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Supplementary Table 1. Twenty eight wetland sites sampled for characterization of phosphorus composition.

	Wetland	Location	Wetland Type[†]	Vegetation Type[‡]	Dominant species[§]	Potential impacts[¶]
1	8 mile	Al, USA	Bog	Persistent emergent (Moss)	*Sphagnum, Carex sp.*	
2	Laguna Papallacta,	Ecuador	Cushion forming, Paramo	Persistent emergent (Herbaceous)	Self-emergent succulent species *Distichia muscoides, Spagnum*	Cattle Grazing
3	Wicken Fen	UK	Fen	Persistent emergent (Herbaceous)	*Cladium mariscus*	Sedge Harvesting since 1419
4	Houghton lake (CT350)	MI, USA	Treatment wetland	Persistent emergent (Herbaceous)	Typha sp.	Intermediate P loading
5	Houghton lake (550C)	MI, USA	Treatment wetland	Persistent emergent (Herbaceous)	Cyperacea sp. Typha	Low P loading
6	Houghton lake (P)	MI, USA	Treatment wetland	Persistent emergent (Herbaceous)	Typha.	High P loading
7	Francis Marion National Forest (FMNF) Bay 1	SC,USA	Carolina Bay	Persistent emergent (Forested)	*Acer rubrum* (var. *trilobum*), *Nyssa biflora* and *Nyssa aquatica, Lyonia lucida, Ilex myrtifolia*	
8	Francis Marion National Forest (FMNF) Bay 2	SC,USA	Carolina Bay	Persistent emergent (Forested)	*Taxodium ascendans, Nyssa biflora, Lyonia lucida, Carex striata, Woodwardia virginica*	
9	Francis Marion National Forest (FMNF) Bay 3	SC,USA	Carolina Bay	Persistent emergent (Herbaceous)	*Ilex glabra, Iris tridentata, Amphicarpum muhlenbergianum, Eleocharis* spp., *Melanocarpa, tricostata*, and *Lachnanthes caroliniana*	Periodic burning
10	Francis Marion National Forest (FMNF) Bay 4	SC,USA	Carolina Bay	Persistent emergent (Forested)	*Nyssa biflora, Taxodium ascendans, Acer rubrum, Lyonia lucida, Cyrilla racemiflora, Pinus taeda*	
11	Savannah River Site (SRS) Bay 1	SC,USA	Carolina Bay	Persistent emergent (forested/herbaceous)	*Panicum hemitomon, Nyssa biflora, Cephalanthus occidentalis,Utricularia* spp., *Sphagnum* spp., *Pontederia cordata* var. *lancifolia*	
12	Savannah River Site (SRS) Bay 2	SC,USA	Carolina Bay	Persistent emergent (Herbaceous)	*Panicum hemitomon, Sphagnum* spp., *Pontederia cordata* var. *lancifolia, Juncus canadensis, Cephalanthus occidentalis, Acer rubrum* (var. *trilobum*)	
13	Savannah River Site (SRS) Bay 3	SC,USA	Carolina Bay	Open water /herbaceous	*Nymphaea odorata, Panicum hemitomon, Utricularia spp., Leersia hexandra, Eleocharis melanocarpa*	
14	Svannah River Site (SRS) Bay 4	SC,USA	Carolina Bay	Persistent emergent (Forested)	*Liquidambar styraciflua, Acer rubrum* (var. *trilobum*), *Nyssa biflora, Taxodium ascendans, Smilax rotundifolia*	
15	Larry Fen	NY, USA	Rich Fen	Persistent emergent	Carex sp. Campylium stellatum	

				(Herbaceous)		
16	Fish Fen	NY, USA	Rich Fen	Persistent emergent (Herbaceous)	Typha angustifolia. Carex sp. Campylium stellatum, Sphagnum spp.Calliergonella cuspidata	
17	Hidden	Belize	Oligotrophic Sumpland	Persistent emergent (Herbaceous/ Cyanobacteria)	Eleocharis cellulosa, Cyanobacteria spp.	salt intrusion
18	Quiet	Belize	Sumpland	Persistent emergent (Herbaceous/ Cyanobacteria)	Eleocharis cellulosa, Cyanobacteria spp.	salt intrusion
19	Doubloon	Belize	Sumpland	Persistent emergent (Herbaceous/ Cyanobacteria)	Eleocharis cellulosa, Cyanobacteria spp.	salt intrusion
20	Changuinola Site 1	Panama	Tropical peat dome	Persistent emergent (Forested)	Raphia tadeiga	
21	Changuinola Site 2	Panama	Tropical peat dome	Persistent emergent (Forested)	Campnosperma panamensis, Cassipourea elliptica (Sw.) Poir, Drypetes standleyi G.L. Webster	
22	Changuinola Site 3	Panama	Tropical peat dome	Persistent emergent (Forested)	*Campnosperma panamensis*, *Cyrilla racemiflora*, sawgrass	
23	WCA 3A	Fl, USA	Calcareous Fen	Open water	*Nymphaea* sp. *Utricularia*	
24	Everglades National Park	Fl, USA	Calcareous Fen	Persistent emergent (Herbaceous)	*Cladium* jamaicense	
25	Ny Alesund	Spitsbergen, Norway	Wet tundra	Persistent emergent (Moss)	*Calliergon* richardsoni, *Poa arctica*, *Dupotia* species	Geese grazing
26	Stordalen	Abisko, Sweden	Mire	Persistent emergent (Moss)	Spagnum fuscum, Betula nana, Rubus chamaemorus,Vaccinium vitis ideae, Empetrum nigrum	
27	Bog 8	Canada	Ombrotrophic Bog	Persistent emergent (Moss)	*Sphagnum fuscum,* graminoids, Lichens	
28	Fen 1	Canada	Fen	Persistent emergent (Herbaceous)	*Carex* sp.	

† = common wetland description
‡ = vegetation descriptor based upon Cowardin (1979) classification
§ = dominant vegetation species noted in the field
¶ = potential external impacts noted that may affect P cycling

Supplementary Table 2. Biogeochemical properties of surface (0 – 10 cm) soils in 28 palustrine wetland systems. Values represent arithmetic mean ± 1 SD.

Wetland	pH	Organic matter	Phosphorus	Total C	Total N	Total Al	Total Ca	Total Fe	Molar Ratio C:P	Molar Ratio N:P
		%	μg g^{-1}	mg g^{-1}					C:P	N:P
Group A										
27	3.9	97 ± 1	356 ± 62	436 ± 11	7.8 ± 0.3	0.5 ± 0.2	3.2 ± 0.7	0.3 ± 0.0	3220 ± 493	49 ± 8
26	4.1	100 ± NA	238 ± NA	424 ± NA	6.3 ±	0.4 ± NA	1.8 ± NA	0.2 ± NA	4596 ± NA	59 ± NA
22	3.7	84 ± 5	579 ± 102	424 ± 30	21.7 ± 3.1	1.2 ± 0.2	1.0 ± 0.1	1.5 ± 0.4	1929 ± 289	83 ± 5
21	3.6	93 ± 1	852 ± 130	485 ± 12	25.1 ± 1.8	1.3 ± 0.1	3.3 ± 0.5	3.7 ± 0.6	1498 ± 234	66 ± 7
20	3.8	88 ± 1	1124 ± 38	489 ± 4	27.7 ± 0.8	3.0 ± 0.1	1.4 ± 0.2	6.2 ± 0.7	1125 ± 40	55 ± 3
1	4.6	92 ± 1	986 ± 72	410 ± 9	12.4 ± 1.5	3.0 ± 0.5	4.7 ± 0.5	15.0 ± 2.5	1060 ± 70	27 ± 2
mean	4.0	92	689	445	16.8	1.6	2.6	4.5	2238	57
min	3.6	84	238	410	6.3	0.4	1.0	0.2	1060	27
max	4.6	100	1124	489	27.7	3.0	4.7	15.0	4596	83
Group B										
14	4.4	23 ± 5	918 ± 253	94 ± 25	7.2 ± 2.3	77.1 ± 3.3	0.2 ± 0.1	6.2 ± 1.9	285 ± 120	18 ± 7
13	4	25 ± 18	347 ± 233	117 ± 89	9.3 ± 6.9	26.2 ± 6.7	0.2 ± 0.2	2.9 ± 0.7	814 ± 121	56 ± 6
12	3.9	55 ± 10	1056 ± 120	307 ± 67	21.4 ± 4.5	15.7 ± 4.0	1.2 ± 0.6	3.7 ± 0.5	745 ± 97	45 ± 6
11	4.3	24 ± 11	918 ± 320	105 ± 58	8.7 ± 4.1	72.9 ± 8.2	0.4 ± 0.3	5.6 ± 0.8	283 ± 59	21 ± 3
10	4.4	48 ± 18	752 ± 422	239 ± 115	12.7 ± 6.0	34.7 ± 7.6	0.3 ± 0.3	4.7 ± 1.1	1079 ± 65	49 ± 4
9	4.2	9 ± 4	51 ± 35	44 ± 16	2.2 ± 0.8	2.9 ± 1.5	−0.1 ± 0.1	0.7 ± 0.3	2551 ± 748	111 ± 26
8	3.5	69 ± 21	750 ± 165	376 ± 131	19.0 ± 5.3	8.2 ± 2.6	2.0 ± 1.3	2.1 ± 0.5	1275 ± 189	56 ± 4
7	3.6	50 ± 17	925 ± 169	260 ± 87	14.5 ± 3.6	25.8 ± 2.0	0.7 ± 0.4	3.3 ± 1.6	729 ± 191	35 ± 6
mean	4.0	38	715	193	11.9	32.9	0.6	3.6	970	49
min	3.5	9	51	44	2.2	2.9	-0.1	0.7	283	18
max	4.4	69	1056	376	21.4	77.1	2.0	6.2	2551	111
Group C										
2	6.3	89 ± 1	679 ± 5	406 ± 2	26.3 ± 5.0	1.0 ± 0.3	18.4 ± 4.4	0.4 ± 0.0	1545 ± 19	86 ± 15
28	6.1	90 ± 1	310 ± 55	443 ± 12	30.4 ± 2.7	3.5 ± 1.6	26.1 ± 1.7	0.2 ± 0.0	3800 ± 843	225 ± 62
24	5.9	93 ± 1	277 ± 16	445 ± 14	36.1 ± 2.0	2.3 ± 0.5	26.0 ± 1.2	0.2 ± 0.0	4170 ± 348	290 ± 31
23	7	85 ± 2	1184 ± 138	421 ± 17	28.3 ± 1.3	3.6 ± 1.4	31.6 ± 1.5	4.6 ± 1.6	929 ± 120	53 ± 6
16	7	56 ± 5	1184 ± 52	270 ± 24	20.3 ± 1.7	20.4 ± 4.2	27.3 ± 2.6	18.8 ± 1.0	591 ± 74	38 ± 5
15	6.4	70 ± 6	3516 ± 442	353 ± 26	35.2 ± 2.8	15.2 ± 3.7	23.0 ± 5.0	18.9 ± 5.4	261 ± 15	22 ± 1
6	6.1	94 ± 0	982 ± 67	455 ± 6	20.1 ± 1.2	0.9 ± 0.1	8.6 ± 0.8	7.2 ± 0.8	1201 ± 87	45 ± 4
5	7.2	94 ± 0	1439 ± 59	452 ± 1	26.2 ± 0.6	1.0 ± 0.2	14.0 ± 1.1	6.0 ± 0.2	811 ± 31	40 ± 1
4	7.3	78 ± 15	937 ± 85	353 ± 14	26.3 ± 2.2	3.7 ± 0.6	96.2 ± 24.5	12.2 ± 1.5	976 ± 60	62 ± 1

	3	6.7	84 ± 2	875 ± 175	399 ± 14	14.8 ± 2.1	3.4 ± 0.8	20.1 ± 2.3	3.7 ± 1.2	1213 ± 230	38 ± 4
mean		6.6	83	1138	400	26.4	5.5	29.1	7.2	1550	90
min		5.9	56	277	270	14.8	0.9	8.6	0.2	261	22
max		7.3	94	3516	455	36.1	20.4	96.2	18.9	4170	290
Group D											
	25	7	29 ± 10	1513 ± 773	133 ± 57	5.8 ± 2.0	19.9 ± 2.5	15.1 ± 3.3	0.2 ± 0.0	247 ± 114	9 ± 3
	19	7.6	16 ± 3	126 ± 25	153 ± 0	5.3 ± 0.1	2.3 ± 0.7	333.5 ± 15.4	0.2 ± 0.0	3213 ± 603	96 ± 19
	18	7.5	30 ± 1	287 ± 324	70 ± 6	6.0 ± 0.5	45.8 ± 3.2	14.4 ± 0.8	0.2 ± 0.0	1338 ± 954	94 ± 65
	17	7.3	25 ± 2	192 ± 55	162 ± 12	11.4 ± 0.2	15.3 ± 7.1	232.3 ± 51.1	0.2 ± 0.0	2305 ± 654	137 ± 34
mean		7.4	25	530	129	7.1	20.8	148.8	0.2	1776	84
min		7.0	16	126	70	5.3	2.3	14.4	0.2	247	9
max		7.6	30	1513	162	11.4	45.8	333.5	0.2	3213	137

Supplementary Table 3: Phosphorus composition of surface soils as determined by solution ^{31}P NMR spectroscopy. Values represent concentration µg g^{-1} (% of total soil P)

	NaOH- TP[‡]		Phosph-P[§]		Ortho-P[¶]		Mono-P[††]		DNA		Phospholipids		Total inorganic Polyphosphates		Organic P		Mono:Dies[‡‡]
	µg g^{-1} (% of total soil P)																
Group A																	
27	138	(39)			36	(10)	31	(9)	23	(7)	9	(3)	38	(11)	64	(18)	0.9
26	190	(80)			70	(29)	44	(18)	25	(11)	10	(4)	41	(17)	79	(33)	1.3
22	261	(45)			54	(9)	68	(12)	57	(10)	3	(1)	79	(14)	128	(22)	1.1
21	320	(38)	8	(1)	95	(11)	55	(6)	31	(4)	12	(1)	118	(14)	107	(13)	1.3
20	516	(46)	20	(2)	171	(15)	162	(14)	35	(3)	6	(1)	123	(11)	222	(20)	3.9
1	758	(77)			201	(20)	337	(34)	135	(14)	42	(4)	43	(4)	514	(52)	1.9
mean	364	(54)	14	(2)	105	(16)	116	(16)	51	(8)	14	(2)	74	(12)	186	(26)	1.7
max	758	(80)	20	(2)	201	(29)	337	(34)	135	(14)	42	(4)	123	(17)	514	(52)	3.7
min	138	(38)	8	(1)	36	(9)	31	(6)	23	(3)	3	(1)	38	(4)	64	(13)	0.9
Group B																	
14	534	(58)	12	(1)	267	(29)	189	(21)	47	(5)	10	(1)	9	(1)	258	(28)	3.3
13	219	(63)	4	(1)	56	(16)	110	(32)	25	(7)	15	(4)	9	(3)	154	(44)	2.8
12	722	(68)	44	(4)	179	(17)	390	(37)	65	(6)	19	(2)	25	(2)	518	(49)	4.6
11	598	(65)	14	(2)	128	(14)	408	(44)	32	(3)	12	(1)	4	(0)	466	(51)	9.3
10	497	(66)	18	(2)	120	(16)	252	(33)	57	(8)	24	(3)	26	(3)	351	(47)	3.1
9[†]	*63*	*(125)*			*14*	*(27)*	*38*	*(76)*	*6*	*(12)*			*5*	*(10)*	*45*	*(88)*	*6.2*
8	476	(63)	16	(2)	138	(18)	192	(26)	67	(9)	14	(2)	50	(7)	288	(38)	2.4
7	637	(69)	29	(3)	137	(15)	368	(40)	56	(6)	17	(2)	30	(3)	470	(51)	5
mean	526	(65)	20	(2)	146	(18)	273	(33)	50	(6)	16	(2)	22	(3)	358	(44)	4
max	722	(69)	44	(4)	267	(29)	408	(44)	67	(9)	24	(4)	50	(7)	518	(51)	9.3
min	219	(58)	4	(1)	56	(14)	110	(21)	25	(3)	10	(1)	4	(1)	154	(28)	2.4
Group C																	
2	609	(70)			244	(28)	176	(20)	76	(9)	31	(4)	81	(9)	284	(32)	1.6
28	283	(42)			54	(8)	77	(11)	57	(8)	22	(3)	74	(11)	156	(23)	1
24	130	(42)			46	(15)	38	(12)	27	(9)	9	(3)	10	(3)	75	(24)	1.1
23	102	(37)			38	(14)	28	(10)	18	(7)	6	(2)	11	(4)	53	(19)	1.2

16	595	(50)	131	(11)	270	(23)	106	(9)	28	(2)	60	(5)	404	(34)	2
15	753	(64)	118	(10)	461	(39)	88	(7)	37	(3)	50	(4)	586	(49)	3.7
6	2569	(73)	1759	(50)	407	(12)	141	(4)	64	(2)	197	(6)	612	(17)	2
5	593	(60)	225	(23)	170	(17)	96	(10)	30	(3)	72	(7)	296	(30)	1.3
4	909	(63)	295	(20)	317	(22)	142	(10)	67	(5)	88	(6)	526	(37)	1.5
3	789	(84)	167	(18)	344	(37)	144	(15)	62	(7)	73	(8)	549	(59)	1.7
mean	733	(59)	308	(20)	229	(20)	90	(9)	36	(3)	72	(6)	354	(32	2
max	2569	(84)	1759	(50)	461	(39)	144	(15)	67	(7)	197	(11)	612	(59	4
min	102	(37)	38	(8)	28	(10)	18	(4)	6	(2)	10	(3)	53	(17)	1
Group D															
25	534	(35)	292	(19)	221	(15)	11	(1)	10	(1)			242	(16)	10.6
19	33	(26)	33	(26)											
18	53	(46)	53	(46)											
17	47	(25)	36	(19)	8	(4)	3	(2)					11	(6)	2.3
mean	167	(33)	104	(28)	57	(5)	4	(1)	3	(0)			127	(11)	6
max	534	(46)	292	(46)	221	(15)	11	(2)	10	(1)			242	(16)	11
min	33	(25)	33	(19)	0	(0)	0	(0)	0	(0)			11	(6)	2

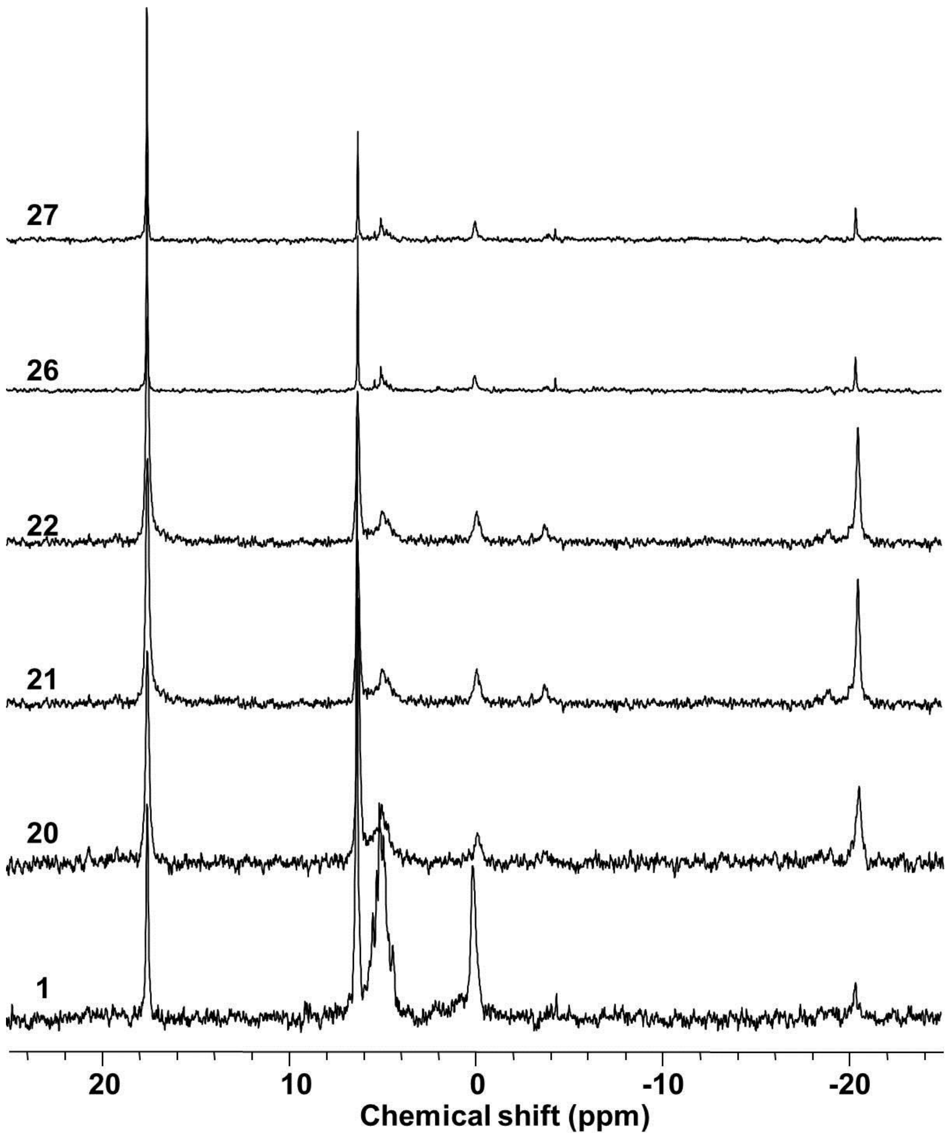
† suspected error associated with determination of total P composition, site removed from subsequent analysis.
‡ Total P recovered by alkaline extraction
§ Total phosphonates
¶ Total orthophosphate
†† Total phosphomonoesters
‡‡ Ratio of total phosphomonoesters: total phosphodiesters

Supplementary Table 4. Inorganic polyphosphates as determined by solution ^{31}P NMR spectroscopy of wetland soils. Values represent total inorganic polyphosphates delineated into pyrophosphate, and the terminal (TR) and mid-chain (MR) of long chain (n > 3) polyphosphates.

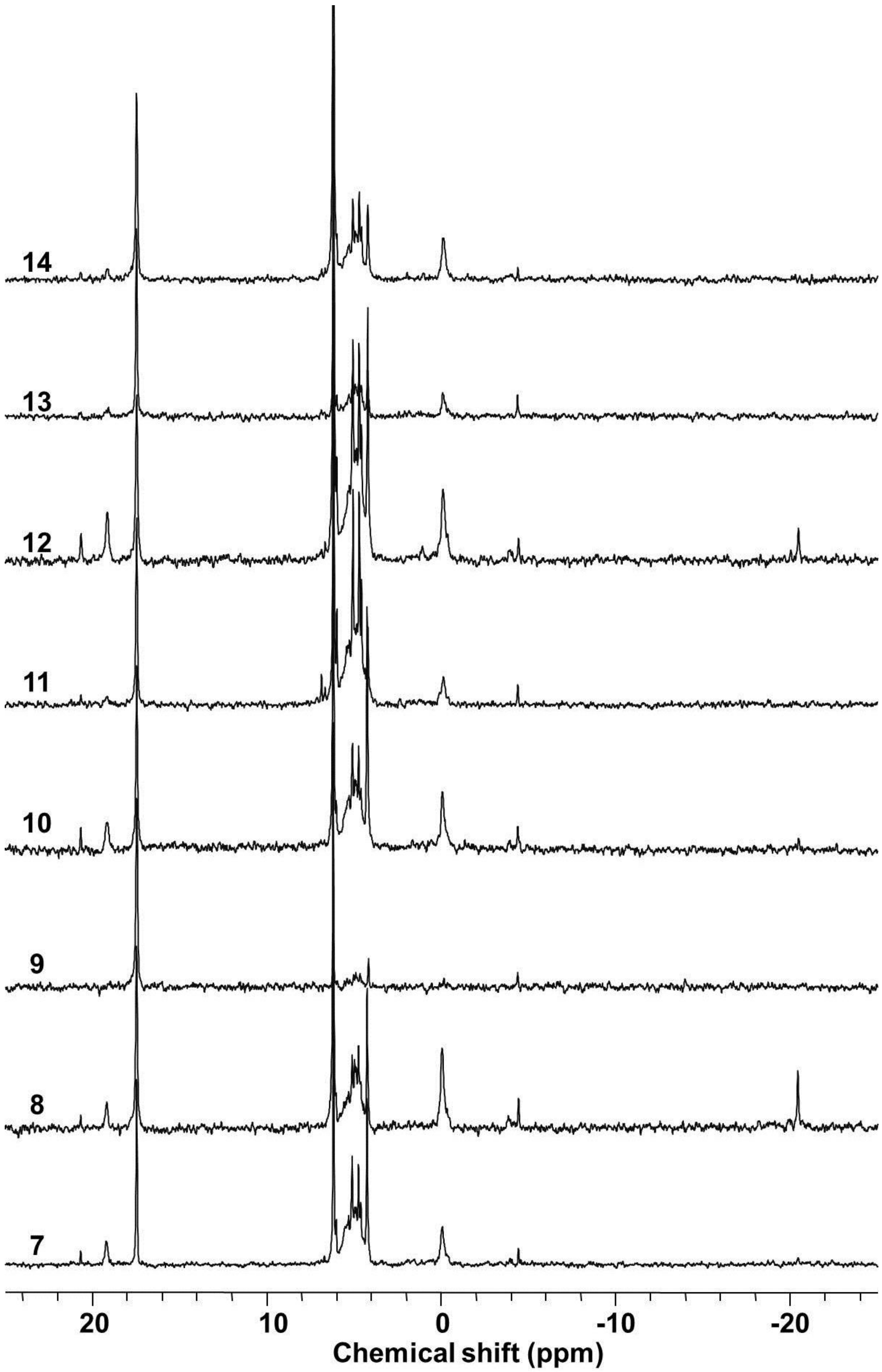
	Pyrophosphate		Long chain polyphosphate		
	$\mu g\ g^{-1}$	% total P	$\mu g\ g^{-1}$		% of total P
			TR	MR	
Group A					
1	7.5	0.8	trace	35.5	3.6
20	12.6	1.1	trace	110.1	9.8
21	19.5	2.3	trace	98.9	11.6
22	7.5	1.3	trace	71.6	12.4
26	4.9	2.1	7.9	28.0	15.1
27	4.3	1.2	6.2	27.3	9.4
mean	9.4	1.5	2.4	61.9	10.3
Group B					
7	9.1	1.0	6.3	14.2	2.2
8	5.4	0.7	7.0	37.6	6.0
9	4.9	9.8	-	-	
10	9.7	1.3	6.2	9.9	2.2
11	4.3	0.5	-	-	
12	5.6	0.5	5.6	13.6	1.8
13	9.2	2.6	-	-	
14	8.8	1.0	-	-	
mean	7.1	2.2	3.9	9.4	1.5
Group C					
2	30.9	3.5	19.5	31.1	5.8
3	41.6	4.4	25.9	5.9	3.4
4	40.2	2.8	17.5	30.6	3.3
5	24.6	2.5	12.1	35.2	4.8
6	136.3	3.9	30.1	31.1	1.7
15	32.3	2.7	10.6	6.8	1.5
16	46.2	3.9	6.3	7.8	1.2
23	6.6	2.4	1.7	3.1	1.7
24	9.6	3.1	-	-	
28	10.3	1.5	23.6	39.8	9.3
mean	37.9	3.1	14.7	19.1	3.3
Group D	No inorganic polyphosphates detected				

Supplementary Table 5. Correlation coefficients between microbial P (% of total P) and P forms determined by solution ^{31}P NMR spectroscopy (% of total P).

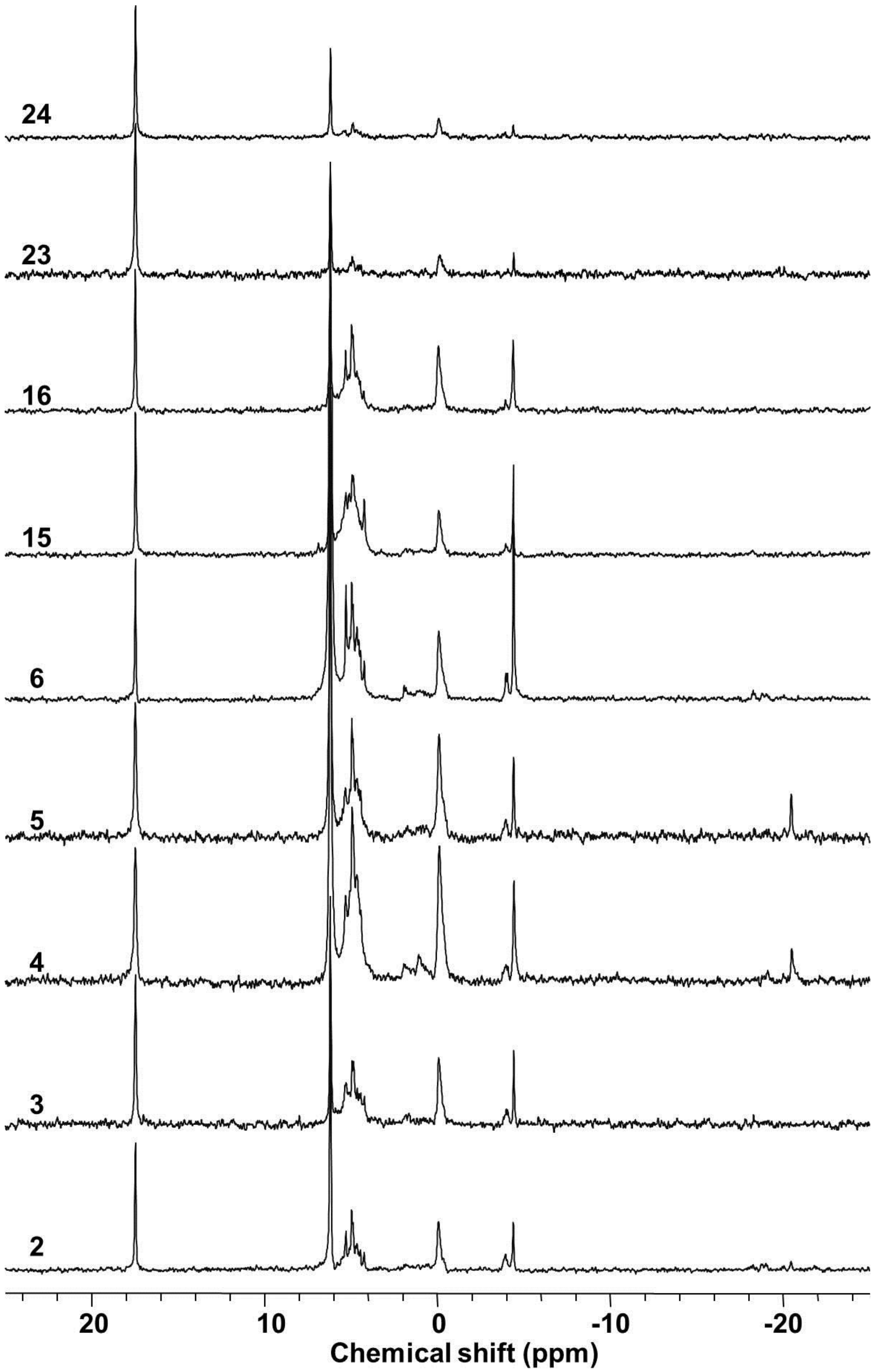
Phosphorus form	Spearman rho correlation	*p*
Phosphonate	–0.21	ns
Orthophosphate	–0.38	ns
Phosphomonoesters	–0.15	ns
DNA	0.57	<0.01
Other phosphodiesters	0.30	ns
Pyrophosphate	0.38	ns
Long chain Polyphosphate	0.80	<0.001
Residual	–0.05	ns



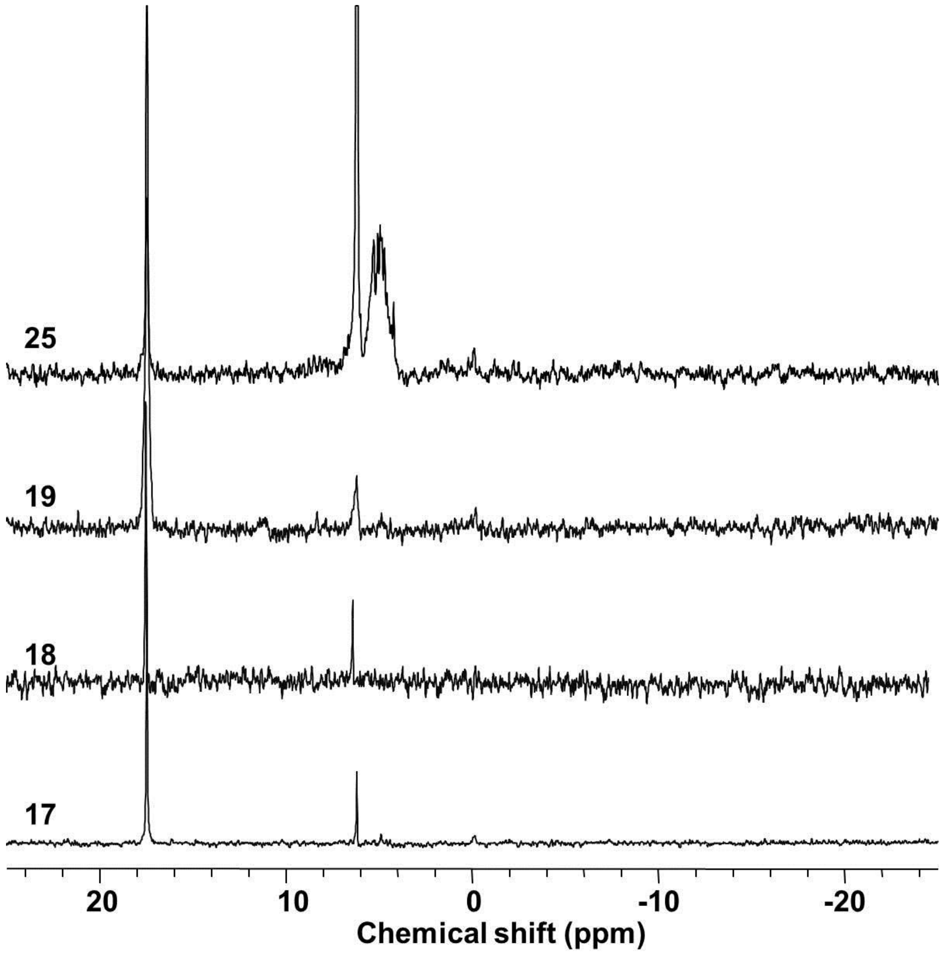
Supplementary Figure 1: Solution 31P NMR spectra of biogenic P composition within group A wetlands (high organic low pH). Spectra acquired using an Avance-500 (500.4 MHz 1H), Magnex 11.8 Tesla/54 mm Bore, at pH > 13 using a simple zgig pulse program and calibrated 30° pulse angle. Spectra presented here using 15 Hz line broadening scaled and referenced to internal standard methylenediphosphonic acid (δ = 17.46 ppm).



Supplementary Figure 2: Solution 31P NMR spectra of biogenic P composition within group B wetlands (low organic low pH). Spectra acquired using an Avance-500 (500.4 MHz 1H), Magnex 11.8 Tesla/54 mm Bore, at pH > 13 using a simple zgig pulse program and calibrated 30° pulse angle. Spectra presented here using 15 Hz line broadening scaled and referenced to internal standard methylenediphosphonic acid (δ = 17.46 ppm).



Supplementary Figure 3: Solution 31P NMR spectra of biogenic P composition within group C wetlands (high organic matter high pH). Spectra acquired using an Avance-500 (500.4 MHz 1H), Magnex 11.8 Tesla/54 mm Bore, at pH > 13 using a simple zgig pulse program and calibrated 30° pulse angle. Spectra presented here using 15 Hz line broadening scaled and referenced to internal standard methylenediphosphonic acid (δ = 17.46 ppm).



Supplementary Figure 4: Solution 31P NMR spectra of biogenic P composition within group D wetlands (low organic matter high pH). Spectra acquired using an Avance-500 (500.4 MHz 1H), Magnex 11.8 Tesla/54 mm Bore, at pH > 13 using a simple zgig pulse program and calibrated 30° pulse angle. Spectra presented here using 15 Hz line broadening scaled and referenced to internal standard methylenediphosphonic acid (δ = 17.46 ppm).