Sediment-Nutrient Interactions in Little Pine Creek Watershed Drainage Ditches

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ABSTRACT

Although a substantial number of studies have discussed nutrient transport and dynamics in natural streams, little consideration has been given to nutrient transport processes in artificial ditch environments, especially in tile-fed drainage ditches. In this study, sediments were collected and extracted at specific locations every three months from July 2007 to July 2008. Extracted aliquots were analyzed for EPCo, ExP, PSI, and ExN. Results suggested that sediments are not in equilibrium with water column P but have the tendency to act as source during cold months of the year, and sink during warm months. This behavior of sediments underlined the important role of biological activities in nutrient uptake.

INTRODUCTION

Benthic sediments play an active role in nutrient uptake and may actively control nutrient concentrations in the overlying water column (Haggard et al., 2004; Smith et al., 2005). Although a substantial number of studies have discussed nutrient dynamics and sediment-nutrient interactions in natural streams, little consideration has been given to nutrient transport processes in artificial ditch environments receiving inputs from tile drains. Therefore, there is a critical need to examine the effects of nutrient discharge from tile drains on the interactions between sediments and nutrients in these drainage ditches.

OBJECTIVES

The objectives of this study were to:

1. Assess equilibrium between sediments and water column P in Marshall and Box ditches.
2. Evaluate seasonal variations in readily available nutrients to biota and sediment P sorption capacity.

STUDY SITE DESCRIPTION

The study was conducted in Box and Marshall ditches in West Lafayette, Indiana. The two ditches are both headwaters and drain approximately 2000 acresof agricultural and livestock field of corn and soybeans into Little Pine Creek-McFarland/Otterbein Watershed. The watershed is located approximately 7 miles northwest from Purdue University (northwest Tippecanoe County, Indiana) and covers 13,175.3 acres.

Tile drain

Marshall ditch

Box ditch

Little Pine Creek Watershed

METHODOLOGY

- Sediments were collected and extracted for Ex-P, Ex-N, PSI, and EPCo using methods outlined by Chaubey et al. (2007).
- ExN and ExP, respectively exchangeable N and P, represent fractions of nutrients loosely bound to sediments.
- PSI is a single point measurement of the ability of sediments to adsorb P (Chaubey et al., 2007).
- EPCo is the concentration of water column P at which net P exchange rate between benthic sediments and water is zero (Haggard et al, 2004).

Sediment collection

Sediment extraction

RESULTS

Table 1: EPC_0 and background values in µg/L

Ditch		Jul-Sep		Oct-Dec		Jan-Mar		Apr-Jun	
Marshall		***Bkg***	***EPC_0***	***Bkg***	***EPC_0***	***Bkg***	***EPC_0***	***Bkg***	***EPC_0***
	S1	73	72.8	126	62.8	53	61.4	28	57.1
	S2	62	85.3	194	109.3	75	51.2	36	51.0
	S3	102	97.6	154	64.1	44	36.6	35	47.7
Box									
	S1	54	60.76	280	239.8	130	156.7	45	139.7
	S2	40	51.73	263	156.5	103	482.0	44	130.1
	S3	151	44.79	96	332.9	95	143.2	26	74.2
	S4	150	51.22	105	138.3	99	104.2	22	83.4
	S5	136	26.80	101	140.8	74	127.9	29	103.6

S: sampling station; ***Bkg***: background concentration of nutrients

Table 2: ExP, ExN, and PSI values

		ExP (mg P kg^{-1} dry soil)		ExN (mg N kg^{-1} dry soil)		PSI	
	Ditch	***Mean***	***Range***	***Mean***	***Range***	***Mean***	***Range***
Jul-Sep							
	Marshall	1.5	1.5-1.6	70.1	33.5-110.4	7.9	7.0-8.6
	Box	1.5	1.0-2.1	231.02	38.0-878.4	8.9	8.5-10.2
Oct-Dec							
	Marshall	1.9	1.7-2.1	138.4	34.1-306.0	7.2	5.8-8.9
	Box	6	3.5-7.0	20.2	11.5-29.3	9.6	7.3-14.1
Jan-Mar							
	Marshall	1.5	0.8-2.7	22.1	8.5-32.6	6.5	5.6-7.3
	Box	5.4	4.0-7.4	88.6	14.7-316.1	8.2	7.4-9.1
Apr-Jun							
	Marshall	1.4	1.1-1.9	104.3	32.4-245.5	7.4	6.5-7.9
	Box	1.8	1.3-2.3	33.7	5.88-63.5	7.7	6.8-8.3

- A two sample t-test with α = 0.05 indicated that there was no spatial difference in mean between the two sites from April to September (warmest months of the year) but a spatial difference in mean exited from October to Mars for ExP, ExN and PSI.
- An analysis of variances using Tukey adjustment showed that there is no statistically significant difference in ExP within Box ditch between Apr-Jun and Jul-Sep, and between Oct-Dec and Jan-Mar. There was no difference in PSI within ditches and across seasons.

REFERENCES

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