

Golf Course Environmental Profile

Property Profile and Environmental Stewardship of Golf Courses
Volume I



With Forewords by Greg Norman, World Golf Hall of Fame Member, and
Ricky D. Heine, CGCS, 2007 GCSAA President



Golf Course Superintendents Association of America



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Funded by:
The Environmental Institute for Golf
and
The Toro Foundation



Table of Contents

Mission Statements.....	4
Acknowledgments.....	5
Forewords	6-7
▶ Greg Norman, World Golf Hall of Fame Member	6
▶ Ricky D. Heine, CGCS, 2007 GCSAA President.....	7
Executive Summary.....	8
Introduction	9
Summary of Methodology	10
Survey Results.....	11-22
▶ Land Use Characteristics	12
▶ Maintained Turfgrass on Golf Courses.....	13-16
▶ Bermudagrass	14
▶ Creeping Bentgrass	14
▶ Kentucky Bluegrass.....	15
▶ Annual Bluegrass and Perennial Ryegrass.....	15
▶ Winter Overseeding Practices	16
▶ Non-Turfgrass Land Use Characteristics.....	17-19
▶ Changes.....	18
▶ Water Bodies.....	18
▶ Bunkers, Parking Lots and Car Paths.....	19
▶ Environmental Stewardship Efforts	20-22
▶ Environmental Improvements.....	22
Conclusions	23
Literature Cited	24
Appendix	25-40

Our Mission



GCSAA is dedicated to serving its members, advancing their profession and enhancing the enjoyment, growth and vitality of the game of golf.



The Environmental Institute for Golf is committed to strengthening the compatibility of the game of golf with our natural environment.

Acknowledgments

*The Golf Course Superintendents Association of America and
The Environmental Institute for Golf wishes to thank:*

The Toro Foundation for providing a grant to help fund this research.

*The thousands of golf course superintendents who took the time and effort
to complete the survey.*

Golf's allied associations for their support in this endeavor.

Foreword

Proof Positive: Evidence of Golf's Environmental Benefits

To me, it's tremendous that 27 million people in the United States are golfers. However, that means less than 10 percent of the population enjoys the game on a regular basis. I believe it's time to show the other 90 percent what it's missing.

The game of golf has so much to offer and it is my sincere hope that more people will experience its many benefits and challenges, which I believe set it apart from virtually every other sport and leisure activity.

Anyone who has ever thrown a bag over his or her shoulder knows that the game is much more than fairways and greens. When you add up the revenue from all its various components, golf is roughly the size of the movie and music industries put together, and only slightly smaller than the total electronics and appliance market. Plain and simple, golf has a distinct and undeniably powerful position in our lives – present and future.

Today, more than any other sport or recreational activity, golf has a profound impact on the American economy, both nationally and locally. The golf course itself provides green space as part of a community's master plan. Then there's the impact of operations for the course and clubhouse, renovations, ongoing maintenance, merchandise, instruction, communications and employment of all sorts.

Furthermore, golf fosters and promotes tourism and travel like no other sport. If they're not making pilgrimages to Scotland or Ireland to play the great historic courses, golfers are visiting mecca's such as Hilton Head, Scottsdale or Myrtle Beach, where the concentration and variety of quality courses means more rounds with less travel time in between. No two golf courses are the same – every layout is unique, and one of the special pleasures of golf is to play as many of them as possible.

There has never been a better time to espouse the many benefits of this great game. Thanks to a growing amount of data, the golf industry is able to state with even greater confidence that golf courses can be compatible with the environment. For far too long, golf has suffered from the stigma of catering only to the elite and leaving a negative footprint on the environment. It is time to put those misconceptions to rest.

Public access to golf is at an all-time high. Alternative setups, executive courses, off-peak rates and a myriad of other options have opened the game to people of all backgrounds. From an environmental perspective, advances in science, technology and education have had a profound impact on advancing golf's relationship with nature. Thanks to the work of The Environmental Institute for Golf, the Golf Course Superintendents Association of America, The Toro Foundation and thousands of superintendents nationwide, we now have the data that supports golf's compatibility with the environment.

The following report is just one of a series that will be released in the near future that will communicate in great detail the environmental profile of golf courses. The industry now has at its disposal data on every aspect of golf course management from an environmental perspective.

I encourage you to use these reports to demonstrate your work in ensuring golf's compatibility with the environment. And don't be surprised if some of this information provides an opportunity to further enhance what your facility has to offer.

We are fortunate to be a part of a great industry. Golf provides communities with significant economic, recreational and environmental benefits. It is a story worth telling.

Regards,



Greg Norman
Advisory Council Chair
The Environmental Institute for Golf



Foreword

Strength in Numbers

We live in a world that is increasingly data driven.

It is rare when we make a decision that is not based on fact, information or historical trend. Data allows us to be more efficient and effective in our operations.

The golf industry is flush with data. We know how many people partake in the sport, how many rounds are played, how many golf balls, clubs and shirts are sold, and how much money the industry generates. But for all of these facts and figures, there has been a gaping hole regarding the environmental profile of golf courses.

Research indicates that golf courses can be compatible with the environment, and oftentimes they enhance it. But research efforts to date have not provided a comprehensive picture of golf course properties and management practices. Until now, we have not had reliable data that will allow the industry to make informed decisions or communicate to regulatory agencies, lawmaking bodies, the environmental community and the media.

I am pleased to report that the data we seek is available thanks to the efforts of nearly 3,000 golf course superintendents nationwide. The Golf Course Superintendents Association of America (GCSAA) is in a position to share new information regarding golf course management. The first phase of this multi-year survey is featured in this report. It focuses on golf course land use, including the acreage of the playing surface, grass species, out-of-play areas and environmental stewardship efforts from across the nation. Future reports will highlight water use/conservation, nutrient inputs, pesticide applications and energy use.

After all of the surveys are completed, they will be replicated to measure trends in management. This Herculean project would not have been possible without the funding of The Environmental Institute for Golf, thanks in part to a grant from The Toro Foundation.

How will this data be used? To be succinct, it will enable GCSAA to develop improved programs and services, and ultimately foster golf course superintendents to be better managers. It also will help the golf industry better respond to information requests from a variety of audiences.

I encourage you to read this report and refer to it frequently. Use it to assist in your management. Let it serve as a source to communicate to the public, golfers, employers/operators, the environmental community, community leaders and the media. To those who have participated in this project, I express my sincere appreciation. For those who have not completed past surveys, it is not too late to become engaged. More surveys will be forthcoming, as we seek to build a database that will be of benefit to us all.

Sincerely,



Ricky D. Heine, CGCS
2007 GCSAA President



Executive Summary

GCSAA's Golf Course Environmental Profile is a data collection project that will provide new insight into the property features, management practices and inputs associated with golf courses across the United States.

This is the first report on the project. The research detailed within helps portray the current environmental state of golf facilities, determine the future direction of environmental efforts, provide information for inquiries about environmental issues, document change over time made by golf facilities with regard to the environment and identify key issues for potential future research.

This is the first of a series of planned surveys, conducted to collect the data necessary to develop a national Golf Course Environmental Profile.

Overall, it offers an accurate portrayal of golf course land use to guide the golf industry's agronomic and environmental initiatives, and it establishes a baseline that can be compared to data from future surveys to identify change over time.

The objectives of the first survey, and translated into volume one of this report, were to determine the following:

- ▶ Total acreage of a golf course
- ▶ Land-use characteristics
- ▶ Acreage devoted to each component of the golf course
- ▶ Grass species grown on each golf course component
- ▶ Acreage dedicated to natural resources and environmental stewardship practices

The survey was sent to 16,009 golf course superintendents in the U.S. Golf courses were stratified by agronomic region, course type and number of holes. All types of golf courses were adequately represented in the results.

Highlighting the report are the following results:

- ▶ The total acreage of an average 18-hole golf course in the U.S. is 150 acres, of which 100 acres (67 percent) is maintained turfgrass.
- ▶ The remaining acreage includes:
 - Non-turfgrass vegetation (16 percent)
 - Water bodies (7 percent)
 - Buildings (4 percent)
 - Bunkers (3 percent)
 - Parking lots (3 percent)
- ▶ Cool-season grasses are grown on 66 percent of all maintained turfgrass acreage of golf courses, while warm-season grasses comprise 34 percent.
- ▶ Approximately 44 percent of golf courses have increased their non-turfgrass areas by nearly 10 acres over the past decade.
- ▶ In that time period, an average of five environmental improvements were made on 18-hole golf courses.
- ▶ At courses involved in voluntary environmental programs, an average of seven environmental improvements were made from 1996 to 2006.

Introduction

This report focuses on golf facility property features, such as acreage, land use and grass species, as well as environmental stewardship efforts. Future research will examine water use and conservation, nutrient use, pesticide use, energy use and environmental practices in order to evaluate change over time.

Since 2004, members of the golf industry and environmental community have participated in meetings hosted by The Environmental Institute for Golf to discuss environmental issues facing the golf industry and identify future research, education and outreach opportunities.

Golf course superintendents, golf industry leaders, golf association leaders, environmental advocates, university turfgrass scientists and regulators have attended the gatherings, reaching several important conclusions about the environmental aspects of golf, including:

- ▶ The golf industry did not have comprehensive national data on the property features, management practices, and inputs associated with golf courses and golf course maintenance.
- ▶ Although many individual golf courses are environmentally proactive, there was no systematic process in place to document current practices or track changes that the golf industry nationwide has made to protect and enhance the environment.
- ▶ In short, an environmental “snapshot” of golf facilities across the nation was needed to provide an in-depth look into golf industry data, land and water management, and environmental stewardship practices.

In 2006, the Golf Course Superintendents Association of America (GCSAA) initiated a project, funded by The Environmental Institute for Golf through a grant from The Toro Foundation, to collect data nationally on the property features, management practices, and inputs associated with golf courses and golf course maintenance. A series of surveys will be conducted over multiple years to collect the data. The surveys will be repeated so that change in golf courses and golf course maintenance practices over time can be measured.

A manuscript featuring the survey’s data, analysis and conclusions was published in the *Applied Turfgrass Science (ATS) Journal* in November 2007. To request a copy of the manuscript, click the following link. (<http://www.plantmanagementnetwork.org/ats/element/sum2.asp?id=6714>). Information included in the *ATS* manuscript is presented in this report.

For more information on GCSAA’s Golf Course Environmental Profile, please contact Mark Johnson, senior manager of environmental programs, at 800.472.7878, ext. 5161, or mjohnson@gcsaa.org.



Summary of Methodology

Input on the survey questions was collected from golf, environmental, academic and regulatory sources. GCSAA staff drafted survey questions, which were reviewed and revised by a group of golf course superintendents, golf association leaders and environmental advocates.

The National Golf Foundation (NGF) was contracted to conduct the survey, manage the recruitment of participants and complete the analysis of the data in collaboration with GCSAA.

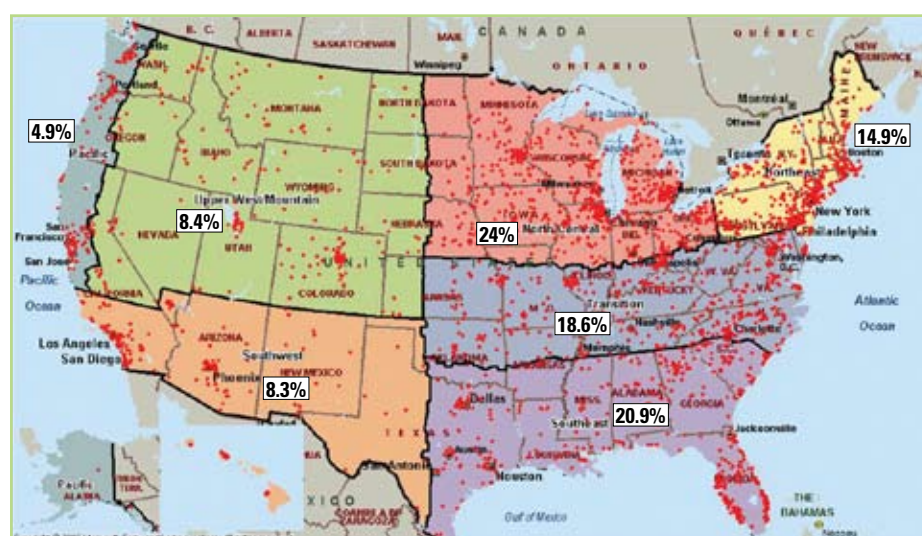
The NGF adheres to The Code of Marketing Research Standards developed by the Marketing Research Association (4). The NGF refined and formatted the survey instrument for online and paper versions.

While not theoretically possible to reach all superintendents in the United States, an invitation to participate in the survey was sent to superintendents at 16,009 golf facilities nationwide. Surveys were distributed via e-mail and U.S. Postal Service in March 2006. To increase response rate, follow-up surveys were mailed in mid-April to all non-respondents who had not previously received a paper copy. In addition, reminders to complete and submit the survey were sent by e-mail and mail. Surveys were accepted until early July 2006.

A total of 2,981 usable surveys were returned, yielding an 18.6 percent return rate. The analysis classified the golf courses by agronomic region, course type (daily fee, municipal or private) and number of holes. All types of golf courses in all regions of the country were adequately represented

in the final data set. Agronomic regions were determined by grouping geographic areas with similar climatic characteristics, and boundaries were drawn using county borders. Analysis of the returned surveys indicated a representative sample of U.S. golf facilities was received (Table 1, Appendix).

Figure 1 – Agronomic regions and the percentage of golf facilities in each region responding to the survey.



Data were analyzed to run descriptive statistics and explore relationships between the variables such as agronomic region, course type and number of holes. Total acres, acreage of each golf course component (greens, fairways, tees, rough, etc.) and turfgrass species (bermudagrass, Kentucky bluegrass, perennial ryegrass, etc.) used on each golf course component were calculated by multiplying the number of 18-hole equivalents by the average acreage for each golf course component or each turfgrass species grown on it. The number of 18-hole equivalents in the U.S. is 14,969, and was determined by taking the total number of golf holes and dividing by 18 (5).

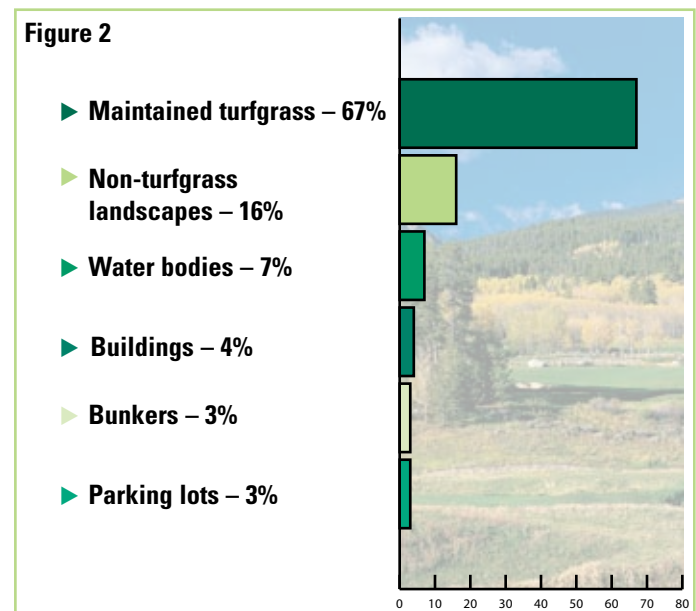
Survey Results

Land Use Characteristics

There are an estimated 2,244,512 total acres of land on golf facilities in the U.S., including 1,504,210 acres of maintained turfgrass and 740,302 acres of non-turfgrass landscapes, water bodies, buildings, bunkers or parking lots (Figure 2) (Table 2, Appendix).

- ▶ An average 18-hole golf course comprises 150 acres (Table 3, Appendix).
- ▶ Of that, approximately 100 acres are maintained turfgrass, which, on average, includes the following:
 - 51 acres of rough
 - 30 acres of fairways
 - 7 acres of driving ranges/practice areas
 - 3 acres of greens
 - 3 acres of tees
 - 3 acres of clubhouse grounds
 - 1 acre of turfgrass nurseries
- ▶ The remaining approximate 50 acres are calculated to be dedicated to the following features:
 - 24.0 acres of non-turfgrass landscapes
 - 11.0 acres of water bodies
 - 6.0 acres of buildings
 - 4.5 acres of bunkers
 - 4.5 acres of parking lots

Figure 2 – Land use (by percentage) on an average 18-hole golf course.



- ▶ The North Central region has the highest total acreage of maintained turfgrass with 400,882 acres, while the Pacific region has the least with 55,093 acres. The acreage fluctuates considerably across regions (Table 4, Appendix).

Maintained Turfgrass on Golf Courses

The total acreage was estimated for each turfgrass species grown on U.S. golf courses. In addition, the total acreage was estimated for each species within the seven geographic regions and for each component of the golf course (tees, fairways, rough, greens, etc.).

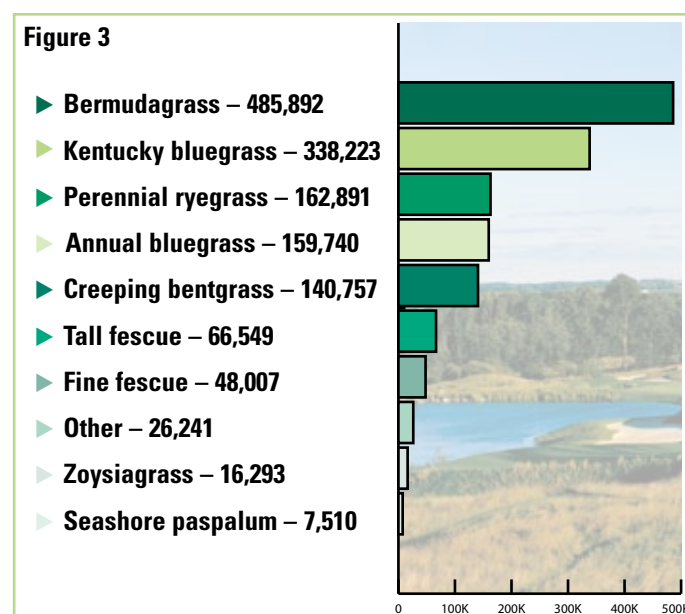
To distinguish between the permanent turfgrass species and the winter overseeded turfgrass species, respondents were asked separate questions to collect information on the permanent turfgrass species and the species, if any, used for winter overseeding. Data from permanent turfgrass species and winter overseeded species were analyzed separately.

On many golf courses, particularly those with cool-season grasses, more than one turfgrass species is likely to be present. To account for this, superintendents were asked to estimate the acreage of each component of the golf course, along with the percentage of each turfgrass species present on that component. The total acreage for each species was calculated by multiplying the acreage of the component by the percentage of each species present. For example, if a superintendent reported 30 acres of fairways comprised of 50 percent creeping

bentgrass and 50 percent annual bluegrass, a total of 30 acres of fairways would be recorded for the fairway, and 15 acres of creeping bentgrass and 15 acres of annual bluegrass would be recorded for the species present in the fairways.

The total acreage for turfgrass species grown nationally is described in Figure 3. The total for each region is found in Table 5 (Appendix), and estimates for each component of the golf course are described in Tables 6-11 (Appendix).

Figure 3 – Total estimated acreage for turfgrass species on U.S. golf courses.



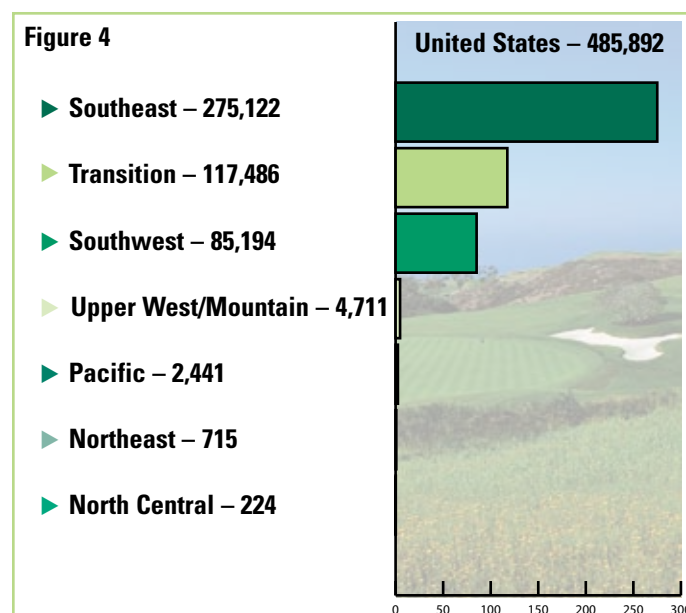
Maintained Turfgrass on Golf Courses

Bermudagrass

More golf course acreage is planted with bermudagrass (*Cynodon spp.*) than in any other species in the U.S. (Table 5, Appendix).

- ▶ Most of the bermudagrass is grown in the Southeast, the Southwest and the Transition regions, where it is widely used for tees, fairways, rough, driving ranges and practice areas.
- ▶ Bermudagrass also predominates on putting greens and turfgrass nurseries in the Southeast. In the Southwest, however, the acreage of bermudagrass and creeping bentgrass on putting greens and turfgrass nurseries are nearly identical.

Figure 4 – Estimated bermudagrass acreage used on golf courses for the U.S. and within each agronomic region.

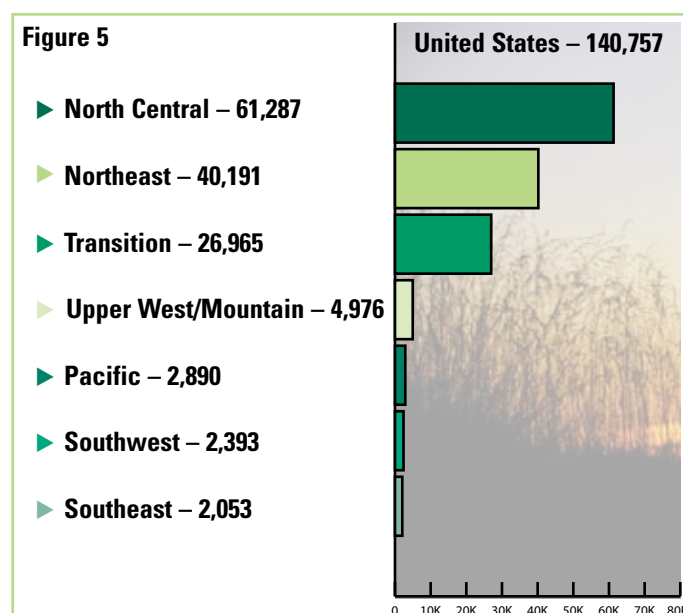


Creeping Bentgrass

Creeping bentgrass (*Agrostis palustris spp. Stolonifera L.*) is used on most of the putting green acreage in the U.S., especially in the Northeast, North Central and Transition regions.

- ▶ Most of the creeping bentgrass grown on fairways and tees is in the Northeast, North Central and Transition regions (Tables 6, 7, Appendix).
- ▶ Creeping bentgrass comprises nearly three-quarters of putting green acreage in the Upper West/Mountain region (Table 10, Appendix).
- ▶ Creeping bentgrass is the most common grass on tees (Table 6, Appendix) and fairways (Table 7, Appendix) in the Northeast and North Central regions, as well as on turfgrass nurseries in the Northeast, North Central, Transition and Upper West/Mountain regions (Table 11, Appendix).

Figure 5 – Estimated creeping bentgrass acreage used on golf courses for the U.S. and within each agronomic region.

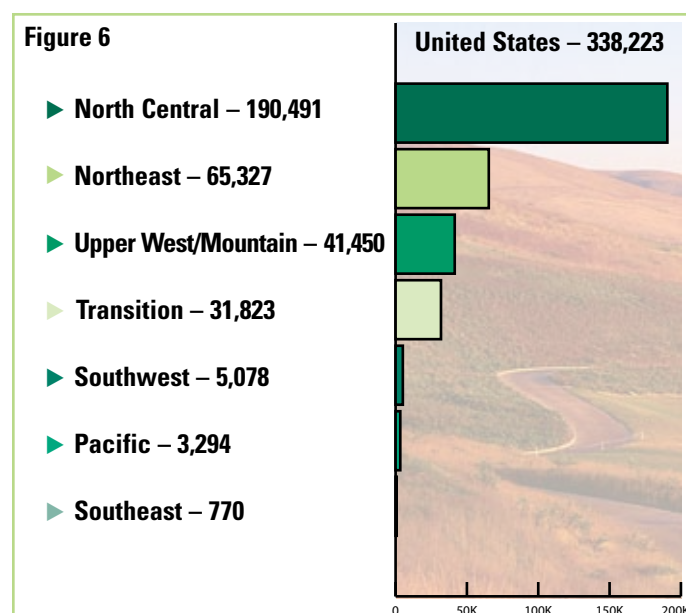


Maintained Turfgrass on Golf Courses

Kentucky Bluegrass

- ▶ Kentucky bluegrass (*Poa pratensis* L.) is the most common species of turfgrass on golf courses in the Northeast, North Central and Upper West/Mountain regions (Table 5, Appendix).
- ▶ In these regions, it predominates on rough (Table 8, Appendix), driving ranges and practice areas (Table 9, Appendix).
- ▶ Kentucky bluegrass also predominates on tees (Table 6, Appendix) and fairways (Table 7, Appendix) in the Upper West/Mountain region.

Figure 6 – Estimated Kentucky bluegrass acreage used on golf courses for the U.S. and within each agronomic region.



Annual Bluegrass and Perennial Ryegrass

- ▶ Annual bluegrass (*Poa annua* L.) is grown on more acreage nationally than creeping bentgrass (*Agrostis palustris* spp. *Stolonifera* L.)
- ▶ Annual bluegrass and perennial ryegrass (*Lolium perenne* L.) (Table 5, Appendix) are the two most common turfgrass species on golf courses in the Pacific Northwest.
- ▶ More perennial ryegrass than annual bluegrass is grown for tees (Table 6, Appendix), rough (Table 8,

Appendix) and driving ranges and practice areas (Table 9, Appendix) in the region. However, the opposite is true for fairways (Table 7, Appendix) (Figures 7, 8).

Figure 7 – Estimated annual bluegrass acreage used on golf courses for the U.S. and within each agronomic region.

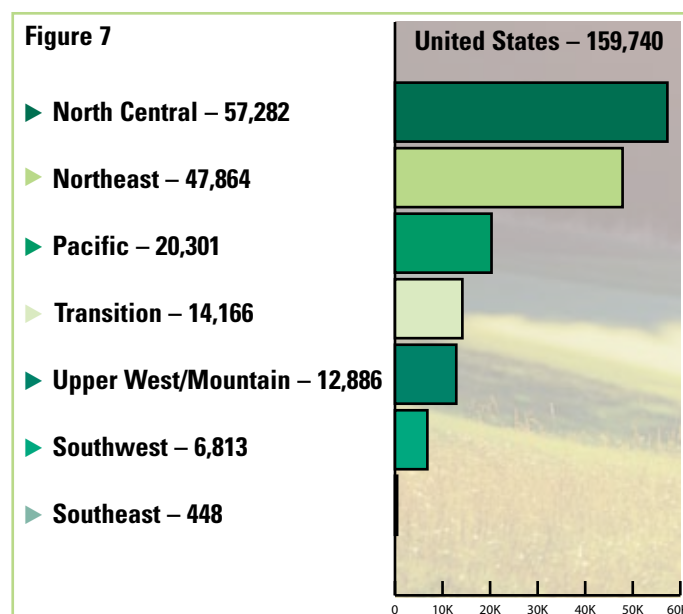
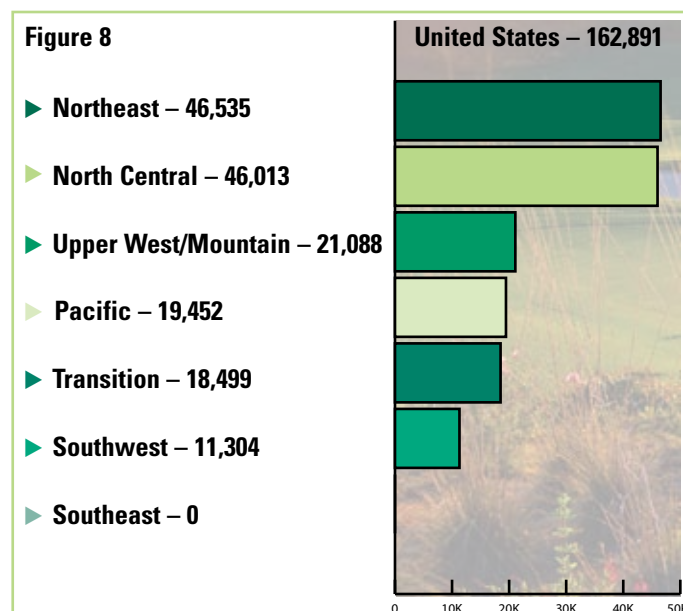


Figure 8 – Estimated perennial ryegrass acreage used on golf courses for the U.S. and within each agronomic region.

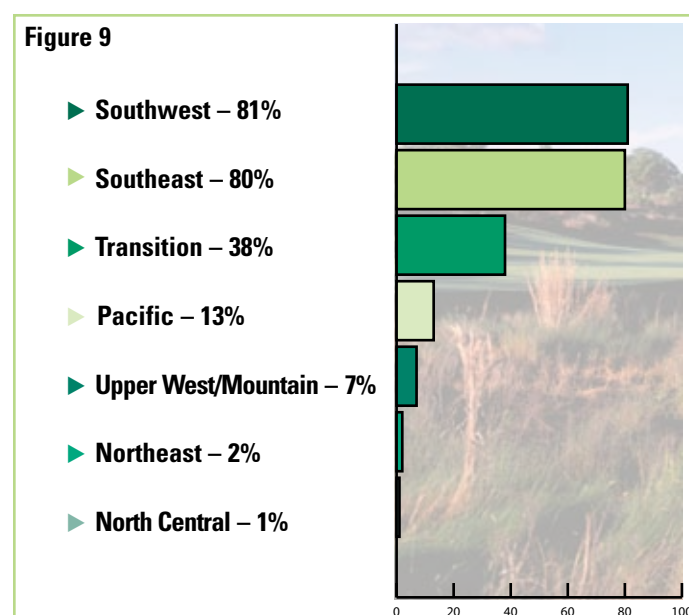


Maintained Turfgrass on Golf Courses

Winter Overseeding Practices

By definition, winter overseeding is to seed onto an existing warm-season turfgrass, usually with temporary cool-season turfgrasses to provide green active grass growth during dormancy of the original turfgrass, usually a warm-season turfgrass (8).

Figure 9 – Percent of golf facilities conducting winter overseeding on one or more components of golf courses in each agronomic region.



► In the Southeast, 4,230 acres of putting greens are overseeded, compared to 1,321 acres in the Southwest and 190 acres in the Transition region (Table 12, Appendix).

► On putting greens:

- 75 percent of golf courses that overseed greens in the Southeast and 44 percent of courses that overseed greens in the Southwest use rough bluegrass (*Poa trivialis*).
- 55 percent of golf courses that overseed greens in the Transition region use creeping bentgrass (Table 12, Appendix).

► A total of 14,872 acres of tees; 76,118 acres of fairways; 42,995 acres of rough; 13,103 acres of driving ranges/practice areas; and 574 acres of turfgrass nurseries are overseeded in the Transition, Southeast and Southwest regions. More than 95 percent of these golf course components are overseeded with perennial ryegrass (Table 12, Appendix).

► Of the golf courses that overseed:

- 81 percent overseed tees
- 50 percent overseed fairways
- 40 percent overseed greens
- 19 percent overseed rough
- 37 percent overseed the driving ranges and practice areas
- 11 percent overseed the turfgrass nursery

Non-Turfgrass Land Use Characteristics

There are an estimated 740,302 acres on U.S. golf courses comprised of non-turfgrass landscapes, water bodies, buildings, bunkers or parking lots (Table 2, Appendix).

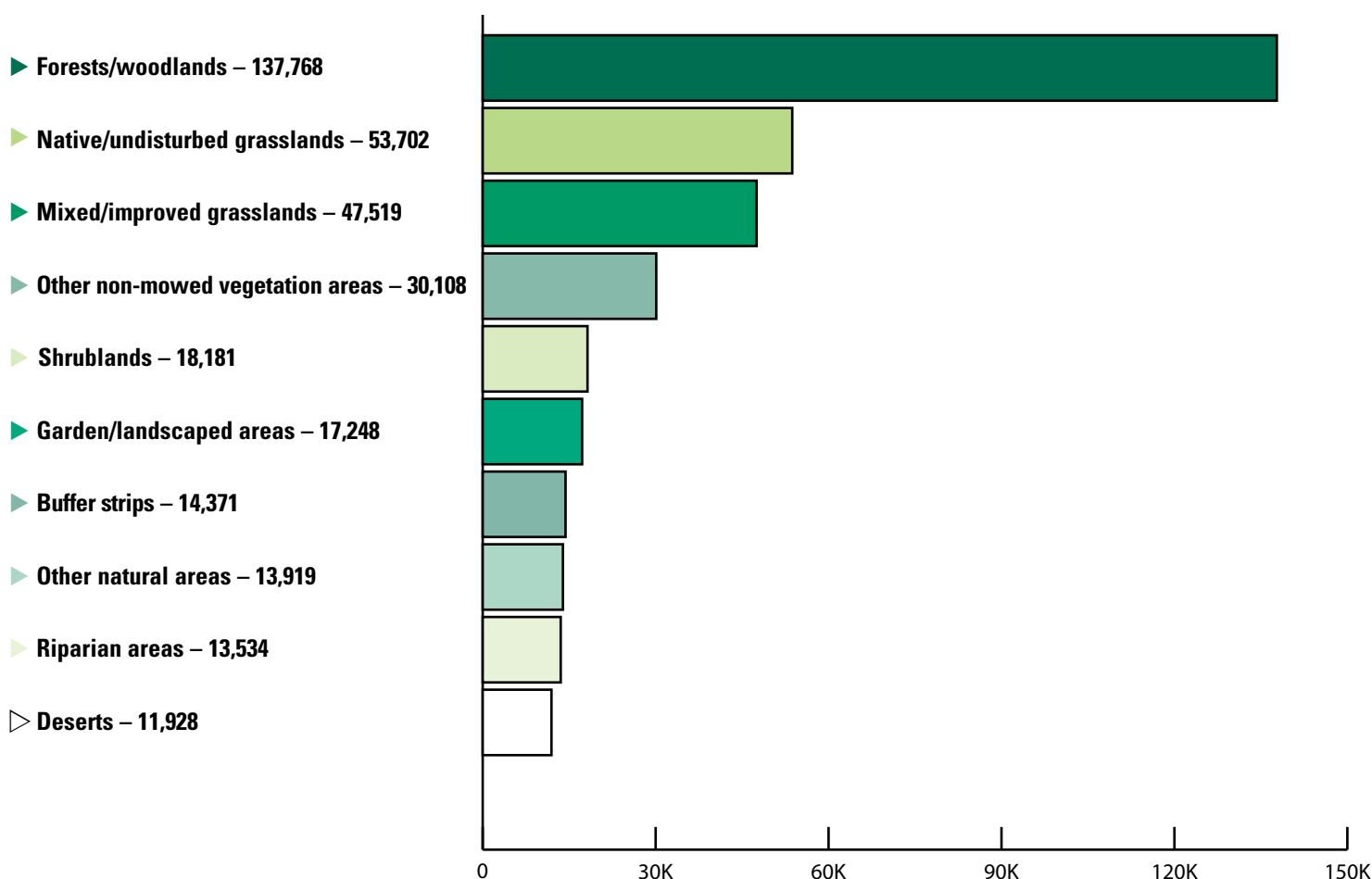
The estimated 358,278 acres of non-turfgrass landscapes in the U.S. include the following:

- ▶ forests/woodlands
- ▶ native/undisturbed grasslands
- ▶ mixed/improved grasslands
- ▶ non-mowed areas
- ▶ shrublands

- ▶ garden/landscape areas
- ▶ buffer strips
- ▶ other natural areas by geographic region (Table 13, Appendix)
- ▶ riparian areas
- ▶ deserts

Forests/woodlands and grasslands (native/undisturbed and mixed/improved) are the predominate features representing approximately two-thirds of the non-turfgrass landscape (Figure 10).

Figure 10 – Non-Turfgrass Landscape Acreage (Total U.S. Acreage – 358,278)



Non-Turfgrass Land Use Characteristics

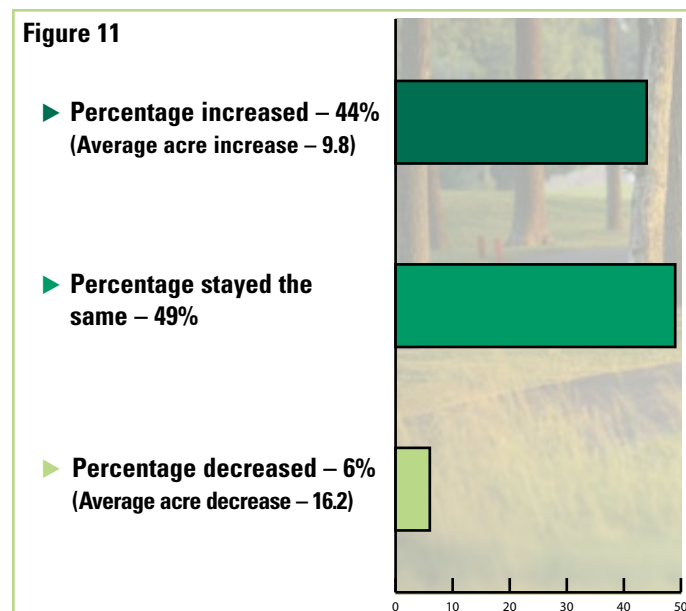
Changes

Superintendents were asked to identify the changes made to non-turfgrass landscapes over the past 10 years using individual knowledge or facility records.

The national total of non-turfgrass landscape has increased since 1996 (Figure 11) (Table 14, Appendix).

- ▶ 44 percent indicated an average increase of 9.8 acres.
- ▶ 49 percent reported non-turfgrass landscapes have stayed the same since 1996.
- ▶ 6 percent have reduced their acreage by an average of nearly 16 acres.
- ▶ Compared to other regions, the Southeast and Southwest report a significantly higher percentage of golf courses that have not altered the acreage dedicated to non-turfgrass landscapes.

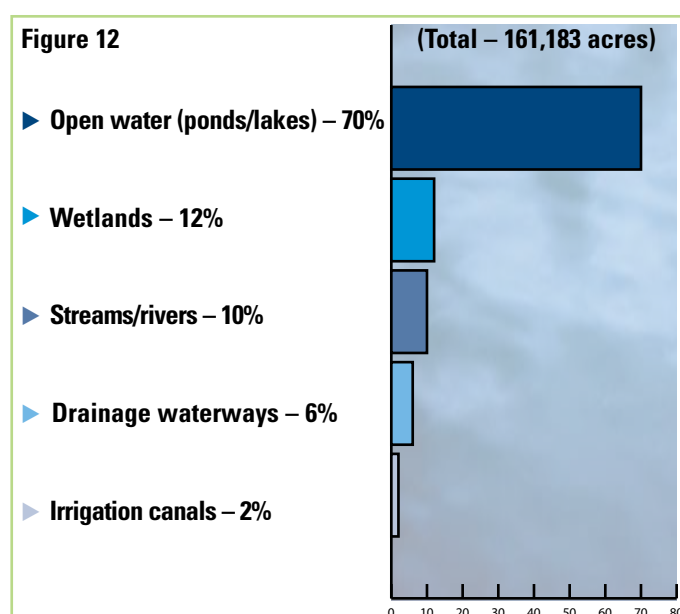
Figure 11 – Changes in non-turfgrass acres since 1996.



Water Bodies

Water bodies account for approximately 11 acres or seven percent of the total acreage on an average 18-hole golf course (Figure 12). There are an estimated 161,183 acres of water bodies on golf course facilities in the U.S. (Table 15).

Figure 12 – Water bodies (by percentage) for an average 18-hole U.S. golf facility.



Non-Turfgrass Land Use Characteristics

Bunkers, Parking Lots and Car Paths

Sand bunkers are an integral part of golf, both as a hazard for the players and as an architectural design element. The following is a breakdown by region of the estimated 74,382 acres of bunkers on U.S. golf courses:

- ▶ 18,163 acres in the Southeast region
- ▶ 17,122 acres in the North Central region
- ▶ 14,287 acres in the Northeast region
- ▶ 13,471 acres in the Transition region
- ▶ 5,562 acres in the Southwest region
- ▶ 3,580 acres in the Upper West/Mountain region
- ▶ 2,197 acres in the Pacific region

Parking lots represent three percent of the average 18-hole facility's acreage, resulting in an estimated average of 4.5 acres of parking lot per facility. There are an estimated 67,644 total acres of parking lots on U.S. golf courses (Table 16, Appendix) and approximately 90 percent of parking lots are constructed with impervious materials.

Participants reported the average length and width of car paths on their golf course property as part of the total property acreage. There are approximately 2.8 acres of car paths on an average U.S. 18-hole facility. The average width is 7 feet and the estimated total acreage is 38,419 (Table 17, Appendix).

There are some variances in car path acreage by agronomic region.

- ▶ The North Central, Northeast and Upper West/Mountain regions have significantly less acreage in car paths than the Transition, Southeast and Southwest regions.
- ▶ The North Central and Northeast regions have significantly less acreage in car paths than the Pacific region.
- ▶ Approximately 80 percent of the respondents reported that the car paths are constructed of impervious materials; the remaining car paths are made of pervious materials.



Environmental Stewardship Efforts

Survey participants were asked to indicate specific environmental stewardship practices, participation in voluntary environmental stewardship programs, and environmental upgrades to the golf facility since 1996. Facilities currently enrolled in one or more environmental stewardship programs are defined as “program participants.” Survey respondents chose from the following list of environmental stewardship programs:

- ▶ Audubon Cooperative Sanctuary Program
- ▶ Audubon Signature Program
- ▶ Club Managers Association of America’s Environmental Performance Audit
- ▶ Golf Course Environmental Management Program
- ▶ Florida Green Building Coalition
- ▶ Michigan Turfgrass Environmental Stewardship Program

- ▶ Oregon Stewardship Guidelines
- ▶ San Antonio Water System Environmental Program
- ▶ Any other official program

Responses indicated that 29 percent of 18-hole golf facilities in the U.S. currently participate in a voluntary environmental stewardship program. The following is a region-by-region look at the participation rate of 18-hole golf courses (Figure 13):

- ▶ 53 percent in the Pacific region
- ▶ 34 percent in the Southeast region
- ▶ 29 percent in the North Central region
- ▶ 28 percent in the Northeast region
- ▶ 27 percent in the Upper West/Mountain region
- ▶ 23 percent in the Southwest and Transition regions

Figure 13 – Participation rate (by percentage) of 18-hole golf courses by region.

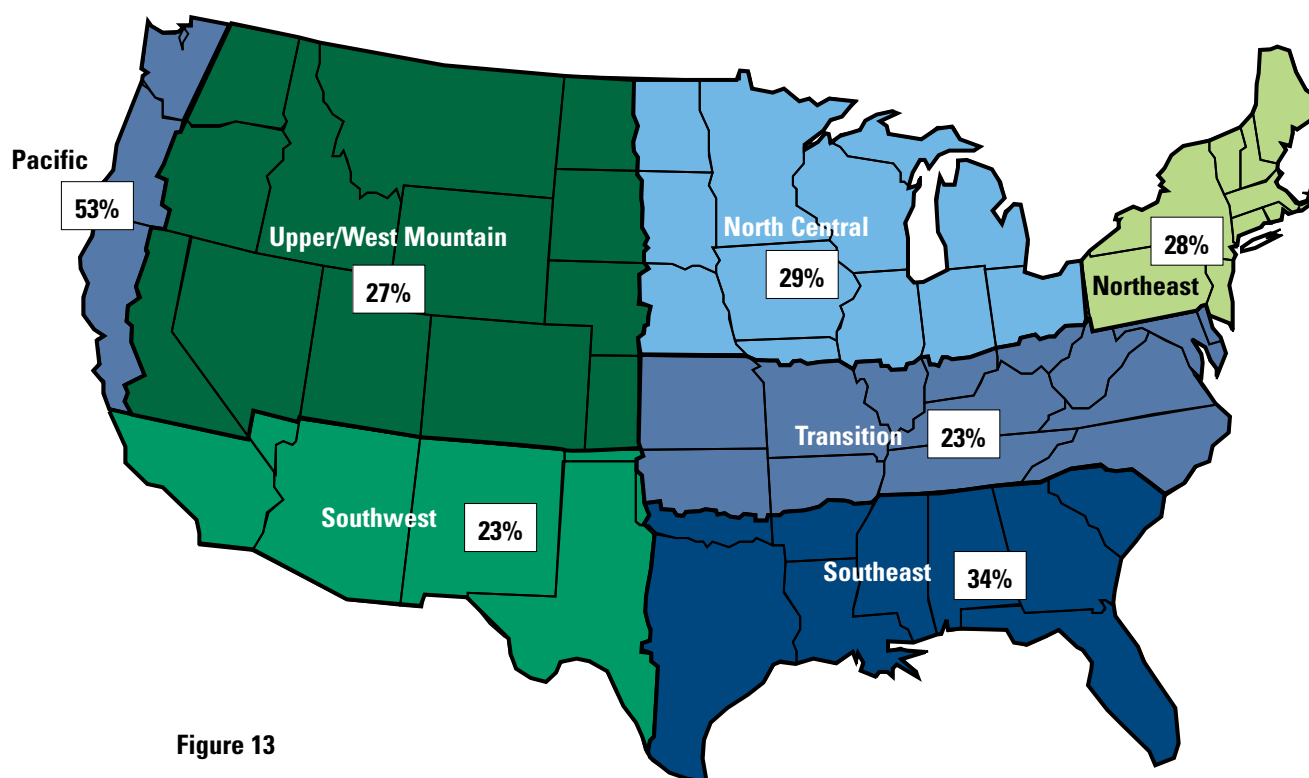


Figure 13

Environmental Stewardship Efforts

More respondents (24 percent) participate in The Audubon Cooperative Sanctuary Program than in any other voluntary environmental stewardship program. The other programs tend to be highly regionalized.

Also, golf facilities that have more than nine holes, are private, have higher maintenance budgets and employ a GCSAA member superintendent, also have a higher participation rate in formal voluntary environmental stewardship programs (Table 18, Appendix).

In general, the golf course profile of 18-hole facilities participating in an environmental stewardship program is similar to that of facilities not involved in environmental stewardship programs (Table 19, Appendix). However, there are several key

differences between facilities that are involved with an environmental stewardship program and those that are not. For example:

- ▶ Golf facilities that participate in environmental stewardship programs have a significantly lower percentage of maintained turfgrass (63 percent of total property size) than facilities that do not participate (69 percent).
- ▶ Since 1996, 56 percent of environmental stewardship program participants (compared to 40 percent of non-participants) have increased the acreage of non-turfgrass areas (native/naturalized plantings, buffer areas, lower-maintenance vegetation, etc.).
- ▶ Those 18-hole golf facilities that increased non-turfgrass areas added approximately 10 acres (Table 20, Appendix).

Figure 14 – Percent of total acreage of specific features on U.S. golf facilities participating and not participating in an environmental stewardship program.

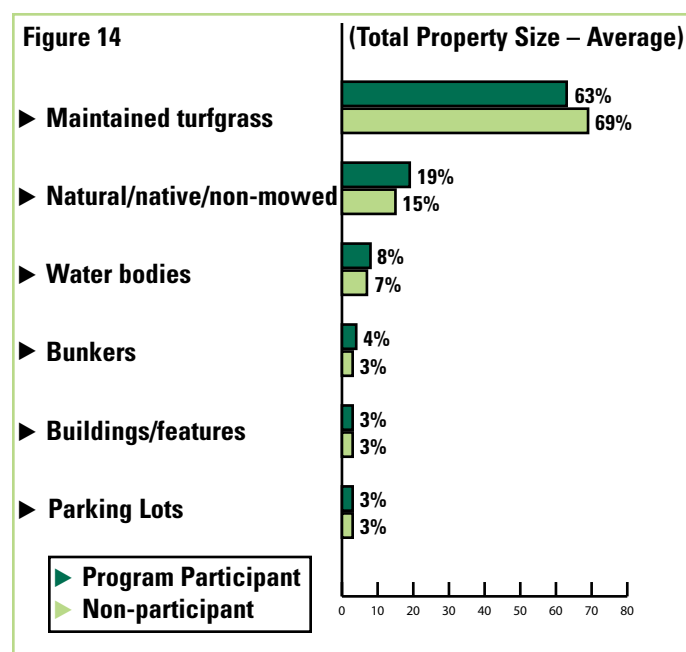
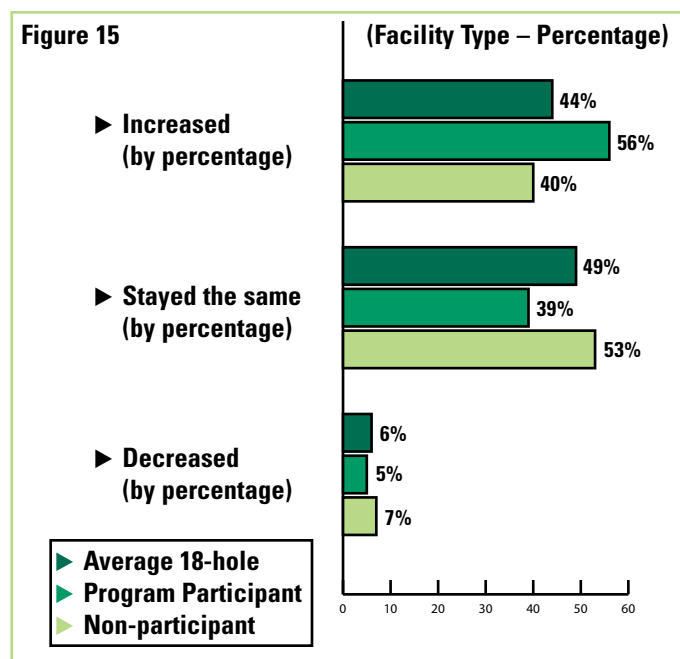


Figure 15 – Percent and acreage change to natural/native/non-mowed areas since 1996.



Environmental Stewardship Efforts

Environmental Improvements

Nearly all facilities (96 percent) have made at least one environmental improvement since 1996 (Table 21, Appendix). Environmental stewardship program participants have made significantly more improvements over the last 10 years (an average of 7.1 improvements) in comparison to the non-participants (a 4.7 average).

The five environmental improvements most often completed by 18-hole facilities are (Table 22, Appendix):

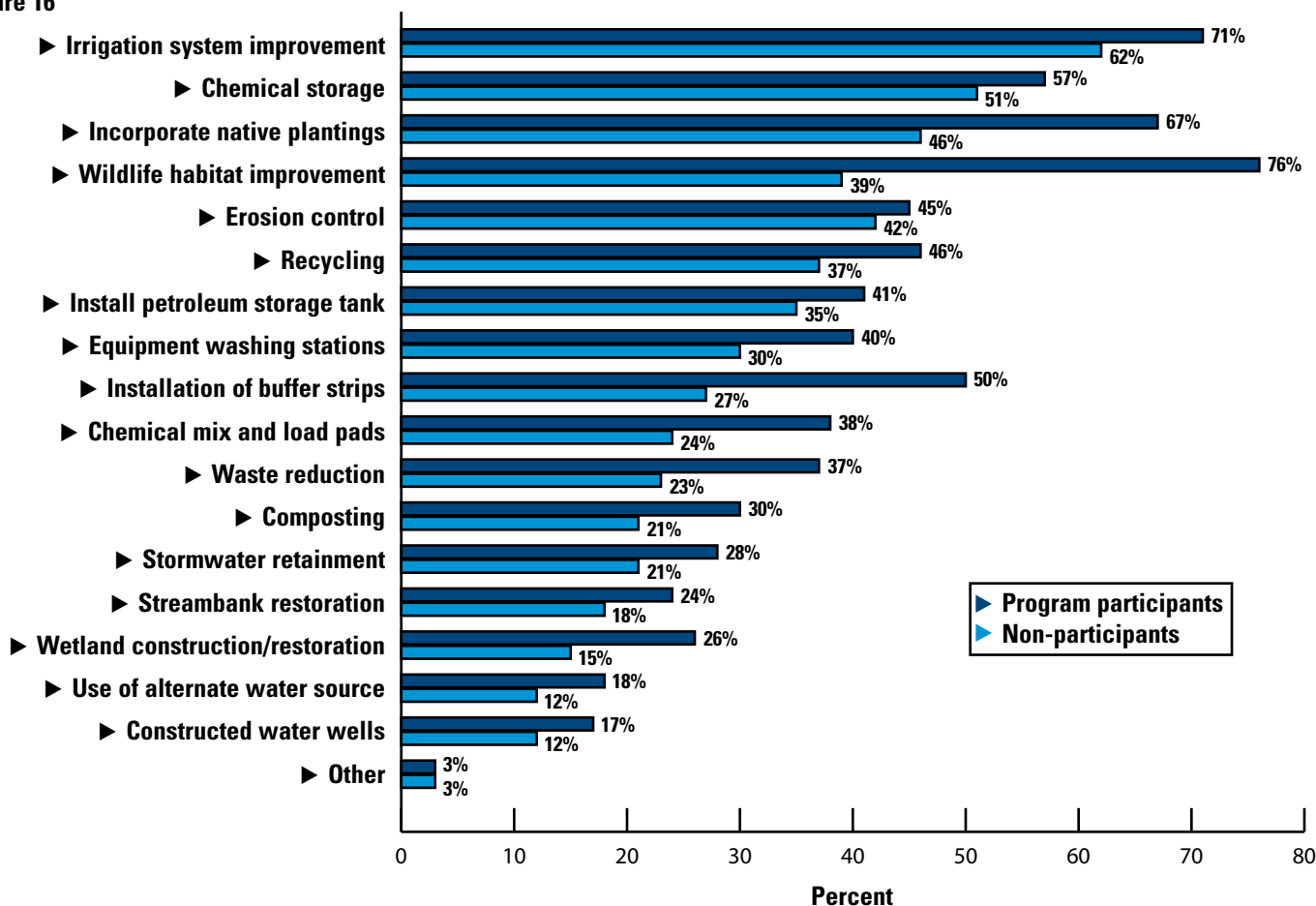
- ▶ Irrigation system improvement (65 percent)
- ▶ Chemical storage (53 percent)

- ▶ Incorporate native plantings (51 percent)
- ▶ Wildlife habitat improvement (47 percent)
- ▶ Erosion control (42 percent)

Environmental stewardship program participants have made significantly more improvements than non-participants in the areas of incorporate native plantings, wildlife habitat improvement, installation of buffer strips, chemical mix/load pads, waste reduction and wetland construction/restoration (Figure 14).

Figure 16 – Facility improvements (by percentage) made since 1996.

Figure 16



Conclusions

This report provides a review of land use on golf courses. The results of this initial survey establish a baseline that can be compared to data from future surveys to identify change over time and highlight golf course land use to guide golf industry agronomic and environmental initiatives.

The following outlines highlights from the report:

Maintained Turfgrass

- ▶ Contrary to popular belief, the entire golf course is not composed of high-maintenance turfgrass.
- ▶ The total acreage of an average 18-hole golf course is 150 acres. Of that total, 100 acres are maintained turfgrass. Fifty-eight acres, the rough and driving range, are not highly maintained areas.
- ▶ On most golf courses, the highly maintained turfgrass is dedicated to the three acres of greens and three acres of tees.
- ▶ Additionally, some golf courses have highly maintained turfgrass on the fairways, which comprise 30 acres of an average 18-hole golf course.

Turfgrass Species

- ▶ The grass species grown on each component of a golf course varies depending on the agronomic region of the country, supporting the principle of growing the best adapted turfgrass species for the particular geographic location.
- ▶ Cool-season grasses are grown on 66 percent of all maintained turfgrass acreage.
- ▶ Kentucky bluegrass is the most widely grown cool-season grass, found on 23 percent of all maintained turfgrass acres.
- ▶ Warm-season grasses, mainly bermudagrass, are grown on 34 percent of all maintained turfgrass acreage.

Non-Turfgrass Acreage

- ▶ The non-turfgrass landscape on golf courses is substantial and can make an important contribution to green space and wildlife habitats for local communities (1, 2, 3, 6, 7, 9).
- ▶ Non-turfgrass landscape of an average 18-hole golf course is 50 acres, including 35 acres of elements such as forests, wetlands, ponds, streams or other specialized habitats.
- ▶ Facilities have the opportunity and the responsibility to maintain these areas in a sustainable manner to further enhance the environmental qualities of a golf facility.

Environmental Improvements

- ▶ On average, over the last 10 years, an 18-hole golf course has made five environmental improvements.
- ▶ Approximately 29 percent of 18-hole golf courses are involved in a formal, voluntary environmental stewardship program.
- ▶ Facilities involved in formal, voluntary environmental programs have made an average of seven improvements to enhance the golf course environment in that 10-year period.
- ▶ The data suggests that such programs are having a positive impact on the golf course environment.

Literature Cited

1. Dodson, R.G. 2000. *Managing Wildlife Habitat on Golf Courses*. Sleeping Bear Press, Chelsea, Mich.
2. Gillihan, S.W. 2000. *Bird Conservation on Golf Courses: A Design and Management Manual*. Sleeping Bear Press, Chelsea, Mich.
3. Libby, G. , Harker, D., Harker, K., Mackay, J. 2004. *Managing Wetlands on Golf Courses*. Wiley, Hoboken, N.J.
4. Marketing Research Association. 2007. The code of marketing research standards. MRA, Glastonbury, Conn. Available at www.mra-net.org/pdf/expanded_code.pdf (Verified June 28, 2007).
5. National Golf Foundation. 2007. *Golf facilities in the U.S.*, 2007 ed. National Golf Foundation, Jupiter, Fla.
6. Shepherd, M., 2002. *Making Room for Native Pollinators: How to Create Habitat for Pollinator Insects on Golf Courses*. United States Golf Association, Far Hills, N.J. and The Xerces Society, Portland, Ore.
7. Stangel, P., and K. Distler. 2002. *Golf courses for wildlife: Looking beyond the turf*. United States Golf Association Turfgrass and Environmental Research. Online. 1(2): 1-6. Far Hills, N.J.
8. Turgeon, A.J. 2002. *Turfgrass Management*, 6th ed. Prentice Hall, Upper Saddle River, N.J.
9. United States Golf Association. 1994. *Golf and Wildlife*. United States Golf Association, Far Hills, N.J.

Appendix

Table 1. Number of golf courses by region, course type and number of holes; percent of the total number of golf courses nationally by region, course type and number of holes; completed surveys received by region, course type or number of holes; percent of the total number of golf courses nationally returning completed surveys by region; course type and number of holes; percent of golf courses returning completed surveys within a region, course type and number of holes; and margin of error for agronomic region, course type and number of holes.

Region ^a	No. of golf courses	Total no. of golf courses by percentage	No. of completed surveys received	Percentage of completed surveys based on the national total of golf courses	Percentage of completed surveys within a region, course type or no. of holes	Margin of error (percentage) ^b
Northeast	3,061	17.1	438	14.9	14.3	3.6
North Central	4,490	25.1	708	24.0	15.8	2.8
Transition	3,344	18.7	548	18.6	16.4	3.2
Southeast	3,764	21.0	615	20.9	16.3	3.0
Southwest	1,352	7.6	245	8.3	18.1	4.8
Upper West/ Mountain	1,175	6.6	246	8.4	20.9	4.7
Pacific	720	4.0	144	4.9	20.0	6.1
Type^a						
Daily fee	10,111	56.2	1,324	45.3	13.2	2.1
Municipal	2,615	14.7	469	16.0	17.9	3.4
Private	5,181	29.1	1,132	38.7	21.8	2.2
No. of holes^a						
9	4,557	28.5	381	12.8	8.4	4.0
18	9,965	62.2	2,118	71.0	21.3	1.6
27+	1,487	9.3	482	16.2	32.4	3.1

^a The number of golf courses under region, type and number of holes does not add up to the same total because information was incomplete for some records.

^b At 90 percent confidence interval.

Table 2. Acreage estimates for land use on U.S. golf courses.

Golf course land use	Acreage	Percentage total
Maintained turfgrass	1,504,210	67
Non-turfgrass landscapes	358,278	16
Water bodies	161,183	7
Buildings	78,814	4
Bunkers	74,383	3
Parking lots	67,644	3
Total	2,244,512	100

Table 3. Average acreage, acreage of maintained turfgrass, and playing length of 9-, 18- and 27-hole golf courses.

No. of golf holes	Total acreage	Maintained turf (acres)	Median playing length (yards)
9	60	45	3,100
18	150	100	6,710
27	217	145	6,800 ^a

^a18-hole course with the greatest number of rounds of golf played.

Table 4. Total acreage of maintained turfgrass on U.S. golf courses, and acreage of turfgrass for each golf course component in each agronomic region.

Golf course component	Agronomic region							
	United States	Northeast	North Central	Transition	Southeast	Southwest	Upper West/ Mountain	Pacific
Total	1,504,210	239,872	400,882	277,593	309,240	129,409	92,121	55,093
Greens	47,525	9,595	12,026	8,328	9,277	3,882	2,764	1,653
Tees	53,761	7,196	12,026	11,104	12,370	5,176	3,685	2,204
Fairways	443,061	64,765	100,220	80,502	102,049	43,999	32,242	19,283
Rough	777,051	131,930	224,494	144,348	145,343	62,116	42,376	26,445
Driving ranges/ practice areas	112,766	16,791	32,071	19,432	24,739	9,059	7,370	3,306
Turfgrass nurseries	21,827	2,399	8,018	5,552	3,092	1,294	921	551
Clubhouse grounds	48,219	7,196	12,026	8,328	12,370	3,882	2,764	1,653

Table 5. Total acres of each grass species in the U.S., and acres of each grass species within each agronomic region.

	United States	Northeast	North Central	Transition	Southeast	Southwest	Upper West/ Mountain	Pacific
Cool-season grasses								
Annual bluegrass	159,740	47,864	57,282	14,166	448	6,813	12,886	20,301
Creeping bentgrass	140,757	40,191	61,287	26,965	2,053	2,393	4,976	2,890
Fine fescue	48,007	17,520	19,956	6,357	631	625	1,613	1,305
Kentucky bluegrass	338,223	65,327	190,491	31,823	770	5,078	41,450	3,294
Perennial ryegrass	162,891	46,535	46,013	18,499	0	11,304	21,088	19,452
Tall fescue	66,549	10,288	10,447	38,902	2,690	1,471	1,765	987
Warm-season grasses								
Bermuda-grass	485,892	715	224	117,486	275,122	85,194	4,711	2,441
Seashore paspalum	7,510	0	0	0	5,919	1,539	0	53
Zoysia-grass	16,293	2	16	13,133	3,006	129	0	7
Other	26,241	2,811	1,856	1,854	6,231	10,496	608	2,384

Table 6. Acreage for tees: Total golf course acreage and total acreage of each species in the U.S., as well as within each agronomic region.

Agronomic region								
	United States	Northeast	North Central	Transition	Southeast	Southwest	Upper West/ Mountain	Pacific
Total	53,761	7,196	12,026	11,104	12,370	5,176	3,685	2,204
Cool-season grasses								
Annual bluegrass	6,640	1,741	2,670	655	25	207	520	822
Creeping bentgrass	11,472	3,008	5,628	2,176	25	36	431	167
Kentucky bluegrass	5,914	957	2,634	511	12	243	1,481	75
Perennial ryegrass	5,625	1,317	986	866	0	461	1,021	974
Warm-season grasses								
Bermuda-grass	21,252	22	0	5,485	11,553	3,867	206	119
Seashore paspalum	543	0	0	0	408	135	0	0
Zoysia-grass	1,713	0	0	1,399	309	5	0	0
Other	602	151	108	11	37	223	26	46

Table 7. Acreage for fairways: Total golf course acreage and total acreage of each species in the U.S., and within each agronomic region.

Agronomic region								
	United States	Northeast	North Central	Transition	Southeast	Southwest	Upper West/ Mountain	Pacific
Total	443,061	64,765	100,220	80,502	102,049	43,999	32,242	19,283
Cool-season grasses								
Annual bluegrass	64,121	17,810	25,656	4,911	204	2,068	5,642	7,829
Creeping bentgrass	73,439	24,352	33,975	12,156	204	132	1,386	1,234
Fine fescue	2,984	1,166	1,102	0	0	220	226	270
Kentucky bluegrass	58,855	7,966	29,966	3,784	102	1,848	14,187	1,003
Perennial ryegrass	46,236	11,917	8,719	6,682	0	2,904	8,899	7,115
Tall fescue	894	259	200	81	0	264	32	58
Warm-season grasses								
Bermuda-grass	175,584	194	0	42,747	97,763	31,943	1,838	1,099
Seashore paspalum	2,877	0	0	0	2,041	836	0	0
Zoysia-grass	11,491	0	0	10,063	1,429	0	0	0
Other	6,580	1,101	601	81	306	3,784	32	675

Table 8. Acreage for rough: Total golf course acreage and total acreage of each species in the U.S., and within each agronomic region.

Agronomic region								
	United States	Northeast	North Central	Transition	Southeast	Southwest	Upper West/ Mountain	Pacific
Total	777,051	131,930	224,494	144,348	145,343	62,116	42,376	26,445
Cool-season grasses								
Annual bluegrass	66,992	21,900	21,102	6,496	145	3,230	4,916	9,203
Creeping bentgrass	8,532	2,639	2,694	1,877	0	248	466	608
Fine fescue	44,286	16,359	18,184	5,918	581	559	1,441	1,243
Kentucky bluegrass	243,590	51,057	140,309	25,117	581	2,609	21,908	2,010
Perennial ryegrass	96,105	29,025	31,429	9,383	0	7,019	9,280	9,970
Tall fescue	61,945	9,499	9,653	36,231	2,616	1,367	1,653	926
Warm-season grasses								
Bermuda-grass	234,417	396	224	57,018	132,407	41,121	2,246	1,005
Seashore paspalum	2,980	0	0	0	2,616	311	0	53
Zoysia-grass	2,009	0	0	722	1,163	124	0	0
Other	16,196	1,055	898	1,588	5,232	5,528	466	1,428

Table 9. Acreage for driving ranges and practice areas: Total golf course acreage and total acres of each species in the U.S., and within each agronomic region.

Agronomic region								
	United States	Northeast	North Central	Transition	Southeast	Southwest	Upper West/ Mountain	Pacific
Total	112,766	16,791	32,071	19,432	24,739	9,059	7,370	3,306
Cool-season grasses								
Annual bluegrass	10,031	2,854	3,881	836	25	272	951	1,213
Creeping bentgrass	7,912	2,183	4,426	1,030	25	54	125	69
Fine fescue	3,640	1,142	1,732	427	49	63	170	66
Kentucky bluegrass	28,133	5,205	16,484	2,137	74	344	3,692	195
Perennial ryegrass	14,423	4,231	4,618	1,535	0	915	1,828	1,296
Tall fescue	4,399	756	738	2,565	74	100	111	56
Warm-season grasses								
Bermuda-grass	40,728	84	0	10,338	23,428	6,250	413	215
Seashore paspalum	732	0	0	0	569	163	0	0
Zoysia-grass	469	0	0	389	74	0	0	7
Other	2,300	336	192	175	421	897	81	198

Table 10. Acreage for putting greens: Total golf course acreage and total acreage of each species in the U.S., and within each agronomic region.

Agronomic region								
	United States	Northeast	North Central	Transition	Southeast	Southwest	Upper West/ Mountain	Pacific
Total	47,525	9,595	12,026	8,328	9,277	3,882	2,764	1,653
Cool-season grasses								
Annual bluegrass	10,000	3,147	3,103	1,091	46	877	743	992
Creeping bentgrass	27,531	6,294	8,815	6,879	1,494	1,425	2,006	618
Kentucky bluegrass	78	10	24	8	0	16	11	10
Perennial ryegrass	67	0	60	0	0	0	0	7
Warm-season grasses								
Bermuda-grass	9,195	19	0	350	7,366	1,460	0	0
Seashore paspalum	235	0	0	0	176	58	0	0
Other	419	125	24	0	195	47	3	26

Table 11. Acreage for turfgrass nurseries: Total golf course acreage and total acreage of each species in the U.S., and within each agronomic region.

Agronomic region								
	United States	Northeast	North Central	Transition	Southeast	Southwest	Upper West/ Mountain	Pacific
Total	21,827	2,399	8,018	5,552	3,092	1,294	921	551
Cool-season grasses								
Annual bluegrass	1,957	410	850	178	3	159	114	242
Creeping bentgrass	11,871	1,715	5,749	2,848	306	497	563	193
Fine fescue	81	19	40	11	0	3	3	6
Kentucky bluegrass	1,663	132	1,074	266	0	18	170	2
Perennial ryegrass	436	46	200	33	0	5	61	90
Tall fescue	205	31	56	105	0	5	2	6
Warm-season grasses								
Bermuda-grass	4,716	0	0	1,549	2,604	553	8	3
Seashore paspalum	144	0	0	0	108	36	0	0
Zoysia-grass	610	2	16	561	31	0	0	0
Other	143	43	32	0	40	18	0	10

Table 12. Acreage for winter overseeded turfgrass: Total acreage of golf course components and acreage of turfgrass species by component used for the Transition, Southeast and Southwest regions.

Golf course component and turfgrass species	Agronomic region		
	Transition	Southeast	Southwest
Greens	190	4,230	1,321
Rough bluegrass	55	3,173	594
Perennial ryegrass	23	635	462
Creeping bentgrass	104	212	211
Intermediate ryegrass	0	42	0
Other	8	169	53
Tees	2,827	8,213	3,832
Rough bluegrass	28	246	77
Perennial ryegrass	2,657	7,638	3,641
Creeping bentgrass	28	0	38
Intermediate ryegrass	113	246	0
Other	0	82	77
Fairways	10,707	40,820	24,591
Perennial ryegrass	9,957	39,595	24,099
Creeping bentgrass	0	0	246
Intermediate ryegrass	535	816	0
Other	214	408	246
Rough	4,388	13,953	24,654
Rough bluegrass	176	0	0
Perennial ryegrass	2,677	12,418	24,161
Intermediate ryegrass	0	977	0
Fine fescue	702	0	493
Other	834	558	0
Driving Ranges / Practice Areas	1,920	6,927	4,256
Rough bluegrass	19	208	43
Perennial ryegrass	1,805	6,442	4,128
Creeping bentgrass	19	0	0
Intermediate ryegrass	58	139	0
Other	19	139	85
Turfgrass Nurseries	84	322	168
Rough bluegrass	7	161	34
Perennial ryegrass	35	138	104
Creeping bentgrass	42	10	29
Other	0	10	2

Table 13. Acreage of non-turfgrass landscapes on U.S. golf courses.

Non-turfgrass areas	Agronomic region							U.S.	
	Northeast	North Central	Transition	Southeast	Southwest	Upper West/ Mountain	Pacific	Total	Percent total
Forests/ woodlands	37,682	38,022	27,555	24,294	2,229	3,898	4,088	137,768	38.5
Native/ undisturbed grasslands	8,951	13,688	9,614	8,157	2,972	7,490	2,830	53,702	14.9
Mixed/ improved grasslands	7,868	15,779	7,287	6,690	3,065	4,764	2,066	47,519	13.3
Other non-mowed areas	4,692	11,311	3,980	4,108	3,065	1,350	1,602	30,108	8.4
Shrublands	3,393	3,517	2,449	4,577	2,694	892	659	18,181	5.1
Garden/ landscape areas	2,599	3,707	2,694	3,051	3,901	637	659	17,248	4.8
Buffer strips	2,743	3,802	2,449	2,875	712	892	898	14,371	4.0
Other natural areas	2,166	2,662	2,572	2,699	1,517	1,554	749	13,919	3.9
Riparian areas	1,805	2,566	2,633	2,230	898	2,114	1,288	13,534	3.8
Deserts	0	0	0	0	9,908	1,885	135	11,928	3.3
Total	71,899	95,054	61,233	58,681	30,961	25,476	14,974	358,278	100

Table 14. Changes since 1996 in non-turfgrass landscapes on golf facilities.

Changes in non-turf-grass acres since 1996	Agronomic region							
	Northeast	North Central	Transition	Southeast	Southwest	Upper West/Mountain	Pacific	U.S. avg.
Percentage increased ^y	48 ab	50 ab	46 b	32 c	27 c	45 b	52 a	44
Avg. acre increase	7.8	10.3	9.7	9.5	9.9	12.9	8.4	9.8
Percentage stayed the same ^y	44 b	45 b	48 b	61 a	67 a	49 b	44 b	49
Percentage decreased	8	5	6	7	6	6	4	6
Avg. acre decrease ^z								16.2

^yWithin a row, values followed by the same letter are not significantly different from one another. Letters denote significance at the 90 percent confidence level.

^zThe base size of respondents to this specific question was too low for agronomic regions. However, the total for the United States was sufficient for reporting.

Table 15. Acreage estimates of water bodies on U.S. golf courses.

Water body	Agronomic region							
	Northeast	North Central	Transition	Southeast	Southwest	Upper West/Mountain	Pacific	Total U.S. acreage
Open water (ponds/lakes)	14,528	28,062	19,931	36,040	5,871	5,951	2,950	113,333
Wetlands	3,722	6,406	2,165	6,064	280	905	414	19,956
Streams/rivers	2,662	4,794	3,498	3,423	343	1,007	518	16,245
Drainage waterways	1,308	1,818	1,804	2,347	1,036	418	371	9,102
Irrigation canals	338	248	361	1,027	257	256	60	2,547
Total	22,558	41,328	27,759	48,901	7,787	8,537	4,313	161,183

Table 16. Acreage dedicated to parking lots at U.S. golf facilities.

Agronomic region	Parking lot characteristics		
	Estimated total surface (acres)	Percentage impervious surface/18 holes ^z	Percentage pervious surface/18 holes ^z
Northeast	12,783	81 d	19 a
North Central	17,122	89 bc	11 ab
Transition	12,655	92 ab	8 bc
Southeast	13,506	93 a	7 bc
Southwest	5,006	93 a	7 bc
Upper West/Mountain	4,131	86 c	14 ab
Pacific	2,441	94 a	6 c
Estimated U.S. total	67,644	89.7	10.3

^zWithin a row, values followed by the same letter are not significantly different from one another. Letters denote significance at the 90 percent confidence level.

Table 17. Acreage dedicated to golf course car paths on U.S. golf facilities.

Agronomic region	Car path characteristics			
	Linear feet/ 18 holes (median) ^z	Width/18 holes (avg.)	Estimated acres/ 18 holes ^z	Estimated total acres for region
Northeast	8,860 c	7.0	1.4 c	3,567
North Central	9,970 c	7.0	1.6 c	5,911
Transition	21,920 a	7.0	3.5 a	9,586
Southeast	20,910 a	7.1	3.4 a	11,257
Southwest	20,310 a	7.2	3.4 a	4,149
Upper West/ Mountain	13,100 bc	7.2	2.2 bc	1,988
Pacific	19,970 ab	7.2	3.3 ab	1,961
U.S. avg. or totals based on total response	17,670	7.0	2.8	38,419

^zWithin a row, values followed by the same letter are not significantly different from one another. Letters denote significance at the 90 percent confidence level.

Table 18. Environmental program participation of U.S. golf facilities.

Facility characteristic	Percentage of participation ^a
No. of holes	
9	9 a
18	29 b
27	39 c
Course type	
Public	26 a
Private	36 b
Maintenance budget	
< \$500,000	18 a
\$500,000 – \$1,000,000	38 b
> \$1,000,000	47 c
GCSAA membership	
GCSAA member	32 a
Non-GCSAA member	17 b

^aValues followed by the same letter are not significantly different from one another. Letters denote significance at the 90 percent confidence level.

Table 19. Percent of total acreage of specific features on U.S. golf facilities participating and not participating in an environmental stewardship program.

	Program participants	Non-participants
	Total property size (average)	
	160 acres	150 acres
Golf course feature	Total acreage by percentage	
Maintained turfgrass	63 ^a	69
Bunkers	4	3
Buildings/features	3	3
Parking lots	3	3
Water bodies	8	7
Natural/native/non-mowed	19	15

^aSignificant within row at the 90 percent confidence level.

Table 20. Percent and acreage change to natural/native/non-mowed areas since 1996.

Status	Facility type		
	18-hole	Program participant	Non-participant
Increased (by percentage)	44	56 ^a	40
Stayed the same (by percentage)	49	39	53 ^a
Decreased (by percentage)	6	5	7
Avg. no. acres of increase	9.8	10.1	9.6

^aSignificant within the row at the 90 percent confidence level.

Table 21. Number of environmental improvements on U.S. golf facilities since 1996.

No. of improvements	Percentage of all facilities	Percentage of program participants	Percentage of non-participants
1	96	98	94
2	90	97	87
3	81	93	76
4	69	84	63
5	57	74	50
6	45	65	37
7	34	52	27
8	25	38	19
9	19	31	13
10 +	13	22	9

Table 22. Environmental improvements made since 1996 by U.S. 18-hole golf facilities participating (and not participating) in a voluntary environmental stewardship program.

Improvement	Percentage of facilities making the improvement		
	All facilities	Program participants	Non-participants
Irrigation system improvement	65	71	62
Chemical storage	53	57	51
Incorporate native plantings	51	67 ^a	46
Wildlife habitat improvement	47	76 ^a	39
Erosion control	42	45	42
Recycling	40	46	37
Install petroleum storage tank	37	41	35
Equipment washing stations	32	40	30
Installation of buffer strips	32	50 ^a	27
Chemical mix and load pads	28	38 ^a	24
Waste reduction	27	37 ^a	23
Composting	23	30	21
Stormwater retainment	22	28	21
Streambank restoration	19	24	18
Wetland construction/restoration	17	26 ^a	15
Use of alternate water source	15	18	12
Constructed water wells	14	17	12
Other	3	3	3

^aSignificant within row at the 90 percent confidence level.