



Photo courtesy of Coral Canyon GC

Golf Course Environmental Profile

Phase II, Volume IV
Land Use Characteristics and
Environmental Stewardship Programs
on U.S. Golf Courses



Golf Course Superintendents Association of America

Golf Course Environmental Profile

Phase II, Volume IV

Land Use Characteristics and Environmental Stewardship Programs on U.S. Golf Courses

The second phase of the Golf Course Environmental Profile was conducted by the Golf Course Superintendents Association of America through the Environmental Institute for Golf and funded by the United States Golf Association.

Copyright 2017 GCSAA. All rights reserved.



Table of Contents

FOREWORD	4	Non-turf acreage	21
EXECUTIVE SUMMARY	5	Turf features	22
Objectives	5	Turf types	22
Key results	5	Pacific region	23
Land use characteristics	5	Climate	23
Trends in land use, 2005-2015	6	Facility size	23
Environmental improvements	6	Maintained turf acreage	23
Turf types	6	Irrigated acreage	23
INTRODUCTION	7	Non-turf acreage	23
RESULTS	8	Turf features	24
National Trends	8	Turf types	24
Golf facility acreage	8	Southeast region	25
Maintained turf acreage	8	Climate	25
Winter overseeding practices	10	Facility size	25
Irrigated turf acreage	11	Maintained turf acreage	25
Turf type acreage	11	Winter overseeding	25
Bermudagrass	13	Irrigated acreage	25
Kentucky bluegrass	13	Non-turf acreage	25
Annual bluegrass	14	Turf features	26
Perennial ryegrass	14	Turf types	26
Creeping bentgrass	14	Southwest region	27
Tall fescue	14	Climate	27
Fine fescue	14	Facility size	27
Zoysiagrass and seashore paspalum	14	Maintained turf acreage	27
Water feature acreage	15	Winter overseeding	27
Natural/native/unmowed acreage	15	Irrigated acreage	27
Non-landscaped acreage	16	Non-turf acreage	27
Buildings	16	Turf features	28
Parking lots	16	Turf types	28
Bunkers	16	Transition region	29
Cart paths	16	Climate	29
Environmental improvements	17	Facility size	29
Environmental stewardship program participation.....	17	Maintained turf acreage	29
Regional Trends	18	Winter overseeding	29
Key results	18	Irrigated acreage	29
Facility size	18	Non-turf acreage	29
Maintained turf acreage	18	Turf features	30
Overseeded turf acreage	18	Turf types	30
Irrigated turf acreage	18	Upper West/Mountain region	31
North Central region	19	Climate	31
Climate	19	Facility size	31
Facility size	19	Maintained turf acreage	31
Maintained turf acreage	19	Irrigated acreage	31
Irrigated acreage	19	Non-turf acreage	31
Non-turf acreage	19	Turf features	32
Turf features	20	Turf types	32
Turf types	20	CONCLUSIONS AND RECOMMENDATIONS	
Northeast region	21	METHODOLOGY	33
Climate	21	Survey response	33
Facility size	21	Data analysis	33
Maintained turf acreage	21	LITERATURE CITED	33
Irrigated acreage.....	21	FURTHER READING	33
		APPENDIX	35



Foreword

Study shows significant changes in golf course land use and maintenance

As results from the latest Golf Course Environmental Profile (GCEP) survey demonstrate, a lot can change in golf course management in a decade. I'm pleased to note we are moving in a positive direction for the sustainability of golf and the environment.

The goal of this Land Use Characteristics and Environmental Stewardship Programs survey was to compare results of the initial 2006 survey with those from the follow-up survey taken 10 years later. Conducted by GCSAA and funded by the EIFG through sponsorship by the United States Golf Association, Phase II GCEP surveys began in 2014 to mirror the earlier surveys documenting water use, fertilizer use, pest management practices, energy use, environmental stewardship and property profiles.

Land use and management practices are the foundation for lowering the environmental footprint of the golf industry. Survey results show that over the last 10 years, approximately 46 percent of facilities have increased their acreage of natural/native or unmowed areas; while in the southern and Transition regions, acreage of winter-overseeded turf decreased by 49 percent. In addition, facilities have reduced the acreage of fairways, practice areas and grounds, and the number of facilities conducting recycling activities has grown from 38 percent to 53 percent.

On behalf of your board of directors, I want to thank every superintendent who participated in this study. The information we have gained from the GCEP surveys has proven invaluable in our communications with regulators, legislators and the public, as well as in the operation of our own golf facilities and in guiding our profession's ongoing efforts to be responsible stewards of the land.



Bill Maynard, CGCS
2017 GCSAA President



Executive Summary

Objectives

Land use characteristics and environmental stewardship programs on U.S. golf courses were documented for the first time in a survey conducted in 2006 by the Golf Course Superintendents Association of America.

The objectives of the second Land Use Characteristics and Environmental Stewardship Programs Survey were to compare results from two surveys taken 10 years apart in an attempt to document, characterize and/or quantify both national and regional trends in:

- land use on U.S. golf courses
- the use of turf types and overseeding practices
- the role of climate, geography and facility type on land use patterns
- participation in environmental stewardship programs.

Acreage of golf course components for 18-hole facilities

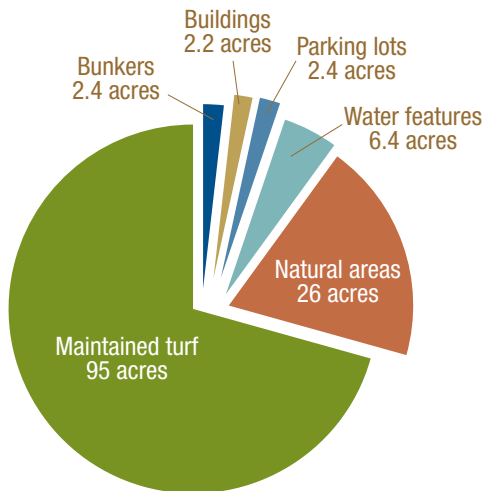


Figure 1. Acreage of golf course components on an average 18-hole facility, 2015.

Key results

Land use characteristics

In 2015, an average 18-hole golf facility contained a median of 150 acres and was made up of the following features (Figure 1):

- 95 acres maintained turf
 - o 3.2 acres of greens
 - o 3.1 acres of tees
 - o 28 acres of fairways
 - o 48 acres of roughs
 - o 6.0 acres of practice/driving range areas
 - o 0.9 acres of nursery
 - o 1.7 acres of clubhouse grounds

Median acreage of 18-hole golf facilities

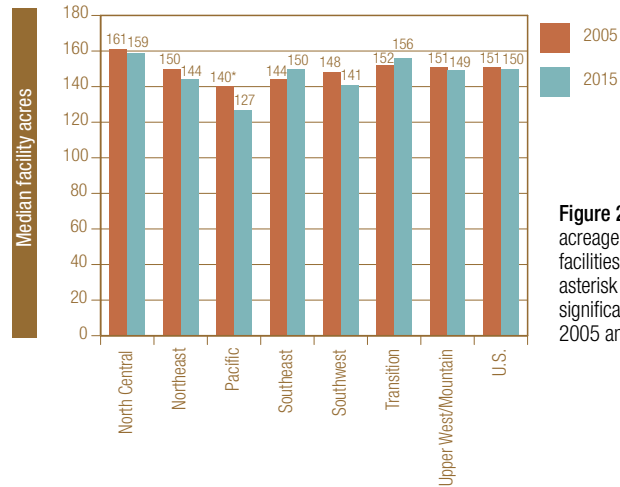


Figure 2. Trends in median acreage of 18-hole golf facilities, 2005 vs. 2015. An asterisk indicates a statistically significant difference between 2005 and 2015 values.

Median acreage of maintained turf

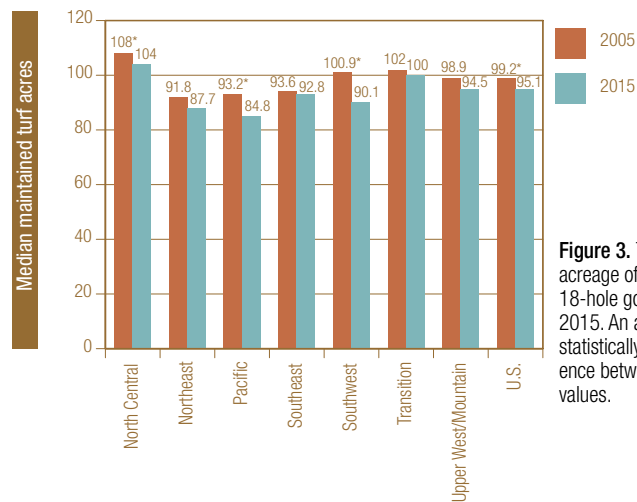


Figure 3. Trends in median acreage of maintained turf for 18-hole golf facilities, 2005 vs. 2015. An asterisk indicates a statistically significant difference between 2005 and 2015 values.

Allocation of maintained turf

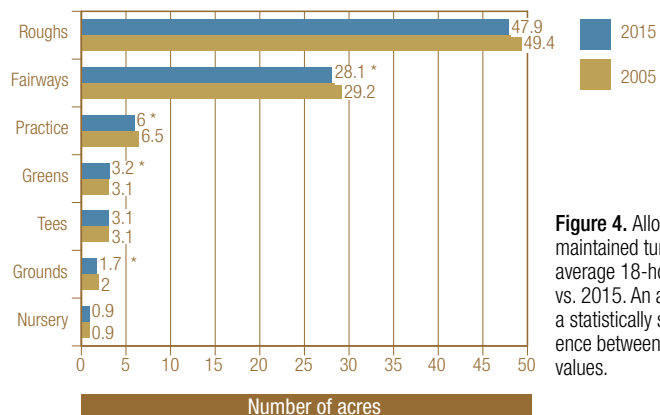


Figure 4. Allocation of maintained turf acreage on an average 18-hole facility, 2005 vs. 2015. An asterisk indicates a statistically significant difference between 2005 and 2015 values.

- 26 acres of natural/unmowed/native areas
- 6.4 acres of water features
- 2.4 acres of bunkers
- 2.4 acres of parking lots
- 2.2 acres of buildings

Trends in land use, 2005-2015

- Overall size of the average U.S. 18-hole facility has not changed, with a median of 151 acres in 2005 and 150 acres in 2015 (Figure 2).
- The Pacific region was the only region where facility size has decreased significantly since 2005 (Figure 2).
- Since 2005, maintained turf acreage for U.S. 18-hole facilities has decreased significantly from 99 acres (66% of total facility acreage) to 95 acres (63% of total facility acreage) per 18-hole facility (Figure 3).
- There were decreases in the acreage of fairways, practice areas and grounds (Figure 4).

Environmental improvements

Trends other than reductions in the acreage of maintained turf also have had a positive environmental impact.

- The total projected acreage of winter overseeded turfgrass in the Southeast, Southwest and Transition regions has decreased by 49% since 2005 (Figure 5). (These are the only three regions where winter overseeding is a common practice).
- Comparison of the current survey results (see Table 11 under "Irrigated turf acreage" in the Results section) with a 2013 survey that used comparable methods (4) shows a trend toward reduction of irrigated acreage.
- Approximately 46% of facilities have increased their acreage of natural/native or unmowed areas since 2005.
- The number of facilities conducting recycling activities has increased significantly, from 38% in 2005 to 53% in 2015.

Turf types

- In 2015, cool-season grasses were grown on 63% of all maintained turfgrass acreage, while warm-season turf was grown on 37%. These proportions have remained stable over the past 10 years (Figure 6).
- Bermudagrass remained the most heavily used turf type, making up approximately 34% of all maintained turf acreage in 2015. Kentucky bluegrass made up 23% of turf acreage, and annual bluegrass made up 11%. This pattern is very similar to that observed in 2005 (Figure 7).

Winter-overseeded acres in the U.S.

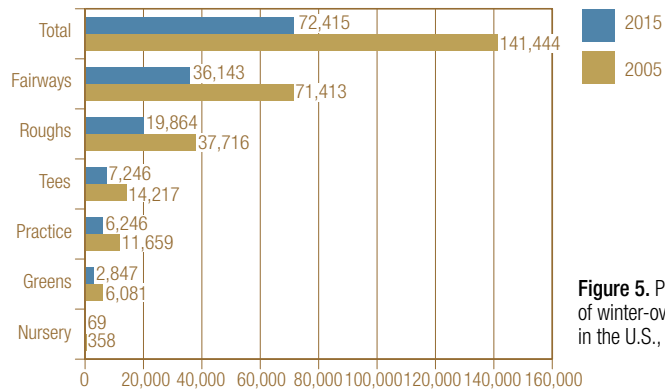


Figure 5. Projected number of winter-overseeded acres in the U.S., 2005 vs. 2015.

Warm-season and cool-season turf acreage

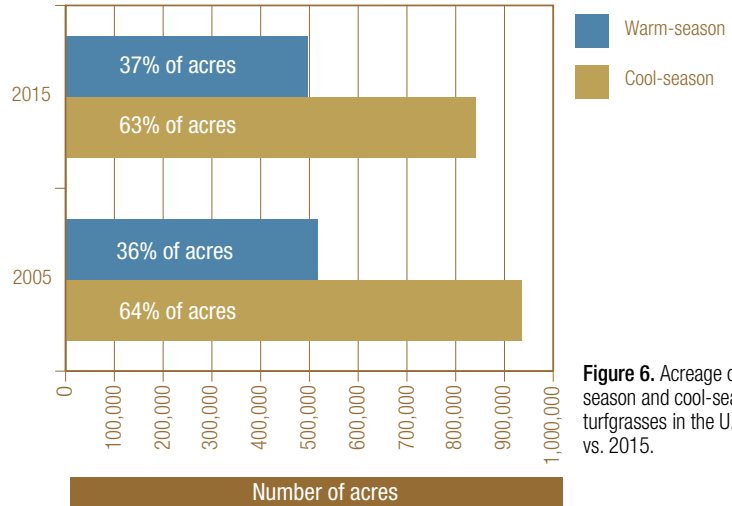


Figure 6. Acreage of warm-season and cool-season turfgrasses in the U.S., 2005 vs. 2015.

Projected acreage for turf species

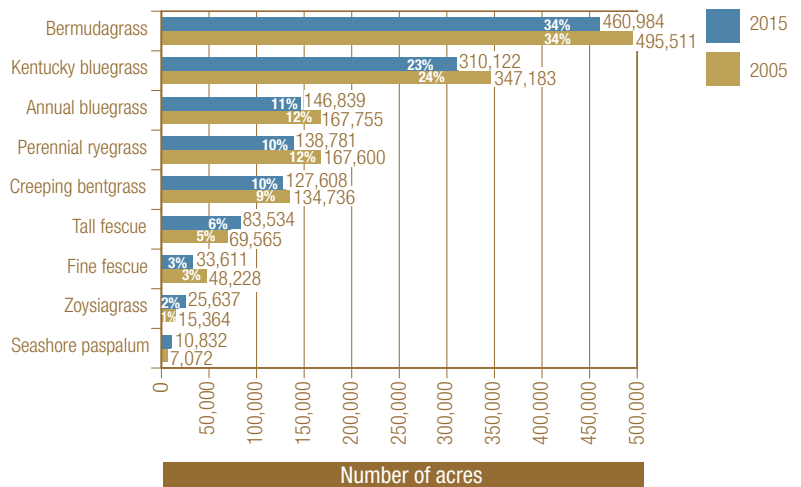


Figure 7. Projected acreage for turf species, 2005 vs. 2015.

Introduction

Why do we need a golf course environmental profile?

The Environmental Institute for Golf (EIFG) is sponsoring a long-range initiative to address the golf industry's lack of comprehensive national data on management practices, property features and environmental stewardship on the nation's golf courses. In the past, it has been difficult to document current practices or to track changes in the industry — information that would be valuable to golf course superintendents, golf industry leaders, turfgrass scientists and environmental regulators in their joint efforts to enhance environmental stewardship on the nation's golf courses.

To respond to this need, the Golf Course Superintendents Association of America (GCSAA) and the EIFG initiated a project in 2006 to conduct a series of surveys to document water use, fertilizer use, pest management practices, energy use, environmental stewardship and property profiles. Collectively known as the Golf Course Environmental Profile, the results were released from 2007 to 2012 and provided a baseline of information for use in the management of golf facilities. It also offered an opportunity to communicate golf's environmental efforts to the public.

Results were published in the peer-reviewed scientific journal *Applied Turfgrass Science* (recently renamed *Crop, Forage and Turfgrass Management*), as well as in *Golf Course Management* and in online documents. All reports from the first phase of the Environmental Profile project are available online (www.gcsaa.org/environment/golf-course-environmental-profile).

In fall 2014, the second phase of the Golf Course Environmental Profile began, with a follow-up set of surveys that mirrors the previous series. The surveys were conducted by the GCSAA through the EIFG and funded by the United States Golf Association (USGA). The fourth survey to be released in the second phase focuses on land use and environmental stewardship programs, and explores trends, changes and progress that have occurred since the initial



Since the first surveys were taken in 2006, the Golf Course Environmental Profile has collected information about water use, fertilizer use, pest management practices, energy use, environmental stewardship and property profiles of golf courses throughout the United States.

Photo courtesy of Stone Mountain Golf Club

land use survey was conducted in 2005.

A listing of the published articles from both the first and second phase of the Environmental Profiles appears in the “Further Reading” section of this report.

The objective of the current land use and environmental stewardship survey was to compare results from 2015 with those from the initial 2005 survey, in an attempt to document, characterize and/or quantify national and regional trends in:

- land use on U.S. golf courses
- the use of turf types and overseeding practices
- the role of climate, geography and facility type on land use patterns
- participation in environmental stewardship programs.

Projections vs. medians

Two types of measurements are reported in this report: medians and projections.

The median data reported here describes the land use characteristics of the average 18-hole facility for both 2005 and 2015. For example, the average (median) size of an 18-hole U.S. golf facility in 2005 was 151 acres, but in 2015, it was 150 acres.

The projection data extrapolates or projects the survey data to produce estimates on how an entire region, or the entire nation, is dealing with land use. For example, the projected acreage for all U.S. golf facilities in 2005 was 2,421,605, but in 2015, it was somewhat less, 2,301,808 acres. Projections take into account the average behavior at the individual golf course level, but also incorporate the impact of the number of golf facilities in the geographic area of interest.

Each type of analysis yields different and equally useful insights, as highlighted in the Results section of this report.

Median facility size for 18-hole golf courses in the U.S.

Region	2005	2015	% change
	18-hole facility median acreage		
North Central	161 c	159 c	-1.3
Northeast	150 bc	144 ab	-3.7
Pacific	140 a	127 a*	-9.4
Southeast	144 ab	150 bc	4.8
Southwest	148 abc	141 ab	-4.6
Transition	152 bc	156 bc	2.9
Upper West/Mountain	151 bc	149 abc	-1.4
U.S.	151	150	-0.7

Table 1. Median facility size for 18-hole golf courses in 2005 vs. 2015. Within each column, medians followed by the same letter are not significantly different at the 90% confidence level. For each regional comparison within a row, an asterisk indicates that values for 2005 vs. 2015 are significantly different at the 90% confidence level.

Projected total U.S. acreage of all golf facilities, 2005 vs. 2015

Region	2005	2015	Change	% change
	Projected acreage for all golf facilities			
North Central	629,957	585,532	-44,425	-7.1
Northeast	394,247	368,877	-25,370	-6.4
Pacific	90,282	83,144	-7,138	-7.9
Southeast	508,134	501,079	-7,055	-1.4
Southwest	198,205	184,562	-13,643	-6.9
Transition	447,796	425,963	-21,833	-4.9
Upper West/Mountain	152,985	152,650	-335	-0.2
U.S.	2,421,605	2,301,808	-119,797	-4.9

Table 2. Projected total U.S. acreage for all golf facilities in 2005 vs. 2015.

Changes in number of golf facilities

Region	2005	2015	Change, 2005-2015
	No. of facilities (18-hole equivalents)		
North Central	3,690	3,476	-214
Northeast	2,507	2,445	-62
Pacific	594	579	-15
Southeast	3,303	3,078	-226
Southwest	1,236	1,207	-29
Transition	2,722	2,565	-157
Upper West/Mountain	918	940	22
U.S.	14,969	14,289	-681

Table 3. Changes in number of golf facilities, 2005 vs. 2015.

Results

National trends

Golf facility acreage

- The median size for an 18-hole facility was 150 acres in 2015, with no significant change from the 151 acres documented in 2005 (Figure 2, Table 1).
- The Pacific region was the only region that has had a significant decrease in total facility acreage for 18-hole golf courses since 2005 (Figure 2, Table 1).
- The Pacific region had the smallest 18-hole facilities in both 2005 and 2015, while the North Central region had the largest facilities in both years (Figure 2, Table 1).
- The playing length for 18-hole facilities has increased since 2005, from a median of 6,722 yards to 6,800 yards. This trend toward longer courses has been influenced by changes in the design of balls and clubs that allow golfers to hit longer and straighter than in the past (3).
- The playing length of nine-hole facilities, however, has not changed significantly since 2005, with median values of 3,100 yards in 2005 and 3,105 yards in 2015.
- There was also no significant change since 2015 in the median facility acreage for nine-hole golf courses, which was 59.0 acres in 2005 and 58.6 acres in 2015 (data not shown).
- The projected total acreage of golf facilities in the U.S. in 2015 was 2,301,808 acres, which represents a 4.9%, or 119,797-acre, decrease in total facility acres since 2005 (Table 2).
- Since median facility acreage has not changed since 2005 (Figure 2, Table 1), the decrease in total acreage of U.S. golf facilities was entirely due to the reduction in the number of U.S. golf facilities since 2005 (Table 3).

Maintained turf acreage

Maintained turf refers to all greens (including putting/practice greens), tees, fairways, roughs, driving range/practice areas (excluding putting/practice greens), turf nurseries and clubhouse grounds (landscaped areas, grass recreational areas) at the golf facility. Maintained turf makes up the largest component of the golf facility, comprising 63% of total facility acreage on an average 18-hole golf course in 2015 (Figure 1).

- Maintained turf acreage of nine-hole and 18-hole golf courses has decreased significantly since 2005 (Table 4).
- While public facilities significantly reduced their acreage of maintained turf, private courses did not. Private courses also had significantly higher acreages of total maintained turf than public courses in both 2005 and 2015 (Table 5).

Median maintained turf acreage for 9-hole vs. 18-hole golf facilities

Facility type	Greens		Tees		Fairways		Roughs		Practice		Nursery		Grounds		Total	
	2005	2015	2005	2015	2005	2015	2005	2015	2005	2015	2005	2015	2005	2015	2005	2015
Nine holes	1.35	1.38	1.18	1.19	14.2	13.2*	17.9	15.5	4.02	3.26*	0.75	0.91	1.33	1.18	42.5	37.6*
18 holes	3.10*	3.22	3.08	3.07	29.2	28.1*	49.4	47.9	6.53	6.00*	0.91	0.87	2.02	1.70*	99.2	95.1*

Table 4. Median maintained turf acreage, 2005 vs. 2015, for nine-hole vs. 18-hole golf facilities. For each facility type/feature combination within a row, values in bold type with the lower value followed by an asterisk indicate a significant difference between the 2005 and 2015 values at the 90% confidence level.

Median maintained turf acreage for public vs. private facilities

Facility type	Greens		Tees		Fairways		Roughs		Practice		Nursery		Grounds		Total	
	2005	2015	2005	2015	2005	2015	2005	2015	2005	2015	2005	2015	2005	2015	2005	2015
Public (18-hole)	3.11 a*	3.18 a	3.21 b	3.21 b	29.5 b	28.3 a*	47.3 a	44.4 a*	6.72 b	6.06 a*	0.95 b	0.90 a	1.84 a	1.58 a*	97.7 a	92.2 a*
Private (18-hole)	3.08 a*	3.27 b	2.91 a	2.90 a	28.7 a	27.7 a*	52.3 b	52.8 b	6.31 a	5.91 a*	0.88 a	0.85 a	2.27 b	1.87 b*	101.2 b	98.9 b

Table 5. Median maintained turf acreage for public vs. private facilities in 2005 vs. 2015. Within each column, medians followed by the same letter are not significantly different at the 90% confidence level. For each facility type/feature combination within a row, values in bold type with the lower value followed by an asterisk indicate a significant difference between the 2005 and 2015 values at the 90% confidence level.

Median maintained turf acreage, for 18-hole facilities for the U.S. and seven agronomic regions

Region	Greens			Tees			Fairways			Roughs		
	2005	2015	% change	2005	2015	% change	2005	2015	% change	2005	2015	% change
North Central	3.25 d*	3.44 b	5.8	2.92 b*	3.15 bc	7.9	27.4 bc	27.0 b	-1.5	60.1 c	56.7 d	-5.7
Northeast	3.24 d*	3.43 b	5.9	2.58 a	2.65 a	2.7	25.8 a	24.8 a*	-3.9	48.0 ab	45.6 bc	-5.0
Pacific	2.90 a	3.01 a	3.8	2.96 bc	2.74 ab	-7.4	31.4 d	30.7 cd	-2.2	42.7 a	36.3 a*	-15
Southeast	2.97 ab	3.04 a	2.4	3.45 c	3.24 c	-6.1	31.1 d	29.3 cd	-5.8	42.0 a	45.1 b	7.4
Southwest	3.03 bc	3.12 a	3.0	3.23 bc	3.07 bc	-5.0	33.0 d	30.3 cd*	-8.2	47.0 ab	41.9 ab*	-11
Transition	3.11 cd	3.21 ab	3.2	3.23 c	3.31 c	2.5	28.9 c	28.1 bc	-2.8	52.3 b	52.8 cd	1.0
Upper West/Mtn	3.00 bc	3.11 a	3.7	3.15 bc	3.09 bc	-1.9	33.3 d	31.0 d*	-6.9	44.4 a	44.3 ab	-0.2
U.S.	3.10*	3.22	3.9	3.08	3.07	-0.3	29.2	28.1*	-3.8	49.4	47.9	-3.0

	Practice			Nursery			Clubhouse grounds			Total maintained turf		
	2005	2015	% change	2005	2015	% change	2005	2015	% change	2005	2015	% change
North Central	7.37 d	6.37 b*	-14	0.98 bc	0.91 a	-7.1	2.12 bc	1.84 bc*	-13	108 c	104 c*	-4.0
Northeast	5.38 a	5.10 a	-5.2	0.84 ab	0.80 a	-4.8	2.07 abc	1.73 bc*	-16	91.8 a	87.7 a	-4.5
Pacific	5.51 ab	5.11 ab	-7.3	0.87 abc	0.81 a	-6.9	1.55 a	1.40 abc	-9.7	93.2 ab	84.8 a*	-9.0
Southeast	6.36 bc	6.13 ab	-3.6	0.84 ab	0.82 a	-2.4	2.39 c	1.93 c*	-19	93.6 ab	92.8 ab	-0.9
Southwest	6.92 cd	6.20 ab	-10	0.70 a	0.87 a	24.3	1.73 ab	1.33 ab*	-23	100.9 bc	90.1 a*	-11
Transition	6.45 bc	6.19 ab	-4.0	1.08 c	0.98 a	-9.3	1.88 ab	1.92 c	2.1	102 bc	100 bc	-1.3
Upper West/Mtn	7.51 d	6.33 ab*	-16	0.90 abc	0.82 a	-8.9	1.68 ab	1.14 a*	-32	98.9 ab	94.5 ab	-4.4
U.S.	6.53	6.00*	-8.1	0.91	0.87	-4.4	2.02	1.07*	-16	99.2	95.1*	-4.1

Table 6. Median maintained turf acreage, for 18-hole facilities, 2005 vs. 2015, for the U.S. and seven agronomic regions. Within each column, medians followed by the same letter are not significantly different at the 90% confidence level. For each facility type/feature combination, values in bold type with the lower value followed by an asterisk indicate a significant difference between the 2005 and 2015 values at the 90% confidence level.

Projected total U.S. acreage for maintained turf in 2005 vs. 2015

Region	2005	2015	Decrease in acreage	
	Projected acres of maintained turf			% change
North Central	411,804	368,977	-42,827	-10
Northeast	241,376	216,187	-25,189	-10
Pacific	58,509	51,826	-6,683	-11
Southeast	315,767	298,702	-17,065	-5.4
Southwest	128,173	113,168	-15,005	-12
Transition	284,941	264,887	-20,054	-7.0
Upper West/Mountain	95,197	94,664	-533	-0.6
U.S.	1,535,767	1,408,412	-127,355	-8.3

Table 7. Projected total U.S. acreage for maintained turf in 2005 vs. 2015.

- Eighteen-hole golf courses have significantly reduced the acreage for fairways, practice areas and grounds since 2005 (Table 6, Figure 4).
- On 18-hole golf courses, greens were the only feature for which acreage has significantly increased over the past 10 years (Table 6, Figure 4).
- While the median acreage of maintained turf has either stayed the same or has been significantly reduced since 2005 in all regions, the Southwest had the largest percentage decrease, largely because of significant reductions in acreage devoted to fairways and roughs (Table 6).
- On a national scale, there were a projected 1,408,412 total acres of maintained turf in the U.S. in 2015, which represents an 8.3%, or 127,355-acre, decrease since 2005 (Table 7).

Projected number and percentage of overseeded turf acres

Region	Greens				Tees				Fairways				Roughs			
	2005	2015	2005	2015	2005	2015	2005	2015	2005	2015	2005	2015	2005	2015	2005	2015
	Acres		% overseeded acres		Acres		% overseeded acres		Acres		% overseeded acres		Acres		% overseeded acres	
Southeast	4,478	1,577	46	16	8,146	3,796	66	35	37,822	17,609	35	18	11,734	4,890	7.9	3.2
Southwest	1,375	1,270	35	33	3,428	2,534	73	63	23,327	14,814	53	39	21,929	13,520	36	24
Transition	228	0	2.6	0	2,643	916	26	10	10,264	3,720	12	4.9	4,053	1,454	2.7	1.0
Total	6,081	2,847	27	13	14,217	7,246	52	30	71,413	36,143	31	17	37,716	19,864	10	5.6

Region	Practice				Nursery				Total				
	2005	2015	2005	2015	2005	2015	2005	2015	2005	2015	2005	2015	% change in overseeded acres
	Acres		% overseeded acres		Acres		% overseeded acres		Acres		% overseeded acres		
Southeast	5,797	3,094	25	16	235	27	9.0	1.7	68,212	30,993	22	10	-55
Southwest	4,082	2,432	44	30	89	42	12	4.9	54,230	34,612	42	31	-36
Transition	1,780	720	9.4	4.4	34	0	1.1	0.0	19,002	6,810	6.7	2.6	-64
Total	11,659	6,246	23	14	358	69	5.7	1.6	141,444	72,415	19	11	-49

Table 8. Projected number of overseeded turf acres, and the percentage of overseeded acreage, in the Transition, Southeast and Southwest regions, 2005 vs. 2015. These three regions are the only areas of the U.S. where winter overseeding is a common practice.

Projected acreage of turf types for overseeding

Turf species	2005	2015
	Projected acres	
Fine fescue	1,089	37
Creeping bentgrass	768	155
Intermediate ryegrass	2,779	1,754
Rough bluegrass	4,612	2,336
Perennial ryegrass	115,829	59,685

Table 9. Projected acreage of turf types used for winter overseeding in the Southeast, Southwest and Transition regions. These three regions are the only areas of the U.S. where winter overseeding is a common practice. Regional acreages for each turf type and each golf course feature are shown in Tables A1-A6.

- All regions demonstrated a decline in projected maintained turf acreage, with the Southwest and Pacific regions showing the largest percentage decrease (Table 7).
- These trends are the result of two factors. Net reductions since 2005 in the number of golf facilities in each region (Table 3) were responsible for approximately 55% of the decrease in maintained turf acres. Voluntary reductions in the acreage of maintained turf features were responsible for approximately 45% of the decreased acreage.

Winter overseeding practices

Winter overseeding of warm-season turf with cool-season varieties allows facilities in southerly cli-

mates to maintain year-round green turf and golf play. The data below refers only to the regions where winter overseeding occurs — the Southeast, Southwest and Transition regions.

- The projected acreage of overseeded turf has been reduced by 49% since 2005 (Table 8, Figure 8).
- Since 2005, the percentage of facilities that overseed at least one feature has been reduced from 61% to 50% (Figure 9), with the greatest reductions in the Southeast and Southwest (Figure 10).
- While acreage of overseeded turf was reduced on all golf features, the biggest acreage decrease occurred on fairways (Figure 5, Table 8).
- The most common reasons cited for decreasing overseeded acreage were savings in money (86%), labor (74%), water (66%), fuel/energy (62%), fertilizer (61%), wear and tear on equipment (47%) and pesticides (36%) (data not shown).
- Tees were the most frequently overseeded feature in both 2005 and 2015, and roughs and nurseries were the least frequently overseeded features (Table 8).
- Perennial ryegrass was, by far, the turf type most used for overseeding in both 2005 and 2015 (Table 9). The only feature on which perennial ryegrass did not dominate was greens, where rough bluegrass (*Poa trivialis*) was the most commonly used turf type (Tables A1-A6).

Irrigated turf acreage

- U.S. golf courses irrigated approximately 76% of projected maintained turf acreage in 2015 (Table 10).
- Facilities in the cool and rainy North Central and Northeast regions had the lowest percentages of irrigated turf, while the warmer, more arid Upper West/Mountain and Southwest regions had the highest percentages (Table 10, Figure 11).
- The nature of the facility had a strong influence on irrigated turf acreage, with private 18-hole facilities irrigating 85% of their acreage, and public facilities irrigating 72%. Likewise, nine-hole facilities irrigated 54% of their turf acreage, while 18-hole facilities irrigated 78% (data not shown).
- Data on irrigated acres was not solicited in the initial survey in 2005. However, a comparison of the 2015 national median of 74.0 acres of irrigated turf for 18-hole facilities (Table 11) with the median value of 80.2 acres reported in a 2013 report that used comparable survey methods (5) appears to show a trend toward reduction of irrigated acreage across the country.

Turf type acreage

The turf type acreages discussed in this section do not include overseeded turf for winter play. These acreages are dealt with separately in the “Winter overseeding practices” section above.

Projected number of overseeded acres

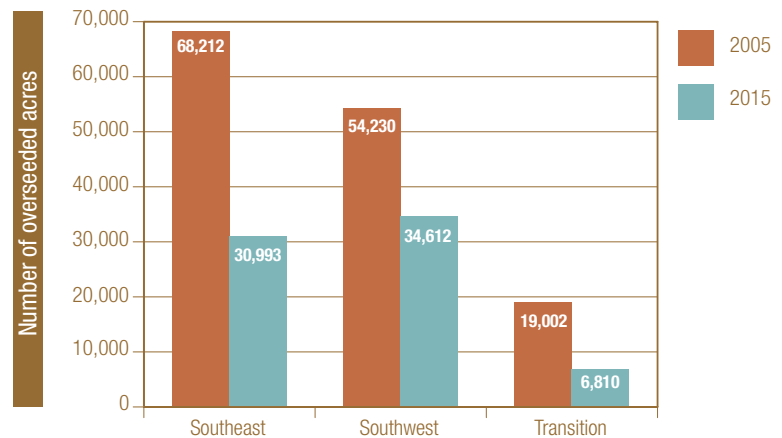


Figure 8. Projected number of overseeded acres in 2005 and 2015.

% facilities with winter-overseeded turf

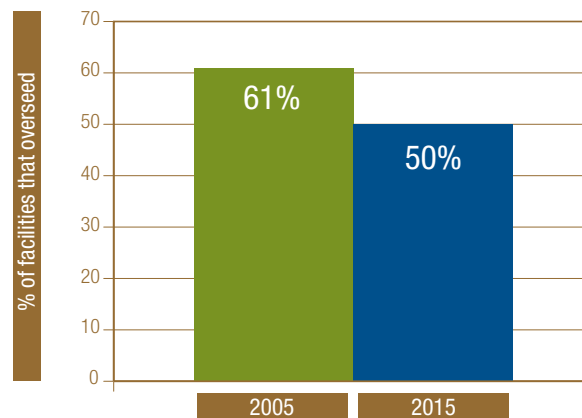


Figure 9. Percentage of facilities with winter-overseeded turf in the Transition, Southeast and Southwest regions, 2005 vs. 2015.

% facilities that overseeded at least one feature



Figure 10. Percentage of facilities that overseeded at least one feature in 2005 and 2015.

% irrigated turf acres, 2015

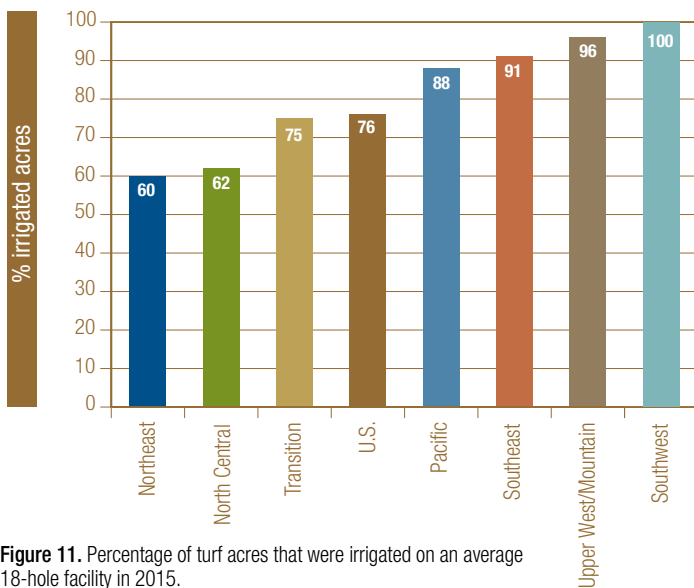


Figure 11. Percentage of turf acres that were irrigated on an average 18-hole facility in 2015.

On many golf courses, blends of two or more turf types were present. To account for this, the survey asked superintendents to estimate the percentage of each turf species present on each component of the facility. If a superintendent reported 40 acres of roughs made up of 50% creeping bentgrass and 50% annual bluegrass, then a total of 20 acres of creeping bentgrass and 20 acres of annual bluegrass would be recorded for those roughs.

- In terms of total U.S. acreage, bermudagrass (*Cynodon* species) made up approximately one-third (34%) of all maintained turf acreage in 2015, and was, by far, the most used turf type in the nation (Figure 7).
- Kentucky bluegrass (*Poa pratensis* L.) made up 23% of all maintained turf acreage, while annual bluegrass (*Poa annua* L.) covered approximately 11% of maintained turf acreage (Figure 7).
- This pattern occurred in both 2005 and 2015. Similarly, the proportion of cool-season to warm-season turf has remained stable over the past 10 years (Figure 6).

Projected acres of irrigated turf and % total maintained turf that is irrigated, 2015

Region	Greens		Tees		Fairways		Roughs		Practice/Driving		Nursery		Grounds		Total	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
North Central	11,818	98	11,471	98	95,938	97	83,772	40	15,990	64	2,086	98	6,257	65	227,330	62
Northeast	8,558	99	6,846	99	57,458	93	51,101	43	7,580	62	734	75	2,934	41	135,209	63
Pacific	1,795	97	1,737	94	19,223	97	18,296	77	2,606	81	290	98	926	78	44,873	87
Southeast	9,540	98	10,771	98	93,556	96	123,408	82	17,234	89	1,231	79	6,463	76	262,203	88
Southwest	3,862	99	3,983	99	37,779	99	55,401	99	7,846	98	845	99	2,293	99	112,010	99
Transition	8,206	98	8,976	98	70,524	93	87,706	60	11,027	68	1,795	98	3,077	47	191,312	72
Upper West/Mountain	3,006	98	3,100	98	32,319	98	44,063	94	6,295	94	376	98	1,315	92	90,474	96
U.S.	46,786	98	46,884	98	406,796	96	463,746	62	68,576	76	7,355	91	23,266	63	1,063,410	76

Table 10. Projected acres of irrigated turf, and percentage of total maintained turf that is irrigated, 2015. See Table 7 for projected acreage of total maintained turf.

Median acreage of irrigated turf on 18-hole facilities, 2015

Region	Greens	Tees	Fairways	Roughs	Practice	Nursery	Grounds	Total
	Acres							
North Central	3.42 b	2.67 a	26.7 b	27.4 a	4.56 ab	0.87 a	1.72 b	64.4 b
Northeast	3.41 b	3.14 b	24.3 a	24.7 a	3.69 a	0.76 a	1.38 ab	52.9 a
Pacific	3.00 a	3.30 c	30.5 cd	28.1 a	4.26 ab	0.86 a	1.33 ab	75.0 c
Southeast	3.03 a	3.08 a	29.0 cd	40.2 b	5.74 b	0.82 a	1.75 b	84.1 cd
Southwest	3.12 a	3.18 c	30.2 cd	41.7 b	6.25 b	0.87 a	1.31 ab	90.3 d
Transition	3.20 a	3.04 a	27.7 bc	39.1 b	4.82 ab	0.96 a	1.57 b	74.9 c
Upper West/Mountain	3.10 a	2.69 a	30.9 d	41.5 b	6.01 b	0.85 a	1.13 a	91.0 d
U.S.	3.21	3.05	28.8	34.5	5.02	0.86	1.51	74.00

Table 11. Median acreage of irrigated turf on 18-hole facilities, 2015. Within each column, medians followed by the same letter are not significantly different at the 90% confidence level.

- At least partly because of the net loss of golf facilities (Table 3), the absolute acreage of most turf types has decreased since 2005, with the notable exception of tall fescue, which covered 20% more acres in 2005 than in 2015 (Figure 7, Table 12), primarily in the roughs of the North Central, Northeast and Transition regions (Table A10).
- Acreage increases also occurred for zoysia-grass (*Zoysia* species) (primarily in the Transition region) and seashore paspalum (*Paspalum vaginatum*) (in the Southeast and Southwest regions), although the absolute increases in acreage were much smaller than those for tall fescue (Table 12).

Bermudagrass

- More golf course acreage was planted with bermudagrass than with any other species (Figure 7).
- Bermudagrass was the most heavily used turf

type on tees (Table A8), fairways (Table A9), roughs (Table A10) and driving range/practice areas (Table A11) in both 2005 and 2015.

- It was also the most commonly used turf type on greens in the Southeast region (Table A7).
- Bermudagrass dominated the acreage in the Southeast, Southwest and Transition regions (Figure A1), because of its suitability for the warmer climates below 30 degrees north latitude, where sunshine is abundant and summers are hot.

Kentucky bluegrass

- Covering 23% of the national acreage of maintained turf (Figure 7), Kentucky bluegrass was used most heavily in the cooler climates of the North Central, Northeast, Transition and Upper West/Mountain regions (Figure A2), where it was most frequently planted on roughs (Table A10).
- Since 2005, Kentucky bluegrass acreage has increased 7.4% in the Upper West/Mountain

Projected total acres of each grass species, 2005 vs. 2015, and % change since 2005

Region [†]	Cool-season grasses																	
	Annual bluegrass			Creeping bentgrass			Fine fescue			Kentucky bluegrass			Perennial ryegrass			Tall fescue		
	2005	2015	% change	2005	2015	% change	2005	2015	% change	2005	2015	% change	2005	2015	% change	2005	2015	% change
NC	60,983	53,626	-12	58,284	53,560	-8.1	20,013	14,612	-27	197,488	178,634	-9.5	48,836	42,580	-13	10,803	11,965	11
NE	48,200	41,087	-15	38,740	42,186	8.9	17,441	11,324	-35	65,152	57,725	-11	48,094	39,976	-17	10,615	14,261	34
PAC	22,746	21,733	-4.5	2,843	2,927	3.0	1,363	1,978	45	3,534	2,589	-27	19,585	16,105	-18	1,047	486	-54
SE	513	75	-85	2,054	1,523	-26	645	652	1.1	822	311	-62	4	577	NA [‡]	3,071	1,829	-40
SW	6,654	5,550	-17	2,264	2,346	3.6	807	359	-56	5,357	4,695	-12	10,762	9,656	-10	1,546	1,701	10
TR	14,574	10,315	-29	25,479	19,489	-24	6,270	2,879	-54	32,502	20,706	-36	18,881	10,299	-46	40,534	52,488	30
UW/Mtn	14,084	14,452	2.6	5,072	5,576	9.9	1,691	1,807	6.9	42,328	45,461	7.4	21,438	19,587	-8.6	1,950	805	-59
U.S.	167,755	146,839	-13	134,736	127,608	-5.3	48,228	33,611	-30	347,183	310,122	-11	167,600	138,781	-17	69,565	83,534	20

Region	Warm-season grasses											
	Bermudagrass			Zoysiagrass			Seashore paspalum			Other		
	2005	2015	% change	2005	2015	% change	2005	2015	% change	2005	2015	% change
NC	239	27	-89	8	287	3,412	0	0	NA	2,189	2,850	30
NE	689	97	-86	55	99	80	0	0	NA	2,432	851	-65
PAC	2,690	2,372	-12	6	0	NA	51	14	-73	2,772	1,315	53
SE	282,298	264,085	-6.5	2,777	4,334	56	5,710	7,293	28	6,073	9,229	52
SW	82,425	71,492	-13	88	815	822	1,311	3,510	>100%	12,493	9,973	20
TR	122,464	119,200	-2.7	12,430	20,102	62	0	15	NA	2,026	1,504	26
UW/Mtn	4,706	3,712	-21	0	1	NA	0	0	NA	531	1,085	104
U.S.	495,511	460,984	-7.0	15,364	25,637	67	7,072	10,832	53	28,517	26,807	-6.0

[†]Regions: NC, North Central; NE, Northeast; PAC, Pacific; SE, Southeast; SW, Southwest; TR, Transition; UW/Mtn, Upper West/Mountain.

[‡]NA: Percent change was not computed when 10 or fewer acres were reported for either 2005 or 2015.

Table 12. Projected total acreage of each grass species for all golf features combined, 2005 vs. 2015, and percent change in acreage for each species since 2005.

region. The only other significant changes in Kentucky bluegrass acreage have been decreases driven primarily by net reductions in the number of golf facilities (Table 12).

Annual bluegrass

- Third in popularity among turf types, annual bluegrass made up 11% of all maintained turf acreage, a proportion that has changed very little since 2005 (Figure 7).
- Alone among the turf types discussed here, annual bluegrass is not a cultivated turf species, but is instead a weed population composed of many biotypes managed to conform to golfing and aesthetic requirements.
- The greatest use of annual bluegrass occurred in the cool climates of the North Central and Northeast regions (Figure A3), where it was second only to creeping bentgrass (*Agrostis stolonifera* L.) acreage for use on greens and tees (Tables A7, A8).

Perennial ryegrass

- Used primarily in the cooler climates of the North Central, Northeast and Upper West/ Mountain regions (Figure A4), perennial ryegrass (*Lolium perenne* L.) was most frequently found on fairways (Table A9) and roughs (Table A10) (use of this turf type on overseeded turf is discussed below). The proportion of acres devoted to perennial ryegrass has declined slightly over time, from 12% in 2005 to 10% in 2015 (Figure 7).
- Since 2005, large decreases (>10%) in perennial ryegrass acreage have occurred in the North Central, Northeast, Pacific and Transition regions, primarily on roughs (Table A10).

Creeping bentgrass

- On a national scale, creeping bentgrass (*Agrostis stolonifera* L.) was the most widely used turf type

on greens (Table A7) and nurseries (Table A12). Its greatest acreage occurred in the North Central and Northeast regions (Figure A5).

- Creeping bentgrass was also the most popular turf type for use on greens in all regions except the Southeast (Table A7).
- On golf course features other than greens, creeping bentgrass was most commonly used in the cooler climates of the North Central, Northeast and Transition regions on fairways (Table A9).
- Creeping bentgrass acreage has increased in the Northeast region since 2005 (Figure A5). No other significant changes in acreage have occurred since 2005, except for decreases driven primarily by net reductions in the number of golf facilities.

Tall fescue

- One of the few turf types to have increased in acreage since 2005 (Figure A6), tall fescue (*Lolium arundinaceum*) was used primarily in the cooler regions of the North Central, Northeast and Transition regions, primarily on roughs (Table A10).
- Some of the perennial ryegrass acreage on roughs in these regions may have transitioned to the more heat-, drought- and traffic-tolerant tall fescues.

Fine fescue

- The least used of the cool-season grasses (Table 12), fine fescue (*Festuca* species) is a grouping of several fine-leaved fescue species and subspecies (2).
- Fine fescue was most common in the cool climates of the North Central and Northeast regions (Figure A7), where it was used primarily on fairways (Table A9) and roughs (Table A10). Its use has decreased since 2005.

Zoysiagrass and seashore paspalum

- Even though absolute acreage was still small, both zoysiagrass (*Zoysia* species) and seashore pas-

Median acreage for subfeatures that make up 18-hole facility acreage, 2015

Region	Bunkers		Buildings		Parking lots		Water features		Natural areas		Maintained turf		Total facility acres
	Acres	% of facility	Acres	% of facility	Acres	% of facility	Acres	% of facility	Acres	% of facility	Acres	% of facility	
North Central	2.33 a	1.5	2.18 a	1.4	2.53 a	1.6	6.84 b	4.3	17.4 b	10.9	104 c	65.4	159
Northeast	2.29 a	1.6	2.26 a	1.6	2.57 a	1.8	4.82 a	3.3	21.6 b	15.0	87.7 a	60.9	144
Pacific	2.13 a	1.7	2.17 a	1.7	2.54 a	2.0	4.28 a	3.4	17.6 b	13.8	84.8 a	66.8	127
Southeast	2.65 a	1.8	2.56 a	1.7	2.29 a	1.5	11.81 c	7.9	12.7 a	8.4	92.8 ab	61.9	150
Southwest	2.57 a	1.8	1.94 a	1.4	2.22 a	1.6	4.22 a	3.0	18.8 b	13.3	90.1 a	63.9	141
Transition	2.18 a	1.4	2.31 a	1.5	2.38 a	1.5	5.90 ab	3.8	15.3 ab	9.8	100 bc	64.1	156
Upper West/Mtn	2.34 a	1.6	2.05 a	1.4	2.22 a	1.5	5.38 ab	3.6	19.4 b	13.0	94.5 ab	63.4	149
U.S.	2.36	1.6	2.24	1.5	2.40	1.6	6.36	4.2	25.8	17.2	95.1	63.4	150

Table 13. Median acreage for subfeatures that make up 18-hole facility acreage, 2015. Within each column, medians followed by the same letter are not significantly different at the 90% confidence level.

palum have increased in turf acreage since 2005 (Figures A8, A9).

- Seashore paspalum was most commonly used on fairways (Table A9) and roughs (Table A10) in the Southeast and Southwest regions, where its tolerance to high-salinity conditions is a sought-after attribute. It was not used in other regions of the country.
- Zoysiagrass was most common in the Southeast and Transition zones (Figure A9), where it was used primarily on tees (Table A8), fairways (Table A9) and roughs (Table A10).

Water feature acreage

Water features include open water (ponds and lakes), wetlands (areas within the property that receive sufficient water to grow wetland plants), streams/rivers, drainage waterways (areas of conveyance that tie into or connect to a stream or river) and irrigation canals (man-made canals used for irrigation).

- For an average 18-hole facility in 2015, water features made up 6.36 acres, or 4.2% of facility acreage (Table 13).
- On a national scale, there were a total of 159,072 projected acres of water features for all golf facilities in 2015, comprising 6.9% of all golf facility acreage in the U.S. (Table A13).
- The area taken up by water features varied widely — from 3.0% of the total facility in the Southwest region, to 7.9% in the Southeast (Table 13).
- Open water made up by far the largest acreage water feature in all regions of the country. In all regions except the Southwest, wetlands were the second largest water feature in terms of acreage (Table A14).
- Streams and rivers were more common in areas with higher rainfall, such as the North Central, Northeast and Pacific regions, but still comprised



For the average 18-hole facility in the Southwest region, natural areas make up 13.3% of the acreage, which is less than the average of 17.2% for the U.S. as a whole. Photo by Teresa Carson

only 7.4% of water feature acreage on a national level. Drainage waterways and irrigation canals each occupied less than 5% of the acreage for all water features on a national level (Table A14).

Natural/native/unmowed acreage

Natural acres are the combined total of forests/woodland, native/undisturbed grasslands (all native grasses/forbs with minimal non-native plants/wildflowers); mixed/improved grasslands (combination of native and non-native grasses/forbs/wildflowers); shrublands (woody plants, with a mix of herbaceous and mostly open canopies); deserts; riparian areas (undisturbed or re-established vegetation along moving water composed of trees, forbs and native grasses); buffer strips (grasses transitioning between

Median acreage of cart paths, parking lots and buildings, and acres of impervious surfaces for each, 2015

Region	Cart paths		Parking lots		Buildings		All impervious surfaces		All impervious + pervious surfaces	
	Acres	Impervious acres	Acres	Impervious acres	Acres	Impervious acres	Acres	% of facility	Acres	% of facility
North Central	1.64 ab	1.21 ab	2.53 a	2.31 a	2.18 a	2.18 a	6.54 a	4.0 a	7.13 a	4.3 a
Northeast	1.45 a	1.00 a	2.57 a	2.25 a	2.26 a	2.26 a	6.58 a	4.5 a	7.51 a	5.1 ab
Pacific	3.01 b	2.88 cd	2.54 a	2.44 a	2.17 a	2.17 a	7.96 abc	6.3 c	8.37 a	6.5 c
Southeast	3.31 b	3.03 cd	2.29 a	2.13 a	2.56 a	2.56 a	8.17 bc	5.5 bc	8.65 a	5.8 bc
Southwest	2.30 ab	2.20 bc	2.22 a	2.04 a	1.94 a	1.94 a	6.62 ab	4.5 ab	6.90 a	4.7 ab
Transition	3.73 b	3.73 d	2.38 a	2.30 a	2.31 a	2.31 a	8.46 c	5.4 bc	8.74 a	5.6 bc
Upper West/Mtn	1.89 ab	1.53 bc	2.22 a	1.93 a	2.05 a	2.05 a	6.33 a	4.2 a	7.05 a	4.7 ab
U.S.	1.84	1.45	2.40	2.20	2.24	2.24	7.27	4.8	7.82	5.1

Table 14. Median acreage of all cart paths, parking lots and buildings, and acres of impervious surfaces for each on 18-hole facilities, 2015. Within a column, values followed by the same letter are not significantly different at the 90% confidence level.

aquatic and terrestrial communities); beaches; alkaline areas; and garden/landscaped areas.

- For an average 18-hole facility in 2015, natural features made up 25.8 acres, or 17.2% of facility acreage, and were second only to maintained turf in size (Table 13).
- On a national scale, natural areas comprised a total of 589,778 projected acres of in the U.S. in 2015, equaling 26% of all golf facility acreage (Table A13).
- In 2015, 46% of all respondents reported that they had increased their natural areas acreage over the past 10 years, while only 5% reported a decrease.
- It is likely that at least some of the maintained turf acreage decreases documented in Table 6 have been converted to natural areas over the past 10 years, which would account for the lack of change in total facility acreage since 2005 (Figure 2).
- Forests were the dominant natural area in regions with higher rainfall, while native/undisturbed grasslands and/or deserts predominated in areas with low rainfall (Table A15).

Non-landscaped acreage

Buildings

- “Buildings” refers to clubhouse, deck, patio pool, tennis courts and maintenance buildings.
- For an average 18-hole facility in 2015, buildings made up 2.24 acres, or 1.5% of facility acreage (Table 13).
- On a national scale, there were 52,632 projected acres of buildings in the nation in 2015, comprising 2.3% of total projected facility acreage (Table A13).

Parking lots

- For an average 18-hole facility in 2015, parking lots made up 2.40 acres, or 1.6% of facility acreage (Table 13)
- Nationwide, there were 45,779 projected acres of parking lots at golf course facilities in 2015, comprising 2.0% of total projected facility acreage (Table A13).

Bunkers

- For an average 18-hole facility in 2015, bunkers made up 2.36 acres, or 1.6% of facility acreage (Table 13).
- Bunkers made up a total of 46,136 projected acres at golf facilities in the U.S. in 2015, comprising 2.0% of total projected facility acreage (Table A13).

Cart paths

- For an average 18-hole facility in 2015, cart paths made up 1.84 acres, or 1.2% of facility acreage (Table 14).
- On a national scale, there were 36,617 projected acres of cart paths in 2015, comprising 1.6% of total projected facility acreage (Table 15). This represents a reduction in the percentage of the golf course devoted to cart paths, which dropped from 1.8% in 2005 to 1.6% in 2015.
- For the nation overall, the total median length of cart paths decreased significantly from 17,000 linear feet in 2005 to 15,000 linear feet in 2015, while the median width remained stable, at approximately 7 feet (Table 15).
- There were striking regional differences in cart path length, with the Northeast, North Central, Southwest and Upper West/Mountain regions all well below 15,000 linear feet in 2015, and the

Projected acreage and total length and width of cart paths

Region	2005	2015	2005	2015	2005	2015
	Projected acres		Total length (median feet)		Estimated width (median feet)	
North Central	8,988	6,854	10,000 a	8,500 a	7.05 a	7.14 a
Northeast	4,840	4,330	8,500 a	7,089 a*	6.94 a	7.01 a
Pacific	2,044	1,871	20,000 bc	18,740 ab	7.12 a	6.99 a
Southeast	11,189	9,929	21,000 bc	21,000 ab	7.03 a	6.99 a
Southwest	4,621	3,084	20,000 b	13,500 a*	7.05 a	6.92 a
Transition	9,923	8,356	21,900 c	23,140 b	6.97 a	7.12 a
Upper West/Mountain	2,585	2,191	12,600 a	10,560 a	7.15 a	7.10 a
U.S.	44,190	36,617	17,000	15,000*	7.03	7.06

Table 15. Projected acreage for cart paths, and median total length and width of cart paths on 18-hole facilities, 2005 vs. 2015. Within a column, values followed by the same letter are not significantly different at the 90% confidence level. For length or width, values in bold type with the lower value followed by an asterisk indicate a significant difference between the 2005 and 2015 values at the 90% confidence level.

Pacific, Southeast and Transition regions with almost twice as much length devoted to cart paths (Table 15).

Environmental improvements

In addition to the acreage reductions in maintained, overseeded, and irrigated turf detailed above, further improvements to facility design and management can also have positive environmental impacts.

- Impervious surfaces such as paved parking lots, cart paths, sidewalks and rooftops are impermeable to the flow of water or other liquids. Hydrologists promote reductions in the acreage of impervious surfaces as a means of reducing urban runoff, water pollution, and negative impact on aquatic life (5).
- Cities have the highest percentages of impervious surfaces (>20%), while forests and other undisturbed areas have low percentages (<1%) (1).
- On golf courses, impervious surfaces (buildings, cart paths and parking lots) made up approximately 4.8% of the acreage for an average 18-hole facility, compared with the 5.1% of the acreage that comprised all cart paths, parking lots and buildings, both pervious and impervious (Table 14).
- Collection of surface runoff can also help reduce water pollution. In 2015, 58% of all survey respondents reported that they collected surface runoff from neighboring properties, and 74% reported collecting runoff from their own property.
- Since 2005, facilities have focused on irrigation system improvements, recycling, native plantings and wildlife habitat improvement as means of further fostering environmental compatibility (Table 16). However, recycling was the only activity for which increased participation was reported for 2015 vs. 2005.
- The apparent decreased frequency of environmental improvements was at least partly due to the one-time nature of some activities, such as installation of petroleum storage tanks, wetland construction, buffer strips, etc. If those projects were completed several years ago, they would not have been reported in the 2015 survey.
- In addition, since the period from 2005 to 2015 encompassed the Great Recession, it is perhaps not surprising that golf facilities deferred non-critical improvements until budgets had been restored to their pre-Recession levels.

Environmental stewardship program participation

A wide variety of publicly and privately administered environmental stewardship programs are available to golf courses. Most focus on improving golf course environmental stewardship through education, self-assessment, compliance with environmen-

tal laws and regulations, recognition/certification of achievements and communication among the golf industry, regulatory agencies and citizen's groups.

- Little change in participation in stewardship programs has taken place since 2005. As in 2005, the Audubon Cooperative Sanctuary Program had the greatest participation (Table A16).
- The majority of golf courses indicated they were not involved in any of the listed programs (Table A16).
- The most commonly cited reasons for lack of participation were lack of funds (41% of respondents), practices already in place before survey (40%), or lack of time needed for implementation (39% of respondents) (data not shown).

% of all facilities making improvements to protect the environment

Type of improvement	2005	2015
	% making improvement	
Irrigation system	64	61*
Recycling	38*	53
Incorporation of native plantings	50	42*
Wildlife habitat	46	41*
Chemical storage	52	36*
Erosion control	41	34*
Installation of buffer strips	31	32
Waste reduction	26*	30
Chemical mix and load pads	28	21*
Stream bank restoration	19	19
Composting	24	18*
Stormwater retention	21	16*
Installation of petroleum storage tank	37	15*
Wetland construction/restorations	16	13*
Use of alternate water source	15	12*
Wild pollinator habitat (not including bee hives/apiaries)	NA [†]	10
Capped/closed water wells	13	8.2*
Bee hives/apiaries	NA	4.9
Installation of rain garden	NA	2.3
Equipment washing stations	4.0	1.6

[†]NA: Question not asked previously.

Table 16. Percent of all facilities that made improvements to help protect the environment in the past 10 years. For each comparison between years, values in the same row in bold type with the lowest value followed by an asterisk indicate a significant difference between the 2005 and 2015 values at the 90% confidence level.



A significant number of facilities have stopped overseeding, and the greatest drop in acreage of overseeded turfgrass has occurred in the Transition region, which saw a 64% decrease from 2005 to 2015. Photo courtesy of Paul Carter

Regional trends

Key results

The sections that follow provide detailed accounts of trends in land use and environmental stewardship for each of the survey's seven agronomic regions. Some of the key regional results are listed below.

Facility size

- The smallest facilities were found in the Pacific region. The Pacific region was also the only area of the country where facility size decreased significantly from 2005 to 2015 (Figure 2, Table 1).
- The largest facilities were in the North Central region (Figure 2, Table 1).
- The regional range in facility size did not correlate with environmental factors such as rainfall, and was likely a reflection of varying real estate values across the U.S. Regions such as the Pacific, Southwest, Southeast and Northeast that are host to large cities and/or large resorts tended to have the smallest facility sizes, while regions such as the North Central, Transition and Upper West/Mountain had larger facilities.

Maintained turf acreage

- The Pacific region had the lowest acreage of maintained turf in 2015, while the North Central region had the highest acreage (Figure 3, Table 6).
- The greatest percentage decreases in maintained turf acreage between 2005 and 2015 took place in the Southwest and Pacific regions (Figure 3, Table 6).
- The incentives for maintained turf acreage

decreases varied by region, with the Southwest region citing water savings as the most important factor, while other regions considered reduced labor the major factor.

Overseeded turf acreage

- A significant percentage of facilities, particularly in the Southeast and Southwest regions, have completely stopped overseeding since 2005 (Figure 10).
- The greatest percentage decrease in overseeded acres occurred in the Transition region (64% reduction), while the Southeast and Southwest regions had reductions of 55% and 36%, respectively (Figure 8).

Irrigated turf acreage

- The percentage of turf irrigated per 18-hole facility varied regionally, from a low of 60% for the North Central region to 100% for the Southwest region (Figure 11).
- Climate was responsible for this variation. Cool and rainy weather allows facilities in the Northeast and North Central regions to irrigate a lower percentage of their turf acreage than facilities in the drier and/or hotter climates of the Southwest and Upper West/Mountain regions.
- The percentage of acres irrigated varied most for roughs, ranging from 40% of rough acreage irrigated in the North Central region, to 99% in the Southwest region (Table 10).

North Central region

Climate

- Average temperatures in the North Central region are some of the coolest in the U.S., and have a relatively small range, from a low of 37.6 F to a high of 53.7 F, depending on the location (Table 17).
- Rainfall is moderate, with average levels ranging from 1.5 feet to 3.9 feet per year, depending on location (Table 17).

Facility size

- In terms of the average 18-hole facility, the North Central region had the largest facilities in the nation. This was the case in 2005 as well (Figure 2, Table 1).
- There has been no significant change in facility size since 2005 (Figure 2, Table 1).
- These larger acreages may be a function of lower real estate values in this region, which has fewer large, expensive cities than other areas of the country.
- In the North Central region, projected total facility acreage for all golf courses has decreased 7.1% since 2005. This was due to the net loss of 214 facilities since 2005 (Table 18).

Maintained turf acreage

- In terms of the average 18-hole facility, the North Central region had the largest acreages of maintained turf in the nation in both 2005 and 2015 (Figure 3, Table 6).
- Maintained turf acreage for the average 18-hole facility has decreased significantly since 2005, however (Figure 3, Table 6).
- Total maintained turf acreage for all golf courses in the North Central region has seen a 10% decrease since 2005 (Table 18), the largest decline in absolute acreage among all agronomic regions.
- The decline in total projected acreage was due to the reduced number of facilities in the region (accounting for approximately 56% of the acreage reduction), as well as to voluntary reductions (accounting for approximately 44%) in maintained turf acreage.

Irrigated acreage

- An average 18-hole North Central region facility irrigated only 60% of its maintained turf, or 64.4 of 104 acres (Figure 11), making it second only to the Northeast in its low percentage of irrigated acreage. This practice was aided by the region's cool and wet climate (Table 17).

Non-turf acreage

- The acreage for water features in the region was slightly larger than that for the average 18-hole U.S. facility (Figure 12). As for most other

regions of the country, the majority of water feature acreage was devoted to open water, followed by wetlands (Table A14).

- At 17.4 acres per 18-hole facility, the acreage for natural/native/unmowed areas comprised 10.9% of the total facility (Table 13). This acreage was somewhat smaller than the national average (Figure 12). Forests were the most common type of acreage for natural areas (Table A15).
- Bunker, building and parking lot sizes were similar to those for the nation overall (Figure 12).

Variation in climate: North Central region

	Lowest	Highest
Average temperature (F)	37.6	53.7
Rainfall (feet)	1.5	3.9
Active turf growth (months)	5	7

Table 17. Variation in North Central region climate. Temperature and rainfall values are based on 30-year normal annual average temperatures.

Projected acreage and no. of facilities: North Central region

	2005	2015
No. of facilities (18-hole equivalents)	3,690	3,476
Total facility (acres)	629,957	585,532
Maintained turf (acres)	411,804	368,977

Table 18. Projected acreage and number of facilities for the North Central region, 2005 vs. 2015.

Land use: North Central region, 2015

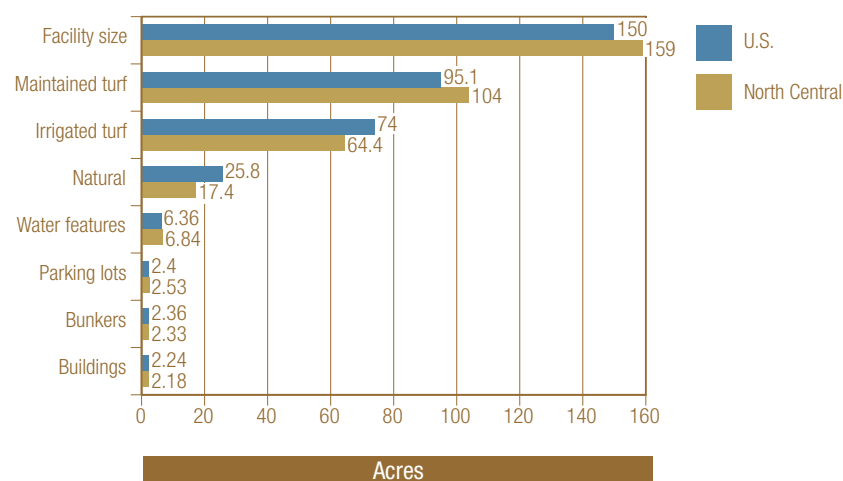


Figure 12. Land use (median acres) on an average 18-hole facility in the North Central region vs. the U.S., 2015.



In 2015, linear footage of cart paths in the North Central region was the second lowest in the country at 8,500 feet. Only the Northeast region — at 7,089 linear feet — had fewer linear feet of cart paths. Photo by Scott Hollister

Median acreage for turf features: North Central region, 2015

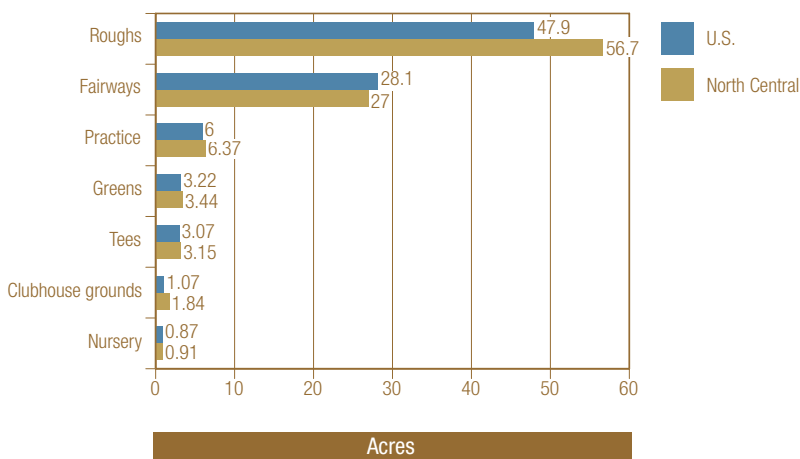


Figure 13. Median acreage for turf features on an average 18-hole facility in the North Central region, 2015.

- The number of linear feet devoted to cart paths was the second lowest in the country (Table 15).
- The North Central region had the lowest percentage of impervious surfaces in the nation (Table 14).

Turf features

- In 2015, the 18-hole facility acreage for greens, tees and, especially, roughs was larger than for the average U.S. facility. However, fairways were among the smallest in the country (Figure 13, Table 6).
- Since 2005, there has been a significant increase in the size of greens and tees, and a significant decrease in the size of practice areas and clubhouse grounds for 18-hole facilities. There was no significant change in the size of either fairways or roughs. (Table 6).

Turf types

- Because of its relatively cool and wet climate, cool-season turf types dominated in the North Central region (Table 12).
- This region had more acres of Kentucky bluegrass than any other turf type, with annual bluegrass and creeping bentgrass second and third in acreage, respectively (Table 12).
- The large majority of greens and tees were creeping bentgrass (Tables A7, A8), while fairways were roughly divided among Kentucky bluegrass, creeping bentgrass and annual bluegrass (Table A9). Kentucky bluegrass was, by far, the dominant turf type on roughs (Table A10).

Northeast region Climate

- Average temperatures in the Northeast region are cool and have a relatively small range, from a low of 38.4 F to a high of 56.2 F, depending on the location (Table 19).
- Rainfall is moderate to substantial, with average levels ranging from 2.7 feet to 4.6 feet per year, depending on location (Table 19).

Facility size

- The average 18-hole facility in Northeast region was slightly smaller than the national average (Figure 14) in 2005 and 2015 (Figure 2, Table 1).
- Facility size has not changed significantly since 2005 (Figure 2, Table 1).
- Total facility acreage for all golf courses in the Northeast region, has decreased by 6.4% since 2005 because the region has suffered a net loss of 62 facilities since 2005 (Table 20).

Maintained turf acreage

- In terms of the average 18-hole facility, the Northeast region had some of the lowest acreages of maintained turf in the nation (Figure 14). This was the case in 2005 as well (Figure 3, Table 6).
- Total maintained turf acreage for all golf courses in the Northeast region has seen a 10% decrease since 2005 (Table 20).
- The decline in acreage was due primarily to voluntary reductions in maintained turf acreage, which accounted for approximately 76% of the reduced acreage. The reduced number of facilities in the region accounted for approximately 24% of the reduction.

Irrigated acreage

- With 52.9 acres of irrigated turf, an average 18-hole Northeast facility irrigated 62% of its maintained turf (Figure 11).
- This practice was aided by the region's cool and wet climate (Table 19).

Non-turf acreage

- In the Northeast region, the acreage for water features at the average 18-hole facility was lower than that for the average 18-hole facility nationwide (Figure 14). As for most other regions of the country, the majority of water feature acreage was devoted to open water, followed by wetlands (Table A14).
- At 21.6 acres per 18-hole facility, the acreage for natural/native/unmowed areas comprised 15% of the total facility (Table 13). This acreage was somewhat smaller than the national average (Figure 14), but in terms of percentage of the facility, this region was the highest in the nation. Forests were the most common type of acreage for natu-

ral areas (Table A15).

- Bunker, building and parking lot sizes were similar to those for the nation overall (Figure 14).
- The number of linear feet devoted to cart paths was the lowest in the country (Table 15).
- The percentage of impervious surfaces in the Northeast region was similar to that of the nation as a whole (Table 14).

Variation in climate: Northeast region

	Lowest	Highest
Average temperature (F)	38.4	56.2
Rainfall (feet)	2.7	4.6
Active turf growth (months)	6	7

Table 19. Variation in Northeast region climate. Temperature and rainfall values are based on 30-year normal annual average temperatures.

Projected acreage and no. of facilities: Northeast region

	2005	2015
No. of facilities	2,507	2,445
Total facility (acres)	394,247	368,877
Maintained turf (acres)	241,376	216,187

Table 20. Projected acreage and number of facilities for the Northeast region, 2005 vs. 2015.

Land use: Northeast region, 2015

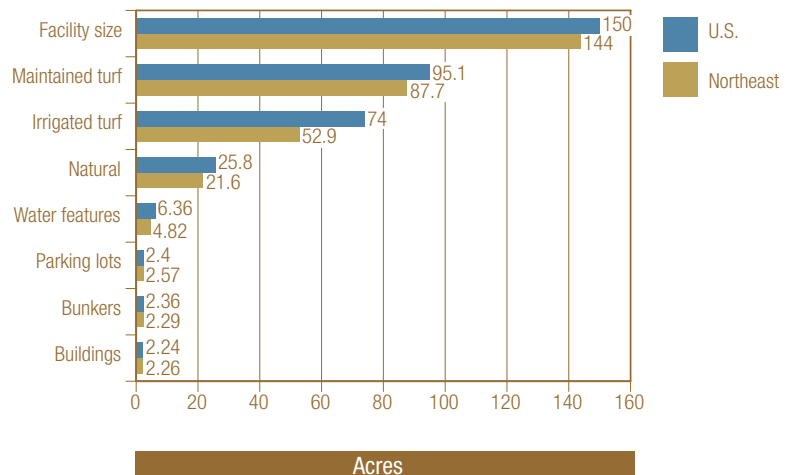


Figure 14. Land use (median acres) on an average 18-hole facility in the Northeast region vs. the U.S., 2015.



In the Northeast region in 2015, the average 18-hole facility had 21.6 acres of natural/native/unmowed areas, which is less than the national average of 25.8 acres. However, this acreage makes up 15% of the average facility in the Northeast — the highest percentage in the nation. The natural area of this course in New York state provides habitat for pollinators. Photo by Matt Ceplo

Median acreage for turf features: Northeast region, 2015

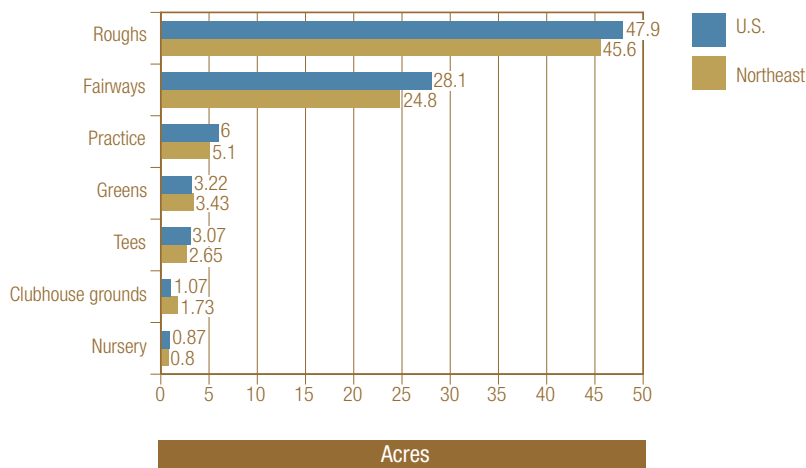


Figure 15. Median acreage for turf features on an average 18-hole facility in the Northeast region, 2015.

Turf features

- In 2015, most maintained turf features for 18-hole facilities in the Northeast were smaller than those of the average U.S. facility, and tees, fairways, practice areas and nurseries were the smallest in the nation (Figure 15, Table 6).
- Since 2005, the size of fairways and clubhouse grounds for 18-hole facilities has decreased significantly, and the size of greens has increased significantly (Table 6).

Turf types

- Because of its relatively cool and wet climate, cool-season turf types dominated in the Northeast region (Table 12).
- In this region, there were more acres of Kentucky bluegrass than any other turf type, with creeping bentgrass and annual bluegrass placing a distant second and third, respectively (Table 12).
- The large majority of greens, tees and fairways were creeping bentgrass (Tables A7-A9), while roughs were dominated by Kentucky bluegrass (Table A10).

Pacific region Climate

- The Pacific region covers a diverse area of the U.S. that ranges from the hot Central Valley of California, to the long winters of Alaska, to the cool redwood forests of Oregon.
- Average temperatures have a large range, from a low of 34.0 F to a high of 62.1 F, depending on the location (Table 21).
- Precipitation varies significantly, depending on the location, from some of the driest areas, which receive an average of only 0.8 feet per year, to some of the highest precipitation areas in the country, with a high of 14.2 feet per year (Table 21).

Facility size

- The Pacific region had the smallest average 18-hole facility size in the nation in both 2005 and 2015 (Figure 2, Table 1).
- Facility size has decreased significantly since 2005 (Figure 2, Table 1). The Pacific region was the only region where this occurred.
- These smaller acreages may be a function of higher real estate values in this region, which has more large, expensive cities than other areas of the country.
- In terms of total facility acreage for all golf courses in the Pacific region, acreage has decreased 7.9% since 2005. The causes of this decrease were voluntary reductions in facility acreage, which accounted for approximately 78% of the reduced acreage, and the net loss of 15 facilities since 2005 (Table 22).

Maintained turf acreage

- In terms of the average 18-hole facility, the Pacific region had the smallest average acreages of maintained turf in the nation (Figure 3, Table 6).
- Maintained turf acreage for the average 18-hole facility has decreased significantly since 2005 (Figure 3, Table 6).
- Since 2005, total maintained turf acreage has decreased 11% for all golf courses in the Pacific region. The primary reasons for this loss were voluntary reductions in maintained turf acreage, which accounted for 78% of the reduced acreage, and the net loss of 15 facilities in the region (Table 22).

Irrigated acreage

- An average 18-hole Pacific region facility irrigated 88% (or 75 of 84.8 acres) of its maintained turf (Figure 11).
- Low rainfall in portions of this region was responsible for the higher percentage of irrigated turf (Table 21).

Non-turf acreage

- The acreage for water features was smaller than that for the average 18-hole U.S. facility (Figure 16). As for most other regions of the country, the majority of water feature acreage was devoted to open water (Table A14).
- At 17.6 acres per 18-hole facility, the acreage for natural/native/unmowed areas comprised 13.8% of the total facility (Table 13). This acreage was somewhat smaller than the national average (Figure 16), but the percentage of the facility devoted

Variation in climate: Pacific region

	Lowest	Highest
Average temperature (F)	34.0	62.1
Precipitation (feet)	0.8	14.2
Active turf growth (months)	4	11

Table 21. Variation in Pacific region climate. Temperature and rainfall values are based on 30-year normal annual average temperatures.

Projected acreage and no. of facilities: Pacific region

	2005	2015
No. of facilities	594	579
Total facility (acres)	90,282	83,144
Maintained turf (acres)	58,509	51,826

Table 22. Projected acreage and number of facilities for the Pacific region, 2005 vs. 2015.

Land use: Pacific region, 2015

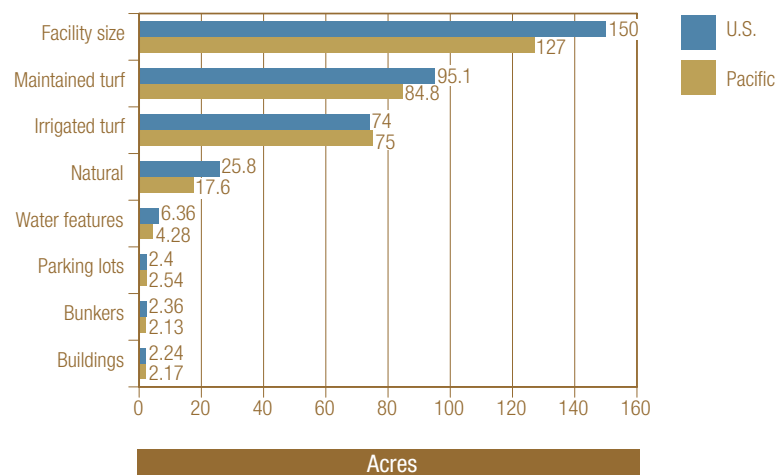


Figure 16. Land use (median acres) on an average 18-hole facility in the Pacific region vs. the U.S., 2015.



Average acreage of maintained turf in the Pacific region is the lowest in the nation and has decreased significantly since 2005. Total maintained turf acreage has decreased by 11% since 2005, mainly because of voluntary reductions, which were responsible for 78% of the decline. Photo courtesy of Matt Muhlenbruch

Median acreage for turf features: Pacific region, 2015

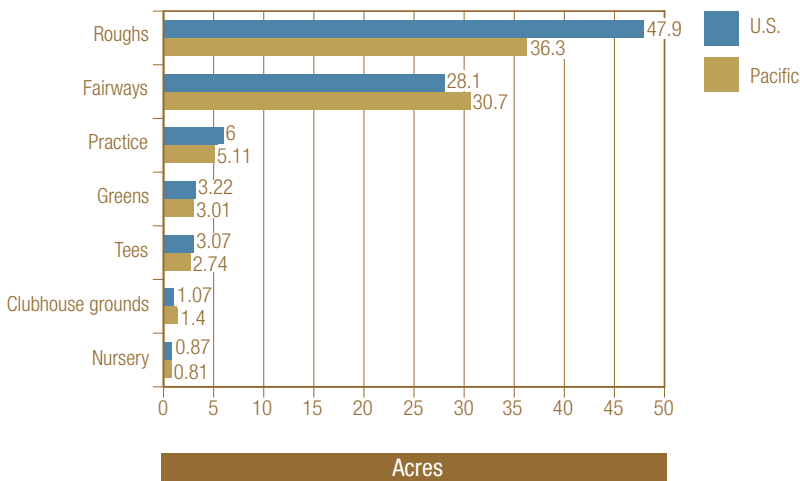


Figure 17. Median acreage for turf features on an average 18-hole facility in the Pacific region, 2015.

to natural areas was among the largest, because overall facility size was smaller (Table 1). Forests had the highest acreage of all possible natural features (Table A15).

- Bunker, building and parking lot sizes were similar to those for the nation overall (Figure 16).
- The number of linear feet devoted to cart paths was somewhat higher than the national average. This value has not changed significantly since 2005 (Table 15).
- Compared with the rest of the nation, this region had a relatively high percentage of impervious surfaces (Table 14).

Turf features

- In 2015, all features on 18-hole facilities, except fairways, were smaller than the national median (Figure 17, Table 6).
- Since 2005, there has been a significant decrease in the size of roughs for 18-hole facilities and in overall acreage of maintained turf. (Table 6).

Turf types

- Because of its moderate climate, cool-season turf types dominated in the Pacific region (Table 12).
- This region had more acres of annual bluegrass than any other turf type, with perennial ryegrass in second place (Table 12).
- Annual bluegrass was the major turf type used on all turf features (Tables A7-A12).

Southeast region

Climate

- Average temperatures in the Southeast region are the warmest in the country, and range very widely from 45.8 F all the way to 77.8 F, depending on location (Table 23).
- Rainfall varies from moderate to heavy, depending on location (Table 23).

Facility size

- The size of the average 18-hole facility in the Southeast region was the same as the national average (Figure 18).
- No significant change in facility size has occurred since 2005 (Figure 2, Table 1).
- For all golf courses in the Southeast region, total facility acreage has seen only a negligible decrease since 2005 (Table 24).
- The Southeast region had the largest decrease in number of facilities since 2005 (Table 3).

Maintained turf acreage

- The average 18-hole facility in the Southeast region had slightly lower acreage than the national average. This was the case in 2005 as well (Figure 3, Table 6).
- Maintained turf acreage for the average 18-hole facility has changed little since 2005 (Figure 3, Table 6).
- Total maintained turf acreage for all golf courses in the Southeast region has declined 5.4% since 2005 (Table 24). This was due almost exclusively to the reduced number of facilities in the region (Table 3), as voluntary reductions in the acreage of maintained turf were minimal (Table 6).

Winter overseeding

- The Southeast region has reduced its acreage of overseeded turf by more than 37,000 acres, or 55%, since 2005 (Figure 8, Table 8).
- The percentage of facilities that overseed at least one feature decreased from 80% in 2005 to 53% in 2015 (Figure 10).
- Perennial ryegrass was, by far, the most commonly used overseeded turf type, except on greens, where rough bluegrass was used more often (Tables A1-A6).

Irrigated acreage

- An average 18-hole facility in the Southeast region irrigated 91% of its maintained turf, or 84.1 of 92.8 acres (Figure 11).
- The high percentage of irrigated turf was due to the year-round hot temperatures in this region (Table 23).

Non-turf acreage

- The acreage for water features was much larger

than that for the average 18-hole U.S. facility (Figure 18). As for most other regions of the country, the majority of water feature acreage was devoted to open water (Table A14).

- At 12.7 acres per 18-hole facility, the acreage for natural/native/unmowed areas comprised 8.4% of the total facility (Table 13). This acreage was the smallest in the nation (Table 13, Figure 18). Forests had the highest acreage of all natural features.

Variation in climate: Southeast region

	Lowest	Highest
Average temperature (F)	45.8	77.8
Rainfall (feet)	1.7	5.7
Active turf growth (months)	12	12

Table 23. Variation in Southeast region climate. Temperature and rainfall values are based on 30-year normal annual average temperatures.

Projected acreage and no. of facilities: Southeast region

	2005	2015
No. of facilities	3,303	3,078
Total facility (acres)	508,134	501,079
Maintained turf (acres)	315,767	298,702
Overseeded turf (acres)	68,212	30,993

Table 24. Projected acreage and number of facilities for the Southeast region, 2005 vs. 2015.

Land use: Southeast region, 2015

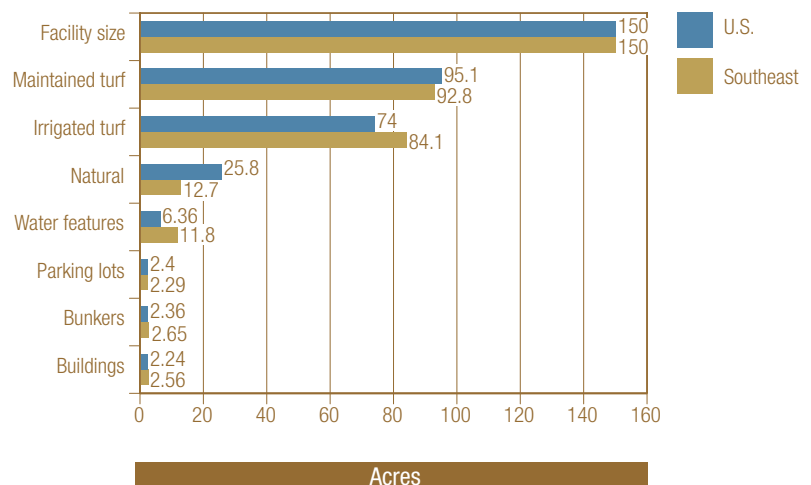


Figure 18. Land use (median acres) on an average 18-hole facility in the Southeast region vs. the U.S., 2015.



The majority of water feature acreage on golf facilities in the Southeast region, as in the United States as a whole, is made up of open water, such as ponds and lakes.
Photo by Montana Pritchard Photos

Median acreage for turf features: Southeast region, 2015

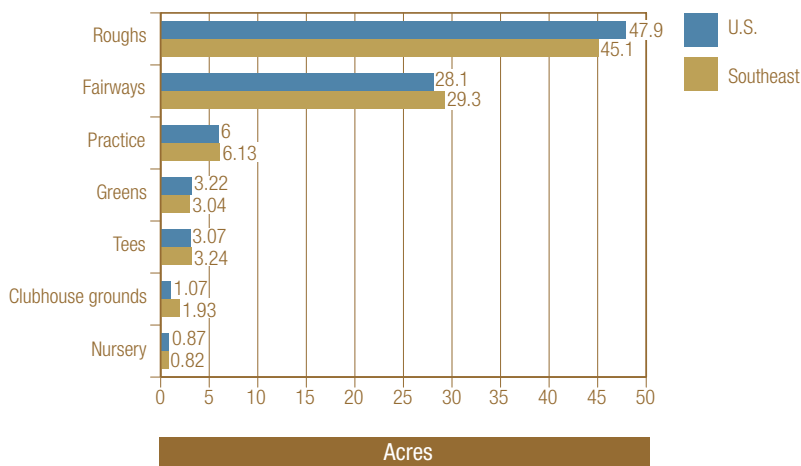


Figure 19. Median acreage for turf features on an average 18-hole facility in the Southeast region, 2015.

- Bunker, building and parking lot sizes were similar to those for the nation overall (Figure 18).
- The number of linear feet devoted to cart paths was somewhat higher than the national average. This value has not changed significantly since 2005 (Table 15).
- The percentage of impervious surfaces was relatively high for this region in comparison with the national percentage (Table 14).

Turf features

- In 2015, acreages for all turf features on 18-hole facilities were roughly comparable to those for the nation overall (Figure 19, Table 6).
- Clubhouse grounds showed the only significant decrease in maintained turf acreage since 2005 (Table 6).

Turf types

Bermudagrass was, by far, the most common turf type used in the Southeast region (Table 12).

- Bermudagrass was also the dominant turf type for all turf features except nurseries (Tables A7-A12).

Southwest region

Climate

- Average temperatures in the Southwest region are warm, and range very widely from 40.5 F all the way to 75.2 F, depending on location (Table 25).
- Rainfall varies from almost nothing, in the deserts, to heavy, depending on location (Table 25).

Facility size

- The average 18-hole facility in the Southwest region was smaller than the national average (Figure 20). This was the case in 2005 as well (Figure 2, Table 1).
- Facility size has not changed significantly since 2005 (Figure 2, Table 1).
- These smaller acreages may be a function of higher real estate values in this region, as well as arid conditions in much of this area.
- In terms of total facility acreage for all golf courses in the Southwest region, there has been a 6.9% decrease in acres since 2005. This was due to the loss of a net 29 facilities since 2005 (Table 26).

Maintained turf acreage

- The Southwest region has had the largest percentage decrease in maintained turf acres for 18-hole facilities since 2005 (Figure 3, Table 6).
- In the Southwest region, total maintained turf acreage for all golf courses has experienced a 12% decrease since 2005. This decline was partly the result of a reduction in the number of facilities in the region, which accounted for approximately 20% of the reduced acreage. More significantly, voluntary reductions in maintained turf acreage accounted for 80% of the reduced acreage.

Winter overseeding

- The Southwest region has reduced its acreage of overseeded turf by more than 15,000 acres, or by 36%, since 2005 (Figure 8, Table 8).
- The percentage of facilities that overseed at least one feature decreased from 81% in 2005, to 55% in 2015 (Figure 10).
- Perennial ryegrass was by far the most commonly used overseeded turf type (Tables A1-A6).

Irrigated acreage

- Facilities in this region irrigated 100% of their maintained turf (Figure 11).
- This practice is due primarily to the region's arid and warm climate (Table 25).

Non-turf acreage

- When compared to the average 18-hole U.S. facility, the average 18-hole facility in the Southwest region had the smallest acreage for water features in the nation (Figure 20). As for most other regions of the country, the majority of

water feature acreage was devoted to open water (Table A14).

- At 18.8 acres per 18-hole facility, the acreage for natural/native/unmowed areas comprised 13.3% of the total facility (Table 13). This acreage was smaller than the national average (Figure 20). In the Southwest, unlike most other regions, deserts had the highest acreage of all natural features (Table A15).

Variation in climate: Southwest region

	Lowest	Highest
Average temperature (F)	40.5	75.2
Rainfall (feet)	0.3	10.2
Active turf growth (months)	12	12

Table 25. Variation in Southwest region climate. Temperature and rainfall values are based on 30-year normal annual average temperatures.

Projected acreage and no. of facilities: Southwest region

	2005	2015
No. of facilities	1,236	1,207
Total facility (acres)	198,205	184,562
Maintained turf (acres)	128,173	113,168
Overseeded turf (acres)	54,230	34,612

Table 26. Projected acreage and number of facilities for the Southwest region, 2005 vs. 2015.

Land use: Southwest region, 2015

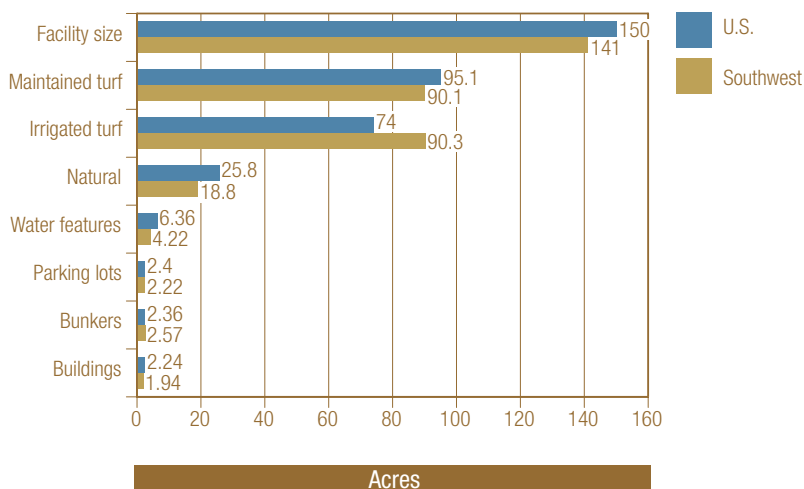


Figure 20. Land use (median acres) on an average 18-hole facility in the Southwest region vs. the U.S., 2015.



At 141 acres, facility sizes in the Southwest are slightly smaller than the national average of 150 acres. The number of acres occupied by bunkers, buildings and parking lots is similar to that in the rest of the country, but linear feet of cart paths is somewhat smaller. Photo by Teresa Carson

Median acreage for turf features: Southwest region, 2015

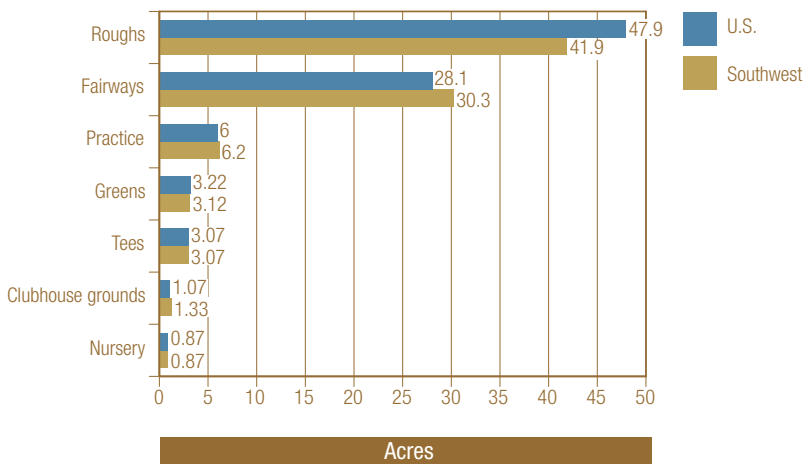


Figure 21. Median acreage for turf features on an average 18-hole facility in the Southwest region, 2015.

- Bunker, building and parking lot sizes were similar to those for the nation overall (Figure 20).
- The number of linear feet devoted to cart paths was somewhat lower than the national average. This value has decreased significantly since 2005 (Table 15).
- The percentage of impervious surfaces in this region was similar to that of the nation overall (Table 14).

Turf features

- In 2015, sizes of greens and tees on 18-hole facilities were comparable to those for the nation overall, while fairways were slightly larger and roughs smaller than the national average (Figure 21, Table 6).
- Since 2005, fairways and roughs for 18-hole facilities in the Southwest have shown the largest percentage decreases in size in the nation (Table 6).

Turf types

- Bermudagrass was the most commonly used turf type in the Southwest region (Table 12).
- On greens, preferred turf types were divided roughly evenly among annual bluegrass, creeping bentgrass and bermudagrass (Table A7). For all other turf features except nurseries, bermudagrass was favored (Tables A7-A11), while creeping bentgrass was favored for nurseries (Table A12).

Transition region

Climate

- Average temperatures in the Transition region are moderate, and vary only slightly across the region, from 47.2 F to 68.6 F (Table 27).
- This region has highly variable average precipitation rates, ranging from only 2.0 feet to as high as 7.1 feet per year (Table 27).

Facility size

- The size of the average 18-hole facility in the Transition region was slightly larger than the national average (Figure 22). This was the case in 2005 as well (Figure 2, Table 1).
- Facility size has not changed significantly since 2005 (Figure 2, Table 1).
- These larger acreages may be a function of lower real estate values in this region, which has fewer large, expensive cities than other areas of the country.
- For all golf courses in the Transition region, total facility acreage has decreased 4.9% since 2005. This was due to the loss of a net 157 facilities since 2005 (Table 28).

Maintained turf acreage

- The acreage of the average 18-hole facility in the Transition region was among the largest acreages in the country. This was the case in 2005 as well (Figure 3, Table 6).
- Maintained turf acreage has not changed significantly since 2005 (Figure 3, Table 6).
- Total maintained turf acreage for all golf courses in the Transition region has decreased 7% since 2005 (Table 28). This was due primarily to the reduced number of facilities in the region (Table 3), which accounted for 82% of the reduced acreage.

Winter overseeding

- The Transition region has reduced its acreage of overseeded turf by more than 12,000 acres, or 64%, since 2005 (Figure 8, Table 8).
- The percentage of facilities that overseed at least one feature decreased from 38% in 2005 to 31% in 2015 (Figure 10).
- Perennial ryegrass was by far the most commonly used overseeded turf type (Tables A1-A6).

Irrigated acreage

- An average 18-hole Transition region facility irrigated 75% (74.9 of 100 acres) of its maintained turf (Figure 11).

Non-turf acreage

- The acreage for water features in the Transition region was slightly smaller than that for the average 18-hole U.S. facility (Figure 22). As for most other regions of the country, the majority of

water feature acreage was devoted to open water (Table A14).

- At 15.3 acres per 18-hole facility, the acreage for natural/native/unmowed areas comprised 9.8% of the total facility (Table 13). This acreage was smaller than the national average (Figure 22). Forests had the highest acreage of all natural area features (Table A15).

Variation in climate: Transition region

	Lowest	Highest
Average temperature (F)	47.2	68.6
Rainfall (feet)	2.0	7.1
Active turf growth (months)	9	9

Table 27. Variation in Transition region climate. Temperature and rainfall values are based on 30-year normal annual average temperatures.

Projected acreage and no. of facilities: Transition region

	2005	2015
No. of facilities	2,722	2,565
Total facility (acres)	447,796	425,963
Maintained turf (acres)	284,941	264,887
Overseeded turf (acres)	19,002	6,810

Table 28. Projected acreage and number of facilities for the Transition region, 2005 vs. 2015.

Land use: Transition region, 2015

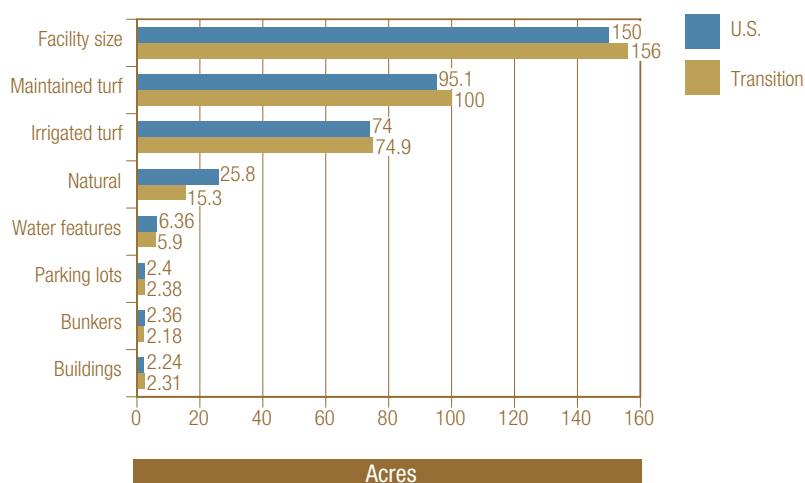


Figure 22. Land use (median acres) on an average 18-hole facility in the Transition region vs. the U.S., 2015.



Natural areas in the Transition region comprised, on average, 9.8% or 15.3 acres of the average facility, and were primarily forests. Photo courtesy of Paul Carter

Median acreage for turf features: Transition region, 2015

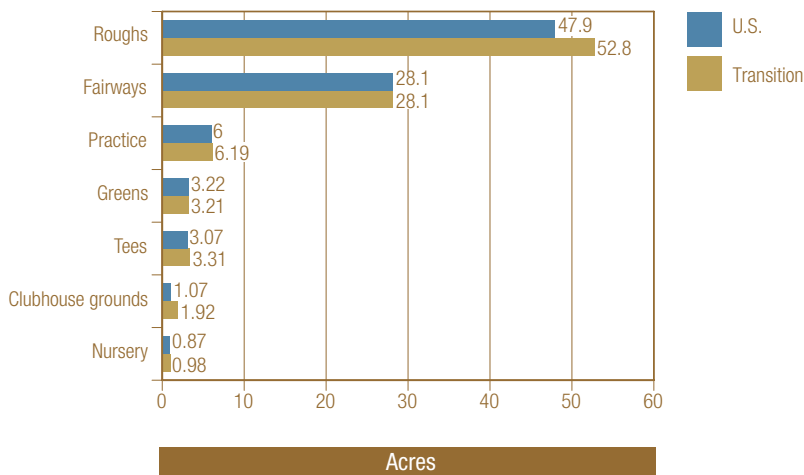


Figure 23. Median acreage for turf features on an average 18-hole facility in the Transition region, 2015.

- Bunker, building and parking lot sizes were similar to those for the nation overall (Figure 22).
- The number of linear feet devoted to cart paths was the highest in the country. This value has not changed significantly since 2005 (Table 15).
- This region had a slightly higher percentage of impervious surfaces when compared with the nation overall (Table 14).

Turf features

- In 2015, the acreage for most turf features on 18-hole facilities in the Transition region was similar to the national average. However, roughs were among the largest in the country (Figure 23, Table 6).
- Since 2005, there have been no significant changes in the size of any turf features on 18-hole facilities. (Table 6).

Turf types

- Bermudagrass was the most commonly used turf type in this region (Table 12).
- Creeping bentgrass was the most popular turf type for use on greens (Table A7) and nurseries (Table A12), but bermudagrass was the dominant turf type for tees, fairways, roughs and driving ranges, (Tables A8-A11).

Upper West/Mountain region Climate

- The Upper West/Mountain region encompasses the largest of the agronomic regions, in terms of area. Climates vary greatly, from the deserts of Nevada to the mountains of Colorado, to the cold winters of North Dakota.
- Average temperatures in the Upper West/Mountain region are comparatively cool, ranging from 34.4 F to 64.6 F (Table 29).
- Rainfall varies from quite low to moderate (Table 29).

Facility size

- The size of the average 18-hole facility in the Upper West/Mountain region was almost identical to that in the nation overall (Figure 24). This was the case in 2005 as well (Figure 2, Table 1).
- Facility size has not changed significantly since 2005 (Figure 2, Table 1).
- Total facility acreage for all golf courses in the Upper West/Mountain region has remained stable since 2005. This was the only region where the number of facilities has increased since 2005 (Table 30).

Maintained turf acreage

- Acreage of the average 18-hole facility in the Upper West/Mountain region was very similar to that for the nation overall (Figure 24). This was the case in 2005 as well (Figure 3, Table 6).
- No change has occurred in total maintained turf acreage for all golf courses in the Upper West/Mountain region since 2005, despite an increase in facility numbers. This region was the only area of the nation where the number of facilities has increased since 2005 (Table 3). The stability of the maintained turf acreage was therefore due exclusively to voluntary reductions in maintained turf acreage for the region.

Irrigated acreage

- An average 18-hole Upper West/Mountain region facility irrigated 96% of its maintained turf, or 91 of 94.5 acres (Figure 11).
- The relatively arid conditions in much of this region are responsible for these practices (Table 29).

Non-turf acreage

- The acreage for water features was smaller than that of the average 18-hole U.S. facility (Figure 24). As for most other regions of the country, the majority of water feature acreage was devoted to open water (Table A14).
- At 19.4 acres per 18-hole facility, the acreage for natural/native/unmowed areas comprised 13% of the total facility (Table 13). This acreage was

- somewhat smaller than the national average (Figure 24). Native grasslands had the highest acreage of all natural area features (Table A15).
- Bunker, building and parking lot sizes were similar to those for the nation overall (Figure 24).
- The number of linear feet devoted to cart paths was lower than the national average. There has been no significant change in this value since 2005 (Table 15).

Variation in climate: Upper West/Mountain region

	Lowest	Highest
Average temperature (F)	34.4	64.6
Rainfall (feet)	0.4	4.9
Active turf growth (months)	5	9

Table 29. Variation in Upper West/Mountain region climate. Temperature and rainfall values are based on 30-year normal annual average temperatures.

Projected acreage and no. of facilities: Upper West/Mountain region

	2005	2015
No. of facilities	918	940
Total facility (acres)	152,985	152,650
Maintained turf (acres)	95,197	94,664

Table 30. Projected acreage and number of facilities for the Upper West/Mountain region, 2005 vs. 2015.

Land use: Upper West/Mountain, 2015

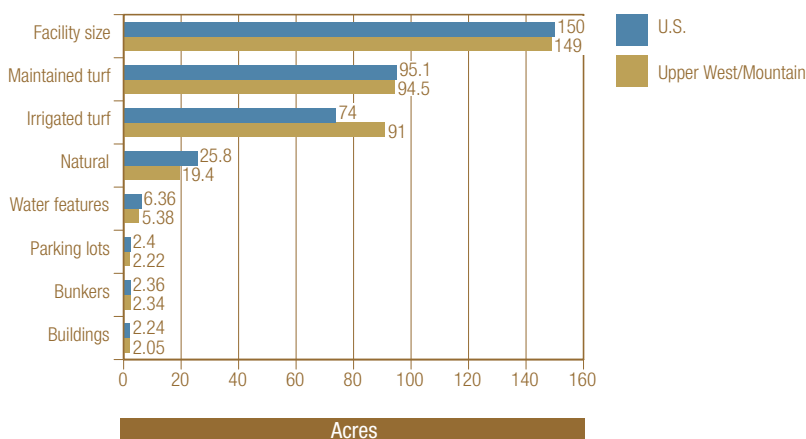


Figure 24. Land use (median acres) on an average 18-hole facility in the Upper West/Mountain region vs. the U.S., 2015.



The largest agronomic region, the UpperWest/Mountain region is the only region that has seen an increase in the number of golf facilities since 2005. Despite having more golf courses, the region has not seen an increase in the number of maintained acres of turf. Photo by Pamela C. Smith

Median acreage for turf features: Upper West/Mountain, 2015

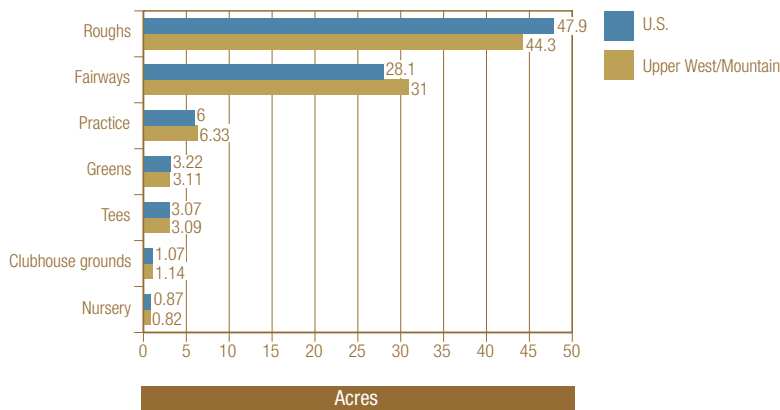


Figure 25. Median acreage for turf features on an average 18-hole facility in the Upper West/Mountain region vs. the U.S., 2015.

- This region had a slightly smaller percentage of impervious surfaces compared with the nation overall (Table 14).

Turf features

- In 2015, the average 18-hole facility in the Upper West/Mountain region devoted more acreage to fairways and less to roughs than the national average (Figure 25, Table 6).
- The sizes of fairways, practice areas and clubhouse grounds for 18-hole golf facilities have decreased since 2005. The acreage for all other features did not change significantly (Table 6).

Turf types

- Kentucky bluegrass was the dominant turf type in the region and on all turf features except for greens (Tables 12, A8, A12).
- Creeping bentgrass was the most popular turf type on greens (Table A7).

Conclusions and recommendations

- The golf industry has made significant reductions in the acreage of maintained turf since 2005. While 55% of these decreases were due to the decreased number of facilities in the nation since 2005, 45% of these decreases were implemented voluntarily.
- Further significant reductions were made in acreage of overseeded turf and irrigated turf.
- Looking toward the future, further reductions in the acreage of maintained turf, overseeded turf and irrigated turf will have the greatest impact on golf's environmental footprint.
- Future reductions in the acreage and percentage of impervious surfaces will occur if facilities rely on the use of materials such as pervious concrete in the construction or remodeling of cart paths and parking lots, and/or the use of green rooftops on buildings.
- Facility participation in initiatives that seek to educate, motivate and monitor environmental stewardship on U.S. golf courses will be important tools as the golf industry continues its efforts in this vein.
- In future decades, it is unlikely that the dramatic improvements observed from 2005 to 2015 can be matched, as all the obvious and relatively straightforward changes will have already been made.

Methodology

Survey questions adhered as closely as possible to those in the 2005 survey. However, input from golf, environmental, academic and regulatory sources was integrated into the 2015 survey in order to clarify questions or to integrate information on new technologies and issues in golf course management.

PACE Turf was contracted to provide technical oversight of the survey, analyze and summarize the data, and to prepare reports for publication in peer-reviewed scientific journals, as well as in GCSAA publications and websites. The National Golf Foundation (NGF) was contracted to refine and format the survey instrument for online use, conduct the survey, manage the recruitment of participants, collate the data, and complete the analysis in collaboration with GCSAA and PACE Turf.

Survey response

Of the 15,121 golf facilities in the U.S. at the time the survey was completed, 12,951 golf courses managed by superintendents with available email addresses were identified by integrating GCSAA and NGF databases. An initial email invitation, which included a link to the online survey, was sent to prospective participants in March 2016, followed by three email reminders sent in April 2016. A total of 1,707 completed surveys were received, which rep-

resents an 11.3% response coverage (Tables A17a, A17b). This is somewhat lower than the 18.6% response coverage from the earlier survey, which also included a mail survey campaign. Although both surveys targeted the same population, respondents in 2015 were not identical to those in 2005.

To gain insights into survey data, respondents were stratified by agronomic region (Figure A10, Tables A17a, A17b), as well as by golf course type, number of holes and green fees.

Data analysis

To ensure that the data was representative of the broad spectrum of golf facilities in the nation, responses were weighted so that the diversity in golf course size, type and geographic location were accurately reflected in the survey data. When data was restricted to specific regions or specific golf course sizes, weighted data was not used.

Literature cited

1. Bauer, M.E., B.C. Loffelholz and B. Wilson. 2007. Estimating and mapping impervious surface area by regression analysis of Landsat imagery. Pages 3-19 in Q. Weng, ed. Remote sensing of impervious surfaces. CRC Press, Boca Raton, Fla.
2. Bonos, S.A., and D.R. Huff. 2013. Cool-season grasses: biology and breeding. Pages 591-660 in J.C. Stier, B.P. Horgan and S.A. Bonos, eds. Turfgrass: Biology, use and management. Agronomy Monograph 56. ASA, CSSA and SSA, Madison, Wis.
3. Coleman, M. 2016. Long on design. Grounds Maintenance http://grounds-mag.com/construction/grounds_maintenance_long_design/
4. Gelernter, W.D., L.J. Stowell, M.E. Johnson, C.D. Brown and J.F. Beditz. 2015. Documenting trends in water use and conservation practices on U.S. golf courses. *Crop, Forage and Turfgrass Management* doi:10.2134/cftm2015.014
5. Schueler, T.R. 2000. The importance of imperviousness. Pages 7-18 in T.R. Schueler and H.K. Holland, eds. The practice of watershed protection. Center for Watershed Protection, Ellicott City, Md.

Further reading

1. Gelernter, W.D., L.J. Stowell, M.E. Johnson and C.D. Brown. 2016. Documenting trends in nutrient use and management practices on U.S. golf courses. *Crop, Forage and Turfgrass Management* doi:10.2134/cftm2015.0225
2. Gelernter, W.D., L.J. Stowell, M.E. Johnson and C.D. Brown. 2016. Documenting trends in pest management practices on U.S. Golf Courses. *Crop, Forage and Turfgrass Management* doi:10.2134/cftm2016.04.0032

3. Gelernter, W.D., L.J. Stowell, M.E. Johnson and C.D. Brown. 2017. Documenting trends in land use characteristics and environmental stewardship programs on U.S. golf courses. *Crop, Forage and Turfgrass Management* doi:10.2134/cftm2016.10.0066
4. Lyman, G.T., M.E. Johnson, G.A. Stacey and C.D. Brown. 2012a. Golf course environmental profile measures energy use and energy management practices. *Applied Turfgrass Science* doi:10.1094/ATS-2012-0228-01-RS
5. Lyman, G.T., M.E. Johnson, G.A. Stacey and C.D. Brown. 2012b. Golf course environmental profile measures pesticide use practices and trends. *Applied Turfgrass Science* doi:10.1094/ATS-2012-1220-01-RS
6. Lyman, G.T., C.S. Throssell, M.E. Johnson, G.A. Stacey and C.D. Brown. 2007. Golf course profile describes turfgrass, landscape and environmental stewardship features. *Applied Turfgrass Science* doi:10.1094/ATS-2007-1107-01-RS
7. Throssell, C.S., G.T. Lyman, M.E. Johnson, G.A. Stacey and C.D. Brown. 2009a. Golf course environmental profile measures nutrient use management and fertilizer restrictions, storage and equipment calibration. *Applied Turfgrass Science* doi:10.1094/ATS-2009-1203-01-RS
8. Throssell, C.S., G.T. Lyman, M.E. Johnson, G.A. Stacey and C.D. Brown. 2009b. Golf course environmental profile measures water use, source, cost, quality, and management and conservation strategies. *Applied Turfgrass Science* doi:10.1094/ATS-2009-0129-01-RS

Appendix

Bermudagrass acreage

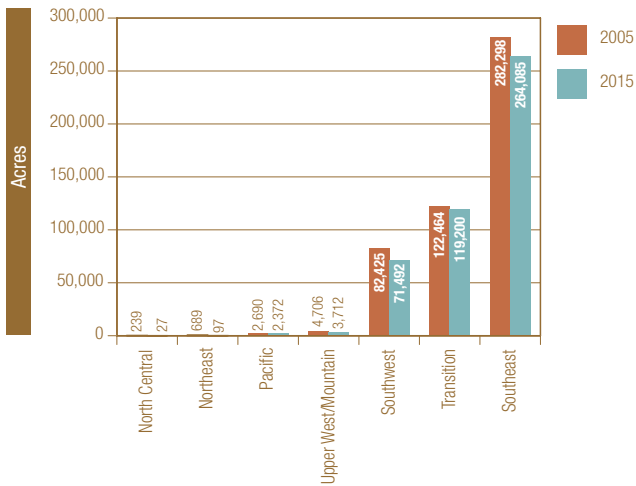


Figure A1. Projected bermudagrass acreage, 2005 vs. 2015.

Kentucky bluegrass acreage

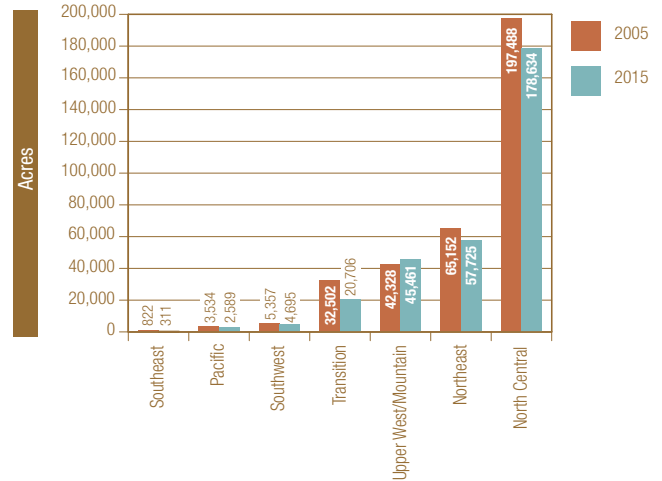


Figure A2. Projected Kentucky bluegrass acreage, 2005 vs. 2015.

Annual bluegrass acreage

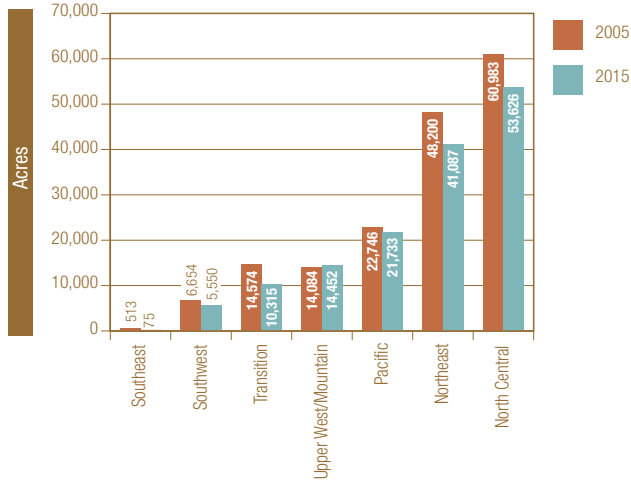


Figure A3. Projected annual bluegrass acreage, 2005 vs. 2015.

Perennial ryegrass acreage

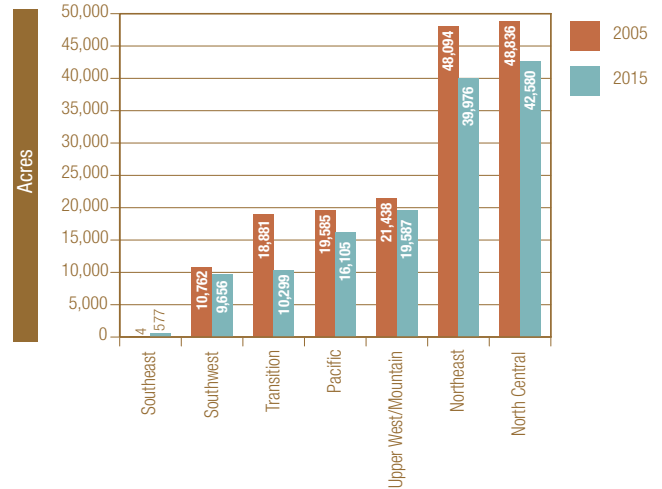


Figure A4. Projected perennial ryegrass acreage, 2005 vs. 2015.

Creeping bentgrass acreage

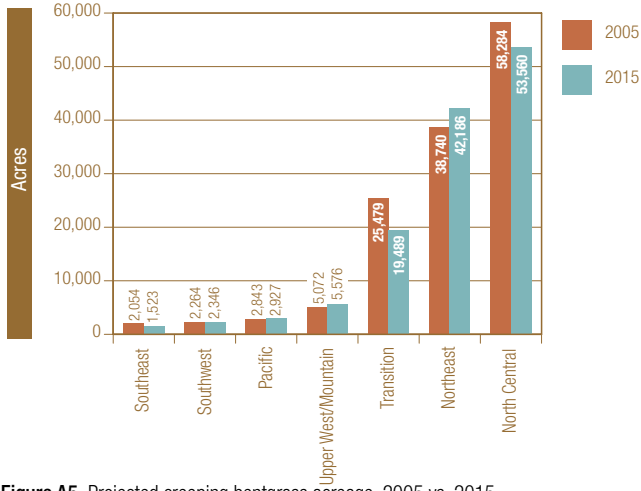


Figure A5. Projected creeping bentgrass acreage, 2005 vs. 2015.

Tall fescue acreage

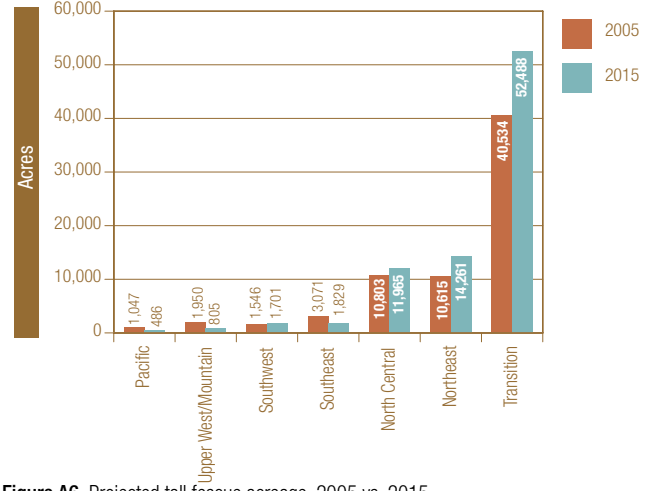


Figure A6. Projected tall fescue acreage, 2005 vs. 2015.

Fine fescue acreage

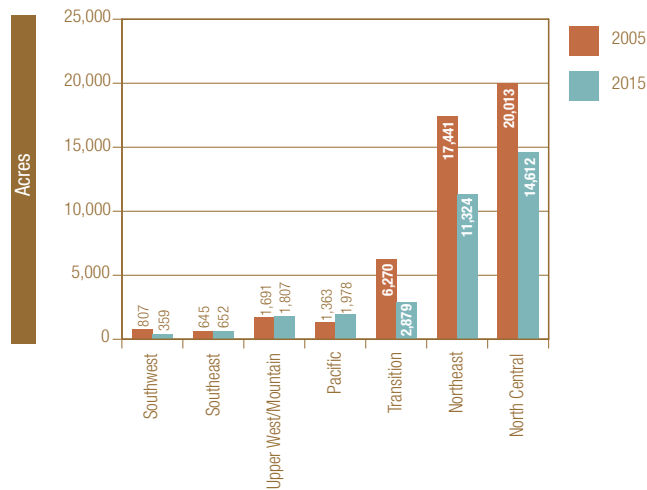


Figure A7. Projected fine fescue acreage, 2005 vs. 2015.

Seashore paspalum acreage

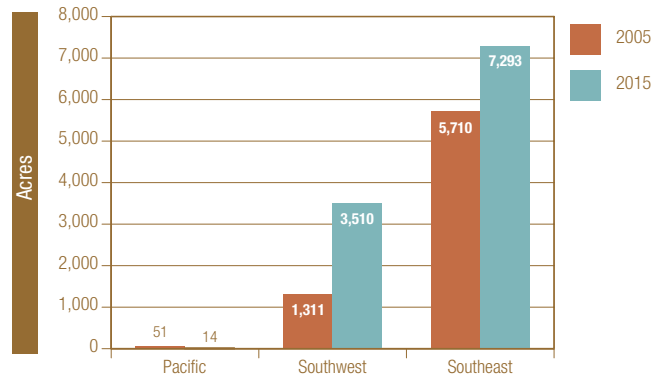


Figure A8. Projected seashore paspalum acreage, 2005 vs. 2015.

Zoysiagrass acreage

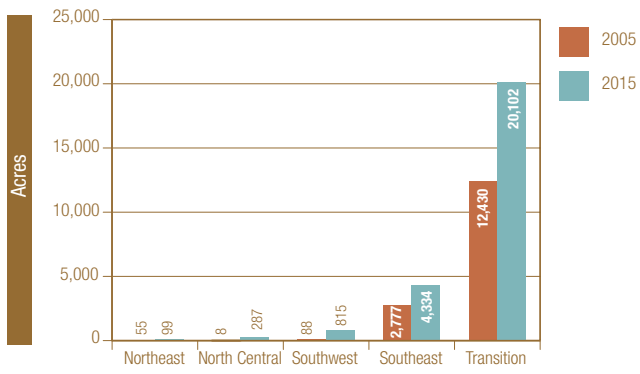


Figure A9. Projected zoysiagrass acreage, 2005 vs. 2015.

Distribution of 2015 survey responses



Figure A10. Distribution of 2015 survey responses across the survey's seven agro-nomic regions.

Appendix Tables

Projected acreage of overseeded greens by grass species

Region	Rough bluegrass		Perennial ryegrass		Creeping bentgrass		Intermediate ryegrass		Other	
	2005	2015	2005	2015	2005	2015	2005	2015	2005	2015
Southeast	3,159	1,491	895	81	199	5	44	0	181	0
Southwest	599	685	499	398	214	150	0	0	63	36
Transition	61	0	35	0	120	0	0	0	12	0

Table A1. Projected acreage of overseeded greens by grass species, 2005 vs. 2015. Data are shown only for regions where overseeding is commonly practiced.

Projected acreage of overseeded tees by grass species

Region	Perennial ryegrass		Rough bluegrass		Intermediate ryegrass		Creeping bentgrass		Other	
	2005	2015	2005	2015	2005	2015	2005	2015	2005	2015
Southeast	7,578	3,697	292	57	184	19	2	0	90	23
Southwest	3,213	2,438	74	39	0	54	14	0	127	3
Transition	2,464	882	16	0	130	34	13	0	20	0

Table A2. Projected acreage for overseeded tees by grass species, 2005 vs. 2015. Data are shown only for regions where overseeding is commonly practiced.

Projected acreage of overseeded fairways by grass species

Region	Perennial ryegrass		Intermediate ryegrass		Creeping bentgrass		Other	
	2005	2015	2005	2015	2005	2015	2005	2015
Southeast	36,861	17,389	787	220	0	0	174	0
Southwest	22,804	14,333	0	446	152	0	371	36
Transition	9,442	3,566	457	154	0	0	364	0

Table A3. Projected acreage of overseeded fairways by grass species, 2005 vs. 2015. Data are shown only for regions where overseeding is commonly practiced.

Projected acres of overseeded roughs by grass species

Region	Perennial ryegrass		Fine fescue		Rough bluegrass		Intermediate ryegrass		Other	
	2005	2015	2005	2015	2005	2015	2005	2015	2005	2015
Southeast	10,225	4,652	0	0	0	0	1,015	238	494	0
Southwest	21,569	13,052	340	37	20	18	0	376	0	37
Transition	2,279	206	749	0	114	0	0	0	911	1,247

Table A4. Projected acres of overseeded roughs by grass species, 2005 vs. 2015. Data are shown only for regions where overseeding is commonly practiced.

Projected acreage of overseeded driving range/ practice areas by grass species

Region	Perennial ryegrass		Rough bluegrass		Intermediate ryegrass		Creeping bentgrass		Other	
	2005	2015	2005	2015	2005	2015	2005	2015	2005	2015
Southeast	5,455	3,059	121	15	90	20	0	0	130	0
Southwest	3,924	2,245	24	0	0	152	0	0	133	36
Transition	1,657	666	9	0	72	41	14	0	28	13

Table A5. Projected acreage of overseeded driving range/practice areas, by grass species, 2005 vs. 2015. Data are shown only for regions where overseeding is commonly practiced.

Projected acreage of overseeded turf nurseries by grass species

Region	Perennial ryegrass		Rough bluegrass		Creeping bentgrass		Other	
	2005	2015	2005	2015	2005	2015	2005	2015
Southeast	116	3	100	24	9	0	10	0
Southwest	55	35	20	7	13	0	1	0
Transition	13	0	3	0	18	0	0	0

Table A6. Projected acreage of overseeded turf nurseries by grass species, 2005 vs. 2015. Data are shown only for regions where overseeding is commonly practiced.

Projected acreage of greens by grass species

Region	Cool-season grasses						Warm-season grass		
	Annual bluegrass			Creeping bentgrass			Bermudagrass		
	2005	2015	% change	2005	2015	% change	2005	2015	% change
North Central	3,440	3,316	-3.6	9,242	8,643	-6.5	0	0	NA [†]
Northeast	2,886	3,195	11	5,650	5,384	-4.7	20	0	NA
Pacific	1,165	1,161	<1	625	608	-2.7	0	3	NA
Southeast	39	47	21	1,644	982	-40	7,621	7,930	4.1
Southwest	927	1,144	23	1,423	1,273	-11	1,428	1,224	-14
Transition	1,170	967	-17	7,345	6,462	-12	400	899	125
Upper West/Mtn	886	1,047	18	2,097	1,976	-5.8	0	0	NA
U.S.	10,514	10,877	3.4	28,025	25,327	-9.6	9,469	10,055	6.2

[†]NA: Percent change was not computed when 10 or fewer acres were reported for either 2005 or 2015.

Table A7. Projected acres of each grass species for greens, 2005 vs. 2015, and percent change in acreage for each species since 2005.

Projected acreage of tees by grass species

Region	Cool-season grasses												Warm-season grasses					
	Annual bluegrass			Creeping bentgrass			Kentucky bluegrass			Perennial ryegrass			Bermudagrass			Zoysiagrass		
	2005	2015	% change	2005	2015	% change	2005	2015	% change	2005	2015	% change	2005	2015	% change	2005	2015	% change
North Central	2,672	2,428	-9.1	5,136	4,985	-2.9	2,725	3,050	12	1,037	1,029	<-1	0	0	NA†	0	30	NA
Northeast	1,685	1,550	-8.0	2,814	3,265	16	952	931	-2.2	1,328	1,054	-21	19	0	NA	0	0	NA
Pacific	857	864	<1	173	175	1.2	77	89	16	895	532	-41	122	76	-38	0	0	NA
Southeast	19	3	NA†	11	67	509	14	0	NA	1	42	NA	11,661	9,948	-15	320	259	-19
Southwest	183	164	-10	32	123	284	249	140	-44	410	381	-7.1	3,455	2,756	-20	5	33	NA
Transition	612	411	-33	1,874	1,711	-8.7	519	193	-63	808	481	-41	5,169	4,458	-14	1,278	1,823	43
Upper West/Mtn	480	531	11	376	392	4.3	1,240	1,245	<1	894	769	-14	165	130	-21	0	1	NA
U.S.	6,507	5,952	-8.5	10,416	10,718	2.9	5,776	5,647	-2.2	5,374	4,286	-20	20,592	17,368	-16	1,603	2,146	34

†NA: Percent change was not computed when 10 or fewer acres were reported for either 2005 or 2015.

Table A8. Projected acreage of tees for each grass species, 2005 vs. 2015, and percent change in acreage for each species since 2005.

Projected acreage of fairways by grass species

Region†	Cool-season grasses												Warm-season grasses					
	Annual bluegrass			Creeping bentgrass			Fine fescue			Kentucky bluegrass			Perennial ryegrass			Tall fescue		
	2005	2015	% change	2005	2015	% change	2005	2015	% change	2005	2015	% change	2005	2015	% change	2005	2015	% change
NC	28,039	23,853	-15	33,162	31,929	-3.7	1,065	1,188	12	33,172	31,167	-6.0	9,914	9,907	<1	213	69	-68
NE	18,212	14,318	-21	24,004	27,362	14	1,249	1,256	<1	8,199	7,356	-10	12,531	10,699	-15	276	185	-33
PAC	8,534	8,669	1.6	1,145	1,433	25	325	1,035	218	1,101	1,035	-6.0	7,094	5,696	-20	71	83	17
SE	171	10	-94	86	341	297	0	341	NA†	86	0	NA	0	127	NA	32	0	NA
SW	1,999	1,301	-35	114	441	287	381	0	NA	2,016	1,560	-23	2,757	2,446	-11	267	761	185
TR	5,121	3,263	-36	11,732	8,849	-25	8	515	NA	4,388	1,431	-67	6,819	4,125	-40	42	825	1,864
UW/M	5,941	6,530	10	1,431	2,080	45	197	689	250	13,868	14,075	1.5	8,980	7,868	-12	23	53	130
U.S.	68,017	57,943	-15	71,674	72,435	1.1	3,226	5,023	56	62,830	56,624	-9.9	48,097	40,869	-15	924	1,976	114

Region	Warm-season grasses											
	Bermudagrass			Zoysiagrass			Seashore paspalum			Other		
	2005	2015	% change	2005	2015	% change	2005	2015	% change	2005	2015	% change
NC	0	0	NA	0	178	NA	0	0	NA	671	693	3.3
NE	197	0	NA	0	0	NA	0	0	NA	1,072	382	-64
PAC	1,202	1,029	-14	0	0	NA	8	14	NA	829	798	-3.7
SE	103,085	91,571	-11	1,251	1,802	44	1,988	2,931	47	192	253	32
SW	31,155	25,805	-17	9	460	NA	754	1,560	107	4,379	3,713	-15
TR	45,321	40,271	-11	9,784	16,335	67	0	0	NA	50	106	112
UW/M	1,845	1,559	-16	0	0	NA	0	0	NA	23	105	357
U.S.	182,805	160,235	-12	11,043	18,775	70	2,750	4,505	64	7,215	6,050	-16

†Regions: NC, North Central; NE, Northeast; PAC, Pacific; SE, Southeast; SW, Southwest; TR, Transition; UW/M, Upper West/Mountain.

†NA: Percent change was not computed when 10 or fewer acres were reported for either 2005 or 2015.

Table A9. Projected acreage of fairways for each grass species, 2005 vs. 2015, and percent change in acreage for each species since 2005.

Projected acreage of roughs by grass species

Region†	Cool-season grasses																	
	Annual bluegrass			Creeping bentgrass			Fine fescue			Kentucky bluegrass			Perennial ryegrass			Tall fescue		
	2005	2015	% change	2005	2015	% change	2005	2015	% change	2005	2015	% change	2005	2015	% change	2005	2015	% change
NC	22,517	20,821	-7.5	2,973	3,040	2.3	18,444	13,902	-25	145,374	131,070	-9.8	33,190	28,265	-15	10,041	11,071	10
NE	22,347	19,950	-11	2,800	3,584	28	16,385	10,456	-36	51,111	45,847	-10	30,171	25,042	-17	9,847	13,435	36
PAC	10,514	9,497	-10	629	549	-13	1,289	1,826	42	2,131	1,289	-40	10,138	8,759	-14	973	454	-53
SE	253	15	-94	0	0	NA‡	626	575	-8.2	656	272	-59	0	393	NA	2,967	1,769	-40
SW	3,171	2,471	-22	340	140	-59	705	359	-49	2,707	2,600	-4.0	6,706	6,097	-9.1	1,428	1,507	5.5
TR	6,773	5,306	-22	2,021	897	-56	5,883	2,837	-52	25,449	18,136	-29	9,790	4,879	-50	37,894	48,838	29
UW/M	5,575	5,568	<1	481	751	56	1,514	1,610	6.3	23,177	26,617	15	9,641	9,131	-5.3	1,842	728	-61
U.S.	71,150	63,628	-11	9,244	8,961	-3.1	44,846	31,564	-30	250,605	225,831	-9.9	99,636	82,566	-17	64,991	77,802	20

Region	Warm-season grasses											
	Bermudagrass			Zoysiagrass			Seashore paspalum			Other		
	2005	2015	% change	2005	2015	% change	2005	2015	% change	2005	2015	% change
NC	234	0	NA	0	21	NA	0	0	NA	1,241	1,489	20
NE	375	71	-81	54	59	9.3	0	0	NA	871	237	-73
PAC	1,130	1,015	-10	0	0	NA	43	0	NA	1,611	265	-84
SE	135,850	135,095	<-1	1,103	1,951	77	2,609	2,661	2.0	4,994	8,498	70
SW	39,786	36,166	-9.1	74	196	164	253	1,300	413	6,638	5,200	-22
TR	60,567	64,020	5.7	679	926	36	0	15	NA	1,795	1,132	-37
UW/M	2,278	1,742	-24	0	0	NA	0	0	NA	413	803	94
U.S.	240,219	238,109	<-1	1,910	3,153	65	2,905	3,976	37	17,563	17,624	<1

†Regions: NC, North Central; NE, Northeast; PAC, Pacific; SE, Southeast; SW, Southwest; TR, Transition; UW/M, Upper West/Mountain.
‡NA: Percent change was not computed when 10 or fewer acres were reported for either 2005 or 2015.

Table A10. Projected acreage of roughs for each grass species, 2005 vs. 2015, and percent change in acreage for each species since 2005.

Projected acres of driving range/practice areas by grass species

Region [†]	Cool-season grasses																	
	Annual bluegrass			Creeping bentgrass			Fine fescue			Kentucky bluegrass			Perennial ryegrass			Tall fescue		
	2005	2015	% change	2005	2015	% change	2005	2015	% change	2005	2015	% change	2005	2015	% change	2005	2015	% change
NC	3,763	2,963	-21	4,133	3,549	-14	1,542	703	-54	15,501	12,953	-16	4,490	3,333	-26	724	874	21
NE	2,684	1,885	-30	1,875	1,895	1.1	1,040	854	-18	4,761	3,550	-25	4,020	3,105	-23	737	821	11
PAC	1,403	1,401	0	85	55	-35	67	138	106	212	170	-20	1,352	1,064	-21	68	29	-57
SE	28	0	NA [‡]	14	47	236	19	78	311	67	39	-42	2	16	NA	104	60	-42
SW	278	283	1.8	63	77	22	100	0	NA	363	388	6.9	884	721	-18	113	193	71
TR	791	325	-59	967	645	-33	380	29	-92	2,010	939	-53	1,446	806	-44	2,593	3,528	36
UW/M	1,083	730	-33	143	168	18	174	188	8.1	3,860	3,459	-10	1,862	1,781	-4.4	106	77	-27
U.S.	10,029	7,586	-24	7,278	6,434	-12	3,323	1,991	-40	26,774	21,498	-20	14,057	10,824	-23	4,446	5,582	26

Region	Warm-season grasses					
	Bermudagrass			Zoysiagrass		
	2005	2015	% change	2005	2015	% change
NC	3	27	NA	0	50	NA
NE	77	26	-66	0	39	NA
PAC	234	249	6.4	6	0	NA
SE	21,911	18,219	-17	77	181	135
SW	6,299	5,310	-16	0	71	NA
TR	10,182	9,093	-11	386	708	83
UW/M	413	273	-34	0	0	NA
U.S.	39,119	33,197	-15	469	1,049	124

[†]Regions: NC, North Central; NE, Northeast; PAC, Pacific; SE, Southeast; SW, Southwest; TR, Transition; UW/M, Upper West/Mountain.

[‡]NA: Percent change was not computed when 10 or fewer acres were reported for either 2005 or 2015.

Table A11. Projected acres of driving range/practice areas for each grass species, 2005 vs. 2015, and percent change in acreage for each species since 2005.

Projected acres of turf nurseries by grass species

	Cool-season grasses									Warm-season grass		
	Annual bluegrass			Creeping bentgrass			Kentucky bluegrass			Bermudagrass		
	2005	2015	% change	2005	2015	% change	2015	2015	% change	2005	2015	% change
North Central	552	245	-56	3,639	2	NA [†]	0	360	NA	2	0	NA
Northeast	387	189	-51	1,597	0	NA	0	42	NA	0	0	NA
Pacific	274	141	-49	187	2	NA	0	5	NA	2	0	NA
Southeast	4	0	NA	300	2,170	623	1,321	0	NA	2,170	1,321	-39
Southwest	96	186	94	292	301	3	231	8	NA	301	231	-23
Transition	106	45	-58	1,539	824	-47	460	8	NA	824	460	-44
Upper West/Mtn	119	46	-61	545	6	NA	8	64	NA	6	8	NA
U.S.	1,538	852	-45	8,099	3,306	-59	2,020	486	-76	3,306	2,020	-39

[†]NA: Percent change was not computed when 10 or fewer acres were reported for either 2005 or 2015.

Table A12. Projected acres of turf nurseries for each grass species, 2005 vs. 2015, and percent change in acreage for each species since 2005.

Projected acreage of facility subfeatures and their % of total facility acreage, 2015

Region	Bunkers		Buildings		Parking lots		Water features		Natural areas		Maintained turf	
	Acres	% of total	Acres	% of total	Acres	% of total	Acres	% of total	Acres	% of total	Acres	% of total
North Central	12,027	2.1	10,393	1.8	11,818	2.0	38,514	6.6	143,802	25	369,977	63
Northeast	7,702	2.1	7,995	2.2	8,166	2.2	21,589	5.9	107,238	29	216,187	59
Pacific	1,974	2.4	1,714	2.1	2,096	2.5	3,874	4.7	21,660	26	51,826	62
Southeast	10,740	2.1	17,726	3.5	9,879	2.0	52,964	11	111,067	22	298,702	60
Southwest	3,754	2.0	3,235	1.8	3,030	1.6	7,266	3.9	54,110	29	113,168	61
Transition	7,129	1.7	8,694	2.0	7,642	1.8	27,697	6.5	109,914	26	264,887	62
Upper West/Mountain	2,809	1.8	2,875	1.9	3,147	2.1	7,168	4.7	41,986	28	94,664	62
U.S.	46,136	2.0	52,632	2.3	45,779	2.0	159,072	6.9	589,778	26	1,408,412	61

Table A13. Projected acreage for subfeatures that make up total facility acreage, and each subfeature's percentage of total facility acreage for 2015.

Projected acreage of water features, and their % of total water feature acreage, 2015

Region	Open water		Wetlands		Streams/rivers		Drainage waterways		Irrigation canals		Total water features
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres
North Central	21,681	56	11,009	29	3,905	10	1,481	3.8	438	1.1	38,514
Northeast	10,748	50	6,406	30	2,558	12	1,009	4.7	868	4.0	21,589
Pacific	2,338	60	599	15	727	19	189	4.9	20	0.5	3,874
Southeast	40,196	76	7,961	15	1,682	3.2	1,682	3.2	1,442	2.7	52,964
Southwest	5,638	78	262	3.6	80	1.1	1,241	17	46	0.6	7,266
Transition	20,463	74	4,235	15	2,260	8.2	642	2.3	95	0.3	27,697
Upper West/Mountain	4,531	63	1,531	21	602	8.4	319	4.5	186	2.6	7,168
U.S.	105,595	66	32,003	20	11,814	7.4	6,564	4.1	3,095	1.9	159,072

Table A14. Projected acreage for water features and each feature's percentage of total facility acreage for 2015.

Projected acreage of natural/native/unmowed areas, and their % of total natural acreage, 2015

Region [†]	Forests		Native grasslands		Mixed		Shrublands		Deserts	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
NC	56,615	39	36,141	25	28,394	20	2,490	1.7	35	<0.1
NE	64,557	60	11,888	11	12,375	12	3,143	2.9	0	0.0
PAC	8,265	38	5,444	25	2,774	13	1,066	4.9	52	0.2
SE	62,081	56	13,952	13	9,913	8.9	5,722	5.2	275	0.2
SW	4,510	8.3	12,119	22	2,728	5.0	3,517	6.5	24,608	45.5
TR	54,201	49	26,574	24	15,519	14	2,976	2.7	77	0.1
UW/M	9,415	22	16,448	39	8,178	19	2,382	5.7	1,358	3.2
U.S.	259,643	44	122,567	21	79,881	14	21,294	3.6	26,406	4.5

Region	Riparian		Buffer		Garden		Other No-Mow		Other Natural		Total natural areas
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres
NC	2,974	2.1	3,078	2.1	1,418	1.0	7,090	4.9	5,568	3.9	143,802
NE	2,095	2.0	2,460	2.3	1,608	1.5	5,798	5.4	3,313	3.1	107,238
PAC	707	3.3	347	1.6	232	1.1	1,425	6.6	1,349	6.2	21,660
SE	1,530	1.4	3,304	3.0	2,325	2.1	3,243	2.9	8,720	7.9	111,067
SW	586	1.1	287	0.5	2,165	4.0	1,711	3.2	1,878	3.5	54,110
TR	821	0.7	2,206	2.0	846	0.8	5,156	4.7	1,539	1.4	109,914
UW/M	754	1.8	586	1.4	344	0.8	2,056	4.9	465	1.1	41,986
U.S.	9,466	1.6	12,270	2.1	8,939	1.5	26,478	4.5	22,833	3.9	589,778

[†]Regions: NC, North Central; NE, Northeast; PAC, Pacific; SE, Southeast; SW, Southwest; TR, Transition; UW/M, Upper West/Mountain.

Table A15. Projected acreage for natural/native/unmowed areas, and each feature's percentage of total natural acreage, 2015.

% of facilities participating in environmental stewardship programs

Environmental stewardship program	2005	2015
	% participating	
Audubon Cooperative Sanctuary	25	25
Michigan Turfgrass Environmental Stewardship Program (MTESP)	2.3	1.7
Audubon International Signature Program	2.2	2.6
Oregon Stewardship Guidelines	1.1	1.2
CMAA's Environmental Performance Audit	<1	<1
San Antonio Water System Environmental Program (SAWS)	<1	<1
Golf Course Environmental Management Program (GEM)	1.6	2.1
Florida Green Building Coalition	<1	<1
Rhode Island Golf Course Green Certification Program	NA	0
Other state: BMP program	NA	6.0
Florida: BMPs for the Enhancement of Environmental Quality on Florida Golf Courses	NA	5.8
GCSAA's IPM Planning Guide	NA	5.7
Other clean streams or river water quality programs	NA	4.0
Operation Pollinator or other similar pollinator programs	NA	3.0
New York: BMPs for NY State Golf Courses	NA	2.9
ePar USA	NA	2.6
Groundwater Guardian Green Site Program	NA	1.8
Virginia: Environmental BMPs for Virginia's Golf Courses	NA	1.6
Golf Environment Organization (GEO)	NA	<1
Pennsylvania: Golf Course BMPs	NA	<1
Golf Course Water Resource Handbook of BMPs	NA	2.7
Pennsylvania: Golf Course Water Resources Handbook of BMPs	NA	<1
Vermont Green Links Program	NA	<1
Clean Corporate Citizens	NA	<1

NA: question not asked previously; BMPs: best management practices

Table A16. Percent of all facilities participating in environmental stewardship programs. There were no significant differences between 2005 and 2015 data.

LAND USE Property profile survey responses in Phase II, 2016

Facility description				2016 U.S. golf facilities		2016 survey response	
Region	No. holes	Type	Green fees	No.	% of total	No. responses	% response
Northeast	9	All	All	714	4.7	36	2.1
Northeast	18	Public	<\$55	638	4.2	41	2.4
Northeast	18	Public	>\$55	504	3.3	52	3
Northeast	18	Private	All	596	3.9	99	5.8
Northeast	27+	All	All	195	1.3	21	1.2
North Central	9	All	All	1,265	8.4	48	2.8
North Central	18	Public	<\$55	1,429	9.5	110	6.4
North Central	18	Public	>\$55	349	2.3	65	3.8
North Central	18	Private	All	481	3.2	117	6.9
North Central	27+	All	All	327	2.2	54	3.2
Transition	9	All	All	712	4.7	10	0.6
Transition	18	Public	<\$55	981	6.5	79	4.6
Transition	18	Public	>\$55	313	2.1	51	3
Transition	18	Private	All	552	3.7	97	5.7
Transition	27+	All	All	190	1.3	36	2.1
Southeast	9	All	All	520	3.4	9	0.5
Southeast	18	Public	<\$55	958	6.3	78	4.6
Southeast	18	Public	>\$55	421	2.8	58	3.4
Southeast	18	Private	All	679	4.5	129	7.6
Southeast	27+	All	All	380	2.5	66	3.9
Southwest	9	All	All	262	1.7	6	0.4
Southwest	18	Public	<\$55	235	1.6	24	1.4
Southwest	18	Public	>\$55	308	2.0	48	2.8
Southwest	18	Private	All	225	1.5	33	1.9
Southwest	27+	All	All	169	1.1	37	2.2
Up-West/Mtn	9	All	All	408	2.7	23	1.3
Up-West/Mtn	18	Public	<\$55	247	1.6	41	2.4
Up-West/Mtn	18	Public	>\$55	217	1.4	63	3.7
Up-West/Mtn	18	Private	All	145	1.0	41	2.4
Up-West/Mtn	27+	All	All	74	0.5	40	2.3
Pacific	9	All	All	194	1.3	6	0.4
Pacific	18	Public	<\$55	100	0.7	19	1.1
Pacific	18	Public	>\$55	159	1.1	34	2
Pacific	18	Private	All	115	0.8	34	2
Pacific	27+	All	All	59	0.4	2	0.1
Total				15,121	100	1,707	100

Table A17a. Property profile survey responses in Phase II, 2016. Survey responses in 2016 were characterized by agronomic region, golf facility type, number of holes and green fees. Data was weighted to compensate for under- or overrepresentation when compared to U.S. golf course proportions, Facilities refer to a business location where golf can be played on one or more golf courses.

Property profile survey responses in Phase I, 2006

Facility description				2006 U.S. Golf Facilities		2006 Survey Response	
Region	No. holes	Type	Green fees	No.	% total	No. of responses	% of responses
Northeast	9	All	All	772	4.8	72	2.4
Northeast	18	Public	<\$55	770	4.8	97	3.3
Northeast	18	Public	>\$55	347	2.2	59	2
Northeast	18	Private	All	646	4.0	160	5.4
Northeast	27+	All	All	204	1.3	58	1.9
North Central	9	All	All	1,405	8.8	122	4.1
North Central	18	Public	<\$55	1,543	9.6	265	8.9
North Central	18	Public	>\$55	275	1.7	81	2.7
North Central	18	Private	All	551	3.4	156	5.2
North Central	27+	All	All	349	2.2	89	3
Transition	9	All	All	810	5.1	56	1.9
Transition	18	Public	<\$55	1,057	6.6	159	5.3
Transition	18	Public	>\$55	257	1.6	66	2.2
Transition	18	Private	All	621	3.9	198	6.6
Transition	27+	All	All	206	1.3	75	2.5
Southeast	9	All	All	629	3.9	31	1
Southeast	18	Public	<\$55	1,011	6.3	122	4.1
Southeast	18	Public	>\$55	387	2.4	113	3.8
Southeast	18	Private	All	766	4.8	215	7.2
Southeast	27+	All	All	423	2.6	145	4.9
Southwest	9	All	All	274	1.7	13	0.4
Southwest	18	Public	<\$55	266	1.7	37	1.2
Southwest	18	Public	>\$55	251	1.6	53	1.8
Southwest	18	Private	All	253	1.6	82	2.8
Southwest	27+	All	All	177	1.1	62	2.1
Upper West/Mtn	9	All	All	435	2.7	37	1.2
Upper West/Mtn	18	Public	<\$55	305	1.9	79	2.7
Upper West/Mtn	18	Public	>\$55	134	0.8	44	1.5
Upper West/Mtn	18	Private	All	146	0.9	49	1.6
Upper West/Mtn	27+	All	All	68	0.4	40	1.3
Pacific	9	All	All	215	1.3	18	0.6
Pacific	18	Public	<\$55	138	0.9	32	1.1
Pacific	18	Public	>\$55	108	0.7	39	1.3
Pacific	18	Private	All	126	0.8	43	1.4
Pacific	27+	All	All	65	0.4	14	0.5
Total				15,990	100	2,981	100

Table A17b. Property profile responses in Phase I, 2006. Survey responses in 2006 were characterized by agronomic region, golf facility type, number of holes and green fees. Data was weighted to compensate for under- or over-representation when compared to U.S. golf course proportions. Facilities refer to a business location where golf can be played on one or more golf courses.



1421 Research Park Drive
Lawrence, KS 66049-3859
Toll Free 800.472.7878