Land-Use Effects on Water Quality

A s suburban areas continue to grow in the majority of the United States, their role in water quality protection is of the utmost importance. Concern about increasing pollution in suburban waters has raised questions about the contribution of differing land uses to surface water contamination.

Suburban environments are composed of a mosaic of land uses from impervious surfaces like roads, parking lots, building rooftops, and sidewalks to pervious landscapes like parks, lawns, athletic fields, wooded areas, abandoned lots, cemeteries, and golf courses. It is unclear how and if these land uses detrimentally impact water quality. Therefore, the function of these areas must be studied in greater depth and more intensively to draw conclusions as to the role of suburban land uses in water quality and ecosystem function.

Nitrogen (N) and phosphorus (P) historically have been of primary concern in surface water bodies due to their roles as limiting nutrients for aquatic plant growth. In freshwater, N is generally not the limiting nutrient (however, it can be in costal estuaries), and tends to flush from the system relatively quickly, leaving P as the major limiting nutrient in freshwater surface supplies in the temperate Northeast. Phosphorus detected at the µg L⁻¹ level can cause eutrophication, and as a result impaired water quality. Recent work done by Owens, et. al. in the New York City watershed indicates that dissolved phosphorus (DP) levels as low as 0.024 mg L⁻¹ can cause the growth and subsequent proliferation of cyanobacteria. Frossard, et al. have shown DP to have a larger effect on eutrophication levels than particulate P.

Multifunction Land Use

Landscape performance is increasingly important in mixed land use areas such as suburban areas. The landscape is expected to function as a filter and reservoir for drinking water, filter storm runoff, and provide habitat and recreational benefits to residents. There is increasing scrutiny of how land uses impact the surrounding ecosystem. In these mixed land use watersheds, there are numerous sources of contaminants which can affect water quality. Some are clearly anthropogenic, and applied purposely, such as fertilizers and pesticides applied to home lawns, or deicing and traction enhancing materials applied to roadways. Some are anthropogenic, but not purposely applied, such as the volatilization and subsequent airborne deposition of pesticides, leaking hydrocarbons from an automobile or misapplication of fertilizers and pesticides to impervious surfaces. Some sources are natural, such as pollen deposition from trees, leaching of nutrients from plant tissue or airborne particulate deposition. The impact of each source on pollutant loads in surface waters is heavily dependent on the characteristics of each watershed. However, continued on page 9

A Fast-Food Model

An example of how this approach can work has taken place in the fast-food industry. A report in The New York Times outlined the ripple effects on the apple industry caused by McDonald’s Apple Dippers snack.

In response to a demand for healthier fast food options, McDonald’s launched a line of items, including fresh apple slices, aimed at health-conscious consumers. According to The New York Times report, McDonald’s instantly became the nation’s largest buyer of apples, purchasing more than 54 million pounds this year.

With this level of buying power, McDonald’s has the ability to exercise its influence on the apple industry. When a representative from the company communicated to apple growers that McDonald’s prefers such varieties as cameo and pink lady (neither of which are widely grown) because of their flavor and crispness, production of both types skyrocketed. For example, production of cameo apples in Washington—which produces more than half of all apples grown in the United States—shot up 58 percent so far this year.

According to the U.S. Department of Agriculture, apples are one of the world’s most coveted crops.
To capitalize on this market, the golf industry needs a “McDonald’s” to demand a certain level of standards. If the PGA Tour, for example, demanded that courses on which its events are played establish and maintain standards of environmental compatibility that exceed those already set by Audubon International, I believe the rest of the industry would follow.

There is no questioning the demand for a lifestyle that includes healthier food options and less exposure to synthetic chemicals. A report from a group known as Lifestyles of Health and Sustainability, which tracks business and consumer trends for goods and services that focus on health and the environment, claims there are as many as 68 million Americans interested in living a healthier lifestyle. This group spends nearly $30 billion annually on natural food and personal care products. Although many golfers seem to be interested in living a more eco-friendly lifestyle, there is a disconnect between what they say they want and how they act in the marketplace.

One might argue that the golf industry’s potential to change is hindered by the high cost of products such as organic fertilizer, which is 3 to 5 times more expensive than conventional fertilizer. However, there are ways to reduce costs without sacrificing quality. For example, some golf courses have found that they can achieve similar results with lower application rates of organic fertilizer. By reducing the amount of fertilizer applied, they can save money while still maintaining a healthy and attractive turfgrass area.

Talking in Code

Obviously, such talk is code for using less pesticides. Chemical runoff and water use are two hot-button issues regarding the environment and how it affects the golf course. There is much to be learned from the organic agriculture industry. For example, organic farming does not necessarily mean “no pesticides.” There are some pest problems for which no alternative to pesticide use exists. Such products are categorized as a level of organic that is less than 10 percent.

The GCSAA Environmental Institute could help expedite the process of changing perceptions by educating industry leaders, such as the PGA Tour, that superintendents are capable of delivering a product that is well maintained and environmentally responsible.

Of course, this won’t happen overnight—consider that it took nearly 5 years of market research and testing for McDonald’s to launch Apple Dippers. But the same people who die there is an audience willing to buy yet another $500 dollar also can help define potential new golfers. While the industry seeks new ways to attract others to the game, and change the expectations of conditions that are a result of televised golf.

Land-Use effects on Water Quality

when numerous contaminant sources are subjected to high runoff losses inherent in developed areas, the impact on water quality can be great.

Land use and land cover within a suburban area can clearly influence nutrient runoff losses to surface water. Fertilization, construction, road debris, and plant matter can all introduce nutrients and sediments to surface water bodies. Forested areas, while generally unfertilized, can introduce nutrients to surface water by sediment erosion, through leaching of nutrients (especially P) from leaf litter, as well as soil erosion of nutrients directly to water bodies or to the soil surface where the potential exists for transport via runoff.

Atmospheric deposition of nutrients via precipitation or dry deposition can often be significant and can contribute to surface water nutrient loading. Septic systems can also be a source of considerable contamination in many watersheds. In many suburban areas, high value landscapes (i.e., turfgrass, ornamentals, etc.) receive water application to maintain turf and promote growth. Fertilization on steep slopes or saturated soils can result in nutrient contamination of surface water. However, much research has shown that fertilization can increase plant biomass and density, ultimately reducing loss. Unmanaged or low maintenance landscapes (i.e., abandoned areas, minimally managed home landscapes) are a potential source of nutrients and particularly sediment loss. Runoff losses from these landscapes tend to be higher than from the more managed landscapes, due in part to reduced plant density and biomass which can reduce evapotranspiration and subsequent uptake of nutrients.

Nitrogen

Graffman, et al. report NO₃⁻N losses from urban and suburban watersheds to be 10-20 times higher than from forested watersheds in the Baltimore, Maryland area. They identified residential developments as potential sinks for N due to the significant amounts of lawn fertilization; treatment sites for suburban storm water, and residential stormwater ponds. Nearly 75% of the N input (dominated by fertilizer) was retained in the watershed. This is particularly intriguing considering that turfgrass areas are increasingly being considered as treatment sites for suburban storm water. Therefore, practices that promote infiltration and subsequent uptake by plants can provide significant biological remediation and storage for suburban nonpoint source pollutants.

Gold, et al. also found fertilized home lawns to be a potential N sink. In this Rhode Island study, N concentrations and leachate mass losses from home lawns and forests were identical. Over the two-year study, the average N concentrations were 0.21 mg L⁻¹ and N mass losses were 1.35 kg m⁻² for both fertilized lawns and forest.

Phosphorus

Other research has shown that the mass of P lost to surface water (P loading rate) varies by site conditions (infiltration rate, rainfall intensity, soil moisture level), P application rate and source, and plant density, but is generally elevated in suburban areas which may be elevated by a number of sources. Washburn, et al. found that forested areas, roofs and streets all contributed significant amounts of P in water. Garn determined the concentration of N and P in runoff collected from four landscapes in Wisconsin: regular fertilized lawns, non-P fertilized lawns, unfertilized lawns, and unfertilized wooded sites. Of the analyzed data, DP concentrations were highest in the fertilized lawns receiving P. However, the highest concentration of total P (TP) or DP in runoff water was from the unfertilized wooded sites, but the author excluded these data from the statistical analysis because they were unexpectedly higher than the lawn data and could be representative of other wooded sites because of steep slopes. The author estimated that lawns contributed about 1.14 kg ha⁻¹ yr⁻¹ of P to the lake from the 89 ha of lawns surrounding the lake. Easton and Petrovic found annual P loading rates in turfgrass runoff to range between 0.2 and 1.3 kg ha⁻¹, depending on fertilizer source and application rate, with the highest loading from low density-unfertilized turfgrass.

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