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Concerning Phosphorus

A nationwide survey of golf course water resources supports regulatory restrictions regarding the use of phosphorus.

BY JEFF NUS, PH.D.

If asked what you think is the most serious environmental challenge facing golf courses today, what would you say? Pesticide runoff? Scarce water resources? Maintaining wildlife habitat? Although these issues are important, to an increasing number of turfgrass and environmental scientists, the answer is the threat from nutrient runoff — specifically phosphorus.

The results of a recently published survey of 44 water-quality studies at 80 golf courses support that conclusion (1, 2). All the studies were in the U.S., except for two that were conducted in Canada (Figure 1). Scientists led by Dr. Stuart Cohen from Environmental & Turf Services, Inc. (E&TS), of Wheaton, Maryland, analyzed the golf course water quality data. The USGA Turfgrass and Environmental Research Program, as well as the GCSAA's Environmental Institute for Golf, financially supported the research effort.

In the mid-90s, E&TS obtained and evaluated relevant ground and surface water quality data, which included monitoring from 17 studies that involved 36 golf courses. That work was published in 1999 and concluded that widespread or repeated impacts did not occur at the golf course sites studied (5, 6). However, there were major geographic gaps in the available data, and that study did not include phosphorus data.

The current effort to assess golf course water quality evaluated 44 studies and involved 80 golf courses over a 20-year period (1, 2). The study appraised both surface and ground water samples for 161 turf-related pesticides and pesticide metabolites, as well as nitrate-nitrogen and total phosphorus. "The lack of focus on total phosphorus in our 1999 paper, coupled with the new, strict 2002 ecoregional criteria, led us to include total phosphorus in the most recent review of golf course water quality monitoring studies," Dr. Cohen explained.

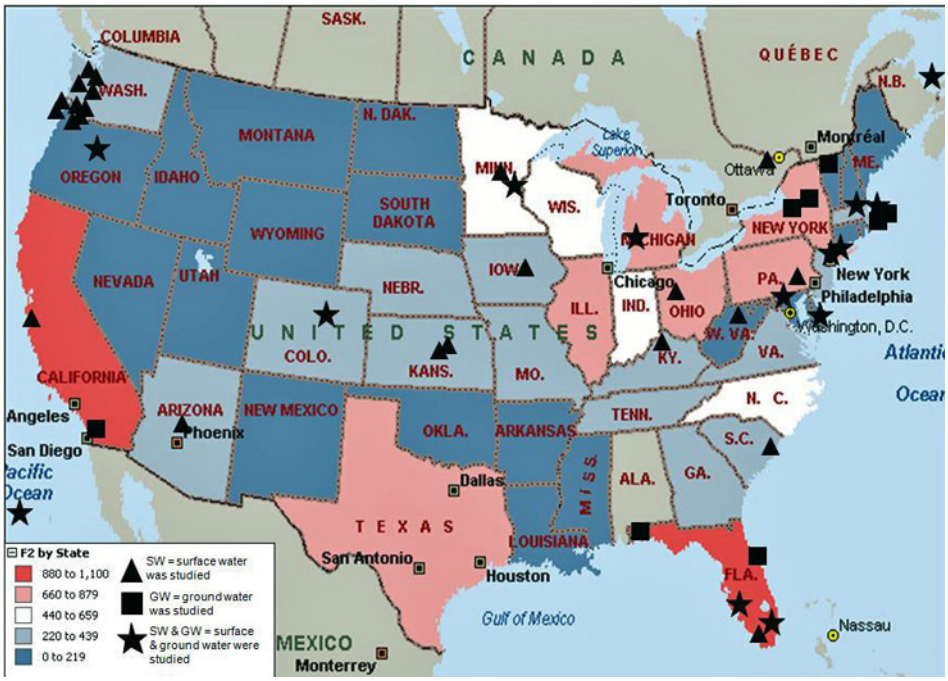

Figure 1. Golf course distribution in the United States and location of study sites (adapted from J. Kass, Director of Research, National Golf Foundation, Jupiter, Fla., personal communication, 2007). Figure is reprinted from Environmental Toxicology and Chemistry*, 29(6), page 1,225, with permission from* ET&C *editors.*

The extent of golf course water quality impacts is determined by comparing 38,101 data points of water quality with toxicological and ecological reference points. The published results first appeared online in *Environmental Toxicology and Chemistry* on April 1, 2010 (1). A summarized version is available at USGA Turfgrass and Environmental Research Online, August 1, 2010 (2) (http://usgatero.msu.edu/v09/n15.pdf).

The concentrations for pesticides, pesticide metabolites, and nitrate-nitrogen were not alarming. Individual pesticide entries exceeded toxicity reference points for ground water and surface water (0.15% and 0.56%), respectively. Less than one percent of the ground water samples exceeded the maximum contaminant level (10 ppm) for nitrate-nitrogen. However, 86.5% of the surface water samples for total phosphorus exceeded their ecoregional criteria. Thus, phosphorus appears to present the greatest water quality problem as shown by this extensive study (2).

In a study led by Dr. Stuart Cohen, Environmental & Turf Services, Inc., Wheaton, Md., conducted surveys and evaluated water quality data from 44 studies covering a 20-year period. The work involved 80 golf courses to comprehensively assess the impact those courses had on surface and ground water quality with respect to pesticides, pesticide metabolites, nitrate-nitrogen, and total phosphorus. Results in those studies indicate that phosphorus appears to present the greatest water quality problem.

Part of the reason for the large percentage of water samples exceeding the ecoregional criteria for phosphorus is the very low concentrations of total phosphorus allowed by the United States Environmental Protection Agency (US EPA). During the period 2000-2002, the US EPA developed a series of stringent criteria for total phosphorus, stipulating the maximum amount of total phosphorus that managed watersheds could contribute to surface waters. These were developed for lakes, ponds, rivers, and streams in a dozen ecoregions. The US EPA defines ecoregions by the geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology of areas in the United States.

"We were a bit surprised at how low the total phosphorus criteria were," says Dr. Cohen. "In our experience, Mother Nature was out of compliance approximately 15-20% of the time." This occurs because plants take up phosphorus, an essential element used in structural and metabolic functions. The phosphorous released into the environment happens when plants die due to freezing or high temperatures, drought, disease, insect damage, or at the end of its life cycle. So, even in unmanaged, unfertilized, vegetated areas, nutrient exceedances may occur. "We have observed spikes in total nitrogen and total phosphorus that we believe were due to decaying wetland vegetation," Dr. Cohen adds. "This process tends to increase the so-called 'irreducible concentrations' of total phosphorus and total nitrogen, sometimes to concentrations exceeding the EPA's ecoregional criteria."

So, what should superintendents be most concerned about? "Superintendents should be most concerned with our conclusions about total phosphorus," Dr. Cohen adds. "We recommend regular annual soil testing for available phosphorus prior to decisions to apply it. Also, superintendents should take advantage of recent work at the University of Minnesota (9) and University of Wisconsin (8) for management techniques to reduce runoff. For our part, we need to focus on the more stringent, environmentally sophisticated approach underlying the new total nitrogen and total phosphorous ecoregional criteria."

Links to Related Work

http://turf.lib.msu.edu/ressum/2007/54.pdf

http://turf.lib.msu.edu/2000s/2009/090724.pdf

http://archive.lib.msu.edu/tic/its/articles/1993jou162.pdf

http://turf.lib.msu.edu/ressum/1997/84.pdf

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There has been increased focus on turf pesticides since the early 1990s due to intense public scrutiny proposed golf courses receive during the local permitting process.

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