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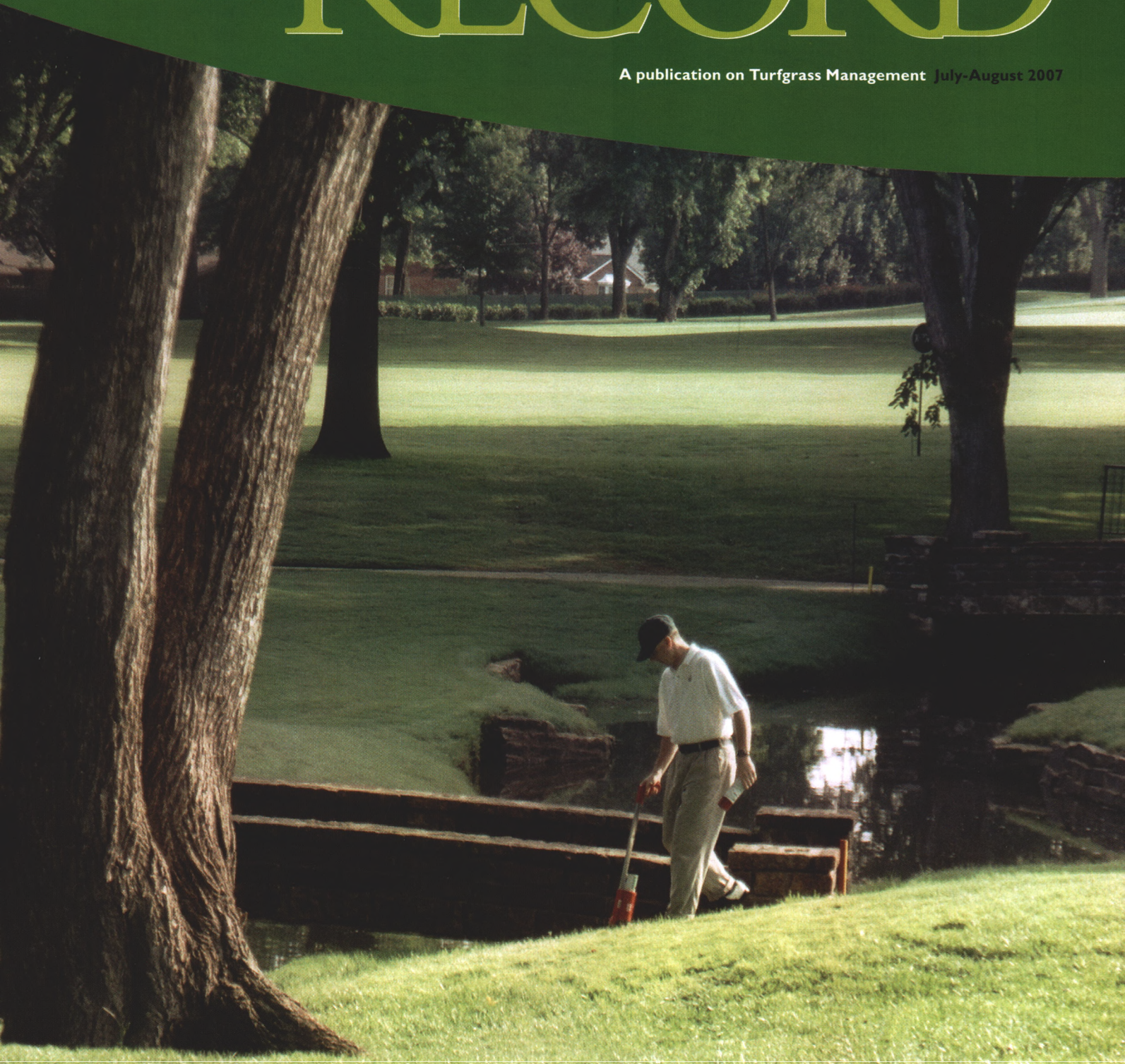

The Superintendent, The Rules of Golf, and Course Maintenance

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Cover Photo
The absence of painted lines to define a *water hazard* means that more stakes will be needed to fully encompass the *hazard* margin. The best approach is to use painted lines for definition and stakes to identify.

The Superintendent, The Rules of Golf, and Course Maintenance

Compartmentalizing is a common mistake with course maintenance and the Rules.

BY BOB BRAME

AUTHOR'S NOTE: *The words and phrases in italics are definitions within The Rules of Golf.*

Golf course maintenance, or the conditioning of the course upon which golf is played, cannot be separated from the Rules that define the game. The Rules of Golf, in combination with the Decisions on The Rules of Golf, are thorough and precise. They guide the play of the game and define the course upon which it is played. Golf is the Rules — if The Rules of Golf aren't being applied, don't call it "golf." The Bible tells us in 2 Timothy 2:5, ". . . if anyone competes as an athlete, he does not receive the victor's crown unless he competes according to the rules." The Rules should guide course maintenance and not the other way around.

Superintendents are faced with an assortment of challenges in today's golf course maintenance,

This overhanging tree compromises turf quality and forces the need to mark *ground under repair*; however, the marking is inconsistent and opens the door to legitimate complaints from players.

Ruling challenges can occur when adjacent *obstructions* like this cart path and drainage inlet become an *obstruction* with bordering *casual water* following a rainfall.

and they typically do a good job of balancing the demands and expectations. Yet, for most, credibility would be elevated if The Rules of Golf were given full consideration. In addition, fully merging the Rules and course maintenance will improve the final product and serve to properly accommodate players. To these ends, this article identifies the top ten Rules-related mistakes as seen by select USGA staff within the Championship, Regional Affairs, and Green Section departments. Those polled were independently asked, "How would you list and prioritize the top-ten Rules-related mistakes made by superintendents?" Candidly identifying and learning from past mistakes is the best way to avoid repeats in the future.

#10 — TREES AND ROUGH

Although some golfers continue to resist acknowledging that trees (too many and/or poorly positioned) compromise turf health, this is not a gray area — they do. Not only will thin, weak turf directly impact playability, it also opens the door to more serious issues like equipment damage and the effectual marking of *ground under repair.* In addition, tree roots creeping along or just below the surface are dangerous and may force a player to declare the ball unplayable, which brings a penalty stroke.

While it is important for the rough to inflict some penalty and in so doing reward a ball hit on the fairway or *putting green*, pace of play and *lost balls* (stroke and distance) should be carefully considered. The rough height and density should be appropriate for the grass being grown, course/hole design, and the median skill level of players.

#9 — OBSTRUCTIONS

The Rules cover both movable and immovable *obstructions.* However, too many *obstructions* can adversely impact play, as can even a few that are too close to the centerline. Give careful consideration to tee signs, benches, ball washers, irrigation control boxes, yardage markers, tree stakes and cables, hazard stakes, and the like. If immovable, how straightforward is obtaining relief? Two adjacent obstructions can pose a challenge. Or can it be moved without unreasonable effort, without unduly delaying play, and without causing damage? While the *Committee* may activate a Local Rule declaring a movable *obstruction* to be an immovable *obstruction* (i.e., marking stakes, other than *out-of-bounds* stakes that are deemed fixed — Decision 33-8/16), this is normally not recommended. Clashes can occur when adjacent *obstructions* like cart paths and drainage inlets become, following a rainfall, *obstructions* overlapped with *casual water.* Care should also be exercised to minimize the chances of a ball being lost in an *obstruction* like a drainage inlet grate with openings larger than a ball.

#8 — LOCAL RULES

Local abnormal conditions may require the *Committee* to establish Local Rules. Yet The Rules of Golf must not be waived by a Local Rule. Aeration, as an example, is common and necessary for the conditioning of healthy and dependable golf turf. This may bring the need to implement a Local Rule granting relief when a ball is on or in an aeration hole. Implementing the suggested Local Rule (The Rules of Golf,

Appendix I, Part B: 3c) is a far better strategy than skipping needed aeration work. Extreme wet weather may suggest value in activating a Local Rule for "preferred lies." The Local Rule for "embedded ball" (Appendix I, Part B: 3a), on the other hand, is always used at USGA Championships, and it is recommended that clubs/courses do likewise for regular play. Stones in *bunkers* may need to be declared movable *obstructions* (Appendix I, Part B: 4) to improve player safety and help hold down the operating budget. Power lines, ant hills (certain situations — Decision 33-8/22), and play from *wrong putting green* collars (Decision 33-8/33) may also point to the proper utilization of Local Rules. Conversely, providing relief without penalty should a player's stroke be interfered with by exposed tree roots is not an authorized Local Rule (Decision 33-8/8) — cut down the problematic trees.

#7 — DIVOT FILLING

On one hand, the unfortunate fate of a ball settling into a divot scar cavity is part of the game. While it may be a bit irritating to hit a ball straight down the fairway and find it in a divot scar, such occurrences will likely balance out and impact all players reasonably the same over a long enough period of time. On the other hand, it is far better to fill divot scars with a mix that improves playability and maximizes recovery growth. The middle ground of doing some and not others or being inconsistent with the process is likely the worst posture. The preference is to fill divot scars on a regular schedule and provide a smooth playing surface. While this applies primarily to fairways and approaches, it's also important on tees for recovery more so than playability; and don't forget ball drops, as a properly dropped ball must be played as it lies. Sand and loose soil (the components of divot filling mixes) are *loose impediments* on the *putting green*, but not elsewhere, which means it cannot be removed or smoothed without penalty if doing so would improve the lie of the ball, area of intended *stance* or swing, or *line of play* (Rule 13-2). Fill those divot scars completely and smoothly.

#6 — HOLE PLACEMENT, LINERS, AND FLAGSTICK

It's important to position the *hole* on the *putting green* to facilitate good pace of play. Caution must be exercised near slopes or contour changes and close to the edges of the putting surface. Green speed, hole design, putting surface contours/slope, weather conditions, play volume, and the median skill level of players must be factored into *hole* placement decisions. It's also important to avoid cutting a new *hole* close to a recovering *hole* plug. The frequency of *hole* changing should be such that a crisp, clean edge is provided. A player touching or attempting to repair a ragged or grown-over edge prior to holing out could result in a penalty (Decisions 16-1a/5 and 16-1a/6). Liners, if they are used (and they always are in today's golf course maintenance), must be sunk at least one inch below the surface. Cutting the *hole* straight and the subsequent insertion of a liner should hold the *flagstick* directly in the middle and in so doing yield uniform access around the perimeter.

Decision 16-1c/3 states that a player may attempt to raise or lower an old *hole* plug to make it level with the surface. Recognizing that the superintendent and maintenance staff are not going to want players attempting such repairs, it's important for the staff to provide a smooth surface that stays smooth throughout the season following a *hole* change. A high or low *hole* plug that cannot be readily repaired could result in *ground under repair* on the putting surface (see Decisions 16-1c/3 and 25/17).

#5 — GREEN MOWING

A player is allowed privileges and also is subject to restrictions on the *putting green* that don't apply *through the green* or in *hazards*. This means that it is very important to accurately determine when a ball is on the putting surface. A ball is on the *putting green* when any part of it touches the *putting green*. Mowing must be done frequently enough to provide a clear distinction between the *putting green* and the adjacent turf, commonly called the collar or approach. Greens are usually mowed daily during the playing season, although it is not unusual for the cleanup passes around the edge to be skipped occasionally in an effort to

Careful thought should be given to hole locations, which includes an evaluation of green speed, hole design, putting surface contour/slope, weather conditions, play volume, and the median skill level of players. Spread the wear around the green, but be fair and sensible.

minimize turf wear and possible thinning. This practice must be closely monitored to ensure that good definition is maintained. Utilizing lighter-weight mowers equipped with solid front rollers to maintain the cleanup passes can aid in minimizing wear while still allowing regular mowing. In the process, the same acual cutting height (not necessarily the same bench setting) should be provided by all *putting green* mowers to guard uniform playability. The height and mowing frequency of the adjacent turf must be in sync with greens to achieve the desired definition.

There must be a distinct edge defining *bunker* margins for the Rules of Golf to be applied.

#4 — BRUSH AND CLIPPING PILES

Grass clippings and other brush or debris that have been abandoned and are not intended for removal are not *ground under repair* unless so marked. If the intention is to remove the piles, they are *ground under repair*, even if not so marked. The question is: Why make someone ask? Remove grass clippings and brush or debris piles immediately. Not only will this eliminate *ground under repair* status confusion, it will also help reduce the related risk of *lost balls* and in so doing guard the pace of play. Clippings that are spread in the predominately out-of-play rough or in areas between holes should be spread so that they cannot be found later by the same person who did the original spreading. Even slight clumping should be prevented if the area is in play (inside the *out-of-bounds* marking).

While there may be times when economics suggest returning clippings during fairway or approach mowing, this can pose a problem. Clippings (*loose impediments*) that adhere to a ball cannot be removed other than on the *putting green*. As such, when clippings are not caught and removed on fairways and approaches, some type of follow-up cleaning like blowing or dragging may be needed to disperse and settle clippings into the turf canopy. Regulating growth to reduce clipping production may also aid both playability and agronomics.

#3 — BUNKERS: EDGING AND RAKES

Similar to the *putting green*, it's important for a player to know whether or not the ball is in a *bunker*. A ball is in a *bunker* when any part of it touches the bunker. A player's activities in a bunker are regulated. Since *bunkers* are *hazards*, a strong case could, and for many should, be made for holding *bunker* maintenance to more reasonable levels. However, there must be a distinct edge defining the interface for The Rules of Golf to be applied. Sand must not be spilled or pulled over the *bunker* margins (Decision 13/1). Adequate sand depth and good internal drainage should coexist with proper edging. Maintenance must also consider Rule 23 (*Loose Impediments*) — if the ball lies in a *hazard*, the player must not touch or move any *loose impediment* lying in or touching the same *hazard*. *Loose impediments* are natural objects, which includes twigs, branches, leaves, and stones, although a Local Rule can be activated that changes the status of a stone to a movable *obstruction*.

Decision Misc./2 states that the *Committee* must decide on the placement of rakes in *bunkers*. However, it is recommended that rakes be placed outside of bunkers on the away side and parallel to the intended *line of play*. It is common for too many rakes to be utilized, which further complicates control and placement. Keeping rakes in their proper place is a matter of significant and ongoing communication with players, but it starts with the maintenance staff.

Please note that a *bunker* is a *bunker*. The term "low maintenance" or "waste" added to "*bunker*" changes nothing. If there is a desire to have a low-maintenance or waste area, where clubs can be grounded and *loose impediments* removed, eliminate any descriptive tie to the word *bunker*. Design adjustments may also be

Rakes should be placed outside of *bunkers*, but also on the away side and parallel to the intended *line of play*. Rakes should not be placed between a *bunker* and a *putting green*.

needed — *bunkers* are prepared areas; natural sandy areas are not!

#2 — TEE MAINTENANCE AND MARKER PLACEMENT

The *teeing ground* is the starting place for the hole to be played. This means it must be clearly defined and free of interferences. The surface should be smooth and firm, and there should be no surrounding obstructions, trees, or other plant growth compromising full access. Depending upon the size of the mowed surface and the hole design, markers (the outside edge of which defines the front and sides of the *teeing ground*) will commonly be placed five to six paces apart. They should be positioned so that a perpendicular line off the middle of the straight line between the two markers aligns with the hole's centerline; incorrect alignment can lead to a player accidentally hitting from outside the *teeing ground* (penalty of disqualification unless corrected — Rule 11). The depth of the *teeing ground* is two club-lengths. Full access allows a player to stand outside the *teeing ground* to play a ball within. A ball is within the *teeing ground* when any part of it touches the *teeing ground*. Considering both right- and left-handed players, an adequate margin must be maintained for stance and swing. Markers should be moved regularly and systematically (usually daily or between *stipulated rounds* as authorized by the *Committee*). A player cannot legally move markers for the purpose of realigning them or to avoid interference from them (Decision 11-2/2).

As a side note, there are occasions when architecture prevents the allowed two club-length depth and ability to stand outside the *teeing ground* when playing a ball within. Design issues that compromise the Rules and course maintenance are topics for another article.

#1 — COURSE MARKING

It's amazing how often a course is not properly marked. Amazing because the game is the Rules and they are dependent upon accurate marking. The common shortfalls in course marking include the following:

- Incomplete — not enough stakes, or missing painted lines.
- Inability to site between stakes or along painted lines due to tall grass, brush, and/or tree growth. This can make it difficult to determine where a ball last crossed the margin of a *hazard* and to then drop and play a ball.

Detailed manicuring does not compensate for improper marking. The margins of a *water hazard* must be clear and precise, and encircle the hazard.

- Excessive use of red for *lateral water hazard* marking when some should be yellow (*water hazard*) or white (*out of bounds*).
- Incorrect marking of desert, rough, or wooded areas as a *lateral water hazard* when the area does not meet the definition of a *water hazard* (Decision 33-8/35).
- A *Committee*-declared environmentally sensitive area when such a distinction must come from an appropriate authority (i.e., a government agency or the like).
- Excessive or inadequate *ground-under-repair* marking. The most common issue is marking that is excessive and/or inconsistent. Tour the course carefully before marking and then be consistent. Avoid marking what is well out in the rough. *Casual water* is not *ground under repair.* Damage next to a cart path should normally be tied into the path (*obstruction*). When in doubt, miss on the no-paint side.
- Incorrect positioning of ball drops (i.e., *putting green* side of a *water hazard*).

CONCLUSION

To move away from the identified mistakes and to eliminate compartmentalizing, there must be good communication within the maintenance department and between the superintendent and other key staff at the course. A clear understanding of responsibilities will set the stage for confidently moving forward. It's common for the golf professional and pro shop staff to take the lead in determining how the course will be marked and oversee the initial marking, with the maintenance staff then expected to keep the marking fresh and clear. Nonetheless, whether your course follows this model or utilizes a different approach, in the final analysis course maintenance and setup are the superintendent's responsibilities and as such he/she should ensure that The Rules of Golf are in fact guiding maintenance activities. Knowing the Rules and applying them to the art and science of golf course maintenance will elevate credibility and present the full challenge of the game.

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AUTHOR'S NOTE: *Thanks to all of the USGA staff who participated in the survey upon which this article is based. Special thanks to Jeff Hall and Tim Moraghan for their input.*

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Research *You Can Use*

Using Golf Courses to Bolster Amphibian Communities

University of Missouri scientists provide amphibian management guidelines for ecologically minded superintendents.

BY RAYMOND D. SEMLITSCH, MICHELLE D. BOONE, AND J. RUSSELL BODIE

Many wildlife species are declining and we face a general biodiversity crisis worldwide. One of the primary reasons for this crisis is the loss and alteration of natural habitat for species.[16] As human populations expand, wildlife is displaced and needed resources are eliminated.

Along with development of living space for humans, we crave green recreational areas to pursue leisure pastimes such as golf and enjoying the outdoors. In fact, in the United States, more than 24.5 million men, women, and youth spend 2.4 billion hours playing on 16,000-plus golf courses.[14] Managing landscapes with an eye for both human use and preservation of natural resources can create a win-win situation for humans and wildlife.[9] Our goal is to provide managers with biologically determined criteria and techniques for bolstering the diversity of amphibians on golf courses.

Restricted practices should include "no mow, no spray" 25-feet-wide buffers adjacent to all core habitats including uplands, followed by another 25-feet-wide buffer where organic fertilizers only are allowed.

AQUATIC HABITAT NEEDS

Amphibians are known to use man-made ponds, like water hazards, sediment retention basins, or farm ponds, so golf course ponds can be managed in such a way to promote amphibian abundance and diversity. Three key factors should be considered when establishing amphibian communities. First, eliminating fish from ponds is a critical step, because ponds without fish allow for greater amphibian abundance and more diverse communities. The presence of fish eliminates most amphibian species through predation on eggs, larvae, and juveniles, and through competition for food resources.[3,6,7,12] Additionally, fish also can carry diseases that are associated with amphibian mortality,[17] especially stock fish obtained from hatcheries.

Man-made ponds are frequently stocked with fish to control mosquitoes or algae; however, amphibians can serve the same role in the aquatic environment,[1,8] as well as insect control in the terrestrial environment. This can be achieved without stocking costs and effort, and without negatively affecting native populations. Researchers have found that removing fish by either draining ponds or repetitive netting can allow amphibian communities to recover.[15]

While common sense might suggest that permanent ponds would be better for amphibians, the greatest amphibian diversity is actually associated with ponds that dry for a short part of the year. Pond drying increases amphibian diversity because it eliminates fish and reduces insect predators as well as large competitors. Many insects live part or all of their life cycle in ponds, and many of these are voracious predators that can eat amphibians 10 to 20 times their own size.

Permanent ponds favor amphibian species with long larval periods that typically exceed one year, like bullfrogs and green frogs. The larger tadpoles of bullfrogs and green frogs have

The greatest amphibian diversity is associated with ponds that dry for a short portion of the year. Pond drying increases amphibian diversity at sites because it eliminates fish and reduces insect predators as well as large competitors.

a greater ability to secure resources and can negatively affect smaller tadpoles of native species that have to reach metamorphosis in a shorter amount of time.[2] The negative effect of bullfrogs has been associated with amphibian declines, especially in areas where they have been introduced.[4,5]

Although characteristics associated with pond hydroperiod and the predators or competitors that inhabit the pond are important, chemical contamination is another factor that can influence aquatic communities. Because golf courses are routinely treated with chemicals and fertilizers, golf course wetlands are potentially exposed to contaminants.

Indirect effects are those that do not affect individual physiology or behavior, but instead affect the species of interest through changes in the food web, such as decreases in food resources or decreases in the number of predators. Tiny zooplankton and algae are generally more sensitive to insecticides and herbicides, respectively, than are amphibians. Because zooplankton are the food resources for larval salamanders, reduction in zooplankton can result in larval death by starvation, even though environmental concentrations may not be directly lethal to the larvae.

Many contaminants appear to have endocrine-disrupting properties, and such effects also may compromise the sustainability of populations if a significant portion of the population is sterile or all one sex. For these reasons, it would be ideal to minimize the potential for ponds to be exposed to contaminants by increasing no-spray zones or vegetative buffers, which will help filter contaminants so that increased concentrations of contaminants will not reach the aquatic environment. Also, using chemicals only when necessary rather than preventatively should improve water quality for pond-breeding amphibians and other species that live in golf course aquatic habitats.

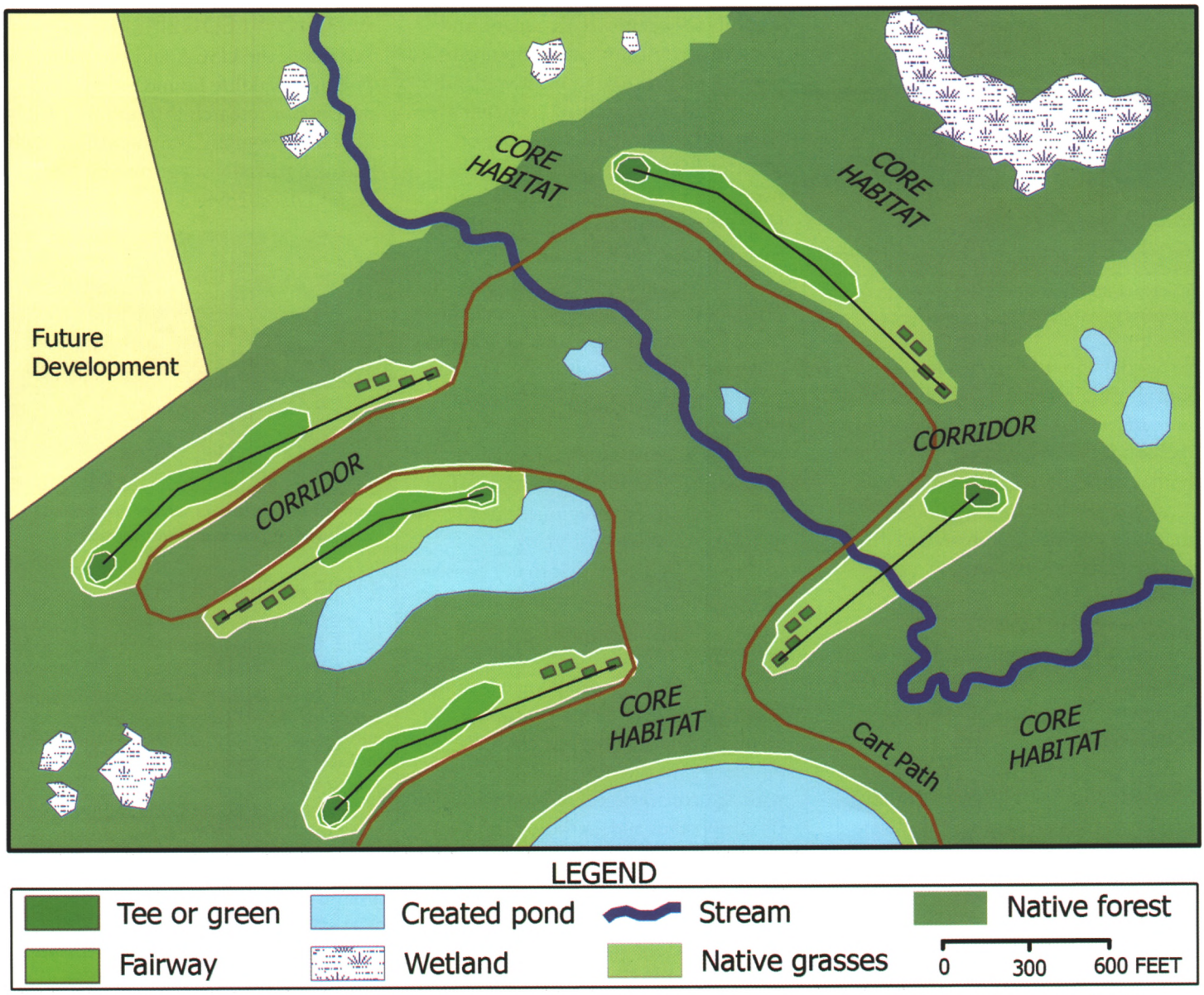
TADPOLE SURVIVAL IN GOLF COURSE PONDS

We recently conducted a study on several golf courses where we placed a total of 40 enclosures in two golf ponds and two reference ponds. Into each enclosure, tadpoles of American toads and southern leopard frogs, and larvae of spotted salamanders were placed; half of the enclosures also included five over-wintered bullfrog tadpoles. We found greater tadpole survival in golf course ponds compared to reference sites.

This outcome may be surprising, but it can be easily explained by a reduction of insect predators found in golf course ponds, as well as greater food resources — both of which could be attributed to chemical contamination. This suggests that amphibians could survive in golf course ponds or other habitats that receive some chemical contamination. Yet, interestingly, over-wintered bullfrog tadpoles negatively affected survival to metamorphosis of amphibians whether on golf course or reference ponds. This result highlights the importance of creating environments that are less favorable to competitors and predators of amphibians in order to support diverse amphibian communities.

While amphibians frequently appear at newly created wetlands, there are conditions that will favor more or less diverse communities. The least diverse communities are very likely ones that contain bullfrogs only, which often results with the presence of fish in permanent ponds. Having bullfrogs in ponds is not a sign of successfully managing a site for amphibian population diversity; in fact, it indicates just the opposite. This species has been widely introduced around the world where it has become a pest species, causing amphibian extinctions and reducing abundance of native amphibian populations.

Designing and constructing aquatic environments that support diverse amphibian communities can be accomplished through periodic drying of wetlands in the late summer to eliminate or reduce fish and bullfrog populations, and through reduced chemical contamination. These straightforward techniques can increase the likelihood



Good amphibian habitat requires complementation between aquatic and terrestrial habitats so that each is readily available for their respective function. Separating aquatic and terrestrial habitats by fairways, roads, or buildings disrupts or potentially stops natural migrations for many species and leads to population declines.

of supporting amphibians in a critical portion of their life cycle, and they could help buffer amphibian populations from declines in regions experiencing rapid habitat loss and alteration.

TERRESTRIAL HABITAT NEEDS

Although many amphibians can be seen in ponds around golf courses, for most species, the majority of their time is actually spent on land. We have only recently begun to discover where and how far amphibians go after breeding and what habitats are important for their survival and for persistence of the population. Ponds are often used for breeding by a single population. They are faithful to that pond and migrate to and from the pond each breeding season. They also appear to be faithful to the terrestrial habitat surrounding ponds. We know that individuals migrate in and out of the pond in the same place each year and that they travel several hundred yards away from ponds into the forest or fields, depending on species' preference.[13]

It is not just distance from the pond that is critical for protection of terrestrial amphibian populations; attention must be focused on protection of specific features necessary for life functions. It becomes imperative that we protect areas that include specific critical habitats as determined for the particular set of species in a region.

We need to maintain the complementation between aquatic and terrestrial habitats (e.g., foraging and overwintering habitats) so that each is readily available for its respective life history function. This means that aquatic habitats are readily available to adults for breeding and for growth and development of larvae. Further, the

Spadefoot toads are often associated with temporary wetlands located in grasslands.

terrestrial core habitat needed by metamorphosing juveniles and adults after breeding should be directly adjacent to the pond. Natural and created water bodies, including seasonal shallow wet areas, are the best starting points as these are sites of amphibian breeding. For long-term persistence of amphibians on the golf course, it is important to connect core habitats (where amphibians spend most of their time) not only within your property but also to potential core habitats adjacent to your property.

We believe that amphibians can provide a number of hidden benefits to golf courses and the golfing community. First, because pond-breeding amphibians occupy both aquatic and terrestrial environments, amphibians play an integral role in most wetland, stream, and adjacent forest ecosystems.[10,11] As such, they provide a number of functions and services that can be beneficial to all members, including humans. As herbivores (plant eaters), frog and toad tadpoles consume vast amounts of algae, periphyton, and plant material in the aquatic environment that would otherwise clog waterways and create unsightly algal mats caused by fertilizer runoff. As carnivores (meat eaters), salamander larvae consume zooplankton and aquatic insects like mosquito larvae that infest ponds and, in some regions, carry diseases like West Nile virus.

There is no doubt that many conservation biologists perceive golf and golf courses as contributing to the growing problem of habitat loss and alteration. However, the recreational needs of the human population are a legitimate and an important use of resources. Balancing the use of these natural resources with the conservation of biodiversity is also important and, as biologists, we consider it our ultimate objective.

Table 1

Summary of major recommendations for bolstering amphibians on golf courses.

1. Preserve and restore existing seasonal or temporary wetlands and streams, including their natural ability to fill and dry, typically in late summer/autumn.
2. Provide created ponds without fish by regularly netting or by draining during late summer/autumn.
3. Preserve, restore, and create many sizes and types of ponds, wetlands, and streams with and without forest canopy and no more than 200-500 yards apart.
4. Include forested and grassed uplands around aquatic sites that extend 150-300 yards from the water with management for native habitat at least in the 100 yards closest to the water. Manage aquatic and surrounding terrestrial areas as amphibian core habitat.
5. Augment core habitats with minimum 50-yard-wide corridors of managed native forest and grasses.
6. Use Best Management Practices (BMPs), Integrated Pest Management (IPM), and a management plan during construction and maintenance of the golf course, especially to reduce or eliminate pollutants.
7. Monitor surface and ground water quality to assess the effectiveness of the management plan.
8. Monitor amphibian populations for successful reproduction, juvenile recruitment, and a diverse group of species.
9. Adapt management as needed based on monitoring and current research.
10. Reach out to local, regional, and national groups to educate and be educated on amphibians and golf.

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Some amphibian species such as the spotted salamander are associated with forests.

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CONNECTING THE DOTS

A Q&A with Dr. Raymond Semlitsch, *University of Missouri, regarding the use of golf courses to bolster populations of amphibians.*

Q: *How serious is the decline of amphibian populations throughout the U.S.? Are there wildlife census data that depict just how serious this is?*

A: There are a number of reliable published accounts of species declines in the U.S. and globally. The most recent study estimates one-third or 1,896 species of amphibians are threatened with extinction worldwide. Amphibians are now considered more threatened than birds or mammals.

Q: *It seems to me that one of the first things that a typical landowner may want to do with a newly constructed pond is to stock it with fish. For that reason, do you think that golf course water features could be more successful than homeowner ponds in bolstering amphibian populations?*

A: Building a pond in your backyard for fishing is great, especially if you have children who can learn about wildlife through fishing. But not every pond needs to have fish, especially on golf courses where fishing is not the primary activity. For that reason, golf course ponds can be maintained fish-free more easily and may supplant natural wetlands to promote amphibian diversity. I see golf courses as potential nature sanctuaries.

Q: *If bullfrogs or green frogs have taken over water features, can they be selectively removed to allow greater species diversity of the amphibians using that water feature? How?*

A: The adult bullfrogs and green frogs are recruited from metamorphosing tadpoles within that pond. The only effective method to remove them is by stopping the recruitment through drying the pond once a year, at the end of the summer or in early fall, after all other species have metamorphosed.

Q: *How important are amphibians as a food source to other wildlife predators? Is it likely if golf course water features are managed to bolster amphibian populations that additional predator wildlife species will be attracted to the area? If so, what predators would that include?*

A: A primary role of amphibians in any ecosystem is that of providing food for predators. Their presence will increase the diversity of predator species and create a more natural complex and balanced community. I would predict that more birds, especially wading or shore birds, would be seen in or around golf course water features during the day. Other predators, like small mammals and snakes would also increase, but most of these are noctural and less easily encountered.

Q: *You mentioned that many potential contaminants to wetlands have endocrine-disrupting properties. What are some of these? Is there evidence that golf courses are a source of these contaminants?*

A: The primary source of endocrine-disrupting chemicals is from herbicides; both atrazine and glyphosate are typically the active chemical ingredients. It is less likely that golf courses are a major source of endocrine disruptors or even use much herbicide compared to agricultural landscapes in the Midwestern U.S.

Q: *What are some instances where endocrine-disrupting contaminants have been detected in water features, and what has been the effect on wetland species?*

A: Endocrine-disrupting chemicals in herbicides are very commonly found in agricultural fields, ditches, and streams flowing through farming regions of the U.S. Effects that have been reported include feminizing of male frogs, skewed sex ratios toward female frogs, an increase in the number of inter-sex (half male/half female) frogs, and abnormal sexual development.

Q: *Did it surprise you that your study showed greater tadpole survival in the golf course ponds compared to the reference ponds? Do you think that would hold true for most golf courses?*

A: It was very surprising. We really thought most golf course ponds were full of chemicals from years and years of runoff and that our tadpoles would die overnight. When we thought about it, however, we understood that managers are more careful using chemicals, probably using fewer and safer chemicals now than 10 or 20 years ago. Of course, our study clearly showed that chemicals were still present in levels great enough to eliminate insects, the main reason tadpoles did poorly in our permanent reference ponds. I really think our results are applicable to other golf courses; how broadly, we don't know. That would be interesting to pursue, especially across regions that may have different management guidelines for chemical use.

Q: *What's the best reason that golf course superintendents should consider managing wetlands and water features to support amphibian populations?*

A: I think the bigger reason is that it would be a chance for superintendents to contribute to a "greater good" of their town and its citizens, to our society, and to our planet by helping to conserve our natural wildlife. At the same time, it would create a different environment than people would envision on most golf courses; it would help create a more balanced, complex, and natural ecosystem. The golf course would become a showcase for nature and attract more people to enjoy a stroll, birdwatch, or just listen to frogs peeping as the moon rises. I think it would generate great pride in any superintendents to know that they played an active role in helping to educate the public about the natural world and that they may have helped save a species or two.

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

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Editor's Note: *A more complete report of this work can be found at USGA Turfgrass and Environmental Research Online at http://usgatero.msu.edu/v06/n01.pdf.*

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Research *You Can Use*

Of Moss and Men

Research trials from across the U.S. have identified control options for this invasive weed of putting green turf. Field observations indicate management is an important component of successful eradication.

BY MATT NELSON

Moss invasion of putting green turf has become an increasing problem at golf courses across the United States over the past ten years. Moss encroachment into putting greens has progressed from a regional concern a few decades ago to a more widespread problem on creeping bentgrass greens with sand rootzones during the late 1990s, to an even wider problem today on greens with mixed stands of creeping bentgrass and annual bluegrass growing in a variety of rootzone compositions. As a result, research conducted at various sites across the country has identified control methods and probable causes of moss invasion.

WHERE DID IT COME FROM?

Silvery thread moss (*Bryum argenteum*), the moss species that invades putting green turf, is a primitive plant adapted to a variety of climates around the world.[1,3,6,11] Moss is a non-vascular plant that must be in contact with free water to establish. Moss also can tolerate nearly 80% dehydration, however, which makes it extremely well adapted to and competitive in putting greens. It reproduces sexually via spores that can be disseminated over great distances by wind. Moss also can reproduce asexually from displaced fragments, which is a likely means of spreading across golf course putting greens. Water, wind, maintenance equipment, or foot traffic can effectively spread moss.

Research agronomists speculate that increased moss encroachment problems can be correlated to discontinued use of mercury fungicides and perhaps a change in pesticide formulations.[3,9,11,12,13] A more likely explanation is continued reductions in mowing height and insufficient nitrogen fertilization of putting green turf with the intent of promoting faster green speed.[3,6,7,8,9,12,13] Lower mowing heights and reduced fertility compromise the competitive ability of turf and increase opportunity for weed invasion. This claim is supported by the progression of moss invasion from select regions of the country to more widespread observation on creeping bentgrass turf growing in sand rootzones, to greens of all mixes of annual bluegrass and creeping bentgrass in a wide variety of soil media. Sand retains less nutrients and water than soil, and bentgrass typically has less density (shoots per unit area) than perennial biotypes of *Poa annua* at mowing heights below ⅛ inch. Moss invasion problems in collars, tees, and fairways are undocumented.

As a result of more widespread moss problems, golf course superintendents and researchers have experimented with a plethora of potential control agents, including liquid soaps, fatty acids, baking soda, mouthwash, fabric softener, various metals, fungicides, herbicides, peroxides, various combinations of these materials, and who knows what else. Fortunately, controlled research efforts have yielded some positive results.

CALL IT . . . HEAVY METAL!

In the past, heavy metal fungicides were a one-way ticket to moss-free greens. For good reasons, these products are no longer available for use in the turf industry. Weber and McAvoy demonstrated effective moss control with silver nitrate by electromotive destruction of chlorophyll, whereby the magnesium ion at the core of the chlorophyll molecule is oxidized by the metal ion.[11] A silver nitrate pesticide has not been registered for use on golf turf.

Iron sulfate has long been recognized as a viable control tool, although repeated application at high rates is necessary to provide good control.[3,7,12] High rates of iron sulfate applied repeatedly with very high water volume have demonstrated effective eradication of moss at several golf courses in the western U.S., although some researchers have questioned the long-term consequences of such a program.[2]

Copper hydroxide fungicides have been shown to provide effective moss suppression through research conducted at Oregon State University, Cornell University, and Penn State University.[3,7,9] Four to six applications of copper hydroxide fungicides at weekly intervals in the fall have provided the best results. Water pH is critical to control and additives are

necessary to be sure that water in the spray tank is adjusted to a pH of 5-6.5 prior to adding the copper hydroxide product. Repeated copper applications can inhibit iron metabolism in the plant and result in toxicity problems in the soil. Observation in the Rocky Mountain region of the U.S. indicates copper hydroxide can effectively control moss, but this approach has not been widely practiced.

ANOTHER "CIDE" OF CONTROL

Researchers have discovered that another fungicide (chlorothalonil) and one herbicide (carfentrazone) can provide selective control of moss in putting green turf.[10,12,13] Results indicate that sequential applications of chlorothalonil can provide good control of moss without turfgrass phytotoxicity when daytime temperatures are above 80 degrees F.[12] Use of this product when temperatures are cool exhibits limited efficacy on moss, so using this product in a disease management program will provide moss suppression. Label limitations on annual chlorothalonil use on greens must be considered when using this product for moss control.

Carfentrazone (Quicksilver, FMC Corp., Philadelphia, Pa.) has recently gained registration for silvery thread moss control on putting greens, and research trials have shown good to excellent control.[10,13] Carfentrazone appears to provide good control of moss over a broad temperature range. Field observation in the western U.S. has shown excellent moss control results when applications are made between daytime temperatures of 55 and 85 degrees F. Two or three applications 7 to 14 days apart at the label rate in 100 gallons of water per acre with a non-ionic surfactant at a rate of 0.25% volume/volume have demonstrated the best results. Since moss lacks roots and vascular tissue and has an extremely high biomass surface relative to volume, spray volume and surfactant

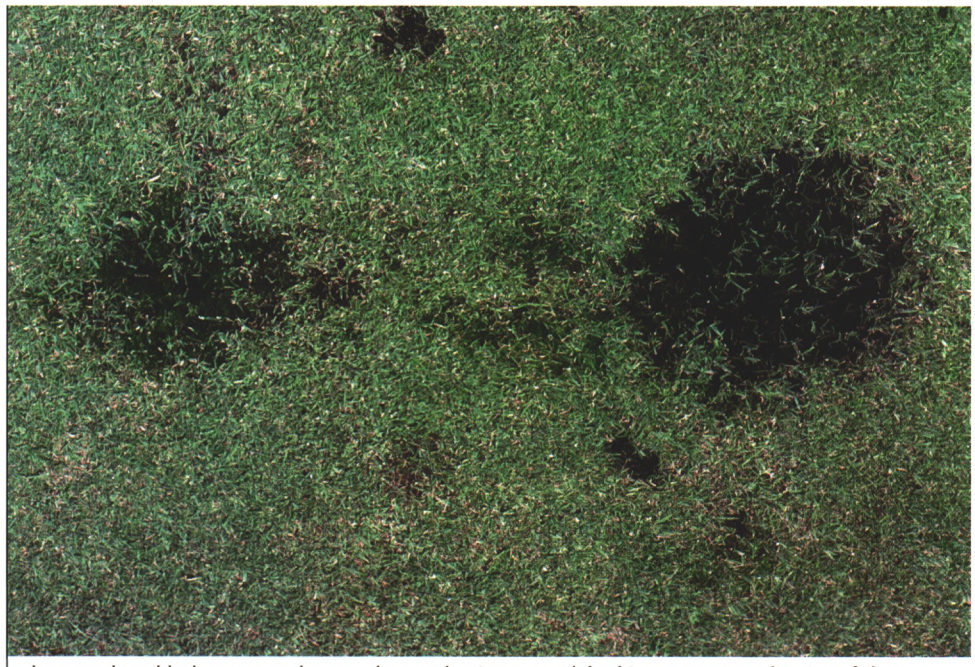
Moss invasion has been linked to low mowing, and invasion is often first noticed on ridges or crowns in putting greens where scalping is more likely.

use are important for maximum coverage, absorption of product, and control. To date, carfentrazone has provided the best selective control of moss in putting greens across the western U.S.

OTHER OPTIONS

As mentioned previously, many different materials have been evaluated for moss control in the field. Researchers in Illinois have shown that baking soda, when spot applied in a solution of 6 oz. baking soda/gallon of water, is capable of providing season-long control, although significant turf injury is probable with baking soda use.[10] Also, broad application of this product may be difficult, and spot treatment with any product rarely provides acceptable moss control. Visible moss colonies often indicate a more widespread moss invasion when close analysis of the turfgrass canopy is conducted. Baking soda is not registered as a pesticide.

Dawn Ultra dishwashing liquid has provided variable moss suppression in the field, although researchers at Penn State University were unable to demonstrate effective control.[7] Spot applications of Dawn Ultra at a 4 oz./gal. of water dilution rate seem to provide better moss desiccation than broadcast applications in field observations. Again, this product is not a registered pesticide.



Iron tends to blacken moss when used as a selective control. In this case spot applications fail to control smaller moss plants evident in the turf canopy, and they seldom provide acceptable control.

Copper products, desiccation control agents, and carfentrazone typically cause moss to turn a bronze or brownish color, indicating efficacy. Repeated applications are usually required with any product to provide acceptable moss eradication.

Sodium carbonate peroxyhydrate (Terracyte, Biosafe Systems, Glastonbury, Conn.) is currently marketed for selective control of silvery thread moss on golf courses, and field observations have demonstrated poor to excellent moss control. This product uses ground dolomitic limestone as a carrier and can be difficult to apply accurately. Terracyte may cause some turf injury to annual bluegrass and creeping bentgrass during high temperatures and/or humidity, especially if consecutive day treatments are used.[7] At PSU, 4 to 5 applications of Terracyte at 8 lb. per 1,000 sq. ft. every two weeks provided good control, although it did not eradicate moss. As with copper products, Cornell University researchers have found better control with this product in fall vs. spring.[9] They speculate that moss is either more susceptible to control or has less recuperative potential in the fall. Best results with this product in field observations from the western U.S. occur when turf is lightly irrigated immediately before and after application at an 8 lb. per 1,000 sq. ft. rate with a drop spreader. Spot applications do not typically provide acceptable moss control.

THE CULTURE OF MOSS CONTROL

While research continues to identify selective controls of silvery thread moss in putting green turf, adjustments in cultural management programs are the real key to achieving long-term moss suppression. Without question, low mowing and insufficient fertilization are the primary causes of moss infestation. Ridges, crowns, and other areas prone to scalping injury are typically those that moss first invades. Increasing the height of cut and fertility when applying products to selectively control moss will improve success. Utilize rolling or double mowing to achieve the desired green speed in lieu of mowing too low.[5] Field observation indicates moss infestation problems are absent or much less severe when nitrogen fertilizer is applied at 0.4-0.5 lbs. N per 1,000 sq. ft. per month of active growth.

Since moss must be in contact with free water to establish, even microscopic layers in the upper soil profile may be sufficient to effectively perch water and favor moss. Controlling organic matter in the upper soil profile with aeration and topdressing is integral to good moss control. Other factors that affect turfgrass vigor, including the growing environment, irrigation practices, traffic management, and drainage, should be evaluated if moss infestation is noticed or has become a serious problem. Minor amounts of moss can quickly become a major problem if left unchecked, so review the research and implement a complete control strategy early. Ultimately, the best advice when battling moss is to evaluate all factors and grow grass, not moss.

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MATT NELSON *has observed moss across a wide range of climates, management programs, and construction types as senior agronomist in the Green Section's Northwest Region.*

Thatch and/or layering in the upper soil profile can predispose turf to moss invasion. Notice the lack of moss in the perimeter of this green where mowing imparts more wear injury and limits productivity and thatch production.

There is Strength in Numbers

Teamwork pays off.

BY ERIC MATEKOWSKI

Wildwood Golf Club is a private facility of 500-plus members located 12 miles north of Pittsburgh. In early 2007, Wildwood Golf Club completed construction of a new golf turf maintenance facility. The successful completion of this project can be credited to a team of dedicated individuals who worked together toward a common goal.

Our team consisted of the club president, grounds chairman (a past president), general manager, golf professional, and golf course superintendent. Each team member had responsibilities unique to his role at the club. For example, my role as superintendent was to define, quantify, and communicate the need for a new building. In addition to defining the project parameters and building specifications for the new facility, during construction I also had to ensure that there would be no interruptions to golf play.

The general manager's responsibilities included securing the resources required to complete this project as well as managing potential cost overruns. The club president's and grounds committee chairman's roles focused on maintaining open lines of communication with the board, committees, and general membership. It was important for us to update the membership on the status of the project. Wildwood's golf professional was a valuable conduit to the membership, as he fielded questions when golfers passed through the pro shop. The most important aspect of his participation was that he always came to the team to obtain the information necessary to answer members' questions accurately, in addition to bringing to light concerns expressed by the members. This interaction allowed us to remain proactive and share the responsibilities of guiding the project from concept to completion. We were all dedicated to this worthy investment in the club's future.

Steve Gonzalez, general manager, and Eric Matekowski, golf course superintendent, met on a regular basis to examine the progress of our new facility. The weekly meetings helped monitor the project and control costs by minimizing the need for change orders.

The grounds and turf care department at Wildwood Golf Club had clearly outgrown the existing 4,400 sq. ft. maintenance building. It had served the club well for 50-plus years, but now we needed to upgrade the maintenance infrastructure. Prior to construction, the team worked together to address six particular issues:

1. How would the importance and value of investing in a new maintenance facility be stressed to the membership?

2. Where would the new structure be located?

3. How would the building be designed to meet present *and* future needs?

4. Who would handle permitting and licensing?

5. How would the bid process and awarding the contract be handled?

6. Would the current capitalization plan need to be amended to complete this project as desired?

The construction of a new maintenance building was initially funded as part of a two-phase capital improvement program that had been approved by the membership in 2001. The first phase, completed in 2002, involved resurfacing the clubhouse parking lot, renovating and resurfacing cart paths, and renovating significant areas of the course. The second phase centered on construction of the new maintenance facility. However, following completion of the first phase, Wildwood's board of directors elected to delay the second phase until the economic environment improved. This vote was prompted by the post-9/11 economy and the tenuous state of country club membership; it was an uncertain time.

In the summer of 2005, the board of directors began to discuss enacting the

second phase assessment of the original capital improvement plan. While the issue of selling the new facility to the membership had been discussed in 2001, it had not been pursued in earnest. Convincing the membership to initiate the construction process would first have to begin by defining the financial needs of the project. To clarify need and urgency, we examined the existing building. It needed a new roof, garage doors, and several other costly integral structural repairs. Additionally, the existing building could not be expanded and, even if it could, no one would allow this to happen because of its current location.

The old maintenance building at Wildwood Golf Club was woefully inadequate. It served the club well for 50-plus years, but it needed to be replaced.

GETTING ORGANIZED BEFORE GOING TO THE MEMBERSHIP

Prior to presenting the project to the membership, we felt it was important for the team to resolve the design and determine where the new building would be constructed. The existing building, located at the entrance to the club, was unsightly, small, located far from most of the golf course, had no room for expansion, and had no public sewage. To further support our case that a new building was needed, cost estimates for repairing and even expanding the present facility were gathered. The multiple limitations of the existing site made any thought of upgrading the current building unrealistic. When cost estimates were compiled, they were presented to the membership to further support moving ahead with other options for the development of a maintenance facility. Under the leadership of the club's president, general manager, grounds committee chairman, the head golf professional, and me, the team began evaluating five potential sites for the new building.

Our search revealed a site that offered access to a public road, easy access to the golf course, and could be cost effectively connected to public utilities. The chosen site was located to the right of the fourth fairway and behind the fifth tee. Access to the golf course could be facilitated by installing a 30-foot-long by 10-foot-wide path from the new building site to the existing continuous cart path. Although space is somewhat limited at the course, the proposed site offered the opportunity to expand, if necessary, in the future. One tremendous advantage over the old location was the adequate space for parking and storage. Access to a public road and proximity to utilities helped to keep construction costs down, and the proposed location minimized the impact on daily club operations as construction progressed.

The next step was designing a building that would meet present and future needs. One of the team's most important goals was to be able to house all of the equipment. The construction of a new golf course maintenance facility is rarely a high-profile item, but when our membership approved funding for the new facility, our team was unanimously supportive of maximizing the size of the building within the confines of the budget. Requirements included housing all equipment, office space for the superintendent, assistant superintendent, and mechanic, men's and ladies' locker rooms, and a break room large enough for the entire crew during peak season. Once the budget and space requirements were determined (10,000 square feet), the general manager and I began to tour recently constructed maintenance facilities in our area. This planning was informative and allowed us to learn from others on how best to manage the use of space. To be able to maximize usable space, the team felt the building design should minimize the use of interior walls (although this meant putting sprinklers throughout the building) and the office space, lockers, and break room should be built on a mezzanine above the mechanic's area. It was now time to present our concept to the general membership.

The board of directors presented the project to the general membership at the 2006 annual meeting. We wanted to tell the entire story, so the general manager and I constructed a collage displaying the condition of the existing building. Renderings of the proposed building were placed prominently in the entrance hall to the clubhouse and in the men's grille well in advance of the annual meeting. These initial efforts provided an opportunity to answer questions before the proposals were presented to the entire membership. Our homework and preparation paid off. The president and grounds committee chairman, representing the board of directors, presented the proposal to the general membership and it was well received. The membership agreed that Wildwood Golf Club needed to proceed with this project, particularly when information was

The new 10,200 sq. ft. maintenance facility can house all of the equipment and accommodate the employees. Through the efforts of a dedicated team, something special happened at Wildwood Golf Club.

presented regarding the cost, environmental impact of upgrading the present facility, and the fact that there was no real opportunity to expand the current facility. With the blessing of the membership, the board of directors approved the $550,000 assessment.

OBTAINING PERMITS

The permitting phase of the project involved multiple governmental agencies and necessitated being present at numerous meetings. The team enlisted the services of a project management firm to help lead this process.

- The site had to be approved by the township, and a formal storm water management plan needed to be developed. Multiple neighborhood hearings were conducted. Noise and storm water drainage issues had to be addressed, and neighbor's concerns needed to be alleviated before the permits were issued.
- The county had to approve the environmental impact plan before an actual building permit could be obtained.
- The general manager met on several occasions with the township manager and land management supervisor to provide all of the necessary documentation.
- The team, including Wildwood's legal counsel (also a member of the board of directors), attended multiple township meetings to openly address all concerns of the golf course neighbors.

We underestimated the demands of this phase of the project. Almost eight months of time and effort were required to complete the permitting process. Wildwood Golf Club incurred additional expenses for storm water drainage ($30,000), sprinklers throughout the building ($38,000), disability (ADA) compliance issues ($5,000), and the placement of a fire hydrant within 100 feet of the new building ($5,000). The delay also resulted in significant increases in construction costs due to the rising prices of steel and other construction material. Throughout this process, the team's commitment to the new maintenance facility was tested. However, in August 2006, we finally had all of the necessary permits and could begin construction.

After we obtained and evaluated project bids, the construction contract was awarded to the general contractor who had built our pro shop and cart maintenance facility. Given our history with the general contractor and the fact that the project was awarded early, preliminary excavation and site work preparation were initiated while waiting for building permits to be issued. The team agreed that our general manager would serve as Wildwood Golf Club's project manager. During construction, my role as superintendent was to monitor and coordinate daily on-site activity and, most important, ensure that there was no disruption to play while work was being done on the new building.

The team met twice a week to discuss the project status and progress. Often these meetings consisted of the team simply walking the construction site. Progress could be monitored and, if necessary, suggestions were offered

to the general contractor. Our general manager served as the point of contact to funnel all concerns and suggestions to the general contractor, who was committed to this project and frequently participated in these informal meetings. The regular site visit schedule allowed the team to stay current with the construction progress. We kept the membership informed and made sure that communications to those inquiring about the project were consistent. Most important, we avoided issuing major change orders so that costs were controlled.

By November 2006 concrete floors had been poured, the walls and roof had been erected, the storm water management system had been installed, utility lines had been connected, and garage doors were attached. From the outside, the building appeared complete. As the new facility took form, the general membership began to take notice. The team received questions regarding the state of construction, expected completion date, and demolition of the old maintenance facility. Our goal was to have the demolition and reclamation of the old building site completed prior to the start of the 2007 golf season. An open house and tour of the new maintenance facility were scheduled for opening day.

THE FINAL STEPS

Construction was completed in late January 2007, and the occupancy permit was awarded. Prior to moving in, workbenches, shelves, and storage areas were constructed. By early February everything had been built, painted, and positioned in the shop. By the second week of February 2007, all of the equipment was moved and we were operating out of the new building.

While construction costs were higher than initially projected in 2001, we were able to complete the project within budget. Several construction items, such as interior finish work, originally planned to be outsourced, were completed with in-house staff to control costs. These costs were absorbed in the operating budget or capitalized under 2007 proposed expenditures. The entire process, beginning with the board's approval of the second phase to completion of construction, took 15 months. The entire membership is proud of what has been accomplished.

The grounds department went from a building that was too small, in poor repair, and had no public sewage, to a 10,200 sq. ft. building that accommodates all of our current needs. This project could not have happened without the commitment of a group of dedicated people with a vision for the future. I would like to personally thank the team: General Manager Steve Gonzalez, Club President Dr. Ron Stoller, Grounds Chairman David Fitzsimmons, Head Golf Professional Bernie Hough, General Contractor Bob Glancy, the Wildwood membership, and my crew for all of their help and support throughout the process. Through their concerted efforts we were able to make something special happen for Wildwood Golf Club.

ERIC MATEKOWSKI *is the current golf course superintendent at Wildwood Golf Club in Allison Park, Pennsylvania.*

The golf course team worked to be as proactive as possible with the membership. As the building took shape, many questions were asked about the state of construction, expected completion date, and when the old building would be demolished. The questions were accurately answered on a regular basis.

Data Loggers Help Reveal Old Secrets

Monitoring weather conditions with data loggers can bring a new understanding to some old problems.

BY JIM SKORULSKI

Chris Frielinghaus, superintendent at Glens Falls Country Club, uses a data shuttle device in the field to download temperature data from the data logger to be later transferred to his computer.

The tools available to manage turfgrass continue to improve. Remote sensing, satellite imaging, GPS, GIS, and smart sprayer technology are just a few of the tools that are now being utilized to monitor turfgrass more closely, improve irrigation precision, and manage pests successfully. Technologies to monitor climatic conditions and forecast weather have improved significantly, and advances in satellite technology and weather modeling have improved longer-range weather forecasting. The Internet has made real-time radar and multiple sources of weather data more available to most operations.

Golf course superintendents looking for more site-specific weather data are also realizing the benefits of improved technology. Automated weather stations are available to monitor temperature, relative humidity, wind speed and direction, solar radiation, barometric pressure, rainfall, soil moisture, evapotranspiration, leaf wetness, and more. The machines collect the data and can incorporate it into weather-based forecasting models that have been developed for diseases, insect pests, and weeds of turfgrass. The weather stations are comprised of a sophisticated data logger that collects and stores data from the various sensors. The data are transmitted directly to a computer through hardwire or wireless connections, where the information is used to track weather conditions, program irrigation, and forecast potential pest problems.

A la carte versions of weather stations are available for those who do not require a complete station. The smaller weather station version can be crafted using a battery-operated data logger device equipped with sensors for the specific conditions that will be monitored. The systems can range from simple, inexpensive single-sensor units to more complex multi-sensor devices, depending on the information desired. The smaller systems can be placed at different locations on the golf course to obtain data from various microclimates. The battery life is long and the data storage capabilities in the devices are significant. Unlike most conventional weather stations, the data stored in the data logger must be transferred manually from the field to a computer.

The value of data logger equipment has been realized by those wishing to monitor temperatures or other weather conditions at remote or multiple sites on the golf course. Let's take a

closer look at the devices and how temperature monitoring can improve a management program.

GETTING STARTED

Creating a weather monitoring system with a data logger can be accomplished for as little as $400-$500. The system includes a battery-operated data logger device equipped with both internal and external sensors, a radiation shield to protect the data logger, a USB base station, and software required to launch the device and interpret the data. The USB base station is used to complete a connection between the computer and data logger device. A data shuttle device is not required, but it is a highly recommended accessory that eliminates having to carry a laptop computer in the field to collect data or launch the operation of data loggers in the field.

PUTTING THE LOGGERS TO WORK FOR YOU

Data loggers can be used on golf courses primarily to monitor winter temperatures. The temperature data have proven useful for managing winter covers and in increasing our understanding of weather, snow, and ice effects on turfgrass survival. The data loggers are set out adjacent to greens in late fall at the same time winter covers are installed and final winter preparations are completed. The data logger contains an internal sensor to measure air temperature and an external port to which a thermocouple is attached to provide green canopy temperature measurements under snow, ice sheets, or winter covers. The data logger is activated to collect temperature data at the time interval desired. The data are downloaded from the data logger either with a data shuttle device or a laptop computer. The data are then available for closer analysis and to formulate charts.

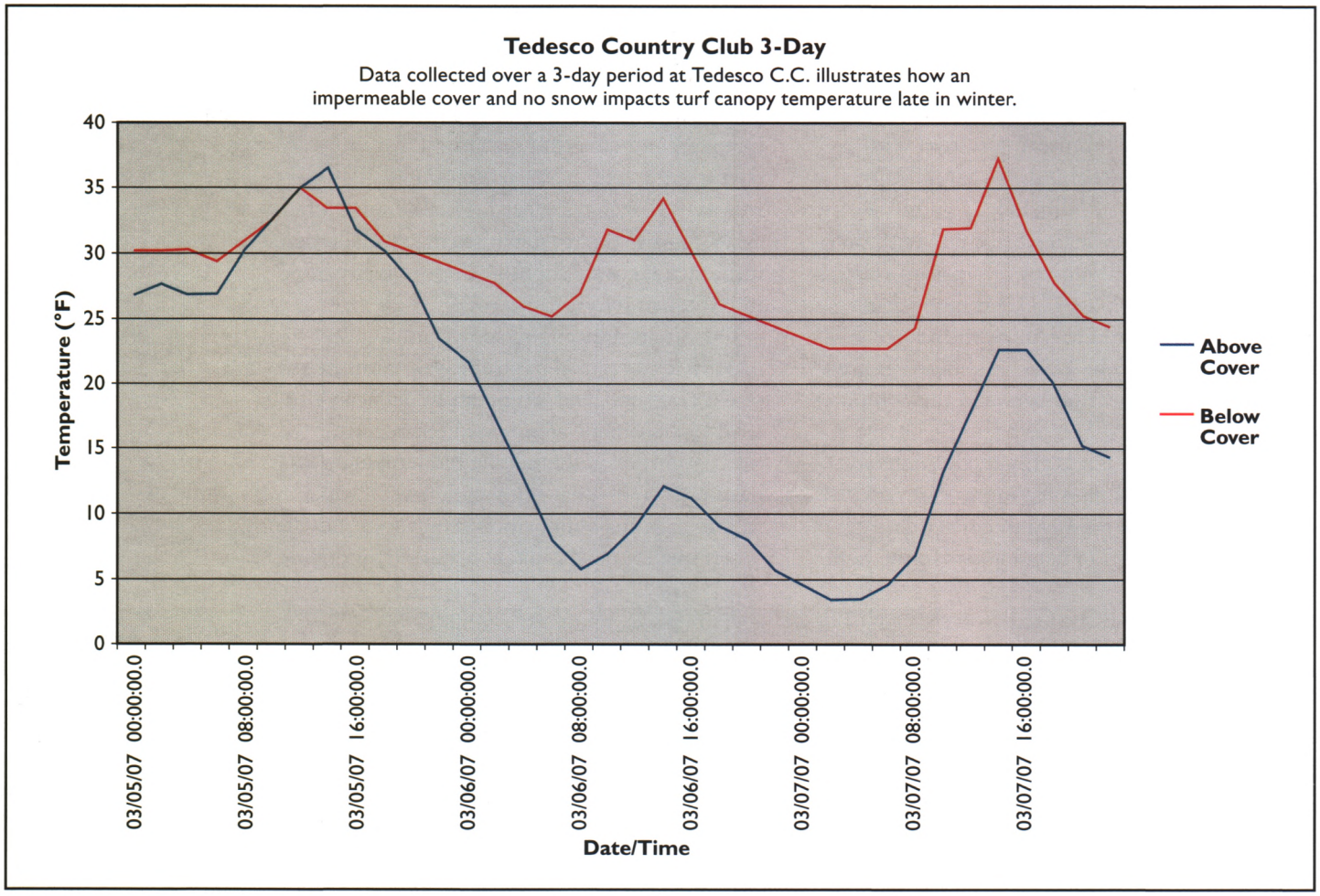
Superintendents managing annual bluegrass in the northern regions have learned that putting green survival in the winter months is often dependent on the plant's exposure to lethal cold temperatures and hydration. Covering systems are being used more often to buffer cold temperatures and prevent excessive plant hydration. The data loggers provide invaluable temperature information that has improved our understanding of how winter covers influence canopy temperatures and is helping evaluate different types of covers and covering systems. The temperature data are also helpful for evaluating insulating materials that may be used. Finally, superintendents can use the temperature data to help determine when covers should be temporarily lifted in winter or removed in spring.

Our understanding of snow's impact on canopy temperature has improved with the use of data loggers. The temperature data can also be used to document when rapid temperature fluctuations or potentially lethal temperatures have occurred. That information will help a manager gain a better understanding of how and when turf injury has likely occurred, and it should be useful for formulating strategies to prevent similar damage in the future. It is safe to say that collection of temperature data will increase your understanding of winter injury and its management at your course.

Data logger devices like the one pictured are durable enough for use in the field and will operate effectively for months on their battery source. The device collects and stores large quantities of data that can be transferred to a computer for analysis.

NOT JUST A WINTER THING

The use of data loggers can be extended well beyond winter. Equipping the data loggers with sensors to measure light intensity, relative humidity, leaf wetness, or other weather condi-



tions might be useful for comparison purposes or documenting problems at a challenging site.

Temperature data can also be used to calculate degree-day accumulations that are used to predict pest activity. The software provided with the data logger completes the degree-day calculation that measures the difference between average daily temperature and a reference base temperature. The reference base temperature is the temperature that has been determined through research to be optimal for a pest's activity. Accurate degree-day models have been developed for crabgrass and annual bluegrass seed head emergence, and that information is readily available in the literature. Models and base temperatures have also been developed for a number of insect pests, including black turfgrass ataenius, hairy chinch bug, annual bluegrass weevil, and others. A number of these models are currently in place or are being refined and field tested, and that information will soon be available. The degree-day information can be correlated to actual pest activity in the field and used to refine monitoring and spray programs.

So how does a data logger fit into your program? Perhaps it doesn't at this point. But, for northern golf courses dealing with winter injury issues and courses battling pest problems, the small investment in the equipment and time will pay large dividends by increasing your knowledge of the impacts of the weather and management practices used during the winter season. Those in the warmer climates can benefit from the ability to monitor specific site conditions for especially problematic areas or to gain more intimate knowledge of pest activities on the golf course. The technology behind the data loggers and sensors will certainly improve, and with it our ability to manage the golf course.

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Environmental Management Systems

A new standard for environmental management is coming.

BY ROBERT N. CARROW AND KEVIN A. FLETCHER

Identifying your golf course's environmental attributes and impacts is an important part of the planning process (Itasca Country Club, Itasca, Illinois).

Management of the natural environment by businesses has been dominated for nearly 40 years by legal, regulatory, command-and-control approaches. From the Clean Water Act to chemical use and regulation, business owners and managers, including in golf, have addressed environmental issues in prescribed manners — answering to federal, state, and even local law. While legal requirements are not going away in the near future, more and more agencies and businesses are gravitating toward a new standard for enhancing environmental management and stewardship, one that emphasizes proactivity and systematic detail. This new focus on Environmental Management Systems is something that is sure to infiltrate the management of golf courses in the years to come.

Environmental Management Systems (EMS) are rapidly becoming the accepted standard to identify and manage all environmental issues comprehensively for all enterprises (manufacturing plants, restaurants, businesses, waste treatment facilities, agricultural facilities, golf course facilities, etc.). The EPA's position statement on EMS illustrates this point (USEPA 2007):

- EPA will encourage widespread use of EMSs across a range of organizations and settings, with particular emphasis on adoption of EMSs to achieve improved environmental performance and compliance, pollution prevention through source reduction, and continual improvement . . . .
- EPA will promote the voluntary adoption of EMSs. To encourage voluntary adoption of EMSs, EPA will rely on public education and voluntary programs.
- This document is EPA's strategy for addressing the question of whether — and if so, how — it may also be appropriate to consider EMSs in the context of the Federal regulatory structure, either to improve the design of regulatory programs, to encourage the use of EMSs, or both. EPA wishes to make clear that it has no intention of mandating the use of EMSs in rules and permits. Rather, the aim of this strategy is to determine whether there could be benefits from providing options within the regulatory structure for organizations that choose to adopt an EMS. In addition, this strategy does not signal any intent on the part of the agency to modify its existing policy of promoting the widespread use of EMSs on a voluntary basis.

Prior to the EMS concept, management of environmental issues for a facility was issue by issue, but an EMS is: a) a new management approach, b) for the whole system, c) for all environmental issues, and d) for daily environmental management decisions at all management levels within an organization to be the normal practice. As the EMS approach is increasingly adopted by golf courses, it will dramatically impact how management and operations are conducted in all components of a facility. Thus, it is important for course owners, officials, and members to understand it. In a

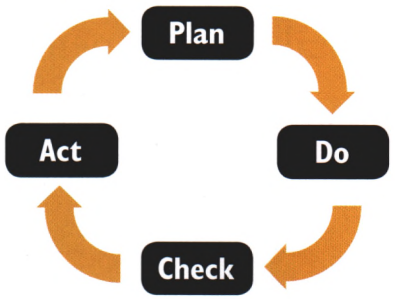
second paper in this two-part series, we will focus more specifically on what a golf course EMS may entail and the implications, but in the current paper the focus will be on understanding the EMS concept. For additional information, Carrow and Fletcher (2007) recently developed an educational guidebook for golf courses on the EMS concept and implications.

HISTORY OF EMS

With the birth of the environmental movement in the 1960s, businesses of all shapes and sizes found themselves responding to a new set of legal and social demands. Most of the early impacts on businesses were centered on legal and regulatory compliance. However, the past decade has seen a growth in the number of new tools businesses are using to manage their environmental issues. One very simple, yet growingly pervasive trend in business is the implementation of Environmental Management Systems (EMSs).

An EMS is a proactive approach to environmental stewardship that involves establishing an environmental policy and a long-term commitment

Figure 1
Key components of USEPA.



to environmental management. The most common EMSs are based upon the framework developed by the International Organization of Standards (ISO), a non-governmental network of national standards institutes from various countries. ISO is the world's largest organization devoted to the development of standards, especially technical standards (ISO 2007) and standards for quality (ISO 9000). In 1996, with revision in 2004, the ISO developed a standard for environmental management entitled "ISO 14001 Environmental Management System." The ISO 14001 standard is defined as "the part of the overall management system that includes organizational structure, planning activities, responsibilities, practices, procedures, processes, and resources for developing, implementing, achieving, reviewing, and maintaining the environment." ISO 14001 (1996) consisted of five principal or key components in a cyclic process:

- Commitment and Policy
- Planning
- Implementation
- Measurement and Evaluation
- Review and Improvement

Within agriculture, horticulture, and the golf course industries, the EMS concept is the furthest developed in Australia. The February issue of *Australian Journal of Experimental Agriculture*, Volume 47(3), 2007, was dedicated to EMS in agriculture and horticulture. Environmental Business Solution (EBS, 2007, Australia) developed the e-PAR program in conjunction with the AU EPA and Australian Golf Course Superintendents Association, and it is the most advanced program applying the EMS concept to golf courses in the world. Other voluntary environmental programs, such as the Audubon Cooperative Sanctuary Program for Golf Courses, also rely upon this general approach.

RELATED ENVIRONMENTAL TERMS OR CONCEPTS

Terms or programs that may be confused with EMS are **Environmental Management Plan (EMP)**, **Environmental Audit (EA)**, and **National Environmental Performance Track (NEPT)** program (NEPT, 2007). An EMP is much narrower than an EMS and is generally considered a plan to mitigate and monitor a single environmental issue. A very similar concept to an EMP is Best Management Plans (BMPs), which are developed to manage a particular environmental issue (Carrow et al., 2005). Thus, EMPs or BMPs are part of an overall EMS, while the EMS refers to the whole *system* or approach.

An Environmental Audit is a means to determine whether an EMS is effectively implemented or not. As such, an EA is a part of the overall EMS — i.e., one of the components. The ISO 14001 definition of an EA is, "An EMS Audit is a systematic and documented verification process of objectively obtaining and evaluating evidence to determine whether an organization's EMS conforms to the EMS audit criteria set by the organization and for communication of the results of this process to management" (ISO 2007). The Club Manager's Full Facility Environmental Audit (www.cmaa.org/audubon.htm) is one example of a stand-alone facility audit.

The EPA has a National Environmental Performance Track (NEPT 2007) program that is "a voluntary partnership program that recognizes and rewards private and public facilities that demonstrate strong environmental performance beyond current requirements. Performance Track is designed to augment the existing regulatory system by creating incentives for facilities to achieve environmental results beyond those required by law. To qualify, applicants must have implemented an independently assessed environmental managment system (i.e., EMS), have a record of sustained compliance with environmental laws and regulations, commit to achieving measurable environmental results that go beyond compliance, and provide information to the local community on their environmental activities. Members are subject to the same legal requirements as other regulated facilities. In some cases, EPA and states have reduced routine reporting or given some flexibility to program members in how they meet regulatory requirements. This approach is recognized by more than 20 states that have adopted similar performance-based leadership programs." Thus, a facility that has an EMS may wish to participate in the NEPT program as an addition, but it is not a part of the EMS. One of the criteria for the NEPT program is to have a comprehensive independent assessment of the organization's EMS. Thus far, only one golf facility, Colonial Acres Golf Course in New York, has completed the NEPT process — using much of the documentation required for certification in the ACSP for Golf Courses as a baseline EMS.

USEPA EMS MODEL

The ISO 14001 was, therefore, developed to "standardize" a management approach for entities to manage environmental issues in a systematic manner. Since 1996, the ISO 14001 EMS approach has been increasingly adopted in many areas of the world, including the USA, but often with some modification. The USEPA modified the ISO 14001 so that the EPA EMS entails a continual cycle with four key components, summarized in a *plan, do, check, act* format, where these key components are defined as (USEPA 2007a):

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

The cyclic design of EMS illustrates that management of environmental issues is to be an ongoing process with changes made over time.

ELEMENTS OF THE TRADITIONAL EMS

The principal components (plan, do, check, act) of the USEPA EMS are normally expanded into 17 key elements or steps related to the development and implementation of an EMS for an entity. The 17 key elements as outlined by the EPA are (USEPA 2007b):

1. Environmental principles and policy: Develop a statement of your organization's commitment to the environment. Use this policy as a framework for planning and action.

2. Legal and other requirements: Identify and ensure access to relevant laws and regulations, as well as other requirements to which your organization adheres.

3. Identify/assess significant environmental aspects and impacts: Identify environmental attributes of your products, activities, and services. Determine those that could have significant impacts on the environment.

4. Objectives and targets: Establish environmental goals for your organization in line with your policy, environmental impacts, the views of interested parties, and other factors.

Improving environmental performance has numerous benefits, including risk reduction, improved efficiency, enhanced image and reputation, and reduced costs. (Sterling National Country Club, Sterling, Massachusetts).

5. Develop environmental management programs: For each environmental issue, an action plan is formulated. Plan actions necessary to achieve your objectives and targets.

6. Structure and responsibility: Establish roles and responsibilities for environmental management and provide appropriate resources.

7. Training, awareness, and competence: Ensure that your employees are trained and capable of carrying out their environmental responsibilities.

8. Communication and outreach: Establish processes for internal and external communications on environmental management issues.

9. EMS documentation: Maintain information on your EMS and related documents. This would include BMPs for each environmental impact issue.

10. Document control: Ensure effective management of procedures and other system documents.

11. Operational control: Identify, plan, and manage your operations and activities in line with your policy, objectives, and targets.

12. Emergency preparedness and response: Identify potential emergencies and develop procedures for preventing and responding to them.

13. Monitoring and measurement: Monitor key activities and track performance. Conduct periodic assessments of compliance with legal requirements.

14. Nonconformance and corrective and preventive action: Identify and correct problems and prevent their recurrence.

15. Environmental records: Maintain and manage records of EMS performance.

16. EMS audit: Periodically verify that your EMS is operating as intended.

17. Management review: Periodically review your EMS with an eye to continual improvement.

A review of the 17 steps reveals several important points. First, when a facility embarks on development and implementation of an EMS, management, policy issues, training, and communications are significant activities in terms of time and commitment. When reading USEPA or other governmental agency materials related to EMSs, most of the material will be related to the areas of management structure, management activities, development of effective communication lines within a facility, and educational needs at various levels. Much of the discussion also relates to facilities larger than most golf courses, where management structure and activities, communications, and educational aspects can be integrated into existing management structures with fewer challenges than facilities with more complex management hierarchies. However, when reading these materials, one can easily get "bogged down" in the management emphasis and suggested changes.

Second, in contrast to the extensive materials on management, communications, and education, limited information will be noted relative to *the real "core" of an EMS plan*, which includes: a) Element 3 — Identify/assess significant environmental aspects and impacts, and b) Element 5 — Develop environmental management programs for each significant environmental issue. Since the foundational ISO 14001 EMS is really a standardized approach to managing environmental issues for all types of entities, their materials emphasize the common areas of management, communications, and education challenges. However, the actual environmental issues that may be present at a facility vary substantially, depending on the nature of the entity — e.g., the environmental issues of a golf course would differ from those of a manufacturing plant — and therefore are not discussed.

Third, a central purpose of the EMS concept is to incorporate environmental management into daily management decision-making at all management levels of a facility. Attention to environmental issues at all management levels is added to current parameters that may influence daily management decisions. In this way, an EMS-type system can help to foster an environmental culture at a facility — making environmental stewardship "the way we do things around here."

EMS BENEFITS AND COSTS

Since the EMS approach to management of environmental issues is voluntary and integrated into daily management of a facility, the aspects of benefits and costs related to an EMS are important components in the development and implementation of a facility EMS. Potential benefits and costs of EMS in terms of both business and environmental aspects are (USEPA 2007a):

BENEFITS TO A BUSINESS

- Improve overall environmental performance.
- Prevent pollution.
- Save money on landscape maintenance, energy, materials, etc.
- Enhance existing compliance efforts related to environmental aspects.
- Reduce or mitigate risks and liabilities.
- Exhibit environmental due diligence.
- Increase efficiency.
- Reduce costs.
- Enhance employee morale and possibly enhance recruitment of new employees.
- Achieve/improve employee awareness of environmental issues, responsibilities, and initiatives.
- Promote a positive, proactive corporate image related to environmental issues and club achievements with regulators, lenders, investors, and the public.
- Qualify for recognition/incentive programs such as the EPA Performance Track Program (NETP 2007) and other state-based voluntary environmental performance recognition programs.

As noted, development and implementation of an EMS by a golf club demonstrates to the public and regulators a proactive attitude toward environmental stewardship that does enhance the corporate image. An EMS program and associated documentation can be valuable tools for planned community outreach and educational efforts by a golf course. A good outreach and educational program involving club officials can result in significant benefits at the community level.

COSTS TO A BUSINESS

- An investment of internal resources, including staff/employee time.
- Costs for training of personnel.
- Costs associated with hiring consulting assistance, if needed.
- Costs for technical resources to analyze environmental impacts and improvement options, if needed.

Like any investment of resources, these potential costs must be balanced against the anticipated return on investment (benefits).

KEY IMPLICATIONS

Not all in the golf industry or other industries will be pleased with another environmental program, concept, or acronym. More limited environmental management programs have evolved in the past out of concern over particular environmental issues, and these have substantially impacted how golf courses operate. For example, starting about 30 years ago, the U.S. Environmental Protection Agency (EPA) Clean Water Act, targeted to protection of surface and subsurface water quality from pesticides, nutrients, and sediments, resulted in the "Best Management Practices" (BMPs) concept as well as the "Integrated Pest Management" (IPM) concept (Rawson 1995, EPA 2005).

Over time, however, EMS will have a much more profound impact on the golf industry than any previous environmental initiative, but it will be relatively easy to understand and implement since it is built on encompassing current BMPs, IPM programs, and even traditional business management approaches (i.e., Total Quality Management). It is good to remember that the alternative to this voluntary program is likely to be more rigid regulations.

With acceptance at international and multiple industry levels, EMS should best be viewed as an opportunity rather than an obstacle. It is wise for the golf industry to understand and accept this concept. For golf course owners and managers, the following points are especially pertinent:

- The EMS concept is promoted by regulatory agencies on an international basis as the best means to mitigate or manage environmental issues for all businesses or entities that have potential environmental impact.
- EMSs are for all facilities of an industry — i.e., all golf courses will very likely need to develop their own site-specific EMS plan.
- The EMS concept binds together all environmental issues at the whole facility — i.e., clubhouse, maintenance facility, general grounds, pool, golf course, and any other part of the facility.
- All environmental issues are to be assessed and management plans developed and implemented for all environmental issues at a facility. An EMS allows combining together into one system the various BMPs for each particular environmental issue.
- The term Environmental Management Systems (EMS) truly reflects the nature of EMS as: a) a new management approach, b) for the whole system, c) for all environmental issues, and d) for daily environmental management decisions at all management levels within an organization to be the normal practice.
- Since EMS is for the whole facility, upper management and organization-wide commitment are necessary. This entails organization-wide training.

An Environmental Management System (EMS) offers an integrated environmental strategy for the entire golf maintenance program, from best management practices, to emergency preparedness, to employee training.

While this first article has provided a summary of the EMS concept, the application to golf course facilities still relies on wrestling with the "devil" in the details. The second article of this series will focus more specifically on golf courses and challenges that may arise, especially in assessing environmental issues, developing BMPs for each issue, and auditing. It is important to remember that no one "owns" an EMS for golf — it is a concept and approach available to anyone willing to think and act systematically toward the environment. However, the elements that golf owners and managers should pay attention to are both the details of the process of an EMS as well as the content of identified environmental issues and related BMPs. An EMS alone will not solve all the environmental problems of golf course management, but it can be an effective part of the solution.

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To Insure Professional Success

A few tips for your next green construction project.

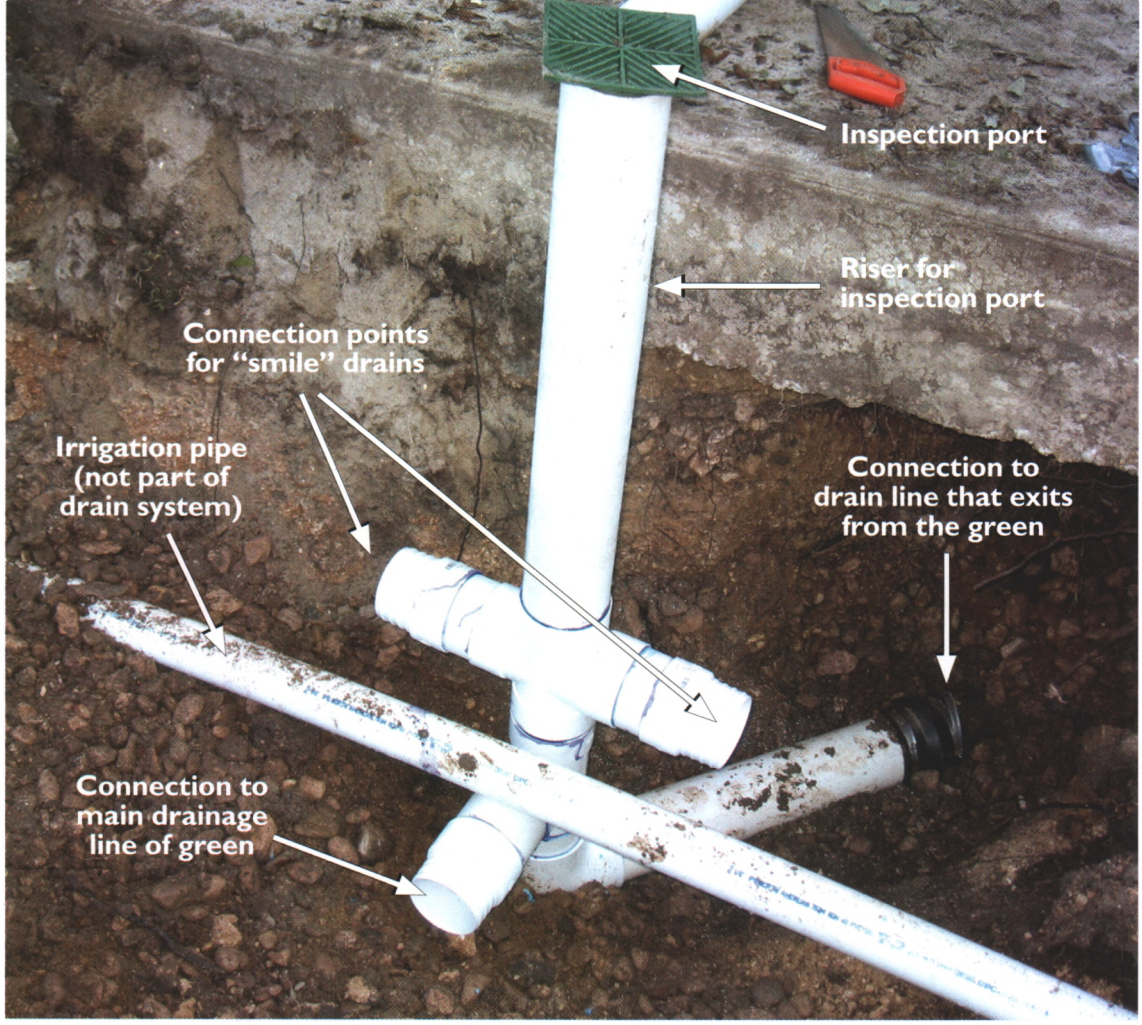
BY JAMES F. MOORE

Although the USGA's *Recommendations for a Method of Putting Green Construction* are very specific when it comes to particle size distribution, porosity, and other technical details, there are many different building techniques that can be used during the construction process itself. Those who have made their living building greens have developed many tips for success to make the process easier and more efficient without sacrificing quality. The USGA's publication *Building the USGA Green — Tips for Success* details many of these tips and is available from the USGA Order Department (800-336-4446) or can be downloaded from the USGA Web site (http://www.usga.org/turf/articles/articles_and_resources.html).

Here are three more tips that will prove helpful on your next green construction project.

JAMES F. MOORE *offers plenty of tips as director of the USGA's construction education program.*

Paint lines on the floor of the green cavity to show the trencher operator where to dig. At the point where the lateral lines connect into the main line, it is important to set the trenches at the proper angle. Failure to do so will result in a great deal of additional hand digging at each connection, since the pipe will not match up with the fitting. To make these connections, 45-degree fittings are most commonly used. To be sure everything lines up properly, simply attach a fitting on each end of a length of 4-inch pipe. A 3-foot-long section of pipe works well. Place your new tool on the main line at the point where your laterals are going to connect. Attach a section of rope to an old golf club shaft and insert the shaft into the subgrade at the connection point. Stretch the rope on a line extending from the fitting opening and paint over the rope. Once the ditches are dug, everything will line up perfectly.



Here is another green construction tip. The point at which the main drain line exits the green is critical. If the drainage pipe is damaged here, the drainage for the entire green can be adversely affected. Although flexible drainage pipe is fine for most of the system, it is a good idea to use rigid pipe at the point where the main line and the "smile" drains connect. (Note: The "extra" PVC pipe is an irrigation pipe in the same area.)

The third tip involves settling the new rootzone mixture as quickly as possible. A vibratory packer can be used on the mix even during the spreading process. This step helps compact the mix to a settled depth, making it easy to see where additional mix is needed. It also helps speed up the process of making the mix firm enough to be planted.

Dollar Spot Control

Treatment of this disease in creeping bentgrass fairway turf as influenced by fungicide spray volume and application timing.

BY STEVEN J. McDONALD, PETER H. DERNOEDEN, AND CALE A. BIGELOW

Dollar spot continues to be a difficult disease to control in creeping bentgrass fairways in many regions. Chlorothalonil is a contact fungicide that remains on plant surfaces and is perhaps the most common chemical used on turf for disease control. Furthermore, this fungicide is highly valued in disease resistance management programs, and methods for improving its performance need to be investigated. There have been no reported cases of pathogen resistance to chlorothalonil, but there have been resistance problems with other fungicides used to control turfgrass diseases.[4,6] Propiconazole, commonly used to control dollar spot (DS), penetrates tissues and therefore generally provides a longer period of control than chlorothalonil.

Due to playability issues, pesticide exposure, and demands from golfers, superintendents normally make pesticide applications early in the morning. The effect of the presence of dew at the time a fungicide is applied is unknown. Furthermore, there has been little study on the impact of spray volume (SV) or water carrier volume on fungicide performance. Couch[2] evaluated chlorothalonil and triadimefon in SVs ranging from 0.5 to 32 gallons of water per 1,000 sq. ft. (gal/1,000ft^2) for DS control in creeping bentgrass. He observed that chlorothalonil performed best at 1 gal/1,000ft^2, while triadimefon performed best when applied at 2 gal/1,000ft^2. Other researchers,[1,6] however, reported that there were no differences in the level of DS control among SVs (0.5, 1.0, 2, and 4 gal/1,000ft^2) with chlorothalonil, triadimefon, or iprodione.

Dollar spot is characterized by circular spots one to two inches in diameter. This disease is difficult to control in creeping bentgrass turf.

Due to conflicting research results and varying SVs and/or methods of application, further study is needed to evaluate the importance of SV as well as the presence or absence of dew on the ability of fungicides to control DS. For logistical reasons, superintendents would prefer to utilize lower rather than higher SVs. Hence, an important aspect of this study was to determine if the level of DS control would be diminished if a lower rather than higher SV were utilized. The purpose of this study was to investigate the efficacy of a contact (chlorothalonil) and a penetrant (propiconazole) fungicide for their ability to control DS as influenced by SV (1.1 and 2.5 gal/1,000ft^2) and by the presence or absence of dew (AM dew present or displaced, and PM dry turf).

EVALUATING SPRAY VOLUME AND APPLICATION TIMING ON DOLLAR SPOT CONTROL

Field studies were conducted from 2002 to 2004 at the University of Maryland in creeping bentgrass maintained as fairway turf. Treatments were applied with a CO_2 pressurized sprayer (35 psi) equipped with either an 8004 (1.1 gal/1,000ft^2, low SV) or 8010 (2.5 gal/1,000ft^2, high SV) flat fan nozzle. A reapplication threshold was subjectively established at 8 to 10 infection centers (ICs) or 0.5% plot area blighted (% PAB). In all years, AM treatments were applied at 8 AM and PM treatments were applied to a dry canopy.

Table 1
Number of *Sclerotinia homoeocarpa* infection centers as affected by chlorothalonil application timing and spray volume, 2002.

Timing[y]	Spray Volume	Infection Centers Plot^{-1} 28 June	1 August	7 August
	(gallons per 1,000ft^2)		(no.)	
AM	1.1	3.8 bc[z]	0.0 c	15.8 d
AM	2.5	11.5 b	3.5 b	45.8. b
PM	1.1	2.0 c	0.3 c	19.8 cd
PM	2.5	10.0 b	3.5 b	33.5 bc
—	Untreated Control	26.0 a	117.8 a	116.5 a

[y]Chlorothalonil was applied on 20 June and 21 July 2002.
[z]Means in the same column followed by the same letter are not significantly different.

In 2003 and 2004, dew was displaced using the reverse side of an aluminum rake immediately before treatments were applied.

SITE DESCRIPTIONS AND TREATMENTS

L-93, Crenshaw, and Southshore creeping bentgrass were used in 2002, 2003, and 2004, respectively. In 2002, fungicide treatments were as follows: chlorothalonil alone (Daconil Ultrex WDG 82.5, Syngenta Crop Protection, Greensboro, N.C.) applied at 3.2 oz. product/1,000 ft^2 in the AM in the low dilution (1.1 gal/1,000ft^2, low SV) or the high dilution (2.5 gal/1,000ft^2, high SV), and again to separate plots in the PM on the same day. There were two application timings (AM and PM) in 2002 and no "dew displaced" treatment. In 2003 and 2004, fungicide treatments were as follows: chlorothalonil alone, propiconazole alone (Banner MAXX 1.3 MC, Syngenta Crop Protection, Greensboro, N.C.), and a tank-mix combination of chlorothalonil and propiconazole were each applied in the AM with "dew present," AM with "dew displaced," and in the PM with the canopy dry. In 2003 and 2004, the chlorothalonil rate was 1.8 fl. oz. product/1,000ft^2. In 2003, the propiconazole rate was 1.0 fl. oz. product/1,000ft^2; however, in 2004 it was reduced to 0.5 fl. oz. product/1,000ft^2, regardless of being applied alone or tank mixed.

Ratings were obtained by counting the number of dollar spot (*S. homoeocarpa*) ICs/plot or by estimating the % PAB once ICs coalesced. Percent of plot area blighted was assessed visually on a 0-to-100 scale with 0 = no DS and 100 = entire plot area blighted. Data were analyzed using several statistical methods as described by McDonald et al.[3] In 2003 and 2004, preplanned contrasts were used to separate treatments of interest and are shown in Tables 2 and 3. A preplanned contrast is a statistical test that compares individual or groups of treatments against each other and can amplify differences that may exist between specific treatments. Area under disease progress curve (AUDPC) data were used to compare fungicide treatments during each of the three study periods. An AUDPC value provides a single value that expresses disease level over a defined period.

Table 2
Contrasts among spray volume, application timing, and fungicide treatments and their effect on dollar spot control, 2003.

Date	Contrast: Chlorothalonil 1.1 vs. 2.5 pgm[x]	Chlorothalonil AM dew present vs. AM dew displaced[x]	Chlorothalonil AM dew present vs. PM[x]	Chlorothalonil AM dew displaced vs. PM[x]	Propiconazole vs. Tank mix[y]
11 August	**[z]	NS	*	*	NS
13 August	NS	NS	NS	*	*
16 August	**	NS	NS	NS	***
18 August	NS	NS	NS	NS	***
7 September	***	NS	**	**	*
10 September	***	NS	**	*	*
12 September	***	NS	**	*	***
29 September	**	NS	**	**	NS
1 October	**	NS	**	**	NS
AUDPC	***	NS	***	***	**

[x]Chlorothalonil-alone treatments were applied on 23 July and 7 and 23 August 2003.
[y]Propiconazole alone and tank mix were applied on 23 July and 19 August 2003.
[z]*, **, ***, and NS refer to the 0.05, 0.01, 0.001 significance levels and non-significant, respectively.

Table 3
Contrasts among spray volume, application timing, and fungicide treatments and their effect on dollar spot control, 2004.

	Contrast				
Date	Chlorothalonil 1.1 vs. 2.5 pgm[x]	Chlorothalonil AM dew present vs. AM dew displaced[x]	Chlorothalonil AM dew present vs. PM[x]	Chlorothalonil AM dew displaced vs. PM[x]	Propiconazole vs. Tank mix[y]
2 June	[z]NS[z]	**	***	*	NS
3 June	NS	NS	**	NS	NS
8 June	NS	NS	*	NS	*
11 June	NS	NS	*	NS	*
13 June	*	NS	NS	NS	NS
15 June	***	NS	NS	NS	*
17 June	**	NS	NS	NS	NS
22 June	NS	*	**	NS	***
25 June	*	NS	**	NS	**
30 June	*	**	**	NS	***
2 July	NS	*	**	NS	***
7 July	**	NS	NS	NS	***
9 July	*	*	NS	NS	***
12 July	*	NS	NS	NS	**
16 July	***	NS	NS	NS	***
AUDPC	**	*	**	NS	***

[x]Chlorothalonil-alone treatments were applied on 12 May, 4 and 23 June 2004.
[y]Propiconazole alone and tank mix were applied on 12 May and 18 June 2004.
[z]*, **, ***, and NS refer to the 0.05, 0.01, 0.001 significance levels and non-significant, respectively.

THE INFLUENCE OF SPRAY VOLUME AND APPLICATION TIMING ON DOLLAR SPOT CONTROL

2002: Eight days after the initial fungicide application (28 June), all treatments significantly reduced DS levels when compared to the untreated control (Table 1). At this time, the PM application of chlorothalonil in the low SV provided better DS suppression (2 ICs) than both treatments applied in the high SV (10 to 12 ICs). Furthermore, on 29 July chlorothalonil applied in the low SV provided better DS control (2 to 4 ICs) versus those applied in the high SV (6 to 10 ICs). By 1 August, plots treated with chlorothalonil in the low SV and both timings had lower levels of DS (0.0 and 0.3 ICs), when compared to treatments applied in the high SV (3.5 ICs) and the untreated control (118 ICs).

2003: In 2003, dollar spot peaked on 16 August, at which time 7.9% PAB was observed in untreated plots. On 16 August, the SV contrast data showed that chlorothalonil applied in the low SV (0.1% PAB) gave better DS control when compared to plots treated with the high SV (0.2% PAB, Table 2). From that point on, the SV contrast data revealed that chlorothalonil applied in low SV provided better DS control when compared to treatments applied in the high SV (Table 2). Contrasts for the AUDPC values also showed that chlorothalonil alone provided better DS control when applied in the PM and in the low SV when compared to AM applications with dew present or displaced or in the high SV. Contrasts for data collected on 11 and 13 August and from 7 September to 1 October showed that chlorothalonil applied in the PM provided better DS control when compared to AM applications with the dew displaced.

When comparing propiconazole-alone treatments among themselves, few differences were observed throughout 2003. However, the contrast statements showed that the tank mix provided better DS control than propiconazole alone on 9 of the 21 rating dates (Table 2, all data not shown).

2004: On 9 of 18 rating dates in 2004, chlorothalonil applied in the low SV provided better DS control when compared to treatments applied in the high SV. Data from early June 2004 showed that plots treated with chlorothalonil in the PM (1.9 ICs) had less DS when compared to plots treated with chlorothalonil in the AM with dew displaced (4.7 ICs). On 5 of 18 rating dates, chlorothalonil provided better DS control when applied in the

AM with the dew displaced when compared to the AM application with the dew present. Also, on 8 of 18 rating dates, chlorothalonil provided better DS control when applied in the PM when compared to AM treatments with the dew present.

No differences were observed on any 2004 rating date when propiconazole or tank-mix treatments were compared to themselves. However, the tank mix provided better dollar spot control than propiconazole alone on 11 of 18 rating dates.

SUMMARY AND RECOMMENDATIONS

On 25 of 46 dates over the three years, chlorothalonil applied alone provided better DS control when applied in 1.1 versus 2.5 gal/1,000ft^2. There were no dates in any year when the higher SV provided better DS control versus the low SV. Couch[2] previously reported that chlorothalonil provided better DS control using a similar SV (1.0 gal/1,000ft^2) when compared to higher SVs (≥ 2.0 gal/1,000ft^2). Applying chlorothalonil to a dry canopy in the PM generally increased efficacy when compared to both AM treatments. In 2003, there were no DS differences on any rating date between AM dew present and displaced treatments using chlorothalonil. On 5 of 16 rating dates in 2004, however, chlorothalonil applied in the AM with the dew displaced resulted in better DS control when compared to AM applications with the dew present. While there was no consistent benefit provided by displacing dew between years, 2004 data suggest that displacing dew can be beneficial when using chlorothalonil alone. Morning (8 AM) dew measurements were obtained on four days between 4 June and 22 August in 2003 and 2004 using the method described by Williams et al.[7] Dew levels ranged from 2.2 to 5.9 gal/1,000ft^2, with a mean of 4.3 gal/1,000ft^2. It is possible that significant amounts of chlorothalonil did not adhere to the foliage when it was applied in the higher SV or in the presence of dew.

No differences were observed in the level of DS control in either year among dew and SV treatments using propiconazole alone and propiconazole + chlorothalonil. Evidently, SV and the presence of dew did not affect the ability of effective levels of propiconazole to penetrate plants rapidly and move upwards. The tank mix, however, provided better and extended levels of DS control on 29 of 39 rating dates when compared to propiconazole alone. Previous research has shown that chlorothalonil tank mixed with a penetrant can improve the level of DS control when compared to either fungicide applied alone.[4,5]

Control applications need to be timed to work both with the best timing for control of the disease as well as with the golf play schedule.

Field studies were conducted at the University of Maryland to investigate the ability of contact and penetrant fungicides to control dollar spot. The treatments included variations in spray volume and application timing.

Data showed that golf course superintendents can effectively use a 1.1 gal/1,000ft^2 SV for targeting DS in fairway-height turf with the fungicides evaluated. These results pertain only to preventive DS control programs in creeping bentgrass fairways with chlorothalonil and propiconazole. Applying fungicides in higher dilution may be more beneficial when targeting root pathogens or in curative programs for foliar diseases.

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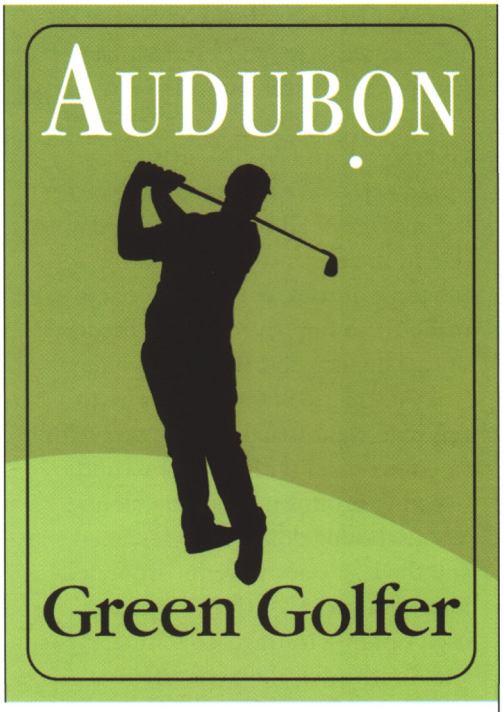
Take the Pledge for Greener Golf

It's time for golfers to dedicate themselves to making nature an integral part of their game.

BY JEAN MACKAY

Golf industry and environmental experts have long recognized the power of America's 25 million golfers in supporting or rejecting environmental best management practices on the country's 15,000 golf courses. Golfers can be a demanding breed — and their demands for fast greens and perfectly manicured conditions have often trumped sound agronomic practices and nature conservation.

But it doesn't have to be that way. Golfers also can be a force for preserving the *nature of the game*. Throughout 2007, Audubon International, along with the USGA and The PGA of America, is inviting golfers to take the *Audubon Green Golfer Pledge* (see sidebar). The pledge is a simple way for golfers to support environmental stewardship while playing. From replacing divots to picking up trash, the simple actions golfers can take are good for the game, good for the golf course, and good for the environment.



76% of golfers surveyed in 2007 by *Golf Digest* said that a golf course that integrates natural habitat increases golfer enjoyment of the game ("Golf & The Environment 2007," *Golf Digest Publications*). The Audubon Green Golfer Pledge builds awareness and support among golfers for doing just that.

"The pledge is a great way for golfers to celebrate the sport's venerable tradition of making nature an integral part of the game," says Kevin Fletcher, executive director, Audubon International. "We want golfers to recognize that quality playing conditions and good stewardship go hand in hand."

Golfers can take the free pledge online or via a pledge sheet distributed to golf courses that wish to participate in promoting the pledge. Green Golfers — and participating courses — are eligible for golf-related prizes to be given at the end of 2007.

For more information and golfer education resources, or to get involved in promoting the pledge, please visit www.golfandenvironment.org and click on *Audubon Green Golfer.*

AUDUBON GREEN GOLFER PLEDGE

We value the nature of the game and accept our responsibility to ensure that golf courses are managed in harmony with the environment. We pledge to:

- Be kind to the course: repair ball marks and replace divots to help maintain playability.
- Walk, rather than use a cart, when possible. Walking promotes physical fitness, healthy turf, and a clean environment.
- Look for consistent, true ball roll on greens, rather than speed. Lower mowing heights required for fast greens are at the root of many turf and environmental problems.
- Keep play on the course and stay out of natural areas. Respect designated environmentally sensitive areas and wildlife habitats within the course.
- Use trash and recycling receptacles and encourage others to do the same. If you see trash, don't pass it up . . . pick it up!
- Appreciate the nature of the game. Watch for wildlife as you play and support the course's efforts to provide habitat.
- Educate others about the benefits of environmentally responsible golf course management for the future of the game and the environment.
- Encourage the golf course to be an active participant in environmental programs for golf courses, such as those offered by Audubon International.

JEAN MACKAY, *formerly served as director of educational services for Audubon International. Currently she is director of communications and outreach for the Erie Canalway National Historic Corridor in New York State. To find out more about the Audubon Cooperative Sanctuary or Audubon Signature Programs sponsored by the USGA, visit www.audubonintemational.org.*

Turfgrass Breeders: Golf's Unsung Heroes

Working behind the scenes to improve course conditions.

BY PATRICK O'BRIEN

They are smart. They are world travelers. And they are unknown to many who play the game. They are golf's unsung heroes — turfgrass breeders. The development of new turfgrasses is one of the greatest improvements to golf courses. Plant breeders have released a plethora of new turfgrass varieties that offer improvements in appearance, survivability, and playability. All these advances have impacted how golfers play the game.

From the 1950s through the 1980s, golf was played mainly on Penncross bentgrass; Tifway, Tifdwarf, and Tifgreen bermudagrass; Meyer zoysia; Kentucky 31 tall fescue; and Merion Kentucky bluegrass. Although it is easy to see how far we have come, there was a time when turfgrass breeders believed the older grasses could not be improved upon and that new varieties could not be marketed in a way to compete with the existing standard grasses. Once these issues were resolved, it opened the door for many improvements.

In 1982, the USGA Turfgrass and Environmental Research program developed far-reaching goals to develop improved genetic plant material for golf to meet new environmental concerns and water quality issues. The USGA provided funding to university plant breeding programs to improve plant genetics. A total of $18 million has been invested since then, and today more varieties than ever are available to golf courses, many of which meet the USGA's original research goals.

Nowhere are the new turfgrasses more obvious than on the putting greens. Grasses such as Crenshaw, SR 1020, and the A and G series turfgrasses offer better summer survival and better playing quality. TifEagle, Champion, and Mini-Verde ultradwarfs have rendered Tifdwarf bermudagrass all but obsolete today due to their adaptability to lower mowing. It took years for breeders to make these improvements to the level of turf quality demanded by golfers.

Breeders used many strategies to improve plant material, some traveling to golf courses with Penncross and selecting promising-looking clones. Thousands of clones were screened and the best ones were incorporated into new varieties. Other breeders used funding to travel to China, Japan, and South Africa, where different species originated from and where the greatest genetic diversity existed.

Grasses new to golf courses have started to appear. Paspalum did not exist on golf courses 20 years ago, but today it is considered a premium golf surface on sites with poor water quality, especially in Hawaii and Florida. While zoysiagrass is not new to golf courses, new zoysia varieties have a much finer leaf texture and population density than Meyer zoysiagrass.

University-based plant breeders are not the only ones who have impacted golf. Sod producers and superintendents with keen eyes have selected unique plant biotypes during their day-to-day turfgrass management. It is no wonder this happens due to the environmental extremes grasses are exposed to on golf courses relative to mowing, drought, disease, traffic, and other stress factors. These selections are evaluated and sometimes released. Champion bermudagrass is one of the most popular ultradwarf varieties developed with this method.

New varieties take less time for release today because, according to Dr. Michael Kenna, USGA research director, "Once a certain level of turf quality has been reached, smaller incremental improvements take less time. It took many years to develop Rebel tall fescue from Kentucky 31-fall fescue due to the many genetic issues that had to be overcome to turn a forage plant into a turfgrass." The next advancements will be better tolerance to biotic and environmental stresses such as diseases, insects, heat, drought, and water quality.

Turfgrass breeders are taking the lead and providing the best possible information to maintain the new turfgrasses. New releases today have high expectations, and if a variety fails in the field, it will not be around long. Providing management information specific to a given variety is not a luxury; it is a necessity. Buyers must still do their homework, but there is more information available today than at any other time.

Turfgrass breeders have done a great service to the game of golf. The next time you make a par, birdie, or eagle, remember to give some credit to these unsung heroes of the game of golf.

PATRICK O'BRIEN *has admired turfgrass breeders for a long time, and even more so since he recently had holes-in-one on two newer bentgrass varieties, Crenshaw and G-2.*

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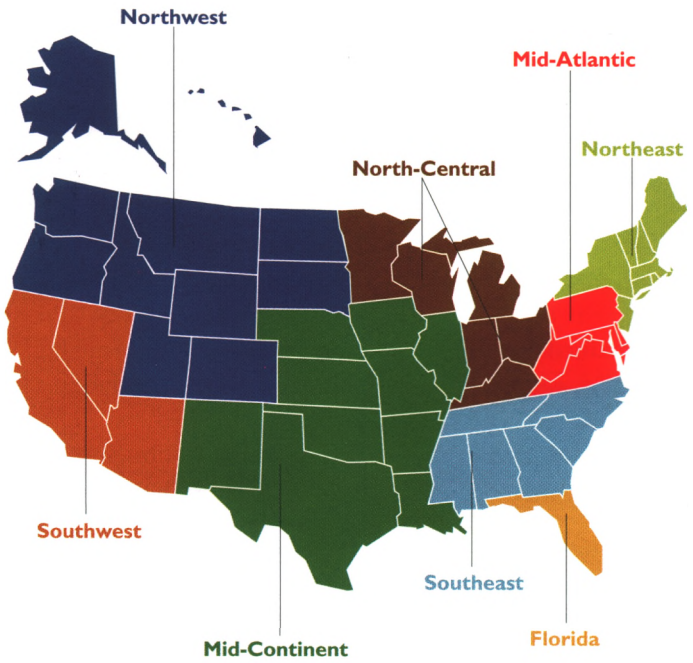

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Turf *Twisters*

Q: Fairy rings were a serious problem on my greens last summer despite several drenches of fungicides labeled to control this disease. I made the extra effort to aerate the affected site first, and followed up the fungicide application with plenty of irrigation water to move the treatment well into the soil. Am I on the right track? (Michigan)

A: Dr. Joe Vargas, turfgrass pathologist at Michigan State University, suggests that many treatments for fairy ring control are being washed beyond the optimal zone for effective control by overly aggressive core cultivation and irrigation. This makes plenty of sense because the active zone of mycelial growth from fairy rings is often found in the upper half inch or so of the rootzone. A better option is to ensure that the fungicide treatments are moved through the turf canopy and only into the upper zone of organic matter accumulation that is found on most greens. Spiking the green just before spraying is a good idea, but only apply enough additional irrigation to move the treatment off the foliage and into the upper inch of the rootzone.

Q: To what depth should sand be installed in a bunker? Is there a way to determine an appropriate depth? (West Virginia)

A: Laboratory testing can eliminate much of the guesswork. An accredited lab can determine the level of moisture retention by examining particle size distribution and saturated hydraulic conductivity. The degree to which moisture will be retained can affect the firmness of the bunker sand and whether or not drainage-related problems will occur. If the depth of the sand is too shallow, anaerobic conditions could develop. The laboratory can help determine to what depth sand should be installed.

Q: We recently purchased a new sprayer to apply plant protectants and fertilizers on our course. Although the sprayer has functioned superbly, the length and effectiveness of fungicide control has decreased. Does our new sprayer have something to do with this? (Pennsylvania)

A: Yes and no. If the sprayer is functioning properly in term of pressure and volume output, it is not the problem. However, your new sprayer may have different nozzles that are not providing proper distribution of the materials you are applying. Nozzles used to apply fungicides can have a dramatic influence on efficacy. Nozzles that produce larger droplet sizes reduce drift, but they can compromise coverage. Consult with your sprayer or nozzle manufacturer to determine the best nozzle for your situation, preferably one that minimizes drift but still provides adequate coverage. A nozzle "turret" that allows different nozzles to be used for different applications also can help. In addition, check the sprayer's calibration. Spray volume of 1 to 2 gallons per 1,000 sq. ft. should be used for fungicide applications.

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