Upon leaving BELL, a wind turbine seemed like an ideal endeavor for me to encourage sustainability in my school community. When I returned to school, namely, Poly Prep Country Day School, in September, however, I learned that two students had begun an independent study on installing a wind turbine at Poly Prep and was quickly forced to shift my interest. I then changed my focus to the environmental sustainability of freshwater ecosystems. I continued extensive research on the independent study I began the previous year, 2008, on the effects of an organic herbicide on *Daphnia magna*. *Daphnia magna* are indigenous to pond communities in the northeast region of the United States and function as indicator species which, “by their presence, abundance, lack of abundance, or chemical composition, demonstrate some distinctive aspect of the character or quality of an environment [such as disease epidemic, pollution, or climate change],” [1]. The effects of Nature’s Avenger Organic Herbicide, my selected herbicide, on daphnids have elucidated the detrimental effects of organic herbicides on pond communities which I predicted in my initial hypothesis. I hypothesized that when exposed to levels of 1 part per million or higher of Nature’s Avenger Organic Herbicide *Daphnia* would show alterations in anatomy or reproduction because of its active ingredient, d-Limonene. D-Limonene is toxic to aquatic organisms. [4]

The living world on the largest scale is dependent on the successful functioning of aquatic environments. Factors such as foreign chemical runoff into bodies of water have been demonstrated to throw off the biological cycles within a pond ecosystem. Our societies based on agriculture have been using enhancers to stimulate productivity of the soil and control unwanted weeds and pests for thousands of years. Those interventions that are chemically based have had unintended consequences for non-farming ecosystems disrupted by water-borne
transport of these substances. Such substances wither into the immediate ground water or as runoff, then into flowing water, and then into larger bodies of sedentary water where they accumulate. Disruptive chemicals can include fertilizers, pesticides, and herbicides.

Historically, the replacements (often marketed as “natural” or “organic”) ultimately prove harmful, too.

My reasoning for choosing this particular organic herbicide, Nature’s Avenger Organic Herbicide, is because in its product description, it claims to be safe “to children, animals, and the water supply,” [2]. The company also places a heavy stress on the herbicide’s “organic” quality. “Organics” is the current advertising buzzword for the environmentally conscious consumer, which they advertise as the “environmentally friendly” solution to killing unwanted weeds and unwanted weeds only, and I tested the validity of their claims. [3]

The daphnids were maintained in open, glass jars filled with 200 ml of distilled water, 140 ml of Prospect Park pond water, and a pinch of duckweed. The water level was maintained by adding distilled water as needed. Ten 24-hr old daphnids were placed in each jar and 1 ppm of Nature’s Avenger Organic Herbicide was added to the jars. After 48 and 72 hours I recorded the body, head, and tail lengths for the existing daphnids. I observed severe morphological changes. The table I composed below expresses those changes in percents.

Table 1. Examples of morphological change induced by 1 ppm organic herbicide*

<table>
<thead>
<tr>
<th>Age (in hours)</th>
<th>Body length</th>
<th>Head length</th>
<th>Tail Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td>24</td>
<td>88</td>
<td>ND</td>
</tr>
<tr>
<td>72</td>
<td>2</td>
<td>1</td>
<td>20</td>
</tr>
</tbody>
</table>

Abbreviations: NS, no significant difference; ND, no data. *Changes are expressed as percent of the control average. Average values are given for statistically significant differences (ANOVA, p< 0.05).
The ANOVA (analysis of variance) model above represents the sole fallacy in the table which I am in the process of correcting. A correct ANOVA model is highly significant to my morphological findings; it is the percent by which the observed morphological changes are indeed detrimental. Otherwise, the table accurately displays the changes I have observed in daphnids after 48 and 72 hours of 1 part per million acute toxicity exposures.

I documented the daphnids’ growth with a photographic microscope. I inserted a ruler cut-out with millimeter increments next to the daphnids on the slide to measure their head, body and tail lengths. All the water from the slide that remained was absorbed with a dry paper towel. I then determined the actual measure of the 1 mm on the photograph with an actual ruler. I measured the head, body, and tail length of the daphnids with an actual ruler as well after they were photographed. The actual measure of the 1 mm cut-out of the ruler divided by the actual measure of the daphnids yielded the correct head, body, and tail lengths for my daphnids.

My findings thus far are very clearly representative of Nature’s Avenger Organic Herbicide harmful effects on daphnid populations. Such damage being done unto the daphnids puts entire pond and lake ecosystems in danger because daphnids, being at the base of their food chains, feed the larger freshwater organisms. Moreover, I plan, in the coming weeks, to conduct long-term as opposed to acute exposure tests on *D. magna* which is more similar to the exposure daphnids receive in real-life freshwater ecosystems. I researched that *Daphnia magna* reportedly experience the following effects, other than morphological alterations, under environmental stress: (1) immobilization, (2) lower turbidity levels of water (daphnia, when healthy, regulate algae populations in their ecosystems through consumption), (3) lower clutch (number of egg) size and/or (4) mortality. Any or all of these effects not only cause severe disruptions to daphnia populations in ponds, but also to their larger aquatic neighbors who are dependent on the daphnia
as a key food supply. I finally hope to relate the effects I observe in the lab to the welfare of Poly Prep’s own ponds in which daphnids are indigenous. I plan to research the methods and chemicals for upkeep used by Poly’s maintenance staff to see whether or not anthropogenic runoff of any sort enters the pond as serves as a potential threat to daphnids and, consequently, the posterity and health of both ponds.


