	425	440	455	470	486	502	517	533	550	583	634	724	822	931	1055	1202	1121
0.1	49	358	395	421	436	450	465	481	496	511	527	543	575	624	712	806	911	1030	1169	1107
0.2	48	358	392	417	432	446	461	476	490	505	521	536	567	615	700	792	893	1006	1138	1093
0.3	47	358	390	414	428	442	456	471	485	500	515	530	560	607	689	778	875	984	1109	1079
0.4	46	358	388	411	425	438	452	466	480	495	509	524	553	599	678	764	858	962	1082	1066
0.5	45	358	386	408	421	435	448	462	476	490	504	518	547	591	668	751	841	941	1055	1053
0.7	43	358	383	402	415	428	441	454	467	481	494	507	535	577	650	727	811	903	1006	1028
1.0	40	358	378	396	408	420	432	444	456	468	481	493	519	557	624	695	770	852	942	992
1.5	36	358	373	387	397	408	419	430	441	452	463	474	496	530	588	649	713	780	853	938
2.0	32	358	369	380	390	399	409	419	428	438	448	458	478	508	559	612	666	723	782	890
2.5	29	358	366	375	384	392	401	410	419	427	436	445	463	490	535	581	628	676	726	848
3.0	26	358	364	371	379	387	395	403	411	419	427	435	450	474	514	555	596	638	680	810
3.5	24	358	362	369	376	383	390	397	404	411	419	426	440	462	497	533	569	606	642	776
4.0	22	358	361	366	373	379	386	392	399	405	412	418	431	450	483	515	547	578	610	747
4.5	20	358	360	364	370	376	381	387	393	399	405	411	422	440	469	498	526	554	582	720
5.0	18	358	360	363	368	374	379	385	390	395	401	406	417	432	459	485	510	536	560	697
6.0	15	358	360	362	367	371	376	380	385	389	394	398	407	420	442	464	485	505	526	658
7.0	12	358	360	361	365	369	372	376	380	384	388	391	399	410	428	447	464	482	499	627
8.0	11	358	360	361	364	367	371	374	377	381	384	387	393	403	419	434	450	464	479	603
10.0	8	358	360	361	363	366	368	371	373	376	378	381	386	393	405	417	429	441	452	570
12.0	7	358	360	361	363	365	367	369	371	373	375	377	381	387	397	407	417	426	435	549

Cattail Density (%) at End of Calendar Year

Distance	Wtr-Col Total P	Time in Years																		
		0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2014	2017	2022	2027	2032	2037	2042	SS
0.0	50	1%	1%	1%	2%	2%	3%	3%	4%	5%	6%	8%	12%	21%	49%	79%	95%	99%	100%	100%
0.1	49	1%	1%	1%	2%	2%	2%	3%	4%	5%	6%	7%	10%	19%	44%	75%	93%	99%	100%	100%
0.2	48	1%	1%	1%	2%	2%	2%	3%	3%	4%	5%	6%	9%	17%	40%	71%	91%	98%	100%	100%
0.3	47	1%	1%	1%	1%	2%	2%	3%	3%	4%	5%	6%	9%	15%	37%	67%	89%	97%	100%	100%
0.4	46	1%	1%	1%	1%	2%	2%	2%	3%	4%	4%	5%	8%	14%	33%	63%	86%	96%	99%	100%
0.5	45	1%	1%	1%	1%	2%	2%	2%	3%	3%	4%	5%	7%	13%	30%	58%	83%	95%	99%	100%
0.7	43	1%	1%	1%	1%	1%	2%	2%	3%	3%	4%	4%	6%	11%	25%	50%	76%	92%	98%	99%
1.0	40	1%	1%	1%	1%	1%	2%	2%	2%	3%	3%	4%	5%	8%	19%	39%	64%	85%	95%	99%
1.5	36	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	3%	4%	6%	12%	25%	45%	68%	85%	97%
2.0	32	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	3%	4%	9%	16%	30%	48%	68%	93%
2.5	29	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	3%	6%	11%	20%	33%	49%	88%
3.0	26	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	3%	5%	8%	14%	22%	34%	80%
3.5	24	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	4%	6%	10%	15%	23%	70%
4.0	22	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	3%	5%	7%	11%	16%	60%
4.5	20	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	3%	4%	6%	8%	11%	49%
5.0	18	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	3%	5%	6%	9%	40%
6.0	15	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	3%	4%	6%	28%
7.0	12	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	3%	4%	19%
8.0	11	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	3%	14%
10.0	8	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	10%
12.0	7	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	7%
Total Cattail Area (ha)		118	127	138	149	162	177	194	213	235	261	290	364	523	983	1715	2581	3428	4201	7616

SS = Steady State

Input Variables

Variable	Units	Values	Input Variable	Units	Values
Rainfall P Conc.	ppb	30	Soil Depth	cm	20
Rainfall	m/yr	1.23	Initial Bulk Density	g/cm3	0.197
ET	m/yr	1.38	Initial P Content	mg/kg	376
STA Outflow Conc.	ppb	50	Initial Gradient	mg/cm3/cm	-0.0052
STA Outflow Volume	hm3/yr	37.9	Final Bulk Density	g/cm3	0.080
Flow Path Width	km	3.0	P Settling Rate, Yr 1	m/yr	30.0
Hydroperiod	-	69%	P Settling Rate, Yr 2	m/yr	20.0
Logisitic Coef - Spread	-	71.2	P Settling Rate, Yr >=3	m/yr	10.2
Logistic Coef - MidPoint	-	727.7	Spatial Resolution	ha	30

Profile at Beginning of Year 2007

Distance	km	0.0	0.5	1.0	2.0	4.0	8.0
Soil Accretion Rate	cm/yr	0.45	0.40	0.35	0.26	0.16	0.10
P Accretion Rate	mg/m2-yr	352	277	219	142	71	41
Bulk Density	g/cm3	0.176	0.179	0.182	0.187	0.191	0.193
Soil TP Conc.	mg/kg	498	459	436	412	395	388
Volumetric TP Conc.	mg/cm3	0.088	0.082	0.080	0.077	0.075	0.075
Cattail Density	%	4%	2%	2%	1%	1%	1%
Water Column TP	ppb	50	39	31	20	10	6

Water-Column P Impacts

		Threshold Criterion		
Variable	**Units**	**Low**	**Medium**	**High**
Water Column Conc.	ppb	10	20	30
Distance Exceeded	km	4.05	2.05	1.05
Area Exceeded	ha	1215	615	315

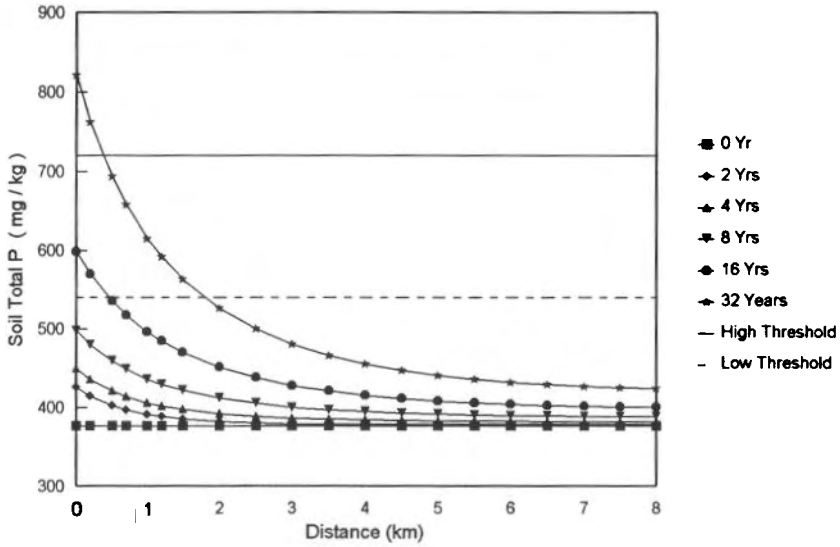
Soil P Impacts

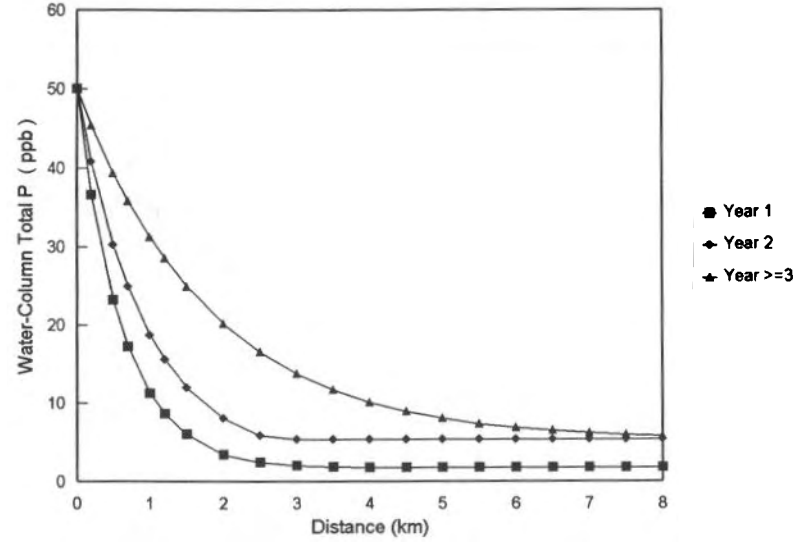
		Threshold Criterion		
Variable	**Units**	**Low**	**Medium**	**High**
Threshold Soil P	mg/kg	540	610	720
Equivalent Threshold Conc	ppb	7	14	25
Time to Steady State				
At C = 50 ppb	years	45	45	45
At C = Threshold	years	165	97	66
Exceedance of Soil P Criteria				
Initial Time	years	12	17	26
Calendar Year		2010	2015	2024
Maximum Time	years	40	39	27
Calendar Year		2038	2037	2025
Maximum Distance	km	2.4	1.5	0.8
Maximum Area	ha	705	435	225
Exceedance of Soil P Criteria at End of Year 2006				
Distance Exceeded	km	0.0	0.0	0.0
Area Exceeded	ha	0	0	0

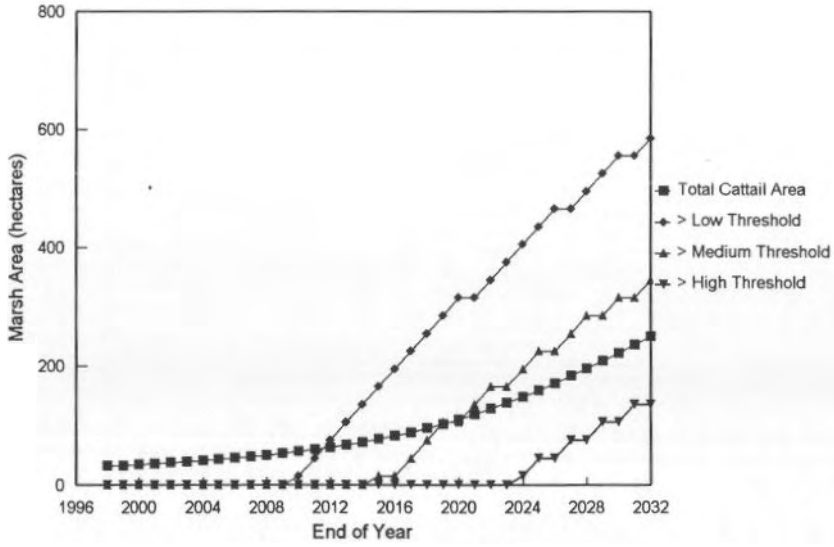
Soil P & Cattail Time Series

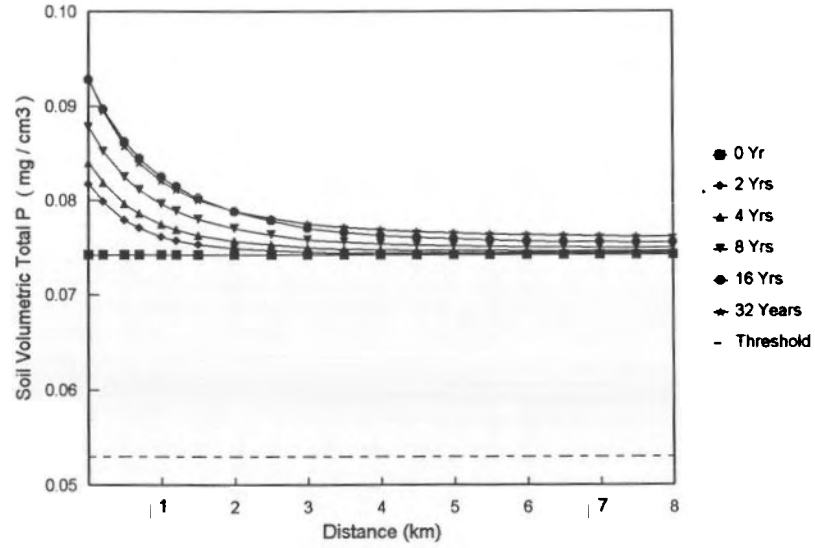
End of Year	1998	2000	2002	2004	2006	2008	2010
Soil P @ 0 km (mg/kg)	376	426	450	474	498	523	547
Cattail Density @ 0 km	1%	1%	2%	3%	4%	5%	7%
Cattail Density @ 1 km	1%	1%	1%	1%	2%	2%	2%
Cattail Density @ 2 km	1%	1%	1%	1%	1%	1%	2%
Total Cattail Area (ha)	32	35	38	41	46	51	56
Area Increase (ha)	0	2	6	9	13	18	24
Area with Density > 5%	0	0	0	0	0	15	75
Area with Density > 10%	0	0	0	0	0	0	0
Area with Density > 50%	0	0	0	0	0	0	0
Area with Density > 90%	0	0	0	0	0	0	0

EPGM **STA-5** **Depth = 20 cm** **Startup Date = 1999**









Soil P Concentrations (mg / kg) at End of Year

Distance	Wtr-Col Total P	Time in Years																		
		0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2010	2013	2018	2023	2028	2033	2038	SS
0.0	50	376	405	426	438	450	462	474	486	498	510	523	547	585	650	718	791	868	954	979
0.1	48	376	401	420	431	443	454	465	477	488	500	512	535	571	632	695	762	833	910	955
0.2	45	376	398	415	426	436	447	458	469	480	491	502	524	558	615	675	736	801	870	931
0.3	43	376	395	410	420	431	441	451	462	472	483	493	514	546	600	656	713	773	836	909
0.4	41	376	392	406	416	426	436	446	456	465	475	485	505	536	587	639	692	747	804	889
0.5	39	376	390	403	412	422	431	440	450	459	469	478	497	526	574	623	673	724	777	869
0.7	36	376	387	397	406	414	423	432	440	449	457	466	483	509	553	596	640	684	729	832
1.0	31	376	383	391	399	406	414	421	429	436	444	451	466	489	526	563	600	637	673	785
1.5	25	376	380	385	391	397	404	410	416	422	428	434	446	464	494	523	552	579	607	720
2.0	20	376	379	382	387	392	397	402	407	412	417	422	432	447	471	495	518	540	562	671
2.5	17	376	378	381	385	389	393	397	401	406	410	414	422	434	454	474	493	512	529	634
3.0	14	376	378	379	383	386	390	393	397	400	404	407	414	425	441	458	474	490	505	605
3.5	12	376	378	379	382	385	388	391	394	397	400	403	409	418	433	447	461	474	487	584
4.0	10	376	378	379	382	384	387	390	392	395	398	400	405	413	426	438	450	462	474	568
4.5	9	376	378	379	381	384	386	388	391	393	395	398	402	409	421	432	443	453	464	555
5.0	8	376	378	379	381	383	385	388	390	392	394	396	400	406	417	427	437	446	456	546
6.0	7	376	378	379	381	383	385	386	388	390	392	394	397	403	411	420	429	437	445	534
7.0	6	376	378	379	381	382	384	386	387	389	391	392	396	400	408	416	424	432	440	527
8.0	6	376	378	379	381	382	384	385	387	388	390	392	395	399	407	414	422	429	436	523
10.0	5	376	378	379	381	382	383	385	386	388	389	391	394	398	405	412	419	426	433	520
12.0	5	376	378	379	380	382	383	385	386	388	389	391	394	398	405	412	419	426	432	519

Cattail Density (%) at End of Calendar Year

Distance	Wtr-Col Total P	Time in Years																		
		0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2010	2013	2018	2023	2028	2033	2038	SS
0.0	50	1%	1%	1%	2%	2%	2%	3%	3%	4%	5%	5%	7%	12%	25%	47%	71%	88%	96%	99%
0.1	48	1%	1%	1%	2%	2%	2%	2%	3%	3%	4%	5%	6%	10%	21%	39%	62%	81%	93%	98%
0.2	45	1%	1%	1%	1%	2%	2%	2%	3%	3%	3%	4%	5%	8%	17%	32%	53%	74%	88%	97%
0.3	43	1%	1%	1%	1%	2%	2%	2%	2%	3%	3%	4%	5%	7%	14%	27%	45%	65%	82%	96%
0.4	41	1%	1%	1%	1%	1%	2%	2%	2%	2%	3%	3%	4%	6%	12%	22%	38%	57%	75%	95%
0.5	39	1%	1%	1%	1%	1%	2%	2%	2%	2%	3%	3%	4%	6%	10%	19%	32%	49%	67%	92%
0.7	36	1%	1%	1%	1%	1%	1%	2%	2%	2%	2%	2%	3%	4%	8%	14%	23%	35%	50%	87%
1.0	31	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	2%	3%	6%	9%	14%	22%	32%	75%
1.5	25	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	4%	5%	8%	11%	15%	52%
2.0	20	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	3%	4%	5%	7%	9%	34%
2.5	17	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	3%	4%	5%	6%	23%
3.0	14	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	3%	3%	4%	16%
3.5	12	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	3%	3%	12%
4.0	10	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	3%	10%
4.5	9	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	2%	9%
5.0	8	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	8%
6.0	7	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	7%
7.0	6	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	6%
8.0	6	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	6%
10.0	5	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	6%
12.0	5	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	6%
Total Cattail Area (ha)		32	33	35	36	38	39	41	43	46	48	51	56	68	95	138	196	264	333	744

SS = Steady State

Input Variables

Variable	Units	Values	Input Variable	Units	Values
Rainfall P Conc.	ppb	30	Soil Depth	cm	20
Rainfall	m/yr	1.23	Initial Bulk Density	g/cm3	0.232
ET	m/yr	1.38	Initial P Content	mg/kg	330
STA Outflow Conc.	ppb	50	Initial Gradient	mg/cm3/cm	-0.0054
STA Outflow Volume	hm3/yr	79.5	Final Bulk Density	g/cm3	0.080
Flow Path Width	km	6.0	P Settling Rate, Yr 1	m/yr	30.0
Hydroperiod	-	61%	P Settling Rate, Yr 2	m/yr	20.0
Logisitic Coef - Spread	-	71.2	P Settling Rate, Yr >=3	m/yr	10.2
Logistic Coef - MidPoint	-	727.7	Spatial Resolution	ha	60

Profile at Beginning of Year 2007

Distance	km	0.0	0.5	1.0	2.0	4.0	8.0
Soil Accretion Rate	cm/yr	0.42	0.38	0.34	0.27	0.17	0.10
P Accretion Rate	mg/m2-yr	311	255	210	146	80	44
Bulk Density	g/cm3	0.206	0.210	0.213	0.218	0.223	0.226
Soil TP Conc.	mg/kg	428	401	384	366	349	342
Volumetric TP Conc.	mg/cm3	0.088	0.084	0.082	0.080	0.078	0.077
Cattail Density	%	1%	1%	1%	1%	0%	0%
Water Column TP	ppb	50	41	34	23	13	7

Water-Column P Impacts

		Threshold Criterion		
Variable	Units	Low	Medium	High
Water Column Conc.	ppb	10	20	30
Distance Exceeded	km	5.15	2.45	1.35
Area Exceeded	ha	3090	1470	810

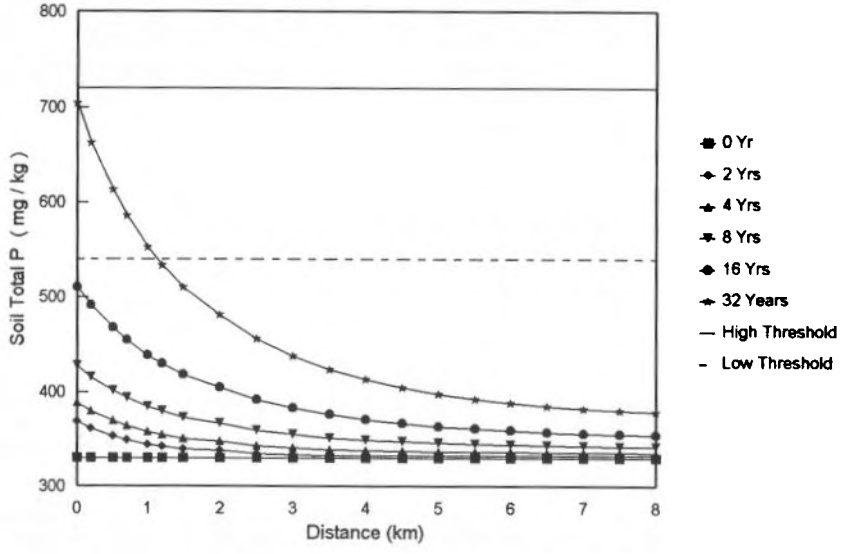
Soil P Impacts

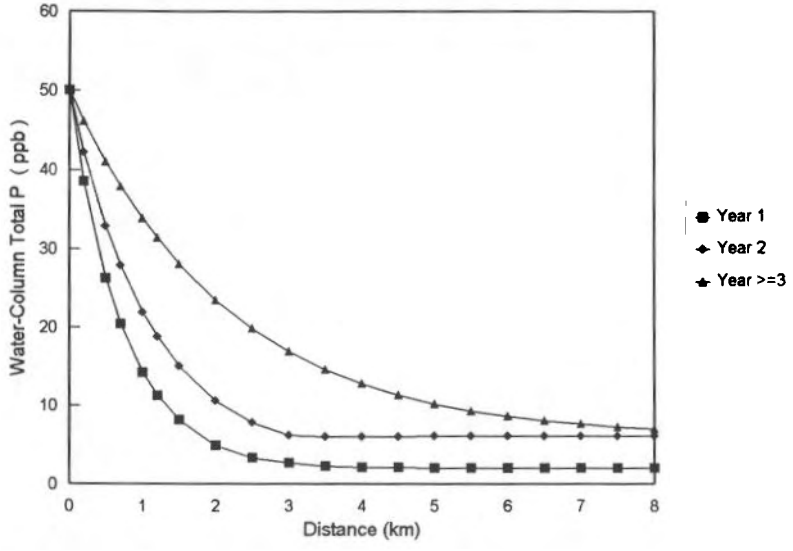
		Threshold Criterion		
Variable	Units	Low	Medium	High
Threshold Soil P	mg/kg	540	610	720
Equivalent Threshold Conc	ppb	8	16	28
Time to Steady State				
At C = 50 ppb	years	47	47	47
At C = Threshold	years	165	97	66
Exceedance of Soil P Criteria				
Initial Time	years	19	25	34
Calendar Year		2017	2023	2032
Maximum Time	years	39	40	29
Calendar Year		2037	2038	2027
Maximum Distance	km	1.7	1.1	0.4
Maximum Area	ha	990	630	210
Exceedance of Soil P Criteria at End of Year 2006				
Distance Exceeded	km	0.0	0.0	0.0
Area Exceeded	ha	0	0	0

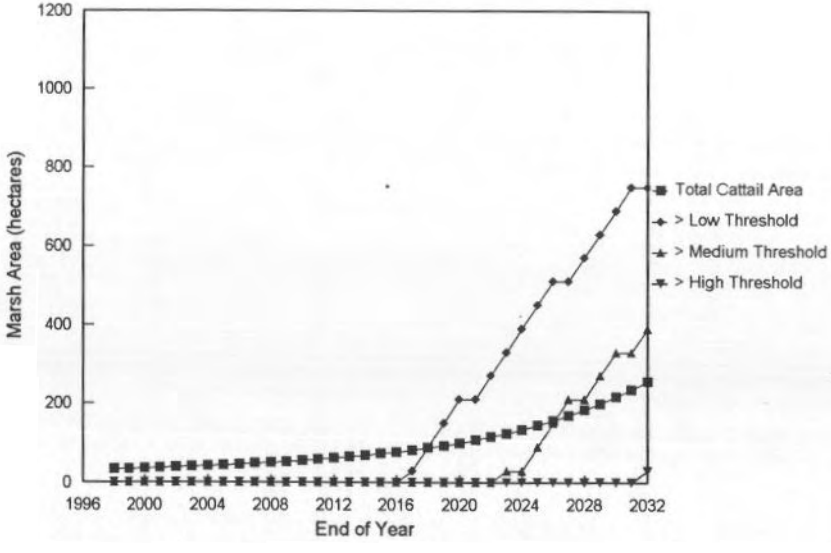
Soil P & Cattail Time Series

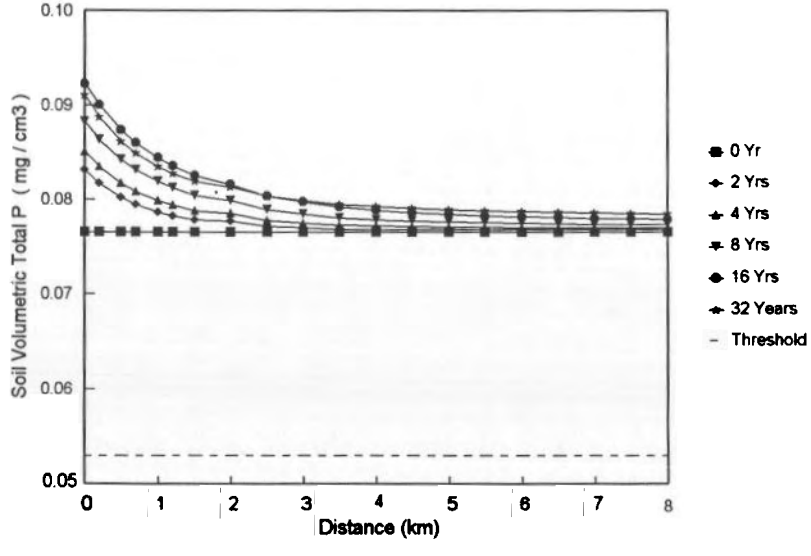
End of Year	1998	2000	2002	2004	2006	2008	2010
Soil P @ 0 km (mg/kg)	330	369	388	408	428	448	468
Cattail Density @ 0 km	0%	1%	1%	1%	1%	2%	3%
Cattail Density @ 1 km	0%	0%	1%	1%	1%	1%	1%
Cattail Density @ 2 km	0%	0%	0%	1%	1%	1%	1%
Total Cattail Area (ha)	34	36	39	42	46	51	56
Area Increase (ha)	0	2	5	9	12	17	22
Area with Density > 5%	0	0	0	0	0	0	0
Area with Density > 10%	0	0	0	0	0	0	0
Area with Density > 50%	0	0	0	0	0	0	0
Area with Density > 90%	0	0	0	0	0	0	0

E P G M **STA-6** **Depth = 20 cm** **Startup Date =** **1999**









Soil P Concentrations (mg / kg) at End of Year

Distance	Wtr-Col Total P	Time in Years																		
		0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2010	2013	2018	2023	2028	2033	2038	SS
0.0	50	330	353	369	378	388	398	408	418	428	438	448	468	500	555	613	677	747	827	919
0.1	48	330	350	365	374	383	393	402	412	421	431	441	460	490	542	598	657	722	795	901
0.2	46	330	348	361	370	379	388	397	406	416	425	434	453	482	531	583	639	699	767	884
0.3	44	330	346	358	367	375	384	393	402	410	419	428	446	474	521	570	623	679	741	868
0.4	43	330	344	356	364	372	380	389	397	406	414	423	440	466	511	558	607	660	717	852
0.5	41	330	342	353	361	369	377	385	393	401	409	418	434	459	502	547	593	643	696	837
0.7	38	330	340	349	356	364	371	379	386	394	401	409	424	447	486	527	569	612	659	809
1.0	34	330	337	344	351	358	364	371	378	384	391	398	411	432	466	502	538	575	613	771
1.5	28	330	334	339	345	350	356	362	367	373	379	384	395	413	441	470	498	528	557	719
2.0	23	330	334	338	342	347	352	357	362	366	371	376	386	400	424	448	472	496	519	677
2.5	20	330	332	335	339	343	347	351	355	359	363	367	375	388	408	428	448	468	488	644
3.0	17	330	331	333	337	341	344	348	351	355	358	362	369	379	397	414	431	448	465	617
3.5	15	330	331	333	336	339	342	345	348	351	354	357	364	373	388	403	418	433	447	596
4.0	13	330	331	333	335	338	341	344	346	349	352	354	360	368	381	395	408	421	434	580
4.5	11	330	331	333	335	337	340	342	345	347	350	352	357	364	376	388	400	412	423	567
5.0	10	330	331	333	335	337	339	341	344	346	348	350	355	361	372	383	394	404	415	556
6.0	9	330	331	333	334	336	338	340	342	344	346	348	351	357	366	375	385	394	403	542
7.0	8	330	331	333	334	336	338	339	341	343	344	346	349	354	363	371	379	387	395	533
8.0	7	330	331	333	334	336	337	339	340	342	343	345	348	353	360	368	375	383	390	527
10.0	6	330	331	333	334	335	337	338	340	341	343	344	347	351	358	365	372	379	386	522
12.0	6	330	331	333	334	335	337	338	339	341	342	344	346	350	357	364	371	377	384	520

Cattail Density (%) at End of Calendar Year

Distance	Wtr-Col Total P	Time in Years																		
		0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2010	2013	2018	2023	2028	2033	2038	SS
0.0	50	0%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	3%	4%	8%	17%	33%	57%	80%	97%
0.1	48	0%	0%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	3%	7%	14%	27%	48%	72%	96%
0.2	46	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	3%	6%	12%	22%	40%	63%	95%
0.3	44	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	3%	5%	10%	19%	34%	55%	93%
0.4	43	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	5%	8%	16%	28%	46%	91%
0.5	41	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	4%	7%	13%	23%	39%	89%
0.7	38	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	3%	6%	10%	17%	27%	83%
1.0	34	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	4%	6%	10%	17%	72%
1.5	28	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	2%	3%	4%	6%	8%	53%
2.0	23	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	3%	4%	5%	39%
2.5	20	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	3%	3%	26%
3.0	17	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	19%
3.5	15	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	14%
4.0	13	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	2%	12%
4.5	11	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	10%
5.0	10	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	9%
6.0	9	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	7%
7.0	8	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	7%
8.0	7	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	6%
10.0	6	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	6%
12.0	6	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	6%
Total Cattail Area (ha)		34	35	36	37	39	41	42	44	46	48	51	56	65	88	124	184	277	403	1524

Input Variables

Variable	Units	Values	Input Variable	Units	Values
Rainfall P Conc.	ppb	30	Soil Depth	cm	10
Rainfall	m/yr	1.23	Initial Bulk Density	g/cm3	0.080
ET	m/yr	1.38	Initial P Content	mg/kg	442
STA Outflow Conc.	ppb	40	Initial Gradient	mg/cm3/cm	-0.0018
STA Outflow Volume	hm3/yr	304.5	Final Bulk Density	g/cm3	0.080
Flow Path Width	km	12.1	P Settling Rate, Yr 1	m/yr	30.0
Hydroperiod	-	92%	P Settling Rate, Yr 2	m/yr	20.0
Logisitic Coef - Spread	-	144.1	P Settling Rate, Yr >=3	m/yr	10.2
Logistic Coef - MidPoint	-	1034.4	Spatial Resolution	ha	121

Profile at Beginning of Year 2007

Distance	km	0.0	0.5	1.0	2.0	4.0	8.0
Soil Accretion Rate	cm/yr	0.46	0.43	0.39	0.33	0.23	0.12
P Accretion Rate	mg/m2-yr	375	319	271	199	114	54
Bulk Density	g/cm3	0.080	0.080	0.080	0.080	0.080	0.080
Soil TP Conc.	mg/kg	816	706	635	553	487	460
Volumetric TP Conc.	mg/cm3	0.065	0.057	0.051	0.044	0.039	0.037
Cattail Density	%	18%	9%	6%	3%	2%	2%
Water Column TP	ppb	40	34	29	21	12	6

Water-Column P Impacts

		Threshold Criterion		
Variable	**Units**	**Low**	**Medium**	**High**
Water Column Conc.	ppb	10	20	30
Distance Exceeded	km	4.85	2.15	0.85
Area Exceeded	ha	5869	2602	1029

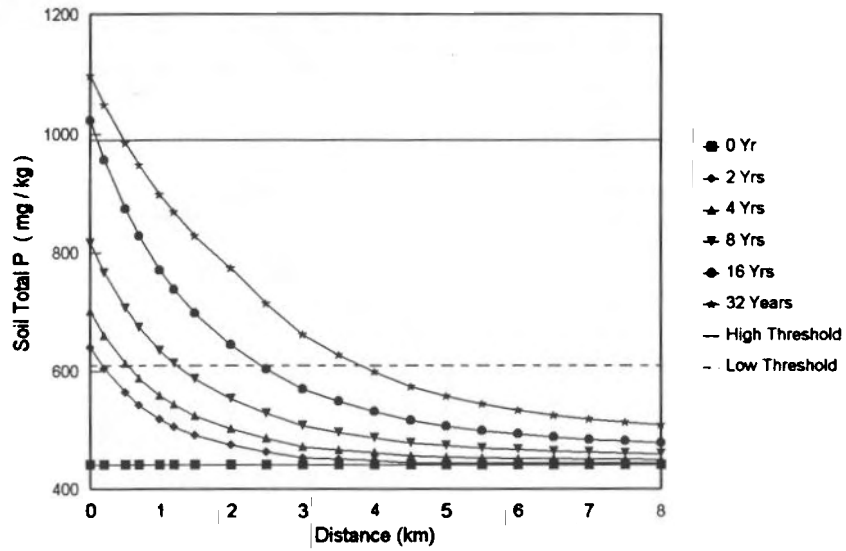
Soil P Impacts

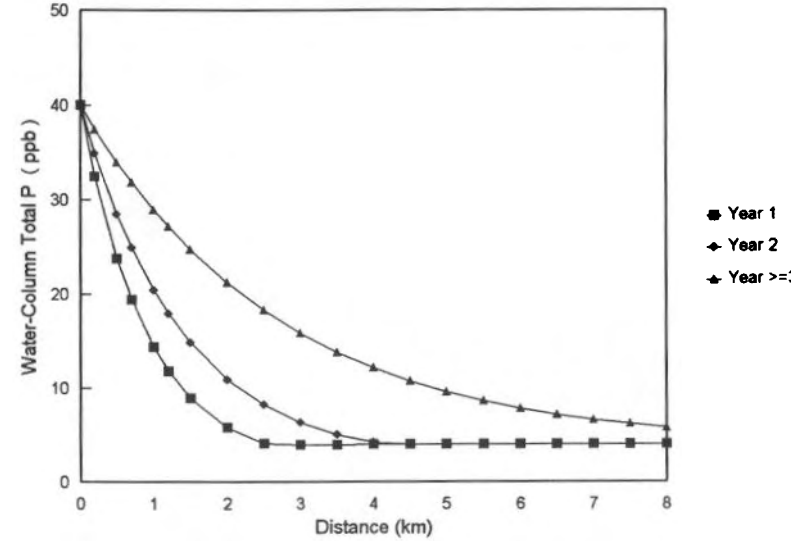
		Threshold Criterion		
Variable	Units	Low	Medium	High
Threshold Soil P	mg/kg	610	870	990
Equivalent Threshold Conc	ppb	11	30	38
Time to Steady State				
At C = 50 ppb	years	20	20	20
At C = Threshold	years	49	25	22
Exceedance of Soil P Criteria				
Initial Time	years	2	10	15
Calendar Year		2000	2008	2013
Maximum Time	years	38	27	16
Calendar Year		2036	2025	2014
Maximum Distance	km	4.2	1.3	0.6
Maximum Area	ha	5022	1513	666
Exceedance of Soil P Criteria at End of Year 2006				
Distance Exceeded	km	1.3	0.0	0.0
Area Exceeded	ha	1513	0	0

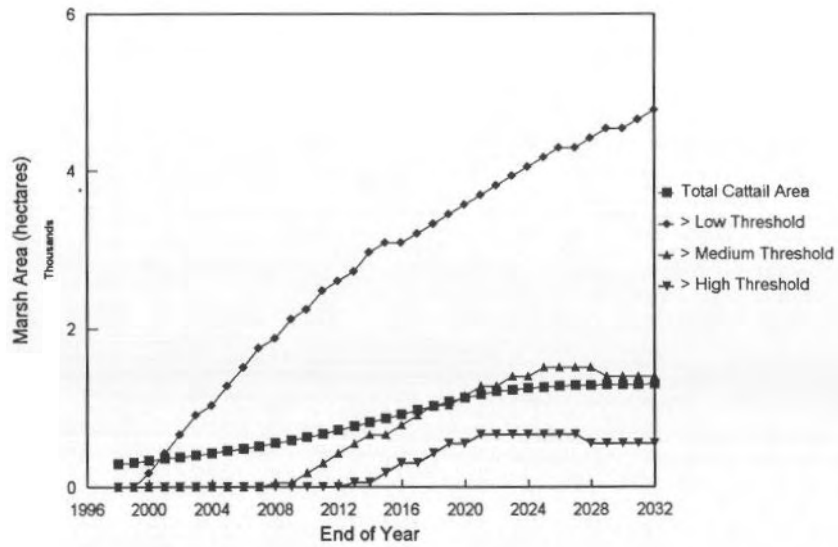
Soil P & Cattail Time Series

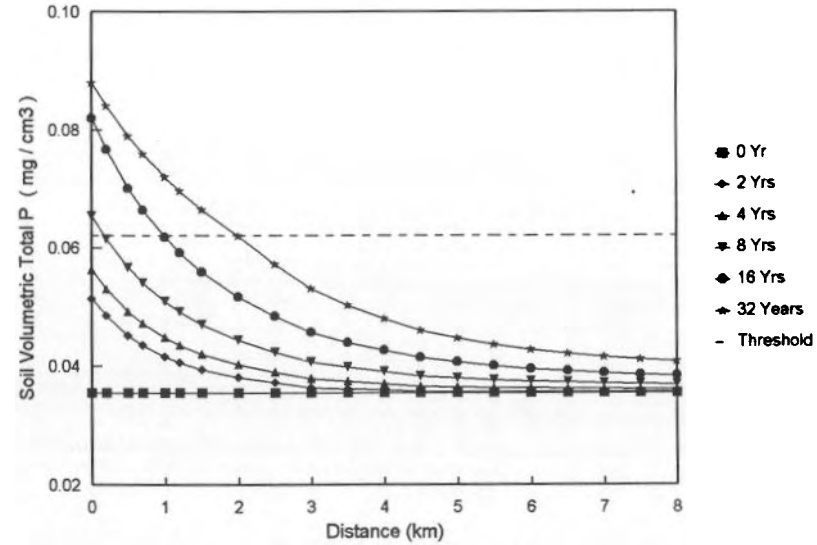
End of Year	1998	2000	2002	2004	2006	2008	2010
Soil P @ 0 km (mg/kg)	442	640	701	759	816	870	923
Cattail Density @ 0 km	2%	6%	9%	13%	18%	24%	32%
Cattail Density @ 1 km	2%	3%	4%	5%	6%	7%	9%
Cattail Density @ 2 km	2%	2%	2%	3%	3%	4%	5%
Total Cattail Area (ha)	291	337	377	426	484	552	630
Area Increase (ha)	0	45	86	134	192	260	338
Area with Density > 5%	0	182	666	1029	1513	1876	2239
Area with Density > 10%	0	0	0	182	545	787	1150
Area with Density > 50%	0	0	0	0	0	0	0
Area with Density > 90%	0	0	0	0	0	0	0

EPGM **STA-2GDR** **Depth = 10 cm** **Startup Date =** **1999**









Soil P Concentrations (mg / kg) at End of Year

	Wtr-Col	Time in Years																		
Distance	Total P	0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2010	2013	2018	2023	2028	2033	2038	SS
0.0	40	442	564	640	671	701	730	759	788	816	843	870	923	999	1114	1129	1105	1086	1071	1014
0.1	39	442	551	621	650	679	708	735	763	790	816	842	893	965	1076	1101	1079	1062	1048	996
0.2	37	442	539	604	632	660	687	714	740	766	791	816	865	934	1040	1075	1055	1039	1027	978
0.3	36	442	529	589	616	643	669	695	720	745	769	793	839	905	1007	1050	1032	1018	1006	962
0.4	35	442	520	576	602	627	652	677	701	725	748	771	815	879	976	1026	1010	997	987	946
0.5	34	442	511	563	588	613	637	660	684	706	729	751	793	854	947	1004	989	978	968	930
0.7	32	442	498	543	565	588	610	632	653	674	695	715	754	810	895	963	951	941	934	901
1.0	29	442	482	518	538	558	578	597	616	635	653	671	705	755	830	896	900	893	887	861
1.5	25	442	466	491	508	524	540	556	571	587	601	616	644	684	745	799	830	826	822	803
2.0	21	442	457	475	488	502	515	528	541	553	565	577	601	634	683	727	765	772	769	755
2.5	18	442	450	463	475	486	497	507	518	528	538	548	567	595	636	672	703	726	725	715
3.0	16	442	443	453	462	472	481	490	498	507	515	524	540	562	597	627	653	674	685	681
3.5	14	442	443	451	459	466	474	482	489	496	503	510	523	543	572	597	619	637	652	653
4.0	12	442	443	449	455	462	468	475	481	487	493	499	510	527	551	573	592	608	621	630
4.5	11	442	443	445	451	456	462	467	473	478	483	488	498	512	533	552	568	582	594	611
5.0	10	442	443	445	450	455	459	464	469	473	478	482	491	503	521	538	552	565	575	595
6.0	8	442	443	445	449	452	456	460	463	467	470	474	480	490	505	518	530	540	549	571
7.0	7	442	443	445	448	451	454	457	460	463	466	468	474	482	494	505	515	523	531	554
8.0	6	442	443	445	448	450	453	455	458	460	463	465	470	476	487	496	505	513	519	542
10.0	5	442	443	445	447	449	451	453	455	457	459	461	465	470	479	487	494	501	506	529
12.0	4	442	443	445	447	449	450	452	454	456	458	459	463	468	475	482	489	495	501	523

Cattail Density (%) at End of Calendar Year

	Wtr-Col	Time in Years																		
Distance	Total P	0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2010	2013	2018	2023	2028	2033	2038	SS
0.0	40	2%	4%	6%	7%	9%	11%	13%	15%	18%	21%	24%	32%	44%	64%	66%	62%	59%	56%	57%
0.1	39	2%	3%	5%	7%	8%	9%	11%	13%	15%	18%	21%	27%	38%	57%	61%	58%	55%	52%	53%
0.2	37	2%	3%	5%	6%	7%	8%	10%	11%	13%	16%	18%	24%	33%	51%	57%	54%	51%	49%	49%
0.3	36	2%	3%	4%	5%	6%	7%	9%	10%	12%	14%	16%	20%	29%	45%	53%	50%	47%	45%	46%
0.4	35	2%	3%	4%	5%	6%	7%	8%	9%	10%	12%	14%	18%	25%	40%	49%	46%	44%	42%	42%
0.5	34	2%	3%	4%	4%	5%	6%	7%	8%	9%	11%	12%	16%	22%	35%	45%	42%	40%	39%	39%
0.7	32	2%	2%	3%	4%	4%	5%	6%	7%	8%	9%	10%	13%	17%	28%	38%	36%	34%	33%	33%
1.0	29	2%	2%	3%	3%	4%	4%	5%	5%	6%	7%	7%	9%	13%	19%	28%	28%	27%	26%	27%
1.5	25	2%	2%	2%	3%	3%	3%	3%	4%	4%	5%	5%	6%	8%	12%	16%	20%	19%	19%	19%
2.0	21	2%	2%	2%	2%	2%	3%	3%	3%	3%	4%	4%	5%	6%	8%	11%	13%	14%	14%	14%
2.5	18	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	3%	4%	5%	6%	7%	9%	11%	10%	10%
3.0	16	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	4%	5%	6%	7%	8%	8%	8%
3.5	14	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	4%	5%	5%	6%	7%	7%
4.0	12	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	4%	4%	5%	5%	6%
4.5	11	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	4%	4%	4%	5%
5.0	10	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	4%	4%	4%
6.0	8	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	4%
7.0	7	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%
8.0	6	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%
10.0	5	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%
12.0	4	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%
Total Cattail Area (ha)		291	312	337	356	377	400	426	453	484	516	552	630	765	1022	1227	1283	1296	1297	1361

SS = Steady State

Input Variables

Variable	Units	Values	Input Variable	Units	Values
Rainfall P Conc.	ppb	30	Soil Depth	cm	20
Rainfall	m/yr	1.23	Initial Bulk Density	g/cm3	0.071
ET	m/yr	1.38	Initial P Content	mg/kg	366
STA Outflow Conc.	ppb	40	Initial Gradient	mg/cm3/cm	-0.0018
STA Outflow Volume	hm3/yr	304.5	Final Bulk Density	g/cm3	0.080
Flow Path Width	km	12.1	P Settling Rate, Yr 1	m/yr	30.0
Hydroperiod	-	92%	P Settling Rate, Yr 2	m/yr	20.0
Logisitic Coef - Spread	-	71.2	P Settling Rate, Yr >=3	m/yr	10.2
Logistic Coef - MidPoint	-	727.7	Spatial Resolution	ha	121

Profile at Beginning of Year 2007

Distance	km	0.0	0.5	1.0	2.0	4.0	8.0
Soil Accretion Rate	cm/yr	0.46	0.43	0.39	0.33	0.23	0.12
P Accretion Rate	mg/m2-yr	375	319	271	199	114	54
Bulk Density	g/cm3	0.073	0.073	0.073	0.072	0.072	0.072
Soil TP Conc.	mg/kg	610	546	504	452	408	387
Volumetric TP Conc.	mg/cm3	0.045	0.040	0.037	0.033	0.029	0.028
Cattail Density	%	16%	7%	4%	2%	1%	1%
Water Column TP	ppb	40	34	29	21	12	6

Water-Column P Impacts

		Threshold Criterion		
Variable	Units	Low	Medium	High
Water Column Conc.	ppb	10	20	30
Distance Exceeded	km	4.85	2.15	0.85
Area Exceeded	ha	5869	2602	1029

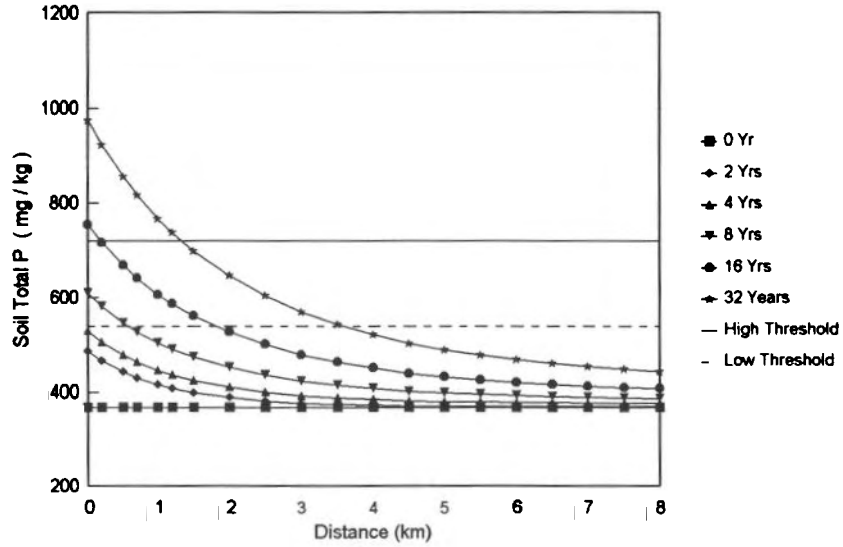
Soil P Impacts

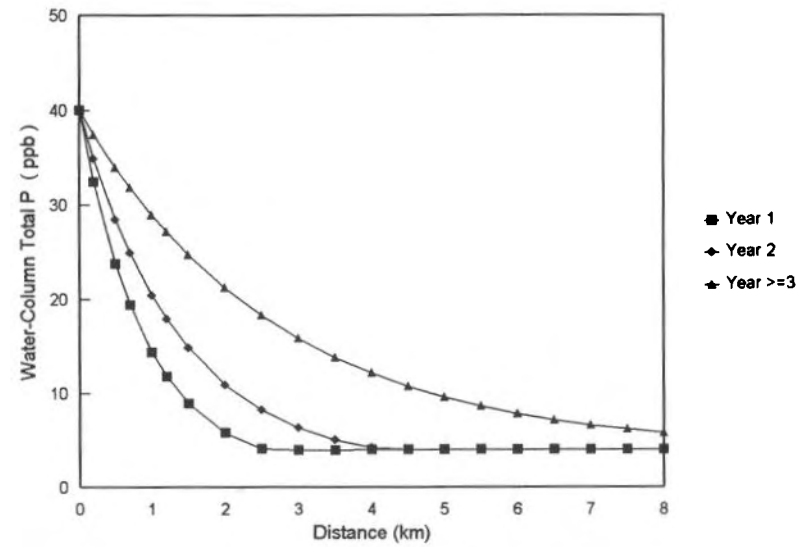
		Threshold Criterion		
Variable	Units	Low	Medium	High
Threshold Soil P	mg/kg	540	610	720
Equivalent Threshold Conc	ppb	6	11	19
Time to Steady State				
At C = 50 ppb	years	39	39	39
At C = Threshold	years	165	97	66
Exceedance of Soil P Criteria				
Initial Time	years	5	8	15
Calendar Year		2003	2006	2013
Maximum Time	years	40	40	24
Calendar Year		2038	2038	2022
Maximum Distance	km	4.3	3.0	1.8
Maximum Area	ha	5143	3570	2118
Exceedance of Soil P Criteria at End of Year 2006				
Distance Exceeded	km	0.6	0.1	0.0
Area Exceeded	ha	666	61	0

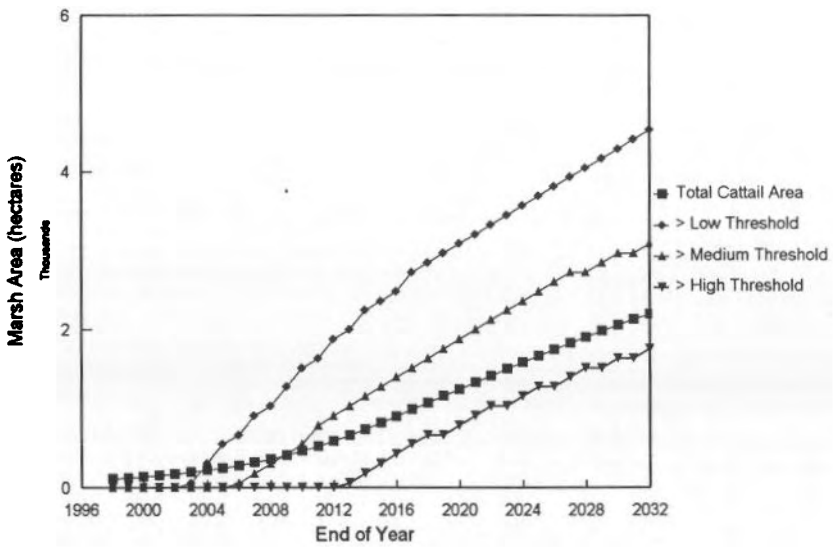
Soil P & Cattail Time Series

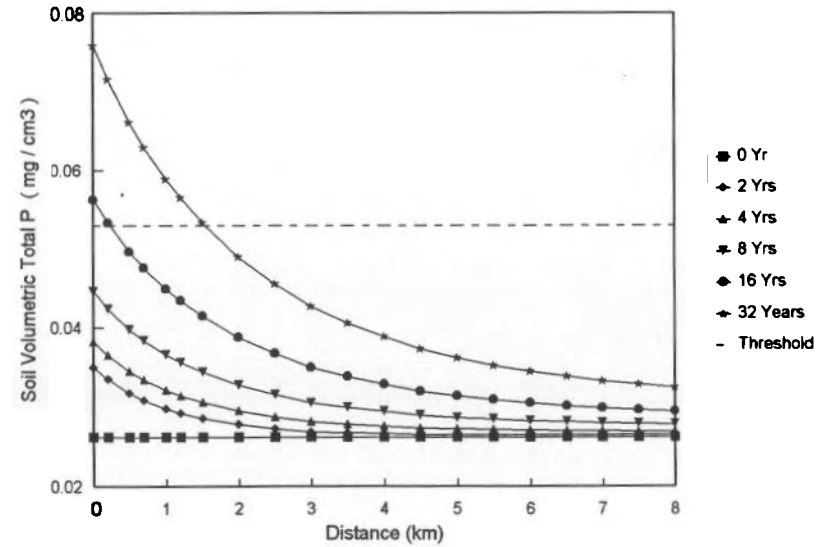
End of Year	1998	2000	2002	2004	2006	2008	2010
Soil P @ 0 km (mg/kg)	366	487	529	571	610	648	685
Cattail Density @ 0 km	1%	3%	6%	10%	16%	25%	35%
Cattail Density @ 1 km	1%	1%	2%	3%	4%	6%	8%
Cattail Density @ 2 km	1%	1%	1%	2%	2%	3%	3%
Total Cattail Area (ha)	113	141	173	218	279	361	465
Area Increase (ha)	0	28	60	105	167	248	352
Area with Density > 5%	0	0	61	545	1029	1392	1876
Area with Density > 10%	0	0	0	0	303	666	1029
Area with Density > 50%	0	0	0	0	0	0	0
Area with Density > 90%	0	0	0	0	0	0	0

E P G M **STA-2GDR Depth = 20 cm** **Startup Date = 1999**









Soil P Concentrations (mg / kg) at End of Year

Distance	Wtr-Col Total P	Time in Years																		
		0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2010	2013	2018	2023	2028	2033	2038	SS
0.0	40	366	440	487	508	529	550	571	591	610	629	648	685	737	817	888	951	1007	1054	1014
0.1	39	366	432	476	497	517	537	557	576	595	614	632	667	718	795	864	925	978	1025	996
0.2	37	366	425	466	486	506	525	544	563	581	599	617	651	700	775	841	900	952	997	978
0.3	36	366	419	457	477	496	515	533	551	569	586	603	636	683	756	820	877	927	971	962
0.4	35	366	414	450	468	487	505	523	540	557	574	590	622	668	738	800	856	904	946	946
0.5	34	366	409	442	461	478	496	513	530	546	563	579	610	654	721	782	835	882	923	930
0.7	32	366	401	430	447	464	480	496	512	527	543	557	586	628	691	748	798	842	880	901
1.0	29	366	392	415	431	446	461	475	490	504	517	531	557	595	652	704	749	790	824	861
1.5	25	366	382	399	412	425	437	450	462	474	485	497	519	551	601	645	684	719	749	803
2.0	21	366	376	389	400	411	421	432	442	452	462	472	491	519	561	599	634	664	691	755
2.5	18	366	372	381	391	400	409	418	427	436	445	453	470	493	530	563	593	620	643	715
3.0	16	366	368	375	383	391	399	407	415	422	430	437	451	472	504	533	559	583	604	681
3.5	14	366	368	374	381	388	395	401	408	414	421	427	440	458	486	511	535	556	575	653
4.0	12	366	368	372	379	385	391	396	402	408	414	419	430	446	471	493	514	533	550	630
4.5	11	366	368	370	376	381	386	391	397	402	407	411	421	435	457	477	496	513	529	611
5.0	10	366	368	370	375	380	384	389	394	398	402	407	415	428	448	466	483	499	513	595
6.0	8	366	368	370	374	378	382	385	389	393	396	400	407	417	433	449	463	476	489	571
7.0	7	366	368	370	373	377	380	383	386	389	392	395	401	410	424	437	449	461	472	554
8.0	6	366	368	370	373	376	379	381	384	387	389	392	397	405	417	428	439	450	460	542
10.0	5	366	368	370	373	375	377	379	382	384	386	388	393	399	409	419	428	437	446	529
12.0	4	366	368	370	372	374	376	379	381	383	385	387	390	396	406	415	423	431	439	523

Cattail Density (%) at End of Calendar Year

Distance	Wtr-Col Total P	Time in Years																		
		0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2010	2013	2018	2023	2028	2033	2038	SS
0.0	40	1%	2%	3%	4%	6%	8%	10%	13%	16%	20%	25%	35%	53%	78%	90%	96%	98%	99%	99%
0.1	39	1%	2%	3%	4%	5%	6%	8%	11%	13%	17%	21%	30%	46%	72%	87%	94%	97%	98%	99%
0.2	37	1%	1%	2%	3%	4%	6%	7%	9%	11%	14%	17%	25%	40%	66%	83%	92%	96%	98%	99%
0.3	36	1%	1%	2%	3%	4%	5%	6%	8%	10%	12%	15%	22%	35%	60%	79%	89%	94%	97%	98%
0.4	35	1%	1%	2%	3%	3%	4%	5%	7%	8%	10%	13%	19%	30%	54%	74%	86%	92%	96%	98%
0.5	34	1%	1%	2%	2%	3%	4%	5%	6%	7%	9%	11%	16%	26%	48%	68%	82%	90%	94%	97%
0.7	32	1%	1%	2%	2%	2%	3%	4%	5%	6%	7%	8%	12%	20%	37%	57%	73%	83%	89%	95%
1.0	29	1%	1%	1%	2%	2%	2%	3%	3%	4%	5%	6%	8%	13%	26%	42%	58%	70%	80%	91%
1.5	25	1%	1%	1%	1%	1%	2%	2%	2%	3%	3%	4%	5%	8%	14%	24%	35%	47%	57%	79%
2.0	21	1%	1%	1%	1%	1%	1%	2%	2%	2%	2%	3%	3%	5%	9%	14%	21%	29%	37%	64%
2.5	18	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	3%	4%	6%	9%	13%	18%	23%	49%
3.0	16	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	3%	4%	6%	9%	12%	15%	35%
3.5	14	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	3%	5%	6%	8%	10%	27%
4.0	12	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	3%	4%	5%	6%	8%	21%
4.5	11	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	3%	4%	5%	6%	16%
5.0	10	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	3%	4%	5%	13%
6.0	8	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	3%	3%	10%
7.0	7	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	3%	8%
8.0	6	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	7%
10.0	5	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	6%
12.0	4	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	5%
Total Cattail Area (ha)		113	125	141	156	173	194	218	247	279	317	361	465	663	1069	1499	1902	2262	2578	4043

SS = Steady State

put Variables

Variable	Units	Values	Input Variable	Units	Values
Rainfall P Conc.	ppb	37	Soil Depth	cm	10
Rainfall	m/yr	1.16	Initial Bulk Density	g/cm3	0.102
ET	m/yr	1.38	Initial P Content	mg/kg	198
STA Outflow Conc.	ppb	122	Initial Gradient	mg/cm3/cm	-0.0018
STA Outflow Volume	hm3/yr	347.2	Final Bulk Density	g/cm3	0.080
Flow Path Width	km	10.5	P Settling Rate, Yr 1	m/yr	10.2
Hydroperiod	-	91%	P Settling Rate, Yr 2	m/yr	10.2
Logisitic Coef - Spread	-	144.1	P Settling Rate, Yr >=3	m/yr	10.2
Logistic Coef - MidPoint	-	1034.4	Spatial Resolution	ha	105

Profile at Beginning of Year 2007

Distance	km	0.0	0.5	1.0	2.0	4.0	8.0
Soil Accretion Rate	cm/yr	0.67	0.65	0.63	0.58	0.48	0.28
P Accretion Rate	mg/m2-yr	1137	997	873	672	402	158
Bulk Density	g/cm3	0.080	0.080	0.080	0.080	0.080	0.080
Soil TP Conc.	mg/kg	2131	1925	1744	1449	1053	694
Volumetric TP Conc.	mg/cm3	0.171	0.154	0.140	0.116	0.084	0.056
Cattail Density	%	100%	100%	99%	95%	53%	9%
Water Column TP	ppb	122	107	94	72	43	17

Water-Column P Impacts

		Threshold Criterion		
Variable	Units	Low	Medium	High
Water Column Conc.	ppb	10	20	30
Distance Exceeded	km	10.85	7.25	5.45
Area Exceeded	ha	11393	7613	5723

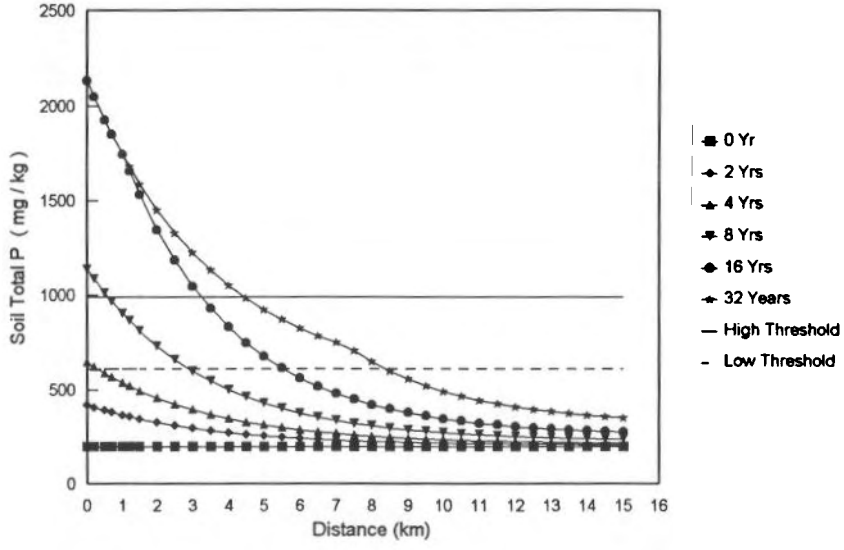
Soil P Impacts

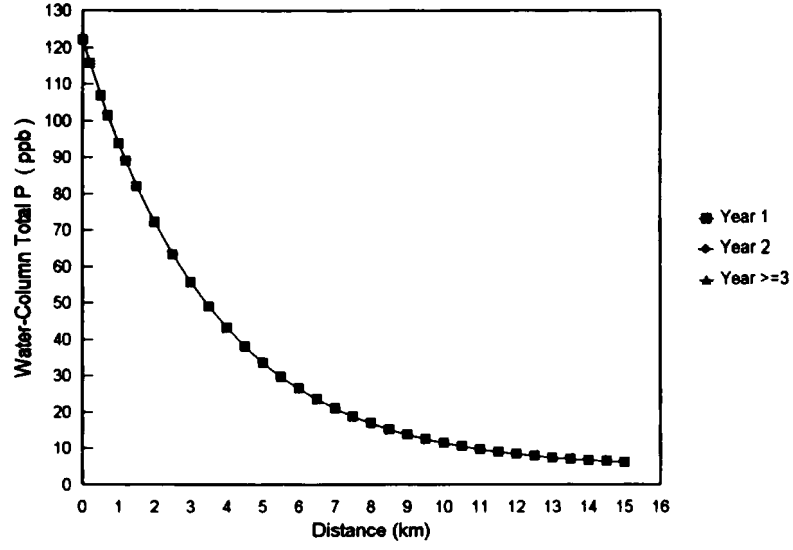
		Threshold Criterion		
Variable	Units	Low	Medium	High
Threshold Soil P	mg/kg	610	870	990
Equivalent Threshold Conc	ppb	11	30	39
Time to Steady State				
At C = 50 ppb	years	20	20	20
At C = Threshold	years	49	25	22
Exceedance of Soil P Criteria				
Initial Time	years	4	6	7
Calendar Year		1965	1967	1968
Maximum Time	years	48	26	19
Calendar Year		2009	1987	1980
Maximum Distance	km	10.4	5.6	4.5
Maximum Area	ha	10868	5828	4673
Exceedance of Soil P Criteria at End of Year 2006				
Distance Exceeded	km	10.0	5.6	4.5
Area Exceeded	ha	10448	5828	4673

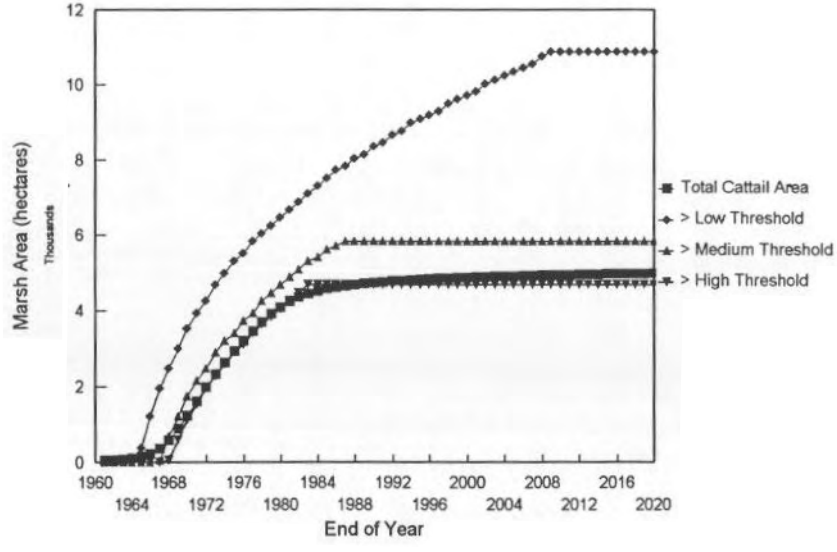
Soil P & Cattail Time Series

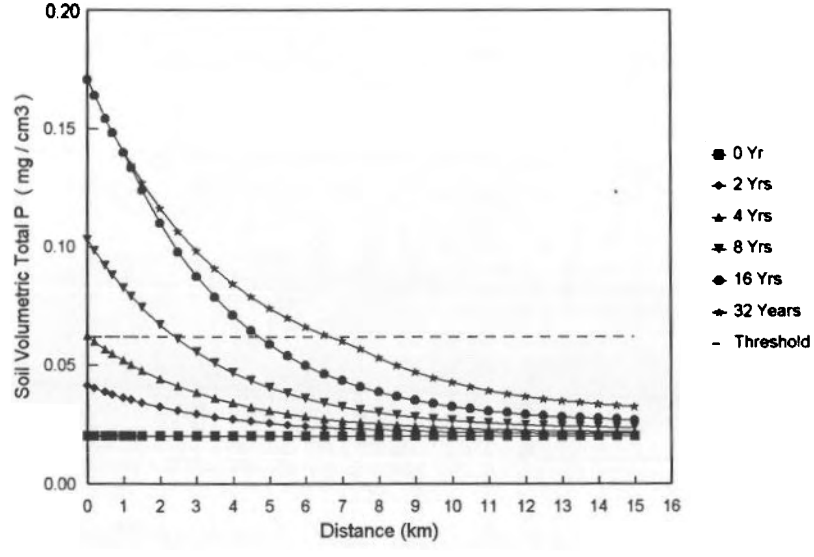
End of Year	1961	2000	2002	2004	2006	2008	2010
Soil P @ 0 km (mg/kg)	198	2131	2131	2131	2131	2131	2131
Cattail Density @ 0 km	0%	100%	100%	100%	100%	100%	100%
Cattail Density @ 1 km	0%	99%	99%	99%	99%	99%	99%
Cattail Density @ 2 km	0%	95%	95%	95%	95%	95%	95%
Total Cattail Area (ha)	47	4871	4887	4902	4915	4927	4938
Area Increase (ha)	0	4823	4840	4855	4868	4880	4891
Area with Density > 5%	0	9713	10028	10238	10448	10763	10868
Area with Density > 10%	0	7928	7928	7928	7928	7928	7928
Area with Density > 50%	0	4358	4358	4358	4358	4358	4358
Area with Density > 90%	0	2573	2573	2573	2573	2573	2573

E P G M **S10's** **Depth = 10 cm** **Startup Date = 1962**









Soil P Concentrations (mg / kg) at End of Year

Distance	Wtr-Col Total P	Time in Years																		
		0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1973	1976	1981	1986	1991	1996	2001	SS
0.0	122	198	306	417	530	646	765	886	1010	1138	1269	1403	1682	2131	2131	2131	2131	2131	2131	2131
0.1	119	198	303	411	521	634	749	867	988	1111	1238	1369	1640	2076	2088	2088	2088	2088	2088	2088
0.2	116	198	301	405	512	622	734	848	965	1086	1209	1335	1598	2021	2045	2045	2045	2045	2045	2045
0.3	113	198	298	400	504	610	719	830	944	1061	1180	1303	1558	1967	2004	2004	2004	2004	2004	2004
0.4	110	198	295	394	495	599	704	812	923	1036	1152	1271	1518	1915	1964	1964	1964	1964	1964	1964
0.5	107	198	292	389	487	588	690	795	903	1013	1125	1241	1480	1864	1925	1925	1925	1925	1925	1925
0.7	101	198	287	379	472	566	663	763	864	967	1073	1182	1407	1767	1850	1850	1850	1850	1850	1850
1.0	94	198	280	364	450	537	626	717	809	904	1001	1100	1305	1632	1744	1744	1744	1744	1744	1744
1.5	82	198	270	343	417	493	570	648	728	810	893	978	1154	1433	1587	1587	1587	1587	1587	1587
2.0	72	198	261	324	389	454	521	589	658	729	800	873	1024	1261	1449	1449	1449	1449	1449	1449
2.5	63	198	253	308	364	421	479	538	598	658	720	783	911	1114	1329	1329	1329	1329	1329	1329
3.0	56	198	246	294	343	392	443	494	545	598	651	705	815	987	1224	1224	1224	1224	1224	1224
3.5	49	198	240	282	324	368	411	455	500	545	591	638	732	880	1132	1132	1132	1132	1132	1132
4.0	43	198	234	271	308	346	384	422	461	500	540	580	661	788	1009	1053	1053	1053	1053	1053
4.5	38	198	230	262	295	327	361	394	428	462	496	530	601	709	898	983	983	983	983	983
5.0	34	198	226	254	283	311	340	369	399	428	458	488	549	642	803	923	923	923	923	923
6.0	26	198	220	242	264	286	308	330	353	375	398	421	467	537	656	780	825	825	825	825
7.0	21	198	215	232	249	267	284	301	319	336	354	371	407	460	551	643	738	750	750	750
8.0	17	198	212	225	239	253	266	280	294	308	321	335	363	405	475	546	618	691	694	694
10.0	12	198	207	216	225	234	244	253	262	271	280	289	307	335	380	426	472	517	563	620
12.0	8	198	205	211	218	224	231	238	244	251	257	264	277	297	330	362	395	427	460	579

Cattail Density (%) at End of Calendar Year

Distance	Wtr-Col Total P	Time in Years																		
		0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1973	1976	1981	1986	1991	1996	2001	SS
0.0	122	0%	1%	1%	3%	6%	13%	26%	46%	67%	84%	93%	99%	100%	100%	100%	100%	100%	100%	100%
0.1	119	0%	1%	1%	3%	6%	12%	24%	42%	63%	80%	91%	99%	100%	100%	100%	100%	100%	100%	100%
0.2	116	0%	1%	1%	3%	5%	11%	22%	38%	59%	77%	89%	98%	100%	100%	100%	100%	100%	100%	100%
0.3	113	0%	1%	1%	2%	5%	10%	19%	35%	55%	73%	87%	97%	100%	100%	100%	100%	100%	100%	100%
0.4	110	0%	1%	1%	2%	5%	9%	18%	32%	50%	69%	84%	97%	100%	100%	100%	100%	100%	100%	100%
0.5	107	0%	1%	1%	2%	4%	8%	16%	29%	46%	65%	81%	96%	100%	100%	100%	100%	100%	100%	100%
0.7	101	0%	1%	1%	2%	4%	7%	13%	23%	39%	57%	74%	93%	99%	100%	100%	100%	100%	100%	100%
1.0	94	0%	1%	1%	2%	3%	6%	10%	17%	29%	44%	61%	87%	98%	99%	99%	99%	99%	99%	99%
1.5	82	0%	0%	1%	1%	2%	4%	6%	11%	17%	27%	40%	70%	94%	98%	98%	98%	98%	98%	98%
2.0	72	0%	0%	1%	1%	2%	3%	4%	7%	11%	16%	25%	48%	83%	95%	95%	95%	95%	95%	95%
2.5	63	0%	0%	1%	1%	1%	2%	3%	5%	7%	10%	15%	30%	63%	89%	89%	89%	89%	89%	89%
3.0	56	0%	0%	1%	1%	1%	2%	2%	3%	5%	7%	9%	18%	42%	79%	79%	79%	79%	79%	79%
3.5	49	0%	0%	1%	1%	1%	1%	2%	2%	3%	4%	6%	11%	25%	66%	66%	66%	66%	66%	66%
4.0	43	0%	0%	0%	1%	1%	1%	1%	2%	2%	3%	4%	7%	15%	46%	53%	53%	53%	53%	53%
4.5	38	0%	0%	0%	1%	1%	1%	1%	1%	2%	2%	3%	5%	9%	28%	41%	41%	41%	41%	41%
5.0	34	0%	0%	0%	1%	1%	1%	1%	1%	1%	2%	2%	3%	6%	17%	32%	32%	32%	32%	32%
6.0	26	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	2%	3%	7%	15%	19%	19%	19%	19%
7.0	21	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	2%	3%	6%	11%	12%	12%	12%
8.0	17	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	2%	3%	5%	8%	9%	9%
10.0	12	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	2%	3%	4%	5%
12.0	8	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	2%	4%
Total Cattail Area (ha)		47	58	75	102	148	227	362	577	876	1232	1605	2311	3202	4239	4615	4755	4830	4879	5005

SS = Steady State

Input Variables

Variable	Units	Values	Input Variable	Units	Values
Rainfall P Conc.	ppb	37	Soil Depth	cm	20
Rainfall	m/yr	1.16	Initial Bulk Density	g/cm3	0.102
ET	m/yr	1.38	Initial P Content	mg/kg	198
STA Outflow Conc.	ppb	122	Initial Gradient	mg/cm3/cm	-0.0018
STA Outflow Volume	hm3/yr	347.2	Final Bulk Density	g/cm3	0.080
Flow Path Width	km	10.5	P Settling Rate, Yr 1	m/yr	10.2
Hydroperiod	-	91%	P Settling Rate, Yr 2	m/yr	10.2
Logisitic Coef - Spread	-	71.2	P Settling Rate, Yr >=3	m/yr	10.2
Logistic Coef - MidPoint	-	727.7	Spatial Resolution	ha	105

Profile at Beginning of Year 2007

Distance	km	0.0	0.5	1.0	2.0	4.0	8.0
Soil Accretion Rate	cm/yr	0.67	0.65	0.63	0.58	0.48	0.28
P Accretion Rate	mg/m2-yr	1137	997	873	672	402	158
Bulk Density	g/cm3	0.080	0.080	0.080	0.080	0.080	0.088
Soil TP Conc.	mg/kg	2131	1925	1744	1449	1053	535
Volumetric TP Conc.	mg/cm3	0.171	0.154	0.140	0.116	0.084	0.047
Cattail Density	%	100%	100%	100%	100%	99%	6%
Water Column TP	ppb	122	107	94	72	43	17

Water-Column P Impacts

		Threshold Criterion		
Variable	Units	Low	Medium	High
Water Column Conc.	ppb	10	20	30
Distance Exceeded	km	10.85	7.25	5.45
Area Exceeded	ha	11393	7613	5723

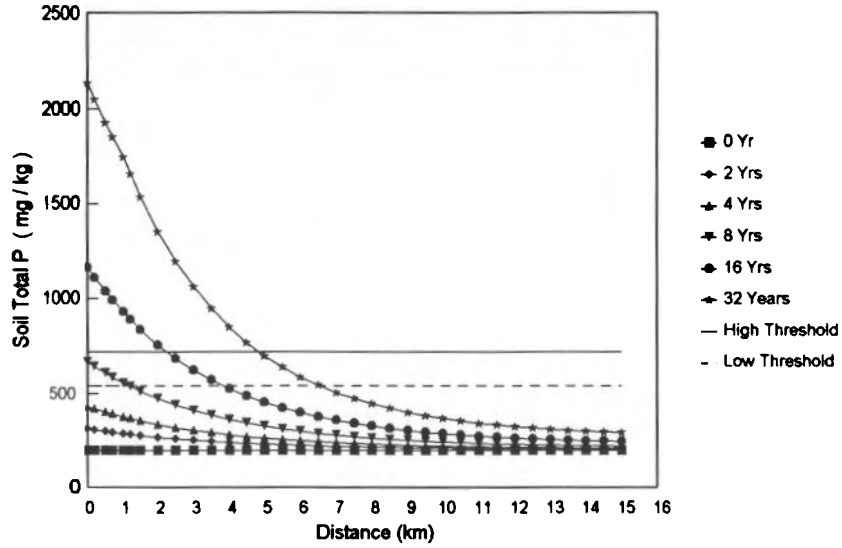
Soil P Impacts

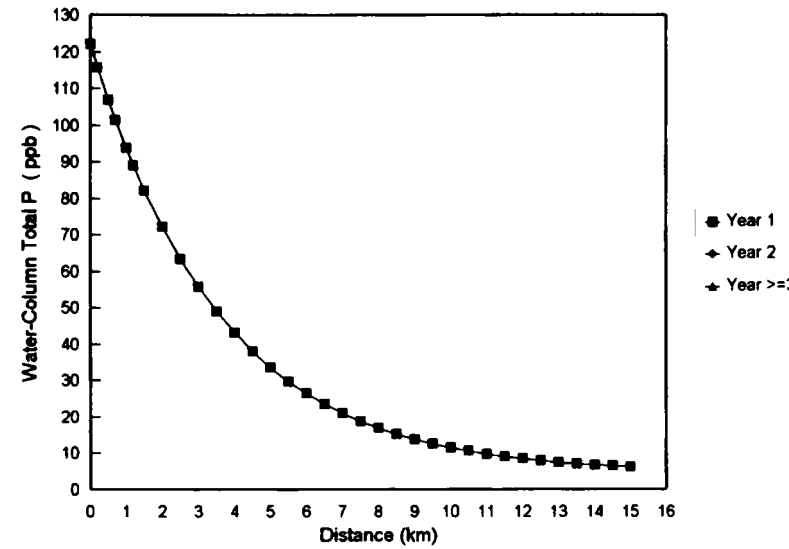
		Threshold Criterion		
Variable	Units	Low	Medium	High
Threshold Soil P	mg/kg	540	610	720
Equivalent Threshold Conc	ppb	6	11	19
Time to Steady State				
At C = 50 ppb	years	39	39	39
At C = Threshold	years	164	97	66
Exceedance of Soil P Criteria				
Initial Time	years	6	8	9
Calendar Year		1967	1969	1970
Maximum Time	years	66	66	50
Calendar Year		2027	2027	2011
Maximum Distance	km	9.7	8.7	7.6
Maximum Area	ha	10133	9083	7928
Exceedance of Soil P Criteria at End of Year 2006				
Distance Exceeded	km	8.0	7.1	6.1
Area Exceeded	ha	8348	7403	6353

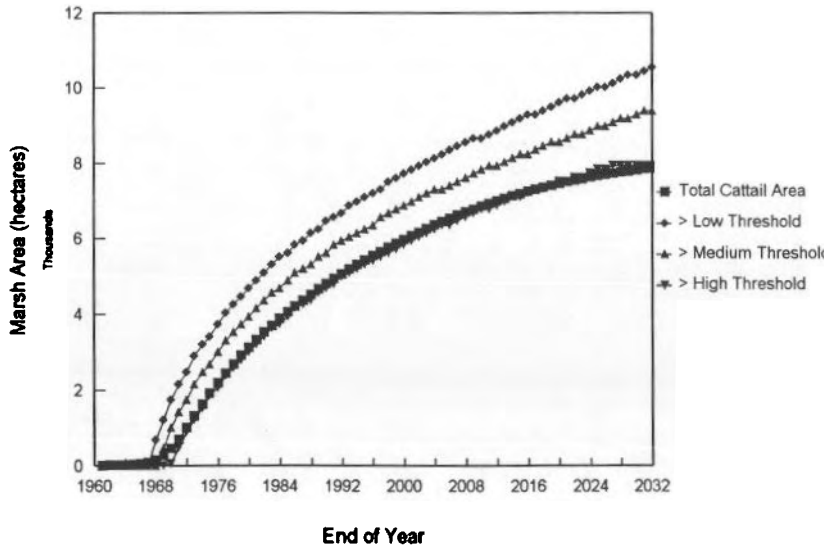
Soil P & Cattail Time Series

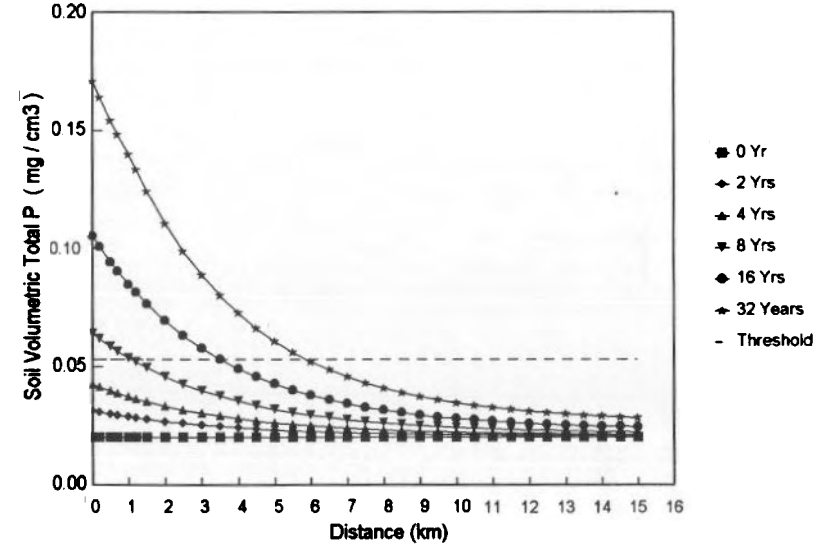
End of Year	1961	2000	2002	2004	2006	2008	2010
Soil P @ 0 km (mg/kg)	198	2131	2131	2131	2131	2131	2131
Cattail Density @ 0 km	0%	100%	100%	100%	100%	100%	100%
Cattail Density @ 1 km	0%	100%	100%	100%	100%	100%	100%
Cattail Density @ 2 km	0%	100%	100%	100%	100%	100%	100%
Total Cattail Area (ha)	9	5971	6169	6357	6534	6700	6855
Area Increase (ha)	0	5962	6160	6347	6524	6691	6846
Area with Density > 5%	0	8033	8243	8453	8663	8873	9083
Area with Density > 10%	0	7298	7508	7718	7928	8138	8243
Area with Density > 50%	0	5828	5933	6143	6353	6458	6668
Area with Density > 90%	0	4778	4988	5093	5303	5408	5618

E P G M S10's Depth = 20 cm Startup Date = 1962









Soil P Concentrations (mg / kg) at End of Year

	Wtr-Col	Time in Years																		
Distance	Total P	0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1973	1976	1981	1986	1991	1996	2001	SS
0.0	122	198	255	312	370	428	486	545	605	665	725	786	910	1099	1426	1770	2131	2131	2131	2131
0.1	119	198	253	309	365	422	479	536	594	652	711	770	890	1074	1392	1725	2076	2088	2088	2088
0.2	116	198	252	306	361	416	471	527	583	640	697	755	872	1050	1359	1682	2022	2045	2045	2045
0.3	113	198	250	303	357	410	464	519	573	628	684	740	854	1027	1326	1640	1969	2004	2004	2004
0.4	110	198	249	301	352	405	457	510	563	617	671	726	836	1004	1295	1599	1917	1964	1964	1964
0.5	107	198	248	298	348	399	450	502	554	606	659	712	819	982	1264	1559	1867	1925	1925	1925
0.7	101	198	245	293	341	389	437	486	535	585	634	684	786	940	1206	1483	1772	1850	1850	1850
1.0	94	198	242	286	330	374	419	464	509	555	601	647	740	881	1124	1376	1639	1744	1744	1744
1.5	82	198	236	275	314	353	392	431	470	510	550	590	671	794	1003	1219	1442	1587	1587	1587
2.0	72	198	232	266	300	334	368	402	437	471	506	541	611	718	898	1083	1273	1449	1449	1449
2.5	63	198	228	257	287	317	347	377	407	438	468	498	559	652	808	967	1129	1294	1329	1329
3.0	56	198	224	250	276	303	329	355	382	408	435	461	515	595	730	867	1005	1146	1224	1224
3.5	49	198	221	244	267	290	313	336	360	383	406	429	476	546	663	781	899	1019	1132	1132
4.0	43	198	218	239	259	279	300	320	340	361	381	401	442	503	605	707	809	911	1014	1053
4.5	38	198	216	234	252	270	288	306	323	341	359	377	413	466	555	644	732	820	908	983
5.0	34	198	214	230	246	261	277	293	309	325	340	356	388	434	512	590	666	742	818	923
6.0	26	198	211	223	236	248	260	273	285	298	310	322	347	383	444	503	562	620	677	825
7.0	21	198	208	218	228	238	248	258	267	277	287	297	316	345	393	439	485	531	575	750
8.0	17	198	206	214	222	230	238	246	254	262	270	278	293	317	355	392	429	465	500	694
10.0	12	198	204	209	215	220	225	231	236	242	247	252	263	279	305	331	356	381	405	620
12.0	8	198	202	206	210	214	218	222	226	230	234	238	246	258	277	296	315	333	352	579

Cattail Density (%) at End of Calendar Year

	Wtr-Col	Time in Years																		
Distance	Total P	0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	SS
km	ppb	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1973	1976	1981	1986	1991	1996	2001	SS
0.0	122	0%	0%	0%	1%	1%	3%	7%	15%	29%	49%	69%	93%	99%	100%	100%	100%	100%	100%	100%
0.1	119	0%	0%	0%	1%	1%	3%	6%	13%	26%	44%	65%	91%	99%	100%	100%	100%	100%	100%	100%
0.2	116	0%	0%	0%	1%	1%	3%	6%	12%	23%	40%	59%	88%	99%	100%	100%	100%	100%	100%	100%
0.3	113	0%	0%	0%	1%	1%	2%	5%	10%	20%	35%	54%	85%	99%	100%	100%	100%	100%	100%	100%
0.4	110	0%	0%	0%	1%	1%	2%	4%	9%	17%	31%	49%	82%	98%	100%	100%	100%	100%	100%	100%
0.5	107	0%	0%	0%	0%	1%	2%	4%	8%	15%	27%	44%	78%	97%	100%	100%	100%	100%	100%	100%
0.7	101	0%	0%	0%	0%	1%	2%	3%	6%	12%	21%	35%	69%	95%	100%	100%	100%	100%	100%	100%
1.0	94	0%	0%	0%	0%	1%	1%	2%	4%	8%	14%	24%	54%	90%	100%	100%	100%	100%	100%	100%
1.5	82	0%	0%	0%	0%	1%	1%	2%	3%	4%	8%	13%	31%	72%	98%	100%	100%	100%	100%	100%
2.0	72	0%	0%	0%	0%	0%	1%	1%	2%	3%	4%	7%	16%	46%	92%	99%	100%	100%	100%	100%
2.5	63	0%	0%	0%	0%	0%	0%	1%	1%	2%	3%	4%	9%	26%	76%	97%	100%	100%	100%	100%
3.0	56	0%	0%	0%	0%	0%	0%	1%	1%	1%	2%	2%	5%	13%	51%	88%	98%	100%	100%	100%
3.5	49	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	3%	7%	29%	68%	92%	98%	100%	100%
4.0	43	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	2%	4%	15%	43%	76%	93%	98%	99%
4.5	38	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	2%	8%	24%	52%	79%	93%	97%
5.0	34	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	2%	5%	13%	30%	55%	78%	94%
6.0	26	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	2%	4%	9%	18%	33%	80%
7.0	21	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	2%	3%	6%	10%	58%
8.0	17	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	2%	4%	38%
10.0	12	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	18%
12.0	8	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	11%
Total Cattail Area (ha)		9	12	15	22	33	52	88	154	269	452	703	1309	2178	3323	4209	4931	5542	6071	8489

SS = Steady State

A Model for Simulating Phosphorus Concentrations in Waters and Soils Downstream of Everglades Stormwater Treatment Areas

Addendum

prepared for

U.S. Department of the Interior

by

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September 12, 1996

Introduction

This report summarizes results of additional analyses which have been performed in response to questions raised on the draft report (August 13, 1996). The following topics are considered:

1. Additional testing of the model using soil phosphorus and cattail density data from the Holeyland;

2. Sensitivity of model predictions to reductions in initial soil density.

3. Simulation of by-pass alternatives for STA-2.

Testing of Model against Holeyland Data.

The Draft identifies uncertainties in model predictions for northern WCA-3A and Rotenberger resulting from the fact that the model has been calibrated primarily to data from WCA-2A. Although the general consistency of the model calibration with soils and vegetation data from Holeyland and Rotenberger was discussed (pp. 26-27), no quantitative comparisons were made. Observations of soil phosphorus and cattail density from the Holeyland have been provided by SFWMD staff. The data are described by Newman et al., (1996). To a limited extent, these data can be used to test the cattail vs. soil P relationships derived for WCA-2A, as described Figure 13 of the Draft.

Rapid expansion of cattail populations was observed in the Holeyland following reflooding in 1991. As discussed in the Draft, regions of elevated soil P concentrations in the Holeyland are thought reflect effects of drought and/or fire, not external P loads. Observations of soil phosphorus and cattail density are available for 36 locations. Unlike the WCA-2A data, the observations are not accurately paired because cattail densities were not measured simultaneously with soil sampling, cattail densities were estimated from areal point sampling, and the locations of soil sampling stations were approximate. Pairing of the soil P and cattail observations is uncertain in regions with strong gradients. The model is tested based upon data from 23 stations located in regions with relatively uniform in cattail density.

Figure 1 compares observed cattail densities in 1993 (after flooding) with densities predicted from soil P measurements in 1990 (before flooding) using the WCA-2A threshold model (Draft, Equations 31 & 32). This situation is analogous to prediction of cattail densities below hydropattern restoration structures in Rotenberger and WCA-3A using soil phosphorus measurements collected prior to flooding. Although the data are limited and scattered, there is some correlation between observed and predicted densities. More

importantly, there is no indication that moderate or high cattail densities developed in regions with soil P levels below the threshold values estimated from the more intensive WCA-2A data set.

Given that soil sampling sites are distributed in a uniform grid, estimates of total cattail area can be derived by averaging point densities across all 36 sites and multiplying by the total area of the Holeyland (14,306 ha). Cattail area estimates of 2,525 and 1,556 ha are derived from the 0-10 and 0-20 cm soil phosphorus measurements in 1990. An estimate of 2,153 ha is derived from the average observed cattail density at the 36 sampling sites in 1993. Based upon areal point sampling at 200 locations distributed over the entire area (Newman et al., 1996), total cattail areas were 731, 1,543, and 2,187 ha in 1992, 1993, and 1994, respectively. These results demonstrate the applicability of the cattail threshold model to Holeyland soils, which are similar to those found in Rotenberger and northern WCA-3A with respect to historical hydroperiod, bulk densities, and soil phosphorus levels.

Sensitivity of Model Predictions to Reductions in Initial Soil Density

As described in the Draft, predicted rates of soil enrichment and cattail expansion below STA-2 are generally higher than those predicted below STA's 34, 5, and 6. The slower response of WCA-3A and Rotenberger soils is partially attributed to higher initial bulk densities (0.18 - 0.23 vs. 0.08 g/cm^3). The simulations assume that the initial densities do not change after flooding of the soils. Figure 2 shows bulk densities at Holeyland sites before (1990) and after (1993) flooding. An decrease in density is evident between the two sampling periods. Although differences in sampling technique could contribute to these variations, the data suggest a change in structure following flooding. It is possible that soils in Rotenberger and northern WCA-3A would respond in a similar fashion.

Simulations of STA's -34, 5, and 6 have been repeated with a lower initial bulk density of 0.12 g/cm^3 (~average for Holeyland soils after flooding). Figure 3 shows the effects on simulated cattail densities at the end of 2006. Densities have not been altered for STA-2 because measured densities in WCA-2A are already low and typical of marsh soils. Impact areas for STA's 34, 5, and 6 are approximately doubled, but remain below the areas predicted for STA-2. Actual density response may depend on initial soil properties, historical hydroperiod, fire, etc... Additional data (experiments ?) would be needed to resolve predictions within the general ranges shown in Figure 3.

Simulation of By-Pass Alternatives for STA-2.

Considerable interest has been expressed in using the model to predict recovery of soil P levels following reductions in surface-water concentration in areas which have been impacted by historical phosphorus loads. This type of simulation would be needed to evaluate by-pass alternatives for the STA discharges. In its current form, the model does not incorporate certain mechanisms which are thought to be important for simulating soil P recovery. These mechanisms may be incorporated in future model revisions. Without these mechanisms, it is likely that the existing model will initially over-predict recovery rates at the downstream boundaries of impacted areas. Simulations of by-pass alternatives using the existing model may be useful for placing bounds on expected responses, however.

The following simulations have been performed to compare options for STA-2. Three options have been considered (No Action, Current Plan, and Bypass to S10's). Flow / load allocations and results are summarized in Figure 4.

Under the No Action alternative, S10 flows and loads continue at historical values through 2006 and STA-2 is not constructed. Under the Current Plan, STA-2 discharges to NW WCA-2A at 50 ppb between 1999 and 2006; in 1999, S10 flows are reduced by the STA-2 flow; S10 concentration remains at the historical value. Under the By-Pass alternative, the S10 flow remains at its historical value through 2000; in 2001, the S10 concentration is reduced from 122 to 69 ppb to reflect partial treatment occurring in STA-2.

Total flows and loads for the Bypass alternative are identical to total flows and loads for the Current Plan during each time interval (before and after STA-2 completion). The plans differ only with respect to the location of the STA-2 discharge. The expected 2-year delay in STA-2 construction is also considered in the Bypass simulation.

Both inflow zones (NW & NE WCA-2A) are simulated for each alternative. The growth of the total impacted area (sum of both regions) between 1999 and 2006 is used a basis for comparing STA-2 alternatives (Figure 4). Total increases in impacted areas at the end of 2006 are 771 ha for the No Action alternative (all below S10's), 367 ha for the Current Plan (131 below S10's and 236 below hydropattern structures), and 553 ha for the By-Pass alternative (all below S10's). The Current Plan results in the lowest total impacted area over the entire period. The difference between the Current Plan and the By-Pass alternative is attributed primarily to the 2-year delay in STA-2 completion under

the latter. Once STA-2 is on line, total rates of cattail expansion are nearly identical for the Current Plan and By-Pass alternative.

Because of model limitations discussed above, it is likely that these simulations under-estimate expansion rates below the S10's for both the Current and By-Pass alternatives. Impacts attributed to delay in STA completion (or No Action) do not rely on simulation of recovery, however, and are adequately represented by the model.

Evaluation of the second By-Pass alternative for STA-2 (discharge through S7) is more difficult because the downstream flow path is more complex. Although the model cannot resolve geographic locations under these conditions, approximate estimates of total impact area can be derived. The analysis follows that conducted above for the S10 bypass, substituting average historical S7 flows and loads for the average historical S10 flows and loads. Initial (1961) soil conditions in the S7 discharge zone are assumed to equal those in the S10 discharge zone. In terms of relative impact areas, differences between the Current Plan and S7 By-Pass are similar to those shown in Figure 4 for the S10 By-Pass.

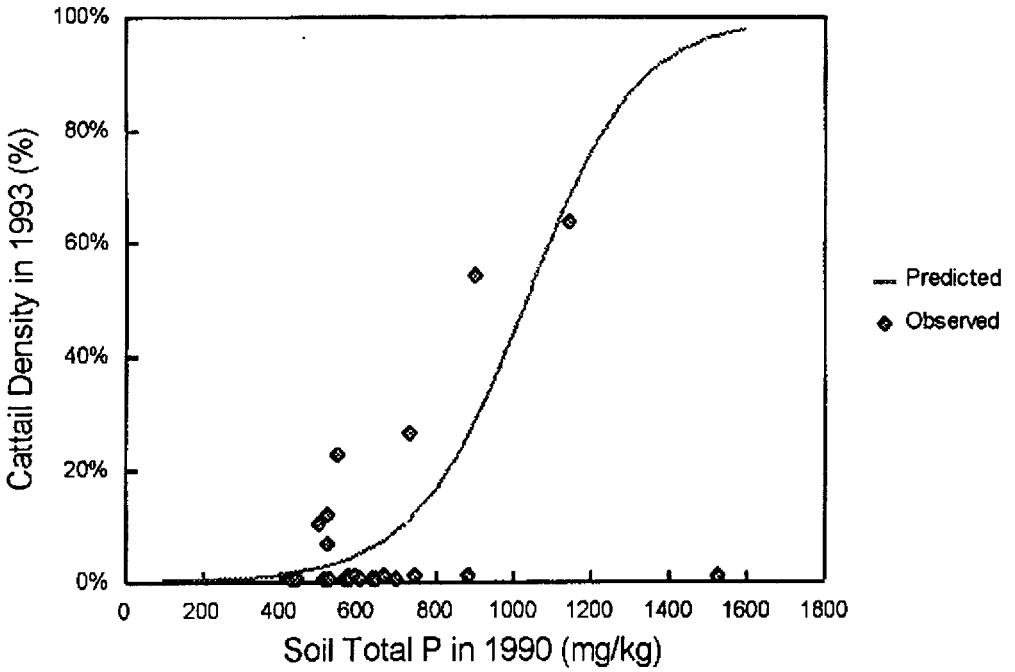
Reference

Newman, S., J. Schuette, J.B. Grace, K. Rutchey, T. Fontaine, M. Campbell, M. Pietrucha, & K.R. Reddy, "Factors Influencing Cattail Abundance in the Northern Everglades", Draft Manuscript, South Florida Water Management District, 1996.

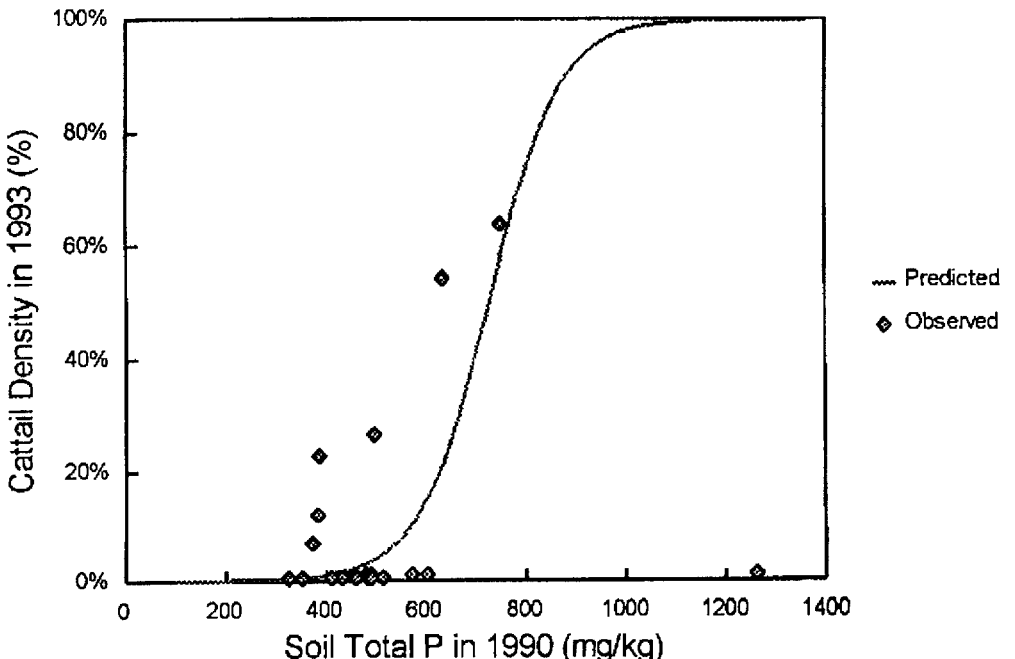
List of Figures

Prediction of 1993 Cattail Densities in Holeyland Using Threshold Model Calibrated to WCA-2A Data

Soil Depth = 10 cm

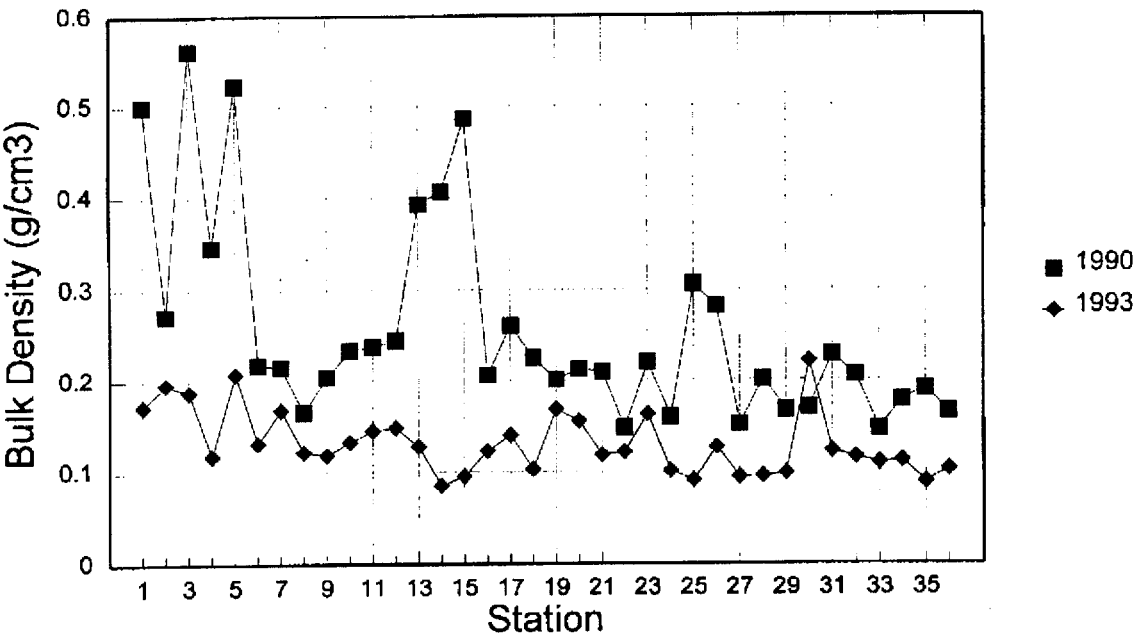


Soil Depth = 20 cm

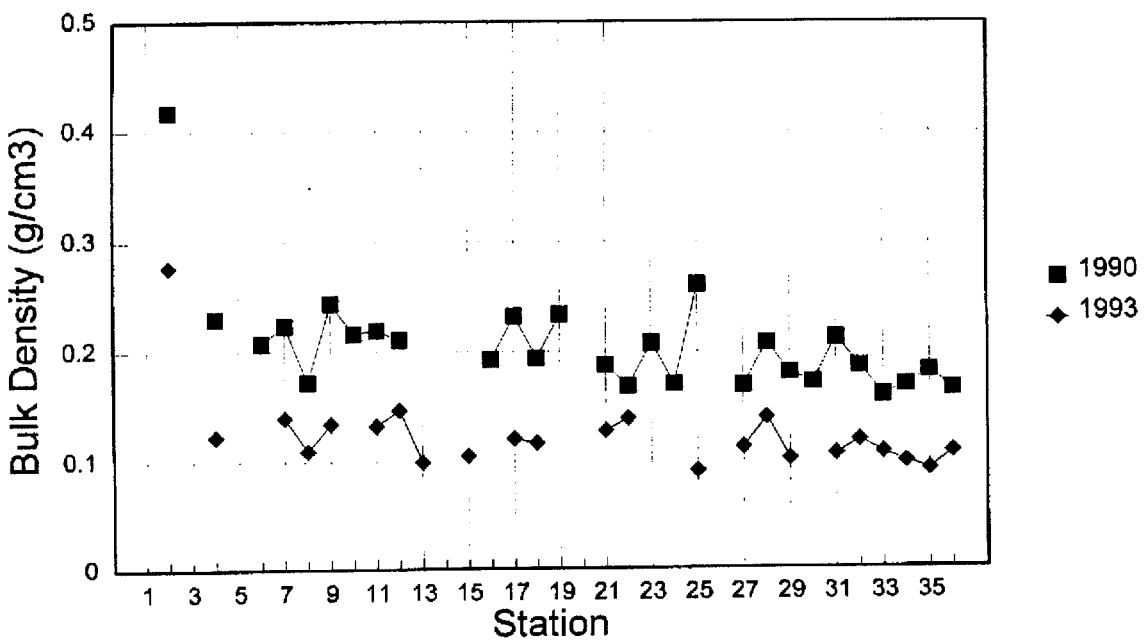


Changes in Bulk Density of Holeyland Soils Following Flooding

1990 **before flooding**
1993 **after flooding**

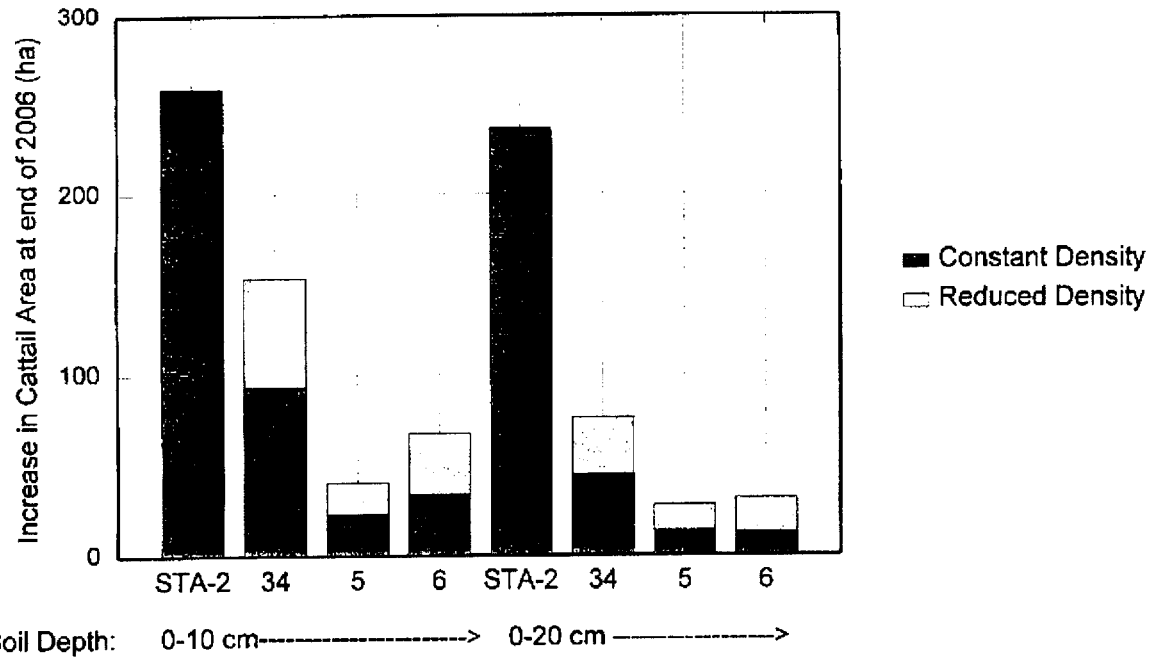


Depth = 10 cm



Depth = 20 cm

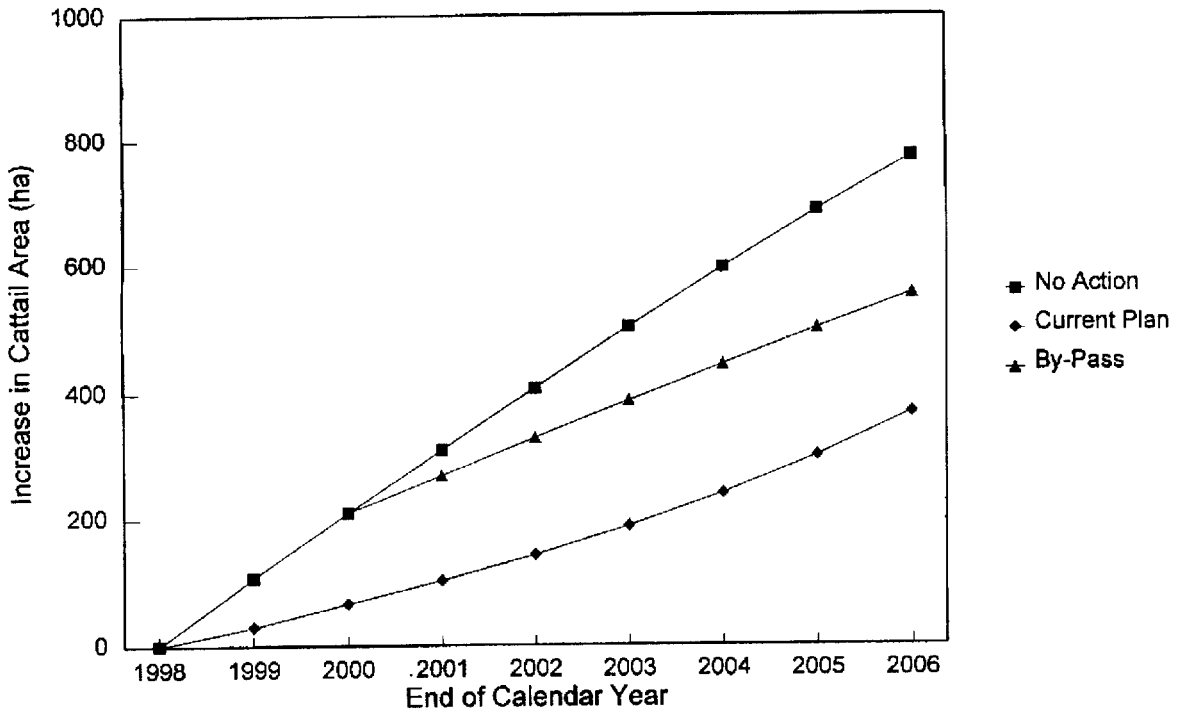
Sensitivity of Predicted Cattail Areas to Reductions in Initial Soil Density



Increase in Cattail Area at End of 2006 (hectares) Density	STA-2	STA-34	STA-5	STA-6
Soil Depth = 10 cm				
Constant	259	93	23	33
Reduced	259	153	40	67
Soil Depth = 20 cm				
Constant	236	44	13	12
Reduced	236	76	27	31

Initial Density Assumptions				
Soil Depth = 10 cm				
Constant	0.080	0.179	0.197	0.222
Reduced	0.080	0.120	0.120	0.120
Soil Depth = 20 cm				
Constant	0.071	0.176	0.197	0.232
Reduced	0.071	0.120	0.120	0.120

Simulation of STA-2 Discharge Alternatives



Scenario	Years		S10's			STA-2 Hydropattern			Total		
	Start	Stop	Flow hm3/yr	Conc ppb	Load mtons/yr	Flow hm3/yr	Conc ppb	Load mtons/yr	Flow hm3/yr	Conc ppb	Load mtons/yr
No Action	1962	2010	347.2	122	42.4	0.0	0	0.0	347.2	122	42.4
Current Plan	1962	1998	347.2	122	42.4	0.0	0	0.0	347.2	122	42.4
	1999	2010	93.2	122	11.4	254.0	50	12.7	347.2	69	24.1
By-Pass	1962	2000	347.2	122	42.4	0.0	0	0.0	347.2	122	42.4
	2001	2010	347.2	69	24.1	0.0	0	0.0	347.2	69	24.1

Increase in Cattail Area at End of 2006 (hectares)

	S10's	HydroP.	Total
No Action	771	0	771
Current Plan	131	236	367
By-Pass	553	0	553

M E M O

To: Mike Zimmerman, ENP; Frank Nearhoof, FDEP

From: Bill Walker & Bob Kadlec

Topic: Responses to FDEP Comments on Draft Report
"A Model for Simulating Phosphorus Concentrations in Waters and Soils Downstream of Everglades Stormwater Treatment Areas"

Date: February 26, 1997

Following are responses to comments provided by Frank Nearhoof of FDEP on October 14, 1996 regarding the above referenced report.

1. *The draft report states on page 4 that background water column P concentration (Cb) is calculated as PCp/(FwKe). The spreadsheet uses PCp/(FwKe)+(P-E).*

The equation in the report is correct. The same equation is used in the spreadsheet (EPGM.WK4, Profile Page, Columns O & S). We can't find the alternative formula listed above anywhere in the spreadsheet.

2. *The document states that the most meaningful measure of soil P content with respect to plant response would be a weighted average of P concentrations for the entire 0-30 cm rooting zone. The decision was made (based, I assume, on the difficulty of establishing a suitable weighting scheme and on the additional model complexity this would entail) to use unweighted 0-20 cm averages to substitute for 0-30 cm weighted averages. One result of this approach is that the 20-30 cm depths will have no effect on modeling results, and steady state will therefore be reached more rapidly than if the 20-30 cm depths were considered. The model may therefore predict an inaccurately short time to reach steady state if in reality the 20-30 cm depth has a significant effect on the successional process. Simulations using unweighted 0-10 cm averages were tested and found to be inferior to those using the 0-20 cm average. It might be instructive to try using the unweighted 0-30 cm average. Another useful exercise might be to modify the model structure to accommodate weighted averages, with weights based on expected root densities. Expected root densities could be a function of depth and perhaps P concentration.*

The model keeps track of the average P content of soil deposited since the start of simulation. To predict the time series of weighted-average P content, we would have to simulate more discrete soil layers and make assumptions about the appropriate shape of the weighting function, base upon data which we do not have. The unweighted 0-30 average P content is about as good a predictor of vegetation type (cattail vs. sawgrass) in WCA-2A as is the 0-20 cm average (1.4% error, as represented in Table 2). The nominal

threshold value for 0-30 cm would be approximately 480 mg/kg, instead of 610 mg/kg for 0-20 cm, however. Although consideration of the 10-30 cm horizon would increase the time required to reach steady-state soil p concentrations, the predicted biological response would not necessarily be slower because of the lower threshold value.

3. *A logistic response curve was chosen to simulate cattail response to soil P. How strongly do existing data support this choice, particularly at the ends of the curve? Is it possible, for instance, that populations of competing species decline very rapidly when cattail density reaches a certain threshold, resulting in a J-shaped response curve?*

The logistic is used because it is a convenient function often used to represent "dose/response" relationships. As shown in Figure 13, we do not have data to distinguish a logistic from a J-shaped function because there are no points at the upper ends of the curve. Such points would represent, for example, soil P levels in areas evolving from 75% to 100% cattail. Perhaps more recent data collected by Duke University would be useful for calibrating this portion of the response. This portion of the curve would be less important than the lower portion for predicting community transitions in response to phosphorus load. The EPGM spreadsheet can be used to investigate sensitivity to shape and location of the logistic.

4. *Because the model is based on depth-averaged mass-based P concentrations, low bulk density soils are predicted to respond more rapidly to P enrichment than soils with higher bulk densities. This is intuitively appealing--the high bulk density soils would have more mass to buffer the effects of added P. Because the model employs simple depth averaging, response speed is linearly related to initial soil bulk density. Again, a weighted average might yield more realistic results by accounting for the notion that plant response would more influenced by the overlying, high P layer of soil than by the underlying soil.*

See response to question 2. A much more complex model and more assumptions would be needed to simulate discrete depth intervals. The threshold values (logistic curves) have been calibrated using unweighted averages and are therefore consistent with the soil P-balance calculations. The model does not assume that there is no differential sensitivity with respect to depth, only that such sensitivity would be reflected in the calibration (i.e., that the vertical distributions of concentrations and effects would be similar to those reflected in the WCA-2A data set).

5. *The model assumes that without input from precipitation the water column P concentration would reach zero; i.e., there is no chemical return from static compartments (C*=0). Is this true, and particularly, is this true for water overlying P-enriched soil? If elevated soil P caused C* to rise significantly above zero, a slow-moving front would occur both for soil P (as predicted by the model) and water column P. The moving front for water column P would delay*

the time required for steady state to be reached for soil P.

The model simulates response to increasing nutrient loads. Soil feedback mechanisms would have to be considered in order to simulate response to decreasing loads (i.e. recovery). The scenario posed in the question (water overlying P-enriched soil in the absence of atmospheric load or surface load) clearly represents a recovery situation. Enhancement of the model to represent such situations is a high priority from a research perspective, but is not required for simulating the hydropattern-restoration facilities.

6. *I had difficulty understanding exactly what Figure 12 is trying to convey. More detailed explanatory notes or a better legend would be helpful.*

It may be helpful to think of this as a discriminant analysis. We have two groups (e.g. cattail and sawgrass) and a continuous variable measured in each group (soil P). One group tends to have higher soil P levels than the other. The discriminant model predicts group membership (sawgrass or cattail) based upon whether the measured soil P level is below or above some "threshold" level. The threshold is selected to minimize classification error (i.e. the number of cattail sites below the threshold plus the number of sawgrass sites above the threshold). The analysis is repeated for different soil depths and vegetation groupings. Graphical elaboration will be provided.

7. *The flow balance on page 3 includes precipitation and evapotranspiration terms. Should there also be a term that represents infiltration/exfiltration? It would seem that the seasonal fluctuations in soil saturation would be important in modeling phosphorus both in the water column and soil.*

The equations are easily modified to include such terms (see Kadlec & Knight, 1996) There are insufficient data to estimate the appropriate rates, however. Given head potentials in the STA discharge zones, infiltration seems more likely than exfiltration. To the extent that this is true, the existing model would tend to over-predict water-column concentrations and rates of soil P increase. The problem and data do not require or support a seasonal model. Fluctuations in soil saturation is only one of several processes that would have to be represented in a seasonal model.

8. *Is vertical recycling of phosphorus an important pathway that has not been addressed in this model? Rooted vegetation is obtaining phosphorus via roots in the 0-30 cm depth zone and some of the vegetation becomes detrital material in the new upper layer that becomes soil in the model. What fraction of the 0.2 to 1.0 cm of soil accreted annually is comprised of this detrital material?*

See 2 & ? above. Translocation of P by plant roots is likely. The model represents the average mass balance and soil P content of the new (enriched) soil layer. In order to influence this mass balance, plants would have to move P from unenriched (initial) soils to the enriched (new) soils or vice versa. If these processes were important, they would be

expected to show up on the comparison of observed and predicted soil P concentrations in WCA-2A (Figure 14). Mining of soil P by rooted plants is more likely to occur in a recovery mode.

9. *There was an atmospheric contribution of phosphorus from rainfall in the model. Should there also be a contribution from dry deposition? Some work by SJRWMD around Lake Apopka indicated that the contribution from dry deposition could be much higher than the rainfall contribution.*

The P concentration used in the model is a bulk estimate (wet + dry deposition).

10. *The paper did not discuss how longitudinal transport was modeled. Graphs were presented that showed water column and soil phosphorus concentrations as a function of distance from the discharge point. What type of computational scheme was used to account for the various inputs and outputs at each element as a function of time and space?*

As discussed in the report, transport occurs via sheet flow (i.e. plug flow). Inputs and outputs are represented in the differential equations (1,9,16). Analytical solutions are also given.

11. *On the bottom of page 8 there was a discussion of higher settling rates for the first two years. It was unclear why during this period, T was constrained to a value based on the long term settling term. Was this done for computational ease? Just how was the excess phosphorus determined and the soil phosphorus content increased?*

A variety of scenarios are possible for the startup period, when higher setting rates would be expected. There is a lack of data for defining a relationship between accretion rate and soil P content during startup (analogous to the long-term average relationships shown in Figure 7). As stated in the text, the assumption of constant T was made to generate a conservative estimate of soil P impact. Excess uptake during the first few years is more likely to be stored in the form of increased biomass, rather than in the soil. This is an important area for future model refinement.

12. *On page 9, modified equations are presented for Ys and T. Changes in the settling term Ke affect S and would seem to be more appropriately reflected in an adjustment to the coefficient b rather than coefficient a. The original value for b was 1.467 as compared to a value of 463 for a. Multiplication of coefficient a by f is going to have a must larger affect on Ys and T than multiplying b by f.*

The equations used correctly implement the stated assumption of constant soil mass accretion rate during the startup period when setting rate exceeds the long-term average.

13. *On page 9, the gradient value obtained from Figure 10 has an r2 of 0.39. If a regression was done separately for each vertical profile at a site and then averaged would a better estimate (and higher r2) be obtained?*

Possibly. A more detailed analysis would be needed to generate the appropriate statistics. Given the distribution of values and since the entire depth range is represented for each location, the slope estimate is not expected to vary much. The intent of this figure and the derived coefficient was to provide general perspective on the magnitude of the gradient and consistency across sites. The precise value of the slope is of no direct consequence to the modeling effort, since measured values for the gradient were used at each location with vertical soil P profile data.

14. *The model does not consider any phosphorus flux from the sediments. In the graphs that show very low water column phosphorus concentrations beyond 5 km, is it possible that phosphorus exchange between the soil and water column is occurring and represents an important process not included in the model?*

See answer to Question?. The model (more precisely, Ke) represents the NET settling rate (difference between the flux from water column to soil and the flux from soil to water column). The model does not assume that there is no transport of P from the soil to the water. Phosphorus occurring at the lower end of the profile reflects that transported in overland flow, atmospheric sources, and net settling.

15. *In Tables 4 and 5 it appears that the sensitivity ratios have been multiplied by 100 to convert the ratios to a percent.*

Yes.

The following are minor editorial comments:

1. *On page 7 it is stated that Equation 23 is a combination of Equations 22 and 18. Equation 18 does not appear to be relevant here.*

We will fix this.

2. *The Y axis on the top graph of Figure 7 is incorrectly labeled kg/km2-yr rather than kg/m2-yr.*

Yes. Will fix.