until cars replaced horses, reducing the amount of available manure, and synthetically produced fertilizers began gaining ascendancy.

■ Turf irrigation followed a somewhat similar path with hose-end fixed sprinklers giving way to traveling rotary sprinklers. Pop-up rotary sprinklers appeared on scene during the 1930s.

■ Many of the substances used to control turfgrass pests prior to and including the WWII era were pretty nasty, he related. They included sulfuric acid, sodium arsenate, Bordeaux mix and mercurous chloride.

■ With the introduction of phenoxy herbicides and chlorinated hydrocarbon insecticides, the growing realization of the importance of core cultivation (the first coring unit is thought to have been developed by Tom Mascaro in 1946) and the development of Merion Kentucky bluegrass and Tifway bermudagrass in the 1950s, Beard said the decade saw major changes in turf management.

### Future of the industry

The more recent history of the turfgrass industry, at least the last 50 years, parallels Beard's involvement with it. In address-

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ing turf managers 16 years ago he predicted the industry would enter the computer age, that there would be continued turfgrass cultivar and equipment improvements and there would be increased emphasis on employee training and safety. He even predicted there would be growing public concern over industry pesticide and fertilizer use.

What does Beard see in the industry's future from this point forward?

The trend to reduce chemical use is real. "Biologicals are coming," he said, pointing out the major companies are investing in their development. In a related matter, he predicted that pest control products will target specific pests and be used correctively rather than preventatively. Pest scouting and predictive modeling will grow in importance with an eye to earlier diagnosis of pest problems. Eventually, genetically modified cultivars will be developed to reduce disease pressure.

Beard predicted that turf managers will reduce nitrogen rates while using more controlled-release carriers. The practice of measuring leaf growth rate in selecting nitrogen rates and timing will become more important. For sports turf, in particular, he stressed that potassium is necessary to help turfgrass resist traffic stress, meaning that turf managers will be attempting to maintain adequate potassium tissue levels with light, frequent applications. You will have to be able to document and defend your use of fertilizers, as well, Beard said.

Advances in turfgrass breeding will be a big aid to turf managers, said Beard, including the development of cool-season grasses that grow an extra four or five weeks into fall and bermudagrasses that can be sustained further north. Even so, he said that cyclical warm/cold cycles every 11 or 25 years will challenge both trends. One certainty, he added, will be the development of cultivars with increased tillering, enhanced rootzone water retention and reduced ET rates.

In probably his boldest prediction, Beard said digital pest recognition systems are in turf's future. They might involve a sensor and computer on the front of a sprayer unit that can identify specific weeds and spot-treat the weed with correct herbicide. "It's being worked on and it's going to happen," he said. ■

*Ron Hall, Golfdom editor-at-large, has been covering the green industry for 30 years.*

# Clark  Talks Turf

TIMELY TURF ADVICE

## Stressed Annual Bluegrass or Creeping Bentgrass Greens? Anthracnose is Likely to Follow

**Bruce Clarke is a professor of turfgrass pathology and Jim Murphy is a professor of turfgrass science at Rutgers University. They are devoted to learning more about anthracnose and how to manage it.**

**Q Let's start with the anthracnose fungi. What conditions are most favorable for an outbreak of anthracnose? Bruce Clarke (BC):** Any stress, both weather and cultural, that weakens the plant makes turf more susceptible to anthracnose (*Colletotrichum cereale*). We have determined there are cool weather anthracnose isolates that thrive when air temperatures are in the 50s and 60s and warm weather isolates that thrive when air temperatures are in the upper 80s and 90s. Most courses have the warm weather anthracnose isolates, some courses have just the cool weather isolates, and a few have both.

**Q What is the distribution of anthracnose? BC:** Anthracnose is found worldwide on annual bluegrass and/or creeping bentgrass greens that are under stress. Annual bluegrass is the primary host but creeping bentgrass greens under stress can also be susceptible to anthracnose.

**Q What steps can a superintendent take on a preventive basis to manage anthracnose? BC:** Reduce stress on the grass. Even the best fungicide programs won't be completely effective unless management practices are implemented to reduce stress on the grass and improve turf health.

A preventive fungicide program is recommended if the course has a history of anthracnose. In general, we recommend the first fungicide application to manage anthracnose be made three to four weeks prior to the normal date of anthracnose occurrence.

There are eight or nine groups of fungicides that show effectiveness controlling anthracnose. Some isolates of anthracnose have shown resistance to certain fungicides so it is very important to design the fungicide program to control anthracnose while limiting the potential for resistance to develop.

**Q What do you recommend for a curative fungicide approach if a course is experiencing anthracnose for the first time? BC:** Again, reduce stress on the turfgrass and improve plant health.

We suggest a superintendent apply a tank mix of two fungicides; one of which should be either chlorothalonil or a phosphonate product. Both chlorothalonil and the phosphonates have been shown to be very effective controlling anthracnose. The second fungicide can be selected from a number of effective fungicide groups such as the DMIs, strobilurins, benzimidazoles, phenylpyrroles, dicarboximides, or antibiotics (polyoxin-D).

**Q On to stress reduction and cultural management with Jim Murphy. I know you and the group at Rutgers have investigated the influence of many cultural practices on anthracnose. Where should a superintendent start? Jim Murphy (JM):** Raise the mowing height. Even slightly increasing mowing height will improve turfgrass health and reduce the severity of anthracnose. I know it's easier said than done. Let's face it, green speed drives mowing height. We examined combinations of mowing height, double mowing every day and rolling every day to provide acceptable green speed. We were able to develop combinations of a slightly increased mowing height along with either double mowing every day or rolling every day that improved turfgrass health and reduced anthracnose severity while providing green speed over 10 feet.

**Q What nitrogen fertility practices do you recommend to reduce anthracnose severity and improve turfgrass health? JM:** Increasing the nitrogen fertility rate in the summer will have a big impact. Applying 0.1 or 0.2 lbs. nitrogen per 1,000 sq. ft. every week or every other week will improve turfgrass health and reduce anthracnose severity. We have seen up to a 50 percent disease reduction by increasing nitrogen fertilization in summer. Increasing nitrogen fertilization in spring is also helpful to reduce anthracnose.

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*See the remainder of this interview, which discusses how topdressing affects anthracnose and upcoming research, in the Golfdom Insider email newsletter available at www.Golfdom.com.*

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Clark Throssell, Ph.D., loves to talk turf. He can be reached at Clarkthrossell@bresnan.net.

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WETTING AGENTS

# How Wetting Agents Work on Wet Ground

A Wisconsin study reveals more on how wetting agents respond in wet weather. *By Doug Soldat*

Superintendents have a plethora of wetting agents to choose from. Each product comes with a relatively non-descript list of proprietary ingredients yet a long list of potential benefits. Only 13% of superintendents surveyed by Karnok and Tucker (2009) indicated that they felt all wetting agents were basically the same in terms of performance. In addition, 72% felt that some wetting agents tend to hold water in the surface of the soil while others tend to keep the soil surface dry by moving water deeper. Indeed, some wetting agent manufacturers claim their products move water down through the root zone, while others claim to hold it near the surface, but others promise to do both. While the claim of doing both seems a bit like double-dipping, it's probably the closest to the truth.

Water has three properties that control its behavior in the soil and elsewhere. First, it has a high degree of cohesion, and therefore, water molecules have a tendency to "stick" to other water molecules. You can see this property the next time you are driving somewhere in the rain. Take a look at a raindrop as it runs down the windshield; it will veer off course from a straight line to gobble up other smaller rain drops on the window. Water's cohesive properties give rise to the second important property: surface tension. Surface tension is a measure of how hard it is to break through the surface of a liquid. The high surface tension of water allows some bugs to walk across its surface. The final important property, adhesion, describes the attraction of water to other materials. Adhesive forces between water and a material like wax paper are very low. When that's the case, cohesive forces overwhelm the adhesive forces and water forms a fairly round droplet (think car wax). However, when adhesive forces between a material and water are high, the adhesive force overcomes the cohesive force of the water, and the droplet will flatten out across the wettable surface.

In general, wetting agents do two things; first they decrease the surface tension of the water, thus (to quote an oft-used marketing term) making "water wetter." In a soil with only wettable surfaces, decreasing the surface tension should lead to less water being held in the soil pores (remember, it will be flatter). Second, they prevent soils from becoming hydrophobic or non-wettable. Therefore, in a hydrophobic soil, using wetting agents will increase the moisture-holding capacity of the soil compared to an untreated, hydrophobic control area. However, if the soil does not become

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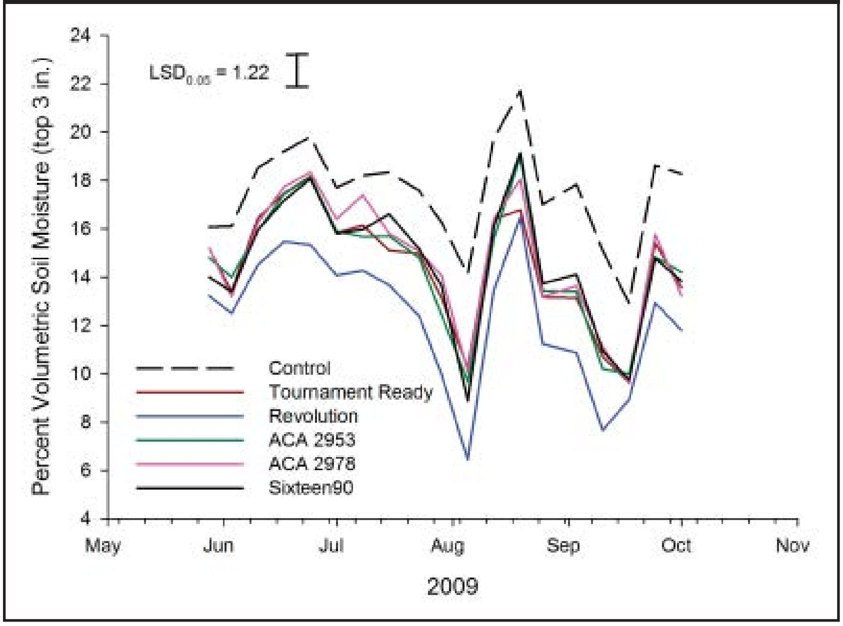
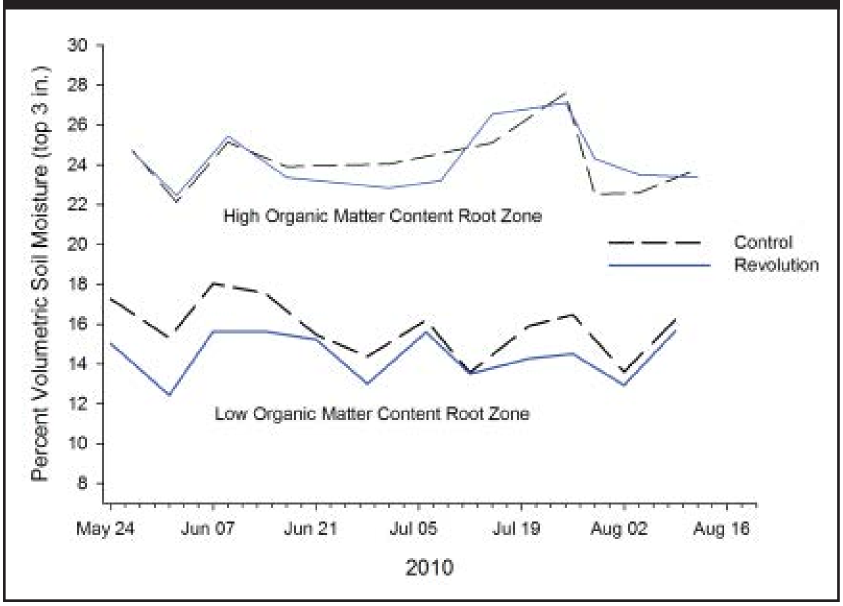
## FIGURE 1: 2009 STUDY




***Season-long soil moisture content in the upper three inches as affected by various wetting agents applied to a 1-year-old 'A4' creeping bentgrass sand putting green with 0.7% soil organic matter. 2009 was a very wet season.***

## FIGURE 2: 2010 STUDY




***Soil moisture content in the upper three inches as on the same site (low organic matter content) and another higher organic matter content sand putting green in 2010 as affected by Revolution, the only wetting agent re-tested from the 2009 group. 2010 was wet as well, but results are much less pronounced than those seen in 2009.***

*Continued from page 35*

hydrophobic, using wetting agents can lead to slightly lower soil moisture than untreated areas. This phenomenon was observed and described in the August 2010 issue of *GCM* (Soldat et al., 2010), when a putting green soil treated with wetting agents (Aqueduct, Primer 604, or Revolution) had lower moisture content than the untreated control early in the season under wet conditions, and greater moisture content than the control later in the season under dry conditions. Hence, the marketing experts can have their cake and eat it too: Some wetting agents can decrease moisture under wet conditions and increase it under hydrophobic conditions. For more information on wetting agents see "Wetting Agents: What are they, and how do they work?" (Karnok et al., 2004).

But now let's take a closer look at some differences among products during two very wet years in Wisconsin. We definitely learned that the behavior of wetting agents can be site specific (soils, weather, etc.) from the 2004 GCSAA Wetting Agent Evaluation (Throssell et al., 2005a, 2005b). With this in mind, the following results are from a one-year-old A4 creeping bentgrass USGA putting green with no amendment. The organic matter content of the root zone averages a paltry 0.7%. The putting green was mowed six days a week at 0.125-inch with a Toro 1000. To this putting green, five wetting agents were applied and compared to a non-treated control. Each treatment was replicated three times in a randomized complete block design. We measured the volumetric soil moisture content in the upper three inches every week with a TDR probe.

The wetting agents evaluated in 2009 included Tournament-Ready from KALO, Inc. and four compounds from Aquatrols: Revolution, Sixteen90, and two experimental products, ACA 2953 and ACA 2978. In 2010, the same study was repeated on the same A4 putting green using other surfactants with only Revolution being the same from 2009. We also tested Revolution versus a control under the exact same conditions except on an 8-year-old L-93 sand-based putting green with about 4% organic matter.

Some wetting agents can decrease moisture under wet conditions and increase it under hydrophobic conditions.

The weather during 2009 was a superintendent's dream. We seemed to have a quarter inch of rain every four or five days with below average temperatures. In the Upper Midwest, 2010 was very hot and wet, which led to lots of dead annual bluegrass all over the state.

Figure 1 shows clear and consistent differences in soil moisture between the wetting agent treatments and the untreated control. For most of the season, the wetting agent treatments had significantly lower soil moisture than the untreated control. While Tournament-Ready, ACA 2953, 2978 and Sixteen90 tended to group together in soil moisture content, Revolution had significantly lower soil moisture than the others for most of the season. These results imply that in a sand-based, low-organic-matter root zone, the wetting agents tested decreased soil moisture, presumably leading to firmer playing conditions compared to the untreated control. Furthermore, it shows that all wetting agents are not identical, and some substantial differences in soil moisture can be seen among products.

In 2010, the only product tested from the 2009 group was Revolution. Again, we tested Revolution on the same low-organic-matter putting green as in 2009, and also on an 8-year-old sand root zone with substantial organic matter accumulation (~4%). Figure 2 shows the difference between the wetting agent treatment and the control on the low-organic-matter root zone is less dramatic in 2010 compared to 2009. The difference also appears to vanish in the high-organic-matter content root zone.

In conclusion, over the last two wet years we have learned quite a bit about how wetting agents behave in wet conditions. It appears that on low-organic-matter sand root zones, wetting agents can decrease the soil moisture content in the upper three inches. However, results vary. We saw differences in the degree to which moisture content decreased from 2009 to 2010. In addition, there was no difference in soil moisture content in 2010 on a high-organic-matter-content sand-based root zone.

This information will help clarify the role that wetting agents play under wet conditions. It would be beneficial for researchers to continue to evaluate and publish the performance of various wetting agents in wet conditions in a variety of soil types and drainage rates (i.e. high surface organic matter and/or poor internal drainage rates). In a perfect world, there would be a set of standard conditions under which all surfactants could be quickly and easily tested in laboratory conditions. Until then, superintendents must make decisions based on experience and peer recommendations, and piece together results from studies conducted under conditions that most closely approximate their own.

Doug Soldat is an assistant professor and extension soil scientist at the University of Wisconsin-Madison. Reach Soldat at djsoldat@wisc.edu.

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# Monitoring Techniques for the Annual Bluegrass Weevil

By Benjamin A. McGraw and Albrecht M. Koppenhöfer

As spring has arrived in the Mid-Atlantic and Northeast, it is time to start thinking about doing battle with an annual foe: the annual bluegrass weevil (ABW) (*Listronotus maculicollis*) ( "*Hyperodes* weevil"). The ABW is particularly destructive on short mown areas around the golf course (tees, fairways, collars, greens) with a high percentage of *Poa annua*. Limited damage has also recently been observed in pure creeping bentgrass stands.

*A modified blower/ vacuum collects ABWs to measure the population.*

Adult weevils overwinter in protected habitats such as leaf litter, tall grasses, and rough (Diaz and Peck 2007). In spring, weevils migrate to the playing surfaces where they feed, mate, and deposit eggs into the turfgrass stem. Most management plans seek to control adults prior to egg laying, for once eggs have been deposited, chemical insecticides are less effective. The first three larval instars tunnel within the stem whereas the last two instar feed externally on the crown. It is the feeding by the 4th and 5th instars that cause the most extensive turf damage.

Preventive management requires an accurate assessment of the timing of the adult migration. However, rather than gauging adult populations and potential turf loss, most superintendents rely on unrelated plant phenological indicators to estimate the presence of adults on the playing surfaces. Observations made in the late 1970s suggest that full bloom of *Forsythia* spp. indicates that overwintering adult populations have begun moving onto short mown areas and that the full bloom of flowering dogwood (*Cornus* spp.) indicates the end of the migration (Tashiro et al. 1978). Sometime between the two events adult population densities peak and preventive insecticides should be applied for maximum control before significant numbers of eggs can be laid. However, observations of variable ABW adult emergence from overwintering sites (McGraw and Koppenhöfer 2009) and variability in development of Forsythia spp. within sites have led us to question the reliability of these plant indicators.

Recently, "softer" chemicals (e.g., indoxacarb, spinosad) have been brought to market for a curative approach to reducing ABW larval populations. This approach is more environmentally sensitive than preventive management with broad-spectrum insecticides such as pyrethroids, especially if applied only where populations are above thresholds (30 to 80 larvae per ft2). Unfortunately, there are no effective sampling methods to forecast the probability of larval damage. Each of the current larval monitoring practices has drawbacks, and typically no monitoring is done due to the expense (i.e., time and labor) or damage caused by sampling. Sampling larvae involves taking core samples from the turf followed by extraction with irritants (e.g., saline) to estimate population densities relative to arbitrarily set thresholds.

We conducted field studies over a two-year period to find new approaches to monitoring overwintered adult populations and potentially forecast larval densities. Since adults are easier to see (and therefore monitor) than larvae, we sought to determine if a modified leaf blower/vacuum could provide a rapid and accurate estimate of ABW adult density and then determine if there is a correlation between adult densities and future larval densities.

Fairways on three golf courses in central and northern New Jersey were sampled weekly by vacuum and core sampling from late March through the end of the third generation in mid-October to estimate adult abundance and to compare techniques. A leaf blower/vacuum was fit with a mesh (324 openings per square inch) basket to capture adults as they entered the nozzle. A section of fairway (36 square feet) was vacuumed by placing the nozzle directly on the turf and vacuuming in a zig-zag pattern while maintaining a tight fit of nozzle and turf. The entire section was covered during 10 seconds of vacuuming. Afterward, the basket was emptied on a tray and the numbers of adults counted. The estimate of adults in vacuum samples was compared to destructive soil sampling with a turf plugger followed by saline extraction in the laboratory.

The relationship between the number of adults vacuumed and future larval densities was studied on the edges of six fairways. On each fairway 32 plots (each 36 square feet) were sampled to estimate adult density. Each plot was vacuumed weekly between the start of adult emergence from overwintering sites through the end of the egg laying period of the overwintered adults (mid May in northern New Jersey). Once the egg laying period was complete, the plots were sampled for larvae, and larval densities were compared to the numbers of adults captured in weekly sampling periods as well as during the entire adult sampling period.

## Results

ABW vacuum sampling proved as reliable and consistent as soil coring + saline extraction for estimating adult densities and peaks in abundance. But vacuum sampling was non-damaging to the turf, took less time to process a sample, and gave instantaneous information on presence and density.

Additionally, vacuum sampling detected adults in low densities on fairways prior to when plant indicators *(Forsythia* full bloom) would have indicated in both years of the study. In each year of the study, vacuuming sampling allowed us to detect two separate peaks in adult densities, indicating staggered emergence from overwintering sites. The timing of the two peaks was similar between courses and years (1st = April 21-23; 2nd = May 5-7).

Strong relationships were found between number of adults collected in vacuum samples and future larval densities in both years. The number of adults collected either during the second peak of adult abundance or across the entire 6-week sampling period was significantly correlated with larval densities. These correlations suggest that egg laying occurs over an extended period, yet the majority of eggs are deposited during the second peak in abundance. Future work is needed to optimize the size of the area sampled and the number of samples needed to adequately correlate adult and larval densities to best integrate curative controls.

## Conclusions

Turfgrass managers have several methodologies to assess ABW populations. Unfortunately, most turf managers opt to manage ABW without assessing presence or population density. Our studies indicate that vacuum sampling can be an effective tool and provide a rapid estimate of ABW adult density. In addition, we found that adult counts on fairways are correlated to future larval densities. Future work is needed to determine adult ABW density thresholds and if this information can aid in targeting curative controls against larval stages.

Dr. Benjamin McGraw is an assistant professor in the Department of Golf and Plant Sciences at the State University of New York (SUNY) at Delhi. Dr. Albrecht Koppenhöfer is a professor and turfgrass extension specialist in the Department of Entomology at Rutgers University in New Brunswick, N.J.

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ABW vacuum sampling proved as reliable and consistent as soil coring.

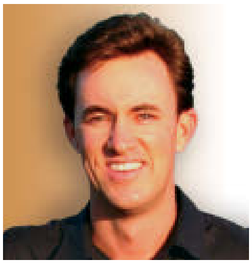
PHOTO COURTESY: BENJAMIN A. MCGRAW

## Ad Index

# Taking a Step Back

## IF EVERYDAY GOLFERS START TEEING IT FORWARD AND HAVING THE SAME WAITS AS THE PGA TOUR PRO, WHAT FUN WILL THAT BE?

BY GEOFF SHACKELFORD



By now you've probably heard or seen the public service announcements promoting "Tee It Forward." This is the USGA and PGA of America's joint answer to golf's ills. The campaign hits full throttle July 5th through 17th when the associations encourage "all golfers to play the course at a length that is aligned with their average driving distance."

The benefits of the concept? "Golfers can speed up play by utilizing tees that provide the greatest playability and enjoyment. With many more golfers hitting approach shots with 6- and 7-irons instead of hybrids and long irons, their chances for enjoyment increase."

There's no question many golfers play from the wrong tees. Since the USGA and R&A bungled equipment regulation over the last twenty years, elite golfers now launch the ball like never before. New courses were built to accommodate the new game while everyday courses compensated for the seemingly overnight changes by building new tees, planting trees, growing rough and most costly of all, speeding up greens. So as new technology gave a disproportionate boost to low handicappers and pros, hacks only saw marginal distance gains.

The reaction to these changes in the game finally caught up to us as rounds take too long and only the wealthy or retired can commit to an 18-hole "experience."

In other words, teeing it forward won't make a bit of difference, especially since the USGA and PGA of America are not offering any financial enticement for golfers to move forward.

Even as they sit on huge hordes of cash, neither organization is backing their faith in Tee It Forward by offering golfers a token reimbursement for committing to move forward. Such a rebate, even if it's a token $3 for playing up one set of tees, would have shown just how serious they are about a concept that figures to only wreak havoc at courses where unified implementation actually happens July 5-17.

For starters, Tee It Forward offers a yardage chart that makes no sense. The associations list the proper yardage for a PGA Tour Professional at 7,600 to 7,900 yards, meaning only one tour venue is officially long enough (Cog Hill). The rest of the time, the PGA Tour is essentially teeing it forward by the USGA and PGA's calculations.

And if you've been to a PGA Tour event lately, you know that the fields are backing up on nearly every par-5 — now that most of the field can reach even the longer three-shotters. Driveable par-4s where only a few bombers could get home a decade ago are now essentially long par-3s, creating another backup.

If everyday golfers start teeing it forward and having the same waits as the PGA Tour pro, what fun will that be? And how safe will it be? Missed shots off the faces of today's incredibly well designed clubs travel farther offline when combined with today's longer flying balls. So just when you thought you had the safety issues at your course figured out, Tee It Forward is likely to introduce new issues.

Ultimately, the state of the game still comes down to this: The golf course industry has four times the impact that the equipment industry has on our economy, yet it keeps working around what a few manufacturers believe is necessary to sell the latest and greatest equipment to meet their earnings estimates. We gave the equipment companies a chance over the last decade to let this model play out, and look where it got us.

The only way out of the spiral: Create a tournament ball for professionals to eliminate this silly distance chase. Return the emphasis to shot making, fun and skill, returning the championship golf course to something around 7,000 yards. Golfers will relate to the professional game again. Who knows, they might even tee it forward without prompting.

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