Decreases of Carbon and Nitrogen in the Soils of a 20-Year Chronosequence of Restored Wetlands Washington State, USA

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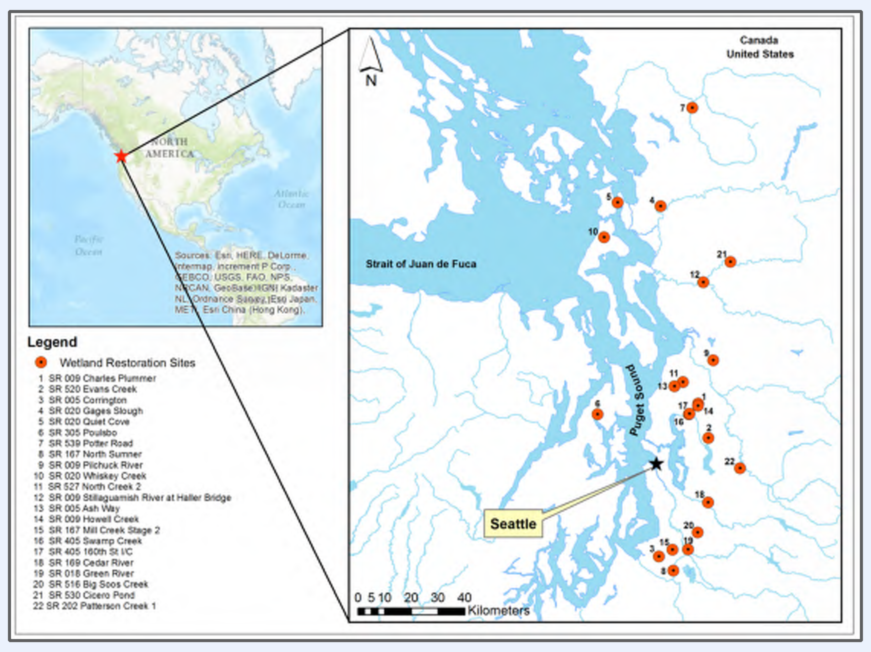
INTRODUCTION

- Wetlands are estimated to store as much as 30 percent of the earth's total carbon even though they only comprise 4 to 6 percent of its land area (Mitra et al. 2005, Mitsch & Gosselink 2007).
- Carbon in peat and estuarine wetlands are often studied because of their large carbon stores and accumulation rates, respectively (Bridgham et al. 2006, Ouyang & Lee 2014).
- Carbon accumulation in restored, freshwater wetlands has been studied significantly less than estuarine wetlands and peat systems, even though they are one of the wetland types most impacted by current development in the United States.

STUDY QUESTIONS

- What is the estimated carbon accumulation rate for restored freshwater wetlands?
- Do vegetative strata, nitrogen concentration, bulk density, hydrology, hydrologic regime, or soil type influence carbon accumulation in the soils of restored wetlands?
- Can the results of this study provide restoration ecologists with data or methodology on how wetland restoration design decisions can influence/enhance carbon accumulation?

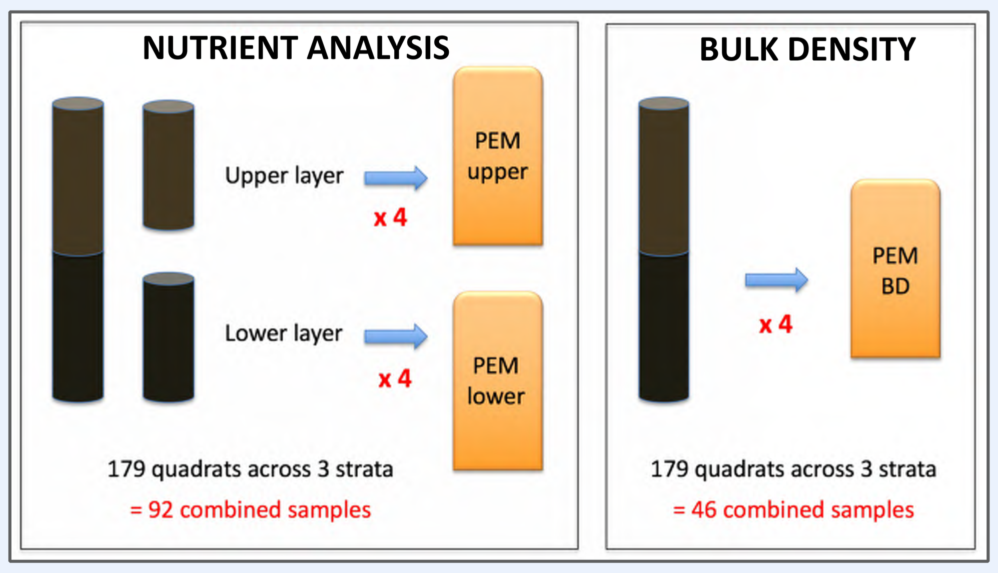
METHODS



SOILS
- ~40 cm depth
- Color
- Texture
- Redoximorphic features

VEGETATION
- Strata
- Species
- Absolute aerial cover

HYDROLOGY
- Hydrogeomorphic class
- Hydroperiod
- Soil moisture



SOIL PROCESSING
- Dried, sieved (2 mm, 0.5 mm), and weighed (gr)
- CHN analyzer (mg gr^{-1})

CALCULATIONS
- Bulk density (gr cm^{-3})
- Masses of C and N (gr cm^{-3})
- Total C and total N (density in Mg ha^{-1})
- C:N ratio
- C and N accumulation rates (Mg ha^{-1} yr^{-1})

22 RESTORATION SITES → **SAMPLING UNITS** → **CHARACTERIZATION** → **SOIL COLLECTION** → **ANALYSIS**

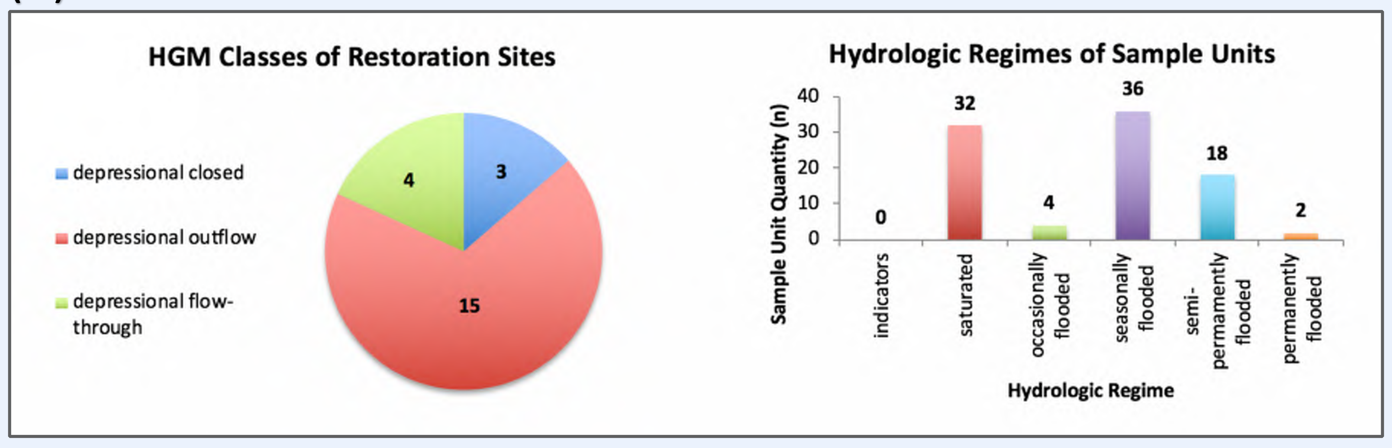
RESULTS

(a) C AND N ACCUMULATION RATES

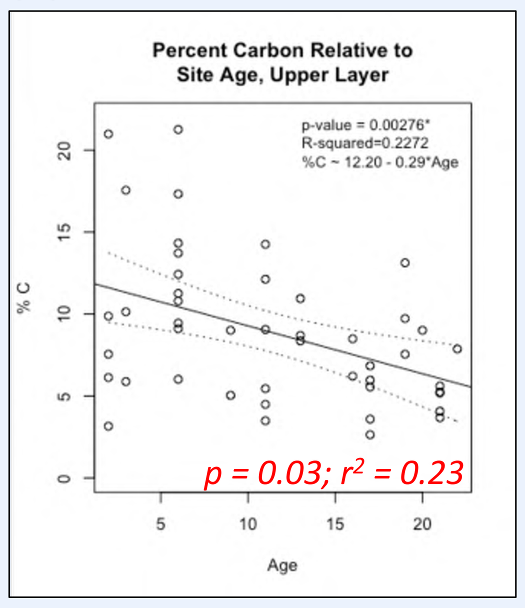
Vegetative stratum			Soil layer		Accumulation Rate		Sample size (# of 20-22 y.o. sites, # of 2-3 y.o. sites)
PEM	PSS	PFO	upper	lower	Mg C ha^{-1} yr^{-1}	Mg N ha^{-1} yr^{-1}	
x	x	x	x	x	-0.70	0.004	14, 15
x	x	x	x		-1.18	-0.01	7, 8
x	x	x		x	-0.12	0.03	7, 7
x			x	x	-2.39	-0.10	2, 4
	x		x	x	-0.70	0.003	4, 6
		x	x	x	-0.64	-0.31	7, 5
x			x		-2.51	-0.10	1, 2
x				x	-2.26	-0.13	1, 2
	x		x		-1.44	-0.02	2, 3
	x			x	0.03	0.05	2, 3
		x	x		-1.53	-0.05	4, 2
		x		x	0.58	0.07	4, 2

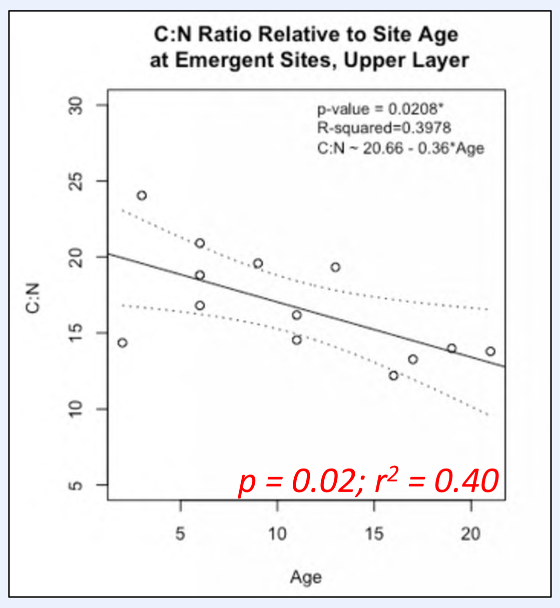
- When all strata and both soil layers considered, general trends in the decrease of C and slight increase of N were found (a).
- There were no significant relationships relative to hydrology (b).
- The percent C and the C:N ratio decreased over time in the upper soil layer, while the bulk density of forested sites increased over time in the upper soil layer (c).

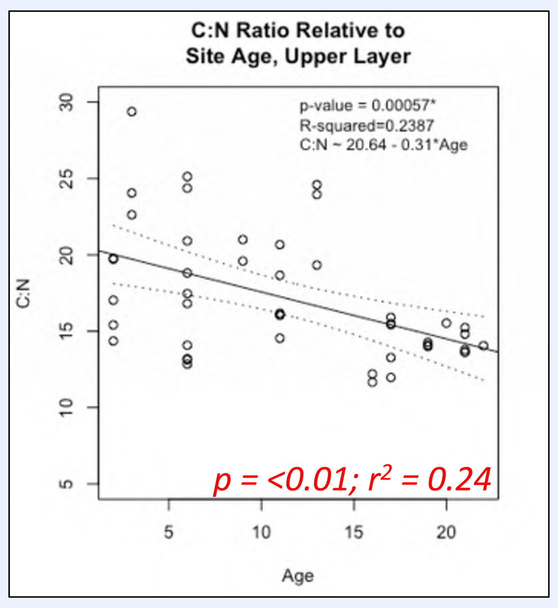
(b) HYDROLOGIC INFLUENCES

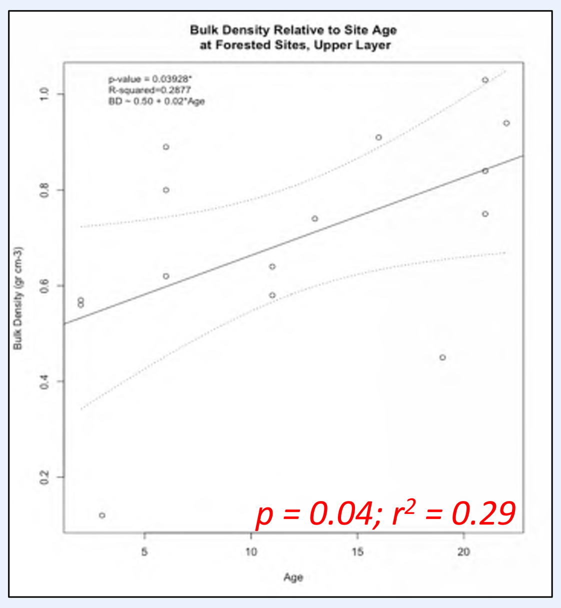


(c) CARBON, NITROGEN, AND BULK DENSITY BY LAYER AND STRATUM



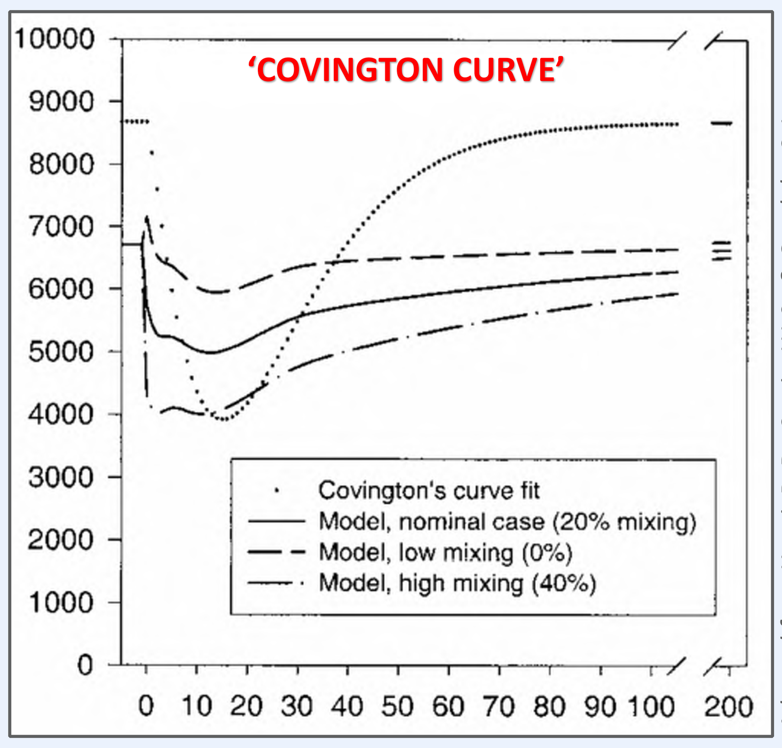






DISCUSSION

- Ranges for percent carbon and nitrogen, total carbon, C:N and bulk density consistent with ranges in literature (Ballantine et al. 2012)
- Decreases in carbon and increases in bulk density contrasts with much of literature
- Decreases in C:N consistent with literature
- Increases in bulk density may be attributed to compaction from site construction on older sites versus more soil amendments and better practices on younger sites
- Decreasing carbon may be due to large amount of soil amendments; similar to soil dynamics of managed forests, which have curvilinear pattern for C accumulation



Adapted from Yanai, R. D., Currie, W. S., & Goodale, C. L. (2003). Soil carbon dynamics after forest harvest: An ecosystem paradigm reconsidered. Ecosystems, 6(3), 197-212.

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