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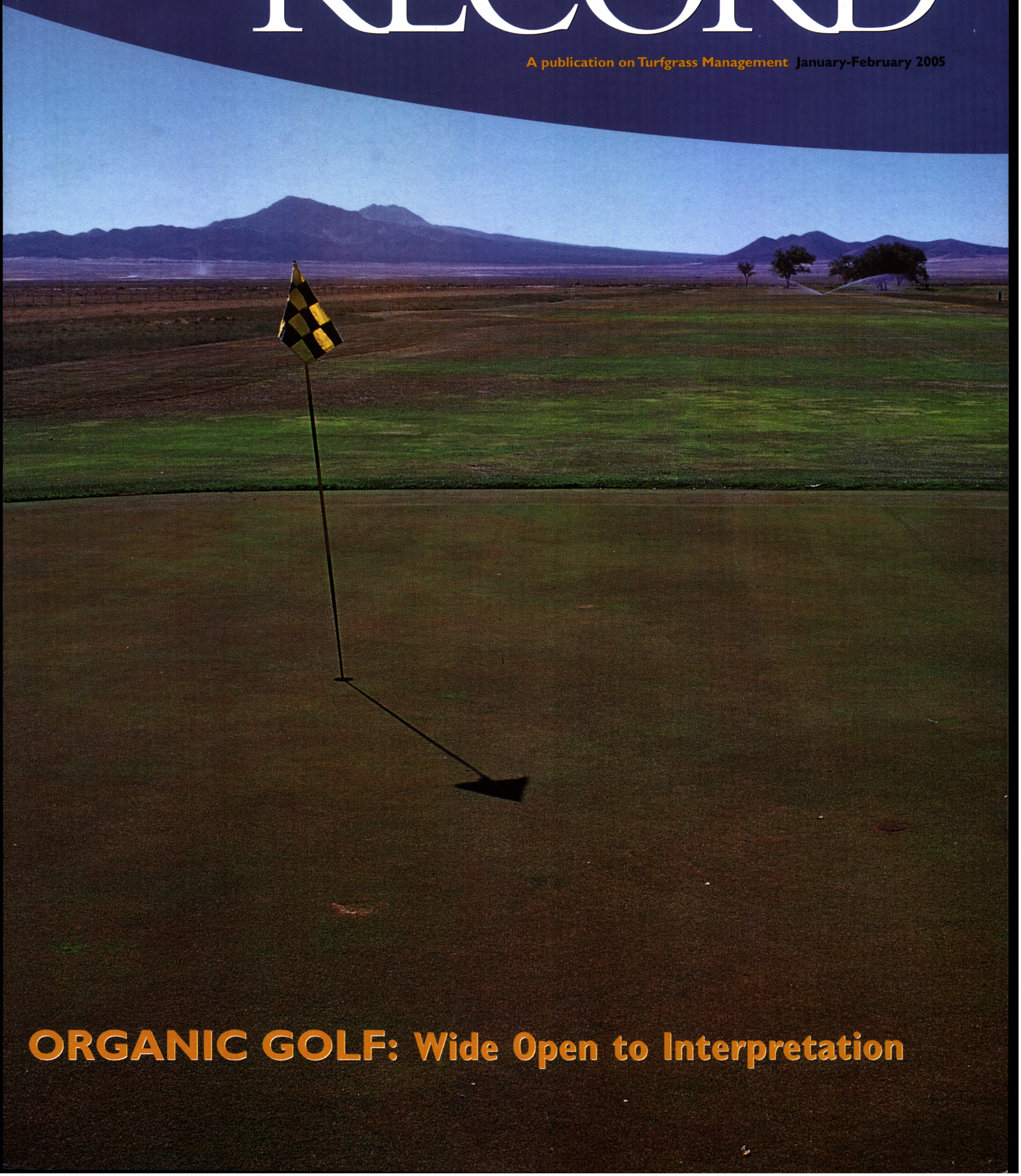

ORGANIC GOLF: Wide Open to Interpretation

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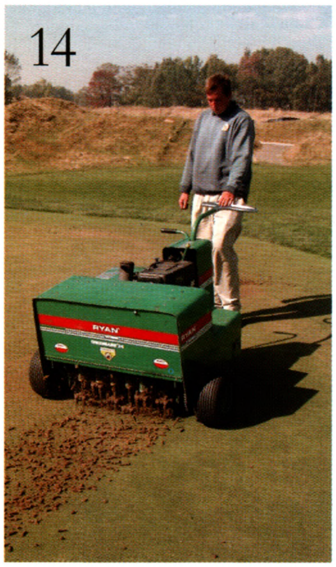

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Cover Photo
The golf industry would change dramatically if present-day organic standards were imposed on maintenance.

IS INORGANIC OR ORGANIC IN?

Organic or non-chemical turfgrass management will require more skilled employees who can scout for pests constantly and be familiar with turf health across the golf course.

Public scrutiny of golf course maintenance practices and an expanding organic industry are challenging golf course management to abandon synthetic fertilizers and pesticides. Can it be done?

BY MATT NELSON

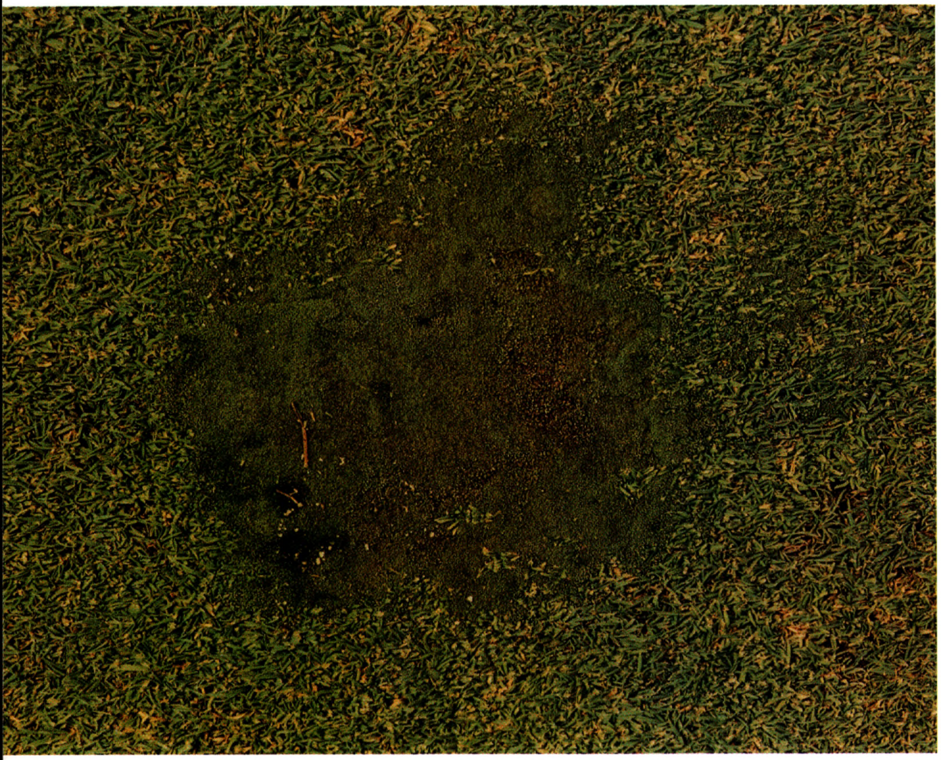
Organic production has become big business throughout North America and is an increasingly marketable niche for many producers of various agricultural products. Implementation of the National Organic Program Standards (NOPS) on October 21, 2002, established clear labeling regulations for organic products that guarantee they are certified by a United States Department of Agriculture (USDA) accredited certification organization.[9] These standards were developed by the National Organic Standards Board (NOSB) as mandated by the Organic Food Production Act of 1990. The NOSB is appointed by the U.S. Secretary of

Agriculture and consists of 15 members representing farmers, food processors, retailers, consumers, environmentalists, scientists, and certifying agents.[9] The NOPS were created to protect producers against marketing fraud and assure consumers that organic products meet uniform and consistent standards.

The national standards governing the labeling and marketing of organic products have raised public awareness regarding organic products in the marketplace. A tour through most any supermarket will reveal choices for organic fruit, vegetables, meat, breads, dairy, baby food, pancake mix, potato chips, frozen meals, alcoholic beverages, and almost any other type of food product. Although organic production is nothing new, the labeling laws, consumer confidence, industry growth, and marketability are new, and the rise in organic popularity is spilling over into other sectors of agriculture beyond food products, including golf.

The push to eliminate or reduce the use of synthetic fertilizer and pesticides in golf course management has risen in many communities across North America, including Seattle, San Francisco, Long Island, Quebec, and others. This groundswell of community support for organic golf management has prompted debate within and outside the golf industry regarding its feasibility and at least one research project aimed specifically at evaluating non-chemical turf management.[5]

Moss and other invasive weeds of putting green turf pose difficult problems for golf course superintendents to solve without all available tools.



Would the game of golf survive if only organic maintenance practices could be employed? The answer would have to be a qualified "yes." If, for argument's sake, the game of golf is 500 years old, then it has been totally organic for about 400 of those years. Golf is truly a great game and has endured many challenges throughout its history, but maintenance practices have evolved with advances in agronomy, equipment, travel, and marketing.

The business of golf, on the other hand, would change dramatically if present-day organic standards and products were imposed on maintenance. Turf is perennial (ideally) and golf is played around the world. The myriad of pests, environmental extremes, and traffic stress would limit a turf manager's ability to maintain a competitive product at many sites without plant protectants and synthetic fertilizers. While organic maintenance programs might mean that opening day for golf courses in the Rocky Mountains would typically be around July 15th, spring and fall would be the "seasons" in St. Louis, and overseeding wouldn't be a marketing option in the South but rather an annual necessity, there may exist a market for organic golf somewhere in the United States. What that implies for the golf industry is the focus of this article.

DEFINITIONS OF *ORGANIC*

Webster's Dictionary defines *organic* as "1) of or pertaining to an organ or its functions, 2) produced by the organs, 3) acting of instruments of nature or of art to a certain destined function or end, 4) forming a whole composed of organs, and 5) of or pertaining to compounds which are derivatives of hydrocarbons." The Oxford American Dictionary defines *organic* as "of, relating to, or derived from living organisms." The regulatory text of the National Organic Program (NOP) defines *organic* as "a labeling term that refers to an agricultural product produced in accordance with the Organic Foods Production Act and its regulations."[9] The NOSB defines *organic agriculture* as "an ecological production management system that promotes and enhances biodiversity, biological cycles, and soil biological activity."[7] Of course, there also is popular slang use, and little could be more "organic" to a golfer than playing the back nine solo at the local track just after a late afternoon summer rain. *Organic*

Studies and field experience have shown that IPM strategies can reduce pesticide use, safeguard environmental quality, and provide acceptable playing conditions.

means different things to different people. While the OFPA provides coverage and standards for crops, livestock, and derivative products, the USDA has no organic standards for health-care products, cosmetics, fertilizers, or turf and ornamentals, including golf courses.[8]

This is an extremely important distinction for golf and for the turf industry as a whole. Without applicable standards for organic management or, perhaps more importantly, no official certification, the term *organic* carries less weight. Without official standards for organic turf management and a formal certification process, it is conceivable that different golf courses in the same geographic area adhering to "organic" management practices could be following different rules, yet competing against each other for the same golfers. *Organic* is no longer a catch-all term to be used loosely when describing any agricultural or horticultural system — the USDA has made sure of that.[4] In fact, agricultural producers selling more than $5,000 worth of product annually must be certified to use the term *organic* on any labeling or else face a fine.[9]

CAN IT BE DONE? — CORNELL UNIVERSITY RESEARCH

Without dependable pest control products, golf course turf management would be an extreme challenge in most areas of the United States. Golfer demands for high-quality turf and fast green speeds cause stiff competition among golf courses and considerable stress on the turfgrass. Currently there are many turfgrass pest, weed, and disease problems without a dependable and/or economical organic solution, including snow mold diseases, anthracnose, goosegrass, nematodes, and many others.[3] Turf quality and the game of golf would change radically if organic management practices (strictly defined as no synthetic pesticides or fertilizers) were imposed on golf courses across the United States. The game might also become much more expensive than at present, especially if any semblance of modern playability were to be retained.

In response to anti-pesticide legislation on Long Island, N.Y., researchers at Cornell University initiated a study at Bethpage State Park in 2001 to evaluate the agronomic, environmental, and economic impact of managing putting greens with few or no chemicals.[12] The study was conducted at the Green Course of Bethpage State Park, which is a public access golf course that receives about 50,000 rounds of golf annually with turf that is subject to an array of fungal diseases, turf insect pests, and invasive weeds.

This research study produced several interesting findings and has generated significant outreach to

Organic turf management may require additional cultivation inputs such as fairway topdressing to improve the growing medium.

thousands of people within the golf industry and to environmental advocates worldwide.[5] Putting green treatments receiving no chemical application suffered significantly in all three years and several had to be closed during part of the season each year. In the last two years of the study, non-chemical greens reached unacceptable quality by late summer, despite receiving emergency fungicide applications.[5] Integrated pest management (IPM) strategies, including scouting, establishing pest thresholds, and using weather forecasts and all available management options, were employed as one of the treatments, and the study found that pesticide use on these IPM greens could be significantly reduced in *some* years and still provide acceptable quality, but further research is needed to realize acceptable results with few or no chemicals.[5] The significance of this finding is that proposed legislation banning pesticide use on Suffolk County-owned (Long Island) golf courses was modified based upon this scientific study.[12]

Another important discovery in this research is that a minimum of one or two additional employees per 18-hole golf course will be required to implement IPM or non-chemical golf course management.[5,12] Specialized equipment and occasional renovation to establish new turfgrass also may result in additional expenses. While the results from this study are fascinating, the reality is that the treatments in this research project and common golf course maintenance practices are a long way from organic.

CAN IT BE DONE? — A SCIENTIFIC EVALUATION

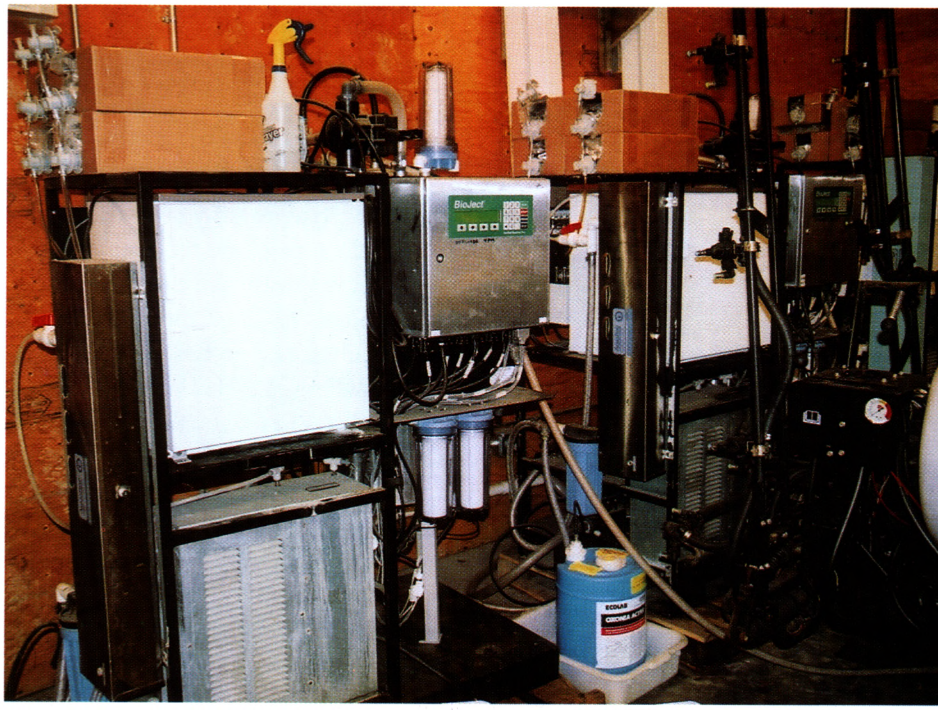
Environmental and Turf Services (ETS) of Wheaton, Maryland, completed a thorough scientific evaluation for the town of Stone Point, N.Y., concerning the potential for organic turf management and concluded through scientific evidence and field experience that a pesticide-free golf course is not feasible in this location.[3] The goal of the construction project was to build a high-end daily-fee golf course with anticipated annual play of 50,000 rounds. ETS considered their conclusion valid even if natural organic pesticides were allowed. They further determined that nine natural organic pesticides were suitable for use at the site, but would best be used in an integrated pest management program that involved scouting for pests, using pesticides preventatively rarely, using curative pesticide applications only when established pest thresholds had been exceeded, using a combination of synthetic and natural organic pesticides, and using cultural practices to minimize the need for pesticides.[3] These conclusions are consistent with the Cornell study and assert that a chemical-free approach is not realistic and that IPM techniques can reduce pesticide use without sacrificing playing quality.

CAN IT BE DONE? — THE VINEYARD GOLF CLUB

The application to build The Vineyard Golf Club (Edgartown, Massachusetts) was approved in 1999 by the Martha's Vineyard County Commission on the condition that the golf course be maintained by way of an organic program. The term *organic* was defined as "derived from plant materials or biological organisms or mined from natural deposits."[2] Further conditions specified the types of fertilizer to be used and the limits on nutrient loading per year. A review committee consisting of one member of the Edgartown Board of Health, the Edgartown Ponds Advisory Committee, and the UMASS/Amherst extension service was established, with the club furnishing the necessary funding to define and implement protocols concerning water quality monitoring on an annual basis.[2] The committee consists of five individuals, including one member from the club. Quarterly updates from monitoring wells and lysimeters are provided to the committee, along with all pesticide and fertilizer requests. The committee has established the approved list of pesticides and fertilizers.

The golf course superintendent, Jeff Carlson, CGCS, a champion of environmental stewardship in the golf industry, has discovered some interesting challenges and findings with respect to organic golf course management.[1] Dollar spot is the most significant fungal disease at the site, and nightly applications of *Pseudomonas aureofaciens* and biweekly applications of *Bacillus licheniformis* have helped keep this disease in check. Nightly applications, however, add considerable expense to the maintenance cost (labor, fuel), not to mention accelerated wear and tear on sophisticated and expensive spraying equipment and increased wear injury to collar turf from sprayer traffic. Polyoxin D zinc salt (Endorse) fungicide had been used to combat brown patch at The Vineyard Golf Club through 2003, but this product is not on the National List of approved substances in the NOP, even though the EPA considers this a biochemical-like pesticide and required only limited toxicological data for federal registration and waived the requirement for environmental fate data.[13] A limited amount of synthetic soluble fertilizer is used to stimulate growth and recovery during cool weather or following pest pressure or other forms of injury, and both the rate per application and annual rate are closely monitored. Leachate is constantly measured in monitoring wells and lysimeters, but the use of synthetic fertilizers would not comply with the NOP even though it clearly would follow best management practices. According to the NOP, this golf course would have to cease using polyoxin D zinc salt and synthetic fertilizer for three years before they would be considered organic.[9]

Mr. Carlson also has made the shrewd observation that their success with managing acceptable playing quality with "almost" (at least according to the NOP) organic maintenance programs has a lot to do with the fact that The Vineyard Golf Club is a new golf course with a new stand of turf that was chosen carefully for pest resistance and local adaptation. As populations of *Poa annua* (annual bluegrass) increase, pest problems and environmental stress will become more severe. This may require periodic regrassing of the golf course to achieve acceptable quality, and sod will almost certainly be required to expedite the renovation in an effort to minimize golf course disruption. Technically, that would require organically grown sod, which would be a serious limitation. Assuming standards for organic turf management are ever adopted, it may be possible to obtain an exemption from this requirement in the absence of any alternative.



The Vineyard Golf Club (Edgartown, Mass.) brews a microbial product on site that is applied every evening throughout the golf season to suppress dollar spot.

While commitment to environmental stewardship at The Vineyard Golf Club is commendable and their maintenance achievements to date are nothing short of remarkable, the definition of *organic* they established and the list of approved products does not conform to the USDA National Organic Program, nor is there any formal certification beyond the approval from the locally established committee. National standards for organic turf maintenance are needed to protect all parties presently or potentially involved with organic golf and to assure everybody that we're all talking about the same thing, even if those standards don't necessarily represent best management practices with respect to agronomics or the environment.

CAN IT BE DONE? — HYPOTHETICAL SCENARIO

The Rocky Mountain region of the United States is a favorable place to grow cool-season turfgrass with minimal pesticide requirements. This is not to say it is an easy place to grow grass; winters can be a huge challenge and render catastrophic turf failure, and golfers are just as demanding as anywhere else. But low summer humidity, cool nights, and few turf insect pests limit the use of pesticides as compared to many other areas of the U.S. It may be a good site to hypothetically construct "Holistic Golf Club" in an attempt to follow the agricultural standards of the NOP.

Assuming there is no organic sod available, commercially grown Kentucky bluegrass sod will be used to establish the tees, fairways, and rough. Fairways will be capped with 6-12 inches of sand, surface drainage will be excellent, shade and air circulation will not be issues, not a dime will be cut from irrigation design and installation, and greens will be built to USGA guidelines and seeded to the best available creeping bentgrass cultivar.

Weeds will be removed physically, regardless of the labor requirement. Any summer insect or disease pressure will be dealt with through cultural methods including, but not limited to, fertility (organic), irrigation, mowing height, cultivation, and manipulation of the growing environment to the extent possible. Approved pesticides on the NOP National List will be utilized if deemed worthy. Damaged areas will be replaced with sod. This all sounds fairly rosy until about October, when a decision regarding snow mold control must be made.

Snow cover in the Rocky Mountains can extend for at least five months at northern or higher elevation sites. Pressure from pink and gray snow mold diseases can be fierce, often resulting in widespread turf loss that may require months of good growing weather to recover or be largely displaced by annual bluegrass. The latter possibility results in decreasing turf reliability from year to year and an increase in pest-related problems. Without the use of pesticides to combat pests of annual bluegrass or the use of synthetic fertilizer to promote rapid recovery from winter damage, Holistic G.C. becomes less competitive in the golf market and financial woes ensue.

This imaginary scenario is not too far removed from some of the newer golf courses in the Rocky Mountains. Many golf course superintendents in this region use very few pesticides during the golf season, but none will risk their jobs or the viability of the operation by forgoing preventative snow mold applications to at least the greens. At this time there are no biological or organic alternatives for snow mold control that have been proven to work at golf courses in the field.[6,11] While golf courses in the Rocky Mountain region of the U.S. could conceivably get by with pesticide applications for the control of just one pest (snow mold), they wouldn't be organic. Dr. Frank Rossi, associate professor of turfgrass science at Cornell University, puts it best when he says, "The difference between organic and almost organic is the Grand Canyon."

WHAT ABOUT THE ENVIRONMENT?

There is a widespread assumption that organic production systems are naturally better for the environment. Organic systems have many positive environmental attributes, but organic does not imply best management. The USDA or FDA will not state that organic foods are more nutritious or healthy. Similarly, organic systems may not always be best for the environment.

Nutrient loading is a consideration with natural organic fertilizers. Exclusive use of these fertilizers can result in nutrient loading of the soil system and watershed, and untimely and uncontrolled nutrient release can make available more nutrient than the plant and soil fauna are able to utilize. Mineralization of organic nutrient sources requires microbial processes dependent on soil temperature. Another concern is the high amount of phosphorus contained in most natural organic

Snow mold is a potentially devastating fungal disease of cool-season turf without any dependable alternatives to fungicide for control.

fertilizers. Satisfying a plant's nitrogen requirement with natural organic fertilizers can resuilt in overloading of the soil system with phosphorus and a potential for eutrophication of water features.

Approved organic pesticides may also present concerns. One of these is copper sulfate, among the oldest pesticides used worldwide. Copper sulfate is relatively immobile in soil and is quickly bound by organic matter and clay particles, but it is highly water soluble. Regular use of copper products will result in copper accumulation in the soil and can be a concern if flooding occurs.[14] Copper sulfate is classified by the EPA as a General Use Pesticide with a toxicity rating of class 1 (highly toxic) and requiring signal words "Danger – Poison."[14] Copper sulfate is highly toxic to fish and other aquatic organisms, but it is regularly used for disease control in organic farming operations, even in regions with endangered anadromous fish runs.

IS INORGANIC OR ORGANIC IN?

There may well be a growing market for organic golf at certain locations in the United States and a definite opportunity for golf course superintendents willing to embrace that challenge. Anybody who can rise to that challenge and meet the expectations and desires of the clientele should be compensated accordingly. Research and practical experience would suggest that it isn't possible if current industry standards for golf are to be met and a true adherence to organic management is followed.

Use of the term *organic* as it applies to golf course management is questionable at best. Strictly developed standards for organic production by the USDA and the hugeness of the organic industry likely preclude the casual use of the term as any meaningful management definition for golf courses. Any effort to expand the scope of the NOP to address certification of nontraditional crops such as turf should include input from various stakeholders, including the USGA, GCSAA, university and industry turfgrass scientists, golf course owners, golfers, and environmentalists. The golf industry is much too large to allow community action groups like the Long Island Neighborhood Network to be the sole crafter of legislation concerning organic or any other form of golf course maintenance. An economic impact study of the Colorado golf industry conducted by Colorado State University and THK Associates, Inc., found that in 2002 the Colorado golf industry contributed $560 million in direct revenues to the state's economy and produced a golf-related economic impact of $1.2 billion in Colorado![10] Representatives of the golf industry need to be at the table for any discussions of organic golf maintenance.

The pressure from factions of the public to reduce pesticide use on golf courses is not going away. Golf industry officials need to stay apprised of efforts to impose non-chemical or organic maintenance protocol and the science and regulations concerning pesticide use. The USGA has invested $25 million since 1983 in turfgrass and environmental research, much of which has focused on the development of turfgrass species requiring less pesticide, fertilizer, and water, and best management practices aimed at reducing risk to the environment. Audubon International has promoted resource conservation, habitat development, community involvement, and environmental stewardship at golf courses through their cooperative sanctuary program since 1990. Chemical manufacturers have continued to develop reduced-risk products for safer use alternatives to many pesticides. University researchers continue to evaluate best management practices to safeguard environmental quality. There also are examples of interactions and cooperation among public and private entities concerning ecologically responsible golf course management, such as the Peconic Estuary Nitrogen Management Challenge.[15]

The development of non-chemical alternatives to pest problems and holistic management solutions is some of the most exciting agricultural science research being conducted today. We all have a stake in environmental stewardship, whether we realize it or not, but this does not mean that legal agricultural practices should be abandoned when economic viability is at risk and no suitable pest control alternatives exist.

Organic golf management will continue to be discussed and promoted throughout the country, but uniform and consistent standards, along with third-party certification, need to be adopted before the term *organic* has any meaningful application for the golf industry.

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Salts Influence Nematodes in Seashore Paspalum

Are seashore paspalum roots affected by plant-parasitic nematodes under high-salinity irrigation?

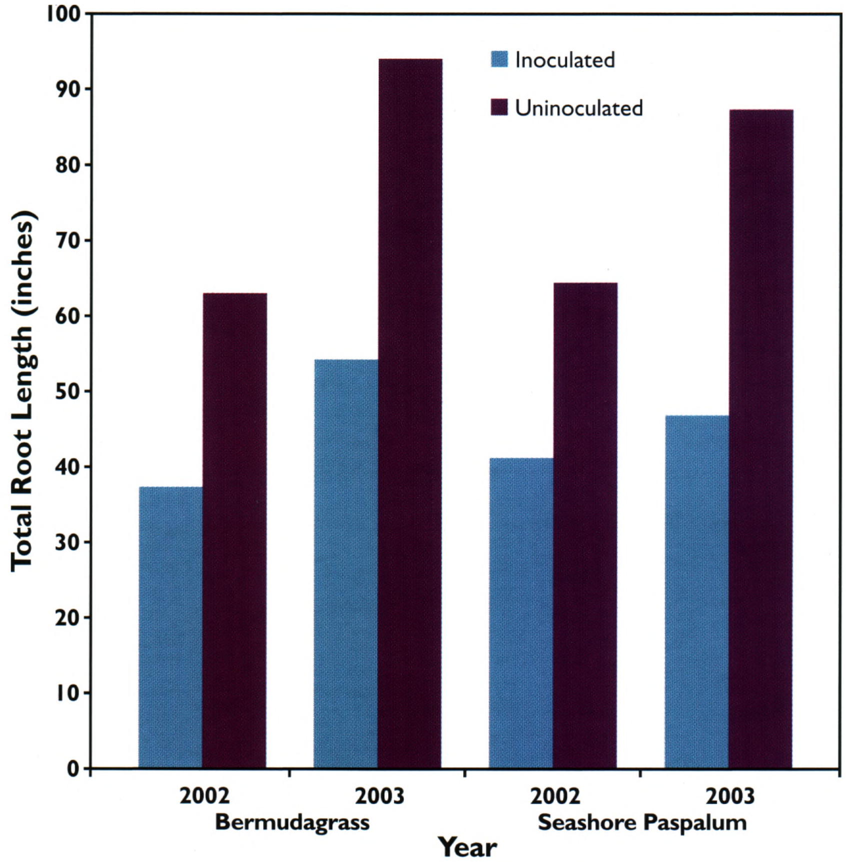
BY ADAM C. HIXSON, TODD LOWE, AND WILLIAM T. CROW

Seashore paspalum can quickly spread in saline conditions as long as proper nutrients and soil conditions are present.

Water quality is an ever-increasing issue on golf courses as the demand for potable water increases and alternative water sources are utilized for golf course irrigation. In fact, recycled water as the primary source of irrigation has increased for Florida golf courses from 8% in 1974 to nearly 50% in 2000.[3] As a result, salt-tolerant turfgrasses are becoming necessary in many areas because of groundwater use restrictions, salt accumulation in soil, and saltwater intrusion into groundwater. Seashore paspalum (*Paspalum vaginatum*) is a warm-season turfgrass adapted for saline conditions and has been utilized on salt-affected sites for the past 30 years. Breeding efforts over the past decade have provided several varieties with improved leaf texture, color, and overall quality, and its use on golf courses throughout Florida and the coastal southeastern U.S. is increasing.

Figure 1

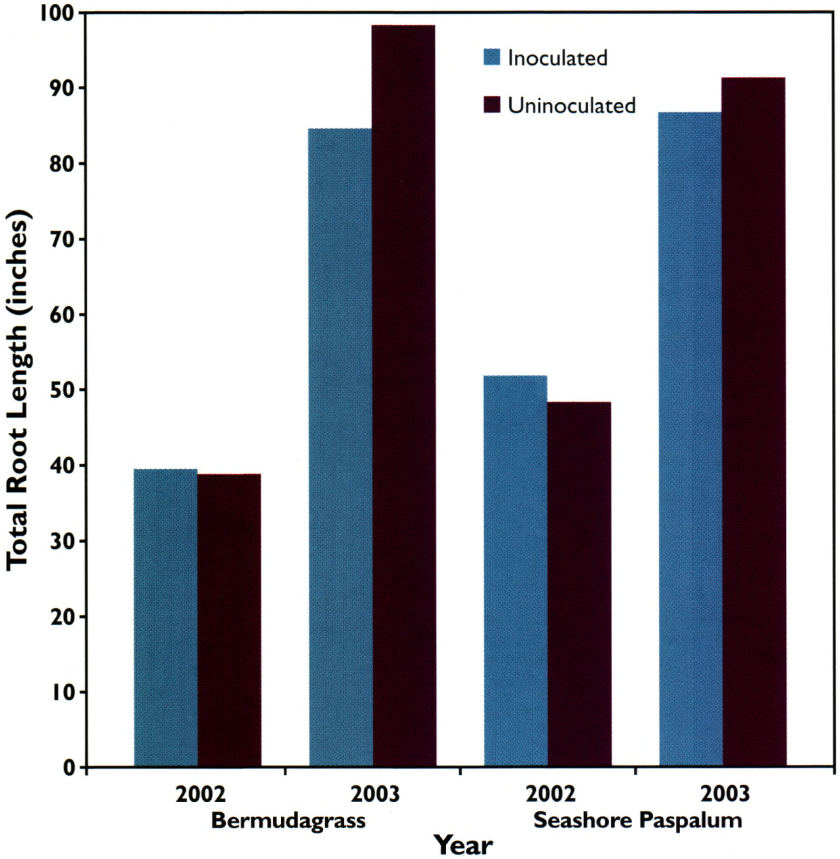
Effects of sting nematode (*Belonolaimus longicaudatus*) on total root lengths of SeaIsle 1 seashore paspalum compared to Tifdwarf bermudagrass. Total root lengths are the combined lengths of all roots present in a soil core taken from experimental pots, not actual root depth.



A major limitation of growing turfgrass in sandy soils throughout the southeastern U.S. is the destruction of roots by plant-parasitic nematodes. There are several types of plant-parasitic nematodes, but the most injurious nematodes throughout the southeastern U.S. are sting (*Belonolaimus longicaudatus*) and lance (*Hoplolaimus galeatus*) nematodes. Sting nematodes are ecto-parasites that live outside plant roots and damage lateral roots as soon as they are formed. Lance nematodes are migratory endo-parasites that enter turfgrass roots and cause damage by feeding as well as physically tunneling through cell walls. Ultimately, plant-parasitic nematodes decrease root growth and the plant's

Figure 2

Effects of lance nematode (*Hoplolaimus galeatus*) on total root lengths of SeaIsle 1 seashore paspalum compared to Tifdwarf bermudagrass. Total root lengths are the combined lengths of all roots present in a soil core taken from experimental pots, not actual root depth.



Lance nematodes are able to enter seashore paspalum roots, causing damage to the root cortex.

ability to take up water and nutrients. Aboveground symptoms of plant parasitic nematode damage become evident in the form of sporadic turf thinning and chlorosis.

Sting and lance nematodes are destructive pests on a variety of turfgrasses, but little is known about their damage to seashore paspalum. Seashore paspalum has only recently been determined to be susceptible to sting nematodes, while the effects of lance nematodes on seashore paspalum root health remain unclear (Figures 1 and 2). Maintaining acceptable turfgrass quality is increasingly difficult when the manager is forced to reduce water consumption or switch to alternative water sources. An additional unknown aspect is the effect of salinity levels on sting and lance nematode populations in seashore paspalum. Plant-parasitic nematodes are primarily aquatic animals residing in films of water surrounding soil particles. The premise of this research is to investigate if disruptions in this habitat, such as saline irrigation, can affect biological processes and possibly decrease nematode populations.

GREENHOUSE TRIALS

Experiments were performed to establish relationships between increasing irrigation salinity levels and population levels of sting nematodes and lance nematodes. Greenhouse experiments were conducted in 2002 from April to September and repeated in the spring and summer of 2003 at the University of Florida Turfgrass Envirotron research facility in Gainesville, Florida.

Nematode-free plugs of SeaIsle 1 seashore paspalum were planted into 6-inch clay pots filled with 100% USGA specification sand in a climate-controlled greenhouse. Sting and lance nematodes were then inoculated into the clay pots and exposed to salinity irrigation levels ranging from 3,200 to 35,200 total dissolved salts (TDS) and deionized water (0 TDS) to serve as a control. Nematode population densities

Plant parasitic nematodes significantly reduce bermudagrass root growth, reducing the turf's ability to take up nutrients and water.

were evaluated 120 days after salinity irrigation treatments began.

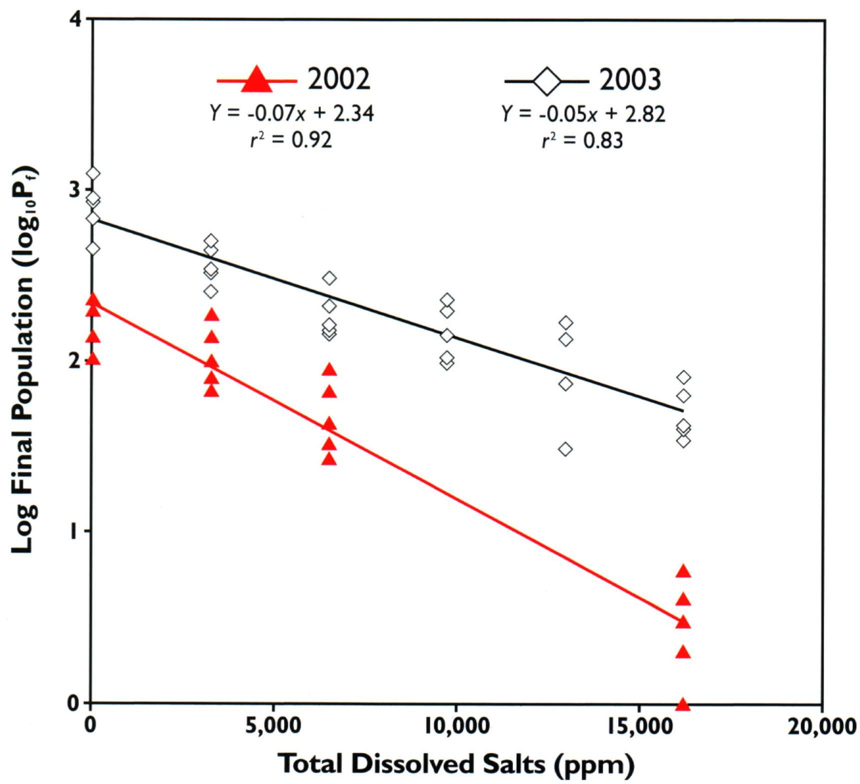
In 2003, root length analysis was performed in addition to the nematode population measurements. Stained root samples were placed into a glass-bottom tray and scanned using a desktop scanner to create a black-and-white bitmap image of the roots. The GSRoot (Louisiana State University, Baton Rouge, Louisiana) software program was used to analyze the bitmap images. This program measures root lengths and surface areas from scanned images. Root length data were recorded for seven root diameter ranges, and the resulting values were summed to determine the total root length of each root sample.

RESULTS AND DISCUSSION

In both years of the study, reproduction of sting and lance nematodes was affected by increasing salinity levels (Figures 3 and 4). Lance nematode populations decreased linearly with increasing salinity irrigation treatments (Figure 3). Lower salinity treatments, 0

Figure 3

Relationship between log transformation of final population densities (P_f) of lance nematodes (*Hoplolaimus galeatus*) (nematodes 100 cm^{-3} of soil) (Y) and salinity treatment (x) in 2002 and 2003 greenhouse experiments.



to 6,400 TDS, resulted in higher lance nematode reproduction than the higher salinity irrigation treatments (Figure 3). The ability of lance nematodes to enter roots as migratory endoparasites also decreased as salinity levels increased. The nematodes were probably not able to escape the effects of the salinity by entering the roots because the root cortex tissue does not exclude the elevated ion concentrations associated with saline water. Their ability to enter the roots typically gives them the capability to escape the effects of most nematicides[2]; therefore, irrigating with high-salinity irrigation may increase nematicide efficacy.

In 2003, second-stage juveniles or J2 (the life stage of the nematode that hatches from the egg) of sting nematodes comprised a majority of the population in the 9,600 and 12,800 TDS treatments, and an abundance of J2 at moderate salinity levels resulted in elevated total population numbers (Figure 4). Usually, J2 can be easily separated from other life stages by their dark color and stout body shape, but J2 in our study had a clear body cavity, indicating they were probably unable to feed. Root length data in 2003 support this hypothesis, with normal root growth at salinity levels between 9,600 and 16,000 TDS as opposed to nematode feeding that occurred on roots in lower salinity treatment levels (Figure 5). Reproduction and maturation of the nematodes at higher salinity treatments probably occurred early in the experiment, before the salinity was able to build up in the soil. These results indicate that the ability of sting nematodes to stunt root growth decreased as salinity levels increased above 9,600 TDS.

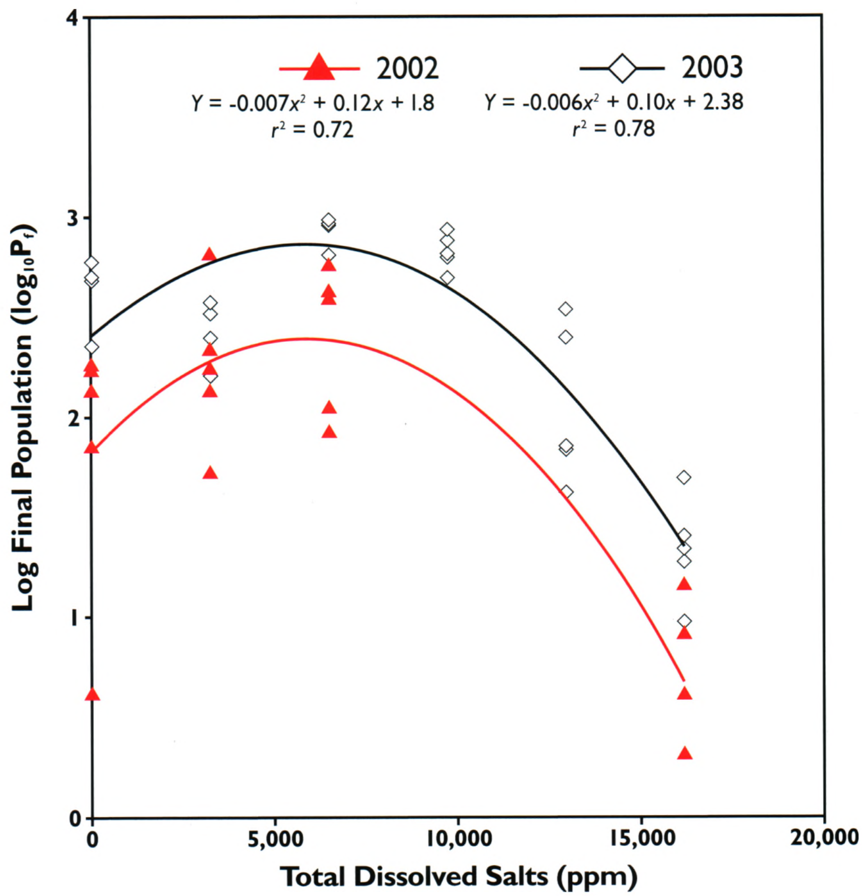
Moderate- to high-salinity irrigation had an impact on sting and lance nematode reproduction.

In 2002, repeated applications of high-salinity irrigation (25,600 and 35,200 TDS) caused nearly complete mortality for both nematodes, but the shoot growth of the grass was stunted and yellowed. Even though sting and lance nematodes were effectively controlled, the turfgrass was visually unacceptable. Seashore paspalum can be irrigated with seawater (34,560 TDS) in the field when soil conditions and increased irrigation allow for sufficient leaching to occur and turfgrass managers fertilize, amend, and cultivate the soil properly.[1] In the greenhouse, we were unable to provide sufficient leaching, proper amendments, and cultivation of soil necessary for seashore paspalum survival at salinity levels near that of seawater, which may account for the poor turfgrass quality that occurred.

Results from greenhouse experiments are difficult to extrapolate to field conditions, but we can conclude that moderate- to high-salinity irrigation had an impact on sting and lance nematode reproduction. The treatment salinity levels were routinely applied throughout the experiment; therefore, nematodes did not recover from salinity stress. A discontinuous high-salinity irrigation regime would be more similar to irrigation of poor quality on golf courses where rainfall can leach salt from the soil profile.[4] Our data suggest that irrigation with pure seawater or with seawater as a high percentage of the blended irrigation water may have potential as an effective option for suppression of sting and lance nematodes. This information may be vital to turfgrass managers currently maintaining seashore paspalum known to have a nematode problem. Further investigation

Figure 4

Relationship between log transformation of final population densities (P_f) of sting nematodes (*Belonolaimus longicaudatus*) (nematodes 100 cm^{-3} of soil) (Y) and salinity treatment (x) in 2002 and 2003 greenhouse experiments.



is necessary to determine if frequency and timing of high-salinity irrigation, in addition to salinity concentration, reduces nematode reproduction and feeding.

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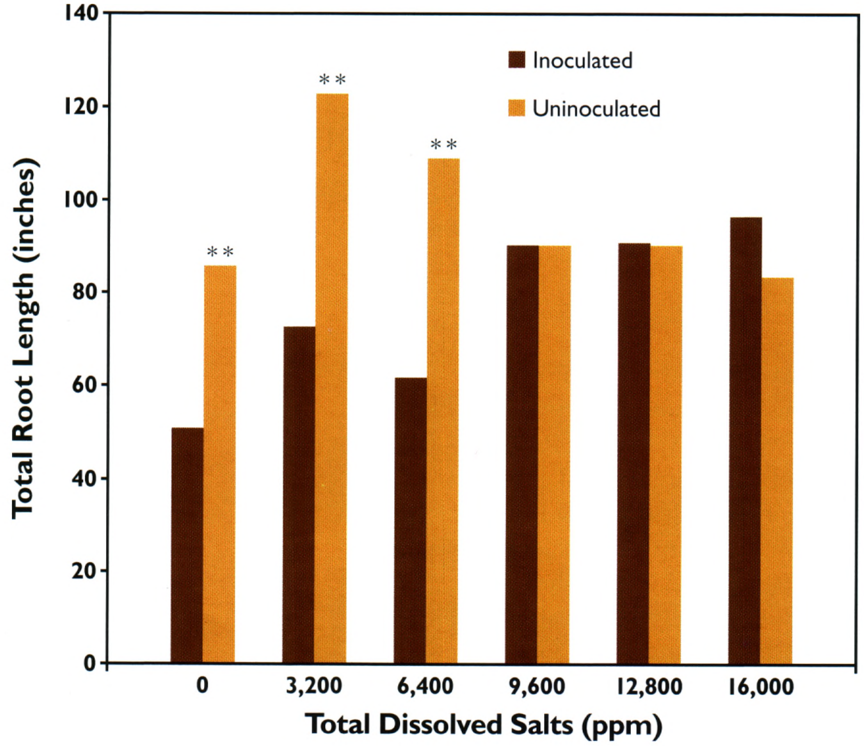
Figure 5

Effects of sting nematodes (*Belonolaimus longicaudatus*) and salinity level on root length of SeaIsle I seashore paspalum (*Paspalum vaginatum*). Total root lengths are the combined lengths of all roots present in a soil core taken from experimental pots, not actual root depth.



* * Indicates a statistical difference from inoculated

Plant-parasitic nematodes feed on bermudagrass roots, causing irregular chlorotic and drought-like patches.

Excess Organic Matter is No Laughing Matter at The Straits

When you strive to provide 100% customer satisfaction, it can be a challenge to incorporate important but disruptive maintenance operations into the turf management program.

BY DAVE SWIFT

The Straits and Irish Courses at Whistling Straits, along with the Meadow Valley and River Courses at Blackwolf Run, make up the 72-hole golf resort designed by Pete Dye known as Destination Kohler in Kohler, Wisconsin. The Straits hosted the 1999 PGA Club Professional Championship and the 2004 PGA Championship, and it is scheduled to hold the 2007 USGA Senior Open.

The Straits is a rugged, links-type layout with extensive dunes and more than 1,000 bunkers located along two miles of Lake Michigan coastline that can play more than 7,600 yards from the back tees. This unique public facility is a *walking only* course that averages 30,000 rounds of golf annually.

Core cultivation with a unit capable of close spacing is the key to success for removing excess organic matter from greens. Filling the holes with sand is accomplished easily when using dry sand and blowers.

THE CONCERN

Construction of the Straits started in 1995, and the course opened in July of 1998. The greens were built to USGA recommendations and seeded with Providence creeping bentgrass. During construction and grow-in, important cultural practices for new greens, such as topdressing, were sometimes placed on the back burner in an effort to complete the project in a timely manner.

Extended periods of cool, humid weather during spring and fall are standard fare along Lake Michigan. A healthy stand of bentgrass naturally recycles organic matter into the upper soil profile of greens when roots,


Cleaning up the cores is the most labor-intensive stage of the aeration operation.

Buffalo turbine blowers are used to move dry sand into the holes. Keeping brushes and dragmats off the turf causes minimal injury to the putting surface.

shoots, stolons, and other plant parts are replaced throughout the season. The natural soil microbial processes responsible for organic matter decay are temperature dependent. Consequently, the cool microclimate along the lake produced ideal conditions for thatch accumulation.

After hosting the Club Professionals Championship in 1999, we started to address the concerns associated with excessive organic matter accumulation that had developed in the upper inch or so of the greens. Problems with scalping and *Poa annua*/moss encroachment increased as mowing heights were lowered to increase green speed, especially across severe undulations.

THE SOLUTION

During the next three years a maintenance plan was developed and fine-tuned to prepare the greens for the 2004 PGA Championship. Our goals were:

- Reduce organic matter accumulation in the upper rootzone to provide golfers smoother and firmer greens.
- Eliminate moss and reduce *Poa annua* encroachment.
- Achieve these goals while causing minimal inconvenience to golfers.

From 1999 to 2002, various management practices were assessed to manage thatch. We would lightly topdress greens more frequently throughout the season to prevent further thatch accumulation, but we needed a way to remove the excess organic matter that had already created a layer in the soil profile. Ideally, we needed to develop an aggressive aeration program without closing the golf course or reducing green fees.

By trial and error we found that when nine or more greens were cultivated at one time, we received an unacceptable number of complaints and requests for reduced green fees. With this in mind, we implemented a schedule of cultivating only six greens at a time using quarter-inch hollow tines. When the first six greens would heal completely, six more were cultivated, and then the last six greens were treated. Furthermore, the sequence of cultivation was staggered so that only a few consecutive holes were affected at any one time. Complaints practically disappeared.

The program was started during the spring of 2000. The goal of significantly reducing organic matter was not being achieved despite two to three aeration operations per season. More aggressive cultivation with the Graden vertical mower was employed twice during the fall of 2001 to modify the upper soil profile. The unit removed considerably more material from greens than the

A backpack blower is used to eliminate the buildup of sand that occurs at the interface between the collar and the rough.

quarter-inch aeration, but the increased number of complaints from guests was unacceptable.

Using the *Green Section Record* article "Core Aeration by the Numbers," found in the July/August 2001 issue as a guide, the decision was made to use larger tines in a closely spaced pattern to affect a greater percentage of the greens per cultivation. The goal was to impact 30% to 40% of the green's surface area during 2002 and 2003 in preparation for the 2004 PGA Championship.

THE CURRENT PROGRAM

The Ryan GA 24 unit equipped with quadratine holders is used because the relatively slow speed of the unit produces a clean, vertical hole. The tine holders are machined to accept half-inch-diameter hollow tines. One pass of the unit affects approximately 9% to 10% of the putting surface. Each green would need to be cultivated three or four times a year to achieve this goal of impacting 30% to 40% of the green's surface.

Greens are cultivated twice during April before the course is opened and once during early September. A few of the problem greens that were contaminated by soil from washouts during construction are aerated three times during spring. Most superintendents would cringe at the thought of the damage and bruising to greens caused by three back-to-back aeration operations during April — a time when turf growth is typically slow due to cool soil temperatures. The key to success is keeping brushes and mats off the putting surface.

Fertilizer and a moderately heavy rate of sand are applied to greens during late fall. This sets the table for aggressive cultivation the following April. The dark topdressing absorbs heat from early spring sunlight and the turf greens up quickly. Early green-up and the availability of nutrients help the holes heal over quickly in spite of the aggressive cultivation. The heavy layer of sand also helps support the aeration and topdressing equipment that could easily rut the soft, wet greens during spring.

After the first cultivation, the cores are blown to the center of the greens with Buffalo Turbine units. This shakes sand loose from the cores and minimizes the wear that would have been caused by scraping cores off greens with snow shovels. Sand from cores and sand from last fall's topdressing begin to fill the holes. The tufts of turf and thatch that remain are removed. A little additional sand is applied to the greens where needed, and it is blown into the partially filled holes. The use of dry sand is an absolute necessity. The green is rolled after the holes are filled and then the process is started all over again.

During early September the process is repeated once, but only six greens are cultivated at a time to minimize the inconvenience to golfers. Cores are removed as soon as they are ejected from the tines. Heavier applications of sand are made to fill the holes, but the turbine blowers are still employed to work sand into the holes. The ability to keep brushes and dragmats off the putting surface greatly reduces turf damage and accelerates the rate of recovery. Again, dry sand is a must.

If we had tried to brush or drag sand into the holes, we would have likely bruised the turf and added several more days to the healing process. Another benefit to using blowers is that any excess surface sand on the greens is sent into the roughs. A clean surface causes less damage to mowers.

Double aeration during spring requires about four days for 20 greens with dry weather. Our weather is pretty chilly in early April and sometimes we have had the plugs freeze to the green. The operation requires two aerifiers, one or two turbine blowers, one topdresser, one roller, and a crew of 15-18 employees. The September operation takes approximately three weeks to complete.

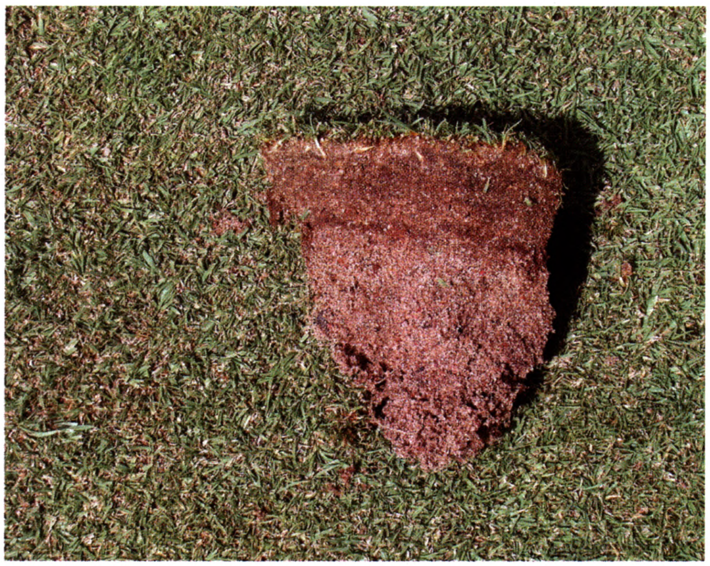
Dry sand is stored in a silo. Moist sand cannot be moved into aeration holes efficiently.

It takes about three weeks for the greens to heal over during spring and a week or two to heal during September. Greens aerated twice in spring take the same amount of time to recover as greens aerated three consecutive times. After all, the holes are all the same size; only the spacing varies.

So far, the only drawback with the turbine blower method has been excess sand accumulation along the outside perimeter of the collar where the short bentgrass collar meets the higher fine fescue rough. The sand buildup due to overaggressive blowing operations resulted in occasional, but significant scalping injury to turf due to the uneven change in grade. Elevated turf needed to be aerated by hand to remove excess sand and was then rolled. Now we spend much more time with backpack blowers along the perimeters to remove excess sand accumulations.

How successful is the program? Complaints are few and far between. The greens are firm and smooth, and they drain rapidly after heavy rainfall events. Root growth is excellent. Want more proof? The noticeable improvement in putting surface quality on the Straits Course has prompted the management team at Destination Kohler to approve these operations for the other three courses at the resort.

DAVID SWIFT, *golf course superintendent, arrived at Whistling Straits in 1999, straight from the golf course management program at Penn State University.*



Above left: An appropriate amount of topdressing applied to new greens during and after establishment eliminates organic matter layers in the upper soil profile. Above right: Excess organic matter can accumulate quickly in the upper rootzone of new sand-based greens unless an aggressive topdressing program is initiated during the grow-in.

FAIRWAY TOPDRESSING IN THE MID-ATLANTIC REGION

Taking fairways to the next level.

BY STANLEY J. ZONTEK

Fairway topdressing programs have been popular and successful in the Northwest for many years. The goal has been to firm up and dry up fairways in that region of the country because of their heavy soils and unique climate. In all honesty, this author was skeptical that this program would ever be used by all that many golf courses in the eastern United States. I was wrong.

This article will support the concept of fairway topdressing. This program works for many reasons, some of which are slightly different from those in the Pacific Northwest. The article will describe how the program is being adapted by turf managers in the Green Section's Mid-Atlantic Region.

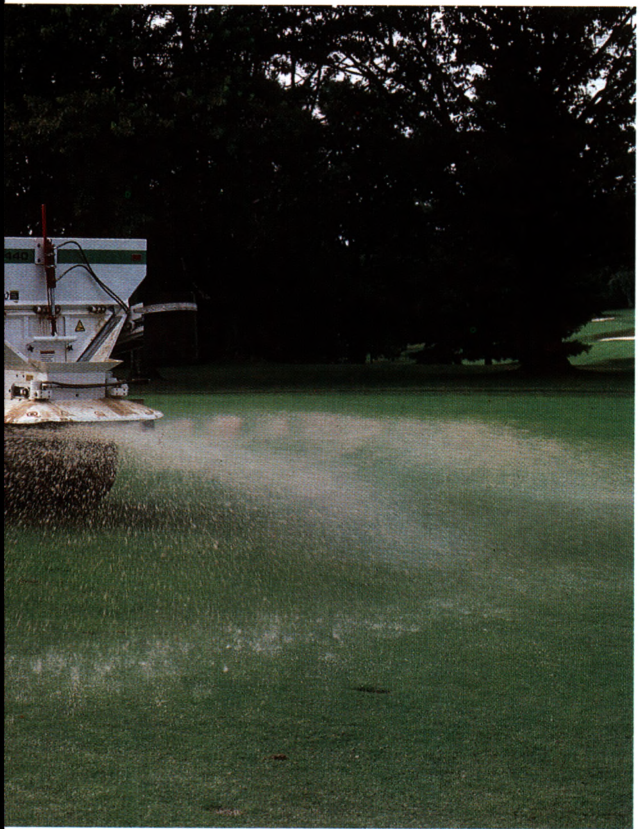
Why topdress fairways? There are a number of very good reasons. Interestingly, some benefit the golfers and others benefit the grass.

GOLFER BENEFITS

Firmer fairways. As topdressing sand accumulates, soft and sometimes puffy bentgrass (and *Poa annua*) fairways become firmer. This makes for better ball roll and overall fairway playability. Increased turf density also occurs, along with nice tight lies. Firmer fairways also mean . . .

Drier fairways. Due to a combination of factors, such as less thatch and better rooting, fairways need less water, and water that is applied soaks in better. With topdressing, sand intermixes with thatch, as opposed to there being a mat of organic matter that can hold water like a sponge. Topdressed fairways hold less water near the surface and are drier underfoot compared to non-topdressed fairways. Water percolates better through thatch that is diluted with sand. This means . . .

Fewer traffic restrictions. Golf carts and turf equipment can return to fairways sooner after heavy rainfall events, which are so common in the eastern United States. One of the major benefits in the Pacific Northwest has been firmer and drier fairways during those extended periods of soggy weather so common in that area. In the East, it is much more common to have thunderstorms with large amounts of rainfall in a short period of time, causing flooding and saturating everything. Then, the sun comes out and the golfers want to play and ride their carts on fairways. The benefit of the return of traffic on fairways was made clear to me while making a Green Section Turf Advisory Service visit to Aronimink Golf Club in Newtown Square, Pennsylvania, the day after torrential rains. These storms dumped more than 2.5 inches of rain on the course. Guess what? The fairways were firm and dry enough for them to be topdressed after heavy rains that would normally have left them saturated for days! I became a believer. Sure, there were a few drainage swales that were still wet, but the vast acreage of fairway turf was incredibly firm and dry. This means . . .



Topdressing the fairways at Aronimink Golf Club (Newtown Square, Pa.). This is considered a light rate.

A heavier rate of fairway topdressing. In this case the small stones may ultimately present headaches for the mechanic and the mowers.

One pass of the fairway topdresser applies the topdressing material evenly. The impact on play should be minimal.

Happer golfers. How can it not be worth the cost of topdressing when golfers now can use their course more fully more days of the year? Maybe, just maybe, with fewer complaints during wet weather, this means . . .
a happier superintendent!

TURFGRASS BENEFITS

Improved drainage. In conjunction with a good fairway aeration program, sand-diluted thatch, and sand accumulation over heavy topsoil, water percolates through the soil profile better and faster. Again, less water also is held in the thatch layer, which means . . .

Less disease. The primary disease of bentgrass and *Poa annua* fairways is dollar spot. Classically, dollar spot is made worse by thatch. Also, other diseases of bentgrass and combination bentgrass/*Poa annua* fairways are *Pythium* and brown patch. Both of these diseases have been associated with high levels of soil moisture. Therefore, diluted organic matter, which holds

Between a light dragging and irrigation, most of the fairway topdressing sand is worked into the grass.

less water and is less thick, has the potential for less disease. This means . . .

Reduced/offset costs. A topdressing program is, after all, a program above and beyond how fairways traditionally have been maintained. In theory, part of the extra cost of fairway topdressing can be offset by less chemical usage, more days of cart traffic, and potentially even fewer days when the course is closed.

THE PROGRAM

Programs vary. Nonetheless, in conducting an informal survey prior to writing this article, most of the superintendents I spoke with who topdress their fairways basically use variations of the following program. Eventually, each superintendent needs to work out what is best for his or her course. Generally speaking, most superintendents topdress their fairways once per month during the grass growing season, for an average of six or seven topdressings per year in the Mid-Atlantic region. Rates of sand range from four to six tons per acre. Initially, some courses topdressed their fairways more heavily and less frequently. Unfortunately, this led to layering concerns similar to those experienced when topdressing greens using the same approach. It also led to unhappy mechanics. Coincidentally, the industry has developed large-capacity fairway topdressers that make lighter and more frequent applications of topdressing easy to accomplish. In fact, it is the availability of this large-capacity equipment that is the key to the success of such a program.

Which sand should be used? Generally, use a locally available (and less expensive) mason's type sand. Sand used for fairway topdressing does not have to meet the same requirements as sand used to topdress greens or tees or for use in sand bunkers. Such a sand can have more fines and can even have a few more coarse particles than sands associated with other uses. Work with a physical soil testing laboratory or ask your local Green Section agronomists for their opinions. *There are no specifications for fairway topdressing sands.* In all honesty, choosing the right sand is as much *art* as it is *science*. The final determination could be the availability of the sand and its cost. Sands used for topdressing fairways do not have to be costly.

The cost of sand. The golf course superintendents I surveyed have experienced a wide range in sand costs. Some have found sands for as little as $10 a ton, delivered, whereas others must pay nearly $20 per ton. Obviously, the cost of the sand can and will have a huge impact on the cost of this program. High-quality (and expensive) putting green-grade sands, while more than appropriate for use, do not seem to be necessary. Find a local sand company, choose a goodlooking sand and see if they will sell directly to you. With the volume of sand you will be using, sand companies seem more than willing to negotiate. This can save a lot of money!

What about labor? Most superintendents use their existing crew. While a little extra labor is necessary once the program begins, with the right equipment the extra labor hours are not burdensome. Nonetheless, with the high-capacity fairway topdressers now available, two or three operators can fill, spread, let dry, and then mat in a topdressed fairway. Light fairway watering also can help work in the sand.

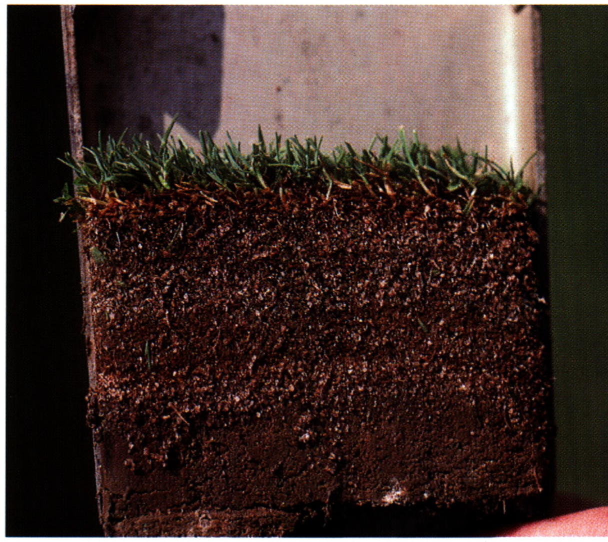
What about time to do the work? Obviously, having the course closed for a day to do this work is preferable. However, most superintendents tend to topdress when time is available, even through regular weekly play. They seem to receive few complaints.

What about special equipment needs? Obviously, walking topdressers designed for spreading sand on greens or tees would not be appropriate for topdressing fairways. Our industry has several models of large-area topdressers to choose from. Also, each golf course needs to have a dedicated topdressing storage area (preferably an asphalt or cement base), a front-end loader to fill the topdresser, a tractor to tow the topdresser, and a drag mat to brush the sand into the grass.

What about fairway aeration? Initially, traditional core aeration should continue until such time as the sand begins to accumulate. Then, fairways are aerated more with solid tines and less with hollow coring tines. The thought is to not contaminate the sand as it accumulates. In reality, an eventual switch to the use of solid tines is one of the real benefits of this program. Traditional core aeration is despised by most golfers, even though it is a necessary operation. Potentially, fairway topdressing with sand can allow traditional core aeration to be replaced by less-disruptive solid-tine aeration. In the long term, especially as the sand accumulates, there can be a return to core aeration when all the material that is brought up in the aerating process is the accumulated topdressing sand. That's years away. In the final analysis, each course must adjust its fairway aeration program to its own conditions.

Are there other concerns? The answer is "yes." They include:

- **Rocks in your topdressing.** Rocks and gravel can come from a less-than-adequate storage area or sometimes they occur as a contaminant/carryover from the bulk hauler that delivered the sand. In any case, stones in the topdressing sand, which cannot be worked into the grass, are bad for obvious reasons.
- **Shocked mechanics.** The thought of topdressing fairways will not make most mechanics very happy. Be prepared for, "You want to do what?" Yes, there will be some extra reel sharpening and more mower maintenance. Tell your mechanics that this program will help ensure their long-term job security! Seriously, as the program evolves it becomes just another maintenance chore to which the staff must adjust.
- **Communication.** It takes some work, legwork in fact, to prepare for this program. You need to find a source for an economical sand of reasonable quality. The proper equipment and a reasonable storage area where sand can be dumped are necessities. You must have adequate labor for this program and communicate with everyone at the course about the short-term as well as the long-term goals of this program. It may even be a good idea to take a field trip to visit other golf courses that topdress their fairways.



Sand accumulating on a topdressed fairway. Note the healthy roots and how the organic matter is intermixed with the sand topdressing.

IN CONCLUSION

This article cannot discuss all aspects and details associated with a program of such a massive scale. Each course will have to adapt this program to its own special needs. For example, we are seeing golf courses with bermudagrass, zoysiagrass, and even perennial ryegrass fairways beginning a sand topdressing program for all of the same reasons, including, on ryegrass fairways, earthworm cast suppression.

In the Mid-Atlantic Region, which is a transition zone area, topdressing fairways is a program that is being embraced on different grasses, sometimes for different reasons. Nonetheless, to use perhaps an overused cliché, this program can take fairways "to the next level."

STANLEY J. ZONTEK, *Director of the Mid-Atlantic Region, has visited courses in the transition zone for more than 20 years.*

Research *You Can Use*

Florida Golf Courses Help an Endangered Butterfly

Golf courses in the Florida Keys offer their help to save a colorful and rare butterfly.

BY JARET C. DANIELS AND THOMAS C. EMMEL

The plight of imperiled butterfly species around the world continues to generate increased public interest and funding support. Recent management plans created to conserve many critically endangered butterflies mirror the aggressive, creative, and cooperative nature of those types of plans historically implemented for traditional vertebrate conservation programs. Laboratory and field-based ecological research combined with captive propagation, organism reintroduction and translocation, habitat restoration or augmentation, and movement corridor development have helped unite university researchers, governmental agencies, non-governmental conservation organizations, and private landowners in a common goal of biodiversity conservation. Although not yet fully realized, the outcome of such ambitious recovery measures has helped bring invertebrate conservation to the forefront and led to cautious, but optimistic forecasts for the future of the species involved.

Native larval host plants and adult nectar sources were planted on golf courses to create natural habitat suitable to maintain transient adult butterflies, encourage adult movement and gene flow between existing colonies, and allow for the natural establishment of new breeding colonies within the Florida Keys.

THE CASE OF THE SCHAUS SWALLOWTAIL

By far one of the most successful and highly publicized projects has centered on the only endangered swallowtail butterfly in the United States. The Schaus swallowtail (*Papilio aristodemus ponceanus*) is a large, colorful butterfly endemic to southern Florida; additional subspecies occur in the West Indies.[12] It is considered one of the rarest resident butterflies in North America and is listed as an endangered species by both the state of Florida and the federal government. It is one of seven swallowtail butterflies out of about 573 known species that are listed by the International Union for Conservation of Nature and Natural Resources.[1]

Historically, the species was once widespread from the greater Miami area south to Lower Matecumbe Key in the Florida Keys. It was formally named as a species, *Papilio ponceanus*, in 1911 by William Schaus, a physician stationed in Miami during the Spanish-American War to help treat American soldiers evacuated from Cuba because of yellow fever. He was an amateur naturalist who in his spare time discovered and collected specimens of a new swallowtail.

When discovered, the Schaus swallowtail inhabited tropical hardwood hammocks on the south Florida mainland. This globally endangered habitat type, one of the most imperiled plant communities in Florida, also occurs throughout the Florida Keys and is composed of slightly elevated limestone areas that support broad-leaved tropical deciduous trees. Due to poor nutrient availability, sparse soils, lack of fresh water, and harsh growing conditions, the dense hammock canopy remains diminutive, rarely reaching over 40 feet high. High, stable ground in southern Florida was a highly sought-after commodity, and soon it was rapidly dwindling due to expanding urban development surrounding Miami.

Also during this period, a collector took a specimen of the swallowtail on Key West in 1885. It is not surprising that the Schaus swallowtail was first recorded in the Lower Keys, then some 200 miles from the south Florida mainland, as the only viable means of travel to the Keys was via boat, and Key West was a major port. In fact, Key West was the largest city in Florida in 1890, exceeding even Miami in population. It was not until some years later in 1912 that Henry Flagler built a new railroad through the Keys, linking the mainland to Key West and opening up the numerous small islands to tourism and colonization. By then the remaining tropical hardwood hammock habitat on Key West had already been cleared for housing and commercial development, and the butterfly was extirpated there while inhabiting the less-settled Keys to the north.

DEVELOPMENT AND ANDREW THREATEN SURVIVAL

In the ensuing decade, better roads, mosquito control, widespread electricity (making air conditioning possible), and fresh water piped in from the Florida mainland brought rapid development to much of the Keys. As a result, the overall trends in the Schaus swallowtail's range and numerical abundance continued to decline. It was last recorded on the Florida mainland on May 31, 1924,[11] and during the 1940s to 1970s was reduced in range to Key Largo and numerous small islands to the north within Biscayne National Park. Up to 1972, naturalists could come to Key Largo and regularly see several hundred swallowtails along the sun-dappled hammock trails on the island's northern end.

But following the 1972 flight season, the Schaus swallowtail population on Key Largo underwent a rapid and dramatic decline. In 1977, it was listed as a threatened species by the U.S. Fish and Wildlife Service (USFWS), and several quick studies were completed to determine the status of the butterfly, culminating in a recovery plan written by the Florida Game and Freshwater Fish Commission and published in 1982.

In May 1984, at the direct request of the USFWS office in Jacksonville, a University of Florida research team was assembled to carry out status surveys in south Florida and make recommendations for action on the existing recovery plan. The resulting data indicated that the observed decline in the swallowtail's historic range and numerical abundance from 1924 to 1981 had continued, with less than 70 adults recorded during the 1984 flight season. The only three colonies of any significant size were located, all within Biscayne National Park on Elliott Key, Old Rhodes Key, and Totten Key, with a fourth small colony in the remaining intact hammock on northern Key Largo being represented by only a single adult. Following this report in 1984, the Schaus swallowtail was upgraded in listing from threatened to endangered status.

Field and laboratory research indicated that the two principal factors contributing to the demise of the Schaus swallowtail throughout much of its former range were habitat loss and mosquito control adulticide spraying. The final blow, starting in 1973, had been the initiation that year of the use of two new organophosphate adulticides, Dibrom and Batex, in the Keys by the Monroe County Mosquito Control District. The resulting spraying had far-reaching effects on the butterfly and contributed to it being reduced to an extremely limited geographic range.

Researchers at the University of Florida initiated efforts to improve and expand suitable breeding habitat for the endangered Schaus swallowtail butterfly. Native larval host plants and adult nectar sources are being planted on golf courses in southern Florida to assist that effort.

Despite these setbacks, ensuing restrictions on the use of these chemicals resulted in the slow increase in population, and the Schaus remained relatively secure from human-promoted influences in the small but protected hammocks of Biscayne National Park. The Nongame Wildlife Section of the Florida Game and Freshwater Fish Commission subsequently funded three successive two-year grants (1985-86, 1987-88, 1991-92), along with additional assistance from the dePont Fund during 1988-90, in order to continue the status surveys of this clearly endangered butterfly.

The additional threat to the species resulting from the impact of a major natural disaster was realized on August 24, 1992, when hurricane Andrew slammed into southern Florida, destroying or heavily damaging all habitat areas fostering remaining butterfly populations. Field surveys conducted during the following flight season in 1993 revealed that Schaus swallowtail populations in Biscayne National Park and northern Key Largo were extremely reduced (17 adults on Elliott Key, 33 on Adams Key, and 7 on Key Largo).

RESEARCHERS RESPOND

In a truly serendipitous occurrence, just two months prior to Hurricane Andrew, the U.S. Fish and Wildlife Service had given the University of Florida permission to remove 100 eggs in June 1992 as the starter nucleus of a large-scale captive propagation program. Following the destruction wrought by Hurricane Andrew, the USFWS committed major funding to continue the field surveys and captive propagation program, and implement experimental reintroduction of the species within protected habitat areas. The bulk of the captive propagation work was carried out at the University of Florida, where the Boender/USFWS Endangered Species Laboratory became available in June 1993, along with screened enclosures and greenhouse support facilities. As a result, the captive holding became the only readily available source for livestock reintroductions and prompted the rapid expansion of existing livestock breeding to become one of the largest endangered invertebrate captive propagation programs in the U.S.

This highly fortuitous timing allowed for the first successful mating of captive adults (via hand-pairing) in March 1993 and the successful captive production of 31 diapausing pupae by July 1993. Eggs produced from these captive females were increased by additional eggs brought from Adams Key in Biscayne National Park in June 1993 and produced 49 healthy pupae early that fall, the nucleus of the 1994, 1995, and 1996 captive propagation programs[2,5,6,9,10,11] for the 1995, 1996, and 1997 reintroduction releases.

In spring 1995, the first reintroduction efforts were initiated. A total of 764 pupae were released at 7 sites, from the Deering Estate in south Miami on the mainland to Key Largo. Despite heavy predation by migrating warblers, successful adult emergence and subsequent reproduction were identified at all sites, representing the first time since 1924 that the Schaus swallowtail was found on the south Florida mainland. The subsequent 1996 and 1997 releases of 500 and 209 adult butterflies enhanced the previous year's offspring in the existing population and established, directly or indirectly (via local movements), 6 additional colonies in the Upper to Middle Keys.

Following these three years of introductions, as of June 1997, the butterfly occupied sites stretching from the south Miami area in Dade County to Lower Matecumbe Key in the Middle Keys of Monroe County, across a graphic range of 57 miles. Thus the reintroductions have resulted in the quadrupling of the species' geographic range from what it was in the 20 years prior to the destruction by Hurricane Andrew. Additionally, the total annual wild adult Schaus swallowtail population rose to more than 1,200 butterflies as of the 1997 flight season. Still, the celebration of the project's success was tempered by lingering concerns regarding existing habitat quality and long-term management as well as efficient gene flow between populations.

In early 1998, under direct funding support from the National Fish and Wildlife Foundation (NFWF), habitat improvement was initiated by the planting of hundreds of wild lime trees (*Zanthoxylum fagara*), one of two native larval host plants, within several selected Key Largo colonies. The ultimate goal was to improve and expand the suitable breeding habitat available to the butterfly within already existing protected colony sites and allow for the natural increase of the wild population to sufficient and stable levels. While habitat improvement was currently being addressed, efficient gene flow between the numerous existing and newly established colonies remained a critical concern.

Historically, the Schaus swallowtail enjoyed an intact range of pristine tropical hardwood hammock habitat throughout much of the Florida Keys, broken only by periodic but negotiable water barriers. Individuals from neighboring colonies regularly infiltrated each other, allowing for more or less constant gene flow between populations. Additionally, wild population numbers annually waxed and waned, creating periodic localized extinctions that could be overcome by founder individuals wandering in from nearby colonies.

Today, the remaining Schaus swallowtail populations no longer have that simple luxury. Adult butterflies now have to deal with urban development that has left the Florida Keys with a patchwork of isolated and often distant pockets of suitable habitat, making contact between colonies an ever increasingly difficult task. Since all newly established colonies were derived from a relatively small initial nucleus of material obtained from a single colony, all clearly face the continued threat of a narrowing genetic base, as well as unforeseen future natural disasters.

USGA AND FLORIDA GOLF COURSES GET INVOLVED

The opportunity to develop a viable corridor system to encourage adult butterfly movement and regular gene flow between colonies presented itself in the spring of 1999 through grant funding from the USGA's Wildlife Links Program and the NFWF, and with the direct cooperation of the U.S. Fish and Wildlife Service, the University of Florida, and two private golf clubs. The project, funded for three years, involved improving and restoring remaining tropical hardwood hammock habitat on the golf course property of Sombrero Country Club in Marathon and Cheeca Lodge on Islamorada.

Native larval host plants and adult nectar sources are being planted to create sufficient natural habitat suitable to maintain transient adult butterflies, encourage adult movement and gene flow between existing colonies, and allow for the natural establishment of new breeding colonies within the Keys. Central to the project's success is the cooperation achieved between the government agencies, private organizations, and private landowners involved, including the current development of two Safe Harbor agreements.

If the current project proceeds as expected and additional funding becomes available for additional years of captive propagation, reintroduction, and monitoring, the Schaus swallowtail will occur over a broad enough geographic range in protected habitat areas and in sufficient areas and in sufficient numbers outside of the Biscayne National Park population that a major catastrophic event such as a hurricane, fire, or other focused environmental event no longer threatens extinction or major depletion of the species. At such a point, it seems evident that reclassification of the butterfly's status from endangered to threatened can occur, making it the first invertebrate successfully removed from the U.S. endangered species list.

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The Schaus swallowtail is considered one of the rarest resident butterflies in North America and is listed as an endangered species by both the state of Florida and the federal government. Wild lime plants serve as host sites for swallowtail eggs.

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Research *You Can Use*

Best Management Practices to Reduce Pesticide Runoff from Turf

A common-sense approach can greatly reduce the risk of water contamination.

BY B. E. BRANHAM, F. Z. KANDIL, AND J. MUELLER

Golf turf management has made huge strides over the past 40 years that have allowed golf course superintendents to achieve excellent turf quality. However, achieving these very high levels of turf quality requires numerous inputs, including fertilizers, irrigation, topdressing, cultivation, wetting agents, biostimulants, and pesticides. While practices such as topdressing, cultivation, and wetting agents are considered environmentally benign, fertilizers and pesticides have received much scrutiny since some of these products can move off the turf and into ground and surface water.

Pesticide leaching from turf has been studied intensively,[1,5,6,9] and while pesticide leaching is a major problem in row crops, leaching of pesticides from turf presents much less risk than previously suspected. Pesticide leaching in turf is a much smaller problem than in row crops for two primary reasons.

First, the acreage treated with pesticides on all the golf courses in the United States is a drop in the proverbial bucket compared to row crop agriculture. The National Golf Foundation reported that at the end of 2002, there was the equivalent of 14,725 18-hole golf facilities in the United States. If we assume that each golf course contains, on average, 3 acres of putting greens, 5 acres of tees, and 30 acres of fairways, then the total number of golf course acres in the United States receiving pesticide applications (roughs typically receive little in the way of pesticide applications, although weed control may be practiced) would total 559,550 acres. This is less total acreage than the amount of corn and soybeans planted in a typical county in central Illinois. Nationally, in 2001, approximately 75.752 million acres of land were planted to corn, while 74.105 million acres were planted to soybeans. Most of these receive some kind of pesticide application. All the intensively managed golf course acres in the United States represent less than 0.4% of the total acreage planted to the two largest crops grown in the U.S.

A second reason why turf presents less of a risk for pesticide leaching is the turf itself. A previous USGA-funded research project examined the effect of turf on pesticide movement and degradation.[2,3,4] We found that when pesticides are applied to turf, leaching is reduced and degradation rates are increased when compared to the same pesticides applied to bare soil (a common practice in row crops).

These two differences have led many to conclude that the risk of groundwater contamination from turfgrass pesticides is low, but not non-existent. Proper management is still key, and on certain sites, particularly those with sandy soils, shallow groundwater, and proximity to water bodies, turf managers need to pick the pesticides they do use with care.

Pesticide runoff, however, is a completely different issue. What is runoff? Runoff is a natural event that occurs when a rain or irrigation event produces more water than the soil/turf can accept. This is a fairly common occurrence, and depending upon soil types, slopes, etc., it may occur often or rarely on a particular site. Runoff per se is not a bad thing, but when the runoff carries pesticides, nutrients, or other pollutants, problems may arise.

Whereas pesticide leaching is mostly a threat to groundwater (although the use of tile drains also can threaten surface waters with pesticide leachate), pesticide runoff is a threat to surface water. Most golf courses have some water features associated with them, and often streams, rivers, or storm drains are used to accept runoff from golf courses. Some initial research has shown that pesticide runoff can be significant, with some researchers reporting as much as 10% of the applied pesticide transported in runoff.[7]

INVESTIGATING RUNOFF

With this background in mind, we examined some management practices that might reduce the concentration of pesticides when runoff does occur from a golf course. We first constructed a site

Runoff plots with a 5% slope were constructed at the University of Illinois to study the effects of post-application irrigation and clipping management on runoff of pesticides of varying solubilities.

to conduct runoff research. This site was sloped, but it did require some modification to suit our needs. That modification was provided by Munie Outdoor Services, a St. Louis-based company that donated time and equipment to produce a plot area with a uniform 5% slope that was approximately 150 ft. × 35 ft.

They also installed a mist irrigation system that could provide two intensities of simulated rain events. Rain drops have much different energy than the output from a mist head, which is very important on bare soil, but we believe the energy difference is less important when a turf cover is in place. After the plots were constructed in the fall, they were allowed to settle over the winter and were sodded the next spring with creeping bentgrass. The rest of the summer was spent installing the runoff collection equipment and testing the system, and by the end of the summer we conducted a test run.

In the summer of 2003, we had the personnel and equipment in place to conduct the experiments. We evaluated three possible strategies to reduce pesticide runoff. First, can irrigation applied a short time after pesticide application significantly reduce pesticide runoff? By washing the pesticide off the leaf surface and deeper into thatch and soil, can the concentration and total quantity of pesticide in runoff be reduced?

The second experiment examined the length of time between pesticide application and runoff event. Some turf managers and many homeowners use natural rainfall in place of irrigation. If rain is forecast, an application of pesticide or fertilizer may be applied and the rain is used to water-in the product. Of course if the rain produces runoff, pesticide loss could be quite high. Can runoff potential be reduced by applying a small amount of irrigation prior to the runoff event and thus reduce pesticide runoff?

The third experiment centered on clipping management. Turf is a unique crop in that each pesticide application is made directly onto the foliage. Even when a pesticide is primarily root-absorbed, a significant quantity of the pesticide will adhere to leaf tissue. I don't believe that we have considered clippings to be a source of pesticide contamination, but the first mowing following a pesticide application effectively frees up a significant portion of the pesticide application. If a rain event moves these clippings, a significant amount of pesticide will be transported with the clippings.

An even thornier issue results when clippings are collected. If the clippings are composted, rapid degradation of the pesticide residues will result, but care must be taken to prevent rainfall from leaching pesticides from the clippings. If the clippings are simply scattered in the rough, turf managers may be unintentionally producing areas with high concentrations of pesticides that may be susceptible to leaching or runoff.

EXPERIMENTAL PROCEDURES

In each experiment, pesticides were applied as a three-way tank mix. We selected pesticides based upon their water solubility and ease of analysis by high-performance liquid chromatography (HPLC). Each tank mix contained a pesticide we classified as having high, medium, or low water solubility. Water solubility plays a dominant role in the availability of the pesticide for runoff. Pesticides with higher water solubilities are more readily moved with flowing water. Pesticides with very low water solubilities will move in lower concen-

Following pesticide application, irrigation was applied until all plots produced at least 40 liters of runoff.

trations in water. Best management practices may need to be modified based upon water solubility. In other words, what works best to reduce runoff of a highly water-soluble pesticide may not be as effective with a water-insoluble pesticide.

Following pesticide application, the mist irrigation system was turned on at the appropriate time for each experiment to produce runoff. Irrigation was applied until all plots produced at least 40 liters of runoff. In each experiment, approximately 2 hours of irrigation was applied. From each 40-liter runoff sample, a 4-liter subsample was collected into amber glass jugs. The samples were analyzed by HPLC to determine the amount of each pesticide present in the water samples.

The first experiment examined the effectiveness of post-application irrigation in reducing pesticide runoff. Three pesticides — chlorothalonil (Daconil Ultrex™), paclobutrazol (Trimmit™), and mefanoxam (Subdue Maxx™) — were applied and 0.2 inch of post-application irrigation was hand applied at 0.25, 1, 4, 8, or 24 hours after pesticide application. The simulated runoff-producing rain event was initiated at 25 hours after pesticide application (i.e., simulated rainfall began 1 hour after the last pesticide washoff treatment was applied).

RESULTS

The results of the first experiment were disappointing. No matter how we examined the data, there were few meaningful differences. The largest point from the trial was that post-application irrigation was not effective in reducing the amount of pesticide available for runoff. Closer inspection of the data yielded one significant finding. Chlorothalonil runoff was reduced by post-application irrigation at 15 minutes after pesticide application. This may make sense from a pesticide chemistry viewpoint. Chlorothalonil is very water insoluble, with a commonly accepted water solubility of 0.6 PPM.[8] Products with water solubilities this low are usually applied as an emulsion in water in order to get the product into a sprayable form. Once the spray dries on the leaf surface, the emulsifying characteristics are lost and the pesticide behaves according to its natural water solubility.

A pesticide, or any organic chemical, with water solubility below 1 PPM will be very strongly sorbed to the wax and other non-polar compounds of the leaf surface. Once these pesticides dry on the leaf surface, they're literally stuck there. By applying irrigation soon after application, some of this drying will be prevented and a larger mass of the pesticide can be moved deeper into the turf profile. Once a water-insoluble pesticide has dried on the leaf surface, post-application irrigation will not be effective in moving the pesticide off the leaf.

With the fungicide chlorothalonil, post-application irrigation immediately after application would not be a good practice since the product needs to be on the leaf surface to exert its fungicidal activity. However, if the intended site of action is the soil or thatch surface, as, for example, preemergence herbicides, these products should receive post-application irrigation as soon as the application is completed. This not only reduces the amount of pesticide available for runoff; it also increases the amount of pesticide reaching the soil or thatch surface.

The second experiment examined the impact of the interval between pesticide application and runoff event. While no one can control when it rains, it is still instructive to understand the importance of the interval between pesticide application and runoff. In this experiment, pesticides were applied at 12, 24, 48, or 72 hours prior to the runoff event. The pesticides applied were pendimethalin (PreM™), propiconazole (Banner Maxx™), and mefanoxam (Subdue Maxx™).

In this experiment, the results were dramatic. Regardless of water solubility, the longer the time between pesticide application and runoff, the less pesticide was detected in runoff. And while this would be expected, what was interest-

Table 1

Pesticides used in runoff studies at the University of Illinois

Common Name	Trade Name	Water Solubility (mg/L)
mefanoxam	Subdue Maxx	26,000
propiconazole	Banner Maxx	110
paclobutrazol	Trimmit	35
chlorothalonil	Daconil	0.6
pendimethalin	Pendulum	0.3

ing was that, in general, the differences in runoff were significant between runoff at 12 hours following application versus 24, 48, or 72 hours after application. In other words, if runoff occurs 1, 2, or 3 days following application, there is not a great difference in the amount of pesticide that runs off. But if the runoff event occurs at 12 hours or less after application, there will be a substantial increase in the amount of pesticide runoff that occurs. For example, on a mass basis, we recovered 8.9 mg of pendimethalin in runoff water when runoff occurred at 12 hours after application, but only 1.5, 1.6, or 1.2 mg if runoff occurred at 72, 48, or 24 hours following application, respectively. Similar results were obtained for the other two pesticides in this study.

One surprising result of this trial was that, on a mass basis, there was more propiconazole in the runoff than mefanoxam. This result was counter to our hypothesis that the more water soluble a pesticide, the more susceptible it is to runoff. In general, the initial concentration of mefanoxam in the runoff was higher than propiconazole, but as more runoff came off, the concentration of mefanoxam decreased while that of propiconazole did not decrease appreciably. Perhaps since mefanoxam is much more water soluble (see Table 1), some of it may move into the soil and thatch more readily with the onset of precipitation, whereas propiconazole, which is less water soluble, may remain in the upper canopy where it can continue to partition into water flowing across the turf surface.

Our third experiment evaluated the effects of removing clippings on pesticide runoff. On golf course greens, tees, and fairways, pesticides are applied as often as once every two weeks during the summer. A significant portion of the pesticide application is deposited on the leaf tissue, and much of the application will remain sorbed (a term that describes substances that can be both adsorbed and absorbed) to the leaf tissue. This study was simplified so that we compared only two treatments, clippings removed versus clippings returned. In this experiment, pesticides were applied at 9 a.m. on July 15, 2003. The plots were mowed the following day at 9 a.m. and the runoff event was initiated one hour later at 10 a.m. by simulating runoff via irrigation.

As might be expected, removing clippings reduced pesticide runoff (Table 2). When examining the data on a mass basis, i.e., the total quantity of pesticide removed, the data must be considered in view of several important factors. First, an important factor in reducing pesticide runoff (as well as other forms of off-site transport) is to use pesticides that require smaller amounts of active ingredient. On a mass basis, more chlorothalonil was lost than either of the other two pesticides. However, on a percent-of-applied basis, chlorothalonil lost much less than the other two pesticides (Table 2). Chlorothalonil is an older product that requires higher use rates than many newer pesticides, thus chlorothalonil was applied at a rate of 11.2 lbs. ai/A, while newer chemistries are usually applied at rates of 1 lb. ai/A or less. Even though chlorothalonil is very water insoluble and less likely to run off (as shown by the percentage data), more chlorothalonil was recovered in runoff because it was applied at rates of 16 to 44 times higher than the other two pesticides. Second, pesticide mass is the product of pesticide concentration in runoff and the total volume of runoff collected. The plots we used in this trial were developed to be as uniform as possible, and yet there were still large differences in runoff volumes between plots. This directly affects the runoff mass and can make the data difficult to interpret.

Clipping management can have a big impact on pesticide runoff. Pesticide runoff was reduced by 34% to 57% by removing clippings. We doubt that the higher mass of pesticide runoff where clippings were returned can be attributed to clippings in the runoff. While we did observe some clippings in the runoff water, we removed the clippings by filtration prior to analysis. The mass of pesticide found on the sediment (clippings and other particles) was a small fraction of the amounts recovered from the runoff water. Thus, the reduc-

Table 2

Mass of pesticide loss during runoff — effect of clipping removal

Pesticide	Application Rate (lbs. ai/A)	Clipping Treatment	Total Mass Lost (mg)	Percent of Applied
mefanoxam	0.7	Removed	21.3	0.98
		Returned	37.2	1.70
paclobutrazol	0.25	Removed	8.3	1.06
		Returned	12.7	1.62
chlorothalonil	11.2	Removed	65.4	0.19
		Returned	153.7	0.44

tion in pesticide runoff where clippings were removed is most likely a direct result of the decrease in the amount of pesticide available when the runoff occurs. However, while the reduction in pesticide in the runoff was substantial, it begs the question of what happens to the clippings. If the clippings are simply deposited elsewhere on the golf course, then the runoff problem hasn't necessarily been reduced; it's just redistributed.

LESSONS LEARNED

The purpose of this research was to develop best management practices to reduce pesticide runoff. The most effective practice was to remove clippings, but the clippings themselves contain a significant amount of pesticide, and these must be dealt with responsibly. The turf in the field represents what is termed a non-point source pollution problem; that is, the potential pollutants are distributed across a large area at low concentrations. Collecting clippings and putting them in a pile would essentially create a point source pollution problem. However, creating a compost pile of clippings should permit relatively rapid degradation of the pesticides in the pile, and if drainage is controlled, this would be a particularly good option.

Regardless of whether or not you remove clippings as part of a best management program to reduce pesticide runoff, this research illustrates that clippings can be an important source of pesticides. Whether you return clippings or collect them, be aware that clippings harvested immediately following a pesticide application will contain a significant quantity of pesticide. Returning those clippings to the turf would be valuable particularly in the case of soil-active pesticides such as preemergence annual grass control herbicides and root-absorbed products such as the plant growth regulators paclobutrazol or flurprimidol.

Pesticide application within 12 hours of an expected rain event should be avoided. Runoff events occurring at 24-72 hours after pesticide application will contain reduced pesticide concentrations versus runoff that occurs within 12 hours of a pesticide application.

Choosing pesticides that require low active ingredient application rates dramatically reduces the amount of pesticide runoff. Many newer pesticide chemistries have application rates of 30-120 grams ai/A (~0.1-0.3 lbs. ai/A). The best way to reduce pesticide runoff or leaching is to not use a pesticide. The second best way is to choose a pesticide with good environmental properties, and one of the best is a low application rate.

Lastly, the use of buffer strips is a best management practice. A buffer strip is a vegetated strip that is not treated with pesticide. In our runoff experiments, the pesticides were applied within 2 feet of the runoff collection apparatus. Any increase in the length of untreated turf or other landscape plantings between the treated turf and the point where runoff water would enter a stream, drain, or other direct access to water will dramatically reduce pesticide runoff. This occurs for two reasons. First, turf will remove some of the pesticide that is flowing across it; that is, some pesticide will absorb to the turfgrass plants. Second, as runoff containing pesticide enters the buffer strip where no pesticide is present, simple dilution reduces the pesticide concentration that ultimately enters the water body.

Pesticide runoff is an important issue that golf course superintendents must be aware of and recognize where potential problems exist. Bodies of water flowing through the golf course need to be protected. Even if your golf course does not have a surface water feature, care must still be exercised. Many golf course superintendents use surface drains to remove excess water from low-lying or poorly drained areas. Often these drains ultimately lead to a surface water body. As a result, pesticides applied to a fairway may be readily moved off the golf course if surface drains are used to remove excess water.

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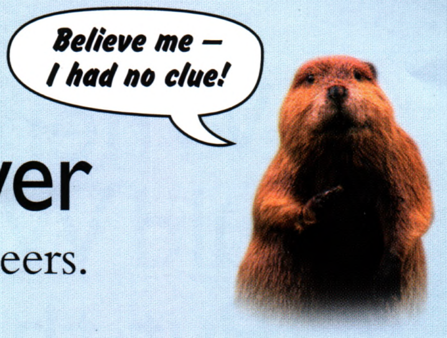
On Course *With Nature*

Telluride Leaves It to Beaver



Resort finds a way to co-exist with native engineers.

BY PAT DREW

We consider beavers to be one of Colorado's most fascinating and watchable wildlife species. But they sometimes interfere with human engineering, as was the case of Telluride Golf Club when they flooded our 13th fairway. When beavers moved into one of our wetland restoration sites, we quickly began to seek solutions.

Among the options for controlling beaver are fencing, trapping, and live trap and transfer. But these fall short of being good permanent solutions. We wanted a solution that would prevent the beaver's harmful impact to the golf course, but still allow them to build and develop wetland ecosystems while co-existing with golfers.

What we discovered is a device called a beaver pond leveler or *Beaver Deceiver.* The Beaver Deceiver was invented by Skip Lisle, a wildlife biologist who beaver-proofed 130,000 acres of Penobscot Indian lands in Maine. He coined the name Beaver Deceiver, though the device is one you build yourself to meet site-specific needs.

The Beaver Deceiver is a simple device that will set and maintain the maximum water surface elevation for a body of water that is being manipulated by beavers. Essentially, it consists of a caged filter that feeds a culvert that runs through the beaver dam. An upright drain is set at the maximum water surface elevation determined for the pond. When the pond reaches the maximum height set, water begins to flow through the culvert rather than continue to raise the pond water level and cause flooding. Since the beavers are unable to plug the caged filter, the desired water level is maintained.

IMPLEMENTATION AND MAINTENANCE

Before installing the Beaver Deceiver, we gathered resources from a local wildlife organization and from Clemson University, which has a useful video entitled *Beaver Pond Leveler.* This gave us helpful information on beavers, as well as good instructions for the project.

Approval for the project was granted by the EPA and Army Corps of Engineers, since the site was wetland mitigation associated with a permit for golf course development. The beavers were essential in creating and maintaining the wetland mitigation complex, so finding a solution that would not displace them was imperative.

We removed the beaver dam initially to drain the beaver pond and install our Beaver Deceiver. We set the culvert and upright drain to go through the dam and then covered it with some of the logs from the original dam. This encouraged the beavers to reconstruct and repair their dam. Since the device is set up to drain only at the set maximum water elevation, the beavers continue to build and service their dam until the maximum water level is reached.

We set the maximum water surface elevation high enough to cover the entire apparatus underwater, so it is hidden from the casual observer. The unit requires minimal maintenance, but we monitor it regularly to ensure that it is functioning properly.

RESULTS

Our Beaver Deceiver has been in place for three years now and *it works.* The beavers rebuilt their dam and ponds and are maintaining a healthy wetland ecosystem. Several bird species use this habitat for nesting or rearing fledglings, and deer, elk, and other mammals also take advantage of the habitat.

For an investment of $250 from our resort's environmental department and 20 hours of labor to install the device, we save 10 man-hours a week from no longer having to remove the dam and deal with associated damage.

The golfers take interest in the habitat created by the beavers and enjoy the wildlife and waterfowl that thrive here because of it. The site has been used for demonstrations on the functioning of the Beaver Deceiver, as well as for school field trips to learn about and watch the beaver ecosystem. The project also has been written up in our local watershed newsletter as a sensitive solution for dealing with growing beaver populations.

The project is a complete success, and I would recommend it to other courses experiencing beaver problems. Be sure to get proper permit approvals before attempting installation of any devices in streams and wetlands.

RESOURCES

The Clemson Beaver Pond Leveler: http://-www.clemson.edu/psapublishing/PAGES/-AFW/AFW1.PDF.

Department of Natural Resources and Parks, King County, Wash.: http://dnr.metrokc.gov/-wlr/Dss/beavers/beaverintro.htm.

The Humane Society of the United States: http://www.hsus.org/ace/14333.

Skip Lisle, Beaver Deceivers, Inc., (802) 843-1017.

The U.S. Fish and Wildlife Service Partners for Wildlife Program — may supply funding and/or materials for a beaver water level control device if an organized entity applies: http://partners.fws.gov/.

PAT DREW *is the hydrologic technician at Telluride Golf Club in Colorado. For more information about this project, contact him at pdrew@tellurideskiresort.com.*

Where Should We Put the Bunker Rakes?

Proper bunker rake placement requires a review of the Rules and common sense.

BY MATT NELSON

A common question asked of USGA field staff is, "Where should the bunker rakes be placed?" Although there is no Rule that specifies whether bunker rakes should be placed in or out of the bunkers, a miscellaneous Decision on the Rules of Golf sheds useful light on this topic.

Decision Misc./2 recommends that bunker rakes be placed outside of bunkers in areas where they are least likely to affect play. The reason for this Decision has to do with Rule 24-1 and Rule 20-3d. If a ball comes to rest against a bunker rake, the rake may be treated as a moveable obstruction. This situation could occur where a rake is positioned on a steep slope, and when the rake is moved the ball rolls to the bottom of the bunker. If the slope is too steep or the sand too firm, it may not be possible to replace the ball on the original spot without it rolling away. It also is possible that all points of the bunker would be closer to the hole than the original position of the ball when it came to rest against the bunker rake, and there would be no other spot in the bunker to place the ball without being closer to the hole (see Decision 20-3d/2). Nothing in the Rules of Golf allows a player to press the ball into the sand to make it stay in position. Therefore, since the player could not place the ball in conformity with the Rules, he would proceed under the stroke-and-distance option of the unplayable ball Rule (Rule 28a), or, in equity (Rule 1-4), drop the ball outside of the bunker, keeping the point where the ball lay between himself and the hole, under penlty of one stroke.

Obviously, the ruling is much simpler when a ball comes to rest against a rake placed outside of the bunker. For this reason, placing the bunker rakes outside of bunkers results in cleaner and less costly rulings.

There is no perfect answer regarding the placement of bunker rakes. Some players will always argue that rakes outside of bunkers can deflect balls into the bunker. The maintenance staff that mows rough and green surrounds would surely rather see the rakes in the bunker. But when rakes are left in bunkers, they are commonly left near the edge of the bunkers where slopes are common and the ruling complications stated previously may arise. The best advice is to use common sense and place the rakes outside of the bunkers where they are least likely to affect the movement of the ball. Once the Committee decides where bunker rakes should go, the maintenance staff (and the golfers!) should be trained to put the rakes in the proper place.

Now, as bunkers are *hazards*, I suppose one great way to deal with this controversial issue would be to make one trip around the course with a pickup, collect all of the rakes, and . . . but this would be a whole new discussion, wouldn't it?

MATT NELSON *is an agronomist in the USGA Green Section's Northwest Region.*

Golf courses have been very creative in placing bunker rakes to encourage golfers to use them, with both good and bad results.

2005 USGA Green Section Education Conference Golf Industry Show

Friday, February 11, 2005
Orlando, Florida

FOR THE GOOD OF THE GAME

10:00 a.m.
Opening Remarks
DAVID OATIS, *Director, Northeast Region*

10:05 a.m.
Golf's Environmental Situation for 2005 — Where Do We Stand?
KIMBERLY ERUSHA, PH.D., *Director of Education*
The golf industry must stay actively involved in environmental issues. Attendees will be updated on USGA environmental programs to sustain effective communication with supporters and adversaries.

10:15 a.m.
Where is Green Speed Taking the Game?
MATT NELSON, *Agronomist*, and
LARRY GILHULY, *Director, Northwest Region*
How much has green speed really changed in 25 years? Real numbers from USGA archives shed light on the dramatic change in putting green speed and how speed affects pace of play, setup, and enjoyment of the game. Is this trend good for the game?

10:25 a.m.
Organic Fertilizer Considerations
STAN ZONTEK, *Director, Mid-Atlantic Region*
Organic fertilizers should exhibit agronomic reliability, predictable release characteristics, appropriate physical properties, and consideration for the environment.

10:35 a.m.
Presentation of 2005 USGA Green Section Award
BRUCE RICHARDS, *USGA Executive Committee*

10:45 a.m.
Distance Control: The Game We Love, and the USGA
FRED RIDLEY, *USGA President*
President Ridley offers an overview of some of the major issues impacting the game of golf.

11:05 a.m.
Using Turf and Environmental Research to Your Advantage
MIKE KENNA, PH.D., *Director, USGA Research Program*
Accessing research results is just a click away. Learn how to refine search strategies and distill information into a useable form for members, owners, committees, and other interested parties.

11:15 a.m.
Strategies for Organic Matter Control in Putting Greens
CHRIS HARTWIGER, *Agronomist, Southeast Region*, and
PAUL VERMEULEN, *Director, Mid-Continent Region*
Climatic differences require different cultivation strategies, but the bottom line is satisfying agronomic objectives while minimizing disruption to golf course playability. Balancing politics and agronomy requires conviction, communication, and a good plan for managing putting greens.

11:30 a.m.
Developing Guidelines for Tee Construction
JIM MOORE, *Director, Construction Education Program*
Tee construction guidelines would help protect owners, builders, and golf course superintendents.

11:45 a.m.
Alternative Turfgrasses: Panacea or Problems?
JOHN FOY, *Director, Florida Region*, and
BUD WHITE, *Senior Agronomist, Mid-Continent Region*
Do alternative turfgrass species provide the total solution? Experience suggests an integrated management program is necessary.

12:00 p.m.
Adjourn

2005 USGA NATIONAL & REGIONAL CONFERENCES

National Conference
February 11 — Orange County Convention Center, Orlando, Florida

Florida Region
January 18 — *Quail West Golf and Country Club, Naples, Florida
November TBA — Palm Beach Gardens Marriott, Palm Beach Gardens, Florida

Mid-Atlantic Region
February 28 — Pittsburgh Expo Mart, Monroeville, Pennsylvania
March 17 — Woodholme Country Club, Pikesville, Maryland

Mid-Continent Region
March 15 — Brook Hollow Country Club, Dallas, Texas

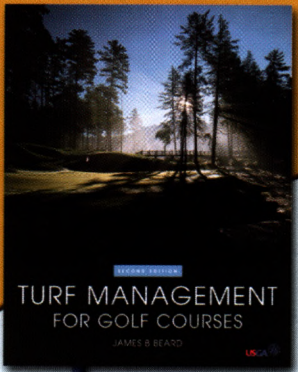
Northeast Region
March 8 — Rhode Island Convention Center, Providence, Rhode Island
March 16 — Wheatley Hills Country Club, Long Island, New York
March 22 — Oak Hill Country Club, Rochester, New York

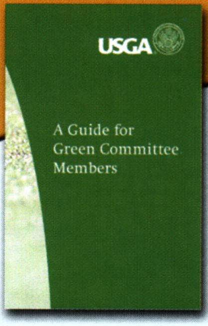
Southeast Region
March 15 — Pinehurst Country Club, Pinehurst, North Carolina

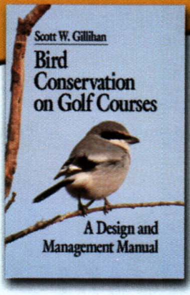
Northwest Region
March 9 — Holiday Inn, Bozeman, Montana
March 21 — Inglewood Country Club, Seattle, Washington
March 22 — Lakewood Country Club, Lakewood, Colorado
April 5 — Waialae Country Club, Honolulu, Hawaii

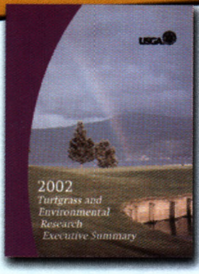
Southwest Region
January 10 — Old Ranch Country Club, Seal Beach, California
March 16 — The Arizona Biltmore, Phoenix, Arizona
March 21 — Castlewood Country Club, Pleasanton, California
March 22 — Spanish Trail Country Club, Las Vegas, Nevada

**Program focused on turf issues for golfers*









Publications

Turf Management for Golf Courses: 2nd Edition

by James B. Beard and the USGA Green Section staff

This comprehensive volume is an invaluable guide to turf cultivation and management. It is designed for golf course supertintendents and Green Committee members, and contains hundreds of step-by-step instructions, techniques, and methods that cover every important aspect of a successful turf management program. 793 pages. **PG1100 $125.00**

Building the USGA Green: Tips for Success

by USGA Green Section staff

This 34-page booklet will guide you through the process of building a USGA Green. **PG1112 $4.50**

Golf Course Management & Construction: Environmental Issues

edited by Dr. J. C. Balogh and Dr. W. J. Walker

A comprehensive summary and assessment of scientific research on the environmental effects of construction and management of golf courses. An excellent reference book for golf course architects, developers, superintendents, and Green Committee members. 937 pages. **PG5275 $104.95**

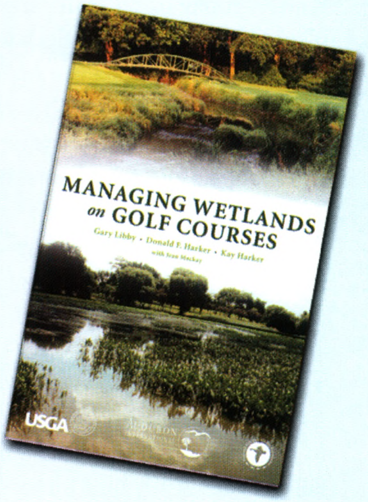
A Guide for Green Committee Members

This booklet is designed to help guide Green Committees past the common pitfalls, show the opportunities of participation in the Green Committee, and assist in making the Committee work as an asset to the golf course. It highlights the features of the Green Section, defines common agronomic terminology, and provides a list of references and resources for additional information. **PG1715 $2.00**

Making Room for Native Pollinators

by Xerces Society

These guidelines help golf course superintendents plan and manage out-of-play areas for beneficial pollinating insects. **PG5002 $5.00**



Bird Conservation on Golf Courses

by Scott Gillihan

Funded through a grant from the USGA's Wildlife Links Program, this practical, hands-on manual is an excellent reference for golf course superintendents, golf course architects, and land managers. The book discusses managing habitat areas on golf courses and similar settings to benefit birds. 335 pages. **PG5250 $34.95**

2003 Turfgrass and Environmental Research Summary & 2003 Executive Summary

The accomplishments of the current research projects funded through the USGA Turfgrass and Environmental Research Program are summarized. Also included in the document is a list of the ten research projects to be conducted on the construction and maintenance of greens. **NS1640 and NS1651 No charge**

Managing Wetlands on Golf Courses — NEW!

by Gary Libby, Donald F. Harker, Kay Harker, with Jean Mackay

A comprehensive guide to managing wetlands on the golf course. *Managing Wetlands on Golf Courses* provides the most effective techniques for managing wetlands to maintain or enhance water quality, wildlife habitat, and the natural hydrology of the golf course landscape. A cooperative publication of the USGA, Audubon International, and the National Fish & Wildlife Foundation. 224 pages. **PG5000 $60.00**

Reviewing Golf Course Proposals: Materials for Local Officials

by Billie Jo Hance and Jim Morris

An informational packet oriented to community land-use planners to assist communities in the crucial planning phase of golf course development. Includes basic environmental questions communities should ask when reviewing golf course proposals. **PG1718 $5.00**

To order publications and for further information, contact the USGA Order Department:

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All Things *Considered*

Growing, Growing, Gone!

Use common sense when planting trees on your golf course.

BY LARRY GILHULY

"A society grows great when old men plant trees in whose shade they know they shall never sit." — Rudyard Kipling

"A golf course grows great when trees are planted in the right locations and whose shade, roots, and size do not cause problems with turf growth and playing conditions."
— USGA Green Section

While Kipling may not have had golf courses in mind with his timeless quote, there is no question that many golf courses today suffer from the wholesale planting of trees many decades ago with little thought to the full size of the trees. This epidemic has come home to roost in the form of massive tree removal programs on several top golf courses throughout the country as well-informed memberships are beginning to understand the negative impacts of trees on surrounding turf.

THE PROBLEM

The purpose of this brief discussion is to suggest how to avoid the major pitfalls of tree planting. All too often trees are planted on golf courses without seriously considering the following questions:

- How tall and wide will the tree be when fully grown?
- Where will the shade of the tree fall in relation to the greens, tees, and landing zones?
- Will the roots of the trees be at or near the surface, causing injury to players and damage to mowers?
- How long will the tree live?

There are several other criteria for tree selection (shape, color, disease resistance, etc.) that are involved in the selection process, but making a mistake in any of the preceding "Big 4" areas can result in premature tree removal and all of the associated emotional issues generally noted at golf courses with poor tree planting schemes.

THE SOLUTION

It is amazing how simple it is to avoid the "plant and pull" syndrome noted at many golf courses, yet the same mistakes occur time and again due to poor plant selection and placement. Use the following guidelines to make your golf course great.

Plant all trees with the full size in mind! A common mistake in the Pacific Northwest is the use of massive trees (primarily firs, redwoods, Western red cedar, and maples) for the purpose of "strengthening the course" either immediately or in the near future. *Avoid this mindset!* Trees that will grow more than 100 feet and spread 10-15 or more yards in each direction need plenty of room and years to grow before they produce the type of results often desired by the "strengthen the course" crowd.

Avoid short-lived trees with roots near the surface and limbs that are brittle! Every part of the country has trees that damage mowers, grow fast, die within 3-5 decades, and drop substantial limbs and debris at the hint of a breeze. Avoid these types of trees, even if they are donated.

Always plant with shade in mind! When trees and turf square off, trees always win the competition for water, sunlight, and fertilizer. Avoid planting large trees on the south side of greens, tees, and critical fairway landing zones. If large specimen trees must be planted, avoid filling every open space with trees. The great golf courses allow individual trees to stand alone, developing full shapes and allowing for openings between the trees.

Use professionals to assist in placement and tree selection! It may be tempting to add trees with the help of your golf course superintendent, golf professional, and Green Committee, but it is best to use the services of a trained arborist for tree selection and a qualified golf course architect for the placement to avoid mistakes.

We can all learn from Kipling and plant long-lived trees! Many portions of the country have beautiful oaks and other grand species that seem to take forever to grow. However, great golf courses were planted and planned by "old men in whose shade they knew they would never sit." If you choose to ignore these simple guidelines in tree planting, then you will face an unfortunate future of "growing, growing, gone" with the trees on your golf course.

LARRY GILHULY *is rapidly approaching "old man" status in the Northwest Region of the USGA Green Section, where he provides Turf Advisory Service visits.*

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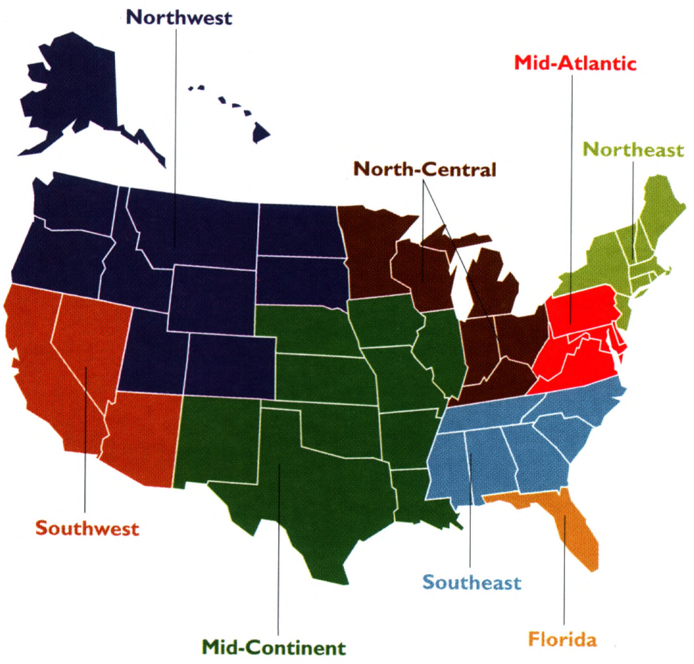

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Turf *Twisters*

Q: We've been utilizing a couple different plant growth regulators with seemingly good results. However, it is common to hear an assortment of different frequencies and rates discussed at turf conferences. What's the best way to sort through what we've been hearing to achieve the best combination at our course? (Indiana)

A: First of all, be sure that any rate and frequency being considered is in line with the product label. The label should guide everything that is done; however, if specific questions arise, contact the manufacturer. Then, evaluate any label-allowed differences on a turf nursery before moving out onto the course.

Q: Our bunkers are too wet. Would installing pop-up sprinklers on adjacent banks help keep the bunkers drier? (California)

A: Installing smaller-diameter pop-up sprinklers has helped some courses keep bunkers drier, but this degree of fine-tuning has its downside:

1. Be prepared to monitor, repair, and adjust hundreds more sprinklers.
2. Despite more sprinklers, there are often gaps in irrigation coverage that will require more hand watering to keep the turf alive around the bunkers.
3. The lack of moisture can often make the sand too soft and create plugged lies.

The best advice is to limit the use of pop-up sprinklers and focus on sand quality, drainage, and raking programs in the bunkers.

Q: Many of our grassed slopes around bunkers turn brown and weedy in the summer. Can you offer any advice to prevent this occurrence? (New Jersey)

A: Chances are that south-facing slopes are providing the greatest turf growing challenges. These areas heat up and remain warmer relative to other locations due to their orientation to the sun. Cool-season turfgrass species are not well adapted to this degree of warmth and dryness without frequent irrigation or natural precipitation. Monitor soil temperatures in these areas to determine the proper timing for application of a pre-emergence herbicide. On steep slopes, consider using a sprayable formulation rather than a granular to provide better coverage, followed by the recommended irrigation. Also, closely monitor and treat these areas for insect and disease activity. In the transition zone, another strategy would be to re-establish these areas with a warm-season turfgrass species such as zoysiagrass for better heat, drought, and pest tolerance. Keep in mind that warm-season turf becomes dormant and loses its green color more rapidly and for longer periods of time with the onset of cooler temperatures, and it is more prone to winter injury compared to cool-season turf.