Golf Courses Can Benefit the Environment

By Dr. John Stier, *Department of Horticulture, University of Wisconsin - Madison*

In the last issue I discussed the environmental issues faced by golf course superintendents in the Lake Tahoe region. The reason I was in Lake Tahoe was to provide two invited poster presentations at the 2nd annual National Natural Resources Extension Conference. One of the presentations was on the environmental impact of golf courses. I see many golf course projects hampered from the proposal phase through the permitting, construction, and occasionally management phases because of a lack of understanding of the environmental effects of golf courses. This article provides the gist of that presentation at Lake Tahoe.

Perceived problems of golf courses

Golf course construction is booming in the U.S. due to the strong economy. There are currently 16,069 golf courses in the U.S. with approximately another 879 under construction as of January 2000 (Source: National Golf Foundation). Golf courses require a high degree of manicuring to provide the necessary appeal and function for the game of golf. The public lack of understanding of golf course maintenance and environmental fate of fertilizers and pesticides results in golf courses being viewed as environmental polluters without providing benefits other than golf. Much time, money, and effort are being spent at local levels for golf course permitting, and decisions may be made with little or no regard for research data. Permitting often requires water quality or other environmental monitoring for nutrients and pesticides though these data are rarely published. The lack of shared information results in excessive reiterations of processes each time a golf course is permitted. The objective of the article is to provide examples of research that has been conducted on golf course environmental impacts and to discuss the implications of the findings.

Who's funding research and what research has been conducted?

Much of the research involving golf course effects on the environment has been funded by the United States Golf Association because they are one of the few large organizations willing to fund these types of research. Since 1991, the USGA has funded over $3 million of environmentally-related research projects (Kenna, 1995). Other projects have been funded by state or local turfgrass or golf course superintendent organizations. Projects range from environmental fate of nutrients and pesticides to prairie restoration and wildlife ecology. The effects of golf courses on water quality have been a major theme across all areas.

Key Projects

Water Quality: Nutrient Runoff/Leaching. Numerous studies have been conducted on the potential of turf management practices to contaminate ground and surface waters. The general finding is that turf systems filter out chemicals from water and inhibit water runoff and soil erosion as much or more than other plant systems. This is due to the high plant density, thick intertwining root systems, high microbial activities, and the absorbent thatch layers (Cisar and Snyder, 1996; Linde et al., 1995). Thatch is a layer of dead and living organic matter above the soil which has high absorption capacity for water and chemicals. Contrary to popular opinion, research from many sites indicates turf readily absorbs the nutrients supplied in fertilizer, while runoff and leaching are minimal to nonexistent.

University of Wisconsin-Madison Turf Runoff Study (Kussow, 1997). The purpose of the study was to quantify N and P losses from a turf surface constructed on a 5-6% slope at the O.J. Noer Turfgrass Facility in Verona, WI. The turf was maintained at 2.5 inch height, similar to a golf course rough. Treatments consisted of Scotts Turfbuilder 29-3-4, Milorganite 6-2-0 (a "natural" fertilizer from composted sewage sludge), and no fertilizer. Fertilizer was applied four times annually at 43 lb/acre. This is twice the amount that would be used on a typical fairway, and

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greater than twice the amount typically applied to a golf course rough. The turf was mulch mowed in half the plots and clippings were removed from the other plots. The experimental design was a randomized complete block with two replications and conducted over a six-year period, 1993-98. Weirs at the bottom slope of the plots collected runoff. Lysimeters were installed in the plots to collect leachate.

Total runoff for the two year period averaged 1.32 inches for all treatments. Approximately 80% of the runoff came from frozen soil. These results indicate much of the potential P runoff comes from vegetation, not fertilizer, a conclusion also arrived at by an Illinois study (Northeast Illinois Planning Commision, 1983). Fertilized turf actually reduced runoff, including N and P, compared to non-fertilized plots. This was due to the greater turf density that resulted from fertilization which was able to extract the nutrients from the water and by increasing the infiltration of the water into the soil while slowing sheet flow. Nitrate-N in leachate was well below the EPA drinking water standard of 10 ppm. Miltner et al. (1996) showed similar results with 50% of the N staying in the clippings, verdue, and thatch two years after a single N application; 13.6% was found in soil and only 1.3% leached through a sandy loam soil (the remaining 35% was apparently lost through denitrification and/or mineralization.

Water Quality: Pesticide Runoff/Leaching. Golf courses are often viewed as area of indiscriminate pesticide usage. This is not typically the case as pesticides are expensive and superintendents are typically educated, through seminars, workshops, and increasingly, through college degree programs. Putting greens, which comprise less than 2% of the acreage, receive the most frequent applications (primarily fungicides). In southeastern states insecticides may be applied at least once each year. Herbicides use is usually limited to spot treatments on areas other than putting greens. Compared to major U.S. crops, pesticide use on golf courses ranks in the 30th to 50th percentile (Cohen, 1995). Research indicates the turf ecosystem (plants, sunlight, soil chemistry, and microbes) readily latch onto and degrade pesticides with minimal amounts entering ground and surface waters.

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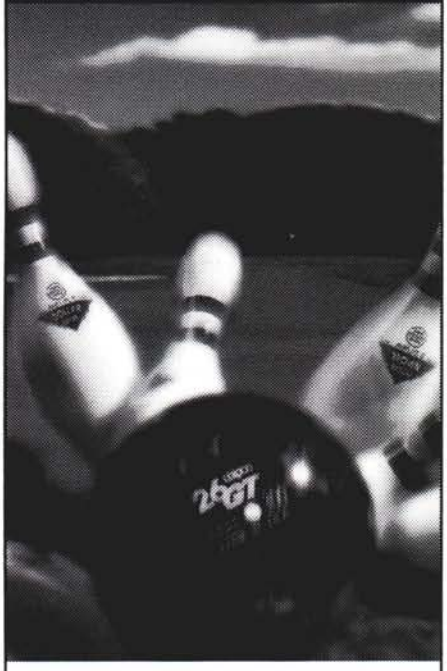

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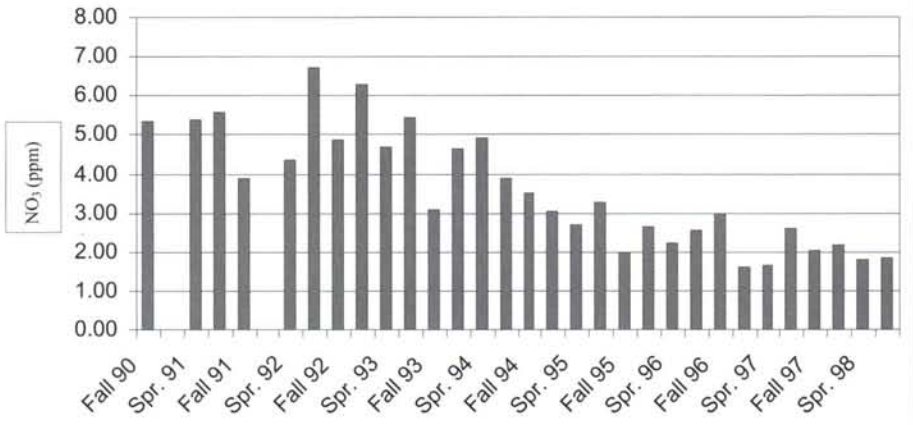

Fig. 1. Average nitrate-N levels from 16 wells across Queenstown Golf Links in Maryland from pre-construction to several years post-construction.

Synthetic pesticides are degraded into CO_2, H_2O, and some elements (nitrogen, sulfur, magnesium, etc.). Water solubility, soil and organic adsorption coefficients (K_d and K_{oc}), and half-lives are useful in determining a pesticide's potential for leaching and runoff. Soil type will influence leaching, with sandy soils allowing more leaching than silt or clay soils. Much of these data are readily available for various compounds. Sources for these data include the Turfgrass Information File, chemical company technical data sheets, and USGA-sponsored publications.

Queenstown Harbor Golf Links: A case study of golf course pesticide leaching in the Chesapeake Bay watershed. Located within 1,000 feet of Chesapeake Bay, the approval process for Queenstown Harbor GL required the developers to hire an environmental monitoring firm. Sixteen test wells were installed from one end of the property to another. In 1990, before the course was constructed, water samples showed nitrate levels exceeded EPA drinking water standards from some of the wells along with high levels of P (Shirk, 1996). Three wells showed pesticide contamination from carbofuran, carbaryl, pendimethalin, atrazine, chlorothalonil and iprodione. The area had been operated as a farm for the previous 25 years. Within four years, the average concentration of N decreased significantly well below drinking water standards (Fig. 1) except for one well adjacent to an active farm. No pesticides were detected in water samples five years after monitoring began. Although it wasn't designed as an experiment, the results indicate golf courses can have benign, if not beneficial, effects on water quality.

Wildlife

Golf courses can provide habitat for mammals, birds, amphibians, insects, aquatic life and plant species. Studies are only now being started to determine the effects of golf course architecture on animal ecology. Its easy to go to golf courses and find deer, small mammals, birds, and other wildlife. Elk rut on putting greens in northern Michigan. Black bears ravage berry trees on a golf course in Wisconsin. Just how diverse is wildlife on a golf course? A study conducted by

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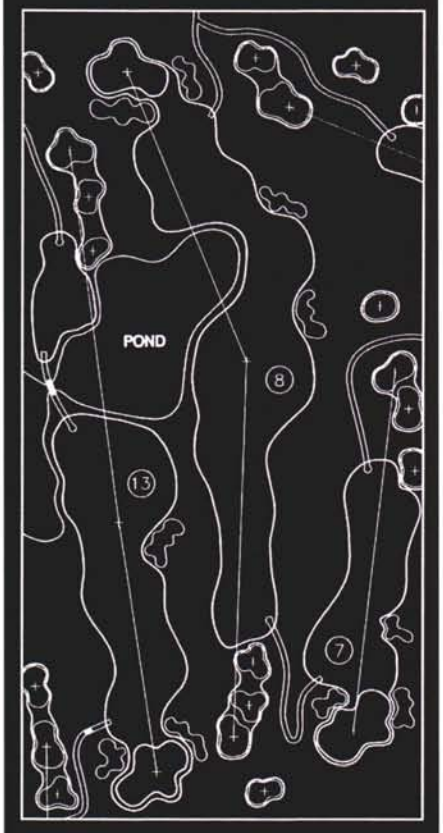

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Table 1. Summary of bird populations between Prairie Dunes Country Club and Sand Hills State Park, Kansas†.

Species Diversity Indices	Prairie Dunes	Sand Hills
Number of species	57	63
Number of individuals/kilometer	459	286
Number of equally abundant species	19.59	34.12
Simpson diversity (range 0-1)	0.912	0.964
Sheldon eveness (range 0-1)	0.343	0.541

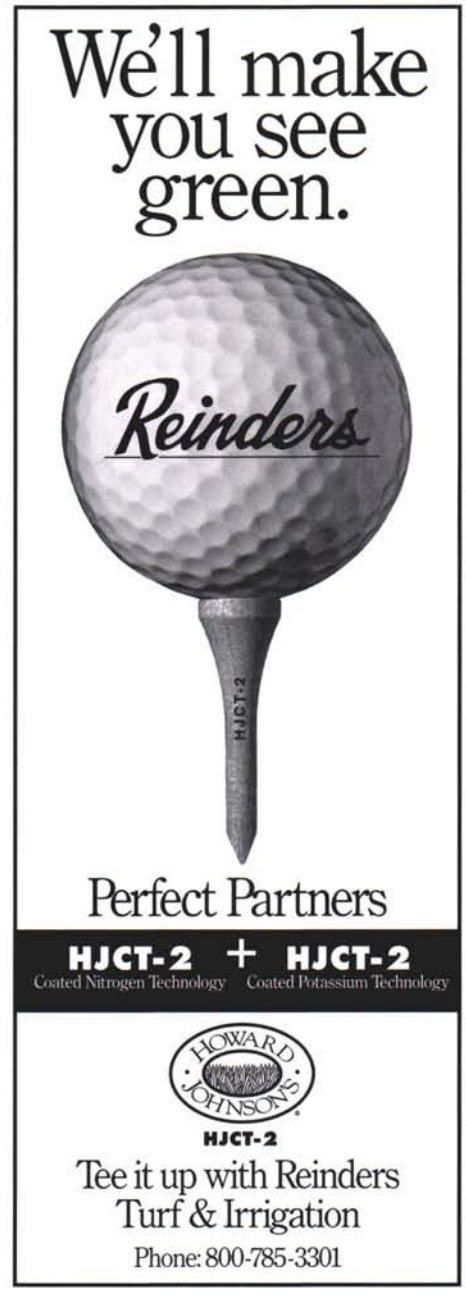
† Adapted from Terman, 1996.

Tabor College compared bird populations and diversity between Prairie Dunes Country Club in Kansas and nearby Sand Hills State Park. Birds were only counted which were visible from paths in both areas, thus the off-course natural areas at the golf course were not censused. Results showed remarkable similarity and some differences (Table 1). Sand Hills had greater diversity but lower numbers, with birds that required larger, undisturbed areas (e.g., least flycatcher, yellow-breasted chat) while the golf course contained more species that had less fastidious requirements (e.g., robins, eastern kingbird).

In 1998 the USGA sponsored 10 projects totalling $200,000 through the Wildlife Links Program in cooperation with the National Fish and Wildlife Service. Topics ranged from wetlands management to determining the effects of golf course architecture and maintenance (grass selection, etc.) on movements of amphibians on golf courses. Created in 1991, Audobon International and the USGA developed the Audobon Cooperative Sanctuary Program (ACSP). The ACSP assists golf courses in their development of wildlife-friendly habitats. Over 2,200 golf courses are members of the Audobon program. Not only does it add value to the course, but golf course superintendents, often are the force behind individual programs, truly enjoy the outdoors: that's why they are superintendents.

Projects in Development

Historically few environmental studies have been conducted on golf courses due to the complexity of conducting statistically sound studies on golf courses as opposed to field research stations and greenhouses. Several universities are reversing this trend, however, and are using university-owned golf courses to accomplish this feat. At Colbert Hills Golf Course, researchers from Kansas State University are comparing nutrient losses from the golf course against losses from the nearby Konza Prairie. Researchers from Purdue University are studying water relations on the Kampen golf course. The golf course, constructed around a natural marsh called Celery Bog, is being used to filter runoff from adjacent businesses (Bockert, 1999). At the University of Wisconsin-Madison, researchers will be using the planned 18-hole expansion of the University Ridge golf course to research runoff, groundwater recharge, filtering, and interactions with plant and wildlife biodiversity. The golf course will be constructed to allow replicated treatments with fairways as blocks. One proposed project would use fairways designed to allow runoff into discrete drainage areas which will be planted with monostands or various mixtures of plants. Data will be collected to determine the best composition of plant species for surface water filtration. Results will be readily transferable to new suburban developments which may use synthetic wetlands to pre-filter urban runoff. The project could also provide information on how plant



diversity affects wildlife populations.

The Big Picture

Golf contributes approximately $16 billion annually to the U.S. economy and the numbers are growing fast. Approximately 45% of the 897 golf courses under construction are built with real estate functions. As our environment continues to urbanize due to increasing human population, golf courses are being viewed more frequently as an estuary of greenscape for wildlife and aesthetic purposes. Audobon International has taken the lead with its Cooperative Sanctuary Programs; many golf courses and superintendents like the idea of providing habitat for wildlife ranging from bear and elk to fish and birds. Since less than 50% of the typical golf course property is manicured and used for play, golf courses are being used to maintain pockets of prairie, sometimes with rare or endangered species, in areas where development has supplanted natural areas. With proper planning, golf courses in urban areas can be used to control and filter runoff water from hardscapes (roads, homes, driveways, etc.). Golf courses could be used as recharge areas to prevent water from leaving an urban area by negating the need to send the water downstream for treatment without being sent back to recharge the aquifer. In many locations, golf courses provide greenscape in an otherwise concrete jungle. Extension programs can use research data to supply necessary information for permitting processes, which fulfills a real public service. Items to consider include the soil type, water table, topography, plant species. Permitting may provide certain pesticide restrictions based on half-lives, leaching and runoff potential. Newer pesticides are more environmentally benign than ones currently in use, which are themselves often more benign than pesticides commonly used 20 years ago.

The information presented here does not necessarily tell the whole story. It's not meant to. One can always find abuses where poor management practices, misuse of pesticides, or construction mishaps contribute to environmental degradation. But these instances are becoming fewer as stricter regula-

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tions are developed and public pressure comes to bear on golf courses. Perhaps the biggest force, however, is the superintendent. Today's superintendent is more likely to be aware of how construction and management practices may impact the environment than 10 years ago. Some day, golf courses and the superintendents may be seen as the true environmental stewards of urban areas.

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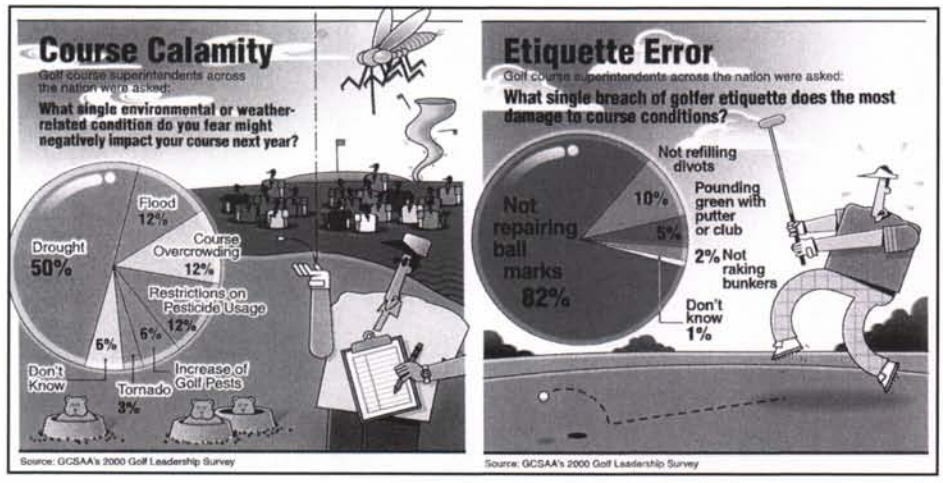

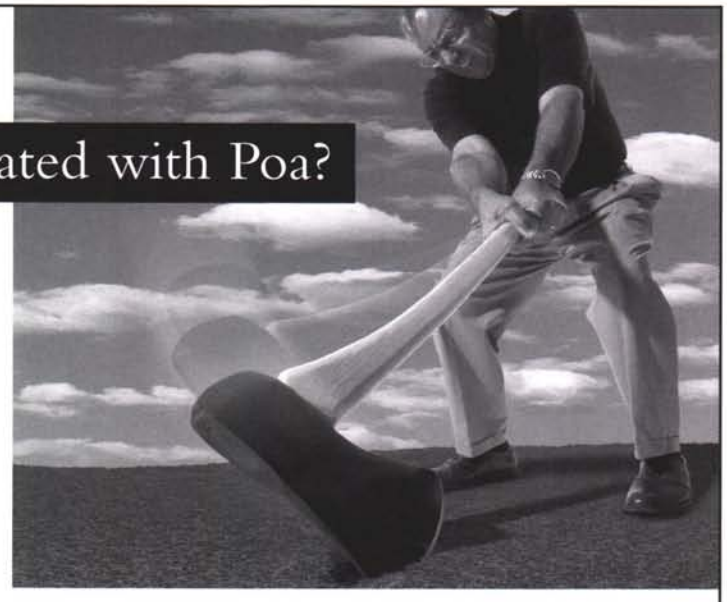

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