Pesticides and Nutrients in Surface Waters Associated with Golf Courses and Their Effects on on Benthic Macroinvertebrates

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Number of Years: 2
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Objectives:

1. *Measure the concentration of pesticides and nutrients residing in the water column of streams associated with golf courses.*
2. *Measure the concentration of pesticides reding in the sediments and sediment porewater of streams associated with golf courses.*
3. *Assess the impact of golf courses on stream macroinvertebrate communities.*
4. *Determine the sublethal impacts of selected pesticides on benthic macroinvertebrates.*

Golf courses provide citizens with a convenient recreational opportunity while preserving green space and natural settings. Yet, their intensive management necessitates the use of pesticides and fertilizers, thus provoking concerns of environmental damage. One of the overall goals of this project is to determine if surface waters, and their sediments, associated with golf courses are contaminated by pesticides and/or fertilizers. Contamination is expected to occur in association with high runoff events such as storms. However, because contamination varies with time, a second overall goal is to develop the use of stream macroinvertebrates and their communities as long term indicators of water quality. This will allow us to determine if pesticides and/or fertilizers affect stream macroinvertebrate communities.

Water samples for nutrient level measurement have been collected and analyzed once or twice every month since March 1998. In addition, we have collected water from five runoff events and have analyzed this water for nutrients. Water and sediment samples for pesticide analysis have been collected five times following runoff events. The water samples have been filtered and processed using solid phase extraction. On the basis of this data, it does appear as though pesticides and fertilizers used on golf courses are found in streams associated with golf courses, especially in association with runoff events of a large magnitude. Higher concentrations were found at the downstream locations. However, routine sampling for nutrient levels indicated that golf courses do not cause nutrient enrichment of streams.

Macroinvertebrates associated with natural leaf packs are collected using artificial leaf pack samplers. Five leaf packs, each consisting of dried leaves (standardized by leaf taxa and dry weight) connected to a brick with a strap, were placed in the stream 21 days prior to the sampling date to allow for colonization by benthic macroinvertebrates. On the sampling date, the leaf packs are collected and water quality parameters measured. In the laboratory, invertebrates in each sample are sorted, preserved, and identified to family

level. Community comparisons, using taxonomic diversity and invertebrate density, have been performed by calculating various community statistics for each golf course and site. During 1997 and 1998, invertebrates were collected five times. These samples yielded 42,557 individuals representing 79 families of invertebrates. The most abundant types of invertebrates collected were members of the families *Chironomidae* (midge flies), *Simuhidae* (black flies), *Hydropsychidae* (net spinning caddisflies), *Elmidae* (riffle beetles), and *Capniidae* (winter stoneflies). The overall analysis for taxa richness showed a significant difference (increase) in the number of taxa at sites downstream of the course. However, the analysis did not indicate a significant difference in taxa richness at upstream and downstream locations for any of the courses when the analysis by course was completed. The overall analysis for total invertebrate abundance showed a significant difference (increase) in abundance at sites downstream of the course. In addition, analysis of the data showed a significant difference (increase) in abundance of invertebrates at the downstream location for two of the courses. Total abundance of invertebrates can either increase or decrease in the presence of pollution, depending, on the type of pollution. However, pesticide presence (at least at toxic levels) would be expected to be correlated with a decrease in total abundance.

While the communities at upstream and downstream sites do appear to differ slightly, at least in terms of taxa richness and total abundance, the pesticide and nutrient data don't provide any explanation for these differences. The pesticide concentrations, even at their highest, at sites downstream of the courses are not close to toxic levels for fish and aquatic invertebrates. In addition, when the pesticide levels are high in the water columns from sites downstream of the course, the EPT richness and taxa richness of benthic macroinvertebrates from the same sites are higher than they are at the upstream sites. Also, the nitrate and phosphorus concentrations at sites downstream of the course are less than (in the case of nitrate) or equal to (in the case of phosphate) the concentrations at sites upstream of the course.