



# Controlled Algal Growth for Water Quality Improvement on the Baltimore Inner Harbor

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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 led 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 water quality in an urban setting.



## SITE DESCRIPTION

An experimental algal turf scrubber (ATS)<sup>TM</sup> was studied on the Baltimore Inner Harbor from December 2011 through December 2012. The site was on the Honeywell property near Fells Point in Baltimore. Water was pumped from a canal at the Living Classrooms Foundation marina to the system. Water temperature data over the annual cycle are given in Figure 1. Salinity at the site was brackish (Figure 2).

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

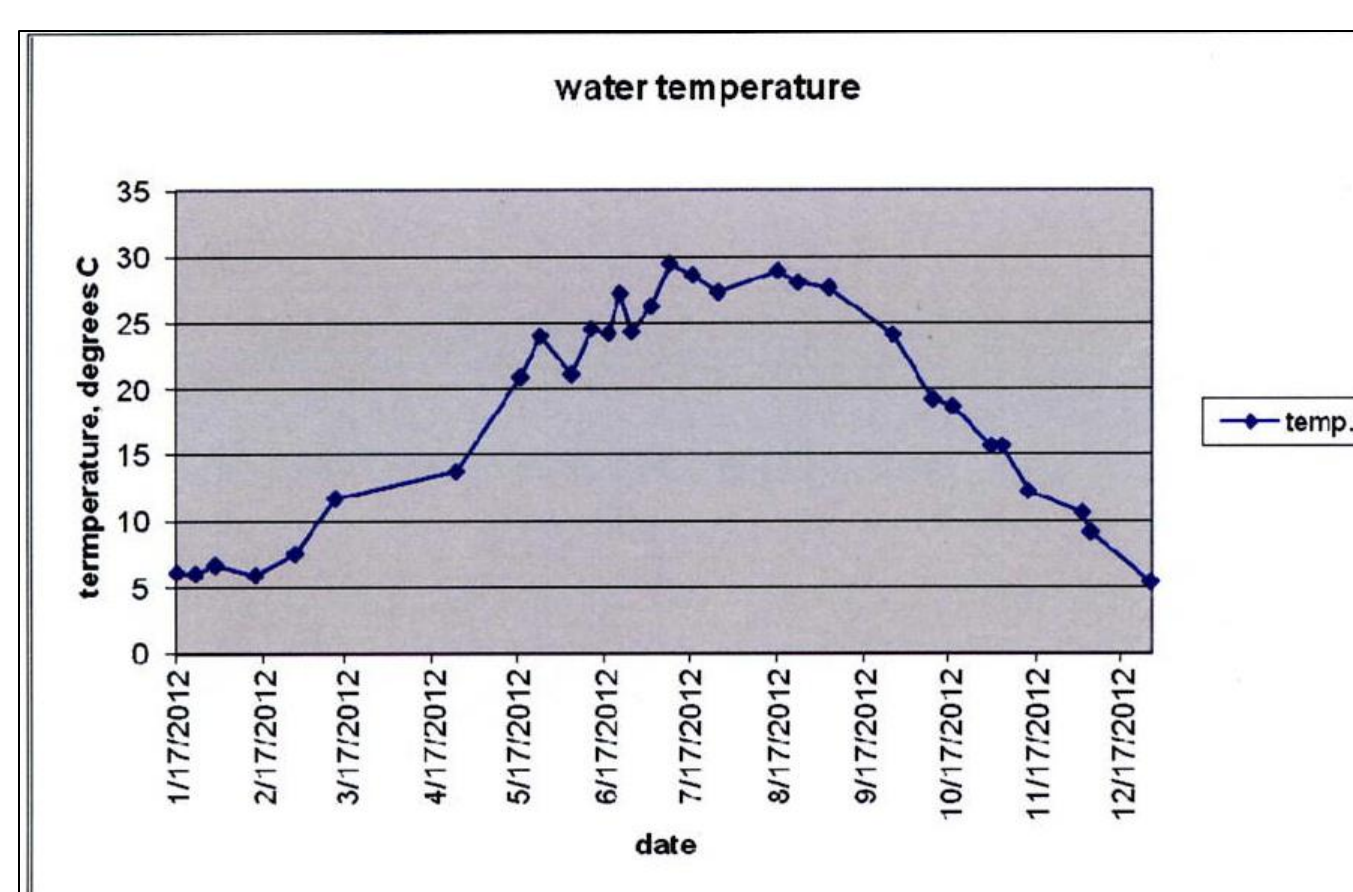


Figure 1. Incoming water temperature data during the study period.

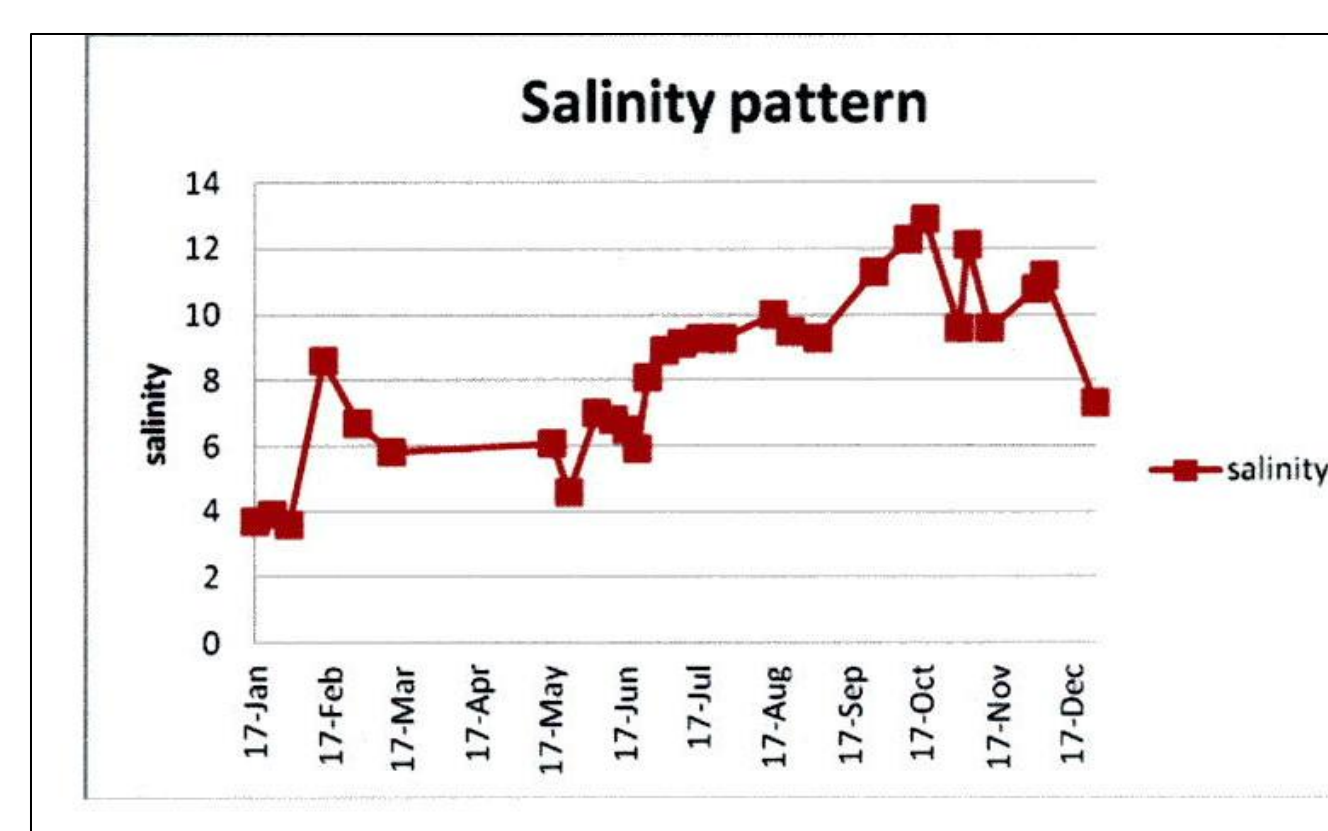


Figure 2. Incoming salinity data during the study period.

## THE ALGAL PRODUCTION SYSTEMS

The ATS system was 1' wide and 300' long with a 1% slope and it was constructed out of wood with fiberglass coating. Periphytic algae were grown on a plastic screen placed in the bottom of the system with a mesh size of 0.25 cm<sup>2</sup>. Water was pumped to the system with a Flotec submersible pump at a rate that averaged 28.9 gallons/minute. Algal biomass was harvested from the system every 1-2 weeks during the study period.

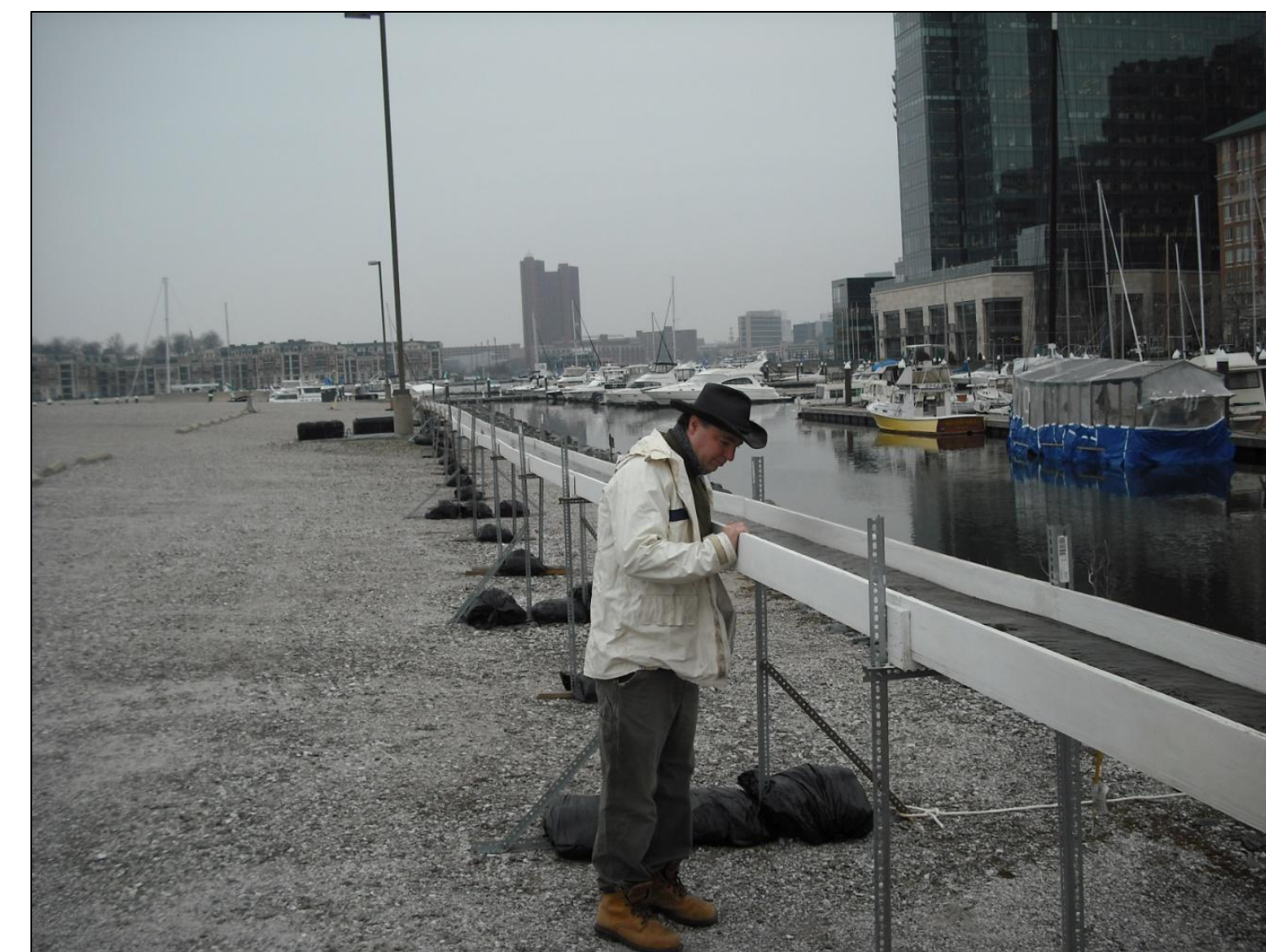


Table 1. Algal biomass production rates for the Baltimore Inner Harbor ATS during 2012. Data are air-dried weights.

Time period	productivity (grams/m <sup>2</sup> /day)
Winter-spring (1/12-5/12)	5.7
Summer (6/12-8/12)	12.2
Fall-winter (9/12-12/12)	4.8

## NUTRIENT REMOVAL RATE

Total biomass production was highest during the summer months and averaged about 7.5 grams dry weight/m<sup>2</sup>/day (Table 1). Ash content was measured to be 59% of biomass.

Nitrogen content averaged 3.20% and phosphorus content averaged 0.05% of the algal biomass. Nutrient uptake by the ATS was found by multiplying the biomass production rate (g dry weight/m<sup>2</sup>/day) by the nutrient contents of the biomass (%). Using data given above, the total annual uptake rate for nitrogen would be about 745 lbs N/acre-year (836 kg/N/ha-year) and for phosphorus about 12 lbs P/acre-year (13 kg/P/ha-year).

## OXYGEN PRODUCTION RATE

At one seasonal extreme, during the summer, input dissolved oxygen concentration was low at around 0.5-3 mg/l with about 10-20 % saturation. At the other seasonal extreme, during the winter, input dissolved oxygen concentration was high at around 10-12 mg/l with about 90-100 % saturation. Passage of the input water through the ATS increases dissolved oxygen concentration in proportion to ecosystem metabolism of the ATS. During mid-day these increases between the top and bottom of the ATS in dissolved oxygen concentration were dramatic (Table 2). These increases are especially noteworthy given that the turnover time of water in the system was less than 10 minutes.

Table 2. Dissolved oxygen data for the Baltimore Inner Harbor ATS during 2012. Input and output data are concentrations in mg/l. Percent change was calculated as follows: (output concentration - input concentration)/output concentration.

Time period	input	output	percent change
Winter-spring (1/12-4/12)	9.3	12.7	+27
Summer (5/12-8/12)	2.7	13.4	+80
Fall-winter (9/12-12/12)	6.6	13.8	+52

## CONCLUSIONS

An algal production system was shown to be effective at removing nutrients from and adding dissolved oxygen to waters of the Baltimore Inner Harbor.

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

Algal production systems may play a special role in urban settings by providing oxygen refuges that reduce mass mortality of fishes and macroinvertebrates during extreme low dissolved oxygen events.

