

# Perchlorate in turfgrass systems, Suffolk County, Long Island, NY

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## INTRODUCTION

Since perchlorates' placement on the U.S. Environmental Protection Agency (EPA) contaminant candidate list in 1998 EPA has yet to set a national drinking water standard. EPA asserts that more information is needed on perchlorate exposure and the relative source contribution to the human diet. Perchlorate is known to inhibit iodide uptake of the thyroid gland, which is of particular concern for women and children with iodide deficiencies. This health concern, coupled with the mobility of perchlorate poses a threat to groundwater. Our study area, Suffolk County, Long Island, NY is particularly sensitive to groundwater contamination as all potable water is derived from the local aquifers. New York State has implemented levels of 18  $\mu\text{g ClO}_4$  per L for public notification level and 5  $\mu\text{g/L}$  for drinking water planning levels in groundwater, however, state levels are as low as 1  $\mu\text{g/L}$  in New Mexico, Maryland and Massachusetts (EPA, 2005).

One probably threat in increasing perchlorate in drinking water of residential land use is organic turfgrass fertilizer (Urbansky, 2004). To evaluate the impact from fertilizer we measured perchlorate concentrations in soil water collected at 100 cm beneath fertilized lawns, grass clippings and bulk precipitation samples.

## **METHODS**

Perchlorate concentrations in precipitation, grass clippings, and soil water were analyzed at nine turfgrass plots in Suffolk County, NY. The bulk precipitation samples were collected monthly between December, 2005 and January, 2007. Soil water was collected monthly from suction lysimeters at 100 cm depth from April, 2006 to January, 2007. Grass clippings, cut with scissors to the ground surface from a 14 cm by 24.3 cm area, were collected monthly at each plot from June, 2006 to January, 2007. Four of the plots were treated with chemical fertilizer, three with organic fertilizer and two were not fertilized.

Samples were filtered in the field using a 0.2  $\mu\text{m}$  surfactant-free cellulose acetate (SFCA) filter and stored at 4°C until analyzed. Perchlorate was analyzed using a sequential ion chromatography-mass spectroscopy/mass spectroscopy (IC-MS/MS) technique (Aribi and Sakuma, 2005) with a method detection limit of 0.005  $\mu\text{g L}^{-1}$ . To account for matrix effects, all samples were spiked with an oxygen-isotope ( $^{18}\text{O}$ ) labeled  $\text{ClO}_4$  internal standard.

## **RESULTS**

Concentrations of  $\text{ClO}_4$  in grass clippings and soil water, at the sites treated with chemical fertilizer or not treated with fertilizer, are found to increase when spikes of  $\text{ClO}_4$  concentrations in bulk precipitation are observed. We believe that the spikes in perchlorate in precipitation collected shortly after the Fourth of July are due to firework displays (Figure 1). The concentration of  $\text{ClO}_4$  in soil water are 1 to 3 times higher than the maximum perchlorate concentrations in precipitation, with maximum soil water concentrations ranging from 0.5 to 3.0  $\mu\text{g/L}$  (Figure 2). The  $\text{ClO}_4$  concentrations above 3.0  $\mu\text{g/L}$  at the Oakdale plot treated with chemical fertilizer are elevated due to improper fertilized application in October, 2005, where this site received organic fertilizer instead of chemical fertilizer.

At the sites treated with organic fertilizer, grass clippings and soil water  $\text{ClO}_4$  concentrations increase after the fertilizer application in May. The organic fertilizer that was applied has nine mg  $\text{ClO}_4$  per kg (9,000  $\mu\text{g}$  per kg). Soil water concentrations at the

sites treated with organic fertilizer increase 100 to 300 times the maximum  $\text{ClO}_4$  concentration observed in precipitation, with maximum soil water concentrations ranging from 120 to 625  $\mu\text{g/L}$  (Figure 2).

The increase in  $\text{ClO}_4$  concentrations in the soil water cannot be explained by evaporation of perchlorate from precipitation since the  $\text{Cl}$  to  $\text{ClO}_4$  ratios decrease in the soil water relative to precipitation. This decrease in the  $\text{Cl}$  to  $\text{ClO}_4$  ratio suggests another source of perchlorate besides precipitation. We postulate that this additional source, besides the perchlorate from the organic fertilizer, is associated with the decomposition of mulched grass left after mowing. Grass takes only a few weeks to decompose after mulching, thus providing a continuous source of perchlorate throughout the mowing season. The  $\text{Cl}$  to  $\text{ClO}_4$  ratio of the grass is unknown although perchlorate concentrations of the grass were measured (Figure 3).

## **CONCLUSIONS**

Further study is needed to understand the impact of perchlorate leaching from lawn to Suffolk County groundwater. However, the preliminary data collected in this study suggest that lawns treated with chemical fertilizer are a minimal threat while lawns fertilized with organic fertilizer have the potential to increase groundwater concentrations significantly above the current NY state drinking water planning level of 5  $\mu\text{g/L}$ .

## **REFERENCES**

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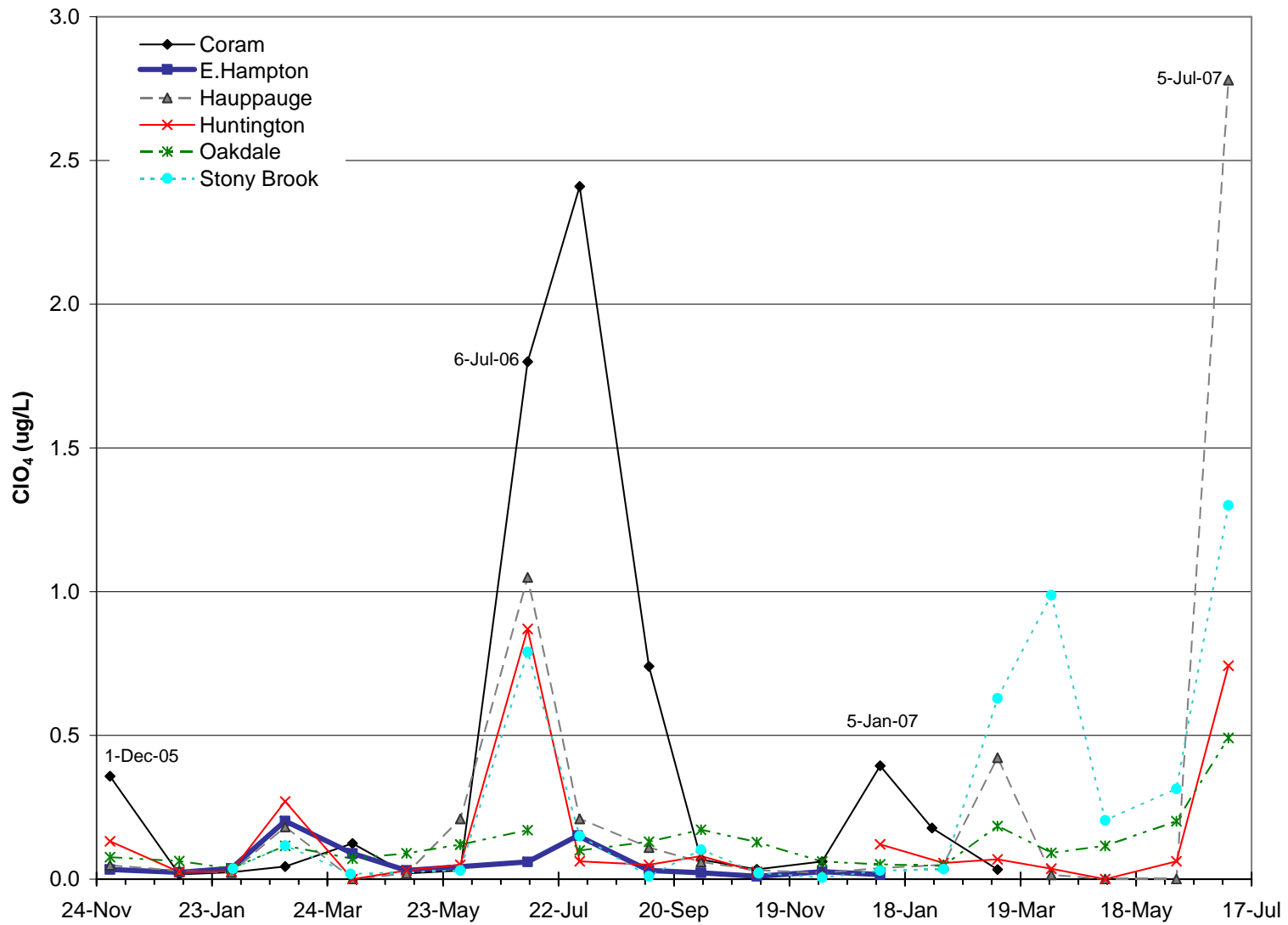
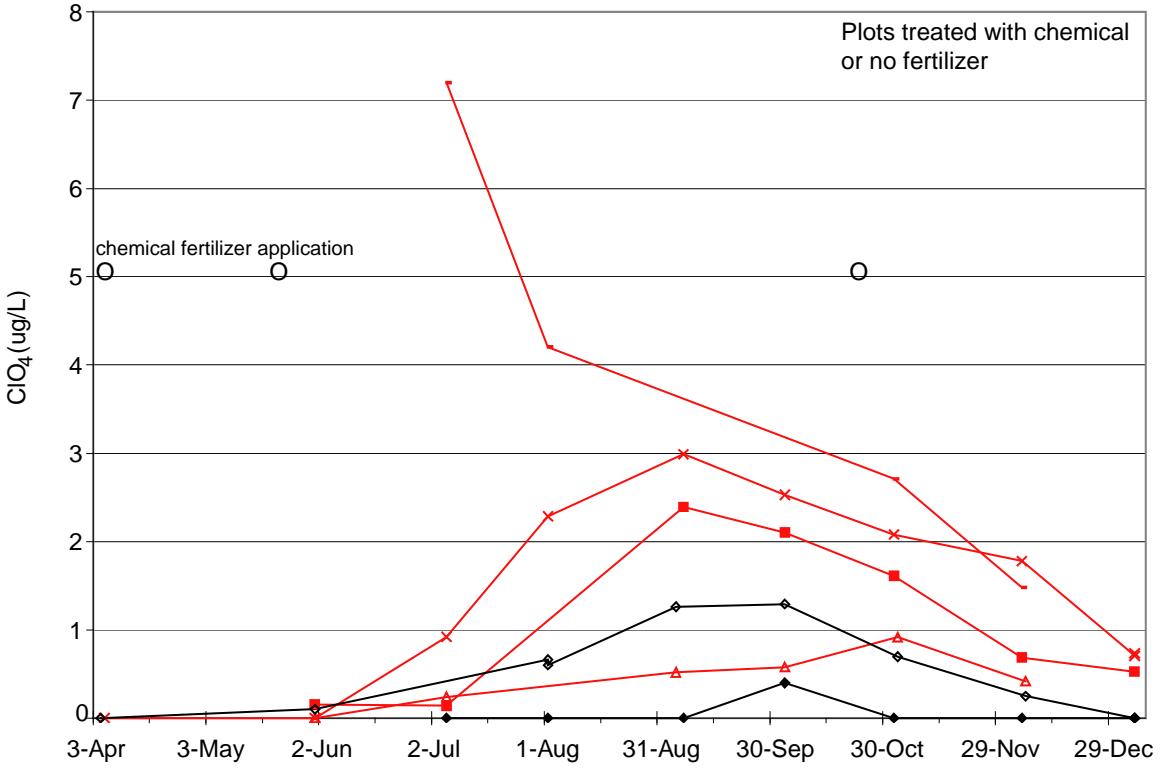
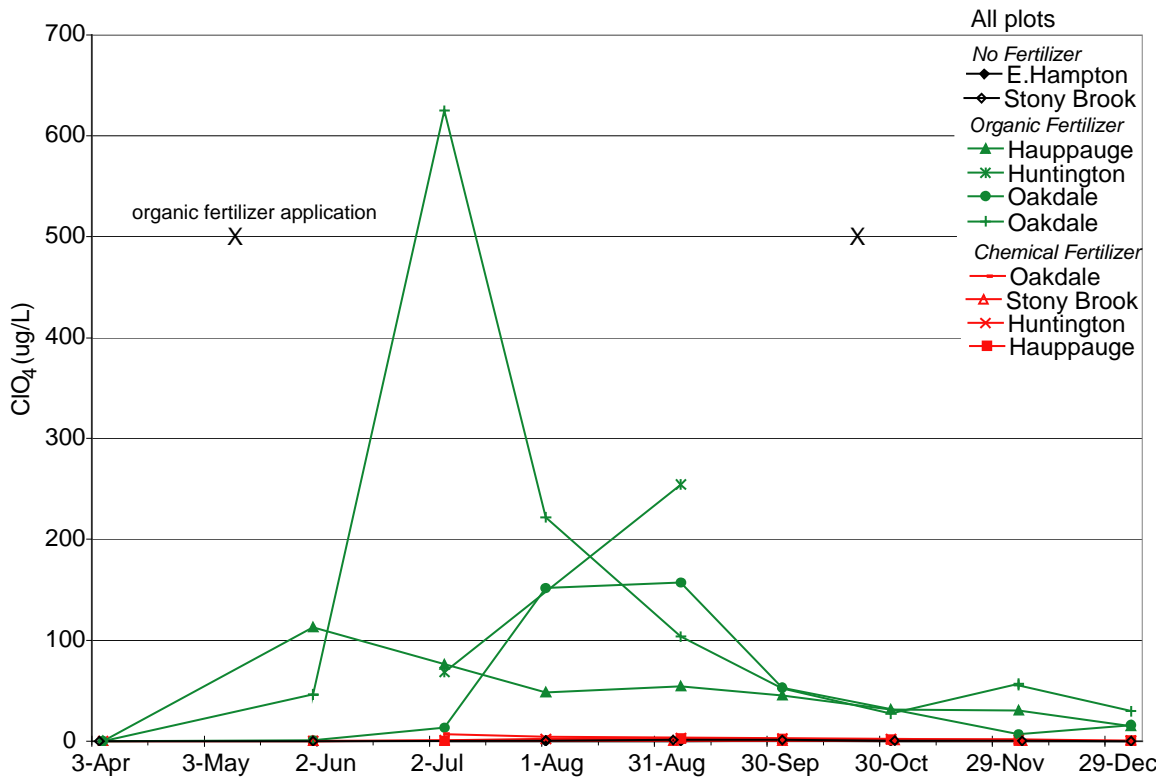
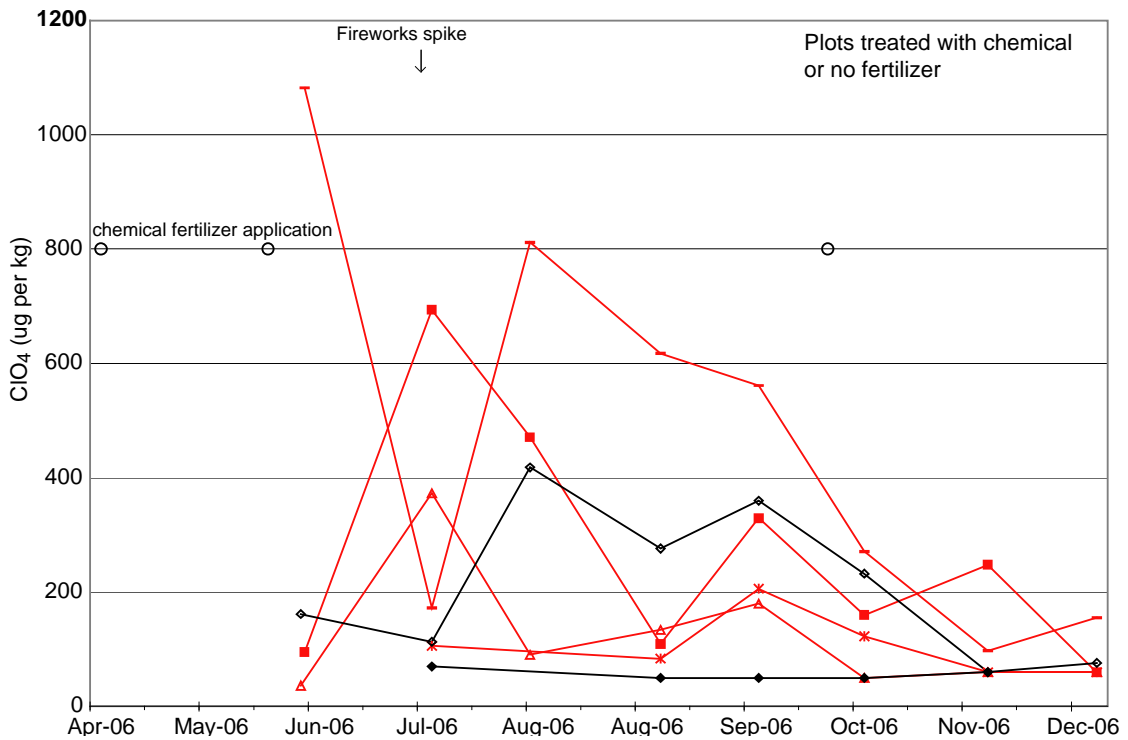
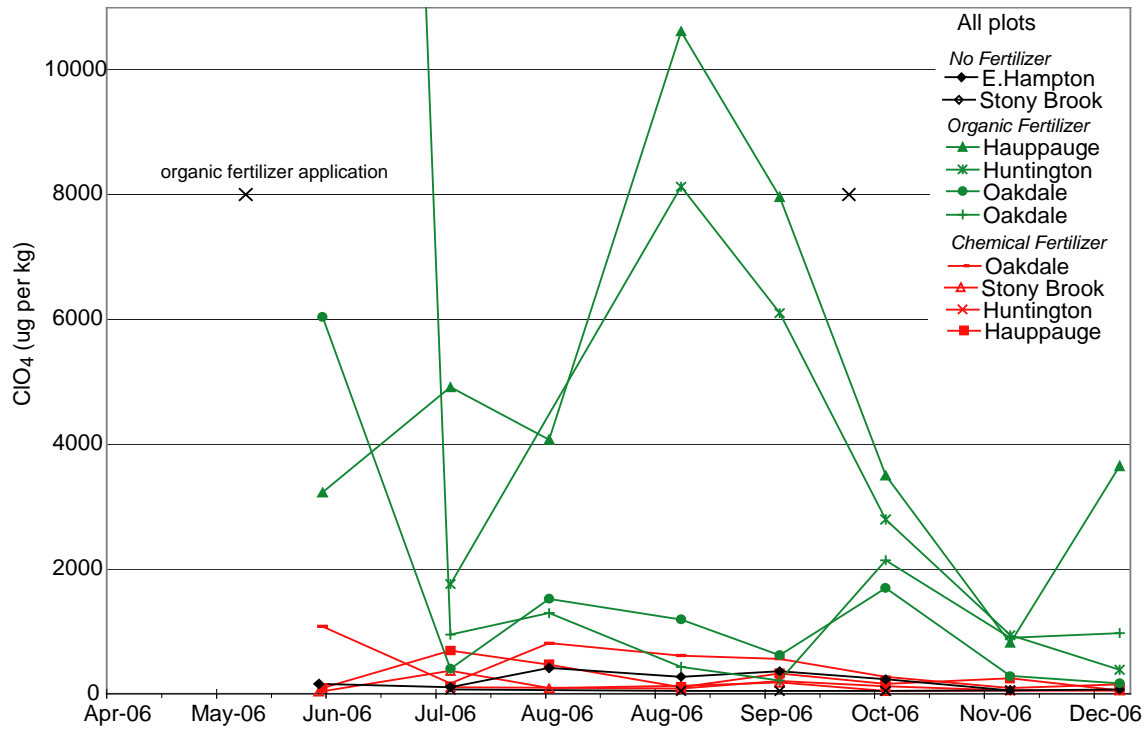


Figure 1 Perchlorate concentrations of bulk precipitation, collected monthly from December 2005 through July 2007.



**Figure 2** Perchlorate concentrations of soil water collected at 100 cm beneath lawns from April 2006 through January 2007. Fertilizer at the Oakdale chemical plot and the second Oakdale organic plot were mixed up in October 2005, when the chemical plot received organic fertilizer and the organic plot received chemical fertilizer.



**Figure 3** Perchlorate content of grass clippings, dry weight basis, of samples collected from June 2006 through January 2007. The off scale value for the second Oakdale organic plot in June 2006 is 47,145 ug per kg.