Land-Use Effects on Water Quality

A 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 levels 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 Feb. 20, 2005 edition of 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 continued on page 4.

McTurf: A Model for the Turfgrass Industry

It’s not enough for those who work in turf maintenance to talk about being environmentally responsible; they must prove it, especially to those who believe otherwise. Changing the perceptions that some hold about the golf industry’s effects on the environment might even help grow the game.

An environmental movement in golf needs two things to be successful: demand from customers and an industry leader to set the standards. The demand for environmental stewardship—from within and outside the industry—already exists. But what’s missing is a leader willing to step forward to set standards and effect change. Once that happens, getting the market to embrace those standards should be relatively easy.
It might sound farfetched, but who ever thought you’d be able to buy apple slices at McDonald’s?

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 Lifeways 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 little more than perfect playing conditions, some are drawn to the game because of the natural beauty that comes with being outdoors. The industry potentially could grow the game by trying to attract others interested in taking up another outdoor activity.

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Talking in Code

Obviously, such talk is code for using less pesticides. Chemical runoff and water use are two hot-button issues regarding the game and how it affects the environment. There is much to be learned from the organic agriculture industry. For example, organic 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 100 percent. The GCSAA Environmental Institute could help expedite the process of changing perceptions by convincing industry leaders, such as the PGA Tour, that superintendents are capable of delivering a product that is well maintained and environmentally responsible.

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It also has the potential to attract new participants to the game.

Land-Use effects on Water Quality

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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 pollution deposition either 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 fertilizer application to maintain 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

Groffman, 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 treatments sites for suburban storm water. However, studies have shown 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 ha-1 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 due to a number of sources. Waschbusch, 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 fertilized wooded sites. Of the analyzed data, DP concentrations were highest in the fertilized lawns receiving P applications.

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 results and speculated that these sites may not be representative of other wooded sites because of steep slopes. The author estimated that lawns contributed about 1.1 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 P application rate, with the highest loading from low density- unfertilized turfgrass.

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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$_3^-$-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 developed areas to enhance water quality. To safeguard significant increases in NO$_3^-$ concentrations and tested for freeze stress tolerance under controlled environment conditions in the Quabbin Reservoir watershed provides water to 40% of the state's residents. The challenge has always been: what can we do to prevent it and, more specifically, can we enhance winter hardiness 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 9 lbs. per 1000 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 controlled environment conditions in the lab. In general, the research found that N and K rates independently did not afford enhanced winter hardiness, however, as has been suggested in other studies, the N:K ratio seemed to be critical. For example, maximum cold hardiness measured at LT$_{50}$ (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 conclusive and more work is needed to assess this response on annual bluegrass, this is important work for improving our understanding of winter injury.


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 (15 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 challenge has always been: what can we do to prevent it and, more specifically, can we enhance winter hardiness with fertility?

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Quiet Loyalty

Last November I had the chance to participate in a party honoring Bob Emmons on the occasion of his retirement from SUNY Cobleskill. Who would have thought that such a quiet unassuming guy would have touched so many lives. The litany of praise from former students had me choked up for most of the evening. Bob was loyal to us and now this was our chance to let him know how his belief in us, his quiet loyalty, made a difference in our lives.

I feel fortunate to have a forum to write about Bob, but to be honest, I wouldn’t have this forum if he hadn’t inspired me 25 years ago. His inspiration wasn’t the passionate and vocal “rah-rah” kind rather it was the quiet kind. I remember feeling that Bob really listened to me and for an 18-20 year old, it might have been the first time I felt that anyone listened to me.

I’ve spent many long trips over the years with Bob traveling to speaking engagements, visiting students, a few times finding a fishing hole and volunteering at the US Open at Bethpage in 2002. Getting to know him has been one of the great joys of my life. Not just professionally but personally as well.

Here’s a guy that was about to embark upon an Ivy League law career and instead enlists in a war that most people didn’t want any part of. An educated guy as a squad leader, reminds me of the Matt Modine character in Stanley Kubrick’s Full Metal Jacket. I don’t really know if loyalty and patriotism are the same thing, but something motivated this quiet guy to make the sacrifice because I thought it was the right thing to do, only to get shot on when he returned to the US.

Next thing you know, after a brief and not memorable stint as a golf course superintendent he is studying with Bill Knoop at the University of New Hampshire. Of all places he and his lovely bride Holly end up in Cobleskill and the rest is history.

As an advisor myself now I often think about how Bob listened to me and how that made me feel like what I thought mattered. I remember feeling that it was the work and your effort that mattered not that you came from a big “turf program.” It is an honor for me to work with people in this industry knowing that I have a responsibility to inspire others to find the talent they have within just like Bob inspired me.

In some ways now that he is retired I have my own quiet loyalty to the ideals I learned from him. Not just about turf but about life as well. It is truly the end of an era at Cobleskill but I am sure Alex Ellis is the kind of guy that will begin a new and successful era. I am sure Alex Ellis is the kind of guy that will begin a new and successful era. I am sure Alex Ellis is the kind of guy that will begin a new and successful era.

Frank S. Rossi, Ph.D.

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Adirondack Regional Conference

Lake Placid Resort, Holiday Inn, Lake Placid NY
March 30, 2006

Info: NYSTA
(518) 783-1229 or (800) 873-8873

A study was conducted at Cornell to better understand how three different landscapes—high maintenance, low maintenance and wooded—in a small suburban watershed affect stream flow nutrient losses via runoff.

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Zachary Easton

Cornell Research

A study was conducted at Cornell to better understand how three different landscapes—high maintenance (HM), low maintenance (LM) and wooded (FR)—in a small suburban watershed affect stream flow nutrient losses via runoff. The study began by first measuring the runoff. Similar to compacted, heavily trafficked soil in agricultural watersheds, compacted soil in many suburban areas may increase runoff losses as well.

Storm drains, sewers and gutters often drain directly into streams and or surface water bodies which can short circuit the natural attenuation process provided by the soil. The combination of these factors can cause runoff losses from suburban watersheds to be orders of magnitude higher than from forested watersheds.

In many suburban watersheds, storm runoff is generally the source of the greatest pollutant losses and these events tend to dominate flow from the watersheds. This is of concern because pollutants are less likely to be remediated by sorption to soil particles or organic matter or undergo biological uptake if they are first subjected to runoff processes.

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