RELATIONSHIPS BETWEEN METAL CONTAMINATION IN WADABLE STREAMS IN SOUTH CAROLINA AND LAND USE CHARACTERISTICS

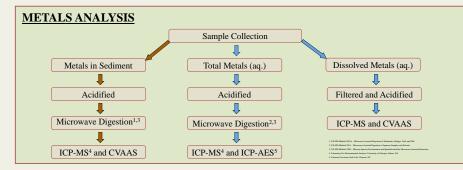


ABSTRACT

At present, little data is available concerning the overall quality of small aquatic ecosystems in South Carolina. A study of wadeable streams in South Carolina is currently being conducted in cooperation with the South Carolina Department of Natural Resources (SCDNR). The overall goal of this work is to assess overall ecosystem quality in order to provide information needed for improved management strategies. The project assesses fish population and health and in addition performs measurements of stream characteristics, chemical contaminants present, and fish exposure to chemical contaminants. This presentation focuses on metal contaminants found in water and sediments in 2006 and 2007 and relationship between metals and land use in the drainage areas or watersheds of the sites sampled. Sites were randomly selected using known streams and GIS-determined watersheds of appropriate size (less than 150 km2). GIS and the National Land Cover Data Set (NLCD) were used to determine the land use distribution for each sampled watershed. Water and sediment samples were collected and analyzed using ICP-MS, ICP-AES and Cold Vapor AAS. Among the metals of interest are aluminum, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, zinc, and others. Results indicate that a small number of sites exceed the published US EPA constant contaminant concentration and contaminant maximum concentration for a few waterhome or dissolved metals (e.g., cadmium, copper and nickel). In addition, a small number of sites exceed published risk threshold values for metal-contaminated sediments. Linear regression was used to correlate individual dissolved metal measurements with land use activities in individual and combined watersheds. Results indicate that changes in land use can change pollutant loads and impact the quality of the stream. The strongest relationships were observed for agricultural and forest land use with several metals (e.g., chromium, nickel, selenium, and potassium). Developed land area has not shown significant effects in these small and largely rural watersheds. Correlations are also considered for the whole study and are separated by watershed and corregion. Principle components analysis (PCA) is applied to watershed land uses to simplify interpretation and to reveal parameters responsible for metal contamination variability.

OBJECTIVE

To support South Carolina Department of Natural Resources in their goal to design an implement an effective strategy to protect, conserve, and restore the aquatic resources of the State of South Carolina



AQUEOUS RESULTS

fotal		a, Non-	% Nem-	10%	25 ^m	SPA	75*	310	Maximum
Ar	98	94	detects 96	Percentile 0.341	Percentile 0.404	0.549	0.78	Dercentile 0.996	1.14
Ag	98	94	96	10.2	22	0.549	0.78	207	986
	97 98	0	0	0.394	0.452	0.854	129	2.45	986
As						0.854			4.69
B Ca	97 97	35	36	6.1	13.3	5484	26	32 28268	57823
Cd	97	30	31	0.132	0.184	0.321	0.489	0.756	13.4
Cr	98	17	17	0.239	0.373	0.367	0.998	3.55	15.4
Cu	98	0	0	1.13	1.54	2.91	4.57	10.7	49.4
Fe	97	0	0	43.6	133	64	888	1683	13497
K	97	0	0	127	533	1594	2796	4314.4	6777
Mg	97	0	0	187	427	1799	2626	3385	12634
Mn	97	0	0	9.8	22	42	84	264	1358
Na	97	0	0	520	2268	4254	5672	73.93	136643
Ni	98	0	0	0.529	0.772	1.35	2.05	4.16	484
P	97	14	14	8	18.5	37	66.5	167	1466
Pb	928	3	3	0.197	0.297	0.522	0.878	0.227	15.7
				176	495	1153	2394	1997	44432
S	97	0	0						
S	97 98		0						3.66
S Sc		0 11 42		176 0.147 0.129	495 0.206 0.16	0.314 0.224	0.445	0.767	
S Se Tl Zn	58	11 42 0	11 43 0	0.147 0.129 3.92	0.206	0.314	0.445	0.767	3.66
S Se Tl Zn hove: Ac	98 98 98	11 42 0 ults summ	11 43 0 nary table (p	0.147 0.129 3.92	0.206 0.16	0.314 0.224 12.6	0.445 0.544	0.767 0.848 27.7	3.66 0.976 98.3
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S Se Tl Zn hove: Ao	98 98 98 gueous metals res CCC Equatio NA y=0.0714x ^{6.76}	11 42 0 ults sumr n C Equ y=0.0	11 43 0 nary table (p MC ation	0.147 0.129 3.92 pb).	0.206 0.16 7.37 Sites > 0	0.314 0.224 12.6	0.445 0.544 21.4 ft: Equations served metal ter hardness ere x=hardn	0.767 0.848 27.7 i used to adji concentratii (form y=Ax ess) and nur	3.66 0.976 98.3 nst ons for 8 nber
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SITE SELECTION

(GIS) -based selection program.

Mid Atlantic Coastal Plain (Carolina Pl SE Plains (Atlantic S Loam/SE Flood) SE Plains (Sand Hills)

Piedmont (S Outer Piedmont) Piedmont (Carolina Slate Belt

Pledmont (5 Inner Pledmont

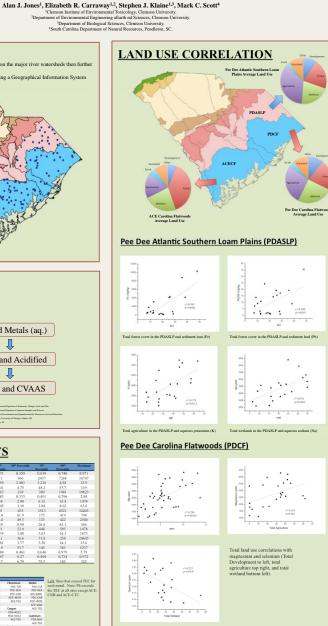
Bue Ridge

Legend

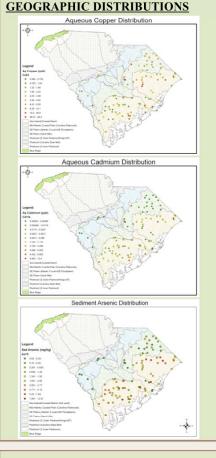
 South Carolina was divided into ecoregions based on the major river watersheds then further subdivided into smaller wadeable watersheds.

Sites were randomly selected in each ecoregion using a Geographical Information System

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ACECK	TI Zn Albone: Sec Metal Arsenic (A Cadmium (Copper (C Lead (Pb Nickel (N Selenium () Selenium () Seler (A) Zinc (Zn Backgroup	98 98 Backe M) 1 (Cr) 7- (U) 10- (Cr) 7- (Cr) 7-	41 2 s results surr round 1 1 5 0.3 0 13 4 25 3 17 0 9 2 19 5 18 Effects Con	42 2 mary table (179 3 199 4 13.4 11.6 22.7 4 22.7 4 22.7 4 22.7 4 22.7 4 5 4 5 4 5 4 5 5 5 5 5 5 5 5 5 5 5 5 5	0.140 1.21 mg kg). 40 13.0 13.0 13.55 111 149 128 18.5 * 4.5 455 459 TEC)	0.167 3.17 703-MUD 703-MUD 703-MUD 703-MUD 703-TGR 703	0.27 6.79 POC TUR POC TUR POC CAR PDC-CAR	0.494 75.3 PDC-TLR PDC-TLR PDC-NUR ACE-NUS ACE-NUS ACE-TUS PDC-WOB ACE-TUS Codmum PDE-NUS	0.714 105 Left: Sites that e each metal. Not the TEC at all si	0.972 325 exceed TEC for it: Pb exceeds ites except ACI
	TI Zn Albone: Sec Metal Arsenic (A Cadmium (Copper (C Lead (Pb Nickel (N Selenium () Selenium () Seler (A) Zinc (Zn Backgroup	98 98 Backe M) 1 (Cr) 7- (U) 10- (Cr) 7- (Cr) 7-	41 2 s results surr round 1 1 5 0.3 0 13 4 25 3 17 0 9 2 19 5 18 Effects Con	42 2 mary table (179 3 199 4 13.4 11.6 22.7 4 22.7 4 22.7 4 22.7 4 22.7 4 5 4 5 4 5 4 5 5 5 5 5 5 5 5 5 5 5 5 5	0.140 1.21 mg kg). 40 13.0 13.0 13.55 111 149 128 18.5 * 4.5 455 459 TEC)	0.167 3.17 703-MUD 703-MUD 703-MUD 703-MUD 703-TGR 703	0.27 6.79 POC-TUR POC-TUR POC-AUR PDC-AUR PDC-AUR PDC-AUR PDC-AUR ACC-TOS ACC-	0.494 75.3 PDC-TLR PDC-TLR PDC-NUR ACE-NUS ACE-NUS ACE-TUS PDC-WOB ACE-TUS Codmum PDE-NUS	0.714 105 Left: Sites that e each metal. Not the TEC at all si	0.972 325 exceed TEC for it: Pb exceeds ites except ACI
	TI Zn Albone: Sec Metal Arsenic (A Cadmium (Copper (C Lead (Pb Nickel (N Selenium () Selenium () Seler (A) Zinc (Zn Backgroup	98 98 Backe M) 1 (Cr) 7- (U) 10- (Cr) 7- (Cr) 7-	41 2 s results surr round 1 1 5 0.3 0 13 4 25 3 17 0 9 2 19 5 18 Effects Con	42 2 mary table (179 3 199 4 13.4 11.6 22.7 4 22.7 4 22.7 4 22.7 4 22.7 4 5 4 5 4 5 4 5 5 5 5 5 5 5 5 5 5 5 5 5	0.140 1.21 mg kg). 40 13.0 13.0 13.55 111 149 128 18.5 * 4.5 455 459 TEC)	0.167 3.17 703-MUD 703-MUD 703-MUD 703-MUD 703-TGR 703	0.27 6.79 POC TUR POC TUR POC AUR POC AUR POC AUR POC AUR POC AUR POC AUR POC AUR ACC FOS Seed ACC FOS Seed	0.494 75.3 PDC-TLR PDC-TLR PDC-NUR ACE-NUS ACE-NUS ACE-TUS PDC-WOB ACE-TUS Codmum PDE-NUS	0.714 105 Left: Sites that e each metal. Not the TEC at all si	0.972 325 exceed TEC for it: Pb exceeds ites except ACI
	TI Zn Albone: Sec Metal Arsenic (A Cadmium (Copper (C Lead (Pb Nickel (N Selenium () Selenium () Seler (A) Zinc (Zn Backgroup	98 98 Backe M) 1 (Cr) 7- (U) 10- (Cr) 7- (Cr) 7-	41 2 s results surr round 1 1 5 0.3 0 13 4 25 3 17 0 9 2 19 5 18 Effects Con	42 2 mary table (179 3 199 4 13.4 11.6 22.7 4 22.7 4 22.7 4 22.7 4 22.7 4 5 4 5 4 5 4 5 5 5 5 5 5 5 5 5 5 5 5 5	0.140 1.21 mg kg). 40 13.0 13.0 13.55 111 149 128 18.5 * 4.5 455 459 TEC)	0.167 3.17 703-MUD 703-MUD 703-MUD 703-MUD 703-TGR 703	0.27 6.79 POC TUR POC TUR POC AUR POC AUR POC AUR POC AUR POC AUR POC AUR POC AUR ACC FOS Seed ACC FOS Seed	0.494 75.3 PDC-TLR PDC-TLR PDC-NUR ACE-NUS ACE-NUS ACE-TUS PDC-WOB ACE-TUS Codmum PDE-NUS	0.714 105 Left: Sites that e each metal. Not the TEC at all si	0.972 325 exceed TEC for it: Pb exceeds ites except ACI



ACE Carolina Flatwoods (ACECF) •No correlations were observed in the ACECF with any metals and land use.



DISCUSSION

Results strongly indicate the presence of metals in the water column and in sediments, with several sites at concentrations above the EPA Constant Contaminant Concentration (CCC), Contaminant Maximum Concentration (CMC), and sediment risk thresholds.
Significant trends between metal concentrations and land use within the watersheds are evident.
Geographic hot stops of metal contamination are evident.
This indicates that metals are geographically distributed.

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