USE OF AN ALGAL TREATMENT SYSTEM FOR WATER QUALITY IMPROVEMENT ALONG THE SUSQUEHANNA RIVER

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INTRODUCTION

Water quality degradation has occurred in the Chesapeake Bay primarily due to nutrient pollution. This process of cultural eutrophication has lead to a number of environmental impacts such as reductions in submerged aquatic vegetation, increases in turbidity and the enlargement of "dead zones" or low dissolved oxygen zones in the bottom waters of the bay. New water quality treatment technologies are needed to restore the Chesapeake Bay and other polluted water bodies. In this study the performance of controlled algal growth systems is described as a possible best management practice (BMP) for improving the quality in river water.

SITE DESCRIPTION

The research was carried out at Exelon Corporation's Muddy Run Pumped Storage Hydroelectric Facility on the Susquehanna River in southeastern Pennsylvania. At this facility on a diurnal basis river water is pumped up to the Muddy Run Reservoir when the electricity price is low. Water is then released down from the reservoir and run through turbines to generate power when the electricity price is high. Water from the reservoir was used to grow algae in this study with flow rates of about one liter/sec.

THE ALGAL PRODUCTION SYSTEMS

Algae were grown in two experimental algal turf scrubbers (ATS)™. Each system was 91 meters (300 feet) long and 0.3 meters (1 foot) wide. The first system (from Hydromentia), constructed from aluminum, was operated at a 2% slope from June 2008 to July 2009, after which the slope was reduced to 0.5% through November 2009. A second system, constructed from wood, was operated at a 1% slope from September 2008 to November 2009. Periphytic algae were grown attached to screens that were placed in the bottom of the ATS. Algal biomass was harvested from the systems every 1-2 weeks during the study period.

The algal turf scrubber is a trademark registered to the Hydromentia Company of Ocala, Florida.

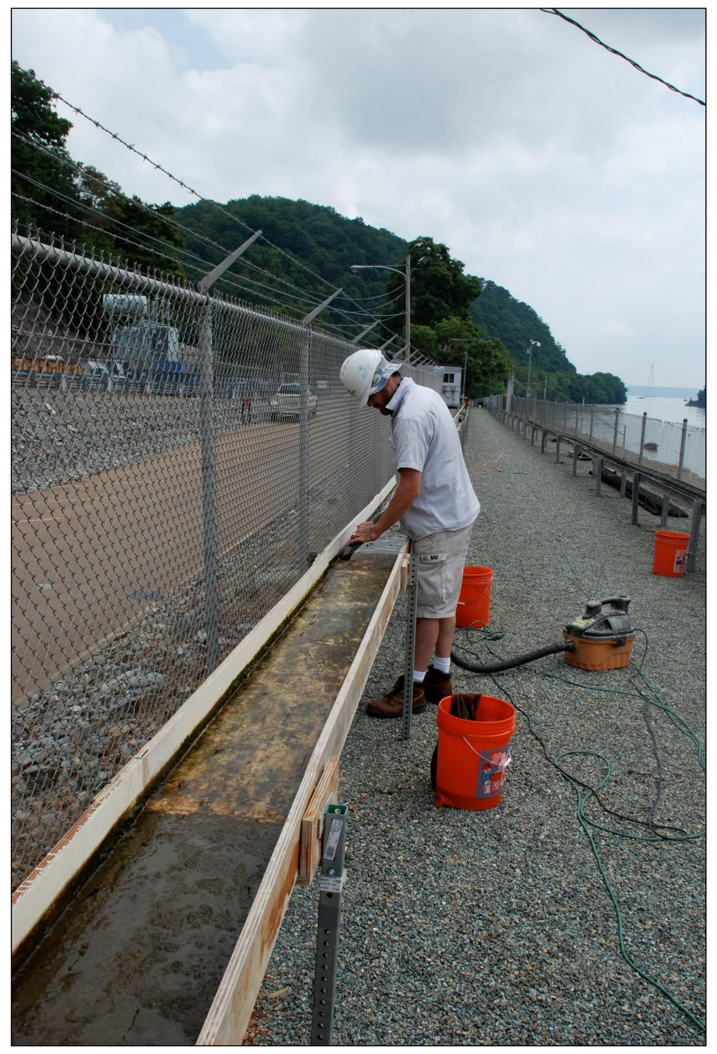

Table 1. Biomass production of the algal production systems. Data are grams dry weight/m2/day. Numbers in parentheses are the months included in the seasons.

Season	Aluminum ATS	Wooden ATS
Summer 2008 (6-8)	18.0	---
Fall 2008 (9-11)	10.9	---
Winter 2008-2009 (12-3)	---	---
Spring 2009 (4-5)	13.3	11.3
Summer 2009 (6-7)	17.6	12.3
Fall 2009* (8-10)	13.6	10.5
Growing Season Averages	14.7	11.4

* at 0.5% slope

NUTRIENT REMOVAL RATE

Nutrient removal in the algal production systems (grams nutrient/m2/day) was calculated by multiplying biomass production in the harvest (grams dry wt./m2/day) by the nutrient content of the biomass (% nutrient).

Biomass production by the two ATS is shown in Table 1. Over the growing season biomass production averaged 14.7 grams dry weight/m2/day for the aluminum ATS and 11.4 grams dry weight/m2/day for the wooden ATS. Algal biomass averaged between 2-3 % nitrogen content and between 0.25-0.35 % phosphorus content over the study period. Thus, total nutrient removal rates were on the order of 0.3 grams of N/m2/day and 0.04 grams of P/m2/day or, if scaled up proportionally, 640 pounds of N/acre/year and 90 pounds of P/acre/year.

OXYGEN PRODUCTION RATE

Diurnal curve analysis of the difference in dissolved oxygen concentration between the top and bottom of the algal production system was used to estimate the oxygen production rate (which is equivalent to ecosystem metabolism) of the algal production systems. Nine diurnal oxygen curves were analyzed during the study period covering all of the growing seasons of the year.

A typical diurnal oxygen production curve is shown in Figure 1. The rate of oxygen production rises during the day due to net primary production and falls at night due to community respiration. Overall, the net oxygen production rate of the two ATS varied seasonally from less than 1.0 to 8.6 grams of oxygen/m2/day.

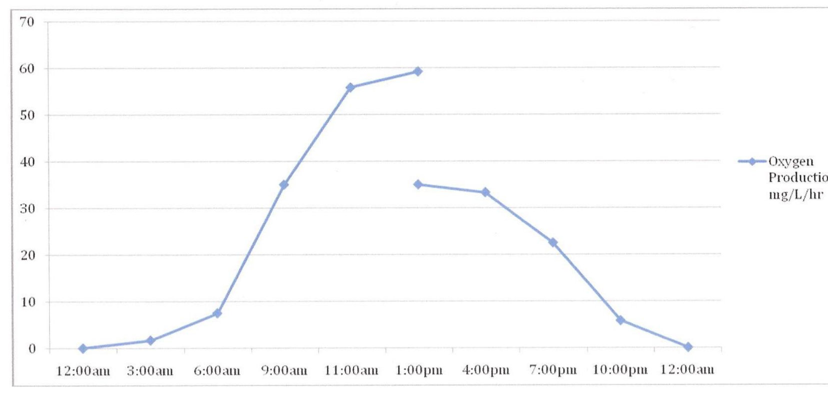

Figure 1. Diurnal oxygen production curve for 6/11/09-6/12/09 for the wooden ATS

CONCLUSIONS

Algal production systems were shown to be effective at removing nutrients and adding dissolved oxygen on the Susquehanna River.

The use of algal production systems can compliment other BMPs to improve water quality in the Chesapeake Bay watershed and to help restore the Bay's ecosystems.

New developments in the technology (such as a three dimensional screen as growth substrate and methods for extending the growing season) promise increased performance in the future.