Supplementary Information for

Landscape drivers of dynamic change in water quality of U.S. rivers

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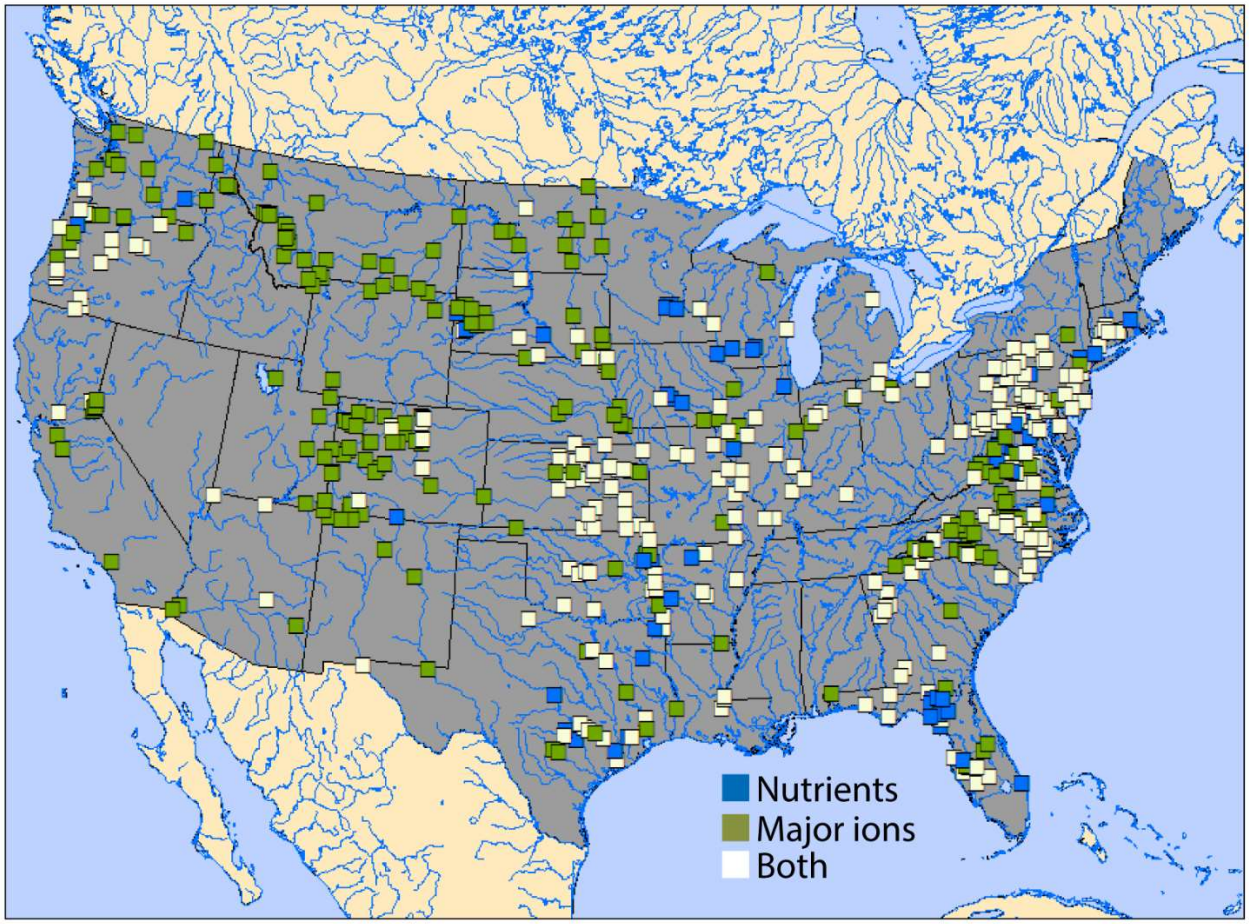

Fig. S1.

Map of trend sites. Colors display whether the site was included in the trend analysis for nutrients, major ions (and/or suspended solids), or both.

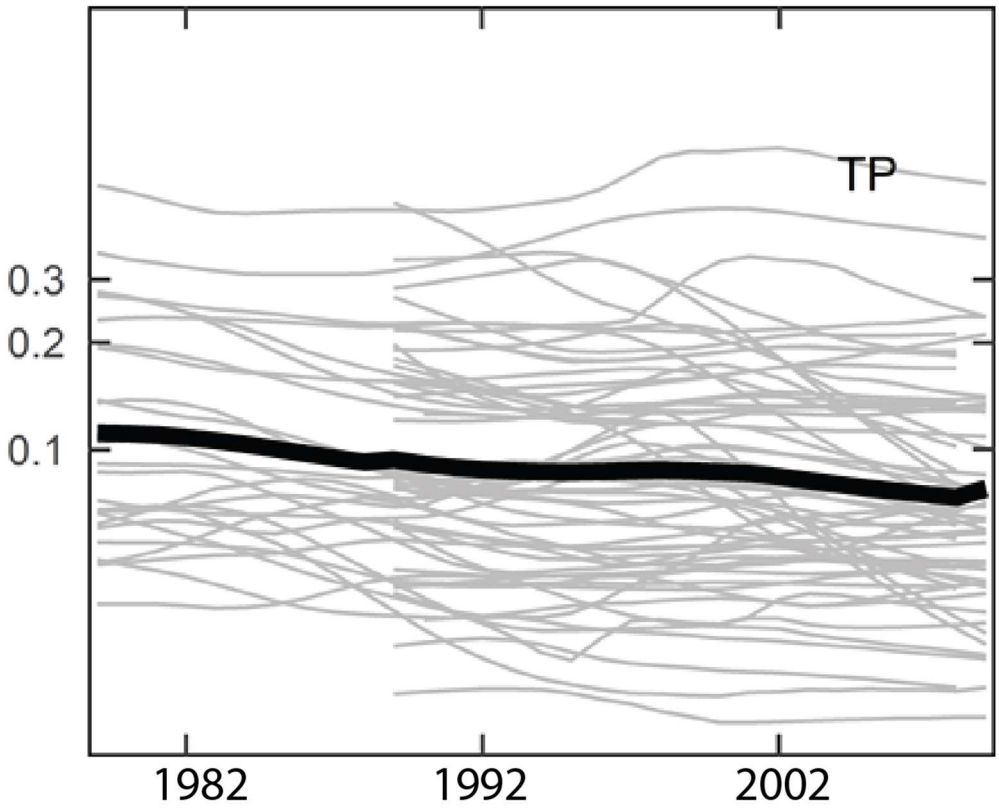

Fig. S2.

Example estimated marginal mean concentration of total phosphorus at mixed land use sites, black line, compared with annual values for all mixed land use stations included in the analysis (n = 63). Note that the y-axis is on a log scale.

Table S1.

Land use category definitions based on the National Wall-to-Wall Anthropogenic Land Use Trends (NWALT) dataset[20].

Land use category	Definition
Undeveloped	NWALT classes 11, 12, 46, 50, 60 are > 75 % of basin
Agricultural	NWALT class 43 > 12.5 % of basin AND classes 43+44 > 25 % of basin.
Urban	NWALT classes 21-27 > 12.5 % of basin and class 43 < 25 % of basin and 43+44 < 50 % of basin.
Mixed	All other combinations.

NWALT land use classes

1 - Water

11 – Open water

12 – Wetlands

2 - Developed

21 – Major transportation (improved roads, highways, rail, airports, etc.)

22 – Commercial / services (retail, office, schools, government buildings, etc.)

23 – Industrial/military (factories, landfills, warehouses, military bases, etc.)

24 – Parks and recreation

25 – High-density residential

26 – Low/medium residential

27 – Other

4 - Production

43 – Crops (row crops, perennials, fallow fields, etc)

44 – Pasture/hay (grasses or legumes typically harvested on a perennial basis)

46 – Grazing potential (areas of good grazing potential that have been used for animal grazing)

5, 6 – Low usage

50 – Low usage

60 – Very low usage / protected or conservation status

Table S2.

Overall trends (i.e. change in concentration) for all constituents 1992-2012.

Constituent	Mean	Median (25th-75th)	N	N UP	N DOWN
Alkalinity	1.43	2.44 (-3.02 - 8.74)	234	130	53
Ammonium	-0.05	-0.02 (-0.05 - -0.01)	154	12	126
Calcium	-1.57	0.03 (-2.78 - 2.1)	84	35	32
Chloride	-8.54	0.92 (-2.76 - 5.93)	141	67	60
Magnesium	0.03	0.21 (-0.95 - 0.94)	84	45	29
Nitrate	-0.07	-0.04 (-0.22 - 0.11)	252	78	141
Potassium	0.13	0.04 (-0.1 - 0.29)	106	28	19
Sodium	-15.73	0.11 (-4.85 - 3.95)	65	36	27
Soluble reactive phosphorus	-0.02	0 (-0.02 - 0)	70	26	56
Specific conductance	-6.9	4.88 (-18.59 - 34.39)	416	230	141
Sulfate	-2.08	-1.79 (-5.01 - 0.49)	104	22	76
Total nitrogen	-0.17	-0.11 (-0.32 - 0.12)	159	52	82
Total organic carbon	-0.06	-0.07 (-0.76 - 0.47)	47	22	15
Total phosphorus	-0.02	-0.01 (-0.03 - 0.02)	230	86	94
Total suspended solids	-7.22	-1.55 (-10.97 - 1.03)	101	31	43

Table S3.
Trends by land use type for nutrients.

Constituent	Land Use	Mean	Median	N	N UP	N DOWN
Ammonium	Undeveloped	-0.01	-0.011 (-0.018 - -0.001)	30	7	21
	Mixed	-0.02	-0.017 (-0.025 - -0.008)	52	3	45
	Agricultural	-0.03	-0.031 (-0.067 - -0.019)	44	2	39
	Urban	-0.06	-0.057 (-0.115 - -0.007)	28	2	22
Nitrate	Undeveloped	-0.01	-0.01 (-0.09 - 0.07)	46	16	25
	Mixed	-0.06	-0.06 (-0.26 - 0.11)	81	32	44
	Agricultural	-0.01	-0.01 (-0.21 - 0.15)	82	26	34
	Urban	-0.11	-0.11 (-0.25 - 0.06)	43	14	27
Soluble reactive phosphorus	Undeveloped	0.000	-0.004 (-0.012 – 0.000)	28	5	19
	Mixed	-0.010	-0.009 (-0.054 - -0.003)	33	3	26
	Agricultural	0.000	0.004 (-0.007 - 0.020)	36	19	10
	Urban	0.000	-0.005 (-0.01 - -0.003)	9	2	7
Total nitrogen	Undeveloped	-0.08	-0.08 (-0.23 - 0.06)	26	8	15
	Mixed	-0.05	-0.05 (-0.34 - 0.16)	59	25	31
	Agricultural	-0.06	-0.06 (-0.27 - 0.17)	42	16	21
	Urban	-0.22	-0.22 (-0.51 - -0.06)	32	6	24
Total organic carbon	Undeveloped	0.24	0.24 (0.04 - 0.49)	17	9	3
	Mixed	-0.20	-0.20 (-0.52 - 0.24)	17	5	9
	Agricultural	-1.30	-1.30 (-1.79 - 0.41)	6	2	4
	Urban	-0.73	-0.73 (-1.51 - -0.20)	7	1	5
Total phosphorus	Undeveloped	-0.01	-0.01 (-0.02 - 0.01)	44	13	23
	Mixed	-0.01	-0.01 (-0.04 – 0.00)	62	10	42
	Agricultural	0.02	0.02 (-0.03 - 0.04)	86	44	29
	Urban	-0.02	-0.02 (-0.10 - 0.01)	38	11	24

Table S4.
Trends for major ions and sediment by land use type during the period 1992-2012.

Constituent	Land Use	Mean	Median	N	N UP	N DOWN
Alkalinity	Undeveloped	-0.13	-0.13 (-7.10 - 2.37)	88	30	37
	Mixed	3.8	3.8 (-0.02 - 9.75)	45	29	8
	Agricultural	5.8	5.8 (-1.25 - 13.47)	73	46	14
	Urban	4.19	4.19 (2.50 - 9.02)	28	22	4
Calcium	Undeveloped	-1.7	-1.7 (-4.55 - 0.02)	37	8	21
	Mixed	0.41	0.41 (-0.14 – 1.00)	12	7	1
	Agricultural	1.32	1.32 (-5.41 - 4.53)	24	13	8
	Urban	2.37	2.37 (0.72 - 6.66)	11	8	1
Chloride	Undeveloped	-0.34	-0.34 (-11.04 - 0.88)	39	13	23
	Mixed	2.27	2.27 (0.78 - 6.06)	20	15	3
	Agricultural	0.6	0.6 (-8.65 - 4.17)	65	29	28
	Urban	25.87	25.87 (9.43 - 51.41)	17	16	1
Magnesium	Undeveloped	-0.15	-0.15 (-2.31 - 0.18)	36	8	20
	Mixed	0.15	0.15 (0.03 - 0.72)	13	10	1
	Agricultural	0.86	0.86 (0.31 - 1.98)	21	13	5
	Urban	0.66	0.66 (0.28 - 1.96)	14	11	1
Potassium	Undeveloped	-0.1	-0.1 (-0.22 - -0.01)	23	3	14
	Mixed	0.23	0.23 (-0.01 - 0.60)	13	8	2
	Agricultural	0.17	0.17 (-0.14 - 0.30)	18	10	5
	Urban	0.12	0.12 (0.05 - 0.35)	11	9	0
Sodium	Undeveloped	-1.48	-1.48 (-12.95 - -0.01)	28	4	20
	Mixed	2.87	2.87 (0.54 - 4.03)	10	8	1
	Agricultural	0.09	0.09 (-6.53 - 2.04)	19	7	9
	Urban	11.97	11.97 (5.85 - 21.19)	13	11	1
Specific conductance	Undeveloped	-1.34	-1.34 (-46.28 - 5.99)	170	64	83
	Mixed	18.82	18.82 (3.30 - 38.99)	87	63	18
	Agricultural	17.94	17.94 (-25.30 - 61.09)	104	56	37
	Urban	18.79	18.79 (-9.84 - 56.55)	55	37	16

Sulfate	Undeveloped	-4.56	-4.56 (-13.92 - -1.50)	31	2	29
	Mixed	-1.18	-1.18 (-3.07 - 0.74)	27	7	18
	Agricultural	0.51	0.51 (-4.33 - 5.94)	26	11	12
	Urban	-1.44	-1.44 (-3.10 - -0.60)	20	4	16
Total suspended solids	Undeveloped	0.9	0.9 (0.07 - 2.69)	29	13	3
	Mixed	-3.42	-3.42 (-7.12 - 0.61)	23	4	13
	Agricultural	-12.69	-12.69 (-25.72 - -2.49)	36	5	27
	Urban	-1.7	-1.7 (-10.97 - 0.76)	13	3	8