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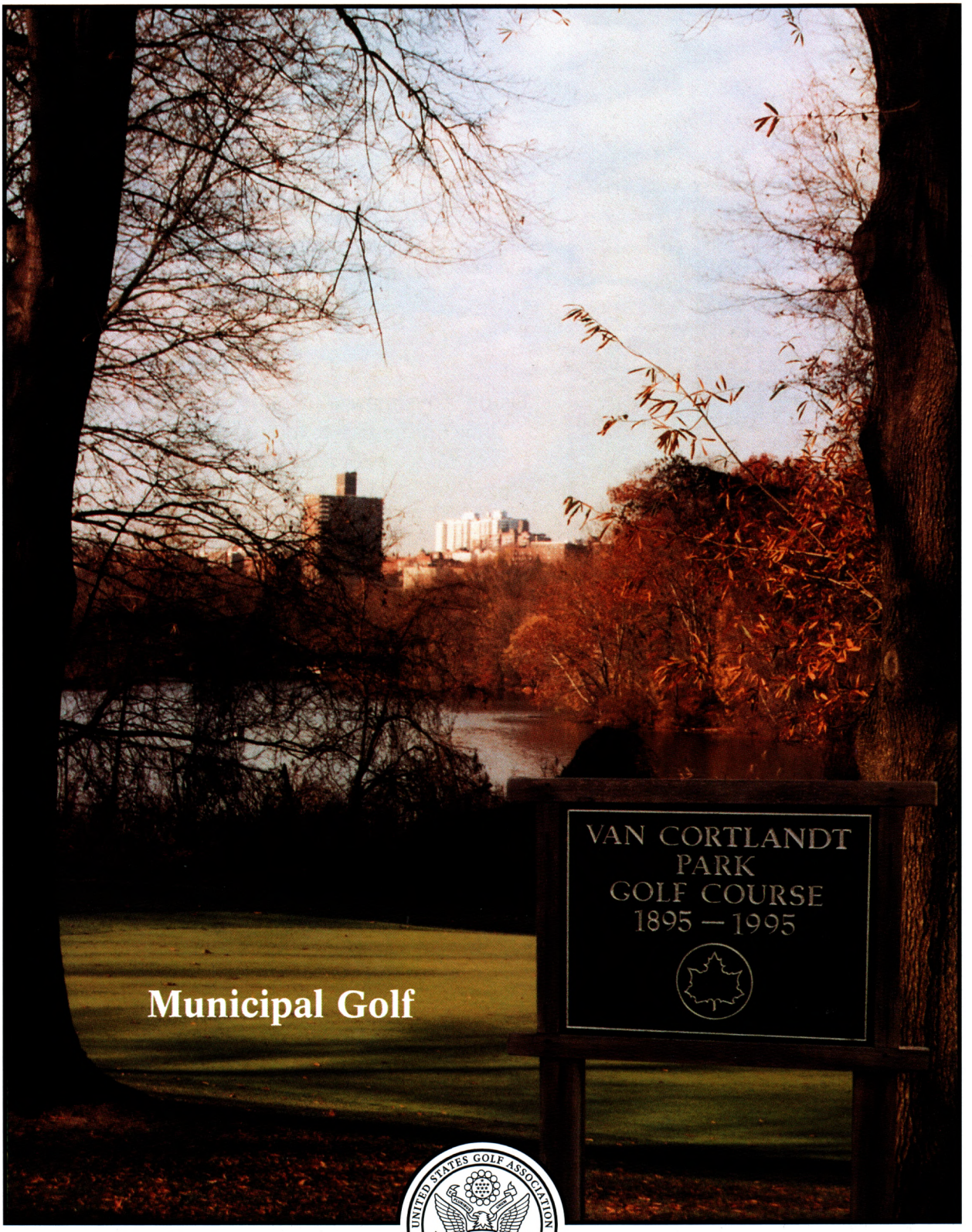

Municipal Golf

A PUBLICATION ON TURFGRASS MANAGEMENT BY THE UNITED STATES GOLF ASSOCIATION®

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Cover Photo:
America's tradition of municipal golf began in 1895 at Van Cortlandt Park in the Bronx, New York.

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In June 2002, Bethpage State Park (New York) will be the first government-operated golf course to host the U.S. Open Championship. See page 1.

Zoysiagrass tolerates sand accumulation commonly found around sand bunkers. See page 9.

Giving credit where credit is due: Bethpage State Park will host the 2002 U.S. Open Championship.

BYPASS ST. PETER: How to Have a Heavenly Municipal Golf Course!

Taking out the politics can lead to a better public golf facility.

by PATRICK M. O'BRIEN

"Municipal golf is one of this country's least appreciated sports traditions. Instead of lavishing praise for the latest and greatest upscale private club, we ought to think more about affordable access to quality courses near where many people actually live." – Bradley S. Klein, Editor, *Golfweek's Superintendent News.*

MUNICIPAL GOLF COURSES have been filling the need for affordable golf in the United States for more than 100 years. Today, 21 million of an estimated 26.5 million golfers in the United States play their golf on public-access courses. The demand for green fees under $40 at municipal courses is staggering.

Unfortunately, a crisis exists today at many municipal golf courses. Poor management and local politics have resulted in unacceptable playing conditions. Excess golf revenues are being diverted to other recreational activities or into the pockets of management companies.

Despite these problems, most municipal golf courses will continue to offer good quality at fair prices. This article reviews the most common mistakes made and examines four case studies of municipal golf courses that have turned things around. Finally, a list of suggestions is provided to help any municipal course get on the road to success.

The History of Municipal Golf

Van Cortlandt Park in the Bronx, N.Y., was built in 1895 and is the oldest municipal golf course in the United States. Thousands of municipal courses have been built since then, and they have provided millions of men, women, and children of all backgrounds with a place to learn the game. Historically, municipal golf courses were operated

by local parks and recreational departments along with other field sport facilities, swimming pools, tennis courts, and area parks. These facilities, including golf courses, were viewed as recreational centers for the local citizens and were supported by tax dollars.

As golf increased in popularity in the 1980s and 1990s, revenues at golf courses boomed. Local politicians began to view their courses as a source of revenue to fund other local recreational programs and facilities. At the same time, politicians bowed to public pressure and reduced fees through the establishment of under-priced annual passes for local residents. Municipal golf courses were directed to operate as businesses, but they were not allowed to use their profits for course improvements, nor could they set fees that were commensurate with the service they were providing. When this occurred, course conditions frequently began to spiral downward rapidly.

Public golfers are becoming more demanding of better golf course conditions at municipal facilities.

When a course hits bottom, the first attempt by local officials at upgrading often is to hire a professional management company to manage the entire golf course and to minimize the politics. Surveys taken prior to 1995 by the Reason Public Policy Institute indicate this trend. The number of privately managed government courses increased 67% from 1987 to 1995, with approximately 25% of all cities employing a management company.

However, the latest trend is away from management companies and toward operation of the courses as a municipal enterprise fund. An enterprise fund is a process of funding the golf course or other municipal service solely through the revenues it generates and without the benefit of taxpayer support. Quasi-independent golf course advisory boards are often established, and they control accounts funded by golf course revenues. Cities are finding out that they can create more efficient, better-maintained courses with fewer political disputes when using the enterprise fund model. Here are a few real-life examples of successful municipal golf courses:

Municipal Enterprise Fund Case Studies

#1 Cottonwood Creek Golf Course (Texas)

The Cottonwood Creek Golf Course in Waco, Texas, was built in the middle 1980s by the city and immediately was leased to a management company. Over the last few years of the lease, the number of rounds of golf had shrunk from 40,000 to the mid-20s as the reputation of the facility diminished in the community due to poor management. The city decided to take over the facility again and formed the Cottonwood Creek Citizens Advisory Board. Each Waco city council person appointed two members to this independent board. A total of 12 persons serve two-year appointments, with six appointments made each year. The Board is composed of all social and economic classes, and both public and private golfers. The perspectives and input from this diverse group have been invaluable. Board meetings are held monthly, usually over lunch, and generally last 90 minutes. Agenda items are discussed and recommendations made to the staff and city council on all aspects of the golf facility.

The Advisory Board took a proactive role and made a determination to reestablish Cottonwood Creek Golf Course as the premier municipal facility in central Texas. The Advisory Board's goal was to set the standard in central Texas for high quality, affordable golf. A mission statement was adopted that reads, "To provide a high quality and affordable golfing experience for central Texas golfers and a golfing facility that provides enjoyment and challenge for golfers of all skill levels," according to Michael Copp, Advisory Board Chairman. The Board then identified and prioritized areas of need and developed a five-year strategic plan to accomplish this mission. The areas of concern in

order of priority were: (1) reconstruction of all putting greens, (2) installation of concrete cart paths throughout all 18 holes, (3) renovation of all bunkers, (4) new maintenance equipment acquisition, (5) update and improve the irrigation system, (6) tree planting and entrance beautification, and (7) new perimeter fencing in select areas. The putting green renovation and reconstruction was completed within months. Cart paths have been installed on the front nine holes, and the back nine holes are nearing completion. Some trees were removed and in other areas new trees were planted. A beautiful new entrance gate and landscaping were put in place. Course maintenance personnel have begun bunker renovation, with several of the bunkers already completed. The irrigation system is next in line to be addressed.

The General Manager at Cottonwood Creek Golf Course, a city employee in the Department of Parks and Recreation, is responsible for the budget. All revenues from the golf course are reallocated back into the facility. The city has been providing temporary subsidies due to the major capital expenditures needed to rejuvenate the course. The annual operational statements are brought to the Advisory Board for recommendations. The City Council ultimately approves the final budget and capital expenditures and generally approves the recommendations of the Advisory Board.

The changes in conditions have made a dramatic turnaround. In less than two years time, the number of rounds of golf has increased again to over 43,000, with a continuing steady monthly increase trend.

Table 1
Chicopee Woods Golf Course Charter

Our Charter is to provide a quality golf facility for the public golfer. This includes all citizens of Hall County and surrounding communities. It shall be our goal to provide a facility that is in very good condition at a reasonable cost to our players.

In addition, we pledge the following:

1. We shall be financially self-supporting for operational expenses.
2. We will be conscious of environmental concerns and operate the golf course in a manner that will not only protect the natural environment, but will enhance the natural environment whenever and wherever possible.
3. We will support the Chicopee Woods Park Commission with a percentage of our gross income each and every year. This money will be spent in whatever manner the Chicopee Woods Park Commission deems appropriate.
4. We will always try to treat the customers of Chicopee Woods Golf Course with friendly service that is beyond their expectations.
5. We will promote golf within our community as a healthy activity, especially for younger people.
6. We will attempt to provide our full-time employees with benefits that are comparable to local government and/or local private enterprise.
7. To change this Charter (after initial formulation) would require a unanimous approval of the Green Committee.

#2 Chicopee Woods Golf Course (Georgia)

Hall County is a major metropolitan area northeast of Atlanta, Georgia. An 18-hole golf course was built in 1991 on land given to the county by the Johnson & Johnson Company. Over the past 10 years, the golf course has operated with no tax dollars under the jurisdiction of the Chicopee Woods Parks Commission, a subdivision of the State of Georgia. A Green Committee set up by the Parks Commission acts as the governing board that establishes fees, rules, and regulations for the golf course. A charter (Table 1) provides the basic philosophies that the Green Committee carries out. Chicopee Woods is well known in the Atlanta area for its affordable green fees and quality turf conditions, and it attracts over 45,000 rounds of golf annually.

The key to the success of this golf facility has been the governing structure under the direction of the Green Committee. All revenue from the golf course, including green fees, cart fees, and driving range fees, is deposited into a reserve account. An income and expense balance sheet for the 2000 golf season is shown in Table 2. Funds from a special reserve account are used for golf carts, landscaping, maintenance equipment, capital improvements, golf course expansion, and golf cart paths. The Budget and Finance Committee, made up of the Vice Chairman and the Treasurer of the Green Committee, prepares the annual budget for submission to the Green Committee with assistance from Dave Feser, golf superintendent, and Jim Arendt, golf professional. All financial information is public and given to the city and county officials, and is audited annually.

Overall, the Green Committee consists of nine members who live in the community and have been appointed by the Parks Commission. Each member is appointed for a three-year term, and each member may serve a second term. The Chairman serves a two-year term. The Green Committee also hires the golf course superintendent and golf professional. At the monthly meetings, long-range plans, fees, and other topics are discussed and reviewed by the Green Committee. This "citizen committee" system works at Chicopee Woods and helps to insure quality golf for the public golfer. Chicopee Woods is currently building a third nine holes, designed by course architect Dennis Griffiths. This will be financed by a bank loan and paid for within 13 years from generated revenues. Truly a success!

Table 2
Chicopee Woods
Fiscal Year 2000 Facility Budget

Income	$1,350,000
Expenses	
Golf Course Maintenance	$ 650,000
General Operations	$ 400,000
Reserve Fund (will be spent in fiscal year 2001)	$ 300,000

#3 Olde Barnstable Fairgrounds Golf Course (Massachusetts)

The Olde Barnstable Fairgrounds Golf Course, built in 1991, has set up an Enterprise Account Fund to operate this popular golf facility in the town

of Barnstable, Massachusetts, on Cape Cod. Olde Barnstable Fairgrounds has a reputation as one of the best municipal facilities in the Northeast. The course averages over 63,000 rounds per year and has a modest budget of approximately $550,000 annually. The town oversees the Enterprise Account and an independent Golf Advisory Committee made up of concerned citizens of the town meets monthly to discuss potential issues facing the facility. The seven-member Golf Advisory Committee has several sub-committees to deal with tournaments, fee schedules, budgetary issues, etc., and makes recommendations regarding long- and short-range planning.

The golf course is operated without any tax-generated revenue and spends what it makes. It is fully responsible for all debt service and bonds. The golf facility charter includes a goal to provide reasonable green fees for the residents of the community. Non-residents are charged higher fees, and approximately 25% of the annual play comes from this income source that generates a significant portion of the annual revenue. With the popularity of golf in this resort town, a certain percentage of the daily tee times are allocated for non-resident play due to their income value. Every holiday and weekend day in the summer typically is sold out for these tee times, and if any openings come about, they are offered to residents first.

The golf course operates out of the Department of Recreation, with the Pro/Manager at the golf facility, Gary Philbrick, PGA professional, reporting to the Recreation Director. Bruce McIntyre, CGCS, is the golf superintendent who carries out the capital improvements and directs the daily course operations. The Pro/Manager and Golf Course Superintendent develop the annual budget and make recommendations for how to spend the money in the Enterprise Account through the Recreation Director. After the Recreation Director and Golf Advisory Board review the budget, it is passed on to the Town Manager, who generally approves the proposed budget. The Town Manager will then take the budget to the Town Council for final approval. In 1999, capital improvements for cart paths, new equipment, and irrigation improvements totaling over $200,000 were completed, with an approximate $100,000 surplus left in the Enterprise Account. These funds will be spent next year for additional course improvements or debt service.

One major decision that really has promoted quality turf conditions with the high play is the fee system. Green fees for residents average between $29 and $36 for 18 holes, while non-resident fees are between $55 and $69. Annual passes and discounts are available for residents of the town for $595, and a "punch ticket" for 10 rounds can be purchased for $225. Junior passes are also available for $195 annually, and this includes college students. Seniors purchase 70% of the annual passes.

Whether the golf course is a municipal or private facility, periodic renovations are important. A new concrete cart path project was financed at Chicopee Woods G.C. by revenues from the reserve account.

#4 Monmouth County Golf Courses (New Jersey)

The Monmouth County Park System in central New Jersey has seven golf courses, including two facilities (Hominy Hill and Howell Park) in the *Golf Digest* Top 50 Public Courses. Dave Pease, General Manager of the MCPS Golf Courses, places a premium on course conditions. This management philosophy provides the best playing conditions possible for the daily-fee patron. Every facility is operated with annual budgets in the range of $700,000 to $800,000. The successes of the management programs are based on the continuous support from all departments and administrations. Most importantly, the Board of Recreation Commissioners, an independent commission within the Department of Parks, has been a big plus for the famous conditions at these facilities.

This board consists of 10 members appointed by the Board of Chosen Freeholders, who are elected county officials. Since the appointment is for a lifetime and without pay, only individuals who have a vested interest in the county are chosen. The appointees come from all types of backgrounds, including blue-collar workers and professionals. The lifetime appointments help to insure a stable infrastructure.

The Board of Recreational Commisioners is primarily a policy-making board rather than a working board. This board meets twice monthly and sets the direction not only for the golf facilities, but also the rest of the Monmouth County park system. A few of their important responsibilities include approving course policies, operational and capital budgets, contract approval, and long-range plans. The golf course staff drafts all golf course budget issues for the Board of Recreation Commisioners, and Mr. Pease serves as a technical advisor for golf course operations. "I keep the wheel greased for golf expenditures," explained Mr. Pease, "as all the recreational heads want a piece of the pie." Final decisions regarding the budget rest with the Board of Recreational Commissioners, but they must operate within the budget set by the Board of Chosen Freeholders.

Funds to operate the golf courses come from the green fees, cart fees, and pro shop sales, and are deposited into the county treasury, but several trust funds also exist that retain a percentage of certain revenues for capital improvements. Non-resident green fees are double those of the county residents at each of the seven golf courses, and these fees usually generate 40% of the total revenue, even though non-residents are only 15% to 20% of the total play. Overall, every dollar generated by the seven golf facilities is returned to golf from the county treasury and trust funds.

The system works very well in Monmouth County, and over 50,000 rounds are played annually at each facility. The major complaint from the public is that "you can't get a tee time" and *not* that "there isn't any turf on the tees."

Other Tips for Success for Public Golf Courses

Municipal golf courses are a big business today, but they still offer the best opportunity to introduce new golfers to the game. The municipal facilities profiled in this article have experienced firsthand the challenges encountered with the operation of golf courses and have shared a few tips to help others stay on the road to success.

Administrative

- Find public-spirited golfers who play on your course and live in your community to serve on your advisory board.
- Appoint citizens with varying playing ability.
- Consider small business people, accountants, superintendents, attorneys, and others who may have skills that you could draw upon.
- Select as your first chairperson a very strong individual with strong organizational skills.
- Appoint positive people to your governing board, not those who just complain.
- Write a charter with your purpose clearly stated.
- Hire the very best employees you can afford. Remember, excellent employees will pay their way, while poor employees will not be cost effective.
- Make the playability of the golf course your top priority when budgeting any funds, either operational or for capital improvements. Eventually, the golf course reputation and consequent play will be able to pay for a few frills.

Make some improvements on the golf course each year. Critically evaluate expenditures to allocate money to the appropriate area.

- Keep "clubhouse" operations to a minimum! Remember, golfers come to play golf.
- Remember that you are in a competitive situation with other golf courses and, as government or municipal operations, your only conflict might be that you have a community obligation to provide for the young, the old, and the disadvantaged. This does not mean cheap golf for the average player.
- Raise your income through an increase in fees each year – perhaps a minimum of 3% to 5%, and slightly more if you want to make some capital improvements.
- Consider a discount for people from your political jurisdiction.
- Stay strictly daily fee.
- Do not issue season tickets.
- Do not "yo-yo" prices, i.e., not increase fees for three or four years and then make a 20% increase.
- Do not spend money for "fancy" when you don't have the basics.
- Keep track of financial ratios and differences from year to year. Example:

Chicopee Woods Golf Course (Georgia) operates under the jurisdiction of the Chicopee Woods Parks Commission. A Green Committee, established by the Parks Commission, conducts monthly meetings to establish fees and rules, review current activities on the golf course, and discuss long-range plans.

Total income divided by rounds played equals dollars brought in by an average customer. Is this number going up or down from year to year? This can be done with many different sets of numbers and tracked.

- Remember to act as much as possible as any for-profit business would.
- Price yourself at an optimum, i.e., not so high you can't attract players and not so low that you either leave money on the table or can't give a reasonable quality product.
- Be flexible with issues regarding unions, bureaucracy, and difficult clientele.
- Hire rangers to police the players and ensure that customers follow the philosophies of the facility.

Golf Maintenance

- Make golf course maintenance the highest priority.
- Keep uniform playing conditions throughout the golf course.
- Do not attempt to have the "perfect" conditions of TV golf, but do have good playing conditions throughout the golf course, in this order: putting greens, tees, bunkers, fairways, and rough.
- Make fertilizer applications somewhere between adequate and optimum for turf growth. Too much is a waste, and too little will not give the results desired and therefore is almost a waste, too!
- Chemical plant protectant applications should be made only if absolutely needed.
- Accept some turf damage or weed infestations before initiating control measures.
- Consider spot applications of fertilizers, herbicides and other plant protectants.
- Hire an excellent mechanic and make equipment maintenance a very high priority.
- Do not plant roses if you don't have good turf!
- Dream but be practical.
- Make some course improvements each year.
- Decide where to spend capital monies by evaluating if this expenditure will tend to increase or decrease operational budgets. This is not always easy, but it is very important if funds are hard to come by. For instance, permanently correcting a bunker that is routinely eroded by washouts will reduce operational costs while a pretty flower bed or fountain will tend to raise operating costs. Those kinds of expenditures may be needed, but consider them carefully!
- Remember that golfers come to your course to play golf. Invest as much as possible in the golf course turf conditions.
- Don't spend large amounts of money on architectural improvements if they are really not needed.
- Consult annually with a USGA agronomist to find out the latest information about turfgrass management, new products, and trends.
- Use the largest turf equipment practical. This helps to keep labor costs down.
- Have backups for your most important pieces of equipment.
- Don't compromise on the necessities of fertilization, weed control, aerification, and divot repair.
- Hire a top-notch assistant superintendent.
- Don't let the attitude of "I don't care" develop. Superintendents must be motivated and they, in turn, motivate the crew.
- As a superintendent, be seen and communicate with the golfers. There is a need for constant education.
- Don't give in to the vocal minority. Develop a good agronomic plan and stick to it.
- Mandate the use of non-metal spikes to reduce wear on the course.
- Set up maintenance work schedules to avoid conflict between the workers and golfers during the course of normal daily grooming activities.

Conclusion

The public has a deep-rooted perception that municipal golf is low quality. Times have changed, and many municipalities are providing affordable, accessible, and better-conditioned golf courses for the public golfer. In fact, the 2002 U.S. Open will be played at the Black Course at Bethpage State Park, a state-operated golf course.

There is hope for any municipal facility in need of improvements by following the advice and case studies in this article. Municipal golf courses are still the perfect venue to teach new golfers the traditions and proper etiquette of play in an affordable and safe environment. Today's government officials might not be able to get you to heaven, but there is no reason why they can't provide a heavenly golf course.

Acknowledgements: The author would like to thank Dave Feser, Dave Pease, Angelo Palermo, Bruce McIntyre, and Michael Copp for their assistance with this article.

PATRICK M. O'BRIEN is Director of the USGA Green Section's Southeast Region. His golf career started at the North Park Municipal Golf Course, owned by Allegany County, Pennsylvania, near Pittsburgh.

Light Rate – Results Great!

A simple, fast, and safer way to apply fertilizers, fungicides, and plant growth regulators for the entire golf course.

by WALT SMITH

MOST turf professionals have heard about or experienced the dramatic improvements to turf health, playing conditions, and ease of maintenance resulting from the application of Primo. When combined with light and frequent fertilizer applications, green speed, overall plant density, and mowing requirements can be noticeably enhanced. While many golf course superintendents would like to implement a turf maintenance program with this PGR as their focal point, the whole process seems daunting, excessive, and expensive. We faced this dilemma at Missoula Country Club in 1999, but we were determined to build a sprayer that would greatly reduce the headache of making light, frequent applications of Primo and fertilizer. The spraying system created at Missoula C.C. is efficient, while taking advantage of the spraying process without the corresponding time loss, pain, and negative impact on the budget. Here is a look at the step-by-step process followed to create this spraying system.

Sprayer Capabilities

Once we had determined that Primo and liquid fertilization would be an integral part of our operation, we needed to determine the sprayer capabilities. These included:

- Four-product injection to allow the application of fertilizers, fungicides, and a PGR with one pass and requiring only water in the tank.
- On-course tank refilling to reduce time-consuming transport.
- Enclosed cab for operator protection and comfort.
- All controls located in the cab and simplified for ease of operation.
- Product containers with enough capacity to eliminate the need for refilling and mixing when spraying a minimum of nine holes of tees, greens, and fairways.
- High-volume centrifugal pump that allows operation of the sprayer with very little drop in pressure and has a maximum pressure that is below the limit of typical solenoid-operated valves.

Sprayer Components

With these needs in mind, the first task was to find an accurate, inexpensive, and durable injection method to design the sprayer around. The search led to a manufacturer of greenhouse proportional fertilizer injectors, Dosatron. With unit prices considerably below $1,000, Missoula C.C. decided to try two units for the 1999 season to test their durability and accuracy. As purely mechanical units, they act independently of pressure, viscosity, or any voltage fluctuations. They inject and mix at an adjustable ratio of product to water. Once set, the dose remains constant despite changes in water flow or pressure.

Units are available with a mix ratio of as little as 1 to 500 or as much as 1 to 10. The Dosatrons chosen for this application were from the D8 series. This series accurately injects with flow rates as low as 2.2 gpm and as high as 40 gpm. The units have proven to be accurate even when tank mixing wettable powders. They require very little maintenance, consisting only of cleaning an internal screen after applying wettable powders. After two seasons of spraying nine holes of tees, greens, and fairways every week, the units were devoid of wear or any sign of failure.

Finding an injection system that worked flawlessly made the rest of the sprayer construction a matter of procuring the necessary parts and attaching them accurately to the right vehicle. The choice for a vehicle was a two-wheel-drive Toro Workman with an enclosed cab, flat bed, and a 21 hp diesel engine. This vehicle is very maneuverable and easy to operate. The governor is easy to adjust and, surprisingly, maintains speeds very consistently.

A Hypo centrifugal pump with a gear reduction was chosen, model #9006P-0. The pump is driven by a Honda 5.5 hp electric-start motor. Pulley sizes for the pump and motor were 14" and 3", respectively, using twin-belt pulleys. An electric start allows the operator to turn the pump off and on from the cab. The centrifugal pump is capable of 90 gpm and only about 70 psi. This eliminates the need for a pressure relief-valve and gives us the ability to control pressure with the Honda's engine speed rather than with a pressure-regulating butterfly valve. Very little drop in pressure versus static pressure is desired when spraying. The minimal pressure drop is due to the high volume of water recirculated by the centrifugal pump through 1" plumbing, versus the relatively low demand (6 gpm) of the spraying system. Controls for the engine are located in the cab for easy start, shutoff, and engine speed control, and once the engine speed is set, it does not vary, giving us consistent spraying pressures. After the Honda and Toro governors are set, the operator need only keep vigilance over the area being sprayed.

Spraying controls consist of a bank of three electric solenoid valves, giving us the option of using one, two, or three boom sections. Booms are hydraulically lifted and lowered and are independent of each other. We use a foam marking system with small tube outlets that leave a fine line of foam that disappears in a matter of minutes, and with the small outlets we do not have to worry about running out of foam before we finish a nine-hole application. Electric gate valves are used to control which side the foam is emitted from. The only other control is a pressure gauge so the operator can monitor spraying pressures. With a total of six switches and two throttle controls, operation of the sprayer is very easy after the initial setting of the throttle governors.

Plumbing the tank for a 1" hose and attaching a 1" quick coupler to the end facilitates refilling on the golf course. With 20' of hose, the operator is able to fill up at any green in about a minute. The quick refilling time makes the 100

Missoula Country Club (Montana) built an innovative spray unit capable of making light, frequent liquid applications. There is no need to tank mix the chemicals, the unit can be refilled on-course, and the sprayer can apply multiple products with one pass.

gal. tank adequate for the sprayer's needs. In addition, the use of a 100 gal. tank leaves us with plenty of room on the flatbed for our four product tanks and reduces vehicle spraying weight. Tanks holding 8 gallons were chosen for the PGR, minors fertilizer, and fungicides, yielding enough room for a minimum of two weeks of applications. The main fertilizer tank has a 50 gal. capacity, which at .15 lb. N per 1,000 sq. ft. is just enough capacity to spray nine holes of fairways and tees using a 22-1-2 liquid fertilizer.

What Are The Advantages of This System?

Now that the sprayer is configured, what has been accomplished? This is what has been noted at Missoula C.C. during the past two years of operation:

- The sprayer can now apply multiple products with one pass.
- There is no longer a need to tank-mix chemicals.
- With the enclosed cab, operator exposure to chemicals is extremely limited.
- On-course refilling allows the operator to spray nine holes of greens, tees, and fairways, approximately 17 acres, in about 2.5 hours!
- Triple-rinsing the tank is no longer needed. The operator simply turns off the Dosatrons and sprays out another 25 gal. of water to flush out the lines.
- The spraying activity allows the use of liquid fertilizer to spoon-feed the turf at about a quarter the cost of slow-release granular fertilizers.
- The improvement in playing conditions on the greens, tees, and fairways from the use of Primo has netted complete acceptance of the spraying program by members.

What has been accomplished? As the subtitle of this article states, we've established a fairly simple, fast, and safe way to apply products for the majority of the golf course in one pass.

The Missoula Country Club Spray Program

Through the spray program at Missoula C.C., we apply 0.15 oz. Primo per 1,000 sq. ft. and 0.15 lb. N per 1,000 sq. ft. to nine holes of fairways and tees each week. We apply 0.15 oz. Primo per 1,000 sq. ft., a pythium fungicide, and a leaf spot/pink snow mold fungicide to the greens every other week. On alternate weeks, we apply 0.15 lb. N per 1,000 sq. ft. and 3 oz. per 1,000 sq. ft. of a liquid minors product to the greens. We also apply 1 lb. K per 1,000 sq. ft. in the form of K2O and 1 lb. N per 1,000 sq. ft. in the form of ammonium sulfate to our fairways in both the spring and the fall. We apply our initial applications of Primo the second week of April and end applications at the end of September. The manufacturer recommends waiting until full green-up to start applying Primo (May in Missoula). Waiting until May to make the first application is difficult, but greens can experience a setback after hard frosts in the early spring when under growth regulation. In addition, we applied the entire year 2000 winter PCNB application for the greens, tees, and fairways using the Dosatron. Using a 40% flowable PCNB product in the fertilizer tank, no tank mixing was necessary other than the rinsate from the product containers and the fertilizer tank. The savings in time and operator aggravation were tremendous!

Summary

In essence, Missoula C.C. has traded a small amount of sprayer time for a significant amount of mowing and mechanic setup time. The savings in fertilizer expense offsets the cost of the Primo, with the increased quality of the playing surfaces as the ultimate bonus. We have about $21,000 in hard costs in the sprayer, which is far less than trying to buy one pre-built to these specifications. It is also far less than the cost of another fairway mower that would need to be added to the depreciation schedule if the mowing schedules of the past were maintained over the life of the sprayer. Has it been a bonus for our operation? Ask the players at Missoula Country Club and they will say, "With a light rate, the results are great!"

WALT SMITH *is assistant superintendent at Missoula Country Club in Missoula, Montana. If anyone would like specific information on the sprayer or program, contact Jon Heselwood, golf course superintendent, or Walt Smith at Missoula Country Club, P.O. Box 3057, Missoula, MT 59806, (406) 549-4601.*

In the middle of a hot summer, zoysiagrass provides an excellent stand of grass under difficult conditions.

USING ZOYSIAGRASS ON SAND BUNKER SLOPES

Using a niche grass to solve a growing problem.

by STAN ZONTEK

ZOYSIAGRASS has always been a very interesting and useful turfgrass on golf courses in regions of the country where it is adapted. Zoysiagrass fairways are considered to be some of the finest playing surfaces in the Transition Zone. However, the winter color of zoysiagrass and its intolerance to overseeding has limited its use as a principal fairway turfgrass. Nonetheless, where zoysiagrass has been used, it performs beautifully. The quality, playability, and low maintenance characteristics of zoysiagrass for fairways, however, are not the purpose of this article.

These comments on zoysiagrass will describe an increasingly common practice in the Mid-Atlantic Region of the USGA Green Section. Specifically, zoysiagrass increasingly is used on sand bunker slopes. Why? For one thing, it makes sense. The grass is tolerant of sand accumulation and the heat generated on southern exposures that normally would kill or at least cause a decline of cool-season grasses. Zoysiagrass works well in solving this common problem on golf courses – the maintenance of the slopes of sand bunkers.

Thin and poorly turfed bunker surrounds do not look good or play well. Also, they detract from the general aesthetics of the putting green complex. The old adage is so very true: the best weed control is a thick turf. Thus, as these bunker slopes deteriorate, grassy weeds like crabgrass and goosegrass tend to invade, detracting further from the appearance of these areas.

As turf density and sod strength are lost, bunker slopes and the margins (lips) between the sand and the grass can collapse. It is amazing how golfers tend to walk up bunker faces, which only adds to the deterioration and collapse of bunker slopes and lips. Obviously, something needs to be done.

Replacing the grass on bunker faces with the usual blend of grasses, including various combinations of Kentucky bluegrass, turf-type tall fescues, fine fescues, and perennial ryegrass, is one option. While these grasses have their strengths, they also have a number of weaknesses. For one, three out of four

of these grasses are bunch-type grasses, which inherently are slow to spread and are recognized as being poor sod formers. Only Kentucky bluegrass has good rhizome spread. Most blends of grasses include Kentucky bluegrass for its sod-forming ability. However, none of these grasses, being cool-season grasses, tolerate the heat and drought associated with sand accumulations on bunker slopes in general and on southern exposures in particular. In this situation, warm-season grasses can do a better job.

One final point. As sand thrown from bunkers accumulates, a wonderful environment is created for insects, particularly chinch bugs and billbugs. Most of the commonly used cool-season grasses are susceptible to these insect pests, especially on southern exposures. Unfortunately, turf managers can overlook this insect problem, which only accelerates the deterioration of cool-season grasses on bunker slopes. And, whereas most of the commonly used cool-season grasses are susceptible to these insect pests, warm-season grasses tend to be more insect tolerant. In summary, all of these factors are scenarios for grass decline and failure in these very important play areas.

What's the Bottom Line?

On the grass areas surrounding bunkers, turf managers, golf course architects, and builders are increasingly ringing sand bunkers with zoysiagrass. If properly designed and executed, it is amazing how well zoysiagrass performs in these situations. For the purpose of this article, the zoysiagrass species discussed is the "Meyer" variety of *Zoysia japonica*. There are other varieties of zoysiagrass available, but Meyer zoysia is the grass most used in the Mid-Atlantic Region at this time. Other zoysiagrasses have different levels of winter hardiness, leaf texture, and density, etc. Meyer zoysia has a long track record, being released in the early 1950s. Times could change with a number of zoysiagrasses being released, but for now, Meyer zoysia is the grass of choice for this situation.

Advantages of Using Zoysiagrass on Bunker Slopes

- Winter hardiness. Meyer zoysia is extremely winter hardy. It can be grown successfully north of the Transition Zone.
- Disease resistance. Zoysiagrass has only one principal disease, zoysiapatch, which can be controlled if it develops.
- Insect resistance. Zoysiagrass has a high degree of tolerance to chewing and sucking insects. Grub problems can occur.
- Drought tolerance. Zoysiagrass is recognized as being highly drought tolerant, especially compared to cool-season grasses, which is why it performs well in sand accumulation areas.
- Heat tolerance. Zoysiagrass is a warm-season grass, so the hotter it gets, the better it performs. This is why zoysiagrass grows well on southern exposures.
- Low nitrogen requirement. Zoysiagrass performs well at 2 lb. of nitrogen per 1,000 sq. ft. per year or less.
- Tolerance to herbicides, both selective and non-selective. This makes

During the off-season, cool-season grasses maintain their green color, in contrast to the straw-colored zoysiagrass. The zoysia provides an excellent alternative on sand bunker slopes.

Many people find the color contrast of zoysiagrass to other cool-season grasses attractive. To others, the tan winter color is an ugly alternative.

weed control in zoysiagrass easier to accomplish.

• Excellent sod strength. Zoysiagrass is a tough grass. It tolerates golfers and workers walking on bunker slopes.

• Playability. Zoysiagrass looks and plays differently from most cool-season grasses on bunker faces. Balls can come to rest on zoysiagrass bunker slopes that would otherwise have rolled into the sand after hitting cool-season grasses. Some golfers like it, others do not.

• Zoysiagrass is a low-maintenance grass. Zoysiagrass spreads slowly, especially when compared to bermudagrass, another warm-season grass. It requires far less edging than bermudagrass used on bunker slopes. Also, its growth pattern matches the availability of labor on most golf courses. What exactly does this mean? Think of this. What is one operation on a golf course that requires a huge amount of hand labor? It is hand trimming in general and trimming around bunkers in particular. Being a warm-season grass, zoysiagrass growth naturally slows and should not, in fact, be cut as it enters dormancy in the early fall. This is when most golf courses begin to lose their labor. Thus, this can save many hours of hand work at a time when labor is becoming short. In the spring, zoysiagrass does not need to be cut until late April or mid-May. This is when more labor is becoming available. Thus, the normal growth pattern of this grass closely matches the labor distribution on most golf courses in the transition zone.

While zoysiagrass has many strengths, it does have some disadvantages. These include:

• Winter color. To some, the color contrast is attractive. To others, the tan-brown winter color is ugly. To use a cliché, "beauty is in the eye of the beholder."

• Winter weed control. A long list of winter weeds can become established in dormant zoysiagrass. Thus, the superintendent must learn winter weed control techniques for zoysiagrass.

• Cost of establishment. Most zoysiagrass used for this purpose is established from sod. Zoysiagrass sod is significantly more expensive in comparison to other cool-season grasses. However, the fact that cool-season grasses may have to be replaced more frequently negates, to some extent, the initial cost of zoysiagrass versus other cool-season grass blends.

• Shade tolerance. Few warm-season grasses perform well in shade. Zoysiagrass has reasonable shade tolerance, especially when cut longer as on the slopes surrounding sand bunkers. Nonetheless, using this grass on shaded bunker slopes may be a problem.

• Northern exposures. Zoysiagrass is a warm-season grass. Thus, it grows best on southern exposures. Conversely, on cooler and more shaded absolute northern exposures, zoysiagrass is not at its best. This could result in some bunkers, or portions of bunkers, being grassed with cool-season grasses and other bunkers with better sunlight exposure being grassed with zoysiagrass.

• Playability. Again, some golfers prefer to play from cool-season grasses.

In conclusion, if you compare the strengths and weaknesses of zoysiagrass on bunker surrounds, it is easy to see why more zoysiagrass is being used on golf courses in the transition zone. Can zoysiagrass be used farther north, outside the transition zone? You bet. This is especially true on those southern exposures where sand accumulates. In this situation, for all practical purposes, it is like growing grass hundreds of miles farther south. It may be worth a try. Maintaining grass on the slopes surrounding sand bunkers is a unique challenge that perhaps requires a unique grass to solve *a growing* problem.

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A Multiple Index Environmental Quality Evaluation and Management System

A method that can be applied to a golf course.

by DR. STEVE THIEN, DR. STEVE STARRETT, DR. ROBERT ROBEL, PATRICK SHEA, DAVE GOURLAY, CAL ROTH

The construction of Colbert Hills Golf Course near Manhattan, Kansas, provided the opportunity for what is perhaps the most extensive environmental research evaluation ever conducted on a golf course.

A METHOD for evaluating environmental quality of large-scale landscapes that bridges scientific research and public use is in great demand. Resource managers, industry and community planners, government policy makers, and scientists all support an improved environment, but connections between processes, remediation, and management aren't always readily available or understandable to such a diverse community. This article describes a versatile, simplified, science-based system for making environmental quality assessments and linking outcomes to remedial management. This complex goal becomes attainable by: establishment and use of appropriate scientific databanks, determination of targets for acceptable and unacceptable impact on critical ecosystem functions, simplified visual integration of many indicators, and linkage to management databases. The process is being developed by a multidisciplinary study of a grassland ecosystem converted for use as a golf course. The system can be easily customized to local conditions and has wide-range application to many types of natural and managed ecosystems.

Ecosystems and a New Golf Course Every Day!

Golf is one of the fastest-growing industries in the United States, yet its environmental impact is largely unknown. Somewhere in the United States, on average, more than one new golf course opens every day (509 new courses opened in 1999).[1] The 26.4 million U.S. golfers[1] play at more than 16,743[1] courses that occupy well over 3 million acres. The annual impact of the golf industry on the U.S. economy was estimated at $30 billion in 1998 and is growing.[1] With the international golfing scene adding significantly to these numbers, both the golf industry and the public are interested in the impact of golf on the environment.

Golf courses provide unique settings for environmental studies. They typically contain segments progressing from high input zones to relatively undisturbed natural settings. Also, management inputs are commonly well documented. Researchers studying golf-related environmental issues find a receptive audience of superintendents through avenues like the United States Golf Association (USGA) *Green Section Record*[2] and the publications and educational programs of the Golf Course Superintendents Association of America (GCSAA).[3] Contrary to popular belief, evidence from these sources, and others, is building that golf courses, with their combination of plant communities, open expanses and natural areas, can be an accommodating habitat for birds, animals, pollinators, fish, amphibians, and other fauna and flora.[4,5,6] There remains, though, a great need to translate research into working management tools for the betterment of golf course ecosystems. Golf courses present perhaps one of the best living laboratories for the systematic study and monitoring of environmental quality from which the improvement of other natural, large-scale ecosystems can be modeled.

In Quest of Quality

Both the scientific community and the public support practices that improve the environment. Given the world's collective knowledge, abilities, interests, and support, one could reasonably expect our modern society to have developed a more sustainable and less destructive interaction with its environment. The fact that we haven't is troubling; however, there is the opportunity for channeling these mutual interests into a process and resulting solution.

Gifford Pinchot[7] and Frederick Law Olmstead[8], at the end of the 19th century, championed the systematic and scientific management of large-scale

landscapes. They coupled emerging ecological sciences, like botany and silviculture, to traditional biological sciences. By today's standards, their tools were primitive, yet they may have taught us the value of "looking at the whole forest and not just single trees."

In the modern era of powerful molecular-level technology, a case could be made that the scientific community can describe to the public more than it wants to know about a particular tree or molecule of the tree's genome. However, the description often stops short of any effort to describe the forest. Large databases exist that describe scientific aspects of our environment, but most await translation into workable management tools. At the beginning of the 21st century, a holistic, science-based, public-friendly method for evaluating and managing the relative health of large-scale landscapes seems like the missing link in environmental improvement.

Government, industry, university, and public entities have a continuing interest in a variety of ecosystems. Frequently, their interest is in an appropriate management regime to establish or maintain a quality environment. The phrase "quality environment" is vague and susceptible to conflicting interpretations. Too often, environmental quality is touted as a goal, but one typically lacking an itinerary, roadmap, or destination and, therefore, of little practical use.

Although scientists lean toward characterizing the environment through quantifying and interpreting large numbers of indicators, the resulting set of isolated indices falls short of describing the forest (or the "big picture"), particularly for the non-scientist. Alternatively, condensing many indices into a single index introduces significant theoretical and practical shortcomings. This article describes a utilitarian connection between the evaluative and management segments of environmental quality. The article suggests how, by appropriately combining management strategies with environmental databases, environmental quality can be changed from an empty idea into a workable tool, leading to sustained environmental improvement. This approach might best be viewed as "looking at single trees to see the whole forest." We'll demonstrate this concept using a golf course as our living laboratory, but the system's versatility allows its use on practically any ecosystem.

Golf on the Grasslands and Environmental Research

During 1999-2000, Colbert Hills Golf Course was constructed on a 312-acre native grassland site near Manhattan, Kansas. Soils, water resources, flora and fauna on this site represent a natural Kansas tallgrass prairie ecosystem. Environmental researchers at nearby Kansas State University were presented an excellent opportunity to study the impact a golf course has on the environment. Prior to construction on the site, researchers collected baseline data on environmental indicators selected to describe original conditions of the native grassland ecosystem. As architectural plans were being finalized, the course superintendent assisted in the selection of research sites and indicators. Water quality, soil quality, turf management, grassland ecosystems, avian ecosystems, aquatic ecosystems, and insect ecosystems were studied. Subsequent measurement of the same indicators has progressed through construction and, now, operation and use of the course. This project represents perhaps the most extensive environmental research evaluation ever conducted on a golf course.

Coupling with the research team, the course superintendent, an agronomist from the PGA Tour golf course properties, and a scientist from the United States Department of the Interior have used the Colbert Hills project to develop a multiple indexing system to gauge the environmental quality of the golf course. Named the Colbert-Thien (pronounced "teen") Environmental and Evaluation Management system, CTEEM is a versatile, informative, simplified, science-based method for identifying environmental processes in need of remediation and a source of management strategies to apply toward improving those conditions.

With this research, we're attempting to determine the ecological impact of converting a native grassland site to a golf course. We also aim to develop guidelines useful to the golfing industry for minimizing and remediating any negative environmental impacts of golf course construction, operation, and use.

Methodology

As described earlier, characterizing ecosystems requires both data and interpretation. Using today's technology, scientists can measure a large number of indices – so many, however, that they can often be confusing to the non-scientist. Alternatively, reducing many indices to a single index has theoretical shortcomings and practical limits associated with oversimplification of interpretations.

The CTEEM system overcomes both of these limitations by coupling multiple indices from a large-scale landscape into an easily understood visual gauge of environmental quality. By linking the identification of degraded processes and remediation guidelines, the CTEEM system comprises a complete environmental assessment and management package.

A soon-to-be-developed urban area adjacent to the golf course will add a new dimension to our monitoring activities. The flexibility of the environmental evaluation model described here lends promise to its use as a prototype for application to practically any size or type of ecosystem.

For continued comparison of change from original grassland conditions, the researchers have available some undisturbed sites on the Colbert Hills property and databanks from the Konza Prairie, a National Science Foundation designated Long-Term Ecological Research (NSF-LTER) site.[9] Both the Konza Prairie and Colbert Hills sites are representative of the native tallgrass prairie in the Flint Hills of eastern Kansas and physically exist within a few miles of each other.

Environmental quality, in its simplest form, is an assessment of essential ecosystem functions. The CTEEM system blends existing technologies to identify, monitor, assess, illustrate, and offer management strategies for any number of environmental quality indicators in an easy-to-understand format. First, essential functions and their measurable indicators are identified and monitored. Data from individual indicators are then graphed on control charts where sustainable ranges have been identified. Next, control chart indices are logically grouped and illustrated in a "spider radar" graph where environmental indicators outside of sustainable limits are easily detected. Finally, managers can access options for remediating degraded indicators.

Steps necessary for implementing the CTEEM system are:

- Identify critical functions of an ecosystem. Each ecosystem can be subdivided into natural functions (reactions, processes, and/or cycles) criti-

cal to sustaining that ecosystem. Ecological sciences can provide valuable guidance in selecting the functions most reflective of the ecosystem under study. Primary functions in an ecosystem can be further broken into subsystems. For example, in the grassland/golf turf ecosystem currently under study, soils are assigned critical functions in plant growth, soil tilth, environmental buffering, soil life, and natural cycling functions.[10] Within the natural cycling category, carbon sequestration in soil might be one critical function selected for evaluation because of its impact on so many soil properties.

• Select appropriate indicators to evaluate these functions. Several indicators may be necessary to adequately assess each function. Then again, one indicator may be useful in evaluating several functions. The scientific literature provides a wealthy repository of potential indicators. The great diversity in golf courses and scope of the evaluation can both be accommodated in this step by customizing the indicator selection to local conditions. Care should be taken to identify a list that is informative, measurable, and economically feasible. In keeping with the previous example, one indicator of carbon sequestration might be soil organic matter (SOM) content.

• Measure indicator status. Technology has provided access to rapid and comprehensive analyses for most needs. In some cases, modern or historic databases can provide essential information. Measurement frequency will be indicator dependent. With some, annual or seasonal testing will be sufficient, while others may be automated to sample on shorter intervals. Some measurements may be linked to monitor specific episodes (rainfall events, chemical applications, management changes, etc.). For this example, commercial testing laboratories routinely provide analysis of soil samples for organic matter content.

• Establish control chart indices (Figure 1). Control charts offer an informative method of comparing indicator measurements to ranges that delimit sustainable and degrading conditions.[11] The key to using control charts lies in setting appropriate and acceptable target boundaries that delineate sustainability and degradation. In some cases only minimum or maximum boundaries may be appropriate. Control limits can be established with the assistance of state extension services, literature surveys, management experience, model predictions, consultants, regulations, or other sources. For this example, a minimum SOM content of 1% might be selected as a lower control limit for some soils based on diminished soil tilth or water-holding capacity at lower levels. While high SOM is edaphologically desirable, maintaining organic matter content above 3% may prove economically unfeasible on many soils and so could establish an upper control limit.

• Transform multiple indices into environmental quality evaluation graphs (Figure 2). In this step, indices from any number of quality control charts are normalized onto a "spider radar" graph. This format produces an easy-to-understand visual presentation of environmental quality. A high quality ecosystem exhibits a nearly circular "radar" image with all indicators falling in the sustainable range. When some indicators fall outside the sustainable range, the circular "radar" image becomes skewed. The cause of degradation (i.e., which indicator) and its severity (i.e., amount of skewing) are readily apparent based on irregularity in the diagram's form. Alternatively, a circular form could denote a severely degraded environment if all indicators lie outside the sustainable limits.

Appropriate computerization can render either an episodic event or be animated for a systematic view of environmental quality changes over time. The compliance of an individual index to boundary conditions over time can also be viewed. This flexibility allows users to track the status of either an individual indicator or an array of indicators in response to natural cycles, catastrophic events, or normal managed inputs.

• Select appropriate remedial management for degraded indicators. In the CTEEM system, evaluation graphs summarize which indicators (and hence, which ecosystem functions) lie outside their assigned sustainable limits and are contributing towards the degradation of the ecosystem. The obvious next step is to computerize links from these indicators to a remediation databank or website where appropriate management steps for improving the environment can be suggested. That step is currently in development.

• Monitor indicators over time. Long-term monitoring of essential indicators will illustrate how environmental quality responds to natural disruptive events or management programs.

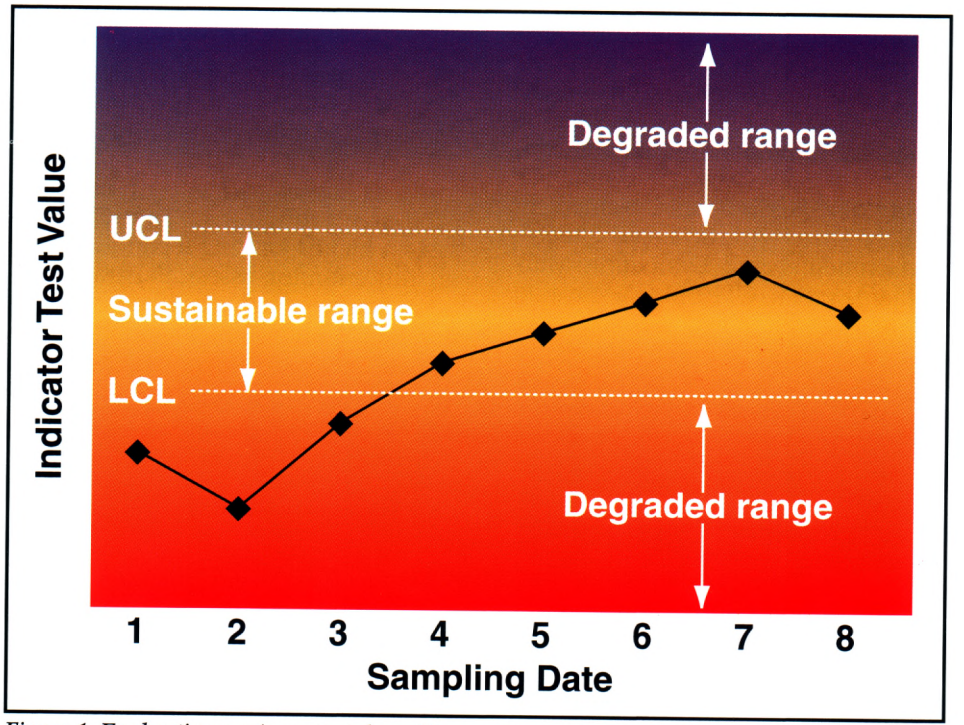

Figure 1. Evaluating environmental quality requires measuring indicators of critical ecological functions over time. These values are modeled onto control charts where test values are plotted on a time line. Superimposed on the control chart are upper (UCL) and lower (LCL) control limits based on known or desired tolerances of degradation. Values between the UCL and LCL would then represent a sustainable condition. Indicators that fall outside the sustainable range would signal a need for targeted remediation. Each indicator used for assessing an ecosystem would be modeled onto a control chart.

Figure 2. An environmental quality evaluation spider radar graph illustrates how well multiple indices conform to the limits of that indicator's sustainable range (as identified with control charts like those in Figures 2, 3, and 5). Indices (purple dots) that lie within their target range (zone between the red lines) show ecosystem indicators operating in a sustainable mode. Indices lying outside their target range, either too high or too low, represent degradation. Only soil porosity and total nitrogen concentration in water represent actual data from this site; the other indices shown in this example do not represent actual data and are for illustrative purposes only. A high-quality ecosystem would show a nearly perfect radar circle (colored area outlined by purple dots) within the sustainable range. Degraded functions lie outside the sustainable range and skew the radar circle. Outer arcs group indicators into management areas (soil, water, fauna, and flora quality).

These seven steps in the CTEEM system present a conceptual scheme for implementing an environmental quality evaluation and management program. It is currently being applied to a grassland ecosystem where portions have been converted into a golf course, but the principles are applicable to a host of ecosystems on practically any scale. Any phase that harbors some shortages of information, procedures, and/or recommendations exposes future research needs. Currently, all techologies necessary for implementing this program are available from a variety of sources. Maximum utility of the CTEEM system will come with future development of computer capability to mesh input and output information. We believe the process has extended application and can have a significant impact on global environmental evaluation, management, and upgrading.

Application of the CTEEM System to a Golf Course

The golf course industry seeks to be environmentally responsible. The burden of meeting this responsibility often falls on golf course superintendents, individuals highly skilled in turf management but not typically trained as ecological scientists. Superintendents already evaluate agronomic indicators on a regular schedule, so adapting to an environmental monitor

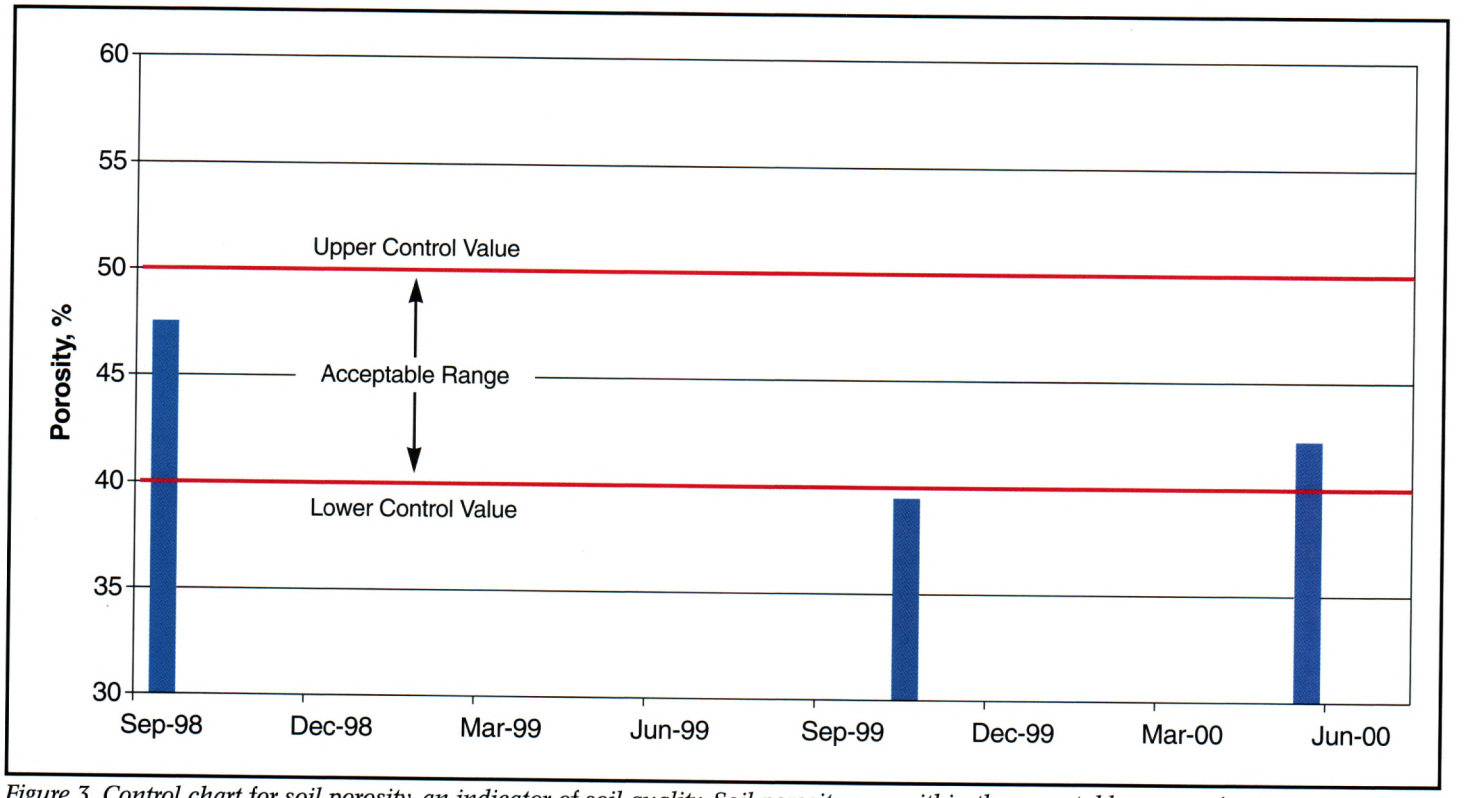

Figure 3. Control chart for soil porosity, an indicator of soil quality. Soil porosity was within the acceptable range prior to construction (Sep-98), but fell below acceptability during construction (Oct-99), causing some sod establishment problems. After one winter of freezing-thawing and wetting-drying, porosity returned to the acceptable range (May-00).

ing program should involve familiar practices. Some may, however, be served by technical education and/or consultation in selecting appropriate evaluation criteria, methods, and target control levels; meeting local compliance requirements; database development; and matching remediation options to environmental indicators. Both the GCSAA and USGA have educational and published resources that can meet that demand. The CTEEM system provides the framework these managers need to make environmental stewardship monitoring just as routine as their current agronomic monitoring. It describes environmental evaluation as a series of steps that are easily customized to individual courses. By adopting an environmental evaluation program, superintendents can identify problem areas, be guided toward remediation, and demonstrate progress toward sustainability.

To illustrate how the CTEEM system is being applied to Colbert Hills Golf Course, we have included examples from the soil quality, water quality, and avian ecosystems work in progress.

Soil Quality Example

Movement of air and water into and throughout the soil body easily qualifies as one indicator of critical soil functions like plant growth, optimum microbial activity, and water cycling, to name a few. Soil porosity, or the non-solid volumetric percentage, is one measure of this redistributive process. Porosity can be calculated from soil bulk density, or volumetric mass, which is an easily measured property.

Bulk density, g cm^{-3} = oven-dry mass, g / sample volume, cm^3

Porosity, % = [1 - (bulk density / particle density*)] × 100

*Particle density for most mineral soils is assumed to be a constant 2.65 g cm^{-3}

The USGA[12] recommends that sand-based golf green rootzones have a porosity between 35 and 55 percent. Finer-textured fairway soils typically have a narrower porosity range in which plant growth is optimized, making a range of 40 to 50 percent porosity our target LCL and UCL for fairway and rough regions. These latter limits correspond to values of 1.59 g cm^{-3} and 1.33 g cm^{-3}, respectively, on the control chart for bulk density (Figure 3). Data show that bulk density was within the sustainable range prior to construction but rose into the degraded range during construction (note that a rise in bulk density causes a fall in porosity). At this stage, this indicator would skew the soil quality segment of the spider radar graph (Figure 2) and alert the superintendent to apply some management strategy, perhaps selecting core aeration based on experience, or accessing an available database or linked website for additional options. Further monitoring would determine the effectiveness of the applied management.

Water Quality Example

Several physical and chemical indicators relate surface-water quality to stream life, biological diversity, and suitability for conversion to human consumption. One indicator monitored in this study was the total nitrogen concentration. Nitrogen occurs in various forms in soil, plant residue, and wildlife excrement. It is commonly applied to turfgrass to stimulate growth. Federal regulations are in the planning stage to establish nutrient criteria in streams that would minimize the adverse effects

on humans, livestock, and aquatic life.[13] At this point, we have adopted our lowest detection level (shown as zero on graphs) as the LCL and set the total nitrogen UCL at 3 mg/L for this water quality indicator.[13,14]

Between April and June 1999, surface water leaving Colbert Hills Golf Course exceeded the UCL 6 times (Figure 4). The surface water entering the Colbert Hills site did not exceed the UCL (Figure 4). An increasing index, or one that exceeds the UCL, alerts the superintendent to evaluate management activities that might be a contributory cause. Suggestions linked to excessive nitrogen levels may include fertilizer rate adjustment, change in fertilizer form, timing of application, widening of buffer zones around surface water bodies, etc. Course construction was occurring between April and June 1999, so much of the time the soil surface was bare in preparation for sodding. It is likely that the excessive nitrogen observed in the stream was a product of high erosion rates associated with the unprotected soil surface.[15]

Viewed with other indicators on the composite spider radar graph (Figure 2), total nitrogen in the surface water for this date skews the radar images (i.e., lies outside of the sustainable range) and would need remedial management. Spider radar graphs can also show a time sequence of data for a single indicator (Figure 5). In this case, some total nitrogen levels in stream water fall outside of the control zone and produce some skewing of the radar image over the times indicated. This condition would signal an indicator in need of remedial management, and the cause may be linked to other dated episodes.

Avian and Mammal Ecosystems

The quality of wildlife habitat is being assessed with Habitat Suitability Index (HSI) models.[16] Developed by the U.S. Fish and Wildlife Service and applied to hundreds of species, HSI models quantify relationships between key environmental variables and habitat suitability for a target species. HSI models assign values ranging from zero (totally unsuitable) to 1.0 (provides all needs of the species).

To develop the most meaningful assessment without indexing all species in this complex avian and mammalian ecosystem, the study site was first stratified into vegetative communities. Then, key Great Plains Region species were selected as indicators of each type of site. Suitability of the area for birds will be judged using the meadow lark or field sparrow HSI model in areas that are primarily grassland, the downy woodpecker or black-capped chickadee model for wooded regions, and a brown thrasher or northern bobwhite quail model for shrub-dominated areas. Mammalian habitat assessment will use the HSI model for the eastern cottontail in grasslands, the fox squirrel in wooded areas, and the bobcat in shrub-dominated sites.

Selecting HSI models most appropriate for the geographical region and vegetative composition of the ecosystem being studied will provide the most meaningful assessments. A mix of HSI models can customize assessment to any local interest. For example, if wetland sites were included, HSI models for the mink or muskrat could be used for mammals and the bullfrog or newt models for amphibians.

Generally, an HSI value less than 0.8 reflects environmental conditions (food sources, nesting sites, brood habitat, escape cover, etc.) that will not sustain wildlife populations. Therefore, HSI values of 0.8 and 1.0 constitute the lower and upper control values for this study.

Conclusions

Managing the environmental quality of an ecosystem requires consideration of a spectrum of environmental indicators. An evaluation program using a customized set of indicators applied to control charts can establish whether environmental processes are operating within an acceptable range. Presenting several indicators on normalized spider radar graphs allows for a simplified, composite visualization of environmental quality. Appropriate linking of these evaluation charts to remedial management databases can assist golf course superintendents and managers of other lands of any scale, toward establishing and maintaining a sustainable ecosystem. These studies on a newly constructed golf course are guiding researchers in the development of an environmental evaluation tool with application to a wide range of ecosystems.

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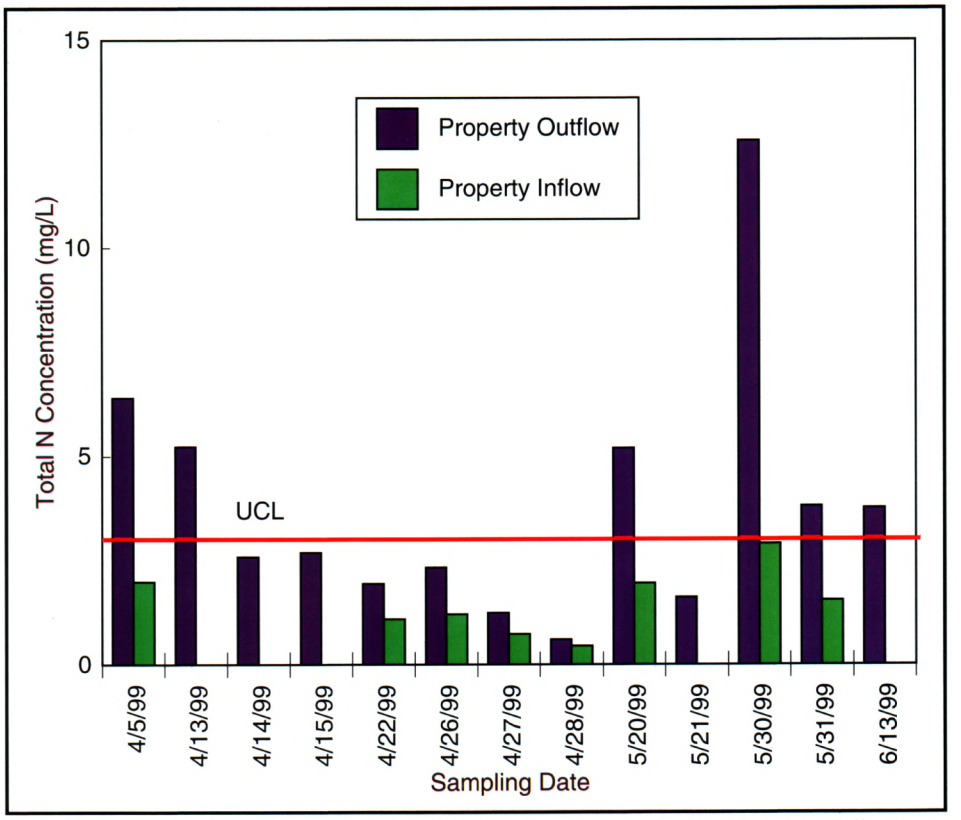

Figure 4. A graph of the nitrogen concentration of water entering and leaving Colbert Hills Golf Course. Water entering the property never exceeded the upper control value, but water leaving the property did exceed the UCL six times, which alerted the superintendent to evaluate management activities that might cause the problem.

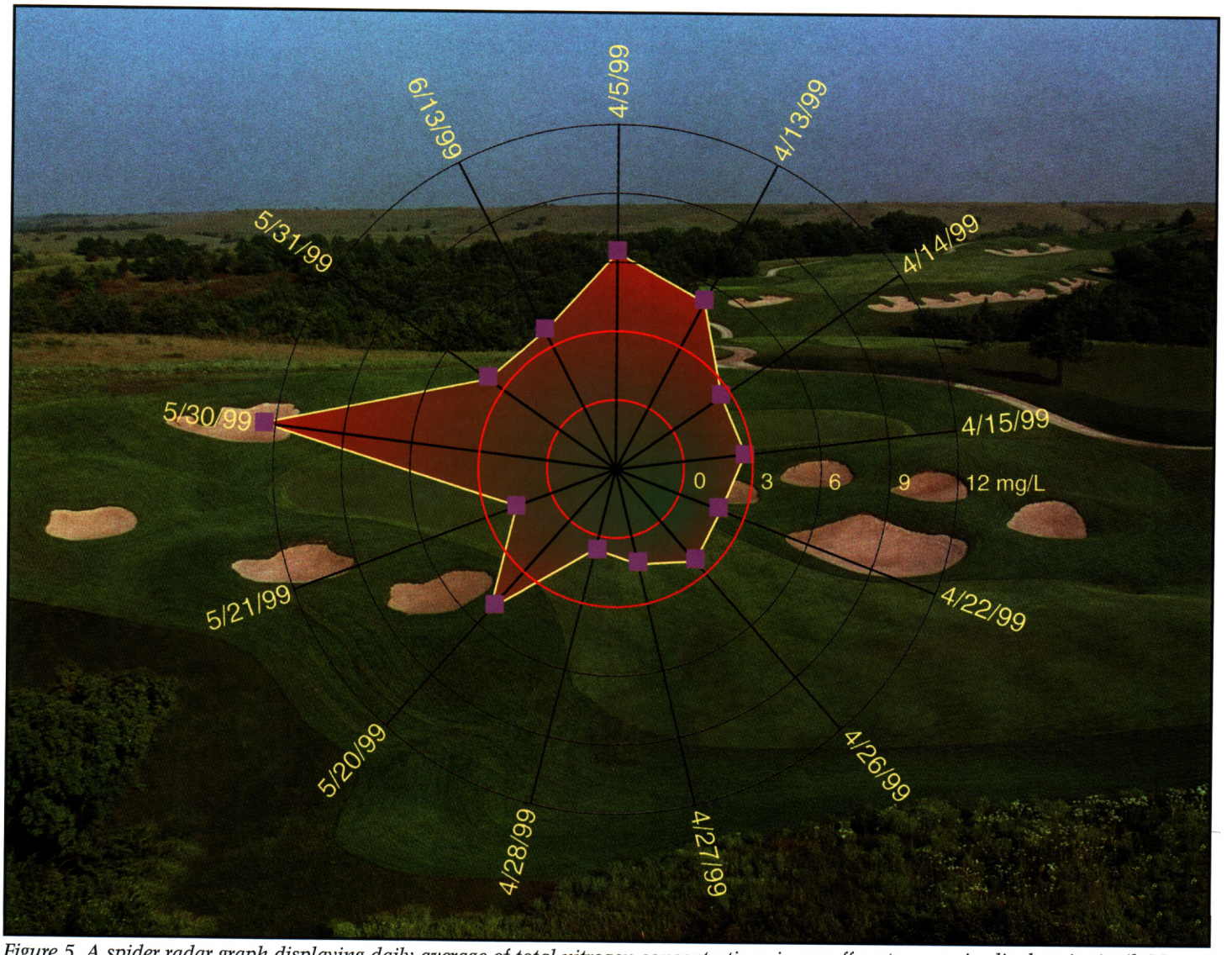

Figure 5. A spider radar graph displaying daily average of total nitrogen concentrations in runoff water on episodic days in April, May, and June, 1999, where Little Kitten Creek exits Colbert Hills Golf Course. The upper control limit (larger red circle) is set at 3 mg L^{-1} and the lower control limit (smaller red circle) is set at 0 mg L^{-1}.

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Edging Away From Manicured Maintenance

A gradual shift to a more natural look benefits wildlife and pleases golfers.

by JEAN MACKAY and PAUL DOTTI

EDGEWOOD Country Club is a private, 27-hole golf course set on 185 acres in Rivervale, New Jersey. Within close proximity to dense residential and commercial development, the golf course serves as one of the larger remaining open spaces in the area.

A predominant natural feature of the property is its many large oak and beech trees, complemented by a diversity of trees and shrubs associated with the Appalachian oak forest ecological region. Twenty-six acres of woods, 25 acres of meadow, and several wetland areas which total three acres comprise the golf course's primary habitats.

Once highly manicured in the same fashion as many "typical" country clubs, Edgewood began to alter many of its maintenance practices as a result of participation in the ACSP, begun in 1996. One of the most dramatic changes can be seen in many of the formerly mown golf course roughs – which now boast a striking array of wildflowers and native grasses. Indeed, the golf course naturalized nearly 30 acres of formerly mown turf, improving both the aesthetics and wildlife habitat throughout the course.

"With rapidly diminishing open space due to increasing land development all around us, it is our duty as superintendents and stewards of the land to preserve wildlife," reflected Paul Dotti, Edgewood Country Club's superintendent. "Our wildlife has greatly increased now that we have created new habitats and preserved the original ones."

Maintenance staff and golfers alike note increased hawk and fox activity, more goldfinches and butterflies in the wildflowers, and a growing number of bluebirds nesting in bird boxes placed in the natural areas. Dotti also reported a decrease in Canada goose activity – mainly due to Edgewood's dogs – but with nighttime assistance from their now resident foxes.

Gaining Member Support

"At first, it was kind of a tough sell," explained Dotti. "Our members are conservative and liked a more maintained appearance. So I tried naturalizing one spot at a time, adding more here and there as support grew. We have a very tight layout, so I have to pick and choose areas carefully."

Dotti used a monthly newsletter column and various committee meetings to communicate about the project and respond to questions and concerns. As the natural areas bloomed, so have compliments from guests, neighboring superintendents, and members themselves.

But for Dotti and his crew, the increased wildlife activity and greater diversity on the golf course are equally satisfying. "That's my favorite part of it," reported Dotti. "Seeing the foxes, hawks, and bluebirds, and knowing that we're doing the right thing for golf and the environment is really great."

JEAN MACKAY *is the Manager of Educational Services at Audubon International. She edits* Stewardship News, *the organization's bimonthly publication, and teaches environmental management to golf course superintendents.* PAUL DOTTI, *superintendent at Edgewood Country Club, coordinates the course's participation in the Audubon Cooperative Sanctuary Program, including certification in 2000. Dotti can be contacted with questions at: 201-666-1204, ext. 234, or edgepaul@hotmail.com.*

Setting Goals

Before naturalizing, Edgewood staff set goals and communicated with club committees and members to increase support for the project.

Edgewood's Goals:

- Return the golf course to a more natural look.
- Create wildlife corridors and protected habitat areas.
- Increase bird nesting sites.
- Reduce pesticide and water use.
- Reduce labor and fuel use.

On The Cutting Edge

Results of Edgewood's Naturalization Project

- **Improved habitat** by naturalizing 30 acres of formerly maintained turf.
- **Increased native and naturalized plantings** by planting bunkers and tee banks with more than 8,000 plants, including little bluestem and weeping love grass, grown in Edgewood's greenhouse.
- **Increased bird populations** by adding 30 bird boxes. Edgewood saw no bluebird activity in 1996, the first year the boxes were placed on the course. By 2000, bluebirds occupied 20 of the boxes, tree swallows occupied five, and wrens nested in three.
- **Increased wildlife activity**; noted increases in species, including foxes, hawks, butterflies, and songbirds.
- **Improved aesthetics** and added diversity and interest to the golf course.
- **Reduced maintenance time**; reduced rough mowing by nearly 16 hours per week.
- **Eliminated chemical use** to control pests in formerly maintained turf areas.
- **Saved water**. The use of approximately 250,000 gallons of water a year was eliminated due to naturalization. Installation of quick-coupler valves and additional part-circle heads also enables staff to more precisely irrigate turfgrass areas.
- **Financial savings**. Edgewood saves about $10,000 annually on pesticides, fuel, labor, and equipment wear and tear from the initial investment of $4,500 for labor, seed, and mulch.

IT MAKES ME CRY!

Golfers have no love affair with weeping lovegrass that is not in "out-of-play areas."

by PATRICK M. O'BRIEN

Weeping lovegrass makes recovery shots nearly impossible.

WEEPING lovegrass (*Eragrostis curvula*), an introduction from East Africa, seems to have found a home at many American golf courses. Over the past 30 years, courses have established lovegrass in the rough or around bunkers for erosion control or ornamental appeal. Lovegrass is also fashionable because it provides a flavor of the British links and seaside appearance. Unfortunately, it has inflicted pain on many golfers who have had the misfortune of hitting into these unplayable and overgrown lovegrass areas, where recovery shots are impossible or severely limited.

Why has weeping lovegrass been so popular when golfers hate it so much? No doubt its fast establishment rate, low cost, drought tolerance, and ability to grow on low-fertility and high-sand soils subject to erosion are valued. It can reach a height of two to four feet in a few months after planting from seed. Weeping lovegrass forms an extensive root system that can stabilize practically any soil. Lovegrass also provides an outstanding visual impact and makes a big statement to golfers wherever it is planted. Superintendents like lovegrass since it is environmentally friendly, requiring minimal mowing, pesticides, and fertilizer.

From the golfer point of view, it is the top of the plant that causes all the problems. Weeping lovegrass is agronomically unique in that it has solid stems without joints. Grasses typically have hollow stems with joints that are easy to mow and play from. Twenty to 50 stems can form at the base of the plant, making it difficult to find the ball and impossible to advance the ball any great distance. If you want to "Tiger-proof" a golf course, weeping lovegrass is the grass to plant in the rough. No miracle recoveries will ever happen at these sites!

William C. Campbell, renowned amateur golfer who played in the U.S. Amateur over six decades from the 1930s through the 1980s, had an incident with lovegrass that would make anyone weep. In the 1980 U.S. Amateur at Pinehurst #2, Mr. Campbell needed only a double bogey on the last hole during the second round of qualifying to advance into match play. Pinehurst #2 is Mr. Campbell's favorite course, and he had played more than 100 competitive rounds at this site over the years. On the 18th hole, he pushed his tee shot right and he got tangled up in the weeping lovegrass. Both the golf ball and club head were impeded by the solid stems of the weeping lovegrass, and he was only able to advance the ball about 20 yards, but right into another lovegrass plant. He faced another impossible shot, and after several attempts he finally got the ball on the putting green, where he holed a long putt for an 8 that allowed him to "avoid a 9," says Mr. Campbell. If he had avoided the weeping lovegrass, he would have easily made it into match play during his 37th Amateur appearance. Pinehurst #2 has since taken out all the weeping lovegrass.

Weeping lovegrass presents too many perils to the golfer to plant it in in-play areas. The golfer is either very lucky to have a shot or not lucky if impeded. Too much chance is involved and the risk is too great, especially if the golfer has not hit that bad of a shot off-line.

There are other alternatives for American golf courses that want to establish native or tall grass areas near "in-play" areas. Broomsedge, a native grass, is an option but establishes more slowly. The good news is that broomsedge has hollow stems and joints, so the golfer has a chance for recovery. Broomsedge can be seeded or plugged into existing weeping lovegrass areas, and over time it will take over these areas and create a desirable landscape without the golfer complaints. Some types of fine fescues work well in cooler climates.

Weeping lovegrass is a fetish at American courses, and it should be removed if it is near play at bunkers, mounds, putting greens, or rough that is close to the fairways. Lovegrass is highly resistant to herbicides, but several sprays with Roundup should eliminate it.

Too many courses are proud of this ornamental grass and won't cut it, and this is a mistake. Weeping lovegrass can enhance a golf course if planted in the right areas, but if planted in the wrong areas, it can make it virtually unplayable. Lovegrass is not a prerequisite to having a traditional golf course. What to do with all those lovegrass plants now on American courses? Weave baskets!

PATRICK M. O'BRIEN *is the Director of the Southeast Region of the USGA Green Section. He visits and plays golf courses in the Carolinas and Georgia, where weeping lovegrass has been known to bring him to tears.*

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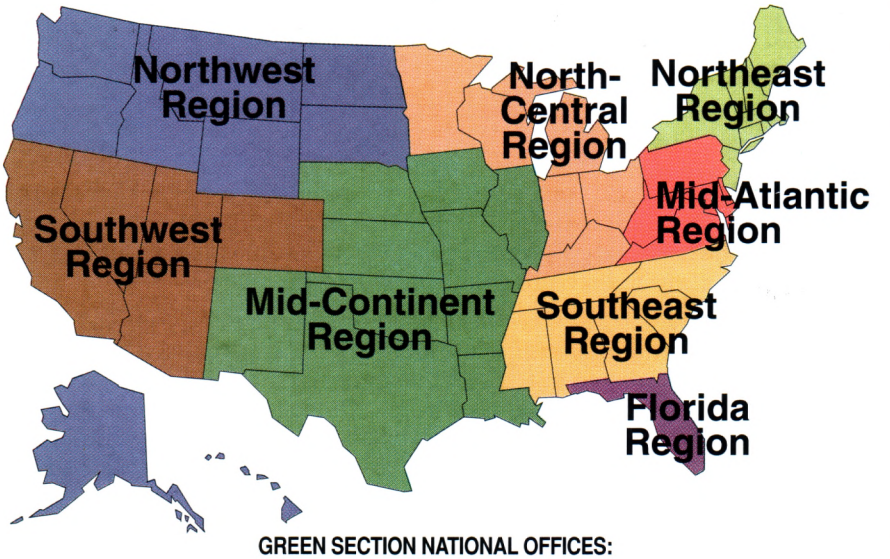

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TURF TWISTERS

QUALITY PUTTING

Question: Our golf course superintendent does an excellent job of providing quality putting surfaces that require a well-struck shot to hold. The problem is that when the shot hits in front of the green it seldom releases onto the putting surfaces. This is especially troublesome on a windy day when a bump-and-run shot is required. Any suggestions to reduce this problem? (Oregon)

Answer: Believe it or not, this is one of the most consistent problems viewed at golf courses from low to high budgets. The answers are many; however, it is a simple problem to solve. In a nutshell, treat the 10- to 15-yard area in front of the greens as a green! Do the following and your problem will go away:

- Water carefully and use wetting agents, if necessary.
- Aerify with large tines two or three times per year and backfill the holes with a good-quality sand.
- Lightly topdress every two or three weeks, just like the greens.
- Fertilize carefully to avoid excess organic near the surface.
- Make sure the subsurface drainage is working properly.

REQUIRES SKILL AND

Question: We are finding that as turf maintenance equipment becomes more complex, and often as expensive as luxury automobiles, there is a need to employ more skilled individuals as repair technicians. Our problem is, where do we find and how do we retain these qualified people? (California)

Answer: Unfortunately, there are only a few specialized programs scattered about the country that train turf equipment technicians. These individuals are in such demand that often they have positions waiting for them upon graduation. A next-best solution may be to contact a local trade school and hire people trained in automotive, truck, or heavy equipment repair and then send them to a local equipment distributor to learn about reel maintenance. Once good technicians are found, providing them with a well-equipped, modern workshop, compensating them fairly, and treating them with respect should help to retain them.

TOOLS

Question: It seems that I have been hearing more about GPS mapping and GIS software lately. Exactly how can the new satellite and computer technology aid our maintenance program? (New York)

Answer: The GPS and aerial imagery are both powerful tools for mapping work on golf courses. The Global Positioning System (GPS) uses a network of satellites for mapping purposes. The Geographical Information System (GIS) is software that can combine the mapping data (derived from imaging or GPS) with a database, allowing the user to access and link information either through the maps or database. The maps or images produced from imaging or GPS technology are invaluable as communication, measurement, and inventory tools, and as "as built" maps for drainage, irrigation, communication, and electrical lines. GIS technology is already incorporated to some degree in many irrigation software packages and will probably become instrumental in future pesticide and fertilizer management programs.