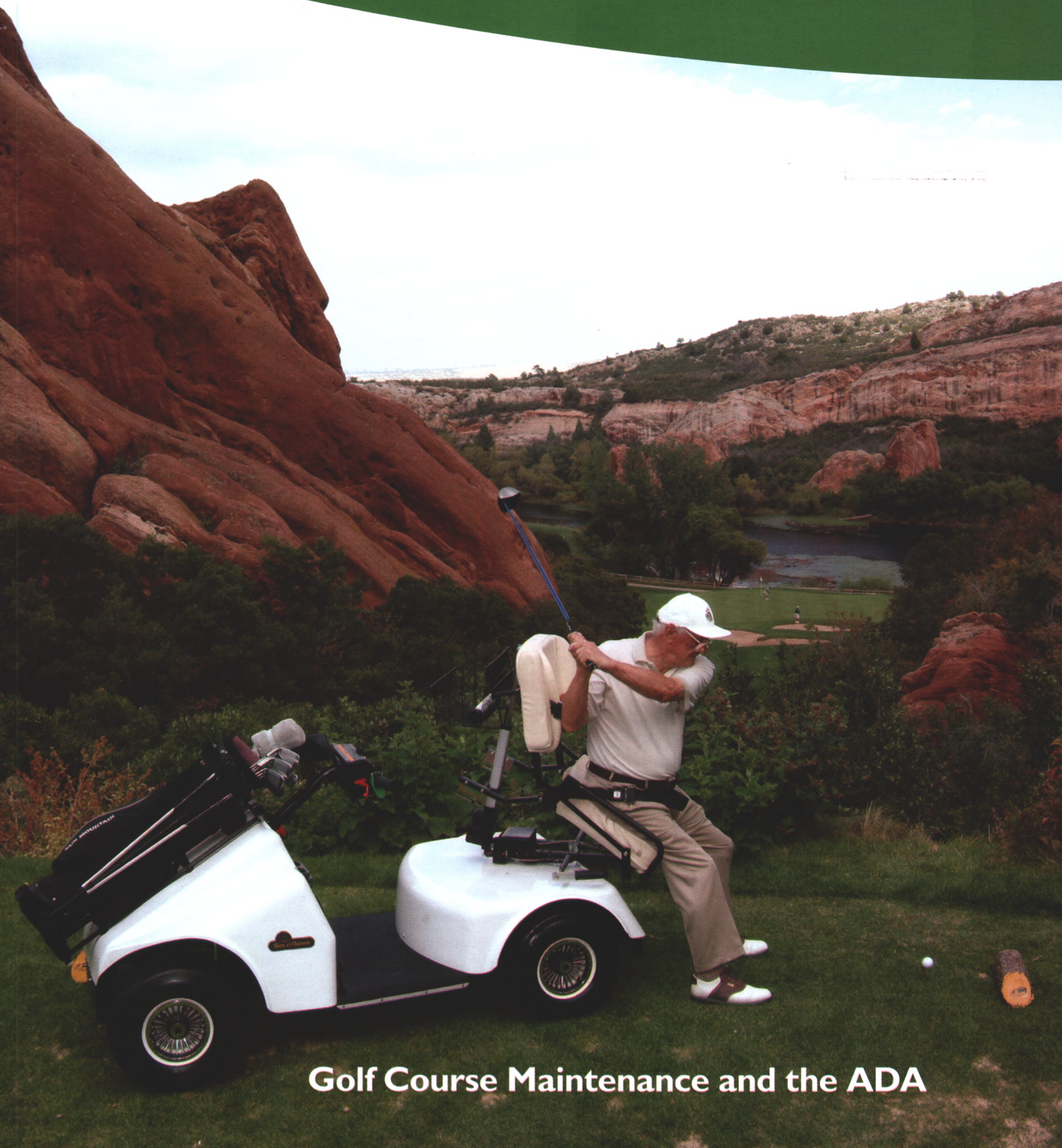


USGA GREEN
SECTION

RECORD

A publication on Turfgrass Management March-April 2007



Golf Course Maintenance and the ADA

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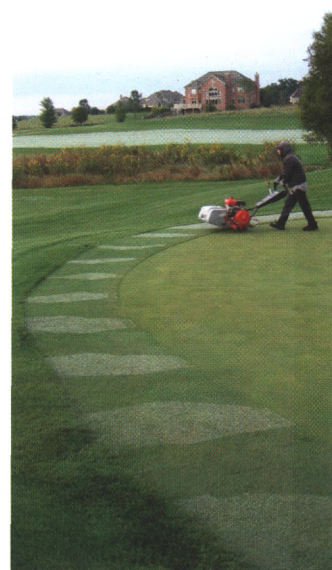
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Addressing a few key areas can make the golf course more playable and enjoyable for all golfers.

Golf Course Maintenance and the ADA

Maintaining a golf course for golfers with disabilities.

BY PATRICK J. GROSS

Golfers come in all shapes, sizes, and abilities, or disabilities, as the case may be, and they have at least one thing in common — they are all golfers. It is estimated that 4 to 5 million disabled Americans either play golf or are interested in learning the game. Since the Americans with Disabilities Act (ADA) was signed into law in 1990, many barriers have been removed to allow people with disabilities to access public buildings, transportation, and recreational activities, including golf.

Many of the provisions of the ADA have already been adopted and are commonplace in the United States. Although the compliance requirements for buildings and other public areas are straightforward, it has taken several years to develop workable standards for various recreational facilities such as golf courses, and still there are issues to be resolved.

Since the law was passed, course owners, professional staff, and superintendents have been apprehensive about how to implement some of the proposed standards. Will they be required to remodel the course? How much will it cost to make the necessary changes? Will they be forced to let wheelchairs and other types of mobility devices drive across greens and potentially cause damage? Will disabled golfers slow the pace of play? The perceived problems and adjustments are not as overwhelming as they may seem. Addressing a few key areas can make your course more playable and enjoyable for all golfers.

ELEMENTS OF THE ADA THAT PERTAIN TO GOLF COURSES

The ADA Accessibility Guidelines (ADAAG) address buildings, golf courses, and other

Since the Americans with Disabilities Act was signed into law in 1990, some superintendents and course owners have been apprehensive about how to implement the proposed standards.

The perceived problems and adjustments are not as overwhelming as they may seem, and addressing a few key areas can make the course more playable and enjoyable for all golfers.





Curbs and other man-made barriers that are often installed along paths may need to be modified to comply with the ADA accessibility guidelines. Openings at least 60" wide are recommended for curbs to allow access to the driving range, teeing grounds, and at 75-yard intervals along fairways.

recreational facilities. These guidelines were developed to make the game of golf accessible to as many golfers as possible and not detract from the fundamental challenge and nature of the game. The following is a brief summary of the proposed guidelines:

1. Accessible Routes: Continuous, unobstructed pathways of at least 48" in width must be available to connect all areas within the boundaries of the entire golf facility, including:

- Bag drop area.
- Parking lot.
- Clubhouse and pro shop.
- Practice facilities.
- Golf course (tees, fairways, greens, and routes between golf holes).
- Course toilet facilities.
- Amenities (snack bar, halfway house).
- Weather shelters.

In most cases, an accessible route will be some form of path.

2. Alternative Golf Cart Passage: The ADAAG recognizes that it may be impractical to provide an accessible route (48" wide path) through all areas of the golf course due to the unpredictable nature of golf ball flight and the fact that altering slopes or the architecture of the course could diminish the challenge of the game. In such instances, an alternative golf cart passage can be substituted for an accessible route. This is simply an area that can be used by golf

carts to gain access to certain areas and does not need to have a prepared surface. As an example, alternative golf cart passages would be a recommended route over a turf area to access greens, fairways, and teeing grounds.

3. Practice Facilities: Driving ranges and practice facilities must have an accessible route or golf cart passage (48" wide) that is connected to accessible teeing stations. At least one teeing station or a minimum of 5% of the total number of stations, whichever is greater, must be accessible and provide space for a golf cart to enter and exit.

4. Teeing Grounds: Access must be provided from the path to at least one teeing ground on each hole. If one or two teeing grounds are provided for a hole, only the forward teeing ground must be accessible. For holes with three or more teeing grounds, two of the teeing grounds must be accessible. The guidelines state that existing courses do not have to provide access to the forward teeing ground if terrain makes compliance infeasible.

5. Course Barriers: Curbs and other man-made barriers are often installed along paths to restrict golf carts from entering at specific points. Where such barriers exist, openings at least 60" wide must be provided at intervals not to exceed 75 yards.

6. Greens: Putting surfaces to be built or renovated must provide at least one accessible

route. The guidelines recognize that limiting the architecture and slope of the greens to the proposed guideline of 1:20 would be too restrictive and unfairly take away from the fundamental nature of the game. There is reasonable flexibility in this regard, and the guidelines simply state that there must be at least one accessible route for golf cart passage.

7. Bunkers: Bunkers have been a particularly difficult issue to tackle because modifying the hazards to make them ADA accessible would change the challenge and character of the golf course. For this reason, there have been no proposed guidelines or design requirements applied to bunkers. From a playability standpoint, the USGA published *A Modification of The Rules of Golf for Golfers with Disabilities* that outlines procedures for retrieving a ball from a bunker, and dropping and playing the next shot from outside the bunker (see Rule 28 — Ball Unplayable). With good design, it is possible to construct bunkers with an accessible route; however, such design guidelines are not mandated at this time.

For more detailed information, obtain a copy of *Accessible Golf Courses — A Summary of Accessibility Guidelines for Recreational Facilities*, available from the United States Access Board (www.access-board.gov).

THE IMPACT OF MOBILITY DEVICES ON TURF

Once the ADA was enacted, superintendents had many concerns about the various assistive devices that could be operated on greens and other sensitive turf areas without restriction, as well as everyday golf cart traffic. Typical concerns included:

- Indentations created by crutches, thin-tire wheelchairs, and single-rider golf carts that could impact playing conditions and ball roll, especially on greens.
- Soil compaction.
- Tearing and scuffing of the turf on greens from making sharp turns and abrupt stops with mobility devices.
- Wear and tear on older greens.
- The potential for significant damage when golf carts and other adaptive equipment are operated under very wet conditions.

The concerns about traffic and turf damage are not unique to mobility devices and can occur with any type of traffic that is applied to turf. There are several references to turf damage

caused by traffic in the scientific literature. Beard (1973) mentions that vehicular and foot traffic can cause damage to turfgrasses and contribute to soil compaction. The mechanism of this injury is due to a combination of factors, including pressure, abrasion, scuffing, and tearing.

Burton and Lance (1966) reported that more wear damage occurred on turf from vehicles with narrow, high-pressure tires, sharp turns, and repeated passes over a specific area. Carrow and Johnson (1989) evaluated two golf cart types and various tire designs and the impact on the amount of wear damage caused to Tifway bermudagrass. They concluded that the most important factors influencing the amount of damage were moderately sharp turns and the number of repeated passes over the turf.

The research that is most pertinent to this topic was conducted by Murphy and Gentilucci at Rutgers University in 1995 and 1996. Their study focused on developing quantitative tests to assess the surface characteristics of putting greens and quantifying the disruption to the playing surfaces when various types of assistive devices were used. The study was conducted on both sand-based greens and amended native soil greens at 11 golf courses in New Jersey. These courses represented a range of conditions, including soil moisture content, soil texture, depth of mat layer, and turfgrass species. The forms of traffic evaluated are summarized in Table 1.



Table 1
Traffic Source and Tire Characteristics
Applied to Putting Greens —
Murphy and Gentilucci, Rutgers University, 1997.

Traffic Source	Diameter	Width	Tire Type
Heel Sneaker		8 cm / 3.1"	
Heel Golf Shoe		7.5 cm / 2.9"	
Rigid-Tire Wheelchair	61 cm / 24"	2.5 cm / 1"	Rigid rubber
Quickie GPS Wheelchair	61 cm / 24"	3.5 cm / 1.4"	Pneumatic
Golf Express Single Rider	33 cm / 13"	16.5 cm / 6.5"	Pneumatic
Lone Rider Single Rider	33 cm / 13"	12.7 cm / 5"	Pneumatic

Although all forms of traffic caused some deflection in ball roll, the results were not as dramatic as anticipated. The following is a brief summary of some of the findings from the study:

- As expected, the worst-case scenario of using a narrow, rigid-tire wheelchair (what most would consider a standard wheelchair) on greens with high soil moisture content caused the greatest depth of depression; however, the average depth of depression was relatively shallow at 1.8 mm (0.07 inch). The 3.5 cm wide pneumatic tires caused even less of a depression at an average of 1.2 mm (0.04 inch).
- The maturity of the mat layer in the top 0-5 cm (0-2 inches) had an impact on the ability of a green to bear traffic and rebound from wheel rutting. Interestingly, the study found that new sand greens with a relatively immature mat layer were more susceptible to rutting when compared to older, modified native soil greens with a mature mat layer.
- Firmer surfaces resulted in less surface impact, especially on sand greens.
- Researchers measured the amount of rebound that occurred on the turf 30 minutes after the traffic was applied. The rebound effect was greater on the older modified native soil greens with a higher organic matter content and greater soil strength. Based on discussions with the researchers, they commented that it was difficult to identify the wheel ruts 30 minutes after the traffic due to the relatively shallow depressions initially made by the wheelchairs and the rapid rebound of the turf.
- Unfortunately, the two models of single-rider golf carts were not available for the duration of the study. Based on the limited amount of data collected, the wider tires of the single-rider golf carts did not cause significant surface depressions.
- The various devices were not tested under excessively wet conditions. The researchers felt that further research should be performed under a wider range of conditions.

MAINTENANCE CONSIDERATIONS

Traffic from Assistive Devices: We know from research and practical experience that all forms of traffic have the potential to cause damage to turf. The amount and intensity of damage is due to a combination of several factors:

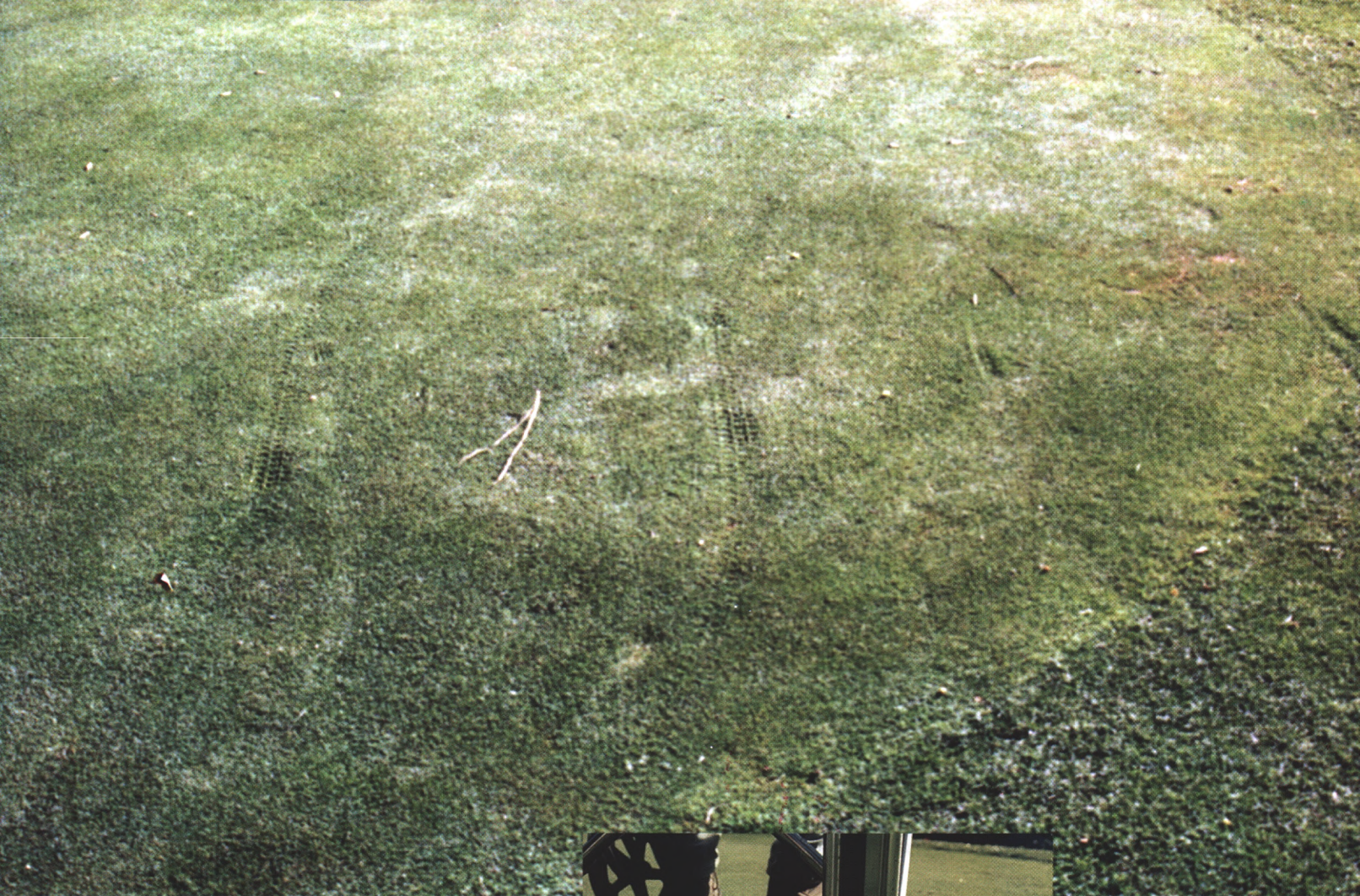
- The health of the turf and strength of the surface mat layer.

- Moisture content of the soil, especially at the surface.
- Intensity of the applied force (psi).
- Shearing and abrasion from sharp turns or the rapid starting and stopping of a vehicle.
- Repeated traffic over a confined area.

Practices for managing wear damage are the same, regardless of the source of traffic. These practices include: dispersing traffic over a wider area; increasing the traffic tolerance of the turf with proper mowing, fertility, and irrigation practices; and applying corrective maintenance procedures such as core aeration, topdressing, and drainage improvement. A strong, resilient turf will be able to withstand various forms of traffic, including maintenance vehicles, regular foot traffic, and assistive devices. Based on the study by Murphy and Gentilucci, as well as interviews with superintendents at courses where these assistive devices have been used, the potential for damage from assistive devices is negligible in most situations. First, the overall amount of traffic from such devices is very limited since golfers with disabilities covered by the ADA are only a small part of the overall golfing population. Second, the technology of the new assistive devices and single-rider golf carts has improved since the Rutgers study in 1997. The majority of these vehicles have wide pneumatic tires that spread the weight over a wider surface area, and the controls allow the vehicle to start and stop smoothly without skidding. Third, the footprint and psi of these vehicles is generally less than most turf equipment routinely used on greens and other turf areas, including triplex mowers, aerators, and topdressers.

Soil Moisture and the Potential for Turf Damage: Any traffic over wet, saturated turf will cause some form of damage. The superintendents who were interviewed for this article universally agreed that keeping the turf on the dry side minimized or eliminated any potential damage from golf carts and assistive devices in addition to improving the overall playing quality of the course. Of course, there will be times when heavy rainfall will create saturated conditions and the use of any type of vehicle (maintenance equipment, golf carts, and assistive devices) should be suspended until the soil is adequately dry to support such traffic.

Accessible Routes: Where curbs exist along paths, it will be necessary to provide a 60"



wide opening at intervals not to exceed 75 feet. Wherever possible, it is ideal to place these openings where there is full sunlight exposure so that the turf will have a good opportunity for healthy growth and recovery from wear. Where traffic is confined to a limited area, it may be necessary to spot treat on a more frequent schedule with extra aeration and fertilizer applications.

Bunkers: Playability and access to bunkers is largely a matter of architecture. Providing a wide, relatively flat entrance to a bunker will make it easier for people using assistive devices to enter and exit the hazard. Firmer sand conditions are preferred for traction and to allow vehicles to travel over the sand without becoming embedded.

Superintendents interviewed for this article indicated that they have not made any changes to their normal maintenance programs to allow the use of mobility devices on their courses. In general, any programs that contribute to a strong, healthy, resilient turf surface and better playing quality will benefit all golfers, including those with disabilities.

SUGGESTIONS FOR DEVELOPING YOUR OWN PROGRAM

Although it is difficult to set a definitive policy until the final guidelines are adopted by the Department of Justice, it is a good idea to address the issue of accessibility proactively. You may wish to consider the following suggestions as part of your programs to operate and maintain a golf course that is accessible to golfers with disabilities:

- Analyze your course for accessibility and compliance with the proposed guidelines. An excellent reference for completing this exercise is *The National Alliance for Accessible Golf: Toolkit for Golf Course Owners and Operators*, available at www.accessgolf.org and the USGA Resource

Research at Rutgers University confirmed that the worst-case scenario of using a narrow, rigid-tire wheelchair on greens with high soil moisture content caused the greatest depth of depression on the turf; however, the depth of depression was relatively shallow at 1.8 mm (0.7 inch). The maturity of the mat layer in the top 0-2 inches had an impact on the ability of a green to bear traffic and rebound from wheel rutting. New sand greens with an immature mat layer were more prone to rutting when compared to older, modified native-soil greens with a mature mat layer.

Center for Individuals with Disabilities at <http://resourcecenter.usga.org>.

- Become educated about the ADA Accessibility Guidelines for Golf Courses and learn more about how to meet the needs of golfers with disabilities. Be open-minded and accommodating with regard to the use of adaptive devices. Research and experience indicate that these devices cause little or no damage to turf when properly operated.

- Mark areas of the course that are too wet and any other areas where mobility devices may have problems navigating. Be sure to relay this information to the starter and course marshals so they can inform golfers of any hazardous conditions.
- Test and evaluate various mobility devices at your course to see what impact they have on turf conditions. Better yet, test one yourself and possibly play a round of golf in a single-rider golf cart or other type of mobility device.

The concerns about traffic and turf damage are not unique to mobility devices and can occur with any type of traffic that is applied to turf, including utility vehicles and tractors typically used for maintenance.



- Be prepared to provide information and training, if necessary, for single-rider carts. Golfers who rent a single-rider cart at Haggin Oaks Golf Course in Sacramento, California, for the first time are given a five-minute training session on the three-hole practice area. Having a system or a procedure in place makes it easier for the customer and the staff.

- Consider making a map of accessible routes and alternate cart passageways for your course. The map also could provide information about accessible tees, bunkers that may be difficult to access, and areas of the course to be avoided. Golfers with disabilities are not risk takers — they want to enjoy their round of golf without getting stranded or causing damage to the course. A map or information card will help them accomplish that goal and enhance their golfing experience.

- There will be times when the course is too wet for maintenance equipment, golf carts, and mobility devices. It is important to be clear and reasonable with your explanation as to why golf carts or adaptive devices cannot be used on a given day. In general, if mowers and turf maintenance vehicles can be used on the course, it is reasonable to allow mobility devices as an accommodation to golfers with disabilities covered under the ADA. This can be a controversial topic and there are likely to be protests from other golfers who wish to use golf carts. While each case will involve a judgment call, it is important to remind other golfers that providing access is a matter of complying with the law.
- Consider a two-flag system for designating golf carts that have unrestricted access and others that simply need permission to drive closer to greens and tees. For example, a red flag can be

Concerns over the potential turf damage that can be caused with various mobility devices can be minimized with proper operation and good course etiquette.

used to designate golfers with disabilities covered under the ADA and a blue flag for other golfers with mobility impairments that allows them to drive closer, but not onto greens and tees.

- Continue to implement sound agronomic programs to grow strong, healthy, resilient turf. This will provide the best possible playing conditions for all golfers, including those with disabilities.

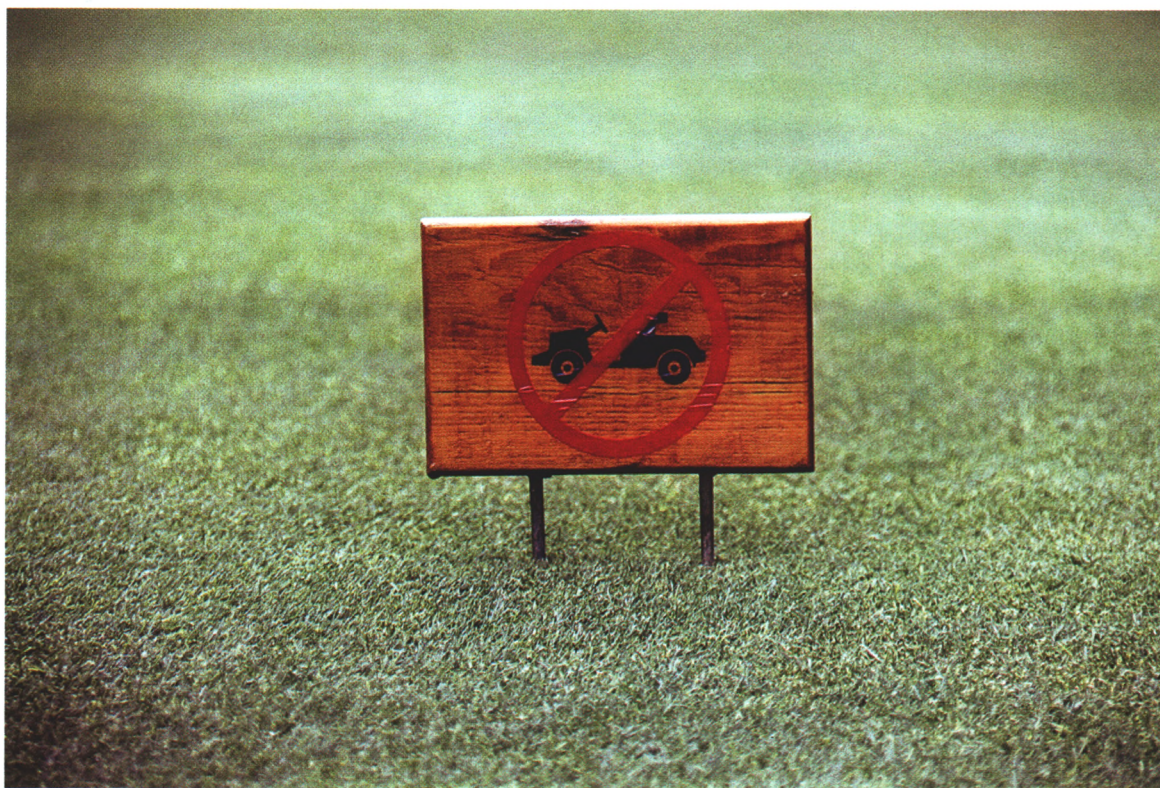
CONCLUSION

Allowing vehicles other than turf maintenance equipment on golf greens and any other sensitive areas can be nerve-wracking for superintendents. There is a fear that all the hard work and effort put into producing an ideal surface can be destroyed in an instant with various mobility devices. Sam Samuelson at Haggin Oaks Golf Course is one superintendent whose attitude has changed as a result of seeing adaptive golf carts in action. "The biggest thing for me was getting over the fear. Once I saw one of those carts drive

across one of my greens, I quickly realized it was no more damaging than the triplex putting green mower I use every day. Those carts can go anywhere they want, as far as I'm concerned."

His comments were echoed by other superintendents who have personal experience with the use of different mobility devices on their courses.

The Rutgers study was very encouraging for turf managers, considering the fact that under the worst-case scenario, there were relatively minor surface impacts caused by the wheelchairs and single-rider golf carts. Hopefully, more research in this area can be done to evaluate the impact of such devices under a wider range of conditions. Concerns about wear injury (scuffing and tearing) and damage to putting surfaces can be minimized with proper operation of the devices and good course etiquette. Since the time of the Rutgers study, there have been many improvements in design and technology to make the various mobility devices even more user-friendly and turf-friendly.



Mark areas of the golf course that are too wet and any other areas where mobility devices may have problems navigating.

The positive news is that the potential turf damage caused by various adaptive devices is negligible, and there should be very little concern on the part of golf course superintendents as long as common sense and good turf management programs are applied. While the provisions of the ADA were focused on removing barriers for people with specific disabilities, all golfers will benefit by making courses more accessible, playable, and easier to maintain. The USGA, through its Grants and Fellowship Program and other activities, has been very involved in growing the game and sharing the many positive

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Slape, C. A for Effort — the golf industry is running ahead of the ultimate policy-makers in meeting the needs of the

Single-rider golf carts are becoming more popular for golfers with mobility impairments. The wide pneumatic tires minimize the potential for turf damage in most situations, even on sensitive areas such as tees and greens.



aspects of golf with all segments of our society, including golfers with disabilities. There are many resources available through the USGA Center for Individuals with Disabilities to help golfers, course operators, and superintendents learn more about this issue. Turf issues are relatively minor compared to the overwhelming positive impact — both physically and psychologically — associated with exposing the game of golf to golfers with disabilities and removing barriers that prevent access to the course. As Sam Samuelson said, “Seeing that smile on the golfer’s face made me realize the power of golf. To him it was truly more than just a game.”

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RESOURCES AND INFORMATION

USGA Resource Center for Individuals with Disabilities: <http://resourcecenter.usga.org>

National Alliance for Accessible Golf: www.accessgolf.org

National Center on Accessibility: www.ncaonline.org

The author wishes to thank the following people who assisted with this article: Don Bigler, Gary Gentilucci, Trey Holland, Bill Jewell, Dennis Lyon, James Murphy, Roger Pretikin, Carrie Riordan, Don Tolson, Sam Samuelson, and Matt Sawicki.

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Research You Can Use

Shade-Resistant Bermudagrass

Research has produced an improved cultivar.

BY WAYNE HANNA AND BRYAN MAW



Bermudagrass will grow in many different environments, but one shortcoming is its poor shade tolerance. The impact of shade on this putting green is evident, with the resulting poor turf quality.

Bermudagrass (*Cynodon sp.*) is a cosmopolitan grass in that it will grow in many different environments around the world. It has long been the dominant warm-season turfgrass species used on golf courses, athletic fields, and ornamental lawns

across the southern portion of the United States. This is because it produces a very dense, high-quality turf cover and is adapted to tolerate a broad range of soil fertility, pH, texture, and temperatures, along with very good wear and drought tolerance. However,

a major weakness of bermudagrass is poor shade tolerance. Bermudagrass must have light — at least 8 to 10 hours of sunlight per day to produce healthy turf.

As part of the long-running bermudagrass breeding and improvement



Tifway and other bermudagrass hybrids were compared for turf quality while receiving just 40% of the light needed for optimal growth.

Research at the Tifton Experiment Station has focused on identifying shade-tolerant cultivars. Bermudagrass hybrids were selected for more extensive testing to identify the best shade-tolerant hybrids for use in the field.



program at the Tifton Experiment Station, we have been identifying shade-resistant cultivars for a number of years. By shade resistant, we mean a grass that requires less sunlight to produce a desirable or acceptable turf than the current industry standards such as Tifway (419) bermudagrass. The grasses we selected performed well when they received only 40% of the light needed for plant growth (light wave length in the 400 to 650 nm range), compared with plants requiring full sunlight.

We originally planted more than 27,000 triploid ($2n=3x=27$) interspecific hybrids between Common (*Cynodon dactylon*) $\times$ African (*C. transvaalensis*) bermudagrasses at Tifton, and selected 448 experimental hybrids from the original hybrids for more detailed test-

ing. Fifty-seven of these experimental hybrids plus five commercial hybrids were planted under the stationary end of a rainout shelter (60% continuous shade). We now have had three of the best of those shade-resistant hybrids in replicated advanced tests (Table 1) since 2003. One hybrid, Tift No. 4, has performed well under shade and non-shade conditions in our plots at Tifton, Ga., and in the National Turfgrass Evaluation Trials (NTEP) since 2003 (non-shade). Tift No. 4 is a dark-green and dense triploid hybrid that was originally selected for its high resistance to tawny mole cricket damage. However, we found that Tift No. 4 also performs well under lower light conditions.

Turf quality is generally rated on a scale of 1 to 9 (where 9 = the best

turf). In replicated plots under a shade regime, Tift No. 4 continues to perform well today. In the 0.5- to 0.65-inch mowed height, non-shade tests of the NTEP trials (mean of 11 states), Tift No. 4 rated 6.8, behind Tifway (7.1) and TifSport (7.0), with an $LSD=0.2$ (needs to be at least this much difference between cultivars to be significant). In the 0.75- to 1.0-inch mowed height, non-shade NTEP trials (11 states), Tift No. 4 rated 6.1, just behind TifSport (6.4), Tifway (6.3), and Patriot (6.2), with an $LSD=0.3$. Table 2 shows the performance of Tift No. 4 by regions. It has performed well in all areas of the USA where it was tested and was in the top 25% of the entries 65% of the time.

Tift No. 4 has performed well in shaded lawns in Roswell and Augusta,

Ga., since 2003, where it is mowed at 1.5 inches height weekly and receives 3 lbs. of nitrogen per 1,000 sq. ft. yearly. It has not needed dethatching and it produces only a few seedheads

under these shade conditions (as well as in our shade tests at Tifton). This hybrid tends to produce more than desirable seedhead numbers in June under non-shade conditions and a

mowing height of 0.5 inch and/or high nitrogen application. Tift No. 4 has been planted in low-light areas on golf courses in Georgia, Alabama, and North Carolina. We have received positive reports from golf course locations where Tift No. 4 has been growing for at least two years.

Why is Tift No. 4 shade resistant? It appears that its dark-green color and its density allow it to produce an acceptable turf under lower light conditions. If low light thins the traditional cultivars, Tift No. 4 will produce a desirable turf. If low light conditions completely kill the traditional cultivars, Tift No. 4 will probably produce a thinner, yet acceptable turf.

In our evaluations, we have been measuring the ability of Tift No. 4 to produce a desirable turf under lower light conditions, but we have not evaluated this hybrid for its ability to compete with tree roots, etc. Tift No. 4 has applications where traditional bermudagrass cultivars are used, yet where light is limiting. We tentatively plan a limited release for Tift No. 4 in 2007.

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BRIAN MAW is an associate professor at
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Table 1 Turf Quality Ratings (9=Best) On shade-resistant (ST) bermudagrasses after two years of 60% continuous shade at Tifton, Ga.			
Entry	Turf Quality in Shade		
	Test 2	Test 3	Test 4
ST03	7.3	7.5	8.1
ST05 (Tift No. 4)	7.8	7.3	8.6
ST07	7.5	6.5	8.1
Tifway	5.3	4.1	4.8
TifSport	6.0	3.6	5.0
LSD – 5%	1.1	1.1	1.0

Table 2 2005 Turf Quality Ratings in NTEP Trials for Tift No. 4 Compared with commercial cultivars in the transition zone (TZ), southeast (SE), and southwest (SW) regions. Number of states is shown in parentheses after each zone.					
Entry	Rank [Rating (9=Best)] for Turf Quality in NTEP Trials (2005)				
	TZ (9)	SE (8)	SW (5)	Overall	% Time in Top 25%
TifSport	2 (6.7)	1 (6.9)	1 (6.4)	1 (6.7)	91
Tifway	2 (6.7)	1 (6.9)	2 (6.3)	2 (6.6)	78
Patriot	1 (6.8)	4 (6.2)	5 (5.7)	4 (6.3)	56
Tift No. 4	4 (6.4)	2 (6.8)	3 (6.1)	3 (6.5)	65
Lowest Rated	13 (5.0)	13 (5.7)	13 (5.6)	13 (5.4)	13
LSD – 5%	(0.3)	(0.3)	(0.3)	(0.2)	



Above left: Although bermudagrass is the dominant species across the southern tier of the United States, its vigor cannot overcome poor light quality. The grass requires at least 8 to 10 hours of sunlight per day to produce a healthy turfgrass stand. Above right: Tift No. 4 has successfully grown in a shaded home lawn situation in Roswell, Georgia, since 2003.



Superintendents must take the time to instruct and then follow up with employees throughout the year. This guidance results in an invaluable degree of quality control over all parts of the golf course.

“Teaching Moments”

Managing the little things can make a difference to the golfers and save grass!

BY KEITH HAPP

In a perfect world, Green Committee members outline conditions for daily play and then agronomic programs are put in place to achieve the goals set forth. Once the level of expected conditioning is established, needed resources are provided to implement timely proactive maintenance strategies. Proper equipment, labor, and maintenance techniques should result in satisfied golfers. If it were only that simple!

A trend is developing. Superintendents are trying to achieve the same course preparation results with fewer people and less time to complete maintenance. Maintenance days are being lost due to the need to generate revenue and the request from members to start play earlier in the morning. It is common to see golfers at the first tee just waiting for enough light to hit the first shot of the day. The frantic race begins.

Rushing a procedure to “get it out of the way” often leads to mistakes or careless damage of the turf. This isn’t intentional. Often, an equipment

operator is just trying to give a little extra or do it a little faster to get the job done! One thing that successful golf course operations have in common is placing importance on managing the details of completing a task. Damage, especially avoidable (human error) damage, leads to frustration and results in unplanned expenditure for turf repair and recovery. When this can be eliminated, the operation is more efficient and effective at meeting course preparation goals.

Recent surveys have found that during periods of peak play for private and resort golf facilities, average course staffing levels are approximately one worker per hole. Investment in labor resources consumes about 55% to 60% of the total annual golf course maintenance budget. Whether it is a crew of five or 50, it is essential that operators of equipment are trained in all aspects of course care. This includes the details of regular tasks such as mowing turf and raking bunkers.

The following are some of the common maintenance *faux pas* seen during the visiting season. Although these mistakes are, in most instances, not committed intentionally, they often result in turf damage and can negatively impact playability.

GREENS

1. Turning sharply on the green or on the collar. While it may not be immediately apparent, bruised turf is compromised, and this condition can easily result in disease infection, weed encroachment, or even turf loss. The time of year this occurs makes a difference. Adjusting procedures early in the year will minimize potential for serious damage in the summer. Instruct operators to make wide turns in the intermediate or primary rough surrounding the green. Focusing on quality rather than expediency will pay off. Golfers can participate by allowing sufficient time to complete essential preparation tasks. Nothing is more important than having time to prepare putting greens for play.

2. Not emptying grass-catching baskets frequently enough, especially before the outside pass of the green (clean-up pass) is mowed. When the greens are mowed before play in the morning, often there is dew on the grass. This moisture increases the weight of the clippings collected in the basket, causing problems when the mower is lowered onto the putting surface. Abruptly dropping the mower onto the playing surface can result in scalping of the turf canopy. It takes time to develop a feel for the particular mower used to complete mowing tasks. Reduce the risk of damage by telling operators to empty baskets when they are half full.

It is not uncommon for the outside cleanup pass on the green to be skipped once or twice per week to provide relief from focused mower wear. When this area is mowed, clipping harvest will be greater compared to other portions of the green. If the grass is wet, there is increased potential for mower damage. Suggest that baskets be emptied before the outside pass is completed.

Bruising from these *faux pas* is more frequently seen during the summer, especially during environmental extremes such as high humidity or while the turf is under drought stress. Once again, adjusting procedures early in the year will make a difference later in the season.

3. Failure to inspect equipment (mower or backpack blower) before use. Check to see that the gas cap is tight. Check grease fittings on the rollers of mowers. The operator may not see gas splash from the tank or grease fall off the machine in the early morning when trying to complete mowing before golfers get on the course. They will, however, see it later when the grass is dead.

4. Inattention to clipping dispersion. Under the Rules of Golf, a player can receive relief if his or her ball comes to rest in grass clippings that are piled for removal. Wet clippings are

Providing incomplete instructions can produce results that will be visible for weeks. Pictured are the results of an employee who was too aggressive in spot-treating clover. Better instruction may have avoided this problem.



One or more passes through standing water can result in long-lasting turf damage. Establish mowing guidelines and reinforce procedures that will help to avoid unnecessary damage.

difficult to spread. While it may take time, find out-of-play areas for dispersing clippings. Dumping clippings next to the green never works well.

5. Repeated abrupt change of direction on collars will result in damage. Rolling is a frequently used practice to prepare putting surfaces for daily play. The damage from rolling occurs most frequently where the unit is turned. The turf on the collars and even approaches can suffer from concentrated mechanical wear. Abrupt turning and rapid change in direction result in compromised turf health, and bruising becomes apparent in the middle of the summer. Suggest that the machine come to a complete stop, allowing for gradual acceleration back across the green.

Scattering the clippings from a mower basket sounds simple. It is one aspect of mowing that has to be taught and then reinforced during the season. No relief is provided to the golfer when a ball rests in piled grass clippings that are not destined for removal.

BUNKERS

1. Edges become worn and/or damaged from focused traffic just outside of the margin of the hazard. Rake the edges of a bunker from inside rather than walking a path into the grass around the outside edge of the sand. Avoid developing a *cow trail*. A playability issue can be eliminated and turf damage can be minimized. If it is

necessary to rake the edges from outside the bunker, then it may be prudent to use a special rake with an extended handle.

2. Repeatedly entering and exiting a bunker at the same spot. If possible, alter the point of entry to and exit from a bunker when raking is performed. Minimize the potential for dragging sand out of a bunker. Sand anywhere other than on the putting surface is not a loose impediment. Stress the importance of not altering the defined margin of a hazard.

3. Tracking sand from a bunker across the approach of the green. Avoid traveling across the approach to get to the next bunker. Sand will stick to tires if it is wet. Sand is often tracked on the approach, creating a difficult playing condition and poor appearance. In this case, the shortest distance between two points may not be the best path. Driving around behind the green to the next bunker is a better option.

4. Not using the correct tool to manage undulating terrain. Define which tools will be used to manage turf around a bunker to minimize scalping damage. The direction in which the turf is mowed makes a difference. When mowing is performed, make every effort not to blow the grass clippings on the green.





It is amazing how many golfers think that anyone can be put on a mower or other machine and the task will be completed without any complications. Superintendents know from experience that there is a window of opportunity to train a new employee in the spring. The margin for error early in the season is greater due to less stressful weather conditions. However, later in the season, when environmental conditions become harsher, the simplest of mistakes can result in turf loss and frustrated golfers.

Operating a machine is the first step, but instruction in the nuances and explanations of consequences of improper operation of that machine/tool are significant elements in achieving the desired outcomes. How tasks are completed makes a difference. Improper technique can lead to problems that often do not express themselves until later in the growing season.

When training is conducted, emphasis should be placed on controlling as many stress variables as possible. It is unrealistic to expect that everything can be covered during an instruction session, but if supervision is available, it is realistic to take advantage of *teaching moments*. A teaching moment is the opportunity to further instruct an equipment operator, and it is usually conducted

immediately after a problem or damage has occurred. Being able to do so depends greatly on having good supervisory personnel.

The instructors consist of key personnel who are capable of training new employees. They are familiar with defined procedures and can communicate them to others in an understandable manner. They may be familiar with many types of problems or common mistakes made by new employees because they may have committed a maintenance *faux pas* themselves.

Every effort should be made not to limit resources for labor to the point that supervision and follow-up with the staff are compromised. If key employees such as the superintendent and assistant superintendent are completing tasks, they may not be able to monitor maintenance activity and make the necessary adjustments. It is all too common to see the results of correctable errors and damage after the fact. All employees should be offered some level of feedback regarding the finished product of their work. No doubt, there will always be a need to fine-tune procedures and techniques.

KEITH HAPP is Senior Agronomist of the USGA Green Section's Mid-Atlantic Region.

Turning the mower sharply on a green or collar can result in turf damage that will be slow to recover. Take advantage of a teaching moment to reinforce the importance of how and where equipment should be operated.

Buffer Strips, Runoff, and Leachate

Research compares nutrient loading in runoff and leachate when buffer strips are used alongside golf course fairways.

BY JOHN C. STIER AND WAYNE R. KUSSOW

Federal mandates to decrease nutrient pollution of water supplies are resulting in various local and state regulations aimed at reducing phosphorus (P) movement into surface waters and nitrogen movement into groundwater. Some regulations aim to reduce nutrient and sediment loading into surface waters based on the idea that “native” or prairie vegetation should be used as buffer strips between mowed turf and natural areas or surface water.

Some research indicates that dense turf vegetation is more effective at reducing runoff and nutrient leaching than other strategies, including mulched landscaped beds. Data are just starting to be published that report on the effectiveness of prairie buffer strips to reduce nutrient loading in water runoff and leachate relative to turf. Also unknown is the size requirement of buffer strips relative to the area they are to be buffering.

Turf is often used as a ground cover throughout inhabited areas, including golf course roughs, because it is relatively easy to establish and maintain, provides contiguous ground cover throughout the year under traffic and mowing, and the low mowing height



The slower establishment of prairie vegetation allowed annual weeds and grasses to dominate in the research buffer strip plots.

facilitates human activity while discouraging vermin and insect pests. The various turf species allow some type of turf to be established across a diversity of situations, including moist or dry soils, and moderately shaded to full-sun conditions.

Prairie plantings are being increasingly promoted as a low-cost alternative to managed turf. They are also seen as “native,” while most cool-season turf species were introduced from Eurasia. Although management is usually much less intensive than turf, establishment of prairie vegetation is not necessarily less expensive than turf, as prairie seed may cost considerably more. Prairie establishment may take years, during which time weeds,

especially noxious weeds, must be regularly controlled. Lastly, prairie plantings are not necessarily suited for many habitats, such as wooded golf courses. A number of golf courses utilize fine fescues as low-maintenance roughs, which receive almost as little attention as prairie areas, yet establish quickly and easily. Generic regulations that require the installation of prairie buffer strips can be costly, reduce valuable golf turf areas, and promote the assumption that turf

has inherently negative environmental consequences.

Data from various projects suggest that annual nutrient loading from mowed turf may be similar to that from prairies, as most of the nutrient loss occurs when nutrients are leached from dead foliage. When we began the study in 2003, there were no data that directly compared the efficiency of turf to prairie vegetation for its ability to minimize runoff and leachate pollution, particularly during the establishment phase, which can last for two to three years.

The project goal was to compare the relative amount of nutrient loading in runoff and leachate when prairie and fine fescues were used as buffer strips

Table 1

Vegetative buffer strip treatments at Wisconsin River Golf Club, Stevens Point, Wis.

Vegetation Type	Ratio	Mean Area (m ²)
No buffer, fairway only (annual bluegrass)	Not applicable	12.45
Fairway: prairie (narrow buffer strip)	8:1	14.01
Fairway: fine fescue (narrow buffer strip)	8:1	14.01
Fairway: prairie (medium buffer strip)	4:1	15.58
Fairway: fine fescue (medium buffer strip)	4:1	15.58
Fairway: prairie (wide buffer strip)	2:1	18.68
Fairway: fine fescue (wide buffer strip)	2:1	18.68

alongside golf course fairways. We also wanted to determine the effect of three different ratios of buffer strips relative to the fairway area draining into the buffer strips. The information will be useful for predicting effectiveness of different vegetation types and buffer strip sizes on golf courses.

GROWING BUFFER STRIPS AND INSTALLING WATER SAMPLERS

Research plots were constructed in 2003 at the Wisconsin River Golf Club (WRGC) in Stevens Point, Wis. The golf course is adjacent to and drains into the Wisconsin River. Two large natural areas exist within the course and the course is surrounded primarily by forest with a small amount of agricultural land. The plots were developed in the roughs that drain fairways 4, 8, and 9. Fairways were approximately 85 feet wide and crowned in the middle with 1-2% slopes. Fairway turf was predominantly annual bluegrass (*Poa annua* L.).

Buffer strip plots were installed at the edge of the fairways and had slopes ranging from approximately 1 to 4%. Plots on fairway 9 were in full sun, plots on fairway 8 were in slight shade, while plots on fairway 4 were moderately shaded. Treatments included 2:1, 4:1, and 8:1 fairway-to-buffer-strip ratios, with one ratio each of prairie or fine fescue mixtures (Table 1). A seventh treatment in each replicate was a no-buffer-strip plot.

Runoff collection flumes (1-meter width) were installed at the lower end

of each buffer strip plot. Each collection flume had a cover to prevent debris from falling into the flume, while a screen-covered slit at the soil surface allowed runoff water to enter. Leachate was collected in each buffer strip, using a low-tension lysimeter

installed just upslope of the runoff-collection weir.

Plots were dormant-seeded in October, as recommended for prairie plantings, and they were covered with a biodegradable wood fiber erosion control blanket. Prairie plots were planted to a commercial prairie seed mixture that included flowers and grasses (Table 2). Fine fescue plots were seeded to a commercial seed mix containing Chewings, creeping red, blue, and hard fescues.

None of the plots were irrigated, treated with pesticide, or fertilized during the study. Plots were mowed (clippings returned) at 30-inch height in early spring 2004 and 2005 to encourage new growth in accordance

Table 2

Species and cultivars used for vegetative buffer strips at Wisconsin River Golf Club, Stevens Point, Wis.

Perennial Flowers		
Blooms		
Species*	Color	Month**
<i>Asclepias incarnata</i> (Red Milkweed)	Pink/Red	6-7
<i>Aster novae-angliae</i> (New England Aster)	Purple	8-10
<i>Iris shrevei</i> (Wild Iris)	Blue	5-8
<i>Liatris pycnostachya</i> (Dense Blazingstar)	Purple	8-9
<i>Lobelia siphilitica</i> (Great Blue Lobelia)	Blue	8-9
<i>Lobelia cardinalis</i> (Cardinal Flower)	Scarlet	7-8
<i>Eupatorium purpureum</i> (Woodland Joe Pye Weed)	Pink	7-8
<i>Monarda fistulosa</i> (Bergamot)	Purple	7-9
<i>Rudbeckia subtomentosa</i> (Sweet Black-Eyed Susan)	Yellow	7-10
<i>Verbena hastata</i> (Vervain)	Purple	7-10
<i>Vernonia fasciculata</i> (Ironweed)		
<i>Zizia aurea</i> (Divided Leaf Golden Alexander)	Yellow	5-6
Grasses and Sedges		
<i>Andropogon gerardi</i> (Big Bluestem)	<i>Elymus canadensis</i> (Canada Wild Rye)	
<i>Carex vulpinoidea</i> (Fox Sedge)	<i>Glyceria striata</i> (Fowl Manna Grass)	
Fine Fescue Mixture		
Species/Cultivar	Scientific Name	% in Mix
Creeping Red Fescue (SR5210)	<i>Festuca rubra</i> ssp. <i>rubra</i>	19.6
Slender Creeping Red Fescue (Dawson)	<i>F. rubra</i> ssp. <i>litoralis</i>	19.6
Blue Fescue (SR3210)	<i>F. glauca</i>	14.7
Chewings Fescue (SR5100)	<i>F. rubra</i> spp. <i>commutata</i>	14.7
Chewings Fescue (Sandpiper)	<i>F. rubra</i> spp. <i>commutata</i>	9.8
Hard Fescue (SR3150)	<i>F. longifolia</i>	9.8
Hard Fescue (Scaldis)	<i>F. longifolia</i>	9.8
*Quantity of species varies depending upon that year's seed production and harvest; was supposed to include at least 12 perennial flower species. Due to the nature of prairie seed production and collection, certified seed is unavailable.		
**Number corresponds to month of year, e.g., 7 = July, 8 = August, etc.		



Establishing buffer strips around natural water features on a golf course has long been recommended to protect water quality and improve wildlife habitat. Research indicates that dense turf vegetation is effective at reducing runoff.

with recommendations for prairie establishment. Fairways received 108 to 216 lb. N acre⁻¹ annually in one or two applications (spring and fall), with approximately 5.5 to 11 lb. P acre⁻¹ each year. Fairways received little to no irrigation, so snow melt and rainfall provided the source of runoff water. The 9th fairway remained flooded from excessive rainfall throughout

most of 2004 and part of 2005 and was dropped from the study.

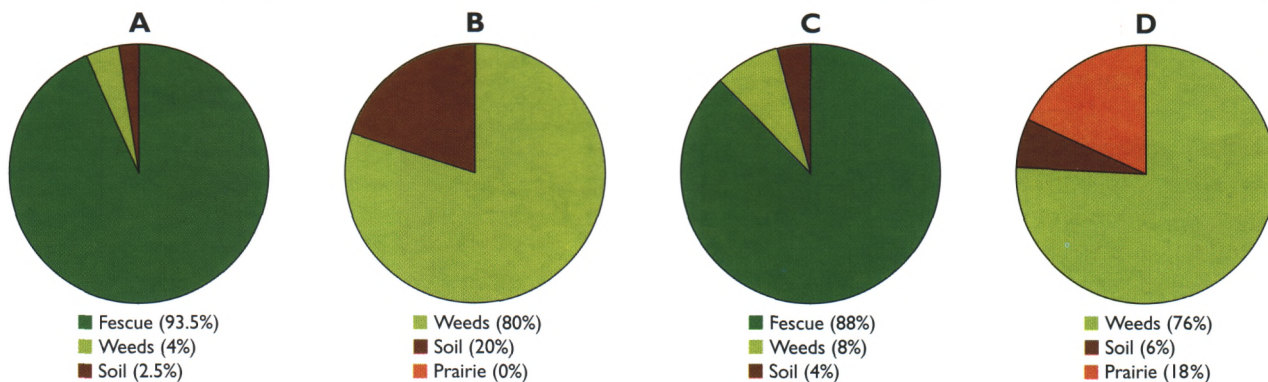
ANALYZING WATER QUALITY AND VEGETATION

The leachate water samples were analyzed for nitrate- and ammoniacal-N and soluble phosphorus. Runoff samples were analyzed for three P types:

soluble P, biologically active phosphorus (BAP), and total phosphorus (TP), which were extracted from both sediment in the water as well as the water itself. Sediment in runoff was collected and quantified. Turfgrass and prairie plant stands were analyzed two to three times each year by determining the percentage of desirable plants (turf or prairie), weeds, and bare soil.

Figure 1

Type and amount of vegetative cover in fine fescue and prairie buffer strips following seeding in October 2003, Wisconsin River Golf Club, Stevens Point, Wis. **A** and **D** show ground cover in fine fescue and prairie plots, respectively, in August 2004. **C** and **D** show ground cover in fine fescue and prairie plots, respectively, in June 2005.





are not favorable are likely to result in unwanted vegetation and/or exposed soil that will not necessarily decrease nutrients in runoff or leachate.

In our study, less than 5% of the total rainfall during the sampling period in 2004 ran off fairway and buffer strip surfaces, while less than 1% of rainfall ran off during 2005 (Tables 3 and 4). The minimal slopes of the fairways (1-2%) likely helped infiltration to occur by reducing speed of runoff despite periods of heavy rain.

The nearly complete ground cover was likely just as, if not more, important for reducing runoff by slowing its rate and allowing it to infiltrate into the soil.

None of the buffer strips changed runoff or phosphorus loading compared to the fairway alone, indicating fertilizer was not an important source of phosphorus (Table 4). Total phosphorus losses on a land area basis were similar, or less than, the annual 0.1 kg P ha⁻¹ loss reported for native prairie in Minnesota when rainfall-induced

RESULTS AND DISCUSSION

Fine fescues covered nearly 40% of the ground by early May 2004, while weed seedlings were the only vegetation on the prairie plots. Fescue cover was excellent by August, while annual weeds covered 80% of the ground in prairie plantings (Figures 1A, 1B). A few prairie plants were present, but they comprised less than 1% of the ground cover. By June 2005, fescue cover remained dense and prairie vegetation had increased to 18%, though weeds still covered more than three quarters of the plot area (Figures 1C, 1D). Several of the prairie flower species were evident by summer 2005, though few bloomed that year. None of the prairie grasses were ever observed, consistent with several of our other establishment projects using similar prairie seed mixtures. Prairie plots on fairway 4 had more weeds, especially *Poa annua*, than plots on fairway 8 that were less shaded. Regulations requiring native vegetation for buffer strips in situations where climatic conditions

Table 3
Monthly rainfall (mm) during runoff sampling periods
at Wisconsin River Golf Club, Stevens Point, Wis.

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
2004								
32.3	222.0	171.7	148.8	121.7	30.2	132.8	48.3	907.8
2005								
92.5	73.9	167.1	33.3	151.9	188.0	32.3	83.1	822.1

Table 4
Total annual runoff volumes and phosphorus (P) losses from *Poa annua* fairways with
or without various buffer strips of either prairie or fine fescue, Stevens Point, Wis.

Buffer Treatment ¹	Water Runoff (mm)	Total P (kg ha ⁻¹)	Bioavailable P (kg ha ⁻¹)
2004²			
No buffer	36.6	0.12	0.04
Short, Prairie	42.9	0.17	0.03
Short, Fescue	45.6	0.19	0.04
Medium, Prairie	50.1	0.17	0.04
Medium, Fescue	38.1	0.16	0.04
Long, Prairie	36.6	0.12	0.03
Long, Fescue	50.2	0.22	0.02
Significance (P≤0.05)	ns	ns	ns
2005³			
No buffer	3.5	0.04	0.01
Short, Prairie	4.2	0.03	0.02
Short, Fescue	4.6	0.04	0.03
Medium, Prairie	5.5	0.04	0.02
Medium, Fescue	5.5	0.05	0.02
Long, Prairie	3.5	0.03	0.02
Long, Fescue	4.1	0.02	0.02
Significance (P≤0.05)	ns	ns	ns

ns = not significant at P≤0.05.

¹Short buffer = 8:1 fairway:buffer length, medium = 4:1 fairway:buffer, long = 2:1 fairway:buffer.

²May through October.

³April through November.

Table 5

Mean monthly soluble phosphorus (P) and total nitrogen (N) in leachate under *Poa annua* fairway and prairie or fine fescue buffer strips, Wisconsin River Golf Club, Stevens Point, Wis.

Buffer Treatment ¹	Soluble P (mg L ⁻¹)	Total N (mg L ⁻¹)
2004²		
No buffer	0.33	2.89
Short, Prairie	0.32	7.60
Short, Fescue	0.12	32.08
Medium, Prairie	0.24	7.05
Medium, Fescue	0.05	30.15
Long, Prairie	0.13	6.28
Long, Fescue	0.07	25.66
Significance (P≤0.05)	ns	ns
2005³		
No buffer	0.58	3.91
Short, Prairie	0.56	4.15
Short, Fescue	0.36	5.02
Medium, Prairie	0.20	2.33
Medium, Fescue	0.36	4.00
Long, Prairie	0.26	3.61
Long, Fescue	0.49	3.72
Significance (P≤0.05)	ns	ns

ns = not significant at P≤0.05.

¹Short buffer = 8:1 fairway:buffer length, medium = 4:1 fairway:buffer, long = 2:1 fairway:buffer.

²May through October.

³April through November.

runoff averaged 6 mm per year, and similar, or less, than the 0.18 to 7.04 kg P ha⁻¹ in surface runoff from a variety of grazing lands in Oklahoma.

Phosphorus runoff in our study was more than 20 times less than that reported for wheat production, probably due to greater vegetative cover in the golf course system. Phosphorus sources in our study likely included natural sources such as vegetation, soil, and precipitation. We've found similar results when comparing Kentucky bluegrass (*Poa pratensis*) and prairie buffer strips for controlling urban runoff.

A growing body of evidence indicates that when ground is well covered by vegetation (e.g., 70%), total P losses may be much reduced compared to predominantly exposed soil. In exposed soil situations, sediment-bound P is often the primary type of P. Vegetation greatly reduces total P runoff by reducing both runoff volume

and sediment, though soluble P may increase as it leaches from vegetation and organic P-containing particles move in runoff. Prairie plants may be especially prone to P loss from vegetation, as they are predominantly C₄ plants with foliage that dies in early autumn, while C₃ turf foliage may survive the winter and has a steady but low turnover rate coupled with less abundant above-ground biomass than prairie vegetation.

In our study, about 25–50% of the total P in runoff was bio-available P (BAP). This is the type that stimulates algae blooms in ponds, lakes, and rivers. Values in our study were at least 20 times less than BAP in wheat field runoff and similar to BAP runoff from native grassland. Our data are important because they represent natural background levels of phosphorus. Consequently, regulations to limit phosphorus fertilization would in this case be ineffective at reducing phos-

phorus loading. Ultimately it is impossible to achieve zero P runoff.

Buffer strips did not affect phosphorus or nitrogen leaching below the soil surface (Table 5). Nitrogen is the most important nutrient contaminant in leachate water because excessive levels in drinking water may have adverse human health effects, such as blue baby syndrome. The U.S. Environmental Protection Agency sets the drinking water limit at 10 parts per million (ppm) nitrate-nitrogen. In our study, this level was exceeded in 2004 under the fine fescue plots, but the results were not statistically different from leachate under prairie plots or fairway alone. The higher concentrations in 2004 were likely due to soil disturbance effects from the establishment process and lack of vegetative cover until May 2004. In 2005, all nitrogen concentrations were below 10 ppm and were likely lower than 2004 because more vegetation existed in the second year.

Phosphorus has generally been regarded as having little movement in soil and so most leaching studies do not measure phosphorus. However, increasing awareness of ties between ground and surface water may soon require additional knowledge of phosphorus leaching. Easton and Petrovic reported more than 50% of P applied to turf from swine compost leached below the surface, while synthetic fertilizer sources had significantly lower leachate losses. Our study indicates that an unfertilized prairie stand has similar levels of P leachate compared to unfertilized fine fescue turf and fertilized *P. annua* fairways. Phosphorus and nitrogen contamination of runoff and leachate water from golf course fairways was similar to natural background levels reported for non-fertilized native prairies and was not affected by buffer strip type or size.

Acknowledgements: The authors wish to express their appreciation for funding provided by the USGA's Turfgrass and

CONNECTING THE DOTS

A Q&A with DR. JOHN STIER, University of Wisconsin, regarding the use of prairie versus fescue buffer strips to minimize nutrient and sediment fairway runoff.

Q: Your article points to recent regulations that buffer strips, to reduce nutrient and sediment loading into surface waters, should use native, or prairie, vegetation. How do you think regulators chose to stipulate prairie vegetation for this purpose? Is there scientific data to show that a prairie strategy is effective for this purpose?

A: Regulators chose prairie vegetation for use as native buffer strips because much of the southern part of Wisconsin was largely prairie (e.g., oak savannah) before the 1800s. The other alternative is trees, which because of their height and relatively slow growth are illogical to meet immediate needs, even though the northern half of the state is naturally forested. We decided to investigate the utility of prairie buffer strips to control runoff specifically because no previous scientific data existed.

Q: Given the differences in speed of establishment of fescues (and other turfgrasses) versus prairie ground cover, do you think that using prairie vegetation for fairway buffer strips is a sound strategy?

A: While prairie ecosystems can take several years to become established, we found that the annual weeds that developed in the prairie plots functioned as well as fescues to mitigate runoff and sediment loss. The question is, will people accept weeds as a vegetative cover during the years required to establish a prairie ecosystem? We also noticed that in one of the sites, heavily shaded by trees, the prairie plants did not establish as well as the site with more sunshine.

Q: In your study, less than 5% (in 2004) and 1% (in 2005) of the total rainfall ran off the fairway and buffer strip surfaces. Do you think the differences in sediment and nutrient losses between prairie and fescue buffers would have been greater if the plots had been tested on a golf course receiving greater rainfall or having more severe slopes?

A: The differences might have been greater if slopes were more severe. As for rainfall, factors to consider include pre-existing soil moisture at the time of rainfall

and rate of rainfall compared to infiltration rate. For example, if the soil is saturated from previous rainfalls, even a minor rainfall might cause runoff, while a more severe rainfall may not cause any runoff if the soil is dry at the time of rainfall.

Q: It was interesting that your research showed that applied fertilizer did not appear to be an important source of runoff phosphorus. Do you think the extent that significant phosphorus runoff comes from dead or dormant vegetation (i.e., C₄ prairie plants) is well understood by regulators?

A: Unfortunately, the idea that vegetation itself can serve as a source of nutrients does not appear to be well understood by regulators or the general public — it would be interesting to survey scientists to determine their understanding of vegetation as a source of nutrients in runoff. The idea is not completely new, as several studies have shown that nutrients can be leached from tree leaves.

Q: Your study demonstrated that bio-available phosphorus runoff from WRGC fairways was 20 times less than that reported for wheat production. Do you sometimes get the feeling that regulators target golf courses rather than conventional agriculture, where the cumulative runoff from row-crop, small grain, forage production, and pasture and feed-lot operations seem to be a much greater threat to surface water quality?

A: The turf and allied green industries do not seem to have the political infrastructure that organized row-crop agriculture has. Also, most of the public is very familiar with urban landscapes because the vast majority of U.S. residents live in urban areas: they are unfamiliar with row-crop agricultural systems.

Q: What is the take-home message for golf course superintendents from this work?

A: Well-vegetated areas, regardless of the species, are important for minimizing runoff and sediment losses. There will always be a background level of nutrients in runoff water because the vegetation itself may serve as a source of nutrients in addition to atmospheric deposition and other sources unrelated to fertilizer.

JEFF NUS, PH.D., manager, Green Section Research.

Environmental Research Program and the Northern Great Lakes Golf Course Superintendents Association, and co-operation from the owners and superintendent of Wisconsin River Golf Club.

Editor's Note: A more complete version of this report can be found at USGA Turfgrass and Environmental Research Online: <http://usgatero.msu.edu/v05/n22.pdf>.

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Don't Get Washed Away

New advances in erosion control blankets are shifting the decision to seeding versus sodding.

BY HAL PHILLIPS



To prevent soil erosion on large areas, such as newly constructed fairways, superintendents in many areas of the country are beginning to recognize the value of improved erosion control blankets.

Progress — a new way of doing something that is an improvement on current operating procedures. Recent advances in the manufacturing of erosion control blankets provide a different twist, however, in that they allow superintendents, contractors, and architects to move ahead by doing something an old-fashioned way.

That time-tested method is establishing new turf areas via seeding, as opposed to sodding. Everyone agrees that seeding takes a little longer, but the turf health benefits, such as stronger root development, are usually superior to those yielded by sod. Yes, there are further downsides to seeding: one can only seed in cool-season climates during certain windows of time, and on steep inclines, like bunker faces, sod has traditionally provided a leg up in terms of erosion control.

In comparison to sod, seeded areas will always take longer to grow in. But, according to superintendents and architects involved in construction projects, the new generation of blankets provides comparable erosion control and actually lengthens the fall germination window. What's more, the addition of erosion control blankets to the seeding process does not change the bottom line: seed and blankets are more economical than sod. And that saving can continue over time, given the man-hours a superintendent must spend hand-watering and repairing sodded bunker faces whose establishment may never overcome an incompatible soil layer issue.

“What we definitely see happening across the country is that turf conditions in the rough and, in particular, on bunker faces are subject to increasing expectations,” says Paul Vermeulen, former USGA Director of the Mid-Continent Region. “Perfection on the putting surface is expected. Fairways, too. And we’re quickly getting to the point where that sort of standard is expected every day on areas like bunker faces. It’s achieving that sort of perfection with the imperfect legacy of sodding that is getting troublesome.

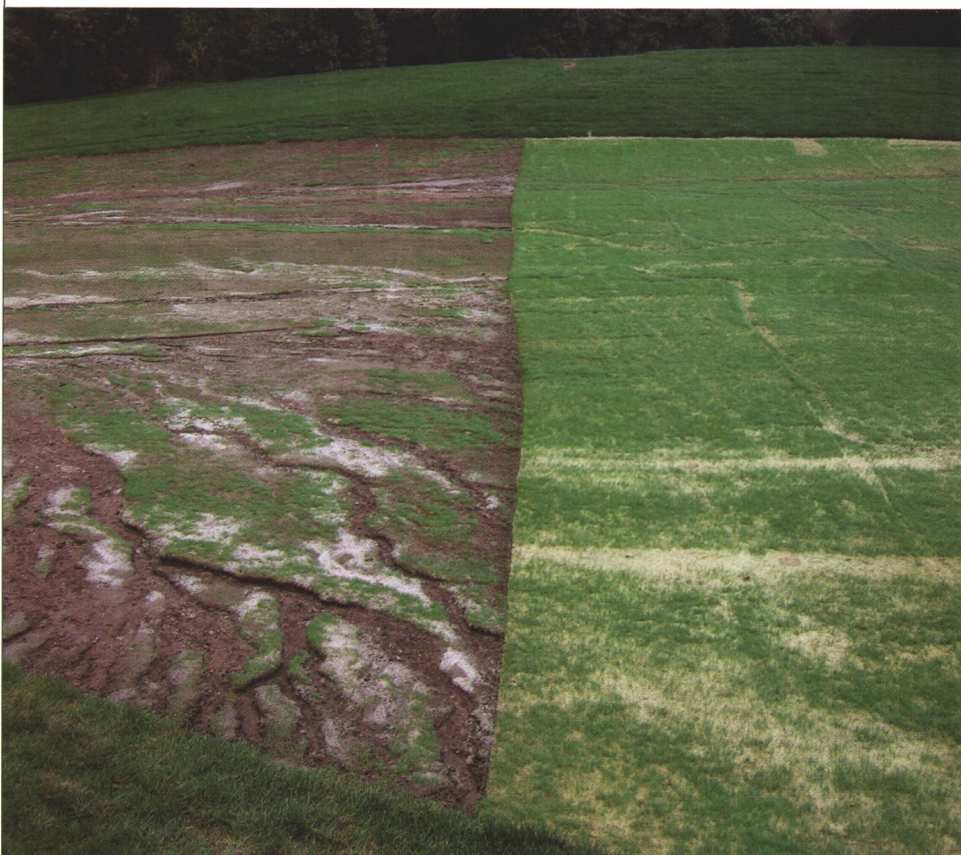
“If our path is to try and produce the best stand of turf around bunkers and greens, we need to be honest about how best to establish that turf. If it’s better to seed, let’s seed. And, if the only thing keeping us from that is erosion and a narrow establishment window, then let’s try something new. I’m not plugging one erosion control product over another, but this is an improving technology that, over the past several years, has made tremendous strides.”

Of course, the main thing that keeps superintendents, contractors, and architects from going with seed is time, not erosion. On a new course project, the decision to sod or seed is often reached before a golf course superintendent is even on site. Still, it is the superintendent who is left holding the bag.

“Suppose you have a limited construction window. Put simply, that becomes the guiding force in all the other decisions that follow,” explains Bob Lohmann, whose design firm, Lohmann Golf Designs, has been a leading proponent of seeding/blanketing for the last decade. “One of the options that contractors tend to latch onto very quickly is the idea of establishing a large part of a property with sod, because now you have more time to build. But that’s giving in to poor planning. We just opened a course called Blackstone G.C. [Marengo, Illinois], where we had about a seven- to eight-month construction window, which is fast by any standard, and we



One of the most common methods for controlling soil erosion and establishing a stable worksite for equipment operation is to surround newly constructed areas with sod. Given recent improvements in erosion control blanket technology, however, superintendents can do equally well with seeding.



Taming soil erosion on new construction sites, superintendents, architects, and golf course builders are turning to the use of improved erosion control blankets.



With improvements in erosion control blankets, their use on new construction sites is on the rise. In addition to being less expensive, high-quality blankets extend the establishment window of cool-season turf species and provide better-than-expected ground stabilization.

were able to complete the entire project with seed and blanket.”

“With a renovation, because you’ve closed a portion of the course, everyone is even more interested in getting the work done as fast as possible. So, the pressure to sod is even greater. In cool-season climates like the Midwest, you need to seed renovated holes and features by about September 15th. But, what if you don’t make that deadline? Well, the decision to sod gets easier and easier for a project manager, who doesn’t necessarily factor in the long-term downsides: the poor rooting of turf for years to come and the need for repeated core aeration (on a bunker face!) to disturb the layer of soil imported with the sod.

“All these downsides are left to the superintendent. The project manager looks good when he walks off the property. He finished ‘on time.’ But the superintendent deals with the consequences.”

Lohmann admits that, until blanket technology improved over the last five years, sodding was still the preferred method of erosion control. And, because bunker reconstruction is such a routine staple of course renovation, the sodding of new bunker faces quickly became standard practice.

“Today, however, the more expensive blankets will stabilize the seeded area on steep slopes just as well as sod,” he says. “They also hold the moisture for you, so the seed will germinate quicker. A great example of this is a driving range project we did for Chenequa Country Club [Hartland, Wisconsin]. Because of budget limitations, we seeded and blanketed only the very steep sloping area immediately below the tee. In the range itself, which is mildly sloped, we seeded with no blankets. Chenequa was hit with some pretty major storms right after the seeding, and they’re still struggling with the low areas where the seed and

topsoil were washed away. But, the slopes around the tee are perfect. In the long run, cutting money on erosion control early in the budget process probably cost the club more money — in washout repairs.”

Brad Minnick, CGCS, is the head golf course superintendent at Lawrence Country Club in Kansas, which closed down in July 2005 for a comprehensive, 18-hole renovation. Minnick had originally specified sod for his new bunker faces (“I had used straw blankets in the past and didn’t enjoy success.”), but during a Turf Advisory Service visit Paul Vermeulen suggested he try seeding again — this time with the new generation of blankets.

“Paul turned me on to the idea and once I tried it on a trial basis, it was obviously going to be the better solution,” says Minnick, whose course reopened in September 2006. “I always believed that seeding was best, but that erosion was the problem that sod



Sodding steep banks around new bunkers has gained wide acceptance because it yields quick results and provides excellent erosion control. Maintaining the turf in good condition long-term, however, can necessitate the installation of pop-up sprinklers to compensate for poor root development.

helped cure. I don't believe that anymore. It's a leap of faith, going with blankets. It's not mainstream. But, it works."

The time pressures will never go away, but neither will the obvious cost savings. When the renovation budget was put together in Lawrence, for example, there was a line item for one acre of sod; the remaining 60 acres were to be seeded with no erosion control. By going with seed and blankets on that one acre and eliminating the sodding line item, there was money available to blanket 40 of the 60 remaining acres.

Lohmann sees the beginning of a sea change in the way the golf industry views sodding. He sees the rest of the golf industry coming his way.

"The practice of sodding has, over time, become more and more popular, but I think we've reached a point where enough courses are having long-term problems that we need to

pull back," he says. "It's one thing to sod a fairway or two because you've run out of time, but sodding around elaborate bunker contours is just a bad idea. Sure it's difficult to aerate a 10-degree slope, but what about the man-hours you devote to something like that? And, what about the man-hours you need to hand-water those sodded areas during establishment — or the supplemental sprinkler heads you need to install to care for those sodded bunker faces long term?"

"Ten years ago, we never saw pop-up heads around bunker banks, but now it's becoming commonplace. We do a lot of classic course renovation, and you never see an 80-year-old course with pop-up heads around bunkers. They don't need it. But when you visit an 80-year-old course that's been renovated with sodded bunker faces, you see it all the time because the turf isn't healthy. That should tell you something."

Another sodding misconception is that an area around a newly constructed green or tee needs to be partially or completely sodded in order to access that green or tee with equipment, such as mowers. "Many think that a bridge of sod is the only option," Vermeulen says. "People assume that if you seed and follow up with an erosion control blanket, the ground won't be stable enough. But it is stable enough. We all went to school and learned things one way, and then we had that reinforced in the field. This sort of change has to start with superintendents because they understand the long-term as well as the short-term. They have to be the spokespersons for this improving technology."

HAL PHILLIPS is a former editor of Golf Course News and a freelance writer based in Maine, where the season is short and sweet.

Nematodes for White Grub Control

Rutgers University scientists investigate soil effects on nematode suppression of white grubs.

BY ALBRECHT M. KOPPENHÖFER AND EUGENE M. FUZY



At present, synthetic insecticides are still the primary means of controlling white grubs. With the implementation of the Food Quality Protection Act of 1996, golf turf managers have already lost many options for curative white grub control.

Species of white grubs are the most widespread and destructive turfgrass insect pests in the United States. Key species are the Japanese beetle (*Popillia japonica*) throughout much of the eastern United States, and masked chafers (*Cyclocephala spp.*) in the Midwest and western states. However, in the Northeast and along the eastern seaboard, the oriental beetle (*Anomala orientalis*), European chafer (*Rhizotrogus*

majalis), and Asiatic garden beetle (*Maladera castanea*) have become similarly important pests. At present, synthetic insecticides are still the primary means of controlling white grubs, but due to the implementation of the Food Quality Protection Act of 1996 (FQPA), golf turf managers have already lost many options, and may lose more, for curative white grub control.

Neonicotinoid insecticides (imidacloprid, clothianidin) and insect growth regulators (halofenozide) are less hazardous than organophosphates and carbamates, but they are only effective when used preventively, resulting in the treatment of large areas that otherwise would have needed only partial or no treatment. In the long term, these insecticides' high efficacy against many turfgrass pests

combined with their large-area applications is likely to reduce predators, parasitoids, and pathogens of white grubs and other insect pests by depriving them of prey/hosts. Ultimately, this approach may increase dependency on chemical control.

ENTOMOPATHOGENIC NEMATODES AS AN ALTERNATIVE

Entomopathogenic nematodes (Heterorhabditidae and Steinernematidae) offer a non-toxic, environmentally safe, and IPM-compatible alternative to synthetic insecticides in turfgrass. These nematodes occur in natural and agricultural soils around the world and are used for biological control of insects, primarily soil-dwelling insects.

The only free-living stage of entomopathogenic nematodes is the infective juvenile that must persist in the soil until it can locate and infect a suitable host. After penetrating into the host's body cavity, the infective juvenile regurgitates species-specific symbiotically associated bacteria. The nematode and bacteria cooperate to kill the host within a few days. The developing nematodes feed on the bacteria and host tissues digested by the bacteria and develop through up to three generations, until hundreds to hundreds of thousands of new infective juveniles emerge from the depleted host cadaver to search for new hosts.

Research in the U.S. has shown that these nematodes can be as effective as synthetic insecticides against Japanese beetle larvae. However, recent research

has shown that the masked chafer, oriental beetle, European chafer, Asiatic garden beetle, and other white grub species are less susceptible than the Japanese beetle to the commonly used nematode species such as *Heterorhabditis bacteriophora* and *Steinernema glaseri*.

STEINERNEMA SCARABAEI: A NEW HIGHLY VIRULENT NEMATODE

We have recently isolated a new nematode species, *Steinernema scarabaei*,

well adapted to infecting sedentary hosts below the soil surface, but performs poorly against mobile hosts on the soil surface.

In laboratory, greenhouse, and field studies, *S. scarabaei* has shown exceptional virulence to a wide range of white grub species, including the Japanese beetle, oriental beetle, European chafer, Asiatic garden beetle, and several May/June beetle species. It dramatically outperformed any other nematode species tested in greenhouse

and field studies, even at rates as low as one fourth of the other species applied. In ongoing field studies supported by the USGA, we have seen significant suppression of oriental beetle larval populations by *S. scarabaei* at least one year, often two years, after application. This long-term effect is due to the high virulence of *S. scarabaei*, the long persistence of its infective juveniles, and its effective reproduction and recycling in the infected white grubs.

FACTORS AFFECTING NEMATODE EFFICACY AND SURVIVAL

The performance of entomopathogenic nematodes can be

affected by many environmental factors. Two of the most important factors are soil moisture and soil type/texture. In soil, infective juveniles move through the water film that coats the pore spaces. If this film becomes too thin (in dry soil) or the pore spaces are completely filled with water (in water-saturated soil), nematode movement can be restricted. In field



Rutgers University scientists investigated the effects of soil moisture and soil type on the infectivity and persistence of nematodes for short- and long-term suppression of white grubs. Shown above is a white grub infected with *Steinernema scarabaei*.

living in Japanese and oriental beetle larvae in New Jersey turfgrass areas. This nematode was highly virulent to and reproduced very well in oriental beetle and Japanese beetle larvae, but its virulence to and reproduction in the larvae or adults of species from various other families of Coleoptera, Lepidoptera, and other insect orders was generally low to non-existent. It is

studies, soil moisture was positively related to *H. bacteriophora* efficacy against Japanese beetle larvae. Infective juveniles can survive dessiccation to relatively low moisture levels if water removal is gradual, giving them time to adapt to an inactive stage.

Generally, nematode survival and dispersal tend to be lower in fine-textured soils, but the effect of soil moisture and texture on nematode infectivity and survival varies with nematode species and may depend on nematode size, behavior, and physiology. In turfgrass trials against Japanese beetle larvae, *H. bacteriophora* was more effective in fine-textured soils than sandy soil, probably because finer soils retain moisture better and restrict nematode movement to the upper soil layers where most of the white grubs are found.

STUDIES ON THE EFFECT OF SOIL TYPE AND SOIL MOISTURE

To improve the predictability of *S. scarabaei* applications in the field, both for short-term and long-term white grub management, we conducted a series of laboratory and greenhouse experiments studying the effect of different soil types and moisture levels on the infectivity and survival of this species. For comparison, the well-known and widely available species *H. bacteriophora* was included in the study.

Five typical mineral soils were collected from turfgrass areas, acidic sand from a blueberry field, and a typical potting mix from a nursery. Soil characteristics and soil moisture release curves were established. Third-instar oriental beetles and Japanese beetles were collected in turf areas and stored individually at 50°F for one to ten weeks in a mixture of organic compost and loamy sand. The nematodes *H. bacteriophora* (GPS11 strain) and *S. scarabaei* (AMK001 strain) were cultured and stored following standard procedures.

EFFECT OF SOIL TYPE ON NEMATODE INFECTIVITY

Two laboratory experiments tested the effect of six substrates on nematode infectivity. Experiment 1 tested the infectivity of *S. scarabaei* (0 or 200 infective juveniles per vial) against oriental beetle larvae. Experiment 2 tested the infectivity of *H. bacteriophora* (0 or 500 infective juveniles per vial) against Japanese beetle larvae. At seven days after treatment (DAT), the larvae were recovered and infected larvae were dissected and digested in a pepsin solution, and the number of nematodes established in them were counted.

The number of *S. scarabaei* established in the larvae was significantly lower in acidic sand than in potting mix, and significantly lower in potting mix than

in loam, sandy loam, and loamy sand, and significantly lower in silt loam than in loamy sand (Figure 1A). Larval mortality followed a very similar pattern, with significantly lower mortality in acidic sand (50%) and potting mix (67%) than in the other soils (90–100%). *H. bacteriophora* establishment in larvae (Figure 1B) was the highest in potting mix and the lowest in acidic sand and did not differ significantly among loamy sand, sandy loam, silt loam, and clay loam. Larval mortality also was the highest in potting mix (93%) and the lowest in acidic sand (13%) and did not differ significantly among loamy sand, sandy loam, silt loam, and clay loam (57–63%).

Two greenhouse experiments were with perennial ryegrass growing on the various substrates. Experiment 1

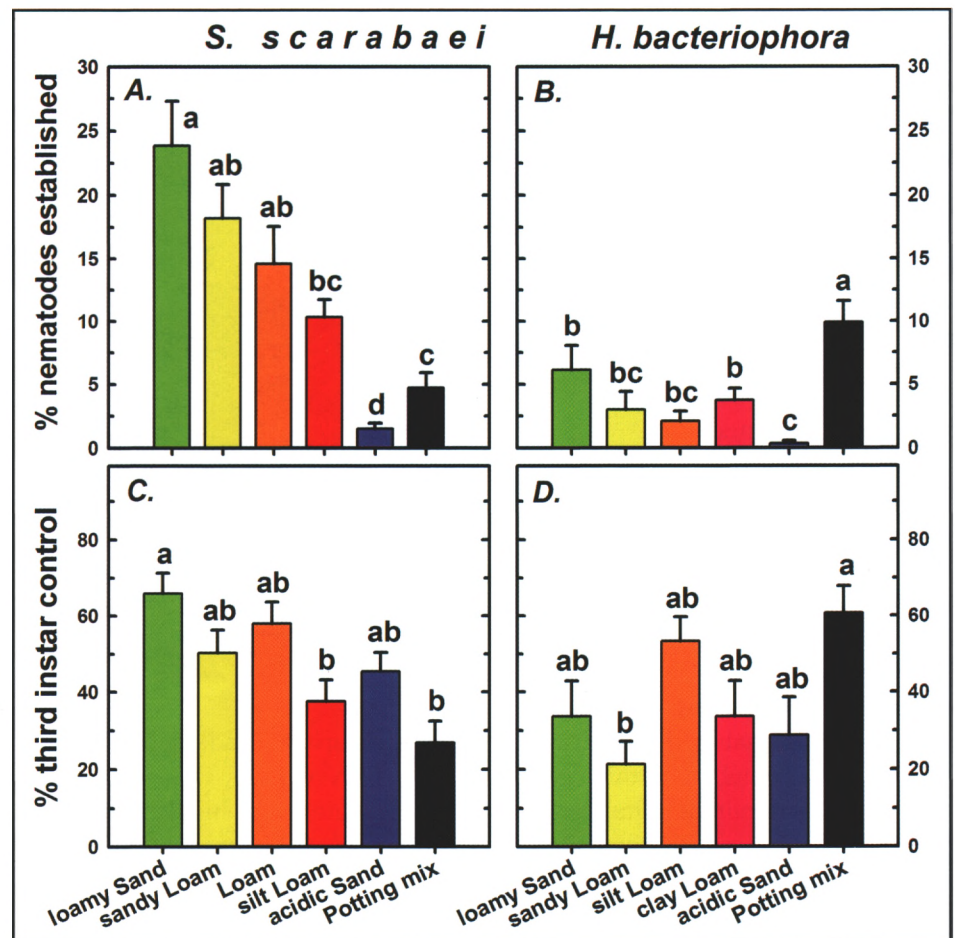


Figure 1. Effect of different substrates on infectivity (A-B) and efficacy (C-D) of the entomopathogenic nematode *Steinernema scarabaei* against the third-instar oriental beetle (A, C) and *Heterorhabditis bacteriophora* against the third-instar Japanese beetle (B, D). Columns with the same letter are not significantly different ($P < 0.05$).

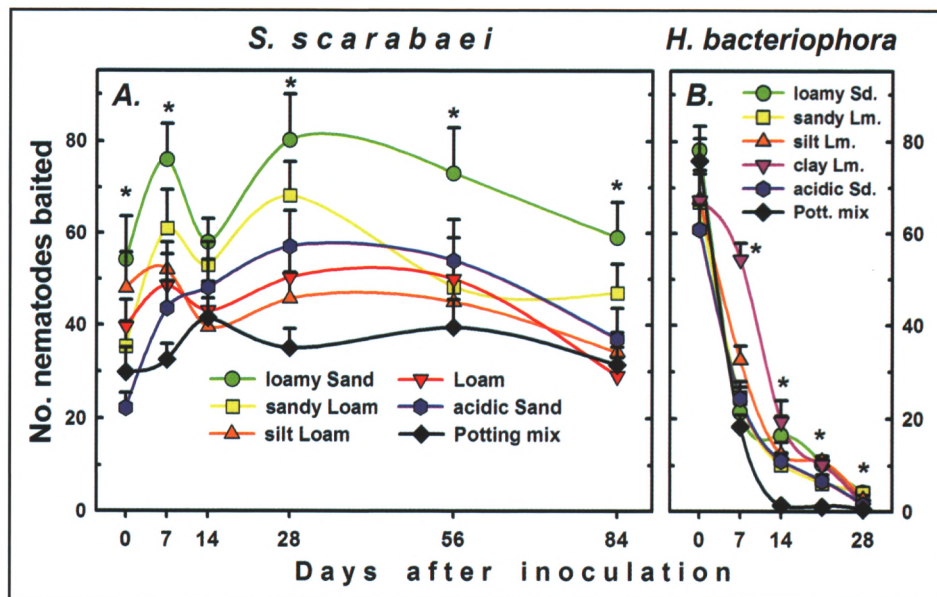


Figure 2. Persistence of *Steinernema scarabaei* (A) and *Heterorhabditis bacteriophora* (B) in different substrates. Asterisk (*) indicates significant differences in recovery among substrate types per baiting date ($P < 0.05$). A significant decline in recovery was found in no substrate for *S. scarabaei* and in all substrates for *H. bacteriophora*.

tested *S. scarabaei* (0 or 156 infective juveniles per pot) against oriental beetles. Experiment 2 tested *H. bacteriophora* (0 or 625 infective juveniles per pot) against Japanese beetles. The pots were destructively sampled at 14 DAT to determine the number of surviving larvae.

Mortality in the greenhouse experiment followed a trend similar to the mortality in the laboratory experiment, except that the negative effect of acidic sand was less pronounced, possibly modulated by the presence of grass roots (Figure 1). *S. scarabaei* caused higher mortality in loamy sand than in silt loam and potting mix, with sandy loam, loam, and acidic sand not significantly different from either group (Figure 1C). *H. bacteriophora* caused higher mortality in potting mix than in sandy loam, and the remaining soils were not significantly different from either group (Figure 1D).

EFFECT OF SOIL TYPE ON NEMATODE PERSISTENCE

Two laboratory experiments tested the effect of six soil types on persistence of *S. scarabaei* and *H. bacteriophora*. At different times after adding 200 infec-

tive juveniles per cup treatment (Figure 2), five cups from each treatment were opened and the soil baited with five wax moth larvae for four three-day baiting rounds. Infected larvae were dissected and digested to count the

number of nematodes established in them.

S. scarabaei showed excellent persistence with no significant decline in recovery over time in any of the substrates (Figure 2A). Over the entire experiment, recovery was significantly higher in loamy sand than in all other soils, and significantly higher in sandy loam than in potting mix. *H. bacteriophora* persistence was much shorter, and recovery significantly declined in all substrates (Figure 2B). Overall, recovery was significantly higher in clay loam than in sandy loam and acidic sand, and was lower in potting mix than in all other soils.

EFFECT OF SOIL MOISTURE ON NEMATODE INFECTIVITY

Sandy loam was prepared at different soil water potentials (from wettest to driest: -1, -10, -100, -1000, -3000 kPa), allowed to equilibrate for four days, mixed again, and filled into plastic vials. Into each vial, one third-instar Japanese beetle was released and, one day later, 0 nematodes, 200 *S.*

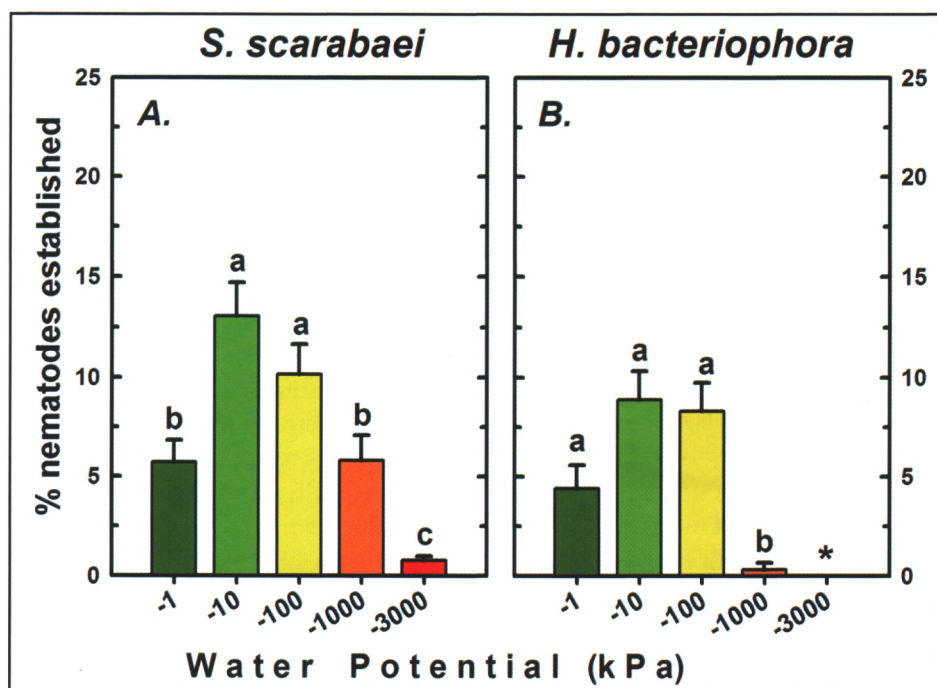


Figure 3. Effect of soil water potential on infectivity of the entomopathogenic nematodes *Steinernema scarabaei* (A) and *Heterorhabditis bacteriophora* (B) in different substrates against the third-instar *Popillia japonica*. Columns with the same letter are not significantly different ($P < 0.05$). Asterisk (*) indicates that no infection and mortality occurred at these data points.

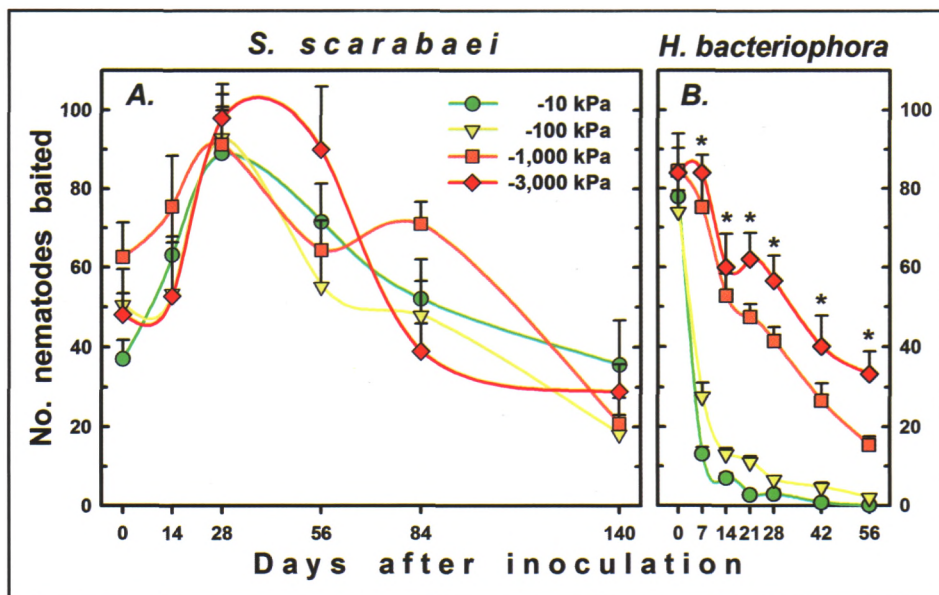


Figure 4. Persistence of *Steinernema scarabaei* or *Heterorhabditis bacteriophora* in sandy loam at four soil water potentials. Asterisk (*) indicates significant differences in recovery among water potential per baiting date ($P<0.05$). A significant linear decline in recovery was found for -100 kPa and -1000 kPa in *S. scarabaei* and for -10 kPa to -3000 kPa in *H. bacteriophora* ($P<0.05$).

scarabaei, or 1,000 *H. bacteriophora* were added to the soil. At seven days after treatment (DAT), the larvae were recovered and infected larvae were dissected and the nematodes established in them counted.

The number of *S. scarabaei* established in larvae was higher at -10 kPa and -100 kPa than at -1 kPa and -1000 kPa, but was the lowest at -3000 kPa (Figure 3A). Larval mortality by *S. scarabaei* was significantly higher at -100 kPa (100%), -10 kPa (97%), and -1000 kPa (87%), than at -3000 kPa (50%), with mortality at -1 kPa (77%) not significantly different from either group. *H. bacteriophora* establishment followed a similar pattern as for *S. scarabaei* at -1 kPa to -100 kPa, but was more restricted in drier soil with very low establishment at -1000 kPa and no establishment at -3000 kPa (Figure 3B). Similarly, larval mortality by *H. bacteriophora* was significantly higher at -1 kPa (57%), -10 kPa (77%), and -100 kPa (67%) than at -1000 kPa (17%), with no mortality at -3000 kPa.

S. scarabaei persistence was also excellent and was not affected by soil water potential (Figure 4A). Averaged across all soil water potentials, *S.*

scarabaei recovery initially increased but declined thereafter and was significantly lower on day 140 than all other days. *H. bacteriophora* significantly declined much more quickly at all soil water potentials (Figure 4B), but declined the fastest at -10 kPa, somewhat slower at -100 kPa, much slower at -1000 kPa, and particularly -3000 kPa.

CONCLUSIONS

Our observations further illuminate the excellent potential of *S. scarabaei* for short-term and long-term suppression of white grub populations. In addition to its high virulence against a wide range of white grub species, it also showed high virulence across a wide range of substrate types. While *S. scarabaei* infectivity tended to decline from the coarser sandy soils to the finer clay soils, significant mortality was observed in greenhouse pot experiments even in the finest soils. Even in clay loam, *S. scarabaei* was only somewhat less infective in laboratory and greenhouse experiments. Only in highly acidic sand (pH 3.9) and highly organic potting mix did *S. scarabaei* infectivity decline significantly, though it still caused significant mortality.

In comparison, *H. bacteriophora* showed similar infectivity from the coarser to the finer soils, was also negatively affected in acidic sand, but was the most infective in the potting mix. Both *S. scarabaei* and *H. bacteriophora* were most infective at moderate soil moisture and less in saturated soil and drier soil. However, the infectivity range of *S. scarabaei* extended further into the dry range, with significant mortality even in dry soil (-3000 kPa), where *H. bacteriophora* did not cause infections. *S. scarabaei* also showed excellent persistence over all substrate types and soil moisture levels, whereas *H. bacteriophora* generally had shorter persistence, with more useful persistence levels only in the drier soils, where it becomes inactive.

The present study indicates that long-term white grub suppression should be achievable over a wide range of soil conditions. The major problem still to overcome in the commercialization of *S. scarabaei* is the development of effective mass production technology, which has proven to be difficult and may require more in-depth studies on *S. scarabaei*'s nutritional requirements.

ACKNOWLEDGMENTS

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Editor's Note: This complete report can be found at USGA Turfgrass and Environmental Research Online: <http://usgatero.msu.edu/v05/n19.pdf>.

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CONNECTING THE DOTS

A Q&A with DR. ALBRECHT KOPPENHÖFER, Rutgers University, regarding the use of nematodes to control white grubs.

Q: In your opinion, what is the main obstacle that impedes the widespread use of entomopathogenic nematodes as a biological control of white grubs?

A: For nematodes in general, I would think that absence of good formulations is the biggest impediment. For *Steinernema carpocapsae*, a nematode that is highly effective for control of black cutworm and other caterpillar pests, a formulation exists (wetttable dispersible granules) with up to five months shelf life at room temperature. For other species and formulations, the nematodes will not last as long and often have to be kept refrigerated. What we need are formulations with tolerance to short-term temperature extremes and a shelf-life of several months at room temperature, one year and more. Nematode products also will have to become more competitive with available chemical insecticides as far as pricing and/or efficacy is concerned.

Q: What do you believe are the most compelling reasons that future golf course superintendents should consider in using entomopathogenic nematodes for grub control?

A: Public and legislative pressure to reduce chemical pesticide use is likely to increase in the future. In other parts of the world (e.g., Europe, Canada) and even in some parts of the USA, pesticide use is already more restricted. Nematode species that can provide long-term suppression of white grub populations would be another good reason. *Steinernema scapterisci* has already proven to effectively suppress mole cricket populations long-term, and its use is slowly gaining momentum. *Steinernema scarabaei*, should it become commercially available, could be used in a similar fashion.

Q: Are there data from other studies to suggest the geographical range that entomopathogenic nematodes could be used to manage white grubs? Is their use restricted to less cold climates?

A: It depends on the nematode species. *Heterorhabditis bacteriophora*, the best studied and most widely available species for grub control, should be used at soil temperatures above 68°F for maximum efficacy. This excludes spring applications and also applications after late August or even mid-August in the northern areas of the lower 48 states. *S. scarabaei*, on the other hand, has provided excellent control in late spring applications and appears to retain high activity to about 62°F. This species, however, may not do as well at soil temperatures above 85°F, and may therefore have to be applied in spring or fall in the more southern regions of the USA.

Q: These studies involved laboratory and greenhouse experiments. How well do these results relate to field tests?

A: These studies can only give us a general idea. Soils occur in an almost unimaginable variety, with texture, organic matter, and pH being some of the most important factors that may influence nematode performance. For example, in our experiments, *H. bacteriophora* was similarly effective across the different soil textures, but a summary of numerous field tests against Japanese beetle larvae suggested that it was more effective in the finer-textured than the coarser soils. The reason may be that finer soils retained soil moisture better and also confined the nematodes more to the upper soil layers where most of the grubs are active. Since *S. scarabaei* effectiveness declined from coarser to finer soils, it may be that it would be similarly effective across soil textures under field conditions.

Q: The USGA has funded several research projects involving biological control of turfgrass pests. Although experiments in the lab and greenhouse may look promising, oftentimes when taken to the field, promising results cannot be repeated. What hope is there for the use of entomopathogenic nematodes as a biological control strategy?

A: We have conducted numerous field tests in which *S. scarabaei* has provided excellent curative grub control. It has persisted in the field plots for up to four years and consistently provided significant grub control even one year after application, often also two years after application. Another very host-specific nematode, *S. scapterisci*, is providing very good long-term suppression of mole crickets in the southeastern USA. Species that are highly adapted to one of the key insect pests and provide long-term suppression may be the key to more widespread nematode use in turfgrass.

Q: You mentioned that effective mass production technology represents the major problem in commercializing nematodes. How likely is it that effective mass production technologies will be developed?

A: Effective mass production technologies already exist for various nematode species, including *H. bacteriophora*, *S. carpocapsae*, and *S. scapterisci*. *S. scarabaei* is difficult to mass produce. One of the companies we have collaborated with has already produced *S. scarabaei* *in vitro* (i.e., in media without insects), and these nematodes were as virulent and viable as the ones produced in grubs. However, production in larger quantities in liquid media has proven to be too variable. Mass production of *S. scarabaei* should be feasible, but it may take some more basic research on its nutritional requirements, and with that, more time before commercialization will be possible.

JEFF NUS, PH.D., manager, Green Section Research.

On Course *With Nature*

Seeing is Believing

Certification verification yields public relations benefits.

BY JEAN MACKAY AND JEREMY TAYLOR



Active participation in the Audubon Cooperative Sanctuary Program helps golf courses highlight their environmental efforts and promote the fact that they are doing right by the environment (Beaver Creek Golf Club, Avon, Colo., fully certified in 2003).



Site visits offer a great opportunity for golf courses to showcase their environmental efforts. Larry and Jan Schlipper of Commonwealth National Golf Club in Horsham, Pa., show off their Audubon display during their site visit.

Verification. It's a critical issue when it comes to running a certification program. How do you know that people are doing what they claim? Without verification, the credibility of the program and the integrity of its members are both at stake.

We know that only too well at Audubon International. Since the inception of the Audubon Cooperative Sanctuary Program for Golf Courses (ACSP) in 1991, we have grappled with how to verify the environmental best practices of members without adding undo costs or burden to participants. Though written and photographic documentation have always been required, and certified golf courses have long been environmental leaders in the golf industry, the question of on-site verification remained crucial for program critics and supporters alike.

To address the credibility gap, Audubon International changed its

certification requirements in 2005 to include a site visit — and the results have exceeded all expectations. To date (December 1, 2006), 110 golf courses have hosted a site visit. Within the next four years, all 595 currently certified golf courses will have had a third-party site visit.

ABOUT SITE VISITS

Site visits are designed to help Audubon International verify some of the more visible aspects of golf course environmental management activities. They are conducted by a third-party representative not affiliated with the golf course, such as a local conservation organization, governmental agency, cooperative extension, or Audubon International staff or steward. The site visit generally takes several hours, with course personnel touring the course with the third-party verifier, who then completes a checklist and returns it to Audubon International for review. Used in combination with written and

photographic documentation, certification is strengthened dramatically.

Equally important, the site visit provides an opportunity for golf course representatives to demonstrate some of the voluntary actions they have taken to protect the environment. In some cases, the reviewer is already aware of the ACSP and somewhat familiar with the efforts that the golf course has taken to protect the environment. But for the majority of golf courses, the site visit brings new eyes and a fresh perspective to the course — with much to be gained by both parties.

“[The reviewer] was impressed with the program and said ‘I had no idea’ quite a few times,” reported Greg Blik at Tahoe Donner Golf Course in Truckee, Calif. “I think it comes as a shock to most people that we actually care about the environment.”

Blik's perception was echoed independently by Scott Terrell of the Truckee Donner Public Utility District, who conducted the site visit. “As an

individual who has been involved in green business and personal practices, I was very pleasantly surprised to see the amount of green practices being conducted at Tahoe Donner Golf Course,” Terrell commented in the site visit report.

Blik and Terrell’s experiences are not exceptions. Similar comments appear again and again on site visit reports:

“It was a great opportunity to show an independent third party the projects we are involved in at our course. It allowed us an opportunity to receive constructive criticism and new ideas for existing and future projects.” —

Ben Kozlovsky, Assistant Superintendent, Barton Creek Resort, Palmer Lakeside Course, Spicewood, Texas.

“Our [third-party verifier] just reviewed our golf course and had some very insightful and positive things to say. He seemed to be quite happy about the whole situation. It was actually a very good experience.” — Chris Hart, Assistant Superintendent, Coyote Moon Golf Course, Truckee, Calif.

“After visiting Brooks Golf Club for the ACSP, I am very impressed with all the efforts they are putting forth to maintain and improve the environment and water quality.” — Mark Ingwersen, Commissioner, Dickinson



A clean, well-organized maintenance facility speaks volumes during a site visit at Commonwealth National Golf Club.

County Soil & Water Conservation District, Recertification Site Visit for Brooks Golf Club, Okoboji, Iowa.

“Forest Hills Country Club exceeds the expectations of environmental stewardship that an ecologist would expect from a golf course.” — Cory Ritterbusch, Ecologist, Native Landscapes, Recertification Site Visit for Forest Hills Country Club, Loves Park, Ill.

“Heron Lakes Golf Course staff and management practices demonstrate a strong commitment to good environmental stewardship in the Columbia Slough watershed.” — Charles F. Sams III, Executive Director, Columbia Slough Watershed Council, Recertifi-

cation Site Visit for Heron Lakes Golf Course, Portland, Ore.

“Notre Dame and the managers of the Warren Golf Course have done a terrific job at preserving this property as wildlife habitat while simultaneously keeping a lot of golfers happy. Audubon International could use Warren Golf Course as a model for training other golf courses.” — Laura Fuderer, Conservation Chair, South Bend-Elkhart Audubon Society, Recertification Site Visit for Warren Golf Course, Notre Dame, Ind.

By participating in the ACSP, golf course representatives gain assurance that they are doing right by the environment and the ability to invite others in with confidence. It is clear from the site visits that have been conducted thus far that ACSP golf courses are making new allies while maintaining Audubon Cooperative Sanctuary certification. And who would have guessed that on-site verification might become some of the best public relations a golf course could have?

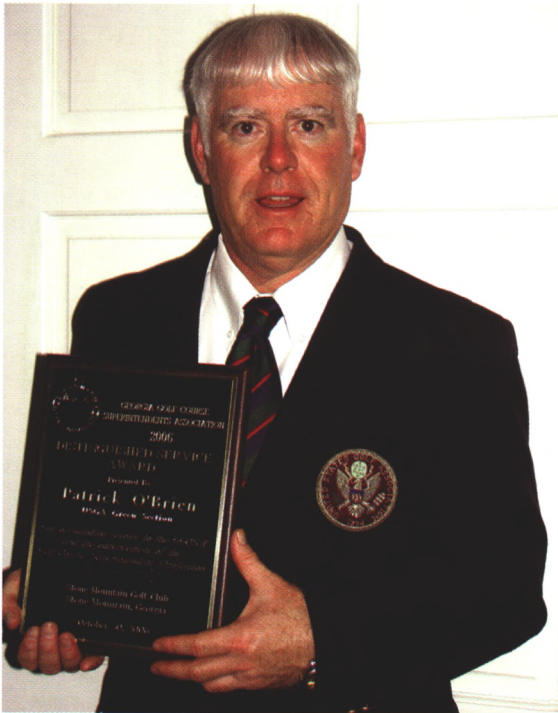
“I have had amazing wildlife encounters on golf courses, and I run a nature center!” reports Dr. Karen Shragg, who has conducted numerous site visits for ACSP members. Shragg is director of the City of Richfield’s Woodlake Nature Center in Richfield, Minn.



JEAN MACKAY is the director of educational services and JEREMY TAYLOR is staff ecologist for Audubon International. For more information, visit: www.auduboninternational.org or contact Jean Mackay at jmackay@auduboninternational.org.

News Notes

O'BRIEN LAUDED FOR DISTINGUISHED SERVICE



Patrick O'Brien, director of the USGA Green Section Southeast Region, was honored by the Georgia Golf Course Superintendents Association (GGCSA) with its 2006 Distinguished Service Award. The annual award is presented for outstanding service to the GGCSA and the advancement of the golf course superintendent profession. The plaque was presented by GGCSA President Richard Staughton, CGCS. Patrick joined the USGA Green Section staff in 1979.

TY McCLELLAN JOINS THE GREEN SECTION STAFF AS MID-CONTINENT AGRONOMIST

The USGA Green Section is proud to announce that Ty McClellan has joined the Mid-Continent Region as an agronomist. He will be working with Bud White, who has been promoted to director of the Mid-Continent Region, after the departure of Paul Vermeulen, who left the staff in November 2006.

Ty holds an M.S. degree in horticulture, specializing in turfgrass science, from the University of Nebraska-Lincoln. Most recently he worked at the Golf Course Superintendents Association of America as a chapter liaison for organizational development in their Member Services Department. In 2003, Ty was selected as one of the 15 students from across the country to participate in the USGA Green Section Internship Program, during which he spent a week making Turf Advisory Service visits with Green Section agronomists.

Ty will be making Turf Advisory Service visits in the states of Kansas, Missouri, Nebraska, Iowa, and Illinois. The USGA Green Section staff welcomes him aboard and wishes him much success.



PHYSICAL SOIL TESTING LABORATORIES

The following laboratories are accredited by the American Association for Laboratory Accreditation (A2LA), having demonstrated ongoing competency in testing materials specified in the USGA's Recommendations for Putting Green Construction. The USGA recommends that only A2LA-accredited laboratories be used for testing and analyzing materials for building greens according to our guidelines.

Brookside Laboratories, Inc.

308 Main Street, New Knoxville, OH 45871
Attn: Mark Flock
Voice phone: (419) 753-2448
FAX: (419) 753-2949
E-Mail: mflock@BLINC.COM

Dakota Analytical, Inc.

1503 11th Ave. NE, E. Grand Forks, MN 56721
Attn: Diane Rindt, Laboratory Manager
Voice phone: (701) 746-4300 or (800) 424-3443
FAX: (218) 773-3151
E-Mail: lab@dakotapeat.com

European Turfgrass Laboratories Ltd.

Unit 58, Stirling Enterprise Park
Stirling FK7 7RP Scotland
Attn: Ann Murray
Voice phone: (44) 1786-449195
FAX: (44) 1786-449688

Hummel & Co.

35 King Street, P.O. Box 606
Trumansburg, NY 14886
Attn: Norm Hummel
Voice phone: (607) 387-5694
FAX: (607) 387-9499
E-Mail: soildr1@zoom-dsl.com

ISTRC New Mix Lab LLC

1530 Kansas City Road, Suite 110
Olathe, KS 66061
Voice phone: (800) 362-8873
FAX: (913) 829-8873
E-Mail: istrnewmixlab@worldnet.att.net

Sports Turf Research Institute

hyperlink to www.stri.co.uk
St. Ives Estate, Bingley
West Yorkshire BD16 1AU
England
Attn: Michael Baines
Voice phone: +44 (0) 1274-565131
FAX: +44 (0) 1274-561891
E-Mail: stephen.baker@stri.org.uk

Thomas Turf Services, Inc.

2151 Harvey Mitchell Parkway South, Suite 302
College Station, TX 77840-5247
Attn: Bob Yzaguirre, Lab Manager
Voice phone: (979) 764-2050
FAX: (979) 764-2152
E-Mail: soiltest@thomasturf.com

Tifton Physical Soil Testing Laboratory, Inc.

1412 Murray Avenue, Tifton, GA 31794
Attn: Powell Gaines
Voice phone: (229) 382-7292
FAX: (229) 382-7992
E-Mail: pgaines@friendlycity.net

Turf Diagnostics & Design, Inc.

613 E. First Street, Linwood, KS 66052
Attn: Sam Ferro
Voice phone: (913) 723-3700
FAX: (913) 723-3701
E-Mail: sferro@turfdiag.com

“Sometimes We Just Need Handcuffs”

Nothing is sometimes the best thing to do.

BY DAVID A. OATIS

The title of this article is a favorite quote from a wise and very experienced superintendent. When turf is in trouble and the weather is extreme, the hardest thing for a golf course superintendent to do is nothing. Surprisingly, sometimes that may be the best thing to do.

The pressures of maintaining good turf and good playability sometimes push superintendents towards implementing solutions that may be unwise. Some solutions may have no basis in science and have minimal chances of success, some may be a waste of money, and others may just be too aggressive. The “kitchen sink” syndrome, trying everything imaginable to stop the decline of turf, is easy to fall into, and it is easy to understand why. The pressure to maintain good turf and good playability, and the desire to keep a job, can be excruciating!

There are a few problems with the kitchen-sink approach: it can be expensive and it can be impossible to determine what actually is responsible for the turf improvement. Worse yet, aggressive treatments can ruin playability and push more turf over the edge, causing further turf decline and loss.

What is the right approach? In some situations, the turf is so weak and the weather is so extreme that there is little that can be done to avoid turf loss. In extreme situations, just about anything that is done to the turf adds to the stress level. The 2005 and 2006 seasons in the Northeast Region were very difficult, and stress and physical injury (from mowing, rolling, traffic, etc. under high temperatures) seemed to

kill as much turf as diseases did. Cutting too low for too long depletes the turf’s energy reserves and weakens it to a point where nearly any disease, or possibly even traffic alone, can kill it. The keys in these situations are to minimize losses and avoid compounding mistakes.

There are times when it is important to show golfers that something is being done to protect the turf, and one of most common reactions is to get out the aerator and “punch some holes in the ground.” If soils are anaerobic and the timing is right, cultivation can breathe new life into tired, declining turf. There are times when getting out the aerator can make the difference between life and death for turf, but keep in mind that cultivation causes turf injury and can disrupt putting surfaces. Aerators can kill turf if they are used improperly or at the wrong time. So, before you reach for the aerator or make the next application of fertilizer, pesticide, or growth regulator, evaluate the risk/reward benefit. Ask yourself what the outcomes of your actions might be. There are innumerable scenarios to consider, but here is a common one in the Northeast:

It is early to mid July and some putting green turf has already been lost. More turf seems to be fading, and there is a strong desire to get seed in the ground to promote recovery. Depending on where your course is geographically and what the problem and weather outlook are, punching small holes may be a good idea. However, aggressive cultivation (large hollow tines and/or deep verticutting, topdressing, dragging, etc.) may cause

more injury and push borderline turf over the edge. Moreover, seed planted in early or mid July is not likely to have a high survival rate, particularly if the green is kept in play, and these disruptive processes can destroy putting quality for the rest of the season. Worse yet, the surface and thatch layer may be so weakened by these practices that it may be impossible to repeat them in a few weeks, when the timing is optimal for turf recovery, without causing extreme surface disruption.

This may be the hardest time of all for a golf course superintendent to do nothing, but it might just be the best time. Waiting a few weeks until early or mid August or until temperatures moderate and the disruptive procedures have a better chance of stimulating recovery could be the best move.

Golf course superintendents tend to be take-charge, can-do people who are accustomed to being faced with problems that require decisive action. It is ingrained in their very nature to identify problems and take action to solve them. However, patience is a virtue and acknowledging that the turf “looks bad but plays fine” for a short period of time can sometimes be the best approach. A wise person once said, “When you find yourself in a hole, the first thing to do is stop digging.” Another way of saying this is, “Sometimes we just need handcuffs.”

DAVID OATIS joined the USGA Green Section in 1988 as an agronomist in the Mid-Atlantic Region and has been director of the Northeast Region since March 1990.

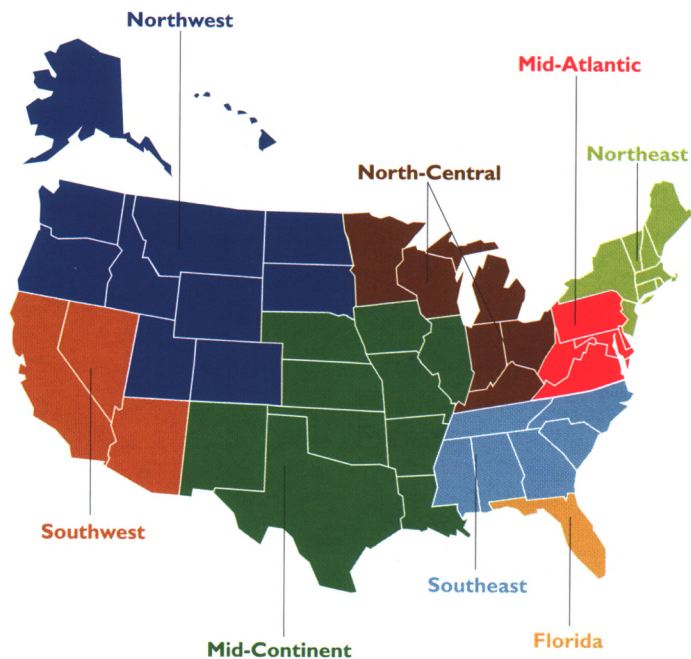


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Turf Twisters

Q: Why does the USGA Web site list only a few of the physical soil testing laboratories in the country? Isn't this biased against the labs that are not on the list? (Arizona)

A: The laboratories on the USGA Web site have achieved full accreditation with the American Association for Laboratory Accredi-

tation. Accredited labs undergo rigorous testing and inspections to ensure they provide the best information possible. They also work with the USGA to constantly try to improve laboratory testing procedures, which in turn benefits the entire industry. For these reasons, the USGA strongly recommends only accredited labs be used.



Q: Some members of my Green Committee feel that we should change hole locations on our greens on a daily basis. We have not done this in the past because we receive a low number of golf rounds during the week. Should we be changing holes every day? Any thoughts will be appreciated. (West Virginia)

A: The number of times hole locations are changed each week on a given golf course varies, the principal consideration being the level of traffic the greens receive. For daily play, the main purpose for changing the hole is to distribute traffic over the entire surface of the green to prevent wear

damage. Additionally, holes should be changed if they are damaged. After heavy play days, the holes should be changed to prevent wear to specific areas on the greens. Consider that if you change holes every day from May 1 to September 30, you will have approximately 150 *old holes* that will need to

heal. This can lead to more scalped, unsightly plugs and possible effects on putting quality. Lightly played courses generally change holes on Tuesday, Thursday, Saturday, and Sunday, while heavily played courses usually change hole locations daily, depending on the size of the greens and other variables.

Q: I have heard that many courses add a layer of new bunker sand to their bunkers each spring. Is this a good way to prepare the bunkers for play each season? (Delaware)

A: The answer is, *probably not!* Capping the bunkers with new sand is more of a Band-Aid strategy than

correcting a bigger problem. However, there may be good reasons for adding a layer of sand: 1) top off a recently completed bunker renovation, 2) new drainage was installed and the sand finally settled, 3) more sand may be needed to achieve the proper uniform sand depth. If the bunkers drain poorly, are contaminated

with silt and clay, or contain improperly sized sand, then they should be renovated rather than capped with more sand. You are only delaying the inevitable by adding a light layer of sand. The bunker should be rebuilt if the internal drainage system is compromised or if surface drainage channels water into the bunker.

