USGA GREEN SECTION

RECORD

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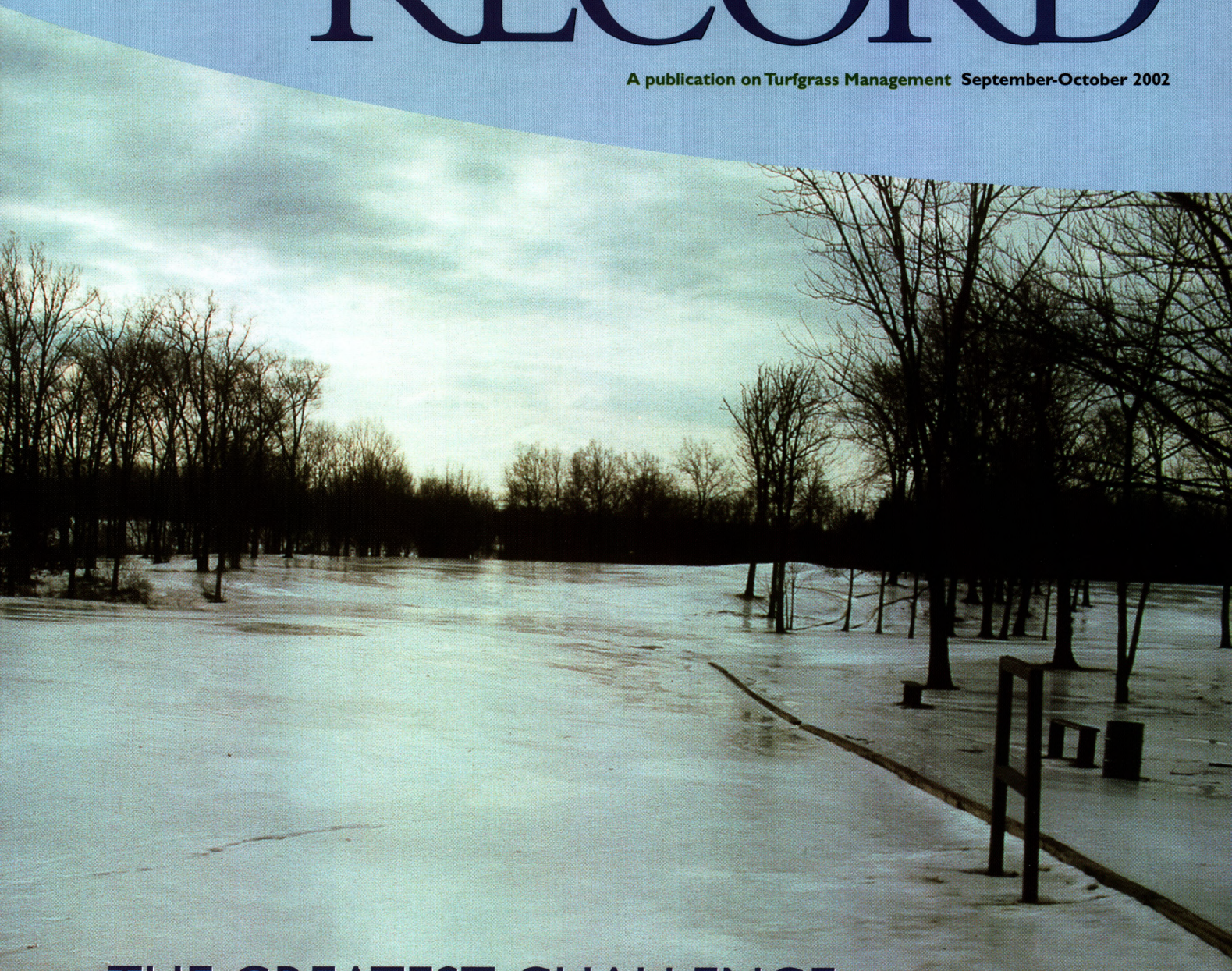

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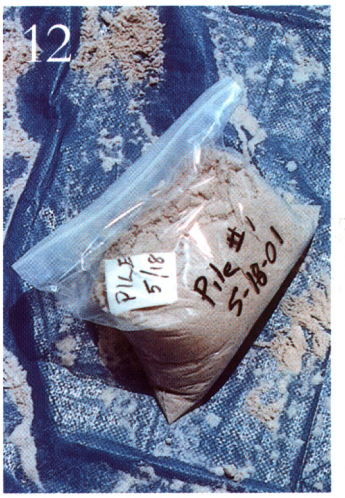

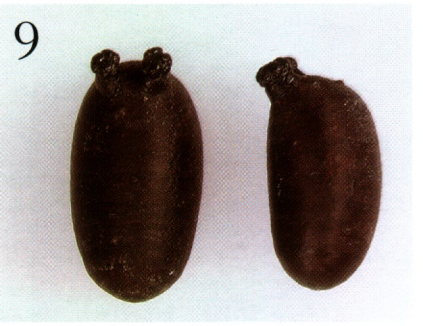

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Just how long can turf withstand being encased in winter ice and snow? It's not completely understood.

THE GREATEST CHALLENGE

Coping with winter weather challenges northern golf course superintendents.

BY JIM SKORULSKI

Freeze injury can devastate annual bluegrass on northern putting greens, damaging 70% of the surface or more.

The most common forms of winter turfgrass damage are caused by snow mold diseases, wind desiccation, exposure to low temperatures (freeze injury) and suffocation under ice. If you're from the northern part of the country, you have likely experienced one or more forms of winter damage. Snow mold diseases are serious but can be managed relatively well with fungicides. Wind desiccation also is a concern where snow cover is sparse. However, the two most widespread and devastating forms of winter injury are associated with freeze injury and suffocation (anoxia). Ice damage is a more general term that often is used synonymously with freeze injury and anoxia when discussing winter damage.

Just how damaging and extensive are the ice-related types of winter damage? Those who have experienced its wrath will say it is the greatest threat facing their golf course. Golf courses with larger populations of annual bluegrass stand to suffer the most and often do, with 70-90 percent kill on greens, tees, and fairways alike. Newer golf courses with higher populations of creeping bentgrass or Kentucky bluegrass usually suffer less damage, but they, too, can experience turf loss when more severe weather occurs. Golf courses that have been extensively damaged often remain closed through spring, or play may be restricted to temporary greens, impacting revenues and testing the golfers' patience. Operating budgets can swell by as much as $100,000 or more for snow and ice removal and recovery efforts. Superintendents and maintenance staffs are worn out by early summer, and playing conditions can be impacted for the entire season and beyond.

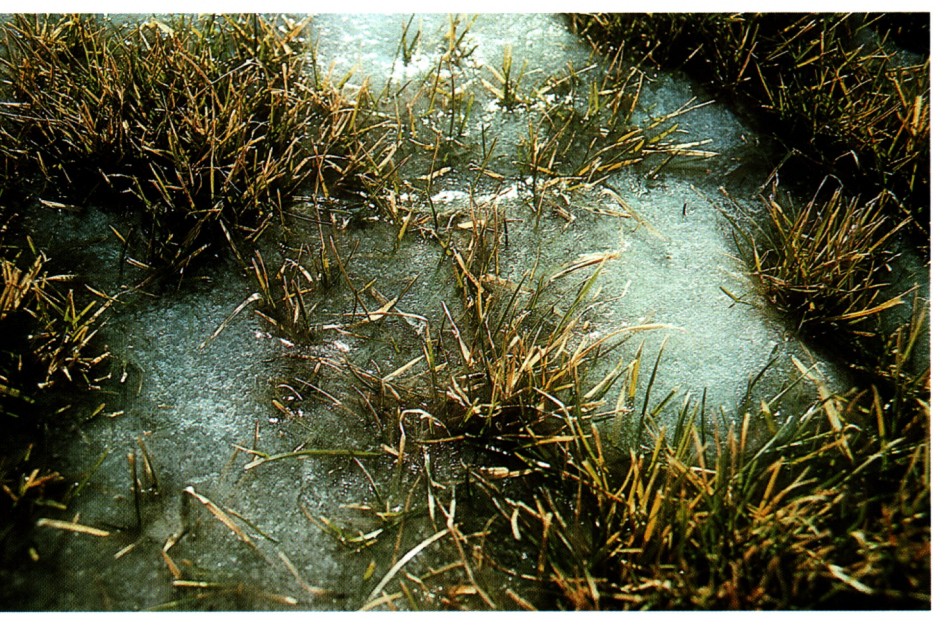
What makes matters worse is that freeze injury requires very specific weather conditions, and the occurrence and extent of injury vary widely depending on location and site conditions. It is often difficult to determine how the damage occurred and even harder to explain. Many turf managers are unjustly blamed for its occurrence. Regardless, suffering extensive winter damage can be a traumatic experience for golfers and turf managers alike.

MECHANISMS OF WINTER INJURY

A basic understanding of the mechanisms behind freeze injury and anoxia is necessary to develop a successful winter management program, yet the mechanisms are extremely complex and are not fully understood. Freeze injury is thought to occur when a plant is subjected to extremely cold temperature or a rapid and severe drop in temperature. Exposure to the cold temperatures causes water to freeze within the plant. Ice crystals can form in and around the cells and, in doing so, can cause physical damage to cell membranes and cell organs. Turfgrass exposed to extremely cold temperatures is often damaged in this way.

Water can also be pulled out of individual cells while ice crystals form around the cells. The cells die from desiccation if enough water is lost. This form of freeze damage often occurs during periods of thaw or in later winter, and is commonly referred to as crown hydration injury. Both forms of freeze injury are implicated in much of the winter damage observed in the field. Rarely does the turfgrass plant recover when the cells in the crown region are damaged by freeze injury.

Suffocation or anoxia can also damage turf that is encased in ice or is under some type of impermeable cover for an extended period. Soil microbes and the plants under the ice cover utilize oxygen as they respire. An anaerobic condition develops as the oxygen is depleted. The anoxic condition can kill the plant directly or predispose it to freeze injury. The trapped gases produce a foul, unforgettable odor that is often referred to in the field as the "smell of death." Its presence in late winter or early spring is the first indication that big problems may lie ahead.



The duration of ice cover alone is not always a good indicator for predicting winter injury. Winter damage may mistakenly be attributed to ice encasement and anoxia because of the foul smell associated with the damage in spring. However, freeze injury probably kills far more grass each winter. The foul smell that is often present does indicate an anaerobic condition, but it may be a by-product of microbial respiration associated with the decay of dead plant tissue. The complexity of anoxia and freeze injury is just now being realized, and continued research will lead to better understanding.

COLD-TEMPERATURE HARDINESS

All plants develop a tolerance or hardiness to cold temperatures. That hardiness serves as a defense against freeze injury. The plants develop the hardiness by storing carbohydrates in cells found in crown and root tissues. The higher concentrations of these materials act as antifreeze that prevents ice crystals from forming within the cells. The carbohydrates or sugars also provide the energy that fuels respiration during the dormancy period. Moisture content in the plant tissues also decreases during the hardening process, and cell walls and membranes undergo changes that improve their ability to tolerate ice crystals. The hardening process begins in late summer with the onset of cooler temperatures and shorter days and can continue through early winter. Maximum cold-temperature hardiness is obtained after the turf has been exposed to sub-freezing temperatures. Other factors that impact the hardening process include soil moisture, growing environment, and fertility.

The level of hardiness varies among plant species and even among cultivars or biotypes within a species. It is no surprise that maximum cold-temperature hardiness levels for annual bluegrass and perennial ryegrass are considerably lower than those for creeping bentgrass, rough bluegrass, and Kentucky bluegrass. Maximum cold-temperature hardiness is measured as the lethal temperature (surface temperature) at which 50 percent of the population survives (LT_{50}). The LT_{50} for most annual bluegrass in the field is approximately 14°F as compared to -38°F for creeping bentgrass. Rough bluegrass has nearly the same low LT_{50} as creeping bentgrass, and

Kentucky bluegrass is greater but still much lower than annual bluegrass.

The level of cold-temperature hardiness obtained by the plant in fall is dependent on weather conditions. Maximum cold-temperature tolerance is usually obtained in early winter. It declines throughout the winter as the grass is exposed to warmer temperatures, freeze-thaw cycles, anoxic conditions, and hydration. It is conceivable that an annual bluegrass plant will survive a 15°F temperature in January but will be killed by that same temperature in early March. Late winter and early spring are probably the most critical periods in regard to winter injury, as the grass plants lose carbohydrate reserves and hardiness and usually become hydrated and begin to break winter dormancy. A rapid and severe temperature drop at that time often spells disaster.

MAXIMIZING COLD-TEMPERATURE HARDINESS

Practices that aid the plant in maximizing cold-temperature hardiness are the basis for programs to combat freeze injury. Plants that gain maximum cold-temperature hardiness stand the greatest chance to survive winter. Obviously, weather has the greatest impact on the process, and a cool, dry fall with some frost on the ground is ideal for preparing the plants for the winter ahead. However, management programs can also be manipulated to improve the hardening process. The following practices are implemented for that purpose.

- Raise the height of cut in late summer to improve the plant's ability to photosynthesize and produce carbohydrates more efficiently.
- Eliminate shade to maximize the turfgrasses' ability to photosynthesize and produce the carbohydrates that provide cold-temperature hardiness. Turf growing in sunny environments also will have a lower tissue moisure content and increased cell wall thickness.
- Supplement the fertility program with potassium to eliminate deficiencies. Potassium is an important nutrient used by the plant during the hardening process. Initiate the applications in early September when the hardening-off process begins.
- Avoid heavy early fall (late September to mid-October) nitrogen applications that can promote excessive shoot growth at the expense of carbohydrate storage and root development. Late fall dormant nitrogen applications made with a controlled-release nitrogen source should not impact the hardening-off process.
- Take steps to alleviate soil compaction in late summer to promote stronger growth that will aid the plant in fall. Many turf managers also hand-fork low areas or cultivate the greens with the VertiDrain machine equipped with solid tines in late fall to provide some winter drainage and perhaps help diffuse toxic gases during the winter months.
- Irrigate sparingly in fall to reduce plant hydration. Predisposing the turfgrass to moderate drought stress will lead to greater hardiness and improve the cells' ability to tolerate dehydration in winter.

A rapid and severe temperature drop could spell disaster for hydrated turf.

DEALING WITH SNOW AND ICE

Perhaps the most difficult management decision for turf managers involves snow and ice removal. The management decision and ultimate success of the actions taken depend on many variables, including the calendar date, weather conditions, and ice cover duration. The insulation provided by the snow cover is beneficial for helping the plants retain their hardiness. Snow removal is not usually initiated until later winter or early spring, unless an ice layer is present below. Paths are sometimes cleared through deep snow to allow water to flow off the greens more rapidly during periods of thaw. The goal is to prevent standing water that hydrates the turfgrass, leaving it more susceptible to freeze injury.

Snow may be removed earlier in winter if it becomes necessary to expose an ice layer. Remov-

Covering systems consisting of a permeable geotextile fabric, an insulating layer of straw, and a non-permeable cover offer protection against freeze injury.

ing a large snowpack can be a daunting task that requires a large staff and special equipment. Hours can be spent just clearing paths to access the green sites. Tractor-mounted snow blowers, snow grooming equipment, truck plows, payloaders, small bulldozers, snow shovels, and darkening agents are all used to remove snow from frozen greens. Heavier snow removal equipment is preferred for the task when a substantial ice layer is present and there is less fear of damaging the playing surface. It is critical that the snow be deposited far enough from the greens so that water will not flow back onto the greens as the snow melts.

Monitor the condition of annual bluegrass that has been under ice cover for 40 days.

A decision to remove ice is a more difficult one that can result in both good and bad consequences. The primary purpose for removing ice is to prevent damage from anoxia. The decision is usually based on the duration of ice cover. A standard rule of thumb often used is to begin monitoring the condition of annual bluegrass that has been under ice cover for 40 days, and begin removal work after 60 days or immediately if anoxic conditions are evident. Creeping bentgrass generally tolerates longer periods of ice cover, and action can be taken at the 60-day mark or longer if there are no signs of anoxic conditions. The type of ice cover can impact the decision as well. It is also important to monitor the green's surface for standing water after ice begins to melt. Take steps to remove ice dams and slush to move water off the greens.

Ice removal can be completed mechanically, with specialized geotextile fabrics, or with darkening agents. Natural organic fertilizers, topdressing sand, inorganic soil amendments, marking paints, sunflower seeds, charcoal dust, and many other substances are used as darkening agents to hasten ice removal when weather conditions are conducive to do so. The agents honeycomb the ice layer, making it porous and easier to remove from the greens.

Ice is also removed mechanically using core cultivation equipment equipped with solid tines. Larger VertiDrain and Aerway machines, vertical mowers, jackhammers, and sledgehammers have also been used when an ice layer has to go fast. Mechanical ice removal is usually made easier when a geotextile fabric is in place over the green. The cover provides some protection to the surface during the removal work, and the exposed ice seems to detach from the covers more easily. Geotextile mats are also installed on greens in late fall with the hope that they will expedite ice melt. One such mat is a black, open-weave material (Enkamat). The ice forms through the mat but is melted more rapidly from the heat absorbed by the exposed dark plastic material.

The actions taken to remove snow and ice covers expose the turf to wider temperature fluctuations, and this can lead to freeze injury. Concerns are greatest with grasses that have begun to break dormancy prematurely or are hydrated. A permeable cover may be reapplied to the exposed greens to offer some protection for the vulnerable plants until they regain some degree of hardiness.

THE USE OF PROTECTIVE COVERS

Permeable geotextile covers have long been used to protect turfgrass from winter wind desiccation and to promote earlier spring growth. The covers are sometimes used as protection against freeze injury as well. Unfortunately, they are usually far less effective for that purpose, as they provide only minimal insulation and do not prevent tissue hydration. More extensive covering systems are being utilized for the winter protection of greens. The covering systems utilize impermeable covers alone or consist of both permeable and impermeable covers and an insulating material. The covering systems are designed to prevent plant hydration and ice encasement and are used as insulation to help maintain plant hardiness.

The covering systems used specifically against freeze injury are not always effective; however, they certainly improve the odds for success in northern regions where injury is most common. More extensive cover systems using an insulating material are preferred where snow cover is not dependable or temperatures are especially cold.

The systems are usually composed of a permeable cover placed over the ground, followed by a 6- to 8-inch layer of clean straw, and finally an impermeable cover. The impermeable cover keeps the insulating material dry and also prevents water from hydrating the turf. The impermeable cover is installed so that water cannot move under the fabric from surrounding areas. This may involve draping the cover over surrounding mounds or inserting the cover edge under the sod.

A curled wood fiber mat (American Excelsior Company) is also used successfully to prevent freeze injury damage. It is applied alone over the surface or with an impermeable cover to provide insulation. Researchers and superintendents are continually experimenting with other insulating materials to simplify, improve, and reduce the costs associated with winter protection.

An impermeable cover alone is sometimes used to prevent plant hydration and associated freeze injury. The cover is usually installed over a permeable cover in the same ways discussed above, but without the insulating material. The use of the single non-permeable cover alone will not offer any insulation, so it is probably most effective in regions where there is a more dependable snowpack.

The cover systems are installed as late as possible in fall after the plants are hardened. The surfaces are first treated with fungicides and rodent repellent to protect against snow mold diseases and animal activity, respectively. Once in place, there is little to be done except to periodically monitor soil temperatures under the covers and to make sure the covers remain secure. The insulating covers should keep soil temperatures cold even as air temperatures climb. So, efforts to remove those cover systems is initiated in early spring, as the greens become accessible. Removing the non-insulated cover systems is more difficult and depends on air and soil temperatures and the condition of the turf. The non-permeable cover is removed when air and soil temperatures rise. The permeable cover is left in place to protect the turf from desiccation and temperature extremes until the plants have acclimated to the cooler weather.

The cover systems are not a guarantee that winter injury will be prevented. There are major concerns about snow mold disease under the covers. Anoxic conditions can also occur under more extensive covering systems, just as they do under ice. A strip of live turfgrass under a cover seam or tear is a telltale sign of cover-induced damage via suffocation. A grid system of perforated 2- to 4-inch drainage pipe is often installed under the cover systems in an attempt to provide some passive air exchange. The pipe is daylighted above the snowpack. Superintendents are installing chimney vents and are using other creative means to improve passive and forced airflow as concerns with anoxia become realized.

LONG-RANGE CONSIDERATIONS

What long-range strategies are available to reduce the likelihood of winter damage? One of the surest and most economical steps to prevent winter damage is to correct poor growing environments. Shaded turf is always more vulnerable to freeze injury for reasons discussed earlier and because annual bluegrass thrives in such environments. Ice cover will last the longest in the dense shade as well. Look at shade patterns in late summer and fall when determining what trees impact the turf most. Conifers tend to be the worst culprits, as they create very dense shade. Do not overlook dense afternoon shade patterns when reviewing green and fairway sites!

Poor surface drainage on greens and in fairways is a prerequisite for prolonged ice cover and freeze injury. Sure, the covering systems discussed above will offer some protection, but a better strategy is to correct the surface drainage problems. Correcting poor drainage may be as simple as lowering a collar lip that impedes water flow, or it may entail more extensive grading work to raise

Annual Cost for the Covering System Used to Cover 18 Greens at Hillsdale Golf and Country Club in Marebel, Quebec*

Fungicide protection	$3,100*
Covers	
3 Evergreen permeable	4,500
3 Ice Shield non-permeable	4,600
(replacement covers purchased annually)	
Straw, 1,000 bales @ $3	3,000
Vent system	700
Labor, 5-7 staff	11,000
(to apply fungicides, covers, straw, and spring removal)	
Total	$28,000

*Costs in Canadian dollars (Canadian $ × $0.66 = U.S. $)

Snow blowers have become invaluable tools for accessing greens and removing snow during the winter months.

water-holding depressions or low-lying areas. Complete reconstruction may be considered to totally redesign a poorly drained green and gain internal drainage. Both reconstruction and surface grading work provide the added benefit of regrassing the putting surfaces with more winter-tolerant bentgrass. The work is disruptive and can be expensive, but the costs and inconvenience are minimal when compared to the costs of winter injury protection and potential damage year after year.

Establishing and maintaining more winter-tolerant grasses will also reduce the occurrence and severity of winter injury. Creeping bentgrass is probably the most tolerant and practical grass for greens, tees, and fairways in the northern regions. However, rough bluegrass, with its extreme cold-temperature tolerance, is now being utilized for greens and fairways in the far north. Kentucky bluegrass is also being considered more and more for fairway plantings because of its relatively good tolerance of cold-temperature threats and disease.

WHERE DO WE GO FROM HERE?

Our knowledge base of winter injury is growing, but much yet needs to be learned. A better understanding of the physiological mechanisms and genes involved with cold-temperature hardiness will provide new tools for breeding more winter-tolerant turf species and cultivars, and provide managers with new strategies to maximize plant hardiness in fall. New and field-practical methods to monitor gases under ice and covering systems will soon be available to help with decisions involving snow and ice removal or a need for venting. Ongoing fieldwork at universities and golf courses will also refine the use of winter protection covering strategies and examine new products and ideas to aid in snow and ice removal.

Our ability to prevent or reduce the severity of damage continues to improve, but it is important to realize that winter injury remains a natural phenomenon whose effects are dictated mostly by weather. Even the most arduous fall preparations and the use of extensive covering systems will never completely prevent winter damage when unique weather conditions favor its occurrence. Experienced turf managers also realize the importance and the greatest challenge of obtaining a dose of good luck when it comes to surviving a northern winter.

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JIM SKORULSKI, *as a USGA agronomist, "covers" golf courses in the New England states and eastern Canada.*

EMPLOYEE TURNOVER: *Are They Really a Dime a Dozen?*

When you analyze it, the cost is actually considerably higher.

BY LIANNE LARSON

How often have you heard the old adage "Don't worry, employees are a dime a dozen"? There is significant cost associated with employee turnover. The Department of Labor's national employee turnover rate for the year 2000 was greater than 10 percent, and the rate for golf courses is frequently much higher.

Most operations can save a substantial amount of money by retaining employees and avoiding turnover, because turnover expense is costly. The direct and indirect costs associated with employment termination and replacement, and the training of new employees, can easily cost a small organization upwards of $50,000 annually.

A Rutgers University School of Management study states the average cost associated with the turnover of a management position to be 1.5 times a full year's salary. For example, a $55,000-per-year position could end up costing an organization $82,500 to replace it. This number may be very conservative in the case of a golf course superintendent, when different maintenance objectives, goals, and programs, along with different equipment and labor needs, are taken into account. Just as surprising is the high cost of replacing the average $9.50-per-hour employee, which occurs much more often. Cumulatively, turnover of these employees can cost your operation thousands of dollars annually.

As a superintendent, it can be frustrating to experience high turnover, and rates as high as 65% annually are not unheard of. Employee turnover affects all aspects of the maintenance operation, and no one is immune. Management spends an inordinate amount of time on the hiring and training processes. Mechanics will be affected by the new employee's learning curve, producing broken equipment, bent reels, incorrect fuel mixtures, and various other errors by inexperienced equipment operators. The veteran crew members might experience longer work weeks, heavier workloads, monotony, and less time for their own advanced training. Oh, and did I mention turf damage? How often have you seen the *rookie stripes* in front of scalped collar edges, gasoline spills from forgotten gas caps, or oil leaks that went undetected for hundreds of feet or possibly even several holes? These are just some of the simple mistakes that new, inexperienced maintenance staff make, and rest assured, the mistakes can be far more serious.

The investment of time, energy, and direction in training new employees before turning them loose on the golf course is worthwhile.

Calculating your facility's turnover cost is a good first step in fully understanding the importance of effective employee training and the value of retaining good employees. The University of Wisconsin Cooperative Extension Center for Community Economic Development has developed a formula to calculate employee turnover cost. The formula consists of four different categories:

1. Separation Cost
   - Cost of exit interview
   - Administrative cost
   - Separation pay
   - Increased unemployment compensation rates
2. Replacement Cost
   - Attracting applicants
   - Entrance interviews
   - Pre-employment screening and administrative cost
   - Acquisition cost
3. Training Cost
   - Formal training
   - Informal training
   - Performance differential
   - Added wear and tear on turf and equipment as a result of training new employees
4. Intangible Cost
   - Uncompensated increased workloads
   - Stress and tension
   - Decreased productivity due to loss of work group synergy
   - Reduction in quality of product

Note: Intangible costs are very real. They are, however, difficult if not impossible to measure.

Use the accompanying Turnover Cost Formula with reasonable cost estimate numbers inserted. Adjust these numbers to fit your situation to obtain an accurate turnover cost estimate for your operation.

TURNOVER COST FORMULA

Separation Cost	
Exit interview (15 minutes preparation, 30 minutes interview, 15 minutes follow-up)	$ 18
Cost of termination time	5
Cost of administrative functions	24
Separation pay (one week)	320
Increased unemployment (based on the Department of Labor)	272
Vacancy Cost	
Overtime (20 hours per week for 3 weeks)	855
Additional labor at 20 hours regular time for 3 weeks	440
Wages saved for 3 weeks	(1,140)
Replacement Cost	
Pre-employment job advertising	750
Pre-employment administrative	36
Cost of entrance interviews (5 at 1 hour and $20 each)	100
Staff cost (meetings necessary to keep morale up)	30
Training Cost	
Cost of information literature (handbooks, employee policies, job descriptions, etc.)	15
Formal training (5 weeks at 40 hours per week at $9.50 per hour)	1,900
Informal training (i.e., mentors)	1,000
Uniforms	250
Performance Differential	
Differential in performance (vacancy lag, reduced productivity, learning curve)	1,000
TOTAL TURNOVER COST PER EMPLOYEE	$5,875

TURNOVER IS NOT ONLY COSTLY . . .

In reality, employee turnover is costly and it can wreak havoc with the turf management program from a quality standpoint. While the intangible costs are sometimes impossible to calculate, they are very real and very significant. The emotional and physical effects of a high turnover rate can create decreased levels of employee morale and employee synergy, decrease productivity, and create higher employee tension and stress. Simply put, high turnover takes much of the fun out of work! It is very important to try to manage the remaining employees with an upbeat, positive management style, but in the rising tide of declining morale and increased turnover, this can be all but impossible.

UNDERSTANDING WHY

Understanding employee turnover is the first step towards learning ways of preventing it. Involuntary turnover is the result of well-known factors such as local economic and labor market conditions. These causes may be impossible to manage directly. Voluntary turnover causes, such as non-competitive compensation, high stress, monotony, and poor guidance and supervision, are easier to identify and easier to manage. One way to address the issue of voluntary employee turnover is to correct the causes. You may not be able to correct them all, but eliminate as many as possible.

Make sure there are no surprises when an employee is hired. It is essential to be up front in the interviewing process. Let prospective employees know both the positive and negative aspects of the job. Let them know that early morning starts are required, weekend work is necessary, weather extremes are part of the job, and any other negative aspects that might cause an employee to leave. Let the prospective employees read and review the job description for the position, the position's necessary training programs, and a solid review of your company's handbook. These tools, and allowing enough uninterrupted time to properly interview prospective employees, will help reduce employee turnover in the long run. *No surprises* should be your goal!

Be open-minded and creative in the type of person you target; do not exclude retirees, homemakers, or other part-time candidates. They can be dedicated and reliable employees who can fill vacancies in a productive and congenial manner.

When you think you have found the person who best fits your team's needs, check their references. This is a way to legitimize information obtained during the interview, and references are not to be taken lightly. Effective background checks can avoid turnovers.

Once the new employee is on board, spend time to adequately introduce the employee to the team, review the club's expectations, and begin the training process. While training employees, look for signs of confusion or stress. Address these feelings and concerns early on. Make the new hire feel an important part of the team as quickly as possible.

Employees are largely responsible for the success or failure of any operation. Remember, the lowliest staff member can make the golf course superintendent look like a genius or a goat in a heartbeat. It is important to spend time with your employees and listen to their ideas and concerns. Keep them informed, challenged, and empowered. It is worth investing the time and effort to hire, train, and develop a competent staff, because employees are not a dime a dozen. If you put a pencil to it, you will see that employees more likely are $70,500 per dozen! And what club could not use an additional $70,500?

For more information, visit the U.S. Department of Labor at www.usdol.gov, the University of Wisconsin's Cooperative Extension Human Resource Center at www.isquare.com, and 2002 Bureau of Labor Statistics at www.bls.gov/jlt.

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Research *You Can Use*

A Parasitic Fly That Kills Mole Crickets

Identifying natural parasites for mole crickets as part of a long-term control strategy.

BY HOWARD FRANK

LYLE BUSS/UF

An *Ormia depleta* pupa next to a dead adult mole cricket. The mole cricket was killed by an *Ormia depleta* larva that then became this pupa. Up to five fly larvae may develop successfully in an adult mole cricket, and the process is always fatal to the mole cricket regardless of the number of fly larvae.

From coastal North Carolina south to Florida and west to Texas, mole crickets are major problems on golf courses. Huge sums of money are spent on pesticides every year to control them, and this seems only to give temporary relief from the problem. What would it take to get some level of *permanent* control?

Not all mole crickets are pests.[3] Although the northern mole cricket (*Neocurtilla hexadactyla*) gets into turf, it seldom becomes numerous enough to do any damage. At least one of the reasons for that is because it is native to the eastern USA and has native natural enemies that keep its numbers in check. These natural enemies include a wasp (*Larra analis*) and a beneficial nematode (*Steinernema neocurtillae*) that seems to attack only this species of mole cricket. The services of these parasites are free wherever they occur naturally and provide permanent control.

The tawny mole cricket (*Scapteriscus vicinus*), southern mole cricket (*Scapteriscus borellii*), and short-winged mole cricket (*Scapteriscus abbreviatus*) are not native to the USA. All three of these pests arrived about 100 years ago and left their natural enemies in their South American homelands. The University of Florida Mole Cricket Research Program began to investigate and import those natural enemies in the 1980s. Currently, two of those imported natural enemies are established year-round in the Gainesville, Florida, area. Together they provide about 95% control of tawny and short-winged mole crickets.[2] Numbers of tawny and southern mole crickets in the Gainesville area are about 95% less than they were in the 1980s due to action of another wasp (*Larra bicolor*) and another beneficial nematode (*Steinernema scapterisci*) from South America.

What is remarkable about these imported wasps and nematodes is that they now occur all around the Gainesville area and provide area-wide control for free. Year by year the area occupied by this wasp and nematode keeps increasing naturally, so that the area where mole crickets are controlled expands.

This article is about a third biological control agent, a fly called *Ormia depleta* that was imported by the University of Florida Mole Cricket Research Program in 1987 and released in 1988. By having a third biological control agent for mole crickets, the overall level of control for mole crickets may be improved. In addition, this fly may help establish biological control of mole crickets in states north of Florida, such as the Carolinas, where mole crickets are also a serious problem.

THE FLY: *ORMIA DEPLETA*

The initial stock of flies imported to Florida came from Piracicaba, a subtropical city at about 23°S in Brazil. Rearing methods were devised,[9] and flies were initially released at three localities: Gainesville (north Florida), Bradenton (central Florida), and Miami (south Florida). Establishment of populations occurred at all three places. Research sponsored by the Florida Turfgrass Association in 1990-1991, which included 28 participating golf courses, allowed for releases to be made at these golf courses in 16 counties covering all regions of Florida.

By the end of 1994, a continuous population of this fly had been established in 38 contiguous peninsular counties,[4] but not farther north. The fly seemed to be poorly adapted to survive the winters north of about 28°N. This seems reasonable since it had come from a subtropical area.[7]

Lack of expansion of the *Ormia depleta* population in north Florida suggested that its origin was too tropical and that it could not survive winters in north Florida because it was unable to diapause. Diapause is a condition (like hibernation) in which individuals enter dormancy during winter (or other periods when resources are not available). It was hoped that additional flies could be collected from farther south in South America, in an area with colder winters, where the local population of flies can diapause. These hardier flies could then be used to expand biological control of mole crickets in the U.S. to states north of Florida.

HOW NEW *ORMIA DEPLETA* WERE OBTAINED

In 1998, the USGA funded a project that would explore the southernmost part of Brazil for a stock of *Ormia depleta*, bring that stock back to quarantine in Florida, and provide flies for release in other southern states. Despite extensive efforts to obtain the flies in 1998, the necessary permit was not processed in time by the Brazilian government, and no flies were brought back to the United States at that time. However, Dr. Howard Frank, University of Florida, returned to Brazil early in February 1999. He was able to collect seven gravid (pregnant) females and remove hundreds of larvae from these flies. Laboratory-reared mole crickets in Gainesville were inoculated with these larvae, and a culture was started.


LYLE BUSS/UF

Ormia depleta adult. Adults are nocturnal. Gravid females are attracted to the song of pest mole crickets and lay living larvae (not eggs) on their hosts.

The new (Osório) strain of *Ormia depleta* has been maintained in culture since. The flies have been reared using laboratory-reared short-winged mole crickets as hosts. When generations of flies were produced that contained more than 10% gravid females, the "surplus" (those that were not essential to maintain the culture) was shipped to other states for release. In 2000-2001, shipments of flies were made to collaborating entomologists in North Carolina, Georgia, Louisiana, and Texas for release in those states.

Each shipment consisted of either approximately 200 fly pupae or six to ten gravid female flies. Recipients were expected to release the flies and after a few months begin monitoring the release area for establishment of a population. To date, no recipient has reported establishment of the flies. Nonetheless, attempts to establish populations in other states continue. Additional flies were shipped to Louisiana in May 2002.

DISCOVERIES ABOUT THE FLY

In the laboratory, adult flies failed to survive long unless they were provided with artificial plant nectar (a mixture of sugars). It had been expected that adult flies in the wild need nectar from some unknown plant or group of plants. Identifying those plants was difficult because the flies are active only at night. One attempt made by the University of Florida Mole Cricket Research Program was to identify pollen grains attached to the bodies of field-trapped *Ormia depleta* (old strain) in Florida in hopes of identifying plants from which adult flies obtain nectar.

A second attempt to understand the flies' diet was made by entomology graduate student Craig Welch. He trapped adult flies at Bradenton (central Florida), took samples of their gut contents, and analyzed the sugars present by chromatography, a technique that allows each sugar present to be identified. Surprisingly, the main sugar present was melezitose.[8] This sugar is not normally present in plant nectars, but it is the principle component of honeydew. Honeydew is the sugary excretion of homopterous insects (aphids, mealy bugs, etc.). This means that the success of using this type of biological control depends on having honeydew-excreting insects in the area.

The principle is the same for butterfly gardening where, if we want to enhance butterfly populations locally, we must provide the plants from which butterflies obtain nectar. This work is

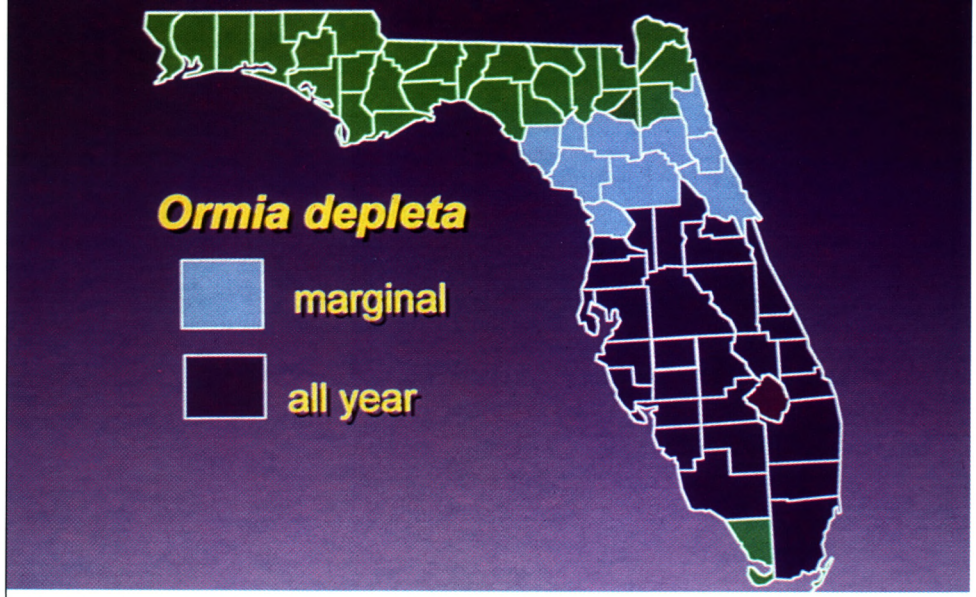
continuing and is investigating what homopterous insects on what plant hosts can be used to enhance *Ormia depleta* populations locally. In other words, how can we provide those resources in the landscaping of golf courses that will lay the foundation for biological control of mole crickets without causing other problems such as unsightly insect-infested plants?

The famed Doral golf course in Miami was one of the sites where *Ormia depleta* flies were released in 1990. Steve Kuhn, then superintendent, thought the fly had achieved about 90% control of pest mole crickets there. Craig Welch's research findings offer an explanation of that high level of success. Doral has a rich landscape of tropical and subtropical plants which can support homopterous insects (aphids, mealy bugs, etc.) throughout the year. It is likely that these newly released flies had the honeydew sources needed for their diets from the homopterous insects living on those tropical and subtropical plants of the golf course landscape.

FUTURE RESEARCH

The simplest and least expensive research is to determine whether the new strain of *Ormia depleta* can undergo diapause. If this new fly strain can do so, it will immediately be useful in other states, and releases will continue in other states until new populations of flies are established there. If the new strain cannot diapause, then one option is to determine whether it can be produced in adequate numbers for annual inoculative release each spring in other states. However, it will take improvements in rearing methods for both mole crickets and the flies, as well as improvements in the proportion of flies becoming gravid before such a strategy becomes viable.

It might be possible to produce a diapausing strain of the fly by genetic engineering, but undoubtedly this would be a very expensive option because the genetics of this fly have not yet been investigated. However, in view of the importance of mole crickets as a serious golf course pest, this should not be ruled out.



Florida counties in which permanent (dark blue) and seasonal (pale blue) populations of the old (Piracicaba) strain of *Ormia depleta* are established. In the counties shaded dark blue, *Ormia depleta* provides partial control of pest mole crickets at no cost. In the areas shaded pale blue, the old strain of the fly seems not to survive the winters and it recolonizes from the south in most years. A strain that can diapause is necessary to occupy the area shaded light blue and northward.

Wherever populations of the fly have become established, there is a strong and inexpensive option of enhancing their populations by providing honeydew sources. It is hoped that by finding the right plants to support honeydew-producing insects, enough parasitic flies can be produced to effectively and permanently control mole crickets. Current research is aimed at this possibility in hopes of benefiting hundreds of golf courses affected by mole crickets.

ACKNOWLEDGMENTS

USGA funding made possible collection of the new strain of *Ormia depleta* from southern Brazil, its maintenance in culture in Florida, and shipment of stock to other southern states. Dr. Luiz Salles (EMBRAPA, Pelotas) provided essential help in southern Brazil. E. Buss and F. Slansky kindly reviewed an early draft of this manuscript.

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Four Steps to Help Ensure a Successful Green Reconstruction Project

By proceeding step by step, this complex process can be made manageable.

BY JIM MOORE

Many golf courses eventually find it necessary to rebuild some or all of their greens. The impetus for such a major reconstruction effort comes from many sources, including:

- Increased play on greens that are too small to withstand the traffic they receive.
- The desire to change to new turfgrasses that are superior both agronomically and in terms of putting quality.
- A decline in the quality of irrigation water, demanding a better-drained rootzone.
- A desire to upgrade the course architecturally.

Although rebuilding putting greens might seem fairly straightforward to some, it is actually a complex process with many opportunities for problems to arise. Selecting the proper construction materials and making certain those materials remain consistent throughout the project are absolutely critical — regardless of the green construction method chosen. On an existing course about to embark on a green reconstruction project, the golf course superintendent is in the best position to implement and conduct a good quality-control program to help ensure the project's success.

The remainder of this article details four major steps that should be part of every greens reconstruction program.

To identify the best materials to be used in a reconstruction project, visit potential sand and gravel suppliers and learn about their products.

STEP 1
Initial Identification of Suitable Materials

When a course determines that green reconstruction is at least a possibility, the process of identifying prospective rootzone materials should begin. Since materials costs are a major component of the total construction costs, and since the costs of materials vary widely from place to place, an accurate estimate of the total cost of the project cannot be determined without identifying the materials to be used.

To identify the best materials, the golf course superintendent should visit potential sand and gravel suppliers. If organic matter is being considered as an amendment, it may also be possible to visit the supplier, if it is local.

The superintendent should make an effort to get to know each of the suppliers and learn about their products and overall operation. He should share with the supplier information about golf green construction in general and specifics about the project being considered. The USGA Green Section can help by providing technical information regarding golf course construction issues to any interested party, free of charge. The superintendent should question the supplier about issues such as production capability, consistency of particle size distribution (virtually all sand and gravel suppliers regularly screen test their products to meet the requirements of other customers, such as concrete producers and the Department of Transportation), the availability of an area for blending and/or stockpiling, and, of course, cost.

When it has been determined that the supplier can produce the sand and/or gravel in sufficient quantities to meet the needs of the project, samples should be collected for laboratory analysis. The superintendent should collect the samples using a standardized collection procedure (see the USGA Green Section document entitled *Quality Control Sampling of Sand and Rootzone Mixture Stockpiles*).

Suppliers often have more than one product that may be suitable for golf green construction. If the greens are to be built to the USGA's guidelines, the particle size specifications included in these guidelines can be compared to the screen tests performed by the supplier. This preliminary comparison can identify which products should be sampled for more detailed analysis.

Samples should be collected of each product that has a good chance of meeting the guidelines. Each sample should be carefully labeled and packed, then shipped to an accredited physical soil-testing laboratory (the USGA maintains a list of accredited soil-testing laboratories at www.usga.org/green/coned). Select *one laboratory to use for all testing throughout the entire project.* Instruct the laboratory to perform a complete analysis of the submitted materials and to develop various mixtures of the sand and organic matter. Most labs keep commonly utilized organic matter materials (such as peats) on hand and can make a wide variety of mixtures. Some organic matter sources (such as composts) are very specific to small parts of the country and probably wouldn't be kept in storage at the lab.

In summary, this first step is merely to identify suitable materials for the project and in what percentages those materials will be mixed together.

STEP 2
Determine Which Laboratory Mixture Best Fits the Needs of the Project

Ideally, the laboratory will report the results of each of the various combinations of sand and organic matter. They also may recommend the mixture they believe is best for the project. Nevertheless, ultimately it should be the owner's representative (ideally the golf course superintendent) who makes the final decision. Consideration should be given to the type of turfgrass to be maintained, climate, irrigation water quality, as well as the cost of the materials. The USGA Green Section agronomists can provide valuable assistance in this decision-making process.

Sampling and testing several candidate materials is the best means to identify the most appropriate and cost-effective products.

STEP 3
Calibration of the Blending Equipment and Development of the Target Values

The next step is to actually begin producing the rootzone material for the greens. It is likely that months will have passed since the first testing process took place in Step 1. By now, the project has been approved, contractors selected, and construction is underway. The sand supplier is ready to provide the sand, the organic matter has been delivered, and the blending contractor is ready to begin producing the mixture to go into the green cavity. The goal now is to produce a mixture that is acceptable to all concerned parties. The blender should be instructed to blend 200 tons of mix, using the materials and mixing ratio identified in Step 1. The superintendent should collect a sample from the 200-ton pile using the standardized sampling procedure. The same laboratory that did the preliminary testing should test the sample. When the lab returns the test results, they should be compared against the results of the preliminary testing. It is unlikely (and unnecessary) that these two tests will be identical.

It is very important to realize that the test results for the 200-ton pile will almost certainly vary from the results of the initial identification phase testing. It is unreasonable to expect the numbers to be identical for the following reasons:

During the identification phase testing, the various mixes were made in the laboratory by hand. Mixing organic matter and sand by hand and in small volumes is a much more gentle process than what occurs when the same materials are blended with large, mechanized augers. During such blending operations, the mix components are literally ground together, which can result in changes in the makeup of the materials.

Collect samples using a standardized collection procedure. The USGA has a publication available that outlines the proper methods.

Even the best sand sources are likely to see some changes in the particle size distribution of the sand harvested from a pit or river. Since months may have elapsed between the initial identification tests and the production of the first 200 tons, the particle size distribution of the sand is likely to have changed.

As mentioned earlier, most laboratories keep on hand caches of the most commonly used organic amendments. Like sand and gravel, organic materials can change from month to month and therefore from lot to lot of the packaged product.

Allowing for these unavoidable variations, if it is determined that the 200-ton pile is of acceptable quality, the blending process can begin on a full-scale basis. The results of the 200-ton pile testing should become the *target values* for all future blending. The USGA Green Section document *Guidelines for Establishing Quality Control Tolerances* outlines the plus or minus values that should be utilized when comparing samples to the target values.

Should the test results of the 200-ton pile prove unacceptable, the testing laboratory should be consulted regarding the best choice of remedial action. If the particle size distribution of the sand and organic matter have remained fairly consistent since the preliminary testing, it may simply be a matter of adjusting the blending ratio to make the mix acceptable. However, if adjusting the blending equipment does not correct the problem, the sand may need to be processed further (through additional washing and/or screening) to achieve a more favorable particle size distribution. It is also possible that the organic material has changed in its composition. Either way, the entire testing process will need to be repeated until a satisfactory 200-ton pile can be achieved. This is critical to establish the target values for the remainder of the blending process.

STEP 4
Production of the Rootzone Mixture

After the physical properties of the target values have been identified, mass production of the rootzone mixture can begin. For most projects, the rootzone mix should be blended in 1,000-ton increments, a quantity acceptable for most projects. However, if the sand and/or organic amendments tend to vary in their makeup, 500-ton lots will provide a greater degree of quality control. Lots of 500 tons are also a good idea when the laboratory test results indicate the materials are borderline in terms of meeting the construction guidelines chosen for the project.

Whether mixed in 500-ton or 1,000-ton increments, each pile of rootzone mix should be sampled using the standardized procedure. The test results of each pile should be compared to the target values. Again, it is highly unlikely that the mass-production samples and the target values will match exactly.

If all of the test results are within acceptable tolerances, the mass-production pile should be marked ready for delivery to the project. However, if any aspect of the testing indicates the pile has deviated from the target values by more than the tolerances identified in the *Guidelines*, and the new properties are unacceptable, the pile should be reblended and retested.

After a mass-production pile has been approved, it can be hauled to the project or stored for later delivery. As each pile is tested and approved, it can be combined with previously approved piles for the sake of storage.

CONCLUSION

By following the above procedure, the golf course superintendent can ensure reasonable consistency of the rootzone mixture throughout the entire blending operation. In addition, most contractual disputes can be avoided by following the five suggestions listed below.

- Select one accredited laboratory and use only that laboratory for all testing.
- Select one sampling procedure and use that procedure for every sample collected.
- One individual (preferably the golf course superintendent or owner's representative) should collect all samples throughout the project.
- Identify a single point at which the rootzone mixture is tested to determine if it meets the requirements of the contract. Ideally, the rootzone mixture should be tested immediately following blending and before it is hauled to the construction site. Note that testing at any other time during the project possibly could result in test results that are significantly different from the target sample and the initial identification samples.
- Prior to blending, all parties should agree on the procedure to follow should a pile fail any part of the quality-control test. The first step should be to repeat the test to ensure a laboratory anomaly has not occurred. Should the second test confirm the results of the first test, options include reblending and/or utilization of the mixture for tee tops or some other area of the course.

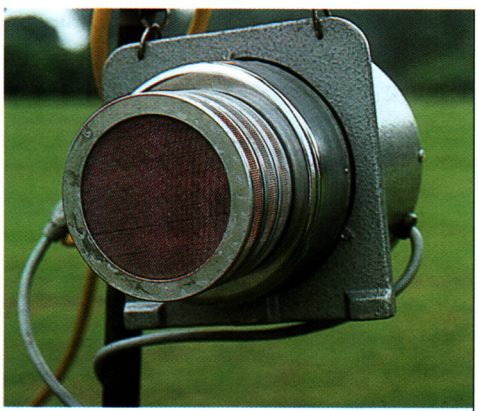
JIM MOORE *is the director of the USGA Green Section's Construction Education Program.*

Research *You Can Use*

Modeling Pesticide Volatilization From Turf

How much pesticide is lost as fumes and vapors from treated turf?

BY DOUGLAS A. HAITH



Using an air sampler to collect vapors from evaporated pesticides, researchers evaluate how environmental conditions impact pesticide evaporation loss.

Control of turf pests has to be one of the least attractive and most worrisome aspects of turf management. While the use of chemical pesticides is generally considered necessary to maintain high turf quality, those same toxic properties that provide pest control may be hazardous to ecosystems and human health. Pest management is a balance between healthy, functional turf and a safe, sustainable environment. The way out of this challenging situation is through the use of *best management practices* that not only limit pest damage, but also have minimal environmental risk.

The search for such control options is a major goal of researchers, managers, and many others in the turf industry. A key requirement for this work is the ability to predict what happens to pesticides after their application to the turf. Are the chemicals taken up by the grass? Do they dissolve and leach into the soil and move to groundwater? Are they washed away in runoff to streams and ponds? Do they vaporize and are the fumes breathed by golfers and others? With such knowledge, we can identify chemicals and application methods that minimize the risk to both the environment and to human health.

The most useful tools for predicting chemical behaviors in the environment are "fate and transport" models. These are mathematical equations of chemical transformations and transport that are converted into computer programs that can be run for any chemical or site of interest. The software user typically provides input data, including weather records, chemical properties, and site characteristics, and the program calculates disposition of the chemical. Fate and transport models are routinely used in assessment of air pollution from combustion emissions (e.g., power plants and automobiles) and water pollution from municipal and industrial wastes, as well as for chemicals applied to agricultural crops. The approach has seldom been applied to turf, however, mainly due to a lack of suitable models.

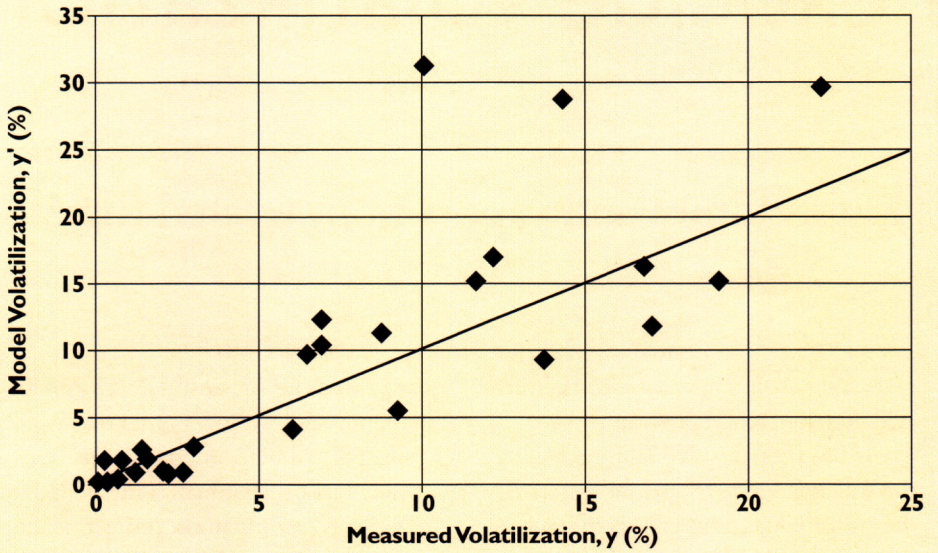
The USGA Turfgrass and Environmental Research Program has sponsored research at Cornell on fate and transport modeling for turf systems for the past several years. A recent *Green Section Record* article (March/April 2002) described the successful development of a pesticide runoff model that is now being distributed to consultants and other turf professionals. This article describes a companion project dealing with volatilization of turf pesticides. The primary goal is the development and testing of a fate and transport model that can be used to predict the amounts of a pesticide that will volatilize from turf under various site and weather conditions. Another goal of the project is to determine the likely effects of those vapors on human health.

PREDICTING PESTICIDE VOLATILIZATION

The physics of volatilization are well understood. Molecules of a substance escape as a gas, typically from a liquid, when sufficient energy is provided. The gas accumulates above the liquid surface, and, in the absence of air movement, eventually saturates the air, limiting further vaporization. In the case of pesticides, however, several factors complicate this simple picture. Pesticide vapors may be transported away from the ground surface by moving air, thus encouraging more volatilization. Pesticides on the grass and thatch may be in solid or liquid form. Portions of the chemicals may be adsorbed by thatch and grass organic matter. Biological and chemical degradation may also occur.

Even considering these complicating factors, there is a volatilization process with which we are very familiar. That

Figure 1
Comparison of Modeled and Measured Pesticide Volatilization for Each Experiment



involves the loss of water vapor from turf through evapotranspiration (ET). Pesticide volatilization is governed by the same processes that affect water evaporation. So factors such as air temperature, solar radiation, and wind movement can be expected to have comparable effects on vaporization of both water and pesticides. Models for estimating ET from turfgrass are readily available. It is reasonable that evaporation values from such models could be converted to pesticide vaporization by scaling factors that reflect the differences in chemical properties of water and pesticide.

This hypothesis was tested by constructing a simple volatilization model that first computed hourly ET using a modified Penman equation. These water values were then adjusted using two chemical properties, vapor pressure and latent heat of vaporization of the water and the pesticide. The model also calculated a simple mass balance of pesticide on the turf vegetation. We did not distinguish between pesticides that were dissolved or in solid form. All were assumed as potentially volatile.

The model was tested using data from field turf experiments conducted at the University of Massachusetts's Turfgrass Research Center in South Deerfield. The plots had well established creeping bentgrass maintained at a half-inch mowing height. Thatch thickness ranged from about 0.4" to 0.6". The soil was a Hadley silt loam. Irrigation was applied as necessary to prevent drought stress.

Testing data included the measured concentrations of volatile residues following application of pesticides in 11 experiments conducted in the 1995-97 growing seasons. Pesticides were applied at the beginning of each experiment, and volatile residues were collected during sampling intervals of one to four hours between 8:00 AM and 7:00 PM.

PREDICTED VERSUS MEASURED

The experimental measured volatilization values are compared with model predictions for six chemicals in Figure 1. Each data point in the figure corresponds to the model prediction and measured pesticide volatilization for an experiment. Points lying on the line $y' = y$ represent perfect model performance. In other words, model values are exactly equal to observations. Points above the line indicate over-prediction by the model where predicted pesticide volatilization is higher than the measured value. Events lying under the line are under-predicted. Most results fall relatively close to the line of perfect prediction ($y' = y$), although in three of the ethoprop experiments, model predictions were much too high.

Table 1 compares the predictions and measurements for each pesticide. In general, it is encouraging that the model appears to be most applicable to those chemicals that have the largest volatilization losses (diazinon, ethoprop, chlorpyrifos). This conclusion is qualified somewhat by the substantial over-prediction of ethoprop vaporization. The results were also relatively good for the two chemicals with moderate vola-

Table 1
Comparison of Modeled and Measured Pesticide Volatilization

Pesticide	Number of Experiments	Mean Volatilization (% of applied)	
		Model	Measured
Bendiocarb	4	1.63	1.74
Carbaryl	4	0.07	0.28
Chlorpyrifos	4	8.16	8.25
Diazinon	4	10.04	10.46
Ethoprop	7	21.82	15.15
Isofenphos	6	0.97	1.53
	Mean (all events)	8.23	6.82

tilization, bendiocarb (1.63%) and isofenphos (1.53%), although the predicted isofenphos mean was only 63% of the observed value. The only severe error was for carbaryl. However, given the very low measured values (0.28%), it is difficult to give much significance to this error. Based on these results, we are confident that an ET-based approach is a reasonable way to estimate pesticide volatilization from turf.

PREDICTION OF HEALTH HAZARDS FROM PESTICIDE VAPORS

The health impact of inhaled pesticide vapors can be described through the concept of a hazard quotient (HQ). The HQ is the estimated inhaled dose for a 70 kg (154 lb.) adult divided by the "chronic reference dose" (Rfd) for the chemical. The Rfd is the level of a chemical in the body which is likely to cause chronic health problems. Pesticide concentrations that produce an HQ greater than "1" are potentially unsafe or hazardous. Thus, given reliable estimates of vapor concentrations, we can relate them directly to human health hazards. The challenge has been to obtain these estimates of vapor concentrations.

One approach is to relate pesticide concentrations in the air above the turf to simple chemical properties, such as vapor pressure. Figure 2 shows the relationship between maximum air concentration and vapor pressure for the pesticides used in the experiments in the previous section. It is apparent that chemicals with the highest vapor pressures also have the highest air concentrations. We used the relationship in Figure 2 to estimate maximum vapor concentrations and associated inhalation hazard quotients (HQs) for eight pesticides included in the Massachusetts experiments. HQs were also calculated using the measured concentrations, and the two sets are compared in Table 2.

Although the vapor pressure relationship results in HQ values that are different from measured values, the differences are not large enough to produce misleading conclusions regarding hazards. The estimated concentrations clearly identify the same hazardous chemicals (HQ > 1) as would be flagged by the measured concentrations. Diazinon, ethoprop, and isazofos appear to have clear volatilization hazards, but bendiocarb, carbaryl, chlorpyrifos, and isofenphos are relatively benign.

In conclusion, this work demonstrates that using an ET-based model to predict volatilization losses of turfgrass pesticides is feasible. It also demonstrates that by using a simple chemical property, such as vapor pressure, hazard quotients can be estimated for turfgrass pesticides that accurately rank their health hazards.

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Figure 2
Relationship Between Maximum Pesticide Comparison in Air Above Turf and Chemical Vapor Pressure

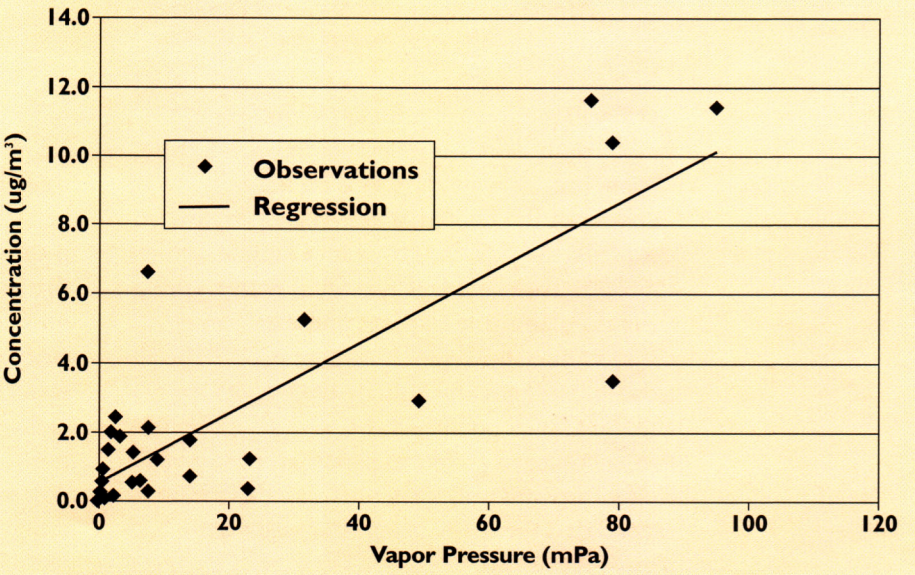

Table 2
Comparison of Volatilization Hazard Quotients (HQs) Based on Measured Pesticide Concentrations and Concentrations Predicted from the Vapor Pressure Relationship in Figure 2

Chemical	Hazard Quotient (HQ) Determined from Measured Concentration	Hazard Quotient (HQ) Determined from Predicted Concentration
Bendiocarb	0.01	0.03
Carbaryl	0.00	0.01
Chlorpyrifos	0.09	0.04
Diazinon	2.8	2.7
Ethoprop	70.2	61.9
Isazofos	5.2	13.1
Isofenphos	0.12	0.17
Trichlorfon	0.04	0.04

TROLLEY FOLLIES

Guidelines for using pull-carts.

BY PATRICK J. GROSS

The popularity of pull-carts is on the rise as more people choose to walk the course without the strain of having to carry their clubs.

Call them what you like — pull-carts, push-carts, or trolleys — the use of these bag-carrying devices is on the rise throughout the United States. Many people choose to use pull-carts to reduce fatigue on the shoulders, back, and legs associated with carrying their clubs. In many respects, pull-carts can be viewed as a positive trend, as more people choose to walk while playing golf. In 1995, *Golf Digest* and the USGA published *A Call to Feet*, a booklet that encouraged golfers to park their motorized riding carts and walk the course. The brochure emphasized the many benefits of walking, including:

- The health benefits of burning more calories and the reduction of cholesterol levels.
- More enjoyment of the quality and beauty of the golf course.
- Getting back to the tradition of the game in which walking the course plays a significant role.
- More time for interaction and conversation with opponents or fellow competitors.

With more golfers walking and using pull-carts, superintendents and course officials are questioning whether pull-carts are damaging the course and if specific rules should be established for the use of pull-carts.

A COMPARISON OF PULL-CARTS AND MOTORIZED GOLF CARTS

Pull-carts come in a variety of shapes, sizes, and styles. Most hand-drawn carts generally weigh 7 lbs. to 17 lbs., with the weight of the cart and golf bag distributed over two or three wheels. The older style two-wheel carts with narrow 2" tires are gradually being replaced by newer, lightweight models that have a tire width of 3" to 4" for better weight displacement. Another development is the three-wheel push-cart with air-filled tires that are easier to push and provide better stability on uneven surfaces. There is an increase in popularity of motorized bag carriers that are propelled by a chain or drive train and powered by a small battery. These models are slightly heavier than the non-motorized pull-cart. There is even experimentation with remote-control bag carriers that follow the golfer throughout the course with the use of a small transmitter worn by the golfer and the use of GPS technology. In general, pull-carts are easy to maneuver and allow the golfer to walk directly to the ball in preparation to hit the next shot.

In contrast, most electric and gas-powered golf carts are relatively standard in design, with seats for two golfers and space at the rear of the vehicle to secure two sets of clubs. Most motorized golf carts weigh between 800 and 900 lbs., not counting the added weight of two riders and golf bags. The weight is displaced over four air-filled tires with a relatively wide contact patch over the turf.

DO PULL-CARTS CAUSE DAMAGE?

Superintendents spend a significant amount of time preventing or correcting damage caused by motorized golf carts with programs including core aeration, sodding ends of cart paths, and managing a network of ropes and stakes to distribute wear. Turf damage by golf carts is mostly a function of

the greater weight of the vehicle combined with the abrasive action of the wheels during turns, starts, and stops, as well as repeated traffic over a confined area.

Intuitively, we know that pull-carts are far lighter than motorized golf carts, but this does not mean that pull-carts do not damage turf. Reported damage is not so much a function of the physical characteristics of the pull-carts, but rather where they are taken. Concentrated foot traffic and pull-cart use in a confined area is likely to cause thin turf conditions comparable to the damage caused by motorized golf carts. Because pull-carts are more maneuverable, golfers are more inclined to take these devices in areas they would not normally drive golf carts. Areas that are most vulnerable include:

- Tees.
- Green fronts (aprons).

Wide tires help, but keep them off the collars.

Golfers with pull-carts are inclined to take the most direct path to their next shot, even if that means pulling their cart across the narrow gap between the green and surrounding bunkers. To avoid damage, pull-carts should always be taken outside the greens and bunker surrounds.

- Narrow areas between greens and surrounding bunkers.
- Edges of greens.
- Poorly drained areas of the course.

Other concerns include the use of pull-carts during the winter when there is less potential for turf recovery and unrestricted pull-cart use when the course is excessively wet, which contributes to rutting and soil compaction.

Some courses have banned the use of pull-carts, citing the smaller tires that may cause greater soil compaction and turf damage. There is little evidence to support this claim, which is usually an attempt to force golfers to rent motorized golf carts. It is important to point out that any vehicle (pull-cart, motorized golf cart, or turf maintenance equipment) will cause damage to wet, saturated turf. Restrictions on pull-carts should be considered on days when conditions are excessively wet and there is potential for the carts to cause ruts in the turf. Under relatively dry conditions, there is very little damage observed from pull-carts except in confined areas. Some of the more exclusive clubs or high-end daily-fee courses do not like the look of pull-carts, in which case the banning of pull-carts is a personal choice and no reflection on the perceived damage cause by pull-carts. There may be legitimate concerns regarding the use of pull-carts due to unusually hilly terrain that may pose a safety risk or where there is an extended distance between greens and tees that would slow the pace of play.

ETIQUETTE AND GUIDELINES FOR USING PULL-CARTS

Golfers who choose to use pull-carts during a round of golf should do so in a way that does not cause damage to the course or negatively influence playing conditions. This is often a matter of good common sense and proper golf etiquette. Tees and greens are the most heavily trafficked sections of the golf course and appear to be the areas most prone to damage by pull-carts. Golfers are especially sensitive to turf conditions on the aprons and green banks, which are important areas for the short game. Unnecessary traffic from pull-carts contributes to matted turf and undesirable playing conditions around greens.

To simplify policy, many courses enforce the same rules for pull-carts as for motorized golf carts, i.e., carts must be kept 30 feet away from all tees and greens. Alternative policies can be formulated based on the following guidelines to accommodate special circumstances at each course:

- Pull-carts should have wide wheels (approximately 3" to 4") or air-filled tires to displace the weight of the cart and golf bag over a wider area. The heavier battery-operated carts should not pose a concern as long as they have relatively wide wheels.
- Pull-carts should be kept a reasonable distance from tees and greens, and they should never be parked directly on tees or greens. A reasonable guideline is to park pull-carts 15 to 30 feet from the edge of tees and greens. Cart paths should be used for parking pull-carts wherever they are available, especially around tees.

Golf course superintendents spend a significant amount of time correcting damage caused by motorized golf carts.

Guidelines for Using Pull-Carts

- Pull-carts should have wide wheels (approximately 3" to 4") or air-filled tires.
- Pull-carts should be kept 15 to 30 feet from the edges of tees and greens.
- Pull-carts should be directed around greenside bunkers and should never be taken in the narrow gap between the green and surrounding bunkers.
- Pull-carts should never be taken across excessively wet areas.
- The use of pull-carts should be suspended or restricted following periods of heavy rainfall or under persistently wet conditions.

• Pull-carts should be directed around greenside bunkers and should never be taken in the narrow gap between the green and surrounding bunkers.
• Pull-carts should never be taken across excessively wet areas, which is likely to cause turf damage and rutting.
• Policies that temporarily suspend the use of pull-carts should be considered following periods of heavy rainfall or in sections of the country that experience persistently wet conditions for an extended period of time.

CONCLUSION

Pull-carts have made the game more enjoyable for many golfers by allowing them to walk the course without the added exertion of carrying their clubs. Golfers have known this for years in England, Ireland, and Scotland, where the use of "trolleys" is common. Superintendents, golf professionals, and course officials should not be overly concerned about the use of pull-carts since they are lighter weight and far easier on the turf than larger motorized vehicles. While many courses have policies for the use of motorized golf carts, few have addressed rules for the use of pull-carts. The points discussed in this article, along with proper golf etiquette and good common sense, should guide the development of such policies. Encouraging golfers to walk the course more often, along with the possible use of a pull-cart, is better for the golfer's health, better for the course, and better for the game.

Pull-carts should always be kept a reasonable distance from the green to avoid matting down the turf in the sensitive playing areas around the greens. Golfers also should take care to avoid taking pull-carts across excessively wet areas.

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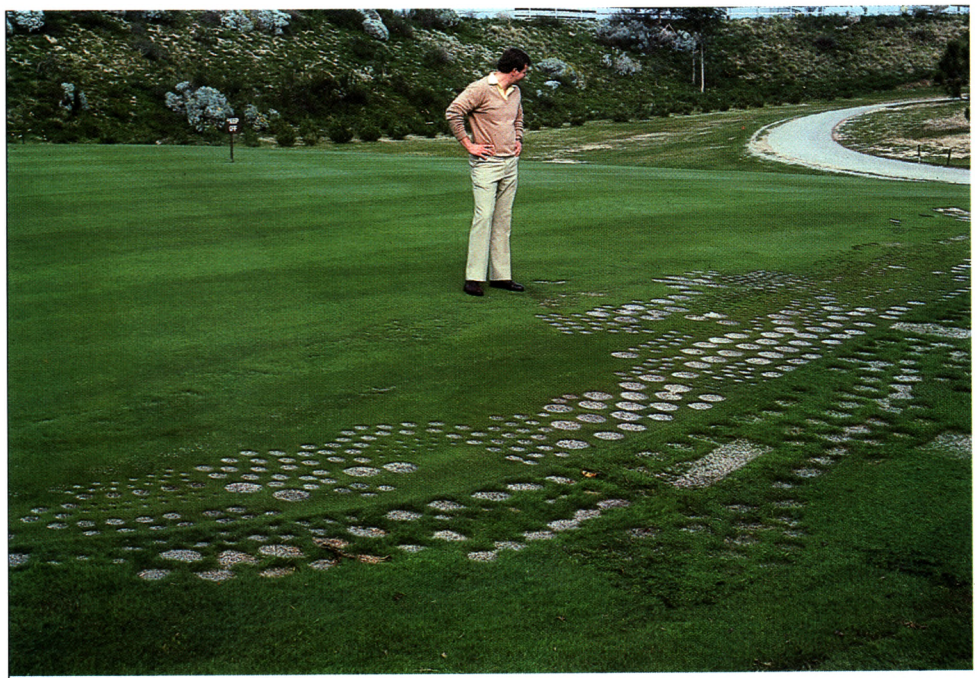
Research *You Can Use*

Oxygenator Solutions for Bentgrass Putting Greens

Maybe soil oxygenator sprays can help your bentgrass putting greens. Or maybe not.

BY BETH GUERTAL



Try products on your nursery area before applying them to the entire golf course.

It's hot, it's humid, and your bentgrass putting greens are in trouble. All the typical management tools have been called into use: fans, syringing, and any other technique you can think of to create air movement and cool the putting green surface. Perhaps you are considering some amendments, a growth-enhancing agent, a bioproduct, or a material designed to increase the oxygen content in the underlying greens mix. Of course, many new growth-promoting additives don't have a long history of use, and it might be difficult to determine if you are really seeing a result from their application. The purpose of this article is to report on the results we saw from a two-year study in which we applied a commercial oxygenator spray to bentgrass putting greens.

The study was conducted in 2000 and 2001 at two locations: the Auburn University Turfgrass Research Unit (TGRU) and Auburn Links (AU Links), a local golf course. Bentgrass at the TGRU was a two-year-old stand of "Crenshaw" growing in a loamy sand push-up putting green, while bentgrass at AU Links was a 10-year-old stand of "Penncross" growing in a USGA-type sand/peat mix. Treatments were:

1) Commercial oxygenator (Comm) spray applied once per week.

2) Comm applied twice a month.

3) Comm applied once a month.

4) hydrogen peroxide (HP) applied once a week.

5) hydrogen peroxide applied twice a month.

6) hydrogen peroxide applied once a month.

7) an untreated control.

The commercial spray, which was ethaneperoxoic acid, was mixed with their recommended stabilizing agent and applied at a rate of 32 oz. product per acre in a 50 GPA spray volume. Because ethaneperoxoic acid is related to hydrogen peroxide, comparable hydrogen peroxide treatments were included in the study. The hydrogen peroxide was purchased at a local drugstore and also applied at 32 oz. per acre. Treatments were applied with a CO_2-powered backpack sprayer and were watered in after application.

Plots at both locations were 5 × 5 feet in size, and there were four replications of each treatment. Collected data included turf color and quality, root length density or dry weight of roots, and soil oxygen diffusion rate. The experiments were conducted from May to September of each year, with the oxygenator treatments applied only during that time.

Soil oxygen diffusion rates were collected by inserting platinum-tipped electrodes into the soil at a 1-inch

depth. There were ten of these electrodes, and when coupled with a silver chloride reference electrode, the resulting equilibrium electrical current was a measure of the capability of the soil to supply oxygen to a plant root. What was measured was the oxygen diffusion rate (ODR), with results reported in ug/cm^2/min.

RESULTS — 2000

Table 1 illustrates differences in oxygen diffusion for the treatments that received weekly spray applications of the commercial product or the drugstore hydrogen peroxide. On August 15th data were collected one hour after spray treatments were applied. The remaining data were collected one day (24 hours) after the treatments were applied. All of this data was collected at the TGRU location.

At this one location in one year of the study, addition of any oxygenator compound did not increase the soil oxygen diffusion rate. Of course, this is only one location and one year of data collection, and these data were collected only at one day (or one hour) after treatments were applied. It could be that results would be observed over a longer period of time, or that this method of oxygen measurement would be missing differences in soil oxygen content.

To determine if the applied products increased bentgrass performance, root length was selected as a variable that could be measured. At the TGRU, samples were collected once a month, washed free of all soil, stained red with Congo red dye, and scanned under a light-scanning table to measure root length density. At AU Links samples were also collected monthly, but they were washed and only dry weight obtained. Table 2 illustrates differences in root length density or weight as affected by treatment. Because there were rarely differences in root length as affected by the number of applications (one, two, or four times a month), the data shown are averaged over the number of applications, and just the means for the different products are shown.

Testing products on your golf course can be as easy as placing a piece of plywood on the back of a green before spraying.

At these two locations, application of any oxygenator treatment did not increase bentgrass root length density or root dry weight. The only significant effect was found on the 26th of September, when plots receiving the hydrogen peroxide treatment had a lower root length density than those that were untreated.

RESULTS — 2001

In the second year of the study there was only one time that application of an oxygenator treatment affected root length density. This was on the 3rd of July at the TGRU, when plots treated with the commercial oxygenator product had a greater root length density than bentgrass roots from plots sprayed with hydrogen peroxide. There was not a significant difference from the untreated control, however.

In 2001 oxygen diffusion rates were recorded one hour after spray treatments were applied (Table 4). Again, because there was no significant effect due to the

Table 1

Oxygen diffusion rates in a native-soil bentgrass putting green (1 inch depth) as affected by weekly oxygenator sprays, TGRU location, 2000.

	Date				
	28 July	15 Aug.	29 Aug.	13 Sept.	20 Sept.
Treatment	ug $O_2/cm^2/min.$				
Commercial	0.33 a*	0.77 a	0.64 a	0.45 a	0.59 a
Hydrogen Peroxide	0.28 a	0.74 a	0.68 a	0.47 a	0.51 a
Untreated	0.39 a	0.73 a	0.69 a	0.64 a	0.53 a

**Within each sampling date, means followed by the same letter are not significantly different from each other at $\alpha = 0.05$.*

Table 2

Effect of oxygenator source on root length density or dry root weight of creeping bentgrass, TGRU and AU Links, 2000.

	TGRU			AU Links	
	25 July	29 Aug.	26 Sept.	15 Aug.	12 Sept.
Treatment	m length			g	
Commercial	14.7 a*	31.0 a	30.5 ab	0.49 a	0.15 a
Hydrogen Peroxide	14.5 a	31.2 a	25.7 b	0.83 a	0.10 a
Untreated	13.5 a	32.0 a	32.3 a	0.36 a	0.11 a

**Within each column, means followed by the same letter are not significantly different from each other at $\alpha = 0.05$.*

Table 3

Effect of oxygenator source on root length density or dry root weight of creeping bentgrass, TGRU and AU Links, 2001.

	TGRU			AU Links		
	3 July	31 July	28 Aug.	3 July	31 July	28 Aug.
Treatment	m length			g		
Commercial	24.6 a*	12.7 a	20.5 a	0.37 a	0.18 a	0.14 a
Hydrogen Peroxide	18.3 b	14.6 a	21.0 a	0.25 a	0.17 a	0.18 a
Untreated	23.5 ab	12.7 a	17.1 a	0.25 a	0.19 a	0.10 a

**Within each column, means followed by the same letter are not significantly different from each other at $\alpha = 0.05$.*

Table 4

Oxygen diffusion rates in a native-soil bentgrass putting green (1 inch depth) as affected by weekly oxygenator sprays, TGRU location, 2001.

	Date	
	3 July	7 Aug.
Treatment	ug $O_2/cm^2/min.$	
Commercial	0.37 a*	0.45 a
Hydrogen Peroxide	0.42 a	0.46 a
Untreated	0.34 a	0.48 a

**Within each sampling date, means followed by the same letter are not significantly different from each other at $\alpha = 0.05$.*

number of spray applications, results were averaged over one, two, or four sprays per month. The two times measurements were recorded in 2001 revealed that there were no significant differences in the soil oxygen diffusion rate due to oxygenator treatments.

CONCLUSIONS

In our limited study (only two years at two locations), we did not see a beneficial effect from applying soil oxygenator sprays to bentgrass putting greens. In this study we tried to measure the impact of the oxygenator sprays by measuring soil oxygen, root growth, and visual quality. Although the data are not presented in this article, we never saw any difference in turf quality or color due to the oxygen sprays.

Does this mean that the products are worthless, or that you may never see a positive effect? No. The long-term, wide-range impact of a product should never be judged on the basis of a somewhat small-scale study such as this one. It may be that the product affects other measures of bentgrass survival, such as shoot density or carbohydrate storage. However, results such as these presented here are a first clue that the product should be evaluated on a test basis or that you might want to ask your sales representative for additional research data.

Should you buy enough product to spray every green on your course? Again, no. Test any new product on a small area such as a practice green or nursery green. Always leave an untreated area as a control. You can't tell if a product is working if you do not have an untreated area as a comparison. The simplest method for making a control plot is the plywood test. Lay a piece of plywood down on the green, spray the material as directed, and remove the plywood. The area under the plywood that was not sprayed is your control.

BETH GUERTAL, PH.D., *is associate professor at Auburn University in Auburn, Alabama.*

On Course *With Nature*

GREENER TROPICS

Garra de Leon Golf Course and Audubon International bring environmental stewardship to Central American golf.

BY PETER BRONSKI

Few people could have guessed that what was once abandoned agricultural land would become one of the most environmentally acclaimed golf courses in Central America. Yet, in the five short years since its establishment in June 1997, Garra de Leon Golf Course at Melia Playa Conchal in Guanacaste, Costa Rica, has successfully achieved such a transformation. Working in partnership with Audubon International's Cooperative Sanctuary Program for Golf Courses, Garra de Leon recently received designation as the first Certified Audubon Cooperative Sanctuary in Latin America.

Audubon International promotes environmental stewardship and sustainability through education and conservation assistance programs. In particular, the Audubon Cooperative Sanctuary Program (ACSP) for Golf Courses encourages golf course superintendents and other officials to take action to enhance wildlife habitat, protect water quality, and conserve natural resources on the golf course property.

Garra de Leon Golf Course demonstrates its commitment to the environment from its maintenance facility to its greens.

Described as "environmentally sensitive golf at its best" by Robert Trent Jones Jr., Garra de Leon Golf Course promotes its own special brand of eco-golf — the opportunity for the golfer to play in an ecologically unique environment with the knowledge that environmental impact and preservation have been major considerations in the design and operation of the course. "We do everything possible to protect and improve the environment that surrounds and is part of the golf course," notes Don Johnson, golf course superintendent.

NURTURING NATURE

Environmental concerns were taken into consideration from the very beginning, when the course was under construction. "I made sure that out-of-play areas were left natural," says Johnson, "and that corridors were available for wildlife." Clearly, there is no shortage of wildlife at Garra de Leon Golf Course. Their wildlife inventory boasts more than 100 species of birds alone, in addition to resident howler monkeys, coatimundi (pizote), blue iguanas, and jaguars, among others.

Native trees like the majestic Guanacaste, Zandal, Madero, Panama, and Cenicero are found throughout the course, and understory vegetation has been left in place, providing valuable corridors for wildlife to move throughout the course property. Even dead trees

(snags) are left standing, and they have become a favorite of the parrots and parakeets.

As a Certified Audubon Cooperative Sanctuary, Garra de Leon had to demonstrate environmental stewardship in six areas: Environmental Planning, Wildlife and Habitat Management, Water Conservation, Water Quality Management, Chemical Use Reduction and Safety, and Outreach and Education. A Resource Advisory Group helped to plan and implement stewardship projects in the six areas. Members of the group included golf course staff, consultants, educators, environmental professionals, and representatives from the local community.

"Our certification would not have been possible without the help and expertise of the Resource Advisory Group members," notes Johnson, "and especially Kay T. Dodge, Ph.D. She contributed many long hours to make this possible, and she pushed me along to achieve this very important certification."

Dr. Dodge, having worked with the Michigan Audubon Society and as an environmental educator, brought valuable experience and expertise to Garra de Leon Golf Course to complement Johnson's motivation and dedication. "I see an enthusiasm and commitment to the concept of a golf course sanctuary at Garra de Leon," reflects Dodge. "So of course I was pleased to act as an advisor and member of the Resource Advisory Group."

WATER WISE

Located in Guanacaste, Costa Rica, Garra de Leon Golf Course sits nestled among the dry tropical forests common to the northern Pacific coast of the country. The region experiences the dramatic contrast of a six-month wet season followed by a six-month dry season. With a scarcity of water for half the year, water conservation was naturally a serious concern for Johnson.

Garra de Leon Golf Course staff implemented a variety of projects to ensure that water was being applied to the course in the most efficient and responsible way possible — the amount of irrigated turf areas was reduced, weather data and evapotranspiration rates were incorporated into irrigation scheduling, and a percentage of course runoff was drained back to the irrigation pond to be reused. As a result of these measures, Johnson and his staff saved more than 100,000 gallons of water per day during the first five months of 2000, even though they experienced a dry season more severe than the year before.

STEWARDSHIP, SUSTAINABILITY, AND PARTNERSHIPS

The various stewardship activities at Garra de Leon were tied together with a comprehensive outreach and education program. Building on the theme of "Stewardship, Sustainability, and Partnerships," Johnson, his staff, and the Resource Advisory Group started a campaign to promote an understanding of the natural and cultural heritage of Guanacaste through environmental stewardship and conservation projects on the golf course.

In an effort to educate golfers, resort guests, and the local community, Dr. Dodge published an article, "Audubon at Melia Conchal: Can Golf Courses Be Good Environmental Neighbors?" in *The Howler,* Guanacaste's English-language magazine.

Johnson spearheaded an effort to partner Garra de Leon Golf Course with local schools, making the course resources available for teachers and students to use as a living, learning laboratory. One such partnership is with Brasilito's Country Day School, located just minutes from the course. "We are excited about the many wonderful opportunities for local students of all ages to use the course as a natural laboratory for water, wildlife, and natural history studies," notes Ruth Lizotte, principal at the Country Day School.

And now Garra de Leon will play host not only to golfers and students, but to resort guests and local community residents as well. The newly constructed Garra de Leon Nature Trail offers an opportunity for everyone to share in the natural heritage of Guanacaste. The self-guided trail includes 20 stations throughout the course that highlight the natural history, ecology, wildlife and plants, and management practices at Garra de Leon. Each station will be accompanied by educational plaques, and a written guide is currently available. There are also plans to develop a second nature trail that will take visitors through a mangrove wetland that borders the southern edge of the course.

By any measure, Garra de Leon's outreach and education efforts can be termed a huge success. "Through the outreach and education program the local community has become more aware that Garra de Leon offers more than just golf," says Dodge, "but also a sanctuary for wildlife and a living laboratory surrounding one of the most beautiful courses in the Americas."

Johnson credits Audubon International with helping to make his environmental stewardship efforts such a success. "We had ideas about how to build our golf course to be as environmentally sensitive as possible," notes Johnson, "but it was the Audubon Cooperative Sanctuary Program that brought it all together." Now that Garra de Leon Golf Course is fully certified as an Audubon Cooperative Sanctuary, they are encouraging other golf courses in Costa Rica to register in the ACSP. "Our goal is to have 100% participation in Costa Rica," concludes Johnson. "We live in paradise, and we have a responsibility to protect and preserve the environment that brought us here."

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Limited Flight Might Be Your Answer

The use of limited-flight golf balls has proven to be the answer for safety issues at many courses.

BY LARRY GILHULY

How many times have you gone to the practice facility at your golf course or the local driving range and heard or observed the male-testosterone-induced comment, "I'm taking this baby over the fence"? Depending on the length and width of the facility, this may or may not be possible; however, the lack of intelligent thought given to this attempt produces one of the most dangerous portions of any golf course — the back end or side of a driving range. Although the problem does not generally exist at recently built golf courses, it is a very common problem at golf courses that were constructed during the early 1900s through the 1960s. In most cases, the answer has been a restriction on woods and long irons, the addition of trees, and, finally, the installation of fences; however, during the past few years the improvement of limited-flight golf balls has provided the answer at many golf courses. Are limited-flight golf balls a reasonable option at your practice facility? Read on with an open mind and you may find that they are the perfect answer for reducing your safety concerns.

WHAT IS THE PROBLEM?

Many golf courses built in the 1960s and earlier did not have available acreage for a practice facility. In addition, most of the golf courses built during the first part of the 20th century provided space for warm-up, but full-scale practicing was simply not normal. For this reason, practice tees and especially the landing areas were small. As golf has changed over the years, practicing your game has become normal; thus, the small landing areas of the past needed to be expanded. Since most were locked in by the golf course, the only answer has been limiting the length of the shots, the addition of trees, and, ultimately, high posts and nets that are an eyesore. Enter the concept of limited-flight balls.

HERE IS THE SOLUTION!

Limited-flight golf balls have been around for a while, but recent improvements have made them a very viable option for many golf courses facing safety concerns that require ever-higher fencing. While the use of *very* limited-flight balls (Cayman) should only be considered as a last resort, many manufacturers supply lower-compression golf balls that fly 20-25% less when struck with long irons and woods. In several cases, these same balls perform exactly the same as a regular ball up to a 6-7 iron, then the reduced distance becomes noticeable. So why haven't more practice facilities become equipped with this logical way to reduce safety concerns? The answer generally lies in the mind of the single-digit player who complains that limited-flight balls are not a "true" practice experience.

TRY THIS TEST

If you have a safety situation at the practice facility at your golf course and the above comment is made regarding limited-flight balls, ask the following question to those who scoff at these balls: "What kind of ball do you play on the course?" If the answer is different from the type of ball currently used for practice (usually very hard and long balls), the next questions should be, "How can you have a 'true' practice experience with a hard ball that is completely different from the ball you play on the course? And why would you place your players in jeopardy of a serious injury when the simple answer is a ball that greatly reduces the odds?"

HAS IT WORKED?

Thus far, more than 25 golf courses visited in the Northwest Region use some form of limited-flight ball. From British Columbia to Hawaii, all have reported an acceptance level of these balls by the vast majority of players, and no golf course has gone back to the "traditional" long and hard ball. Most important, the number of golf balls leaving these facilities has been reduced dramatically, and the negatives of cost and the visual impact of posts and nets have been eliminated. The use of limited-flight balls has caught on at many private, public, and resort golf courses that simply do not have room or do not wish to install high fences. Another positive is that the incidence of ball theft from the practice facility seems to drop significantly when limited-flight balls are used. After all, who in their right mind would want to play with a ball that won't go as far as possible with a driver? Certainly not those who like to swing for the fences!

LARRY GILHULY *is the director of the Green Section's Northwest Region.*

News *Notes*

2003 TURF ADVISORY SERVICE

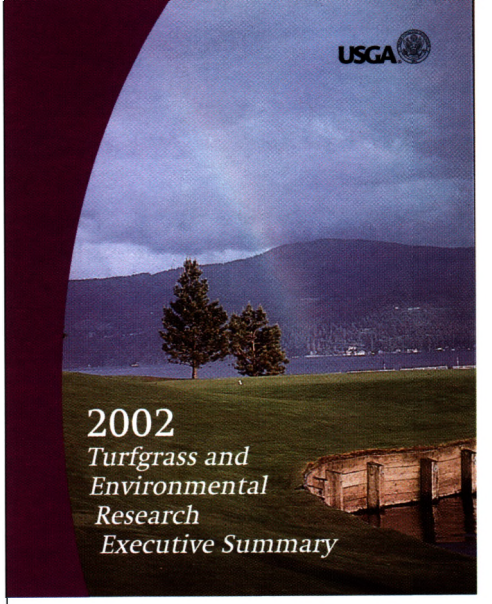
To keep up with the increasing costs of providing a high-quality advisory service to member clubs and the game of golf, it is necessary for the USGA to increase the fees charged for the Green Section's Turf Advisory Service. The 2003 fee schedule continues to offer a $300 discount for fees received by May 15, 2003.

	Payment received by May 15, 2003	Payment received after May 15, 2003
Half-Day Visit	$1,200	$1,500
Full-Day Visit	$1,700	$2,000

Despite the increase, the USGA will subsidize the Turf Advisory Service (TAS) by about 50% in 2003, reflecting a commitment to provide golf courses with the best of services from a top-quality staff of 19 full-time agronomists. A Green Section visit is a bargain for the many benefits that are realized. The TAS strengthens the golf course superintendent's and Green Committee's position, and it provides a positive environment to discuss common problems and realistic solutions and expectations at whatever level of golf course budget is available.

GREEN COMMITTEE MEETING

Green Section Committee representatives from the Mid-Atlantic Region met on May 7, 2002, at the Chevy Chase Club in Chevy Chase, Md. This active committee meets twice annually at various locations in their five-state region to discuss pertinent agronomic topics, review Green Section activities within the region, and provide input to help keep the Green Section's Turf Advisory Service a useful tool for golf course superintendents and course officials. Organized by Green Section agronomists Stan Zontek, Keith Happ, and Darin Bevard, these biannual meetings always draw a good crowd of volunteers, whose participation is very much appreciated. Members of the Green Section Committee in the Mid-Atlantic Region include: Mark A. Bado (Wildwood G.C., Pa.); William C. Battle (Farmington C.C., Va.); Charles Carr, GCS (Radley Run C.C., Pa.); John C. Cummings, CGCS (Berry Hills C.C., W.V.); Joseph M. Duich (Penn State Univ.); C. McD. England, III (Guyan G. & C.C., W.V.); J. Roger Finn (Black Rock G.C., Md.); Ken Flisek, GCS (The Club at Nevillewood, Pa.); Dean M. Graves, GCS (Chevy Chase Club, Md.); George Hauptfuhrer (Huntington Valley C.C., Pa.); Harold James Loke, CGCS (Bent Creek C.C., Pa.); Robert V. Mitchell (Run Enterprises, W.V.); Earl F. Reese, Jr., GCS (The Homestead, Va.); J. Cutler Robinson, Jr., CGCS (Bayville G.C., Va.); Mack Saunders (Glen Oak C.C., Pa.); Mark A. Studer (Oakmont C.C., Pa.); Dan Taylor, CGCS (Independence G.C., Va.); Thomas L. Watschke (Penn State Univ.).



RESEARCH PROGRAM UPDATE

The USGA Executive Committee approved $1.45 million per year funding for the USGA Turfgrass and Environmental Research Program for the next three years. This research program provides funding opportunities to university faculty to conduct golf-related environmental and turfgrass management projects. The USGA's vision for the research program is to "use science as the foundation to benefit golf in the areas of turfgrass and resource management, sustainable development, and environmental protection."

A compilation of the most recent projects funded through the research program can be found in the newly released *2002 Turfgrass and Environmental Research Executive Summary.* The *Summary* briefly describes each project supported by the USGA's Turfgrass and Environmental Research Program. Projects fall into several categories, including: course construction practices, integrated turfgrass management, turfgrass germplasm enhancement, environmental impact of golf, and the Wildlife Links Program.

The *2002 Turfgrass and Environmental Research Executive Summary* can be obtained free of charge by contacting Mary McConnell at 908-234-2300, mmcconnell@usga.org, or P.O. Box 708, Far Hills, NJ 07931. Request publication #NS1651.

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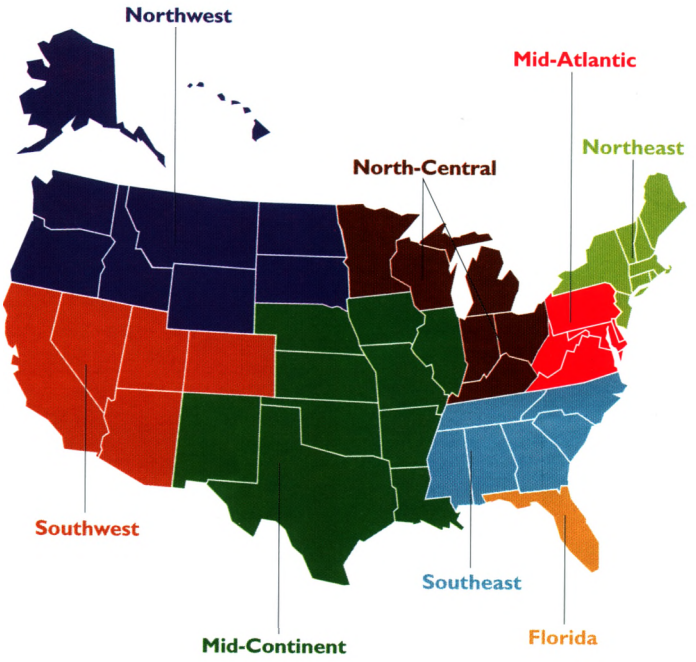

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Turf *Twisters*

Q: I would like to aerify my fairways and roughs during the winter to take maximum advantage of winter rainfall to leach salts and sodium. My main concern is that the holes will not recover during the winter and I will be left with a big mess. Do you have any suggestions on what I can do? (California)

A: Consider a less disruptive form of cultivation such as slicing or solid-tine aeration during the winter. You will avoid most of the mess and still be able to break through surface crust for more effective leaching of soluble salts and sodium. Schedule routine core aeration in the spring and fall when the turf is actively growing for quick recovery of the aeration holes.

Q: Several of my putting greens suffer from tree root competition. How can I prune the tree roots to help the turf without sacrificing tree health? (Rhode Island)

A: Tree roots can adversely affect turf health and playing conditions just as much, if not more, than the overhead canopy. Tree roots are opportunistic and prefer to inhabit moist, fertile, well-aerated soils characteristically found under most putting greens. One strategy is to encourage root growth around the sides of the tree that are farthest away from the green by mulching, fertilizing, and providing supplemental irrigation. In regard to root pruning, remember that each severed root has the potential of sprouting 1 to 6 new roots, so it is best to prune as far away from the green as possible. Root barriers may help reduce re-infestation. From the tree's perspective, root pruning should be limited to outside the drip line, not more than one-third of the entire root system, and at a frequency of every two or more years in autumn.

Q: When we convert out-of-play rough turf to "naturalized" landscape plantings, will all maintenance be eliminated in these areas? (Florida)

A: Once established, naturalized landscape plantings will not require regular inputs such as mowing, irrigation, fertilization, or pesticide treatments. Also, there are other positive benefits such as creating additional wildlife habitat. There's a misperception that naturalized areas don't need maintenance. In Florida, significant annual vegetation

growth occurs and some maintenance of landscape material is still needed. In particular, controlling noxious exotic weeds has been identified as an issue at numerous Florida courses. Maintenance of naturalized areas is definitely less time consuming than maintaining turf, but it is not totally eliminated.

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