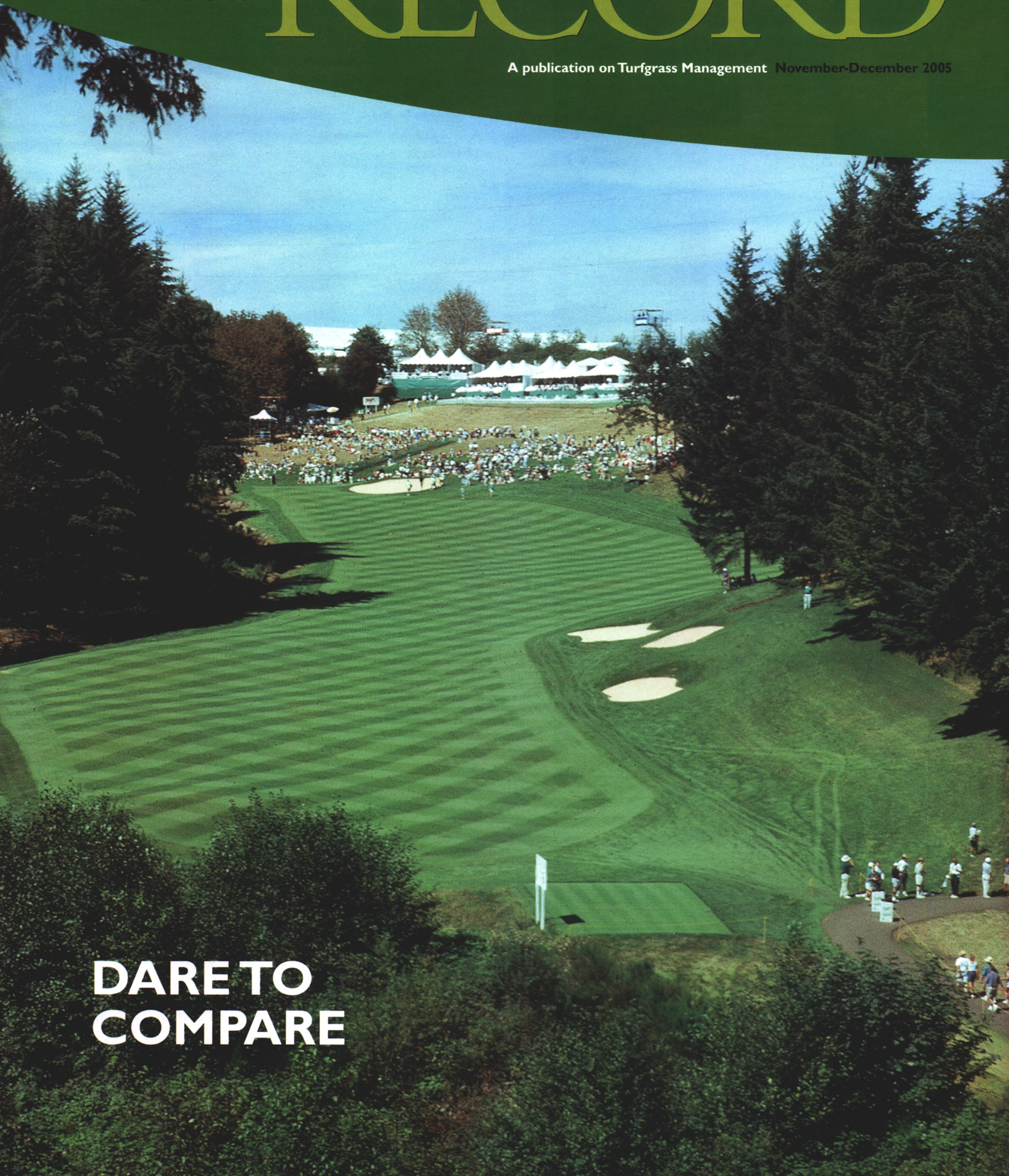
USGA GREEN SECTION
RECORD
A publication on Turfgrass Management November-December 2005



DARE TO COMPARE

Contents

November-December 2005 Volume 43, Number 6

USGA

USGA President
Fred S. Ridley

Green Section Committee Chairman
Bruce C. Richards
12202 NE 31st Place
Bellevue, WA 98005

Executive Director
David B. Fay

Editor
James T. Snow

Associate Editor
Kimberly S. Erusha, Ph.D.

Director of Communications
Marty Parkes

Cover Photo
When comparing golf courses, it is important to remember that tournament conditions are usually quite different from regular course setup.

Death, Taxes, and Comparing Golf Courses

Golf course comparisons are inevitable; however, get the facts first before you "dare to compare."

BY LARRY GILHULY

"All golf courses are good. Some are better than others!"

This great quote was first heard several decades ago when a wide-eyed young assistant superintendent (the author) at Seattle Golf Club was in the company of John Zoller, Sr., superintendent of the Eugene Country Club. After I made an unflattering remark about a recently played golf course, Mr. Zoller was quick to point out that every golf course is good, and it does no good to belittle other golf courses without knowing the facts behind the agronomic and non-agronomic programs that define the condition of the golf course. While architectural discussions are always in the eye of the beholder, let's look a little closer at the comparison dilemma facing virtually every golf course today. More specifically, let's examine why golfers have the need to compare golf courses, the agronomic and non-agronomic differences between golf courses, some tips to avoid comparisons, what to be aware of when comparisons are made in your presence, and the most common comparisons found in the game.

The amount of hand labor required at every golf course is different.

Lights, camera, action may be best for the U.S. Open, but it is not needed at your golf course on a daily basis. When the cameras go away, even the best golf courses tone down their maintenance practices.

SO WHY DO GOLFERS MAKE COMPARISONS?

They can't help it! The inherent inconsistency of the game, combined with a playing field that is constantly changing, results in situations where excuses for one's own ineptitude need to be found. It can never be the fact that the lack of talent caused the missed shot or the short putt that did not fall. Golfers' egos what they are, it must be the fault of the golf course (maintenance staff) that the greens are too slow, the fairways too short, the roughs too long, and (a personal favorite) the bunkers too "inconsistent." When players begin to complain about another hazard (water) found on golf courses being too wet or too dry, then the bunker consistency issue deserves equal attention!

In addition to this basic human tendency, we are also creatures of habit. For example, Darin Bevard stated it correctly in his USGA Green Section *Record* (Nov./Dec. 2004) article titled "No, It Really Is Not Just Your Golf Course!" This article points out two major reasons why many players choose to make comparisons without understanding all the facts:

- **Head-up vs. head-down syndrome.** This fact was pointed out to me nearly two decades ago by Jim Moore, the USGA's Director of Construction Education. His point (and Mr. Bevard's) is that players generally are not prone to enjoy the surroundings at their own golf course as much as a new course where new vistas and architecture beckon the human eye. At home, the eye has seen all of these features countless times; thus, the eyes tend to go down, and all of the flaws are noticed. It's a very interesting observation, and I agree that this is part of the problem.
- **Big event syndrome.** Generally, this is the major problem with comparisons. Players are invited to participate in special events or tournaments that are specifically prepared for one to four days of play. The comparisons ensue, and then you host the same type of event in which other players from visiting courses go home and make the same inane comparisons of their course to yours. I could not agree more with one golf course superintendent at a prominent private club in the Pacific Northwest who describes his club's way of coping with this situation: "If everyone would just stop going over the top for their

Member-Guest Invitational, the comparisons would die down. We maintain our golf course at a certain standard throughout the year, *including our Member-Guest Invitational*. There is no extra mowing or rolling on the greens, since our members cannot adapt to greens that suddenly are two feet faster than what they are used to. We want all of the players to have fun first, *score as low as possible*, get through the golf course fast, and enjoy the great food and other aspects of our facility. Our goal is to not watch balls trickle off greens due to regular hole locations suddenly becoming unplayable." It sounds like their board of directors has nailed it. Must not be a bunch of low-single-digit players!

Good communication is a key to educating players before they begin making comparisons of playing conditions between golf courses.

There are myriad reasons why golfers feel the need to compare golf courses; however, the previous two offer a great starting point for the *comparaholics* out there who simply cannot resist the urge to compare their golf course with others. Hopefully, those who have made it this far will not require shock treatment to get you to wake up and change the way you look at your golf course and others' courses. Get the facts before you "dare to compare."

ARE THERE AGRONOMIC AND NON-AGRONOMIC DIFFERENCES BETWEEN GOLF COURSES?

In a word, yes there are! In early May 2004 I saw a perfect example of a comparaholic at a pro shop that will remain unnamed. This player had just played Perfection C.C., where the bunkers were perfect, the greens were perfect, and the fairways were perfect. The following quote, however, crossed the line: *"My home course is a disgrace and I will not bring guests out there due to embarrassment! We need to hire the superintendent at Perfection C.C. since he knows how to maintain a golf course!"* This player then went on to describe in great detail how nice his *winter* had been while playing golf in Palm Springs, and how much better the golf courses were maintained in that area compared to the Pacific Northwest.

After taking a deep breath, I decided that this golfer needed to be educated on a few of the facts that existed between Perfection C.C. and the course where he was a member. These included:

Facts about Perfection C.C.	Facts about his home course
• Bunkers were renovated winter 2004	• Bunkers are contaminated with fines and scheduled for renovation
• Greens were aerified in March and had completely recovered	• Greens were aerified 10 days before his tirade
• Fairwayss are not topdressed or aerified in the spring	• Fairways were sand topdressed heavily and aerified four days before his tirade
• Dry weather one week before played	• 1" rainfall two days before tirade

Just as there are no two snowflakes the same, there are no two golf courses that are identical, even in regard to the timing of major maintenance programs and weather conditions prior to play. These facts are often forgotten by those who compare the golf course they play all year with a snapshot of a golf course that they may play on one occasion. Unfortunately, most of the differences between golf courses that most impact turf growth, and therefore playing conditions, cannot be seen. As a way of condensing the main differences between golf courses, note the two lists below. The next time you play a golf course, realize that nearly every one of these differences exists between your golf course and the golf course that you just played!

Agronomic Differences

- Climate/geographical
- Grass type
- Construction material used for greens/tees
- Native soil fairways/roughs
- Trees — number and size
- Irrigation age/coverage
- Water quality/quantity
- Timing of major programs — greens/fairway aeration, drainage projects, fairway topdressing, reconstruction

Non-Agronomic Differences

- Amount of play
- Course age
- Architectural style (especially greens)
- Green size
- Bunkers — sand type/amount/drainage/size
- Overall maintained acreage
- Budget — staff size
- Equipment age/amount
- Membership philosophy/handicap
- Wildlife — Canada geese, other grass-feeding birds, elk, voles, ground squirrels

Trees seriously impact turf growth and frost removal during the winter.

WHAT CAN BE DONE TO REDUCE THE NATURAL TENDENCY TO COMPARE GOLF COURSES?

Trying to change a natural human tendency is virtually impossible; however, making golfers aware of the differences between golf courses can be done to at least minimize the potential for comparisons turning into major issues. The next time you feel the urge to compare your course with a recent round at Perfection C.C., consider the following:

- **Be aware of comparisons — especially when you have a bad day on the links!** As mentioned earlier, a bad day on the greens can often result in a negative perception of the greens just played, rather than the possibility that you may need to take a putting lesson. The same goes for bunker sand and fairway mowing height!
- **Educate others when you hear comparisons.** We have all been around players who can't wait to let their recent rounds of golf at another course be shared with everyone! Although positive comments about any golf course are always worth listening to, keep your radar on when the positives are followed by, "I wish our golf course could be that good." A very simple question should be asked immediately: "Did you play in a tournament or special event?" If the answer is yes, then make the player aware that all golf courses generally receive a little extra maintenance for tournaments, just as yours does.
- **Develop maintenance standards.** The establishment of maintenance standards has been successful in instances when golf courses face changing committees and boards that alter maintenance philosophies on a regular basis. When course comparisons begin to happen, it is very easy to simply state that your golf course superintendent follows a solid set of maintenance standards created by the green committee and with

board approval to assure good playing and growing conditions through the main portion of the playing season. You simply cannot maintain a golf course at tournament levels at all times; thus, your maintenance standards need to be realistic with the regular player in mind.

• **Resist making your golf course (especially greens) dramatically different during your Invitational or Member-Guest!** This point cannot be overstated because it is the main reason why so many comparisons occur in the game today. Focus on creating smooth putting surfaces (who said fast equals good?) that are not more than one foot faster than your golfers normally play. Based on the playing skill anticipated at these events, every golf course would be far faster and more fun to play when greens are in a more reasonable Stimpmeter range of 9-10 rather than the 11+ speeds that usually are associated with the major championships for professional golfers.

WHAT ARE THE MOST COMMON COMPARISONS?

During a recent winter visit to a golf course here in the Pacific Northwest, a unique (and increasingly common) comparison was being made about the condition of this golf course at the time of its Member-Guest Invitational (midsummer) and the remainder of the year. A low-single-digit member was appalled enough at the condition of the golf course from August to October to write a rather negative letter about his displeasure with the condition of the golf course when compared to the Invitational and when compared to the other older club in this town. This course had suffered through two major rain events exceeding two inches in one week, the return of summer labor to high school and college, falling leaves, and a major reconstruction of the practice facility. It was no wonder that the overall condition of the course suffered in the late summer and early fall! After this Turf Advisory Service visit, the phone rang while I was sitting in the club parking lot preparing to leave. The call was from the superintendent at *the other club* mentioned in the letter. He laughed when informed about the comparison, as he had just had a letter read at a recent board retreat that complained about the condition of his course and "*how much better the condition was at the course in whose parking lot I was sitting!*"

This true story points out how difficult it can be for golf course superintendents when those who make the comparisons do not take into account what has happened at their own course versus the snapshot of the club across town. Comparisons seem to be inevitable, but what are the most common areas where comparisons are made and how can they be addressed?

Table 1
Stimpmeter Readings 1977-2004

Course	1977	2004
Broadmoor G.C.	6' 8" - 7' 8"	9' 6" - 10' 6"+
Columbia Edgewater C.C.	6'11" - 7' 9"	10' 6" - 11' 0"+
Coos C.C.	7' 2" - 7' 4"	10' 0" - 10' 6"+
Emerald Valley G.C.	7' 4" - 7'10"	10' 0" - 10' 6"+
Eugene C.C.	6' 7" - 7' 1"	10' 6" - 11' 0"+
Illahe Hills C.C.	6' 0" - 6' 4"	10' 6" - 11' 0"+
Jefferson Park G.C.	5'11" - 6' 0"	9' 6" - 10' 6"+
Kitsap G.&C.C.	5' 8" - 6' 2"	9' 6" - 10' 6"+
Longview C.C.	6' 2" - 7' 0"	10' 6" - 11' 0"+
Meridian Valley C.C.	6'10" - 7' 0"	10' 6" - 11' 0"+
Oswego Lake C.C.	7' 0" - 7' 8"	9' 6" - 10' 0"+
Overlake G.&C.C.	6'10" - 7' 1"	9' 6" - 10' 0"+
Portland G.C.	6' 5" - 7' 0"	10' 6" - 11' 0"+
Sahalee C.C.	6'11" - 7' 1"	10' 6" - 11' 0"+
Seattle G.C.	7'11" - 8' 1"	10' 6" - 11' 0"+
Tokatee G.C.	6' 7" - 7' 4"	9' 0" - 9' 6"+
Waverley C.C.	6' 6" - 7' 4"	9' 6" - 10' 6"+

Average Increase = 3-4'

• **Greens — usually speed or smoothness.** "Perfection C.C. had the best greens I have ever played. Why can't our greens be that fast/smooth/firm/consistent/etc.?" Question to player: "What tournament were you playing in and how many putts did you have?" Usually the golfer has played in some type of event and had 36 putts or less.

Another interesting discussion concerning green speed that occurs more than it should is a comparison of eras. There are players who absolutely insist that their greens or the greens of their youth were faster (in some cases much faster) than they currently are maintained. Despite being told that mowing heights were much higher three decades ago, these players are not aware that while their greens may have been the fastest in the area, they were not faster when compared to the modern era. Those who still believe in this myth (and the tooth fairy) should note Table 1, taken from USGA Turf Advisory Service visits in 1977, and compare it to the green speed on the same golf courses in 2004. Also, note

Don't let your cup runneth over with poor internal drainage.

Table 2
Southern California Stimpmeter Readings 1991

Course	Stimpmeter
Annondale G.C.	9' 0"
Antelope Valley C.C.	9' 6"
Bakersfield C.C.	9' 0"
Bermuda Dunes C.C.	8' 0"
Big Canyon C.C.	9' 6"
Bighorn G.C.	8' 6"
Canyon C.C.	10' 0"
DeAnza C.C.	9' 0"
Del Rio C.C.	8' 6"
Desert Falls C.C.	8' 2"
Desert Island G.&C.C.	8' 6" - 9' 0"
Dove Canyon C.C.	9' 6"
El Caballero C.C.	8' 6"
Fairbanks Ranch C.C.	8' 6"
Fallbrook G.C.	8' 0"
The Farms	9' 0"
Glendora C.C.	8' 6" - 9' 0"
Industry Hills	8' 6"
Manifee Lakes C.C.	9' 0"
Marbella G.&C.C.	8' 0"
Mesa Verde C.C.	8' 6"
Mission Hills C.C.	9' 0"
Oakmont C.C.	8' 9"
Ojai Valley Inn	8' 6"
Old Ranch C.C.	8' 6"
Riviera C.C.	9' 4"
Rolling Hills C.C.	7' 6"
San Diego C.C.	10' 0"
Torrey Pines	7' 6" (normal) / 9' 6" - 10' 0" Tour
The Vintage Club	8' 6"
Virginia C.C.	8' 6"
Vista Valley	8' 6"
Yorba Linda	9' 0"

the "+" sign to the right of the 2004 green speed. This denotes the normal green speed for tournaments and/or the Member-Guest Invitational. An increase in green speed of 3-4 feet has elevated playing conditions such that they are actually faster now than U.S. Open green speeds of only 20 years ago.

In addition to the Stimpmeter readings in the Pacific Northwest, note Table 2, where Stimpmeter readings were taken in Southern California during 1991. When compared to modern green speeds similar to those found in the Pacific Northwest, an average increase of at least 1-2 feet has occurred in the last 15 years in this area of the United States. Greens faster in the good old days? The numbers don't support this assertion.

• **Bunkers — usually too soft or too hard.** "The bunkers at Perfection C.C. were perfect. There were no 'fried eggs' and the sand was 'consistent.' Every shot from the bunkers was easy and predictable. Our bunkers stink!" USGA agronomists unanimously agree that the most common complaint heard on golf courses from golfers is inconsistent sand in bunkers. Somewhere between the invention of the game and today, many have forgotten that bunkers are hazards and should be avoided. Golfers never complain that a water hazard is too wet or too dry. They accept (without question) the one-shot penalty and move on to the next shot. However, let one golf ball plug into a bunker, costing a player possibly one shot to extract the ball, or have a ball hit from an area where the sand is thin, and all of the bunkers are considered *inconsistent*. Of course, the bunkers are better at Perfection C.C. — they were prepared for the tournament and it did not rain the day before.

• **Fairways — usually too short.** "The fairways at Perfection C.C. were absolutely perfect. The ball sat up so well that every shot was like hitting off a tee. Why can't we mow our fairways at that height?" When players make this comment, it generally means they played a golf course with good soil, resulting in excellent plant density with very little earthworm activity, few trees in landing zones, and probably covered with Kentucky bluegrass mowed at a higher height! While other cool- and warm-season grasses can produce outstanding fairways at lower mowing heights, many continue to believe that fairways need to be mowed at higher heights to achieve good ball lie. In reality, fairways should be mowed between ½" and ⅝" in most situations to provide a reasonable ball lie while not making the fairways too difficult for the "right arm sweepers" that comprise the majority of all golfers.

• **Color — greenies vs. brownies.** This area of disagreement can trace itself directly back to the beginning of TV golf, with the constant bombardment of nearly perfect conditions shown weekly at your local PGA, LPGA, and Senior PGA tour stops. It has even crossed over the Atlantic Ocean, with Sky TV bringing a growing demand for more green on the local 18-hole links (with a staff of four), while completely forgetting that maintaining grass just for color results in the use of far more "green" than these golf courses have to spend. If we could only turn back the clock in one area of golf course maintenance, it would be to play it fast, firm, and with more brown than viewed on most golf courses in America.

SUMMARY — WARNING SIGNS FOR COMPARAHOLICS

A majority of golfers have fallen into the trap of comparing golf courses without first thinking about the many differences among golf courses, or using a snapshot view of a golf course in tournament condition. To summarize, here are a few observations that can keep you from becoming a comparaholic — a player who simply must compare his golf course to every other golf course in the world.

• Comparaholics are usually found in the pro shop or 19th hole.

• Comparaholics play head down at home and head up away.

• Comparaholics fail to recognize tournament vs. normal playing conditions.

• Comparaholics read far too many "Top 10/100" lists.

• Comparaholics want to make themselves sound important.

• In some cases, comparaholics have an "ax to grind," and the golf course superintendent is the tree!

• Comparaholics played or putted poorly that day.

• And, finally, in the worst case — some comparaholics just don't like anything!

The comparisons of golf courses will never end; however, by being aware of the myriad differences among golf courses and the simple fact that tournament conditions are usually quite different from regular course setup, you are well on your way to understanding the difficulty faced by your golf course superintendent on a daily basis. Avoid the "taking it to the next level" and "wanting to go in a new direction" mentality by giving your golf course superintendent the necessary tools within your budget to make your golf course the best it can be. In the end, you will compare favorably without going in any new direction while taking it to the next level.

LARRY GILHULY *does comparative assistance to subscribing golf courses in the Northwest Region of the USGA Green Section.*

Research *You Can Use*

Overseeding and Nematicides Affect Sting Nematodes in Bermudagrass Fairways

Research shows that when it comes to nematodes, timing is everything.

BY WILLIAM T. CROW, TODD LOWE, AND DARIN LICKFELDT

Sting nematodes injure bermudagrass roots and cause drought-like symptoms to occur.

Nematodes are microscopic, nonsegmented roundworms, with several species being parasitic to turfgrass. Nematodes have become one of the most significant turfgrass pests on Florida golf courses, as there are few chemicals that can effectively control them. The most common nematode that negatively impacts bermudagrass growth on Florida golf courses is the sting nematode (*Belonolaimus longicaudatus*).[1]

Bermudagrass is the dominant turf on Florida golf courses, but it becomes dormant during the primary play season and is often seeded with cool-season grasses to improve winter playability and aesthetics. The cool-season grasses used for overseeding produce a copious amount of new, white roots that provide food for sting nematodes. Environmental factors that regulate sting nematode populations are soil temperature and food availability, and the increased roots from overseeding may increase nematode populations. There continue to be discussions about the benefits and liabilities of overseeding, particularly regarding bermudagrass health, and a potential negative impact of overseeding could be higher numbers of sting nematodes over time.

Nemacur (fenamiphos) has been one of the most effective nematicides for controlling nematodes in bermudagrass turf and, in product evaluation trials, few alternatives significantly improved bermudagrass quality.[2] Curfew™ Soil Fumigant (1,3-dichloropropene) is one of the new nematode management products for use on established golf course turf, having been registered several years ago.[3] This nematicide is generally effective at reducing sting nematode populations in the soil and is typically applied in late spring/early summer, when nematodes are actively feeding and causing damage to bermudagrass turf. The benefits of applying Curfew in late summer/early fall are currently unknown, but it may improve turf quality, particularly on nematode-infested bermudagrass that is overseeded for the winter play season.

GOLF COURSE STUDIES

Field trials were conducted on two common bermudagrass fairways at the Palatka Golf Club in Palatka, Florida. The objectives of these trials were to determine the effects of fall applications of Curfew and ryegrass overseeding on numbers of sting nematodes throughout the winter and during spring transition. Overseed treatments consisted of a blend of 40% Jet perennial rye, 40% Applaud perennial rye, and 20% Gulf Annual rye (Kelly Overseed Blend) at 300 lb. per acre and was applied on November 6, 2003. Curfew treatments were applied on October 1 (six weeks before overseeding) and on October 26 (two weeks before overseeding). Non-overseeded and non-treated check plots were also included in the study.

Soil samples for nematode assays were collected before overseeding, eight weeks after overseeding (January 2, 2004), and at the end of overseeding transition (April 29, 2004). At the same time, the turf was evaluated for color (1-9) and density (0-100%). January evaluations gave an indication of the treatment effects on overseed quality, and April evaluations gave indications of treatment effects on the base bermudagrass.

RESULTS AND DISCUSSION

Overseeding improved turf color and density on both fairways during the winter season. That was no surprise, since that is the main objective for overseeding. By the end of spring transition, there were no significant differences between overseeded and non-overseeded plots, indicating that winter overseeding did not have a negative impact on the bermudagrass coming out of dormancy. Therefore, overseeding had positive effects on overall turf quality in these trials.

The effectiveness of Curfew on nematode reduction varied between the two fairways. Curfew reduced sting nematodes on fairway 10 before overseeding (Figure 1), but it was not effective on fairway 15 (Figure 2). Curfew also improved turf quality of the overseeding cover and the bermudagrass during spring transition on fairway 10 (data not shown). This indicates that fall applications of Curfew can help improve health and quality of winter overseeding cover as well as have a positive effect on bermudagrass quality. An additional observation to be considered is that the overseed established better in and near the Curfew injection slits for treatments applied two weeks before overseeding. This resulted in a striped appearance due to the surface disruption of the Curfew injection, which improved seed-to-soil contact. This occurrence was less pronounced in plots treated six weeks prior to overseeding.

Figure 1

Sting nematode populations as affected by overseeding (O.S.) and nematicide treatments in fairway 10.

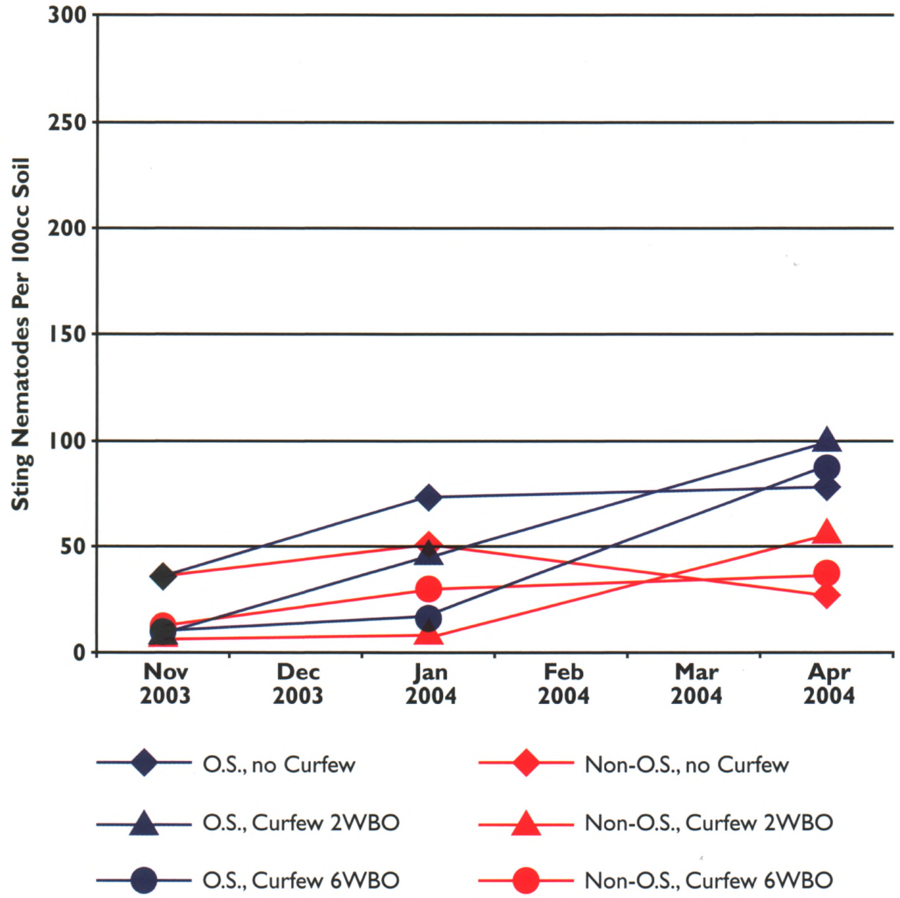
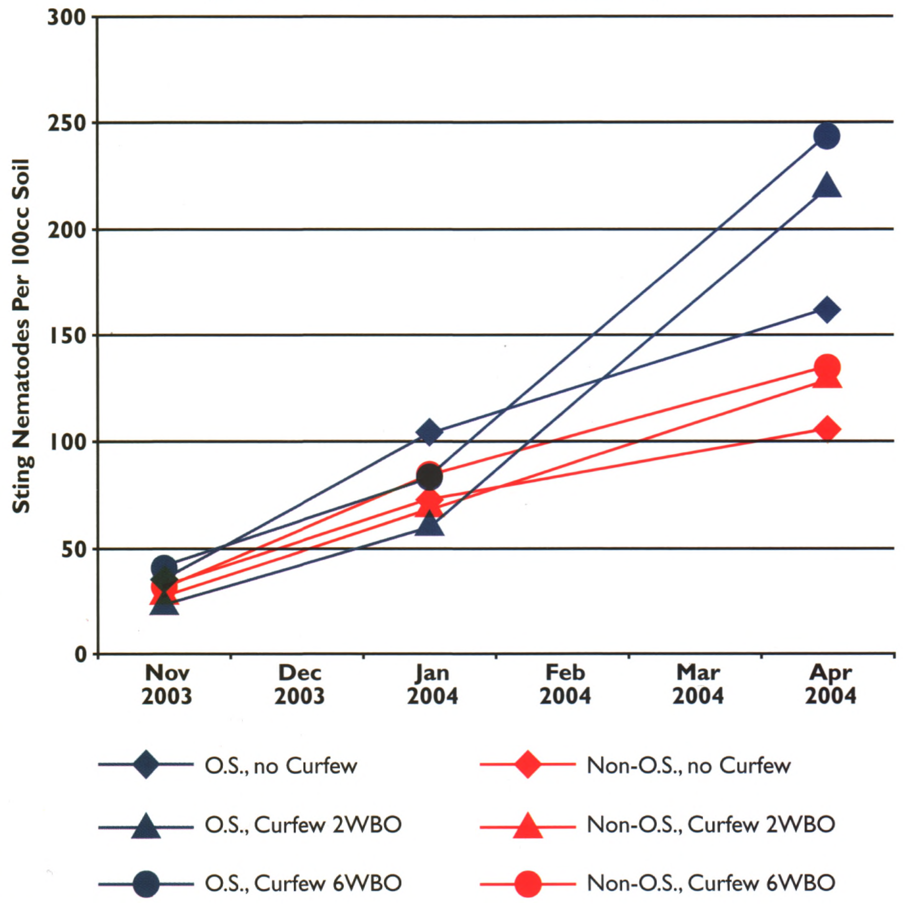


Figure 2

Sting nematode populations as affected by overseeding (O.S.) and nematicide treatments in fairway 15.



Improved turf quality was observed in nematicide-treated plot on left as compared to untreated plot on right. The same treatments were applied to non-overseeded plots in the background.

The results of the nematode assays were interesting in that sting nematode populations nearly doubled in overseeded plots compared to non-overseeded plots on both fairways (Figure 3). This indicates that the food provided by the roots of the winter overseeding was sufficient to increase sting nematode populations despite low soil temperatures. Therefore, the practice of winter overseeding may be problematic on fairways where sting nematode damage occurs. Since 60% of the fairways in Florida are infested with sting nematodes,[1] this could be an important consideration. It should be noted that on both fairways, the highest sting nematode populations after spring transition occurred when Curfew was injected before overseeding. The most likely reason for this is that those plots had the healthiest overseed and hence more nematode food throughout the winter.

Curfew application timing is critical, since it is only applied once yearly. Based on these studies, fall applications of nematicides, like Curfew, can enhance the health of overseed in sting nematode-infested sites and also improve bermudagrass in the spring. Striping from injection slits can be avoided by scheduling application at least six weeks prior to overseeding. More research on the seasonal population dynamics of sting nematodes and comparisons of the efficacy of treatments applied at different times is needed to make specific recommendations. Currently, research is underway at the University of Florida, with additional funds provided by the GCSAA and the Florida Golf Course Superintendents Association, to generate this information.

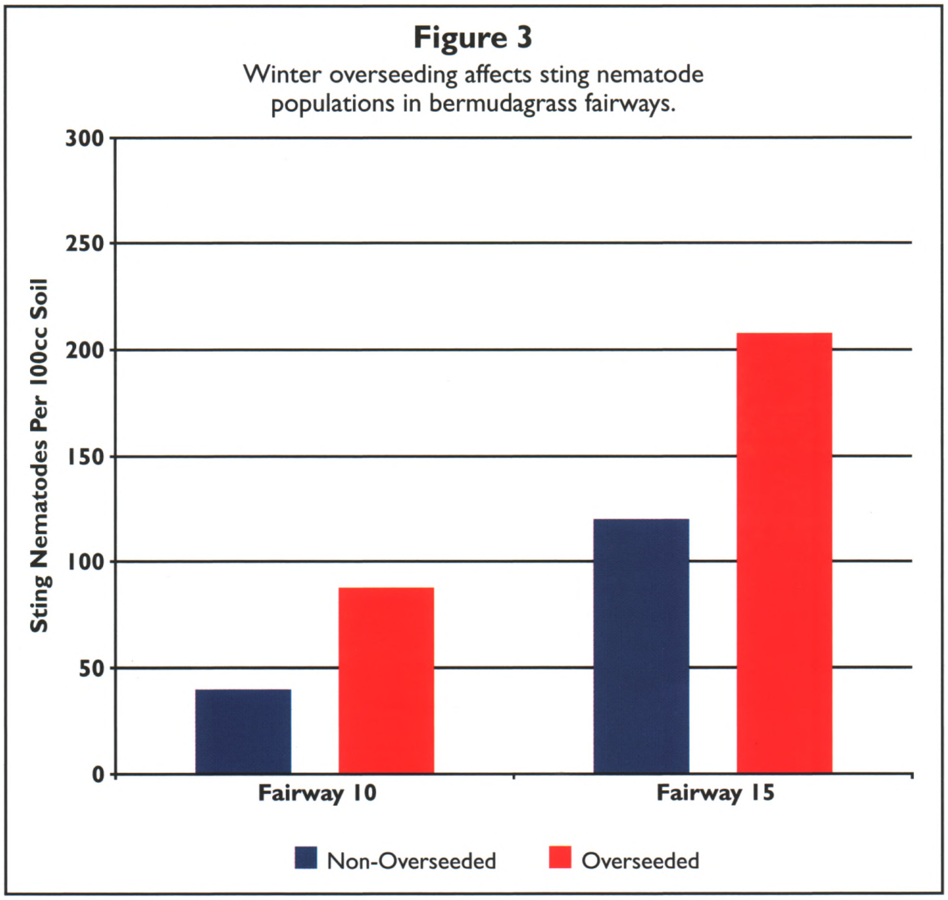
REFERENCES

1. Crow, W.T. 2005. How Bad Are Nematode Problems on Florida's Golf Courses? *Florida Turf Digest*, 22(1):10-12.

2. Crow, W.T. 2003. Are Alternatives to Traditional Nematicides a Real Possibility? *USGA Green Section Record*, 41(6):7-8.

3. Crow, W.T. 2002. Nematode, Where Is Thy Sting? *Golf Course Management*, 70(8):103-106.

Nematodes in this bermudagrass fairway are causing premature spring transition of the winter overseeding.



Sting nematodes damage bermudagrass root systems and cause drought-like symptoms to occur. The stunted root sample on the left was taken from the brown section of this fairway, while the fibrous root sample on the right was taken from the healthy turf.

WILLIAM T. (BILLY) CROW, PH.D., *Landscape Nematologist, University of Florida;* TODD LOWE, *USGA Green Section agronomist, Florida Region;* DARIN W. LICKFELDT, PH.D., *Product Technology Specialist, Dow AgroScience LLC.*

Getting It Right

A success story from Lake Merced Golf Club.

BY BO LINKS AND AL OPPENHEIM

Once all of the improvements on the golf course were done, the membership at Lake Merced Golf Club treated themselves to a new clubhouse with a 19th hole that would make even the rich and famous jealous.

Can it really happen? If it can, how in the world do you get it done? The answer is yes, and it happens when a club's leadership sees an opportunity, confronts political reality, and seizes the opportunity to build for the future.

In this case, "it" is the complete rebuilding of a club's infrastructure — a state-of-the-art recycled water storage/distribution tank, a spanking new maintenance facility, and a completely remodeled clubhouse. And it really did happen, all within a remarkably short time span — and within just a few years after a major golf course renovation project — at a venerable club that is more than 80 years old.

The genesis of these projects stemmed from years of neglect and leadership that, for one reason or another, was unable to accomplish the vital things necessary to propel Lake Merced Golf Club into the future. The sad result was that the club's maintenance staff labored under the roof (and literally on the dirt floor) of an outdated maintenance facility for many years. Well water was drawn exclusively from the local aquifer until political pressure mounted to the point of forcing the club to use recycled water. And, all the while, the membership — yes, the folks who pay the bills — inhabited an old clubhouse that was beginning to fall apart.

Fortunately, the club took the correct first step by restoring its prime asset — the golf course — before anything else. While that sense of priority is cause for celebration, the real miracle is that the club did not stop there, but continued to complete *all* of its major capital projects over a very short time span. Now, with everything completed, the maintenance staff can properly care for the golf course and the membership can enjoy the creature comforts of a first-class golf club.

The purpose of this article is not to provide a cookbook for getting the work done, but rather to recount the experience of one club that made a commitment to the future that many other clubs dream about making, yet somehow never turn into reality. Hopefully, this experience will demonstrate — particularly to green committees and individual members — that progress is possible . . . if you work for it.

SEEING THE NEED, COPING WITH POLITICAL REALITY, AND FORGING A SOLUTION

Where do we begin? Where else but with water, the essential ingredient for any successful golf course operation. At Lake Merced Golf Club in Daly City, California, the chickens came home to roost at the end of the 20th century. Laid out in 1922, the course was first remodeled by Dr. Alister Mackenzie in 1929 and again in 1965 when a freeway gobbled up several holes. By the mid-1990s, the greens had fallen victim to uncontrollable nematodes, poor drainage, and black layer development, so the governing club officials had to act. Under the direction of Rees Jones, celebrated architect who renovated several U.S. Open venues, the course was remodeled and placed back on a sound agronomic footing. (This project was the subject of an earlier article, "Fairway to the Future," *USGA Green Section Record*, July-August 1997.) This aside, one undeniable truth remained unchallenged: The club continued to survive on well water pumped from its own property.

As the club approached its 80th anniversary, the water level in nearby Lake Merced had dropped to low levels and environmental groups began lobbying for curbs on the use of well water by local golf courses. As a consequence, pressure began to mount for Lake Merced Golf Club to convert to recycled water. The conversion issue is nothing new. Esteemed courses around the country have made the switch; a prime example is Pebble Beach Golf Links, the site of four historic U.S. Open Championships.

The first hurdle at Lake Merced Golf Club was for the Board of Directors to become educated as to the need and environmental wisdom of converting to recycled water. That part was easy, although it took a little time. As the club moved forward to negotiate with local government officials, it united with two neighboring clubs, combined resources, shared a collective knowledge base, and proceeded to craft a creative and intelligent program for converting. Among the key strategic moves were the employment of knowledgeable water rights counsel and the retention of an experienced water expert who helped define acceptable benchmarks for recycled water quality. The result was an agreement that guarantees the availability of good quality recycled water, while at the same time preserving reasonable uses of well water for key areas like greens and tees.

That done, the club set about constructing a new storage and delivery system. As we assessed our physical plant, we realized that the superintendent had been balancing on a tightrope for decades. Our existing storage capacity was slightly in excess of 60,000 gallons. Sound like a lot? It isn't. Lake Merced G.C. pumps, on average, upwards of 2,000,000 gallons each week. Although the storage capacity issue had been passed over for years, we knew full well that we were living on borrowed time. If we ever hit a snag with our wells, we would be in for trouble — with a capital T.

We decided to construct a million-gallon underground storage/distribution tank that more than accommodates the course's ongoing needs and provides a reasonable cushion should the wells fail or we encounter a problem with the quality of newly delivered recycled

When the work day starts and ends on dirt floors, who can blame a maintenance staff for having low morale?

After moving into a new, state-of-the-art maintenance building, staff morale hit an all-time high, as it became clear that the members' number-one priority was the proper care of the course.

water. The new tank is divided in half to simultaneously accommodate 500,000 gallons of recycled water and 500,000 gallons of well water. The tank is virtually invisible, as it runs 20 feet underground and the portion that sits above ground is surrounded by an effective greenbelt composed of trees, shrubs, and mounds.

In addition to the tank, we installed the latest computer-controlled delivery components available. In so doing, we are able to blend our water to customized specifications and deploy it to any of 2,300 sprinkler heads at any time. This unique system includes a pump station with two separate motors, one for each type of water. The construction of the storage tank and delivery system began in June 2003 and went on line in January 2004.

GOING FROM DIRT FLOORS TO THE 21ST CENTURY IN ONE EASY PROJECT

While we were dealing with the water issue, it became readily apparent that the maintenance department desperately needed a new facility. The existing facility consisted of a small cluster of corrugated steel buildings, one of which dated back to the club's founding in 1922 and, remarkably, still had the original dirt floors. We were short on storage space, so many pieces of valuable equipment had to be stored outside in the open. Chemical storage was not up to par and the areas for workers, not to mention our professional staff, were sorely lacking in amenities.

The first issue to tackle was location. The existing facility was in the middle of the golf course. Although the membership initially was skeptical of moving the facility to the southwest corner of the property, we made a concerted effort to educate them on three essential facts. First, the cost of the move was negligible, as we could save on underground utilities and related costs by connecting at our property's edge. Second, given the fact that virtually all equipment is motorized, utilizing a corner location (as opposed to a central location) had minimal impact on maintenance activities. Third, and most important, by moving the maintenance building we would avoid having heavy truck traffic passing directly in front of the clubhouse and through the middle of the golf course — as it should be.

We have also gained a wonderful side benefit from relocating the maintenance facility; the area previously occupied by our old maintenance facility has been opened up for other uses. It may remain open space to enhance the look and feel of our parkland course, we may create an additional practice hole where members can hone their short game, or we may even construct quaint bungalows for members and guests to use for golf-related activities. The point is that we now have *much* more flexibility than ever before.

One of the other valuable byproducts of the new maintenance building is the lift in staff morale. It is as if each member of our staff has been reborn, and the superintendent now has an office worthy of his importance to our operation. As a result, the entire maintenance crew is more enthusiastic, and they truly appreciate the fact that the membership has said loud and clear that the care of the course is priority number one.

In one sense, the club leadership is prouder of the new maintenance facility than it is of our new clubhouse. The reason? Getting approval for the maintenance facility took a *lot* more work. Compared to other club projects, the maintenance facility was an orphan, always pushed to the side when seemingly more important needs surfaced to gobble up scarce dollars. The project took slightly less than seven months from start to finish. Construction began in June 2004, and we began phasing in operations in the new facility in January 2005.

ALL THIS AND A NEW CLUBHOUSE, TOO?

It may be impossible to comprehend, but at the same time the club was constructing new water storage and maintenance facilities, it also faced the largest construction project in its history — a new clubhouse. Although we were able to utilize existing structural steel and opted to stay within the same footprint (in part to avoid public hearings on a building permit), the club still faced a massive project of unprecedented financial scope.

After forming a strategic planning committee and thoroughly vetting the alternatives, we were able to build a strong consensus for the project. It was approved by a 10-1 margin. Construction began in August 2003 and the new clubhouse opened in mid-February 2005, just in time for the club's 83rd annual meeting.

The new clubhouse completes the infrastructure renewal. Included in this project was a relocated pro shop, expanded locker rooms, a casual café to complement formal upstairs dining, expanded kitchen space, and updated meeting rooms and administrative areas. While the building has been thoroughly remodeled and several function areas shifted, we were able to preserve views of the golf course that are treasured by the membership. In addition, we replaced a pedestrian, 1960s-style structure with a classic, shingled building that is warmer and much more inviting to the eye. One touch we added was a large street clock near the first tee to help players start on time and also allow those making the turn and completing their rounds to track their pace of play.

Unbeknownst to most members at Lake Merced Golf Club was the fact that valuable maintenance equipment sat outside where exposure to the elements shortened its useful life expectancy.

Lake Merced Golf Club constructed a 1-million-gallon storage tank that runs 20 feet below ground level to store well and recycled water for course irrigation.

DID THIS REALLY HAPPEN?

All of this work was truly remarkable, especially the fact that it was completed over a two-year period. It required a substantial investment that, fortunately, our members supported from start to finish. To be sure, there were concerns about budgets and borrowing, but in the end, everyone came to realize that leadership was doing the things that needed to be done — things that had been delayed for too many years.

The scope of our work represents a renaissance for any golf club. Now that we have the dust behind us and the turf has never been healthier, our members take justifiable pride in knowing that they belong to a club that did the job right — not only for themselves, but for generations yet to come.

BO LINKS *is a USGA Green Section committeeman. He served as president of Lake Merced Golf Club while these projects were completed.* AL OPPENHEIM *served with him on the board of directors and, for the last eight years, has chaired the club's green committee, a standing committee that does not change from year to year.*

One way to avoid overwatering is to have two sets of sprinklers in order to irrigate the green separately from the surrounding rough.

Putting Green Drainage, Drainage, Drainage

Just as location is important in real estate, drainage is the foundation of any good putting green.

BY JAMES H. BAIRD

Drainage has long been considered the single most important element of good quality putting greens, and more often than not, failure of putting green turf can be traced back to one or more factors related to excess moisture and the inability to get rid of it. Poor drainage creates softer conditions on putting greens, exacerbating ball marks, footprints, spike marks, and wear damage, especially around golf holes, all of which adversely affect ball roll and the ability to make a putt. Wet soil is more prone to compaction, which leads to weak, shallow-rooted turf and encroachment of algae, moss, and *Poa annua*. In the end, turf in poorly drained areas usually succumbs to diseases such as anthracnose or *Pythium*, or stress caused by traffic, mower scalping, or weather extremes. In northern climates, loss of turf from winter injury frequently occurs in poorly drained areas of putting greens.

Troubleshooting a drainage challenge is likely to start by examining the underlying soil. However, soil is just one of several factors that can contribute to wet greens. The objectives of this article are to outline the various causes of poor drainage in putting greens and to offer the best and most current solutions.

STEP ONE: LOOK AROUND

Before reaching for your soil probe, take a step back and look around the green. Pay particular attention to irrigation, trees, traffic patterns, sidehill seepage or runoff, and poor surface drainage.

IRRIGATION

Overwatering due to improper irrigation practices, poor irrigation design, or both, is one of the leading pitfalls of golf turf maintenance and can contribute to poor drainage. Unfortunately, some turf managers find it easier and safer to err on the side of applying too much water rather than barely enough, especially since most golfers view lush, green turf as good and anything less as problematic.

Besides reminding golfers that "green is not necessarily great," putting green irrigation systems of today should include properly spaced sprinklers that provide uniform water distribution and are controlled individually for site-specific water management. In addition, a second set of sprinklers should be installed to irrigate the green surrounds separately from the putting surface to account for differences in water use requirements relative to mowing height and turfgrass species. Irrigation scheduling should be based upon a combination of weather data and frequent monitoring of soil moisture to prevent excess irrigation. Finally, having a state-of-the-art irrigation system and employing proper irrigation scheduling methods will significantly reduce but not eliminate the need to hand water.

TREES

Trees contribute to poor drainage by blocking sunlight and air circulation, which reduces both evaporation and transpiration of moisture from the turf canopy. As a result, irrigation must be restricted accordingly to account for reduced water loss. Remove trees that block the direction of the prevailing wind and sunlight, especially during the morning hours when photosynthesis is optimal and in order to dry out the turf canopy to reduce disease incidence. If that is not possible, use fans. These will artificially elevate the evapotranspiration rate and help the turf pull more water from the soil, thereby aiding in drainage.

TRAFFIC

Wet turf is particularly susceptible to wear damage and soil compaction caused by concentrated traffic from equipment and golfers. Switching from triplex to walk-behind mowers, and from grooved to solid front rollers on the cutting units can help reduce turf wear, especially on poorly drained greens. Removal or repositioning of trees, bunkers, or other obstructions around the green can help to improve traffic distribution. Raising the height of cut is the easiest way to increase cupping area on sloped greens without having to level, add to, or rebuild putting greens. Finally, increasing cultivation practices such as aeration and sand topdressing will help reduce surface compaction and improve drainage.

SIDE-HILL SEEPAGE OR RUNOFF

Look for drainage challenges that may be caused by excess water from neighboring slopes. The best solution for side-hill seepage is to install an interceptor or curtain drain just above the wet area near the base of the slope. The bottom of the trench should be positioned just into the less-permeable subsoil and then back-filled with stone or highly permeable sand and drainage pipe. More than one interceptor drain may be necessary, depending upon the depth and volume of water entering the green.

Repeated applications of the deep drill or tine and sand fill procedure usually helps to improve wet greens short of drainage installation or total reconstruction.

SURFACE DRAINAGE

The presence of puddling in low areas of a green following irrigation or natural precipitation is a sign of poor surface drainage. This phenomenon can be caused by poor design and/or construction, or by settling over time. Poor surface drainage can be overcome by additional and selective topdressing of low areas. Broader low areas may require removal of the sod, regrading of and/or addition to the underlying soil, followed by replacement of the sod. Inadvertent topdressing applications to collars may create a "lip" that prevents positive surface drainage from the edge of the green. Extra aeration with core removal and rolling may solve this problem; however, for severe cases, regrading may be necessary.

In extreme cases, for example on a punch-bowl green, it may become necessary to install a surface inlet drain at the lowest point in the depression. Although this type of drain can obstruct playability, it will allow a large volume of water to leave the surface and enter the collector pipe. Be sure to use a large enough grate and pipe to handle the surface water and install a trap to capture sediment or debris before it enters the drainage system.

STEP TWO: LOOK DOWN

After looking around, next grab your soil probe or profiling tool to examine the soil profile. The initial evaluation can be subjective in nature, looking for clues such as color, hardness, root distribution and depth, presence of thatch, or any other visible layers. The most common causes of soil-related poor drainage are layering and impermeable soil.

LAYERING

Layering can be caused by excessive thatch accumulation, poor construction methods, inconsistent use of cultivation practices, including topdressing materials and the frequency of application, or continued use of the same cultivation

Installation of slit drainage is effective, but it is usually more disruptive than subsurface drainage.

practice whereby a "plow-pan" or compacted area develops underneath the penetration depth of the tine or implement. Most of the time, layering problems can be alleviated by aggressive conventional and/or deep-tine aeration combined with sand topdressing to maintain the integrity of the channels.

IMPERMEABLE SOIL

One of the most common causes of poor drainage is impermeable soil underneath the green. The desire to save a buck or two during construction can often lead to use of an improper or poorly drained rootzone mix. On the other hand, even an ideal rootzone mix can become poorly drained if cultivation practices such as aeration, verticutting, and topdressing are not performed as needed to minimize organic matter accumulation. Poor drainage is often associated with greens that were constructed using finer-textured native soils. Over time, drainage in these greens usually worsens due to organic matter accumulation, increased play and resultant compaction, and changes in equipment, irrigation, and other maintenance practices.

If the drainage problem is not too severe, then aggressive aeration and sand topdressing will likely improve the soil to a point where no further action is needed. In more severe cases, it would be best to have an accredited soil testing laboratory conduct a more objective analysis of the soil. The laboratory will provide instructions for submitting undisturbed soil profiles from the green(s) in question using PVC pipe. A complete physical analysis is usually conducted on two or more sections of the profile to determine particle size distribution, density, infiltration rate, porosity, and organic matter content. In most situations, recommendations for improving drainage in impermeable soil will involve either installation of drainage or complete reconstruction of the putting green. The two most common methods of drainage used today in the Northeast are slit drainage and subsurface drainage.

Subsurface drainage installation is tedious work that is often best left to the expertise of a drainage contractor.

Slit drainage can be installed using a customized vibratory plow, which injects coarse sand into veins that are approximately 1 inch wide, 12 inches deep, and on 1- or 2-foot spacing, depending upon subsoil composition, compaction, and surface pitch of the green. Veins are extended away from the green to a low point and then connected into a dry well or interceptor drain. Approximately two tons of material are injected per 1,000 linear feet of drainage installed, equaling about 12 tons for a 6,000-square-foot green. The top of the sand is made flush within a half inch of the putting surface, and then the green is blown, brushed, rolled, and smoothed with topdressing sand in preparation for play.

There are various procedures for installing subsurface drainage. The most critical components include: identification of outlet drain(s); arrangement of laterals, depending upon soil characteristics and perpendicular to the general slope of the green; excavation of narrow trenches by careful removal of sod and underlying soil where the drainage pipe will be placed; installation of 2- or 3-inch-diameter perforated drainage pipe surrounded by gravel or pea stone; backfilling of the trench with a rootzone mixture (something on the order of 60% sand, 20% soil, and 20% peat) using careful tamping along the way to prevent settling; and replacement of the original sod followed by more tamping and hand topdressing to smooth out the surface. Use of narrow trenches and pipe and a "dirty" rootzone mix is critical to prevent drought stress. Also, pipes should be extended out of the high end of the green cavity and marked with a metal tag so they can be located and flushed out if necessary.

The decision to install either type of drainage system is usually based upon several factors, including size and scope of the drainage problem, timing of the project, and availability of the contractor. While subsurface drainage can be installed in-house (see "Wet Greens: Let's Try This First"), the work is tedious and is best left to an experienced contractor who can complete the project on an average-sized green in one day with little or no disruption of the putting surface. Installation of slit drainage is equally or more rapid compared to subsurface; however, the putting surface will likely not be smooth afterwards, and repeated aeration and/or topdressing may be necessary to smooth it to an acceptable degree. Longevity is another consideration when choosing a drainage method, and it would be logical to assume that wider trenches that contain pipe will last longer than narrower veins of sand. The narrow slits may function well initially, but they will likely become silted in from the surrounding soil and eventually become non-functional. Nevertheless, the author has observed continued success of greens with slit drainage more than five years after installation.

FINAL STEP: RECONSTRUCTION

Unfortunately, many courses skip either or both of the two first steps in identifying and solving drainage problems and go straight to complete reconstruction of a green, only to be disappointed later when poor drainage is not solved and playability is far different from the remainder of the greens. In the event that all other measures have been exhausted and reconstruction is necessary, now is not the time to cut corners in the interest of saving money or time. Working together with your agronomist and a soil testing laboratory, it is possible to construct a green that closely matches the others in terms of playability without compromising drainage, drainage, drainage!

REFERENCES

Carpenter, L., and D. A. Oatis. 1994. Wet Greens: Let's Try This First. *USGA Green Section Record*. 32(4):5-8.

Kelly, J., and S. Ami. 2004. Solving Drainage Problems. *Greenmaster.* 39(3):26-28.

McAuliffe, K. W. 1992. Drainage Improvement — Remedy Without Reconstruction in New Zealand. *USGA Green Section Record*. 30(2):6-10.

Snow, J. T. 1991. Finding Solutions for Poorly Drained Greens. *USGA Green Section Record*. 29(1):10-14.

DR. JIM BAIRD *is an agronomist in the Northeast Region of the USGA Green Section.*

Rootzone Depth Affects Putting Green Performance

Research at Michigan State University demonstrates how varying putting green rootzone depth affects moisture retention.

BY KEVIN W. FRANK, B. E. LEACH, J. R. CRUM, P. E. RIEKE, B. R. LEINAUER, T. A. NIKOLAI, AND R. N. CALHOUN

The United States Golf Association (USGA) introduced putting green construction guidelines 45 years ago, and since then the USGA green has become the standard for golf course putting greens. The concept behind the USGA guidelines is to build a green that provides a measure of resistance to compaction in the rootzone and drains quickly to an optimum soil moisture level.[5] Specifications for a USGA putting green require that the sandy rootzone mixture be placed at a uniform depth of 12 inches, plus or minus one inch, across the entire surface of the green. If greens lacked slopes, there is little doubt that most, if not all, USGA greens would perform well. However, with the severe slopes present on some putting greens today, USGA greens do not always perform ideally.

Putting greens constructed to USGA specifications function very well on a relatively level surface[4]; however, when the green has undulating areas, moisture extremes in the rootzone can lead to turfgrass decline.[3] Two conditions associated with moisture extremes in the rootzone are localized dry spot (LDS) and black layer. Both impair turfgrass growth and can be problematic on undulating sand-based putting greens.

Moisture variability problems on USGA putting greens could be attributed to the uniform depth of the rootzone layer. In theory, on a level surface, there is minimal lateral flow of water within the rootzone and the putting green drains at a uniform rate. However, Nektarios et al.[2] have shown that drainage in the rootzone is not always uniform. In an unsaturated putting green rootzone, water does not drain from the rootzone into the gravel layer, thereby allowing water to move laterally along the rootzone/gravel layer interface to lower elevations in the green. The resultant problems associated with this down-slope water movement are particularly evident at the higher elevations of the green, where hand watering is often necessary to prevent turf decline.

Research was initiated to investigate if altering the rootzone depth, decreasing it in high areas and increasing it in low areas, would increase the water content near the soil surface in high areas and decrease the water content near the soil surface in low areas. Our research objective was to determine if modifying the rootzone depth increases soil moisture uniformity across the slope of an undulating sand-based putting green.

MATERIALS AND METHODS

A sloped USGA putting green was constructed at the Hancock Turfgrass Research Center on the campus of Michigan State University in 1998. The putting green was designed for monitoring the down-slope movement of water in the rootzone. Time domain reflectometry (TDR) instrumentation was installed in the green to monitor soil volumetric water content (VWC).

The putting green was constructed with a summit 1.2 feet in height, with two downhill slopes of different magnitude. The peak of the summit was constructed 26 feet from the northern edge of the green and 55 feet from the southern edge. The putting green has a 7% north slope and a gradual 3% south slope. These slope gradients were chosen to represent average and extreme slopes that occur on modern USGA-recommendation putting greens.

The putting green was divided into 12 plots, 8 feet wide and 80 feet long. Six test plots were built to USGA specifications consisting of a uniform depth rootzone (12 inches). The remaining six test plots were built with a variable depth rootzone: 8 inches at the summit and gradually increasing in depth to 16 inches at the base of the slopes (toe slopes, Figure 1). Three rootzone mixes were used in the construction of both the USGA (uniform depth) and variable depth plots: sand, 85:15 sand/peat (reed-sedge), and 85:15 sand/soil. A polyvinyl chloride liner was placed between adjacent plots to prevent the lateral movement of water between plots.

Prior to construction, rootzone materials were tested for particle size distribution, organic content, and soil physical properties following USGA guidelines.[1] The sand/peat rootzone mix conformed to USGA specifications, but the sand/soil and sand rootzone mixes

Figure 1

Cross section view of the standard USGA and variable-depth construction methods. Mean percent volumetric water content for the 0- to 4-inch depth level is presented for day 3 of the dry-down period (2000-2002).

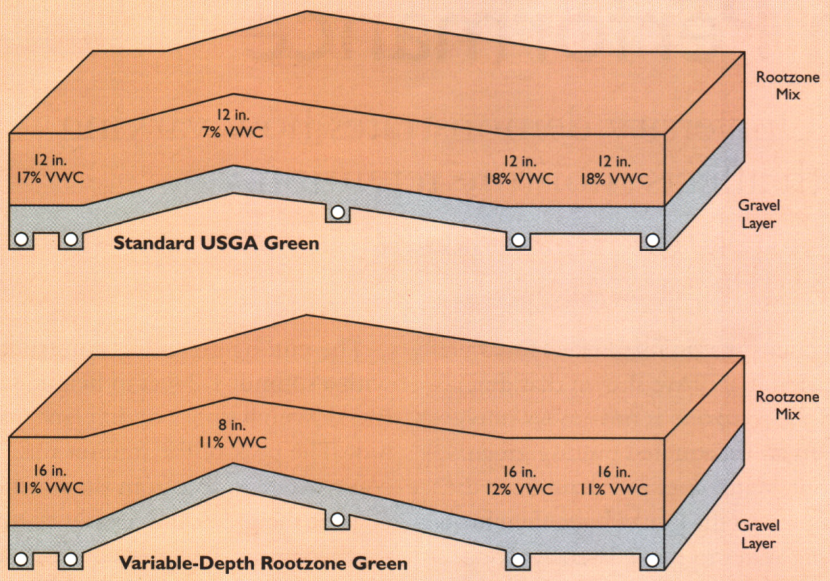


Table 1

Rootzone mix physical properties and particle size distribution.

Physical Properties	USGA Recommendation*	Rootzone Mix: Sand	Sand/Peat	Sand/Soil
Organic Matter (%)	1-5	1.20	3.20	2.00
Hydraulic Conductivity (cm hr^{-1})	Minimum 15	86.20	27.90	15.70
Bulk Density (g cm^{-3})	N/A	1.75	1.57	1.74
Particle Density (g cm^{-3})	N/A	2.64	2.35	2.66
Porosity:				
Total (%)	35-55	35.20	42.80	36.00
Capillary at 40cm tension (%)	15-25	8.90	16.70	15.80
Air Filled at 40cm tension (%)	15-30	27.30	26.10	20.20
Particle Size (mm)			%	
2.0 - 3.4†	Maximum 10	0.1	0.1	0.8
1.0 - 2.0		7.6	7.3	12.0
0.5 - 1.0	Minimum 60	26.0	25.4	24.6
0.25 - 0.50		45.4	46.6	36.8
0.15 - 0.25	Maximum 20	19.1	18.3	16.6
0.05 - 0.15‡	Maximum 5	0.6	1.1	1.3
0.002 - 0.05‡	Maximum 5	1.2	1.2	7.9
<0.002‡	Maximum 3			

*The USGA Green Section Staff, 2004
†Maximum of 3%, preferably none
‡Maximum of 10% total between the three categories

did not conform (Table 1). The sand/soil rootzone did not conform to specifications because of particle size distribution. The sand rootzone mix did not conform to USGA specifications for hydraulic conductivity and percent capillarity.

After the construction of the putting green was completed, 108 TDR probes (locally manufactured by B. R. Leinauer) were buried in the soil to measure volumetric soil moisture at four locations within each test plot: probe location 1 at the base of the north slope, probe location 2 at the summit, probe location 3 at the base of the south slope, and probe location 4 in the middle of the south toe slope (Figure 1). The TDR probes were positioned in the soil at a 45-degree angle to measure VWC at depths of 4-8, 8-12, and 12-16 inches. A hand-held TDR was used to record VWC at the four locations of the surface (0-4 inches).

After installation of the TDR probes in the summer of 1998, the putting green was seeded with L-93 creeping bentgrass. To evaluate soil moisture relationships, the putting green was subjected to "dry-down" cyles, with four cycles in each year from 2000 through 2002. Dry-down cycles were scheduled during dry periods without rainfall, and no irrigation was applied to the putting green. During each cycle, VWC was monitored daily with the TDR probes at the four locations in each plot. VWC was recorded at each location at depths of 0-4 inches and 4-8 inches. At the locations where depths were present, VWC was recorded at 8-12- and 12-16-inch depths.

Each dry-down cycle began with uniform, healthy turf across the entire putting surface. To establish near field capacity soil moisture content, irrigation (1 inch) was applied the night before each cycle, and the morning of "day 0" (0.5 inch). After the morning irrigation, TDR readings were taken at the four locations on each individual plot. The TDR readings were taken at 24-hour intervals for the length of the cycle.

\Table 2

Mean percent volumetric water content for the different rootzone types.

0-4 Inches Depth	Sand	Sand/Soil	Sand/Peat
	----------------	% ----------------	
Aug. 23, 2000	15B†	25A	27A
Aug. 24, 2000	14C	21B	24A
Aug. 25, 2000	13C	18B	23A
Aug. 26, 2000	12C	18B	23A
July 23, 2002	18C	25A	27A
July 24, 2002	17B	23A	27A
July 25, 2002	14B	20A	21A
July 26, 2002	12B	18A	21A
Sept. 28, 2002	20B	27A	29A
Sept. 29, 2002	16B	22A	25A
Sept. 30, 2002	18B	24A	25A
Oct. 1, 2002	13C	21B	24A
4-8 Inches Depth			
July 10, 2002	17B	20A	22A
July 11, 2002	15B	19A	20A
July 12, 2002	14B	18A	20A
Sept. 28, 2002	18‡	20	31
Sept. 29, 2002	15B	19AB	22A
Sept. 30, 2002	16	19	21
Oct. 1, 2002	15B	17AB	21A

†Means in a row followed by the same letter are not significantly different according to t-test ($p=0.05$)

‡Data not followed by letters are not significantly different

Each dry-down cycle was ended after either 3 or 4 days, at which time there were visible signs of severe turfgrass moisture stress on the sand rootzone plots at the peak of the summit.

Statistical analysis was conducted independently for each day and for the measurement depths 0-4 and 4-8 inches, as these were the only depths present at each location within each test plot. Coefficient of variation (CV) was calculated for VWC data in each plot and analyzed for treatment differences. The CV is a relative measure of variation in the data, and it was used to assess the variability of VWC across the slope of the putting green.

RESULTS

Differences in Rootzone Type

VWC for rootzone type, when averaged across the two construction types, was significantly different throughout the dry-down cycles in 2000 and 2002. For the 0-4-inch depth, for the majority of sampling days, there were no differences in VWC among the sand/soil and sand/peat rootzones (Table 2). The sand rootzone consistently had the lowest VWC. For the 4-8-inch depth, the results were similar. There were no VWC differences between the sand/soil and sand/peat rootzones, and the sand rootzone had the lowest VWC. The results indicate that regardless of construction type, the water-holding capacity of the rootzone mixes containing soil or peat is higher than the sand rootzone. Sand rootzones with peat or soil added should not see the extremes in VWC that are often encountered in 100% sand rootzones.

Among USGA greens, the sand rootzone had the highest CV, indicating that the sand rootzone green had the greatest variation in VWC across the slope of the green. Generally, for the USGA greens, there were either no differences in CV among the sand/soil and sand/peat rootzones, or the sand/peat rootzone had the lower CV. For the variable-depth rootzones, there were either no differences in CV among the rootzones or the sand rootzone had the highest CV.

Differences in Construction Type

Comparisons between the two construction types reveal that uniform-depth sand greens had a higher CV than variable-depth sand greens on almost all dates. For the sand/soil greens, there were no differences between the construction types in 2000, but in 2002, the variable-depth rootzones had a lower CV on three of four dates. The sand/peat rootzones did not have a different CV, regardless of construction type. The CV data support our hypothesis that by altering the rootzone depth, the variability of VWC across the slope of the green, especially for the sand rootzone greens, can be greatly reduced.

Mean VWC:
Construction Type and Soil Type

On day zero, the greatest difference in VWC among sampling locations for all rootzone mixes with variable depths was 4%. On day three, the greatest difference among sampling locations was still only 4%.

Differences in VWC among locations remained consistent as the green dried down. In contrast, for USGA greens (with uniform rootzone depths), the greatest difference in VWC among locations on day zero was 6% and for day three was 11%. The differences between USGA (uniform depth rootzone) and variable-depth rootzone construction types on day zero was small (2%), but by day 3 was large (7%). These data further support our conclusions that for variable-depth rootzones, VWC was more uniform across the green.

Also, the difference in VWC among the sampling locations explains the high CV of the standard-depth greens. For the uniform-depth sand greens on day 3, the range in VWC included a low of 7% at location 2 (summit of slope) and

Table 3

Coefficient of variation for volumetric water content for construction and rootzone type, 0-4 inches rootzone depth.

	Construction Type	Sand	Sand/Soil	Sand/Peat
2000		------- Coefficient of Variation	-------	
Aug. 23: Day 0	Standard	31	12	9
	Modified	12	11	9
Aug. 24: Day 1	Standard	44A† a‡	15Ba	20Ba
	Modified	20Ab	18Aa	16Aa
Aug. 25: Day 2	Standard	38¶	16	13
	Modified	29	16	25
Aug. 26: Day 3	Standard	43Aa	19Ba	16Ba
	Modified	11Ab	17Aa	15Aa
2002				
July 23: Day 0	Standard	24Aa	24Aa	8Ba
	Modified	14Aa	10Ab	14Aa
July 24: Day 1	Standard	30	21	10
	Modified	10	12	12
July 25: Day 2	Standard	45Aa	35Ba	15Ca
	Modified	32Ab	19Bb	19Ba
July 26: Day 3	Standard	42Aa	32Ba	22Ca
	Modified	22Ab	13Bb	16ABa

†Means in a row followed by the same upper-case letter are not significantly different according to t-test (p=0.10)

‡Means in a column, for each date, followed by the same lower-case letter are not significantly different according to t-test (p=0.10).

¶Data not followed by letters are not significantly different

Table 4

Mean percent volumetric water content for the 0- to 4-inch depth, 2000-2002.

	Location 1	Location 2	Location 3	Location 4
Day 0				
USGA Sand	21	15	21	20
USGA Sand/Peat	30	26	28	27
USGA Sand/Soil	29	23	27	25
Modified Sand	16	17	18	17
Modified Sand/Peat	26	28	24	24
Modified Sand/Soil	24	26	22	22
Day 3				
USGA Sand	17	7	18	18
USGA Sand/Peat	27	20	26	25
USGA Sand/Soil	27	16	24	21
Modified Sand	11	11	12	11
Modified Sand/Peat	21	22	18	19
Modified Sand/Soil	18	19	16	15

a high of 18% at locations 3 and 4 (Figure 1). In contrast, for the variable-depth sand greens, there was only a 1% difference in VWC among the locations.

CONCLUSIONS

The USGA specifications for putting green construction, first published in 1960, were designed to improve the quality of putting greens. Although the USGA has published several revisions, most recently in 2004, the recommendation for a uniform 12-inch rootzone layer has remained unchanged. The layering of a sand-based rootzone mix over a gravel layer maintains optimum moisture across the putting green on a relatively level putting surface; however, in areas of undulation the uniform rootzone depth can result in moisture extremes at the different elevations.

Our research confirmed that the addition of peat and/or soil to the rootzone mix increased water-holding capacity. Modifying the depth of the sand rootzone improved the uniformity of VWC across the surface of an undulating putting green. When soil or peat was added to the sand rootzone, extremes in soil moisture content between the high and low elevations of the green were reduced, regardless of construction type. For greens constructed with a 100% sand rootzone, it would be beneficial to modify the depth of the rootzone (i.e., shallower in high areas and deeper in low areas) to maintain uniform soil moisture content across the surface of the putting green. Although varying the rootzone depth in this way helps even out rootzone water content, constructing greens in this way may be too impractical and is not currently part of USGA putting green recommendations.

Even if greens are not constructed with a variable-depth rootzone, this research reveals the importance of closely following rootzone depth specifications during construction. Special attention should be given to following rootzone depth specifications

Researchers at Michigan State University investigated the hypothesis that reducing rootzone depth in higher-elevation areas and increasing depth of the rootzone in lower-elevation areas of contoured putting greens may result in more even moisture distribution across the entire putting green.

during construction and not making alterations based on aesthetics. In certain situations, rootzone material unfortunately is excavated from lower areas and moved to other regions of the green to increase elevation changes. The result is that the green would have a shallower rootzone depth in low areas and rootzone depths in excess of 12 inches in higher areas, a worst-case scenario. At a minimum, this research emphasizes the importance of closely monitoring construction activities to ensure that higher points in contoured putting greens do not have rootzone depths greater than 12 inches, which would cause "hot spots," and low points do not have rootzone depths that are too shallow, which could create excessive moisture conditions.

LITERATURE CITED

1. Hummel, N. W. 1993. Laboratory methods for evaluation of putting green rootzone mixes. *USGA Green Section Record*. 31(2):23-33.

2. Nektarios, P. A., T. S. Steenhuis, A. M. Petrovic, and J.-Y. Parlange. 1999. Fingered flow in laboratory golf putting greens. *J. of Turf. Mgt.* 3(1):53-67.

3. Prettyman, G., and E. McCoy. 1999. Subsurface drainage of modern putting greens. *USGA Green Section Record*. 37(4):12-15.

4. Taylor, D. H., S. D. Nelson, and C. F. Williams. 1993. Sub-root layering effects on water retention in sports turf soil profiles. *Agron. J.* 85:626-630.

5. U.S. Golf Association Green Section Staff. 2004. USGA Recommendations for a Method of Putting Green Construction. USGA World Wide Web Site. http://www.usga.org/turf/-course construction/green articles/putting green guidelines.html.

Editor's Note: A more complete research report on this study may be found at: http://usgatero.msu.edu/-v04/n11.pdf.

KEVIN W. FRANK, PH.D., *Assistant Professor;* BRIAN E. LEACH, *former M.S. student;* JIM R. CRUM, PH.D., *Professor;* PAUL E. RIEKE, PH.D., *Professor, Plant and Soil Sciences Department, Michigan State University, East Lansing;* BERND R. LEINAUER, PH.D., *Assistant Professor, Extension Plant Sciences, University of New Mexico, Las Cruces;* THOMAS A. NIKOLAI, PH.D., *Academic Specialist; and* RONALD N. CALHOUN, PH.D., *Environmental Turfgrass Specialist, Plant and Soil Sciences Department, Michigan State University, East Lansing.*

Southwestern Golf Courses Offer Needed Riparian Habitat for Birds

A comparison of golf courses with natural areas underscores the importance of golf courses as bird habitat.

BY MICHELE MEROLA-ZWARTJES AND JOHN P. DELONG

Most studies of birds in urban areas have reported a decrease in avian species richness and/or diversity in association with urbanization, although density typically increases. In the southwestern United States, the greatest diversity of breeding birds is normally found in riparian habitats (areas surrounding rivers or lakes). It is estimated that the bird diversity in riparian zones surpasses that of all other western habitat types combined.

In a region characterized by low rainfall and often sparse vegetation, riparian zones act as an oasis for both migratory and resident birds, offering a relative abundance of the critical elements of water, food, and cover. Natural riparian systems are quickly disappearing, however, in response to the demands of a growing human population on these areas for water, recreation, and development, as well as degradation due to factors such as flood control efforts and improper grazing practices. Estimates are that up to 95% of western riparian habitats have been lost or degraded over the past century, and many of the bird species associated with these systems have been driven out or have experienced severe declines.

This pond at the UNM Championship Course demonstrates how golf courses may provide habitats that are very similar in structure and composition to natural riparian habitats. Cottonwoods, willows, and cattails surround the water, providing habitat for a variety of bird species, including red-winged blackbirds, black-crowned night herons, warbling vireos, yellow warblers, and western tanagers. Thirty-four species of birds were detected on this course, and 21 of these were riparian-associate species that were not found on the paired reference site.

SOUTHWESTERN GOLF COURSES

Most golf courses in the Southwest provide a combination of habitat characteristics that are reminiscent of the riparian systems used by western birds. They often have permanent water sources, used as either water hazards, for irrigation, or both. They have deciduous trees that provide cover, shade, nest sites, and food. Depending upon the extent, composition, and structure of the vegetation in out-of-play areas, golf courses may potentially offer rewarding foraging and/or nesting habitat for birds that utilize shrub habitats as well as those that forage on the turf or in the canopy.

Given the extensive loss of riparian systems throughout the West and the potential similarity of habitats on golf courses to those of riparian areas, we were interested in determining whether golf courses might possibly serve as surrogate riparian habitats for breeding birds in the Southwest. We hypothesized that golf courses in the Southwest would not only have greater avian species richness and abundance when compared to the surrounding natural environment, but that the golf courses would also support a greater number of bird species normally associated with riparian areas. The goals of our study were to determine: (1) how the presence of a golf course impacts the native bird community through comparisons of abundance, species richness, diversity, evenness, and productivity between five golf courses and five undisturbed reference areas assumed to represent the original bird communities; (2) whether golf courses support high numbers of typically riparian bird species; and (3) if possible, identify those features of golf courses that are most conducive to supporting high numbers of native and riparian bird species.

STUDY SITES

Our study sites were five golf courses and five paired reference sites in the high desert region of Albuquerque, New Mexico. Courses were chosen to represent a range of vegetation types, course features (e.g., water sources), and landscape settings. The participating golf courses were the Albuquerque Country Club (ACC), Four Hills Country Club (FH), Paradise Hills Golf Club (PH), PaaKo Ridge Golf Club (PK), and University of New Mexico Championship Course (UNM).

A paired reference site was selected for each golf course. Reference sites were nearby natural areas that reflected, as much as possible, the habitat conditions that would have been present prior to the construction of the companion course. The purpose of these reference sites was to provide an avian community baseline. Birds on the reference sites were assumed to represent the original bird community for its paired golf course.

RESULTS OF THE TWO-YEAR STUDY

Golf courses supported a greater number of birds than surrounding natural areas, a response that is common throughout studies of avian responses to urbanization. In contrast to many such studies, we also found increased avian species richness on most of the golf courses, as well as increased diversity. The increase in avian abundance on golf courses was to a large degree at the expense of more specialized native bird species, as has been witnessed in numerous other studies of urbanization effects. We found that a relatively few widespread and abundant species made up the majority of individuals detected (including, but not limited to, house sparrows, house finches, common grackles, and European starlings), comprising from 69% to 76% of the individuals detected on three out of the five courses.

Although they had fewer species, the reference sites were composed primarily of native bird species, and these communities were more even in their distributions. The PaaKo Ridge golf course was exceptional in several aspects, as it demonstrated greater species richness and diversity, and similar evenness, when compared to its natural area reference site, and it was the only course that did not have significantly fewer native individuals.

Species richness of native birds was greater on golf courses, in contrast to the results of many other studies of birds in urban environments. This result held across all five of the courses we studied. The abundance of these native birds was not as great as that of cosmopolitan or introduced species, but golf courses supported numerous native bird species that were not components of the avian community in the surrounding natural areas. Of birds that were exclusive to our golf course observations, 54 (83%) were native species that we did not consider to be cosmopolitan or introduced species.

Furthermore, we found strong support for our hypothesis that golf courses would provide habitat for riparian birds. More than 70% of the species observed exclusively on golf courses were riparian associates. The numbers of individuals in this group were relatively low, particularly once we excluded those that are also considered cosmopolitan species (e.g., American robin). Still, 25% of the birds observed on golf courses were riparian associate species that were not represented in our samples of the surrounding natural area bird communities.

Pied-billed grebe. Photo by Dennis Larson, courtesy U.S. Fish and Wildlife Service.

Our results add support to the hypothesis that avian species richness and/or diversity does not respond to urbanization in a linear fashion, but instead peaks at a level of intermediate disturbance or development. At the higher levels of urbanization, most of the land area is dominated by buildings or paved areas, and any vegetation is primarily ornamental. Golf courses, however, represent an intermediate level of development in which most of the land area is still vegetated, some areas of native habitat may remain, and trees and ponds are common. Habitat diversity may actually increase under such a scenario, as structural diversity is added through changes in vegetation as well as the introduction of buildings and other structures that may serve as nest sites or perch sites, and openings are created for edge species. Moderate levels of development may increase food resources for some guilds of birds. Scavenging opportunities increase, and areas of lawn or turf are capable of supporting high numbers of ground-foraging birds.

The ponds on the desert golf courses attracted birds such as this black-crowned night heron. Photo by Lee Karney, courtesy U.S. Fish and Wildlife Service.

GOLF COURSE OASES IN THE DESERT LANDSCAPE

This potential increase in habitat diversity at low to moderate levels of development is particularly noticeable in the desert landscape. In general, there is a strong positive correlation between bird species diversity and habitat diversity such that any increase in habitat diversity, particularly in a relatively simple landscape such as a desert, is likely to result in increased species richness. The features added to the landscape during the development of a golf course often stand in sharp contrast to those of the desert environment. Courses may provide numerous shade trees, water sources, turf, structures, and vegetation types that are not available in the surrounding natural areas.

Riparian-like habitats surrounding ponds on the UNM Championship Course offer tall broad-leaved trees, multiple understory vegetation layers, and abundant water with emergent vegetation — all features that are absent from the desert habitat in the immediate area. In conjunction with numerous out-of-play areas dominated by remnant native shrublands and expansive open areas of turf, this golf course collectively provides a range of habitats that supports a wide variety of birds, including such diverse species as yellow warblers, spotted sandpipers, greater roadrunners (*Geococcyx californianus*), ash-throated flycatchers, northern rough-winged swallows, and American robins. Given this diversity of habitat types, it is hardly surprising that the UNM course had a greater number of species, including greater numbers of native species, than its comparison reference site. This contrast in habitat diversity associated with greater species richness was also apparent at the golf courses at Four Hills, Paradise Hills, and PaaKo.

The impact of a golf course on avian community composition in the desert environment appears to be very different from that of one that may be constructed, for example, in a forested area. In other studies, increased development in hardwood forests led to a loss of canopy-foraging or bark-gleaning birds, since canopy trees were lost from the habitat. This is consistent with the observation that the loss of bird diversity is likely when development occurs in an area that had an initially high diversity of habitats.

By contrast, the addition of a golf course actually added this component of habitat diversity (high canopy trees) at three out of five of our study sites (Four Hills, Paradise Hills, and UNM), thereby attracting canopy species or bark-gleaners that would not otherwise be present in the avian community. Several of the species that decreased in response to urbanization in these other studies (1, 2) were species that we detected exclusively on the golf courses in our study, including northern flickers, white-breasted nuthatches, downy woodpeckers, cliff swallows, and western wood-pewees. The only course we studied that had less habitat complexity and structural diversity than its reference site, the Albuquerque Country Club, was also the only course that had lower bird abundance, species richness, and diversity. Our study suggests that in the structurally simple desert landscape, the additional resources and habitat complexity provided by golf courses result in increased avian abundance and

The western tanager was one of the native species observed on several golf courses, but not on any of the paired reference sites in this study. Photo by Gary Kramer, courtesy U.S. Fish and Wildlife Service.

species richness, including increased native species richness.

ECO-FRIENDLY CHARACTERISTICS OF PAAKO RIDGE

Certain characteristics of the PaaKo Ridge golf course deserve attention, as this course was exceptional in both the abundance and diversity of native bird species. PaaKo is what has been termed a "naturalistic" golf course, one that retains "the native vegetation, land form, soils, and typical habitat units of a region." The course at PaaKo is based upon the natural topography of the Sandia foothills, turf is minimized, and the out-of-play areas are indistinguishable from the surrounding pinyon-juniper woodlands. PaaKo was the only course that had greater abundance, species richness, diversity, and comparable evenness of native species with its reference site; 76% of the individuals observed at this course were native species. No native species were excluded from the PaaKo course, and 27 species were added to the community. PaaKo was also the only course where native cavity-nesters used the nest boxes, and the productivity at the golf course was comparable to that of the comparison natural areas.

In addition to increased habitat diversity, the greater native species richness at PaaKo, and the continued dominance of its avian community by native species is likely attributable to the extensive areas of undisturbed native vegetation on the course. Increased numbers of native bird species and the ability to exclude invasive avian species are associated with the amount of native vegetation present.

WHAT WE LEARNED

Golf courses in the high desert area of Albuquerque have the potential to support large numbers of native bird species. In addition, the resources and habitat diversity provided on these courses may mitigate, to some extent, the loss of riparian systems in the Southwest. However, the conservation value of golf course habitats in this desert region could be improved to support greater numbers of native birds and exclude more invasive exotics or pest species by increasing the complex vertical structure and diversity of plant species composition in the out-of-play areas on the courses, and, in particular, by increasing the extent and usage of native plants. Such improvements, even on a very small, localized scale, have the potential to effect changes in bird species composition, and golf courses that are dominated by native vegetation may support significant numbers of native bird species.

Our data showing increased species richness of native birds, and particularly high numbers of riparian species on these courses, demonstrate that these golf courses may be capable of providing valuable stopover habitat for the numerous species of migratory birds that utilize riparian corridors in the Southwest. The potential for desert golf courses to serve as surrogate riparian areas for these species has important conservation implications, as many migratory birds in the western U.S. are currently experiencing population declines associated with the loss of riparian habitats.

The relatively simple habitat structure of the reference site for the UNM Championship Course can be deduced from this photograph. This undeveloped natural area, located directly across from the golf course, offers less for many bird species in terms of habitat diversity, complexity, and resources, which is reflected in lower overall species richness (16 species). However, this site did support some of the desert specialist species that were not detected on any of the golf courses in our study, including scaled quail and burrowing owls.

Editor's Note: For a more complete report of this research, including comparative tables of observed bird species, methodology, and graphs of the results, visit the USGA's Turfgrass and Environmental Research Online at http://usga-tero.msu.edu/v04/n14.pdf. TERO publishes the results of studies funded through USGA's Turfgrass and Environmental Research Program.

Michele Merola-Zwartjes, Ph.D., *and* John P. DeLong, Ph.D., *USDA Forest Service, Rocky Mountain Research Station, 333 Broadway SE, Suite 115, Albuquerque, NM.*

Hole-in-the-Wall Golf Club.

On Course *With Nature*

Great Results

Pictures of success.

BY JEAN MACKAY, NANCY RICHARDSON, AND JEREMY TAYLOR

Putting up nest boxes, planting aquatic vegetation, adding new natural areas, monitoring wildlife activities, leading tours, visiting school classrooms . . . these projects are all in a day's work for the people who spearhead participation in the Audubon Cooperative Sanctuary Program for Golf Courses (ACSP) and the Audubon Signature Program for properties under development. But the results that these dedicated environmental leaders have achieved are far from ordinary.

Since pictures speak a thousand words, we thought we'd share a small sampling of photographs that speak to the many and varied successes Audubon International program members have achieved. Results like these send a strong message that environmental stewardship is as great for golf as it is for the many wildlife species and natural areas that give the game its distinctive natural heritage.

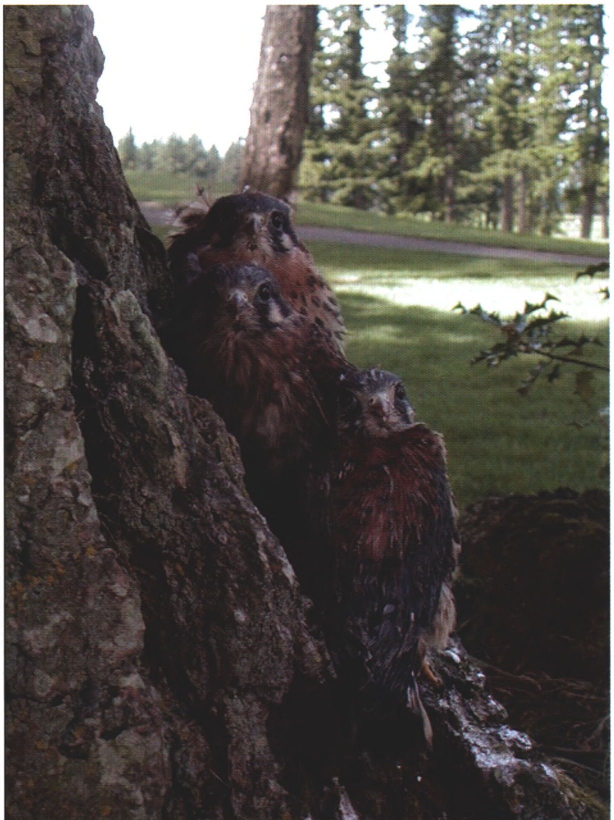
HOLE-IN-THE-WALL GOLF CLUB

Naples, Florida; ACSP Golf Member since 1992; Certified since 1993

Club members and staff erected an osprey platform at the course nearly 10 years ago, but for years it remained unoccupied. Last summer, maintenance

Mississaugua Golf and Country Club.

staff reworked the platform, adding two perches and raising the sides so that it would more easily contain a nest and prevent it from blowing off in a storm. Audubon Steward Fred Yarrington reports that after 10 years of waiting, a pair of osprey successfully raised two young this past spring. "It's been a wonderful event," says Yarrington, "and without the ACSP, our membership might not have had the pleasure of watching two healthy birds develop."



Stone Creek Golf Club.

MISSISSAUGUA GOLF & COUNTRY CLUB

Mississaugua, Ontario, Canada; ACSP Golf Member since 2003

When the Mississaugua Golf & Country Club was built in 1906, the meandering Credit River that traverses the golf course had little development on its upper tributaries. Today, the river is surrounded by metropolitan Toronto. As a result, spring thaws brought increased urban runoff, flooding,

LaPlaya Golf Club.

erosion, and ice damage to the golf course. To remedy the situation, Superintendent Bob Brewster began working with regulatory agencies in 1998 to realign the Credit River to pre-1954 conditions. Brewster and his crew have worked diligently each year since to restore a healthy riparian corridor, taking special care to provide fish habitat. They added a number of pools, riffles, and lunkers (sheltered areas for fish that also help to stabilize stream banks) and hydro-seeded terrestrial and aquatic vegetation along the shore. Their efforts resulted in improved water quality and wildlife habitat, reduced erosion, and a visibly pleasing riverbank.

STONE CREEK GOLF CLUB

Oregon City, Oregon;
ACSP Golf Member since 2004
American kestrels are found throughout much of the United States and Canada, preferring open habitat areas where they can hunt for grasshoppers and other insects. The trio of juvenile kestrels in the photograph were caught on film at the base of a dead fir tree that contains their nesting cavity at Stone Creek Golf Club. The birds are ready to fly after a month of parental care in the nest. Credit for providing good habitat for kestrels and other wildlife is due to Superintendent David Phipps and his crew, who maintain the course in a natural style, with 21 acres of grassland and 30 acres of wooded habitats and natural pond edges complementing more manicured in-play golfing areas.

LAPLAYA GOLF CLUB

Naples, Florida;
ACSP Golf Member since 2002
Since joining the ACSP in 2002, LaPlaya Golf Club, led by Superintendent Brian Beckner and assisted by local avian expert George McBath, has established a variety of nesting structures on the 155-acre golf course. Eastern bluebirds, great crested flycatchers, red-bellied woodpeckers, Carolina wrens, downy woodpeckers, and purple martins are among the birds that have moved in. But this year, Beckner and his crew were especially pleased to see Eastern screech owls take up residence for the first time, in a nesting cylinder placed in a pine scrub habitat, and 12 wood ducks fledged from nest boxes in the course's lakes. The photograph shows a screech owl in a nest box.

MESQUITE GROVE GOLF COURSE

Dyess AFB, Texas; ACSP Golf Member since 2000; Certified since 2000
In the past five years, Superintendent Danny Walters, along with Natural

Mesquite Grove Golf Course.

Resources Manager Kim Walton, and the crew at Mesquite Grove have converted more than 15 acres of formerly managed turfgrass into natural habitat areas. The taller grasses, along with preexisting woods, meadows, and lakes provide food and shelter for more than 100 species of birds, 14 mammals, and 18 species of reptiles and amphibians. Among the menagerie is the largest member of the tree squirrel group — the fox squirrel. Fox squirrels prefer woodland borders, where they feed on nuts, seeds, and fruit. The one in the photograph laid claim to one of the course's 30 nest boxes. Fox squirrels generally have two litters of three to five young each year.

OLD GREENWOOD

Truckee, California; Certified Gold Audubon Signature Sanctuary since 2005

Extraordinary measures were all in a day's work for Old Greenwood's Golf Course Superintendent Michael Cornette (on ladder), Director of Agronomy Joel Blaker, CGCS (top), and Randy Mezger of AMX Excavation (lower right) attempting to save a nesting cavity for resident Lewis's woodpeckers. The Jeffrey pine snag used by the woodpeckers was formerly located in a lot slated for residential development on the property. Staff relocated the dead tree to a conservation area onsite in hopes of drawing the woodpeckers away from development activity. Lewis's woodpecker (named for Merriweather Lewis, who first described it in 1805) is considered to be of high conservation importance because of its small and patchy distribution due to habitat degradation and loss of dead trees suitable for nesting and storing acorns and nuts.

Old Greenwood.

Audubon International staff JEAN MACKAY, *Director of Education;* JEREMY TAYLOR, *Ecologist; and* NANCY RICHARDSON, *Signature Program Director; work with members of the Audubon Cooperative Sanctuary and Audubon Signature Programs, sponsored by the USGA. Program information is available at* www.auduboninternational.org.




"Water Quality & Quantity Issues for Turfgrasses in Urban Landscapes" Workshop

Water management is a key component of healthy turfgrass, and it directly impacts plant health, as well as the potential for nutrient and pesticide losses into the environment. Increasing demands and competition for potable water throughout the United States require that grasses be irrigated more efficiently, even with non-potable water. This workshop will provide a comprehensive review of the technologies available to apply and use irrigation water more efficiently to meet turfgrass needs in diverse urban settings. Current science-based best management practices (BMPs) for efficient water use, including drought-tolerant grass species, grass use in xeriscapes, and integrated pest management (IPM) practices associated with nutrients and pesticides, will be discussed.

DATES

Monday, January 23 – Wednesday, January 25, 2006

PLACE

Renaissance Hotel, Las Vegas, Nevada

SPONSOR

The Council for Agricultural Science and Technology (CAST)

PROGRAM TOPICS

- Science-based summary of turfgrass and water management in urban landscapes.
- Summarize research on the impact of turfgrass management on water quality.
- Review the use of non-potable water sources and their impact on turfgrasses and the environment.
- Best management strategies and technologies to enhance environmental quality of urban turfgrass systems.

INTENDED AUDIENCE

Policymakers and regulators; professionals involved in plant physiology, breeding and genetics, turfgrass science and management, pesticide and fertilizer fate, hydrology, effluent water, soil science, water quantity/quality.

MORE INFORMATION

Dr. Jim Baker, Project Manager, jlbaker@iastate.edu or The CAST Office at 515-292-2125.

Water Quality & Quantity Issues for Turfgrasses in Urban Landscapes

TAS FEE TO RISE IN 2006

Everyone is feeling the pinch of the rise in gas prices and other expenses. To keep up with the increasing costs of providing a high-quality advisory service, it is necessary to increase the fee for the 2006 Turf Advisory Service. The 2006 fee structure will continue to offer a $300 discount for payments received by May 15, 2006.

	Payment received by May 15, 2006	Payment received after May 15, 2006
Half-Day Visit	$1,500	$1,800
Full-Day Visit	$2,100	$2,400

The USGA continues to subsidize the Turf Advisory Service (TAS) by more than 50%, reflecting a commitment to provide golf courses with the best of services from a top-quality staff of 17 full-time agronomists. The TAS strengthens the golf course superintendent's and Green Committee's position, and it provides a positive environment to discuss common problems and realistic solutions and expectations at the level of golf course budget available.

GREEN SECTION STAFF'S WORLD WAR II CONTRIBUTIONS: MARKING THE 60TH ANNIVERSARY OF THE WAR'S CONCLUSION

Dr. Fred V. Grau

Dr. John Monteith, Jr.

Former Green Section men in the war effort: Eight former members of the Green Section technical staff are now working directly in the war effort, six of them contributing in an important way in the establishment and maintenance of turf on airfields.

All of those working with turf are functioning on a civilian status with the exception of Captain George E. Harrington of the Army Air Forces Liaison Office. Dr. John Monteith, Jr., and Dr. Fred V. Grau have their headquarters in Washington, D.C., with the Army Engineer Corps. Also connected with the Army Engineers are John W. Bengtson in Mobile and Gordon H. Jones in Dallas. Alton E. Rabbitt has recently been appointed to the Bureau of Aeronautics of the Navy Department and is responsible for the turf on the Navy airfields.

Although not now working on turf, in addition to these six, two of the younger former members of the Green Section staff have commissions in the Army and the Navy, respectively — Lt. Ian Forbes, Jr., and Ensign Willis H. Skrdla.

— Taken from *Timely Turf Topics,* January 1943

STATEMENT OF OWNERSHIP, MANAGEMENT, AND CIRCULATION

1. Title of Publication — USGA GREEN SECTION RECORD. 3. Date of Filing — September 1, 2005. 4. Frequency of issue — Bimonthly: January/February, March/April, May/June, July/August, September/October, and November/December. 5. Number of issues published annually — 6. 6. Annual Subscription Price — $18.00. 7. Complete mailing address of known office of publication — United States Golf Association (USGA), Golf House, 77 Liberty Corner Road, P.O. Box 708, Far Hills, NJ 07931-0708, Contact Person: James T. Snow, Telephone: 908-234-2300. 8. Complete mailing address of the headquarters or general business office of the publisher — USGA, Golf House, 77 Liberty Corner Road, P.O. Box 708, Far Hills, NJ 07931-0708. 9. Names and addresses of Publisher, Editor, and Managing Editor: Publisher — USGA, Golf House, 77 Liberty Corner Road, P.O. Box 708, Far Hills, NJ 07931-0708. Editor — James T. Snow, USGA, Golf House, 77 Liberty Corner Road, P.O. Box 708, Far Hills, NJ 07931-0708. Managing Editor — James T. Snow, USGA, Golf House, 77 Liberty Corner Road, P.O. Box 708, Far Hills, NJ 07931-0708. 10. Owner (If the publication is owned by a corporation, give the name and address of the corporation immediately followed by the names and addresses of all stockholders owning or holding 1 percent or more of the total amount of stock. If not owned by a corporation, give the names and addresses of the individual owners. If owned by a partnership or other unincorporated firm, give its name and address, as well as those of each individual owner. If the publication is published by a nonprofit organization, give its name and address.) — United States Golf Association (USGA), Golf House, 77 Liberty Corner Road, P.O. Box 708, Far Hills, NJ 07931-0708. 12. For completion by nonprofit organizations authorized to mail at nonprofit rates — The purpose, function, and nonprofit status of this organization and the exempt status for federal income tax purposes has not changed during preceding 12 months. 13. Publication title — USGA Green Section Record. 14. Issue Date for Circulation Data Below — Sept./Oct. 2005. 15. Extent and nature of circulation —

	Average No. Copies Each Issue During Preceding 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
a. Total Number of Copies *(Net press run)*	18,033	17,700
b.1. Paid/Requested Outside-County Mail Subscriptions Stated on Form 3541	16,897	16,585
b.2. Paid In-County Subscriptions Stated on Form 3541	0	0
b.3. Sales Through Dealers and Carriers, Street Vendors, Counter Sales, and Other Non-USPS Paid Distribution	0	0
b.4. Other Classes Mailed Through the USPS	0	0
c. Total Paid and/or Requested Circulation	16,897	16,585
d. Free Distribution by Mail *(Samples, complimentary, and other free)*		
d.1. Outside-County as Stated on Form 3541	788	735
d.2. In-County as Stated on Form 3541	0	0
d.3. Other Classes Mailed Through the USPS	0	0
e. Free Distribution Outside the Mail *(Carriers or other means)*	265	250
f. Total Free Distribution	1,053	985
g. Total Distribution	17,950	17,570
h. Copies Not Distributed	83	130
i. Total	18,033	17,700
j. Percent Paid and/or Requested Circulation	94.1%	94.4%

I certify that the statements made by me above are correct and complete. — JAMES T. SNOW, Editor

All Things *Considered*

Grain on the Brain

Along with putting green speeds, the effects of grain on ball roll receive too much television air time.

BY JOHN FOY

I was bitten by the golf bug early in life, and after almost 40 years I still have a passion for the game. I was fortunate to find a career that allows me to be directly involved in golf. Even though I am out on courses almost every day, I still make it a point each weekend to check out televised golf. However, for the past few years, the volume of the telecast is usually turned down or even muted because I get so frustrated by the constant commentator banter discussing how grain affects putts.

In James B. Beard's book *Turf Management for Golf Courses*, grain is defined as "the undesirable procumbently oriented growth of grass leaves, shoots, and stolons on putting greens; a rolling ball tends to be deflected from a true course in the direction of the turf grain orientation." In other words, the grass leaves and runners are growing horizontally in one or more directions. Historically, grain has occurred with all putting green turfgrass, but it tends to be especially pronounced with stoloniferous turf species such as the creeping bentgrasses and bermudagrass. In the plant world, the stimuli of sunlight and gravity are the primary controlling factors affecting growth habit and bending movements. Thus, while turfgrasses are not considered to have strong phototrophic responses like sunflowers and follow the sun across the sky each day, grain formation in an east-to-west pattern can occur. Gravity has a much stronger influence on turf growth, and as a result grain patterns are consistently oriented downhill.

There is no denying that, in the past, grain was a factor on putting greens. Growing up in the South and playing primarily on Tifgreen (328) bermudagrass greens maintained at a height of cut of 0.186 to 0.250 ($\frac{3}{16}$ to $\frac{1}{4}$) inch, being able to read the grain was essential. Putting into the grain (and uphill) meant that the putt would be extremely slow, and you had to really give it a good rap to get the ball to the hole. Putting down grain or across the grain naturally had an impact on both speed and amount of break to play. Bermudagrass greens were always the worst as far as grain was concerned, but it also occurred on northern bentgrass and less so on *Poa annua* greens.

Beginning in the early 1980s and continuing through today, much more intensive putting green management has been employed in pursuit of faster speeds, but a reduction in grain and its influence on ball roll is a benefit of the advances that have been made in putting green management. Routinely changing the direction of mowing patterns, using grooved rollers on the mowing units, verticutting, brushing, groomer attachments, and frequent, light topdressing are some of the standard practices for promoting an upright shoot growth character and in turn minimizing grain.

There is a consensus among the Green Section staff and golf course superintendents at facilities where professional events are hosted that the biggest reason why the effect of grain is not a factor today is the extremely low heights of cut being practiced. It was not that long ago that a height of cut of 0.156 ($\frac{5}{32}$) inch was considered "pushing the envelope." However, today there are mowing units that can be set at a height of cut of 0.100 ($\frac{1}{10}$) inch or less, and new turf varieties or cultivars can tolerate these extreme heights, at least for short periods of time. At very low heights of cut, there is simply not enough leaf surface area in contact with the ball to affect its roll. In an unpublished university study, it was found that at a height of cut of 0.125 ($\frac{1}{8}$) inch, there was no measurable effect of grain on ball roll. With long putts of 30 feet or more, wind was the principal factor causing balls to go off line.

Along with the practice of lower heights of cut, double cutting and/or rolling of greens are now routine practices used to provide faster and smoother surfaces. It has been my observation that with frequent rolling of bermudagrass greens, grain patterns tend to be highlighted. An interesting phenomenon with the ultradwarf bermudas is the occurrence of swirling patches of gain. Yet again, this horizontal leaf blade orientation does not affect ball roll.

Even with the most intensively managed putting greens, some horizontal leaf growth can be found and no doubt some will continue to expound on the perceived effects of grain on ball roll. However, for the vast majority of golfers, gravity rather than grain should be the concern. Accurately determining whether a putt is going uphill or downhill will lead to greater success compared to constantly having "grain on the brain."

JOHN FOY *is director of the Green Section's Florida Region.*

USGA

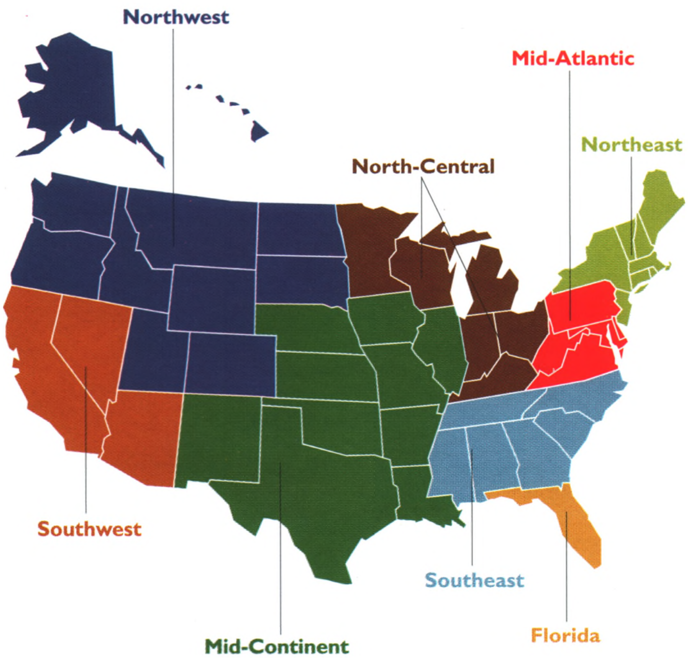
GREEN SECTION NATIONAL OFFICES

United States Golf Association, Golf House
P.O. Box 708
Far Hills, NJ 07931
(908) 234-2300 Fax (908) 781-1736
James T. Snow, *National Director*
jsnow@usga.org
Kimberly S. Erusha, Ph.D., *Director of Education*
kerusha@usga.org

Green Section Research
P.O. Box 2227
Stillwater, OK 74076
(405) 743-3900 Fax (405) 743-3910
Michael P. Kenna, Ph.D., *Director*
mkenna@usga.org

904 Highland Drive
Lawrence, KS 66044
785-832-2300
Jeff Nus, Ph.D., *Manager*
jnus@usga.org

Construction Education Program
770 Sam Bass Road
McGregor, TX 76657
(254) 848-2202 Fax (254) 848-2606
James F. Moore, *Director*
jmoore@usga.org



REGIONAL OFFICES

●Northeast Region
David A. Oatis, *Director*
doatis@usga.org
James H. Baird, Ph.D., *Agronomist*
jbaird@usga.org
P.O. Box 4717
Easton, PA 18043
(610) 515-1660 Fax (610) 515-1663

James E. Skorulski, *Senior Agronomist*
jskorulski@usga.org
1500 North Main Street
Palmer, MA 01069
(413) 283-2237 Fax (413) 283-7741

●Mid-Atlantic Region
Stanley J. Zontek, *Director*
szontek@usga.org
Darin S. Bevard, *Agronomist*
dbevard@usga.org
485 Baltimore Pike, Suite 203
Glen Mills, PA 19342
(610) 558-9066 Fax (610) 558-1135

Keith A. Happ, *Senior Agronomist*
khapp@usga.org
Manor Oak One, Suite 410,
1910 Cochran Road
Pittsburgh, PA 15220
(412) 341-5922 Fax (412) 341-5954

●Southeast Region
Patrick M. O'Brien, *Director*
patobrien@usga.org
P.O. Box 95
Griffin, GA 30224-0095
(770) 229-8125 Fax (770) 229-5974

Christopher E. Hartwiger, *Senior Agronomist*
chartwiger@usga.org
1097 Highlands Drive
Birmingham, AL 35244
(205) 444-5079 Fax (205) 444-9561

●Florida Region
John H. Foy, *Director*
jfoy@usga.org
P.O. Box 1087
Hobe Sound, FL 33475-1087
(772) 546-2620 Fax (772) 546-4653

Todd Lowe, *Agronomist*
tlowe@usga.org
127 Naomi Place
Rotonda West, FL 33947
(941) 828-2625 Fax (941) 828-2629

●Mid-Continent Region
Paul H. Vermeulen, *Director*
pvermeulen@usga.org
9 River Valley Ranch
White Heath, IL 61884
(217) 687-4424 Fax (217) 687-4333

Charles "Bud" White, *Senior Agronomist*
budwhite@usga.org
2601 Green Oak Drive
Carrollton, TX 75010
(972) 662-1138 Fax (972) 662-1168

●North-Central Region
Robert A. Brame, *Director*
bobbrame@usga.org
P.O. Box 15249
Covington, KY 41015-0249
(859) 356-3272 Fax (859) 356-1847

Robert C. Vavrek, Jr., *Senior Agronomist*
rvavrek@usga.org
P.O. Box 5069
Elm Grove, WI 53122
(262) 797-8743 Fax (262) 797-8838

●Northwest Region
Larry W. Gilhuly, *Director*
lgilhuly@usga.org
5610 Old Stump Drive N.W.,
Gig Harbor, WA 98332
(253) 858-2266 Fax (253) 857-6698

Matthew C. Nelson, *Agronomist*
mnelson@usga.org
P.O. Box 5844
Twin Falls, ID 83303
(208) 732-0280 Fax (208) 732-0282

●Southwest Region
Patrick J. Gross, *Director*
pgross@usga.org
505 North Tustin Avenue, Suite 121
Santa Ana, CA 92705
(714) 542-5766 Fax (714) 542-5777

Subscriptions $18 a year, Canada/Mexico $21 a year, and international $33 a year (air mail).

Subscriptions, articles, photographs, and correspondence relevant to published material should be addressed to: United States Golf Association, Green Section, Golf House, P.O. Box 708, Far Hills, NJ 07931.

GREEN SECTION RECORD (ISSN 0041-5502) is published six times a year in January, March, May, July, September, and November by the UNITED STATES GOLF ASSOCIATION®, Golf House, Far Hills, NJ 07931.

Postmaster: Address service requested — USGA Green Section Record, P.O. Box 708, Golf House, Far Hills, NJ 07931-0708.

Periodicals postage paid at Far Hills, NJ, and other locations. Office of Publication, Golf House, Far Hills, NJ 07931.

Printed on recycled paper

Turf *Twisters*

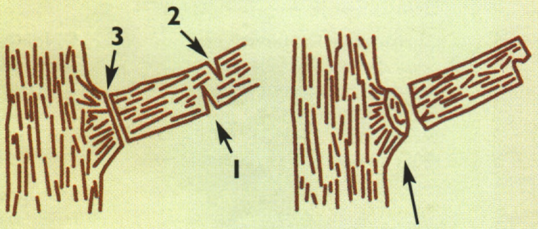
Q: Every fall when we return to South Florida, the fairways and roughs at the course we play are always in great condition. By January, however, the fairways have become very thin, and tight lies are quite penal. Furthermore, the definition between the fairway and rough cuts disappears. Can't the superintendent put out more fertilizer to keep the course in better condition through the winter season? (Florida)

A: Although wintertime temperatures in Central to South Florida are not cold enough to result in the base bermudagrass turf cover going completely dormant and turning brown, its growth rate slows drastically for two to four months. Regardless of inputs, it is impossible to force continued growth and, in turn, produce any degree of recovery from golf cart wear and damage. Complaints about tight lies and no definition are common at facilities that host moderate to heavy winter-season play because the turf literally becomes beaten down. To minimize this normal course deterioration, adherence to cart usage policies and other traffic control measures certainly helps. However, until environmental conditions in the spring are again favorable to sustain turf growth, a degree of patience and understanding must be exercised.

Q: Our head golf professional and superintendent must work together to mark our golf course properly. They disagree about whether our water hazards should be defined with stakes or painted lines on the ground. Any suggestions would be appreciated. (Maryland)

A: They are both correct. Stakes and/or lines can be used to define the margins of water hazards. The benefit of a painted line is that it can more accurately define the actual margin of the water hazard. Stakes provide better visibility for golfers at a distance. Once lines are initially established, they can be repainted periodically to maintain visibility. Because of their irregular shapes, it is nearly impossible to install enough stakes to completely define the margins of water hazards. Stakes and lines together provide the best scenario for defining your water hazards. Where both stakes and lines are used, the stakes identify the hazard and the lines define the margin of the water hazard. Remember, both the stakes and the lines defining the margins of water hazards are considered to be in the hazards.

Q: We are about to begin our annual tree-pruning work, much of which we are able to complete in-house. What is the best pruning cut to promote healing of the wound? (New York)



3-Step Pruning Cut **Branch Collar**

A: The pruning cut should be made at the point where the branch collar joins the branch. Making the cut at this part of the branch collar leads to the most rapid callous tissue formation and helps protect the tree from decay fungi. Be careful to use the "three-cut" method to reduce the weight of heavier branches and avoid bark tearing.

USGA