ORGANIC TURFGRASS MANAGEMENT FOR GOLF COURSES: AN OVERVIEW

The Golf & the Environment Initiative
Center for Resource Management
1861 Beaumont Circle
Salt Lake City UT 84121
801-466-3600
pparker@crm.org
January 2010

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1. PREFACE

There is an ongoing discussion concerning the feasibility of organic golf course maintenance. Organic foods and organic farming are among the fastest growing segments of the agricultural industry. If farms can be organic why not golf courses? A few golf courses around the country are calling themselves organic and several communities in the U.S. and Canada are demanding pesticide free or organic golf courses in their jurisdictions. Golfers themselves don't seem to be demanding organic golf courses although some golf courses are taking an organic approach to gain some marketing advantage.

The discussion over organic management practices quickly bumps into some key questions such as: What is the definition or standard for determining if a golf course is organic or not? And given the player expectations of quality playing conditions and aesthetics, is a truly organic golf course possible in today's competitive golf market? Discolored patches on a putting green may not diminish actual playing conditions, but this flawed aesthetic appearance may drive golfers toward golf courses that look like the ones they see on television where the professionals play .

And what about cost? In the supermarket, people buying organic products pay a premium because they believe organically produced foods are safer and/or taste better. Will golfers pay more to play an organic golf course even if the perceived quality is less than a golf course maintained using synthetic fertilizers and pesticides?

The underlying assumption pushing organic golf forward is that it's better for the environment. Is that really the case? Organic fertilizers produced from animal wastes or sewage treatment facilities can, if improperly applied, pollute streams and lakes with equal or possibly greater impact than synthetic fertilizers. Not using synthetic pesticides certainly eliminates the perceived risks of these products. But is the overall environmental performance superior to well-managed golf courses using IPM and rigorous pollution prevention practices?

Another aspect of organic management is the assumption that it protects or enhances soil health. To our knowledge no comparisons of the impact of organic versus conventional management with use of synthetic fertilizers and pesticides on sod health have been conducted on golf course turfgrass.

These and many other questions emerge in the on-going give-and-take discussion over organic golf. For our part we are not attempting to provide answers to all these questions, but rather to shed light on what is happening in the field and set

forth recommendations for usable definitions and future actions that can provide a path forward. Above all, we approached the task with the belief that there is a need for clarity and consensus to the definition or standard that should apply to organic golf courses.

The term organic is used throughout the report in different contexts. The term "organic golf", generally, refers to the interest in organic turfgrass management for golf courses. Organic golf courses or "organic golf course management" refers to the label or definition applied to golf courses using organic practices and products as a total management regime. Later in the report, we set forth a definition for organic golf course management that we recommend as the standard by which golf courses should be considered organic golf courses.

Paul Parker
Executive Vice President
Center for Resource Management

2. EXECUTIVE SUMMARY

In recent years, various interest groups and, in a few cases, state and local governments have pursued the goal of defining (mandating) organic golf course management. Unfortunately, there is a lack of information about organic management methods for golf courses and a lack of uniform or consistent definitions or standards for determining what constitutes an organic golf course. In response to this need for information and uniform national definitions, the Center for Resource Management (CRM) under the auspices of the Golf & Environment Initiative (G&E) held a workshop on organic golf in 2004 and organized a multi-stakeholder committee to prepare the following overview report. The purpose of the report is to provide information, guidance, and national definitions concerning organic golf course management to the golf industry and its various stakeholders.

Highlights

- Golf courses thought to be organic are rare. Of the approximately 20,000 golf courses in the U.S. and Canada, 23 have been reported to be organic. These golf courses are listed in Appendix II.
- Of the reported organic golf courses that supplied data for this report, most appeared to use limited amounts of some synthetic chemical product such as fertilizer, pesticide, or wetting agent.
- Criteria for purchasing decisions of organic products vary widely including advice of industry representatives, supplier claims, label ingredients, and products with EPA registration.
- This report proposes specific definitions for organic golf course management as well as product definitions previously undefined in this particular golf course management context.

- Golf courses are located in a diversity of settings that vary widely in climate, topography, soils, and drainage and what is effective at one golf course may not translate to all golf courses.
- There are risks associated with organic management as with all management systems.
- Major barriers for wide spread adoption of organic golf course management include golfer expectations for visual perfection of turfgrass and the lack of proven organic pest control products that can adequately and consistently control turfgrass disease, insect, and weeds pests.
- Golf courses using organic turfgrass management methods have developed unique approaches to pest control and report that labor costs are about the same as similar golf courses in their area. This is based on an extremely limited sample size from golf courses in regions that face relatively few pests and have nearly ideal growing conditions.
- Selection of disease resistant turfgrass species is probably the single most important management opportunity for a successful golf course operation.
- Although the number of organic golf courses will probably remain a small percentage of the total number of golf courses in the U.S., the experience of the early pioneers and the expansion and improvement of organic products will benefit all golf courses and other maintained landscapes interested in reducing use of conventional pesticide and fertilizer products.

Lessons Learned from Golf Courses Reported to be Organic: Survey Results and Case Studies

- The primary motivation for implementing organic golf course management included a local government requirement, protection of water supplies, and the belief that it was the right thing to do.
- The effectiveness of organic golf course management on turfgrass quality, golfer satisfaction, and revenue goals varied widely but was generally satisfactory as reported by golf course superintendents.
- Visual perfection is not realistic but excellent playability is attainable.
- For other golf courses interested in transitioning to an organic management regime, current superintendents recommend a go-slow approach beginning with fairways and roughs, use disease resistant and drought tolerant turfgrass species; limit turfgrass stress and ensure good drainage, full sun and good air circulation, lean on other superintendents for advice, and communicate regularly with your golfers.

United States Golf Association (USGA) Supported Research of Organic Practices and Products

- Since 1990, USGA has supported over $9 million of university research on organic products and practices.

- Studies have been conducted in many areas including phermones, light traps, allelopathy, endophytes, mycorrhizae, beneficial bacteria, fungi, nematodes, predator bees, flies, and wasps.
- The results have been disappointing because in most cases pest management controls were at a level unacceptable to most golfers.
- Based on the experience of organic agriculture, effective bio-control agents are often limited in range by climate, environment, competition, etc. and many good bio-control agents have been compromised or eliminated with the use of certain pesticides.
- Some challenges of bio-control as a means of effectively managing disease, weeds, and insects include: the product or technology must produce desired results at a reasonable cost for the end user; significant cost for field testing, marketing and production; sufficient market potential for adequate return on investment; must be consistent, safe, user friendly and have acceptable shelf life.
- Development of host plant resistance to disease, insects, and nematodes via turfgrass breeding and bio-technology is one of the most effective, long-term means of suppressing pest populations.

Proposed Definitions

The proposed definition of organic golf course management is as follows: *"Organic golf course management has the goal of using techniques that are both effective and decrease the risk to human health and the environment, while also providing acceptable and marketable playing conditions. Organic golf course management promotes healthy turfgrass through proper plant selection and care, regular monitoring, correct pest identification, record keeping and evaluation, and by only using natural organic fertilizers, natural organic pesticides, and synthetic natural organic pesticides. Organic golf course management relies on products that consist of naturally occurring organic compounds that are derived from plant materials, biological organisms, or mined from natural deposits such as products defined below as natural organic fertilizer, natural organic pesticides, and synthesized natural organic pesticides." Golf c*ourses that meet this definition of organic golf course management should be considered organic golf courses.

The report includes specific definitions for natural organic fertilizer, natural organic pesticide, and synthesized natural organic pesticide as referenced in the above definition for organic golf course management.

Conclusions

- Wide spread adoption of organic golf course management will depend upon government direction, golfer acceptance or demand, and advances in organic products and practices and economic feasibility of organic management.

- Each golf course is unique and its management system should reflect the desires and resources of players, owners, and managers.
- Golf courses reported to be organic operate with different motivations and can vary widely in turfgrass quality and golfer satisfaction. Although these golf courses do not necessarily meet the proposed definition of organic golf course management or share a common standard of what constitutes an organic golf course, their willingness to explore has paved the way for other golf courses to consider organic management practices.
- A substantial amount of research has been conducted through USGA support of organic products and practices, but, generally, has not met the level of pest control acceptable to most golfers.
- Use of a consistent, uniform standard and definition of organic golf course management is needed to reduce confusion, maintain credibility of organic labels as they are applied to golf, and strengthen the efforts of golf courses striving to eliminate chemical inputs and market themselves as organic.
- The report recommends the adoption of the proposed definitions.
- Although organic golf course management will be a challenge to implement and only a small percentage of golf courses will qualify for the organic label, the increased awareness and improved products will benefit all golf courses.

3. INTRODUCTION

G&E began in 1995 in a two-day conference at the Pebble Beach Resort. The CRM organized the event as a way to get the golf industry and environmental community talking about environmental issues surrounding golf and collaborating on improved policies and practices. Through the subsequent years golf and environmental leaders have worked together on demonstration projects, national conferences, and joint policy and educational materials. (See Appendix V)

As a part of G&E in 2004, CRM organized a workshop on organic golf course management at the Vineyard Golf Club on Martha's Vineyard in Massachusetts. Participants in the workshop toured the golf course that was managed using organic practices and products. The workshop included discussions about the feasibility of organic golf course management in different regions of the country and what standards should define the characteristics, practices, and protocols of an organic golf course. The workshop concluded with a consensus that more information and work were needed.

As a result of the workshop, CRM established the Organic Golf Project with representatives from golf organizations, environmental advocacy groups, regulators and organic agriculture organizations. Among the goals established for the overall project were to develop a consensus-based definition of "organic golf course management" including definitions of organic fertilizers and organic pesticides and to summarize the current state of organic golf course management practices.

In 2006, CRM and the Golf Course Superintendents Association of America (GCSAA), with input and guidance from a working committee, conducted a survey of golf courses that were reported to be pesticide-free or organic to learn more about what they were doing and the products and practices they were using.

With this information in hand, the organic golf working committee set out to prepare this report as an overview of organic golf course management as it is occurring and as it is practiced around the country. Our objectives in this project are to provide information and guidance concerning organic golf course management to the golf industry and its stakeholders. In addition to describing the results of the survey, we have included our recommendations for a set of definitions and future actions that can hopefully provide clarity and consistency in the use of organic terms. We limited the scope of our study to the golf course turfgrass only and did not consider other aspects of the golf course operation and maintenance areas such as forested areas, water bodies, ponds, clubhouse, or maintenance facilities.

This paper is the result of the work and collaboration of individuals from the golf industry and the environmental and organic communities. Members of the organic golf working committee are listed in the appendices. We thank the members of the committee for their hard work and the organizations that helped sponsor the project. Sponsoring organizations are also listed in the appendices.

4. RESULTS OF A SURVEY OF GOLF COURSES REPORTEDLY USING ORGANIC MANAGEMENT PRACTICES

As a part of the organic golf project, it was determined that a survey of golf courses reportedly using organic turfgrass management practices would be useful to help meet the goals for the project. The focus of the survey was turfgrass management practices. No attempt was made to determine the management practices used on other vegetation or on pest management in the clubhouse or other structures. The specific goals for the survey were:

- Determine the products and practices used to maintain turfgrass on golf courses reported to be synthetic pesticide free and/or organic golf courses.
- Determine the definitions or criteria superintendents are using to guide their decision of which products qualify as organic fertilizers and organic pesticides.
- Determine the motivations for using organic fertilizers and organic pesticides.
- Get a general sense of the overall effectiveness of synthetic pesticide free and organic golf courses from a turfgrass quality, golfer satisfaction and economic perspective.

A survey was conducted in the fall of 2006 to collect the desired information. Golf course superintendents were asked to complete the survey based on their 2005 practices and inputs. The survey was sent to 27 golf facilities that were thought to be using organic management practices on the golf course. A mailing list of golf

courses known or thought to use organic practices was obtained from Audubon International (Joellen Lampman), Environmental & Turf Services (Stuart Cohen), and USGA Green Section agronomists (Jim Snow).

Of the 27 golf facilities that were sent the survey, several facilities declined to participate stating they used organic management practices supplemented with synthetic fertilizers and/or pesticides. Six responses were received and the data from those surveys are presented in the following tables. Respondent C provided information on behalf of three separate golf facilities.

No attempt was made to verify the responses provided or determine if these golf courses used organic management practices or if they met the definition of organic golf course management proposed in this document. Two of the respondents did use synthetic pesticides.

Key takeaways from the survey:

- There is no uniform, consistent definition of organic golf course management being used by the respondents to this survey.
- There is no uniform, consistent definition of organic fertilizer or organic pesticide being used by the respondents to this survey.
- The primary motivations for implementing organic golf course management were: the right thing to do; requirement of a local governing body or of the permit process; and the perception of protecting water supplies.
- There are concerns regarding the effectiveness of organic pesticides available in the marketplace.
- The effectiveness of organic golf course management on turfgrass quality, golfer satisfaction, and revenue goals varied widely by facility but most expressed at least satisfactory results in all three categories.

The results of the survey are summarized in Tables 1 – 7. Responses to some questions that aren't suited for a table format are given below. (The labels A-F refer to individual golf course responses. The golf courses are listed by climate/region in Table 1).

What recommendations do you have for other superintendents/golf courses considering a synthetic pesticide free or organic approach to golf course management?

A. Manage your turfgrass well, water deep and infrequent; take soil temperatures and soil samples weekly to maintain deep roots and healthy turfgrass.
B. Take the necessary steps to start conversion. Research alternatives and start implementing them.
C. Choose the best adapted grasses. Have reasonable expectations. Make sure you have good growing conditions –sun/air/drainage. Optimal irrigation. Good construction methods. Plenty of labor.
D. Spray preventatively with the least toxic options especially from Memorial Day through Labor Day. Once the disease flares up recovery is longer.

E. Go slow. Be prepared to replace existing grasses (esp. *Poa*). Communicate. Start with fairways (small areas that are not wet) roughs etc. Consider insect treatments every other or third year instead of annually.
F. If you are a low budget golf course don't be afraid to lean on other superintendents for research information. Research and try out what works best for your own golf course.

What specific resources, training, research, public outreach or education of public officials would be of most assistance to you and your golf course?

A. Your own knowledge is best. You know the golf course best and what you need to do.
B. No response.
C. Certifiable organic management program.
D. Well, if golfers would accept less perfect conditions reducing pesticides would be easy. Public officials need to realize that many "organic" products do not have a lot of research behind them. So while the industry is trying to go "green" it will not happen in a year or two.
E. Resources USGA, GCSAA, university programs (like Cornell) that have specific organic programs. Get a list of other organic golf courses and communicate. Get speakers from industry to address members. Communicate with local advocacy groups.
F. The GCSAA needs to do better promoting our profession to the public, not members.

If you were to give advice on how to design a golf course to facilitate organic management, what would you suggest?

A. Make sure the appropriate grass is chosen; some are more disease resistant than others, and more drought tolerant.
B. Make sure to have adequate water sources. Use excellent material to build your turfgrass on—this is the building blocks for organic structure.
C. Drainage, drainage, drainage. No shade, good air flow, plenty of tee and green space, no water hazards.
D. Drainage, greens with many walk-on/off areas, plenty of sunlight and state of the art irrigation.
E. Cut down all the trees. Put in lots of drainage. Plant fescue. Ban golf carts.
F. No response.

What suggestions do you have for the group working on the CRM Organic Golf Course Project?

A. A pesticide free golf course is a great and challenging way to run a golf course. To see the difference between a typical and pesticide-free golf course really do not differ a lot. It has been a big challenge for me.
B. Get the word going around that organic does not mean expensive and more often than not is cheaper. Just keep doing what you are doing!
C. Affiliate with the organic industry in agriculture rather than try to develop a whole new standard.

D. We need more research (university research) on “organic” products. Many salesmen tout the greatness of their products with testimonial evidence. We also have salesmen, etc. saying these products will control disease, products with no EPA registration. So I see superintendents buying it and then it does not work well and the products like Endorse™/Alude™ which work very well are stigmatized with being organic which some superintendents think does not work. Basically more regulation of these products.
E. Continue the project. Do not abandon the term “organic” or will lose credibility. Get Tiger Woods on board.
F. Don’t forget the little guys (low budgets etc.). Local small group meetings seem most effective – round table discussion instead of formal class.

Table 1. Characteristics of the golf courses.

						Turfgrass species‡			
Golf course	**Golf course Climate/Region**	**Number of holes**	**Number of 18-hole equivalent rounds annually**	**Type of facility**	**Age of course**	**Greens**	**Tees**	**Fairway**	**Rough**
A	Cool, arid Rocky Mountains	18	73,000	Municipal	36	70% CB 30% AB	50% KBG 50% PR	70%PR 30% KBG	100% KBG
B	Cool, humid Pacific Northwest	9	5,000	Daily Fee	13	90% CB 10% AB	80% PR 20% KBG	60% PR 40% FF	50% PR 50% FF
C	Cool, arid Several locations	NR†	NR	NR	NR	NR	NR	NR	NR
D	Cool, humid Mid-Atlantic Coast	90	250,000	Municipal	75	70% AB 30% CB	50% AB 50% PR	70% AB 30% PR	50% AB 25% TF 25% FF
E	Cool, humid New England Coast	18	9,000	Private	5	>99% CB <1% AB	99% CB 1% AB	70% FF 30% ColB	70% FF 30% KBG
F	Cool, arid Sierra Nevada Mnts.	9	30,000	Daily Fee	82	70% AB 30% CB	50% PR 30% KBG 20% AB	40% PR 30% KBG 20% AB 10% CB	50% PR 40% KBG 10% FF

† — No Response

‡ — CB – creeping bentgrass; AB – annual bluegrass; KBG – Kentucky bluegrass; PR – perennial ryegrass; FF – fine fescue; TF – tall fescue; ColB – colonial bentgrass

Table 2. Motivation, awareness, acquiring knowledge and years of using organic maintenance practices on the golf course.

Golf course	Motivation/reasons for using organic maintenance practices	Strategies to make public aware that organic maintenance practices are used	Acquire knowledge regarding organic maintenance practices	Consecutive years using organic maintenance practices
A	Protect aquifer	Posters in the clubhouse; club newsletter	Formal education; books	1
B	Marketing advantage; the right thing to do; protect watershed	Ads in local newspaper; word of mouth; sign along the road	Learned from previous superintendent	10
C	Requirement of permit process; local regulations; marketing advantage; protect water quality	Posters in clubhouse; contact with local environmental advocacy groups	News reports in industry publications; networking with others in industry	NR†
D	The right thing to do	Posters in the clubhouse; club newsletter	Attending conferences and seminars	5 – but not solely organic
E	Requirement of permit process; community pressure	Posters in the clubhouse; club newsletter	Attending conferences and seminars	5
F	Marketing advantage; the right thing to do	Ads in local paper; word of mouth	Books; networking with other superintendents	8
† – No Response				

Table 3. Effectiveness and challenges of organic management practices. (All effectiveness ratings provided by the survey respondents)

Golf course	Effectiveness of organic management on turfgrass quality†	Effectiveness of organic management on golfer satisfaction‡	Effectiveness of organic management on revenue goals	Top challenges faced using organic management
A	9	10	9	Diseases, insects, weed, acceptable green speed
B	8 – but susceptible to drying out	8 – golfers always have positive comments	4 – increasing, but not at set goals	Disease, weeds, application timing and techniques
C	3 to 5	5	NR	Weeds, labor, no consistent definition of organic management, no certification
D	4	4	5	Disease, application techniques and timing
E	Varies seasonally; 10 in mid-June, up and down during summer	On the whole, most members satisfied, a small number critical	9 – added members each year	Insects, weeds, providing excellent playing conditions in mid-August
F	6 to 7	7 to 8	5	Weeds, increased expenditures for organic products, sustained color

† — Rating scale of 1 to 10 with 1 = dead turfgrass; 5 = acceptable turfgrass; and 10 = ideal turfgrass as rated by the golf course superintendent.

‡ — Rating scale of 1 to 10 with 1 = widespread golfer displeasure, dramatic drop in number of rounds; 5 = golfers satisfied with conditions, number of rounds consistent with past play; and 10 = golfers comment on improved playing conditions, number of rounds up substantially as rated by the golf course superintendent.

Table 4. Definitions and criteria used to guide organic golf course management.

	Definitions and criteria used to guide use and purchasing decisions for		
Golf course	**Organic golf management**	**Organic fertilizer**	**Organic pesticide**
A	NR†	Past records and industry representatives	Use no chemicals
B	Using Organic Materials Review Institute products	100% natural and organic guaranteed by supplier	Naturally occurring, but may be harvested or processed
C	Self-defined	NR	Naturally occurring
D	No set definition	NR	Organic pesticides that have EPA registration
E	Defined in permit process; only pesticides with organic active ingredients	Only fertilizer with organic nutrients; limited use of synthetic fertilizers	Active ingredient must be organic
F	No set definition	Brand name ingredients; labels	NR

† — No Response

Table 5. Fertilizers and pesticides used on golf courses purported to use organic management practices.

Golf course	Fertilizers and Analysis	Herbicides	Fungicides	Insecticides
A	Ammonium sulfate 21-0-0 Greens Grade 18-3-18 Fairway Grade 24-0-11	None	Increase nitrogen rate	†
B	Logic Alliance 5-0-5 Logic Alliance 8-2-2 Alasta 5-1-1	Logic Alliance (corn gluten) Logic Alliance (vinegar)	None	Koppert Nematodes (*Steinernemera carpocapsae*)
C	Nature Safe Sustane Milorganite	Salt	Phosphites	†
D	Nature Safe 15-2-8 Sustane 10-2-10	†	Endorse Polyoxin D Alude Spotless	Conserve (Spinosad)
E	Nature Safe 15-2-8 Sustane 8-2-4	Waipuna (hot water sprayed on weeds)	Spotless EcoGuard	Milky spore (*Bacillus popillige*) Experimental entomopathogenic nematodes Conserve (Spinosad)
F	Nature safe Roots 12-2-12	†	Synthetic pesticides used for snow mold control	None

† — No response

Table 6. The most troublesome pest in 2005, practices used to manage the pest and the effectiveness of the management practices.

Golf course	Most troublesome pests	Practices used to manage the pest	Effectiveness of the management practices †
A	Grubs	Remove thatch, deep time, topdress	8
B	Dandelions Silvery thread moss Fusarium patch	Hand removal, aeration, low mowing height Verticutting, low mowing height Verticutting, thatch control, low rates of fall fertilization	5 6 4
C	Anthracnose Weeds Snow Mold	Increase nitrogen rate, increase mowing height Hand removal, healthy turfgrass, salt applications Decrease *Poa annua* population, increase sunlight penetration, good culture practices	Good Fair Fair
D	Dollar Spot Anthracnose Brown patch Summer patch	Hydroject every three weeks, watering in the morning, spike twice a month	3
E	Oriental beetle Clover and crabgrass Dollar spot *Pythium*	Overseed and aerify, shut off irrigation, seed instead of sod, predator (varmint) control Overseed and aerify, hand removal Remove dew, nitrogen applications in mid-summer, mow fairways when dry Tree removal, install drainage, careful water management	‡ ‡ ‡ ‡
F	Snow mold Broadleaf weeds Moss on greens	No nitrogen applied after August, don't mow when grass is dormant Healthy stand of turfgrass Water monitoring	8 9 8

† – The rating scale for effectiveness was 1 = No control at any time, 5 = Significant reduction in the pest population on a consistent basis and 10 = Complete control every
Application as rated by the golf course superintendent.
‡ - No response

Table 7. The top pest problems since implementing synthetic pesticide free or organic products only management strategy and synthetic pesticide use in 2005 and the target pest.

Golf course	Top pest problems since implementing synthetic pesticide free or organic products only management	Synthetic pesticides used in 2005 and the target pest
A	Geese	None
B	†	None
C	Weeds	†
D	Dollar spot, brown patch, annual bluegrass weevil, summer patch, anthracnose	Yes – dollar spot, anthracnose, summer patch
E	Oriental beetle, crabgrass, dollar spot	None
F	Weeds	None – only spot spraying

† — No response

Table 8. Annual maintenance budget, labor costs, change in labor costs and amount spent in 2005 on pesticides, fertilizer and water.

				Amount spent in 2005 on		
Golf course	**Annual maintenance budget – excluding capital budget**	**Labor costs compared to similar golf courses in your area**	**Change in labor costs since implementing synthetic free or organic management**	**Pesticides**	**Fertilizer**	**Water**
A	0 - $250,000	About the same	About the same	0	$15,000 to $30,000	0 to $15,000
B	0- $250,000	About the same	About the same	0 to $25,000	0 to $15,000	0 to $15,000
C	0 - $250,000	About the same	About the same	†	†	†
D	> $750,000	About the same	Increased	> $75,001	> $60,.001	> $60,001
E	> $750,000	About the same	About the same	$25,001 to $50,000	$30,001 to $60,000	0 to $15,000
F	$250,000 - $500,000	Less	About the same	0 to $25,000	0 to $15,000	0 to $15,000

† — No response

5. AN OVERVIEW OF USGA-SUPPORTED RESEARCH PERTAINING TO THE IMPLEMENTATION OF ORGANIC PRACTICES AND PRODUCTS ON GOLF COURSES

In considering the large number of research studies supported by the USGA and connected in a significant way to the evaluation of current organic products, development of new organic products, and implementation of the principles and practices of organic golf course management, it must be said that these outcomes represent only a fraction of the work supported by or conducted by universities, organizations, governmental agencies, companies, inventors, and practitioners.

Yet despite the money spent and the investigations conducted, results have been somewhat disappointing. Many types of studies have been executed, including those involving pheromones, light traps, allelopathy, endophytes, mycorrhizae, beneficial bacteria, beneficial fungi, beneficial nematodes, and predator bees, flies and wasps. A few of these methods and antagonists show good promise, but their efficacy in managing pest populations at a level that is acceptable to most golfers has not been achieved. We have learned a great deal about the difficulties in developing effective bio-control or organic products, and now we must move ahead to learn much more about the biology and behavior of the target pests, along with the predator/antagonists and their interactions. (See below: Challenges of Bio-Control as a Means of Effectively Managing Diseases, Weeds and Pests.)

Having said that, there have been some successes, and there are many promising bio-control products currently being investigated. But first, let's look at a brief overview of the evolution of bio-control and some of the lessons that agriculture learned over the past 130 years.

Consider first that in the early to mid-1800s, the average fruit and vegetable crops suffered a 50% loss each year from insects, diseases and weeds. Farmers tried almost everything to improve yields, including ash, cow dung, urine, sulfur, nicotine, tar, turpentine, whitewash, whale soap and many more. Most did very little to help, and some made the matter much worse. By the early 1870s, arsenic was used and worked reasonably well with certain crops. Major crop pests included the Colorado potato beetle, which reduced crop yields by 35%, and all potatoes in the Mid-West had to be sprayed. In the early 1900s, lead arsenate was widely used on many crops.

In the late 1880s, the vedalia beetle (a type of lady beetle) was introduced to the United States from Australia to combat cottony cushion scale of citrus, which caused infestations so severe that many farmers pulled their trees and burned them. Remarkably, within several months the cottony cushion scale was completely controlled in areas where the beetle had been introduced. The beetle was wildly successful and was exported to dozens of countries around the world, and they worked equally well in nearly all locations. The introduction of the

vedalia beetle is considered the beginning of classical biological control. Later the use of pesticides for another pest of citrus caused a severe decline of the beetle, resulting in another epidemic of cottony cushion scale. The beetle was used in many orchards until the 1990s, when new, more effective chemistry was introduced for cottony cushion scale.

Most bio-controls haven't worked out so well. More than 20 predators of the sugarcane borer have been released with no effect, though fire ants can reduce borer damage by about 20%. For alfalfa weevil, 13 non-native parasites have been introduced, and one has worked well in the Northeast but not elsewhere. Scientists don't know why. There have been about 250 bio-control agents introduced for codling moth of apples, pears, walnuts and other tree fruits, but losses continue to be high. Predators of asparagus aphids obtain only 10% control. There were effective parasites of the walnut aphid, but other parasites became established and decimated the walnut aphid parasite.

There have been successes. Olives, avocados, and filbert nuts have benefited greatly from bio-control agents.

Some lessons learned from agriculture:

- Effective bio-control agents are often limited in range by climate, environment, competition and many other factors
- Many good bio-control agents have been compromised or eliminated with the use of certain pesticides
- Many bio-control agents, if they are useful at all, often provide only a small or modest improvement in yield
- Most bio-controls are usually quite costly and less efficacious compared to synthetic pesticides
- Bio-control agents themselves can become victims of other agents
- Reliance on pesticides, rather than taking an integrated approach, caused the decline or loss of certain bio-control agents. Repercussions included an increase in pesticide use, and eventually the development of disease and pest resistance to certain pesticides
- Farmers and other practitioners have spent huge amounts of money on ineffective products, a problem that continues to this day
- Some introduced potential bio-control agents have become major pests in their own right

Perhaps not unexpectedly, the turfgrass industry, and golf course turfgrass management in particular, has paralleled the bio-control experiences of agriculture.

An important facet of managing diseases, weeds and insects on golf courses is the proper use of cultural practices by the golf course superintendent and staff, including irrigation, cultivation, mowing practices, tree management, drainage, traffic control, etc. When done well, pesticide and water use can be reduced

dramatically. Scientists also need to emphasize the importance of scientific studies of pest biology, physiology and behavior, the basis for developing effective bio-controls. The USGA's turfgrass research program has supported many dozens of these types of projects, investing several millions of dollars that have not been included on the chart below. Finally, development of host plant resistance to diseases, insects and nematodes, via turfgrass breeding and bio-technology is perhaps one of the most effective long-term means of suppressing pest populations.

The references noted at the end of this section provide an outstanding overview of the current state of bio-control in the turfgrass industry.

Challenges of Bio-Control as a Means of Effectively Managing Diseases, Weeds and Insects

Potential Problems

- Determining how to identify the actual antagonist (e.g. in the case of microbial 'soup') may be difficult if not impossible.
- Developing methods for propagating the antagonist and formulating the product may be difficult, costly, or impossible
- The antagonist must be established readily and be persistent in the turfgrass/soil, perhaps requiring daily or other regularly scheduled applications
- The area of adaptation of the control agent must be large enough to provide companies an acceptable return on investment
- The product cost for the end user must be reasonable
- The antagonist must be effective on a wide array of pathogen biotypes
- Most bio-control agents alone do not produce the desired results based upon today's standards
- Funding is needed for field testing over time and in the regions where it will be used
- Is the target pest likely to develop resistance to the antagonist over time?
- The antagonist must be safe for people, wildlife, and the environment
- The disease/pest reduction level must permit a decrease in pesticide usage. (This is not an issue if only organic products are used.)
- Antagonist growth and development must not be affected by pesticide applications. (This is not an issue if only organic products are used.)

Needs for Successful Bio-Control

- Technology that works
- Patented technology
- An effective marketing program
- Product concept that can provide a profit
- A product that is *cost-effective*

Pest Control Systems with Specific Advantages

- Replacement for chemicals lost to regulatory actions
- Replacement for chemicals lost to pest resistance
- Replacement or reduction of chemicals in pesticide-sensitive locations
- Applications where biologicals accomplish tasks not possible for chemicals
- 'Organic' applications

Successful Production Systems

- Consistent, adequate propagule levels
- Good contamination control
- Acceptable shelf life – 1 year without refrigeration
- Down-stream processing and packaging must avoid a decline of propagule level
- Should be user friendly and applicable to existing application equipment and practices

Bio-Control Marketing

- Must educate distributors and users
- Must have numerous demonstrations and field trials
- Must develop a good sales force and strategy
- Must consider shelf-life of product
- Bottom-line – Must have funding for successful product launch

Bio Control Registrations

- Required if pesticidal claims are made
- Post FQPA EPA registrations require 2 – 3 years and several million dollars
- During registration, extensive field trials are difficult and expensive to conduct
- APHIS regulations impede progress further, even for non-toxic, non-pathogenic organisms
- Requires time and money
- Can there be a reasonable return on investment?

Selected References

- Potter, Daniel A. 2005. Prospects for Managing Destructive Turfgrass Insects without Protective Chemicals. 2005. International Turfgrass Society Research Journal. 10(Part 1): p. 42-54. http://archive.lib.msu.edu/TIC/its/Articles/2005jou42.pdf
- McCarty, Lambert B.; Tucker, Brian J. 2005. Prospects for Managing Turf Weeds without Protective Chemicals. International Turfgrass Society Research Journal. 10(Part 1): p. 34-41.

Abstract

"Non-chemical weed control ideally provides an alternative means of weed control for situations where a suitable chemical control does not exist, or where

environmental concerns limit the use of herbicides. Biological weed control is typically achieved by inoculating with a plant pathogen that is specific for a weed species. Both fungal and bacterial plant pathogens exist, and in some instances pathogenic proteins are used for weed control. *Xanthomonas campestris*, a bacterium, has to date been the most promising commercial bioweed control agent in turfgrass. Varying levels of success have occurred for postemergence annual bluegrass (*Poa annua*) control with this bacterium. However, inconsistent results with Xanthomonas *campestris* have been observed due to the pathogenic microbe's extreme sensitivity to changes in their environments. "Bioherbicides" can be expanded to include almost any means of weed control excluding synthetic pesticides. For example, success as a preemergence herbicide for annual grass control has been achieved with corn gluten. In some instances, rock salt (sodium chloride) is selectively applied for weed control in salt-tolerant turfgrasses such as seashore paspalum (*Paspalum vaginatum*) as are isothicyanate extracts from members of the *Brassicaceae* (or *Cruciferae*) Mustard family. The emergence of biotechnology such as genetically modified organisms has enormous potential to increase the success in the bio control arena. Research continues, albeit at a conservative pace, in this field to optimize the potential of bio control of weeds in turf."

(Permission recently has been given to upload the entire text of this paper to the Turfgrass Information File, and will soon be online.)

- Biological Control: A Guide to Natural Enemies in North America. Cornell University. Web site. http://www.nysaes.cornell.edu/ent/biocontrol/
- Evaluation of Reduced Chemical Managements Systems for Putting Green Turf. Jennifer A. Grant and Frank S. Rossi. http://usgatero.msu.edu/v03/n04.pdf

The following tables provide a brief overview of the USGA-supported research pertaining to implementation of organic practices and products on golf courses. Additional information or details about specific studies or research can be obtained by contacting the USGA Green Section.

USGA Green Section Research
Progress Toward the Development of Organic Products and Practices

Project	University & Principal Investigator	Time Frame	Comments	Cost
Diseases and Pathogens				
Use of mycorrizhae in the establishment and maintenance of greens turfgrass.	Univ. Rhode Island (Dr. Noel Jackson)	1990-93	Did not improve turfgrass establishment on sand unless absolutely no fertilizer was used.	$160,000
Cultural practices in reducing damage from Spring Dead Spot in Bermudagrass.	North Carolina St. (Dr. Leon Lucas)	1985-87	A better understanding of the effect of cultural practices, but the results shows only a small effect on disease activity.	30,000
Investigation of Turf Disease Decline for potential development of Biological Control Methods	University of California, Davis (Dr. William Casale)	1991-1994	Antagonist microorganisms were identified in the centers of spring dead spot patches. The microbes did not provide any control of the disease in field trials.	46,000
Brown Patch and Pythium disease resistance in bentgrass and zoysiagrass	Texas A&M (Dr. Phil Colbaugh)	1987-92	Several bentgrass and zoysiagrass accessions used in the plant breeding program were screened for resistance to brown patch and pythium pathogens.	60,000
Identification of parasitic bacteria as a biological control agent against Summer Patch Disease	Rutgers Univ. (Dr. Don Kobayashi)	1993-96	Antagonist microorganisms would provide control of summer patch if applied on a weekly basis to maintain populations above 10^7 colony-forming units per gram of soil.	78,000
Understand basic biology and etiology of Dollar Spot Disease	Cornell Univ. (Dr. Gary Harman)	1998-2000	Made a very small step in understanding the basic biology of Dollar Spot.	75,000
A disease management program to reduce pesticide use on bentgrass greens	North Carolina St. (Dr. Jack Bailey)	1998-2000	The project demonstrated the usefulness of fans to reduce brown patch on creeping bentgrass greens.	75,000
Characterization of two snow molds in Wisconsin	Univ. of Wisconsin (Dr. Steve Millet)	1998	Provided a detailed map of the distribution of pink and gray snow mold in Wisconsin.	$18,000
Genetic basis of biological control in a bacterium antagonistic to	Cornell Univ. (Dr. Eric Nelson)	1994-97	Provided evidence some microorganisms digest substances around turfgrass roots and inhibit the	80,000

turfgrass pathogens			germination of disease spores.	
Potential for physiological management of symptom Expression by turfgrass infected by the pathogen Bipolaris sorokiniana	Iowa State Univ. (Dr. Clint Hodges)	1991-1994	Ethylene applications to Kentucky bluegrass leaves masked the leaf spots caused by the disease pathogen.	65,000
Pathologenicity and bio-control of Gaeumannomyces-like fungi	Univ. of Florida (Dr. Monica Elliott)	1996-2000	Low mowing heights and the overuse of growth inhibiting fungicides increased the incidence of disease responsible for bermudagrass decline.	56,000
Relationship of environment, management and physiology to bermudagrass decline	Texas A&M (Dr. Richard White)	2000-02	Confirmed results of the Florida study above for bermudagrass greens in Texas.	75,000
Understanding Dead Spot, a new disease of bentgrass	Univ. Maryland (Dr. Pete Dernoeden)	2001-03	Provide new information on the behavior and control of this new disease that occurs primarily on bentgrass putting greens.	87,000
Biology and integrated management of Rapid Blight, a new disease of Rough Bluegrass, Perennial Ryegrass, Annual Bluegrass and Creeping Bentgrass.	Clemson Univ. (Dr. Bruce Martin)	2003-05	Provided information on the behavior and control of rapid blight disease. The salinity of irrigation water was a major factor in the occurrence of this disease on hybrid bermudagrass greens overseeded with perennial ryegrass or rough bluegrass.	77,000
			Sub-Total	**$982,000**
Insects and Weeds				
Using pheromones in managing Mole Crickets.	Independent (Dr. Leon Stacy)	1990-91	Early work indicated that sex pheromones could lure female crickets to traps. The results were inconclusive.	20,000
Behavioral studies of the Southern and Tawny Mole Crickets.	North Carolina St. (Dr. Rick Brandenburg)	1994-97	Demonstrated that sex pheromones were not attracting female crickets. Also, provided evidence that mole crickets can detect the presence of insecticides and burrow into the soil to avoid contact.	80,000

Improved Mole Cricket management through the application of an enhanced ecological and behavioral data base	North Carolina St. (Dr. Rick Brandenburg)	1998-2000	Better information on the timing and placement of pesticides to control mole crickets.	$75,000
Use of a parasitic fly that kills Mole Crickets: Can they survive in states north of Florida	Univ. of Florida (Dr. Howard Frank)	1998-2000	A new predator of the mole cricket was introduced from Argentina to help control mole crickets, but its efficacy is not great enough to have a significant impact on mole cricket damage and pesticide use.	27,000
Determine the field efficacy of nematodes, Bacillus thuringiensis, and biorational compounds for control of the annual bluegrass weevil.	Rutgers University (Dr. Albrecht Koppenhofer))	2006-2009	Early work with these predators and compounds shows good promise, but more development is needed.	70,000
Toward three bio-control agents for pest Mole Crickets in Georgia.	Univ. of Florida (Dr. Howard Frank)	2001-02	Three South American predators of mole crickets -- a fly, a wasp, and a nematode --were established and have had a major impact on mole cricket populations in Florida. Trials were established to determine whether the three agents would thrive in Georgia.	24,000
Black Turfgrass Ataenius management	Cornell University (Dr. Doug Haith)	1998-2000	The project has documented the movement of black turfgrass Ataenius from wooded areas onto golf course fairways. The time of year and likely areas of insect infestations may be predicted accurately.	30,000
Black Turfgrass Ataenius management	Univ. of California (Dr. Richard Cowles)	1994-1997	Established that three life-cycles of black turfgrass Ataenius occur on golf courses in the Palm Springs, CA area. Initial work with pesticide timing to control the insect.	30,000
Pasteuria sp. for biological control of the Sting Nematode in turfgrass	Univ. of Florida (Dr. Robin Giblin-Davis)	1994-97	Identified a new bacteria that controls sting nematode; however, it was difficult to produce commercially.	$60,000
Characterization the of sex pheromone of the Southern Masked Chafer	Cornell Univ. (Dr. Athula Attygalle)	2000	The sex pheromone could not be identified.	25,000

Cultural control, risk assessment, and environmentally responsible management of white grubs and cutworms in turfgrass	Univ. of Kentucky (Dr. Dan Potter)	1994-1998	Demonstrated that cutworm eggs are laid on tips of bentgrass putting green leaves. Collecting clippings would reduce incidence of insect problems. Ants were a major predator of white grub eggs on golf courses.	140,000
Integrating natural enemies, cultural control, and plant resistance for sustainable management of insect pests on golf courses	Univ. of Kentucky (Dr. Dan Potter)	1998-2000	This project resulted in a better understanding of how natural predators and cultural controls can reduce pesticide use.	105,000
Enhancing biological control of white grubs by native parasitic wasps and golf courses	Univ. of Kentucky (Dr. Dan Potter)	2000-01	Using nectar producing plants and spraying sugar solutions in trees increased the numbers of wasps that lay eggs on white grubs.	43,000
Biologically-based management of white grubs, cutworms, and mound-building ants on golf courses	Univ. of Kentucky (Dr. Dan Potter)	2003-05	Cutworms migrate from rough areas onto putting greens and Kentucky bluegrass had better resistance to cutworms than perennial ryegrass or creeping bentgrass.	77,000
Natural enemies - pathogens and parasitoids - and their effects on invasive white grubs.	Univ. of Kentucky (Dr. Dan Potter)	2007-2009	Preliminary results look promising in developing bio-insecticides for control of grubs. Tiphia wasps appear to take a large toll on masked chafers.	60,000
Use of a baculovirus for season-long control of black cutworms on golf courses.	Univ. of Kentucky (Dr. Dan Potter)	2007-2009	This baculovirus shows great promise as a bio-insecticide in controlling black cutworms.	60,000
Sustainable white grub management with Steinerneman. sp. – a new highly white grub-pathogenic and specific nematode.	Rutgers Univ. (Dr. Albrecht) Koppenhofer	2003-05	A new, more effective nematode was discovered to control white grubs; however, it was more difficult to produce than commercially available nematodes.	29,000
Mating disruption of oriental beetle with pheromones	Rutgers Univ. (Dr. Albrecht Koppenhofer)	2003-05	The sex pheromone for oriental beetles was successfully used to trap beetles.	$61,000
Suitability of horticultural plants as nectar sources for a parasitoid of mole crickets in the Gulf Coast.	Mississippi State University (Dr. David Weld)	2006-2009	Various flowering plants are being evaluated to attract a wasp that shows promise in reducing mole cricket populations. More work is needed.	29.000
A proposal to establish a regional center to identify genetic insect & mite pest resistance in turfgrasses.	Texas A& M (Dr. Jim Reinhert)	1998-2002	Bermudagrass, zoysiagrass, and Texas bluegrass cultivars were screened for resistance to several insect problems. The resistant lines were used in new cultivar development.	140,000

Identification of mechanisms of resistance in Kentucky bluegrass for control of Black Cutworm in turfgrass	Univ. Wisconsin (Dr. Chris Williamson)	2001-03	There was not enough genetic variation found in Kentucky bluegrass to identify the genetic mechanisms of resistance to black cutworms.	73,000
Integrating biologically-based strategies for turfgrass pest management	Univ. Georgia (Dr. Kris Braman)	2000-02	Bermudagrass and zoysiagrass cultivars had very different populations of insect predators.	38,000
Resistant turfgrasses for improved cinch bug management of golf courses	Univ. Nebraska (Dr. Tiffany Heng-Moss)	2003-05	Improved buffalograss selections were identified and are used in breeding.	20,000
Allelopathy vs. Endophytes vs. Competition Effects on crabgrass suppression by perennial ryegrass	Univ. Arkansas (Dr. John King)	1994-96	Perennial ryegrass actively competes with crabgrass and no allelopathic chemicals were identified.	30,000
			Sub-Total	**$1,346,000**
Host Plant Resistance – turfgrass breeding for managing biotic and abiotic stresses since 1983.	Rutgers, Penn St.; Rhode Island; Texas A&M; Miss. St.; Colo. St.; Mich. St.; Univ. Wisconsin; Univ. Minnesota; Univ. Georgia; OK State; NM State; Univ. Nebraska; AZ St.; Univ. Florida;		The USGA has provided grants for improving host plant resistance for the following turfgrass species: creeping bentgrass; colonial bentgrass; Kentucky bluegrass; annual bluegrass; velvet bentgrass; perennial ryegrass; fine fescues; tall fescue; bermudagrass; zoysiagrass; seashore paspalum; buffalograss; inland saltgrass; alkaligrass; blue grama; curly mesquite; Much progress has been made and continues to be made, but turfgrass breeding will never eliminate disease, insect, weed, nematode and other pest damage. This summary of USGA support of research does not include the many studies in turfgrass physiology and cultural maintenance practices that have produced healthier turfgrass plants, resulting in reduced need for fungicides, insecticides, herbicides and nematicides.	$7,110,000
			Sub-Total	**$7,110,000**
			Total	**$9,438,000**

6. PROPOSED DEFINITIONS AND THE NEED FOR CONSISTENT TERMINOLOGY

Organic farming is a growing segment of the agriculture industry and the use of the term "organic" in popular culture and commerce continues to find new applications and products. In the public mind, organic means natural, non-toxic, and safe. Those who produce and advertise products have been quick to both use and promote organic labels and terms as a means to selling more products and gaining an edge over competitors. Because there was a variety of definitions for organic and to provide a consistent playing field for producers and reliable and safe standards for consumers, Congress passed the Organic Food Production Act of 1990. The United States Department of Agriculture (USDA) was charged with establishing a national organic program including definitions, regulations, and certification mechanisms.

USDA regulations do not, however, include standards or definitions for organic golf course management or organic golf courses. Nevertheless, there is growing support for synthetic pesticide-free or organic golf course management within activist groups and a few communities in the United States and Canada.

Among activist groups, the Long Island Neighborhood Network (LINN) on Long Island, New York has been especially active in promoting organic golf course management. In 1998, LINN won a court ruling that forced Suffolk County, NY to commit to making its two new 18-hole golf courses in Yaphank organic. In 2002, LINN took their campaign a step further when a four judge appellate court ordered the town of Stony Point to comply with the State Environmental Quality Review Act by completing a full EIS before continuing work on the golf course. The court's decision does not force golf courses to be all organic, but it requires developers or communities to seriously evaluate organic alternatives. The recent decision is also important because it expands the required consideration of organic golf course management beyond Suffolk County to other counties in New York State.

Another recent action in the state of New York could significantly impact organic golf course management. In September 2007, then New York Governor Eliot Spitzer announced an agreement on a major new resort complex in the Catskill Mountains, an area that includes the watershed for New York City water supply. The agreement between the resort developer, New York state, environmental groups, and New York City will end a seven year legal and regulatory battle over the proposed development in this sensitive watershed. The development as included in the legal agreement contains a conference center, lodging, hotels, and an organic golf course. The requirements for operating an organic golf course, including approved practices and products, were part of the settlement agreement. (See attached section of the agreement dealing with the organic golf course in Appendix I).

While legal action by a few courts and state governments are requiring golf course development to follow organic management methods, a few local

governments in Canada and the US are also approving ordinances or construction permits requiring synthetic pesticide-free or organic golf courses.

In the U.S., the Vineyard Golf Club, on Martha's Vineyard off the coast of Massachusetts, is a leading example of a local government requiring the new golf course development be organic. The conditions for local government approval of the new golf course included the requirement that the private golf course be managed with natural, organic fertilizers and without traditional synthetic pesticides. Many turfgrass experts point out that Martha's Vineyard is a very forgiving microclimate for growing golf course turfgrass with less pest pressure and environmental stress than most other golf course locations (See Section 7 for case study of the Vineyard Golf Club).

Other golf courses in Canada, the U.S., and Australia have been described as synthetic pesticide free or organic not because of a government mandate, but for reasons of marketing, watershed protection, or general management philosophy. (See attached list of golf courses that are reported to be organic in Appendix II). Because the term organic is being applied to many different products in the market place and because the public has generally accepted the term as more safe or natural than other products, it is not surprising that there is interest in organic golf course management. As a percentage of all golf courses, the numbers that are currently reported to be organic is very small. In the U.S., there are currently about twenty golf courses that are reported to be organic golf courses.

Unlike agriculture, however, there are no accepted definitions or standards for organic golf course management and the golf industry has not asked the government to step in and establish such a framework. There is a need for consistency and clarity of organic terms to provide a level playing field and technical guidance to golf courses and communities considering this management approach. If the terms and standards that define what organic golf course management, or what constitutes an organic golf course, are left to individual golf courses, communities and the courts, the result will be a lack of consumer confidence in the term organic and an inconsistent use of the label within the golf industry.

A diversity of definitions and standards for organic golf course management will produce confusion among golfers, communities, and product suppliers and complicate the efforts of golf courses striving to minimize chemical inputs or market themselves as organic.

In response to this need, a combined task force of interested environmentalists, organic agriculture specialists, industry representatives, and golf course experts have worked to clarify some agreed-upon terms and definitions. Under the auspices of CRM, the task force has prepared this report including proposed definitions for organic golf course management.

Organic Agriculture

The term "organic" emerged in the 1930's as used by J.I. Rodale who envisioned a farming system that would rely on natural products and methods for soil

building, fertility, and pest management without the use of synthetic inputs. By the 1970's the organic agriculture industry had begun to gain recognition and soon various certification groups and standards for production and labeling had been established to assure consumers that products met certain standards.

The U.S. Organic Food Production Act of 1990 established a national organic program. After nearly a decade and over 316,000 public comments, the National Organic Program (NOP) was established in 2000 under the USDA's Agricultural Marketing Service. The NOP is responsible for establishing consistent national standards for agricultural products, facilitating interstate commerce of organic food, assuring standards are met and that consumers are protected. "Under the rules of the NOP, organic products must be grown and handled without synthetic pesticides and fertilizers, human bio-solid wastes, irradiation, or genetically modified organisms, although certain fertilizers and pesticides from natural sources are allowed. Crop production standards include a three-year transition period from conventional farming practices to an organic system that builds healthy soils, prevents erosion, and protects water resources" (National Association of State Departments of Agriculture Policy Statement on Organic Agriculture 9/11/2003).

The national standards also include a National List of Allowed and Prohibited Substances that establishes approved synthetic substances and prohibited non-synthetic substances including pesticides, fertilizers, and processing aids used in organic production and handling.

Before a product can be labeled organic, a government-approved certifier inspects the farm where the food is grown to make sure the farmer is following all the rules necessary to meet USDA organic standards. However, USDA makes no claims that organically produced food is safer or more nutritious than conventionally produced food. Organic food differs from conventionally produced food in the way it is grown, handled, and processed (www.ams.usda.gov).

Limitations and Barriers for Organic Turfgrass Management on Golf Courses
The experience and information from organic agriculture can inform and improve golf's path toward an organic management option for turfgrass. The work that has been done to develop definitions and approved lists or products provide important points of learning and understanding for anyone in the golf course business interested in reducing synthetic chemical inputs and managing golf course properties according to organic standards. But there are also differences between agricultural crops and golf's turfgrass conditions, constraints, and expectations.

The concept of reducing and eliminating synthetic pesticides and fertilizers on golf courses appeals to many environmental and governmental representatives due to the perception of environmental harm from the use of these products. Currently there are few data on a national scale that details the annual pesticide and fertilizer use on a typical golf course. Survey data collected by the GCSAA in 1999 and 2000 indicate that the typical golf course annually made four

applications of herbicides on 31 acres per treatment, two applications of insecticide on an average of 20 acres per application, and six applications of fungicide on 15 acres per treatment. While total amounts of pesticides used or total acres treated were not calculated, it does suggest that pesticide use is limited in both number of applications and areas treated at levels generally below public perceptions. The GCSAA is currently conducting an industry-wide survey of pesticide use that will provide more detailed and up-to-date information.

While organic golf course management may be a goal, it is worth noting some of the more difficult barriers and limitations facing a strictly organic golf course. Among the challenges is the sometimes unrealistic expectation of golfers for "perfect turfgrass" and the intense pressure on golf course operators to deliver aesthetic perfection in a very competitive golf industry. Having watched tournament play on championship golf courses on TV, players often demand a verdant green golf course or they may quickly move to other golf courses that have the aesthetic qualities they desire.

Discolored turfgrass or aesthetically imperfect greens may be agronomically healthy and provide reasonably acceptable playing surfaces, but are often rejected by golfers for not meeting their aesthetic and perceived playing condition expectations. Much progress is needed in creating the awareness that playability and aesthetic perfection do not need to be mutually dependent. Education may be necessary to show that we can have superb playing conditions while not pandering to the perfection syndrome.

Beyond visual turfgrass conditions and player expectations, there are many turfgrass pests for which there is no proven organic pest control product currently on the market that can adequately control the target pest. Organic pest control products for numerous weeds, disease, and insects have neither been identified nor tested by an independent third party for efficacy. In addition, while some organic pest control products have been shown to reduce the population of a specific pest or pests, the reduction in pest pressure is insufficient to prevent unacceptable turfgrass damage.

In a few cases, an organic pest control product has been identified as an effective control of a specific pest in laboratory or small research plot settings, but researchers have been unable to demonstrate consistent, efficacious control on a golf course scale. Once a green, tee, fairway, or rough has sustained unacceptable damage due to a pest, the golf course superintendent must either induce the turfgrass to recovery from the remaining turfgrass plants or reestablish the turfgrass stand from seed, sprigs, or sod. Both inducing turfgrass recovery and reestablishment can be expensive processes that require time to be effective. During the recovery or reestablishment period, revenue from golfers may be lost due to golfers preferring to play on golf courses that have not suffered damage and the resulting reduction in playing quality. While a golf course is devoting resources (seed, sod or sprigs, fertilizer, water, staff time) and money to repair the turfgrass, often revenue is reduced at the same time threatening the long-term financial health of the golf facility.

There is limited availability of natural organic fertilizers that meet other state regulations. Some states have disallowed the use of fertilizers that contain phosphorus, unless a soil test shows there is a need, and very few natural organic fertilizer contain no phosphorus. Additionally, as mentioned in the preface, natural organic fertilizers can pose the same, if not greater, risk to water quality as synthetic fertilizers if applied improperly.

Research performed by Cornell University scientists in 2001 at the Green Course of Bethpage State Park in Long Island, New York studied different pest management approaches on comparable greens. The research results showed that the putting greens that received no synthetic chemical inputs deteriorated in quality so that they had to be closed during part of the season over the three years of the study (See Section 7 for the USGA Green Section Record article, *Evaluation of Reduced Chemical Management Systems for Putting Green Turf*, by Jennifer A. Grant and Frank S. Rossi).

So, is a truly organic golf course realistic; can it be done considering market demands, product availability, technical, and economic constraints? The answer seems to be that it depends. It depends upon the definition of an organic golf course; it depends on the climate conditions, types and cultivar of turfgrass, the tolerance and understanding of players, management flexibility, and many other factors.
Included in this report are five case studies from different golf courses in different parts of the country that describe their particular synthetic pesticide-free, reduced synthetic, or organic management program.

This committee did not attempt to comprehensively evaluate the extent to which organic golf course management is more desirable, or not, compared with conventional turfgrass management that uses integrated pest management principles and modern techniques. For example, some 'organic'/'natural' products may require daily applications, which could significantly increase the overall carbon footprint of the golf course (e.g., more gasoline consumed to operate vehicles more frequently) relative to more typical management methods. Some 'organic'/'natural' herbicides and insecticides can have toxic effects on non-target plants and insects, respectively. An organic approach may require more labor. Thus this document is not an endorsement of the organic approach over more conventional approaches to turfgrass management; rather, this report provides background, and a definition and description of the organic approach if a site-specific cost/risk/benefit analysis indicates it is appropriate.

Recommendations for Definition of Organic Golf Course Management
After much discussion, the drafting committee felt the definition chosen for organic golf course management should be simple and easy to understand by the general public. It was determined the definition should not include a list of exceptions or extreme conditions under which the definition could be waived. The committee discussed the challenges and limitations of managing an organic golf course and realized that the conditions under which organic golf course management is feasible are probably limited to a small group of golf courses or special circumstances. Nevertheless, it was determined that a broad or

complicated definition with multiple exceptions or exemptions would lack credibility and do little to reduce confusion or move the dialogue and acceptance of organic golf forward.

Organic Golf Course Management

The proposed definition of organic golf course management is as follows: *"Organic golf course management has the goal of using techniques that are both effective and decrease the risk to human health and the environment, while also providing acceptable and marketable playing conditions. Organic golf course management promotes healthy turfgrass through proper plant selection and care, regular monitoring, correct pest identification, record keeping and evaluation, by only using natural organic fertilizers, natural organic pesticides, and synthetic natural organic pesticides. Organic golf course management relies on products that consist of naturally occurring organic compounds that are derived from plant materials, biological organisms, or mined from natural deposits such as products defined below as natural organic fertilizer, natural organic pesticides, and synthesized natural organic pesticides." Golf courses that meet this definition of organic golf course management should be considered organic golf courses.*

Natural Organic Fertilizer

"*Materials derived from either plant or animal products containing one or more elements (other than carbon, hydrogen and oxygen) which are essential for plant growth. These materials may be subjected to biological degradation processes under normal conditions of aging, rainfall, sun-curing, air drying, composting, rotting enzymatic, or anaerobic/aerobic bacterial action, or any combination of these. These materials shall not be mixed with synthetic materials or changed in any physical or chemical manner from their initial state except by manipulations such as drying, cooking, chopping, grinding, shredding, hydrolysis, or pelleting*" (Definition T-13; Association of American Plant Food Control Officials (AAPFCO) 2002).

Natural Organic Pesticides

"*Pesticides derived from plant, animal, or microbial products not mixed with synthetic materials or changed in any physical or chemical manner from their initial state except by manipulations such as drying, cooking, chopping, grinding, shredding, hydrolysis or pelleting*". Two examples are the live organism *Trichoderma harzianum*, and potassium salts of fatty acids, that are a hydrolysis product (the molecule has been broken down by alkali) of natural fats.

Synthesized Natural Organic Pesticides

These are pesticidal molecules that are identical to molecules that occur in nature -- e.g., pheromones (insect attractants, which can be used to disrupt mating cycles) -- but are synthesized using standard chemical and chemical engineering

techniques. The molecules must be identical in all structural aspects to their natural counterparts.

Organic Fertilizer

It is important to understand that there is a scientific definition of the term "organic": a descriptor for compounds composed of covalently-bonded carbon. This definition includes compounds of life, such as all proteins and carbohydrates, but is also includes synthetically derived petrochemicals. In this context, there is an existing, standardized definition of "organic fertilizer": "A material containing carbon and one or more elements other than hydrogen and oxygen essential for plant growth" (Definition T-12; AAPFCO 2002).
This definition includes natural organic fertilizers (see above) as well as synthetic organics. Examples of the latter are IBDU (isobutylidene diurea), methylene ureas, and urea, although the latter can be produced synthetically or processed naturally. Clearly, this broad definition, while technically accurate, does not reflect what many people imply when they use the term "organic fertilizer". Thus, in the context of this effort, we suggest that people use the term "natural organic fertilizer", as defined above, and avoid using the term "organic fertilizer", unless the intent is to denote the broad, scientifically-based definition stated in this paragraph.

In proposing these definitions, we hope to engage a broader dialogue within the golf industry and environmental and organic industry stakeholders as we seek input and additional considerations. We realize that organic golf course management, as defined here, is probably an unrealistic proposition for most of the nation's golf courses; but we also recognize that the experience of those managing existing organic golf courses and the development of new products and methods can be an encouragement and stimulus for more wide spread adoption of an organic management approach. Similarly, the efforts to establish organic golf course management can provide guidance for conventionally managed golf courses in reducing chemical inputs.

Alternative Definitions for Organic Terms

In the work of preparing this report, the drafting committee considered a variety of approaches to coming up with an acceptable definition for organic golf course management. These alternative definitions and different approaches provided valuable considerations in the development of the proposed definitions above but were rejected by the committee after thorough review as not being best suited for golf course management. Some of these different approaches were adapted from other definitions or sources and include the following:

A. Organic golf course/organic golf turfgrass management

A.1. An organic golf course is managed "using only products that consist of naturally occurring organic compounds or mixtures of organic compounds".

A.2. An organic golf course is one that is maintained without synthetic pesticides and fertilizers. Pesticides, fertilizers, soil amendments, or other materials that are derived from plant materials, biological organisms, or mined from natural deposits are considered organic and may be used. Adapted from definition from Martha's Vineyard Commission.

A.3. "Organic golf turfgrass management means operating and maintaining a golf course by using biological, cultural, and mechanical practices that foster soil health, maintain biodiversity, and watershed ecology while ensuring playable golf course turf without the use of synthetic chemicals (except as provided for pursuant to Exhibit E of This Agreement in Principle)". Definition of organic golf course in the settlement agreement for the Wildacres Resort, Catskill Mountains in the state of New York.

A.4. An organic golf course is a chemical-free golf course where synthetic chemical pesticides and fertilizers can be used only in an emergency where pest invasion or infestation exceeds a reasonable and established threshold and with approval of the appropriate local government authority.

A.5. An organic golf course relies upon a holistic management system that promotes and enhances ecosystem health, including biodiversity, biological cycles and soil biological activity. This is accomplished by using, where possible, agronomic, biological, and mechanical methods as opposed to using synthetic materials to fulfill any specific function within the systems. Adapted from definition of FAO/WHO Codex Alimentarius Commission.

A.6. Organic golf courses must be managed without synthetic pesticides and fertilizers, human bio-solid wastes, irradiation or genetically modified organisms. Adapted from rule published in Federal Register, Oct 21, 2000 that established the USDA National Organic Program, NOP.

B. Definitions/standards for products used on organic golf courses, some alternatives include:

B.1. Prohibited products include all synthetic, chemical, pesticides-i.e. any products bearing a US Environmental Protection Agency pesticide registration label, excluding those that are classified by USEPA as an exempt material under CFR part 152.25.

B.2. Prohibited products include all synthetic fertilizers - i.e. fertilizers that are not made from vegetable or animal sources or that have been substantially altered. Also prohibited: arsenic, bio-solids, piperonyl butoxide, pyrethroids, and tobacco.

B.3. Adopt for use all products on the national list of approved substances established under the Organic Foods Product Act of 1990 and materials approved as organic by duly accredited certifying organizations.

B.4. Adopt the NOP list in its entirety and petition the National Organic Standards Board and the NOP for specific materials that may be needed to treat local geo-climate conditions and needs.

7. CONSIDERATIONS FOR FUTURE ACTIONS

Those who have worked preparing this report recognize there are many individuals and organizations that have an interest in organic golf course management. We also recognize that for this report's recommendations and proposed definitions to be accepted and used requires input and support from various interests in the golf industry and other stakeholder groups. With that in mind, we propose a three-step process for building clarity, consistency, and consensus regarding the standardization and recognition of golf courses considered as organic golf courses.

With completion of this overview report, we propose the following future actions:

A. Distribution and Completion of the Overview Report

A.1. Circulate report and proposed definitions to organizations in the golf industry, organic agriculture industry, environmental community, and other relevant stakeholder interests.

B. Seek endorsements of proposed definitions

B.1. Seek official review and endorsements of proposed definitions from organizations such as EPA, USGA, GCSAA, ASGCA, the Organic Materials Review Institute (OMRF) and other relevant national organizations.

B.2. Publish definitions and endorsements on the internet and in golf industry publications.

As a common definition for organic golf course management is adopted and more golf courses apply organic management methods, there will evolve a need for a more formal structure to qualify and recognize organic golf courses. Golf courses that are seeking recognition as organic, and other organizations in agriculture and commerce that use the organic label, will likely push for a more formal and systematic approach for use of the organic label in the golf industry. Similar to agriculture, the logical result is the creation of a third-party certification system that will objectively and credibly administer organic golf course qualification. In this report, we do not attempt to define or describe how such a system might be developed or operated other than to recommend that USEPA and USDA be involved, as appropriate, in the process.

Given the difficulty of attaining full compliance with the proposed definition of organic golf course management as outlined in this report, it is realistic to consider a range of different levels of organic certification. Those levels could be a simple gradation such as Level One 60%, Level Two 80%, and Level Three 100%. Such levels might be based on areas of the golf course that are in full compliance such as Level One course includes all fairways, etc. We leave it to others to determine criteria and appropriate labels for designations. Such an approach will provide realistic and attainable goals for golf course owners and superintendents interested in moving toward full compliance as an organic golf course. Recognizing that environmental stewardship involves a full spectrum of issues and strategies moving toward an organic golf course designation is not the only way to be environmentally friendly.

8. CASE STUDIES

Case studies are included in this report to provide additional details and insights concerning the experience of individual golf courses in attempting to apply several organic management practices and products. No impartial evaluation of current golf course conditions or quality of the turfgrass has been conducted and the inclusion of these case studies and the material in Appendix I regarding the Wildacres Resort in New York does not imply any endorsement from the committee of these particular golf courses or their management techniques. These golf courses do not necessarily meet the definition of organic golf course management as contained in this report. The case studies included in this section are: 1) Vineyard Golf Club, Edgartown, Massachusetts, 2) Applewood Golf Course, Golden, Colorado, 3) Old Brockway Course, Lake Tahoe, California, 4) The Wawona Course Yosemite National Park, and 5) USGA article, *Evaluation of Reduced Chemical Management Systems for Putting Green Turf* by Jennifer A. Grant and Frank S. Rossi.

The Vineyard Golf Club, Edgartown, MA

By Jeffrey W. Carlson CGCS, Superintendent

In November 1998, I joined a team of developers attempting to permit an 18-hole golf course on a 238 acre wooded site on the Island of Martha's Vineyard. A year and a half and a mountain of paperwork later, this abandoned 148 lot subdivision was approved for a private 18-hole golf course. One of the 36 conditions of approval was that the golf course be managed organically; with organic defined as eliminating the use of traditional synthetic pesticides and using only natural organic fertilizers.

With some serious concerns, I accepted the position as construction and grow-in superintendent for this new course; The Vineyard Golf Club. Because of an encouraging experiment in the late 90's with a practice green at the Widow's Walk Golf Course that was pesticide free for a year and a half, a faith in some of the recent advances in turfgrass research, a concern about future of pesticide use in the US and a history of not always thinking through the long-term ramifications of my actions, I forged ahead.

Throughout the construction process, we utilized various strategies to give the course an advantage in combating disease "organically". We mixed our topsoil with the partially decomposed forest litter, selected only grasses that tested well against diseases common to our location, cleared away most of the trees on the site, lined all 19 greens with plastic took great pains not to compromise the excellent drainage characteristic of a sandy site and installed perimeter wells prior to grow-in to monitor ground water quality.

Evaluating the course six years later (almost to the day), I can make the following observations:

- I wished we'd cut more trees.
- Do not import sod to a new construction site if you choose to manage organically as this was the primary way that insects (oriental beetle) and weeds (clover etc) were introduced faster and earlier than might otherwise be expected.
- Lined greens are a mixed blessing.
- Grasses can and do adapt to a no/low pesticide regime.
- In some areas of the country fairway fungicide applications are not necessary.
- Golf Carts should be banned.
- Buy divot mix that is weed free rather than using native soil.
- Use very little water.
- Fertilizer can be used as a pesticide.
- While natural organic fertilizers have their place, they should not be the only nutrient source.
- Beneficial nematodes appear to be a viable alternative/partner to synthetic insecticides but timing is critical.
- Organics have not produced viable alternatives for selective weed control in large turfgrass areas like golf courses.
- Visual perfection on all playing areas as a "norm" for golf is not realistic in an organically managed course. Excellent playability, on the other hand, is attainable.
- Some of these bullet points will change next year.

Diseases

When the course opened fungus diseases, specifically dollar spot, were our primary problem and focus. Fairways, roughs and native areas have never been treated with anything. Instead we have managed water, removed dew, aerified annually and managed nitrogen as a fungicide for dollar spot control by spoon feeding during times of severe pressure. We do sacrifice some speed but not as much as I was lead to believe.

Over the years we have altered/modified our arsenal of bio-pesticides, treatment programs, timing of applications and cultural strategies. Although dollar spot never goes away and never seems to be predictable, it has been managed to a point where it does not affect ball roll, speed and overall playability. We have also observed some resistance developing in areas that have had repeated outbreaks

of dollar spot. One thing must be noted at this point: these are non-scientific and anecdotal field observations by this superintendent. It must further be noted that we overseed these areas every season in an effort to fill any voids left from disease scarring.

In years two and three foliar pythium invaded our 6th, 9th and 17th greens to a point where they almost required closing. We removed trees surrounding these greens; improved air circulation and sunlight and have not had a recurring outbreak of pythium. This is an instance where the manipulation of the micro-environment had a significant impact on disease pressure.

Brown patch shows up on our greens and tees annually but does not persist to the point where it takes out any turfgrass. We do not have prolonged snow cover most winters but when we do pink snow mold will appear but does not kill turf grass and disappears in early May.

In summary, we have done much better than I imagined especially with regard to fungus control. But it must be emphasized that steadfast communication to the golfers through member newsletters, informal and formal talks and an occasional round of golf are critical to the success of this program. While it is not perfect all the time, it is a significantly better playing surface than many, including this superintendent, thought it would be when we opened on May 25, 2002.

Insects

When we first noticed grub damage (fall'04), we contacted the Entomology Department of UMASS and initiated what has become a 3 year (and on-going) nematode and mating disruption study on the golf course. In addition we continued our only organic treatment, *bacillus popilliae* (Milky Spore), and repaired the damaged areas every morning before play. This was a time consuming task totaling 120+ man-hours per week starting in late August and continuing weekly until the middle of October. This work did make a difference to our players and minimized their concerns. A smooth, tamped out and seeded portion of a tee, collar or fairway does not affect play and greatly reduces the visual shock of predator damage. If damage was excessive and in a high profile area (ex. #1 white tee), we would sod the area immediately.

During the peak of disease damage, grubs had attacked significant portions of tees, fairways and roughs. In an effort to quantify the extent of the damage, we measured the total areas of damage and compared that to the total unaffected areas of the tees, fairways or rough. We found that less than 1% of the managed turf areas were damaged and yet it was clear that the overall turfgrass "look" is unacceptable.

Each year during the height of grub damage, we have had little or no damage to any of our greens. In some cases the damage would occur up to the edge of the green. We think this may be related to the construction of the greens. Each green is lined with a plastic liner between the greens mix and the sub soil. In the winter of 2003 we had a severe cold spell and the frost went down below 2' in the open areas. This was confirmed by the extensive irrigation breaks we had to repair the

following spring. Since the total greens mix and stone above the liners totals 18", it is conceivable that they simply froze to death that winter in mass. Liners might provide interesting control in areas of the country where the frost routinely goes to 2' or lower.

Predator Control

A good example of member involvement occurred when we identified a serious infestation of grubs (oriental beetle) on the course. Immediately members came forward and suggested the club hire a retired "local fisherman" who specialized in skunk removal at their summer homes. Walter, the fisherman, arrived the next day and for the past three years has removed skunks, crows and raccoons from the course with the zeal and passion that has only been matched by a certain famous golf course assistant greenkeeper, Carl Spackler (Caddyshack). He set dozens of traps baited with white bread slathered on barbeque sauce, or cheese crackers, and unshelled peanuts. He displayed dead crow decoys in an effort to discourage their return and one night we came upon Walter in a golf cart, covered in camouflage, gun poking out and a dead crow swaying from a nearby tree just waiting. The members were now participants in the management program; waving me down to call attention to trapped skunks; point out new areas for Walter set traps or to regale me with the latest tales of their own backyard battles with skunks.

As much fun as this was, a more scientific approach was required to attack the food source for these predators, the Oriental Beetle Grub. As soon as we identified the grub and isolated the infected areas, we moved on two fronts: contracted the local university entomologist (Dr. Pat Vittum) to initiate nematode and mating disruption programs on the course to identify the best system of organic control and informed the membership of the problem and our plan.

The Mating Disruption Program

Dr. Pat Vittum (UMASS) has worked throughout this process with Dr Albrecht Koppenhofer (Rutgers) and their respective staffs. In our area the beetle mating cycle occurs during the summer beginning just after the 4th of July and continuing for two weeks through the third week in July. In year one pheromone traps were scattered throughout the course to determine areas of intense grub activity. Our staff would empty the traps; count beetles, bag, date and freeze them. Once the areas of intense activity were located a special scent was placed in the traps in one acre square plots. Again beetle activity was monitored in the traps (by counting). These mating disruption scents were placed throughout the course in pheromone traps to confuse the males to think everything, plants, twigs, grass are the female of their dreams. The hope is these exhausted males will not successfully mate. This research is on going and the results will be reported through UMass and Rutgers. Our staff was very involved in this research, taking samples from the traps and counting beetles by the hundreds.

Mother Nature also got involved during the time of peak beetle activity with the arrival of a dozen or more Seagulls that camped out on the fairways and devoured adult beetles by the hour. Assuming each gull consumed 10 beetles per minute (a conservative estimate based on our observation) and only fed during daylight

hours, this flock consumed something in the order of 1.5 million beetles on the 10th, 12th and 13th fairways during July. As quickly as they arrived, the gulls departed as soon as the beetles began burrowing underground.

The Nematode Program

As a result of the on-going nematode research, we chose a nematode (Hb2) and treated all 69 acres of managed turfgrass this summer. It is difficult to obtain enough nematodes to treat large turfgrass areas for two reasons: the law of supply and demand-because of the availability of effective insecticides like Merit, there is very little demand for beneficial nematodes; hence low production, especially in the quantities that golf courses demand; the second is the difficulty transporting "live" products.

Our first shipment died in transport due to the heat. It appears that the researchers are ahead of the manufacturers at this time but hopefully that will change soon as there is a bacterium named "buibui" that has done very well at eliminating Oriental Beetle. We are going to be experimenting with this bacterium this season as enough has become available to adequately test a larger area. It should be noted that the tee Dr. Vittum has repeatedly tested for grubs is # 11, a short par three surrounded by severe grub infestation and as of today shows no sign of grub damage.

Once the nematode is on site application should be made during a rain storm two weeks after the beetles have pupated to larvae (early August for us) and after 90% of the rain has fallen (pre-wet is key) and watered in with the remaining 10%. Imagine, for a minute, being able to predict not only when it rains but when 90% of the rain has fallen! We also have to consider the effect of soaking the turfgrass in mid-August; our peak fungus disease time. Because we deal with live organisms that have finite life spans, organic management is often this kind of a balancing act: peak disease time coincides with optimum pesticide management application.

Conclusion

The organic insect management program has demonstrated four important aspects of our management program: member participation; non-traditional turfgrass management programs; utilization of research; and measurable progress. While the initial insect damage was discouraging, it was not surprising; it just occurred a year or two earlier than expected. The members were not only supportive but helpful in the early stages. They were the ones who encouraged us to hire Walter (the skunk man) and vouched for his effectiveness. Walter's approach to controlling insect damage was unique and "in your face" but without question mitigated damage in the early years. Our program has been the recipient of extensive research (on the golf course) with beneficial nematodes and bacterium and has provided test sites for studies in mating disruption of adult beetles. Following-up this research, we were able to acquire sufficient quantities of live nematodes to treat the entire area of managed turfgrass this season and have observed a drop-off in damage this fall. That progress is very encouraging and has given us hope that we have a program in place to address insect damage without the benefit of traditional synthetic pesticides.

Weeds
The Final Frontier. As the course ages we have increasing battles with weed infestation in all playing areas except the greens (this includes *Poa annua*).

Weeds have filled the voids left by severe grub damage especially in our out-of-play fescue roughs. They also filled in fairway divot repair areas when we use screened native soil but not as much when we used composted divot mix.

We have used the following controls:

- Overseeding- This is effective if it is done in the fall when weeds cannot compete here in New England.
- Hand picking- Romantic and maybe practical in your yard but at $2800 per acre not applicable in golf.
- Burning- If the fire is hot enough and the grasses mature enough this can be a form of control, especially for woody plants, but the regulators and fire chiefs in our area frown upon (laugh actually) summertime requests for large scale burns when our weeds are most active. Interesting observation: burning does result in the proliferation of a much sought after native grass here called Little Bluestem.
- Waipuna- This is a machine that spreads hot water and foam on weeds. Because it is organic (and non selective), you can seed into a treated area hours after the kill. For this reason it is very effective on active clover and crabgrass but requires extensive communication with the membership as the "dead" areas persist for a week or more before the seedlings begin to green up the wound.

I must point out that our members have created a far greater fuss about the weeds than they ever did about disease. Even when the weeds are in remote areas and do not affect their shot. Thank you, OM Scott's and Round-Up™ for creating a culture of "zero tolerance" when it comes to weed infestation anywhere on lawns or golf courses.

As I look back five years, I was not sure I would be here to write a story about the organic management program at The Vineyard Golf Club or that there would be a course to write about. But by combining the latest products and research with an understanding and informed membership and throw in an extraordinarily dedicated staff, we have a golf course that is eminently playable. A few summers ago our staff received its greatest compliment when one of our members told me they had a guest play 18-holes with them for the first time; they finished the round and were having lunch when the member had to "remind" the guest that they had just played an "all organic" golf course.

Applewood Golf Course, Golden, Colorado
By Matthew Rusch, Golf Course Superintendent

Applewood Golf Course was established in 1959 and was the original Rolling Hill Country Club. Since its establishment the golf course has been under strict

enforcement for a no-chemical or pesticide use. The enforcement of the no pesticide use is necessary because the property is located on the Coors Brewery water aquifer. The water board at Coors was convinced that chemicals could leach into the aquifer.

During my short two-year tenure, I have implemented a well-balanced, high-maintenance and closely maintained program in order to keep the golf course well maintained and yet please the customer. The program I use consists of a few fertilizers; liquid and granular.

The granular fertilizers I use are blended with materials that come from the earth and synthetic fertilizer to maintain growth and color. I find these few blends have worked well in the second season. It took a little care the first year to get the turfgrass to adapt to these smaller portions of so called food but they were used more frequently. Using fertilizer that has a lower nitrogen percentage and applying it more frequently was key to my high-traffic golf course. Twice a year when I aerate my greens, I have been incorporating a newer variety of bentgrass to my greens. This newer grass is more disease tolerant and withstands high traffic and lower nitrogen rates.

The day-to-day golfer does not recognize the differences that have been happening. Although the lower handicapped golfer has realized changes to the putting surface, they enjoy playing on these newer conditions. I have developed more true green speed, and eliminated the bumpiness of the green surface.

There are many challenges that come with operating Applewood Golf Course. The hours put in during the summer seem endless, but at the end of the day, I leave happy with what I have accomplished.

Some challenges include localized dry spots that occur day-to-day, so we frequently do hand watering with wetting agents. I am still in testing phases with different types of fertilizers and varieties of disease tolerant bentgrasses.

Pest Management Programs
In the spring and fall during aeration, I overseed the greens with Penn A-4 and a Providence bentgrass blend in order to withstand these fungus disease outbreaks. As long as I keep the greens properly fertilized, the outbreaks are minimal.

Concerning dollar spot or anthracnose, I wait until I see early symptoms of the fungus and when the disease is evident I use an ammonium sulfate application at a rate of 1#/M. I do this application in the evening right before the irrigation runs to prevent leaf burn which gets water in right away. This results, unfortunately, in a growth spurt within 2 days. As the disease is pushed out, I verticut and topdress 3-4 days after the disease has ceased.

Some pest issues such as grubs are a little harder to manage on a chemical-free golf course. The greens soil profile is pretty much the same throughout the property so I do the same practice on all greens. When the appearance of grubs is evident, I back off the moisture at night and let the greens go a little lean. I also

back off on the use of the fertilizer which forces the grubs to the surface to find nutrients and moisture. This usually lasts about a week when the larvae are in the adult stage. If the grubs are still there I, take a ballmark tool and pop them out of the soil. After starving the greens for 7 days I run the Hydroject on all greens to get adequate moisture back directly to the roots.

Microclimate Management
I have three of the twenty-one greens that have issues with different climate issues. I have removed a few trees from these areas to incorporate more sunlight and air movement. One area that is always a concern is a green that is undulated and does not have good drainage. When conditions are right and high moisture is an issue, I use a portable fan to help dry the troubled greens. It's a matter of being aware of the conditions and understanding that weather plays a big role in disease pressure. In areas exposed to sunlight all day, I hand water those with a wetting agent and run the Hydroject to prevent localized dry spots.

As far as playing conditions through the season, I keep them consistent all year long, tee to green. I overseed tees and fairways 4 times a year at a rate of .4#/M. I use a blend of 80% perennial rye and 20% bluegrass. I fertilizer the fairways and tees three times during the season using a Polyon coated fertilizer blend. This is a slower release fertilizer and the longevity lasts longer in the turfgrass. Applewood Golf Course has a lot of rounds each year, so traffic on the golf course is high all the time.

Problems Encountered
The key issue I face is traffic control that results in soil compaction throughout the golf course. This is a constant issue so directing traffic and keeping these areas aerated and seeded on a rotation program is critical. Being in such a dry climate, it is always an issue to keep enough moisture on the golf course, and manage the irrigation properly. We need to be aware of the weather to know when disease pressure is on the rise and then manage it quickly and effectively. Applewood Golf Course is a certified Audubon Cooperative Sanctuary golf course. It is a great experience to bring in new wildlife each year and maintain their homes and habitats. Instead of cutting down dead trees and removing from the property, I place them so they are hidden from guests but accessible to the wildlife. I maintain 42 active birdhouses that house many families of birds.

Finally, the other issue I deal with on a day-to-day basis is clover weed patches that frequently appear on the greens. The only way that I can manage this is to plug out these areas and replace them with pure bentgrass plugs. Another way I address this issue is I verticut the greens bi-weekly and rotate with topdressing on the opposite weeks. The weeds can't withstand the verticutting and they die off.

Deep-tine aeration also occurs every two years in the spring to help prevent blacklayer occurring in the green profile. In the summer, I do a solid-tine aeration to move oxygen to the roots during the hot times of the summer.

Old Brockway Golf Course, Lake Tahoe, California
By Dave Laurie, Golf Course Superintendent

Old Brockway was founded in 1924. Harry Comstock and R.O. Sherman hired John Duncan Dunn from North Berwick, Scotland to design and build the course. Chinese Labor and horse-drawn pans were used for construction and shaping. It was designed in the classic style with small push-up greens and narrow fairways. Towering Jeffrey and Ponderosa Pines, as well as White Fir and Red Cedars line each fairway. Twelve holes were originally finished but during the depression it was scaled down to the existing nine holes. Old Brockway was the home of the first Bing Crosby and Bob Hope Golf Tournaments. Not much changed until the early eighties when the first automatic irrigation system was installed that has since been updated in 2000.

We became a certified Audubon Cooperative Sanctuary golf course through Audubon International in 1998. We were also the first nine-hole golf course west of the Mississippi and only the fifth golf course in California at the time. We had pursued certification to inform the public of our stewardship efforts. We were also thinking of expanding to eighteen holes. We started exploring and expanding our organic principles during this time period. More and more organic fertilizers became available. We also discovered that less fertilizer was required to meet our needs on the course. Greens and tees needed only once-a-month application instead of every other week and fairways and roughs need only once-per-year instead of spring and autumn.

Our philosophy is to keep turfgrass vigorously green and growing in order to heal the wear and tear of 30,000+ rounds played on this classic layout per season. Our season is April 1st through Nov 1st with snow cover the rest of the year. Green sizes are approximately 3500 square feet with undulations inhibiting many cup placements. Tees are small with many divots and fairways and roughs deal with a lot of cart traffic.

My organic approach is nothing new. My grandfather used it in New England dairy farming. Our reasons for using organics are: better results, more sustainability, better overall color (meaning not nuclear green), better performance, and longer releases without constant inputs. We think of it as simply “feeding the soil”. Public reaction to our approach has been extremely positive. Organic fertilizers are not complicated to use with a steady, slow release. It is just the right thing to do.

Our management plan is simple, incorporating Best Management Practices and Integrated Pest Management programs. We also came to the realization that it doesn’t matter what you use if you rapidly flush it through the soil profile. Our irrigation system is constantly monitored with daily scouting and adjusting. We do not remove clippings from our fairways or roughs. Clippings from the greens and tees are spread in strategic areas in the roughs. Our objective is to find a height of cut that balances fast playable surfaces with turfgrass sustainability. Height of cut on greens is .150, tees .500, fairways .600, and roughs 2.0.

Disease pressure is low with only gray and pink snow mold being any real concern. Weed pressure is medium with one spray application needed per year. Green color is very desirable for our golfing public. A big concern is snow and ice build-up in the winter months. We aggressively melt and remove the snow starting in February. We spread nitrified humus that has been composted on all playing surfaces. It is used for its dark color and, as it melts the snow, it adds nutrients. Naturesafe, Roots, and Groganics have all been used successfully with their basic makeup of chicken crumbles and bone meal. Due to soils that have grown and sustained a turfgrass playing surface for 80+ years, the soil is close to being balanced. We have noticed a big increase in earthworm activity. Our organic soils seem to hold water and nutrients better, as well as, release them consistently.
Due to our small staff of five, we also use wetting agents to help curtail much spot watering.

Organic Maintenance and Recycled Water Use from the Wawona Golf Course in Yosemite National Park

Kim Porter Superintendent Wawona Golf Course
Yosemite National Park, California

Climate

- Average Max Temp 90.0°F
- Average Min Temp 25.9°F
- Average Mean Temp range: 50 - 55°F
- Average Precipitation is 44.8- inches
- Frost Free Days range: 100 to 150

Soils

- Well drained sandy loam - 91.8% Happyisles-Typic, Dystroxerepts association (mountain slopes)
- Well drained silty loam - 8.2% Ultic Palexeralfs-Humic, Dystroxerepts complex (mountain slopes)

Watershed

- Upper Merced watershed
- South Fork Merced River
  National Wild and Scenic River
  Originates around 10,000 ft elevation in the remote southern reaches of Yosemite National Park. The river is 40 miles long and drains a 241 square-mile watershed.
  Trout species include: rainbow and brown trout

Now thoroughly entwined within the area's rich history, Wawona Golf Course was opened in 1918 by the Washburn brothers. It was constructed in the Wawona Meadow, a hay field used for grazing sheep. On August 20, 1932 the U.S. government purchased the Wawona Hotel Company. Six days later, President Hoover's proclamation adding 8,785 acres of the Wawona Basin, including the golf course, to Yosemite National Park was publicized. Today, the course is a USGA member course and a Certified Audubon Cooperative Sanctuary.

The 9-hole course is located in the Sierra Nevada Mountains at 4,000-feet between the Mariposa Grove of giant sequoias and Yosemite Valley landmarks. Because the course is located within a national park and within an environmentally sensitive area, golf course maintenance practices are organic or "chemical free". In addition, the course has incorporated recycled water from the National Park Service (NPS) for irrigation. Both of these circumstances; organic practices and recycled water use, have help to promote environmental stewardship and maintain a great course to play golf.

Wawona Golf Course is located on approximately 50-acres of which 35-acres consist of managed turfgrass species. The primary species for fairways, roughs, and tees are ryegrass with some fescue and bluegrass. Greens are primarily creeping varieties of bentgrass. The selection of grass species is an important aspect of our organic maintenance practices and specifically the cultural control element of our Integrated Pest Management (IPM) plan. Our IPM plan is not complicated, because we are "chemical free" and have not used biological control methods. Diseases are controlled by selection and diversity of grass species and varieties, watering practices, height of cut, thatch removal and aerification. The ryegrasses seeded in the fairways, collars, approaches, and tees are mixed cultivars and provide improved disease resistance. On our greens, a mix of bentgrasses provides the same benefits, plus the creeping cultivars will help repair damaged areas.

Our disease pressure is not bad, but is generally drought induced brown patch on the collars and our greens hold up fairly well against it. The grass will wilt making it susceptible to damage, but our grass's roots generally do not die. Generally, when we water, the grass will respond well. When the greens are hot we'll cool them down by syringing them with water. As needed for diseased areas, we will use a ballmark repair tool to create small holes like aerification would and simply seed and sand the areas. The grass will respond within 7 to 10 days.

If we have "rust" on the grass, we simply let it grow and then trim the excess growth. Occasionally, verticillium wilt will occur, but not in a vast area and we'll simply aerify and seed the area. The grass comes back in good shape. Because of our isolation from the agricultural community, our insect problem is almost non-existent with the exception of cut worms. Here again we've learned timing is best for prevention. We try to aerify and verticut as soon as the weather allows and before the moths appear. Should we get an infestation, we poke the holes with a piece of wire or sometimes we flood the greens with water in the early morning. When they come out of their holes we'll step on them or let the birds eat them. "Weeds" are controlled by cultural methods such as timing, verticutting, core removal and overseeding.

A well built soil is also essential for healthy turfgrass, disease resistance and recovery. Our soil fertility comes from the normal decomposition of grass clippings as well as composted manure and reclaimed water. We'll remove the grass clippings from the greens only and mix them with horse manure from the park's stables along with dirty sand and other organic waste from the course. Our compost is put into different piles and we allow the compost to age approximately

2-years. This aging process helps to control undesirable plants' seeds that we could inadvertently introduce onto the course through the application of compost.

We don't have a magic ratio of manure to clippings and other trimmings, but we strive to create a consistency equivalent to potting soil. We will use the compost as a top dressing on our greens, tees, and any washed out areas that we may have to repair. We do not have a lot of compost and therefore do not use a lot of it throughout the course. We can not import top soil into the golf course and the compost provides a good product in lieu of a poorer silty product associated with some top soils.

In addition to the compost, our recycled water provides nutrients for our turfgrass in lieu of fertilizers. Our irrigation water source is from the NPS sewer treatment plant that services Wawona basin. The water source for the NPS is the South Fork of the Merced River. After the water goes through the tertiary treatment plant it is stored in two 2.4-million gallon storage tanks.

On average we use approximately 200,000 gallons of recycled water per day when it is available. Our irrigation time is between 9:00 p.m. and 6:00 a.m. and normally we irrigate greens 3 to 4 times a week – deeply. We irrigate the fairways 3-days a week and roughs 2-days a week. We will spot water during the day by hand as necessary. When we water we observe no spray zones to help protect the environment from run-off and we comply with California's regulations regarding the use of recycled water.

The cost for our water is $0.30 / 1000 gallons. Potable irrigation would cost $5.50 / 1000 gallons, but it is not used on the golf course. Because the golf course is the spray field for the treated water we usually have to dispose of some of the stored water in the early spring when the demands of the golf course are low or none. Disposing of the excess water is at no cost to the golf course and we select areas that can handle the excess water. Later towards September and October, the demand for water on the course is higher than the treatment plant's production and allocation of water must be prioritized with greens getting the most and roughs the least.

We do utilize a water conservation plan during times when the recycled water is not readily available. The NPS may use the recycled water for fire-fighting purposes thereby reducing the amount of water available to us. We prioritize the areas we water during these periods with the greens ranking first and then tees. In addition, we adjust the irrigation schedule to compensate for the water budget. Roughs and fairways may not be irrigated. For example; during the summer of 2007, the South Fork Merced River had low flows and in conjunction with NPS restrictions we did not irrigate for 9-days. During these periods the turfgrass goes dormant, but when we water the turfgrass responds quickly and with excessive growth. We are fortunate that our turfgrass root zones are extended to 8 to 12-inches, which helps the turfgrass tolerate drought conditions. This is in-part due to our organic maintenance practices and environment.

However, our mowing frequency may increase from four days per week to five days per week to compensate for the growth from the recycled water. We are fortunate that our recycled water is “clean” without extremely high concentrations of bicarbonates, sodium, etc. A standard mineral test is performed once a year. In September 2006, the sodium level was at 110 mg/liter. Other tests of the effluent water are done monthly with nitrate levels averaging 27 mg/liter and phosphates averaging 12 ppm. All test results are obtained from the Wawona Utilities Yosemite National Park Service.

In addition, soil tests are performed once a year to help monitor the effects of irrigating with recycled water. Staff monitors the pH, concentrations of metals, etc. Because much of the precipitation here falls in the form of snow which melts slowly, natural leaching of sodium and high levels of other metals are reduced. Our last soil amendment was applied about 1990 and was used for pH adjustment as well as sodium control. This was accomplished by applying gypsum at the recommended rate to liberate the sodium ion for leaching, then applying dolomite lime to liberate the sulfur for leaching there by raising pH levels.

We do not use a filter system with our irrigation system and we do not have algae problems. As the water sits within the storage tanks, particulates and solids settle to the bottom of the tank. There is one maintenance issue resulting from the use of recycled water. We have had to work on the irrigation heads due to electrolysis from the recycled water reacting with copper screws. We have replaced the screws with different copper and silicon coated screws and these last much longer. These maintenance activities are minor compared to the benefits we receive from using recycled water.

In addition to using recycled water and organic practices on turfgrass, our native or unmowed areas are part of the environment at Wawona Golf Course. Un-mowed areas on the course consist of native species associated with the fir and pine forest ecosystems. In fact, Wawona is believed to be a Native American term for “big trees” and Wawona is known as an area of “old growth forests” because the trees have large circumferences. Areas of native vegetation help protect nearby surface waters from run-off as well. Tallgrass areas are easily maintained and readily respond in the spring after winter snows. We manually remove weeds including common mullen, purslane, thistle and woody invasives from these areas. The natural areas provide corridors for wildlife species to move throughout the area. Juncos, sparrows, chipmunks, mule deer, and other wildlife can be found throughout the area. We occasionally deal with wildlife damage, but try to keep the wildlife off of the play areas as much as possible. The NPS conducts interpretive tours throughout the area including the golf course.

Wildlife viewing opportunities and the native areas are appreciated by the golfers at Wawona Golf Course. In addition, golfers understand the maintenance practices at Wawona Golf Course including the associated effects from aerification, top dressing, and reduced watering.

My education at California State University, Fresno, helped prepare me for the environmental aspects of being a golf course superintendent. I became superintendent at Wawona in 1980 and have enjoyed the challenges and opportunities provided by maintaining a golf course using organic products and recycled water. I have noticed that visitors and golfers to Wawona Golf Course have come to appreciate the environmental stewardship practices we perform on a daily basis. Without these practices, Wawona Golf Course might not exist in Yosemite National Park.

USGA Turfgrass and Environmental Research Online
Evaluation of Reduced Chemical Management Systems for Putting Green Turf

Jennifer A. Grant and Frank S. Rossi

Communities around the world are increasingly demanding that golf courses be managed with few or no pesticides. Yet managers faced with operating their facilities under constraints on the use of chemical technology need information on how to maintain acceptable golf course turf. At the same time, those advocating pesticide restrictions need to be aware of the costs of implementing the policies and the resulting impacts on golf turf performance. For these reasons, we designed a project to provide information on the feasibility and performance of putting green turf managed using Integrated Pest Management (IPM) systems or no chemical pesticides.

Our objective was to evaluate the aesthetic and functional performance of golf putting greens managed under various cultural and pest management systems for feasibility, biological/physical response and golfer satisfaction. The project explored total management systems, as practiced by turf managers, rather than focusing on individual technologies and isolated practices. The work was conducted at the Bethpage State Park on the Green Course, Farmingdale, NY. This course accommodates approximately 50,000 rounds of golf annually, has push-up soil greens that have been heavily sand topdressed for the last six years, and is typical of a high-use public course in the New York City metropolitan area.

Management Practices

The experiment was designed as a 3 x 2 factorial, with three pest management and two cultural management regimes.

Pest Management

Unrestricted

All legal chemical pesticides in New York State were available for pest management (i.e. practices similar to a medium budget public golf facility in the Northeast US). Preventative control of pests was a significant aspect of weed, insect, and disease management.

IPM

Pest management practices were determined by the specific needs of individual greens. Actions were based on scouting information, action thresholds (when

feasible) and site history. Cultural and biological approaches to prevent and minimize pest problems were emphasized, but any legal practice or pesticide was available. When pesticides were deemed necessary, the least-toxic and most effective products were selected based on potential risk factors such as water quality impact, effects on non-target organisms, and toxicity to humans. In this system, acceptable turfgrass performance was not intentionally sacrificed. Therefore, it was sometimes necessary to select a more toxic method in order to maintain expected performance (e.g. quality ratings above 6 on the NTEP rating scale and ball roll distance >2.4 meters) and to avert significant turfgrass damage or loss of turf. Prophylactic chemical treatments were used only when justified by significant site history of problems, pending weather conditions, limitations of labor force, and lack of curative strategies that were acceptable in the risk assessment process.

Non-Chemical
As in the IPM treatments, cultural and biological approaches to prevent and minimize pest problems were emphasized and decisions were based on the specific needs of individual greens. However, no pesticides registered in EPA class I (danger), II (warning), or III (caution) were allowed. The non chemical treatment criteria were based on current restrictions for several municipally-owned golf courses and other turf facilities in New York State.

Cultural Management

Current Standard
Cultural practices currently being employed at the golf courses of the Bethpage State Park.

Alternative
The cultural practices in place at Bethpage were modified in an effort to reduce turfgrass stress and minimize pest problems, while striving to maintain minimum performance standards (e.g., quality ratings above 6 on the NTEP rating scale and ball roll distance > 2.4 meters). Practices such as increased fertility, double-cutting, and rolling were implemented if necessary to maintain these performance standards.

The experimental design resulted in six management systems as shown in Table 1. Each green served as a replicate, and we used all 18 greens of the Bethpage Green Course to accommodate three replications of the six management systems. System I was typical management for the Green Course--a quality, high-use public golf course. Systems III and V were the same management systems with restrictions on pesticide use. The standard and alternative cultural practices are summarized in Table 2. Practices were frequently adjusted during the season each year to respond to turfgrass performance and weather conditions.

After the first season, the greens in system VI were re-sodded with nine-month-old velvet bentgrass (SR 7200). Halfway through the second year, we conceded that we were unable to maintain acceptable conditions in system V, and we could not guarantee the survival of those greens. Therefore, those three greens are now

being managed with alternative cultural practices providing a comparison of traditional *Poa*/creeping bentgrass greens and velvet bentgrass greens with non chemical pest management. Some cultural and biological practices were employed specifically to prevent or reduce pest problems. These practices were implemented on some or all of the non-chemical and IPM greens (when and where appropriate), such as:

2001

- Rolling greens in the morning to reduce incidence and severity of dollar spot
- Increased fertility to aid recovery from dollar spot injury
- Application of entomopathogenic nematodes (*Heterorhabditis bacteriophora)* against annual bluegrass weevil larvae and cutworm caterpillars
- Manual removal of weeds
- Green closure to reduce traffic and allow for renovation (four non chemical greens, three of which were closed for over one month)
- A winter compost cover of AgreSoil (biosolid-based compost) to reduce snow mold incidence and severity

2002

- Tree removal around four non chemical and one IPM green to increase sunlight and air circulation
- Renovation with velvet bentgrass
- Increased fertility to aid recovery from dollar spot injury, increased use of ammonium sulfate, and use of Sustane fertilizer
- Regular applications of a biological fungicide, *Trichoderma harzianum* (TurfMate)
- Manual removal of weeds
- Green closure to reduce traffic and allow for recovery (one green for three weeks)
- A winter compost cover of NutriBrew (brewery-based compost)
- Occasional applications of compost tea (Earthworks)
- Phosphite product (Nutrigro) for prevention and alleviation of summer stress and decline
- Standard fertility supplied with kelp-based materials from Plant Food Company

2003

- Increased fertility to aid recovery from dollar spot injury, increased use of ammonium sulfate, and use of Sustane fertilizer
- Regular applications of a biological fungicide, *Bacillus licheniformis* (EcoGuard)
- Manual removal of weeds
- Green closure to remove traffic and allow for recovery (2 greens, 3-5 weeks each)

- Phosphite product (Alude) for prevention and alleviation of summer stress and decline
- Reduced risk fungicide, polyoxin-D (Endorse), derived from fermented *Streptomyces cacaoi*, for brown patch control
- Reduced risk insecticide, spinosad (Conserve), produced by a soil-dwelling bacterium (*Saccharopolyspora spinosa*), for cutworm
- control

Performance and Pest Evaluations
Putting greens systems were evaluated throughout each growing season for aesthetic and functional performance, pest occurrence, species population dynamics, and tissue and soil nutrient content. Greens were inspected three to six times per week for signs and symptoms of disease-causing organisms, agronomic stress, insect pests, and weeds. Occurrence was mapped and quantified. In the second and third year, most diseases were recorded by "percent area of the green over threshold", according to action thresholds agreed upon by both researchers and golf course personnel (Table 3). Additional insect monitoring techniques such as irritant sampling (soap flushes), cutworm pheromone traps, pine litter floatation and soil core examination were used at appropriate times to detect and quantify insect populations.

Visual quality of putting greens was assessed periodically using the NTEP rating system (1-9, with 1= dead turf, 6= acceptable turf and 9= ideal turf). Ball roll distance was also measured periodically with a Stimpmeter (six rolls at designated permanent location on green, three times in two directions) for adjustment of treatment practices. In addition, annual bluegrass populations were monitored approximately once a month throughout the project using the point-quadrant method.

Economic Analysis and Golfer Satisfaction
To address the practical implications of our work, we are assessing the feasibility of each management system. Costs of labor and materials for each management regime were recorded for an economic analysis. To assess golfer acceptance, nearly 200 golfers were surveyed in the fall of 2003 for their perceptions of putting green quality and their opinions on pesticide use.

Results

General Observations
Putting greens are involved in at least 75% of the shots in a round of golf and are therefore an integral aspect of the game. High quality expectations and low pest thresholds for these areas present a formidable challenge when reducing pesticide inputs. In most cases we were able to maintain quality of IPM greens while drastically reducing Insecticide e and herbicide use, and to a lesser extent fungicides (Tables 4 and 5). Diseases and heavy traffic were responsible for low quality and sometimes death of non chemical greens. Variable and severe environmental conditions explain much of the difficulty in managing diseases, whereas weeds and insects are not as clearly climatically influenced.

Pests and Pest Management
Throughout the study, dollar spot was the primary pest problem in all treatments and was the target of the majority of pesticide applications. This disease severely reduced visual quality and performance of non chemical greens and was responsible for the closure of four greens during the first year. The three standard culture non chemical greens received an emergency chemical fungicide application in early August of the second season to mitigate dollar spot, and received two to three emergency applications per green in the third season to control dollar spot and other diseases.

It should be noted that regardless of pesticide use, some unrestricted and IPM greens had more days with some portion of the green over threshold for dollar spot than did the non chemical greens (Fig. 1). This does not relate to how widespread problems were on each green, but does demonstrate that some turf areas escape control even with full chemical availability.

Anthracnose was also problematic mainly in the first year and on greens cut at lower heights, but was usually considered to have stemmed from turfgrass stress rather than acting as a primary pathogenic agent. Anthracnose was diagnosed on the velvet bentgrass greens in 2002 and 2003 in areas near bunkers where sand was deposited on the green followed by clean up passes.

Rhizoctonia (brown patch) was a minor problem in the first year, problematic on two greens in 2002, and flourished in the third year of the study when hot, humid conditions persisted into evening hours and favored pathogen development. The reduced risk fungicide, Endorse, was applied regularly in effort to stem the tide of brown patch on IPM and non chemical greens and up to four chemical fungicides were applied to the unrestricted greens for brown patch control.

Fairy ring became a prevalent and sometimes severe problem on the non chemical greens and some of the IPM greens in 2002, and continued into 2003. We associated its occurrence with greens that had been covered with compost the previous winter, and the velvet bentgrass sod that arrived with a significant thatch layer. The disease was often severe enough to create hydrophobic conditions and was managed with wetting agents, hydrojecting, and fungicides on the IPM greens. Diseases other than those discussed were occasionally detected, but were not the target of pesticide applications and did not result in loss of turf.

Insects of significance were black cutworms and annual bluegrass weevils (ABW). In 2001, an application of a biological insecticide (*Heterorhabditis bacteriophora* nematodes) was targeted at second generation ABW control with the benefit of cutworm population reductions also expected.

Nematodes were not applied in 2002 because of their expense and apparent lack of efficacy the previous year. It should be noted, however, that naturally occurring *H. bacteriophora* nematode-infected ABW have been detected at low levels in all years. The heaviest populations of ABW were observed in the collars

and other higher-cut turf. We were fortunate that no damage occurred on the greens. However, if an entire course were managed without pesticides, ABW management could be a significant challenge in the northeast. In 2003, the reduced risk insecticide Conserve was used successfully for cutworm management on IPM and non chemical greens.

Weed concerns in all years were dominated by crabgrass and goosegrass in the *Poa*/creeping bentgrass greens, and *Poa annua* was considered a weed in the velvet bentgrass greens. In 2002, goosegrass incidence was much higher in the standard cultural treatments as opposed to the alternative treatments (Fig. 2). However, differences were not significant due to high variation among greens, and this trend was only seen in the non chemical treatments in 2003.

Throughout the study, weeds were removed manually from IPM and non-chemical greens, and were treated by one annual herbicide treatment to all unrestricted greens. Some IPM greens were also treated with herbicides: four in 2001, two in 2002, but none in 2003. Note that both greens requiring treatment in 2002 were in the standard cultural treatment. Weed populations in the nonchemical *Poa*/creeping bentgrass greens have been increasing, and requiring more time to weed. In addition, the collar of one of these greens was treated with an herbicide in 2003 to reduce pressure of goose and crabgrass invasion.

The number of chemical pesticide applications is summarized in Tables 4 and 5. In all years, most pesticide applications that were avoided on IPM greens occurred early in the season before dollar spot was widely established. The three non chemical, standard culture greens received one emergency fungicide application in 2002, and two to three per green in 2003. No chemical pesticides were used on the velvet bentgrass greens, except that in 2003 one velvet green received a an application of Alliette for suspected Pythium root rot and all received one or two reduced risk insecticide applications.

Fertility

The unrestricted pest management, standard culture greens received the least amount of nitrogen (2.7 lbs./1,000 ft2) (Fig. 3). The alternative culture treatments received more N than their standard counterparts in the unrestricted and IPM treatments. However, in the non chemical treatments, alternative culture greens received less N. This is partly due to different nutrient requirements for velvet bentgrass, and because the standard culture non chemical greens received extra nutrients in an attempt to compensate for pest damage and poor turfgrass health and to promote recovery.

Visual and Performance Quality

In 2001, the quality of all greens was below acceptable in the early season but recovered by June. Quality of all non-chemical greens was unacceptable as of late August to early September, resulting in closed or very low quality greens for the remainder of the season. Quality of five of the six IPM greens equaled that of the unrestricted treatments throughout the season.

In 2002, all IPM and unrestricted treatments maintained acceptable quality throughout the season (Fig. 4). The quality of non-chemical standard greens was better than 2001, but still very low in August. The velvet greens were unacceptable in August, but recovered and were acceptable for the rest of the season. In all treatments, quality of the alternative culture greens was usually higher than their standard culture counterparts.

In 2003 all non chemical greens were below acceptable quality for much of July and August (Fig. 5), and one velvet green was closed for a month. IPM and unrestricted greens were similar in quality for most of the season (Fig. 6), but the IPM greens fared worse in 2003 and were sometimes slightly below acceptable quality in both May and August, and two greens were unacceptable in September.

Throughout the study we struggled to achieve ball roll values of >2.4 meters (Table 6), but measurements were surprisingly low. Even the standard culture, unrestricted pest management systems that mimic normal Bethpage practices often did not produce the targeted ball roll distances. Obviously the use of triplex mowing may be a factor. However, we were still unable to achieve desired distances with topdressing and use of a growth regulator (Primo) on a regular basis. Ball roll distances were slightly lower in the alternative culture unrestricted and IPM greens, but not as much as might be expected based on N input. This raises an interesting question regarding nitrogen use and ball roll. Distances were moderately low for the non chemical velvet bentgrass greens and very low for the *Poa*/creeping bentgrass non chemical greens.

Labor

Increased labor needs are an obvious component of both IPM and non-chemical management. Basic scouting requires two to three hours per day and additional time when specific measurements or sampling protocols must be done (e.g. insect floatations, *Poa* population counts). Other practices essential to these management regimes are listed as follows with the approximate amount of labor hours required to perform each duty on 18 holes: rolling (5 hrs), topdressing (6-8 hrs), Hydrojecting (6 hrs), verticutting (4 hrs), double cutting (4 hrs), hand watering (5-8 hrs), and manual weeding (variable). In addition, extra time was spent repairing and fine tuning the irrigation system, mixing small individual batches of pesticides, and keeping maintenance equipment in excellent condition for proper IPM.

Labor use in 2002 is presented in Figure 7. The majority of labor hours on the golf course are spent on cultural management, and alternative cultural management always took more time than standard culture. Labor time spent on pest management decreased with lower pesticide usage. However, this is a small portion of the overall labor hours. As might be expected, the unrestricted pest management standard culture system was the most efficient in terms of labor hours.

Other labor issues to be considered are that many of these tasks must be performed early in the morning in order to be effective, and scouting time may double if the scout does not stay ahead of golfers when play is heavy. It was very

difficult for Bethpage Green Course staff to carry out the practices mandated by the various management systems in this experiment with first tee times as early as 5:04 a.m. A few tasks were made more labor intensive by the nature of the experiment (e.g. mowing at two different heights). However, most labor needs would be multiplied when implementing one of the management regimes on all 18 holes of a golf course. The course supervisor estimates that a minimum of 9-10 employees would be necessary to replicate the IPM or non-chemical systems on an 18-hole course.

Golfer Satisfaction Survey

Scores showed no differences by treatment in golfer perception of the visual quality of greens (Fig. 8) and the green speed (Fig. 9), and golfers rated all green speeds as "just right" or slightly fast. Golfers did perceive a difference in tracking quality of greens and rated the IPM alternative greens lower than other treatments (Fig. 10). Slow healing of some IPM greens after aerification likely caused these low ratings. When asked how they felt about pesticide use on public golf courses, the majority of golfers surveyed chose the IPM answer: "Keep greens at reasonably good quality, using pesticides judiciously, only as needed" (Fig. 11). Only 14% of golfers wanted pesticide use reduced if it meant a reduction in quality.

Outreach and Impact

Results from this study have been publicized in a number of formal and informal settings, in addition to reporting to the USGA. At a public field day in August 2003, 60 people toured the Green Course and learned about the alternative and IPM practices and products employed in the project. To date we have given 40 presentations and written 15 reports and articles, reaching several thousand golf course superintendents and environmental advocates in the U.S., Canada and beyond.

Discussion

In 2001, no clear differences were seen between the quality of greens managed with standard vs. alternative cultural practices. In 2002, the alternative culture greens generally performed better in all pest management treatments. Less pesticide was also required to maintain alternative greens under both the IPM and non-chemical strategies.

Overall quality was highest in the unrestricted pest management, alternative culture greens. Also, the quality of the IPM alternative culture greens was usually higher than that of the unrestricted standard culture greens in 2002. This might suggest that two management strategies are superior to those currently practiced on many public golf courses. However, differences based on culture were less pronounced in the first and third year. It is likely that the wet weather conditions in 2003 outweighed any positive effect of alternative cultural management practices. In 2003, we utilized more of these biological and reduced risk pesticides, but had less labor.

Greens that were covered with compost in winter greened up more rapidly in spring and produced significantly more clippings than the non-composted

treatments. Compost applications likely increased the population of beneficial microbes in IPM and non chemical greens and may have contributed to reduced dollar spot incidence. However, the winter compost covers left layers in the soil profile and were associated with damaging fairy ring infestations and a high incidence of brown patch. Increased fertility from the compost in the early season resulted in healthy turf with high density and rapid growth that prohibited acceptable ball roll distances.

Several attempts were made to vertical mow and thin the turf, but we were not able to reconcile the desire for a healthy turf stand with the unacceptable ball roll distances in the low to mid 2-meter range. We decided not to use compost covers in the winter of 2003-2004, but the overall benefit of compost covers may be greater in areas with more intense and consistence snow mold pressure. The spoon feeding approach on the standard cultural management greens provided acceptable turf quality, but we still had difficulty attaining ball roll distances in excess of 2.4 meters. Soil tests indicated a significant lack of potassium, although tissue tests did not reveal the deficiency.

The alternative cultural systems utilized Sustane 5-2-4 fertilizer to supply greater than 50% of the nitrogen for the season. The remaining N was supplied with ammonium sulfate in 2002 and 2003 in an effort to reduce surface pH and thereby minimize certain pathogens of annual bluegrass associated with higher surface pH. Also, elemental sulfur was applied (150 kg per hectare) to the velvet greens in an effort to reduce the pH. Theoretically, this would make the surface more hospitable to the velvet bentgrass and less so for the annual bluegrass.

Phosphite products (Nutrigrow in 2002 and Allude in 2003) were donated by Cleary Chemical to mitigate summer decline symptoms. We do not know if the observed benefits of these products are because of nutritional effects on plants and/or direct impacts on pathogens that might be associated with summer decline such as Pythium root rot. Fertility on the velvet bentgrass was high in both 2002 and 2003, yet surfaces still appeared to be off-color and thin for much of the season, especially in July and August. The poor quality in 2003 may have been related to persistent, excessively wet conditions and a significant thatch layer. The major disease has been fairy ring which left depressions that affected ball roll.

While there had been concern for the overall recuperative ability of velvet bentgrass, we found no evidence to suggest that the velvet was any less tolerant of the 50,000 annual rounds of play than the previous mixed stand of creeping bentgrass and annual bluegrass. The velvet, however, was more attractive to cutworms and/or more susceptible to their damage, and healed slowly from ball marks.

Early in the project it was clear that pesticide use in the IPM systems could have been further reduced if it were easier for the superintendent to quickly respond to rising pest levels. A large spray tank makes small spot treatments difficult and inefficient. Furthermore, sprayers at Bethpage are shared among courses and thus not always available on short notice. These factors greens when spraying the

unrestricted greens. An injection sprayer was donated to the project to help overcome these issues.

We are still analyzing the full economic implications of each management regime. However, it is clear that a minimum of one or two extra employees would be required for a course to implement IPM and non chemical management strategies. Golfers in our satisfaction survey were accepting of the greens quality in all treatments. However, we surveyed in October, and need to repeat the survey in the stressful months of July or August. In our study, it has been necessary to close some non chemical greens each year. These conditions on a solitary golf course would undoubtedly be unacceptable and would result in loss of revenues.

The range of results over the three years of the study reflects the variation of environmental conditions. In a wet year like 2003, cultural and biological methods for disease suppression are less effective. In the Northeast, *Poa*/creeping bentgrass greens are highly susceptible to disease and stress pressure in July and August.

Management with few chemical pesticides continues to be a challenge during these summer months. We believe that pesticide use can be significantly reduced in some years without compromising quality. However, research is still needed to develop tools and knowledge to deliver consistent and reliable results with few or no chemical pesticides.

Lastly, it should be noted that this project has already filled a significant role of informing turfgrass managers, environmental advocates and policy makers about golf course management with fewer pesticides. Discussion of this project has opened new dialog in many arenas where interested parties were previously adversarial. An example of the positive impact is that Suffolk County (which borders Bethpage State Park) reassessed their pesticide restrictions and revised their policy to one which is more scientifically based.

The Suffolk County-owned golf courses had been banned from using chemical pesticides, with the potential to obtain up to three application exemptions per year. Through extensive discussions of this project and of basic principles of IPM, the diverse committee guiding implementation of the law decided to amend the law. The committee adopted an IPM approach that now allows pesticide use when specific criteria are met including: research-based thresholds, local tolerance levels for pests and pest damage, site history, forecasted weather, and available management options. Interest in reduced and non chemical management of golf courses in North America has been mounting in recent years. Communities throughout the U.S. and Canada are learning from our results.

Acknowledgements
We would like to thank the USGA, Bethpage State Park, Raven Industries, Toro, the Sustane Corporation, Novozyme, BioWorks, AgreSource, BASF, Tee to Green Sod, Commodity Specialists, Cleary's Chemical, Storr Tractor, Plant Food Company, Maxwell Turf Supply Company, Tamson Yeh and Nassau County

Cooperative Extension and Long Island Golf Course Superintendent Association for their generous support of this project.

Table 1. The design of the experiment using two cultural practices and three pest management strategies resulted in six treatment combinations, or management systems.

Cultural Practices		
Pest Management	Standard	Alternative
Unrestricted	I	II
IPM	III	IV
Nonchemical	V	VI (velvet)

Table 2. Standard and alternative cultural practices utilized on the Green Course's putting greens at Bethpage Sate Park.

Cultural Management*		
Practice	Standard	Alternative
Mowing Height (bench settings; mowing with triplex units)	2.8 – 3.6 mm (0.110 to 0.140") 2003 = 3.3 mm (0.130")	3.8 – 4.8 mm (0.175" to 0.188") Velvet always at 0.130" 2003 = 3.3 mm (0.130")
Mowing Frequency	1x/day, 7 days/week	2x/day, 5 days/week 1x/day, 2 days/week
Rolling	Groove (except 2003)	Solid
Irrigation	Automatic 3-4:00 am	Manually activated 4:30-6:30 am
Hand Watering	When wilting visible	Water known dry spots prior to wilting**
Fertilization	1/8 to 1/4 lb N every 2-3 weeks	1/8 to 1/4 lb N every 2-3 weeks + 1/8 lb Amm. Sulfate. Approx. 60-70% of N supplied via organic sources, notably Sustane
Topdressing	Every 2-3 weeks	Weekly, no brushing
Rolling	1x per week**	Up to 3x per week (if needed for ball roll)**
Vertical Mowing	Occasional	Every 2-3 weeks except during stress periods**
Hydro-ject	Occasional	Every 3 weeks, May-Sept.
Clean up Pass	4x per week	2x per week (3x in 2003)
*Practices adjusted in attempt to attain >2.6 m (8ft) ball roll distance. **Practice seldom or never done in 2003 because of labor constraints.		

Table 3. Disease thresholds that were used to rate putting green performance.

Disease	**Action Threshold**
Anthracnose	Detection
Dollar spot	2 spots/m^2
Fairy ring	If hydrophobic
Pythium root rot	Detection
Rhizoctonia	2 patches/green
Snow mold	10 patches/green
Summer patch	2 patches/green

Table 4. Mean number of pesticide applications in Unrestricted and IPM pest management systems.

Year	Unrestricted	IPM—Standard (% reduction)	IPM—Alternative (% reduction)
2001			
Insecticides	2	1 (-50%)	1 (-50%)
Herbicides	1	0.67 (-33%)	0.67 (-33%)
Fungicides	11	8 (-27%)	7.67 (-30%)
Total	14	9.67 (-31%)	9.34 (-33%)
2002			
Insecticides	4	2 (-50%)	2 (-50%)
Herbicides	1	0.67 (-33%)	0 (-100%)
Fungicides	14	10.3 (-26%)	8.30 (-41%)
Total	19	12.97 (-32%)	10.30 (-46%)
2003 ***Chemical pesticides applications only (not including reduced risk and biological pesticides)***			
Insecticides	2.0	1.0 (-50%)	1.0 (-50%)
Herbicides	1.0	0 (-100%)	0 (-100%)
Fungicides	11.2	8.7 (-22%)	8.0 (-19%)
Total	14.2	9.7 (-32%)	9.0 (-36%)
Reduced risk product and biological control applications			
Reduced Risk Insecticides	0	0	0.7
Reduced Risk Fungicides	2.0	4.0	5.0
Bio Fungicide	0	9.0	9.0

Table 5. Mean number of pesticide applications in non chemical management systems in 2003.

	Standard	Alternative (velvets)
Chemical Insecticide	0	0
Chemical Herbicide	0	0
Chemical Fungicide	2.7	0.3
Total	2.7	0.3
Reduced Risk Insecticide	0	1.3
Reduced Risk Fungicide	7.0	3.3
Total	7.0	4.7
Bio Fungicide	13.7	4.3

Table 6. Mean ball roll distances (meters) in 2003.

Pest Management			
Culture	**Unrestricted**	**IPM**	**Nonchemical**
Standard	2.4	2.4	1.3
Alternative	2.3	2.2	2.3

Overview of Management Practices and Considerations from the Case Studies and Survey Responses

General Considerations

There is no universal set of organic protocols that will work for every golf course. With that in mind, we have attempted to identify some of the practices and strategies used by golf courses that provided information for this report. The various practices and products included in the survey results, case studies, and this overview carry no explicit or implied endorsement of the committee and may not meet the proposed definitions for organic golf course management, natural organic fertilizer, natural organic pesticide, or synthesized natural organic pesticide. We recognize this is a limited sample of information and represents only a brief and incomplete overview. Some general considerations include the following:

- Use disease resistant and drought tolerant turfgrass species
- Visual perfection is not realistic, but excellent playability is attainable
- Add organic soil amendments with top soil during new golf course construction
- Ensure good drainage, full sun, and good air circulation
- Limit turfgrass stress by limiting or banning golf carts and managing mowing heights
- Transition to organic methods over time and begin with fairways and roughs
- Limit soil compaction by directing traffic and keeping these areas aerated and seeded on a rotation program

1. Pest Management	
Diseases	***Management Practices***
For all diseases	Selection of Disease-Resistant Turfgrass
Dollar Spot	Hydroject every 3 weeks, watering in the morning, spike twice a month
	Reduce leaf wetness period by removing dew from turfgrass as early as possible
	Carefully manage water, removing dew, aerate annually and spoon feed nitrogen during times of severe pressure
	Rolling greens in the morning
	Overseed to fill voids left from disease scaring and increase fertility to aid recovery
	Remove dew, nitrogen application in mid-summer, mow fairways when dry
	Increased use of ammonium sulfate and Sustane Fertilizer™
	Regular applications of EcoGard™ (*Bacillus licheniformis*)
Pythium	Improve sunlight and air circulation
	Tree removal, install drainage, careful water management
Brown Patch	Hydroject every 3 weeks, watering in morning, spike twice a month
	Apply Endorse™, a reduced-risk fungicide
Snow Mold	Spread nitrified humus that has been composted on all playing surface to melt snow and add nutrients
	No nitrogen applied after August, don't mow when grass is dormant
	Apply winter compost cover of AgraSoil™ (biosolid-based compost) to reduce incidence and severity
	Decrease *Poa annua* population, increase sunlight penetration, good cultural practices
Anthracnose	Hydroject every 3 weeks, water in morning, spike twice a month
	Increase nitrogen rate, increase mowing height
Fusarium Patch	Verticutting, thatch control, low rates of fall fertilization
Summer Patch	Hydroject every 3 weeks, water in morning, spike twice a month
	Application of Alude™, a phosphite product

Insects	***Management Practices***
Oriental Beetle	Overseed and aerify, shut off irrigation, seed instead of sod, predator (varmint) control
	Beneficial bacterium (Buibui) applied
Grubs	Remove thatch, deep tine, topdress
	Application of milky spore (*Bacillus popilliae*) and repair damaged areas daily
	Restrict water and fertilizer on greens for about 7 days to bring grubs to surface where they are removed
	Use pheromone traps
Bluegrass Weevils	Application of biological insecticide (*Heterorhabditis bacteriophora* nematodes)
Black Cut Worms	Application of Conserve™ a reduced-risk pesticide
	Aerate and verticut greens before moths appear and flood greens if infestation occurs to bring out worms to the surface

Weeds	***Management Practices***
Dandelions	Hand removal, aeration, low mowing height
Silvery Thread Moss	Verticutting, low mowing height
Clover and Crabgrass	Overseed and aerify, hand removal
Broadleaf Weeds	Healthy stand of turfgrass
General Weed Control	Use Waipuna machine that uses hot water and foam to kill weeds
	Use only sod or divot mix that is weed free
	Verticut greens bi-weekly and rotate top dressing on opposite weeks
	Overseed and replace areas such as clover with turfgrass plugs
	Hand picking for small areas

	Management Practices
2. Water Management	Water deep and infrequently
	Take soil temperatures and soil samples weekly
	Use state-of-the-art irrigation system
	Hand water dry spots with wetting agent
3. Fertilization	Leave grass clippings on fairways and roughs
	Increase nutrients to compensate for pest damage and promote recovery
4. Monitoring and Adaptive Management	Monitor golf course conditions daily and record pest management problems and control practices
	Communicate with other golf course managers in local area and others using organic methods
	Adjust pest management and other maintenance practices to respond to changing conditions, new products, and increased experience with organic management
5. Golfer Education	Communicate regularly with golfers about organic management practices and expectations through newsletters, golf course tours, club house displays, and open house discussions

9. SUMMARY AND CONCLUSIONS

In writing this overview report of organic golf course management, the authors have attempted to provide awareness and understanding of current circumstances regarding practice in the field, as well as, clarity of terminology and recommendations for the future. The idea of a totally organic golf course is a goal being pursued by some golf course managers and promoted by some activist and governmental organizations. How widespread organic golf course management becomes depends upon government direction, golfer acceptance or demand, as well as, advances in organic products and practices.

In reviewing the information presented in this report and considering that circumstances will evolve in the future, we offer the following conclusions and observations regarding organic golf course management:

1. Each golf course is unique. Therefore, the turfgrass management system used at each golf course should also be unique and reflect the desires and resources of the people playing at that golf course. Expectations for playing conditions and the corresponding turfgrass management system are best made by the appropriate governing body at each golf course in consultation with the golf course superintendent.

2. A number of golf courses reported to be organic do in fact use some conventional or synthetic pesticides or fertilizers. Despite this minimal use of conventional products, these golf courses operate at levels significantly below typical pesticide use at traditional golf courses. Although these golf courses may not fit the definition of a pure organic golf course, their willingness to explore this management alternative has paved the way for

other golf courses and for additional research into organic golf course management products and practices.

3. Based on the survey of golf courses reported to use organic management practices, there is no uniform, consistent definition of organic golf course management, organic fertilizer, or organic pesticide being used by the respondents.

4. The primary motivations for implementing organic golf course management practices and the effectiveness in turfgrass quality and golfer satisfaction vary widely across the golf courses responding to the survey. The managers of these golf courses recommend that others interested in pursuing organic golf course management start slowly, have reasonable expectations, do the research for the most appropriate practices and grass species for the area, and don't be reluctant to lean on other superintendents for information and advice.

5. A substantial amount of research has been conducted to evaluate current organic products, development of new products, and implementation of the principles and practices of organic golf course management. For pest control purposes some research of methods and products show promise, but, generally, they fall short of the level acceptable to most golfers. Future research will advance the science by learning more about the biology and behavior of target pests and the predator/antagonists and their interactions.

6. As more golf course managers attempt to use more organic products and practices and as more community leaders and activists promote organic golf course management, there is a need for consistent definitions and standards to reduce confusion for the golfing public and to maintain the credibility of organic terms as they are applied to golf.

7. The proposed definitions contained in this report are generally consistent or compatible with other organic labels and standards, however, given golfer expectations of playing conditions and aesthetic appearance of today's golf courses combined with the current availability of organic pest control products, few golf courses will be able to be in full compliance with these definitions. It is recommended that different levels of implementation be established such that golf courses can make the transition to organic golf course management over time with the goal of attaining full compliance with the definition.

8. As new organic pest-control products become available and as the awareness and motivation for organic golf course management increases, more golf courses will meet the definition and should thus be recognized for their achievement.

9. Even though the total number of organic golf courses will probably remain a small percentage of the total number of golf courses in the U.S., the

increased awareness, the experience of those early pioneers, and the expansion and improvement of organic products will benefit all golf courses interested in reducing use of synthetic pesticide and fertilizer products.

10. The golf industry and relevant stakeholder groups should adopt a common, national set of definitions for organic golf course management. This report and the proposed definitions are provided as a common focal point and collaborative framework for the industry and its stakeholders to adopt an accepted set of national definitions. After an appropriate review and revision of these definitions and endorsement by relevant national organizations, they should be adopted and applied in all regions of the country.

11. At an appropriate time in the future, a third-party certification system that is objective and credible should be established to administer organic golf course certification.

12. Organic golf course management can be a challenge to implement, however, attempting to reduce inputs on all golf courses or other maintained landscapes can be beneficial to the environment.

10. SOURCES OF INFORMATION

The sources listed below provide general information about golf courses, turfgrass management, best management practices, soil science, organic agriculture and environmental stewardship organizations active in the golf industry. The list is intended as a starting point for information and is not intended to be a comprehensive list of information sources.

Golf Course Organizations

- American Society of Golf Course Architects (ASGCA) www.asgca.org
- Golf Course Builders Association of America (GCBAA) www.gcbaa.org
- Golf Course Superintendents Association of America (GCSAA) www.gcsaa.org
- United States Golf Association (USGA) Green Section www.usga.org/turf/index.html
- USGA Turfgrass and Environmental Research Online http://turf.lib.msu.edu

Publications

Golf Course

- *An Environmental Approach to Golf Course Development* by W. Love, 1st Edition
- *Building a Practical Golf Facility* by M. Hurdzan 1st Edition
- *Environmental Principles for Golf Courses* www.crm.org

Turfgrass Management

- *Best Golf Course Management Practices* by L.B. McCarty. 2nd Edition
- *Turf Management for Golf Courses* by J.B. Beard. 2nd Edition

Best Management Practices

- *Best Management Practices for the Enhancement of Environmental Quality on Florida Golf Courses* by the Florida Department of Environmental Protection

Soil Science

- *Fundamentals of Soil Science* by H.D. Foth 8th Edition

Organic Agriculture

- Organic Trade Association www.ota.com

Environmental Stewardship Organizations that Focus on Golf

- Audubon International www.audubonintenational.org
- Center for Resource Management www.crm.org
- Environmental Institute for Golf (EIFG) www.eifg.org
- Long Island Neighborhood Network www.neighborhood-network.org
- Michigan Turfgrass Environmental Stewardship Program www.mtesp.org
- Oregon Golf Course Superintendents Association Environmental Stewardship Guidelines www.ogcsa.org
- United States Golf Association www.usga.org
- Xerces Society www.xerces.org

11. APPENDICES

Appendix I

Definition of Organic Golf Course In The Settlement Agreement For The Wildacres Resort, Catskill Mountains In The State Of New York

19. Organic Golf Course: The golf course at Wildacres will be managed as organic. The parties agree to certain principles and criteria for the organic management plan for the SDEIS and golf course operation as set forth below:

a. For the purposes of this Agreement, "organic golf course management" means operating and maintaining a golf course by using biological, cultural and mechanical practices that foster soil health, maintain biodiversity and the watershed ecology while ensuring playable golf course turf, without the use of synthetic chemicals (except as provided for pursuant to Exhibit E of this Agreement in Principle).

b. Organic management of the Wildacres Golf Course will be achieved and maintained by implementing a management approach that places on the site the fewest inputs necessary to provide a sustainable, high quality and nationally recognized golf course operation. To assure organic golf course operation at Wildacres, an annual Organic Management Plan will be developed, implemented and revised as necessary; a dynamic list of approved and prohibited substances will be complied with; and an Organic Golf Course Technical Review committee will be established to oversee implementation of this paragraph and Exhibit E. The Exhibit sets forth implementation details for this paragraph.

c. Provisions for implementing the organic golf course management approach set forth in this agreement and Exhibit E will be incorporated into the Crossroads SPDES permit to be issued by the NYSDEC in connection with this project. Unless modified as provided for in subparagraphs d. and e. below, the operator will adhere to the provisions of this paragraph 19.

d. Following five years of Wildacres Golf Course operation pursuant to this Agreement, the operator may seek approval from the NYSDEC to modify the conditions of its SPDES permit relating to organic golf course operation, provided that the State or federal government or an independent certifying entity adopts and implements an organic golf course program substantially similar to the one set forth in this Agreement and that the operator applies for and receives certification of the Wildacres Golf Course as organic under such a program. In this event, the SPDES permit for the Crossroads project will be modified to incorporate the operator's commitment to continued participation in and compliance with the respective new State or federal or independent certifying program.

e. Following five years of Wildacres Golf Course operation pursuant to this Agreement, Crossroads may seek approval from the NYSDEC to discontinue organic golf course operation and to remove such requirement from its SPDES permit. Should such approval be sought, the NYSDEC will solicit the advice of the Organic Golf Course Technical Committee and will approve such request only if it finds that the operator has demonstrated to the NYSDEC's satisfaction that the operation of the Wildacres Golf Course as a high quality nationally recognized golf course through organic management is infeasible under this provision and that the concerns raised by the operator cannot be adequately addressed through adjustments or modifications to the Organic Management Plan, as provided for in this Agreement and Exhibit E. In the event that NYSDEC finds that the operator has satisfied the above-described conditions for discontinuance of organic golf course operation under this provision, the NYSDEC will modify its SPDES permit for the Crossroads project and include a requirement that the operator implement a state-of-the-art Integrated Pest Management system for the Wildacres Golf Course that utilizes the fewest inputs necessary to provide a sustainable, high quality, nationally recognized golf course operation.

Exhibit E

Organic Golf Course Management Plan, Technical Review Committee, Approved and Prohibited Substances List

A. Organic Golf Course Management Plan. An Organic Management Plan for the Wildacres golf course will be prepared and included in the SDEIS. Any Party may provide Crossroads with information on organic golf course management practices that they recommend for inclusion in the SDEIS Organic Management Plan. The Parties will work cooperatively to provide this information in a timely manner, and in no event later than sixty (60) days after execution of this Agreement. The parties to this Agreement recognize that prevention is essential to organic turf disease management. To that end, the Plan will seek to advance such turf disease prevention strategies as minimizing the turf area that must be managed; planting disease-resistant species and/or cultivars; avoiding over-fertilization and over-irrigation; implementing a comprehensive cultural management regime focused on those practices that promote an environment not conducive to pest proliferation, including practices that enhance the edaphic environment as well as those other factors contributing to turfgrass plant health and ability to resist pest pressure. At a minimum, the Plan will cover the following topics: general turf fertility and health management; biological controls; mechanical controls; pest and weed pest; watershed contamination prevention best management practices, wildlife and habitat consideration, golfer outreach and education, worker training and record keeping and monitoring.

B. After issuance of all permits necessary for construction of the modified project, the Organic Golf Course Management Plan will be submitted to the Technical Review Committee described below, prior to the construction of the golf course and updated on an annual basis thereafter, and more frequently if necessary consistent with paragraph D(3). The Plan will contain, among other things, the protocol for the golf course operation that will establish and preserve a high quality playing surface while adhering to the organic management principles set forth in this Agreement.

C. Organic Golf Course Technical Review Committee
1. Establishment of Committee:
After issuance of all permits necessary for the construction of the modified project, an Organic Golf Course Technical Review Committee will be created by the NYSDEC. The Committee shall be composed of five (5) members, including: a representative of the NYSDEC, who shall chair the Committee; a representative of the NYCDEP and the superintendent of the Wildacres Golf Course or a Crossroads' designee until the superintendent is hired. In addition, Crossroads and the NGO signatories to the Agreement through NRDC will each identify an expert in turf management and/or organic turf management, to serve on the Committee.

2. Authority of the Committee. The Committee will:

a. Review the Organic Management Plan prepared by the operator on an annual basis (and any modifications to the Plan as may be sought by the operator) for the purpose of insuring the consistency of the Plan (and any such modifications) with the goals and objectives of this Agreement;

b. Review implementation of the Organic Management Plan at least annually in conjunction with a yearly audit of Plan implementation;

c. Review pest and input sampling methodologies utilized, monitoring reports prepared and data regarding type and quantity of inputs applied. For any inputs approved by the Committee, data that the Committee will review will also include type and quantity of input as well as surface water and shallow groundwater quality output data collected in accordance with the NYSDEC SPDES permit requirements; the Committee will also review such other monitoring data (and their sampling methodologies) regarding golf course inputs and outputs as may be required by the SPDES permit.

d. Conduct on-site golf course inspections at reasonable times;

e. Approve or disapprove: (i) the Organic Management Plan and proposed modifications to such Plan; (ii) requests for Special Use Exceptions pursuant to subsection D. below; (iii) additions or deletions to the lists of approved and disapproved products, pursuant to subsection D (1) and (2) below; such discretionary authority will be exercised by the Chairperson on the advice and recommendation of the Committee;

f. Make recommendations to the operator that may, in the judgment of the Committee, assist in achieving the objectives and principles of this Agreement relating to organic golf course operation;

g. Certify, on an annual basis, at its discretion, that the Wildacres Golf Course operation is following an organic protocol. Such certification shall be issued only where the committee has: (i) approved an Organic Management Plan submitted annually by the operation; (ii) certified, through an annual audit, that the operator has implemented the Organic Management Plan.

h. Establish its own procedural rules, consistent with paragraph 19 of this Agreement and this Exhibit.

D. List of Approved and Prohibited Products

(1) Approved Products:

a. The following list of products may be used at Wildacres golf course consistent with an approved Organic Management Plan.

1. Beneficial insects
2. Beneficial nematodes
3. Bt (Bacillus thuringiensis)
4. Compost
5. Corn gluten
6. Fish Emulsion
7. Garlic oil/Juice
8. Horticultural oils (preferably vegetable-based instead of petrochemical based)
9. Kelp/seaweed extracts
10. Lemon and vinegar formulations

11. Lime
12. Beneficial Microbes and Microbial Derivatives
13. Milk spore
14. Neem
15. 100% organic fertilizers
16. Pheromone lures
17. Pyrethrin/pyrethrum
18. Rock dust minerals
19. Biopesticides

b. In addition to the approved products listed above, the operator may also use products on the National List of approved substances established under the Organic Foods Product Act of 1990, and products approved as organic by duly accredited certifying organizations such as the Northeast Organic Farming Association (NOFA) and the Organic Materials Review Institute (OMRI), or products or substances defined as "organic" by any future U.S. of New York State organic golf regulatory program. Finally, the Organic Golf Course Technical Review Committee may include or exclude any product from the approved products list when such decision is supported by scientific peer-reviewed data and the site-specific needs of the operation.

(2) Prohibited Products:
The following list of products may not be used at the Wildacres Golf Course unless specifically approved under the special use exemptions set forth in the following paragraph (3) below.

1. All synthetic, chemical pesticides (unless otherwise included on the Approved Products list)
2. Arsenic
3. Biosolids derived from sewage sludge or industrial waste (i.e. Milogranite)
4. Genetically modified products, ingredients, or seeds (Endophytically enhanced seed and improved grass seed cultivars produced through conventional breeding programs are not GM and therefore <u>are</u> permitted).
5. Piperonyl butoxide and other synthetic ingredients
6. Pyrethroids
7. Tobacco
8. Pesticides dispensed by automatic misting systems

(3) Special Use Exemption:

a. As set forth below, the operator may seek a Special Use Exemption allowing the application of synthetic agents to prevent or treat disease or pest outbreaks at the Wildacres Golf Course. Consistent with the limitations set forth in this paragraph, the use of synthetic agents only when such use is determined to be absolutely necessary to maintain a high quality condition of the golf course and where organic treatment is determined to be ineffective or unavailable. Such Special Use Exemption shall cover the smallest area practicable and/or be utilized for the shortest time period necessary to address the problem. A Special Use Exemption may also be sought during the course of the year, after adoption of the annual Organic Golf Management Plan. When a Special Use Exemption

has been sought by the operator during the course of the year on a non-emergency basis, the failure of NYSDEC and the Organic Golf Course Technical Review Committee to respond within seven days of notice via e-mail and telephone to all five members shall de deemed a granting of the operator's request. Under the circumstances defined below, the operator may make an "emergency request" for a Special Use Exemption. An emergency request, for the purposes of this agreement, is defined as a request that within the judgment of the operator must be acted upon immediately so as to ensure the protection of high quality playable golf course turfs. The NYSCEC and the Committee to respond within forty-eight (48) hours shall be deemed a granting of the operator's request. In seeking any Special Use Exemption, the operator shall provide sufficient information (including photos, if appropriate) setting forth the rationale for the request. Whenever such as exemption is granted by NYSDEC during the course of the year, the exemption shall be included as an approved revision to the annual Organic Golf Course Management Plan.

b. In the event that the operator uses any synthetic agent after complying with the procedures of this paragraph, such operator is prohibited from claiming in radio, television, Internet or print advertising, or otherwise representing to the public either orally or in writing, that it operates an organic golf course. Such prohibition shall remain in effect from the date of application of the synthetic agent until the date the Committee certifies that the operator has for three consecutive years continually implemented an organic management protocol as set forth in this agreement with a Special Use Exemption. The prohibition described in this paragraph shall not be interpreted so as to require the operator to destroy any previously printed materials or to cancel any advertisements for which the operator has previously entered into a binding contract. Approval of a Special Use Exemption does not relieve the operator from complying with all other requirements of paragraph 19 and this Exhibit.

Appendix II

Partial List of Golf Courses That Have Been Reported To Be Organic

1. Wawona Hotel Golf Course, Yosemite National Park, California
2. The Presidio Golf Course, San Francisco, California
3. Bethpage State Park Golf Course, Farmingdale New York*
4. Kabi Golf Course, Boreen Point, Australia
5. Blackburn Meadows Golf Club, Salt Spring Island, British Columbia, Canada
6. Fiddlers' Green Executive Golf Course, Williams Point, Nova Scotia, Canada
7. Portland Country Club, Falmouth, Maine
8. Bent Creek Golf Course, Jacksonville, Florida
9. Idlewild Golf Course, Flossmoor, Illinois
10. Theodore Wirth Golf Course, Golden Valley, Minnesota
11. Vineyard Golf Club, Edgartown, Massachusetts
12. Sebonack Golf Club, Southampton, New York
13. French River Golf & Country Club, French River Prince Edward Island, Canada
14. Beaver Creek Golf Club, Beaver Creek, Colorado
15. Old Baldy Club, Saratoga, Wyoming
16. Torreon Golf Club, Show Low, Arizona
17. The Resort at Squaw Creek, Tahoe City, California
18. Harding Park Golf Course, San Francisco, California
19. Applewood Golf Course, Golden, Colorado
20. Loon Lake Golf Course, Loon Lake, New York
21. Delhi College Golf Course, De Lancey, New York
22. Old Brockway Golf Course, Kings Beach, California
23. Lahontan Golf Club, Truckee, California

*Only a portion of one golf course employs organic turfgrass management
A number of the golf courses included on the above list are known to use conventional pesticides.

Appendix III

Members of the Organic Golf Committee

TOM BRENNAN, Chief
Environmental Stewardship Branch
United States Environmental Protection Agency

JEFF CARLSON, Superintendent
Vineyard Golf Club

TROY CARSON, Senior Research Agronomist
The Toro Company

STUART COHEN, President
Environmental & Turf Services, Inc.

STUART HACKWELL, CID
Global Specification Manager
Rain Bird Corporation
Golf Division

THOMAS HARDING, President/CEO
AgriSystems International

CRAIG HOLDEN, President, CEO, Chairman
Sustane Natural Fertilizer of America, Inc.

MIKE HURDZAN, Golf Course Architect
Hurdzan/Fry Golf Course Design

ANDREW MANITT, Research Director
Long Island Neighborhood Network

PAUL PARKER, Executive Vice President
Center for Resource Management

JIM SNOW, National Director
United States Golf Association Green Section

CLARK THROSSELL, Director of Research
Golf Course Superintendents Association of America

JOELLEN LAMPMAN, Program Manager
Audubon International/Northeast Integrated Pest Management Center

Appendix IV

Sponsors of the Organic Turfgrass Management for Golf Courses Report

Golf Course Superintendents Association of America

Rain Bird Corporation

Sustane Natural Fertilizer of America, Inc.

The Toro Company Giving Program

United States Environmental Protection Agency

United States Golf Association

Appendix V

Golf & Environment Initiative

The Golf & the Environment Initiative began in 1995 at the first Golf & the Environment Summit held at the Pebble Beach Resort. At this 1995 meeting, leaders from the golf industry and the environmental community established a framework for working together on environmental issues related to developing and managing golf course facilities. As a result, the Golf & the Environment Initiative was launched.

At the heart of the Initiative, is a coalition of golf and environmental organization whose common mission is "to enhance golf course environmental responsibility and performance through cooperation in environmental stewardship and public education". Working together this coalition has developed and distributed over 26,000 copies of the booklet, *Environmental Principles for Golf Courses in the United States*. The *Environmental Principles* represented a first-ever consensus among leaders in the golf industry and environmental community. It provided a basis of understanding necessary for future collaboration on individual issues. In addition to the *Principles*, the group has conducted three national demonstration projects, held five national conferences, produced and distributed a *Collaboration Guide*, produced two educational videos, published a companion booklet to the *Principles* entitled *Environmental Siting Guide for Golf Course Development*, and developed an environmental guidebook for military golf courses.