GCSAA

Golf Course Environmental Profile

Phase IV Volume I
Water Use and Conservation
on U.S. Golf Courses

GCSAA

WATER USE

Golf Course Superintendents Association of America

Golf Course Environmental Profile

Phase IV, Volume I

2025 Water Use and Conservation on U.S. Golf Courses

The fourth phase of the Golf Course Environmental Profile was conducted by the Golf Course Superintendents Association of America.

GCSAA

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GCEP
Water Phase IV Public Report

Statement by Board President

When the first phase of the Golf Course Environmental Profile (GCEP) was launched in 2005, the goal was to establish a baseline for environmental stewardship across the landscape of golf. One of the many metrics rightly receiving our attention was water use. Since that time, we have had three additional phases of the water survey, each providing unique insights on the management decisions made on U.S. golf courses based on performance pressures, public policy, environmental concerns and competition for other demands.

I am proud to share Phase IV of the GCSAA GCEP Water Survey. The report contains volumes of data from respondents across the country. Perhaps most importantly and of greatest interest to our members and the public, is that the report indicates that water use on golf courses in the United States has continued to trend downward over the last two decades despite ever-increasing unpredictability in water availability and significant weather events. As with past surveys, this report also shows regional results to provide additional insights into weather and other local physical and socio-economic impacts on golf course management decisions.

We believe that this positive trend is reflective of the continuous resources invested in research and education to optimize water use and maximize the sustainability of golf course operations. However, the positive trend in water-use reduction has slowed since the last survey, which means our work is not done. We need to continue to work together to find efficient ways to manage water resources while providing enjoyable conditions.

On behalf of the GCSAA Board of Directors, I want to recognize the continued efforts of the superintendents who are on the front lines of the industry's water conservation practices. I also want to thank all of those who took part in the study. This valuable information allows us to refine the focus of our work, which will lead to positive results and positive messages to policymakers and communities, which is paramount to the sustainability of our industry.

T.A. Barker, CGCS,
2025 GCSAA President

Executive Summary

Water Use and Conservation Practices is the first report in the fourth Golf Course Environmental Profiles survey series, available at www.gcsaa.org. This report offers the most current data on water management for U.S. golf courses, highlighting changes since 2005.

National Water Use

- In 2024, U.S. golf facilities used about 1.63 million acre-feet of water, representing a 31% decrease compared to 2005.
- Two-thirds of this decrease may be associated with operational efficiency improvements resulting in courses using approximately 15% less water per acre in 2024 than in 2005.
- The remaining decrease was likely related to course closures during this time.

Regional Water Use

- Water application within each region decreased in 2024 compared to 2005, with reductions ranging from 15% to 43%.
- The greatest median water volume applied, as well as applied water per acre, was recorded in region with higher average temperatures and lower average rainfall, the Southwest region.
- Approximately half of the projected total applied water (56%) was applied in the Southeast and Southwest regions.

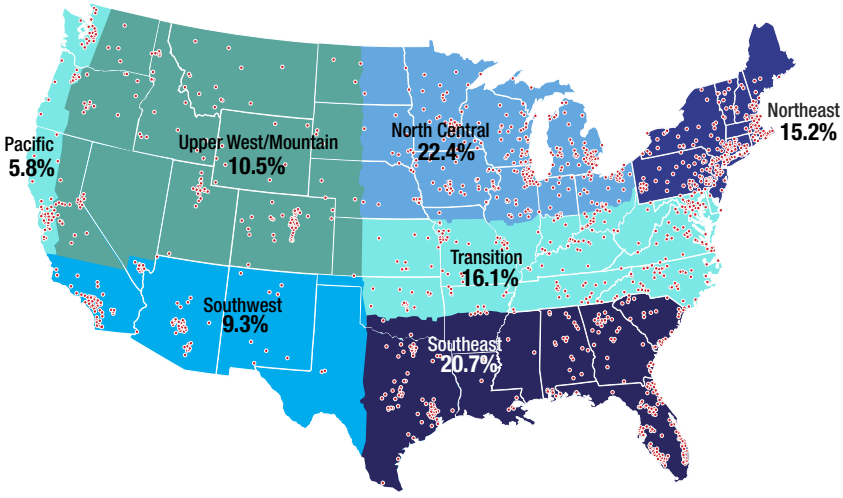


Figure 1. Agronomic regions and proportion of surveys received in 2024.

Water Sources

- In 2024, wells (32%) and lakes/ponds (27%) were the main sources of water.
- In 2024, less water from canals, municipal sources, and lakes/ponds was used than in 2005.

Irrigated Acres

- Irrigated acres at U.S. golf facilities fell 10.5% from 2005 to 2024, totaling 1.05 million acres.
- Median irrigated acres per facility rose 13% to 61.9 acres. The area of the facility that contributed to this increase is unclear. However, roughs contributed 2.2 additional irrigated acres in 2024 compared to 2005.

Management Practices

- The adoption of most best management practices has risen since 2005.
- Since 2005, wetting agents, hand-watering, and maintaining drier turf have been among the most widely implemented best management practices nationwide.

Applied Water Units – What do they mean?

Applied water is reported in three units – projected applied water in acre-feet, median applied water (in acre-feet), and median applied water (in acre-feet) per acre.

An acre-foot of water is one foot of water applied to one acre and is equal to 325,851 gallons.

Projected applied water (national and regional) is the sum product of the average amount of water applied to a 9-, 18-, or 27+-hole facility using the known number of 9-, 18-, or 27+-hole facilities within each region. It is an estimate of the total volume of applied water.

Median applied water is the median water applied to a golf facility regardless of the facility's irrigated acres. It is the amount of water where half of golf facilities apply more, and half apply less.

Median applied water per acre is the median water applied to a golf facility divided by the facility's irrigated acres. It is an estimate of the efficient use of water and allows for a commensurable comparison of applied water across facilities, regions, etc.

Introduction

- The GCEP Survey Series, launched in 2006, was designed to establish baseline data on key industry issues, from land use to the regulations and practices guiding water use, nutrient management, and pest control. The second and third series of surveys, conducted beginning in 2014 and 2020, delivered scientifically valid insights into how the industry had evolved across five core areas: energy use and environmental practices, land use and stewardship programs, pest management, nutrient use and management, and water use and conservation.
- "Benchmark" refers to a standard or point of reference used for measurement and comparison. The Golf Course Superintendents Association of America's (GCSAA) Golf Course Environmental Profile (GCEP) Survey Series—now in its fourth edition—serves as the industry benchmark, delivering in-depth data on the management practices, property characteristics, and environmental stewardship of golf courses across the United States.
- Survey results are published in Golf Course Management and in online reports at [gcsaa.org/what-we-do/environmental-stewardship/golf-course-environmental-profile](https://www.gcsaa.org/what-we-do/environmental-stewardship/golf-course-environmental-profile). The GCSAA and other golf-focused organizations frequently use this data to highlight the industry's commitment to environmental stewardship and to showcase the proactive measures golf course superintendents are implementing. In addition, GCEP survey data guides the future direction of GCSAA's environmental initiatives, informs potential research priorities, supports responses to government and public inquiries, and provides a sound foundation for commenting on proposed regulations impacting the golf industry.
- The GCEP survey results have also been published in in the peer-reviewed scientific journal Crop, Forage and Turfgrass Management (previously Applied Turfgrass Science) benefiting scientists who routinely use the survey data to guide their research direc-

Median vs. Mean

Mean = sum of all values divided by the number of values.
Median = half of all values < median < half of all values.

The mean is more influenced by extremely high or low outliers than the median and is regularly used in agricultural sciences where extremely high or low outliers are rare. The median is less influenced by extremely high or low outliers and is regularly used in survey sciences where extremely high and low outliers are common. Therefore, the use of the median in this survey provides a greater probability of reporting the true value than using the mean.

Significant Differences

Throughout this report, some tables and graphs contain letters such as a, b, or c next to numeric values. These letters indicate whether the values being compared are different. Values followed by a common letter are not different at the 90% confidence level. This means that when we state that two values are different, we are 90% confident that the true values differ.

tion and regulators who must make evidence-based decisions. The current water use survey results are published in HortTechnology.

- The objective of the Water Use and Management Practices Survey was to document water usage on U.S. golf courses in 2024 and to identify potential factors influencing water use and conservation. Data from this survey strengthens the industry benchmarking process.

Methodology

- The GCEP fourth Phase survey questions mirrored those in the prior three GCEP surveys to maintain survey continuity. Slight changes were made to the questions only to provide clarity where needed.
- Dr. Travis Shaddox, Bluegrass Art and Science, LLC, and Dr. J. Bryan Unruh, University of Florida, focused on the scientific aspects of the project including data analysis and interpretation, and writing the peer-reviewed scientific journal article and the GCSAA publications. The National Golf Foundation (NGF) provided oversight of the survey instrument programming, recruited and administered the survey, collated the data, and computed the projected water use data or the U.S. sector, as a whole. GCSAA staff worked closely with the scientists and NGF to bring the project to completion.
- Survey Distribution and Response – The link to the online survey was distributed by e-mail through the mailing lists of the NGF and the GCSAA, which sent the survey link to 13,952 golf facilities (a facility was defined as a business location where golf can be played on one or more golf courses). Each phase of the GCEP surveys target the same population, however, the respondents from 2006, 2014, 2021, and 2024 are not identical. For ease of comparison and to maintain consistency between surveys, respondents were classified using the same agronomic regions (**Figure 1**), facility type (i.e., daily fee, municipal, or private), number of holes (i.e., 9, 18, or 27+), and greens fee (i.e., < $40, $40 - $70, > $70/round).

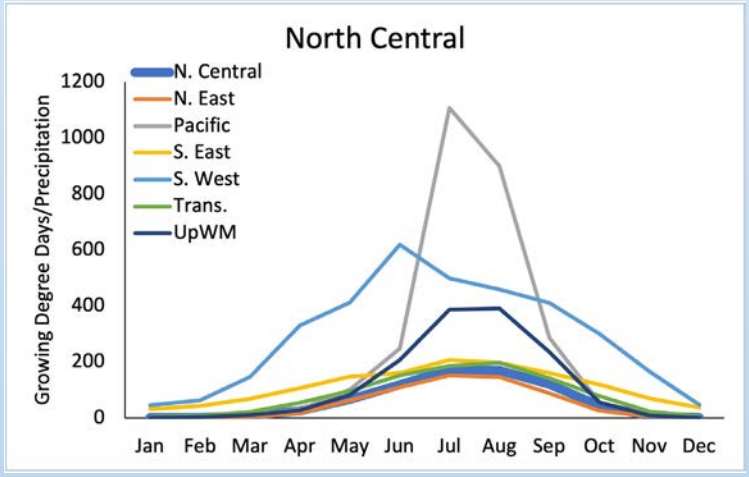
Growing Degree Days

Water, light, temperature, and nutrition are four major drivers of turfgrass growth and development. Of these, temperature is the one that exerts a major influence over most biological processes. Growing Degree Day (GDD) models are often used to quantify temperature accumulation, and many golf course superintendents use GDDs to schedule pesticide applications for weed and insect control as well as timing the application of plant growth regulators.

In its simplest form, a degree day is a measure of heat above a threshold for one day. Growing Degree Day accumulation is the total of GDDs over time. Because the amount of heat varies from one day to another, GDD accumulation provides a more accurate method for tracking the development of biological organisms (turfgrass, pests, etc.) compared to the number of calendar days since their growth and development is more a function of temperature than time.
To calculate GDDs, the daily high and low air temperatures are averaged, and the base temperature (minimum temperature at which growth initiates) is subtracted from this average. These GDDs are then added to the running total resulting in accumulated GDDs.

The usefulness of GDD models can be applied to agronomic practices other than pesticide applications. In this report, the 30-year average accumulated GDDs is divided by the 30-year average precipitation received to graphically illustrate the months of the year when temperature-driven growth may exceed rainfall amounts for the seven agronomic regions. Three regions – Pacific, Southwest, and Upper West/Mountain – reveal a greater magnitude of water need as evidenced by the taller curves on the graph. The taller curves suggest that temperature-driven growth is increasing at a greater rate than precipitation. The resultant effect is a greater need for supplemental irrigation. Conversely, the North Central, Northeast, Southeast, and Transition regions have relatively flat curves suggesting that the increased temperature during summer months is more closely accompanied by precipitation which, in turn, results in less supplemental irrigation required to sustain acceptable turfgrass.

All modeling tools, including GDDs, have limitations and do not always account for other factors that influence plant growth and development. For example, the Southeast region usually receives adequate precipitation throughout the year, yet drought-stricken turf may be observed. In some cases, the limiting factor is not precipitation or high heat, it may be sandy soils with low water-holding capacity. The resultant effect is a greater need for supplemental irrigation.



- The survey, promoted on social media platforms and by GCSAA staff, was available for completion for six consecutive weeks beginning on February 26, 2025. Seven email reminders were sent to encourage survey participation and/or completion by those who had started but not finished. Respondent names were omitted from the data file and each respondent received a unique identifying number, which provided anonymity within the data file and only one response was allowed per golf course.
- Survey responses were received from 1687 facilities representing 12.1% of the U.S. total (**Table 40**). By comparison, the response rates for the 2021, 2014, and 2006 survey were 11.1%, 12.7% and 15.2% respectively.
- Data Analysis – Survey data were downloaded from the survey software and aligned with water use survey data from GCEP Phases 1, 2, and 3 surveys. Prior years' data were analyzed with data from the 2024 survey allowing for statistical comparisons between years.
- Data were weighted to provide a valid representation of U.S. golf courses and were analyzed using appropriate statistical procedures. Projected water use and irrigated acres were determined by calculating the sum product of the regional water use means with the respective number of golf facilities in each region. As a result, statistical separation of projected water use and irrigated acres was not conducted.
- Statistical procedures evolve and change over time. Consequently, water use and acreage data from 2024 and 2021 were analyzed using methodology different from 2014 and 2006, which resulted in minor numeric deviations.
- In the current and prior surveys, respondents were asked if they reported water use by using a water meter, estimation, or both. As with the prior surveys, responses based solely on estimated water use were omitted from water use analysis along with variables that included water use, such as water use per acre.
- To contextualize water use between 2006 and 2024, each region was categorized into drought severity levels using the U.S Drought Monitor classification (National Drought Mitigation Center, 2025). Data for the weekly drought severity level for each county in 2020 and 2024 were pooled by U.S. regions. Additional meteorological data were collected from an online database (National Oceanic and Atmospheric Administration, 2022) and grouped into agronomic regions using the latitude and longitude of each collection station. Degree days were determined using a base temperature of 50 °F and calculated using a parametric method (Thom, 1966) described by Arguez et al. (2012).
- To determine if the percentage of respondents engaged in management practices changed over time, years were paired, and differences between all pair-wise comparisons were determined.

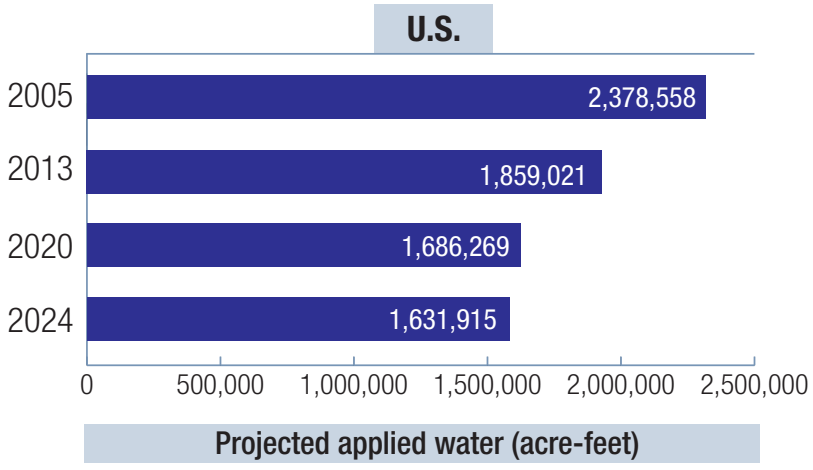


Figure 2. Projected water applied on U.S. golf facilities in 2005, 2013, 2020, and 2024. Ref: Table 1

Water Use

- A projected 1.63 million acre-feet of water was applied to U.S. golf facilities in 2024. This represents a 3.2% reduction of applied water since 2020, a 12.2% reduction since 2013, and a 31.2% reduction since 2005 (**Figure 2 and Table 1**).
- Median applied water per U.S. golf facility in 2024 was 68.9 acre-feet, which was 20.6% less than that reported in 2005 and not significantly different to 2013 and 2020 (**Figure 3 and Table 2**).
- Median acre-feet per acre of applied water per U.S. golf facility in 2024 was 1.1, which was 15.4% less than that reported in 2005. Similar to acre-feet, the acre-feet per acre was also similar to that reported in 2013 and 2020 (**Figure 4 and Table 2**).
- Combined, the Southwest and Southeast regions accounted for 56% of the total applied water in the U.S. in 2024 (**Figure 10**), which was comparable

to 2005, 2013, and 2020. This is not surprising as the very dry Southwest requires more water than other regions and the Southeast is home to over 20% of the golf facilities in the country.

- Water Sources
- Since 2005, a reduction in projected applied water was measured within each water source (**Table 12**).
- Generally, the percentage of water applied from canal, river, municipal, or well sources remained unchanged since 2005. The percentage of water applied from lakes and ponds declined and the percentage of water applied from recycled water increased since 2005. (**Figure 5**).
- Wells and lakes and ponds supplied 59% of the applied water in 2024, whereas wells and lakes and ponds supplied 63% of the applied water in 2005 (**Figure 5**).
- The percentage of golf facilities applying recycled water increased from 10.8% in 2005 to 13.7% in 2024 and was equivalent to 2013 and 2020 (**Figure 6 and Table 3**).
- The projected quantity of recycled water applied to U.S. golf facilities in 2024 was 296,454 acre-feet and was 15.7% less than that applied in 2005 (**Figure 7 and Table 3**).
- The top reason why some U.S. golf facilities did not use recycled water was that there was no source of efflu-

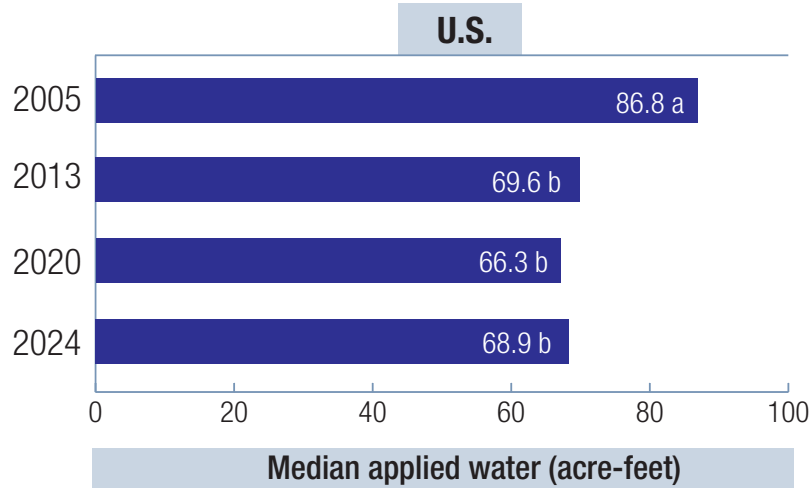


Figure 3. Median acre-feet of applied water on U.S. golf facilities in 2005, 2013, 2020, and 2024. Ref: Table 2

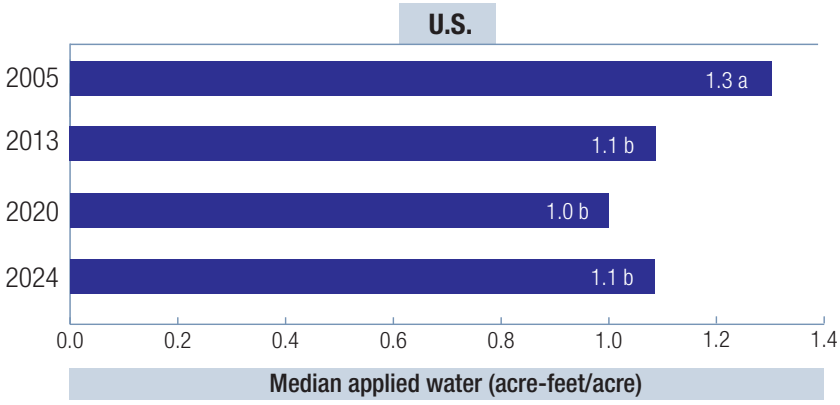


Figure 4. Median acre-feet/acre of applied water on U.S. golf facilities in 2005, 2013, 2020, and 2024. Ref: Table 2

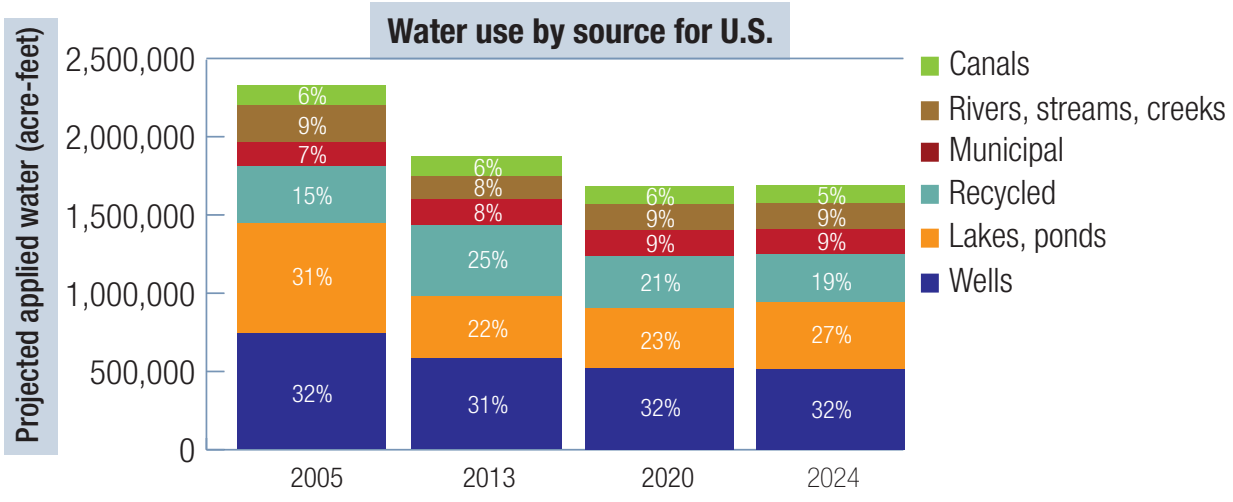


Figure 5. Projected water applied on U.S. golf facilities and percentage of water applied from wells; lakes, ponds; recycled; municipal; rivers, streams, creeks, and canals in 2005, 2013, 2020, and 2024. Ref: Table 5

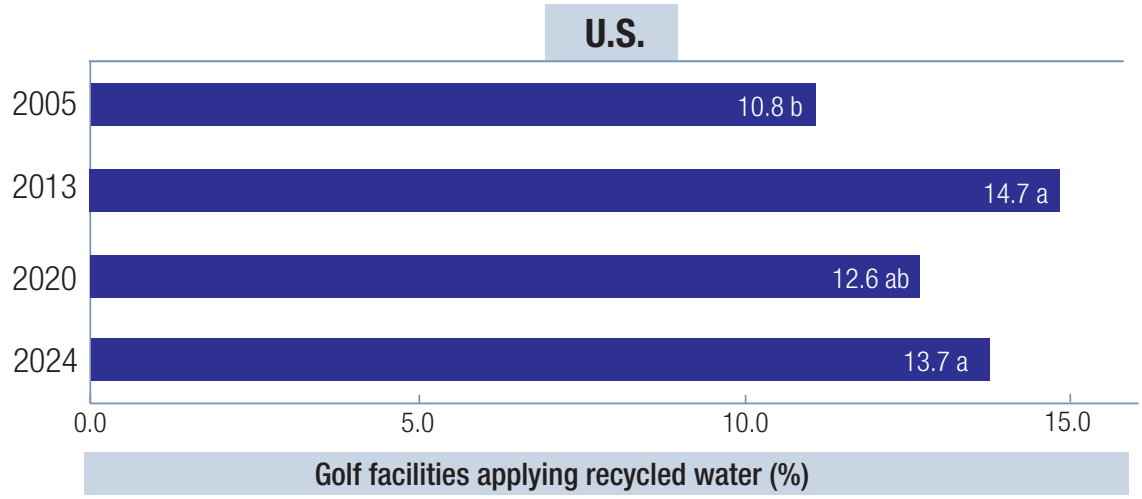


Figure 6. Percent of U.S. golf facilities applying recycled water in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the chi-square test at the 10% significance level. Ref: Table 3

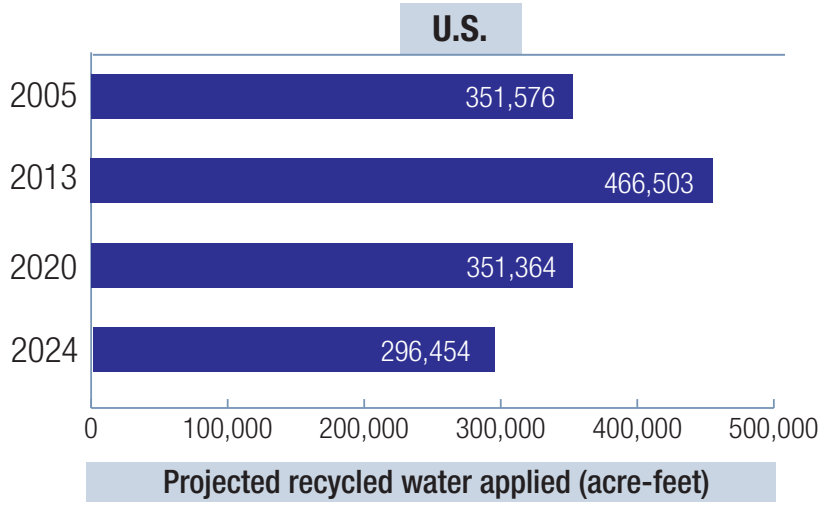


Figure 7. Projected recycled water applied to U.S. golf facilities in 2005, 2013, 2020, and 2024. Ref: Table 3

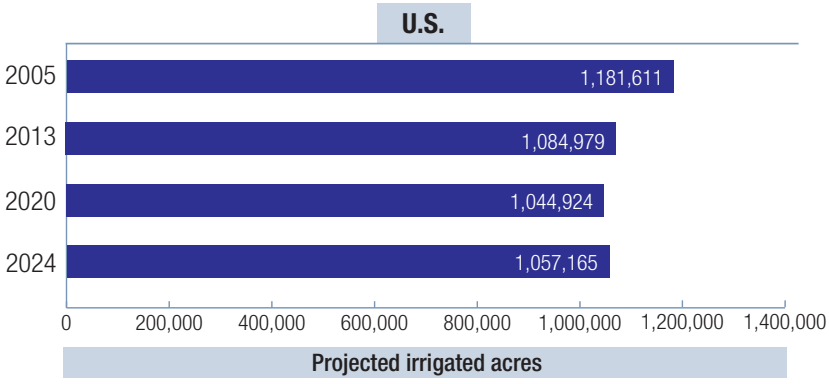


Figure 8. Projected irrigated acres of U.S. golf facilities in 2005, 2013, 2020, and 2024. Ref: Table 4

ent water (55%), recycled water was unnecessary given other available water sources (28%), or there was no infrastructure to deliver the recycled water (12%) (**Table 13**).

- Water scarcity and cost were not major concerns nationally with 45% and 49% of respondents, respectively, stating they were not worried about either at this time . The remainder of the respondents provided responses spread across an incrementally increasing scale of 2-5 points indicating that water scarcity and cost played some role in their consideration of managing water resources. The southwest region scored notably higher in its responses as to the role that water scarcity and cost played in water management decisions.(**Table 14**).

Irrigated Acres

In 2024, the projected irrigated acres of U.S. golf facilities was 1.06 million, representing a 10.5% decrease compared to 2005 (**Figure 8 and Table 4**).

The median irrigated acreage at U.S. golf facilities was 61.9 acres, representing a 13.2% increase compared to 2005 and a 1.6% rise since 2020. While the median irrigated acres of greens and tees have grown since 2005, irrigated fairway acreage has decreased by 9.2%. (**Figure 9 and Table 15**).

Facility Influence

- The total number of U.S. golf facili-

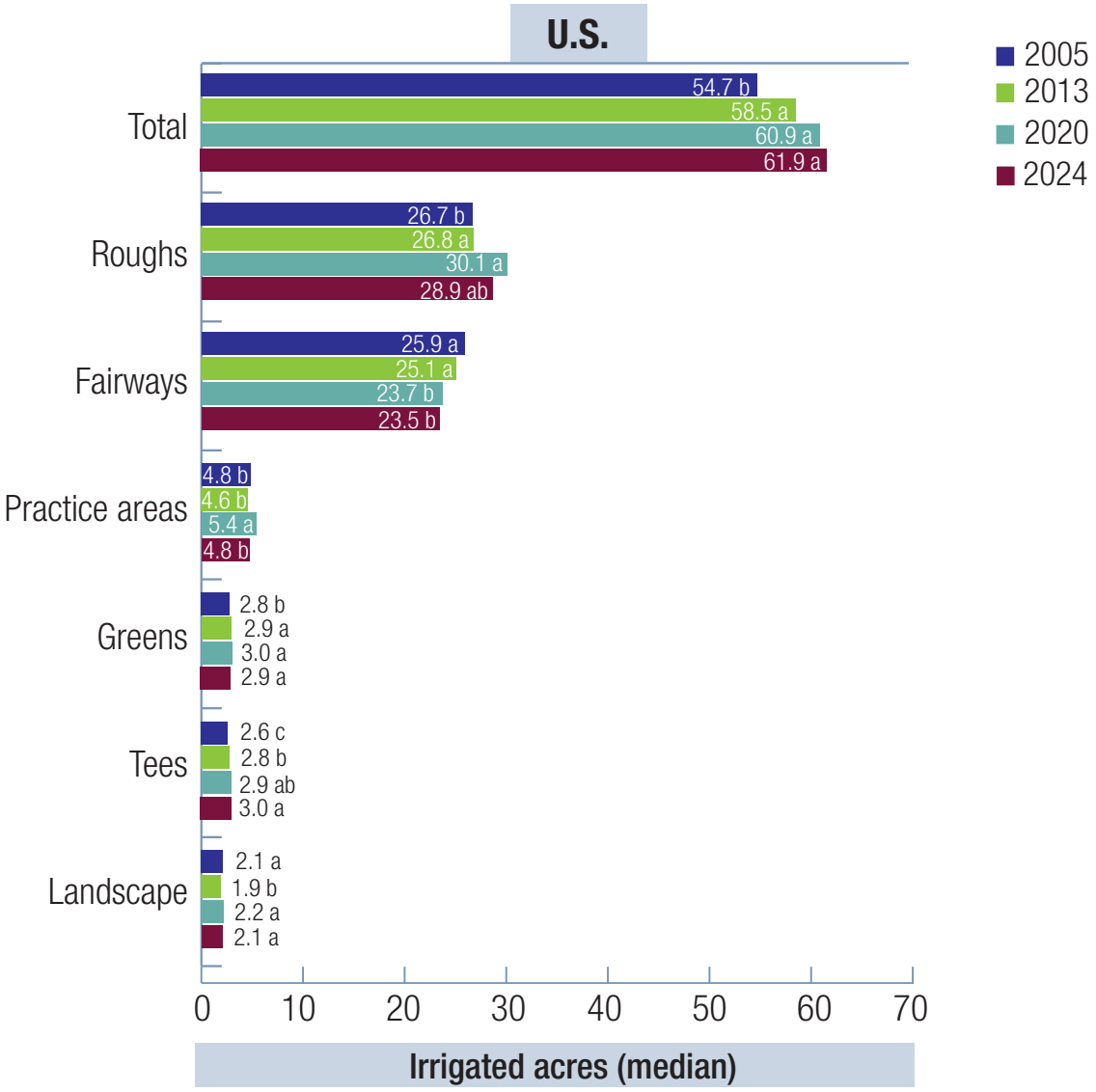


Figure 9. Median irrigated acres of roughs, fairways, practice areas, greens, tees, landscape, and total of U.S. golf facilities in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 8

ties was 13,952, representing a 13.1% decrease since 2005 (**Table 16**).

- Since 2005, facility closures have resulted in a reduction of 252,768 acre-feet of applied water, representing about one-third of the total applied water reduction during this period (Table 1 and Table 16).
- Both public and private facilities reduced applied water per acre by 15.4% since 2005, but levels have remained constant since 2013 (**Table 17**).
- In 2024, operational golf facilities had 3,172 fewer irrigated acres and used 12,128 fewer acre-feet of water compared to 2005 (**Table 19**).

- Management Practices
- The use of most water management practices has become more frequent since 2005 (**Table 18**).
- Since 2020, there has been an increase in the use of hand-held moisture sensors, adjustments to irrigation scheduling, and the frequency of irrigation audits (**Table 18**) as well as using Evapotranspiration (ET) data from onsite weather stations (**Table 20**).
- Since 2005 and 2020, irrigation system components have been upgraded with new nozzles, software, and master controllers (**Table 20**).

Regulations

- Since 2005, required water use reporting rose from 48.4% to 57.5%, annual allocations increased from 21.7% to 28.7%, and mandatory water restrictions dropped from 15.8% to 12.1% (**Table 21**).
- In 2024, the development of formalized drought, water, stormwater, and preventative irrigation management plans was not widespread (**Table 22**). However, most facilities with a written plan (excluding stormwater) have one voluntarily, without a mandate.

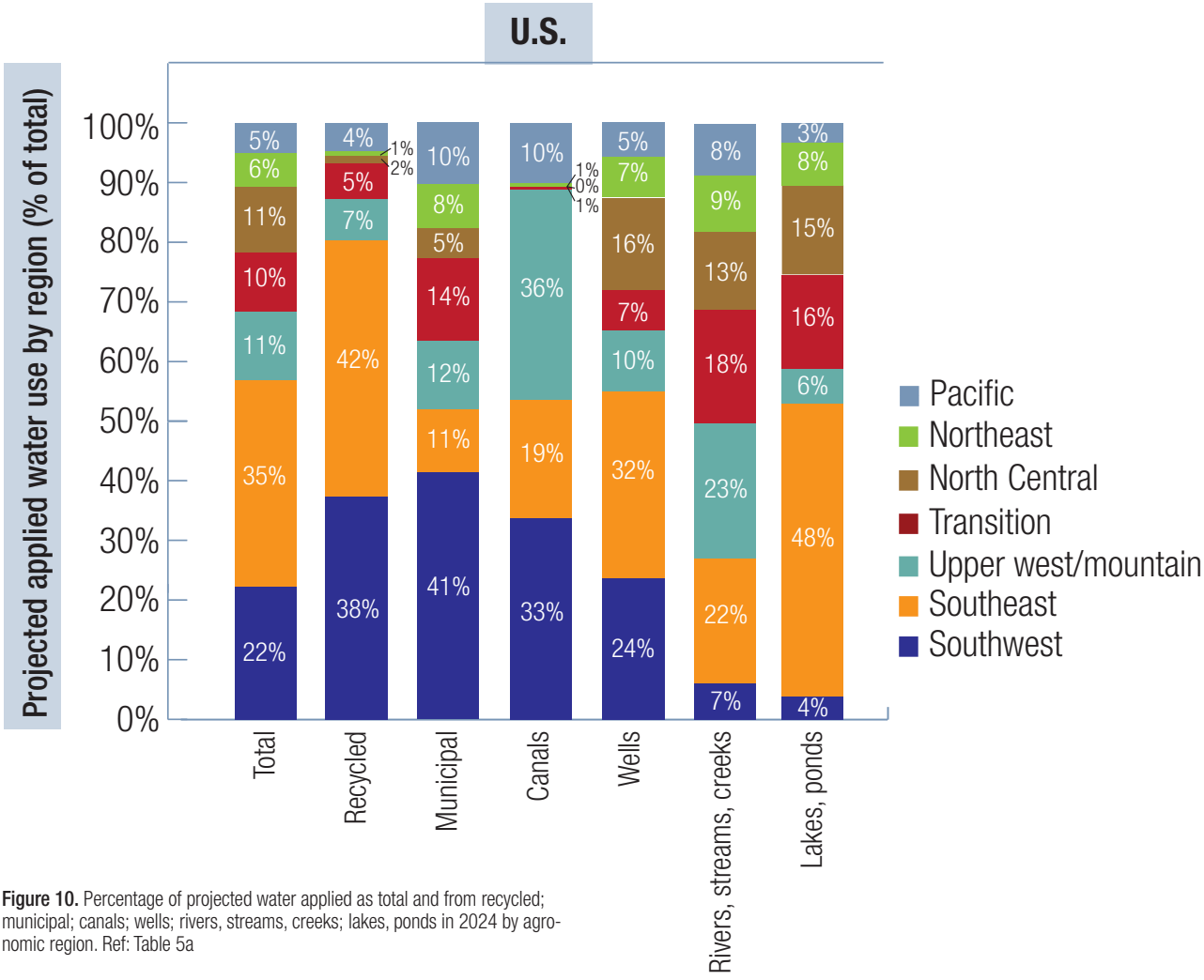


Figure 10. Percentage of projected water applied as total and from recycled; municipal; canals; wells; rivers, streams, creeks; lakes, ponds in 2024 by agronomic region. Ref: Table 5a

Miscellaneous

- 93% of facilities reported soil moisture sensors had a positive impact on operations (**Table 23**).
- 64% of facilities that reduced irrigated acres did so for water conservation (**Table 24**).
- 89% of facilities reporting reduced water use said golfers were receptive (score 3–5) to changes in course appearance (**Table 25**).
- The majority of golf course superintendents report that they conduct irrigation distribution uniformity audits on their golf courses (**Table 26**)
- Wetting agents (33%) and nutrients (13%) were the most common treatments used for irrigation injection (**Table 27**).
- Water Testing
- 90% of facilities had surface water and 39% of those facilities tested their surface water in 2024, which was equivalent to 2008 (**Table 28**).
- 59% of facilities that tested surface water conducted tests at least once per year (**Table 29**).
- Among the facilities that tested surface water, 85% maintained at least one designated monitoring site (**Table 30**).
- Nutrient testing was the most common test conducted (81%) by facilities that tested surface water (**Table 31**).
- 56% of facilities had ground water wells and 43% of those facilities tested their ground water in 2024. The frequency of ground water testing declined since 2008 (**Table 32**).
- Of the facilities that tested ground water, 99% had at least one dedicated monitoring site (**Table 33**), and 88% had protected ground water wells (**Table 34**).
- 45% of facilities that tested ground water tested their water once per year, whereas the remaining facilities tested their ground water more frequently (**Table 35**).
- Nutrient testing was the most common test conducted (66%) by facilities that tested ground water (**Table 36**).
- 50% of facilities that tested ground water did not have a dedicated ground water monitoring site (**Table 37**).

Budget Influence

Golf facilities with annual budgets exceeding $250,000 reported applying fewer acre feet of water in 2024 compared to 2005, while those with budgets below $250,000 indicated no change in the amount of water applied (**Table 38**).

Nine-hole facilities, which tend to have lower maintenance budgets, used the least water, irrigated the fewest acres, and had the lowest water use per acre compared to 18- and 27+-hole facilities in 2005, 2013, 2020, and 2024 (**Table 39**).

Table 1. Projected water applied to U.S. golf courses in 2005, 2013, 2020, and 2024.

	2005	2013	2020	2024	Δ 2005-2024	Δ 2013-2024	Δ 2020-2024
Region	acre-feet				%		
U.S.	2,378,558	1,859,021	1,686,269	1,631,915	-31.4	-12.2	-3.2
North Central	266,575	198,041	183,867	190,924	-28.4	-3.6	3.8
Northeast	116,930	94,194	95,843	99,112	-15.2	5.2	3.4
Pacific	107,811	107,185	72,498	76,271	-29.3	-28.8	5.2
Southeast	904,234	548,524	491,689	515,230	-43.0	-6.1	4.8
Southwest	531,189	532,149	487,332	405,211	-23.7	-23.9	-16.9
Transition	243,034	181,379	158,913	164,257	-32.4	-9.4	3.4
Upper West/ Mountain	208,785	197,548	196,126	180,909	-13.4	-8.4	-7.8

Table 2. Median applied water and applied water per acre on U.S. golf courses by agronomic regions in 2005, 2013, 2020, and 2024.

Year	U.S.	NC	NE	Pac.	SE	SW	Trans.	UWM
	acre-feet							
2005	86.8 a	52.0 a	32.7 a	114.8 a	194.8 a	372.4 a	60.3 a	178.1 a
2013	69.6 b	35.7 b	27.3 a	123.8 a	127.5 bc	358.3 a	44.0 bc	170.6 a
2020	66.3 b	40.5 b	29.0 a	68.4 b	111.1 c	375.7 a	38.5 c	163.2 a
2024	68.9 b	40.0 b	31.3 a	97.3 ab	145.8 b	300.3 a	53.9 ab	143.5 a
	acre-feet/acre							
2005	1.3 a	0.9 a	0.7 a	1.7 a	2.0 a	3.4 a	1.0 a	2.1 a
2013	1.1 b	0.8 b	0.6 a	1.7 a	1.4 bc	3.8 a	0.7 b	2.0 a
2020	1.0 b	0.8 b	0.6 a	1.1 b	1.2 c	4.2 a	0.6 b	2.1 a
2024	1.1 b	0.9 ab	0.7 a	1.4 ab	1.7 ab	3.3 a	0.7 b	1.9 a

Note. NC=North Central, NE=Northeast, Pac.=Pacific, SE=Southeast, SW=Southwest, Trans.=Transition, and UWM=Upper West/ Mountain. Within columns, medians followed by a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level.

Table 3. Frequency of U.S. golf facilities applying recycled water and projected recycled water applied in 2005, 2013, 2020, and 2024.

	Facilities Applying Recycled Water				Projected Recycled Water Applied						
	2005	2013	2020	2024	2005	2013	2020	2024	Δ 2005-2024	Δ 2013-2024	Δ 2020-2024
Region	%				acre-feet						
U.S.	10.8 b	14.7 a	12.6 c	13.7 ab	351,576	466,503	351,364	296,454	-55,122	-170,049	-54,910
North Central	3.5 a	6.5 a	0.8 a	4.0	3,509	9,045	1,675	6,952	3,443	-2,093	5,277
Northeast	3.5 a	1.5 b	2.6 ab	3.1 ab	2,082	2,219	1,898	2,241	159	22	343
Pacific	12.5 a	21.5 a	16.5 a	24.8 a	10,253	24,975	7,858	13,124	2,871	-11,851	5,266
Southeast	23.5 a	28.6 a	27.2 a	27.3 a	145,611	192,849	139,733	125,855	-19,756	-66,994	-13,878
Southwest	33.5 b	44.3 a	39.9 ab	34.2 ab	151,653	193,394	164,937	113,657	-37,996	-79,737	-51,280
Transition	5.3 b	6.4 ab	8.6 ab	10.3 a	12,682	18,856	15,330	14,769	2,087	-4,087	-561
Upper West/ Mountain	14.6 a	17.8 a	12.1 a	15.0 a	25,786	25,165	19,933	19,855	-5,931	-5,310	-78

Note. Within a row, values followed by a common letter are not significantly different according to the chi-square test at the 10% significance level.

Table 4. Projected irrigated acres of U.S. golf courses in 2005, 2013, 2020, and 2024.

	2005	2013	2020	2024
	acres			
U.S.	1,181,611	1,084,979	1,044,924	1,057,165
North Central	242,483	210,340	213,282	209,077
Northeast	136,252	131,570	139,952	133,493
Pacific	52,249	48,083	44,529	47,722
Southeast	319,600	286,439	271,760	272,729
Southwest	136,321	125,462	107,006	111,164
Transition	203,124	193,217	177,266	191,106
Upper West/Mountain	91,582	89,868	91,130	91,874
Golf Holes				
9	122,667	116,443	106,395	117,576
18	810,667	766,343	739,458	732,966
27+	248,278	202,193	199,071	206,622

Irrigation Audits and Efficiency (Table 26)

Irrigation distribution uniformity is a common efficiency irrigation test related to the distribution and/or pattern of water on a golf course feature. This is not a test where 100% is realistic but helps with water management in light of constant improvement. For all courses that conducted irrigation audits across the region's values range:

- Overall - U.S. average was 84% ranging from 96% in the Transition to 68% in the Upper West/Mountain regions.
- Fairways - U.S. average was 64% ranging from 76% in the Southwest to 31% in the Transition regions.
- Tees - U.S. average was 52% ranging from 71% in the Southwest to 29% in the Transition regions.
- Greens - U.S. average was 63% ranging from 77% in the Northeast to 45% in the Southeast regions.

Regional Summary

Water Use

- All regions have reported lower projected applied water since 2005 (**Table 1**).
- Since 2005, the Southeast has experienced the largest percentage and total decrease in projected applied water (**Table 1**).
- From 2020 to 2024, a decline in projected applied water was reported by the Southwest and Upper West/Mountain regions, which experienced a reduction of 16.9% and 7.8%, respectively (**Table 1**).
- The Southwest, a region characterized by low rainfall and/or high temperatures, reported abouttwo times as much or more applied water and applied water per acre compared to other regions (**Table 2**).

Water Sources

- In 2024, recycled water facility use matched 2005 levels in all regions except the Transition region, which increased from 5.3% to 10.3% (**Table 3**).
- In 2024, the Southeast, Southwest, and Upper West/Mountain regions used less recycled water compared to 2005, while the North Central, Northeast, Pacific, and Transition regions saw an increase in recycled water usage (**Table 3**).

- In 2024, the Southwest and Southeast regions represented 80% of recycled water usage and accounted for 56% of well water application (**Figure 10**).
- In 2024, U.S. golf facilities commonly cited lack of available recycled water as the main reason for not using it, followed by it being unnecessary or a lack of required infrastructure (**Table 13**).
- Most respondents did not identify water scarcity as a concern in any region except the Southwest, where 11% indicated no concern and over 23% considered it a major issue (**Table 14**). Most respondents did not consider water cost an issue, except in the Pacific and Southwest regions.
- In 2024, 41% of municipal water use occurred in the Southwest region (**Figure 10**).

Irrigated Acres

- The projected number of irrigated acres decreased from 2005 to 2024 in all regions, with the exception of the Upper West/Mountain region, where the level remained approximately unchanged compared to 2005 (**Table 4**).
- Irrigated acres at 9-, 18-, and 27+-hole facilities decreased between 2005 and 2024 (**Table 4**).
- The Southwest and Southeast had the highest median irrigated acres—87.5 and 90.9—exceeding the national median by 141% and 146% (**Table 15**).
- The number of irrigated rough acres in the Pacific region has increased since 2005, while levels have remained constant in other regions (**Table 15**).
- Since 2005, irrigated fairway acres have decreased in the North Central, Southeast, and Upper West/Mountain regions, with no change elsewhere (**Table 15**).
- Since 2005, irrigated practice acres rose in the Southeast and Upper West/Mountain, with no change elsewhere (**Table 15**).
- Since 2005, irrigated green acres have increased in the North Central, Northeast, and Pacific regions and have remained unchanged in other regions (**Table 15**).
- Since 2005, irrigated tee acres have risen in the North Central, Pacific, and Transition regions, but stayed the same elsewhere (**Table 15**).
- Irrigated landscape acres remained unchanged in each region since 2005 (**Table 15**).

Management Practices

- The most common water management practices in each region were the use of wetting agents, hand-watering, and keeping turf drier than in the past (**Table 18**).

Regulations

- Water use reporting increased in the Northeast, Pacific, and Transition regions, but remained unchanged in other regions since 2005 (**Table 21**).
- Responders note an increase in required water use reporting occurred in the Pacific region and a decrease occurred in the Upper West/Mountain region (**Table 21**).
- 28% of the U.S. facilities have drought plans with the Southwest reporting the greatest percentage at 35% and the Pacific and North Central reporting the least at 23%.
  - Nearly 17% of the U.S. facilities have water management plans, while 31% of facilities in the Northeast have them. Other regions are lower.
  - 17% of U.S. facilities have a stormwater plan, while 35% of the facilities in the Southwest have them. Other regions are lower.
  - 21% of U.S. facilities have preventive irrigation maintenance plans while, 44% the Southwest region facilities have them. Other regions are lower.
  - The majority of facilities in each region do not typically have written drought, water, stormwater, or preventative irrigation management plans (**Table 22**).
- Facilities within each region consistently reported (>90%) a somewhat or very positive impact resulting from the use of soil moisture sensors (**Table 23**).
- Among facilities that reduced irrigated acres, water conservation was the most common reported reason. The percentage ranged from 85% in the Upper West/Mountain to 54% in the Southeast region (**Table 24**).

Course Closures

- Since 2005, course closures were greatest in the North Central (589) followed by the Southeast (546) and the Transition (471) (**Table 16**). The greatest water reduction resulting from course closure was reported in the Southeast (104,929 acre-feet).

Miscellaneous

- Facilities within each region reported that golfers were consistently receptive to any perceived changes in course appearance resulting from a reduction in applied water (**Table 25**). Receptiveness ranged from 84% to 97% in the Southwest and Upper West/Mountain regions, respectively.
- Wetting agents were the most common irrigation injection treatment within each region ranging from 26% to 51% of facilities. Generally, nutrients were the second most common injection treatment followed by acid injection (**Table 27**).

Water Testing

- The prevalence of facilities that had surface water declined since 2008 in the North Central region but remained the same in each remaining region (**Table 28**). The prevalence of facilities that had surface water and tested their surface water declined since 2008 in the Southwest region to 46% of facilities, whereas frequency increased in the Transition region to 51%.
- In 2024, surface water testing was most common in the Transition (51%) and least common in the North Central (25%) (**Table 28**).
- 58% or more of golf facilities that tested their surface water did so at least once per year with 28% of facilities in the Southwest testing their surface water monthly (**Table 29**).
- Of the golf facilities that had surface water and tested their surface water, the most frequent number of surface water monitoring sites was one (**Table 30**).
- In general, the most common variable tested in surface water within each

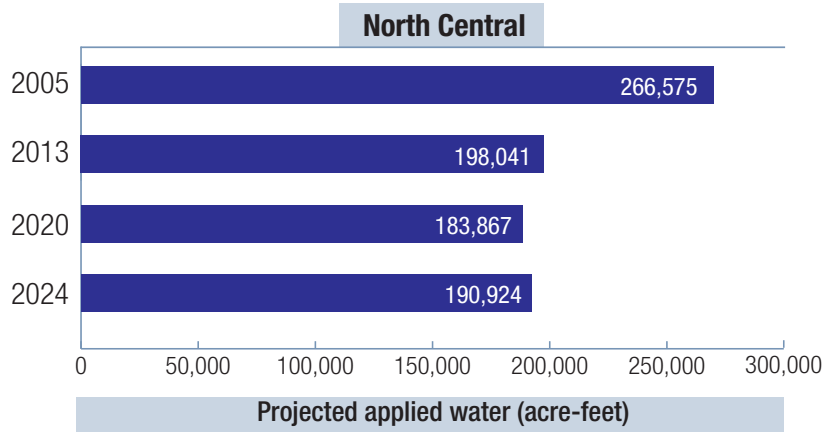


Figure 11. Projected water applied to U.S. golf facilities in the North Central region in 2005, 2013, 2020, and 2024. Ref: Table 1

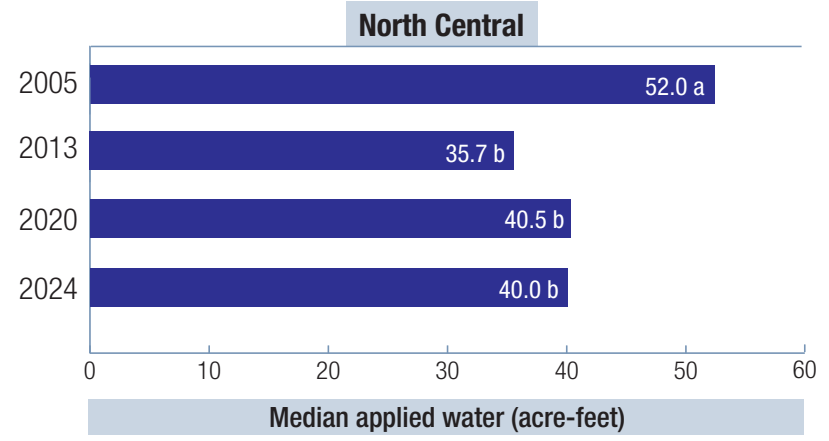


Figure 12. Median acre-feet of applied water on U.S. golf facilities in the North Central region in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 2

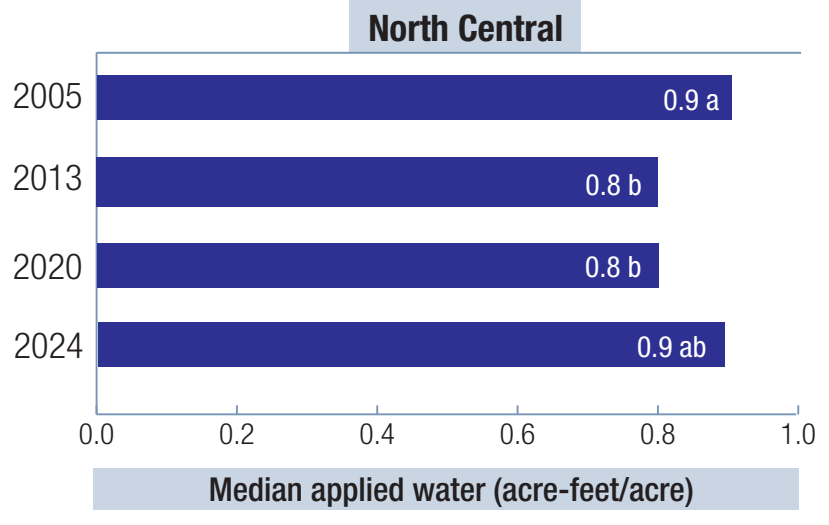


Figure 13. Median acre-feet per acre of applied water on U.S. golf facilities in the North Central region in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 2

region was nutrients followed by oxygen and bacteria (**Table 31**).

- The prevalence of ground water wells declined since 2008 both nationally and within the North Central and Northeast regions, whereas other regions remained unchanged (**Table 32**). The prevalence of facilities that had ground water wells and tested their ground water declined since 2008 within each region except for the Southeast, Southwest, and the Upper West/Mountain regions, which did not change since 2008. Facilities that tested ground water ranged from 34% in the Pacific to 59% in the Southwest.
- Of the golf facilities that had ground water wells and tested their ground water, the most frequent number of ground water monitoring sites (**Table 33**) and protected ground water wells was one (**Table 34**).
- Between 36% and 67% of facilities that test ground water tested their ground water at least once per year (**Table 35**).
- Generally, the most common variable tested in ground water within each region was nutrients followed by bacteria (**Table 36**).
- The majority of facilities that tested ground water in 2024 did not have dedicated ground water monitoring sites except the Southwest where 60% of facilities had at least 1 (**Table 37**).

North Central Region

Water Use

- Projected applied water was 28% less in 2024 than in 2005, resulting in a water savings of 75,651acre-feet (**Figure 11**).
- Median applied water per facility declined from 52.0 acre-feet in 2005 to 40.0 acre-feet in 2024, a 23% reduction (**Figure 12**).
- Median applied water per acre in 2024 was equivalent to that in 2005 at 0.9 acre-feet/acre (**Figure 13**).

Water Sources

- In 2024, projected applied water sourced from lakes and ponds fell slightly to 64,353 acre-feet whereas

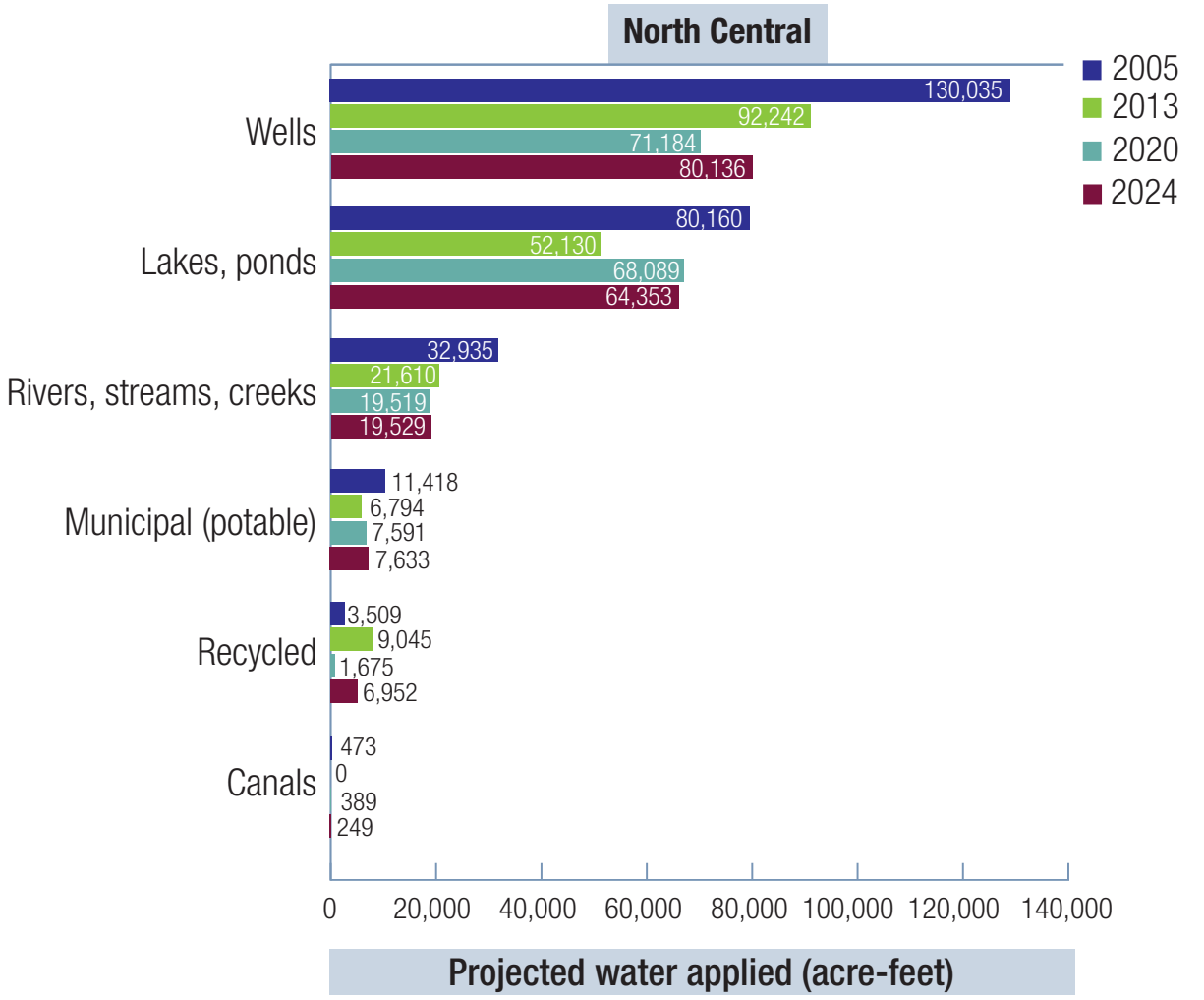


Figure 14. Projected water applied at U.S. golf facilities in the North Central region by water source in 2005, 2013, 2020, and 2024. Ref: Table 5

80,136 acre-feet was sourced from wells, a 13% increase over 2020 (**Figure 14**).

- In 2024, 1% of projected applied water was sourced from recycled water (**Figure 14**).
- The percentage of facilities using recycled water in 2024 was equivalent to 2005 at approximately 4.0% (**Figure 15**).
- Projected recycled water applied increased from 3,509 acre-feet in 2005 to 6,952 acre-feet in 2024 (**Figure 16**).

Irrigated Acres

- Projected irrigated acres declined by 14% from 242,483 acres in 2005 to 209,077 acres in 2024. Irrigated acres have remained static since 2013 (**Figure 17**).
- Since 2005, irrigated acres at 9-, 18-, and 27+-hole facilities declined by 35%, 5%, and 27%, respectively (**Figure 17**).
- Median irrigated acres in 2024 (42.6) remained equivalent to 2005 (41.4) (**Figure 18 and Table 15**).
- Median irrigated acres of roughs, fairways, practice areas, and landscape did not change since 2005, but the median irrigated acres of greens and tees increased about12% since 2005 (**Figure 18 and Table 15**).

Facility Influence

- Operational golf facilities in the North Central Region declined since 2005 by 14% to 3,538, but has remained fairly static since 2020 (**Table 16**).

Management Practices

- The frequency of most management practices increased since 2005, notably: using wetting agents, hand-watering, keeping turf drier, reducing irrigated acres, pruning tree roots, using rain shut off switches, and changing to drought-tolerant turfgrass (**Table 18**).

Regulations

- Required water use reporting remains at 68%, recurring annual allocations increased to 23%, and additional mandatory water restrictions was 6% and was equivalent to 2005 (**Table 21**).
- The prevalence of facilities that have a written drought, water management, stormwater, or preventative irrigation maintenance plan was 23%, 6%, 9%, and 14%, respectively (**Table 22**).

Miscellaneous

- The use of soil moisture sensors had

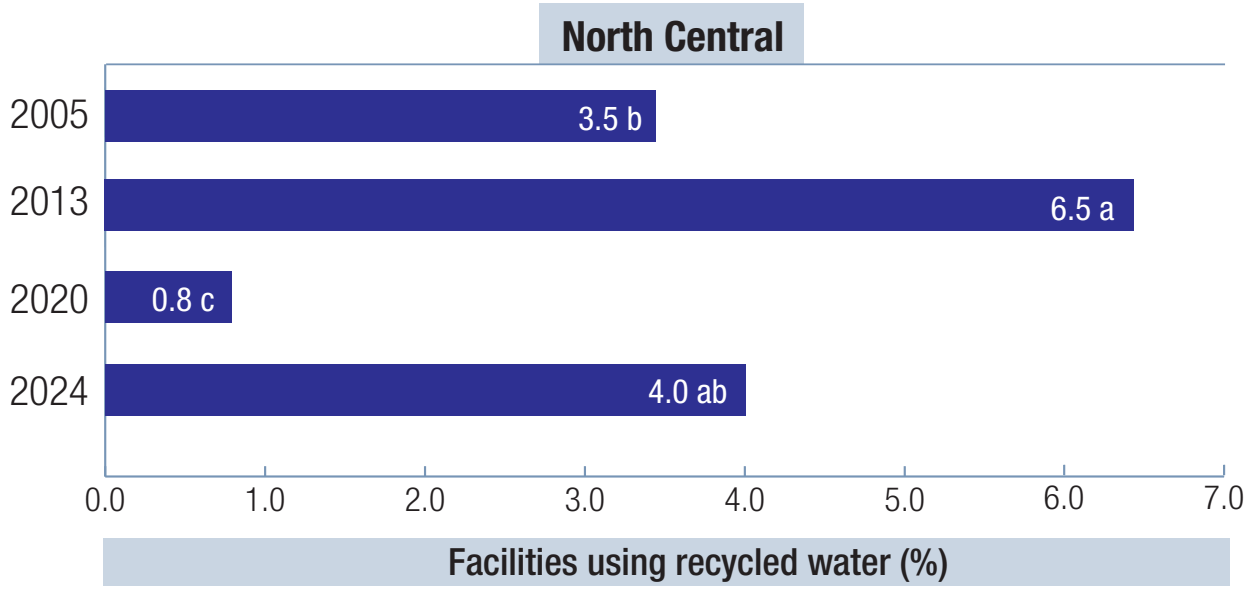


Figure 15. Percent of U.S. golf facilities in the North Central region applying recycled water in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the chi-square test at the 10% significance level. Ref: Table 3

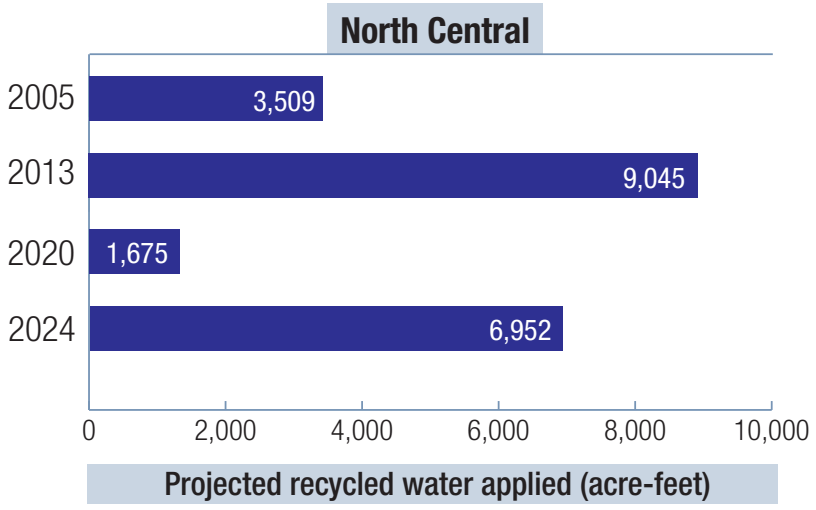


Figure 16. Projected recycled water applied to U.S. golf facilities in the North Central region in 2005, 2013, 2020, and 2024. Ref: Table 3

a somewhat positive or very positive impact on 91% of facilities in 2024 (**Table 23**).

- Water conservation was the most common factor (61%) motivating the decision to reduce irrigated acres (**Table 24**).
- 85% of golfers were receptive to any perceived change in course appearance resulting from a reduction of applied water (**Table 25**).
- The most common irrigation injection treatment was wetting agents used at 28% of facilities (**Table 27**).

Water Testing

- The prevalence of facilities that had surface water and that tested their surface water were 88% and 25%, respectively, and has not changed since 2005 (**Table 28**).
- Among facilities that tested surface water, 67% tested once per year with the remaining facilities testing more frequently (**Table 29**).
- Among facilities that tested surface water, 78% had 1 or more surface water monitoring sites (**Table 30**).
- Among facilities that tested surface water, 86% tested for nutrients, which was the most common variable tested (**Table 31**).
- The prevalence of facilities that had ground water wells and that tested their ground water both declined since 2005 to 67% and 38%, respectively (**Table 32**).
- Among facilities that tested ground water, 99% had 1 or more ground water monitoring sites (**Table 33**).
- Among facilities that tested ground water, 91% had 1 or more protected ground water wells (**Table 34**).
- Among facilities that tested ground water, 41% tested once per year with the remaining facilities testing more frequently (**Table 35**).
- Among facilities that tested ground water, 65% tested for nutrients, whereas 60% tested for bacteria, which were the most common and second most common variables tested (**Table 36**).
- Among facilities that tested ground water, 40% had 1 or more dedicated ground water monitoring sites in 2024 (**Table 37**).

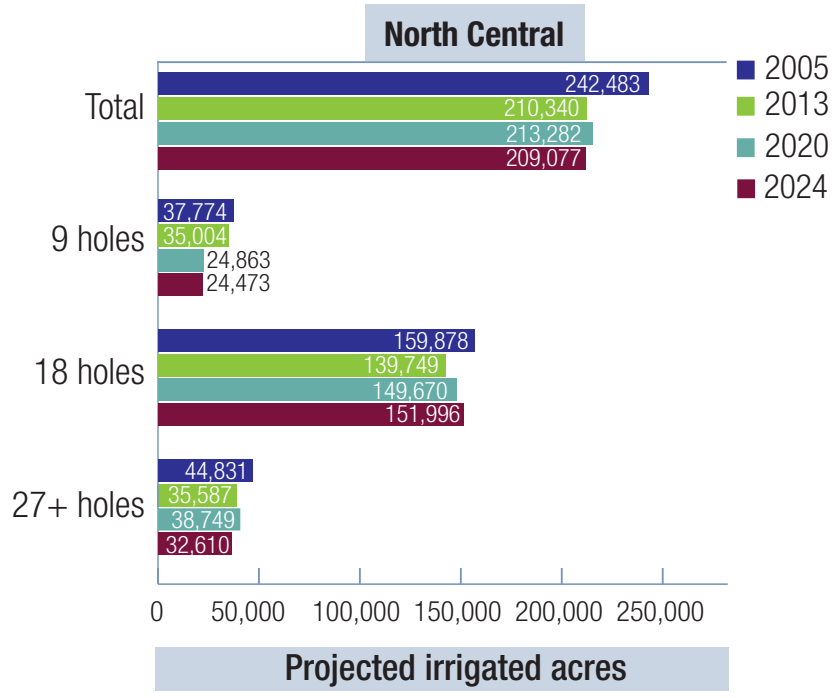


Figure 17. Projected irrigated acres of U.S. golf facilities in the North Central region in 2005, 2013, 2020, and 2024. Ref: Table 4

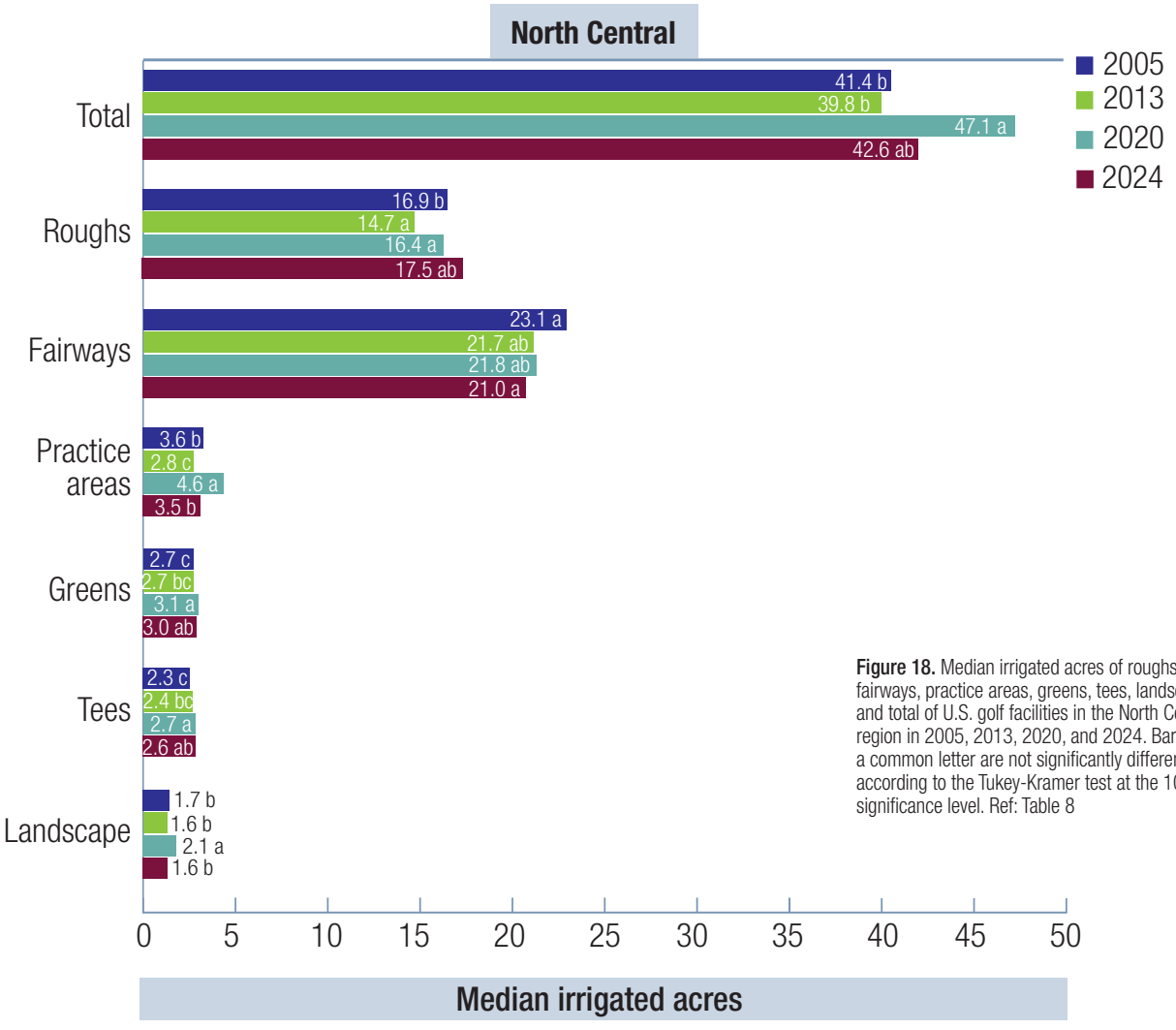


Figure 18. Median irrigated acres of roughs, fairways, practice areas, greens, tees, landscape, and total of U.S. golf facilities in the North Central region in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 8

Table 5. Weeks of drought in the North Central region in 2020 and 2024.

Drought	2020	2024	Δ
	Weeks		
Abnormal	20.0	34.0	14.1
Moderate	12.2	21.0	8.8
Severe	12.9	11.6	-1.3
Extreme	7.0	8.1	1.1
Exceptional		9.6	9.6

Abnormal = Going into drought, short-term dryness slowing planting, growth of crops and pastures; fire risk above average. Coming out of drought, some lingering water deficits, pastures or crops not fully recovered.

Moderate = Some damage to crops, pastures, fire risk high; streams, reservoirs or wells low, some water shortage developing or imminent, voluntary water use restrictions requested.

Severe = Crop or pasture loss likely, fire risk very high, water shortages common, water restrictions imposed.

Extreme = Major crop/pasture losses, extreme fire danger, widespread water shortages or restrictions.

Exceptional = Exceptional and widespread crop and pasture losses, exceptional fire risk, shortages of water in reservoirs, streams and wells causing water emergencies.

Meteorological

- The North Central region experienced 1.1 more weeks of extreme drought in 2024 than in 2020 (**Table 5**).
- Historical average monthly precipitation reached a low of one inch in the winter months of December, January, and February and peaked at 4 inches in June (**Figure 19**).
- The lowest historical average monthly temperature was 19° F in December and January and reached a peak of 70° F in July (**Figure 20**).
- Average growing degree days were zero starting in December and remained until March. A maximum growing degree days of 680 occurred in July (**Figure 21**).
- The greatest gap between average growing degree days and historical average precipitation occurred in July when 171 degree days was accompanied by 1 inch of rainfall (**Figure 22 and Table 41**). This ratio was similar to the Northeast, Southeast, and Transition regions and indicates that turfgrass growing in the North Central region may experience minor heat and moisture related stress and may not require as much supplemental irrigation as turfgrass growing in the Pacific, Southwest, or Upper West/Mountain regions.

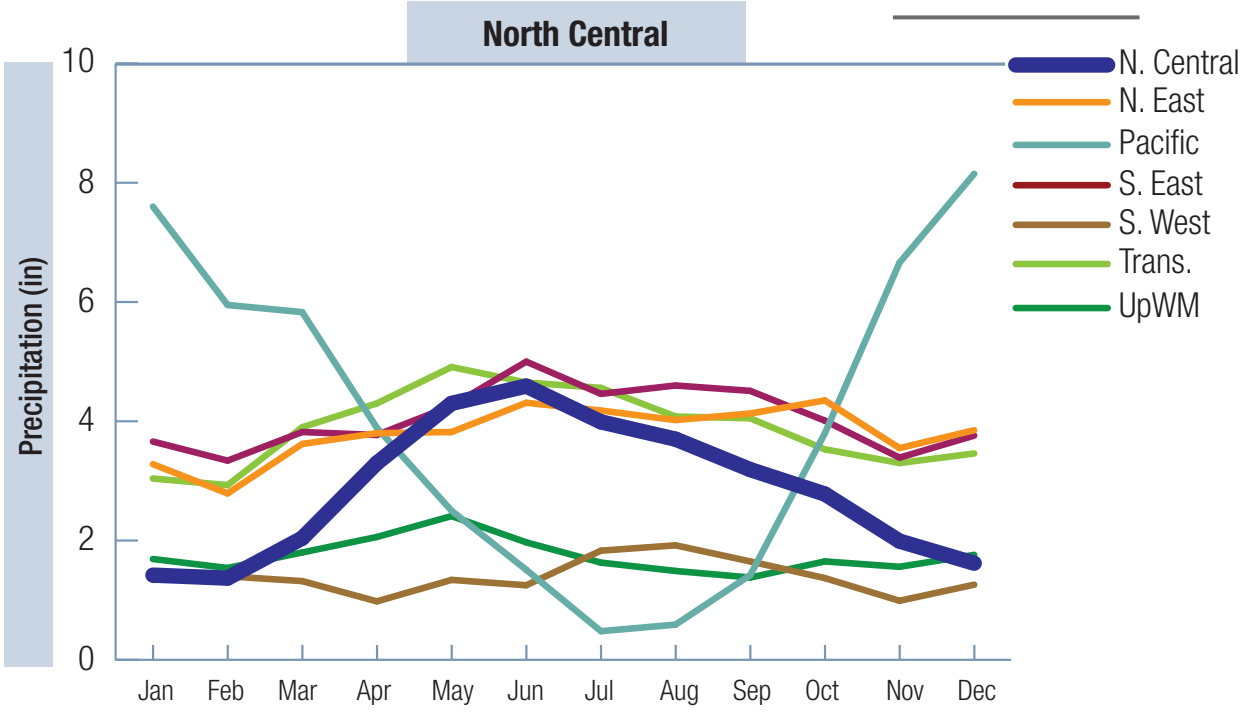


Figure 19. 30-yr monthly average precipitation in the North Central region.

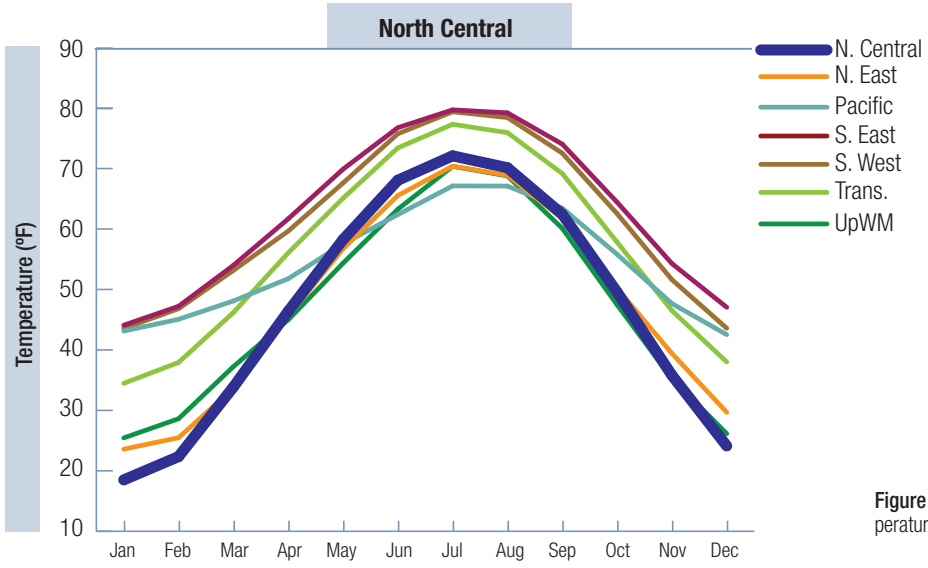


Figure 20. 30-yr monthly average temperature in the North Central region.

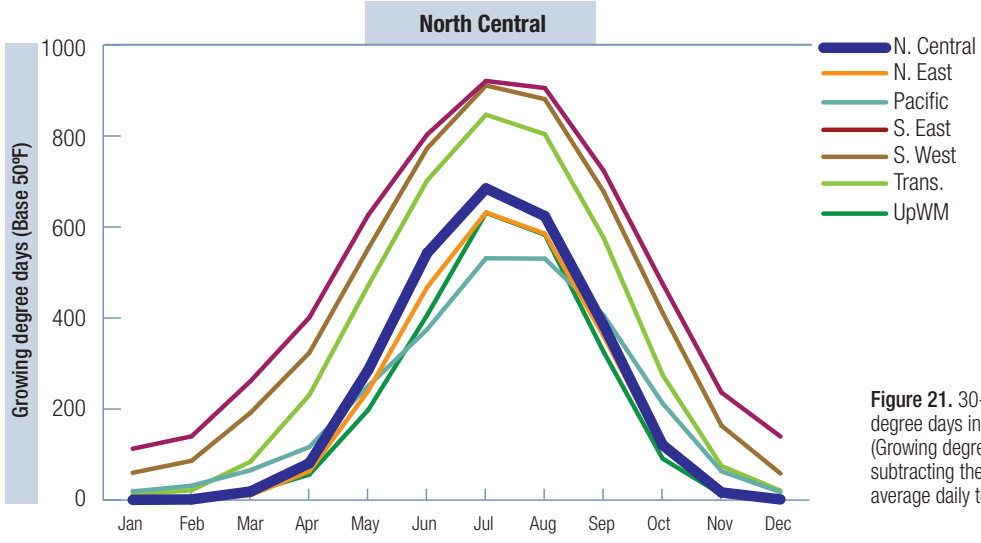


Figure 21. 30-yr monthly average growing degree days in the North Central region. (Growing degree days are calculated by subtracting the base temperature from the average daily temperature

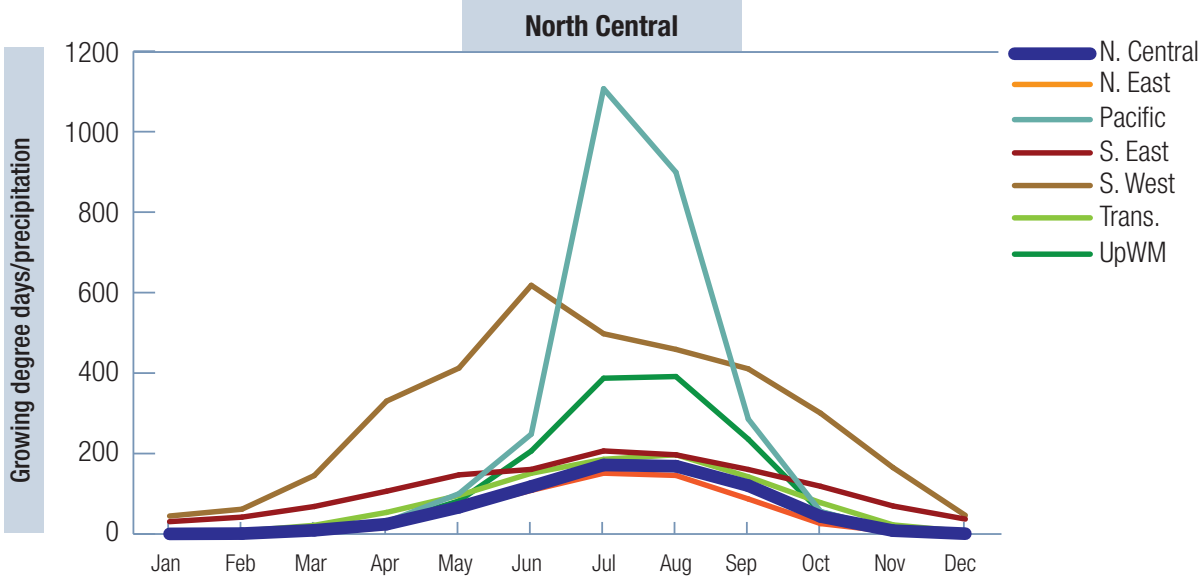


Figure 22. 30-yr monthly average growing degree days/precipitation in the North Central region.

Northeast Region

Water Use

- Projected applied water was 15% less in 2024 than in 2005, but was 3.8% greater than 2020 (**Table 1**) (**Figure 23**).
- Median applied water per facility was 31.3 acre-feet in 2024 and has remained largely unchanged since 2005 (**Figure 24**).
- Median applied water per acre was 0.7 acre-feet in both 2005 and 2024 (**Figure 25**).

Water Sources

- In 2024, 36% of projected applied water was sourced from lakes and ponds, a 27% increase since 2020. 35% was sourced from wells (**Figure 26**).
- In 2024, 2% of projected applied water was sourced from recycled water (**Figure 26**).
- The percentage of facilities using recycled water was 3.1% in 2024, which was equivalent to 2005 (**Figure 27**).
- Projected recycled water applied increased from 2,082 acre-feet in 2005 to 2,241 acre-feet in 2024, an 8% increase (**Figure 28**).

Irrigated Acres

- Projected irrigated acres decreased by 2% from 136,252 acres in 2005 to 133,493 acres in 2024 (**Figure 29**).
- Irrigated acres at 9-hole facilities decreased by 14%, irrigated acres at 18-hole and 27+-hole facilities remained unchanged since 2005 (**Figure 29**).
- Median irrigated acres increased 31% in 2024 compared to 2005 but has remained relatively unchanged since 2013 (**Figure 30 and Table 15**).
- Median irrigated acres of greens increased since 2005 by 22%, whereas the median irrigated acres of all other areas did not change since 2005 (**Figure 30 and Table 15**).

Facility Influence

- Operational golf facilities in the Northeast Region declined since 2005 by 11% to 2,454 (**Table 16**).

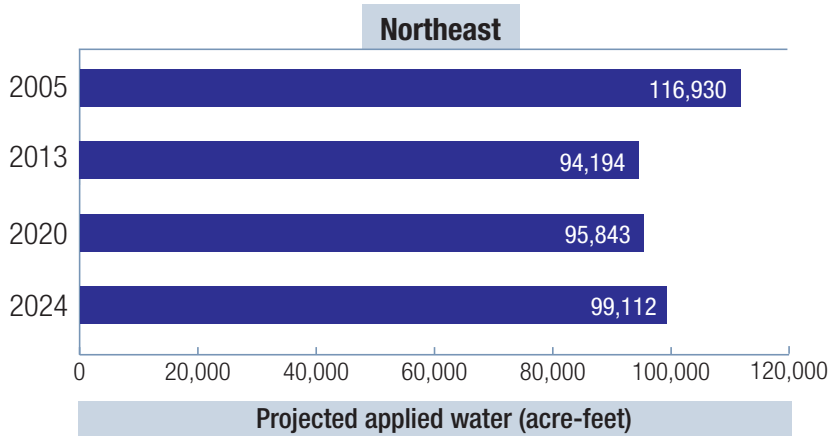


Figure 23. Projected water applied to U.S. golf facilities in the Northeast region in 2005, 2013, 2020, and 2024. Ref: Table 1

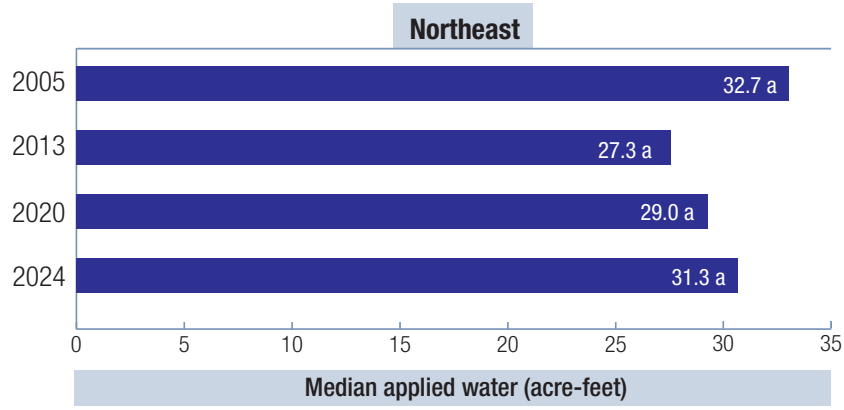


Figure 24. Median acre-feet of applied water on U.S. golf facilities in the Northeast region in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 2

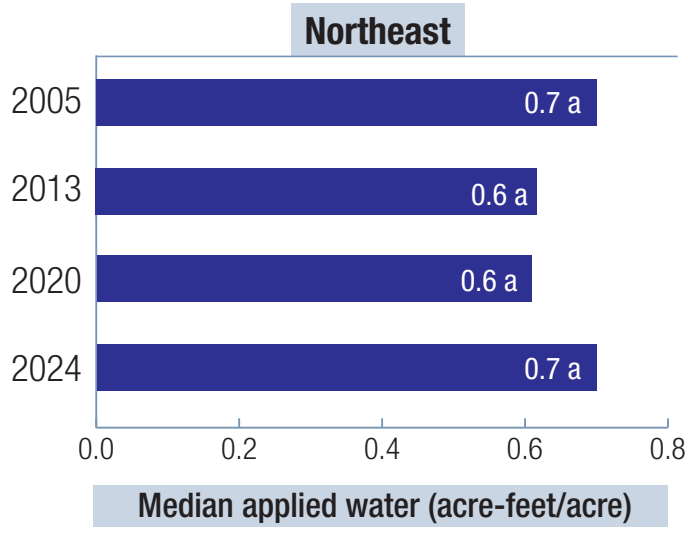


Figure 25. Median acre-feet per acre of applied water on U.S. golf facilities in the Northeast region in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 2

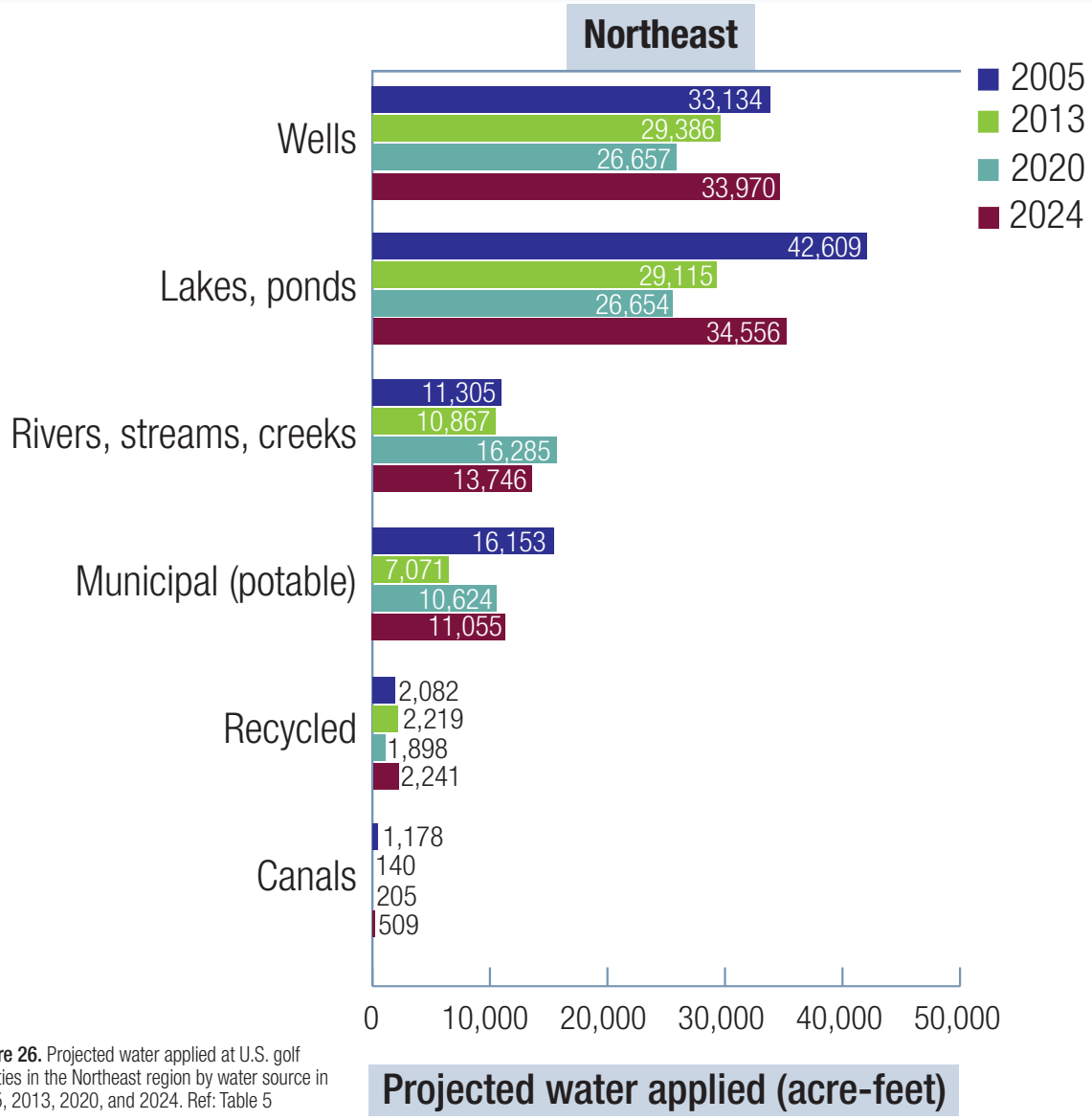


Figure 26. Projected water applied at U.S. golf facilities in the Northeast region by water source in 2005, 2013, 2020, and 2024. Ref: Table 5

Management Practices

- The frequency of every water management practices either remained or increased since 2005 except full irrigation system upgrade, which declined to 15% of facilities (**Table 18**).

Regulations

- Required water use reporting increased to 63%, recurring annual allocations increased to 34%, and additional mandatory water restrictions decreased from 29% to 14% since 2005 (**Table 21**). The prevalence of facilities that had a written drought, water management, stormwater, or preventative irrigation maintenance plan was 23%, 31%, 15%, and 23%, respectively (**Table 22**).
- Miscellaneous
- The use of soil moisture sensors had a somewhat positive or very positive impact on 97% of facilities in 2024 (**Table 23**).
- 69% of facilities identified water conservation as the factor motivating the decision to reduce irrigated acres (**Table 24**).
- 91% of golfers were receptive to any perceived change in course appearance resulting from a reduction of applied water (**Table 25**).
- The most common irrigation injection treatment was wetting agents used at 28% of facilities (**Table 27**).
- Water Testing
- The prevalence of facilities that had surface water and that tested their surface water were 91% and 32%, respectively, and has not changed since 2005 (**Table 28**).
- Among facilities that tested surface water, 66% tested once per year with the remaining facilities testing more frequently (**Table 29**).
- Among facilities that tested surface water, 89% had 1 or more surface water monitoring sites (**Table 30**).
- Among facilities that tested surface water, 78% tested for nutrients, which was the most common tested variable (**Table 31**).
- The prevalence of facilities that had ground water wells was 57% and

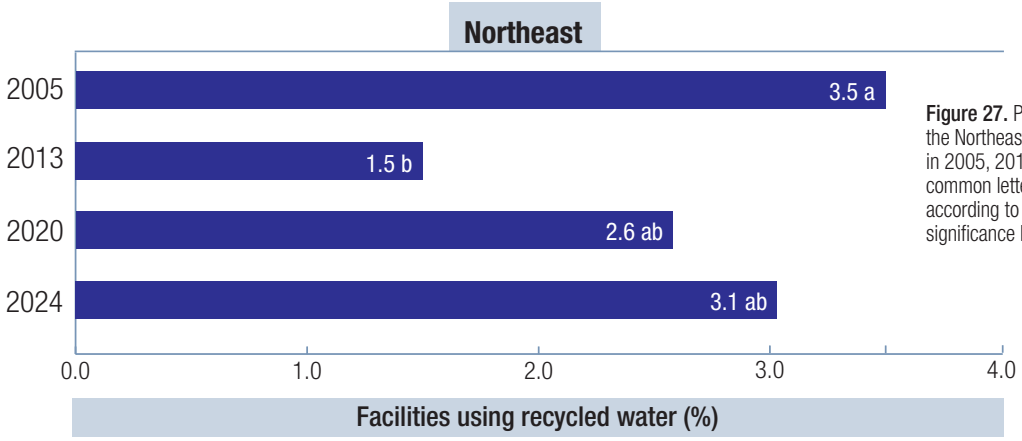


Figure 27. Percent of U.S. golf facilities in the Northeast region applying recycled water in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the chi-square test at the 10% significance level. Ref: Table 3

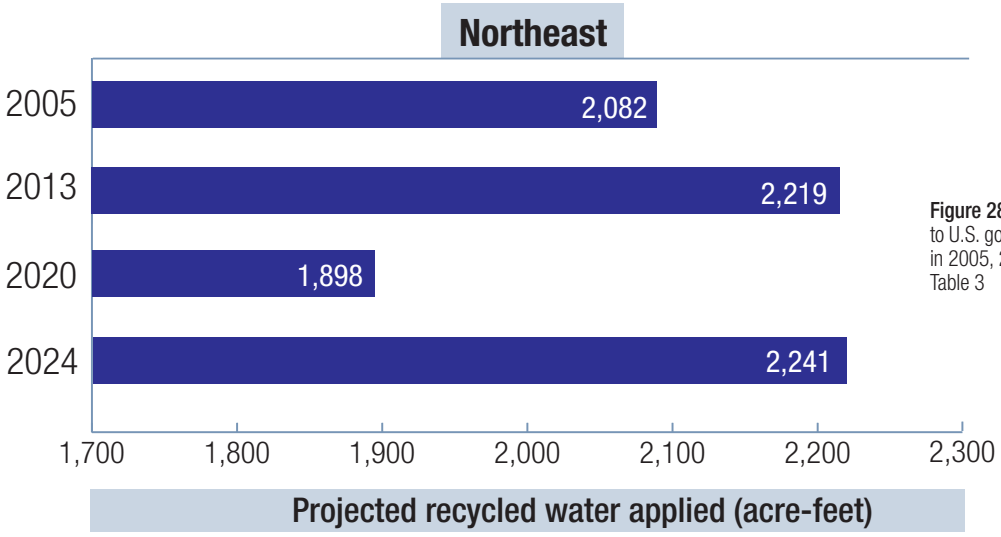


Figure 28. Projected recycled water applied to U.S. golf facilities in the Northeast region in 2005, 2013, 2020, and 2024. Ref: Table 3

Table 6. Drought severity in the Northeast region in 2020 and 2024.

Drought	2020	2024	Δ
	Weeks		
Abnormal	22.8	21.4	-1.3
Moderate	17.1	11.9	-5.2
Severe	9.2	8.6	-0.6
Extreme	5.6	5.3	-0.2
Exceptional			0.0

Abnormal = Going into drought, short-term dryness slowing planting, growth of crops and pastures; fire risk above average. Coming out of drought, some lingering water deficits, pastures or crops not fully recovered.

Moderate = Some damage to crops, pastures, fire risk high; streams, reservoirs or wells low, some water shortage developing or imminent, voluntary water use restrictions requested.

Severe = Crop or pasture loss likely, fire risk very high, water shortages common, water restrictions imposed.

Extreme = Major crop/pasture losses, extreme fire danger, widespread water shortages or restrictions.

Exceptional = Exceptional and widespread crop and pasture losses, exceptional fire risk, shortages of water in reservoirs, streams and wells causing water emergencies.

equivalent to 2005, but those that tested their ground water declined to 51% (**Table 32**).

- Among facilities that tested ground water, 100% had 1 or more ground water monitoring sites (**Table 33**).
- Among facilities that tested ground water, 87% had 1 or more protected ground water wells (**Table 34**).
- Among facilities that tested ground water, 44% tested once per year with the remaining facilities testing more frequently (**Table 35**).
- Among facilities that tested ground water, 59% tested for nutrients, which was the most common tested variable (**Table 36**).
- Among facilities that tested ground water, 55% had 1 or more dedicated ground water monitoring sites in 2020 (**Table 37**).

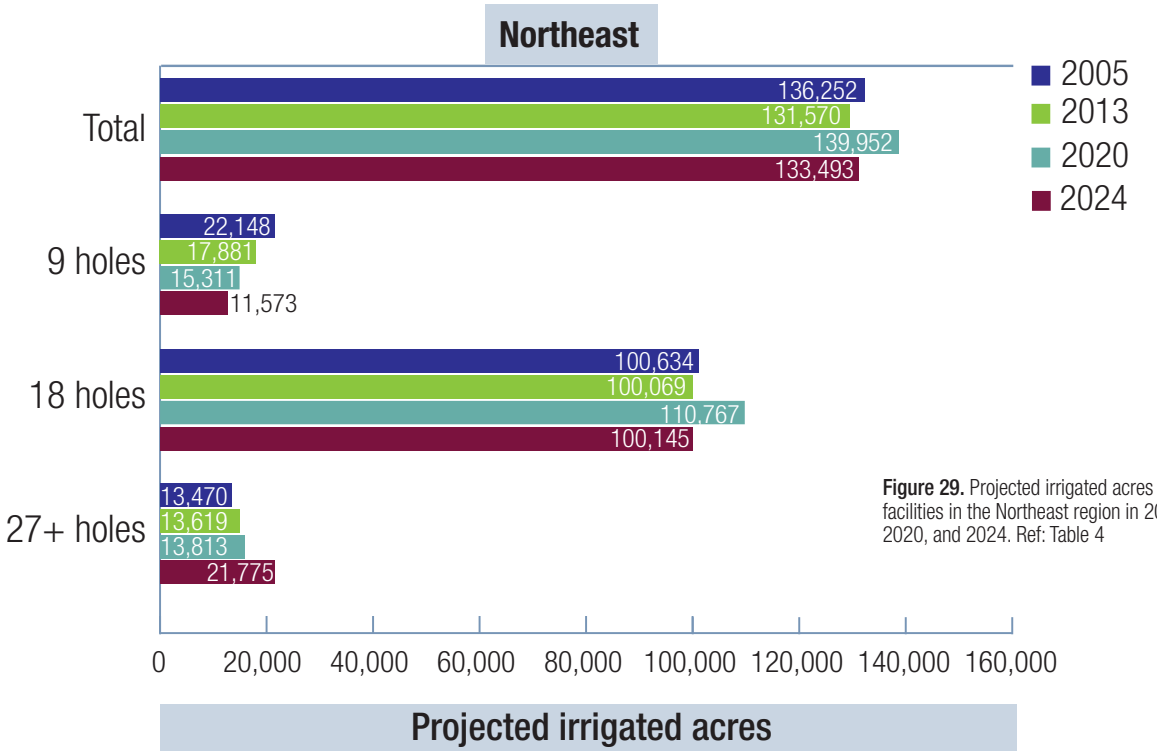


Figure 29. Projected irrigated acres of U.S. golf facilities in the Northeast region in 2005, 2013, 2020, and 2024. Ref: Table 4

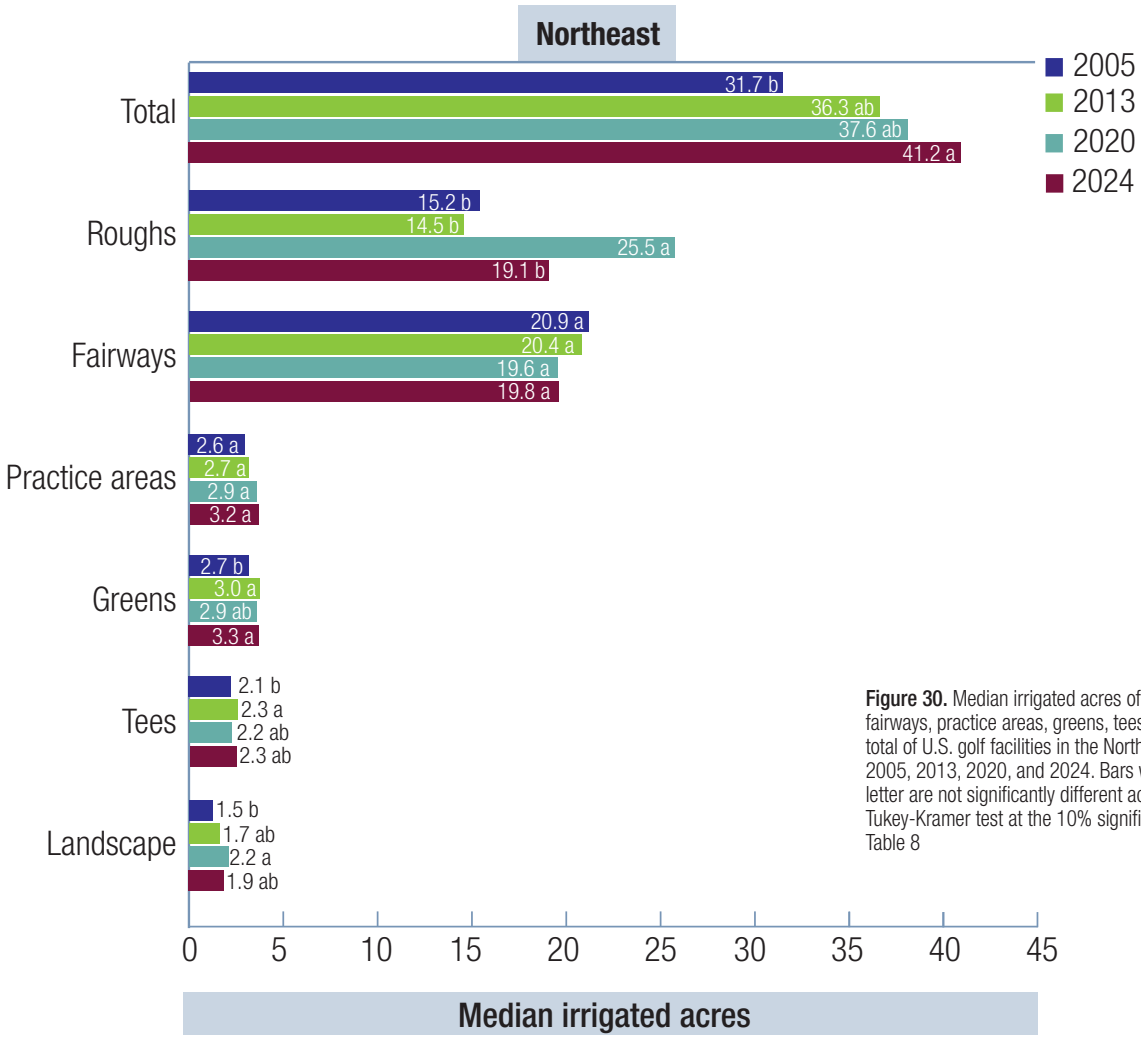


Figure 30. Median irrigated acres of roughs, fairways, practice areas, greens, tees, landscape, and total of U.S. golf facilities in the Northeast region in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 8

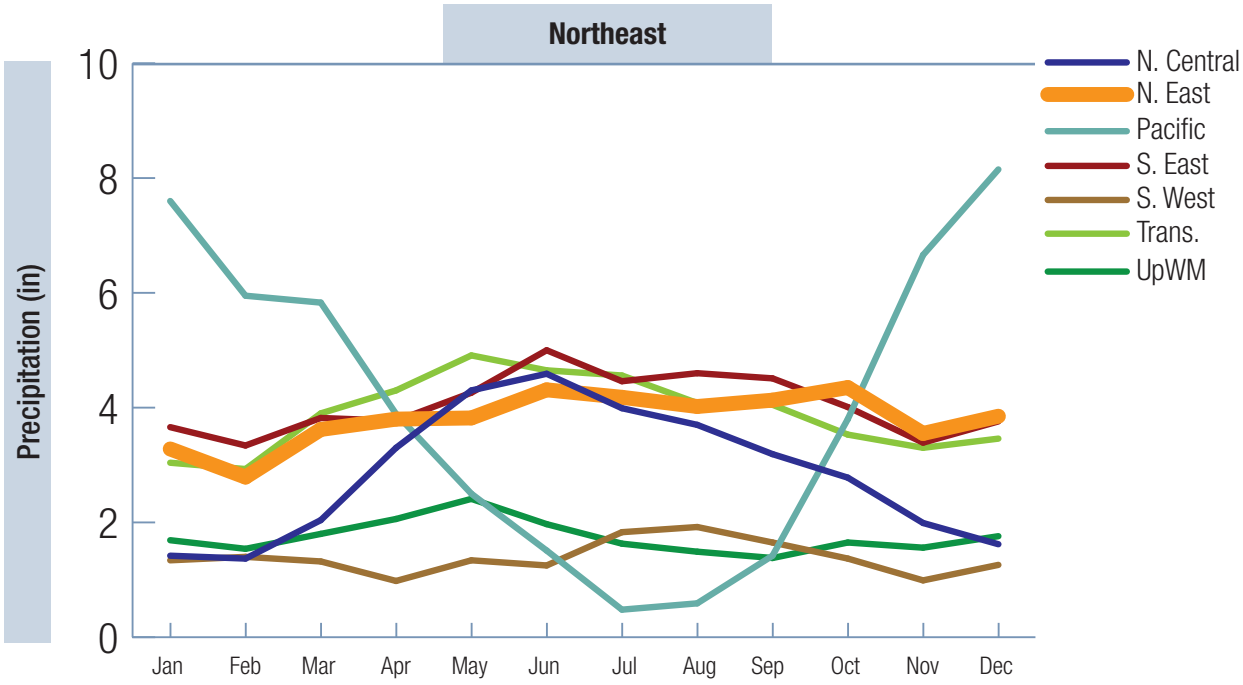


Figure 31. 30-yr monthly average precipitation in the Northeast region.

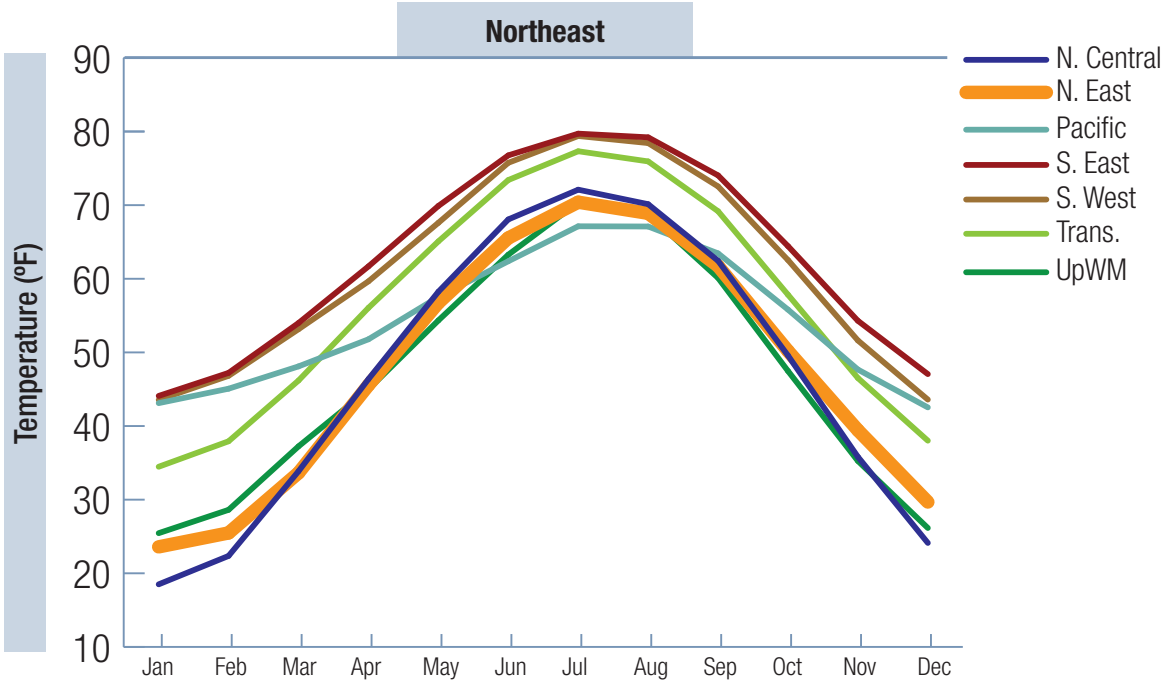


Figure 32. 30-yr monthly average temperature in the Northeast region.

Meteorological

- The Northeast region experienced fewer weeks of drought in 2024 than in 2020 (**Table 6**).
- Historical average monthly precipitation is relatively constant throughout the year ranging from 2.8 to 4.3 inches per month and is similar to the Southeast and Transition regions (**Figure 31**).
- Historical average monthly temperature is similar to the Upper West/Mountain and North Central regions ranging from 23° F in January to 70° F in July (**Figure 32**).
- Growing degree days are zero starting in December and remain until March. A maximum growing degree days of 630 occur in July (**Figure 33**).
- The greatest gap between growing degree days and historical precipita-

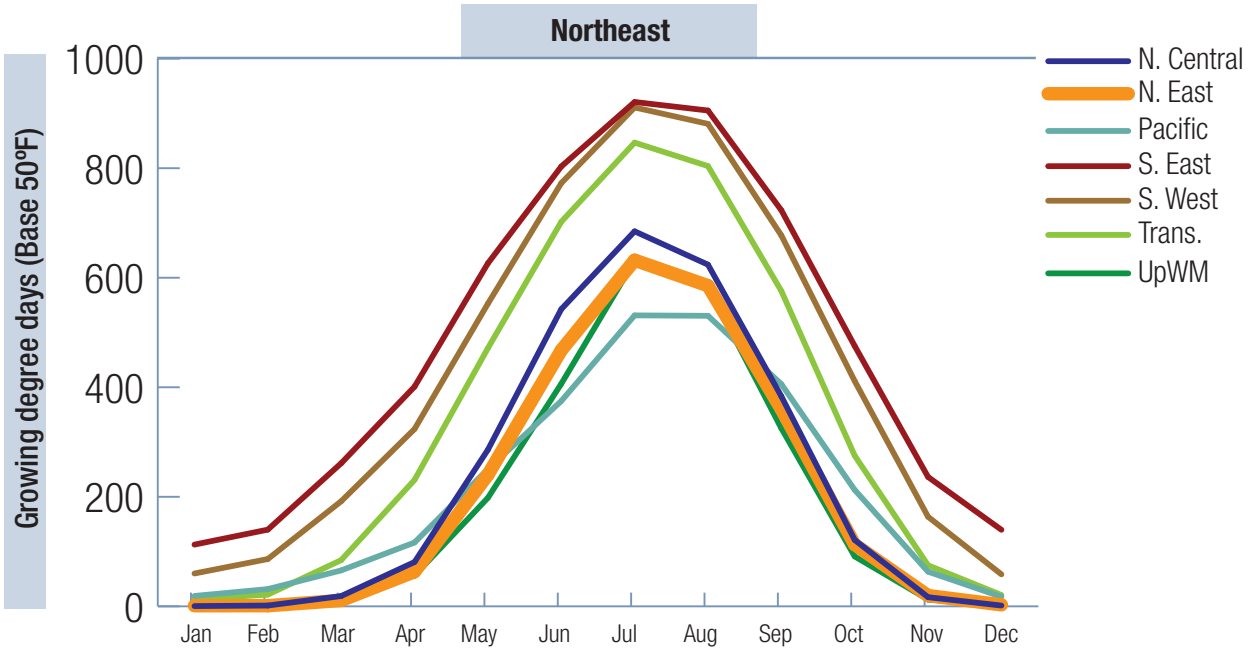


Figure 33. 30-yr monthly average growing degree days in the Northeast region.

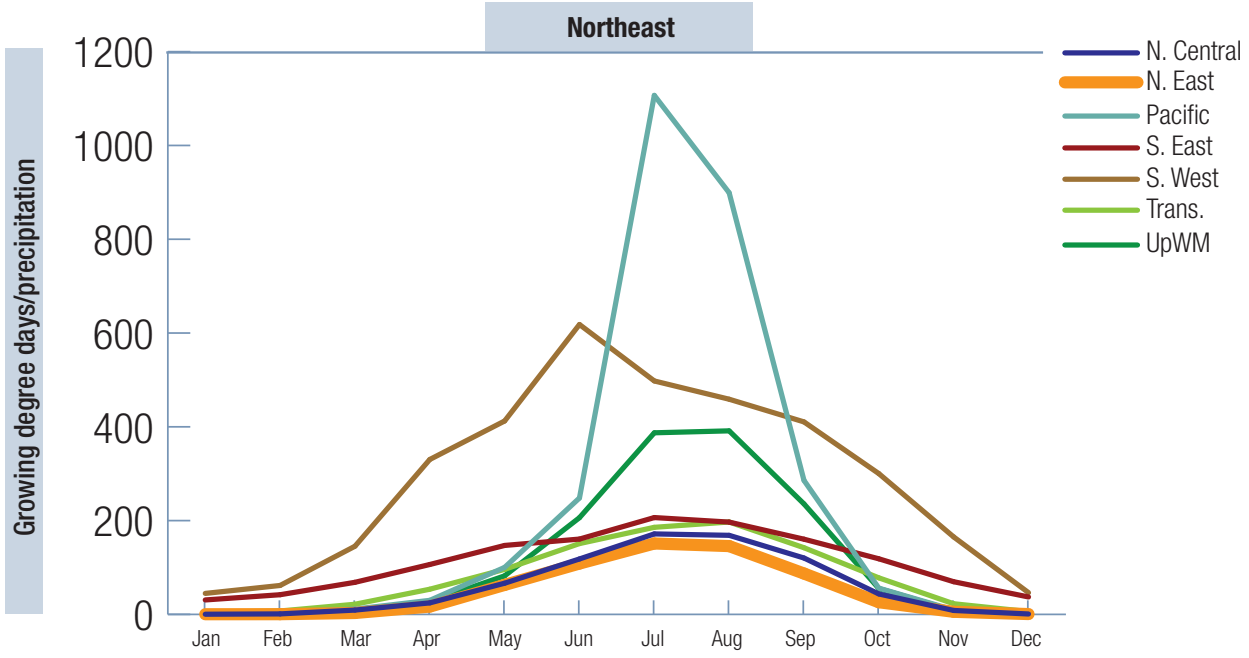


Figure 34. 30-yr monthly average growing degree days/precipitation in the Northeast region.

tion occurs in July when 151 degree days is accompanied by 1 inch of rainfall (**Figure 34 and Table 41**). This ratio is similar to the North Central, Southeast, and Transition regions and indicates that turfgrass growing in the Northeast region may experience minor heat and moisture related stress and may not require as much supplemental irrigation as turfgrass growing in the Pacific, Southwest, or Upper West/Mountain regions.

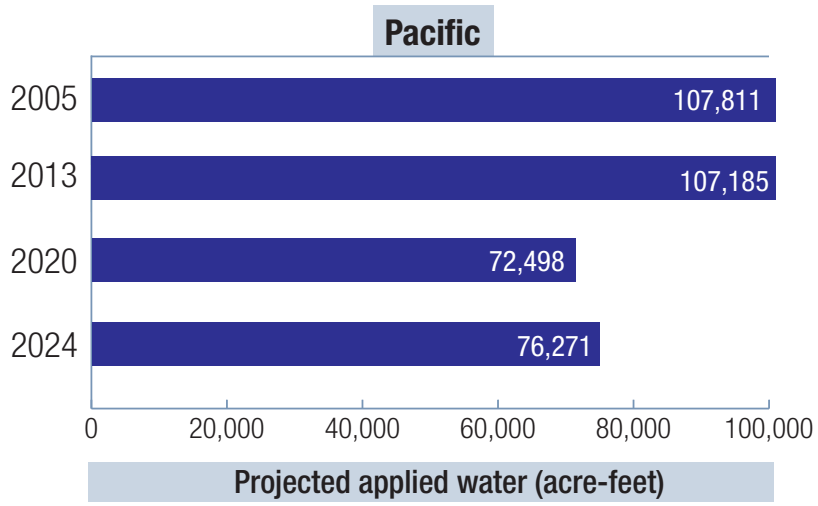


Figure 35. Projected water applied to U.S. golf facilities in the Pacific region in 2005, 2013, 2020, and 2024. Ref: Table 1

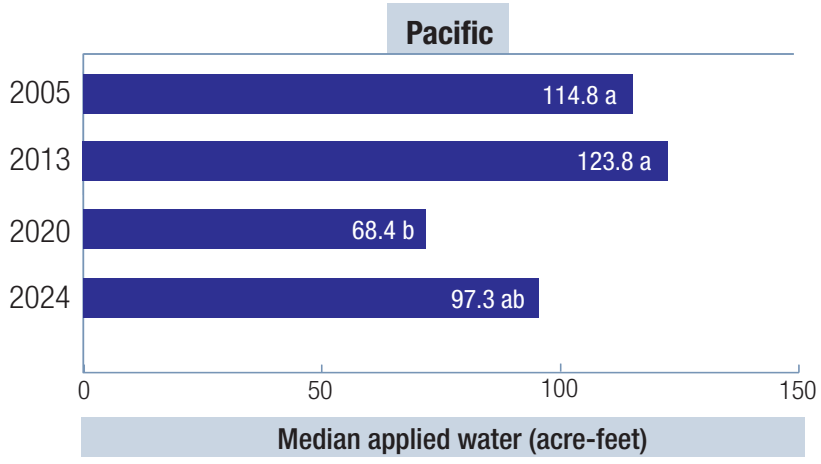


Figure 36. Median acre-feet of applied water on U.S. golf facilities in the Pacific region in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 2

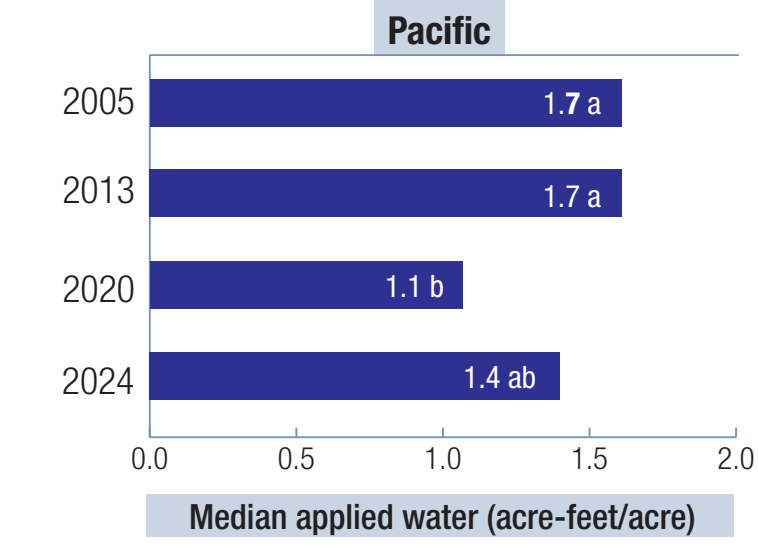


Figure 37. Median acre-feet per acre of applied water on U.S. golf facilities in the Pacific region in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 2

Pacific Region

Water Use

- Projected applied water was 29% less in 2024 than in 2005, resulting in a water savings of 31,540 acre-feet (**Figure 35**).
- Median applied water per facility was 97.3 acre-feet in 2024, a non-statistical 15% reduction (**Figure 36**).
- Median applied water per acre 1.4 acre-feet/acre in 2024, a non-statistical 17% reduction (**Figure 37**).

Water Sources

- In 2024, 29% of projected applied water was sourced from wells and 17% was sourced from municipal water (**Figure 38**).
- In 2024, 16% of projected applied water was sourced from recycled water (**Figure 38**).
- Notable increases in all waters were observed in 2024 versus 2020 with the exception of municipal (potable) and canals (**Figure 38**).
- The percentage of facilities using recycled water was 24.8% in 2024, which was equivalent to 2005 (**Figure 39**).
- Projected recycled water applied increased from 10,253 acre-feet in 2005 to 13,124 acre-feet in 2024, a 28% increase (**Figure 40**).

Irrigated Acres

- Projected irrigated acres decreased by 9% from 52,249 acres in 2005 to 47,722 acres in 2024 (**Figure 41**).
- Irrigated acres at 18-hole facilities slightly increased from 2005 to 2024 by 2%, whereas irrigated acres at 9- and 27+-hole facilities declined by 23% and 28%, respectively(**Figure 41**).
- Median irrigated acres were 75.8 in 2024 representing a 37% increases since 2005 (**Figure 42 and Table 15**).
- Median irrigated acres of roughs, fairways, greens, and tees increased since 2005, whereas the median irrigated acres of landscape and practice areas remained equivalent to 2005 (**Figure 42 and Table 15**).

Facility Influence

- Operational golf facilities in the

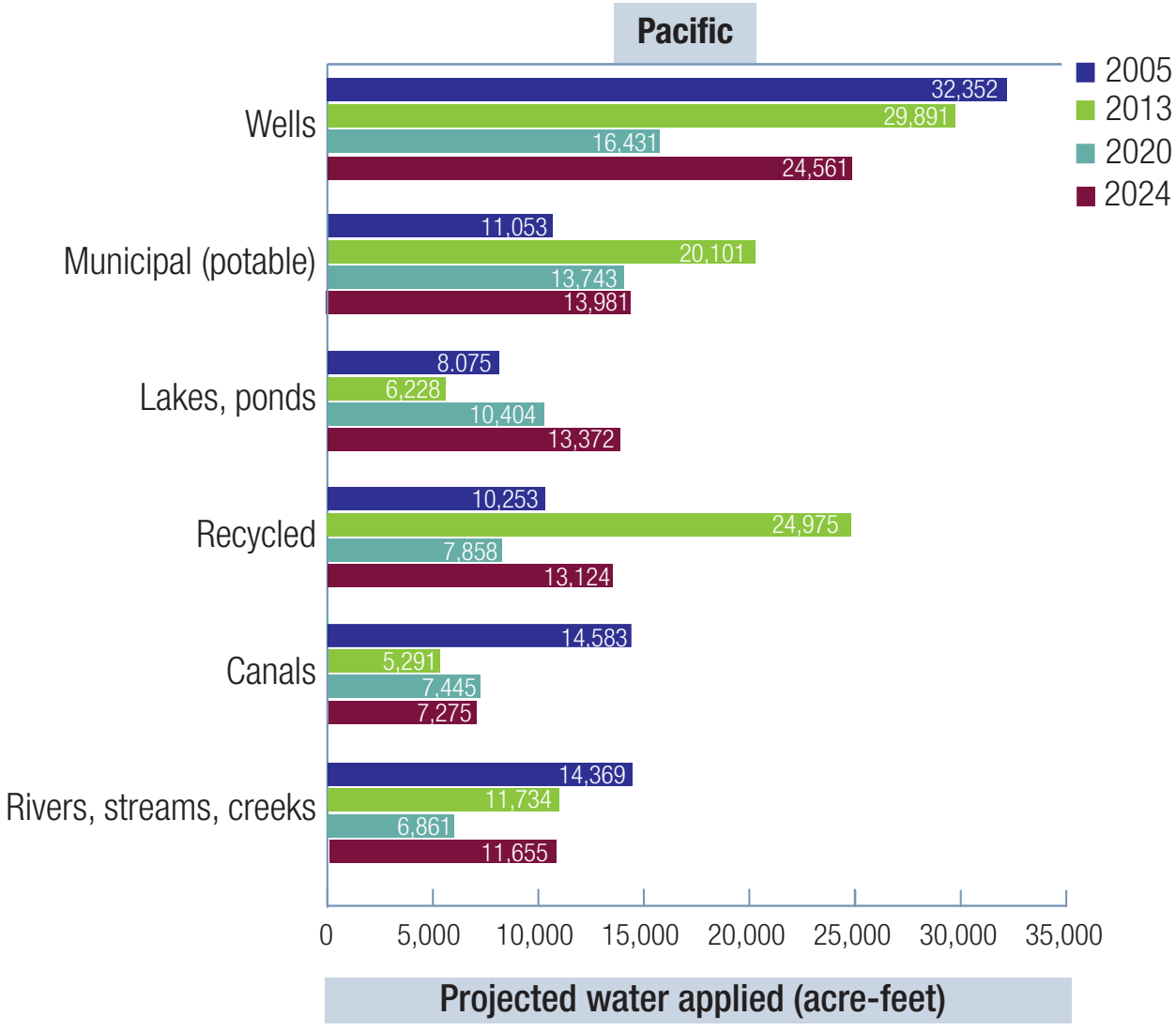


Figure 38. Projected water applied at U.S. golf facilities in the Pacific region by water source in 2005, 2013, 2020, and 2024. Ref: Table 5

Pacific Region declined since 2005 by 14% to 560 (**Table 16**).

- Management Practices
- The frequency of each water management practice was greater than or equivalent to 2005, except increasing no mow acres which was first measured in 2013 and has declined since (**Table 18**).

Regulations

- Required water use reporting increased to 44% since 2005, whereas recurring annual allocations remained unchanged. Additional mandatory water restrictions increased from 2% to 16% between 2005 and 2024 (**Table 21**).
- The prevalence of facilities that had a written drought, water management, stormwater, or preventative irrigation maintenance plan was 23%, 16%, 20%, and 15%, respectively (**Table 22**). Miscellaneous
- The use of soil moisture sensors had a somewhat positive or very positive impact on 100% of facilities in 2024 (**Table 23**).
- Water conservation was the most common factor motivating the decision to reduce irrigated acres (61%) (**Table 24**).
- 93% of golfers were receptive to any perceived change in course appearance resulting from a reduction of applied water (**Table 25**).
- The most common irrigation injection treatment was wetting agents used at 29% of facilities (**Table 27**).
- Water Testing
- The prevalence of facilities that had surface water and those that tested surface water remained the same as 2005 at 91% and 36%, respectively (**Table 28**).
- Among facilities that tested surface water, 57% tested once per year with the remaining facilities testing more

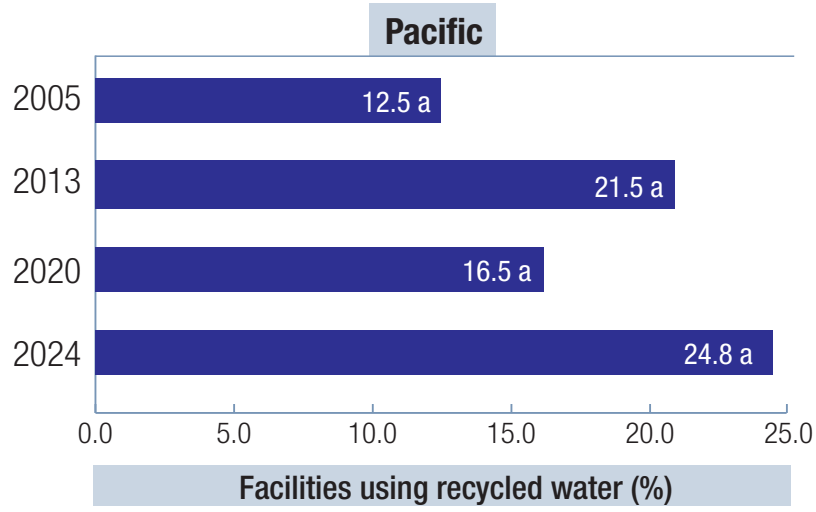


Figure 39. Percent of U.S. golf facilities in the Pacific region applying recycled water in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the chi-square test at the 10% significance level. Ref: Table 3

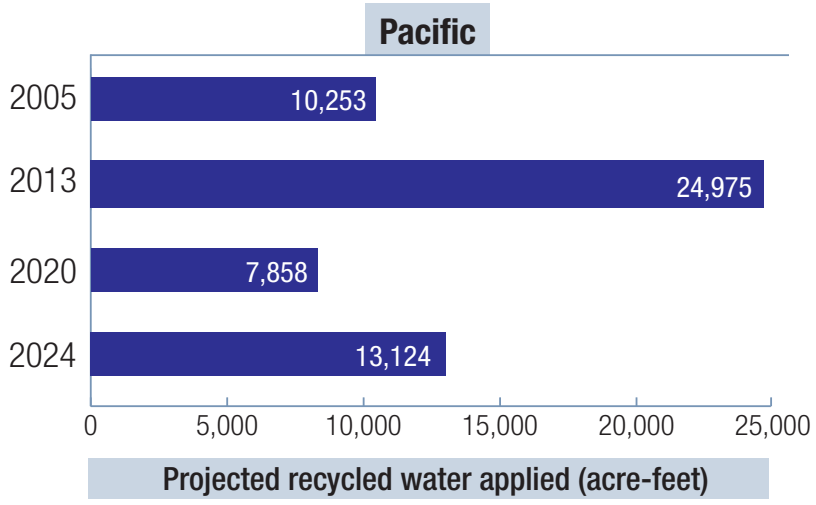


Figure 40. Projected recycled water applied to U.S. golf facilities in the Pacific region in 2005, 2013, 2020, and 2024. Ref: Table 3

frequently (**Table 29**).

- Among facilities that tested surface water, 83% had 1 or more surface water monitoring sites (**Table 30**).
- Among facilities that tested surface water, 73% tested for nutrients, which was the most common tested variable (**Table 31**).
- The prevalence of facilities that had ground water wells was 58% and did not change since 2005, but those that tested their ground water declined to 34% (**Table 32**).
- Among facilities that tested ground water, 100% had 1 or more ground water monitoring sites (**Table 33**).
- Among facilities that tested ground water, 87% had 1 or more protected ground water wells (**Table 34**).
- Among facilities that tested ground water, 60% tested once per year with the remaining facilities testing more frequently (**Table 35**).
- Among facilities that tested ground water, 59% tested for nutrients, which was the most common tested variable (**Table 36**).
- Among facilities that tested ground water, 68% had 1 or more dedicated ground water monitoring sites in 2024 (**Table 37**).

Meteorological

- The Pacific region experienced a decrease of 80 weeks of abnormal, moderate, severe, and extreme drought in 2024 when compared to 2020 (**Table 7**).
- Historical average monthly precipitation is inverse of most other regions and varies greatly throughout the year with a maximum precipitation of 8 inches occurring in December and January and the minimum of less than 0.5 inches occurring in July (**Figure 43**).
- Historical average monthly temperatures varies the least among regions with maximum and minimum monthly averages of 67° F and 42° F occurring in July and December, respectively (**Figure 44**).
- Growing degree days are the least among regions, were zero in January and December, and are maximized at 530 in July (**Figure 45**).
- The greatest gap between growing degree days and historical precipitation occurs in July when 1,106 degree days is accompanied by 1 inch of rainfall (**Figure 46 and Table 41**). This ratio is greater than all other regions and indicates that turfgrass growing in the Pacific region may experience significant heat and moisture related stress and may require greater supplemental irrigation than turfgrass growing in other regions.

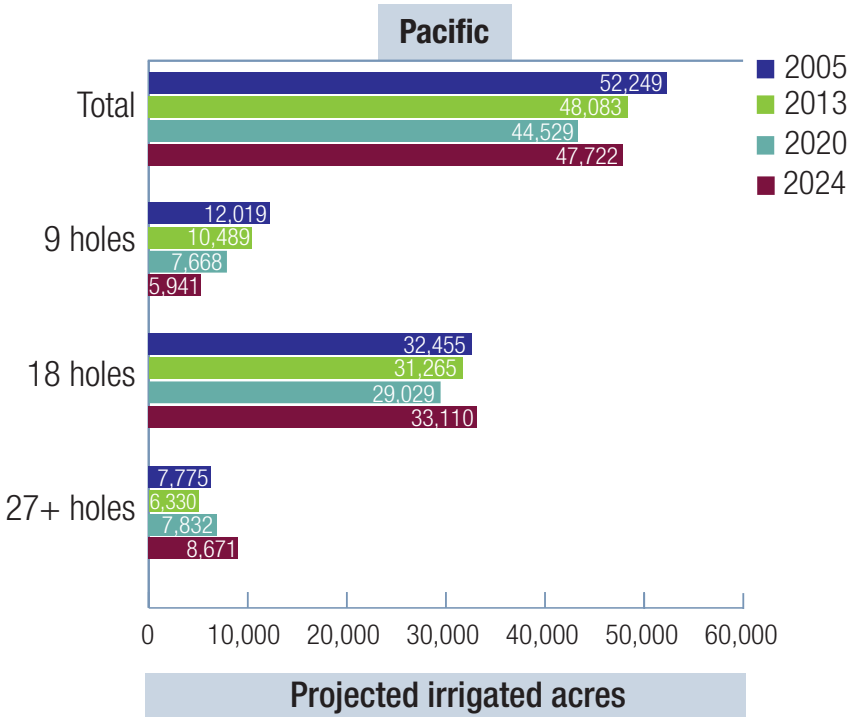


Figure 41. Projected irrigated acres of U.S. golf facilities in the Pacific region in 2005, 2013, 2020, and 2024. Ref: Table 4

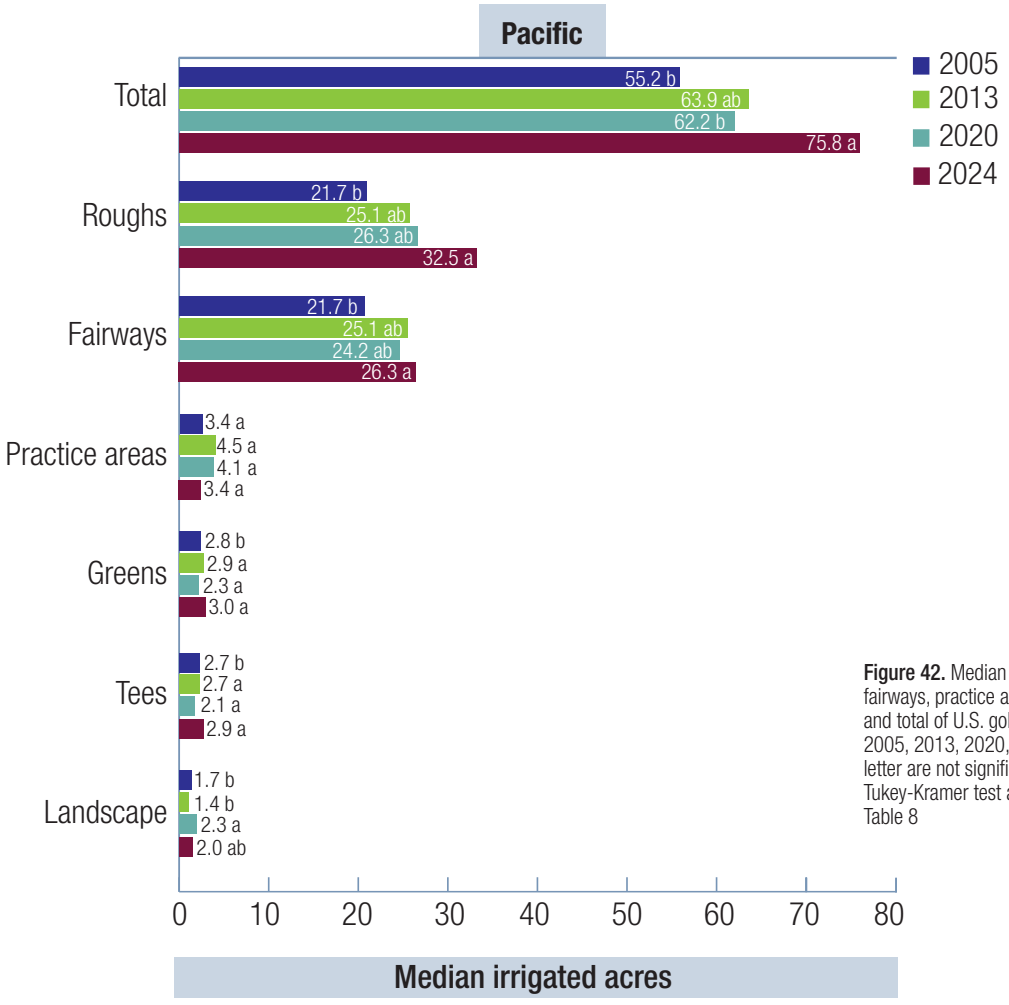


Figure 42. Median irrigated acres of roughs, fairways, practice areas, greens, tees, landscape, and total of U.S. golf facilities in the Pacific region in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 8

Table 7. Drought severity in the Pacific region in 2020 and 2024.

Drought	2020	2024	Δ
	Weeks		
Abnormal	35.0	23.6	-11.3
Moderate	34.2	18.3	-15.9
Severe	34.0	3.3	-30.6
Extreme	22.0		-22.0
Exceptional			0.0

Abnormal = Going into drought, short-term dryness slowing planting, growth of crops and pastures; fire risk above average. Coming out of drought, some lingering water deficits, pastures or crops not fully recovered.

Moderate = Some damage to crops, pastures, fire risk high; streams, reservoirs or wells low, some water shortage developing or imminent, voluntary water use restrictions requested.

Severe = Crop or pasture loss likely, fire risk very high, water shortages common, water restrictions imposed.

Extreme = Major crop/pasture losses, extreme fire danger, widespread water shortages or restrictions.

Exceptional = Exceptional and widespread crop and pasture losses, exceptional fire risk, shortages of water in reservoirs, streams and wells causing water emergencies.

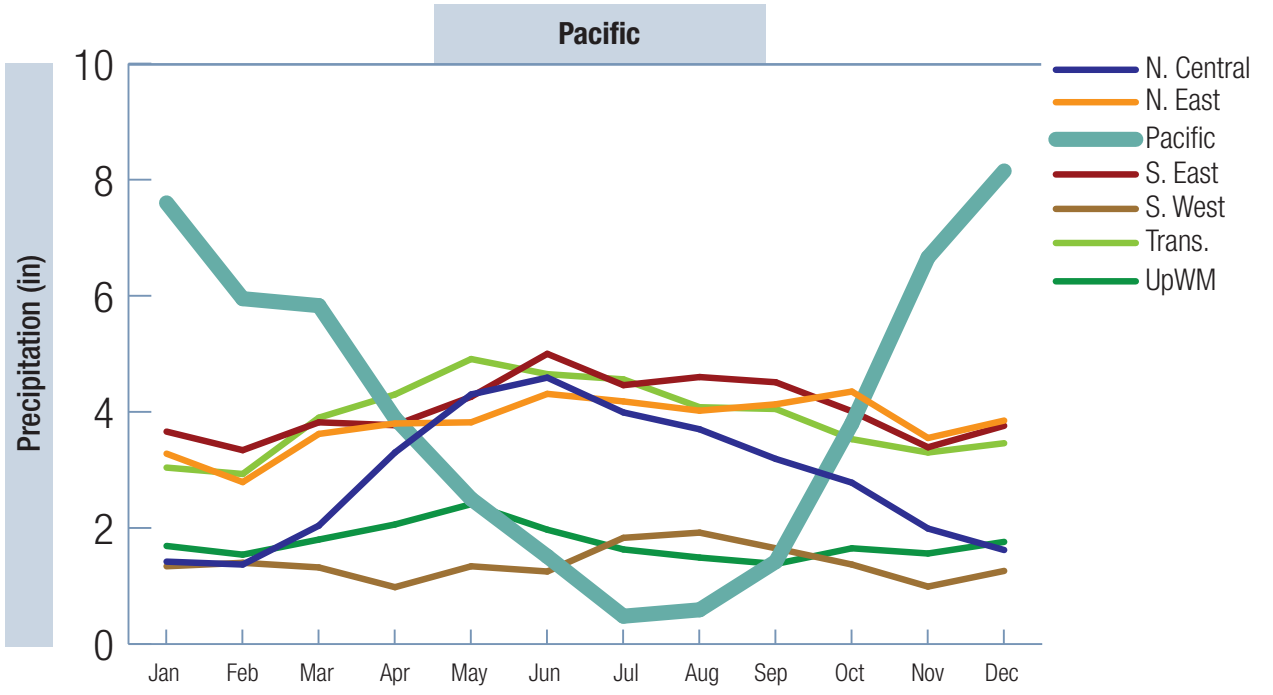


Figure 43. 30-yr monthly average precipitation in the Pacific region.

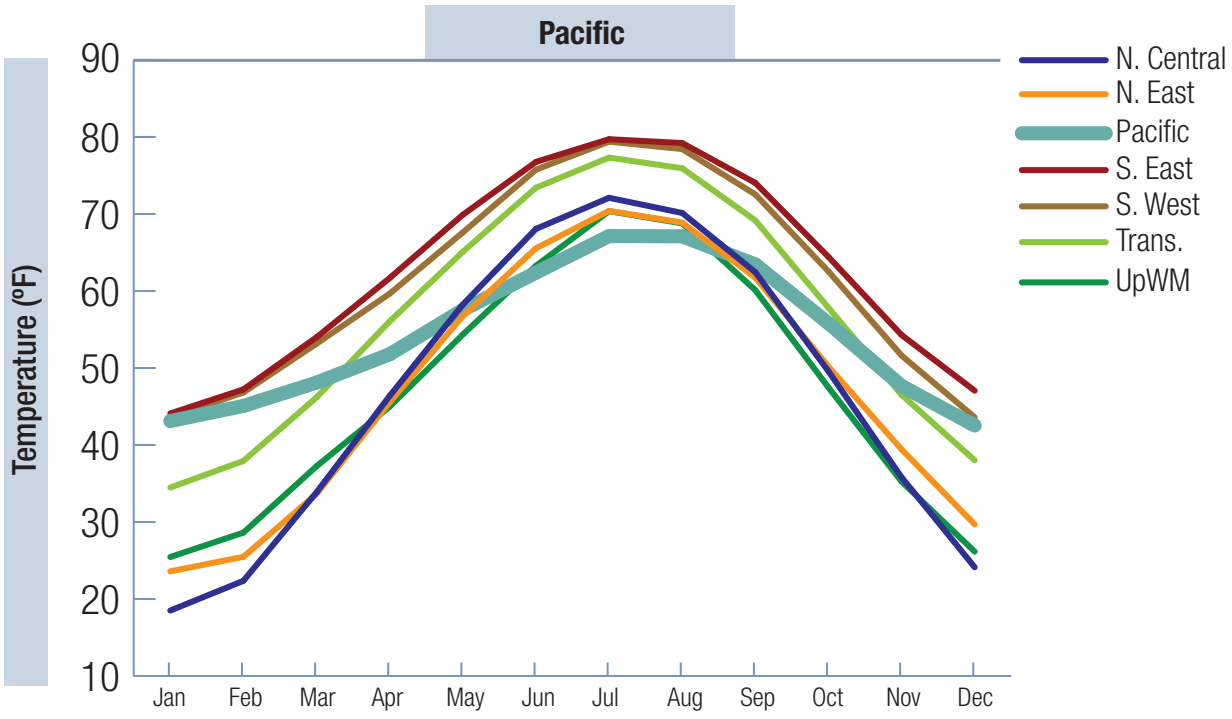


Figure 44. 30-yr monthly average temperature in the Pacific region.

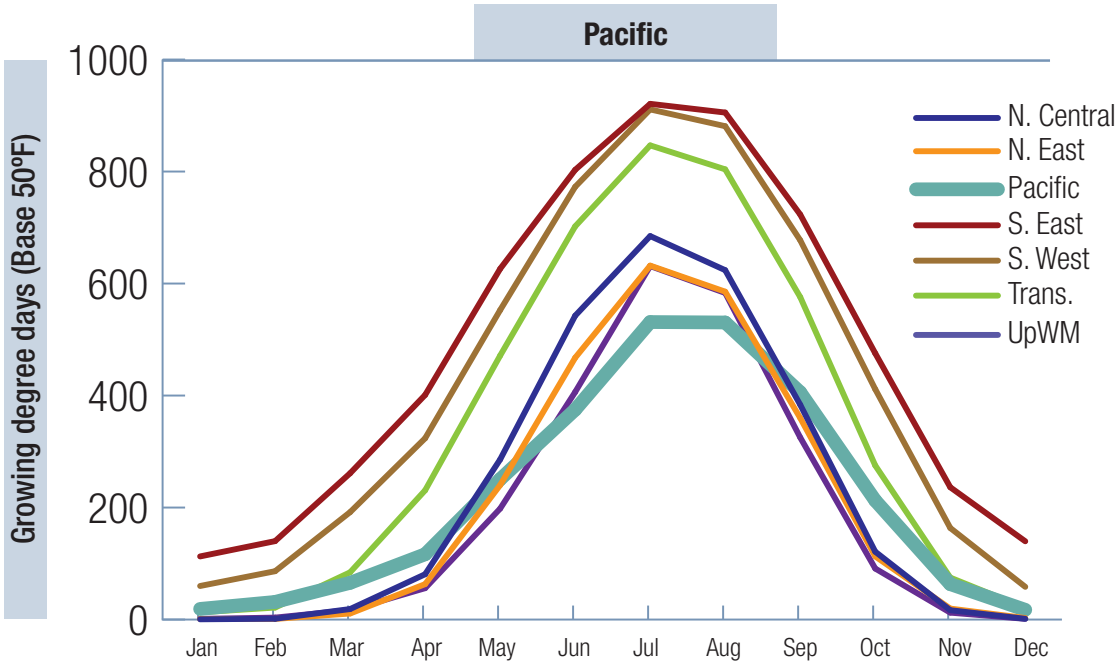


Figure 45. 30-yr monthly average growing degree days in the Pacific region.

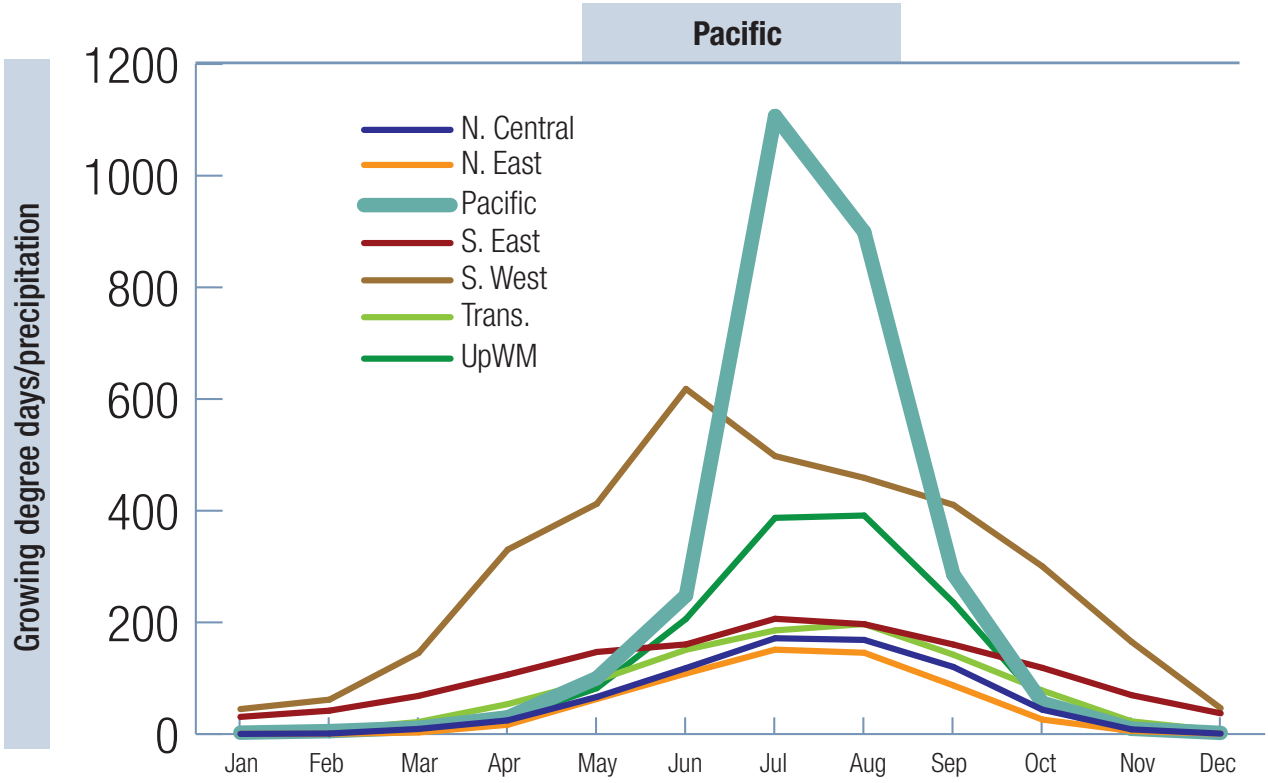


Figure 46. 30-yr monthly average growing degree days/precipitation in the Pacific region.

Southeast Region

Water Use

- Projected applied water was 43% less in 2024 than in 2005, resulting in a water savings of 389,004 acre-feet (**Figure 47**).
- Median applied water per facility declined from 194.8 acre-feet in 2005 to 145.8 acre-feet in 2024, a 25% reduction, but has remained static since 2013 (**Figure 48**).
- Median applied water per acre 1.7 in 2024, which was equivalent to 2005, but was significantly up since 2020 (**Figure 49**).
-

Water Sources

- In 2024, 17% of projected applied water was from municipal sources and 29% was sourced from wells (**Figure 50**).
- In 2024, 16% of projected applied water was sourced from recycled water. Use of recycled water for golf course irrigation has trended downward since 2013 (**Figure 50**).

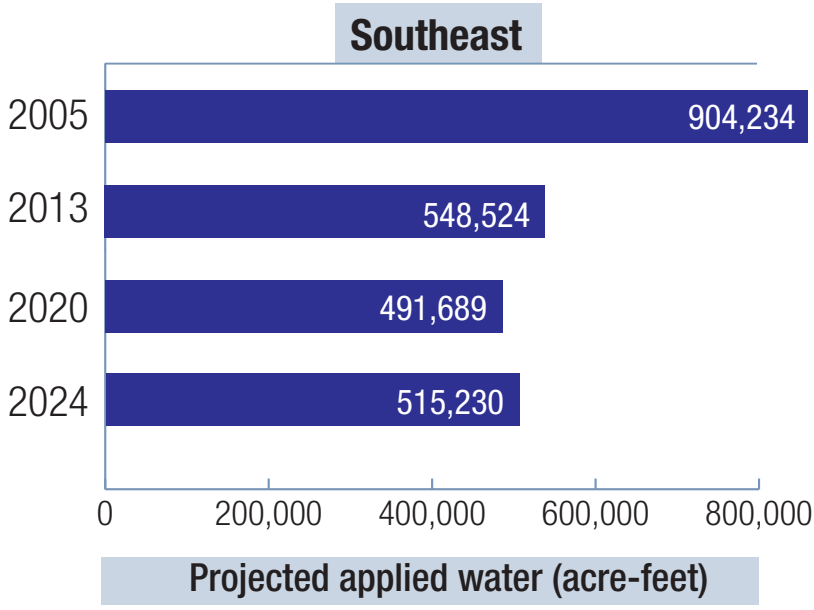


Figure 47. Projected water applied to U.S. golf facilities in the Southeast region in 2005, 2013, 2020, and 2024. Ref: Table 1

- The percentage of facilities using recycled water was 27.3% in 2024, which was equivalent to 2005 (**Figure 51**).
- Projected recycled water applied reduced from 145,611 acre-feet in 2005 to 125,855 acre-feet in 2024, a 13% reduction (**Figure 52**).

Irrigated Acres

- Projected irrigated acres decreased by 15% from 319,600 acres in 2005 to 272,729 acres in 2024 and has remained consistent since 2013 (**Figure 53**).
- Irrigated acres at 9-, 18-, and 27+-hole facilities decreased by 21%, 13%, and 16%, respectively, from 2005 to 2024 (**Figure 53**).
- Median irrigated acres were 90.9 in 2024 and were equivalent to 2005 (**Figure 54 and Table 15**).
- Median irrigated acres of roughs, practice areas, greens, tees, and landscape did not change since 2005, whereas the median irrigated acres of fairways decreased by 12% since 2005 (**Figure 54 and Table 15**).

Facility Influence

- Operational golf facilities in the Southeast Region declined since 2005 by 17% to 2,704 (**Table 16**).

Management Practices

- The frequency of most management practices either remained equivalent or increased since 2005. Some notable increases included using wetting agents, soil amendments, pruning tree roots, and changing to drought tolerant turfgrass (**Table 18**).

Regulations

- Required water use reporting and additional mandatory water restrictions remained unchanged since 2005, whereas recurring annual allocations increased from 34.8% to 43.3% of facilities (**Table 21**).
- The prevalence of facilities that had a written drought, water management, stormwater, or preventative irrigation maintenance plan was 30%, 17%, 23%, and 18%, respectively (**Table 22**).
- The use of soil moisture sensors had a somewhat positive or very positive impact on 100% of facilities in 2024 (**Table 23**).
- Water conservation was the most common factor (54%) motivating the decision to reduce irrigated acres (**Table 24**).
- 97% of golfers were receptive to any perceived change in course appearance resulting from a reduction of applied water (**Table 25**).
- The most common irrigation injection treatment was wetting agents used at 39% of facilities (**Table 27**).

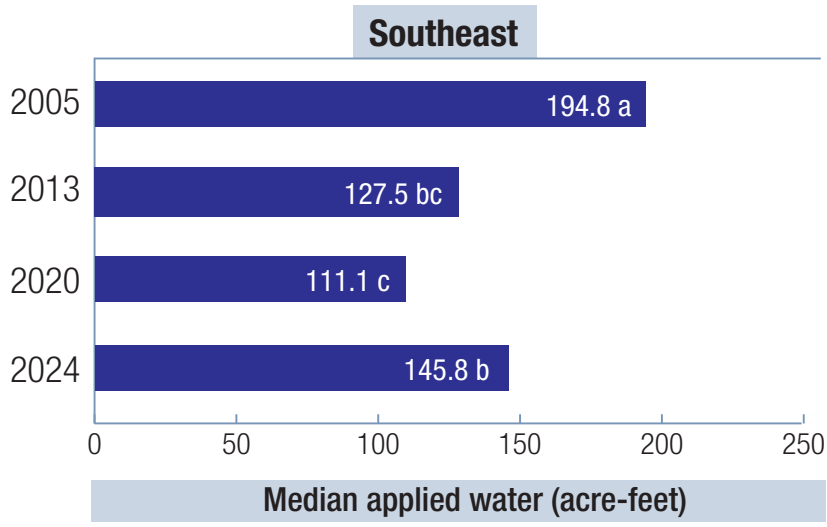


Figure 48. Median acre-feet of applied water on U.S. golf facilities in the Southeast region in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 2

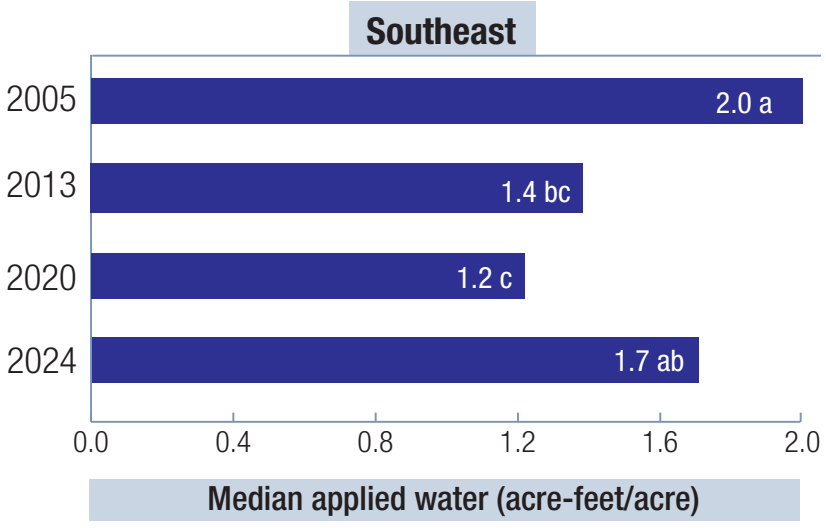


Figure 49. Median acre-feet per acre of applied water on U.S. golf facilities in the Southeast region in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 2

Water Testing

- The prevalence of facilities that had surface water and that tested their surface water were 96% and 47%, respectively, and has not changed since 2005 (**Table 28**).
- Among facilities that tested surface water, 51% tested once per year with the remaining facilities testing more frequently (**Table 29**).

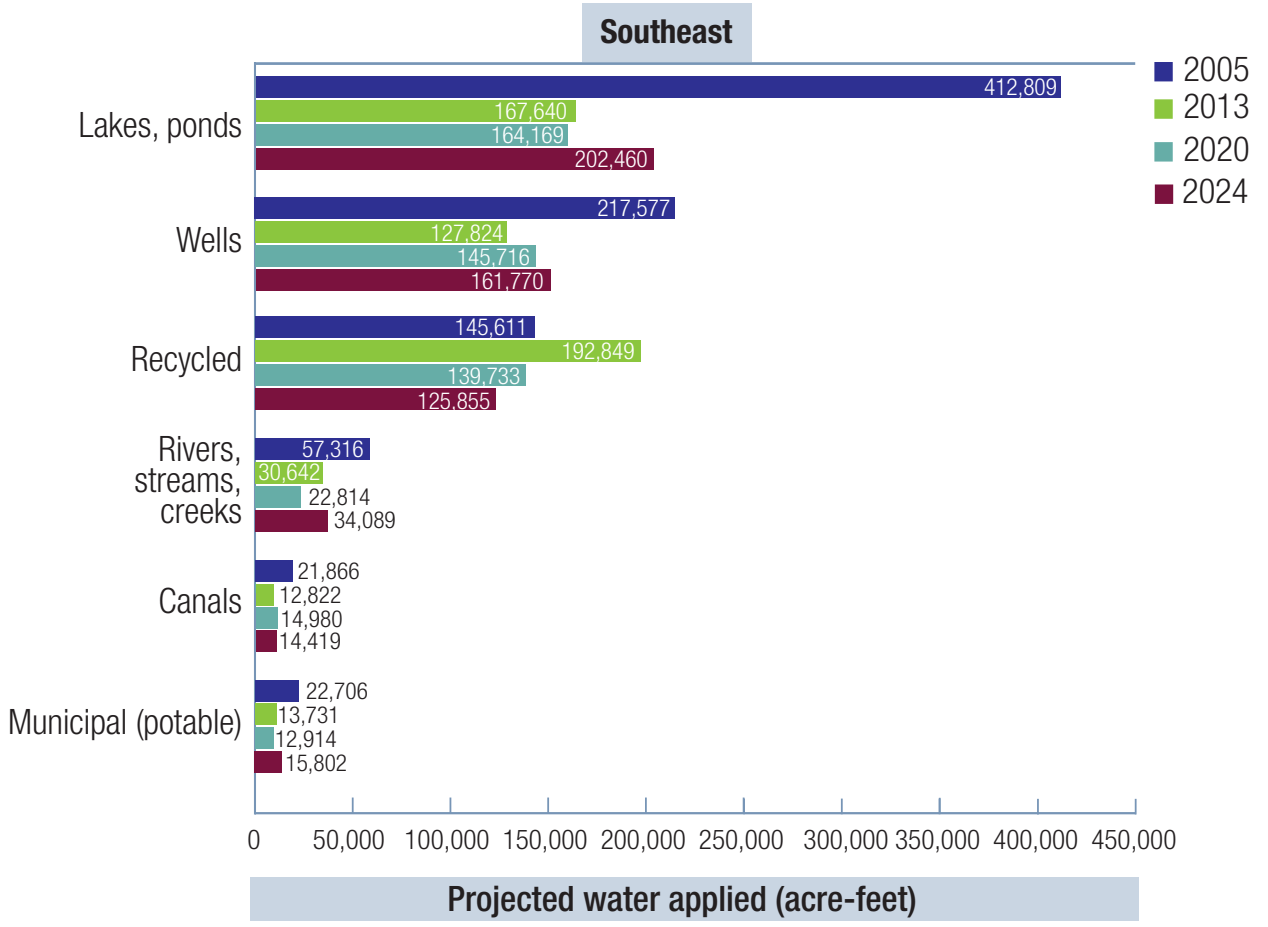


Figure 50. Projected water applied at U.S. golf facilities in the Southeast region by water source in 2005, 2013, 2020, and 2024. Ref: Table 5

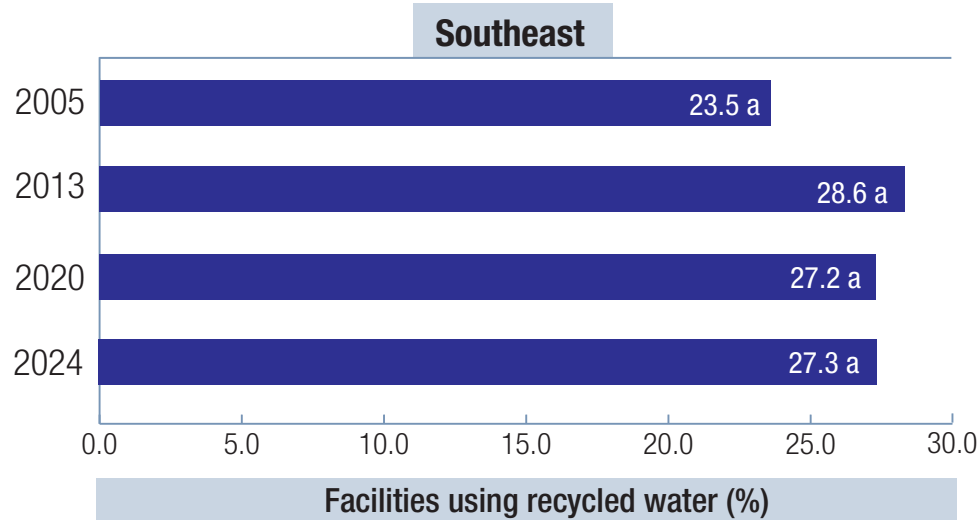


Figure 51. Percent of U.S. golf facilities in the Southeast region applying recycled water in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the chi-square test at the 10% significance level. Ref: Table 3

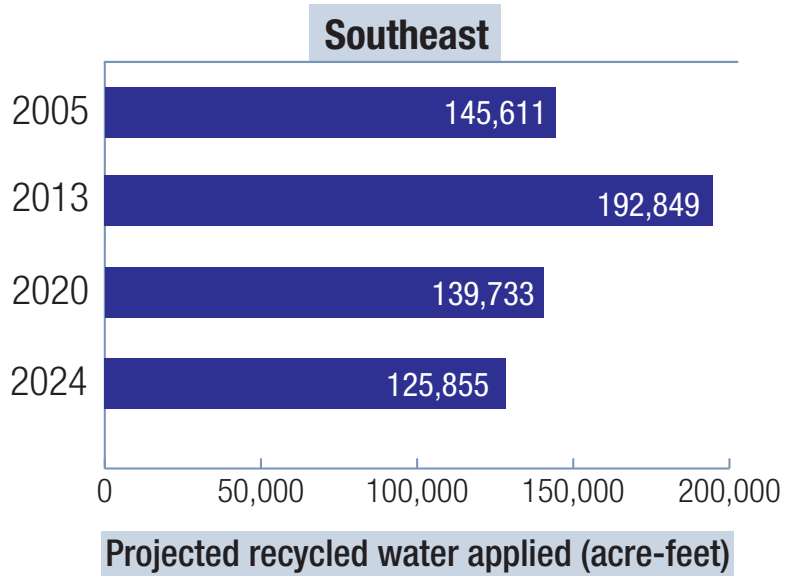


Figure 52. Projected recycled water applied to U.S. golf facilities in the Southeast region in 2005, 2013, 2020, and 2024. Ref: Table 3

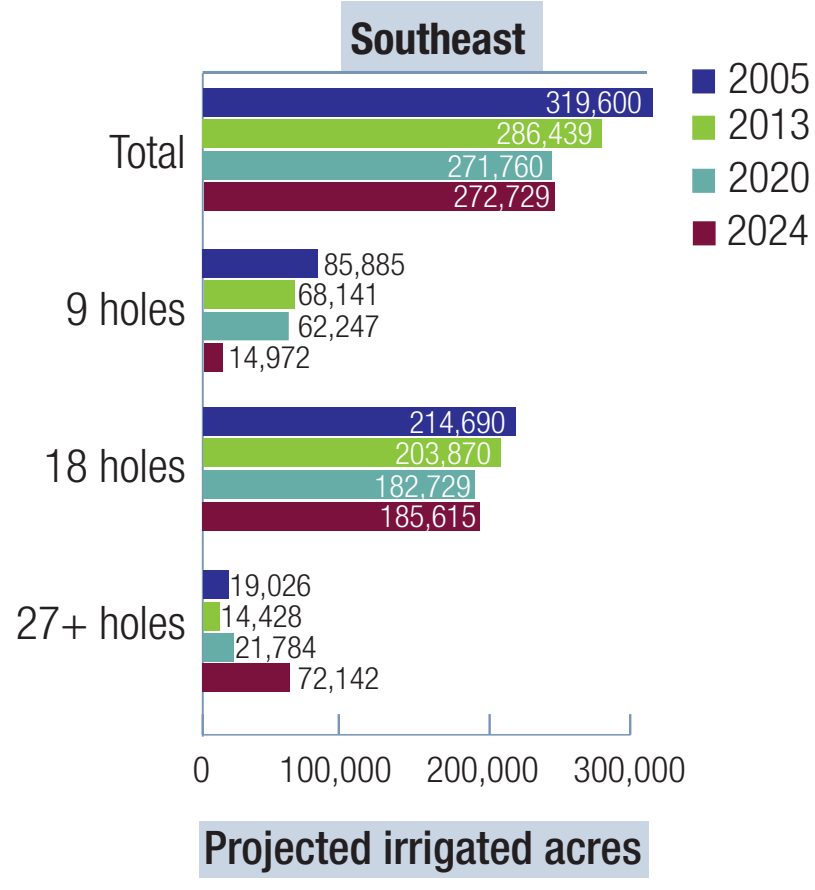


Figure 53. Projected irrigated acres of U.S. golf facilities in the Southeast region in 2005, 2013, 2020, and 2024. Ref: Table 4

- Among facilities that tested surface water, 86% had 1 or more surface water monitoring sites (**Table 30**).
- Among facilities that tested surface water, 81% tested for nutrients, which was the most common tested variable (**Table 31**).
- The prevalence of facilities that had ground water wells and that tested their ground water were 52% and 46%, respectively, and has not changed since 2005 (**Table 32**).
- Among facilities that tested ground water, 100% had 1 or more ground water monitoring sites (**Table 33**).
- Among facilities that tested ground water, 90% had 1 or more protected ground water wells (**Table 34**).
- Among facilities that tested ground water, 43% tested once per year with the remaining facilities testing more frequently (**Table 35**).
- Among facilities that tested ground water, 82% tested for nutrients, which was the most common tested variable (**Table 36**).
- Among facilities that tested ground water, 45% had 1 or more dedicated ground water monitoring sites in 2024 (**Table 37**).

Meteorological

- The Southeast experience 10.7 and 3.5 more weeks of abnormal and moderate drought in 2024 than in 2020, respective (**Table 8**). However, weeks of severe, extreme, and exceptional drought were approximately the same in 2024 as in 2020.
- Historical average monthly precipitation is relatively constant throughout the year ranging from 3.3 to 4.5 inches per month and is similar to the Northeast and Transition regions (**Figure 55**).
- Historical average monthly temperatures is greater each month than in other regions and ranges from 44° F in January to 79° F in July (**Figure 56**).
- Growing degree days are greater each month than other regions ranging from 112 in January to 920 in July (**Figure 57**).
- The greatest gap between growing degree days and historical precipitation occurs in July when 206 degree

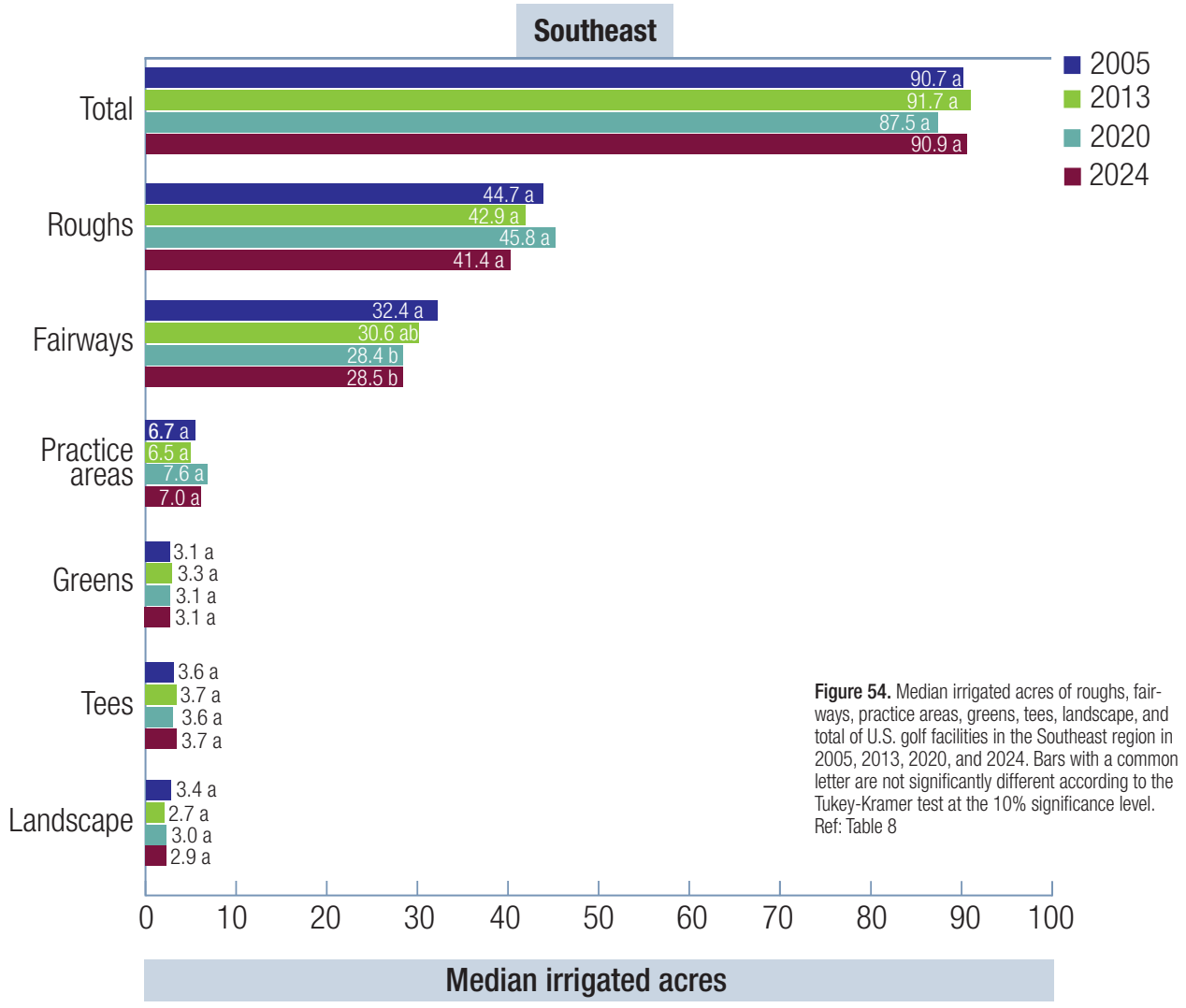


Figure 54. Median irrigated acres of roughs, fairways, practice areas, greens, tees, landscape, and total of U.S. golf facilities in the Southeast region in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 8

Table 8. Drought severity in the Southeast region in 2020 and 2024.

Drought	2020	2024	Δ
	Weeks		
Abnormal	17.0	27.7	10.7
Moderate	12.9	16.4	3.5
Severe	9.8	9.0	-0.8
Extreme	6.6	5.7	-0.9
Exceptional	4.5	4.1	-0.4

Abnormal = Going into drought, short-term dryness slowing planting, growth of crops and pastures; fire risk above average. Coming out of drought, some lingering water deficits, pastures or crops not fully recovered.

Moderate = Some damage to crops, pastures, fire risk high; streams, reservoirs or wells low, some water shortage developing or imminent, voluntary water use restrictions requested.

Severe = Crop or pasture loss likely, fire risk very high, water shortages common, water restrictions imposed.

Extreme = Major crop/pasture losses, extreme fire danger, widespread water shortages or restrictions.

Exceptional = Exceptional and widespread crop and pasture losses, exceptional fire risk, shortages of water in reservoirs, streams and wells causing water emergencies.

days is accompanied by 1 inch of rainfall (**Figure 58 and Table 41**). This ratio is similar to the North Central, Northeast, and Transition regions and indicates that turfgrass growing in the Southeast region may experience heat and moisture related stress and may not require as much supplemental irrigation as turfgrass growing in the Pacific, Southwest, or Upper West/Mountain regions.

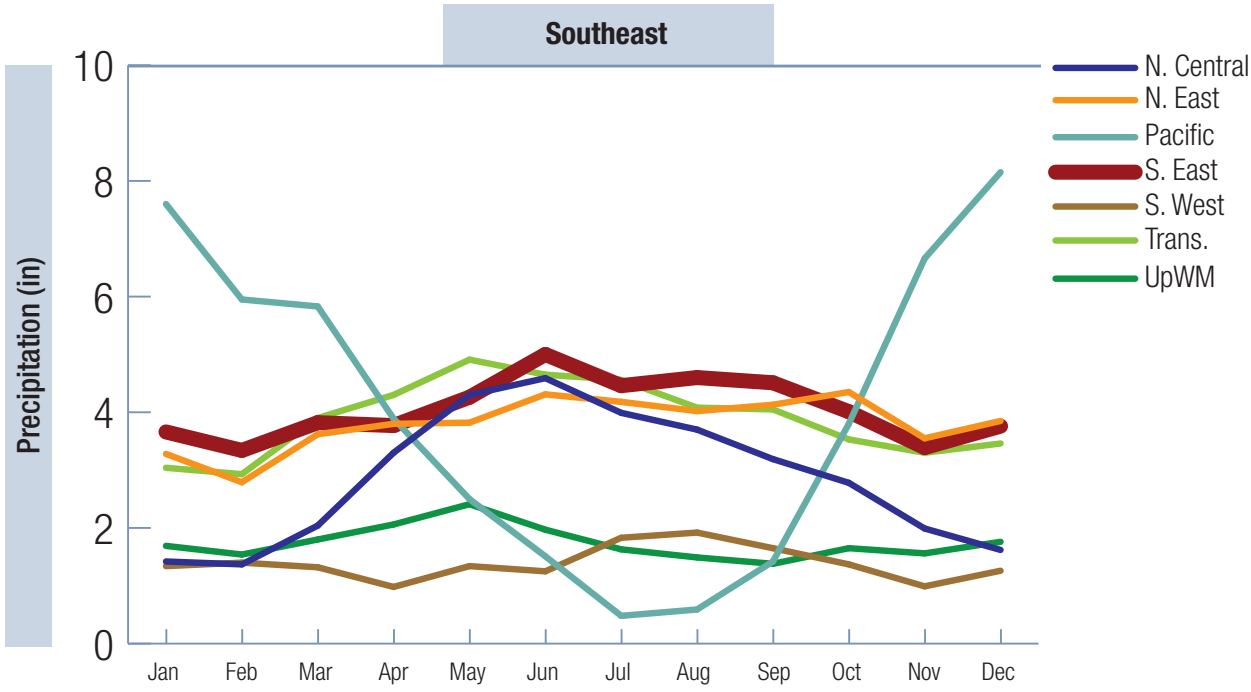


Figure 55. 30-yr monthly average precipitation in the Southeast region.

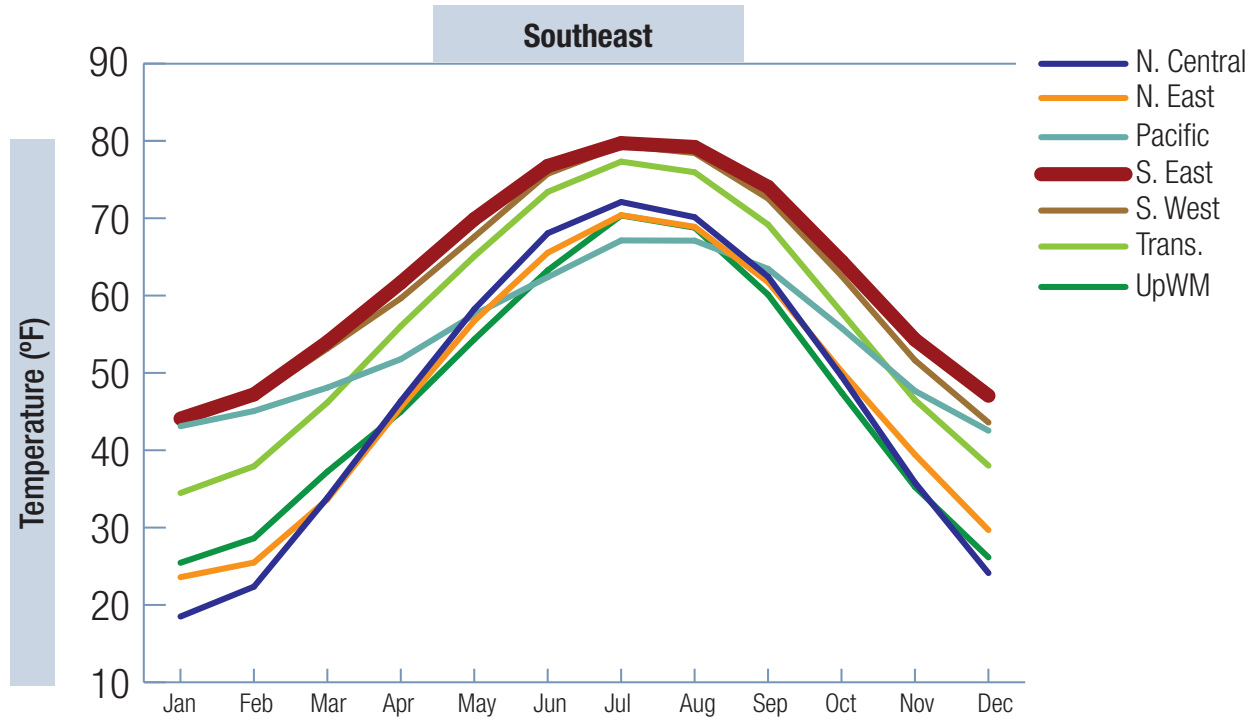


Figure 56. 30-yr monthly average temperature in the Southeast region.

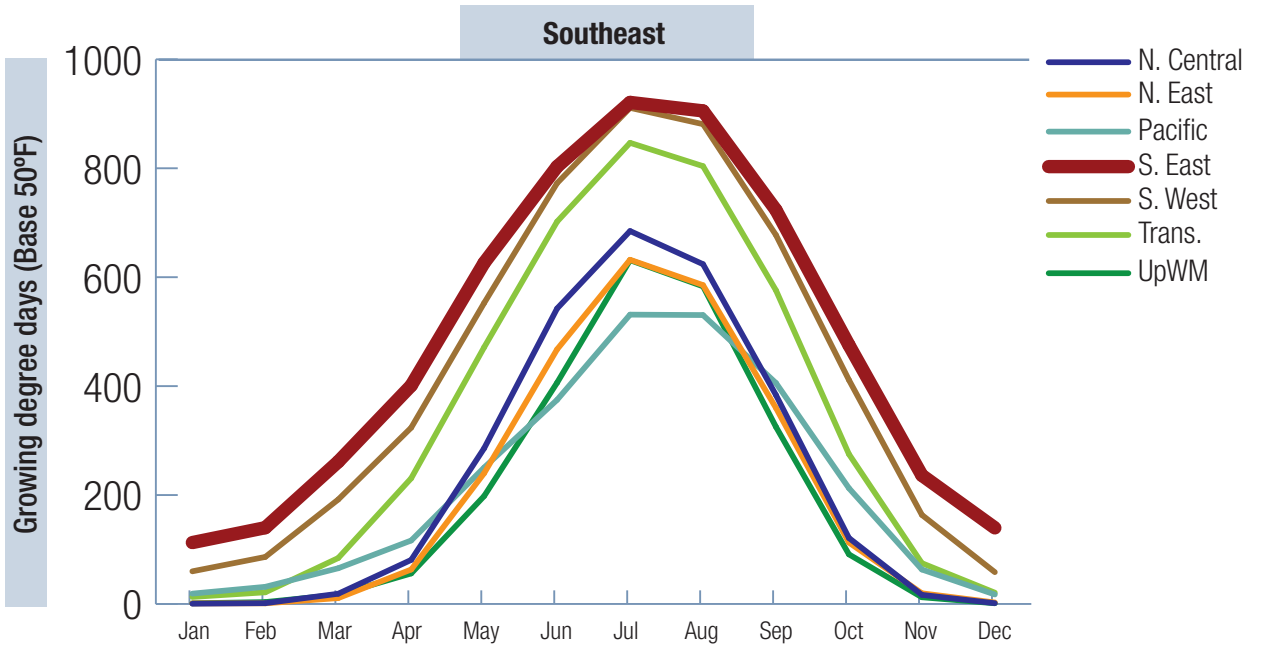


Figure 57. 30-yr monthly average growing degree days in the Southeast region.

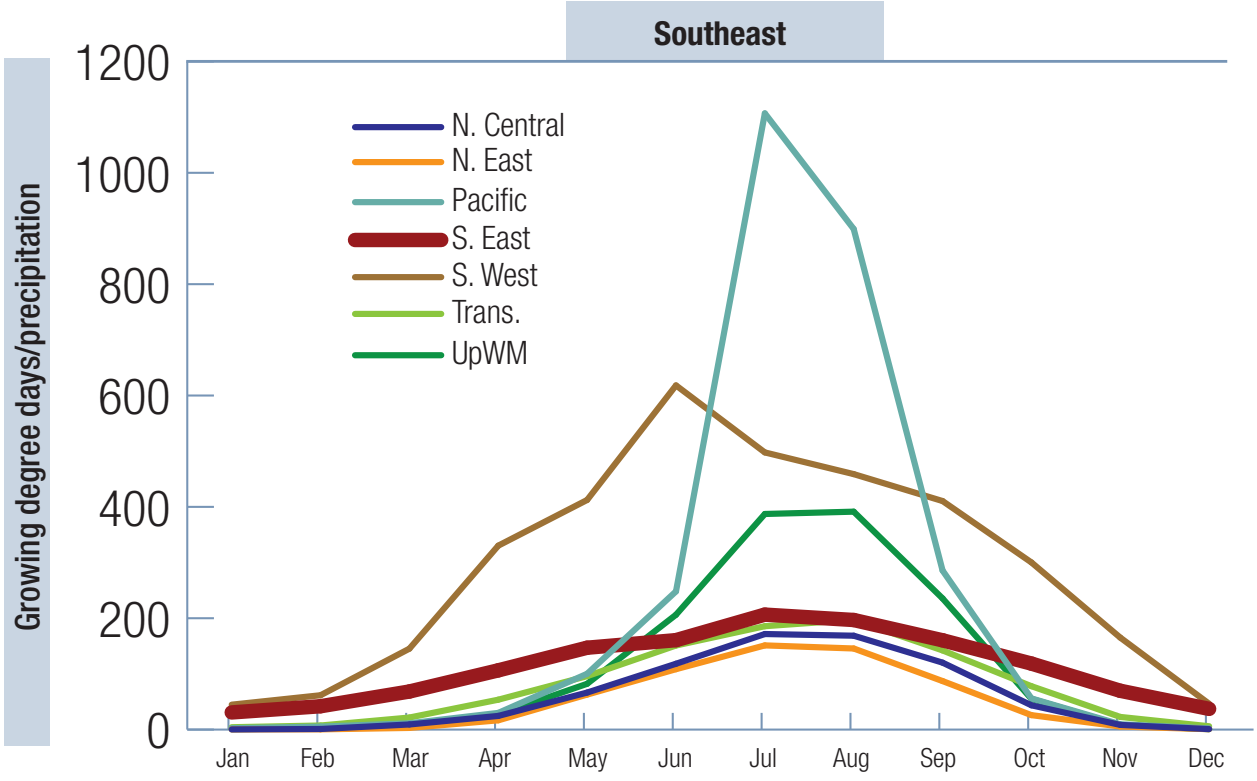


Figure 58. 30-yr monthly average growing degree days/precipitation in the Southeast region.

Southwest Region

Water Use

- Projected applied water was 23% less in 2024 than in 2005, resulting in a water savings of 125,978 acre-feet (**Figure 59**).
- Median applied water per facility was 300.3 acre-feet in 2024 and was equivalent to 2005 (**Figure 60**).
- Median applied water per acre was 3.3 in 2024, which was equivalent to 2005 (**Figure 61**).

Water Sources

- In 2024, 36% of projected applied water was sourced from wells and 17% was sourced from municipal water (**Figure 62**).
- In 2024, 33% of projected applied water was sourced from recycled water (**Figure 62**).
- The percentage of facilities using recycled water was 34.2% in 2024, which was equivalent to 2005 (**Figure 63**).
- Projected recycled water applied declined from 151,653 acre-feet in 2005 to 113,657 acre-feet in 2024, a 25% decrease (**Figure 64**).

Irrigated Acres

- Projected irrigated acres declined by 18% from 136,321 acres in 2005 to 111,164 acres in 2024 (**Figure 65**).
- Irrigated acres at 9-hole facilities increased by 43%, whereas irrigate acres at 18- and 27+-hole facilities declined by 23% and 21%, respectively (**Figure 65**).
- Median irrigated acres has steadily declined from 104.2 in 2005 to 87.5 in 2024 (**Figure 66 and Table 15**).
- Median irrigated acres of roughs, practice areas, greens, tees, and landscape did not change since 2005, whereas the median irrigated acres of fairways has steadily declined by 17% to 27.8 in 2005 (**Figure 66 and Table 15**).
- Facility Influence
- Operational golf facilities in the Southwest Region declined by 7% to 1,133 since 2005 (**Table 16**).
- Management Practices
- The frequency of many management practices increased since 2005. Some notable increases included using wet-

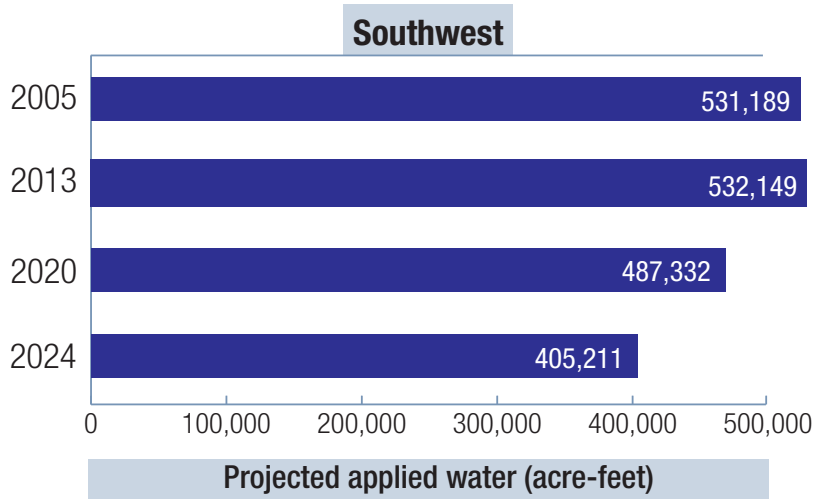


Figure 59. Projected water applied to U.S. golf facilities in the Southwest region in 2005, 2013, 2020, and 2024. Ref: Table 1

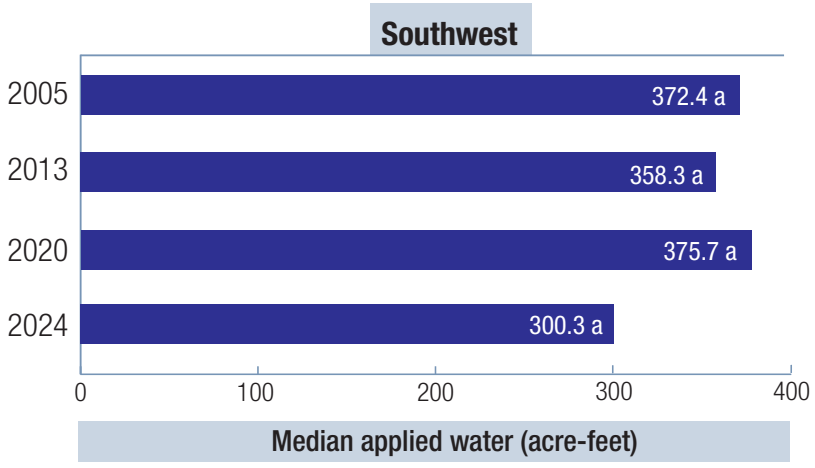


Figure 60. Median acre-feet of applied water on U.S. golf facilities in the Southwest region in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 2

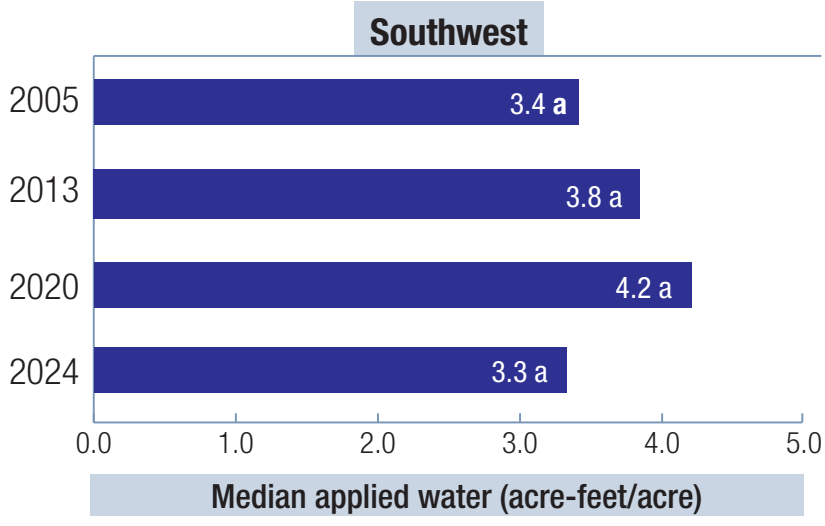


Figure 61. Median acre-feet per acre of applied water on U.S. golf facilities in the Southwest region in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 2

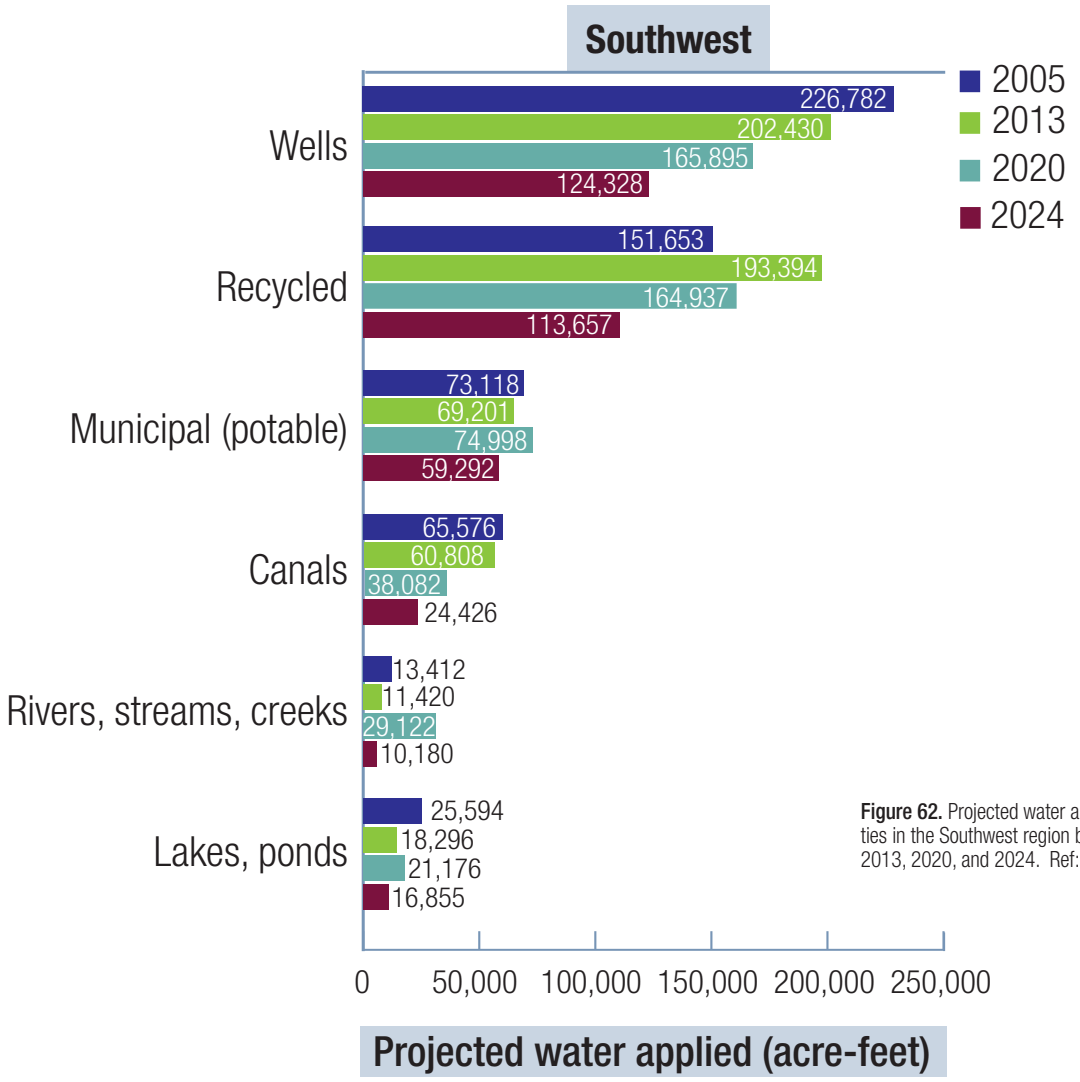


Figure 62. Projected water applied at U.S. golf facilities in the Southwest region by water source in 2005, 2013, 2020, and 2024. Ref: Table 5

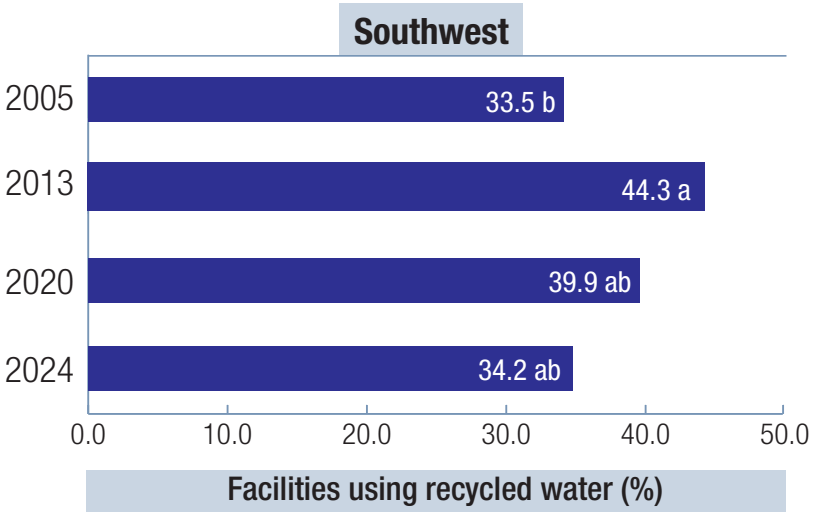


Figure 63. Percent of U.S. golf facilities in the Southwest region applying recycled water in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the chi-square test at the 10% significance level. Ref: Table 3

ting agents, hand-watering, using soil amendments, reducing irrigated acres, and changing to drought tolerant turfgrass (**Table 18**).

Regulations

- Required water use reporting and recurring annual allocations remained unchanged since 2005, whereas the frequency of additional mandatory water restriction nearly tripled to 30% of facilities with notable increase since 2020 (**Table 21**).
- The prevalence of facilities that had a written drought, water management, stormwater, or preventative irrigation maintenance plan was 35%, 29%, 35%, and 44%, respectively (**Table 22**).

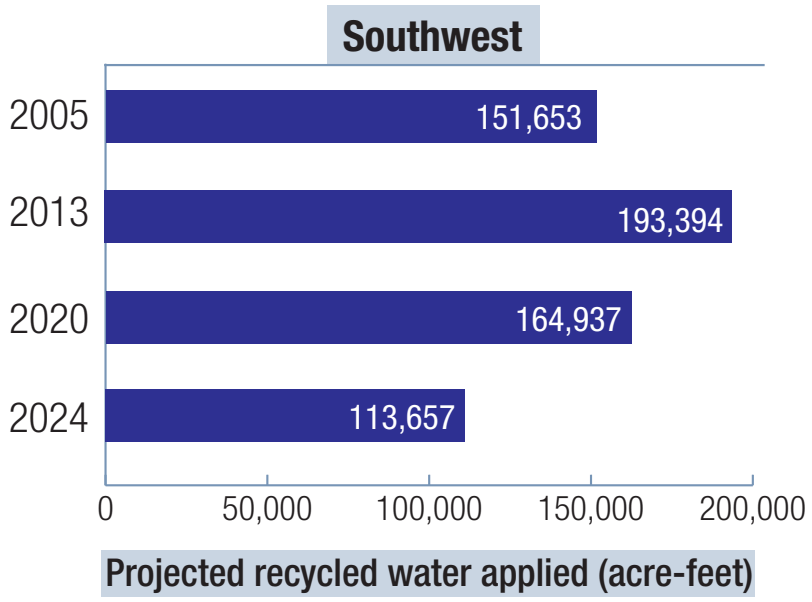


Figure 64. Projected recycled water applied to U.S. golf facilities in the Southwest region in 2005, 2013, 2020, and 2024. Ref: Table 3

Miscellaneous

- The use of soil moisture sensors had a somewhat positive or very positive impact on 79% of facilities in 2024 (**Table 23**). A notable 21% of Southwest Region golf course superintendents report no positive impact of using soil moisture sensors.
- Water conservation was the most common factor (65%) motivating the decision to reduce irrigated acres (**Table 24**).
- 84% of golfers were receptive to any perceived change in course appearance resulting from a reduction of applied water (**Table 25**). Superintendents perceive that golfers in the Southwest Region are least receptive to changes in course appearance and playability due to reduced water use.
- The most common irrigation injection treatment was wetting agents used at 51% of facilities, the highest of any region (**Table 27**).

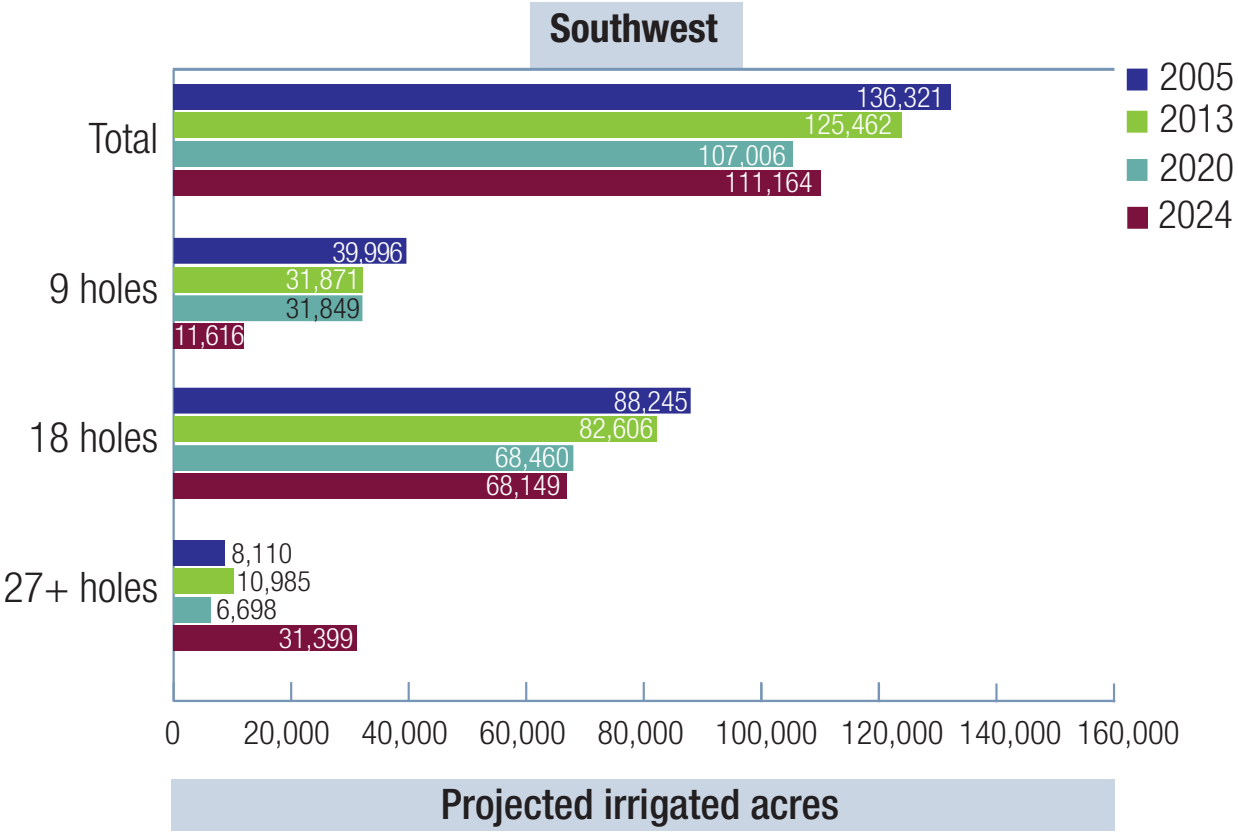


Figure 65. Projected irrigated acres of U.S. golf facilities in the Southwest region in 2005, 2013, 2020, and 2024. Ref: Table 4

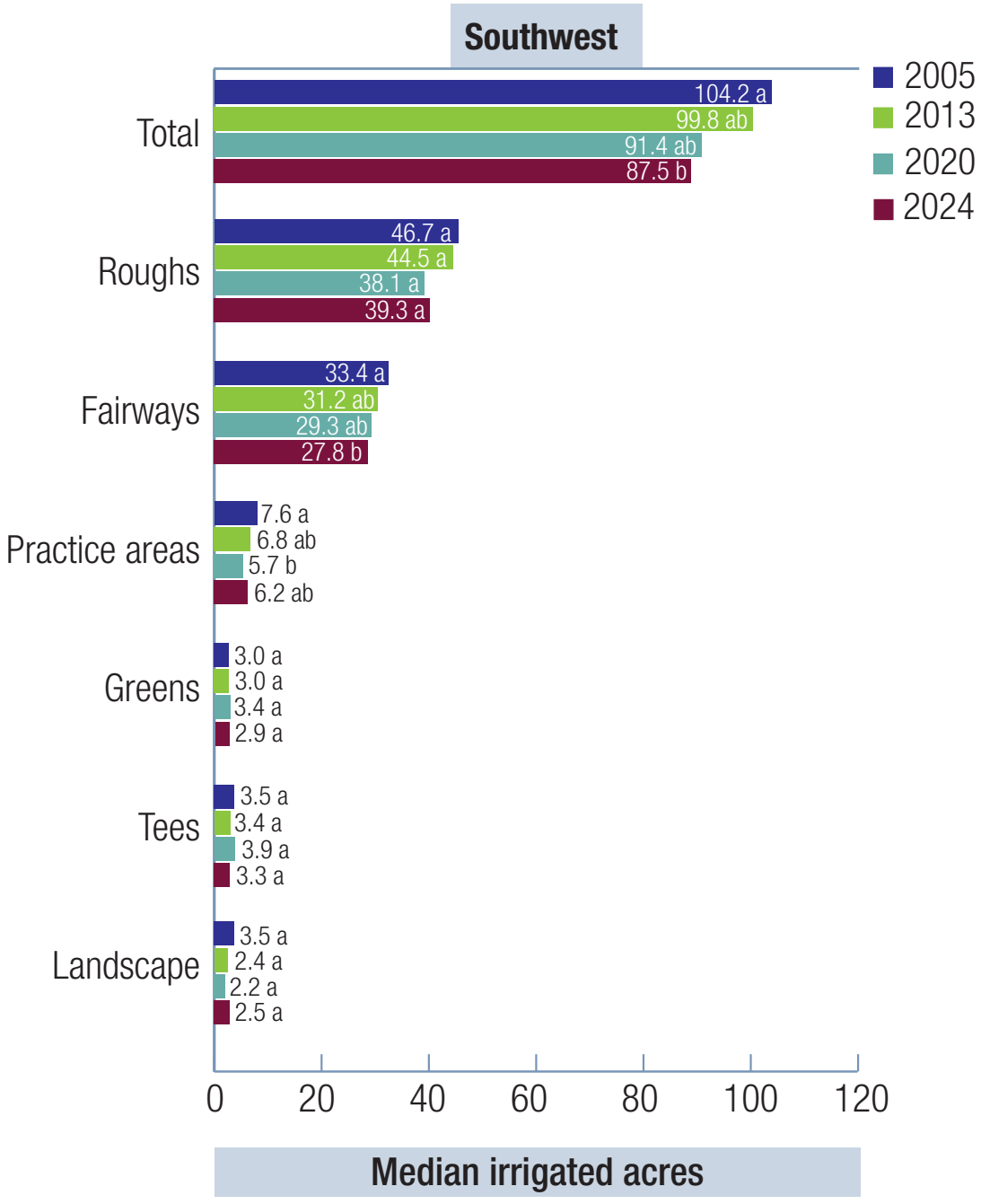


Figure 66. Median irrigated acres of roughs, fairways, practice areas, greens, tees, landscape, and total of U.S. golf facilities in the Southwest region in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 8

Water Testing

- The prevalence of facilities that had surface water was 77% and did not change since 2005, however the percentage of facilities that tested their surface water declined to 46% in 2024 (**Table 28**).
- Among facilities that tested surface water, 28% tested once per month with the remaining facilities testing less frequently (**Table 29**).
- Among facilities that tested surface water, 87% had 1 or more surface water monitoring sites (**Table 30**).
- Among facilities that tested surface water, 71% tested for nutrients, which was the most common tested variable (**Table 31**).
- The prevalence of facilities that had ground water wells and that tested their ground water were 45% and 59%, respectively, and has not changed since 2005 (**Table 32**).
- Among facilities that tested ground water, 100% had 1 or more ground water monitoring sites (**Table 33**).
- Among facilities that tested ground water, 94% had 1 or more protected

Table 9. Drought severity in the Southwest region in 2020 and 2024.

Drought	2020	2024	Δ
	Weeks		
Abnormal	39.5	43.0	3.4
Moderate	31.7	31.9	0.2
Severe	24.0	23.3	-0.7
Extreme	17.0	17.6	0.6
Exceptional	9.8	18.5	8.7

Abnormal = Going into drought, short-term dryness slowing planting, growth of crops and pastures; fire risk above average. Coming out of drought, some lingering water deficits, pastures or crops not fully recovered.

Moderate = Some damage to crops, pastures, fire risk high; streams, reservoirs or wells low, some water shortage developing or imminent, voluntary water use restrictions requested.

Severe = Crop or pasture loss likely, fire risk very high, water shortages common, water restrictions imposed.

Extreme = Major crop/pasture losses, extreme fire danger, widespread water shortages or restrictions.

Exceptional = Exceptional and widespread crop and pasture losses, exceptional fire risk, shortages of water in reservoirs, streams and wells causing water emergencies.

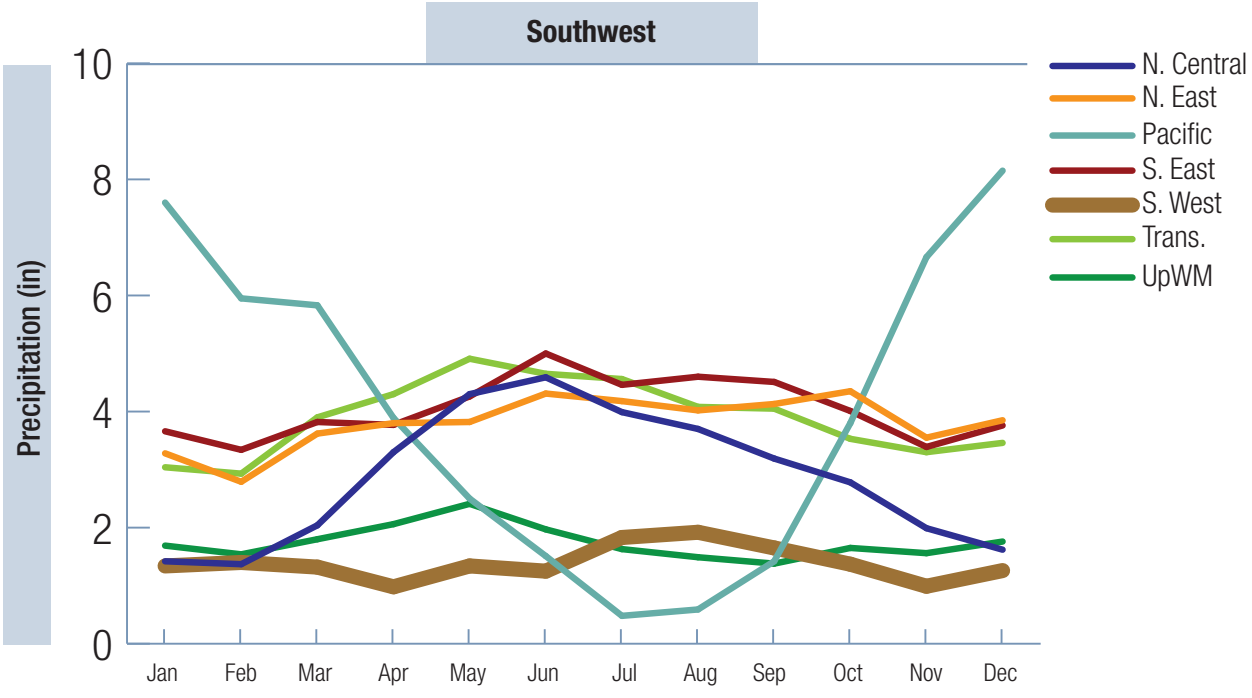


Figure 67. 30-yr monthly average precipitation in the Southwest region.

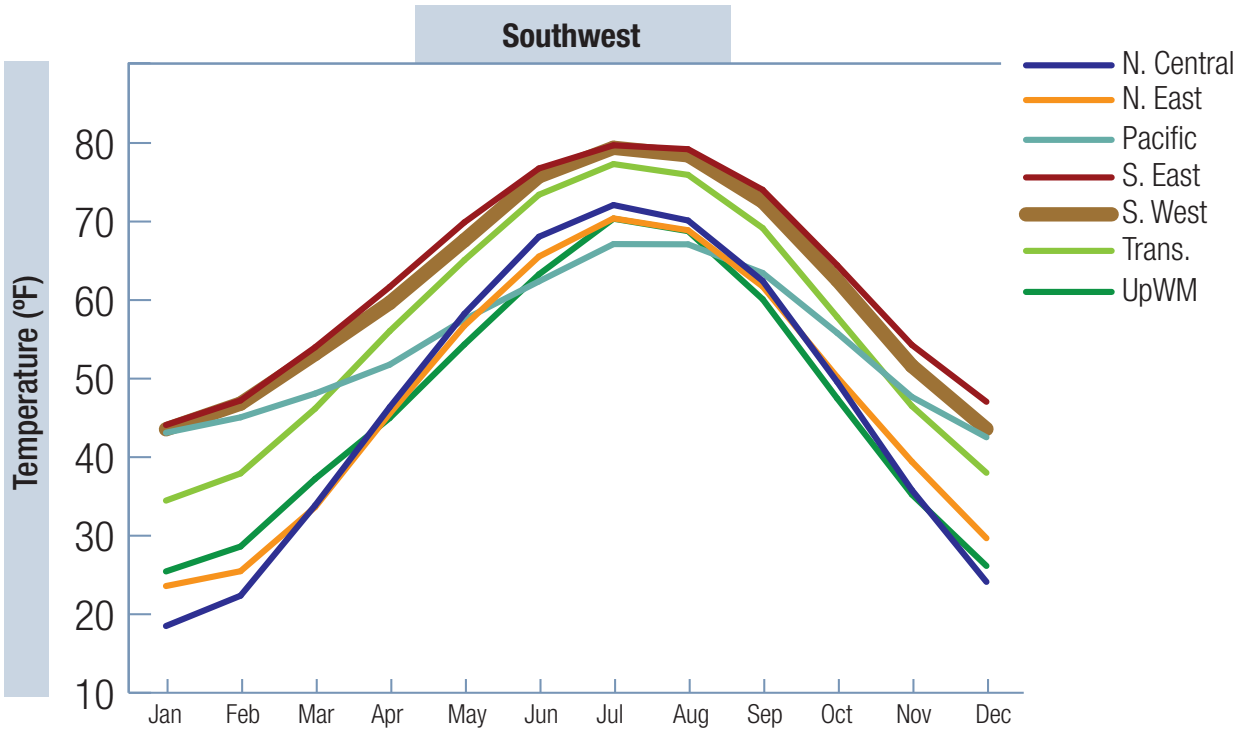


Figure 68. 30-yr monthly average temperature in the Southwest region.

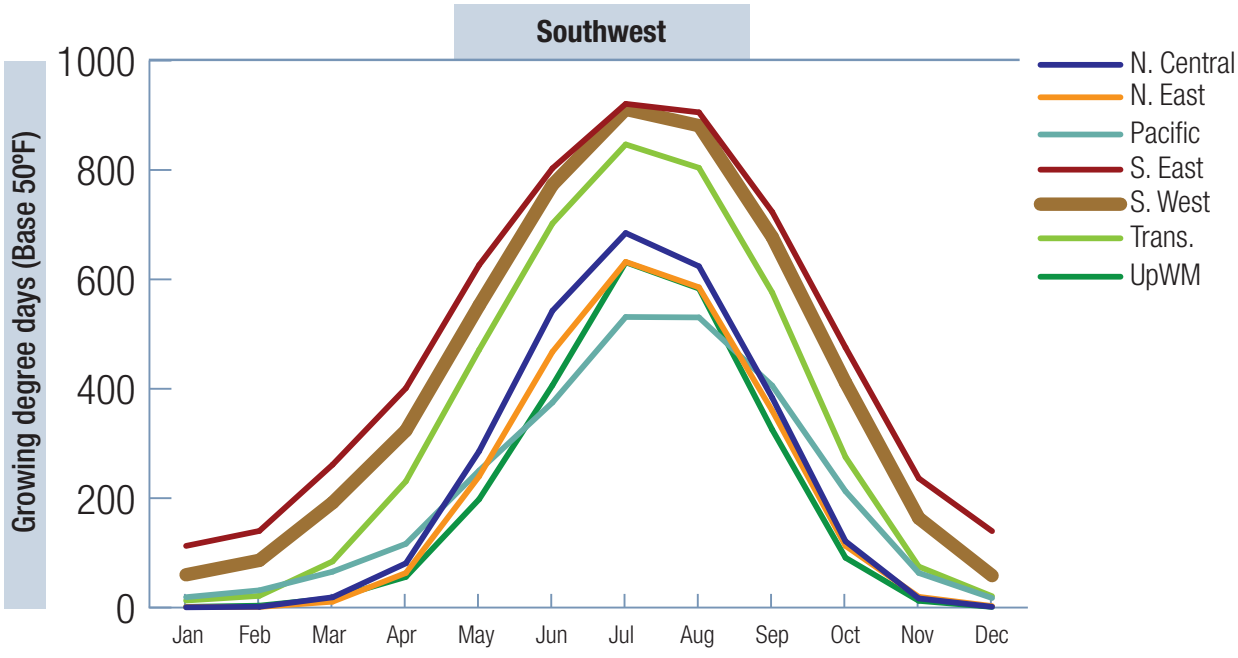


Figure 69. 30-yr monthly average growing degree days in the Southwest region.

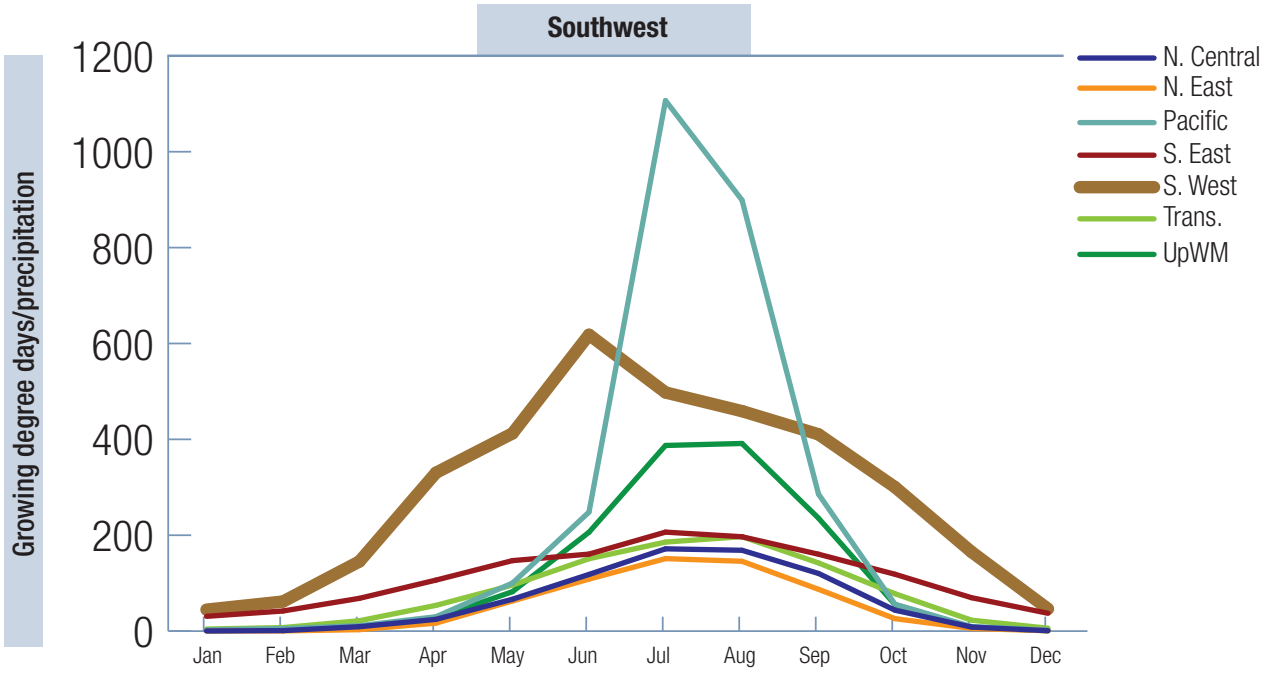


Figure 70. 30-yr monthly average growing degree days/precipitation in the Southwest region.

ground water wells (**Table 34**).

- Among facilities that tested ground water, 37% tested once per year with the remaining facilities testing more frequently (**Table 35**).
- Among facilities that tested ground water, 52% tested for bacteria, which was the most common tested variable (**Table 36**).
- Among facilities that tested ground water, 82% had 1 or more dedicated ground water monitoring sites in 2024 (**Table 37**).

Meteorological

- The Southwest experienced 3.4 more weeks of abnormal drought and 8.7 more weeks of exceptional drought in 2024 than in 2005 (**Table 9**).
- Historical average monthly precipitation is relatively constant throughout the year ranging from 1.0 inch in November to 1.9 inches in August resulting in the least amount of annual precipitation of any region (16.6 inches) (**Figure 67**).
- Historical average monthly temperatures are nearly equal each month to that of the Southeast region with minimum and maximums of 44° F and 79° F occurring in January and July respectively (**Figure 68**).
- Growing degree days are second only to the Southeast each month ranging from 58 to 910 in January and July, respectively (**Figure 69**).
- The greatest gap between growing degree days and historical precipitation occurs in June when 618 degree days is accompanied by 1 inch of rainfall (**Figure 70 and Table 41**). This ratio is greater than all other regions except the Pacific region and indicates that turfgrass growing in the Southwest region may experience significant heat and moisture-related stress and may require greater supplemental irrigation than turfgrass growing in the North Central, Northeast, Southeast, Transition, or Upper West/Mountain regions.

Transition Region

Water Use

- In 2024, projected applied water was 32% lower than in 2005, representing a reduction of 78,777 acre-feet (**Figure 71**).
- In 2024, the median amount of applied water per facility was 53.9 acre-feet, matching the value recorded in 2005 with a notable increase since 2020. (**Figure 72**).
- Median applied water per acre dropped from 1.0 acre-feet in 2005 to 0.7 in 2024, a 30% decrease. (**Figure 73**). However, median applied water per acre has remained static since 2013.

Water Sources

- In 2024, 41% of projected applied water was sourced from lakes and ponds and 21% was sourced from wells (**Figure 74**).
- In 2024, 9% of projected applied water was sourced from recycled water (**Figure 74**).
- Since 2020, notable increases in water from river, streams and creeks was reported (88%) and potable (36%) (**Figure 74**).
- The percentage of facilities using recycled water has steadily increased from 5.3% in 2005 to 10.3% in 2024 (**Figure 75**).
- Projected recycled water applied increased from 12,682 acre-feet in 2005 to 14,769 acre-feet in 2024, a 16% increase (**Figure 76**).

Irrigated Acres

- Projected irrigated acres declined by 6% from 203,124 acres in 2005 to 191,106 acres in 2024 (**Figure 77**).
- Irrigated acres at 9- facilities increased by 64%, whereas irrigated acres at 18- and 27+-hole facilities decreased by

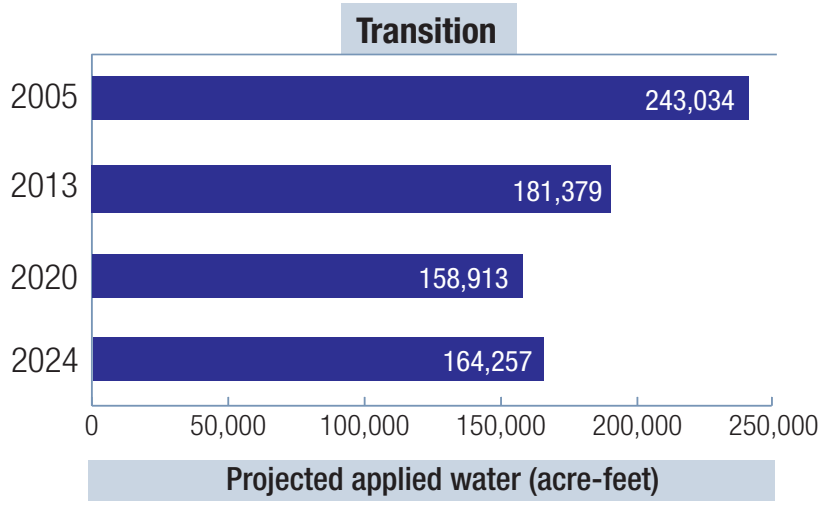


Figure 71. Projected water applied to U.S. golf facilities in the Transition region in 2005, 2013, 2020, and 2024. Ref: Table 1

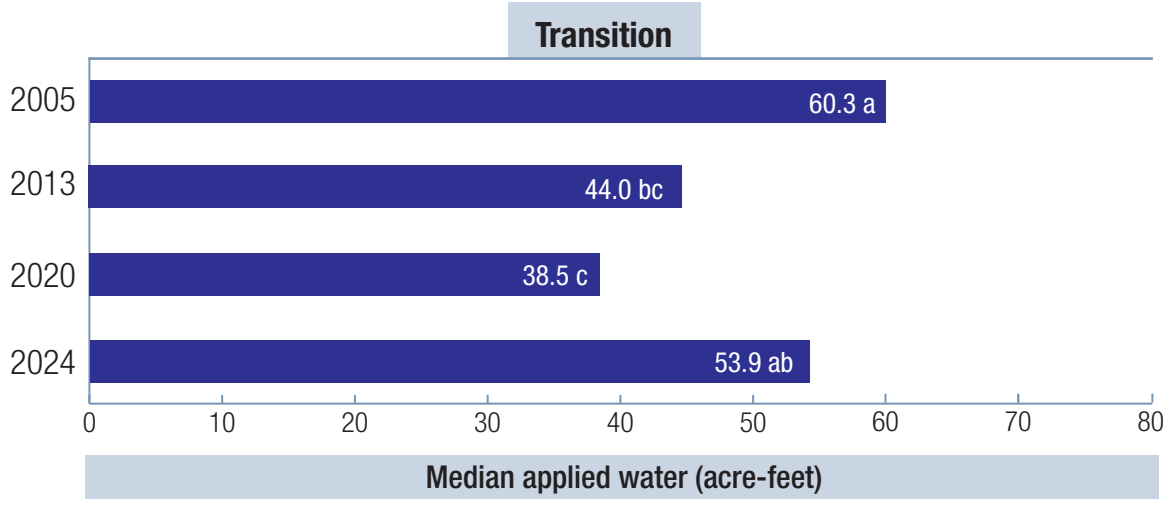


Figure 72. Median acre-feet of applied water on U.S. golf facilities in the Transition region in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 2

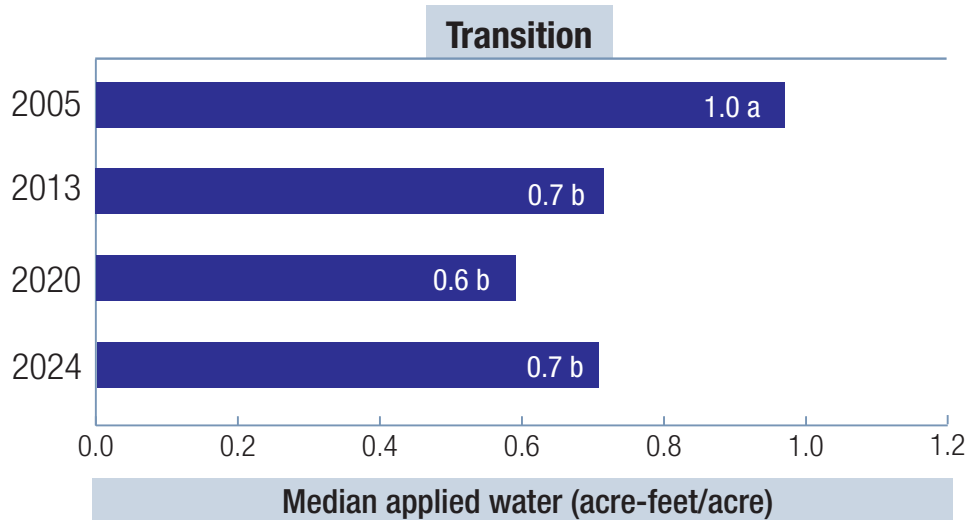


Figure 73. Median acre-feet per acre of applied water on U.S. golf facilities in the Transition region in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 2

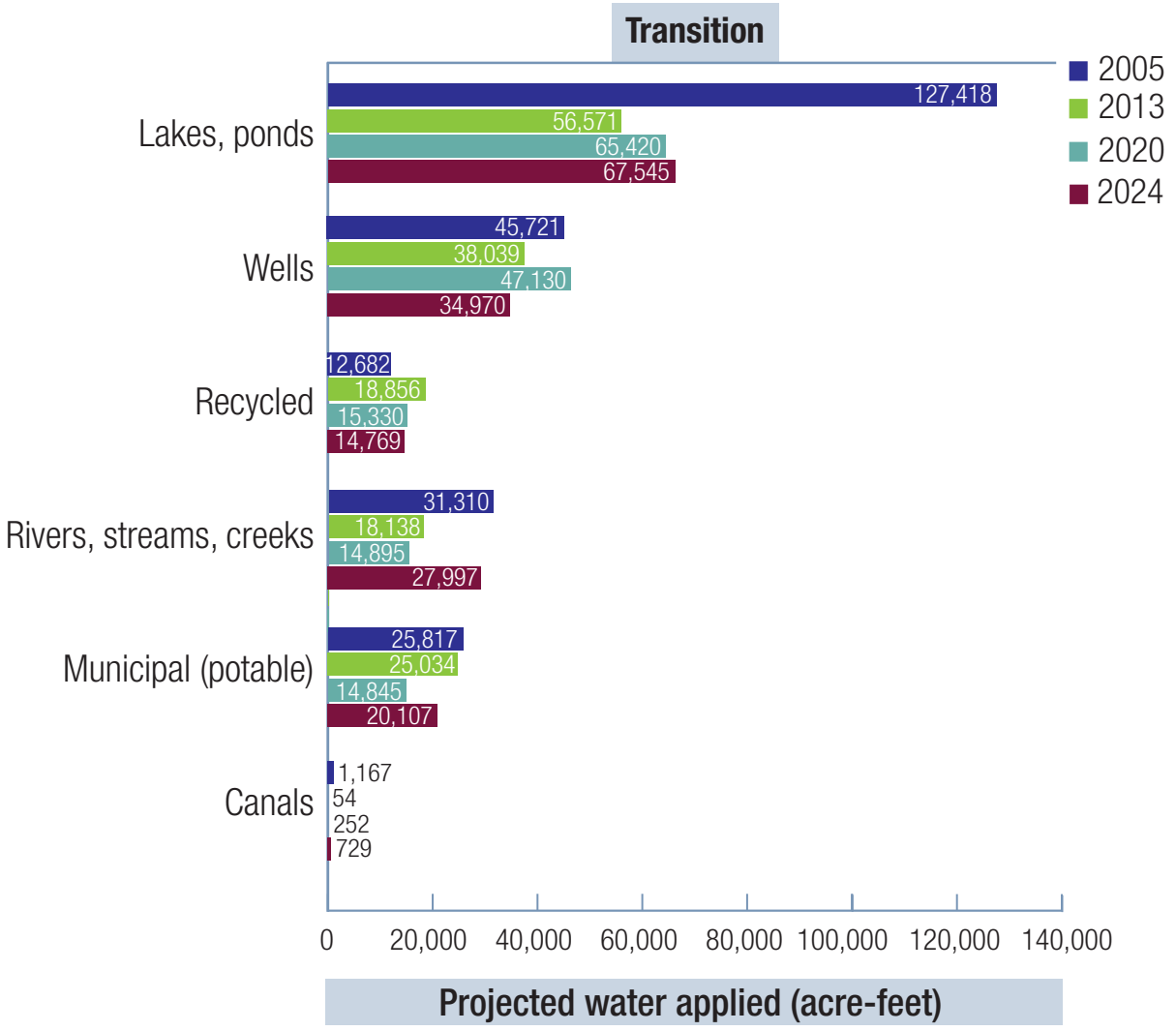


Figure 74. Projected water applied at U.S. golf facilities in the Transition region by water source in 2005, 2013, 2020, and 2024. Ref: Table 5

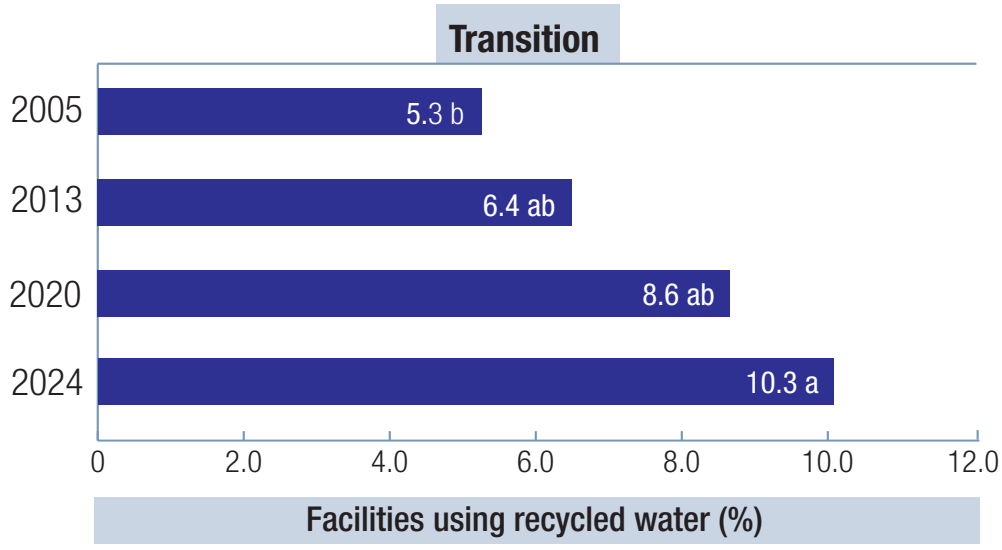


Figure 75. Percent of U.S. golf facilities in the Transition region applying recycled water in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the chi-square test at the 10% significance level. Ref: Table 3

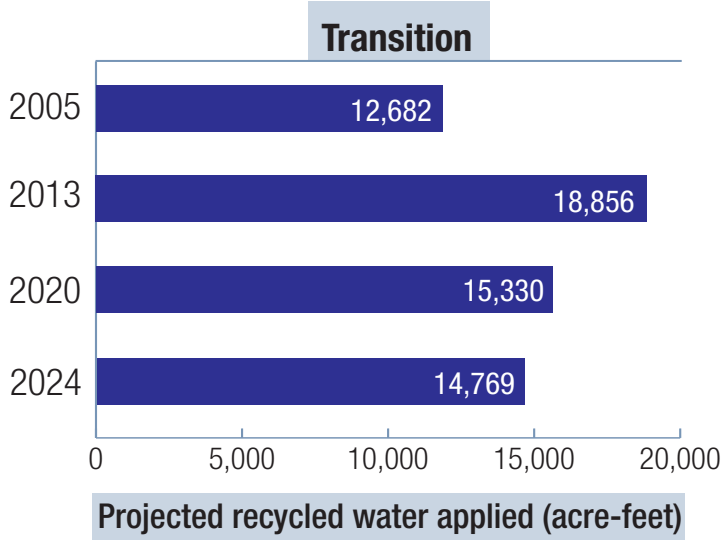


Figure 76. Projected recycled water applied to U.S. golf facilities in the Transition region in 2005, 2013, 2020, and 2024. Ref: Table 3

12% and 13% (**Figure 77**).

- Median irrigated acres increased by 29% since 2005 to 68.6 acres in 2024 (**Figure 78 and Table 15**).
- Median irrigated acres of roughs, fairways, practice areas, greens, and landscape did not change since 2005, whereas the median irrigated acres of tees increased 23% since 2005, most notably since 2020 (**Figure 78 and Table 15**).

Facility Influence

- Operational golf facilities in the Transition Region declined since 2005 by 16% to 2,490 (**Table 16**).

Management Practices

- The frequency of the most common management practices did not change since 2005. However, some notable increases included using soil amendments, adjusting irrigation scheduling, and pruning tree roots (**Table 18**).

Regulations

- Required water use reporting increased to 51%, recurring annual allocations were unchanged at 13%, and additional mandatory water restrictions decreased to 5.4% since 2005 (**Table 21**). The Transition Region is the second least restrictive region behind the Upper West/Mountain Region.
- The prevalence of facilities that had a written drought, water management, stormwater, or preventative irrigation maintenance plan was 31%, 11%, 17%, and 16%, respectively (**Table 22**).
- The use of soil moisture sensors had a somewhat positive or very positive impact on 96% of facilities in 2024 (**Table 23**).
- Water conservation was the most common factor (66%) motivating the decision to reduce irrigated acres (**Table 24**).

- 92% of golfers were receptive to any perceived change in course appearance resulting from a reduction of applied water (**Table 25**).
- The most common irrigation injection treatment was wetting agents used at 26% of facilities (**Table 27**).

Water Testing

- The prevalence of facilities that had surface water in 2024 was equivalent to 2005 at 95%, but those that tested their surface water increased to 51% (**Table 28**).
- Among facilities that tested surface water, 59% tested once per year with the remaining facilities testing more frequently (**Table 29**).
- Among facilities that tested surface water, 85% had 1 or more surface water monitoring sites (**Table 30**).
- Among facilities that tested surface water, 84% tested for nutrients, which was the most common tested variable (**Table 31**).
- The prevalence of facilities that had ground water wells was 46% and did not change since 2005, but those that tested their ground water declined to 35% (**Table 32**).
- Among facilities that tested ground water, 100% had 1 or more ground water monitoring sites (**Table 33**).
- Among facilities that tested ground water, 89% had 1 or more protected ground water wells (**Table 34**).
- Among facilities that tested ground water, 38% tested once per year with the remaining facilities testing more frequently (**Table 35**).
- Among facilities that tested ground water, 69% tested for nutrients, which was the most common tested variable (**Table 36**).
- Among facilities that tested ground water, 60% had 1 or more dedicated ground water monitoring sites in 2020 (**Table 37**).

Meteorological

- The Transition region experienced more weeks of drought in 2024 than in 2005 (**Table 10**). Specifically, abnormal, moderate, extreme, and exceptional drought were 20.9, 9.0, 2.4 and 6.9 weeks greater in 2024 than 2005, respectively.

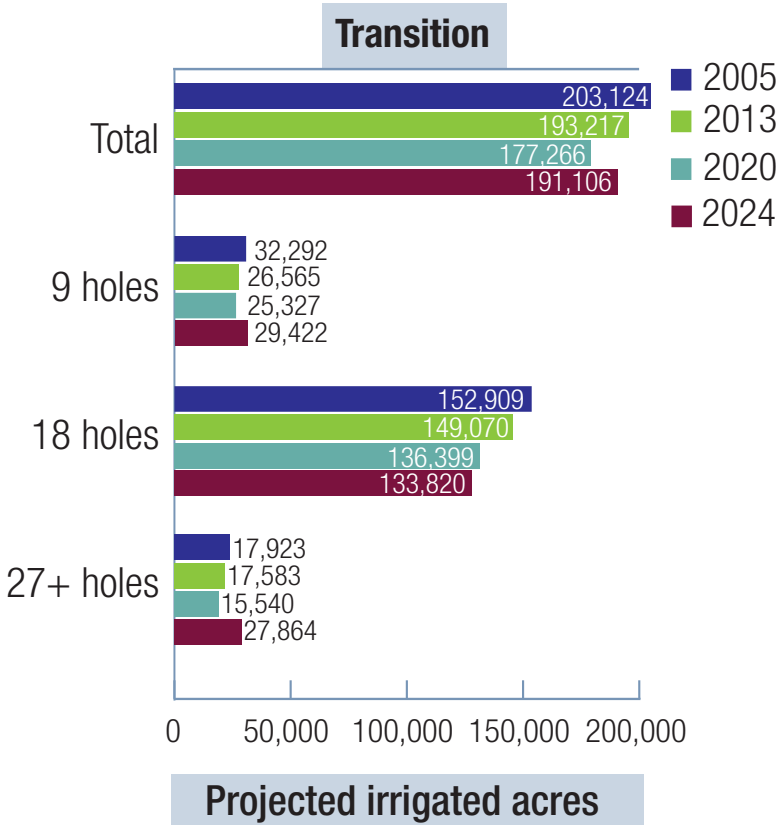


Figure 77. Projected irrigated acres of U.S. golf facilities in the Transition region in 2005, 2013, 2020, and 2024. Ref: Table 4

- Historical average monthly precipitation is relatively constant throughout the year ranging from 3.0 inches in February to 4.9 inches in May and is similar to the precipitation patterns in the Southeast and Northeast regions (**Figure 79**).
- Historical average monthly temperatures varies from 34° F in January to 77° F in July (**Figure 80**).
- Growing degree days are as low as 12 in January and as high as 846 in July and are the third greatest annually among regions (**Figure 81**).
- The greatest gap between growing degree days and historical precipitation occurs in August when 197 degree days was accompanied by 1 inch of rainfall (**Figure 82 and Table 41**). This ratio is similar to the North Central, Northeast, and Southeast regions and indicates that turfgrass growing in the Transition region may experience minor heat and moisture related stress and may not require as much supplemental irrigation as turfgrass growing in the Pacific, Southwest, or Upper West/Mountain regions.

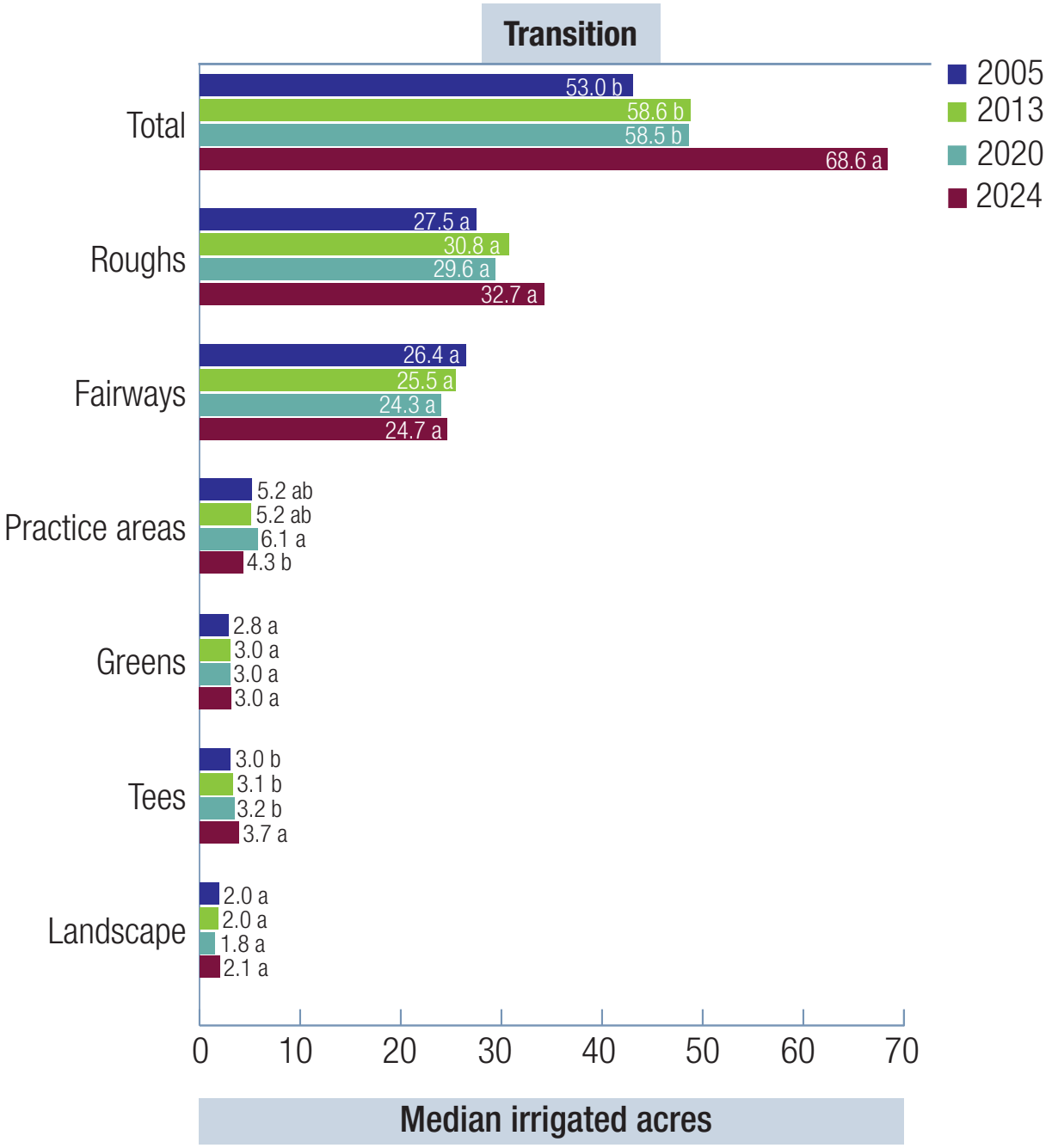


Figure 78. Median irrigated acres of roughs, fairways, practice areas, greens, tees, landscape, and total of U.S. golf facilities in the Transition region in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 8

Table 10. Drought severity in the Transition region in 2020 and 2024.

Drought	2020	2024	Δ
	Weeks		
Abnormal	10.6	31.5	20.9
Moderate	9.1	18.2	9.0
Severe	8.2	9.0	0.8
Extreme	4.3	6.6	2.4
Exceptional		6.9	6.9

Abnormal = Going into drought, short-term dryness slowing planting, growth of crops and pastures; fire risk above average. Coming out of drought, some lingering water deficits, pastures or crops not fully recovered.

Moderate = Some damage to crops, pastures, fire risk high; streams, reservoirs or wells low, some water shortage developing or imminent, voluntary water use restrictions requested.

Severe = Crop or pasture loss likely, fire risk very high, water shortages common, water restrictions imposed.

Extreme = Major crop/pasture losses, extreme fire danger, widespread water shortages or restrictions.

Exceptional = Exceptional and widespread crop and pasture losses, exceptional fire risk, shortages of water in reservoirs, streams and wells causing water emergencies.

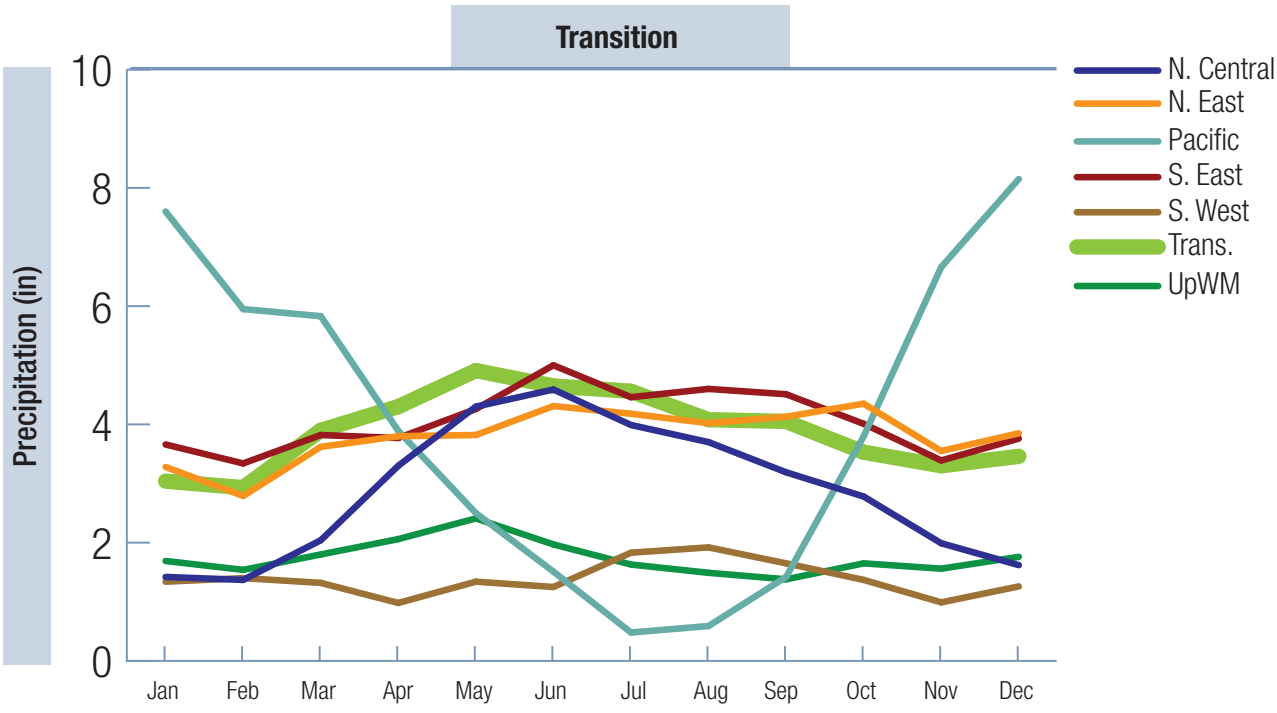


Figure 79. 30-yr monthly average precipitation in the Transition region.

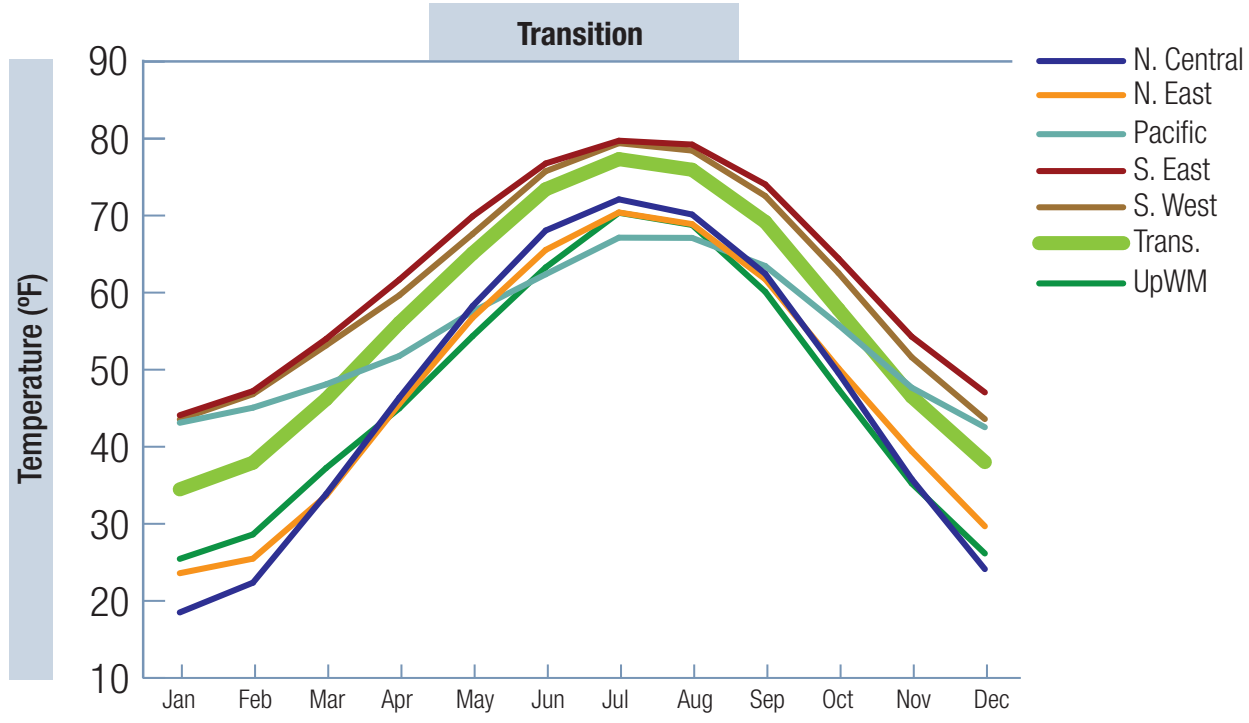


Figure 80. 30-yr monthly average temperature in the Transition region.

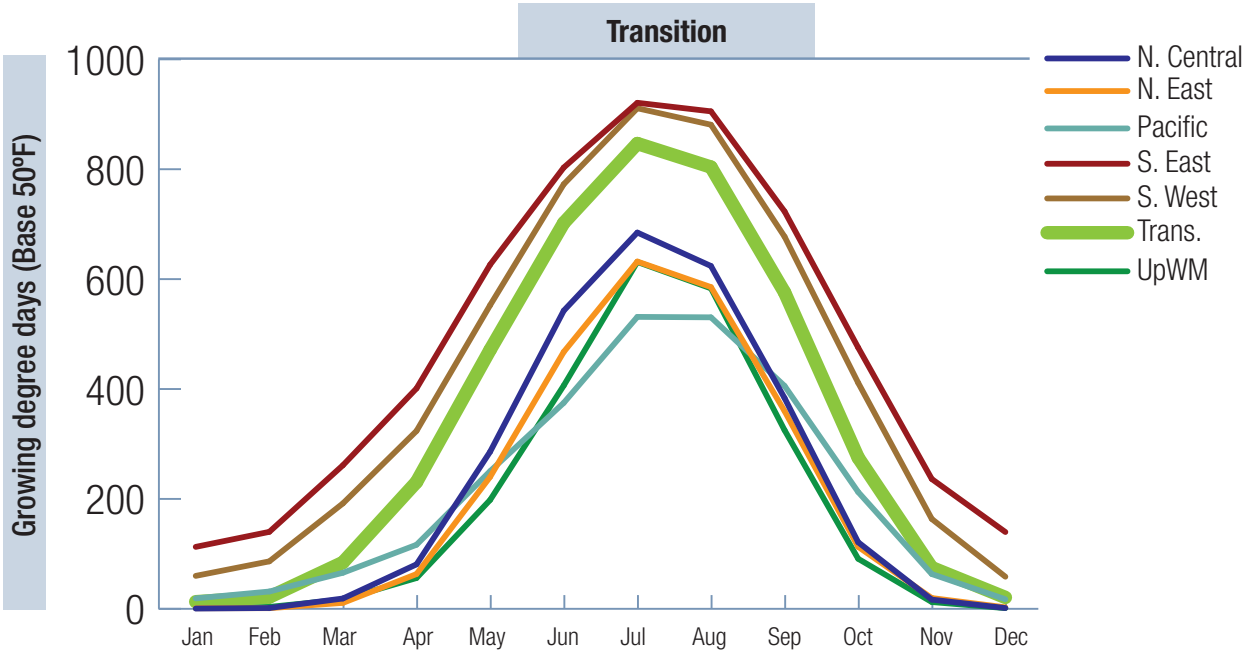


Figure 81. 30-yr monthly average growing degree days in the Transition region.

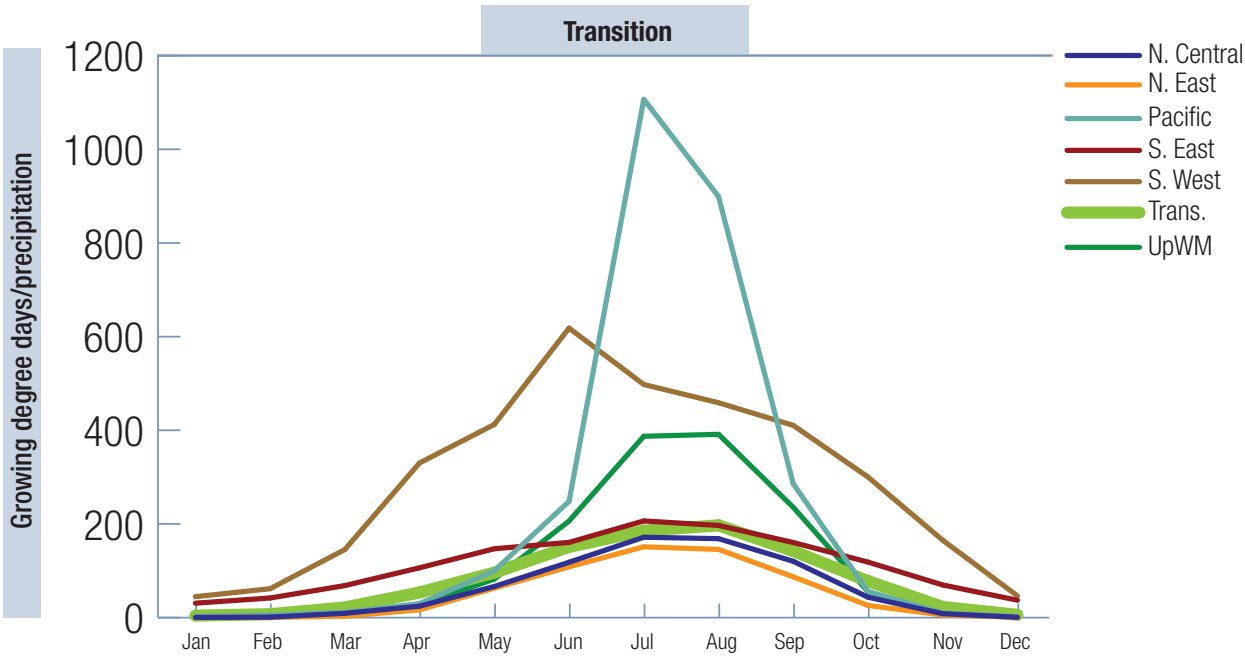


Figure 82. 30-yr monthly average growing degree days/precipitation in the Transition region.

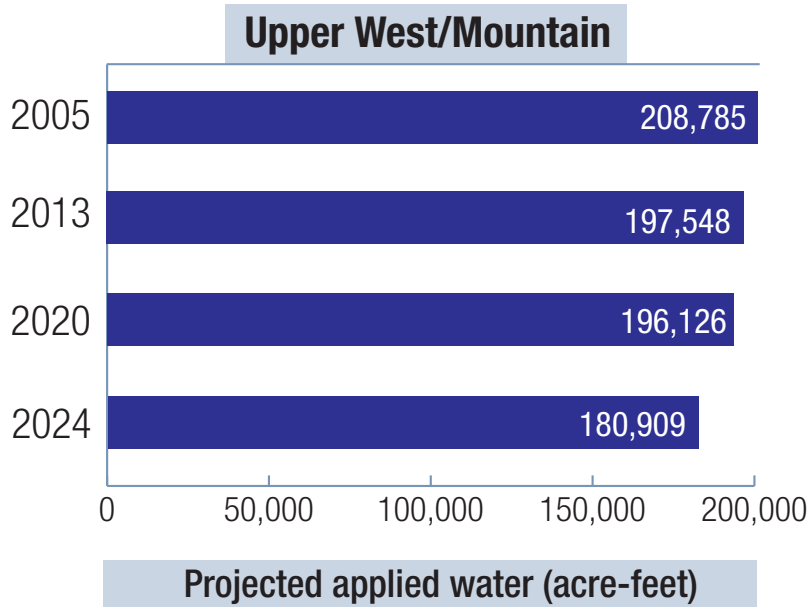


Figure 83. Projected water applied to U.S. golf facilities in the Upper West/Mountain region in 2005, 2013, 2020, and 2024. Ref: Table 1

Upper West/Mountain Region

Water Use

- Projected applied water was 13% less in 2024 than in 2005, resulting in a water savings of 27,876 acre-feet (**Figure 83**).
- Median applied water per facility was 143.5 acre-feet in 2024 and was equivalent to 2005 (**Figure 84**).
- Median applied water per acre was 1.9 acre-feet in 2024 and was equivalent to 2005 (**Figure 85**).

Water Sources

- In 2024, 28% of projected applied water was sourced from wells and 20% was sourced from rivers/streams (**Figure 86**).
- In 2024, 11% of projected applied water was sourced from recycled water (**Figure 86**).
- A 13% increase in potable water use since 2020 was reported (**Figure 86**).
- The percentage of facilities using recycled water was 15.0% in 2024, which was equivalent to 2005 (**Figure 87**).
- Projected recycled water applied decreased from 25,786 acre-feet in

2005 to 19,855 acre-feet in 2024, a 23% decrease (**Figure 88**).

Irrigated Acres

- Projected irrigated acres in 2024 was 91,874 and was approximately equivalent to 2005 (**Figure 89**).
- Irrigated acres remained mostly unchanged at 9- and 27+-hole facilities increasing by 5% and 9%, respectively, and irrigated acres 18-hole facilities declining by 3% since 2005 (**Figure 89**).
- Median irrigated acres were 74.8 in 2024 and were equivalent to 2005 (**Figure 90 and Table 15**).
- Median irrigated acres of roughs, greens, tees, and landscape did not change since 2005, whereas the median irrigated acres of fairways has steadily decreased by 23% to 21.8 acres, and the median irrigated acres of practice areas increased by 27% to 7.1 acres (**Figure 90 and Table 15**).

Facility Influence

- Operational golf facilities in the Upper West/Mountain Region declined since 2005 by 1% to 1,073 (**Table 16**).
- Management Practices
- The frequency of most management practices has not changed since 2005. However, the use of in-ground moisture sensors increased to 6% and the full irrigation system upgrades decreased to 12% since 2005 (**Table 18**).

Regulations

- Required water use reporting and recurring annual allocations were unchanged, and additional mandatory water restrictions decreased to 15% since 2005 (**Table 21**).
- The prevalence of facilities that had a written drought, water management, stormwater, or preventative irrigation maintenance plan was 32%, 25%, 14%, and 37%, respectively (**Table 22**). Miscellaneous
- The use of soil moisture sensors had a somewhat positive or very positive impact on 95% of facilities in 2024 (**Table 23**).
- Water conservation was the most common factor (85%) motivating the deci-

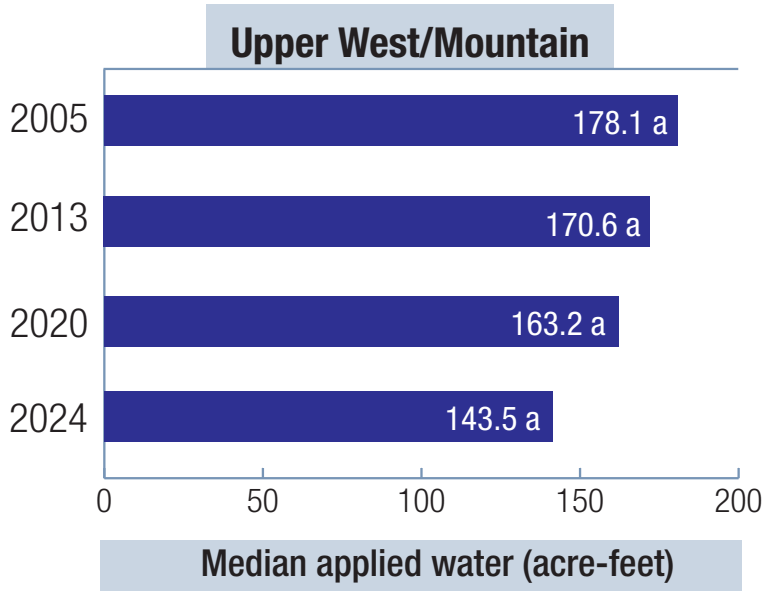


Figure 84. Median acre-feet of applied water on U.S. golf facilities in the Upper West/Mountain region in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 2

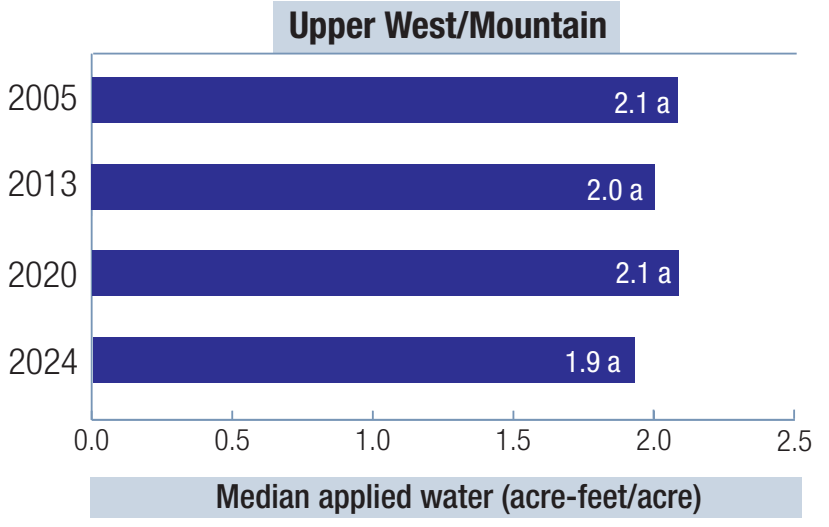


Figure 85. Median acre-feet per acre of applied water on U.S. golf facilities in the Upper West/Mountain region in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 2

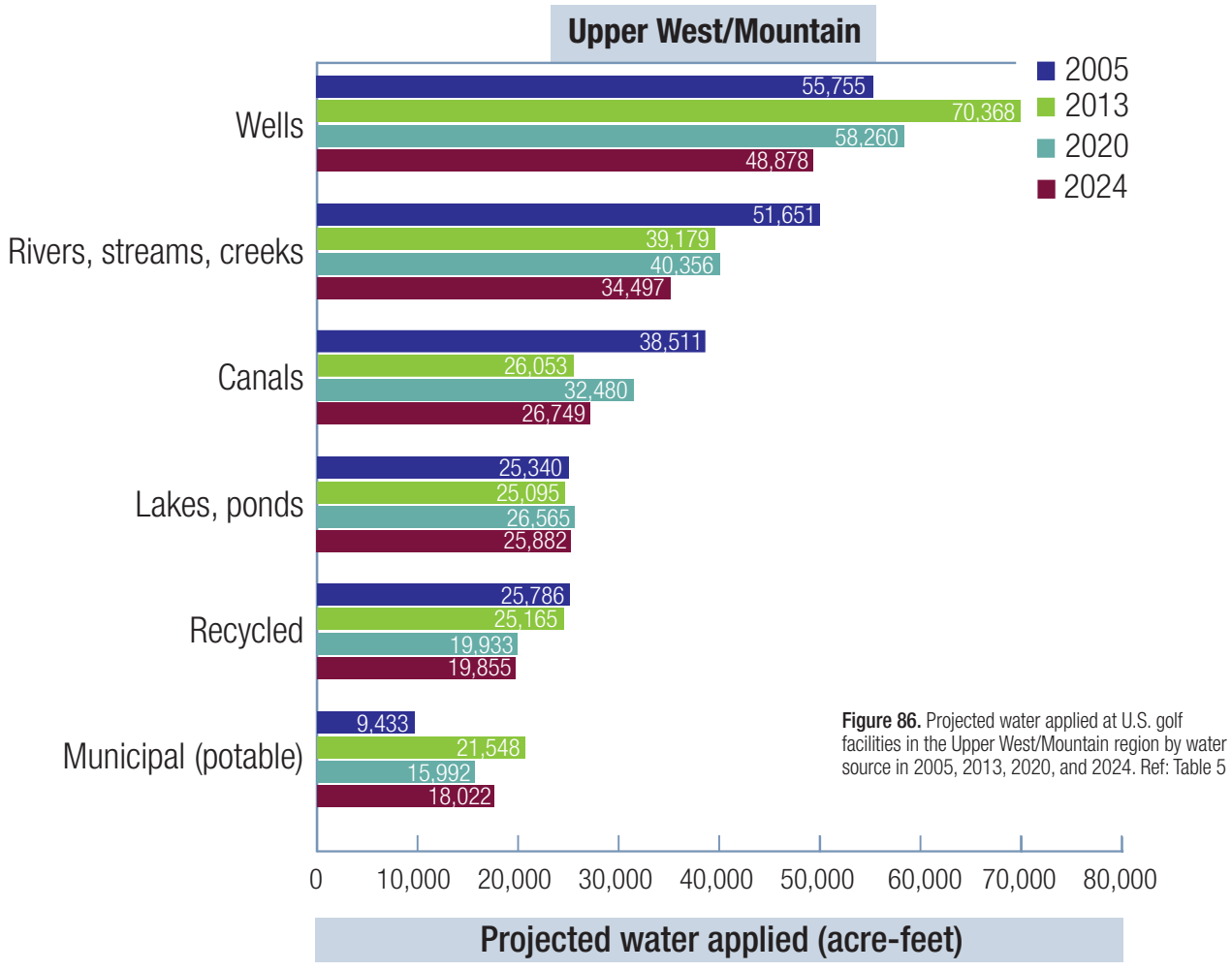


Figure 86. Projected water applied at U.S. golf facilities in the Upper West/Mountain region by water source in 2005, 2013, 2020, and 2024. Ref: Table 5

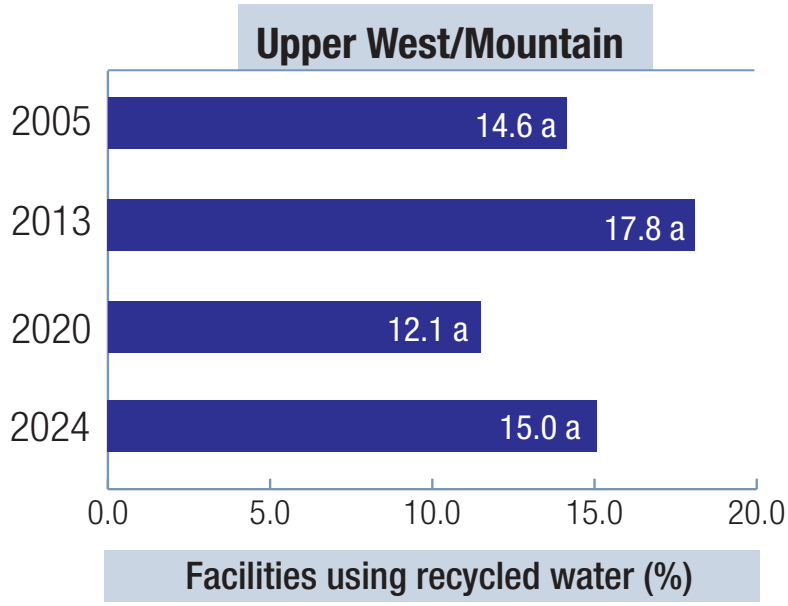


Figure 87. Percent of U.S. golf facilities in the Upper West/Mountain region applying recycled water in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the chi-square test at the 10% significance level. Ref: Table 3

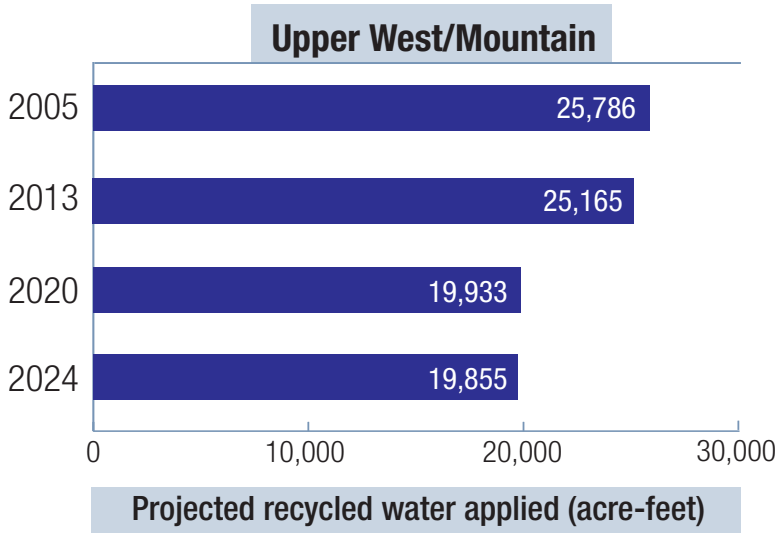


Figure 88. Projected recycled water applied to U.S. golf facilities in the Upper West/Mountain region in 2005, 2013, 2020, and 2024. Ref: Table 3

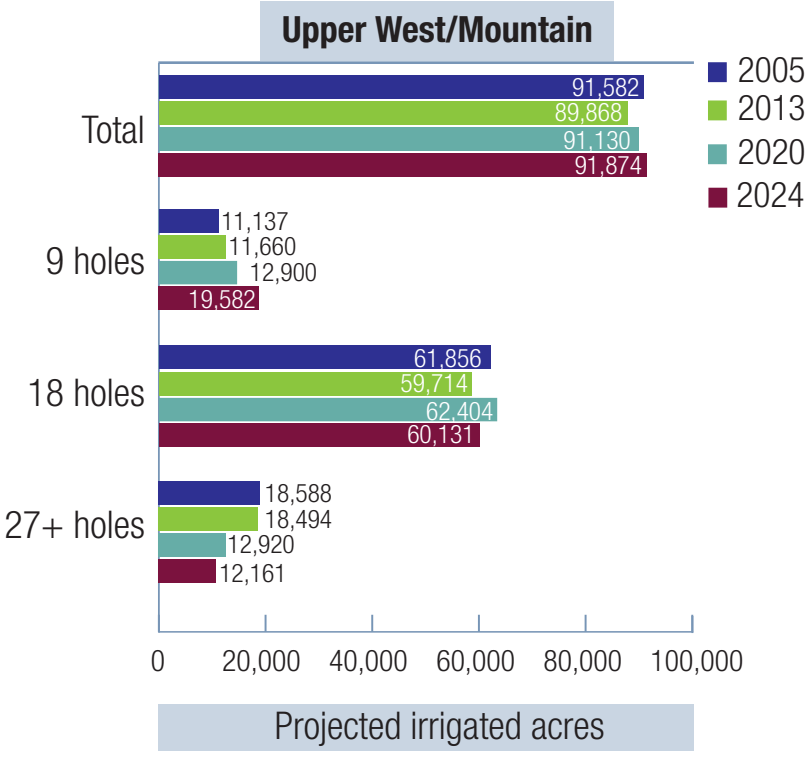


Figure 89. Projected irrigated acres of U.S. golf facilities in the Upper West/Mountain region in 2005, 2013, 2020, and 2024. Table 4

sion to reduce irrigated acres, the highest of all regions (**Table 24**).
- 97% of golfers were receptive to any perceived change in course appearance resulting from a reduction of applied water (**Table 25**).
- The most common irrigation injection treatment was wetting agents used at 37% of facilities (**Table 27**).

Water Testing

- The prevalence of facilities that had surface water and those that tested their surface remained the same as 2005 at 88% and 46%, respectively (**Table 28**).
- Among facilities that tested surface water, 70% tested once per year with the remaining facilities testing more frequently (**Table 29**).
- Among facilities that tested surface water, 93% had 1 or more surface water monitoring sites (**Table 30**).
- Among facilities that tested surface water, 83% tested for nutrients, which was the most common tested variable (**Table 31**).
- The prevalence of facilities that had ground water wells and that tested their ground water were 54% and 47%, respectively, and has not changed since 2005 (**Table 32**).
- Among facilities that tested ground water, 100% had 1 or more ground water monitoring sites (**Table 33**).
- Among facilities that tested ground water, 77% had 1 or more protected ground water wells (**Table 34**).
- Among facilities that tested ground water, 67% tested once per year with the remaining facilities testing more frequently (**Table 35**).
- Among facilities that tested ground water, 70% tested for nutrients, which was the most common variable tested (**Table 36**).
- Among facilities that tested ground water, 43% had 1 or more dedicated ground water monitoring sites in 2024 (**Table 37**).

Meteorological

- The Upper/West Mountain region experienced fewer weeks of abnormal, moderate, severe, and extreme drought in 2024 than in 2020 (**Table 11**).

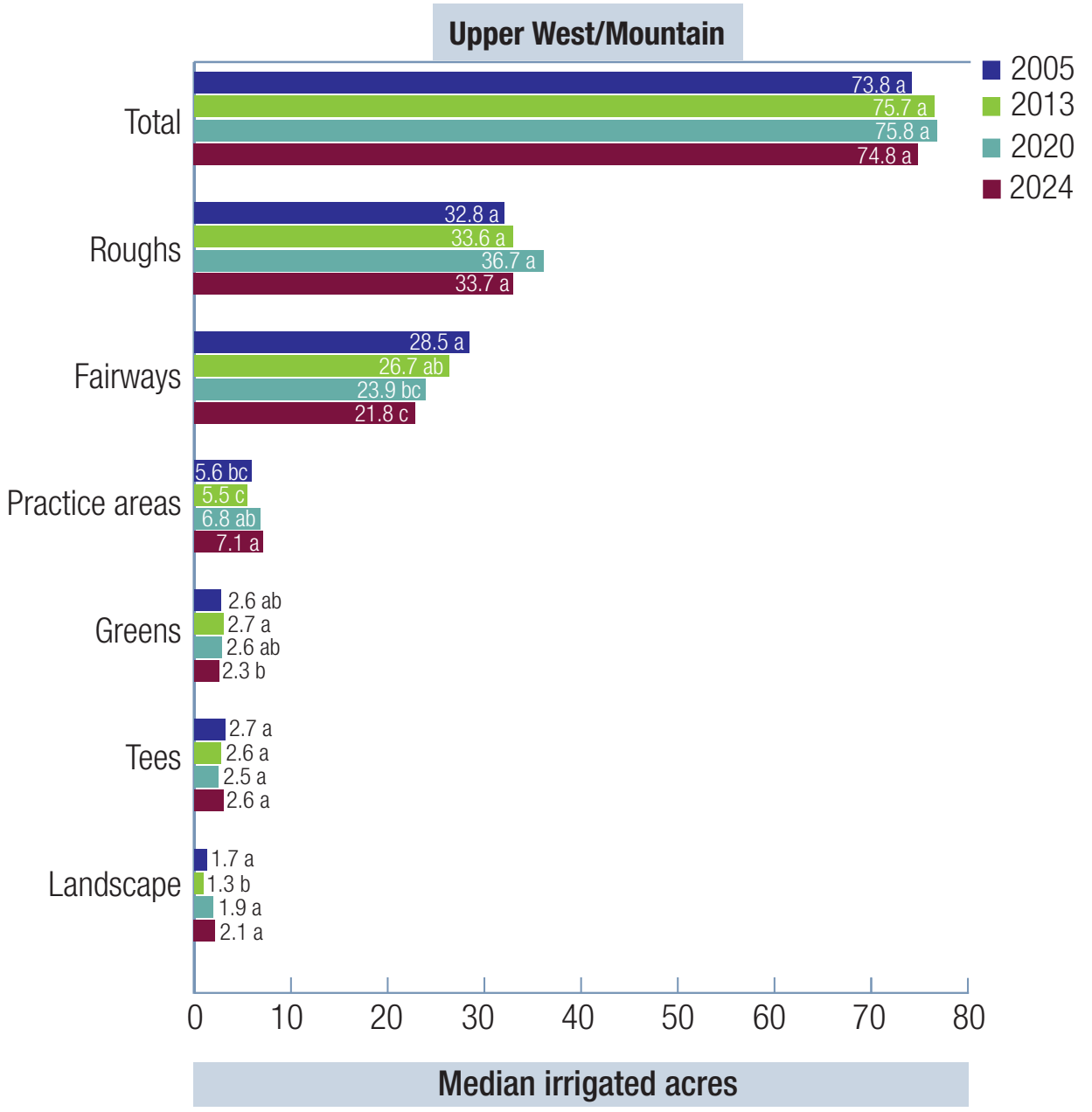


Figure 90. Median irrigated acres of roughs, fairways, practice areas, greens, tees, landscape, and total of U.S. golf facilities in the Upper West/Mountain region in 2005, 2013, 2020, and 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level. Ref: Table 8

Table 11. Drought severity in the Upper West/Mountain region in 2020 and 2024.

Drought	2020	2024	Δ
	Weeks		
Abnormal	41.2	40.5	-0.8
Moderate	31.2	27.2	-4.0
Severe	24.8	16.9	-7.8
Extreme	18.5	11.6	-6.9
Exceptional	11.6	12.0	0.4

Abnormal = Going into drought, short-term dryness slowing planting, growth of crops and pastures; fire risk above average. Coming out of drought, some lingering water deficits, pastures or crops not fully recovered.

Moderate = Some damage to crops, pastures, fire risk high; streams, reservoirs or wells low, some water shortage developing or imminent, voluntary water use restrictions requested.

Severe = Crop or pasture loss likely, fire risk very high, water shortages common, water restrictions imposed.

Extreme = Major crop/pasture losses, extreme fire danger, widespread water shortages or restrictions.

Exceptional = Exceptional and widespread crop and pasture losses, exceptional fire risk, shortages of water in reservoirs, streams and wells causing water emergencies.

- Historical average monthly precipitation is second least only to the Southwest and ranges from 1.5 inches in August to 2.4 inches in May (**Figure 91**).
- Historical average monthly temperatures varies from 25° F in January to 70° F in July (**Figure 92**).
- Growing degree days are as low as 1 in January and as high as 631 in July and are lowest annually among regions (**Figure 93**).
- The greatest gap between growing degree days and historical precipitation occurs in August when 391 degree days is accompanied by 1 inch of rainfall (**Figure 94 and Table 41**). This ratio is greater than all other regions except the Pacific and Southwest regions and indicates that turfgrass growing in the Upper West/Mountain region may experience significant heat and moisture related stress and may require greater supplemental irrigation than turfgrass growing in the North Central, Northeast, Southeast, Transition regions.

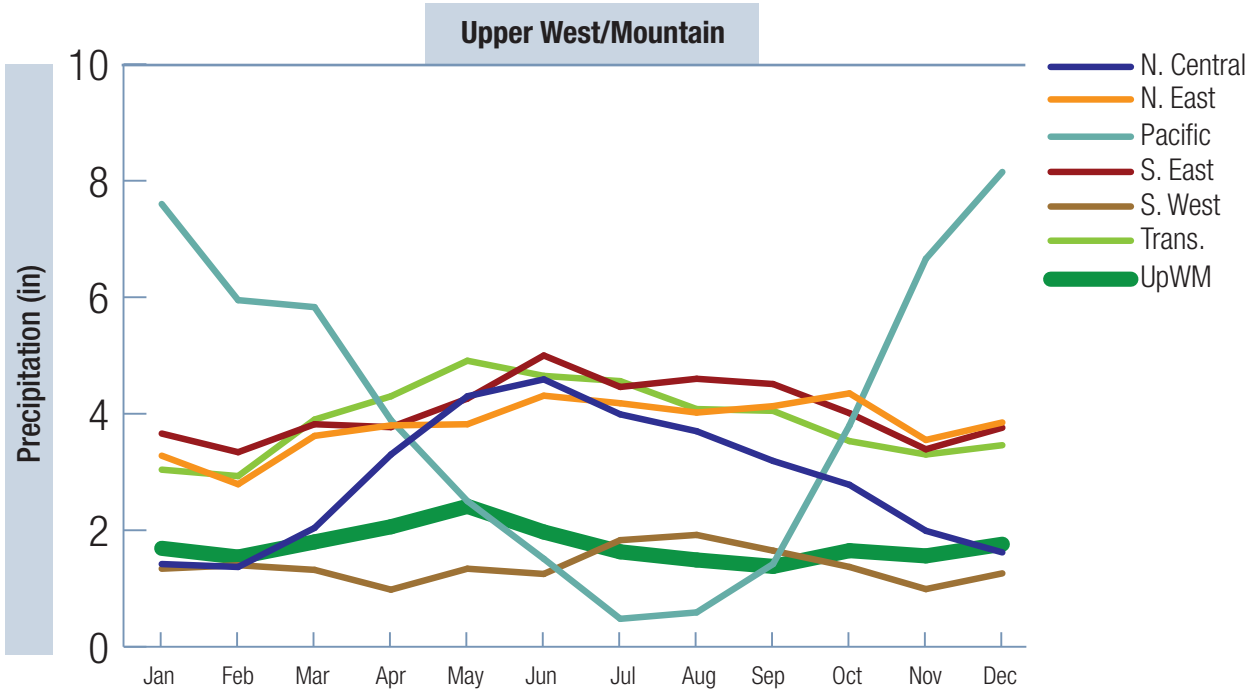


Figure 91. 30-yr monthly average precipitation in the Upper West/Mountain region.

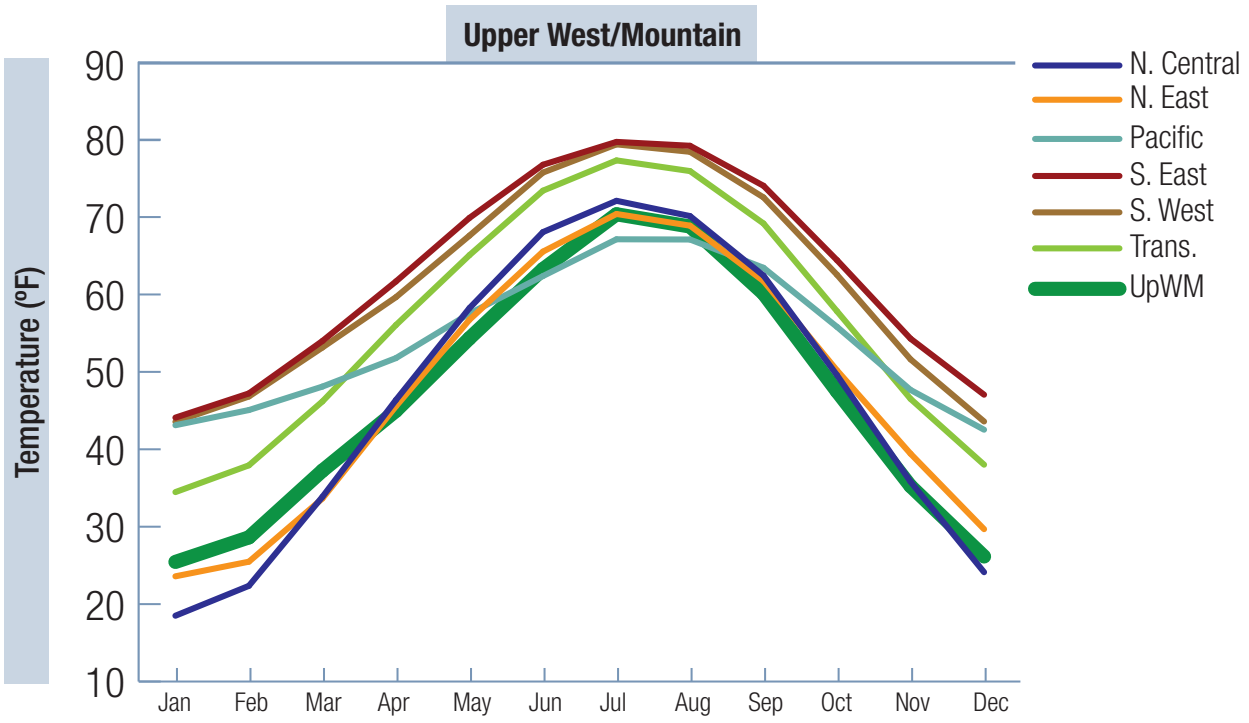


Figure 92. 30-yr monthly average temperature in the Upper West/Mountain region.

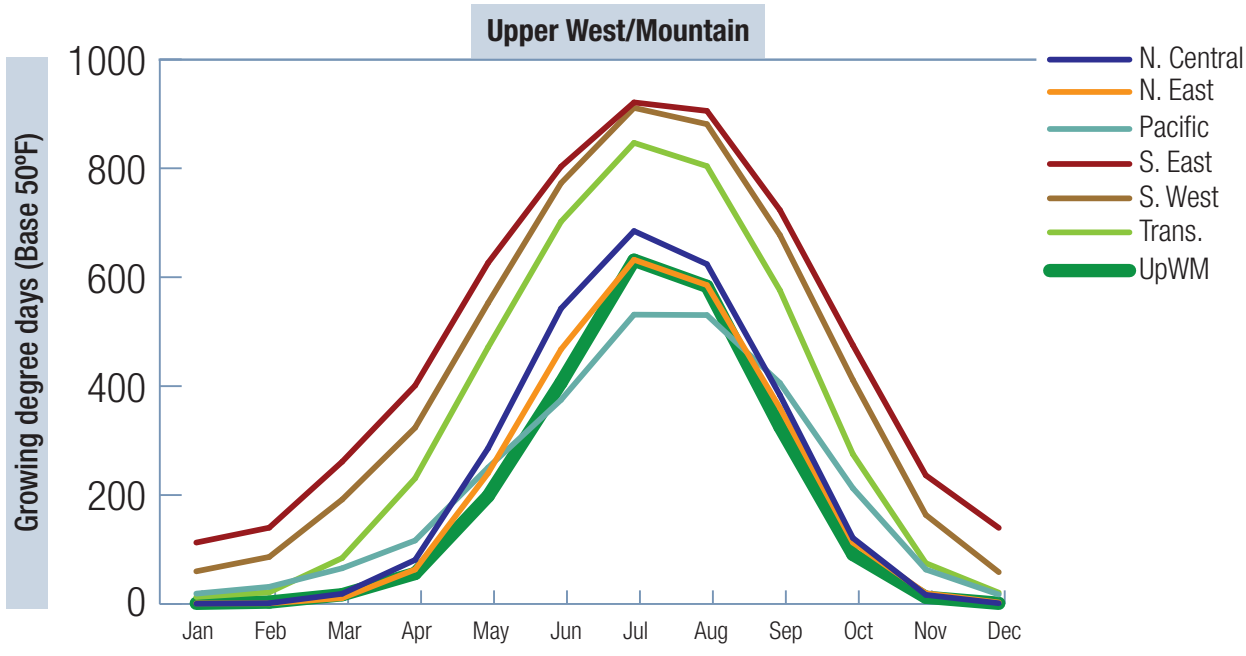


Figure 93. 30-yr monthly average growing degree days in the Upper West/Mountain region.

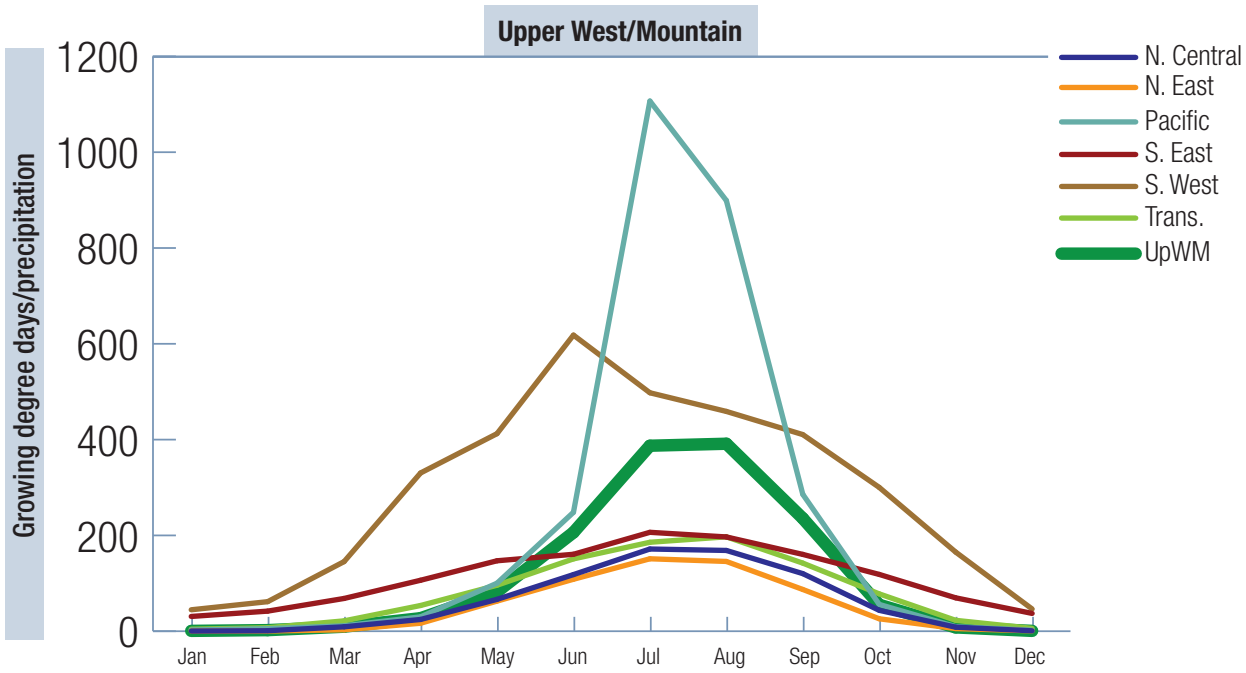


Figure 94. 30-yr monthly average growing degree days/precipitation in the Upper West/Mountain region.

Conclusions and Recommendations

Total Water Use: Water applied to U.S. golf courses has declined 31% since 2005 to 1.63 million acre-feet per year. Of that amount, approximately one third was likely due to course closures with the remaining two thirds due to other factors. A major contributing factor was likely the more efficient use of applied water, a postulation supported by the 15% reduction nationally in water applied per acre. Notably, since 2020, water use in the Southwest Region has been reduced by 16.9% and 7.8% in the Upper West/Mountain Region. All other regions report 3.4 to 5.2% increases in water use. The reasons for these changes since 2020 are only speculative. Other factors may include increasing awareness of water as a valuable resource, increased local water use restrictions and, improved efficiencies in water application.

Recycled Water: The use of recycled water on U.S. golf courses is trending downward in the major use regions (i.e., Southeast and Southwest). In 2024, 81% of recycled water on golf facilities was applied in the Southeast and Southwest, down 6% since 2020. Recycled water use is generally dependent upon the distribution infrastructure requirements that are normally beyond the control of the golf facility. However, where recycled water exists, golf course superintendents are encouraged to forge relationships with their local municipalities to determine if recycled water can be conveyed to their facilities. Similarly, in regions where recycled water is being increasingly commoditized, strategies should be developed to better ensure access to this water source.

Irrigated Acres: The total median irrigated acres of U.S. facilities increased slowly since 2005. However, since 2020, median irrigated acres have remained static in each area of the course except practice areas which dipped slightly.

Acre-feet/Acre: Acre-feet/acre is the most effective metric for evaluating golf course water use because it normalizes total water consumption by the size of the irrigated area. This allows for fair comparisons between golf courses of different sizes and layouts, eliminating misleading interpretations that can arise from total volume alone. The metric also aligns with hydrologic principles, expressing water use in a unit directly tied to depth over a defined surface area. By using acre-feet per acre, golf course superintendents, regulators, and researchers can more accurately assess efficiency, track conservation progress, and set realistic water use goals.

Management Practices: Among the documented management practices, maintaining drier turf, pruning tree roots, converting to more drought-tolerant turfgrass, mulching landscape beds, and expanding no-mow areas were all significantly associated with reduced water use. Facilities that adopt these strategies as part of their program may achieve water savings. Golf facilities should keep their Best Management Practices (BMP) manual up to date and pursue ongoing improvements in water management. A comprehensive water management plan—along with regular water quality testing—is a critical component of any BMP program. For more information, visit https://www.gcsaa.org.

Educational Planning: Strategic educational efforts are most effective when targeted to where they can have the greatest influence. First, regional water-use patterns show that 56% of all applied water in U.S. golf facilities is concentrated in the Southeast and Southwest, with the remaining 44% spread across five other regions—making these two regions prime targets for focused outreach. Second, 18-hole facilities account for 69% of irrigated acres and total water applied, compared to approximately 11% for 9-hole facilities and 20% for 27+ hole facilities, suggesting that education should be scaled accordingly. Finally, median irrigated acres have increased since 2005, even though some areas—such as roughs—can be maintained at acceptable quality without irrigation or, at least, reduced levels. Golf course superintendents consistently report that golfers are receptive to changes in course appearance and playablity due to reduced water use. Sharing case studies of courses that have successfully expanded non-irrigated areas without negatively affecting golfer satisfaction could encourage wider adoption of this water-saving practice.

	Lakes/Ponds				Canals				Rivers, streams, creeks			
	2005	2013	2020	2024	2005	2013	2020	2024	2005	2013	2020	2024
Region	acre-feet											
North Central	80,160	52,130	68,089	64,353	473	—[a]	389	249	32,935	21,610	19,519	19,529
Northeast	42,609	29,115	26,654	34,556	1,178	140	205	509	11,305	10,867	16,285	13,746
Pacific	8,075	6,228	10,404	13,372	14,583	5,291	7,445	7,275	14,369	11,734	6,861	11,655
Southeast	412,809	167,640	164,169	202,460	21,866	12,822	14,980	14,419	57,316	30,642	22,814	34,039
Southwest	25,594	18,296	21,176	16,855	65,576	60,808	38,082	24,426	13,412	11,420	29,122	10,180
Transition	127,418	56,571	65,420	67,545	1,167	54	252	729	31,310	18,138	14,895	27,997
Upper West/ Mountain	25,340	25,095	26,565	25,882	38,511	26,053	32,480	26,749	51,651	39,179	40,356	34,497
U.S.	722,007	409,766	382,476	425,023	143,355	115,020	93,834	74,356	212,298	159,674	148,496	151,644
	Wells				**Recycled**				**Municipal**			
	2005	2013	2020	2024	2005	2013	2020	2024	2005	2013	2020	2024
	acre-feet											
North Central	130,035	92,242	71,184	80,136	3,509	9,045	1,675	6,952	11,418	6,794	7,591	7,633
Northeast	33,134	29,386	26,657	33,970	2,082	2,219	1,898	2,241	16,153	7,071	10,624	11,055
Pacific	32,352	29,891	16,431	24,561	10,253	24,975	7,858	13,124	11,053	20,101	13,743	13,981
Southeast	217,577	127,824	145,716	161,770	145,611	192,849	139,733	125,855	22,706	13,731	12,914	15,802
Southwest	226,782	202,430	165,895	124,328	151,653	193,394	164,937	113,657	73,118	69,201	74,998	59,292
Transition	45,721	38,039	47,130	34,970	12,682	18,856	15,330	14,769	25,817	25,034	14,845	20,107
Upper West/ Mountain	55,755	70,368	58,260	48,878	25,786	25,165	19,933	19,855	9,433	21,548	15,992	18,022
U.S.	741,357	580,204	531,274	508,613	351,576	466,503	351,364	296,454	169,698	155,667	150,707	145,893

[a]Insufficient data to compute a value

Table 12. Projected water applied nationally and within each agronomic region from lakes/ponds; canals; rivers, streams, creeks; wells; recycled; and municipal sources in 2005, 2013, 2020, and 2024.

	No Source	No Infrastructure	Cost	Poor Quality	Unnecessary	Other
	%					
U.S.	55.1	12.3	1.0	1.3	28.5	1.8
North Central	49.6	10.7	1.5	0.8	36.2	1.2
Northeast	62.9	10.1	0.5	0.0	24.8	1.7
Pacific	53.6	13.8	0.0	1.8	29.0	1.8
Southeast	53.8	14.5	1.2	4.7	23.8	2.0
Southwest	44.4	26.9	3.9	1.9	19.0	3.8
Transition	60.4	10.4	0.5	0.7	26.2	1.7
Upper West/Mountain	58.2	12.6	0.0	0.0	26.5	2.7

Table 13. Factors influencing the lack of effluent water use at U.S. golf facilities that did not use effluent water in 2024.

	Water Scarcity					Water Cost				
	1	2	3	4	5	1	2	3	4	5
	%									
U.S.	45.4	21.4	16.6	11.0	5.6	48.6	20.9	17.2	7.6	5.8
North Central	54.8	24.2	11.3	7.3	2.4	54.9	27.4	12.9	3.0	1.7
Northeast	46.2	17.7	23.9	6.8	5.5	47.1	22.0	23.3	4.3	3.3
Pacific	45.1	22.5	18.2	7.0	7.2	34.3	16.8	22.8	13.3	12.8
Southeast	44.8	19.7	16.5	14.9	4.0	47.2	23.3	19.4	6.7	3.4
Southwest	11.3	24.8	18.0	22.5	23.5	12.8	21.9	14.5	23.4	27.5
Transition	51.4	21.3	16.0	8.4	2.9	62.3	15.0	12.2	7.2	3.3
Upper West/ Mountain	37.7	18.5	19.8	17.0	7.0	48.6	9.3	23.8	10.8	7.5

Note. Respondents rated threat on a 1-5 scale, where 1 = Nothing we really need to worry about at this time, and 5 = It is a major issue for our course.

Table 14. Threat of water scarcity or increasing water costs on U.S. golf facilities in 2024.

Year	U.S.	NC	NE	Pac.	SE	SW	Trans.	UWM
	acres							
	Total							
2005	54.7 b	41.4 b	31.7 b	55.2 b	90.7 a	104.2 a	53.0 b	73.8 a
2013	58.5 a	39.8 b	36.3 ab	63.9 ab	91.7 a	99.8 ab	58.6 b	75.7 a
2020	60.9 a	47.1 a	37.6 ab	62.2 b	87.5 a	91.4 ab	58.5 b	75.8 a
2024	61.9 a	42.6 ab	41.2 a	75.8 a	90.9 a	87.5 b	68.6 a	74.8 a
	Roughs							
2005	26.7 b	16.9 a	15.2 b	21.7 b	44.7 a	46.7 a	27.5 a	32.8 a
2013	26.8 b	14.7 a	14.5 b	25.1 ab	42.9 a	44.5 a	30.8 a	33.6 a
2020	30.1 a	16.4 a	25.5 a	26.3 ab	45.8 a	38.1 b	29.6 a	36.7 a
2024	28.9 ab	17.5 a	19.1 b	32.5 a	41.4 a	39.3 a	32.7 a	33.7 a
	Fairways							
2005	25.9 a	23.1 a	20.9 a	24.2 ab	32.4 a	33.4 b	26.4 a	28.5 a
2013	25.1 a	21.7 ab	20.4 a	25.1 ab	30.6 ab	31.2 ab	25.5 a	26.7 ab
2020	23.7 b	21.8 ab	19.6 a	21.7 b	28.4 b	29.3 ab	24.3 a	23.9 bc
2024	23.5 b	21.0 b	19.8 a	26.3 a	28.5 b	27.8 b	24.7 a	21.8 c
	Practice Areas							
2005	4.8 b	3.6 b	2.6 a	4.1 a	6.7 b	7.6 a	5.2 ab	5.6 bc
2013	4.6 b	2.8 c	2.7 a	4.5 a	6.5 b	6.8 ab	5.2 ab	5.5 c
2020	5.4 a	4.6 a	2.9 a	3.4 a	7.6 a	5.7 b	6.1 a	6.8 ab
2024	4.8 b	3.5 b	3.2 a	3.4 a	7.0 a	6.2 ab	4.3 b	7.1 a
	Greens							
2005	2.8 b	2.7 c	2.7 b	2.3 b	3.1 a	3.0 a	2.8 a	2.6 ab
2013	2.9 a	2.7 bc	3.0 a	2.9 a	3.3 a	3.0 a	3.0 a	2.7 a
2020	3.0 a	3.1 a	2.9 ab	2.8 a	3.1 a	3.4 a	3.0 a	2.6 ab
2024	2.9 a	3.0 ab	3.3 a	3.0 a	3.1 a	2.9 a	3.0 a	2.3 b
	Tees							
2005	2.6 c	2.3 c	2.1 b	2.1 b	3.6 a	3.5 a	3.0 b	2.7 a
2013	2.8 b	2.4 bc	2.3 a	2.7 a	3.7 a	3.4 a	3.1 b	2.6 a
2020	2.9 ab	2.7 a	2.2 ab	2.7 a	3.6 a	3.9 a	3.2 b	2.5 a
2024	3.0 a	2.6 ab	2.3 ab	2.9 a	3.7 a	3.3 a	3.7 a	2.6 a
	Landscape							
2005	2.1 a	1.7 b	1.5 b	1.7 b	3.4 a	3.5 a	2.0 a	1.7 a
2013	1.9 b	1.6 b	1.7 ab	1.4 b	2.7 a	2.4a	2.0 a	1.3 a
2020	2.2 a	2.1 a	2.2 a	2.3 a	3.0 a	2.2 a	1.8 a	1.9 a
2024	2.1 a	1.6 b	1.9 ab	2.0 ab	2.9 a	2.5 a	2.1 a	2.1 a

Note. NC=North Central, NE=Northeast, Pac.=Pacific, SE=Southeast, SW=Southwest, Trans.=Transition, and UWM=Upper West/Mountain. Within columns, medians followed by a common letter are not significantly different according to the chi-square test at the 10% significance level.

Table 15. Median irrigated acres of roughs, fairways, practice areas, greens, tees, landscape, and total of all U.S. golf facilities in 2005, 2013, 2020, and 2024.

Region	2005	2013	2020	2024	Δ2005-2024	2024 Irrigated Area	2024 Applied Water	Δ2005-2024	
	U.S. golf facilities					acres	acre-feet	acres	acre-feet
North Central	4,127	3,925	3,592	3,538	-589	72.3	57.4	-42,591	-33,808
Northeast	2,746	2,677	2,482	2,454	-292	61.6	38.9	-17,987	-11,371
Pacific	655	638	571	560	-95	94.9	150.8	-9,014	-14,325
Southeast	3,250	3,046	2,766	2,704	-546	98.0	192.2	-53,481	-104,929
Southwest	1,224	1,201	1,139	1,133	-91	94.2	367.8	-8,569	-33,470
Transition	2,961	2,795	2,528	2,490	-471	80.2	66.8	-37,765	-31,485
Upper West/Mountain	1,089	1,104	1,067	1,073	-16	99.8	180.3	-1,596	-2,885
U.S.	16,052	15,386	14,145	13,952	-2,100	81.4	120.4	-171,001	-252,768

Table 16. U.S. golf facilities, acres, and applied water as influenced by change in golf facilities from 2005 to 2024. The change in acres and acre-feet from 2005 to 2024 was determined by multiplying the change in facility number by the mean acres or acre-feet, respectively.

	Golf course size			Golf course type	
	9 holes	18 holes	27+ holes	Public	Private
	acre-feet/acre				
2005	1.1 a	1.4 a	1.5 a	1.3 a	1.3 a
2013	0.8 bc	1.1 b	1.4 a	1.1 b	1.1 b
2020	0.7 c	1.1 b	1.2 a	1.0 b	1.0 b
2024	1.0 ab	1.1 b	1.2 a	1.1 b	1.1 b

Within columns, medians followed by a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level.

Table 17. Acre-feet of water applied per acre on 9- hole, 18- hole, 27+-hole, public, and private golf facilities in 2005, 2013, 2020, and 2024.

Management Practice	U.S.				NC				NE				Pac.		
	2005	2013	2020	2024	2005	2013	2020	2024	2005	2013	2020	2024	2005	2013	2020
Wetting agents	88 b	94 a	96 a	96 a	90 b	96 a	97 a	96 a	84 a	87 a	92 a	95 a	86 c	94 b	99 a
Hand-watering	72 c	77 b	78 ab	83 a	65 b	71 b	63 b	79 a	70 c	74 bc	83 ab	90 a	79 b	86 ab	92 a
Keep turf drier than in past	62 c	73 a	68 b	65 bc	61 b	70 a	70 a	70 a	62 b	76 a	72 ab	70 ab	57 b	79 a	65 ab
Hand-held moisture sensors	---[a]	33 c	49 b	55 a	---	26 b	41 a	42 a	---	41 b	52 b	65 a	---	23 b	44 a
Irrigation scheduling	42 b	49 a	45 b	53 a	33 b	47 a	37 b	54 a	41 a	49 a	41 a	44 a	45 a	51 a	38 a
Soil amendments	29 c	40 b	42 ab	46 a	22 b	34 a	32 a	36 a	35 b	48 a	52 a	51 a	25 b	33 b	31 b
Adjust fertilizer practices	41 c	52 a	47 ab	43 bc	40 b	49 a	44 b	42 ab	37 b	51 a	39 b	54 a	45 b	47 b	67 a
Mulch landscape beds	43 b	48 a	39 b	41 b	38 b	47 a	41 ab	38 b	42 ab	50 a	37 b	47 ab	36 b	50 a	36 ab
Increase no-mow acres	---	46 a	41 b	39 b	---	48 a	50 a	45 a	---	51 a	54 a	45 a	---	52 a	45 ab
New irrigation nozzles	---	39 a	31 b	31 b	---	34 a	30 a	31 a	---	41 a	29 b	36 ab	---	47 a	38 a
Prune tree roots	17 c	25 b	30 a	31 a	18 b	22 ab	31 a	27 a	23 b	30 a	32 a	35 a	17 a	19 a	17 a
New irrigation software	---	31 a	28 a	30 a	---	28 a	29 a	31 a	---	25 a	27 a	31 a	---	34 a	36 a
Reduced irrigated acres	18 c	35 a	30 b	28 b	13 b	25 a	27 a	23 a	15 b	27 a	36 a	29 a	18 c	49 a	36 ab
New irrigation central controller	---	30 a	26 b	28 ab	---	28 a	25 a	29 a	---	24 a	24 a	27 a	---	33 ab	23 b
Convert irrigation heads to part-circle	---	32 a	26 b	25 b	---	28 a	23 a	26 a	---	29 a	21 a	22 a	---	48 a	43 a
Use rain shut-off switch	16 b	23 a	25 a	23 a	13 c	20 b	29 a	20 ab	11 b	19 a	19 a	24 a	11 a	15 a	12 a
Change to drought-tolerant turfgrass	12 c	18 b	22 a	19 ab	7 b	11 a	12 a	14 a	19 b	28 a	36 a	31 a	8 b	15 a	15 ab
Plant low-water landscape species	14 c	23 a	20 ab	19 b	6 b	15 a	13 a	15 a	11 b	17 a	16 ab	17 a	17 a	26 a	24 a
Drip irrigation for landscape plants	13 b	16 a	15 ab	14 ab	4 a	6 a	5 a	5 a	6 b	7 ab	9 ab	10 a	18 a	27 a	21 a
Full irrigation system upgrade	20 b	14 a	12 a	14 a	20 a	10 b	12 b	8 b	22 a	15 b	13 b	15 b	17 a	18 a	9 b
Irrigation audit	5 c	8 b	7 b	11 a	4 b	3 b	3 b	7 a	4 b	3 b	5 b	12 a	7 a	7 a	8 a
In-ground moisture sensors	1 c	7 a	6 ab	5 b	1 b	4 a	5 a	3 a	1 b	8 a	9 a	7 a	1 b	7 a	4 a
Course designed for water harvesting	7 a	6 ab	5 b	5 b	6 a	7 a	3 b	4 ab	7 a	8 a	8 a	6 a	4 a	4 a	6 a

Note. NC=North Central, NE=Northeast, Pac.=Pacific, SE=Southeast, SW=Southwest, Trans.=Transition, and UWM=Upper West/Mountain.
Within a row and region, values followed by a common letter are not significantly different according to the chi-square test at the 10% significance level.
[a]Question not asked in 2005.

Table 18. Frequency of management practices used at U.S. golf facilities in 2005, 2013, 2020, and 2024.

	SE				SW				Trans.				UWM			
2024	2005	2013	2020	2024	2005	2013	2020	2024	2005	2013	2020	2024	2005	2013	2020	2024
%																
98 ab	91 b	95 b	99 a	98 a	76 b	91 a	92 a	93 a	91 a	94 a	95 a	95 a	90 b	98 a	97 a	96 ab
91 a	69 a	74 a	72 a	72 a	72 c	79 bc	87 a	84 ab	85 a	86 a	85 a	87 a	74 a	81 a	85 a	82 a
49 b	63 b	76 a	61 b	61 b	59 b	74 a	61 ab	43 c	64 a	70 a	68 a	65 a	63 b	78 a	78 a	73 ab
51 a	---	38 b	51 a	59 a	---	29 b	54 a	56 a	---	43 b	53 ab	64 a	---	29 b	53 a	58 a
49 a	49 a	51 a	46 a	54 a	58 a	57 a	59 a	60 a	39 b	43 ab	44 ab	50 a	51 a	58 a	60 a	59 a
53 a	34 c	44 b	50 ab	56 a	33 c	37 bc	47 ab	51 a	27 b	43 a	39 a	49 a	34 a	39 a	44 a	43 a
44 b	47 a	53 a	45 a	35 b	47 b	59 a	61 a	46 ab	38 b	51 a	46 ab	40 b	43 a	51 a	51 a	45 a
48 ab	59 a	64 a	47 b	44 b	27 a	34 a	28 a	31 a	48 a	49 a	39 a	42 a	40 a	37 a	35 a	40 a
32 b	---	38 a	25 b	32 ab	---	28 a	27 a	35 a	---	56 a	42 b	36 b	---	42 a	39 a	37 a
37 a	---	31 a	28 a	26 a	---	46 a	37 a	45 a	---	44 a	23 b	22 b	---	45 a	48 a	37 a
19 a	16 c	25 b	38 a	42 a	12 b	20 a	17 ab	23 a	17 b	29 a	36 a	33 a	14 a	20 a	20 a	27 a
43 a	---	36 a	26 b	28 b	---	33 a	33 a	31 a	---	31 a	27 a	30 a	---	39 a	28 b	25 b
29 b	22 c	37 a	26 b	33 ab	25 b	42 a	51 a	46 a	18 b	42 a	19 b	21 b	24 b	36 a	34 a	23 b
42 a	---	37 a	24 b	30 ab	---	32 b	48 a	25 b	---	29 a	23 ab	22 b	---	34 a	23 a	27 a
35 a	---	35 a	25 b	26 b	---	35 a	32 ab	21 b	---	34 a	20 b	18 b	---	33 a	32 a	35 a
14 a	32 b	39 a	34 ab	35 ab	15 a	21 a	20 a	16 a	14 b	24 a	20 a	21 a	12 b	18 b	27 a	26 ab
22 a	9 b	14 a	18 a	17 a	8 b	22 a	13 b	24 a	18 b	28 a	35 a	15 b	13 ab	9 b	20 a	19 a
20 a	23 b	35 a	26 b	24 b	21 b	38 a	33 a	32 a	12 c	24 a	19 ab	15 bc	17 a	21 a	24 a	17 a
26 a	15 a	18 a	16 a	15 a	38 ab	47 a	40 ab	31 b	9 a	9 a	10 a	8 a	32 a	30 a	28 a	35 a
18 a	23 a	18 a	12 b	25 a	18 a	24 a	15 ab	10 b	16 a	11 ab	10 b	12 ab	20 a	17 ab	10 b	12 b
10 a	9 b	13 a	13 a	14 a	12 bc	22 a	9 c	15 ab	2 c	7 ab	5 b	12 a	6 b	11 ab	12 a	11 ab
5 a	2 b	5 a	4 ab	3 ab	1 b	6 a	8 a	11 a	1 b	7 a	6 a	4 a	<1 c	12 a	6 b	6 ab
4 a	11 a	9 ab	5 b	7 b	4 a	2 a	3 a	6 a	10 a	8 a	6 a	5 a	3 a	2 a	3 a	2 a

	2005		2013		2020		2024	
	Increase	Decrease	Increase	Decrease	Increase	Decrease	Increase	Decrease
Survey respondents (%)	24	8	14	21	10	14	13	15
Mean irrigated area of survey respondents (acres)	13	12	10	11	11	13	12	12
Mean irrigation volume of survey respondents (acre-feet)	21	32	13	23	15	25	17	20
National Projection								
Golf facilities	3,858	1,317	2,098	3,176	1,436	2,006	1,796	2,096
Irrigated area (acres)	51,548	15,790	20,828	35,250	15,395	26,818	21,371	24,543
Applied water (acre-feet)	81,018	42,693	27,703	72,245	20,953	50,247	30,470	42,598
Net irrigated area (Δ acres)	35,758		-14,421		-11,423		-3,172	
Net applied water (Δ acre-feet)	38,324		-44,542		-29,294		-12,128	

Table 19. Change in irrigated acres at operational golf facilities and the resulting impact on projected water use in 2005, 2013, 2020, and 2024.

	2005	2013	2020	2024

Irrigation system improvements	%			
New sprinkler heads	64 ab	66 a	60 c	62 bc
New nozzles	51 a	49 a	47 b	51 a
New hand-held sensors	—[a]	30 b	39 a	41 a
New software to control irrigation	34 b	37 ab	34 b	41 a
New master controller	25 b	24 b	24 b	32 a
New pump	30 a	29 a	24 b	30 a
Added sprinkler heads	48 a	36 b	30 c	27 c
Removed sprinkler heads	25 b	30 a	27 ab	25 b
Pump station	19 b	14 b	19 b	23 a
New Field Controller	31 a	25 b	19 c	21 bc
New lateral lines	17 a	9 b	6 c	12 b
New main lines	12 a	5 b	6 b	10 a
New in-ground sensors	—	6 a	4 b	4 b
Irrigation system automation				
Fully automated	64 c	70 b	73 ab	77 a
Semi-automated	31 a	28 ab	25 b	25 b
Manual system	21 a	16 b	15 bc	12 c
Irrigation scheduling methods				
Observe turf	96 a	89 b	88 b	87 b
Short-term weather forecasts	52 c	54 bc	61 a	57 ab
Observe soil moisture	80 a	59 b	54 c	50 c
Hand-held soil moisture sensors	—	29 c	39 b	46 a
Evapotranspiration from on-site weather station	14 c	18 b	17 b	21 a
Evapotranspiration from weather service	15 b	13 b	14 ab	17 a
Long-term weather records	6 b	5 b	9 a	6 ab
In-ground soil moisture sensors	3 a	4 a	3 a	3 a
Drone	—	—	1 a	<1 b
Mounted Sensor	—	—	<1 a	<1 a

Note. Within a row, values followed by a common letter are not significantly different according to the chi-square test at the 10% significance level.
[a]Question not asked in that year.

Table 20. Irrigation system improvements, system type, and scheduling methods used by respondents in 2005, 2013, 2020, and 2024.

	required water use reporting				recurring annual allocations				additional mandatory water restrictions			
	2005	2013	2020	2024	2005	2013	2020	2024	2005	2013	2020	2024
	%											
U.S.	48.4 b	55.0 a	58.0 a	57.5 a	21.7 c	30.3 a	26.2 b	28.7 ab	15.8 a	10.7 b	7.7 c	12.1 b
North Central	57.7 a	62.3 b	67.6 a	67.8 a	11.5 b	23.5 a	20.5 a	22.6 a	4.4 a	2.1 a	2.7 a	5.7 a
Northeast	50.6 b	63.8 a	64.1 a	62.8 a	24.7 b	33.3 a	31.6 ab	33.9 a	28.8 a	4.6 c	5.5 c	13.7 b
Pacific	28.9 b	25.0 b	28.1 b	43.9 a	13.7 a	15.0 a	19.3 a	20.7 a	2.0 b	13.9 a	17.8 a	15.6 a
Southeast	57.2 b	65.0 a	62.9 ab	61.5 ab	34.8 b	42.6 a	36.1 ab	43.3 a	21.4 a	26.4 a	10.3 b	15.8 ab
Southwest	50.8 a	53.3 a	50.6 a	59.6 a	36.4 a	40.8 a	39.1 a	45.6 a	11.8 b	18.6 b	14.0 b	30.3 a
Transition	36.5 c	48.4 b	59.0 a	51.1 ab	10.4 b	23.4 a	13.8 b	13.5 b	14.5 a	4.2 b	1.0 c	5.4 b
Upper West/ Mountain	35.3 ab	36.0 ab	46.0 a	32.3 b	36.1 a	34.7 a	30.0 a	28.1 a	31.3 a	19.1 b	15.3 b	15.2 b

Note. Within a row, values followed by a common letter are not significantly different according to the chi-square test at the 10% significance level.

Table 21. Frequency of water use restrictions at U.S. golf facilities in 2005, 2013, 2020, and 2024.

Region	Drought		Water management		Stormwater		Preventive irrigation maintenance	
	w/plan	required	w/plan	required	w/plan	required	w/plan	required
	%							
U.S.	27.6	12.6	16.8	38.0	17.0	54.9	21.4	30.9
North Central	22.9	9.3	6.2	18.1	9.0	35.5	14.0	18.0
Northeast	23.0	14.1	30.8	75.5	15.0	63.3	22.7	56.0
Pacific	22.6	16.1	16.5	19.3	20.5	69.9	14.9	27.2
Southeast	30.2	15.4	16.7	40.9	23.4	50.7	18.5	44.9
Southwest	34.8	16.0	28.6	29.1	35.1	57.1	44.2	42.0
Transition	31.4	16.6	11.5	13.0	17.2	58.9	15.9	18.5
Upper West/ Mountain	32.2	3.4	25.1	17.2	14.2	65.7	37.3	14.4

Table 22. Frequency of U.S. golf facilities that have a written drought, water management, stormwater, or preventive irrigation maintenance plan in 2024. For those respondents with written plans, the "required" columns indicate the frequency with which those plans were required by state or local authorities.

	No	Somewhat	Very Positive
	%		
U.S.	7.2	48.2	44.6
North Central	8.0	41.5	50.5
Northeast	3.5	31.8	64.7
Pacific	0.0	57.6	42.4
Southeast	0.0	69.0	31.0
Southwest	21.3	40.4	38.3
Transition	4.2	70.9	24.9
Upper West/Mountain	4.8	47.7	47.5

Table 23. Frequency of U.S. golf facilities indicating whether the use of moisture sensors had a positive impact on operations in 2024.

	Water Cost	Regulations	Water Conservation	Water Availability	Drought	Environmental Stewardship
	%					
U.S.	14.7	4.7	64.1	18.3	27.5	12.4
North Central	6.6	0.7	60.8	7.0	24.9	5.6
Northeast	13.2	9.7	68.8	33.8	38.9	11.9
Pacific	44.8	11.7	61.4	29.7	27.3	8.3
Southeast	10.8	1.9	54.2	14.8	25.8	20.7
Southwest	29.0	13.6	65.1	21.8	20.4	8.3
Transition	13.4	0.0	66.2	13.3	26.3	18.2
Upper West/Mountain	9.9	2.7	85.1	24.8	32.0	11.8

Table 24. Factors motivating the decision to reduce irrigated acres at U.S. golf facilities in 2024.

	1	2	3	4	5
	%				
U.S.	4.1	7.1	26.0	26.9	35.9
North Central	6.5	8.4	23.6	25.1	36.4
Northeast	3.8	5.3	22.8	27.5	40.6
Pacific	3.7	3.5	22.3	32.1	38.4
Southeast	3.2	10.4	25.8	27.4	33.1
Southwest	4.8	11.2	37.6	17.2	29.2
Transition	3.5	4.7	28.6	29.4	33.8
Upper West/Mountain	0.4	2.8	24.6	32.1	40.1

Note. Respondents rated golfer receptiveness on a 1-5 scale, where 1 = not receptive at all, and 5 = very receptive.

Table 25. Golfer receptiveness resulting from reduced water use and any perceived change in course appearance and playability among U.S. golf facilities that reported a reduction in water use in 2024.

	Fairways	Tees	Greens	Overall
	%			
U.S.	63.7	51.8	62.8	83.6
North Central	74.1	53.4	60.8	94.1
Northeast	72.5	69.9	77.4	74.0
Pacific	70.1	61.4	63.4	80.7
Southeast	68.0	47.9	44.6	87.1
Southwest	75.5	70.9	74.3	78.4
Transition	30.6	29.3	54.6	96.0
Upper West/Mountain	65.5	60.5	69.5	67.6

Table 26. Irrigation distribution uniformity on fairways, tees, greens, and overall on U.S. golf facilities that conducted an irrigation audit in 2024.

	Wetting Agent	Acid	Fertigation	BioControl	Sulfur	Gypsum
	%					
US	32.5	7.7	13.2	3.1	0.4	1.1
North Central	28.1	4.3	2.0	2.5	0.0	1.1
Northeast	27.9	8.0	9.6	2.2	0.0	1.2
Pacific	28.7	7.5	7.4	3.0	1.7	2.7
Southeast	39.1	10.4	34.2	5.4	0.3	0.6
Southwest	51.0	23.8	29.9	5.7	1.5	1.9
Transition	25.8	2.5	2.9	1.8	0.0	0.3
Upper Mountain/West	37.1	7.7	19.0	2.4	1.4	2.1

Table 27. Frequency of water treatment used with irrigational systems at U.S. golf facilities in 2024.

	Had Surface Water				Had Surface Water and Tested			
	2008	2015	2020	2024	2008	2015	2020	2024
	%							
U.S.	93.5 a	93.8 ab	92.0 ab	90.2 b	39.1 a	37.9 ab	34.7 b	38.7 ab
North Central	94.6 a	95.0 ab	92.8 ab	87.7 b	27.2 a	24.4 a	26.2 a	24.6 a
Northeast	92.9 a	89.7 a	94.5 a	91.2 a	34.9 a	37.3 a	27.9 a	32.4 a
Pacific	85.3 a	84.8 a	86.1 a	91.3 a	49.3 a	26.8 b	27.3 b	35.8 ab
Southeast	96.6 a	97.2 a	97.7 a	96.4 a	49.0 a	51.1 a	50.6 a	46.6 a
Southwest	85.4 bc	95.7 a	87.8 b	76.7 c	65.9 a	56.3 ab	51.2 ab	46.1 b
Transition	95.4 a	94.6 ab	88.6 b	94.5 ab	34.8 b	37.9 ab	34.0 b	50.7 a
Upper West/Mountain	91.0 a	91.2 a	89.2 a	88.4 a	43.6 a	35.8 ab	29.8 b	45.7 a

Note. Within a row, values followed by a common letter are not significantly different according to the chi-square test at the 10% significance level.

Table 28. Frequency of U.S. golf facilities that had surface water and tested their surface water in 2008, 2015, 2020, and 2024.

	Monthly	Every 3 months	Every 6 months	Annually
	%			
U.S.	10.3	11.4	19.8	58.5
North Central	10.8	5.7	16.9	66.7
Northeast	4.1	18.0	11.2	66.7
Pacific	10.7	5.6	26.3	57.4
Southeast	10.0	12.5	26.7	50.9
Southwest	28.1	16.3	22.5	33.0
Transition	7.5	12.1	21.6	58.8
Upper West/Mountain	9.2	9.0	12.2	69.6

Table 29. Surface water testing frequency of U.S. golf facilities that tested surface water in 2024.

	Monitoring Sites						
	0	1	2	3	4	5	>5
	%						
U.S.	14.4	36.3	18.1	13.4	5.1	4.4	8.2
North Central	22.4	26.1	17.4	22.1	5.3	3.5	3.3
Northeast	11.1	53.0	16.7	8.2	3.1	3.2	4.6
Pacific	16.8	41.4	21.2	9.2	3.0	6.1	2.3
Southeast	14.1	29.4	22.2	12.6	6.2	4.5	11.1
Southwest	13.1	30.1	20.9	13.4	4.6	11.3	5.3
Transition	14.6	47.8	13.1	9.1	4.8	3.2	7.4
Upper West/Mountain	6.6	30.3	18.4	16.6	6.0	4.0	18.1

Table 30. Number of surface water monitoring sites at U.S. golf facilities that tested surface water in 2024.

	Nutrients	Oxygen	Bacteria	Chemicals/ Fuels	Pesticides	Water Level	Biosolids	Temperature	Turbidity	Macroinvertebrates	Stream Flow
	%										
U.S.	81.3	36.8	28.2	28.8	28.1	23.7	20.0	20.6	14.0	4.7	6.8
North Central	86.1	42.7	26.3	22.9	38.2	16.4	13.7	15.4	8.8	1.9	11.2
Northeast	78.4	33.1	25.1	25.4	27.6	14.0	19.2	12.0	22.6	3.8	4.9
Pacific	72.8	40.0	17.8	29.0	23.9	9.4	12.1	36.3	23.9	3.8	2.1
Southeast	80.8	33.6	23.1	20.0	22.1	29.5	20.5	14.2	13.8	6.1	6.7
Southwest	70.8	28.1	32.4	28.8	22.9	28.7	20.1	22.6	13.8	0.0	5.6
Transition	84.1	44.0	36.2	31.7	27.5	26.7	23.9	24.3	13.0	8.3	6.0
Upper West/ Mountain	83.4	29.5	29.1	50.2	31.9	29.2	23.7	32.8	11.3	3.8	7.1

Table 31. Frequency of U.S. golf facilities that tested surface water and tested for the listed variable in 2024.

	Had Ground Water Wells				Had Ground Water Wells and Tested Ground Water			
	2008	2015	2020	2024	2008	2015	2020	2024
	%							
U.S.	61.4 a	59.5 ab	58.1 ab	55.8 b	57.3 a	58.8 a	39.6 b	43.2 b
North Central	75.1 a	70.8 ab	66.4 b	66.7 b	50.8 a	49.9 ab	37.0 b	38.4 b
Northeast	66.7 ab	73.9 a	66.7 ab	57.5 b	71.0 a	59.7 ab	47.5 b	51.5 b
Pacific	57.9 ab	42.8 b	64.2 a	58.1 ab	67.4 a	60.5 a	23.9 b	34.5 b
Southeast	59.4 a	57.1 a	58.3 a	51.7 a	57.2 ab	65.0 a	48.4 b	45.9 b
Southwest	45.8 a	54.2 a	42.6 a	45.0 a	66.5 a	69.3 a	50.6 a	58.6 a
Transition	50.2 a	39.3 a	44.7 a	46.6 a	51.0 b	69.2 a	29.9 c	35.4 c
Upper West/Mountain	52.4 a	58.2 a	56.0 a	54.1 a	49.8 a	49.2 a	37.8 a	47.2 a

Note. Within a row, values followed by a common letter are not significantly different according to the chi-square test at the 10% significance level.

Table 32. Frequency of U.S. golf facilities that had ground water wells in 2008, 2015, 2020, and 2024.

	Monitoring Sites						
	0	1	2	3	4	5	>5
	%						
U.S.	0.3	45.1	25.9	13.4	7.3	3.3	4.6
North Central	1.0	41.4	29.7	15.2	7.4	2.9	2.5
Northeast	0.0	35.7	36.2	7.9	9.1	4.9	6.3
Pacific	0.0	54.4	27.9	8.5	2.8	5.5	0.9
Southeast	0.0	45.4	23.1	19.2	5.8	2.1	4.4
Southwest	0.0	53.2	21.0	9.7	1.5	2.9	11.7
Transition	0.0	52.6	16.2	10.4	9.6	3.6	7.6
Upper West/Mountain	0.0	49.7	19.3	14.3	10.1	3.3	3.4

Table 33. Number of ground water monitoring sites at U.S. golf facilities that tested ground water in 2024.

	Protected Ground Water Wells						
	0	1	2	3	4	5	>5
	%						
U.S.	11.9	42.0	23.6	9.6	5.5	3.0	4.4
North Central	8.5	43.0	26.5	12.6	4.6	2.6	2.1
Northeast	13.1	31.0	34.1	7.9	3.9	4.2	5.9
Pacific	12.9	47.2	26.0	6.0	1.6	5.5	0.9
Southeast	9.7	44.0	22.7	12.5	4.3	2.0	5.0
Southwest	15.8	45.2	16.5	6.1	5.6	2.9	7.9
Transition	10.8	43.9	18.0	8.6	8.7	3.4	6.6
Upper West/Mountain	23.4	42.9	11.6	3.7	9.9	2.4	6.2

Table 34. Number of protected ground water wells at U.S. golf facilities that tested ground water in 2024.

	Monthly	Every 3 months	Every 6 months	Annually
	%			
U.S.	18.5	22.7	14.0	44.9
North Central	18.0	25.0	16.4	40.6
Northeast	33.3	16.3	6.7	43.7
Pacific	10.0	4.7	25.1	60.2
Southeast	15.2	29.2	12.5	43.1
Southwest	17.0	36.3	9.9	36.7
Transition	13.7	23.9	24.0	38.4
Upper West/Mountain	11.3	11.3	10.2	67.3

Table 35. Ground water testing frequency of U.S. golf facilities that tested ground water in 2024.

	Nutrients	Bacteria	Pesticides	Biosolids	Chemicals/ Fuels	Depth to Water	Oxygen	Turbidity	Temperature
	%								
U.S.	65.9	46.0	28.3	22.2	29.1	26.5	15.5	13.7	10.7
North Central	65.3	60.3	18.7	14.2	19.3	11.0	15.7	5.3	8.6
Northeast	58.6	54.6	27.6	21.7	36.5	21.5	22.1	9.5	13.5
Pacific	59.1	29.9	40.6	24.1	34.4	45.3	22.1	13.3	20.2
Southeast	81.6	20.4	28.8	24.1	23.1	16.6	16.5	26.4	8.0
Southwest	45.1	51.7	25.7	19.8	17.6	73.1	8.5	40.0	17.6
Transition	68.8	57.1	34.4	25.6	36.0	16.6	18.2	8.6	13.7
Upper West/Mountain	70.4	25.7	43.9	37.7	51.3	54.2	4.4	7.2	4.2

Table 36. Frequency of U.S. golf facilities that tested ground water and tested for the listed variable in 2024.

	Monitoring Sites						
	0	1	2	3	4	5	>5
	%						
U.S.	50.3	24.9	10.5	5.3	3.9	1.8	3.4
North Central	59.9	28.2	5.6	3.4	1.7	0.7	0.5
Northeast	45.7	20.2	22.4	3.9	2.5	2.1	3.3
Pacific	31.9	14.6	34.4	14.6	0.0	0.0	4.5
Southeast	55.1	12.9	13.9	5.2	1.7	7.3	3.9
Southwest	18.0	60.4	1.8	16.3	0.0	0.0	3.6
Transition	39.9	25.8	9.1	6.6	8.8	0.0	9.8
Upper West/Mountain	57.0	18.3	4.5	2.3	13.3	0.0	4.7

Table 37. Number of dedicated ground water monitoring sites at U.S. golf facilities that tested ground water in 2024.

Operational Budget	Acres				AF				AF per Acre			
	2005	2013	2020	2024	2005	2013	2020	2024	2005	2013	2020	2024
< $250,000	31.9 a	30.5 a	29.0 ab	26.0 b	30.0 a	25.2 ab	20.8 b	25.3 ab	1.0 a	0.9 ab	0.8 b	1.0 a
250,000 to 499,999	62.0 a	60.4 a	56.3 a	42.9 b	70.9 a	55.7 b	46.2 bc	40.7 c	1.2 a	0.9 b	0.9 b	0.9 b
500,000 to 749,999	81.3 a	80.1 a	78.3 a	68.0 b	105.4 a	82.4 b	75.4 b	66.1 b	1.3 a	1.1 b	1.0 b	1.0 b
750,000 to 999,999	95.6 a	94.6 a	95.4 a	86.0 a	127.2 a	116.4 ab	101.4 ab	86.6 b	1.4 a	1.2 ab	1.1 ab	1.1 b
1,000,000 to 1,249,999	106.4 a	100.9 a	104.6 a	95.4 a	177.0 a	148.9 ab	122.6 ab	113.4 b	1.7 a	1.5 ab	1.2 b	1.2 ab
1,250,000 to 1,499,999	104.7 a	109.4 a	102.1 a	99.3 a	194.4 a	142.2 ab	111.1 b	107.3 b	1.8 a	1.3 ab	1.1 b	1.1 b
>1,500,000	154.2 a	125.0 b	123.3 b	116.8 b	377.2 a	252.0 b	220.9 bc	180.5 c	2.5 a	2.0 ab	1.8 bc	1.5 c

Note. Within rows, medians followed by a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level.

Table 38. Median acres, acre-feet, and acre-feet/acre of U.S. golf facilities in 2024 by budget.

Year	Facility Type		
	9-hole	18-hole	27+-hole
	acres		
2005	23.9 Cb	75.9 Ba	142.6 Aa
2013	24.4 Cab	72.6 Ba	136.8 Aa
2020	25.5 Cab	75.0 Ba	138.7 Aa
2024	26.4 Ca	75.9 Ba	143.1 Aa
	acre-feet		
2005	29.1 Ca	105.5 Ba	211.5 Aa
2013	21.4 Cb	84.0 Bb	193.2 Aa
2020	18.7 Cb	79.1 Bb	174.4 Aa
2024	22.8 Cab	83.9 Bb	164.7 Aa
	acre-feet/acre		
2005	1.1 Ba	1.4 Aa	1.5 Aa
2013	0.8 Bbc	1.1 Ab	1.4 Aa
2020	0.7 Bc	1.1 Ab	1.2 Aa
2024	1.0 Bab	1.1 ABb	1.2 Aa

Note. Within columns and rows, medians followed by a lower-case or upper-case common letter, respectively, are not significantly different according to the Tukey-Kramer test at the 10% significance level.

Table 39. Median irrigated acres, acre-feet, and acre-feet per acre at 9-, 18-, and 27+-hole facilities in the U.S. in 2005, 2013, 2020, and 2024.

	U.S. Golf Facilities		Surveys Received	
	Total	Proportion of Facilities (%)	Total	Proportion of Surveys Received (%)
U.S.	13,952	100.0	1,695	100.0
Region				
North Central	3,538	25.4	380	22.4
Northeast	2,454	17.6	258	15.2
Pacific	560	4	99	5.8
Southeast	2,704	19.4	350	20.7
Southwest	1,133	8.1	157	9.3
Transition	2,490	17.8	273	16.1
Upper West/Mountain	1,073	7.7	178	10.5
Type				
Daily Fee	7,640	54.8	615	36.3
Municipal	2,585	18.5	347	20.5
Private	3,727	26.7	733	43.2
Holes				
9	3,658	26.2	108	6.4
18	8,971	64.3	1,284	75.8
27+	1,323	9.5	303	17.8

Table 40. Total U.S. golf facilities and surveys received partitioned by region, type, and holes in 2024.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
	Precipitation (in.)											
North Central	1.42	1.37	2.04	3.30	4.30	4.59	3.99	3.70	3.19	2.78	1.99	1.62
Northeast	3.28	2.79	3.62	3.80	3.82	4.31	4.18	4.02	4.13	4.35	3.55	3.85
Pacific	7.60	5.95	5.83	3.89	2.50	1.51	0.48	0.59	1.42	3.80	6.66	8.15
Southeast	3.66	3.34	3.82	3.77	4.26	5.00	4.46	4.60	4.51	4.01	3.39	3.76
Southwest	1.34	1.40	1.32	0.98	1.34	1.25	1.83	1.92	1.65	1.37	0.99	1.26
Transition	3.04	2.93	3.90	4.30	4.91	4.65	4.56	4.08	4.05	3.53	3.30	3.46
Upper West/Mountain	1.69	1.54	1.80	2.06	2.41	1.97	1.63	1.49	1.38	1.65	1.56	1.76
	Temperature (°F)											
North Central	18.50	22.36	33.86	46.37	58.24	68.06	72.10	70.13	62.44	49.57	35.81	24.12
Northeast	23.59	25.48	33.64	45.55	56.73	65.54	70.40	68.89	61.73	50.19	39.43	29.68
Pacific	43.11	45.07	48.10	51.78	57.53	62.38	67.13	67.10	63.45	55.81	47.67	42.53
Southeast	44.09	47.22	53.99	61.68	69.89	76.76	79.71	79.21	74.04	64.43	54.29	47.05
Southwest	43.55	46.82	53.15	59.65	67.60	75.75	79.39	78.43	72.54	62.54	51.62	43.59
Transition	34.47	37.93	46.18	56.05	65.08	73.41	77.32	75.94	69.17	57.83	46.51	38.01
Upper West/Mountain	25.45	28.62	37.24	44.98	54.34	63.27	70.36	68.78	60.11	47.47	35.25	26.15
	Growing Degree Days											
North Central	0.47	1.44	18.77	80.92	285.91	542.57	684.76	623.88	383.54	121.19	16.72	1.40
Northeast	1.08	1.16	10.80	63.26	240.12	467.54	632.04	585.48	359.91	112.78	19.61	2.72
Pacific	18.99	31.48	65.60	116.54	250.53	374.82	531.26	530.47	405.70	212.58	63.26	17.42
Southeast	112.73	140.05	261.26	401.08	626.34	803.06	920.89	905.33	723.23	475.39	236.23	139.73
Southwest	59.94	86.34	191.83	323.73	552.63	772.73	910.93	880.97	677.31	411.30	163.53	58.40
Transition	12.91	21.40	84.38	230.81	471.38	702.12	846.72	803.90	575.83	275.10	74.94	20.72
Upper West/Mountain	1.24	3.47	16.99	56.03	198.13	406.29	631.20	583.17	325.10	91.09	12.33	1.26
	Growing Degree Days /Precipitation											
North Central	0.33	1.05	9.20	24.52	66.49	118.21	171.62	168.62	120.23	43.59	8.40	0.86
Northeast	0.33	0.42	2.98	16.65	62.86	108.48	151.21	145.64	87.15	25.93	5.52	0.71
Pacific	2.50	5.29	11.25	29.96	100.21	248.23	1106.79	899.10	285.70	55.94	9.50	2.14
Southeast	30.80	41.93	68.39	106.39	147.03	160.61	206.48	196.81	160.36	118.55	69.68	37.16
Southwest	44.73	61.67	145.33	330.34	412.41	618.18	497.78	458.84	410.49	300.22	165.18	46.35
Transition	4.25	7.30	21.64	53.68	96.00	150.99	185.68	197.03	142.18	77.93	22.71	5.99
Upper West/Mountain	0.73	2.25	9.44	27.20	82.21	206.24	387.24	391.39	235.58	55.21	7.90	0.72

Table 41. 30-year monthly average precipitation, temperature, growing degree days, and growing degree days/precipitation for the seven U.S. agronomic regions.

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