

Technical Report on:

**“Evaluation of the Algal Turf Scrubber
Technology for Treatment of Agricultural
Drainage Water”**

A Project for the Caroline County Soil Conservation District

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Introduction

An algal turf scrubber (ATS) system was constructed along a drainage ditch on the Collier Farm in Caroline County, Maryland. The purpose of the system was to test the performance of the ATS technology for nutrient removal from the drainage ditch waters and to develop techniques for operation of the technology away from an electrical power source in an agricultural landscape. Notes on project implementation are given in progress reports (Kangas and Mulbry 2009, 2010).

The ATS system consists of a shallow (about 5 cm deep) basin on graded land with an approximate 2 % slope. The basin is lined with standard pond liner and is 6 meters wide and 50 meters long. Water from the drainage ditch is pumped onto the basin with a solar-powered pump system and is released through six dump buckets that create turbulent flow at the top of the basin. Water moves by gravity down the length of the system and discharges into a lined catch basin at the bottom of the system. This catch basin is connected to an in-field drainage ditch which routes the water back to the source ditch, creating a hydrologic loop of the treated water. Algae grow attached to a mesh screen that is submerged in the basin. Algal species that colonize the screen come from the drainage ditch waters. The surface of the ATS was divided into six parallel 1 meter-wide raceways to allow experimentation.

Methods

The system became operational in the late summer of 2010. Harvesting took place at weekly intervals in August and bi-weekly intervals in October through mid-November. During harvesting, the water flow was turned off and algae were brushed off the screen through abrasion with action of a standard floor broom that was manually pushed down the length of the system. Algal biomass was brushed onto a mesh screen that was suspended above the catch basin on a rack, where it was left to air-dry between harvests. Algal biomass that passes through the suspended screen can be retained in the catch basin and would settle out of the water column. However, samples of this material were not collected during the present study.

Air-dried algal biomass from the rack was returned to the laboratory where it was oven-dried at 70 °C for 24 hours and weighed. Mass data was extrapolated over the surface area of the ATS system and over the time interval between harvests to calculate biomass production values in units of grams dry-weight $\text{m}^{-2} \text{day}^{-1}$. Subsamples of algal biomass were analyzed according to Standard Methods for nitrogen (N) and phosphorus (P) content and other subsamples were ashed at 500 °C for 5 hours in order to determine ash content.

Experimental Design

An experiment was conducted to examine a potential effect of water flow rate on biomass production and nutrient removal. Three treatment levels of water flow were utilized: high (52-72 liters/minute (Lpm)), intermediate (19-20 Lpm) and low (6-7 Lpm). Two adjacent experimental flowways were used as replicates for each treatment level of

water flow rate. Based on literature reports and past studies with small-scale laboratory ATS, we predicted that biomass production and nutrient removal rates would be proportional to water flow rate.

Results and Discussion

Results are given in Table 1 and Figure 1. Biomass production and nutrient removal values were highest on August 3 but declined afterwards. It is likely that growth was inhibited by high water temperatures on the flowways (30-37 °C). Water temperatures increased significantly with decreasing flow rate. Water temperatures were not limiting for algal growth in October and November, but declining productivity during this period was likely due to decreasing light levels. N and P contents of algal biomass were invariant from August and November at about 2.5 % N and 0.2 % P. Surprisingly N/P values of all algal samples were greater than 10, suggesting that the influent water was not enriched in P. Ash content of algae was moderate (compared to other single pass ATS systems) at 40-50 %. Results from the flow rate experiment were highly variable but suggested that productivity and nutrient removal did not increase proportionally with flow rate.

Literature Cited

Kangas, P. and W. Mulbry. 2009. Progress report on “Evaluation of the Algal Turf Scrubber Technology for Treatment of Agricultural Drainage Water”. Report submitted to the Caroline County Soil Conservation District.

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Figure 1

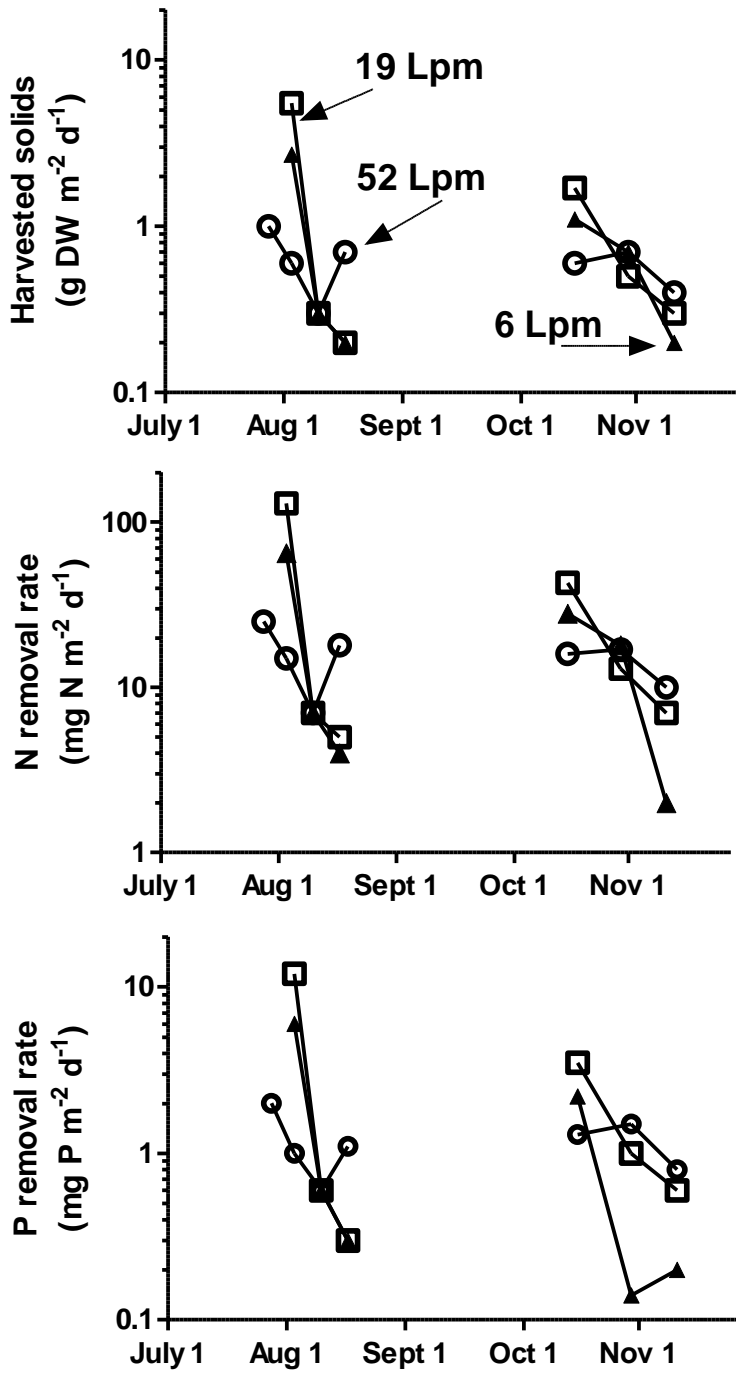


Table 1

Output (m⁻² day⁻¹)*	July 27	Aug 3			Aug 10			Aug 17			Oct 15			Oct 29			Nov 10		
Flowrate (Lpm)	52	52	19	6	52	20	7	72	20	7	72	20	7	72	20	7	72	20	7
Harvested solids (g DW)	1	0.6	5.5	2.7	0.3	0.3	0.3	0.7	0.2	0.2	0.6	1.7	1.1	0.7	0.5	0.7	0.4	0.3	0.1
N content (%)	2.5	2.3	2.3	2.4	2.4	2.4	2.4	2.5	2.6	2.1	2.7	2.5	2.6	2.5	2.5	2.5	2.5	2.3	2.3
P content (%)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
TN in harvested solids (mg)	25	15	130	65	7	7	7	18	5	4	16	43	28	17	13	18	10	7	2
TP in harvested solids (mg)	2	1	12	6	0.6	0.6	0.6	1.1	0.3	0.3	1.3	3.5	2.2	1.5	1.0	1.4	0.8	0.6	0.2
N/P	13	12	12	12	12	12	12	16	16	13	12	12	13	11	12	12	13	13	12
Ash content (%)	50	52	55	50				42	41	40	54	52	46	50	51	43	48	46	37
Effluent Temp (C)					30	35	40	30	33	37									
Influent temp (C)	25				27			25											
Air Temp (C)								32											

*All values are averages from two replicate raceways