USGA GREEN SECTION

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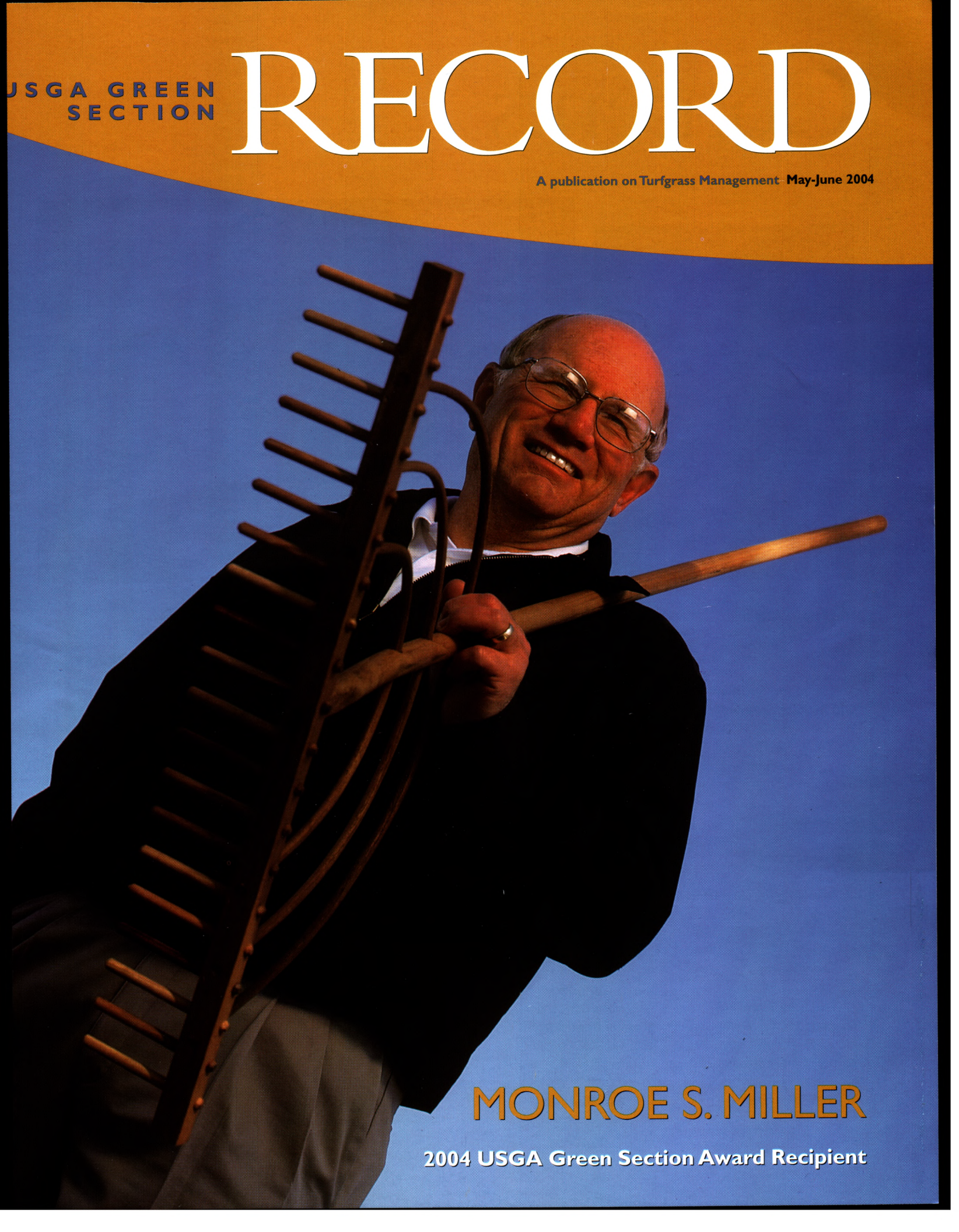

MONROE S. MILLER

2004 USGA Green Section Award Recipient

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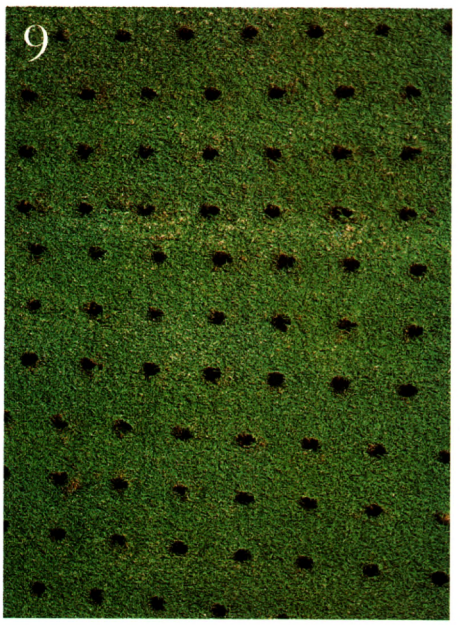

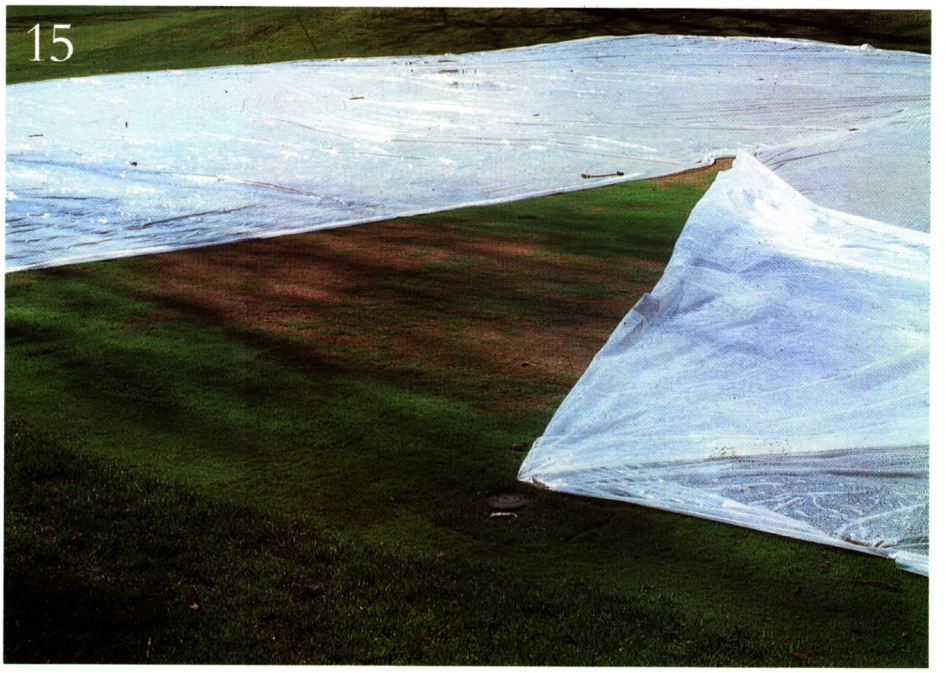

Cover Photo
The 2004 USGA Green Section Award was presented to Monroe S. Miller for his dedication to golf and the turfgrass industry.

COVER PHOTO: © USGA/JOHN MUMMERT

2004 GREEN SECTION EDUCATION CONFERENCE

Constructing New Pathways to the Future

February 13, 2004 • San Diego, California

For the 23rd consecutive year the annual Green Section Education Conference was held in conjunction with the Golf Course Superintendents Association of America Conference and Show. This year more than 1,000 people attended the Green Section's program on Friday, February 13, at the San Diego Convention Center. Bob Brame, director of the USGA Green Section's North-Central Region, served as moderator for the morning's program of 12 speakers who addressed this year's theme, "Constructing New Pathways to the Future."

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2004 USGA GREEN SECTION AWARD

MONROE S. MILLER

Monroe Miller accepts the 2004 Green Section Award from Bruce Richards, USGA Executive Committee.

Monroe S. Miller, golf course superintendent of Blackhawk Country Club in Madison, Wisconsin, was selected by a panel of experts in the turfgrass field to receive the USGA 2004 Green Section Award. This annual award is given in recognition and appreciation to persons for distinguished service to the game of golf through work with turfgrass. It was presented to Miller by Bruce Richards, a member of the USGA Executive Committee, at the Golf Course Superintendents Association of America Conference and Show in San Diego, Calif., on February 13, 2004.

"Not only is this a great honor for me, but really it is the ultimate honor any golf course superintendent could hope for," Miller said. "This honor and these memories will last forever, and I promise I will never stop working to uphold the high standards of the Green Section Award."

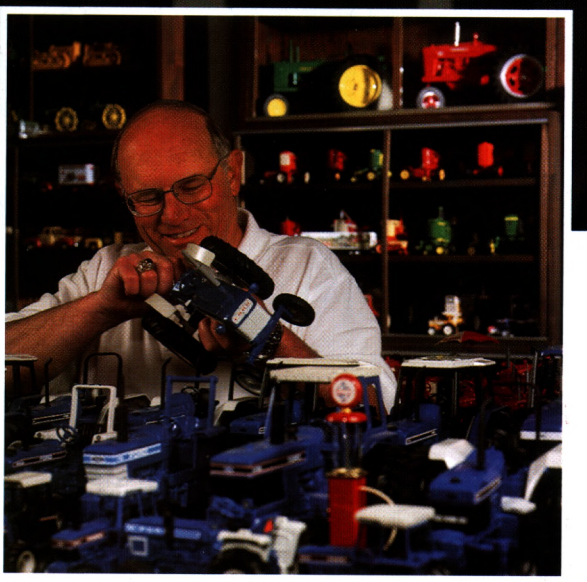
Monroe is the fourth Green Section Award winner with Wisconsin roots; he follows John Monteith, Jr. (1961), O. J. Noer (1963), and Charles Wilson (1982). Miller is best known throughout the turf industry as a prolific writer and the editor/publisher of *The Grass Roots*, the official publication of the Wisconsin Golf Course Superintendents Association (WGCSA). Superintendents and turf professionals within and outside Wisconsin subscribe to *The Grass Roots* for timely educational content and candid editorial commentary. The prestigious GCSAA award for best content in a chapter publication with an unpaid editor has gone to Miller for the past 19 years running.

Growing up on a southwest Wisconsin dairy farm, he credits that experience as giving him much that has held up through the years as a golf course superintendent: self-sufficiency, common sense, hard work, determination, and more. "There also was a chance to learn an appreciation of the seasons, respect for the land, and to become imbued with the practice of planting, cultivation, and harvest — all the things that we enjoy on a golf course," described Miller.

He worked summers at Nakoma Golf Club from 1967 to 1969 while attending the University of Wisconsin-Madison. After attaining his B.S. degree in Soil Science and serving two years in the U.S. Army, he returned to Madison. In 1972 he was a teaching assistant in the U.W. College of Agriculture and also worked at Maple Bluff Country Club. From 1973 to the present, he has been the golf course superintendent at Blackhawk Country Club. His 32-year tenure at one club speaks volumes of his unique ability to adapt to an ever-evolving industry. With kudos to Blackhawk Country Club, Miller stated, "My employer has fostered and encouraged active participation in golf course organizations and university affairs, and considers those responsibilities and activities part of any professional citizenship."

He has served on the board and as president of both the Wisconsin Golf Course Superintendents Association and the Wisconsin Turfgrass Association. In 1989 he was awarded the WGCSA's Distinguished Service Award. Since 1986, he has consistently supported and promoted the Turf Advisory Service and other USGA activities as a member of the Green Section Committee.

Monroe is known as a visionary, and perhaps one of his most important contributions to the turf industry is his least-known effort. More than a decade ago he spearheaded a campaign to raise the $250,000 required to obtain $100,000 in matching funds for a University of Wisconsin field turfgrass research facility. After overseeing the



construction of the O. J. Noer Research Facility, he immediately embarked on an even greater task: the establishment of a stable level of funding that would support graduate student research on problems confronting the turf industry. He leads the Wisconsin Turfgrass Association in their goal to raise $1 million that, when matched and invested by the Wisconsin Research Foundation, will generate enough interest to annually support four graduate research fellowships. Through his determination, the Association is already nearly halfway toward the $1 million goal.

According to Dr. Wayne Kussow, professor of soil science at the University of Wisconsin-Madison: "Of the 200+ students who have graduated from the Turf and Grounds Management Program thus far, nearly one-half of them have benefited immeasurably from having worked for Monroe. He not only imparts to them the technical skills they need, but, as he states it, the *passion* for the job. His willingness to take on students part-time during the school year as well as full-time during the summer creates the unique opportunity for students to experience what goes into shutting down a golf course for the winter and getting it ready for play the following spring. These are valuable learning experiences that the students do not gain through summer internships."

One former Blackhawk Country Club assistant superintendent who sat in the front row while Monroe accepted the Green Section Award said, "I'm up in the front row to show my support for Monroe, just as he always has sat in the front countless times to learn from and support all of his colleagues."

Others may desire and seek recognition from their peers for a job well done. This has never been Miller's style. He tirelessly works quietly behind the scenes in relative anonymity and rarely takes credit for his considerable achievements. He always privately and publicly recognizes others for their contributions to golf turf management or research regardless of how great or small the contribution might be. However, turnabout is fair play; the USGA thanks Monroe S. Miller for his unselfish dedication to golf and the turf industry with the Green Section Award.

Above: Fellow Wisconsinites joined Monroe at the Green Section Education Conference. Here is a small subsample of those former and current assistant superintendents, interns, and colleagues (left to right): Chad Grimm (Blackhawk C.C.), Mike Semler (Bruce Co.), Monroe Miller, Randy Smith (Admire Greenscapes), Bob Erdahl (North Shore C.C.), and Ric Lange (Meadowbrook C.C.).

Left: Monroe has collected model tractors since he was ten years old. He and his wife, Cheryl, have a room in their home, affectionately called The Machine Shed, dedicated to displaying his collection.

Life in the Southeast: Old Problems, New Grasses

Weather extremes in 2003 caused the recurrence of difficulties from the past, but new cultivars give hope for the future.

BY JOHN FOY, TODD LOWE, CHRIS HARTWIGER, AND PATRICK O'BRIEN

The hot topics for the past year for the Green Section's Florida and Southeast Regions included the ultradwarf bermudagrasses, their "perceived" problems, the growing popularity of seashore paspalum, and, as always, the weather. The following is based on experiences and findings during TAS visits by Patrick O'Brien and Chris Hartwiger, who cover the Southeast, and Todd Lowe and myself working in Florida.

There are always challenges for course managers, but environmental extremes in 2003 made it even more difficult and highlighted old problems. During the first half of the year, winter overseeding problems dominated discussions during TAS visits. At a number of facilities, poor or inconsistent overseeding establishment was experienced due to the early onset and persistence of cool to cold temperatures. Yet, successful results were also achieved at a lot of courses across the Southeast. As always, timing is everything.

On the positive side, at the courses where poor overseeding establishment occurred, there was also an early and relatively painless transition back to the bermuda base. Thus, it was possible to provide good quality conditions through the spring and early summer. On the other side of the coin, at the courses where good overseeding results were experienced, the "transition blues" hit hard and persisted into the summer. The merits and necessity of winter overseeding have and will continue to be debated. As a result of experiences during 2003, discontinuing or at least cutting back on this practice is being allowed at some facilities. Across the upper South, painting in lieu of overseeding putting surfaces continues to gain acceptance.

Bermudagrass off-types are common on Tifdwarf putting greens and they disrupt surface consistency. Some off-types respond negatively to aggressive verticutting and low mowing, especially during stressful periods.

After several years of below-average rainfall through portions of the Southeast, the entire region was slammed by storms during the summer of 2003. The period from June through August was the fourth to fifth wettest period recorded during the past 109 years. Along with exacerbating overseeding transition problems, frequent and at times heavy rainfall resulted in the persistence of saturated soils and low root-zone oxygen content. This, in turn, resulted in an increased incidence of disease activity, especially fairy rings. Excessive organic matter accumulation was an interrelated and old problem that was brought to the forefront during this time.

Another old problem that plagued bermudagrass putting greens across the lower South and Florida was summer decline of "off-type" bermudagrass contaminants. Intense environmental stresses of high temperatures, humidity, frequent rain, and reduced sunlight, combined with mechanical stress from low heights of cut or verticutting, often caused a rapid decline in the health and coverage of off-type areas. The adverse weather over the summer of 2003 was ideal for off-type decline problems, and quite a number of "S-O-S" calls came in to the Green Section offices.

When samples from problem areas are sent to diagnostic labs for disease assessment, a variety of pathogens usually are found, especially the fungi associated with bermudagrass decline (BGD). However, in our opinion, a lot of the disease problems are of a secondary nature, a result of the turf being predisposed by environmental and mechanical stresses. Recovery from off-type decline problems does not occur until the stresses are alleviated, regardless of the fungicide treatment regime employed. Off-type decline problems are normally associated with older Tifgreen (328) and Tifdwarf bermudagrass greens. However, at some courses with fairly new or recently renovated bermuda greens, similar problems were encountered. This leads us directly to our next topic: the ultradwarfs.

ULTRADWARF BERMUDAGRASSES

The introduction of Champion bermudagrass, and followed shortly thereafter by Floradwarf, TifEagle, and Mini Verde, marked the first time in almost 40 years that new putting green cultivars were available. These new bermudagrasses have been lumped together and are referred to as ultradwarfs. They are characterized as having a finer leaf blade, greater shoot density, and tolerance to lower heights of cut compared to Tifdwarf. These characteristics make it possible to provide a smoother, truer ball roll and, if desired, fast to very fast putting speeds. The improved putting green conditioning that can be provided with these new cultivars naturally has resulted in their use at practically all new courses and for replanting putting surfaces at existing facilities.

As you might expect, there has been a learning curve with respect to determining the best management practices for the ultradwarfs. During 2003, and no doubt partially as a result of the weather extremes, problems were experienced at some facilities with ultradwarf greens. As the word spread that several high-profile courses had experienced major problems and even total failure, "What is wrong with the ultradwarfs?" became one of the hot topics during TAS visits. Numerous examples, however, can be cited where ultradwarf putting surfaces are being successfully managed at small-, medium-, and large-budget courses. While there are variations in the basic management programs, there are also common denominators at the courses where successful results are being experienced. We believe the following are key points to maintaining healthy ultradwarf greens.

Transition from winter overseeding to the base bermudagrass can occur abruptly during periods of high heat and low humidity.

Rootzone Construction. Regardless of the turfgrass species or cultivar, an agronomically sound foundation is needed. Yet, the thought that faster is better, as it pertains to water percolation, has dominated rootzone construction for far too long and has resulted in the use of very high sand content or straight sand rootzones for maximum drainage. Besides being very droughty and requiring frequent supplemental irrigation, extremely low nutrient retention is a trade-off with high sand content rootzones. At the courses where they have bucked the trend and a properly amended rootzone mix has been used, greater consistency in turf growth and general performance has been enjoyed.

Organic Matter Management. Similar to the high-density bentgrasses, the ultradwarfs produce organic matter at a faster rate. While having a slight amount of organic matter or a "pad" in the upper rootzone is desired, it is also essential that a distinct layer of excessive thatch not be allowed to form. Management of organic matter begins during the grow-in and must be an ongoing consideration of putting green management. For a further discussion of this subject, please refer to the article "Aeration and Topdressing for the 21st Century," published in the March-April 2003 issue of the *Green Section Record*.

Grow Grass. In an attempt to prevent excessive organic matter accumulation, very low fertilization regimes have been tried at some courses. Some people thought that low nitrogen fertility and limiting shoot growth was the best approach for producing and

maintaining fast to very fast putting speeds. The ultradwarfs are bermudagrasses and therefore must be adequately fed to support sustained growth and maintain density. The fallacy of very low fertilization combined with a low nutrient retention capacity rootzone quickly became apparent. Trying to have a cookbook recipe for fertilization of the ultradwarfs is ill-advised. Along with site-specific conditions, growth rates must be constantly evaluated when making fertilization decisions.

Organic matter can accumulate to excessive levels on putting greens, resulting in problems during periods of extended rainfall. Maintaining proper thatch quantities is key to managing successful ultradwarf bermudagrass putting greens.

Realistic Expectations. The ability to tolerate a height of cut (HOC) of 0.125 inch was a primary factor in the selection process for the ultradwarfs. This HOC was considered the magic number to provide conditioning comparable to bentgrass greens. However, because the ultradwarfs also have greater shoot density compared to Tifdwarf, there is increased resistance to ball roll. With the introduction of improved mowers, and in an effort to accommodate incessant demands from some golfers for very fast greens, lower and lower HOCs are being maintained. How low and for how long has been the contest at far too many courses.

The ultradwarfs can indeed tolerate very low HOCs, but this still exerts significant stress on the turf, and when maintained for extended periods of time, a progressive decline in health occurs. Furthermore, when very low HOCs are being maintained, tolerance to various other stress factors such as heat, cold, shade, wear, and diseases is also reduced. Along with the weather and time of year, discretion and common sense must be exercised when it comes to HOC. As is always the case with bermudagrass greens, double cutting and/or rolling is needed to provide fast to very fast putting speeds. The ultradwarfs possess improved performance characteristics, but there is not and never will be a perfect grass that can tolerate environmental and mechanical extremes.

SEASHORE PASPALUM

Like cotton prior to the American Civil War, the bermudagrasses have been the king of golf course turfgrasses in the South. However, seashore paspalum has gained a foothold as an option to bermuda. It is not a new warm-season species, but the introduction of selections with improved turfgrass characteristics has resulted in a dramatic increase in its use over the past four to five years. With ever-increasing concerns about irrigation water availability and quality, there is no doubt that seashore paspalum will be utilized to a greater extent in the future.

Its ability to tolerate poor-quality irrigation water and soil conditions is the primary factor in the increased use of seashore paspalum. Also, when compared to the bermudagrasses, it requires less nitrogen fertilizer and has exhibited better tolerance to periods of low sunlight intensity. Furthermore, seashore paspalum is rated as having good drought and wear tolerance along with better cool-temperature color retention. As a mater of fact, in South Florida, it maintains a vibrant green color similar to a winter overseeding cover. A very common golfer comment is that it is a really pretty grass.

Seashore paspalum is beyond the point of being a novelty or experimental new grass. However, time is still needed to fully define best management practices for long-term success. Along with requiring intensive management to produce optimum conditioning, insect, nematode, weed, and disease control problems have been encountered.

CONCLUSION

Golf turf maintenance in the Southeast was definitely a challenge during 2003. Weather extremes, old problems, and the new grasses were hot topics of discussion during TAS visits. Perhaps in 2004, the weather and old problems will not dominate conversations as much and we can focus more on the opportunities for success offered by the ultradwarf bermudagrasses and seashore paspalum.

JOHN FOY, *director, Florida Region;* TODD LOWE, *agronomist, Florida Region;* CHRIS HARTWIGER, *agronomist, Southeast Region;* PATRICK O'BRIEN, *director, Southeast Region.*

Breeding for the Future

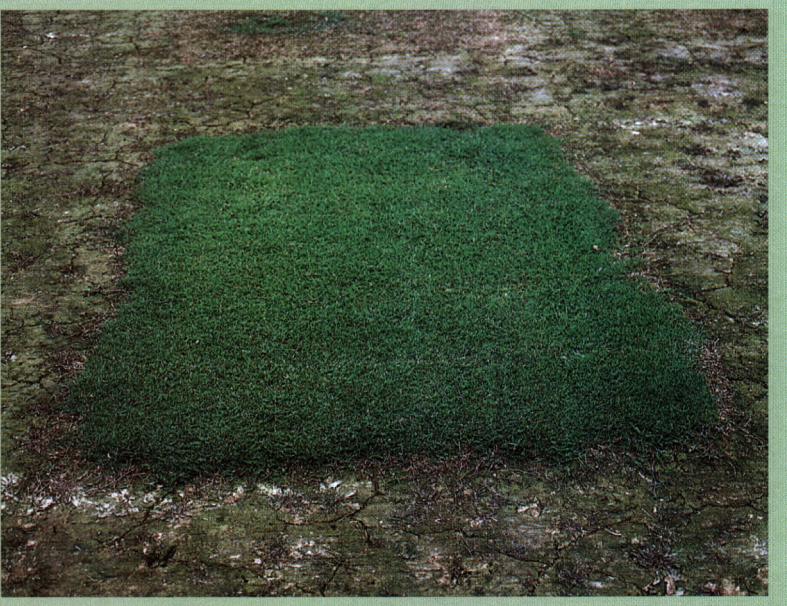
High-quality seeded bermudagrass is now a reality in the transition zone.

BY DARIN S. BEVARD

The development of new turfgrasses for use on golf courses will continue to be an important part of golf course management in the future. Turfgrass breeding efforts are a major component of the USGA's Turfgrass and Environmental Research Program. The breeding program aims to develop improved turfgrass cultivars that will better tolerate environmental stresses such as heat, extreme cold, poor soil quality, and disease and other pests. These grasses may ultimately decrease reliance on pesticides, help conserve water resources, and still provide acceptable turfgrass quality for golf course use.

The contributions of the USGA during turfgrass development often go unnoticed when improved turfgrass varieties and new turfgrass species for the golf course enter the marketplace. The development and origin of experimental turfgrass varieties are often forgotten once trade names are applied. Well-known creeping bentgrass varieties such as Penncross, Crenshaw, Cato, Pennlinks, and Providence received varying degrees of funding from the USGA during their development. In more recent years, breeding efforts of less traditional grasses such as buffalograss, seashore paspalum, saltgrass, and annual bluegrass have been supported by the USGA. Initial research on

Sodding is often the only choice to fix damaged areas when isolated winterkill of bermudagrass occurs. These areas, sodded the previous spring, illustrate the faster spring green-up of improved bermudagrass varieties compared to the surrounding common bermudagrass.



Riviera seeded bermudagrass exhibited excellent cold tolerance and quality in National Turfgrass Evaluation Program (NTEP) evaluations. This plot of Riviera continued to perform well in the Washington, D.C., area while surrounding varieties succumbed to winter damage.

Recently released seeded bermudagrasses have performed as well or better in the transition zone compared to commonly used vegetative varieties with respect to winter survival and spring green-up.

Table 1

Freeze tolerance of turf bermudagrasses. T_{mid} values represent the midpoints of survival-temperature response curves.

Cultivar	T_{mid}
	°F
Princess	19.6a†
Tifway	17.8b
Tifsport	17.8b
Riviera	17.1bc
U-3	16.0cd
Patriot	14.5de
Midlawn	13.5e

†Means of four repetitions are separated by Duncan's New Multiple Range Test at $P \leq 0.05$.

Source: Jeffrey A. Anderson, C. M. Taliaferro, and D. L. Martin. *Crop Science*, 2003, 43:973-977. Longer exposure durations increase freeze damage to turf bermudagrasses.

Roundup Ready creeping bentgrass also received significant USGA support.

One ongoing element of the breeding program is the effort to enhance bermudagrass cold tolerance. As a turfgrass species that uses less water when compared to cool-season grasses, enhancing bermudagrass cold tolerance allows it to be used further north in the United States. Breeding efforts include the genetic mapping of bermudagrass cultivars with a focus on cold tolerance. Research to quickly and accurately assess the cold tolerance of individual bermudagrass varieties in the laboratory is ongoing. A major success of these breeding efforts has been the development of high-quality seeded bermudagrass for use on golf course fairways and rough in the transition zone. The transition zone refers to the climatic area where both cool- and warm-season turfgrasses can be grown. There are times when weather extremes in the transition zone provide challenges for the management of both cool-season and warm-season grasses. Extremely cold winters or prolonged periods of ice cover can promote winterkill of warm-season grasses, while hot, humid summers provide tremendous stress for cool-season grasses.

In the past, seeded bermudagrasses have been unreliable for use in the transition zone because of a lack of winter hardiness or acceptable quality, or both. Spring green-up also is a major concern for bermudagrass varieties in the transition zone. Rapid spring green-up can eliminate the need for perennial ryegrass overseeding on many golf courses. Limited seed production of high-quality bermudagrass cultivars also has provided challenges for their development.

Why seeded bermudagrasses? Reliable seeded bermudagrasses will provide turfgrass managers with more options for bermudagrass establishment in the transition zone. In the past, sprigging, row-planting, and sodding have been the only viable choices for bermudagrass establishment. One example of special concern occurs when small areas of bermudagrass succumb to winterkill. Reestablishment of small winter-killed areas is costly because sod generally must be used. Seeded bermudagrasses will provide the option of reseeding some of these isolated areas rather than resodding.

Since 1986, researchers at Oklahoma State University have been working to develop more cold-tolerant bermudagrasses, and seeded cultivars in particular. One promising commercial variety is Riviera (OKS 95-1). Riviera was licensed for commercial production in 2001 and has been a top performer in overall quality in the NTEP bermudagrass trials established in 1997. Turfgrass quality ratings for Riviera met or exceeded the quality of all other entries. The quality and cold tolerance of Riviera is unsurpassed by any currently available seeded varieties and compares favorably to vegetative bermudagrass cultivars already used in the transition zone with respect to winter survival and spring green-up.

Dr. Charles Taliaferro from Oklahoma State University heads up efforts to improve cold hardiness of bermudagrass, and recently he was awarded the inaugural 2003 Breeders Cup from the Turfgrass Breeders Association. He was recognized for the development of Riviera and its breakthrough in cold tolerance, quality, and seed yield among bermudagrasses.

The USGA continues to support research to evaluate additional bermudagrass cultivars in hopes of providing even more improvement in seeded and vegetative varieties for cold tolerance and spring dead spot resistance. With regards to Riviera, research concerning tolerance to perennial ryegrass overseeding also is needed. While overseeding is not widespread in the transition zone, some golf courses implement this practice during the fall. To date, perennial ryegrass overseeding generally has a negative impact on the quality and survival of all bermudagrass varieties in the transition zone.

The USGA's breeding program continues to move forward in hopes of developing turfgrasses that provide acceptable playing conditions with reduced inputs of water and pesticides. As water restrictions and regulation of traditional pesticides increase, improved turfgrass varieties that perform well when these inputs are reduced will provide acceptable golf course conditions.

DARIN BEVARD *is an agronomist in the Mid-Atlantic Region, which encompasses a large portion of the transition zone. He conducts Turf Advisory Service visits in Virginia, Maryland, Delaware, and Pennsylvania.*

The Importance of Organic Matter Dynamics

How research uncovered the primary cause of secondary problems.

BY CHRIS HARTWIGER

Through the research of Dr. Bob Carrow (University of Georgia) and others, the true cause of summer bentgrass decline has been identified primarily as physiological complications, not pathological.

A great deal of time, effort, and money is spent building putting greens that feature the most advanced construction methods and superior turfgrass varieties and provide excellent playing conditions. Keeping them in top condition is a process that must begin from the day the greens are established.

A putting green rootzone undergoes dynamic changes as plants and root systems grow, mature, and die. The debris or organic matter created in this cycle is deposited in the upper portion of the rootzone. This process of organic matter accumulation, referred to as organic matter dynamics, has a major impact on the soil physical properties of the rootzone. Appropriately managing this cycle will lay the foundation for healthy turfgrass, and failure to do so can lead to many secondary problems. This article will examine research conducted to better understand organic matter dynamics and the role core aeration and sand topdressing play in managing organic matter buildup and preventing secondary problems.

HISTORY

Some readers may be wondering why there is a need to research the relationship between organic matter dynamics and core aeration. Haven't history and field observations demonstrated the benefits of keeping turfgrass areas well aerated? After all, aeration has progressed from greenkeepers with pitch forks to Tom Mascaro's first mechanical aerator in the mid-1940s to today's high-tech machines (Labbance, 2004). Was it not common in the 1960s through the 1980s to aerate the putting greens twice per year with ½" to ⅝" hollow tines and fill the holes with approximately 15 to 20 cu. ft. of sand with each application (Carrow, 2004)? The answer to both questions is a resounding "yes," but several trends in the 1990s brought forth a need to further study organic matter dynamics and its relationship with aeration and topdressing.

The 1990s produced many innovations for putting greens, including improved turfgrass varieties, more sophisticated aeration equipment, more effective fungicides, and superior mowing equipment. As superintendents continued to improve the playing quality of putting greens, pressure mounted to minimize the disruption caused by aeration. It was common for superintendents to meet this demand by reducing hollow tine size, aerating less frequently, or skipping aeration altogether. Disruption to putting surfaces may have decreased in the short term, but in the longer run, summer performance problems were common, particularly in the southern zone of bentgrass adaptation. Many of these problems were blamed on a complex of diseases referred to as "summer bentgrass decline." Experts concluded that if poor summer performance was due to disease, then the answer to solv-

ing this issue must be using the right combination of fungicides. Could it be that turfgrass managers and researchers were overlooking something?

During the early 1990s, Dr. Bob Carrow of the University of Georgia hypothesized that many of the problems on high-sand bentgrass/*Poa annua* putting greens, including summer bentgrass decline, were not caused by diseases but were due to changes in soil physical conditions in the surface zone related to organic matter dynamics (Carrow, 2004). Further, Dr. Carrow believed either too much organic matter accumulation or a rapid death of surface roots could result in reduced infiltration, a higher water content, and a decrease in both the total quantity of oxygen in this zone and movement of oxygen within this zone (Carrow, 1998). A research review conducted by Dr. Carrow failed to uncover any previous research on measuring soil oxygen levels in putting green rootzones. A research idea was born.

ORGANIC MATTER DYNAMICS

Major changes take place in the upper rootzone within the first 24 months after establishment. When seeds germinate, the new turfgrass plants begin to develop a prolific root mass that often extends to the bottom of a 12" rootzone. The beginnings of a layer with higher organic matter can be seen in the top of the soil profile. This layer helps to act as a pad or cushion and offers improvements in wear tolerance compared to the original sand rootzone. As time passes, the organic layer becomes thicker and is mixed with topdressing sand. The rate of development of organic matter is influenced by many factors, including temperature, fertility levels, pH, water quality, and many more. Root depth begins to decrease over time as the development of organic matter impedes oxygen flow into the rootzone.

The initial amount of organic matter (usually peat) in a sand-based rootzone generally is between 0 and 2% by weight, and organic matter content increases most rapidly within the first 24 months through the deposition of fresh organic matter. This initial amount of organic matter is chosen because it offers a good balance between air-filled and water-filled pores. Murphy and McCoy have reported in separate studies that as organic matter content in a sand mix begins to increase above 4 to 5% by weight, the percent of larger soil pores decreases due to plugging with organic matter (Murphy, 1993; McCoy, 1992). Water-filled porosity increases greatly at the expense of air-filled pores.

Insufficient oxygen is common when these levels are exceeded. What started out as a rootzone structure with sand particles bridging together and creating a good balance of air- and water-filled pores has evolved into a rootzone characterized by sand particles "floating" in organic matter.

DR. CARROW'S RESEARCH

Dr. Carrow hypothesized that high organic matter has the potential to cause two major problems on sand-based putting greens. First, the accumulation of organic matter greater than 4 to 5% by weight often causes oxygen content to decrease, saturated hydraulic conductivity (SHC) to decrease, and water content to increase (O'Brien and Hartwiger, 2003). When this primary problem occurs, there is a much higher likelihood that a host of secondary problems, including disease, wet wilt, black layer, soft surfaces, scalping, limited rooting, and more frequent high-temperature injury, will appear.

The second problem is a rapid change in the "nature" of the organic matter from structured OM in the form of live roots to an unstructured form in dead roots. The dead roots swell with water as they begin to decompose, and this can plug macropores (air-filled pores), causing low oxygen levels in the rootzone. Dr. Carrow believed this to be a common problem during the summer months, particularly in the Southeast, where high temperatures and excess rain may extend for long periods of time.

The balance between microbial decomposition of fresh organic matter and deposition of additional organic matter usually is adequate to prevent excessive sealing during the summer months when root systems die back. However, when unusually hot, wet conditions persist, root death can be rapid and extensive. Air-filled pores become plugged, infiltration slows, and the remaining roots become stressed from a lack of oxygen. These remaining roots cannot take up enough water for transpirational cooling because of low oxygen. Microbial demand for oxygen is high, root demand for oxygen is high, and there just is not enough oxygen available. The plants do not die from a lack of live roots. They die from direct high-temperature kill as internal mechanisms force stomatal closure. This can be seen by a yellowing of the turf and death over a 24- to 72-hour period (Carrow, TERO).

As organic matter content increases above 4% by weight, the more likely it is that a massive root dieback from hot, humid weather will occur. This scenario is perceived to be the number-one cause of summer bentgrass decline, which is now considered to be a physiological problem rather than a disease problem. Research by Huang et al and Carrow confirmed the adverse effects of high temperature and low soil oxygen, with Carrow documenting that soil oxygen levels fell below the range of 20 to 40 mg O_2 cm^2 min^{-1} (Huang, 1998; Carrow, 2004).

With the support of USGA funding, Dr. Carrow embarked on a five-year project beginning in 1996 that included, but was not limited to, the following goals:

1. Determine the effectiveness of hollow-tine core aeration and a variety of less-disruptive water-injection or solid-tine treatments on saturated hydraulic conductivity (SHC), soil oxygen levels, and organic matter levels

in the summer months during the period when bentgrass roots typically die back.

2. Determine the effectiveness of selected fall/spring cultivation on bentgrass root maintenance and viability, SHC, and soil oxygen status during spring and fall root development periods (Carrow, USGA Research Summary).

Through Dr. Carrow's research, we learned that the surface zone in a sand-based putting green, where most roots grow and the majority of fresh organic matter is deposited, controls the SHC for the rootzone. When organic matter exceeds 3.5 to 4.5% by weight, macroporosity declines substantially.

Core aeration was the only treatment that reduced the amount of organic matter in the surface zone compared to the control. All treatments, including one hollow-tine core aeration treatment in the spring followed by filling aeration holes with sand, did not keep organic matter levels below 4.5% by weight.

Most cultivation treatments (hollow tine, solid tine, and water injection) that create at least a ¼" hole can dramatically and immediately enhance SHC. Non-disruptive cultivation with holes at least ¼" in diameter will result in a period of improved SHC for approximately three weeks.

The prolific growth of roots during periods of optimum temperatures (soil 55- 65°F, air 60-75°F) can also plug macropores and reduce SHC and soil oxygen levels. Non-disruptive cultivation increases SHC and soil oxygen levels during this important period.

When hollow-tine core aeration is conducted with holes filled by topdressing, the duration of improved SHC is usually five to eight weeks for ½" to ⅝" diameter holes on high-sand greens (Carrow, 2004).

RESEARCH YOU CAN USE

Dr. Carrow's study confirmed his hypothesis that reduced oxygen levels caused by the accumulation of organic matter in the surface zone is the primary cause of many secondary problems experienced in sand-based bentgrass putting greens. Outlined below are examples of how you might be able to use this information:

When organic matter percentages exceed 4-5% by weight, saturated hydraulic conductivity and soil oxygen levels can be compromised. A poor root system and numerous secondary problems may not be far behind.

Core aeration followed by sand topdressing to fill the aeration holes is effective in increasing SHC, increasing soil oxygen levels, and reducing percent organic matter in the zone of organic matter accumulation. In the summer months when bentgrass root dieback is common, use water injection or solid-tine cultivation every 21 days to keep SHC and oxygen levels as high as possible.

Non-disruptive cultivation performed every 21 days during periods of optimum root growth will increase root growth if soil oxygen levels have been limited by plugging of macropores with live roots.

Have an accredited soil testing lab determine the concentration of organic matter in the upper portion of the rootzone. Numerous scientists have confirmed that once organic matter levels increase above 3.5% to 4.5% by weight, the number of macropores decreases below desirable levels. Putting greens with organic matter levels above 4.5% by weight are at much higher risk of severe and rapid turf decline from low soil oxygen levels in the summer months and shallow rooting throughout the entire year. Strive to keep organic matter levels below this level using core aeration and sand topdressing (Carrow, 2004).

CONCLUSION

No one has ever claimed that excellent putting surfaces happen by accident. History has shown that aeration works, and recent research has quantified its benefits on sand-based putting greens. The best putting greens over the long run will be those with the fewest limiting factors. Turfgrass research does not have much meaning unless people take advantage of the discoveries it provides. It is now up to each golf course to use common sense and communication to develop a cultivation program that works toward meeting golfer expectations, not against them. The information is available, it's free, and it works. The rest is up to you.

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Research Results in Use Today: The Bethpage Green Course Project

An unusual project produces useful information that may affect legislation.

BY DAVID A. OATIS

The USGA Research Program solicits research proposals every year or two on fairly broad-based categories. Having sat on the committee for a year and gone through a call for pre-proposals, I can say that it is extremely difficult to choose which few of the many worthy proposals will receive funding. Many are highly technical, extremely innovative and creative, and most are very deserving. Unfortunately, there is never enough money in the budget to fund them all, and some very tough decisions have to be made. The project discussed here, the Bethpage Green Course Project, has been one of the more innovative proposals. It helps answer a question that we could only answer intuitively before: Can we manage putting green turf without pesticides? This project, while quite different from many other studies funded by the USGA, has produced some very useful information.

The principal investigators in the Bethpage Green Course Project are Drs. Jennifer Grant, director of the NYS Community IPM program, and Frank Rossi, associate professor of turfgrass science at Cornell University, and they received tremendous assistance and support from the Bethpage State Park staff. The study was developed as a response to anti-pesticide legislation that has sprung up on Long Island, N.Y., in the last few years. The basic objectives were to:

- Evaluate the performance of putting greens managed with few or no chemicals.
- Determine the environmental and economic impact of greens managed with few or no chemicals.
- Evaluate alternative pest management options.

The study included six separate treatments, each of which was replicated three times.

TREATMENTS

Standard Culture (ball roll > 9 feet)

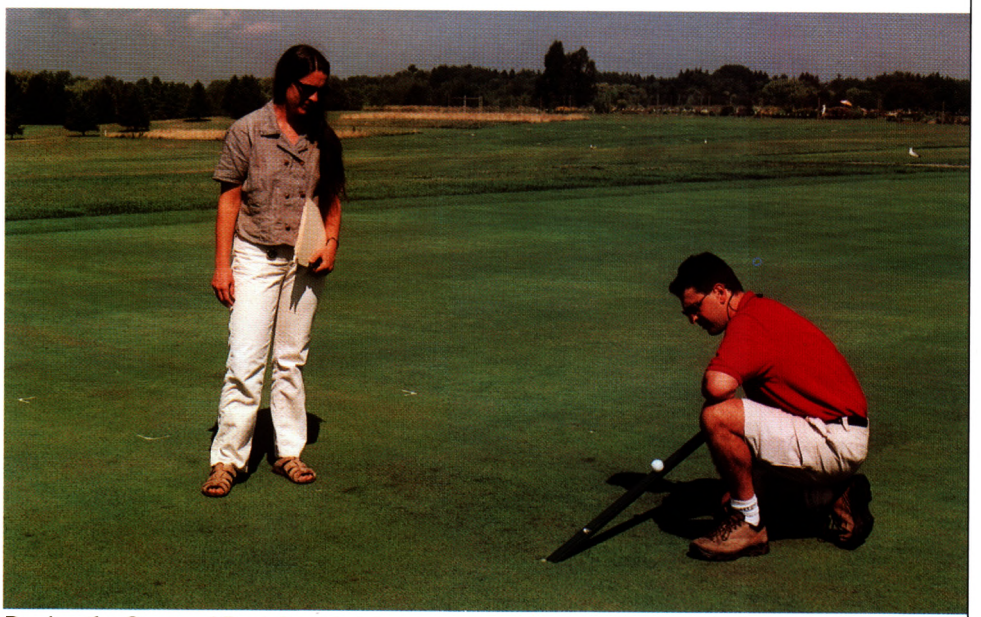
- Unrestricted Chemical Usage (Greens 1, 6, 17)
- Integrated Pest Management (Greens 3, 5, 12)
- No Chemical Usage (Greens 2, 4, 16)

Alternative Culture (ball roll > 8 feet)

- Unrestricted Chemical Usage (Greens 8, 9, 13)
- Integrated Pest Management (Greens 11, 14, 18)
- No Chemical Usage (Greens 7, 10, 15)

Cultural maintenance practices differed under standard and alternative culture treatments in order to achieve the target green speeds. The charts outlining the cultural maintenance activities for each treatment are listed in Figures 1 and 2.

Most turfgrass managers would feel very comfortable with the prediction that putting green turf managed without any pesticides would perform very poorly when subjected to heavy play, stressful weather, and normal maintenance stresses. Not surprisingly, that was one of this study's take-away messages, and these findings can be very useful for turf managers trying to justify the use of pesticides. It also should be noted that the study was performed in the Northeast, specifically on Long Island,



Drs. Jennifer Grant and Frank Rossi led the research activities conducted on the Bethpage Green Course Project. The research was designed in part to investigate if putting greens could be managed without pesticides on Long Island, N.Y.

Figure 1
Standard Treatment — Ball Roll > 9 Feet

Mowing Heights	0.110" to 0.140"
Irrigation	Automatic 3:00-4:00 AM (to prevent wilt)
Fertility	Spoonfeed (synthetic) 2.50 lbs. N 0.75 lbs. P 2.50 lbs. K
Topdressing	Light applications every 3 weeks
Rolling	As needed to maintain speed
Verticut	As needed
Cleanup Pass	Mowed 4x per week

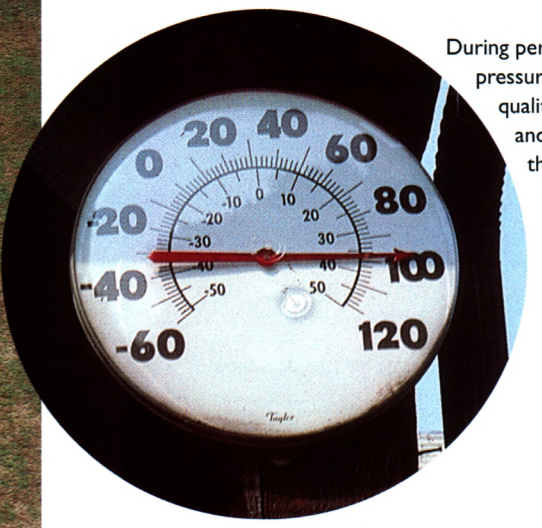
and the results might be different if performed in other geographic areas and under different conditions.

Drs. Rossi and Grant tried many non-traditional techniques and products to improve turf quality without the use of pesticides, including various biological products. They were able to maintain *acceptable* turf quality until mid-August in all three years (2001, 2002, and 2003) of the study. Unfortunately, turf quality declined drastically at that point during each of the three years. *Acceptable* quality was defined as achieving a "6" rating on a scale of 1-9, with 9 being good, and the targeted putting green speeds often were not met. While the study clearly showed that successful turfgrass management, producing even reasonable playability, was not possible without pesticides, many other useful take-away messages can be derived from the study. The following are a few:

- The transition from pesticide usage to non-pesticide usage must be gradual and completed over a period of several years. This is not surprising, given that the greens in the study were nearly 80 years old and had gone through a lengthy period of natural selection to arrive at their current composition. Pesticide usage is a major factor in natural selection, as are many other factors such as irrigation management, fertility, cultivation, etc. The specific microclimate occupied by the turf also can play a significant role.
- The work suggests that mature courses that choose to go the non-pesticide route may have to regrass large turf areas in order to take advantage of the most recently developed turfgrasses and their improved wear tolerance and disease resistance characteristics. While many courses in the Northeast successfully manage old stands of annual bluegrass and creeping bentgrass with the use of pesticides, these same blends will not perform well without pesticide usage. As an example, Colonial bentgrass (*Agrostis tenuis*) has inherently better dollar spot resistance than creeping bentgrass (*Agrostis palustris*). There do not appear to be any Colonial bentgrass varieties that are well adapted for use on putting green turf in the United States, but there are varieties that will work well on fairways in climates where dollar spot (and not brown patch) is the primary pathogen.
- Reduced golfer expectations are an absolute necessity if courses are to reduce or go to no pesticide usage. Current industry standards cannot be maintained without the use of pesticides.
- IPM (integrated pest management) in this and other studies has been shown to be a very effective means of reducing pesticide usage. In fact, pesticide usage in the integrated pest management treatments was reduced 35 and 50 percent, respectively, compared to the unrestricted pesticide use treatments during the first two years of the study. There was no reduction in the third year of this study (2003), probably because disease pressure was extremely high for much of the season. Still, the IPM treatments enjoyed a 28.3% average reduction when compared to the unrestricted pesticide use screens during the three years of the study, and this with no reduction in quality.
- More staff is required to go with a low or no pesticide usage approach. Additional staff are needed to perform the necessary scouting (at least 10-12 hours per week) to monitor pest populations. Extra labor also is needed to spot-treat the various different areas of the course and to experiment with the many biological products.
- Even with additional time and money to perform scouting and spot-

Figure 2
Alternative Treatment — Ball Roll > 8 Feet

Mowing Heights	0.170" to 0.185" (double cut 5 days per week)
Irrigation	After mow (pre-wilt by hand)
Fertility	Spoonfeed (synthetic and organic) 4.20 lbs. N 3.50 lbs. P 4.50 lbs. K
Topdressing	Light applications of sand weekly (no dragging)
Rolling	3x per week
Verticut and Spike	Every 2 weeks (except stress periods)
Hydroject	Every 3 weeks (raised position)
Cleanup Pass	Mowed 2x per week



During periods of high disease pressure, you can expect turf quality to drop off rapidly and significantly without the use of pesticides.

Some of the composts used in the research project seemed to provide some control of dollarspot, but they promoted fairy ring.

Turfgrass quality was maintained in the acceptable range through much of the season, but it declined dramatically in the no-pesticide treatments in mid-August during the three years of the research project.

treating and experimentation with alternative pest management systems, the researchers could not compensate for the lack of pesticides. Thus, based on the three years of this study, it appears that some level of pest control products will have to be used to maintain even reasonable turf quality, particularly during periods of peak stress and disease pressure.

- Course owners, golfers, and members must be willing to accept risk if the decision is made not to use pesticides. The risk could entail a significant drop in playability standards or perhaps even widespread turf loss. A very real risk also is that golfers may choose to go elsewhere to play the game.

So, the question remains: Can we manage putting green turf without pesticides? The answer is a shaky "yes," but only with a major drop in expectations and an equally significant increase in risk. This study suggests that pesticides are necessary to maintain current industry playability standards.

In addition to the integrated pest management approach being shown to be effective, there are several other very positive outcomes from the study. Numerous legislators visited the study site, examined the plots, and discussed the significance of the results and observations with the researchers during the course of the study. The study appears to be shaping legislation, as two counties have already adjusted their proposed legislation because of the results of the study, and three more counties currently are considering doing so.

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Survival 101: Dealing With Ever-Increasing Expectations

Tips from the Northeast on juggling demands for optimal playing conditions with diminishing resources and extreme weather.

BY KEITH HAPP, JIM SKORULSKI, JIM BAIRD, DARIN BEVARD, BOB BRAME, DAVID OATIS, AND STANLEY ZONTEK

The 2003 season provided its fair share of challenges for golf courses in the Northeast, Mid-Atlantic, and North-Central regions. Maintenance plans were altered by harsh winter weather and record-setting spring and summer rainfall that caused considerable turf stress and made it more vulnerable to disease, pests, and both mechanical and traffic injury. At times it seemed like turf managers were expected to walk on water (standing on their golf courses!). In short, it was not the year to abandon common sense and basic agronomic programs.

Tightening budgets, busy golf calendars, and continuing pressure to reduce or eliminate pesticide usage added to the weather challenges. Despite all of this, golfer demands for ideal playing conditions were unwavering. The following tips were gathered from superintendents who successfully weathered the environmental and political storms in 2003.

GROWING ENVIRONMENT

Providing a good growing environment is the best insurance against turf loss due to extreme weather. Annual bluegrass (*Poa annua*) competes best in shaded, wet, and highly trafficked environments. Unfortunately, it is usually the first species to die in response to extreme weather and disease. A positive trend in our regions is that golf courses are now removing trees and other vegetation that impede air movement and compete with turf for available sunlight, moisture, and nutrients. Also, it is important to remove obstructions (e.g., vegetation, fences, bunkers, etc.) that concentrate traffic and increase turf wear.

Courses having ample surface and subsurface drainage were best suited to maintain healthy turf and provide acceptable playing conditions. Installation of subsurface drainage continued to grow and has become popular and effective in older greens constructed with heavier, native soils. In addition, installation of sand-filled slit trenches in greens, tees, or fairways proved valuable in removing moisture from important play areas.

WINTER INJURY AND RECOVERY

One of the many challenges facing superintendents in the North is deciding whether or not to remove accumulations of snow and ice on putting greens. While there is no easy answer, don't forget about the insulating effects provided by snow cover during the winter months. Removing snow and/or ice too early is laborious and can physically damage the turf and/or predispose it to direct cold temperature injury or desiccation. Several superintendents have begun monitoring turf canopy and air temperatures to learn more about winter freeze injury and help in determining when snow, ice layers, and covers should be removed. Battery-operated data loggers and probes are used to record temperatures on an hourly schedule throughout the winter. The condition of the turf also is being monitored more closely through the winter in hopes of determining if winter damage has occurred and if anaerobic conditions exist in the soil profile. Plugs are extracted from select greens periodically or following a severe weather event by using a reciprocating saw or hole-bit. At the very least, this helps determine how and when the damage occurs and provides information to expedite the recovery process.

Early detection, strong and clear communication, sound cultural practices, and golfer cooperation were keys to successful recovery from winter injury. The most effective procedures included: closing the damaged areas to play, implementing recovery efforts as early as the ground is workable, creating a good seedbed by using a slicer seeder or shallow aeration, repeat spiking and spot seeding, light and frequent fertilization, hand-watering, and using covers or dark sand topdressing to elevate soil temperatures and prevent seedling desiccation. Finally, exercising a conservative approach to opening the greens for play and avoiding excessive green speeds were helpful in promoting recovery.

CULTIVATION

Because rainfall persisted throughout most of the spring and summer, many superintendents had to abandon their regularly scheduled aeration programs and make the most of dry days that seemed few and far between. The

Golf course superintendents are occasionally asked to "walk on water" to meet golfer expectations of golf course playing conditions.

immediate goal was to keep the turf alive. A top concern was to vent the soil without adversely disrupting surface quality. Equipping tractors with flotation tires helped to minimize the potential for surface disruption. Many types of aeration devices were used on greens, approaches, tees, roughs, and fairways. Small-diameter solid tines and deep slicing techniques were used regularly and, in fact, were essential to the survival of the turf. Surface disruption was minimal, but the benefits of the procedures were significant.

MOWING

During 2003, it was never more crucial to have mowers that were sharp and properly adjusted. While bench setting is important, field performance was paramount! Emphasis was placed on tending to the variables that were controllable. For example, castor wheels were installed on mowing equipment to minimize scalping potential. Solid front rollers were installed on reel mowers to minimize turf wear. Groomers were raised to prevent damage to the turf canopy. To accommodate mowing adjustments, brushing was used rather than grooming or vertical mowing. The frequency of lightweight rolling was reduced, especially on soil-based greens. Emphasis was placed on ball roll, not pace. Overall, even the simplest of adjustments made a big difference when it came to controlling damage.

FERTILIZATION

Rainfall abundance affected nutrient availability, and many superintendents found themselves applying more fertilizer than normal and during times of the season when fertilization typically is not performed. In light of this, emphasis was placed on spoon feeding of nitrogen to avoid experiencing a flush of top growth. This was accomplished by using readily available, predictable nutrient sources.

GOLFER EXPECTATIONS VS. ENVIRONMENTAL REGULATIONS

Water use on golf courses is being scrutinized more closely throughout our regions. In addition, there is an undercurrent to reduce or completely eliminate pesticides on golf courses in parts of New York and eastern Canada. Superintendents in New York have increased their political involvement by working together with the New York State Turfgrass Association (NYSTA) to organize a Turfgrass Advocacy Day that will provide a forum to voice their concerns and foster relationships with members of the state legislature. NYSTA has also joined with other green industry associations to fund a professional lobbyist who organizes the group's legislative and regulatory agenda and helps promote green industry positions.

Meeting course conditioning expectations is becoming increasingly difficult, and new legislation will emphasize the need to use holistic turfgrass management practices with less emphasis on color and aesthetics. Convincing passionate golfers of this need is no easy task, but it may be the only solution to avoid the onslaught of new regulations. Working with the Audubon Cooperative Sanctuary Program for Golf Courses is an excellent means of increasing environmental awareness both inside and outside of the golf industry. Take time to revisit that program if you have not yet done so, and become more politically astute.

SUMMARY

The 2003 season was just another reminder that the art and science of golf turf management is more fluid than static. What worked best yesterday, last year, or on another golf course may not work today. Failure to plan for and adapt to unexpected and extreme weather conditions will compromise quality and sustainability. Furthermore, failure to recognize the importance of the changing political forces that are at work behind the scenes will have serious and long-term implications for us all.

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COMPLETE RECONSTRUCTION OR PARTIAL RENOVATION

How should you invest your money?

BY PAUL VERMEULEN AND CHARLES "BUD" WHITE

Once hidden in the shadowy recesses of densely planted trees, dozens of classic golf courses built during the early 1900s have undergone extensive restoration to regain their prominence with the American golfer. Notably, the North Course at Olympia Fields Country Club underwent a complete facelift and thus was able to successfully challenge the greatest players in the world during the 2003 United States Open.

In many cases, the restoration of an architectural masterpiece designed by the likes of Willie Park, Jr., requires rebuilding one or more of the greens, or, at a minimum, updating the putting surfaces with a new turf variety. This work acknowledges the fact that maintaining fast, firm putting surfaces expected by today's golfers requires large, well-drained greens established with turf capable of being continually mowed at an eighth of an inch.

To determine if the scope of a restoration project should include the complete reconstruction of all 18 greens or simply some sort of partial renovation requires in-depth design, rootzone, and site analyses. Without giving equal consideration to all three, it would be impossible for the ownership of an older course to make a sound investment in their future.

DESIGN ANALYSIS

As a starting point, the fundamental design of each individual green must be examined with a critical eye. And, as judging putting green design so often includes an overall evaluation of artistic merit, it is always best to solicit the assistance of a knowledgeable golf course architect.

Key elements of design that should be taken into account in the analysis of putting greens are traffic distribution, playability, and surface drainage. Combined, these elements can have a profound effect on both the enjoyment of a round of golf and a superintendent's ability to maintain high-quality turf conditions throughout an entire growing season.

To help determine the cause of a problem green, the rootzone and drainage should be thoroughly examined. Digging one or more inspection holes or removing deep soil cores with a soil probe allows you to look for signs of trouble in the soil profile.

To gain an appreciation for traffic distribution, or, more accurately, how well the wear and tear of normal golfing activities can be dispersed across the surface of a green, it is necessary to count the number of hole locations. Generally speaking, a hole location is a circular area of approximately 250 to 300 square feet with a slope of less than 3%. Courses with a high volume of play should have eight to ten hole locations per green, whereas those with a low volume of play need only six to eight. It is time to start thinking about complete reconstruction when the number of hole locations drops below five.

Judging a green's playability can be very complicated because it requires an interpretation of what is fair or equitable. Nonetheless, as anyone who plays golf knows, when a well-struck putt will not come to rest within a few feet of the hole because of severe contours in the putting surface, the game becomes a great source of frustration rather than fun. This point was certainly well illustrated during the 1998 United States Open at The Olympic Club when Payne Stewart's putt barely missed the hole on the 18th

Water standing in a hole for several hours after a heavy rainfall is a clear indication that a green is an excellent candidate for reconstruction or, at a minimum, new drainpipe installation. In this particular case, it also is noteworthy that the voids created by deep-tine aeration with large solid tines failed to improve subsurface drainage.

green and then rolled back in his direction an additional 20 feet. The fact that many older greens need to be redesigned with less severe contouring can be traced back to several technological advancements that have increased the average Stimpmeter reading during the last 25 years.

Surface drainage, it is said, can never be good enough. In an ideal sense, every green on the course should be designed to shed surface water in at least three directions during heavy rainfall. Due to the overall lay of the land at most sites, however, designing a course to meet this lofty goal is often impossible. The point at which surface drainage typically becomes a serious issue is when 1) the entire putting surface drains toward the front, 2) the putting surface has water-holding hollows, or 3) a large watershed in an adjacent rough area drains directly onto the putting surface.

ROOTZONE ANALYSIS

Analyzing the rootzone for problems should include testing the physical characteristics of the soil and reviewing exactly how a green was built. Testing the physical characteristics of the soil essentially requires submitting an intact core sample for laboratory analysis. Obtaining an intact core sample from a green is as easy as driving a short section of 2" plastic pipe all the way into the surface and then carefully removing it in a manner that prevents soil from falling out the open end. After the sample has been taken, it can be sent to one of several accredited physical soil testing laboratories located throughout the country.

Laboratory testing will determine a number of physical parameters, such as soil type, sand particle size distribution, organic matter content, and porosity. Caution should be exercised, however, when interpreting the test results from soil-based greens. Case in point, if the results from a soil-based green are judged using the specifications for a modern, sand-based green, one can falsely conclude that complete reconstruction is an absolute necessity due to low infiltration and porosity measurements. At most, test results should be used to support other evidence of a green's candidacy for complete reconstruction and not serve as the sole indicator of severe problems.

A visual examination of the rootzone should be performed by digging one or more inspection holes in the surface of a green or by removing several deep soil cores with a standard probe. Common signs of trouble would include such items as layering in the soil profile, inconsistent blending of soil amendments, uneven soil depth, black layer development, compaction, and poor root development.

A thorough visual examination should also include an inspection of the drainage system underneath the rootzone. For greens that were built with a gravel layer, the drainage system can be checked by running water through a ¾" hose into an inspection hole on the high side of a green. If water starts flowing out of the outlet pipe at the low side of the green after 20 to 30 minutes, it suggests that the drainage system is working properly. To be absolutely certain that all of the pipe underneath a green is still functioning, a fiber optic video camera can be used to check the drainage system.

SITE ANALYSIS

In the real estate business, the fundamental law of property value is location, location, location. In the golf course business, location is of equal importance to the laws of successful putting green management. In short, premium sites for putting green management all have two things in common — excellent sunlight exposure and unobstructed air circulation.

Sunlight exposure is pivotal to the management of low-cut turf because it is literally the driving force of photosynthesis. This biological process is responsible for converting carbon dioxide and water into life-sustaining complex carbohydrates. The take-home message regarding sunlight exposure is simply that, if an older green has sparse turf

While some critics of classical golf course restoration might disagree, updating older greens with modern restoration techniques is a great way to invest in the future of the game.

cover because it is in a shady location, there is no reason to consider either complete reconstruction or partial renovation because the result will simply be a disappointing reflection of the green's current condition.

The best approach for making an accurate evaluation of sunlight exposure on a problem green is to have the surrounding trees or other obstacles measured by a landscape surveyor. This information can then be entered into computer software and used to project the total hours of full sunlight exposure on any given day of the year.

The role of air circulation in turf management is admittedly more important in warmer regions of the country. This is because a current of air flowing across the surface of a green has a cooling effect. In warmer regions, this cooling effect can reduce the turf's canopy temperature on hot afternoons by as much as 15°F. If a problem green is situated in a stagnant location, restoring it without improving air circulation should not be attempted.

Based on the findings of design, rootzone, and site analyses, making the right financial decision regarding whether to completely reconstruct all 18 greens or opt for some degree of partial renovation should be much more straightforward. While some critics of classical golf course restoration might disagree, updating older greens with modern restoration techniques is a great way to invest in the future of the game.

PAUL VERMEULEN *and* BUD WHITE *are responsible for making Turf Advisory Service visits in the Mid-Continent Region. During the past few years, they have worked with multiple superintendents who have undertaken complete restorations.*

If the root cause of poor subsurface drainage in older greens is the malfunction or complete absence of drain tile, then the installation of new drainpipe by an experienced contractor can set the stage for making future improvements.

Promoting Reliable Turf

Using the best available turfgrasses can enhance golf course competitiveness.

BY MATT NELSON, LARRY GILHULY, BOB VAVREK, AND PAUL VERMEULEN

Many factors influence competition for players among golf courses in a local market, including location, design, price, customer service, marketing, and surface conditioning. Consistent turf quality throughout the season depends greatly on the species and cultivars of turfgrass established at the golf course. Climate and player expectations define the range of suitability of various turfgrasses. Environmental extremes, pest pressure, traffic, water and soil quality, mowing heights, and other maintenance inputs further define the parameters of turfgrass adaptation.

Providing golfers consistent playing surfaces and remaining competitive in the local market often requires renovation. Weedy grasses commonly invade older stands of turf, and what was accepted in the past is no longer acceptable. Turfgrass breeders have developed improved cultivars of all the major turfgrass species and have even developed commercially available cultivars of turfgrasses, such as paspalum, that were previously considered non-turf species for golf courses. Green Section agronomists have observed improved playing conditions, reduced pesticide use, and better maintenance efficiency across the varied climates of the Mid-Continent, North-Central, Northwest, and Pacific regions of the U.S. and western Canada, where the best-adapted turfgrass species and/or cultivars are established. This article will outline a few examples where cutting-edge turfgrass breeding has provided better playing quality and reliability.

SINGING THE BLUES

The development of Kentucky bluegrass cultivars capable of tolerating modern fairway mowing heights (½" to ⅝") has renewed interest in this species for golf course fairway use across cooler climates of North America. Kentucky bluegrass exhibits excellent color, spreads vegetatively, is relatively disease resistant, and is tolerant of environmental extremes. Kentucky bluegrass is more winter hardy than annual bluegrass and perennial ryegrass, and it is a much more reliable fairway surface in the western U.S. and Canada.

Vigorous rhizome growth is one trait of seashore paspalum that allows it to compete effectively against bermudagrass and weeds. In addition to exceptional salt tolerance, this grass tolerates a range of mowing heights and can withstand concentrated traffic, all with low fertility requirements.

At older golf courses, most of the Kentucky bluegrass established originally in fairways has been displaced by annual bluegrass (*Poa annua*) as heights of cut have been lowered. *Poa annua* is prone to various forms of winterkill, and recovery is usually slow at northern and high-elevation sites. Maintenance costs are increased to promote recovery and revenue generation is compromised by poor playing conditions.

Interseeding the new Kentucky bluegrass cultivars into an existing stand of turf has not proven to be a viable method of turfgrass stand conversion (4, 6). It has been speculated that the long germination period and weak competitive ability of Kentucky bluegrass seedlings are the causes for poor establishment results through interseeding. Although it may be possible to use a non-selective herbicide to eliminate existing turf and establish new Kentucky bluegrass from seed, perhaps a more viable option is to consider sod.

Many golf courses throughout Alberta, Canada, have used the sodding approach successfully. Commonly, two or three fairways are renovated each fall, and this includes correcting drainage or irrigation deficiencies, amending soil, and laying new sod. The golf courses expect a life span of 10-15 years of the new Kentucky bluegrass sod before annual bluegrass populations exceed a threshold level where the amount of winterkill is too great. Sounds disruptive and expensive? At first glance it may seem so, but when the lost revenue between April and July, when annual bluegrass fairways are recovering from extensive winterkill, is factored in, the numbers make a lot more sense. Improved Kentucky bluegrass cultivars enable these courses to enjoy consistently good fairway playing conditions throughout the season.

DO YOU FEEL THE NEED FOR SPEED?

No? Liar. Green speed is a primary factor of competition among golf courses. Better mowers, better products, better management, and often unrealistic player demands have driven the pursuit of faster green speeds. Championship conditions of 20 years ago are now commonplace at many golf courses

An older stand of putting green turf dominated by annual bluegrass will be susceptible to physiological collapse when excessively close mowing and intensive grooming practices for green speed are coupled with stressful heat and humidity. Newer creeping bentgrass cultivars have been developed with improved heat stress, density, and tolerance of close mowing — all of which improve reliability.

across North America. Whether you agree with this trend or not, there is little doubt that new cultivars of creeping bentgrass and bermudagrass improve the odds of success when ultra-fast greens are desired. This is especially true in humid climates where disease pressure and physiological demands are high.

Resurfacing putting greens with an improved turfgrass cultivar involves conviction and identification of every possible factor contributing to turf performance on greens (5, 10). Whether fumigating and establishing new turf with seed, sprigs, or sod, the golf course will experience disruption, the project will be contentious among players, and the cost of construction and lost revenue needs to be carefully estimated. But the benefits will definitely outweigh the negatives. Improved turfgrasses will allow for faster greens and more reliable turf with less pesticide and water. If you want to keep up with the Joneses, make sure you are comparing apples to apples and give your golf course the tools necessary to achieve your goals.

FAIRWAY TO HEAVEN

The gray leaf spot epidemic of 1998 left many golf courses with perennial ryegrass fairways in a wake of carnage throughout the Mid-Atlantic, Northeast, and Midwest. Fungicide programs have been developed to manage this disease (7, 8), but the annual cost is expensive and perhaps prohibitive. Conversion to another turfgrass species, most commonly bentgrass, is a renovation option that will result in more reliable turf throughout the year at sites where gray leaf spot disease may occur (1, 9). The cost of renovation can be recovered over time with reduced pesticide use. Less pesticide loading of the environment is another consideration. While cost of renovation and disruption are real issues in the short term, long-term improvements to turf reliability, maintenance efficiency, and golf course competitiveness should not be ignored.

MAHALO DR. DUNCAN

In the era of modern turfgrass breeding, there arguably is no single greater environmental achievement than the development of commercially available cultivars of seashore paspalum. Although adaptation and use of this turfgrass species is limited to small areas within the United States, numerous golf courses in Hawaii, Florida, and elsewhere in the southern U.S. have utilized this turfgrass successfully. Seashore paspalum is extremely salt tolerant, maintains exceptional vigor at low mowing heights, is very wear tolerant, and can be used in a variety of capacities at golf courses, including greens, tees, fairways, and roughs (2). Seashore paspalum is well suited to warm-season sites with poor water quality (3). Weed, disease, and insect pressure on this turf is minimal, and many weeds can be controlled with applications of table salt! Annual fertility requirements are lower as compared to bermudagrass.

As player misconceptions are straightened out and management protocols are improved, many golf courses in warm-season climates are realizing that this grass is no longer the turfgrass of

Seashore paspalum is well adapted to conditions in Hawaii, often out-competing hybrid or common bermudagrass in greens, tees, fairways, and roughs.

the future, but the turfgrass of today. Reduced maintenance inputs with improved playability and turfgrass reliability are the often-stated goals of turfgrass breeding funded by the USGA's Turfgrass and Environmental Research Program.

IS THERE VALUE IN RENOVATION?

Science and technology have contributed greatly to the modern game of golf. Equipment development has enabled players to hit the golf ball farther than ever, and golf clubs are more forgiving of slightly miss-hit golf shots. Better irrigation technology, mowers, products, construction techniques, and other advances have enabled golf course superintendents to maintain the type of conditions and uniformity that not too many years ago would have been impossible. With little doubt, turfgrass breeding programs have contributed significantly to current golf course conditioning. In fact, attempting to provide the type of playing conditions desired at many golf courses with an inferior turfgrass is the biggest limiting factor in certain climates. Just as older homes or buildings require a new roof or structural improvements periodically, or a classic automobile requires an engine rebuild to keep it running, older golf courses should consider establishing new, improved turfgrasses to maintain desired quality.

The examples illustrated in this article represent but a few management decisions made at golf courses across the Mid-Continent, North-Central, and Northwest regions of the USGA Green Section. When the conditions at your golf course fail to meet expectations, a review of turfgrass species and/or cultivars present on the golf course is one of the first assessments that should be made. In many instances, renovation to take advantage of improved turfgrasses will provide better playing quality and consistency, streamline maintenance efficiency, safeguard environmental quality, and positively affect the bottom line at the course. Choosing the best grass for a specific application is among the first steps of promoting reliable turf.

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Wisdom from the West Coast

Golf course maintenance trends in the Southwest.

BY PAT GROSS, DAVID WIENECKE, AND BUD WHITE

The year 2003 was a year of challenges and innovation for golf courses in the Southwest. The main topics of discussion during Turf Advisory Service visits centered on the impact of the economy on golf revenues and maintenance activities, as well as the long-term outlook for water availability. Other interesting developments and trends in the Southwest included high-speed golf carts that started appearing on golf courses, putting green aeration methods, and new technology for overseeding. This article will provide some insight into these topics and other significant issues in the Southwest.

Because of the drought and ongoing economic concerns, many golf courses in the Southwest are auditing the performance of their irrigation systems. This important practice helps conserve water, reduce irrigation costs, and improve turf quality.

ECONOMIC ISSUES

In general, the downturn in the economy forced most golf operations to take a critical look at their budgets and make some very difficult decisions regarding capital improvement projects, purchasing, labor, and operations. Many courses reported that play was down by 15% to 20% for most of 2003. This significantly impacted revenues, especially at resort and high-end daily-fee courses. Golf courses in California were also hit with increasing costs for workers' compensation insurance, as much as 300% at some facilities, despite the fact that there were no claims! The cost of keeping the doors open increased as play and revenues decreased, which created a significant challenge for general managers and superintendents. How do you fulfill the high expectations for quality when the revenues and budget dollars are not available? Obviously, it took some creativity and good management skills to get through this difficult time. Here are a few of the successful ideas that courses employed during tough economic times:

- Labor and water are consistently the two biggest budget items for Southwestern golf courses. Many courses were forced to lay off employees and make necessary adjustments to the maintenance schedule. Some superintendents made a conscious decision to reduce irrigation by 10% to save irrigation costs, with the emphasis placed on reducing irrigation in out-of-play areas.
- Maintenance procedures were focused on primary playing areas (i.e., greens, fairways, tees), with less emphasis on roughs, bunkers, and out-of-play areas.
- Many courses performed audits of their irrigation systems to insure that water was not wasted and that systems were running efficiently. This involved activities such as catch-can tests to evaluate distribution, checking wear and tear on nozzles, and identifying the cause of chronic wet spots and dry areas.
- Superintendents worked on cross training employees to expand productivity.
- Emphasis was placed on keeping equipment in top condition. Mechanics and employees received extra training on preventive maintenance techniques so that breakdowns and costly repairs could be kept to a minimum.
- Some courses improved labor efficiency by changing mowing patterns on tees and fairways. One course was able to reduce mowing time by 25% and saved 40% on bearing replacement by changing mowing patterns on tees.
- Emphasis was placed on high visual impact areas such as the course entry and first tee. In many cases, improvements could be made for a very low cost, yet golfers readily noticed and appreciated the changes.

WATER ISSUES

The Southwest has experienced increasing drought conditions over the

past four years. Water restrictions were imposed in Arizona and Nevada, and some golf courses had to make difficult decisions to eliminate turf or take sections of the course out of play to conserve water resources. Conflicts over the allotment of Colorado River water required the intervention of the United States Secretary of the Interior, which ultimately forced a deal between farmers in the Imperial Valley of California to relinquish water to the San Diego Water District. The area hardest hit at the moment is Las Vegas, where a state of drought emergency is imposed that has required golf courses to reduce water use by nearly 20% due to record low levels in nearby Lake Mead. It is interesting to note that the cost of irrigating an 18-hole golf course in Las Vegas is already close to $1 million, and costs are likely to remain the same despite declining water availability. In response, some golf courses in Las Vegas have suspended winter overseeding and others are eliminating irrigation in out-of-play areas. So far, courses in California have been spared water rationing, but a few more years of drought will place increasing pressure on water-thirsty Southern California.

Trends in Maintenance During Difficult Economic Conditions

- Use of more part-time labor and a reduction in overall staff sizes.
- Employees were cross trained to expand productivity.
- Maintenance was focused in primary playing areas with less emphasis on rough, bunkers, and out-of-play areas.
- Audits were performed on irrigation systems to save money and conserve water.
- More emphasis was placed on preventive maintenance of equipment to avoid costly repairs.
- Mowing patterns were changed to reduce mowing time and wear on equipment.

HIGH-SPEED GOLF CARTS

We received many inquiries this year regarding the new high-speed electric golf carts, such as the GEM and Think vehicles, that began showing up on golf courses. In general, these vehicles can operate at up to 30 mph in high gear for street operation, with a lower gear for use on the golf course. Obviously, the temptation is to keep the vehicles in high gear on the golf course. Superintendents, golf professionals, and course officials were concerned about possible damage to the turf and golfer safety. While there does not appear to be any research on the issue, we have urged courses to consider the following points:

- The new high-speed golf carts are generally 200 to 300 lbs. heavier than standard golf carts, but the tires and wheel base remain relatively wide to displace the weight. Perhaps weight is not a major concern if you consider that many golf course maintenance vehicles are heavier and do not cause substantial damage, but large numbers of heavy carts could have a negative impact over time.
- Starting, stopping, and turning in high gear are likely to cause more turf injury due to abrasion and compaction. So far, the courses allowing the high-speed golf carts have not reported a significant increase in turf damage.
- The main concern is the potential for accidents and injury when traveling at higher speeds. Golfers often drive carts down canyons, up hills, and across uneven ground, which can cause the cart to tip over. Include the fact that alcohol is served at many golf courses, and you have the potential for serious accidents.

As a precaution, we have urged courses to contact their insurance companies to obtain more details about potential risks and liabilities before developing a policy in favor or against the use of high-speed golf carts.

High-speed electric golf carts that are capable of traveling 30 mph are starting to appear at golf courses. So far, there have not been any negative impacts to turf quality, but superintendents and managers are increasingly concerned about the potential for accidents when traveling at higher speeds.

PUTTING GREEN AERATION METHODS

Golfers hate the disruption caused by putting green aeration just as much as superintendents hate this labor-intensive

project and hearing the complaints of golfers. More and more courses seem to be modifying their aeration programs by using smaller aeration tines on a compressed spacing. The most popular method is the use of ⅜" hollow tines on 1" × 1" centers. This configuration accelerates thatch removal with quicker turf recovery compared to standard core aeration using the larger ⅝" hollow tines on 2" × 2" centers.

OVERSEEDING METHODS

Winter overseeding is a common practice in Palm Springs, Las Vegas, Phoenix, Tucson, and parts of Southern California. During the past two years, a few courses have been using the Turf Solutions Dry Spray Applicator for overseeding. This technology has been used in the Southeast for ten years and is now becoming popular in the West. The tractor-drawn seeder has a very precise metering device and uses forced air to accurately apply seed. This technology has many advantages, including:

- Less renovation of the bermudagrass base is needed prior to overseeding.
- The ability to use lower seeding rates to achieve good overseeding density.
- Very uniform seed distribution for better coverage and even germination.
- Seed application is faster (1-3 days for an 18-hole course) and can be done without closing the course.

The Turf Solutions Dry Spray Applicator also has been used to accurately apply other varieties of grass seed such as bermudagrass at the very low rate of 25 lbs. per acre. For overseeding with perennial ryegrass, good results have been achieved at rates ranging from 150 lbs. to 400 lbs. per acre, which is substantially less than the standard overseeding rates of 650 lbs. to more than 800 lbs. per acre. At the moment, this seeding method is only available as a contractor service.

CONCLUSION

Wisdom often comes from surviving difficult challenges and learning valuable lessons in the process. If that is the case, many superintendents in the Southwest gained wisdom this year as they dealt with challenging economic times while striving to fulfill the high expectations of golfers. As always, the talent and ingenuity of golf course superintendents made it possible to meet these challenges and prepare for the year ahead.

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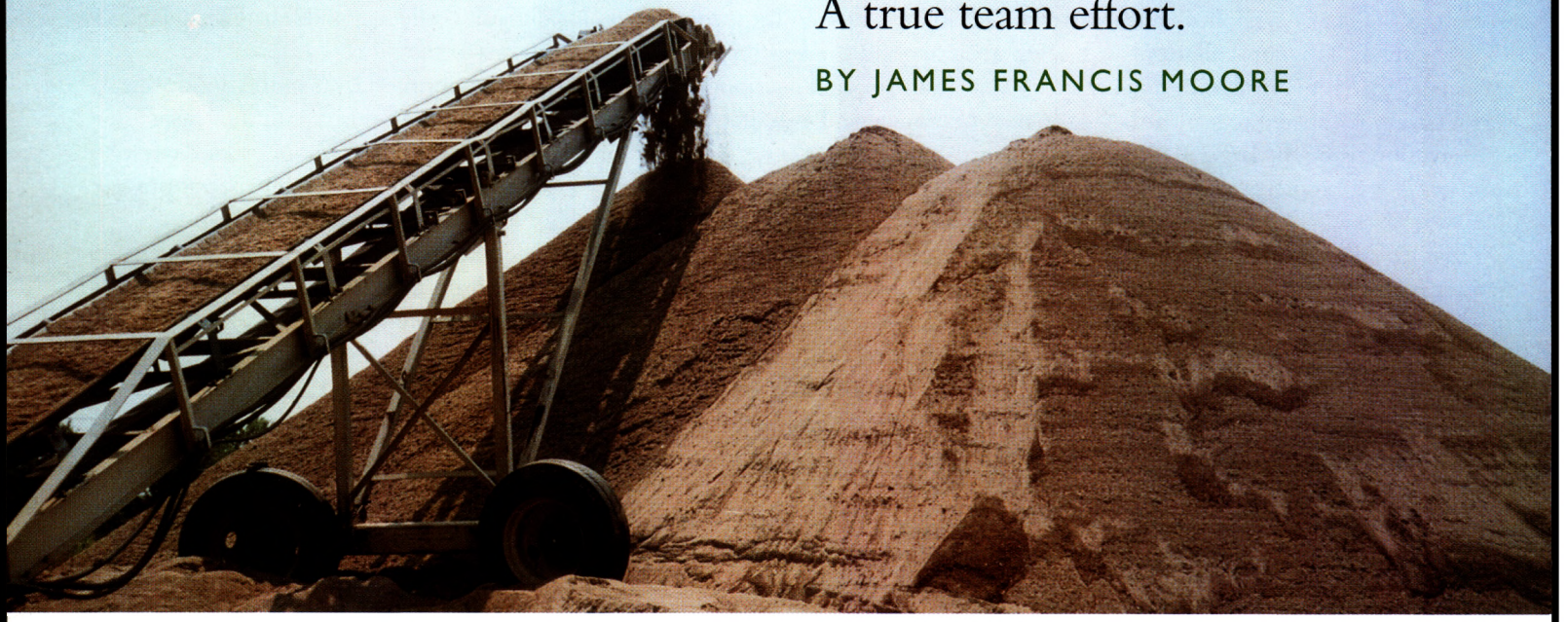
The Southwest has experienced increasing drought conditions during the past four years, and water supplies are getting desperately low.

Revising the USGA's Recommendations for a Method of Putting Green Construction

A true team effort.

BY JAMES FRANCIS MOORE



The 2004 USGA Recommendations broaden the range of materials that can be used in USGA greens, which will help reduce costs.

The USGA's method of putting green construction has served as the industry standard for building greens since it was introduced in 1960. The guidelines for this method have been revised numerous times over the years to include improved construction techniques and new scientific information resulting from turfgrass research, and to better meet the increasing demands on modern putting greens. No other construction method has been so thoroughly researched or extensively used. Thus, the USGA's Recommendations offer the best combination of proven reliability and a continuing research effort to ensure the method remains sound.

With such a track record of success, the question is often asked, "Why change something that works?" After all, the USGA does not profit financially from courses choosing to build greens according to our guidelines. It would be easy to offer the method to the industry and let it stand on its own merits, forgoing expensive construction-related research. There are other green construction methods to choose from and seemingly endless modifications of the USGA method, but none have been researched and used nearly as extensively throughout the United States and the world.

In March of 2004, the Green Section completed yet another intensive review of the Recommendations. The process took well over a year and involved an extraordinary collection of individuals throughout the world. The remainder of this article discusses this review process. Our hope is that by making our readers aware of how changes are made, they will have even more confidence in the method itself.

Shortly after the last revision of the USGA's construction method in 1993 (hereafter referred to as the Recommendations), we increased our investment in construction-related research. With golf enjoying a virtual boom in popularity, new courses were being built at a record pace. This prompted the introduction of countless new products and construction techniques, many of which had little or no scientific research behind them. And then there was the issue of laboratory testing. With so many new greens being built, there were correspondingly large numbers of rootzone mixtures that needed to be tested. To meet the demand, new physical soil testing laboratories joined those that had been in business for many years. Consistency problems arose — particularly when rootzone mixture samples were sent to different laboratories in an effort to achieve more favorable test results.

Since 1993, more than $1 million of USGA-sponsored research efforts have been undertaken in this country and abroad. Eighteen separate

projects were funded on a variety of issues, such as:

- Slope of greens.
- Water movement in USGA and California profiles.
- Engineering characteristics of sand rootzones.
- Impact of inorganic and organic amendments.
- Environmental impact of sand-based greens.
- Status of microorganisms in sand-based greens and in fumigated rootzones.
- Testing protocol for physical soil testing laboratories.
- Development of quality control parameters and procedures.

During this same period the Green Section's Construction Education Program (CEP) was formed. One of the first steps the CEP took was to form an advisory committee comprised of experts from various industry disciplines, including golf course architecture, construction, materials suppliers, and testing laboratories. Over the next five years these experts provided invaluable feedback regarding potential improvements in the Recommendations, as well as guidance for ongoing and future research efforts. A wide variety of possible changes were discussed.

By the time 2003 rolled around, we had identified 18 possible revisions that we felt had the potential to reduce the cost of green construction without sacrificing agronomic quality. It was decided to include the CEP committee in a much larger committee that was given the unwieldy name of the Putting Green Guidelines Review Committee (PGGRC). The PGGRC was composed of more than 80 professionals from throughout the world, including the following:

- Current members of the CEP Committee.
- Current members of the USGA Research Committee.
- Representatives from each of the A2LA accredited laboratories.
- Select individuals from the academic community.
- USGA Green Section staff.
- Other key individuals who did not fit into one of the other categories.

Obviously, it was impractical to assemble so many individuals in one place to discuss the Recommendations. Therefore, a Microsoft application called "Team Services" was employed to provide an on-line forum for the exchange of ideas and documents. The forum proved extremely successful, with more than 200 printed pages submitted and discussed. Pros and cons of each proposal received in-depth review. On-line surveys were conducted to accurately gauge how the group felt on each topic.

By late 2003, the PGGRC had completed its task and it was time to form yet another committee. The PGGRC was culled to a group of 12 (plus the Green Section staff) and was entitled the Final Review Committee (FRC). Once again, a Team Services site was established to facilitate the ready exchange of ideas. In October, the FRC met in Columbus, Ohio, in conjunction with the USGA Research Committee. On-line discussions and conference calls continued through February 2004 to allow time to consider new research that

The USGA continues to fund construction-related research to ensure our guidelines remain the most agronomically sound putting green construction method available.

Previous versions of the USGA Recommendations called for the depth of the rootzone to be 12 inches plus or minus 0.5 inch. The 2004 revisions increase this tolerance to plus or minus 1 inch.

The gravel layer continues to be an integral drainage component of USGA greens. Scientific research has demonstrated another important function of this layer — to help equalize moisture retention levels throughout the green.

addressed some of the laboratory testing issues. Eventually, the list of 18 possible revisions was reduced to six.

By the time the GCSAA meeting in San Diego rolled around in February 2004, we were ready to adopt these six revisions to the Recommendations. These revisions were discussed one last time during the Green Section staff meeting. The decision was then made to publish the revisions to the USGA Web site as soon as they could be written up in their final form.

After reading this article, and upon reviewing the revisions that made it through the entire process, there will probably be some who wonder why we went to so much trouble. The revisions are important, and we believe they will have a very positive impact on green construction for years to come. However, the 2004 Recommendations are by no means a complete rewrite of the 1993 version. In fact, a number of the revisions are quite subtle. The bottom line is that even after undergoing a very intense review process, the Recommendations have been proven sound and without need of major revision.

As stated earlier, the six changes to the 1993 Recommendations are all intended to help make the construction of USGA greens less expensive and less complicated. Although they are briefly presented here for convenience, the reader is encouraged to visit our Web site (www.usga.org) to view the Recommendations in their entirety.

- A great deal of confusion exists in the industry regarding saturated hydraulic conductivity (also referred to as infiltration rate). The 1993 version specified two ranges. *Normal* referred to an SHC value of 6-12 inches per hour. *Accelerated* referred to a value of 12-24 inches per hour. This nomenclature has been eliminated in 2004. The 2004 Recommendations simply call for a minimum SHC value of 6 inches per hour.
- In 1993 the depth of the rootzone was 12 inches, plus or minus 0.5 inch. This is an extremely tight tolerance that proved very difficult to achieve. The 2004 Recommendations widen the tolerance to plus or minus 1 inch.
- Properly sized gravel is sometimes difficult to find, resulting in increased trucking costs. Research has shown that the specification for gravel can be safely widened. The 2004 Recommendations increase the range of gravel that can be used in a USGA green.
- The CU (coefficient of uniformity) factor for gravel has also been increased, which again will make gravel easier to find and thus less costly.
- Previous versions specifically prohibited the use of inorganic amendments. The 2004 Recommendations allow the use of such amendments, pending approval by the physical soil testing laboratory of the final rootzone mixture. If used, the amendments must be incorporated throughout the entire depth of the 12-inch rootzone.
- Previous versions also prohibited the use of *flat pipe*. The 2004 Recommendations allow the use of such materials as long as they meet ASTM 7001, are not covered with a *sock*, and are a minimum of 12 inches in width.

So now that the 2004 Recommendations are out, how long will we wait before we begin considering future revisions? New research projects are already underway and others are being considered to address issues such as highly calcareous sands, laboratory procedures and test equipment, and the use of composts in the rootzone mixture. So don't be surprised if in ten years or so you see another article describing potential changes to the USGA Recommendations!

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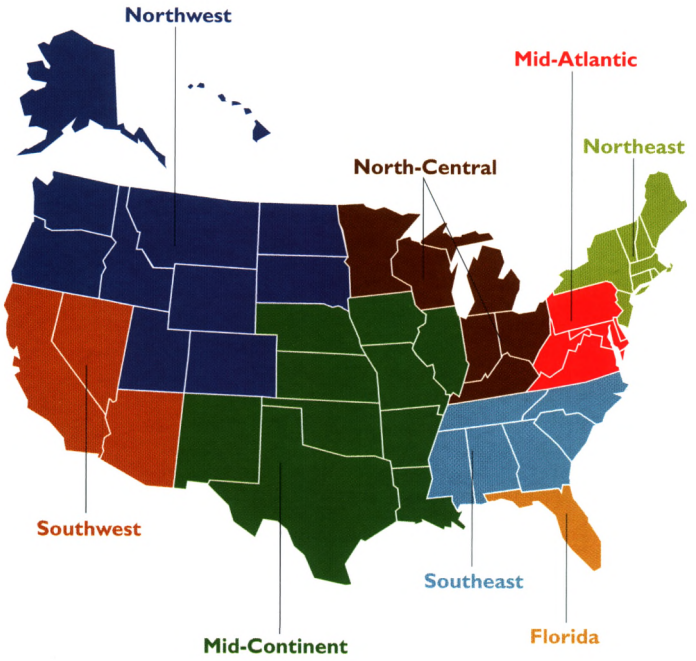

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Turf *Twisters*

Q: We play golf at a course along the Gulf Coast that is considering regrassing the putting greens with an ultradwarf. Just exactly what is an ultradwarf? (Alabama)

A: The term *ultradwarf* refers to the latest generation of bermudagrass varieties being used on golf courses today. Varieties such as Champion, Miniverde, MS Supreme, and TifEagle are all considered ultradwarfs. They were developed to replace Tifdwarf bermudagrass, which was the industry standard for almost 40 years. Although each of the ultradwarf varieties is slightly different, they all tolerate lower mowing heights better than Tifdwarf and they can provide superior putting surfaces, too.

Q: We have experienced a very harsh winter with lots of snow and ice, and our putting greens sustained severe damage. Now we are in a recovery period and we've not been allowed to play on the greens. My question is, if the greens are dead, why the heck can't we play on them? We have a short season already, and what difference can it possibly make? (Impatient in New York)

A: A little patience now will yield big dividends in the long run. Winter injury is unfortunate, but it creates a terrific opportunity to increase populations of the more desirable grass species, creeping bentgrass. Annual bluegrass (*Poa annua*) is always more susceptible to winter injury, whereas bentgrass rarely suffers injury. However, bentgrass is slower to germinate and establish, and it is particularly susceptible to wear injury during the recovery period. Establishing a temporary green (pictured) is never popular, but it speeds up the recovery process dramatically, perhaps even cutting it in half. Thus, keeping the greens out of play until density is reestablished and the turf achieves a modicum of maturity can have a significant and long-term impact on the turf composition of your greens.

Q: We are in the fourth consecutive year of drought. Our superintendent says our turf is yellow because we haven't had enough rain. What is the story? (Arizona)

A: We have been seeing drought-related turf problems for the past several years, and it is primarily due to salt concentration. Nothing moves salts deeply into the soil and away from the turf better than ½" to 1" of natural rainfall. Drought-stressed turf (having small amounts of rainfall) will actually wick salts up into the rootzone and cause the yellowed condition seen throughout the Southwest. The natural flushing action of rainfall also eliminates the hydrophobic (or water repelling) problems seen in drought-impacted soils, making subsequent irrigation much more effective at moving into and through the soil. Although this condition can be seen year round, it is most prevalent in winter on overseeded bermudagrass since the cool-season grasses are less salt tolerant, as a rule, than warm-season turf species.

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