

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.

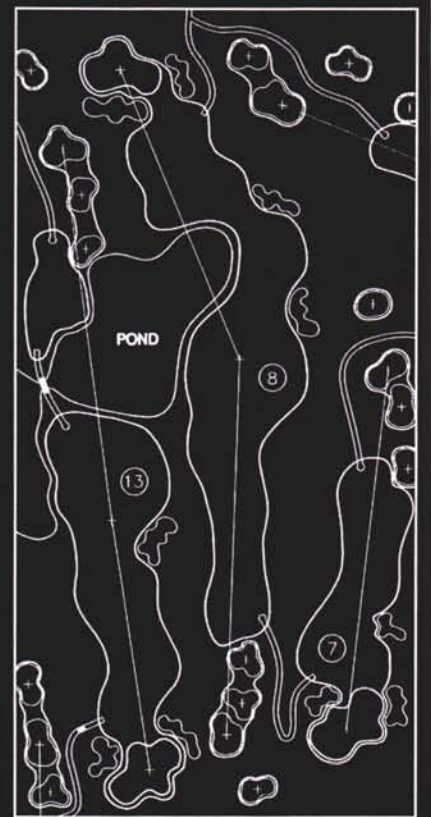
Queenstown Harbor Golf Links: A case study of golf course pesticide leaching in the Chesapeake Bay watershed. Located within 1,000 feet of Chesapeake Bay, the approval process for Queenstown Harbor GL required the developers to hire an environmental monitoring firm. Sixteen test wells were installed 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. It's 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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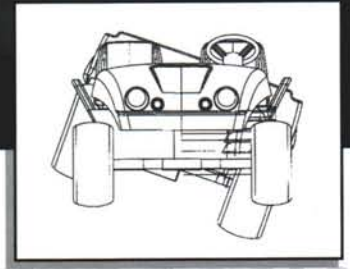
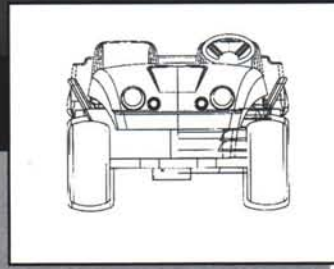
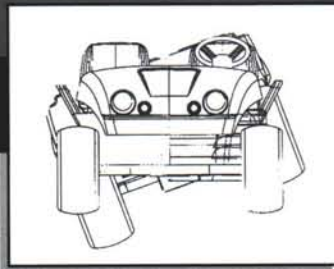
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Table 1. Summary of bird populations between Prairie Dunes Country Club and Sand Hills State Park, Kansas†.

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 evenness (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 superin-

tendents, 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

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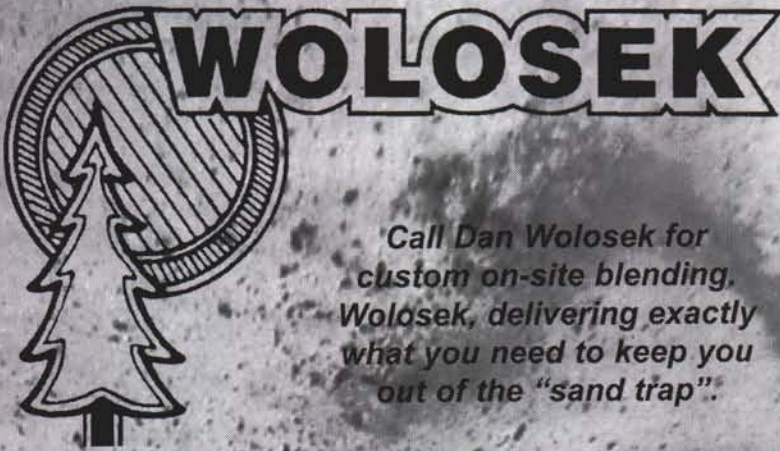
into discrete drainage areas which will be planted with monostands or various mixtures of plants. Data will be collected to determine the best composition of plant species for surface water filtration. Results will be readily transferable to new suburban developments which may use synthetic wetlands to pre-filter urban runoff. The project could also provide information on how plant

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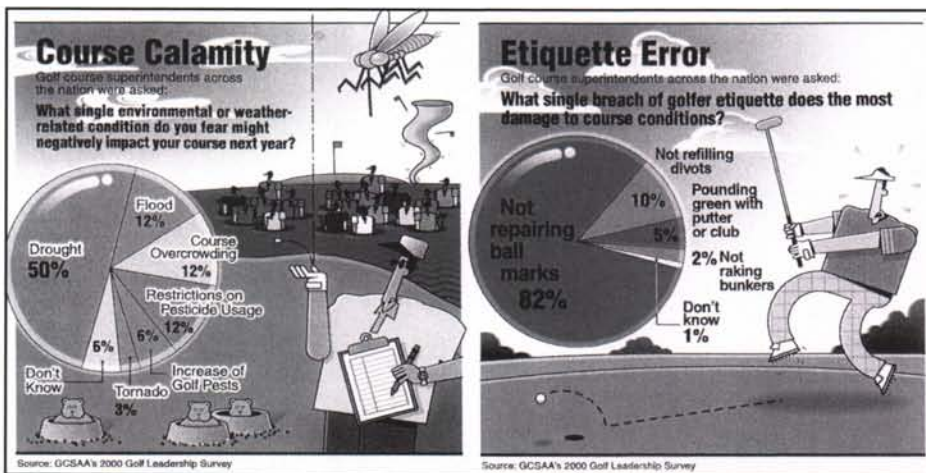
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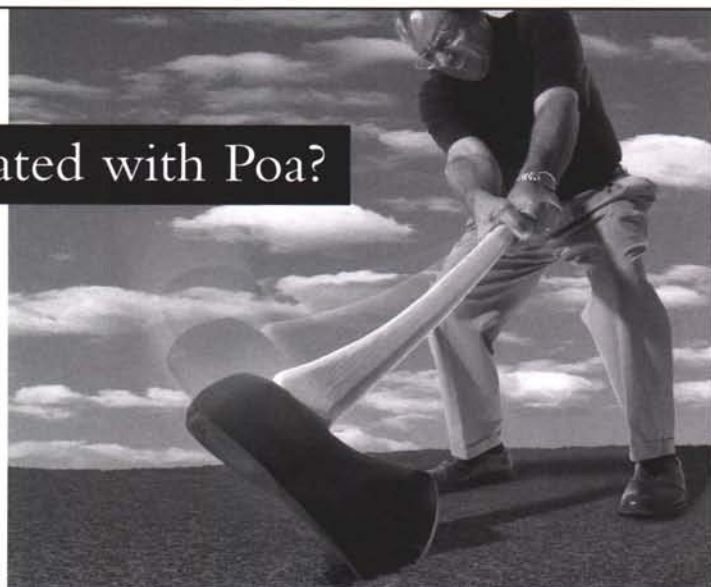
tions are developed and public pressure comes to bear on golf courses. Perhaps the biggest force, however, is the superintendent. Today's superintendent is more likely to be aware of how construction and management practices may impact the environment than 10 years ago. Some day, golf courses and the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

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Blame It On The Committee

By **David Finney**, Golf Course Superintendent, Virginia National Golf Club

Editor's Note: Long time readers of The Grass Roots will recognize David Finney's name. His articles have appeared in this journal many times, always on the subject of the rules of golf. Among golf course superintendents, few are as well versed on the subject as Dave.

Since his last article, he has moved from West Virginia to Virginia and has been involved in the construction and grow-in of the Virginia National Golf Club, located in the mid-Atlantic part of the country about 40 miles west of Washington, D.C. It is set between the Blue Ridge Mountains and the Shenandoah River at the site of the Battle of Cool Spring in the Civil War. It was designed by Jerry

Matthews of Lansing, Michigan. Thanks to Dave for sharing his expertise.

We as superintendents have our jobs to do, and sometimes our operations can be disruptive to golfers. Aerification comes to mind immediately as the #1 irritant to golfers, but we also take a lot of heat unnecessarily for construction projects, and sometimes even leaf removal in the fall tends to get in the way of a friendly four-ball event. Members and golfing guests always want to know, "What are you doing, why do you have to do it today (my day to play golf), and when is it going to be finished?" However, I can't think of a single maintenance function we perform where the golfer doesn't get

relief either under the Rules of Golf, or by local rule.

Let's take a look first at aerification. If a ball in play comes to rest in an aerification hole, is there free relief under the Rules of Golf? Unfortunately, no. However, the Committee may write a temporary local rule granting relief from aerification holes, as outlined in Appendix I, page 95 of the 2000-01 Rule Book. Aerification plugs are considered to be loose impediments, consisting of compacted soil, and the rules do permit a player to move aerification plugs away from the ball before making a shot.

Next let's consider Abnormal Ground Conditions (Rule 25), in particular let's focus on *ground under*

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