Report for 2002MD10B: The Effects of the Removal of Herbaceous Vegetation Along the Stream Edge on Aquatic Invertebrate Community Structure and Ecosystem Function, Summer Research Assistantship - Holly Menninger

There are no reported publications resulting from this project.

Report Follows:

THE EFFECTS OF THE REMOVAL OF HERBACEOUS VEGETATION ALONG THE STREAM EDGE ON AQUATIC INVERTEBRATE COMMUNITY STRUCTURE AND ECOSYSTEM FUNCTION
- PROGRESS REPORT TO THE WRRC -

Holly Menninger

In Maryland, farmers are encouraged to employ best management practices to minimize soil erosion and improve stream water quality (MD Dept. of Agriculture, Office of Resource Conservation 1996). Practices like the planting of vegetative filter strips, the exclusion of livestock, and stream bank stabilization are thought to maintain the riparian buffer zone, which is important for filtering nutrient-enriched run-off and protecting stream integrity (MD Dept. of Agriculture, Office of Resource Conservation 1996). There has been significant debate in the primary literature as to whether land managers should plant grasses or trees in these riparian buffers (Lyons et al. 2000, Montgomery 1997). Research has focused primarily on riparian forest buffers and their large-scale effects, but few have examined how grasses and other herbaceous vegetation growing along stream edges specifically affect invertebrate community structure and stream ecosystem processes at a reach scale. This summer, I examined how the removal of herbaceous vegetation from stream edges 1.) affects the diversity and abundance of aquatic insects in the stream channel and 2.) alters the rates of key ecosystem processes that fuel aquatic food webs (primary production, organic matter decomposition, nutrient uptake). I predicted that removing the dense herbaceous vegetation from stream edges would eliminate a detrital resource base and important habitat structure for the aquatic insect community, thereby causing a decrease in insect diversity and abundance. The removal of herbaceous vegetation may also change the local biotic and physical environment in which stream ecosystem processes occur. I therefore predicted that streams where vegetation was removed would experience higher primary production by algae and lower decomposition rates of organic matter than streams with intact edge vegetation.

With the assistance of the Howard County Soil Conservation District, I identified eight paired headwater stream sites for my study. Sites were selected based on the following criteria: 1.) spring-fed first-order streams, 2.) open canopy with grassy/herbaceous edges, 3.) livestock prohibited from grazing on streams banks, 4.) gravel/cobble substrate in the Piedmont physiographic province. In each pair, one stream was designated the experimental stream in which herbaceous vegetation would be removed and the other designated a reference stream. Unfortunately, the severe drought and subsequent drying of stream channels forced me to drop one pair of streams from the study. I decided to use a before-after-control-impact design in order to measure changes in invertebrate community structure and ecosystem processes before and after vegetation removal as well as to account for natural variability over time during the course of the experiment.

I assayed rates of decomposition in all stream sites before vegetation removal using leaf packs of dried reed canary grass (*Phalaris arundinacea*), a common grass that I had collected and dried in early June. Six leaf packs were attached to each stream bottom on day 0. I collected one pack per stream on days 4, 11, 18, 25, and 32, and then dried and weighed the remaining leaf material to determine mass loss. I calculated decomposition rates using the negative exponential decay model (Webster & Benfield 1986). Decomposition rates ranged from 0.0287 to 0.0649 day^{-1}, breakdown rates considered fast as compared to those known for other non-woody plants (Webster & Benfield 1986). More importantly, the decomposition rates for reed canary grass were not significantly different within each paired stream. I expect this pattern to change when I assay rates of decomposition using the same grass following the removal of vegetation from the three experimental sites.

I used the accrual of algal biomass on unglazed ceramic tiles over a period of two weeks to estimate primary productivity by algae. I set out 3 tiles transects across the width of each stream to capture spatial variation in algal productivity. In addition, I measured photosynthetically active radiation and stream velocity above each tile as covariates that may affect algal growth. After two weeks, I collected the tile substrates, scraped off the algae (appeared to be mostly diatoms), and determined algal biomass using the ash-free dry mass and chlorophyll *a* extraction techniques. Although I have not yet statistically analyzed the data, I can say qualitatively that there was variation in algal growth within single transects of streams. Algae seemed to grow in discrete patches where light passed through the vegetation, analogous to the growth of understory plants in forest light gaps.

In addition to decomposition and primary production, I also measured another important ecosystem function at the six stream sites: the uptake of essential nutrients, specifically ammonium and phosphate, by benthic organisms. Using short-term nutrient injections of ammonium, phosphate, and a conservative bromide tracer, we were able to calculate an uptake length, or the average distance a molecule travels in the water column before being removed, for each nutrient in each stream. Uptake length provides a useful measurement for how efficiently a stream can retain nutrients (Marti and Sabater 1996). Uptake lengths for ammonium ranged between 50 and 500 m, somewhat surprising for such small densely vegetated streams. I am currently investigating the possibility of nitrogen saturation in my study sites by performing water quality analyses. If the streams are in fact nitrogen-saturated, a definite possibility in agricultural streams, we could have unknowingly violated a major assumption of the stream solute dynamics model for calculating uptake lengths, resulting in inaccurate estimates of uptake length (Stream Solute Workshop 1990).

I randomly sampled benthic invertebrates with a Surber sampler at three locations in each stream site. I preserved the samples and will process them following the conclusion of my field season. I also collected and sorted the invertebrates from the leaf packs for the decomposition study. I found a diverse community including aquatic insect larvae (e.g., caddisflies, mayflies, stoneflies, dragonflies, damselflies, beetles, black flies, and midges) and freshwater crustaceans (e.g., amphipods, isopods, copepods).

Following the pre-treatment sampling, a field crew and I used weed trimmers to cut all herbaceous vegetation within 1 m of the stream channel along the 45 m study reach in the three experimental streams. We carefully removed the clipped vegetation from the channel to avoid major inputs of detritus to the stream. Because this removal resulted in some disturbance to the stream bottom, I walked and disturbed the substrate of the reaches of the three reference streams as a control for effects due to disturbance and not the removal of vegetation. Following a 3-week recovery period, I have just begun my post-treatment sampling in all streams and recently deployed temperature loggers at all sites. While I have not officially collected post-treatment data, I can report that the growth of algae in the experimental streams is astounding. I look forward to officially documenting changes in community structure and ecosystem processes in the forthcoming weeks. Ultimately, the results from this study will enable me to develop and test hypotheses about proximate mechanisms for these changes and the specific role herbaceous plants play at the stream edge.

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