Land-Use Effects on Water Quality

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Urbanization

The increase in impervious areas associated with urbanization is considered a major cause of impaired water quality in many watersheds. Impervious areas prevent precipitation from infiltrating the soil, increase soil moisture levels and subsequently increase runoff and pollutant losses, particularly for compounds such as NO\textsubscript{3}-N, sediment and P. In Massachusetts the Quabbin Reservoir watershed provides water to 40% of the state’s residents. Managers have identified urbanization as a major problem affecting water quality and are attempting to restore forest cover to previously developed areas to enhance water quality. Total P and total N concentrations in urban storm water were measured to be in excess of 9 and 18 mg L\textsuperscript{-1}, respectively. Morse et al. measured significant increases in NO\textsubscript{3}-N, total soluble salts and specific conductance, and a decrease in dissolved oxygen, as impervious areas in a watershed increase.

In a study of the Chesapeake Bay watershed, it was found that urbanization increased the freshwater input to the bay due to increased runoff losses. This runoff increased sediment, turbidity and eutrophication in the bay. Increased mass transport of dissolved solutes has been documented as a result of urbanization in the Philadelphia area. They report that the increases are dramatic and directly proportional to the amount of land urbanizing.

Other Factors

In many watersheds, however, the actual land use contribution is likely to be overshadowed by other factors such as landscape position. On temperate Northeast hill slopes there are generally significant gradients in soil particle distribution, depth to the water table or impermeable layer, and soil moisture levels. Since soil water generally follows the hydraulic gradient, water will tend to accumulate at the bottom of slopes, especially when the slope flattens. This causes the water table in these areas to be closer to the surface and more easily influenced by precipitation. In many of these areas the water table can rise to the soil surface causing runoff, even if the unsaturated infiltration rate of the soil is greater than the precipitation rate. This phenomenon, termed ‘shallow through flow’, coupled with finer textured soils can increase soil moisture levels dramatically at the bottom of a hill. Some studies have reported soil moisture differences of up to 35% between the top and bottom of a hill.

Easton and Petrovic report soil moisture differences of 20% between the top and bottom of a slope over a horizontal distance of only 70 m, and runoff losses differed by a factor of five between the bottom and the top of the hill slope. Impermeable or fragipan restricting layers are generally closer to the soil surface near the bottom of a hill slope. Convergence of this layer with the root zone is uncommon and can have important implications for runoff and nutrient management. Impeded drainage and rapid saturation of the root zone can, in some cases (depending upon the depth), cause runoff losses orders of magnitude higher than in similar textured soil, which are not underlain by a shallow restricting layer.

Shallow depth to an impermeable layer coupled with clayey soils can promote runoff losses even in correctly managed landscapes. Roadways, parking lots and building roofs present a significant area of impermeable surface, which prevents runoff from infiltrating the soil, subsequently increasing the likelihood of soil moisture differences and runoff losses.

N, K and Winter Hardiness

Few issues send shivers down a turfgrass manager’s spine as much as winter injury. What seemed to be a once every seven to ten year phenomenon appears to be increasing in frequency. The challenge has always been: what can we do to prevent it and, more specifically, can we enhance winter hardness with fertility?

Researchers at the University of Massachusetts investigated the effect of nitrogen and potassium fertilization on perennial ryegrass cold tolerance while plants are coming out of dormancy in late winter–early spring. They looked at five rates of N from 1 lb. to 5 lbs. per one thousand square feet per year and three rates of K from 1 to 9 lbs per thousand square feet per year. The fertilizer treatments were applied in the field and plants were harvested and tested for freeze stress tolerance under cold environment conditions. In general, the researchers found that N and K rates independently did not afford enhanced winter hardness, however, as has been suggested in other studies, the N:K ratio seemed to be critical. For example, maximum cold hardiness measured at LT\textsubscript{50} (lethal temperature at which 50% of the plant population is killed) occurred when N rates were one to three pounds and applied with five to eight pounds of K. This would be the first peer-reviewed report of K enhancing cold tolerance in turf.

Interestingly, the researchers also reported increased incidence of gray snow mold and freeze stress injury when K rates were high and N rates equally high. While this is not conclusively and more work is needed to assess this response on annual bluegrass, this is important work for improving our understanding of winter injury.


Long-Term Leaching Issues

The effect of turfgrass management on water quality is an important concern for the turfgrass industry. Millions of dollars have been invested to improve our understanding of the fate of nitrogen applied to turf. However, the majority of these studies are conducted on turf from one to seven years old and rarely for longer than a few years, leaving one to wonder: does leaching of N change over time as the turf matures?

Michigan State University researchers, led by Professor Kevin Frank, investigated from a ten year old stand of Kentucky bluegrass fertilized at two or five pounds per one thousand square feet. The higher rate N (5 lb rate) was supplied in one pound increments while the low rate (2 lb rate) was in half pound increments.

The EPA Health Advisory Limit (HAL) for N concentration in water is 10ppm. Leachate collected 3.5 feet below the surface under the low rate was always below 5ppm. However, the leachate collected below the high rate N was always above 10ppm and often greater than 20ppm.

This information is very disconcerting but not entirely unexpected. Cornell University researchers in the late 1960’s and 1970’s suggested that turf accumulates N in organic matter. In fact, there is information from the early 1980’s that indicate a 25 year old stand of turf has enough N stored in organic matter to support annual growth.

As a result of this work and the organic N theory we will likely need to adjust our N recommendations based on the age of the lawn. As lawns age not only will they require less N but may leach more if not managed properly.