Chronic Toxicity Tests on Runoff from a North Augusta Watershed

Brandon Hall and S. Michele Harmon, PhD — Department of Biology and Geology,
The University of South Carolina-Aiken, Aiken, South Carolina 29801

Abstract

This project assessed the extent of nonpoint source pollution in water samples collected from a wetland area located in North Augusta, SC, by performing chronic toxicity tests using *Ceriodaphia dubia*. Nonpoint sources of water pollution are those that cannot be traced to any single, specific point of discharge. Examples of nonpoint source pollution include: oil and gasoline, fertilizers, and pesticides. The watershed of interest feeds into the Savannah River and includes a large commercial area, several housing developments, and a large wetland associated with the River Club golf course located in the floodplain. The stream was sampled both upstream and downstream of the golf course, in fair weather and during a rainstorm, to determine if the levels of pollutants in the water were toxic to aquatic organisms. The chronic toxicity tests involved exposing *Ceriodaphnia dubia* to water collected from the wetland for one full week and subsequent examination of their mortality and reproductive rates. There were three fair-weather tests and one rainstorm event test. Anion analysis was also conducted via ion chromatography to quantify the amounts of nutrients present. The samples were also measured for pH and dissolved oxygen. Results of the fair-weather tests suggest that the golf course wetland filters and removes harmful nonpoint source pollutants from the runoff feeding into the Savannah River. Data from rain samples indicate that the wetland may not be as effective during periods of heavy rain.

Introduction

Sources of water pollution that cannot be traced to any single, specific point of discharge are classified as nonpoint sources of pollution[1]. The types of pollutants found in nonpoint source water pollution include: gasoline and petroleum wastes from city streets, inorganic fertilizers used on agricultural farms and golf courses, pesticides, manure, salts from water used for irrigation, and chemicals from livestock feedlots[1].

Figure 1. Potential sources of nonpoint source pollution include lawns, golf courses, roads and parking lots.

This project assessed the effect of nonpoint source pollution in water collected from a wetland area located in North Augusta, SC, by performing chronic toxicity tests using *Ceriodaphia dubia.* Samples were collected during fair weather and after a rain event.

The wetland of interest (Figure 2) is located in the Savannah River Floodplain, and is fed by a small stream that runs through a large commercial area, several housing developments, and the River Club golf course[2]. This stream collects large volumes of runoff from these areas during rain events. Samples were collected as the stream flowed into the golf course and as it flowed from the golf course into the river (Figure 3).

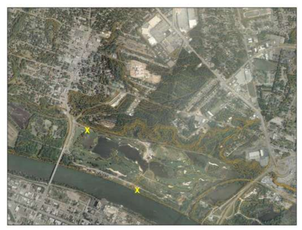

Figure 2. Arial view of the golf course and associated wetland. Yellow "X"s indicate sampling points.

Figure 3. Sampling points and outflow ditch to Savannah River.

Methods

Standard three-brood chronic toxicity tests were performed using *Ceriodaphnia dubia* (Figure 4) following methods prescribed by the ASTM[3] and US EPA[4].

Figure 4. *Ceriodaphnia dubia*, a common aquatic toxicity indicator species.

C. dubia neonates (< 24 hours old) from in-house cultures were exposed to a laboratory control and the upstream and downstream samples. Twenty replicates, each containing one neonate, were prepared for each concentration; replicates consisted of 30-ml vials containing 20 ml of test solution (Figure 5). Moderately hard reconstituted water[4] served as the control solution for these tests. Test solutions were renewed daily, and test organisms were fed at a rate of 250 µl feeding solution/replicate/day (Figure 6).

Tests were conducted in an environmental chamber under controlled photoperiod (16:8 LD) at 23 ± 2ºC. Mortality and reproductive rates of the test organisms were analyzed and compared to a laboratory control group. Three samples were collected during fair-weather conditions and one sample collected during a rainstorm event. Samples were also analyzed for nutrients and basic water quality parameters (dissolved oxygen and pH).

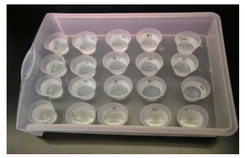

Figure 5. Replicate exposures. Each vial contains one individual.

Basic Experimental Design:

- 3 "treatments": control, upstream, downstream
- 20 test subjects per treatment
- 20 ml aliquots for each test subject
- 7-day exposure period
- Endpoint: reproductive effects
- 4 separate tests: three during dry weather and one immediately after large rainfall event

Figure 6. Feeding test organisms.

Results

Anion analyses indicate that that the wetland reduces the concentration of nitrate (probably from fertilizers) in the stream as it runs through toward the Savannah River (Figure 7). This was true for samples taken during fair weather and immediately after a large storm event.

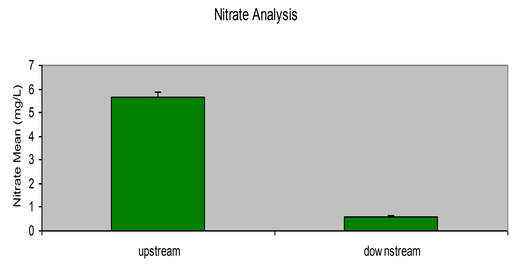

Figure 7. Nitrate concentrations of the samples. The graph is presented as a mean concentration of all samples taken upstream and downstream of the wetland.

The results of chronic 3-brood toxicity tests with *C. dubia* indicated no significant differences in reproduction between samples collected both upstream and downstream of the golf course wetland (Figure 8). There was, however, a difference between the laboratory control and the samples that were taken immediately after a heavy rain event (Figure 8). Data from rain samples indicate that the wetland may not be as effective at toxicant removal during periods of heavy rain. It is of significance to point out that samples taken for Test 3 were taken subsequent to a major weekend storm. Therefore, data from week 3 are representative of storm conditions.

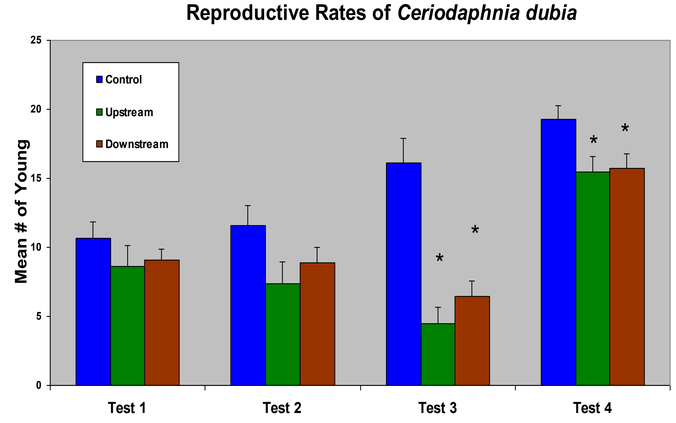

Figure 8. Results of chronic toxicity tests with *C. dubia*. Tests 1, 2 and 4 were conducted with samples taken during dry periods. Test 3 was conducted with samples taken after a major rain event. Asterisks indicate statistical significance.

Conclusions

While this wetland was preserved to add an aesthetic element to the golf course, it also provides a natural filtering system for the water that flows through on its way to the Savannah River. Results from chronic *C. dubia* tests initially indicate that the River Club golf course wetland successfully filters out harmful nonpoint source runoff pollution during fair weather. However, during rainstorm events, there seems to be a "short circuit" of the system owing to the sudden rush of stormwater feeding into the wetland. The wetland is unable to effectively remove nonpoint source runoff pollution from these surges of water as they flow into river. Possible solutions to this problem could be a re-routing of the system, or the construction of a detention pond to slow the movement of runoff through the wetland.

Literature cited

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