At Glendale Country Club, Steve Kealy, CGCS, has increased the amount of nitrogen applied to the course to keep turf healthy. Photo: David Wolff

4,000 feet. In the summer, daytime highs are in the low 80s with little humidity. In Shepherdsville, summers are hot and humid.

"I'm using more fungicides because disease pressure seems to be higher in my new area," Kirchner says.

Heritage Hill, which opened in August 2007, features A-4 bentgrass greens and collars. Tees and fairways are zoysiagrass, the irrigated rough is bluegrass, and the remainder is fescue. Fungicides are applied on greens and fairways regularly and on tees when there's an outbreak of zoysia patch.

"I'll spot spray when necessary," Kirchner says. "Most of my spraying during the grow-in was with herbicides. I rotate fungicides quite a bit, using 10 to 15 different products on greens so we don't build up a tolerance. The new products seem to last longer, even though they have less active ingredient. That's a good thing for the environment, but bad for budget purposes. It seems like I have to buy more, and fungicides are very expensive products."

REVERSE TRENDS

Larry Gilhuly, director for the Northwest region of the USGA Green Section, has seen expectations for course conditions climb off the chart since he joined the Green Section in 1984.

"It's night and day, but the good news is superintendents are growing healthier grass today," Gilhuly says. "The Stimpmeter led to a trend of lowering heights of cut on greens and applying less fertilizer. This caused problems with anthracnose and moss. Now we've got fertilizer levels back up and are using other tools, such as greens rollers."

In the Pacific Northwest, low humidity generally reduces disease pressure. The biggest issues are pink snow mold and anthracnose, but that doesn't mean superintendents don't use fungicides.

"The use of fungicides in our region hasn't necessarily increased," Gilhuly says. "Rates are less because products are more effective."

Gilhuly advocates target rolling for smooth greens with a desirable speed and healthy turf. (See sidebar on page 84.)

"One answer to the green speed issue consists of more rolling and rais-

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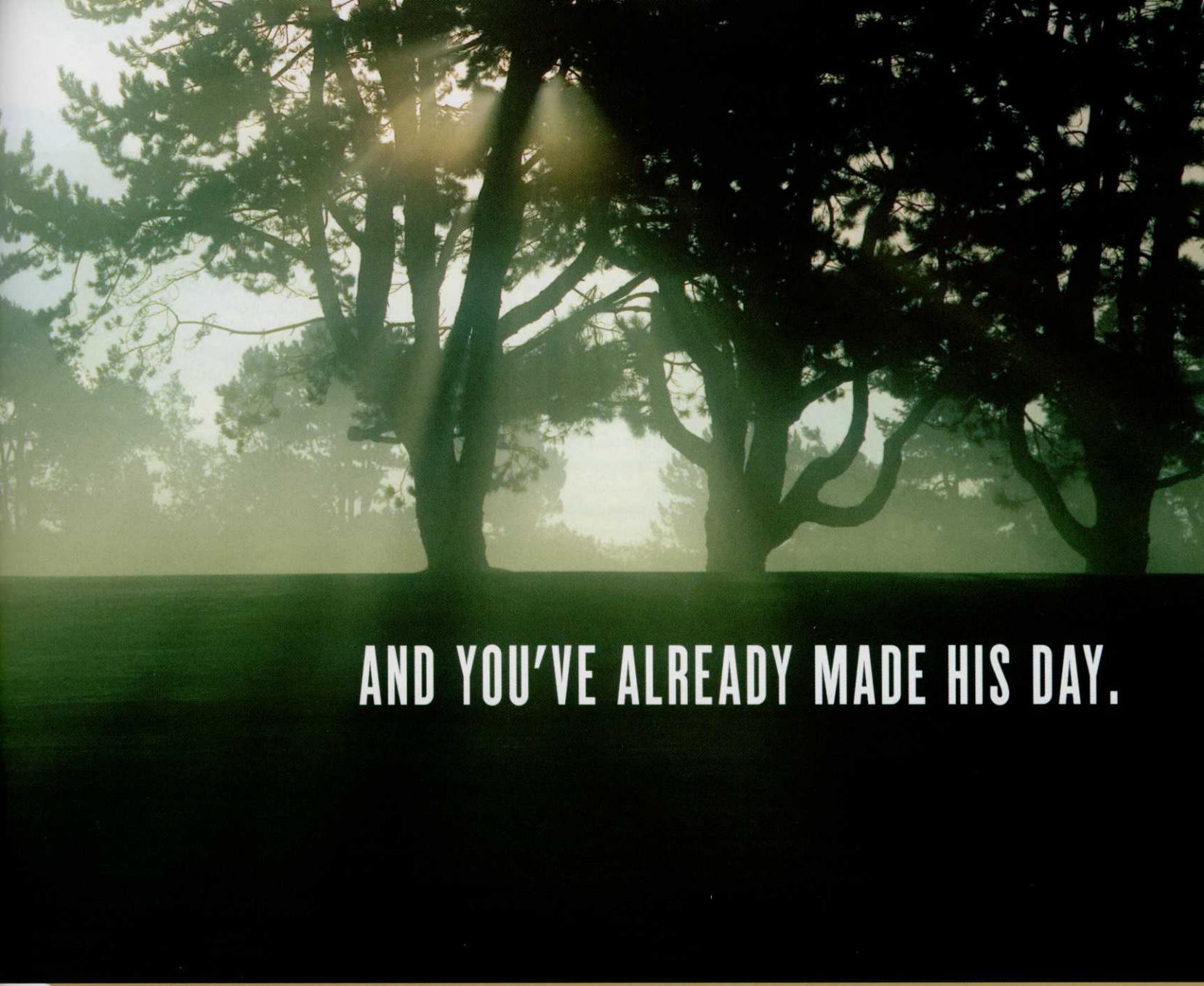

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ing the height of cut," he says. "However, rolling more than three times a week causes problems with turf wear."

The concept of target rolling comes into play to provide a common sense approach to this issue, Gilhuly says. Golfers, generally, are poor judges of green speed, yet they desire smooth greens and judge green speed around the hole, so why not simply roll 20 to 30 feet around the hole, rather than the entire green? For example, if holes are changed six times weekly, and the greens are of adequate size, green rolling in a target manner could be completed six times weekly, which would be equivalent to rolling two or three times because the entire green isn't being rolled every time, Gilhuly says.

"Also, putting green rollers generally increase speed from six to 10 inches, depending on the type of roller used," he says. "Because players have a difficult time determining this magnitude of difference, and rollers make greens smoother, the golfers benefit without placing the turf under more stress."

BALANCED FERTILITY PROGRAM

Growing healthy turf requires a balanced fertility program, says Steve Kealy, CGCS, of Glendale Country Club in Bellevue, Wash.

"We've got fertilization back up to a comfortable level," Kealy says. "Seven to eight years ago we were starving the greens, applying only 2.5 pounds of nitrogen because that was the trend. Sure, the greens were fast, but we were getting every kind of weird, funky disease. The turf was stressed and half-sick. Now we've got nitrogen levels back up to keep the turf healthy. We apply five to 5.5 pounds, and combined with other products and practices. We're far

Try sectional rolling for consistent green speed

Mark Cupit, CGCS, of Ironwood Country Club in Palm Desert, Calif., and Larry Gilhuly, director for the Northwest region of the USGA Green Section, have consulted about the process of sectional, or target, rolling throughout the years. Cupit explains why he uses this method and how it's put into practice:

"Back in the good old days, I remember the first time I dropped my green heights down to three-sixteenths of an inch," he says. "It was pretty scary. Some of you are old enough to remember the speed revolution. We used to scalp them down, withhold fertilizer and water and bring the greens right to the brink of death. Now, with the help of new equipment technology, superintendents have the ability to maintain what every golfer and turf manager wants: smooth, fast putting surfaces without starving the turf and without the damage caused from heavy rollers and ultralow mow heights."

Cupit overseeds the club's Tifdwarf greens each fall with *Poa trivialis*. After the initial grow-in phase, he uses sectional rolling to achieve the best possible putting surface for club members.

"Using one of my lightweight rollers, I start rolling my greens every day, but not the entire green, only the third of the green where the pin will be," he says. "Our course sets pin locations seven times a week using six front, six middle and six back cup set placements."

When initiating this program, it takes about two weeks to normalize speed across the entire putting surface, Cupit says. The third of the green that was rolled Monday will only lose a couple inches of speed before it gets rolled again. Even the best players at the club can't recognize the difference in speed.

"The benefits could be seen as enabling the turf manager to have faster putting surfaces without the ultralow mow heights," he says. "I like to get our greens around 11 feet for the snowbird season. My greens are mown at a bench setting of 0.115 inch with a John Deere 180 walk mower, rolled daily and spiked with a PlanetAir every three weeks. Along with a good fertility and Primo program, I'll continue this for the entire season. For special events when speeds need to be really fast I'll add double cutting for several days before the event and maybe some sand topdressing."

less concerned with green speed and excessive growth. We use Primo plant growth regulator for consistent green speed, lightly topdress for a smooth surface and verticut weekly. We've got healthy grass with no growth spurts. We're actually using less fungicide."

STICK TO THE BASICS

The most important thing superintendents can do to achieve healthy turf is to be flexible and adapt their fertility programs when necessary, says Cutler Robinson, CGCS, of Bayville Golf Club in Virginia Beach, Va.

"Superintendents must be disciplined in following through with their programs," Robinson says. "They can't let every isolated comment or complaint dictate what they do. We have a good base model for what works in an average year on our course. We analyze soil samples two or three times a year and monitor the soil regularly. We also test the pH of our water. We'll change nutrition rates if the situation demands it. For example, if we get a leaching rain, we'll come back sooner with a foliar fertilizer application."

Ultimately, the goal is to marry turf health and playability, Robinson says.

"If greens are overfertilized, they won't putt well, and thatch will start to build up," he says "Low heights of cut reduce the root system, and the turf can't store carbohydrates as efficiently. In this situation, we use frequent, light foliar applications of a balanced fertilizer to maximize root growth and carbohydrate reserves. That's why superintendents must be disciplined, not reactionary, because we can't create carbohydrate reserves in summer. We're a high-end club, and our fertility program is all about sticking to the basics." GCI

Cupit strongly recommend reading "The Superintendent's Guide to Controlling Putting Green Speed" by Thomas A. Nikolai, Ph.D.

"I've been doing this routine for several years now and have found not only very smooth putting surfaces, but very consistent day-in-and-day-out green speeds," he says. "This is what every golfer wants. The best thing for me is having the speed without sacrificing the health of the turf." GCI

Sectional, or target, rolling is implemented at Ironwood Country Club to achieve smooth, fast greens without starving the turf. Photo: David Wolff

BY CALE BIGELOW AND DOUGLAS SMITH

How they measure up

Lab study analyzes physical properties of bunker sand

Most golf hole architectural designs incorporate sand bunkers to add dramatic visual contrast and enhance aesthetic beauty while adding challenge and strategy for golfers (1). Bunkers are considered hazards, yet, for many of the courses in the United States, the demand for manicured perfection throughout the entire golf course has resulted in unrealistic player expectations for perfect lies, even in areas defined as hazards. For golf course managers, this demand results in the pursuit of consistently firm, smooth bunker surfaces.

At many golf facilities, the amount of the maintenance resources spent on bunker management rivals what's spent caring for putting greens. Where sand is installed on steep slopes, regular erosion repair costs can be substantial, and are compounded when improper, highly erodable bunker sands are selected.

Numerous sand-sized materials are available commercially and marketed for use in golf course sand bunkers. Often a particular sand might be chosen based on subjective characteristics such as aesthetic appearance (many golf course architects prefer bright white sands) or subjective functional characteristics such as how a particular golfer perceives the sand's playability. Generally, firm sand is preferred because it allows a golf ball to sit on top of the sand surface, resulting in easier play from the hazard.

Sometimes the long-term consequences of these decisions based on subjective criteria

TABLE 1. Particle size distribution and calculated physical properties of commercially available sand materials from various regions in the United States

	Particle size distribution								Calculated property		
Sand	**>2.0**	**1.0**	**0.5**	**.25**	**.15**	**0.1**	**.05**	**<.05**	**GMD†**	**Cu‡**	**GI§**
	g kg^{-1}								mm	unitless	
Autumn Gold	7	45	64	532	305	24	9	15	0.60	2.00	3.24
Bunker Sand	1	79	261	375	217	27	29	11	0.66	3.63	2.00
Caylor White Sand	3	46	193	599	127	9	5	18	0.66	1.82	3.32
Crushed Limestone	3	363	548	67	11	3	4	1	0.95	1.86	3.53
Extra Firm Bunker Sand	1	59	198	337	263	76	48	1	0.59	2.85	6.23
Fine Topdressing Sand	0	2	2	127	462	190	165	53	0.35	3.60	2.40
Glass beads	0	0	296	704	0	0	0	0	0.71	1.61	2.57
Gray Walreth Double Wash	0	17	204	584	137	16	12	30	0.63	2.22	3.83
Green Plus	6	130	270	448	110	6	5	26	0.71	2.38	5.24
Holliday (Banner Springs)	2	24	173	545	191	38	23	4	0.63	3.94	2.24
Holliday (Miss. River)	1	55	270	533	137	3	0	0	0.70	3.70	1.91
Klassic White Sand	8	77	173	515	206	6	3	12	0.67	2.11	4.74
Kosse White B.S.	2	6	37	372	518	37	13 1	4	0.54	1.47	2.41
Orlando White	4	31	108	430	314	41	20	52	0.55	2.20	3.87
Pro Angle	10	163	328	281	149	30	19	21	0.72	3.33	7.78
Pro White Bunker Sand	0	8	86	649	204	21	10	21	0.60	2.50	4.69
Putting Green Sand	0	48	324	503	84	14	14	13	0.70	5.28	2.56
Shelby Bunker Sand	9	69	306	473	121	6	4	12	0.71	2.00	3.79
Sidley # 1600	10	12	70	415	379	77	35	2	0.56	2.25	4.17
Stone White Sand	0	0	0	350	555	40	14	41	0.50	1.53	2.53
Tan Bunker Sand	3	58	410	401	81	13	10	23	0.71	3.06	3.96
Tour Grade 50/50	43	184	190	307	192	24	13	47	0.68	2.72	8.89
Tour Grade 535	0	14	59	493	370	28	23	12	0.57	1.82	2.76
Tour Grade Signature	58	193	190	315	181	23	17	22	0.71	3.06	8.89
USGA Bunker Sand	0	35	220	495	194	19	10	27	0.63	2.35	8.41
White Bunker Sand	0	35	227	462	197	39	25	14	0.63	4.76	2.65

† Geometric mean particle diameter (GMD) = calculated from the sand particle size distribution.
‡ Cu (Coefficient of uniformity) = where D60/D10; acceptable value = 2 to 4, higher value = less uniformity, optimum value = 2 to 3, a value < 2 less likely to pack tightly.
§ GI (Gradation index) = where D90/D10; lower values indicate a higher potential for surface instability, acceptable range 3 to 6, preferred range 4 to 5.

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such as color might not be realized immediately. A sand that's the desired color but is too coarse or has a predominance of round particles might necessitate additional labor to maintain playability. From a golf course manager's perspective, an appropriate sand for bunkers would be one that maintains firmness, drains quickly, doesn't erode from slopes easily after moderate rainfall or irrigation, and is sized similar to those used for sand-based root zones (8). The latter is so that when it's splashed onto the putting surface it does minimal damage to the mowing equipment when picked up during mowing and doesn't impact the composition of the sand-based root zone negatively over time.

Currently, there are no clear specifications for golf course bunker sands, and the information that exists serves primarily as a guideline, which is based mostly on sand particle size distribution and a measurement of surface firmness. Generally, it's suggested bunker sands should have a large majority of the particles in the 0.25 to 1.0 mm range (7). In terms of sand mineralogy, silica sand is often preferred because silica resists weathering and retains its original shape longer. Other materials also might be suitable, however, limestone sands are more prone to weathering and might result in significant fine particles over time, which can affect drainage and playability.

In terms of sand particle size distribution, research documents particle size distribution greatly influences sand strength and, specifically, the quantity and ratio of fine textured particles can have a strong influence on strength (2, 3). These authors suggest that when evaluating a particle size distribution based on its coefficient of uniformity (Cu), higher Cu values for sands are preferred and that the Cu could be adjusted by adding a small percentage of finer textured particles such as native sandy-loam soil. Increasing the Cu value from 1.8 to 3.0 resulted in the

The demand for manicured perfection throughout the entire golf course has resulted in unrealistic player expectations for perfect lies, even in areas defined as hazards. For the golf course manager, this results in the pursuit of consistently firm, smooth bunker surfaces.

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