Urban Storm Water Effects on the Growth of *Brassica oleracea* Seedings and the Death Rate of *Enallagma exsulans*

Abstract

According to Tsihrintzia (1997) in a 1988 report to congress, the EPA found that urban storm water runoff is the fourth largest cause of decreasing river quality in the United States. As the country continues to become increasingly urbanized, it is likely that storm water runoff is becoming progressively more polluted. Carpenter et al (1998) found that this would be less of an issue if storm water was typically treated before being discharged, but most storm water is never treated and enters directly into the local watershed. The purpose of this study is to assess how storm water may affect flora and fauna present in these watersheds.

To accomplish this, I collected storm water from an effluent into the Huron River in Ann Arbor, Michigan and diluted the water to concentrations of 75%, 25%, and 0% storm water. I then watered broccoli (*Brassica oleracea)* seedlings with the varying concentrations and damselflies (*Enallagma exsulans)* were also placed in the separate concentrations. I found that increasing concentrations of storm water had a positive effect on broccoli growth, though at the same time had a negative effect on damselfly survivorship. I detected elevated levels of phosphorus in the storm water, and thus fertilizer runoff from lawns likely caused the broccoli plants to grow larger with the increasing storm water concentrations. The elevated level of phosphorus may have been harmful to the damselfly health or other toxins may have been present such as heavy metals. This study illustrates the need to carefully manage storm water effluents due to

the effects chemicals present in runoff can have on the health and growth of plants and animals of the watershed.

Introduction

Tsihrintzis (1997) found that in 1972 the Federal Water Pollution Control Act set standards to drastically reduce point source water pollution. Amendments to the Clean Water Act in 1977 and 1983 caused even further reductions in point source water pollution. As a result of these reductions in point source pollution, non-point source water pollution quickly became the major source of water pollution in the United States and continues to be the major contributor even today.

Due to this, in 1990 the EPA mandated that municipalities must develop monitoring programs for their storm water discharges (Tsihrintzis 1997). According to Bobrin (2000) the city of Ann Arbor, Michigan has developed such monitoring programs for its effluents into the Huron River Watershed. From 1995 to 2020, Washtenaw County is expected to see an increase in population by 28% and 26,000 more acres will become developed. This is likely to have a large impact on storm water pollutants if no action is taken. In previous investigations of the Huron River's quality by Wiley and Martin (1999) they have suggested that it may be in the early stages of ecological degradation due to an observed decreasing trend in invertebrate species diversity.

However, according to Bobrin (2000), the Ann Arbor-Ypsilanti Watershed Management Programs focuses on monitoring the river itself and its major tributaries without an emphasis on studying the physical storm effluents into the watershed. Studies

assessing the storm drain effluents could help to better understand specific pollutants entering the watershed, as well as help to locate probable sources of the pollution.

The purpose of this study is to better understand the effects of pollutants directly entering the watershed via storm drains into the Huron River. Broccoli was chosen as a plant of study due to its high rate of germination and quick growth rate. Its function in this study is to represent a plant in the watershed. Damselflies were chosen as the animal of study due to their high sensitivity to pollutants and the fact they are naturally present in many aquatic environments, including the Huron River.

I hypothesized that, first of all, broccoli plants grown in differing concentrations of urban storm water will grow at different rates due to pollutants and toxins present in the runoff. I predicted that in this experiment, a greater overall biomass will be generated by the broccoli seedlings grown in the pure water, with a decreasing amount of biomass created by those plants grown in greater concentrations of storm water due to the growth inhibiting action of such pollutants as motor oil and metals. In addition, I also hypothesized that damselflies placed in varying concentrations of storm water will exhibit different lengths of survivorship also due differing levels of pollutants present in the storm water. I predict that damselflies grown in increasingly greater concentrations of storm water will die quicker due to the toxic effects of motor oil and metals.

Materials and Methods

I collected storm water in a 5 gallon jug from a storm drain effluent emptying into the Huron River near Depot St. and Broadway Rd. I collected the water during a rain event on October 4, 2007. I next diluted the storm water in one gallon jugs with tap

water to 25% and 50%. In addition, 100% storm water was put into a jug and pure tap water was poured into another jug (later referred to as 0% storm water). The 0% storm water acts as the control in this experiment to contrast the effects of storm water against clean water on the growth of plants and animals.

I chose broccoli seeds as a plant of study to determine storm water's effects on plant growth. I chose them due to their high germination rate and fast growth. Ten broccoli seeds were placed into four separate 25 cm x 25 cm plastic planters with about 2.5 cm of potting soil and the seeds sowed 1 cm below the surface. They were watered exclusively with one of the four separate concentrations of storm water every other day for about one month. Eaching watering was about 200 mL. Due to logistical problems, I grew the plants in a 22 C apartment near a glass doorwall. I rotated the planters daily in order to help ensure equal amounts of sunlight to each planter.

After one month, to determine the effect on growth of varying storm water concentrations, I cut the seedlings at the surface and weighed them in order to find the total biomass generated in each of the four planters. Since not all 10 of the seeds germinated in each plot, I calculated the average single plant biomass within each of the four plots in order to standardize the data. Using SPSS stastical software, the average plant mass in each of the four concentrations was ploted against the concentration and a regresion analysis was conducting to determine correlation between plant growth and storm water concentration.

In addition, I harvested 20 damselfly larvae using a net and were taken from the pond at the University of Michigan Matthaei Botanical Gardens in Ann Arbor, Michigan. I filled four 6 oz glasses with each of the concentrations of storm water and five

damselflies were placed in each of the glasses. I recorded their daily survivorship. I kept the damselflies in a 22 C environment, away from direct sunlight. I put a 1 g piece of bread in each glass at day 1 as a food source for the damselflies.

After all of the damselflies had perished, I analyzed the length of lifespan data. In order to avoid pseudo-replication, the average damselfly lifespan for each concentration was calculated rather than treating each damselfly as an individual data point. To determine the effects of storm water concentration on damselfly survivorship, the average damselfly lifespan for each concentration was plotted against the concentration level and a regression analysis was conducted using SPSS statistical software.

Finally, I used test strip indicators to identify the presence of oil, lead and phosphates. I dipped the strips in the 100% storm water concentration mixture and the strips were formulated to change colors upon the presence of each of the various pollutants.

Results

A strong positive correlation is observed between increasing storm water concentrations and average broccoli plant biomass. The r-sqaured value is 0.942. In addition, this correlation is determined to be statistically significant as a 0.05 significance level since the p-value was found to be 0.029.

A moderatley strong negative correlation is observed between incrasing storm water concentrations and length of survival of damselflies. The r-square value is 0.813. This correclation is not statisticaly significant at a 0.05 significance level since the p-value was found to be 0.098.

The test strip indicators determined oil and lead to not be present in the storm water, though a moderately high level of phosphates were found to be presenet.

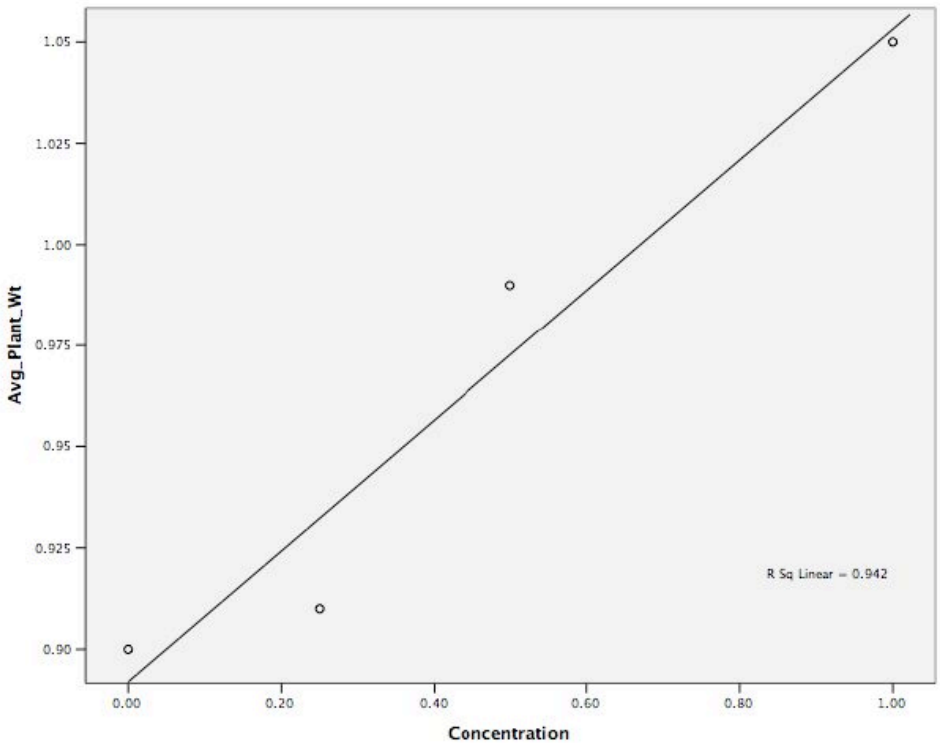

Figure 1 A strong positive correlation is found between storm water concentration and average broccoli biomass.

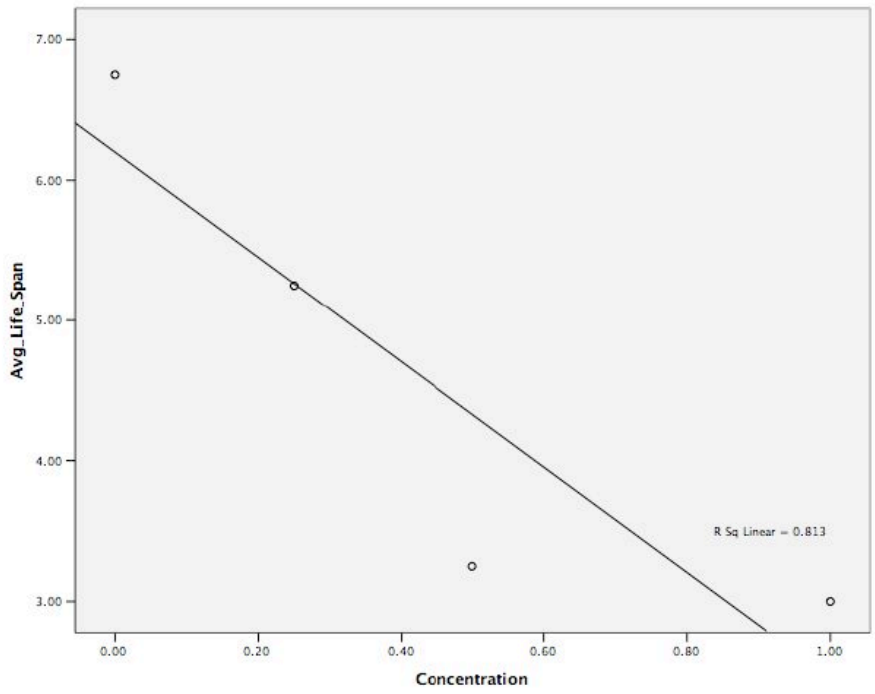

Figure 2 A moderately-strong negative correlation is observed between storm water concentration and average survival time of damselflies.

Water Quality Analysis	
Pollutant	**Presence**
Oil	No
Lead	No
Phosphate	Yes - ~20 ppm

Figure 3 Relatively high levels of phosphates are detected in the storm water.

Discussion

The first hypothesis that broccoli plants grown in differing concentrations of urban storm water will grow at different rates due to pollutants and toxins present in the

runoff is supported by this study since each planter produced a different amount of biomass. However, the prediction that a greater overall biomass will be generated by the broccoli seedlings grown in the pure water with a decreasing amount of biomass created by those plants grown in greater concentrations is not supported by this study. The broccoli plants grown in higher concentrations of storm water produced a greater biomass. Since an R^2-value of near 1 and a p-value of less than 0.05 was determined for this set of data, this provides strong evidence that this sample of storm water contained pollutants capable of increasing plant growth rates.

Since phosphates, possibly from lawn fertilizers, were observed in the storm water, it may be that lawn fertilizers present in the storm water caused the broccoli plants to grow at a higher rate at increasingly higher storm water concentrations. Previous studies of the Huron River by Bobrin (2000) have indicated that the biggest pollutants include suspended solids, phosphorus, bacteria, and metals. In addition, Wiley and Martin (1999) found that large algal blooms in Ford Lake, downstream from Ann Arbor, are frequently observed during heavy fertilizing periods throughout the year.

The second hypothesis that damselflies placed in varying concentrations of storm water will exhibit different lengths of survivorship due to differing levels of pollutants present in the storm water is supported by the general trend illustrated in this study. The data reflects a negative trend in which damselflies generally died quicker when placed in higher concentrations of storm water. However, the damselfly data are not statistically significant and thus further studies should be conducted to verify. Originally I had predicted the negative trend in lifespan would be due to increasing levels of metals and oil, though this study found no oil or lead present. Even though lead and oil were not

detected, it is quite possible that other harmful metals and pollutants are present in the storm water since heavy metals can be correlated in watershed systems with the decline in invertebrate species diversity. Gray (2004) found that heavy metals, once inside the body of aquatic invertebrates, can accumulate and interfere with crucial biological processes such as metabolism.

One major error of this study is the lack of replicates. Ideally, multiple broccoli planters and damselfly sets should have been used for each storm water concentration rather than only one. This would have created a larger sample size and in the case of the damselflies may have provided statistically significant data. In addition, broccoli is not naturally occurring in the Huron River Watershed. Ideally, further follow-up studies should utilize native plants of the watershed. It may be that native plants react differently to some pollutants compared to broccoli plants.

Overall, this study illustrates that storm water does contain pollutants that are capable of effecting both plant growth and aquatic invertebrate survival. Even though this study was conducted at relatively high storm water concentrations that likely are not representative of average conditions in the watershed, it is possible that such concentrations are reached during large rain events and in areas of the watershed in close proximity to sewer effluents. As the watershed region becomes more urbanized, non-point source storm water pollution is likely to become more of a problem. Construction sites, fertilizers, automobiles, and pet wastes are some of the major contributors to decreased watershed health and all of these factors will likely increase as the region grows (Carpenter et al 1998). If polluted storm water can affect plants and animals,

human exposure to polluted storm water in the watershed may be a danger as well, posing threats to the safety of those participating in recreation activities in the region.

Works Cited

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