Evaluation of Water Lettuce for Remediating Stormwaters in Retention Systems

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INTRODUCTION

◆ Storm runoff water from agriculture and urban area has been reported to contain significant amounts of nitrogen (N) and phosphorus (P) in the Indian River area of south Florida. For instance, our monitoring studies measured mean concentrations of total N and total P in the runoff water from representative agricultural fields as high as 4.1 and 1.6 ppm, respectively (He et al., 2005), which are much greater than the USEPA critical levels for surface waters (1.5 ppm for total N and 0.1 ppm for total P) (U.S. Environmental Protection Agency, 1976).

◆ The runoff water from some agricultural fields contained considerable amounts of heavy metals such as copper (Cu) and zinc (Zn) due to repeated use of fungicides that are enriched with these elements (He et al., 2005).

◆ Because of its fast growth, simple growth requirements, and ability to accumulate biogenic elements and toxic substances, water lettuce (*Pistia stratiotes*) may be useful for nutrient and metal removal from stormwater in retention/detention water systems.

OBJECTIVE

The overall goal of this study is to evaluate water lettuce (*Pistia stratiotes*) for its potential in removing N, P, and metals from stormwaters and its effectiveness in the remediation of contaminated waters from agricultural fields in Indian River area.

MATERIALS AND METHODS

Plant: water lettuce (*Pistia stratiotes*)

Plots: control (without plant) and the remediation plot (with plant)

Ponds: East and West Ponds

Sampling: waters were sampled weekly, plants were sampled monthly and periodically harvested to keep a ¾ coverage

Data collected:

➢ **Water:** turbidity, suspended solids, NH_4-N, NO_3-N, PO_4-P, total N, and total P

➢ **Plant:** biomass, plant N, P, and mental contents

RESULTS

1. Improvement in water physical properties: Phytoremediation reduced water turbidity by 60% and suspended solids by 10% (Figs. 1-4).
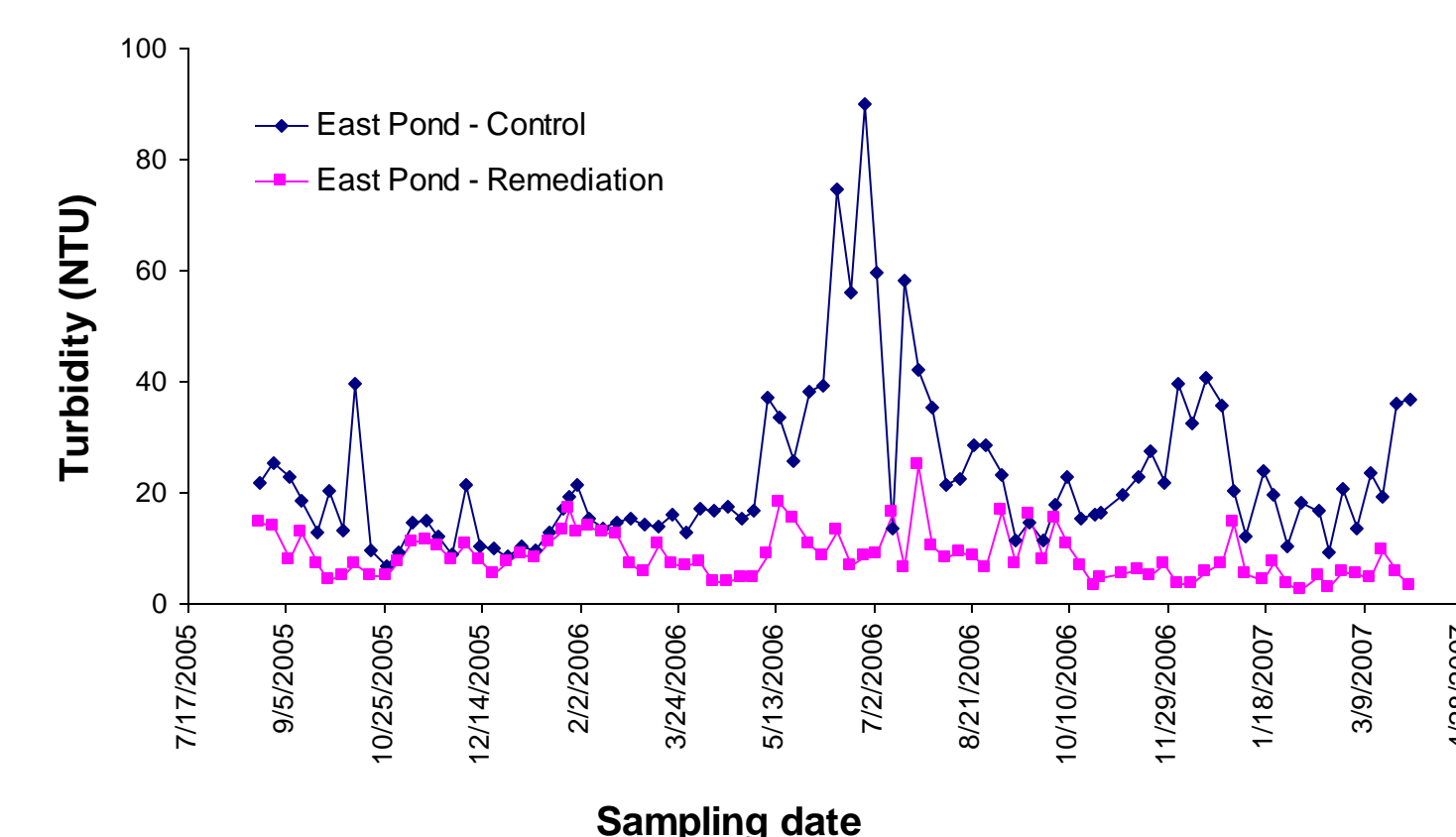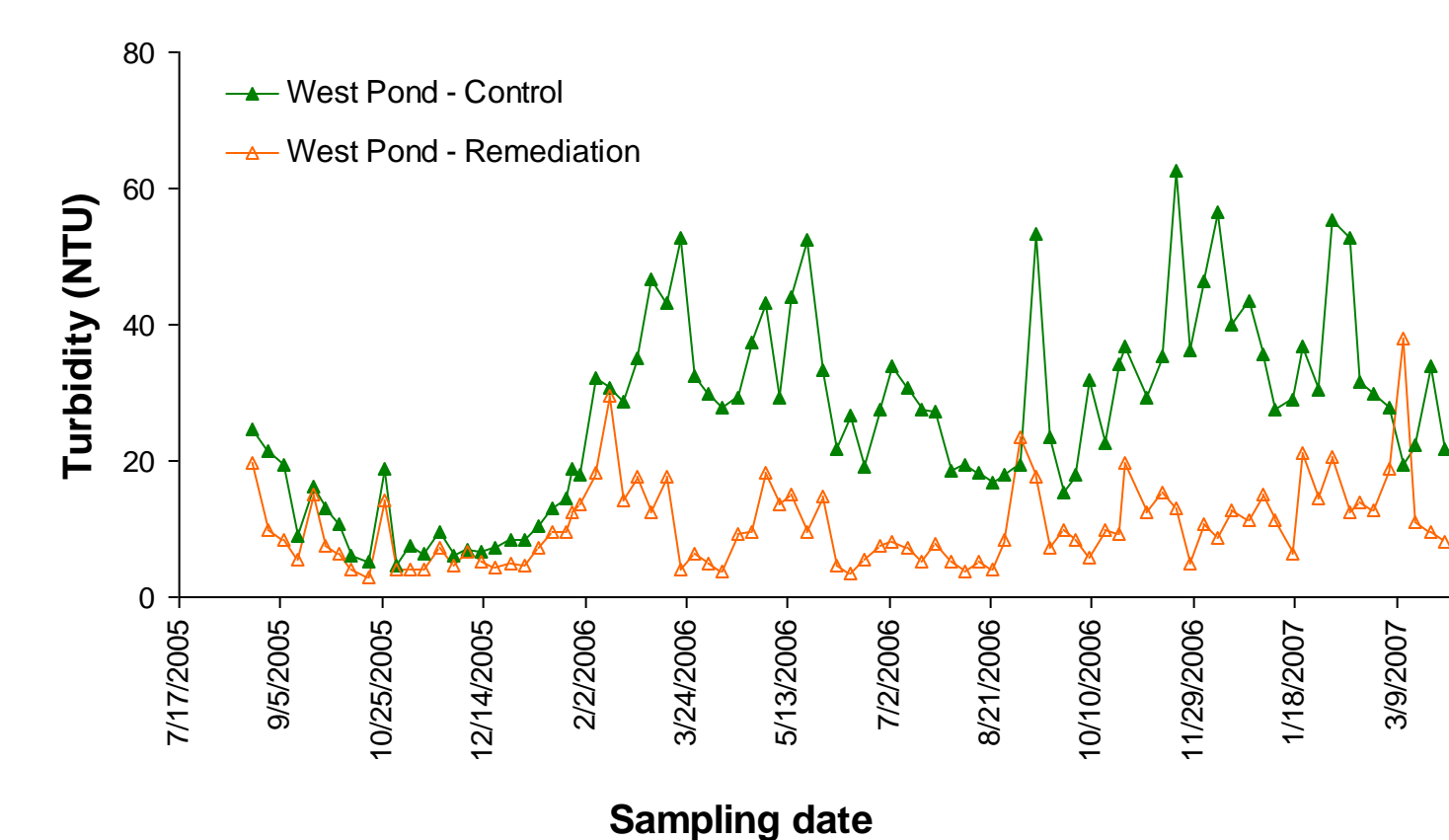

Fig. 1 Turbidity changes in East Pond

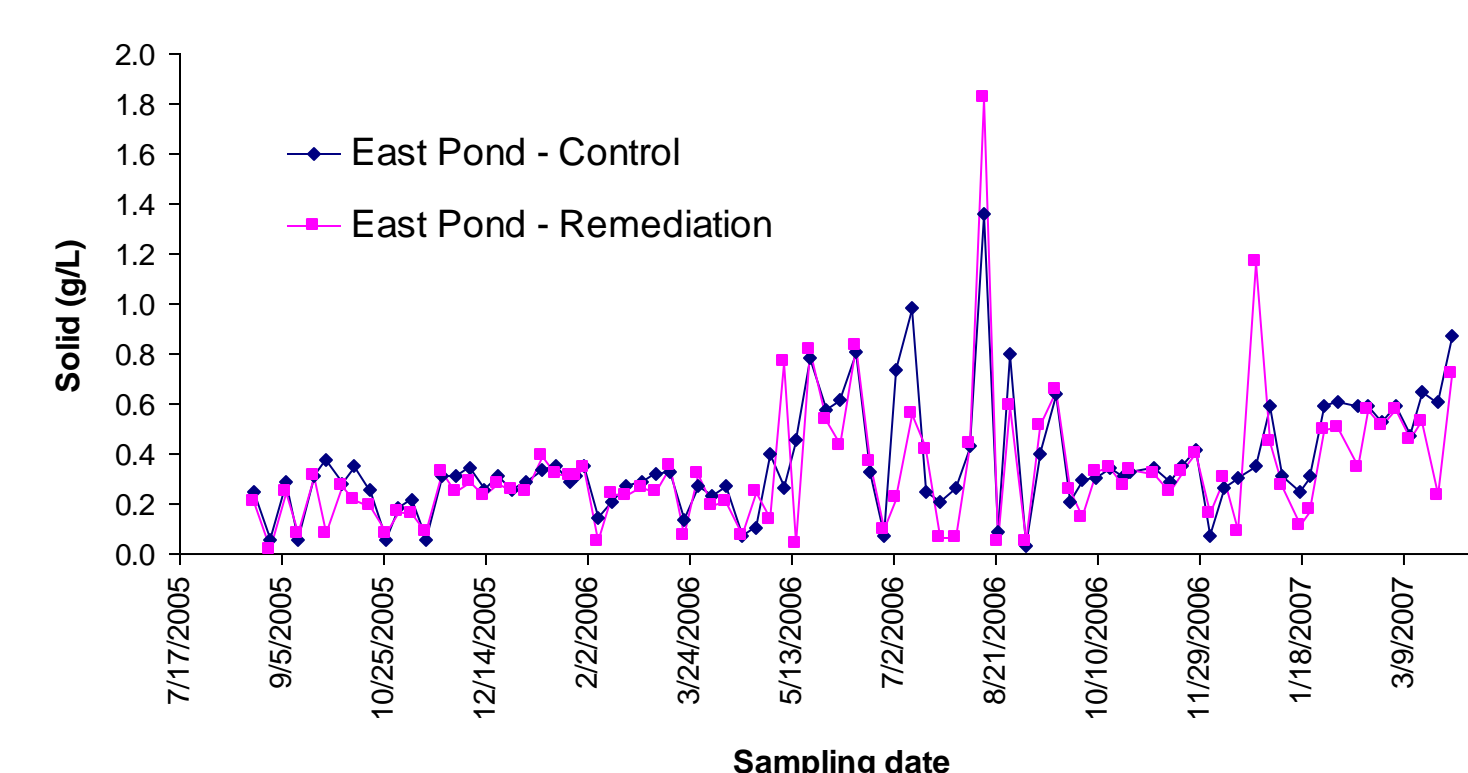
Fig. 2 Turbidity changes in West Pond

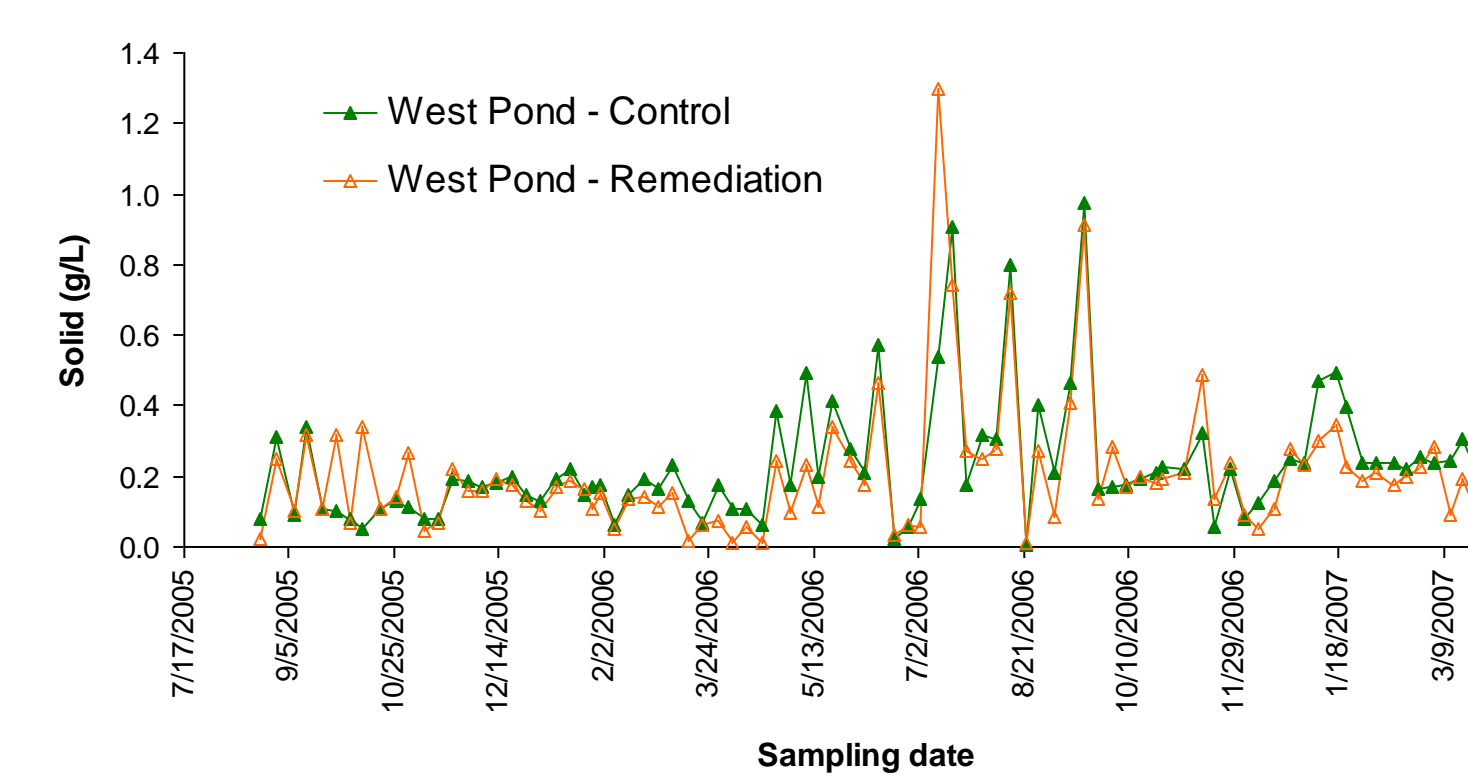**Fig. 3 Suspended solid changes in East Pond**

Fig. 4 Suspended solid changes in West Pond

2. On average, total N decreased by 0.13 and 0.63 mg L^{-1}, total P decreased by 0.17 and 0.32 mg L^{-1} in the East and West Ponds, respectively. Nitrate-N were averagely lowered by 0.01 and 0.13 mg L^{-1}, and PO_4-P by 0.04 and 0.11 mg L^{-1} in the East and West Ponds, respectively (Table 1).

3. The concentrations of N and P in the plant averaged 18 and 3.3 g kg^{-1}, respectively. Copper, Fe, Zn, and Mn were the main metals detected in the plants and their concentrations were much higher in the root than in the shoot (Table 2).

4. Plant biomass yields (dry weight) were 13 and 46 Mg DW ha^{-1} yr^{-1} in East and West Ponds, respectively, which removed large amounts of N, P, and metals per ha water area per year (Table 3).

Table 1. Concentrations of *N and P in waters with and without growing water lettuce*

Location	Treatment	Total N	NO_3-N	Total P	PO_4-P
		------------------------------ mg L^{-1} -----------------------------			
East Pond	Control	1.50	0.01	0.61	0.16
	Remediation	1.37	0	0.44	0.12
West Pond	Control	1.62	0.16	0.78	0.44
	Remediation	0.99	0.03	0.46	0.33

* Data are means of results from Aug. 22, 2005 to April 2, 2007.

Table 2. Nitrogen, P and metal concentrations in water lettuce

Location	Tissue	N	P	Cu	Fe	Zn	Mn
		------ g kg^{-1} -------		-------------------- mg kg^{-1} --------------------			
East Pond	Root	19.5	2.8	14.3	5330	274.1	1176
	Shoot	17.6	3.0	3.7	400.9	102.8	185.2
West Pond	Root	19.2	3.8	26.4	5518	33.1	251.6
	Shoot	17.5	3.7	2.8	265.5	32.5	174.2

* Data are means of results from Feb. 28, 2006 to Mach 18, 2007.

Table 3. Annual removal of N, P and metals by water lettuce

Location	Dry biomass	N	P	Mn	Fe	Zn	Cu
	Mg ha^{-1} yr^{-1}	-------------------- kg ha^{-1} yr^{-1} ---------------------					g ha^{-1} yr^{-1}
East Pond	13	254	39	10	34	2.6	122
West Pond	46	721	176	10	110	2.2	587

CONCLUSIONS

Water lettuce has a great potential for remediating stormwaters and improving water quality: it can effectively remove nutrients, reduce water turbidity and suspended solids, and can also remove heavy metals such as Fe, Mn, Zn, and Cu by plant uptake and root adsorption.

REFERENCES

He, Z.L., D.V. Calvert, P.J. Stoffella, and Y.C. Li. 2005. Assessment and evaluation of nitrogen, phosphorus, and heavy metals (including copper) in surface runoff from citrus groves and vegetable farms in the Indian River area. A Project Final Report. Florida Department of Environmental Protection, Tallahassee, FL.

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