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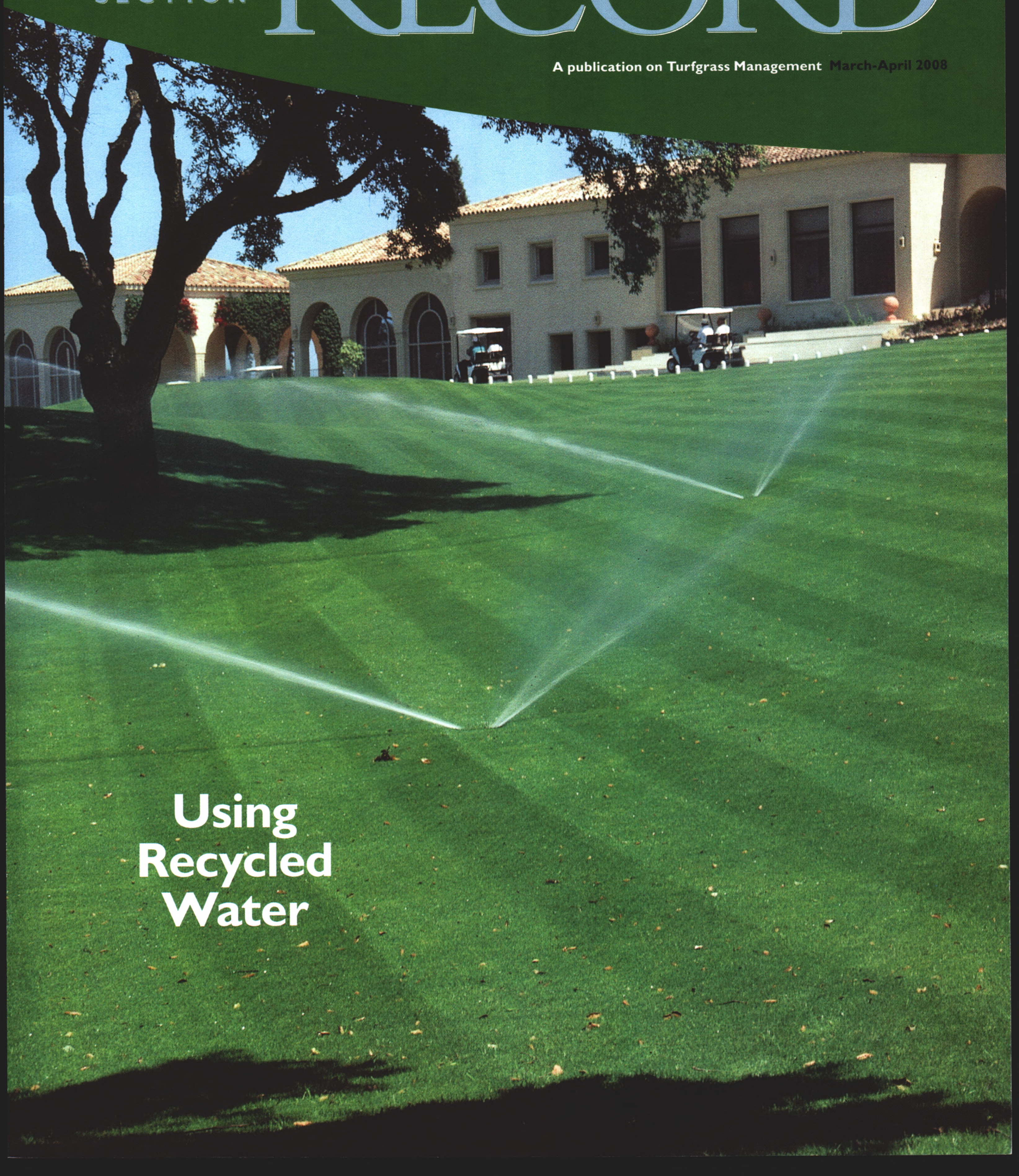

Using Recycled Water

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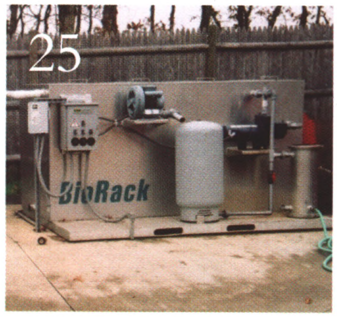

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Cover Photo
Quality golf course conditions are possible while using recycled water as long as proper agronomic programs are in place.

A Step-By-Step Guide For Using Recycled Water

An outline of the costs and maintenance practices necessary to manage this valuable resource.

BY PATRICK J. GROSS

Water is fast becoming the new gasoline. Turf has to have it, and at the same time the supply continues to decline and the costs keep going up. As the water crunch becomes more severe in various regions of the United States, there is heightened awareness that conservation and the use of recycled water are necessary and viable alternatives for the irrigation of golf courses and large turf areas.

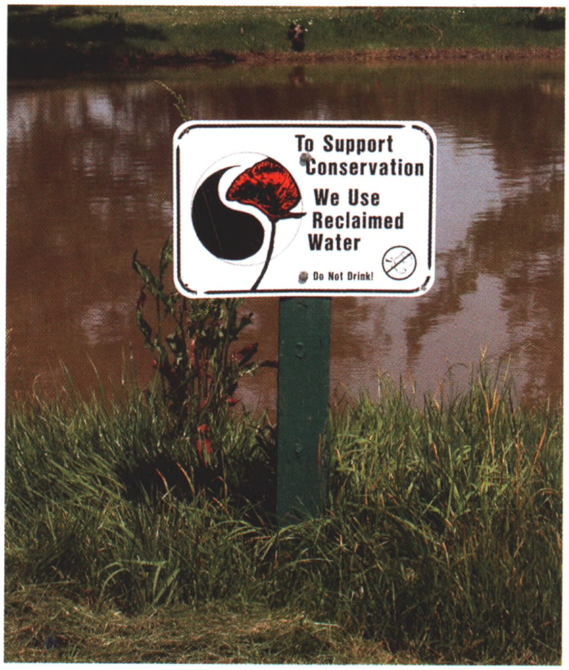
Changing from potable water to recycled water is not an even proposition. Despite the advances in treatment technology, high levels of soluble salts and sodium contained in the water continue to be a major concern when used to irrigate sensitive turfgrass species and landscape plants. Extra maintenance practices must be employed to counteract the negative impacts of salts and sodium, and these practices add time, labor, and expense to the maintenance operation.

Books and articles have been published about how to manage turf irrigated with recycled water, many of which focus on the complex chemical interactions in the soil and water matrix. Once the chemical formulas and mathematical equations start flying, many practitioners throw up their hands. Managers and owners simply want to know the specific practices needed to manage recycled water and how much it will cost. Although the quality of recycled water and necessary management practices vary greatly from region to region, some basic guidelines should be used when irrigating with recycled water. This article offers a step-by-step approach for using recycled water and an estimate of the associated costs based on the experiences of 13 golf courses in the southwestern United States.

SOIL AND WATER TESTING

Routine soil and water testing is a cornerstone of successfully managing the use of recycled water.

Where recycled water is used, vegetative buffer areas around lakes help reduce infestations of algae and aquatic weeds along shorelines.



As the water crunch becomes more severe, there is heightened awareness that conservation and the use of recycled water are necessary and viable alternatives for golf course irrigation.

(Top) Problems with algae and aquatic weed growth can be reduced or eliminated by storing recycled water in a covered reservoir.

(Above) Aquatic weed growth can be prolific in storage reservoirs due to the increased nutrient content of recycled water.

Although laboratory reports may be confusing to some, the information provided by these reports provides a history of soil and water quality and is a valuable tool for implementing preventive maintenance practices and preserving turf quality. The main concerns with recycled water are the increased levels of soluble salts, sodium, bicarbonates, and heavy metals that can have a negative impact on soil structure and directly affect sensitive turfgrass species and landscape plants. The method and frequency of testing is very important. Most recycled water producers will freely share monthly water quality reports with their customers; however, these reports are focused on health quality standards and typically do not provide enough information regarding agricultural suitability. Successful users of recycled water work with an independent soil and water testing laboratory that is familiar with saline and sodic soil conditions as well as golf course requirements. It is important to be aware that various laboratories may use different procedures for analyzing soil and water samples. It is generally recommended that the laboratory follow procedures developed by the United States Salinity Laboratory, including the use of a saturated paste extract for determining EC (electroconductivity) and SAR (sodium adsorption ratio), which is the standard reference used for determining thresholds and management recommendations in the scientific literature (Carrow, Duncan, 1998).

Superintendents who manage recycled water have implemented a variety of strategies for monitoring soil and water quality. Water sampling should be performed at least four times per year, and soil sampling a minimum of two times per year, including representative samples from tees, greens, and fairways. A more accurate approach recommended by Stowell and Gelernter is to arrange for an annual aerial photograph to be taken of the golf course to identify weak areas and evaluate the impact on trees. Once the aerial photograph has been analyzed, at least ten soil samples from fairways should be taken in both good and bad areas to provide a comparison of soil chemical properties (PACE, 1999). Over time, the information provided by these reports can help to identify trends and aid in the development of preventive maintenance programs.

Another useful monitoring technique is to purchase a portable EC meter and moisture sensing equipment that can be used in the field to provide instant feedback on soil salinity and moisture content. Although these instruments are not as accurate as laboratory testing equipment, they provide an acceptable amount of information on which to base management decisions (Vermeulen, 1997).

The superintendents surveyed offered the following information regarding the frequency and annual cost for soil and water testing along with the purchase of monitoring equipment:

- Total cost for monthly water sampling and soil testing two to four times per year — $2,000.
- Portable EC meter — $350.
- Soil moisture probe — $900.

Proper design, along with the use of fountains, bubblers, and other circulation devices, can minimize algae and aquatic weed growth in lakes where recycled water is stored.

- Three to four hours of labor per week for monitoring from May through November.
- Aerial photograph — $1,200 per year.

WATER TREATMENT

Not all recycled water requires treatment. The need for treatment and the specific method depend on an analysis of the soil and water by an independent laboratory familiar with saline and sodic conditions. A variety of treatment options have been used successfully to improve recycled water, including gypsum injection, sulfuric acid injection, the use of a sulfurous generator, and blending. The cost of treatment, if necessary, varies widely based on the soil and water conditions at each site.

During the early phases of planning for the conversion to recycled water, some courses have successfully negotiated agreements to have the recycled water provider pre-treat the water prior to delivery or arrange the periodic delivery of fresh water for leaching fairways. In some parts of the southwestern United States, water agencies appear to be more willing to treat the water prior to delivery to help meet health and safety standards as well as improve agricultural suitability for their customers. The following is a general estimate of the cost for various on-site water treatment programs:

- Gypsum injection — Equipment costs $7,000 to $15,000; gypsum costs $10,000 to $20,000 per year.
- Sulfuric generator — Equipment costs $12,000 to $16,000; sulfur costs $3,000 to $5,000 or more per year.
- Sulfuric acid injection — Equipment costs $15,000 to $18,000; acid costs $8,000 to $25,000 per year.
- Water blending — Equipment cost is variable; operation costs $10,000 to $50,000 or more per year.
- Wetting agents — $8,000 to $10,000 per year (Gross, 2003).

LEACHING TO CONTROL SOLUBLE SALTS

Due to the higher levels of total dissolved salts, sodium, and other constituents, the application of extra water over and above normal irrigation requirements (leaching) typically is required to preserve healthy turf growth. The overall goal is to maintain a net downward movement of water and salts to prevent harmful concentrations in the rootzone (Harivandi, 2007). Although many water agencies sell recycled water for 15% to 20% less than potable water, many superintendents report having to use 10% to 20% more water for leaching programs to control soluble salts — a break-even proposition.

Prerequisites for an effective leaching program include an irrigation system with good distribution uniformity and a regular on-site monitoring program so that leaching can be performed before any visible turfgrass damage occurs (Huck, 2000).

Leaching strategies vary based on site conditions, the demands of the golfing schedule, and the preference/experience of the superintendent. The overall goal is to keep the accumulation of soluble salts below the damage threshold for the specific turf species/variety being grown. This can be done in several ways:

- Periodic leaching with good quality water.
- Including a leaching fraction (extra water) as part of normal irrigation applications.
- Periodic deep watering with the existing recycled water source, using multiple cycles of 15 to 30 minutes with 1 to 2 hours between cycles (Carrow and Duncan, 1998).
- The use of low-precipitation-rate sprinklers for 8 to 12 hours.

Soil salinity must be monitored in the field before and after leaching to determine if salts have been moved effectively beyond the rootzone. The use of a handheld portable EC meter is invaluable in this regard. Some practitioners incorrectly assume that simply doubling the amount of time on the irrigation controllers for a single night will provide effective leaching. Through frequent sampling and monitoring, many superintendents have found that this is not nearly enough water to control soluble salt accumulation and that leaching may need to be performed over two to three consecutive nights.

The costs associated with a successful leaching program will depend on water quality, prevailing site conditions, and the cost of water. The following is a general estimate of the extra water necessary for leaching programs. The added cost will depend on the price of water at each site:

- Greens — In the Southwest, heavy leaching is typically performed monthly from May through November. The amount of water and the associated costs varied among the courses surveyed, but generally it was in the range of 10% to 20% additional water over and above normal irrigation requirements.
- Fairways and tees — Typically, 10% to 20% additional water over and above normal irrigation requirements.

AERATION, DRAINAGE, AND TOPDRESSING

Programs for aeration, drainage improvement, and sand topdressing are of particular importance in the successful management of recycled water. The overall goal is to improve soil properties to enhance water penetration and percolation, allowing for the removal of soluble salts from the rootzone. Aeration frequency needs to be increased, especially in spring and early summer, so that the turf is healthy and able to withstand heat stress and the increasing salt accumulation that typically occurs in late summer and early fall (Huck, 2000). Deep aeration on fairways has become a standard program at sites using recycled water. Although more disruptive and time consuming, this form of aeration does a better job of relieving soil compaction and providing deep channels for the incorporation of gypsum or other soil amendments to preserve soil structure. Various forms of cultivation are typically employed at more frequent intervals on greens, tees, and fairways. Coring and deep-tine aeration in the spring and fall remain the cornerstone of most successful programs. This is typically supplemented at monthly intervals with spiking, slicing, quadratine, or venting techniques to keep surfaces open for gas exchange and to accept larger volumes of water.

Drainage is another essential program for dealing with salt and sodium accumulation. Damage is most prominent in low-lying sections of the course where water accumulates, resulting in a higher concentration of soluble salts and sodium once the water evaporates. The installation of drainage inlets and subsurface drainpipe can help to remove this excess water and prevent the toxic buildup of salts and sodium.

Sand topdressing of fairways is another program that has become popular throughout the Southwest in an effort to improve playing quality, traffic tolerance, turf health, and allow for the rapid removal of excess water. Many courses have implemented a fairway topdressing program, regardless of whether they are using recycled water, in an effort to improve year-round playing quality. A topdressing program is not essential in the management of recycled water; however, it does make it easier to leach salts and sodium while providing firmer turf conditions immediately after deep watering cycles.

The survey indicated the following extra practices and costs associated with aeration, drainage, and topdressing where recycled water is used:

- Greens — An average of three extra aeration treatments per year.
- Fairways — An average of two extra aeration treatments per year.
- Deep aeration of fairways — One to two times per year at an average cost of $10,000 to $11,000 per treatment.
- Drainage improvement — $5,000 to $10,000 per year.
- Fairway topdressing — $25,000 to $65,000 per year.

FERTILITY AND SOIL AMENDMENTS

Particular attention must be paid to fertility and the application of soil amendments when using recycled water. The type and quantity of fertilizer and amendments should be based on routine soil and water quality tests. When significant amounts of sodium are present in the soil, it is typically recommended to apply a calcium-based soil amendment, such as gypsum, at routine intervals. The incorporation of gypsum in conjunction with aeration and leaching helps to preserve soil structure. Many courses surface-apply gypsum to greens in conjunction with monthly spiking or venting, followed by a heavy leaching cycle.

Another strategy typically employed by superintendents who use recycled water is the routine application of a soil wetting agent. Such products help to maintain good water infiltration and percolation, helping flush salts and sodium away from the turfgrass rootzone.

Recycled water may contain a significant amount of nutrients, including nitrogen, phosphorus, and potassium. It is important to track the seasonal variations of nutrients that may be contained in the water and adjust fertility programs accordingly (Huck, 2000). Frequent leaching also can deplete mobile elements, such as potassium, and it is often necessary to make supplemental potassium applications following leaching cycles.

By necessity, sites using recycled water must apply extra water to control soil salts and sodium levels. Soil conditions need careful monitoring by using portable testing devices such as the moisture probe (opposite page), used to monitor soil moisture levels, and an EC meter (above), used in monitoring soluble salt levels to help maintain the critical balance between healthy turf growth and good playing quality.

Superintendents surveyed reported the following costs and/or savings with regard to fertility and the application of soil amendments:

- Fertilizer savings — Only two of the courses reported an annual savings of $7,000 to $9,000 per year due to the nutrient content of recycled water. The other courses noted negligible impacts.
- Additional costs for fertilizer — One of the courses surveyed reported an increased cost of $3,000 to $5,000 per year for the application of potassium and micronutrients.
- Gypsum applications — $5,000 to $30,000 per year (the higher cost is typically associated with multiple applications to fairways by a contract applicator).

IMPACTS ON TURF QUALITY AND PLAYING CONDITIONS

The use of recycled water affects turf quality and playing conditions in several ways:

When significant amounts of sodium are present in the soil, typically it is necessary to apply a calcium-based soil amendment, such as gypsum, at routine intervals. Custom application on a frequency of two times per year can cost approximately $30,000.

Fairway sand topdressing can improve soil properties, making it easier to leach salts and sodium while providing firmer turf conditions immediately after deep watering cycles. The cost of an effective topdressing program is approximately $25,000 to $60,000 per year.

Deep aeration on greens, using 5/16" needle tines, has become a popular program to enhance water percolation and allow for the removal of soluble salts from the rootzone.

- Some turf species are more susceptible to salinity damage.
- Generally wetter turf conditions as a result of leaching programs.
- Additional costs are associated with supplemental seeding or sodding to repair areas damaged by salinity stress.
- Courses that conduct winter overseeding report using higher seeding rates to compensate for seedling mortality as a result of the higher salt content of the water.

Another issue faced by many older golf courses is the management of native soil greens that lack a subsurface drainage system. Such greens are more susceptible to damage due to salt and sodium accumulation and the difficulty of leaching these components from the soil profile (Moore, 1994). In such circumstances, many courses have chosen to install a separate piping system to provide potable water exclusively for the greens. If this is not feasible, frequent deep-tine aeration or possible putting green reconstruction could be the only remedy.

Of the courses surveyed, few have attempted to convert fairways to a more salt-tolerant species, preferring to manage their existing mixture of grasses. Although converting to a more salt-tolerant turf variety such as bermudagrass or seashore paspalum is an effective strategy, the cost and disruption of such a project is viewed as prohibitive by many courses. A few of the courses surveyed have incorporated conversion to a more salt-tolerant turf variety as part of future golf course remodeling plans.

Survey responses regarding the cost associated with turf repair and renovation are as follows:

- Sod for damaged areas — $10,000 per year.
- Increased costs for winter overseeding — $3,000 to $20,000 per year.
- Conversion to a more salt-tolerant turfgrass variety (including the cost of sod, soil improvement, and drainage) — $20,000 to $30,000 per acre.

IRRIGATION SYSTEM RETROFITTING, MAINTENANCE, AND REPAIR

Due to the sensitive nature of *Poa annua* and creeping bentgrass putting greens, many courses have reconfigured the irrigation system to include a separate supply line to deliver potable water to the greens. Since greens typically comprise 2% to 4% of the total golf course acreage, it is a relatively cost-efficient solution to preserving turf quality on this important area of the course.

A slightly higher cost can be expected for managing the irrigation system where recycled water is used. The costs can differ based on the age and design of the irrigation system and whether the water is delivered under pressure or needs to be pumped. Due to the higher salt content, recycled water can be corrosive to metal components typically used in irrigation pumps and valves. There also are additional costs associated with regulatory compliance for annual cross connection checks to ensure that the piping systems for potable and recycled water are not interconnected.

Survey responses regarding maintenance and repair of the irrigation system varied based on the age and design of the system, with many courses reporting no additional costs for maintenance and repair. Regulatory compliance and costs for other items are as follows:

- Regulatory compliance and cross connection check — $150 to $400 per year.
- Accelerated wear on pumps and valves (approximately 50%) — $6,000 per year.
- Repair of plugged irrigation heads — $5,000 per year.
- Installation of a separate piping system to provide fresh water to the greens — $250,000 to $300,000.

MANAGING LAKES

Lakes and reservoirs for the storage of recycled water present a major challenge for superintendents. The increased nutrient content of the water provides a perfect environment for the rapid growth of algae and aquatic weeds, which detract from the general appearance of the water

The lack of water penetration may be a sign that water treatment is necessary. A variety of treatment options are available, from gypsum injection to sulfuric acid injection, at a cost of $3,000 to $25,000 per year, depending on the type of treatment required.

(Above left) Salt and sodium accumulation can cause the decline of sensitive turf species, especially in low areas. Some courses spend approximately $10,000 per year for sod to repair these damaged areas.

(Above right) Routine chemical water testing is essential where recycled water is used. The total cost for monthly water sampling and soil testing two to four times per year is approximately $2,000.

features. Proper design of the lakes and reservoirs can help reduce many of these problems. Depths should be at least 10 to 12 feet or more to reduce sunlight penetration and maintain cooler water temperatures throughout the year (Gill and Rainville, 1994). If given the opportunity to design the lakes prior to the delivery of recycled water, it is recommended to provide at least five days of water storage capacity and provide shading along the banks with trees, shrubs, and vegetative buffer strips (Terry, 1994).

Problems associated with algae and aquatic weeds can be reduced or eliminated by having the water delivered under pressure directly into the mainline piping system. As an alternative, some courses store recycled water in tanks or covered reservoirs.

Survey responses with regard to managing lakes revealed the following information:

- Treatment for algae and aquatic weeds — $20,000 to $40,000 per year.

CONCLUSION

The key word to keep in mind with regard to the management of recycled water is *adjustment*. There need to be adjustments in budgets, management practices, and golfer expectations if recycled water is to be used effectively. Rarely does one find the ideal scenario of sandy soil conditions, perfect drainage, and salt-tolerant turf species. Usually it is a mixed bag of conditions that the superintendent must manage to achieve the best possible playing conditions given the circumstances. The biggest issue remains the management of soluble salts and sodium that are inherent in most recycled waters. Special attention must be given to regular soil and water quality monitoring, aeration, leaching, and developing a sound strategy for the application of soil amendments.

Is it possible to have championship golfing conditions with the use of recycled water? The answer is definitely *yes*! Three future U.S. Open venues currently use recycled water, including Torrey Pines (2008), Pebble Beach (2010), and The Olympic Club (2012). As these courses have done, a step-by-step approach to managing recycled water can address agronomic concerns while still providing good playing quality.

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PAT GROSS *joined the USGA Green Section in 1991 and is the director of the Southwest Region, where water availability and the use of recycled water are major issues.*

Influence of Humic Substances on Moisture Retention and Phosphorus Uptake of Putting Greens

Can superintendents reduce water and fertilizer applications with these natural organic products?

BY ADAM VAN DYKE AND PAUL G. JOHNSON

Humic substance products are now widely available in the turf industry, and many of them have been reported to reduce water and fertilizer use by increasing soil moisture and nutrient availability. Humic acid is the most common humic substance studied, but research results on its effectiveness has been highly variable. Many times, the response of humic acid on turf is difficult to interpret due to confounding effects of nutrients and other ingredients often included in humic substance products.

This study tested a pure humic acid along with commercial humic substance products in both a controlled greenhouse study and a field experiment under golf course conditions. The studies had two objectives: 1) determine if humic substances increase water retention in sand putting greens, and 2) evaluate the ability of humic substances to improve phosphorus uptake in creeping bentgrass grown on calcareous sand.


In the greenhouse, creeping bentgrass sod was grown on calcareous sand on top of gravel to simulate a USGA putting green.

GREENHOUSE EXPERIMENT

In a greenhouse, creeping bentgrass (*Agrostis palustris* L.) sod was grown in tubs of calcareous sand, simulating a USGA putting green. Three organic acids were applied to the turf, delivered through an automated irrigation system and evaluated against a control treatment of water. The organics consisted of a pure leonardite humic acid (Sigma-Aldrich), a tannic acid (J. T. Baker Chemical Co.), and citric acid (Mallinckrodt Chemicals) applied at normalized carbon rates of 250 mg C L^{-1} (carbon per liter) during each irrigation.

Detection probes (Decagon Devices) were buried five inches in the soil and constantly measured the volumetric water content (VWC) of each tub. Data from the probes was used to automate the irrigation system with a datalogger and a relay controller. The soil was allowed to dry to 10% VWC before irrigation.

Turf management included mowing at approximately 0.156 inch with weekly applications of nitrogen (KNO_3) as a drench at 0.1 lb. N/1,000 sq. ft. No additional phosphorus was applied to the turf during the experiment.

None of the organic acids increased the water-holding capacity of the soil. The addition of humic acid had an opposite effect and decreased soil moisture by exhibiting hydrophobic properties that required more frequent irrigation than the control. No differences in plant tissue levels of phosphorus were observed, but humic acid did increase root length over the control in this study.

FIELD EXPERIMENT

This experiment was conducted on established putting greens constructed with calcareous sand and creeping bentgrass at three golf courses along the Wasatch Front in Utah and at a

The field experiment was conducted on established creeping bentgrass putting greens at three golf courses. Individual plots were treated with the same organic materials used in the greenhouse study in addition to four humic substance products available to turf managers.

research green at Utah State University. Individual plots (5 ft. × 5 ft.) were treated with the same organics used in the greenhouse study as well as four additional humic substance products available to turf managers. The commercial products included Focus (PBI Gordon Corp.), Launch (PBI Gordon Corp.), H-85 (Redox Chemicals Inc.), and a fulvic acid (Horizon Ag Products). Treatments were applied at label rates every 30 days during the summer with a CO_2 backpack sprayer and evaluated against a control of water only.

Turf management differed at each golf course site, but each included irrigation to drought stress the turf at the superintendents' discretion. At the Utah State University site, management included mowing at 0.125 inch with weekly applications of a foliar fertilizer at 0.1 lb. N/1,000 sq. ft. Three different irrigation levels of 80%, 70%, and 60% ETo were also imposed on the treatments at the USU site only.

The volumetric water content (VWC) of each plot was measured at weekly intervals throughout the summer, from June 1 to August 30 in 2006 at the golf courses, and in 2006 and 2007 at the Utah State site, with a hand-held TDR probe. Turf color was measured using a CM-1000 chlorophyll meter (Spectrum Technologies) the same days VWC was measured.

In the field, few differences in VWC were observed. Some differences occurred on individual days, but overall the humic substances did not change soil moisture-holding capacity. Tissue phosphorus of the humic acid-treated plots (0.41%) was actually slightly lower than the control plots (0.43%), and chlorophyll content was not different for any treatment.

SUMMARY POINTS

Humic substances did not increase water-holding capacity in sand putting greens.

Humic substances displayed hydrophobic properties, resulting in more frequent irrigation than pure water.

Phosphorus uptake by creeping bentgrass was not increased by humic substances.

Humic acid increased root depth of creeping bentgrass.

No visual differences of turf appearance or color were observed with the use of humic substances.

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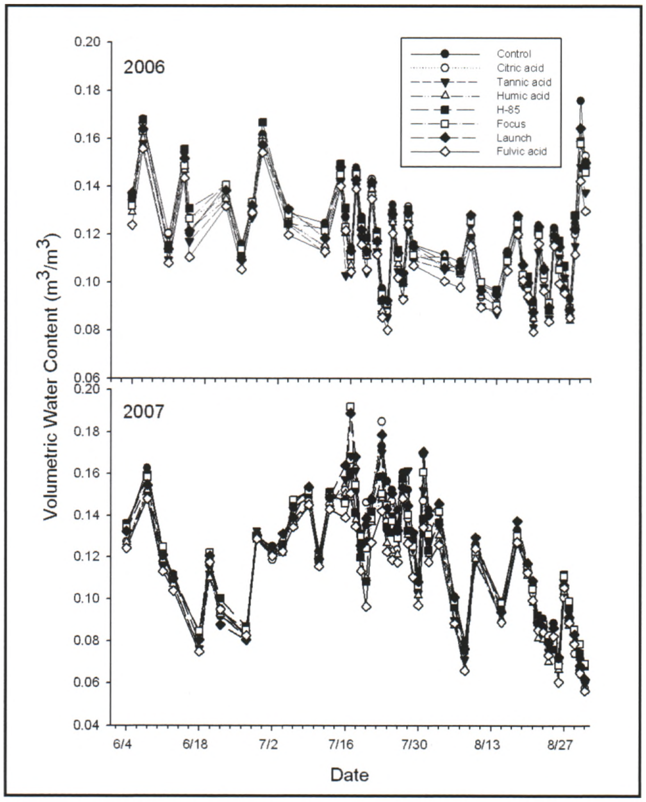

Volumetric water content (VWC) for each treatment in the field experiment was measured at the Utah State University site for the 70% ET irrigation level. In the field work, few differences in VWC were observed.

Season-Long Biological Control of Black Cutworms

A recently discovered baculovirus offers promise for season-long biological control of this common turfgrass pest.

BY DANIEL A. POTTER AND ANDREA BIXBY

(Left) The black cutworm (BCW), *Agrotis ipsilon*, is a major pest of golf courses and sports fields in the U.S. and throughout the world. (Right) In 2003, numerous black cutworms collected from golf courses in Kentucky exhibited disease symptoms including necrotic spots, milky appearance, and liquefaction of larval tissues. A virus isolated from the cadavers offers promise as a season-long biological control for this turfgrass pest.

Objectives:

1. Evaluate AgipMNPV, a naturally occurring baculovirus, as a bio-insecticide for season-long and multi-year preventive control of black cutworms (BCW) on golf courses.

2. Compare infection rates and persistence of AgipMNPV to BCW in sand-based and soil-based putting greens and fairway-height creeping bentgrass.

3. Investigate compatibility and possible synergism of AgipMNPV with soil insecticides used for grub control on golf courses.

4. Investigate compatibility of endophytic and other insect-resistant turfgrasses with biological control of black cutworms by AgipMNPV.

Start Date: 2007

Project Duration: Three Years

Total Funding: $60,000

In 2003, a former University of Kentucky graduate student, Callie Prater, discovered that numerous black cutworm larvae collected from Kentucky golf courses exhibited disease symptoms, including necrotic spots, milky appearance, and liquefaction of larval tissues. A virus isolated from the cadavers was identified as *Agrotis ipsilon* multiple nucleopolyhedrovirus (AgipMNPV).

The USGA-funded research at the University of Kentucky was the first to evaluate use of a baculovirus to suppress an insect pest in turfgrass. It showed that AgipMNPV quickly controls young larvae, but larger ones require higher dosages and continue to feed for several days before being killed. Virus-infected black cutworms rupture in death and spread millions of virus particles onto foliage and thatch that persist and infect subsequent larvae. Spraying a suspension of the virus in water gave good control of third-instar BCW in field trials in creeping bentgrass, including one on a putting green collar where 90-94% infection was achieved. Virus spray residues continued

Once infected with the baculovirus, the insect liquefies internally and dies. The outer covering of the insect body soon ruptures, releasing the liquefied contents and spreading virus particles onto foliage and thatch that infect other larvae.

Once infected by the virus, black cutworm larvae can be used to prepare virus suspensions and applied to the field to further infect resident larvae.

to infect third instars for at least four weeks in the field. That study suggested that establishing a reservoir of the virus in putting green surrounds or other areas could suppress successive generations of black cutworms on golf courses. This new project will evaluate that approach in realistic turfgrass settings.

AgipMNPV was applied to replicated plots on a soil-based green, a sand-based green, and fairway-height creeping bentgrass in the fall of 2007 to evaluate potential for its residues to provide residual control on golf course sites. Third-instar larvae were introduced one week after application, and when those larvae were collected four days later, 50-60% had become infected with the virus on all sites. Additional challenges with black cutworms will be done six weeks after application and in the spring of 2008 to evaluate if the virus remains infective after the winter. Smaller larvae will be used and left in the turf for seven days, which is expected to provide higher infection rates.

A larger study will be conducted on tees and surrounds at two central Kentucky golf courses to evaluate the virus for season-long suppression of black cutworms under field conditions. Six tees, as well as a six-foot buffer of fairway-height grass surrounding them, will be treated with the virus on each golf course. Black cutworms crawl onto tees from adjacent turf, so treating a buffer zone may significantly reduce populations. Six untreated tees on each course will be used for comparison. Virus efficacy will be determined by sampling natural densities of black cutworm populations and also implanting sentinel larvae into the turf. The virus suspension for this whole-tee trial requires about 7,000 virus-killed black cutworms, which are being cultured in the lab, but we are hopeful that methods will be developed to mass-produce the virus on artificial media. We also plan to investigate the compatibility of endophytic and other insect-resistant turfgrasses with biological control of black cutworms by AgipMNPV.

SUMMARY POINTS

- AgipMNPV has the potential to provide season-long or multi-year black cutworm control from a single application. Studies to determine virus persistence on sand-based and soil-based putting greens, fairway-height creeping bentgrass, and whole tees are underway.
- AgipMNPV may be compatible or have a synergistic interaction with insecticides used for grub control, as well as endophytic and other insect-resistant turfgrasses. These interactions will be determined in greenhouse and field experiments planned for 2008.

RELATED INFORMATION

http://usgatero.msu.edu/v03/n12.pdf
http://turf.lib.msu.edu/2000s/2004/041115.pdf
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http://turf.lib.msu.edu/ressum/2005/13.pdf
http://turf.lib.msu.edu/ressum/2004/14.pdf
http://turf.lib.msu.edu/ressum/2003/19.pdf

DANIEL A. POTTER, PH.D., *professor of entomology; and* ANDREA BIXBY, *graduate student; Department of Entomology, University of Kentucky, Lexington, Ky.*

CONNECTING THE DOTS

An interview with Dr. Dan Potter *regarding the use of the AgipMNPV baculovirus to control white grubs.*

Q: *How was the AgipMNPV baculovirus identified and does it infect insects that are pests of other crops?*

A: The virus was accidentally discovered about five years ago when we saw inordinately high mortality of black cutworms collected from Kentucky golf courses. The larvae soon became blackened, flaccid, and liquefied, symptoms indicative of infection by a group of insect pathogens called baculoviruses. Blood samples were sequenced by PCR, a technique that enables organisms to be identified by comparing their DNA sequences with those of known ones archived in a "gene bank." The results matched a virus called AgipMNPV that had recently been described from black cutworms collected from field corn in Illinois. Our discovery was the first documentation of a virus infecting a turfgrass pest. AgipMNPV and other baculoviruses are specific for certain insects. AgipMNPV is highly virulent to black cutworm, slightly infective to a few other closely related caterpillars (e.g., fall armyworm), but does not infect beneficial insects or vertebrates.

Q: *Since the AgipMNPV baculovirus more readily infects young larvae of black cutworms and requires higher dosages to kill more mature black cutworms, how important do you think application timing will prove to be? Or is it more a matter of inoculating black cutworm-infested turf areas anytime during the growing season and let natural infection take its course?*

A: We envision the virus being used to inoculate greens, tees, and surrounds for extended, season-long, or even multi-year control. Baculoviruses can persist for many years once the spore-like occlusion bodies are present in the turf. Larvae that die from the virus spread it to others. So, once established, the virus would suppress infestations by killing many larvae soon after they hatch. Timing would be important if AgipMNPV were used as a curative insecticide against smaller larvae. The virus alone is too slow-acting to be a good knockdown remedy for large cutworms, but we are studying using it with synergists that cause lesions in the insect gut lining and may increase virus efficacy and speed of kill.

Q: *Do you have data or observations of how much different infectivity and death of black cutworms are depending on age of the larvae? Have you performed experiments that compare different developmental stages of black cutworms?*

A: Yes, we have done those tests; they were published in an article in the *Journal of Economic Entomology* 99:1129-1137 (August 2006). Doses that killed 100% of newly hatched larvae (first instars) in a few days caused only 42% and 30% mortality of third and fifth instars, respectively. Higher doses were needed to kill the late instars. But again, we think that combining the virus with synergists can increase speed of kill of even large larvae.

Q: *Your approach for black cutworm control on greens and tees involves treating buffer areas surrounding those areas so that the black cutworms will be exposed to the baculovirus as they move onto greens and tees from the surrounding area. If this approach proves successful, viral suspensions could be used very efficiently. What do you feel is the feasibility of treating whole fairways with this biological control agent?*

A: Currently, production of insect-pathogenic viruses is expensive because most of them are produced by mass-rearing caterpillars, inoculating them, and grinding up the cadavers to make a biological insecticide. There is progress, however, toward being able to mass-produce viruses in artificial media, much like the biological insecticide *Bacillus thuringiensis* (Bt). That technology would reduce cost and make it feasible to inoculate whole fairways. Right now, however, it would probably be too expensive to produce sufficient virus to treat such large areas.

Q: *You suggest that the long-range success for golf courses to use this baculovirus for black cutworm control depends, in large part, on methods being developed for mass production of the baculovirus. Do you know of other cropping systems where mass production systems for biological agents have been produced? How hopeful are you that such mass-production methods can be developed for the AgipMNPV baculovirus?*

A: Yes, baculoviruses are already used to control caterpillar pests on 2 to 3 million hectares per year worldwide. For example, they currently are manufactured on a commercial scale for field application against corn earworm/tobacco budworm in the USA and caterpillar pests of soybean and sugar cane in Brazil. A baculovirus is now a cornerstone of codling moth control in both organic and integrated apple production in Europe. There is much ongoing research on producing baculoviruses in insect cell culture, a process already being used not just for mass production of insect-pathogenic viruses, but also human vaccines. A cell line that grows the black cutworm virus is already available. We plan to test if the virus grown by that method is as infective as wild-type virus.

Q: *Of all the biological control measures that have been investigated for controlling turfgrass insect pests (i.e., parasitic wasps, milky spore disease, entomopathogenic nematodes, etc.), how does the AgipMNPV baculovirus rank as far as the level of control and feasibility as a realistic alternative to conventional insecticides?*

A: I think a commercially available virus would be at the top of the list because of the potential for extended control and reduction of pesticide inputs to high-profile areas such as putting greens and surrounds.

Q: *Do you know if this baculovirus can infect other insect larvae such as armyworms? Are you planning future research to test this virus on larvae of other turfgrass insects?*

A: Studies addressing that question have been done. The virus is slightly infective to a few other pest caterpillars in the same family as black cutworms, but like other baculoviruses, it has a narrow spectrum and has no adverse effects on plants, mammals, birds, fish, or beneficial insects.

Q: *This seems to be a very promising area of research. What would you tell golf course superintendents regarding where this research may lead?*

A: Restrictions on synthetic pesticides are increasing worldwide despite the fact that modern insecticides are much more selective and safer than ones used in the past. Interest in "organic" golf courses is on the rise. This research provides groundwork for developing the first virus-based biological insecticide for turf. Such a product potentially could allow superintendents to permanently suppress cutworms below action thresholds from one application. Many superintendents now treat cutworms multiple times per growing season. Cutting back on pyrethroids and other insecticides around greens and tees may also delay resistance in pests, e.g., annual bluegrass weevil, that inhabit the same golf course settings as cutworms.

Jeff Nus, Ph.D., *manager, Green Section Research.*

Breakfast with Jackie

A straight-shooting Texan shares his views on golf and golf courses.

BY JIM MOORE

In November 2007 at the Champions Golf Club in Houston, Texas, a two-hour meeting took place that will almost certainly help shape the careers of two young men. The principal participants in the meeting were Jackie Burke Jr., Charles Joachim, Brandon Mabry, and Travis Moore.

Compared to Jackie and Charles, Brandon and Travis (both in their early 20s) have just started their golf careers. Brandon is the assistant professional at Ridgewood Country Club, in Waco, Texas, while Travis is the golf course superintendent at the Twin Rivers Golf Club, also in Waco. Both have worked at numerous courses, starting from the bottom and gradually working their way up the ladder.

Charles Joachim developed his love for the game at age 15 on a golf course south of Houston. He played at the high school and college levels before injuries and schoolwork took precedence. While attending Texas A&M, he worked on turfgrass research plots and found a side of the game he had not considered before. Graduating in 1971, he began working on courses and eventually joined Jackie Burke's team at Champions Golf Club, where he has been the golf course superintendent for more than 20 years.

Jackie Burke Jr. is well known in the game of golf for a variety of reasons, not the least of which are his Masters and PGA Championship wins, playing on five Ryder Cup teams, and serving as captain of two more. He has received the PGA Tour Lifetime Achievement Award, the USGA's Bob Jones Award, and is a member of the World Golf Hall of Fame. This past year he received the PGA's highest honor, the Distinguished Service Award. In spite of these accomplishments, Burke may be best known for his love of the game of golf and his willingness to share his passion for the game with others.

Along with Jimmy Demaret, Jackie founded the Champions Golf Club and continues to operate the course to this day. Champions has the well-deserved reputation for being a club for serious golfers. Now 84, Jackie has not lost a step and continues to teach all aspects of the game to those fortunate enough to share his time. Predictably, Jackie has strong feelings about the management of golf courses. This article is a compilation of his opinions shared with the author during a recent meeting and in his book *It's Only a Game — Words of Wisdom from a Lifetime in Golf.*

ON BEING CONSIDERED A "PROFESSIONAL"

When it comes to working at a golf course, the term "pro" should stand for *promoter*, not *professional.* Whether you are the golf pro or the superintendent, your job is to promote the game and your club. You should do everything possible to promote people's love of the game. For the superintendent, come to the board meeting and explain what you're doing out there — don't hide in the barn. Get in here and get it on with these guys. How can they possibly outdo you when it comes to grass? There is no way. But you need to keep it simple so you don't come across as trying to shoot the board member down. You have to make them understand that there are 365 different golf courses out there — that a golf course is different every day. It can't possibly stay the same from day to day. That is part of the player's job — to adapt to the changes. The golf professional's job is to teach the player the game. If you promote the game and your club, you will become a *professional.*

DEALING WITH COMPLAINTS FROM GOLFERS

The way you teach the game of golf is the way you should manage your affairs. The golf swing takes two seconds. You can't manage every aspect of those two seconds and try to control all of them. Instead, you have to learn to trust your swing. When it comes to your work, you have to be able to teach those you work for, and work with, to trust you. You can't manage whispering or bickering. You can't do much about petty complaints. Just concentrate on doing your job as best as you can. People will learn to trust you if you do.

WOULD YOU RECOMMEND YOUNG PEOPLE GO TO WORK IN GOLF?

I definitely recommend they do. But I also recommend they be a big-time part of their community. Be a member of a church. Be a coach in Little League. Be a participating member of your community. Also, you should know all the employees at your club. If they need help, be the guy who offers to help them out. And you have to remember it will never be perfect. If you spend too much time at the course, you will get to the point that you don't love the job anymore. It is extremely important that you love the game. Superintendents and golf professionals need to play golf and play it enough to love it. They need to compete. That is how you learn to love the game.

Since founding the Champions Golf Club (Houston, Texas) in 1957 with Jimmy Demaret, Jack Burke Jr. has remained a hands-on manager. He discusses his golf course management philosophy with Charles Joachim, Brandon Mabry, and Travis Moore (left to right).

GETTING THE GOLF PRO AND THE SUPERINTENDENT TO WORK BETTER TOGETHER

It is simply a matter of communications. They need to let each other know what the other is doing so they can help each other be successful. As a golf pro, I don't need to know about calcium sulfate, but I do need to know that our greens don't drain very well and that they are going to be wet in bad weather no matter what the superintendent does. The golf pro needs to let the superintendent know how the course is going to be used so there are no surprises. In our case, the three of us meet almost every day. All of our department heads meet regularly. And they all know a great deal about all aspects of the club operation so they better understand why certain things have to be done. No one is allowed to be isolated in their operation because every operation affects all the others.

DEALING WITH EMPLOYEES

Charles' employees are dedicated to him because he teaches them to do a good job. He explains things to them; he doesn't just order them around.

THE COST OF GOLF

Golf is expensive. Not everyone can afford this game. The biggest challenge we have is trying to present a facility that people will come and play, and yet keep it reasonably priced so that the young player will be able to come here and be a member. The equipment makes the golf courses play too short, so golf course builders produce back-breaking golf courses that cost a fortune to create and maintain. And golf costs more across the board, from drivers that cost $700 to lessons costing $300 an hour to balls that set you back $50 for a dozen. Green fees are off the chart and joining a private club costs more than a college education. The standards for golf courses have gotten ridiculous. We expect them to be perfect. Anything less than the Gardens of Babylon is unacceptable. This increases the cost of golf and puts tremendous pressure on superintendents. Players see the Masters on television and want their course to look like that, not having any idea how much it costs. They want wall-to-wall green — unless they are watching the British Open. Then brown grass becomes charming. It's insane. It's no wonder the game isn't growing.

You can't grow golf with money. To grow golf you need to teach people to love the game. Good players coming out of college golf programs all want to go to the tour. They don't want to teach the game to others. As a result, we don't have enough good instructors at the course level.

"BAD" COURSES

Golf courses in the early part of the 20th century were often designed and built by amateurs as a one-time thing. In most cases the amateur owned the course he designed, so he poured his heart and soul into it. These courses rarely were very good, even by standards of the time. Mistakes were part of their charm — poor drainage somewhere, a quirky hole or two with misplaced bunkers and misshaped greens, inconsistent turf, et cetera. These mom-and-pop operations were distinctive and had a pleasant atmosphere. They were affordable and gave working-class people and kids a place to play. Sadly, most of them no longer exist. It saddens me to hear an 18-handicapper refer to a course as a "dog track" or a "dump." Those terms are a reflection of that person's perspective and values, which have become warped.

HIGH-END PUBLIC COURSES

They cannot possibly work. A family of four for $400? When it's over, you look in your wallet and think, "I hope the kids don't ask if we can do this again tomorrow."

DEVELOPMENT COURSES

Be careful before taking a job at a development course. These development courses, they (the developers) don't care anything about this game. The course is there just to sell lots. And when the last has been sold, the club is up for sale. And your job is up for sale. You need to find out what the game is and who is signing your checks before you take this type of job.

GOLF CLUB OR COUNTRY CLUB?

I have nothing against tennis, but I'd rather be shot in the leg than see tennis courts built at Champions. The reason I'm against tennis courts, swimming pools, lawn bowling, and the like is that they siphon attention away from golf. I want the club to have some semblance of balance, but in my world that means 90-10 in favor of golf. When Jimmy Demaret and I built Champions in 1957, I had no intention of building a swimming pool or tennis courts. We wanted it to be a golf club, not a country club. Then, in 1960 the fire marshal paid us a visit. Because Champions was in an area that at the time wasn't developed, we had no water resource in the event of a fire. The fire marshal told us there was one solution we might want to consider. Then and only then did we build a swimming pool. I confess I've never liked it. I've always tried to conceal it as best I can, but it's hard to miss because it's right outside my damned office. The wives and kids love it, though, so I accept that it's an imperfect world. And it's only open two months out of the year.

Jackie Burke is well known in the game of golf for his playing ability as well as his many other accomplishments. (USGA photo)

THE ULTRA-PRIVATE CLUB

Many state golf associations are faced with a strange, almost unbelievable problem. When it comes time to line up sites for important state amateur competitions, associations have found that many clubs are unwilling to give up their courses for a week. These clubs invariably are extremely well financed and their courses are among the best, which is why they are sought as venues for competition. But the members at these clubs are against such competitions because it means closing the course for a week. To these members, the attention and adulation the club receives don't outweigh the fact that they won't have a place to play for seven days.

I call such members "gate clangers." They post the guards at the entrance and won't let anybody in. They give golf a bad name. The worst of them are perversely proud of the way they reject entreaties to stage tournaments. "We don't need the attention," they sniff. Gate-clanging clubs usually are filled with members who can't play worth a damn and really don't have golf in their souls. They expect nothing from the game, and to ensure that the arrangement is fair, they give nothing to it.

It is best to let the gate clangers have their way. As a private club, it is their right to manage their organization any way they see fit. The down side is that these clubs will never be all they can be. They have the illusion they are something special, but in truth they are little more than wheat fields.

ON DEATH

When I go down, don't lower the flags. Leave them up. I am on the way to find the head pro and get a starting time.

EDITOR'S NOTE: *Jackie's book,* It's Only a Game, *is a must-read for everyone who loves the game of golf. It is published by Gotham Books, a division of Penguin Group, copyright 2006.*

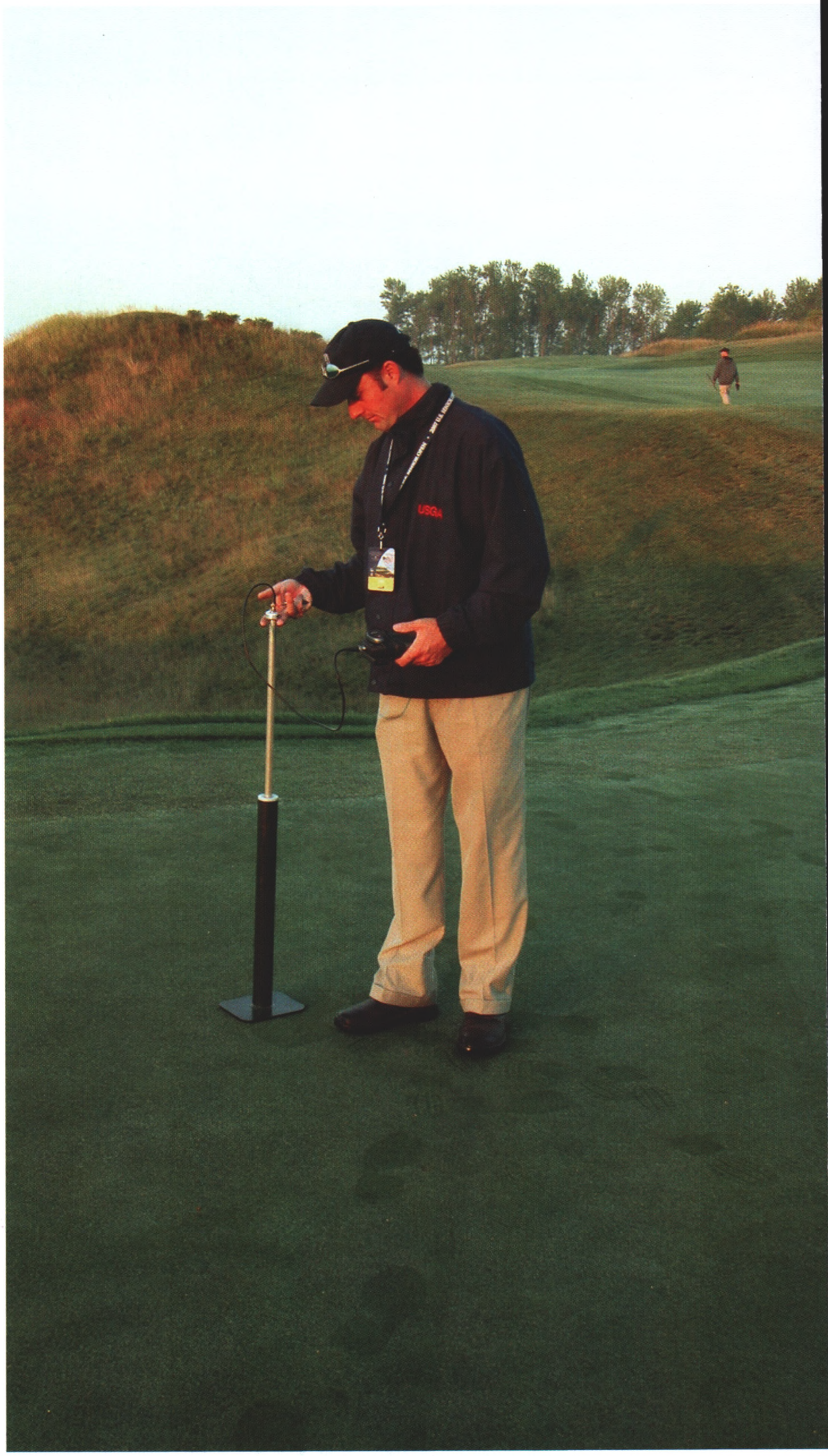
JIM MOORE *is the director of the Green Section's Construction Education Program.*

Affirming Firmness

The golf turf maintenance industry has a new tool. Properly used, it will assist and even improve course maintenance and playability, while helping to guard turf health.

BY BOB BRAME

The pursuit of "firm and fast" playing surfaces is the time-honored objective for championship golf. Yet, keeping that in mind, it is possible to achieve a fast pace with soft surfaces or a slow speed with firm surfaces. As such, it is important to define both *firm* and *fast* to avoid extremes that can compromise turf health and/or playability. Much has been written about putting surface pace and the importance of drawing a line relative to variables such as design, budget, play volume, players' skill level, weather conditions, and the grass(es) being maintained when using the Stimpmeter and defining site- or event-specific *fast*. Not nearly as much has been written about *firm* and the direct tie between firmness and soil moisture — the dry end of the continuum is essential to *firm*. Like fast, *firm* must be defined to achieve balance. Acknowledging the importance of site- or event-specific balance, generally speaking, pushing toward the dry end of the continuum yields healthier turf and more consistent playability, which should be the primary objective with all golf turf conditioning. Bottom line — fast and firm are related and yet independent. We have the Stimpmeter to aid in determining the proper speed for a given operation or event, and now we have a device to assist with firmness and soil moisture effects.



Developer Matt Pringle, Ph.D., spends some time in the early morning hours to collect data. The device slide hammer is fully extended prior to its release and recording of data.

DEVICE DESCRIPTION

Developed by Matt Pringle, Ph.D., Senior Research Engineer with the USGA's Technical Department at Golf House, the original purpose was to (1) compare the USGA's test range to fairways found on championship golf courses

A handheld PC is connected to the slide hammer to record data. The added GPS receiver correlates the location of each data collection drop.

and (2) to predict golf ball/turf bounce and roll characteristics on fairways, approaches, and greens. The tester (final name to be determined) is similar in principle to other impact tools like the Clegg Hammer, which measures soil strength and compaction. The advantage of this unit is that the design includes a hemispherical face (1.68 inches in diameter, the same as a golf ball), and the mass and impact speed of the device is set to mimic the impact energy and momentum of a golf ball. This yields a more representative simulation of the failure mode of the turf on impact. Since both energy and momentum cannot be replicated, the device is a compromise between both. Pitch marks left with the device are very similar to those left by golf balls. The device is equipped with an accelerometer to measure the force/time history of the impact (raw impact signal integrated with acceleration to calculate velocity and penetration time history). The test hammer is connected to a handheld PC to record data. It is also equipped with a GPS (Global Positioning Satellite) receiver, and the location of each impact can be plotted. The mass is dropped from a consistent height, and after the hammer impacts the turf, the acceleration is recorded. This can then be integrated to calculate velocity and penetration time history, yielding the maximum turf penetration depth. The penetration value is the indicator of surface firmness — the lower the penetration value, the firmer the turf.

PAST USAGE

The device has been used at the 2005, 2006, and 2007 U.S. Open Championships. It was also used at the 2005 U.S. Women's Open and the 2007 U.S. Senior Open. Design improvements have been made over this time to yield the current configuration. The information gleaned has played an increasing role in management decisions, particularly water management. At the referenced championships, before and after play each day, the greens were measured at nine locations, spread representatively across each surface. The nine measurements were used to establish an average for that green, which then allowed green-to-green and day-to-day comparisons. With GPS information added, it was possible to map variations in firmness across the test area. Fairway landing zones and approaches were measured only once daily, with six locations across each site. Data collection was started

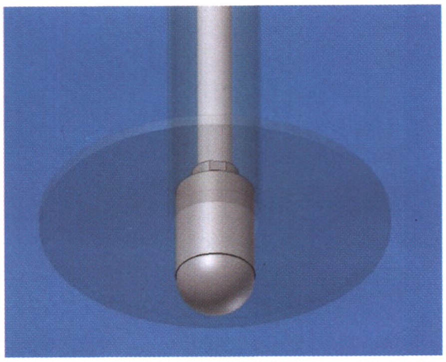
Sunday before the championship and continued through the morning of the final day. Firming trends were analyzed and merged with weather conditions and other site-specific factors to guide watering.

At the 2007 U.S. Open at Oakmont Country Club, turf areas firmed up at similar rates during periods of no rainfall or irrigation. Conversely, the rainfall on Wednesday, June 13, softened all areas significantly. On the mornings of Saturday and Sunday, June 16 and 17, hand watering was used on all greens. Measurements taken approximately 30 minutes after the watering showed noticeable softening, and firming/drying increased gradually from June 10 to the morning of June 13 (the day before the championship started) prior to the rainfall. No irrigation was applied during this time. The softening from the rainfall was then offset by dry weather and no watering on June 14 and 15. By the afternoon of Friday, June 15, the greens were the firmest they had been all week. Saturday morning readings confirmed continued firming, and all greens were hand watered and extra water was applied to the firmest surfaces. The same occurred on Sunday, the final day. Fairway landing zones were, as expected, significantly softer than greens. The firmness of approaches fell between that of fairways and greens. Both fairway landing zone and approach firming trends, before and after the June 13 rainfall, were similar to greens.

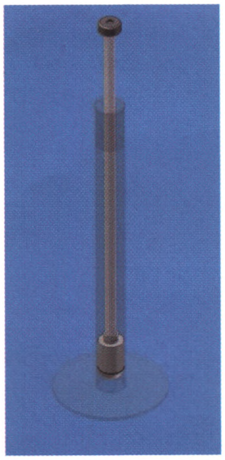
Similar data were recorded at the 2007 U.S. Senior Open at Whistling Straits. The greens firmed during dry weather and no irrigation, whereas rainfall during the practice rounds and again on Thursday (first day of the championship) softened all surfaces. With subsequent drying, hand watering was needed on Saturday and Sunday mornings to hold the desired firmness. As with Oakmont, extra water was applied to the firmest greens in an effort to align the averages. There was less difference between fairway landing zones and approaches as compared to Oakmont; although, here again as expected, greens were significantly firmer than either the fairways or approaches.

APPLICATION

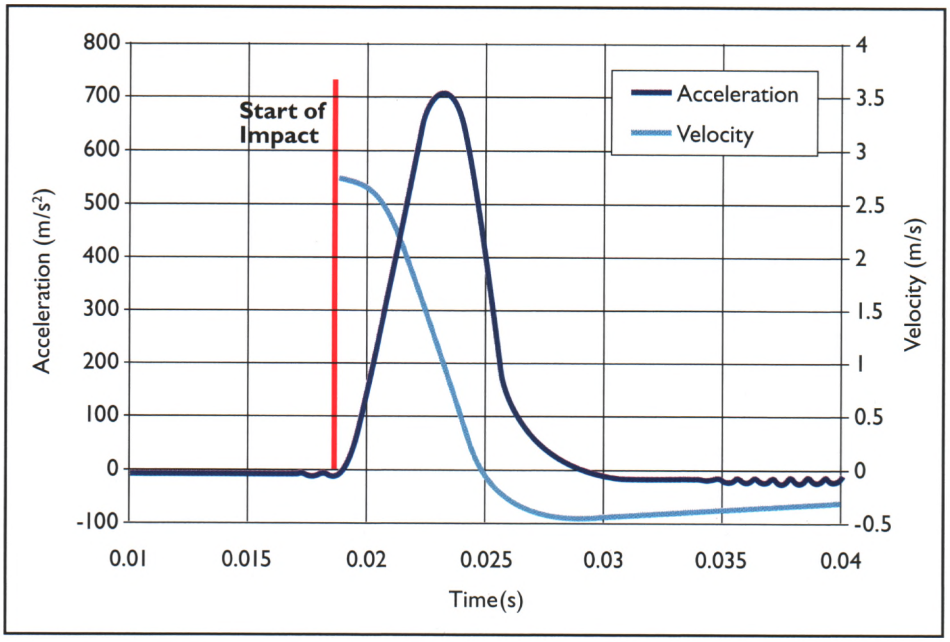
It has become clear — there is a direct relationship between soil moisture and firmness. However, it is not possible to automatically apply what works at one course or championship to another. The firmness desired and achieved at Oakmont was different from that obtained at Whistling Straits. Comparing courses and championships can be useful, yet site-specific data over a period of time should be factored into the decision-making process in order to achieve the best results. This is why the use of this new tool has been initiated several days in advance of a championship. The softest and firmest surfaces can be identified with one data collection cycle, but collections over time should be considered with site-specific factors to properly determine the appropriate firmness for an event. Weaving firmness data with site-specific factors involves taking into account things like design features, soil structure, the grasses being grown, the impact of past maintenance, weather patterns, and available resources (e.g., budget, equipment, irrigation system, and water quality).


The hemispherical face on the slide hammer is the same size and shape of a golf ball.

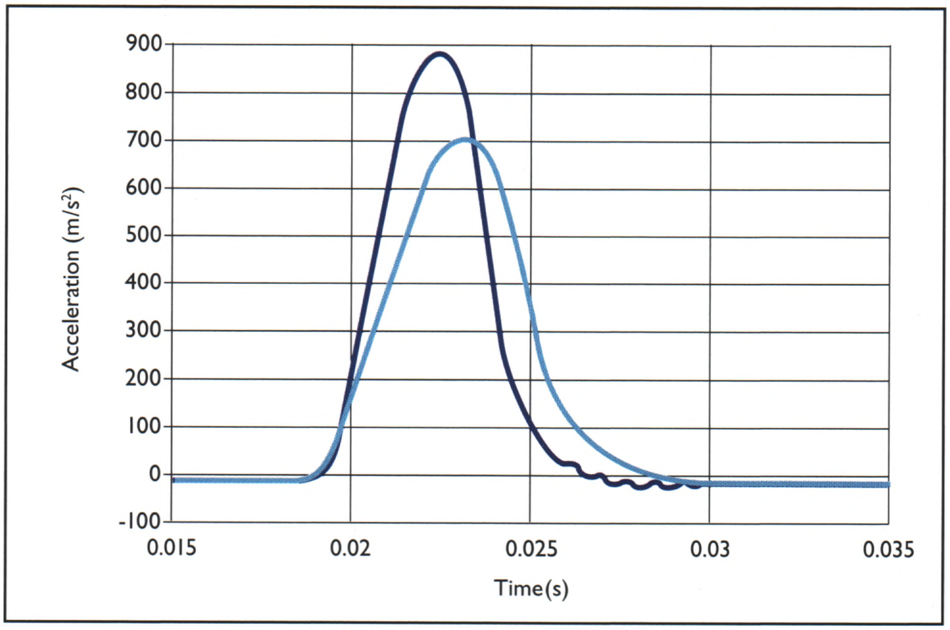
The median skill level of players should also be incorporated into the process of zeroing in on the most appropriate firmness. The careful monitoring, by a few key individuals, of different types of shots and how they respond to the different surfaces will assist in identifying the correct firmness. The existing setup, which includes design, hole length, fairway landing zone width, rough difficulty, hole location, cutting heights, growth rate, and putting surface speed (lightweight rolling and/or multiple mowing will affect putting surface speed, but they have minimal impact on firmness), is directly tied to what is doable for a particular skill and firmness level. Once the ideal is identified, judicious water management can be applied to align and hold all surfaces.


The slide hammer within the tube and its hemispherical face are designed to mimic the energy and momentum of a golf ball. The design provides the same drop height at each test location when the shaft is fully extended.

Turf health also must be carefully considered. In fact, turf health is the trump card that serves to draw lines — too dry and too wet. Too dry means too firm, which can result in turf loss and/or poor playability, possibly even unplayable surfaces. Too wet means too soft, which can



The device is equipped with an accelerometer to measure the force time history of the impact. The initial velocity is calculated from the drop height. After the hammer impacts the turf, the acceleration is recorded. Acceleration is integrated with velocity to identify penetration time history. The point of maximum penetration is the firmness reading.



The data signal differences between soft and firm putting surfaces are obvious.

bring on more intense disease pressure and greater vulnerability to traffic- and weather-related weakening/loss. Although it is much better to miss on the dry (firm) side as opposed to the wet (soft) end of the continuum, the proper use of this device greatly reduces the chances of crossing either line (too wet or too dry), which should be drawn site- and event-specifically relative to the factors outlined in this article.

Beginning in 2008, USGA Green Section agronomists will carry, or have available, the new firmness indicator device. The technology will be used at certain USGA championships and on Turf Advisory Service visits to the extent that courses want feedback on this aspect of golf turf conditioning. In the final analysis, this new tool offers technology that when properly applied will better guard turf health while accommodating improved playability. Healthier and more dependable turf, along with improved playability, does in fact affirm firmness.

BOB BRAME *is the director of the North-Central Region, where firmness is a common discussion topic during TAS visits.*

USGA Sponsored

Research *You Can Use*

Determining Golfer Exposure and Hazard to Pesticides

University of Massachusetts scientists investigate golfers' exposure and hazard to commonly used golf course pesticides.

BY J. MARSHALL CLARK, RAYMOND PUTNAM, AND JEFFERY DOHERTY

Pesticide exposure was measured by dosimetry and biomonitoring. The dosimetry group (on right) wore full-body cotton suits and personal air samplers. The biomonitoring group (on left) wore matching suits cut to simulate the body coverage of normal golfer attire.

Objectives:

1. Determine the level of hazard of volatile and foliar dislodgeable residues of the reduced-resk pesticides — carfentrazone (Quicksilver, Speed Zone, and Power Zone), halofenozide (Mach 2), and azoxystrobin (Heritage) — following full-course, full-rate applications.

2. Determine the effect of partial-course application strategies (e.g., tees and greens) and post-irrigation on volatile and foliar dislodgeable pesticide residues following full-rate applications of carfentrazone, halofenozide, and azoxystrobin.

3. Model the relationship of volatile and dislodgeable foliar residues vs. actual golfer exposure using urinary biological monitoring techniques or, for pesticides that are not amenable to biomonitoring, using dosimetry techniques.

Start Date: 2007

Project Duration: Three Years

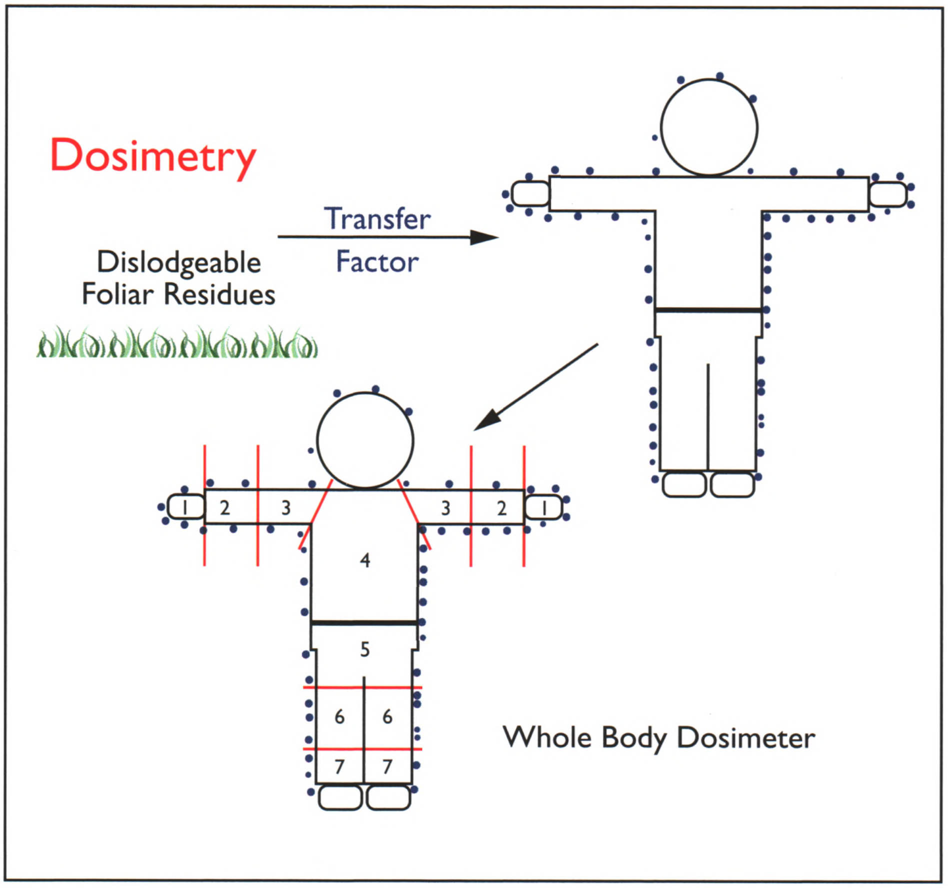
Total Funding: $90,000

This study seeks to determine actual levels of golfer exposure to reduced-risk pesticides following application to turfgrass. A major goal of this research is the development of a model for use by the turf industry and regulatory agencies that accurately predicts golfer exposure using easily collected environmental residue data. Dermal exposure (skin) and inhalation of pesticide residues are the primary routes by which golfers are exposed to turfgrass pesticides following application.

The fate of pesticides after application largely determines how much is available for potential human exposure. This process is influenced by many factors, including post-application irrigation, application rate, and integrated pest management (IPM) strategies such as partial course application, as well as the physiochemical properties such as water solubility and volatility of the pesticide itself. To understand these factors, we have analyzed pesticide residues in the air and on turfgrass leaves (dislodgeable foliar residues, DFR) in more than 40 pesticide applications using either chlorpyrifos (Lorsban), carbaryl (Sevin), cyfluthrin (Tempo), chlorothalonil (Daconil), 2,4-D, MCPP-p (mecoprop), dicamba (Banvel), and imidacloprid (Merit). In the 2007 season, two applications of the reduced-risk herbicide carfentrazone were made. Analysis of these samples is in progress.

This study also evaluates best management practices for reducing golfer exposure to reduced-risk turfgrass pesticides. This information is critical to reduce individual contributions of these pesticides to the USEPA/FQPA risk cup evaluation of agrochemicals, including turfgrass pesticides. While many standard pesticides have been removed from use, new reduced-risk pesticides have been added to the IPM practitioner's toolbox. To date, there is no dosimetry or biomonitoring data on these reduced-risk pesticides, which exhibit low mammalian and environmental toxicity, low potential for

The University of Massachusetts study investigated actual levels of golfer exposure to reduced-risk pesticides following application to turfgrass. Volunteers simulated a four-hour, 18-hole round of golf.



Dosimetry involves measuring pesticide residues on full-body cotton suits, gloves, and personal air samplers. A second method used was biomonitoring, which measured the metabolites excreted through urine. Together the results provide a unique database on golfer exposure.

groundwater contamination, low pest resistance potential, and are compatible with IPM. These comparative benefits are due to these compounds' novel physical and chemical properties.

To determine precisely how much of the environmental residues are actually transferred to and absorbed by golfers during a round of golf, we measure exposure to volunteer golfers using dosimetry (measuring pesticide residues on full-body cotton suits and personal air samplers) and biomonitoring (measuring urinary metabolites), respectively. This work is being done in cooperation with the New England Regional Turfgrass Foundation.

Dosimetry and biomonitoring, together with concurrently collected dislodgeable foliar and airborne residue data, provides a unique database on golfer exposure, and has allowed us to develop a golfer exposure model. The central predictor of exposure in the model is the transfer factor (TF), which is the ratio between the amount that actually ends up transferring to the golfer (as measured by dosimetry) versus the pesticide residues available in the environment (DFRs). We will compare the biomonitoring and dosimetry results for these reduced-risk compounds with those previously determined for chlorpyrifos, carbaryl, cyfluthrin, 2,4-D, MCPP, dicamba, chlorothalonil, and imidacloprid.

Regulators and health professionals now consider biomonitoring data the gold standard for measuring pesticide exposure, and we have used this to validate our TF model for chlorpyrifos, carbaryl, and cyfluthrin, chlorothalonil, MCPP, and dicamba. This season (2007) we determined exposure in 16 rounds of golf following application of carfentrazone without post-application irrigation. With the empirically derived TF model, pesticide exposure can be predicted solely using environmental residues (airborne and DFRs) and converted to dose:

Pesticide Dose (μg/Kg body weight) = DFRs (μg/m^2) × TF (cm^2/hr) × dermal penetration factor × 4 hr/70Kg + inhaled dose (μg)/70Kg).

The hazard associated with a given exposure is evaluated using the hazard quotient (HQ), which is determined by dividing the dose received by the USEPA reference dose (Rfd). HQs less than or equal to 1.0 indicate that the exposure resulted in a pesticide dose at which adverse effects are unlikely. A HQ greater than 1.0 does not necessarily infer the exposure will cause adverse effects, but rather that the absence of adverse effects is less certain.

HQ = Pesticide Dose (μg/Kg body weight/d) / EPA Rfd (μg/Kg body weight/d)

To date, all HQs determined (chlorpyrifos, carbaryl, cyfluthrin, 2,4-D, dicamba, chlorothalonil, MCPP, and imidacloprid) have been 20- to 300-fold below 1.0, indicating safe exposure levels using the EPA Hazard Quotient criteria.

Although biomonitoring is considered the gold standard, not all pesticides are amenable to this approach. Some pesticides do not possess a suitable urinary metabolite, or the pharmacokinetics (absorption, distribution, metabolism, and excretion) of the compound may not be available. In these cases, the TF model still allows us to calculate a hazard quotient in a meaningful fashion.

SUMMARY POINTS

- Researchers have evaluated exposure in 16 rounds of golf following the application of carfentrazone (Quicksilver, Speed Zone, and Power Zone) and will compare this and future results from halofenozide (Mach 2, 2008) and azoxystrobin (Heritage, 2009) with

CONNECTING THE DOTS

An interview with Dr. John Clark, University of Massachusetts, regarding the quantification of exposure and hazard to golf course pesticides.

Q: *Why did you initiate this research? Was there a perceived significant pesticide exposure hazard that golfers are exposed to as they play a round of golf?*

A: The *potential* for significant golfer exposure is quite substantial. There are many golf courses and many golfers. The frequency and level of pesticide use on golf courses is similar to that of many agricultural commodities. To date, there are no restrictions on "re-entry intervals" following pesticide applications to golf courses. The perceived exposure potential was therefore high in the eyes of many pesticide regulatory agencies.

Q: *What specific requirements categorize a pesticide as* reduced risk?

A: Reduced-risk pesticides elicit low mammalian and environmental toxicity (i.e., they are selectively toxic to pest organisms), low potential for groundwater contamination, low pest resistance potential, and are compatible with IPM, due to their novel physical and chemical properties.

Q: *Did your previous work with chlorpyrifos, carbaryl, cyfluthrin, chlorothalonil, 2,4-D, MCPP-p, dicamba, and imidacloprid raise any red flags regarding the hazard to golfers playing a typical 18-hole round of golf?*

A: No, actually quite the contrary. All resulted in Hazard Quotients less than 1.0, indicating safe exposures. Because the reference dose used to determine hazard quotients is based on the No Observable Effect Level (NOEL) that has been further corrected to be more safe by inclusion of uncertainty factors (e.g., incomplete toxicity data) and modifying factors (e.g., children safety factor), this hazard assessment is considered to be quite conservative.

Q: *You refer to the* risk cup *as denoted from the USEPA and the Food Quality Protection Act. Explain what this concept is regarding pesticide exposure.*

A: In 1996, the Food Quality Protection Act required that the U.S. Environmental Protection Agency consider the cumulative effects of exposure to pesticides that have a common mechanism of toxicity. Thus, the toxicity of individual pesticides that belonged to large classes of pesticides that share a common mechanism of toxicity, such as the organophosphorous insecticides, are now added together as a class in any risk assessment and are no longer considered independent of each other. The idea of the *risk cup* is that all the individual risks associated with pesticides that share common mechanisms of toxicity are summed (poured) into a *risk cup*. When the cup overflows (exceeds the critical value of risk), the group of commonly acting pesticides is restricted or removed from use.

Q: *You also refer to* transfer factor *as the ratio of the amount that actually ends up transferring to the golfer versus the pesticides measured in the environment. From your previous studies, what parts of the golfer's body are most prone to pesticide exposure, and what common-sense lessons can we learn?*

A: Our initial assumption (and that of many others) was that the hands of golfers were the most likely route of exposure to pesticides. What we have found by our dosimetry research is that legs are the primary route of exposure, particularly for golfers wearing shorts. This type of transfer is particularly available when pesticides are applied early in the morning when there is still substantial dew on the turfgrass. Once the sun dries the turf, pesticide transfer is greatly reduced. Additionally, post-irrigation of applied pesticides substantially reduced the level of transferable residues from the turf to the golfer. Without post-application irrigation, hands become the primary route of exposure.

Q: *By comparing dosimetry and biomonitoring data, it is possible to calculate a dermal penetration factor (percent of pesticide on the skin that gets absorbed). What are some of these values for different turfgrass pesticides? Do you use these calculated values when you calculate pesticide dose from exposure to specific chemicals, or do you use some other value for the sake of a conservative estimate of hazard?*

A: Dermal penetration factors for most pesticides can range dramatically depending on how the measurements are carried out (0 to ~70%). The degree of skin hydration, skin moisture, and occlusion all affect penetration. Different parts of the body also affect penetration. The palms of the hands and the soles of the feet are usually less susceptible to penetration than, say, the back of the ear or in the bend of the arm. Also, the use of sunscreens and moisturizers affects penetration, as does the concentration of the pesticide, the presence of carriers and formulations, and the ambient temperature. The use of a dermal penetration factor is necessary to estimate the absorbed dose following a skin exposure event. For our penetration estimates, we have usually chosen values in the higher percentage range to model worst-case scenarios.

Q: *All of us face multiple risks every day — driving our cars, playing sports, air travel — you name it. Please put into perspective the typical golfer's pesticide exposure on golf courses. Is there a reason to be concerned by those who love the game?*

A: I personally am not concerned, given our research findings. Nevertheless, there can be many compounding factors (e.g., other non-golf-related exposures, specific health concerns, and health history of families) that make this choice complex and individual. If this is the case, there are a number of safety precautions that one can take: play ~12-24 hours following applications, wear long pants and socks, periodically wipe or wash your exposed skin, play only after the sun has dried the turfgrass, leaving no dew, etc.

Jeff Nus, Ph.D., *manager, Green Section Research.*

those results of previous experiments on chlorpyrifos, cyfluthrin, carbaryl, chlorothalonil, 2,4-D, MCPP-p, dicamba, and imidacloprid.

- Determination of golfer exposure to "reduced-risk" pesticides will provide a novel dataset for these IPM-compatible compounds.

RELATED INFORMATION

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Environmental Stewardship Requires a Successful Plan: Can the Turfgrass Industry State One?

Best management practices all start with planning.

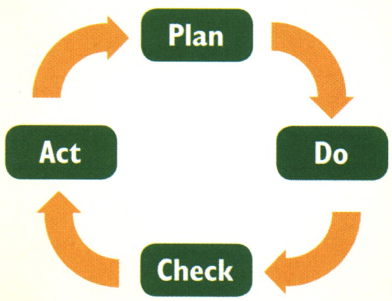
BY DRS. ROBERT N. CARROW, F. CLINT WALTZ, AND KEVIN FLETCHER

Henry Ford was right: "Coming together is a beginning. Keeping together is progress. Working together is success." And "if everyone is moving forward together, then success takes care of itself."

THE FIRST STEP — A PLAN

Environmental stewardship requires that an effective environmental management approach (i.e., plan or model) exists, is recognized, and is implemented for each environmental issue of concern. If each component of the turfgrass industry (golf courses, sod farms, athletic fields, landscape areas, etc.) cannot define, articulate, and support an effective environmental management approach, then we cannot complain if others do the task for us — even in a manner that we may not like. Or, to put it in other terms, the critical first step in addressing any problem is to develop a plan that will truly address the problem.

Without a unified plan rising out of the turfgrass industry, different components of the industry will likely develop diverse environmental management approaches, terminology, and regulatory approaches for different components of the turfgrass industry and each unique environmental issue. The net result will be diverse chaos and, most likely, a strong tendency toward rigid regulations. There have been numerous cases across industry sectors where voluntary, beyond-compliance action on the environment by business has helped to forestall a potential or impending regulatory response to environmental issues, such as the phase-out of halogenated hydrocarbons to reduce the impact on the ozone layer (Piasecki, 1995).



Like many other industries, the turfgrass industry is confronting environmental issues that are numerous, complex, and ongoing. For example, Carrow and Fletcher (2007) noted 17 broad environmental areas of concern to a golf course facility (these may differ for other turfgrass industry areas), namely:

1. Environmental planning and design of golf courses, additions, and renovations.
2. Sustainable maintenance facility design and operation.
3. Turfgrass and landscape plant selection.
4. Water use efficiency/conservation.
5. Irrigation water quality management.
6. Pesticides: water quality management.
7. Nutrients: water quality management.
8. Erosion and sediment control: water quality management.
9. Soil sustainability and quality.
10. Stormwater management.
11. Wildlife habitat management.
12. Wetland and stream mitigation and management.
13. Aquatic biology and management of lakes and ponds.
14. Waste management.
15. Energy management.
16. Clubhouse and building environmental management concepts.
17. Climatic and energy management.

When confronted with numerous and complex issues, can the turfgrass industry present a unified environmental management approach on these issues? We believe that the answer is yes. In this article, the *first purpose* is to propose two environmental management approaches that are highly effective: one for managing *individual* envi-

Whether potable or recycled water is used on the golf course, irrigation water quality management will be an issue of primary concern for many years to come.

ronmental problems (Best Management Practices, BMPs), and one for environmental management of *all* environmental issues at a single facility (Environmental Management Systems, EMS). The *second purpose* is to present the case for adoption of these two approaches, including their underlying characteristics and terminology. While on first view this may appear to be a *cookie-cutter* or *one-size-fits-all* approach, the very nature of BMPs and EMS is flexibility. When it comes to managing turfgrass facilities, given the complexity and diversity of landscapes and ecosystems, this flexibility is a necessity. The *third purpose* is to note a simple *talking points* based plan of action for a turfgrass industry group to become involved in the regulatory and political processes for proactive support of environmental stewardship.

BEST MANAGEMENT PRACTICES (BMPs)

BMPs History. Best management practices (BMPs) is an environmental management approach that focuses on a single environmental issue. The first federal initiative using the term "best management practices" came 30 years ago in the 1977 amendment to the EPA Clean Water Act (CWA) (Rawson, 1995; Gold, 1999; USEPA, 2005; Carrow and Duncan, 2007). The BMPs concept has been refined over 30 years to protect surface and subsurface water quality from pesticides, nutrients, and sediments, and it has culminated in comprehensive regulations supporting BMPs within agriculture (USEPA, 2003) and urban landscapes (USEPA, 2005). The terminology of BMPs remained almost exclusively related to water quality up until recent years when the BMPs term and concept started to be applied to other environmental issues (Carrow and Duncan, 2007). Many other approaches or models can be found in the literature, such as Integrated Pest or Plant Management (IPM, pesticides), Sustainable Agriculture (soil quality, water issues, air quality, etc.), and Precision Agriculture (efficient use of inputs). But these are more limited in scope, while BMPs encompass all possible strategies to address an environmental issue. In the end, it is the solution, rather than the means to the solution, that really matters — but the means must be able to accomplish the best solution.

Characteristics. BMPs have certain inherent characteristics that account for their success in achieving environmental stewardship (ELC, 2005; Carrow and Duncan, 2007). These characteristics have made the BMPs approach highly successful for protection of water quality from pesticides, nutrients, and sediments with a long track record — i.e., the gold standard or premier means of dealing with this complex environmental problem. These same characteristics make it the best model for other individual environmental concerns. Understanding these characteristics is crucial to understanding how this tested and science-based approach can be adopted as a model for other environmental issues, including all those previously noted. The characteristics are as follows:

- *Science-based.* BMPs are science-based and continue to evolve as science advances. The very definition of BMPs illustrates why this approach is effective: a) "best" is used to imply the best combination of strategies that can be adopted on a site or for a particular situation with current technology and resources; b) "management" denotes that environmental problems must be managed, and that management decisions by trained personnel can maximize success; and c) "practices" implies that multiple strategies are necessary to make a positive difference. BMPs can be documented, and accountability can be monitored.
- *Holistic or whole-systems based.* BMPs recognize that no "silver bullet" or single practice can achieve successful stewardship with regard to a specific environmental problem because we work within complex, dynamic ecosystems. In contrast, rigid regulations (or command-and-control approach) are based on limited strategies and a one-size-fits-all concept, ignoring the principle that successful environmental stewardship must consider interactions among ecosystem components (ELC, 2005). For a particular environmental issue, there will be a number of potential strategies or options that can be used to address the issue — for example, with water conservation, strategies may include using water-efficient grasses, irrigation design for uniformity, irrigation scheduling to maximize water-use efficiency, use of alternative irrigation sources, and other practices. A basic principle of BMPs is to keep all strategies available and then to select the best combination for a specific site.
- *Holistic in considering all stakeholders and implications relative to potential environmental and economic effects.* The holistic and multiple-stakeholder dimensions as components of the CWA are noted by: "Evolution of CWA programs over the last decade has also included something of a shift from a program-by-program, source-by-source, pollutant-by-pollutant approach to more holistic watershed-based strategies. Involvement of stakeholder groups in the development and implementation of strategies for achieving and maintaining state water quality and other environmental goals is another hallmark of this approach" (USEPA, 2006). When the BMPs concept is applied to other environmental issues beyond water quality, the same stakeholder principles are inherent in the BMPs — i.e., more reliance on stakeholder voluntary actions than on rigid regulations.

One tool to use as part of best management practices is a hooded sprayer to cut down on spray drift when applying insecticides.

- *Educated site-specific choices and management.* Because no single factor will achieve maximum environmental benefits on a site, adjustments within the whole ecosystem are the basis of the BMPs model; thereby, educated decision making is important. BMPs encourage professionalism and education of the turfgrass manager, including continuing education. Each site is different, and adjustments, therefore, must be site-specific and account for system changes over time. Also, regional differences in climate and soil will modify site-specific BMPs.
- *Fosters entrepreneurial development and implementation of new technology and concepts that will improve environmental*

Managing turfgrass facilities involves many facets, from the turfgrass playing areas to the water features and out-of-play areas. Given the complexity and diversity of these landscapes, flexibility in the use of management tools is a necessity.

stewardship. BMPs encourage ongoing integration of new technology, plants, concepts, and products to achieve the *best practices.*

• *BMPs allow ongoing monitoring of progress.* BMPs require a number of adjustments in individual practices to achieve a high degree of environmental stewardship for a specific issue, and these individual strategies within an overall BMP can often be monitored. However, this is an area where regulatory agencies could go to extremes and develop a more rigid approach — i.e., the overall approach for alleviation of an environmental issue is accepted as a BMPs model, but the agency develops highly regulated monitoring requirements on a number of the individual practices to the point that it is very costly and rigid. The net effect is rigid regulations with all the negative aspects. A more appropriate type of monitoring is to monitor the overall goal for each individual BMP. For example, for water use efficiency/conservation, what is the water use level or degree of efficiency; or for wildlife habitat management, how does the wildlife population change?

• *BMPs terminology is readily recognized within environmental groups and regulatory agencies at all government levels.* One reason is because BMPs for protection of water quality are at multiple governmental levels, starting at the federal level with the CWA, but also at state, regional, watershed, urban, and site-specific levels (DEP, 2002; EIFG, 2006; USEPA, 2005). When the BMPs terms and concepts are presented to these groups as applied to other environmental issues beyond water quality, a common ground is established that consists of the various inherent characteristics of BMPs, even though the actual BMPs strategies differ for each environmental issue.

ENVIRONMENTAL MANAGEMENT SYSTEMS (EMS)

History of EMS. An EMS is a proactive approach to environmental stewardship for all environmental issues at a facility or site. EMS entails establishing an environmental policy and long-term commitment to environmental management to promote stewardship by a business entity. The most common EMS models are patterned after the International Organization of Standards (ISO), a non-governmental network of national standards institutes from various countries. ISO is the world's largest organization devoted to development of standards, especially technical standards. In 1996, with revisions in 2004, the ISO developed a standard for environmental management entitled "ISO 14001 Environmental Management System" (http://www.iso.org/iso/en/ISOOnline.frontpage).

The ISO 14001 standard is defined as: "Environmental Management is the part of the overall management system that includes organizational structure, planning activities, responsibilities, practices, procedures, processes, and resources for developing, implementing, achieving, reviewing, and maintaining the environment." ISO 14001 was, therefore, developed to *standardize* a management approach for entities to manage environmental issues in a systemic manner.

Since 1996, the ISO 14001 EMS approach has been increasingly adopted in many areas of the world, including the USA, but often with some modification. In October 2005, the USEPA published the "EPA's Position on EMS" memorandum, signed by the Acting Administrator, stating its support for Environmental Management System use by organizations and industries. Specifically, the document states, "[t]he plan-do-check-act/continual improvement approach [by EMSs] has been effective as applied to environmental management" . . . and they help an organization to "achieve its environmental obligations and broaden environmental performance goals." While the EPA had been exploring the use of EMS tools for more than a decade, this official memorandum finally formally gave EPA's endorsement to EMS adoption by the business community (http://www.epa.gov/ems/position/position.htm).

The USEPA has modified the ISO 14001 so that the EPA-supported EMS entails a continual cycle with four key components, summarized in a *plan-do-check-act* format (http://www.epa.gov/ems/index.html), where these key components are defined as:

- **Plan** — Planning, including identifying environmental aspects and establishing goals.
- **Do** — Implementing, including training and operational controls.
- **Check** — Checking, including monitoring and corrective action.
- **Act** — Reviewing, including progress reviews and acting to make needed changes to the EMS.

Elements of EMS. The four basic components (plan, do, check, act) of the USEPA EMSs are normally expanded into 17 key elements or steps related to the development and implementation of an EMS for an entity — i.e., these 17 elements are the framework of the *standardized* EMS approach. As outlined on the EPA site, the 17 key elements are (http://www.epa.gov/ems/info/elements.htm):

1. Environmental policy.
2. *Environmental aspects and impacts — identify or access environmental issues present at a facility.*
3. Legal and other requirements.
4. Objectives and targets.

A basic principle of BMPs is to keep all strategies available and then select the best combination for a specific site. Basic cultural practices, such as aeration, are the first line of defense in environmental protection.

5. *Environmental action plans — develop BMPs for each environmental issue.*
6. Structure and responsibility.
7. Training, awareness, and competence.
8. Communication.
9. EMS documentation.
10. Document control.
11. Operational control.
12. Emergency preparedness and response.
13. Monitoring and measurement.
14. Nonconformance and corrective and preventive action.
15. Environmental records.
16. EMS audit.
17. Management review.

The two most important core aspects of an EMS are: a) item 2 — the assessment and identification of what environmental issues are of concern at a facility; and b) item 5 — development of specific action plans to deal with each environmental issue of concern at the facility. It is within this realm that application of BMPs terminology and concepts can be used to avoid confusion. Thus, BMPs for each environmental issue of concern are combined to form section 5 of an EMS, thereby resulting in an environmental management approach or plan for all environmental issues at a facility. The building blocks (individual BMPs) are combined to form the whole site plan (EMS). If the BMPs terminology is not used for each environmental issue, then terminology expands and can become confusing.

Already, at least one golf facility, Colonial Acres in New York, has worked with the EPA to explore the adoption of EMS, using their program participation in the Audubon Cooperative Sanctuary Program as a framework. As a part of the EPA's National Performance Track Program, which relies heavily on the adoption of an EMS for facilities, there has been early study and learning by the EPA, along with Audubon International and the golf sector, on the effectiveness of EMS adoption. This first *experiment* helped to clarify the applicability of the EMS tool for enhanced environmental performance, when coupled with effective golf course BMPs.

AN INITIAL ACTION PLAN

BMPs and EMS approaches encourage stakeholder involvement with regulatory agencies and the political process. Stakeholder involvement for a component of the turfgrass industry at the state level (or other levels) in environmental stewardship normally starts with educated leaders followed by development of *talking points* that they wish to take forward within the regulatory and political realms.

Environmentally Educated Leaders. Effective industry involvement begins with leaders who arise

The golf course maintenance facility itself is an important component in the overall environmental management system.

out of a component of the turfgrass industry and who are well versed in environmental aspects. However, a major hindrance to leaders coming forth can be due to the complexity of environmental issues and the lack of a systematic environmental management system that can be articulated in simple terms.

Since BMPs and EMS are systematic environmental management approaches, the first step is for potential leaders to become familiar with these two concepts. The Environmental/Water section of the www.georgiaturf.com Web site has been developed for this purpose. Articles are from basic to in-depth. One critical issue is water conservation, and the site contains a template that can be used to develop a BMPs plan for water conservation of golf courses or other sites (see "BMPs and Water Use Efficiency/Conservation Plan for Golf Courses: Template and Guidelines").

Talking Points. Leaders must have a message. The most common pathway for turfgrass industry leaders to become involved in the political process as stakeholders has been to proactively develop contacts and relationships in the political and regulatory realms. To facilitate communication and to formulate a consistent, ongoing message, brief *talking points* should be developed. Talking points are often presented verbally as well as with written materials and should include at least three elements:

- **Information on the nature of the industry** — jobs, services, economic impact, and importance. Surveys or documented materials related to these aspects are useful.
- **Commitment statement of the particular industry component to "environmental stewardship" and "sustainability."** The environmental stewardship commitment may be in the form of an official mission statement. Sustainability should be presented as a commitment to: a) sustainability of our natural resources, including the particular issue of concern; and b) economic sustainability of the industry and state economy.
- **A proposed environmental management plan** based on BMPs and EMS concepts that uses terminology accepted by regulatory and political groups, has proven to be highly effective, and can be presented in a systematic manner. If the environmental concern is a single issue (such as water conservation), then the BMPs approach is appropriate; however, if there is more than one environmental concern, then the EMS approach is useful.

Like many industries, the turfgrass industry is facing environmental issues that are numerous, complex, and ongoing.

The last talking point that has often been omitted in turfgrass industry contacts with regulatory and political groups is that an effective environmental plan is not proactively presented. Communication has much more impact when the turf industry can proactively bring forth an environmental management plan that is based on BMPs and their inherent characteristics — i.e., the premier approach for complex environmental issues and one that has evolved out of 30 years of the EPA BMPs for sustainability of clean surface and subsurface water. For a single environmental issue, the industry representative should present a summary list of individual strategies that make up the BMPs, since the regulatory or political entities may not be familiar with all the potential options they have for water quality issues.

In summary, we go back to some modification of Henry Ford's quotes:

- Coming together on a common environmental management approach is a beginning. Keeping together is progress. Working together is success.
- If everyone is moving forward together with the same plan, then success takes care of itself.

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On Course *With Nature*

ACSP — What Your Peers Think

Word from the field is that the ACSP is the way to go.

BY SHELLY FOY

For a long time, I have been urging golf course superintendents to join Audubon International's Cooperative Sanctuary Program for Golf Courses (ACSP). With the recent distribution of various golf course Best Management Practices (BMP) manuals around the country, there are now even more reasons to join this program.

First, many of those BMPs are based on guidelines suggested by Audubon International. Second, several cities and counties have stated that golf courses would be exempt from local fertilizer ordinances if they followed the new BMPs. In order to follow BMPs, you need to have a plan. The Audubon Cooperative Sanctuary Program is a customized plan to help your course achieve BMP compliance.

If you read through Audubon International's Web sites (www.auduboninternational.org or www.golfandenvironment.org), chances are you will run across the list "Top Ten Reasons to Get Certified":

1. Do the right thing for the environment.
2. Enjoy a new and rewarding aspect of your job and be able to share it with others.
3. Gain positive publicity for your golf course.
4. Better organize and coordinate your environmental management efforts.
5. Track environmental improvements.
6. Save money through reduced resource use.
7. Build your skill set and your resume.
8. Promote your stewardship efforts.
9. Be recognized as a community and golf industry environmental leader.
10. Gain valuable feedback from Audubon International.

Environmental issues in general, and concerning golf courses specifically, aren't going away. Here are some reviews from your peers about what the Audubon Cooperative Sanctuary Program has meant to them and their golf courses.

"Water quality has greatly improved over the past year. Visually, the lakes are no longer full of algae and weeds, and the aquatic plants and wildlife are thriving. Since my arrival we have changed the way fertilizers and chemicals are used, especially around the lakes. Fertilizer is no longer thrown into the lakes and chemicals are used as needed. We also have started a bank naturalization plan, which catches and filters runoff going into the lakes. Also, golfers are happy because this catches their golf balls. We will continue to use BMPs to reduce costs and improve the environment." — Ryan J. Costello, CGCS, Audubon Country Club, Naples, Fla.

"I don't think it's an option [to join the ACSP]. What better way is there to showcase your environmental efforts and prove that golf and nature can be harmonious? Our efforts clearly show that golf cares about the environment." — Scott Welder, golf course superintendent, Walt Disney World, Orlando, Fla.

"Achieving certification as an Audubon Cooperative Sanctuary was a goal that brought immense satisfaction. I always believed I was a good steward of the environment, but the program enabled me to quantify my achievements as well as provide me tools to demonstrate the value of the golf course and the programs that we have in place. In a nutshell, it is the right thing to do and it feels good!" — Darren J. Davis, director of golf course operations, Olde Florida Golf Club, Naples, Fla.

"The certification process, from beginning to end, was an education for my staff, our membership, and me. The ACSP sets goals and procedures that can put your course on the leading edge of environmental awareness and promote your efforts throughout the industry as well as your local community. Golf course maintenance operations are scrutinized by employers and the public alike. Involvement in the ACSP proves that your operation is committed to a higher environmental standard. Set certification as a career goal. Your knowledge of your property and understanding of your complete operation will increase as you go through the process. It's a win-win!" — Kyle D. Sweet, CGCS, The Sanctuary Golf Club, Sanibel Island, Fla.

Stone Creek Golf Club, Oregon — certified member of ACSP.

As the program succeeds, course officials, members of the management team, and influential golfers are affected by the positive results. Read on:

"As an Audubon Certified Golf Course, we are often used as a model club for responsible stewardship. The ACSP was the first step in propelling our club into a leadership role in Sarasota County. The county commissioners look at this club in a very positive light and often solicit our input as it relates to environmental issues. The club continues to be recognized for our environmental leadership." — Jim Schell, CCM, general manager, Venice Golf & Country Club, Sarasota, Fla.

"Programs such as this represent the types of positive partnerships that need to be created across the country. This type of effort is the only way that we can positively deal with the many serious environmental issues that we face as a nation." — EPA Administrator Christine Todd Whitman, presenting Audubon International with the EPA Region 2 2001 Environmental Quality Award.

SHELLY FOY *is a member of Audubon International's Board of Directors and is employed by the USGA Green Section Florida Region. For more information on the ACSP, visit www.auduboninternational.org or call (518) 767-9051.*

News *Notes*

DERF SOLLER AND BRIAN WHITLARK JOIN THE GREEN SECTION STAFF

The Green Section is pleased to welcome agronomists **Fred "Derf" Soller Jr.** and **Brian Whitlark** to the staff, filling vacancies in the Northwest and Southwest Regions.

Between 1998 and 2006, Derf served as the grow-in superintendent and later the golf course superintendent at the Jack Nicklaus Signature 27-hole Breckenridge Golf Club in Breckenridge, Colorado. Prior to that, he was involved for three years with the design, construction, grow-in, and establishment of the Old Works Golf Course, a Nicklaus Signature golf course and the first course to be built on an EPA Superfund site. From 1985 to 1995, Derf was the assistant golf course superintendent at the Breckenridge Golf Club

Derf has been very active in regional, state, and national organizations, and is a 22-year member of both the GCSAA and the Rocky Mountain GCSA, having served on its board for five years and as its president in 2003. He also has served on GCSAA's Environmental Stewardship Committee, Environmental Programs Committee, and the Wildlife and Habitat Committee, serving as its chairman.

Derf is a graduate of Miami University (Ohio) and the University of Massachusetts turfgrass program. His family includes wife Terri and sons Danny and Kevin. Derf and family will be based in Grand Junction, Colorado, and he will make Turf Advisory Service visits in Colorado, Wyoming, Idaho, Montana, and Utah in conjunction with Green Section regional director Larry Gilhuly.

Fred "Derf" Soller Jr.

Prior to joining the Green Section, Brian Whitlark worked for four years for the Target Specialty Products Company, based in the Phoenix, Arizona, area. His role in the company involved providing site-specific soil agronomic evaluation and recommendations for golf course superintendents, course officials, sports turf facilities, and other landscapes, covering a territory that included Arizona, California, Nevada, and Portland, Oregon. He is a frequent speaker and writes extensively for practitioners in the areas of soil, water, and interpretation of soil test results.

From 2001 to 2004, Brian served as the assistant golf course superintendent at the Talking Stick Golf Club of Troon Golf Management in Scottsdale, Arizona. Prior to that, he worked for ISA Laboratories, evaluating soil test results and conducting field visits in the sports-turf industry. Since 2000 to the present, Brian has been an adjunct professor of soil science and soil fertility, conducting classes for students at the Mesa Community College in Mesa, Arizona.

Brian received B.S. and M.S. degrees from the Department of Soil, Water, and Environmental Science, with an emphasis on turfgrass science, at the University of Arizona at Tucson. He was raised in the Bay Area and enjoys golf, soccer, and football, and he has completed seven marathons over the years. He and his wife Vanessa and 10-month-old daughter Lily will be based in the Phoenix area, and he will be making Turf Advisory Service visits in Arizona, Nevada, and California with regional director Pat Gross.

Brian Whitlark

Recently, two members of the Green Section staff, **Matt Nelson**, Northwest Region senior agronomist, and **Jim Baird**, Northeast Region agronomist, have left the staff to pursue new and exciting opportunities. Matt is in the process of establishing a bentgrass sod farm, and Jim has joined the turfgrass faculty at the University of California at Riverside. The Green Section staff thanks them sincerely for their many contributions over the years, and wishes them well in their new endeavors.

All Things *Considered*

Older and Wiser (At Least in My Opinion)

The wisdom of the ages.

BY JIM MOORE

Two things happened in my life a few weeks ago that made me realize I'm officially old. First, when I went out to my favorite course to play a few holes, I hit the ball so poorly that I decided to give it up for the day. Since it was far too nice a day to head back indoors, I decided to hawk golf balls for a while. I spent two very enjoyable hours finding other people's Pro Vs and picking up pecans. If that is not proof enough, my wife and I went to the movies that evening and they asked me if I wanted the senior discount. At 56 I barely qualify and have been too proud to take it — up until now. Hey, three bucks is three bucks.

The reason for making the case that I'm officially old is that this then qualifies me to be officially "cranky," although most of my coworkers would argue that I long ago achieved this status. Add to this the fact that recently I had the wonderful opportunity to spend a couple of hours with Jackie Burke Jr., who is one of the most straight-talking persons I have ever met in my life. I so admire his willingness to tell it as he sees it that I decided to follow his lead with a few choice opinions of my own regarding this industry.

- Too many golfers have completely lost their minds when it comes to bunkers. If you don't like the fact that golf has become too expensive, you don't need to look any farther than the bunkers. Superintendents are spending fortunes on sand and even more on labor to try to make the bunkers "consistent." What a waste.
- Any architect who locates a green in a site that does not allow enough light to reach the turf should voluntarily refund the cost of moving the green when everyone finally realizes that grass needs light to grow.
- I don't understand spending thousands of dollars on soil testing when most state universities charge around $25 per sample.
- Green speeds in excess of 10 feet are not fun for most players. The only people who benefit from such speeds are golf professionals, scratch players, fungicide salesmen, people who like to inflict pain on themselves, people who enjoy slow play, and everyone who is involved with rebuilding wonderful old greens that no longer have enough hole locations due to their contouring.
- Back to trees — the three best fungicides on the market are Echo, Stihl, and McCulloch (all three are chainsaws).
- As Jackie Burke emphatically pointed out to me during our visit, the *US* in *USGA* stands for *United States.* There are far too many states out there that don't get to host top-level USGA championships. We in the USGA need to do a better job of promoting the game throughout the entire country.
- Kids just learning the game should get range balls for free or at least darn close to it. As long as a kid can go to a movie for less than the cost of a bucket of balls, we are going to have a hard time getting new players from middle- and lower-income families.
- Golf courses need to pay golf course workers fairly so this industry does not have to rely so heavily on people who come into this country illegally. Take the money that is being wasted on bunkers, trying to grow grass in the shade, and trying to produce U.S. Open conditions on a daily basis and use it to pay people decently.
- Working in golf is not nearly as much fun if you don't truly love the game. While we are all busy all the time, somehow we need to make a little more time to play, or at least find the time to look for a few lost balls and pecans.

Whew. That wore me out. Plus, it is 4:00 PM and I feel like heading down to the cafeteria for dinner.

JIM MOORE *is director of the Green Section's Construction Education Program.*

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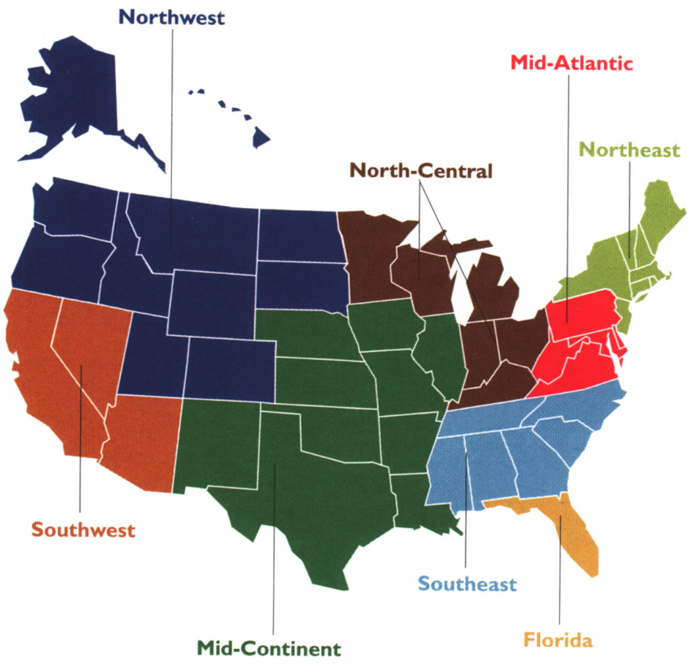

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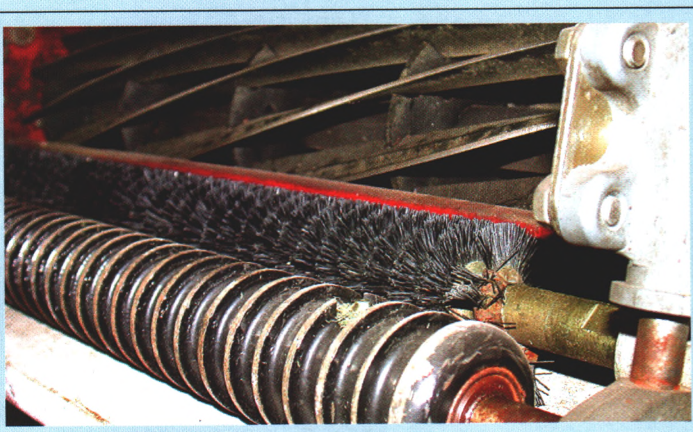
Turf *Twisters*

Q: We've had a problem with our greens for the last couple of years, and our superintendent has recommended cutting a lot of trees down to improve sunlight penetration as a solution. Does this make sense, and how much could it possibly help? The trees have been there for a long time, and we never had problems with the greens before! (New York)

A: If the greens are heavily shaded or receive poor air circulation, tree work could make an enormous difference! Tree growth over a period of a few years may not be very significant, but add it up over 10 or 20 or more years, and the growth and corresponding decrease in sunlight and air circulation can be calamitous. Many courses now are removing sizable numbers of trees that were planted 30-40 years ago or more. Once the trees achieve sufficient size to shade and block air movement, their detrimental effects can be huge, and removal is usually the solution.

Q: Some of my members have been reading about the use of brushes to assist in the preparation of the greens. Can this strategy be used, and is this a better technique than vertical mowing? (Maryland)

A: Brushing the turf prior to mowing is not a new technique; it has been around for a very long time. This practice has experienced renewed interest due to new equipment designs. There are tools that provide very effective brushing just prior to mowing. Brushes can be fit to existing mowing equipment, allowing for the completion of two practices at the same time. With any practice, the dose makes the poison. Too much brushing at the wrong time of year can be harmful.



Brushing and vertical mowing are two separate management techniques. Brushing is more of a surface preparation strategy, and vertical mowing is a technique used to thin the grass stand while also removing thatch in the upper portion of the soil profile. Vertical mowing is much more abrasive and, as such, should be used strategically and sparingly. Brushing (with the right brush), on the other hand, can be used more frequently.

Q: Should our private club close on Mondays to allow the grass to rest? (Alabama)

A: Historically, private clubs often closed on Monday because the low utilization of the club did not warrant keeping staff in the clubhouse and golf shop. With that said, the turf management department has an entire day to work without worrying about disturbing golfers. Ultimately, every golf course must determine what makes sense.

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