



Golf Course Environmental Profile

Phase IV Volume I
Nutrient Use and Management
Practices on U.S. Golf Courses

Golf Course Superintendents Association of America

Golf Course Environmental Profile

Phase IV, Volume I

2024 Nutrient Use and Management Practices on U.S. Golf Courses

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



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GCEP Nutrient Phase IV Public Report

Statement by Board President

Since the Golf Course Environmental Profile (GCEP) began tracking nutrient use in 2006, golf course superintendents have demonstrated an unwavering commitment to responsible nutrient stewardship. The results from the fourth phase of the GCEP continue that story, showing that our profession has fundamentally changed the rate of nutrient application in order to continue to produce healthy playing conditions while protecting natural resources.

Nutrients remain an essential tool for growing healthy turfgrass. Without adequate nutrition, turf becomes more susceptible to stress, pests, and environmental extremes, affecting playability and the long-term health of the golf course. Superintendents understand that nutrients must be applied carefully and precisely. Applying more fertilizer than the turf can use not only increases costs but also raises the potential for nutrients to move beyond the managed turf and impact surrounding water resources.



The latest survey demonstrates that golf course superintendents continue to embrace this balanced approach. Since 2006, total projected applications of nitrogen, phosphorus, and potassium have declined substantially through a combination of lower application rates, fewer fertilized acres, and more selective management of golf course features. These long-term reductions reflect nearly two decades of advances in education, research, improved products, precision application technology, and the adoption of Best Management Practices.

While the greatest reductions occurred during the early years of the GCEP, nutrient use has largely stabilized over the past several survey cycles. That plateau is telling because it suggests that many facilities have already captured the most obvious efficiency gains. The next stage of progress will come not simply from applying less fertilizer, but from applying nutrients more precisely. Facility-specific nutrient management plans, accounting for all nutrient sources—including reclaimed water, composts, and soil reserves—and using data-driven decisions will help superintendents continue improving efficiency while maintaining the exceptional playing conditions golfers expect.

This report reinforces what we have long known: golf course superintendents are environmental stewards. Every day they balance turf performance, golfer expectations, environmental responsibility, and fiscal accountability. Their commitment to continuous improvement ensures that golf courses remain healthy, resilient landscapes that provide recreational, environmental, and economic value to communities across the country.

On behalf of the GCSAA Board of Directors, I sincerely thank the many golf course superintendents who participated in this survey. Your willingness to share information provides the data needed to measure our industry's progress, guide future research, strengthen Best Management Practices, and demonstrate golf's ongoing commitment to environmental stewardship. This important work would not be possible without your participation and dedication.

Together, we continue to build a stronger, more sustainable future for the game of golf.

A handwritten signature in black ink, reading "Paul Carter". The signature is fluid and cursive, with a long horizontal stroke extending to the right.

Paul Carter, CGCS,
2026 GCSAA President

Executive Summary



Objectives

Nutrient use and management practices on U.S. golf facilities were previously documented in 2006, 2014, and 2021. These reports have proven valuable in guiding practitioners and educators toward more efficient turfgrass management.

The objective of the fourth survey was to compare current nutrient use and practices to prior years to determine whether a change has occurred and, if so, to what extent. Specific areas of interest were quantifying the use of nitrogen (N), phosphorus (P_2O_5), and potassium (K_2O) in the following areas:

- National and regional nutrient use
- The influence of management practices on nutrient use
- Use of nutrient sources
- Presence and/or use of storage and equipment calibration

Results

National

The following changes have occurred since 2006:

Applied Nutrients

- Projected applied N decreased by 41% to 54,499 tons.
- Projected applied P_2O_5 decreased by 59% to 13,675 tons.
- Projected applied K_2O decreased 53% to 41,544 tons.

Fertilized Acres

- Projected acres fertilized with N decreased by 23% to 907,271 acres.
- Projected acres fertilized with P_2O_5 decreased by 50% to 500,298 acres.
- Projected acres fertilized with K_2O decreased by 30% to 790,241 acres.
- The national median of fertilized acres per facility decreased by 17% to 100.5 acres.

Operational Facilities

- Operational golf facilities declined by 13% to 13,952.

Application Rates

- Nitrogen application rates decreased by 26% to 1.7 lbs. per 1,000 ft².
- P_2O_5 application rates decreased by 75% to 0.2 lbs. per 1,000 ft².
- K_2O application rates decreased by 47% to 1.0 lbs. per 1,000 ft².

Management Practices

- Fertilizing based on soil test results decreased to 45% of facilities.
- Reducing turfgrass acres decreased to 27% of facilities.
- Using plant growth models increased to 29% of facilities.

Introduction

The Golf Course Superintendents Association of America (GCSAA) launched the Golf Course Environmental Profile (GCEP) Survey Series in 2006 to establish a comprehensive, data-driven understanding of environmental practices across U.S. golf courses. The initial effort focused on establishing baseline metrics for land use and management practices related to water, nutrients, and pest control.

A second survey cycle, initiated in 2014, enabled robust, scientifically valid assessments of industry change over time. This phase examined key areas including energy use and environmental practices; land use and stewardship programs; pest management; nutrient use and management; and water use and conservation. Together, these datasets created one of the most comprehensive longitudinal

records of environmental performance within the golf course industry. A third iteration of the GCEP Survey Series, launched in 2021, further strengthened the dataset on U.S. golf course impacts.

The results are widely used to track trends in environmental performance, guide GCSAA education and outreach priorities, identify emerging research needs, inform responses to regulatory and public inquiries, and highlight the environmental leadership of golf course superintendents. Importantly, the dataset also provides a credible, science-based foundation for engaging in policy and regulatory discussions.

Survey findings are publicly available through GCSAA and are disseminated via industry publications such as *Golf Course Management*, as well as peer-

reviewed journals including *Crop, Forage and Turfgrass Management* and *Hort-Technology*. These outputs support both the scientific community and regulatory agencies by providing reliable, longitudinal data to inform research and evidence-based decision-making.

Nutrient management remains a central component of golf course operations, influencing both economic inputs and environmental outcomes. As such, understanding how nutrients are used and managed is essential for refining and advancing best management practices (BMPs). The objective of this study was to quantify nutrient use and management practices on U.S. golf courses in 2024 and to evaluate how these practices have evolved.

Methodology

To enable comparisons across survey years, all questions were identical to those used in 2006, 2014, and 2021. Nutrient data were reported according to the guaranteed analysis listed on fertilizer labels, with nitrogen, phosphorus, and potassium expressed as N, P₂O₅, and K₂O, respectively. A survey link was distributed via email using mailing lists from the National Golf Foundation and the Golf Course Superintendents Association of America, reaching 13,952 unique golf facilities. For this study, a golf facility was defined as a business where golf is played on one or more courses. The survey was also promoted through GCSAA social media channels. Data collection remained open for seven consecutive weeks, beginning on September 29, 2025. To ensure confidentiality, respondents were not identified by name; instead, each response was

assigned a unique identification number. The dataset was subsequently combined with corresponding data from the 2006, 2014, and 2021 surveys to evaluate changes over time. A total of 1,499 facilities responded, representing 10.7% of all known U.S. golf facilities.

Respondents were grouped by agro-nomic region (**Figure 15**). To ensure that results accurately reflected the U.S. golf course population, responses were weighted. Facilities were categorized into 35 groups based on facility type (public or private), number of holes (9, 18, or 27+), and public green fee (<\$55 or ≥\$55 per round) (**Table 33**). Weights for each category were calculated by dividing the category's proportion in the total facility universe by its proportion in the sample.

Analysis indicated that the data were not normally distributed. Consequently, data were fit to a log-logistic model, and median separations were conducted using the Tukey–Kramer test at an alpha level of 0.10. Projected nutrient applications were estimated by multiplying the total number of golf facilities by the proportion applying nutrients to a given course feature, and then by the average nutrient application rate. Projected fertilized acreage was calculated by dividing the total pounds of nutrients applied by the average application rate per 1,000 ft² and converting the result to acres. Statistical comparisons were not performed on projected values. Golf facility frequencies were calculated using statistical software, and differences among survey years were evaluated using the chi-square (χ^2) test at the 0.10 significance level.

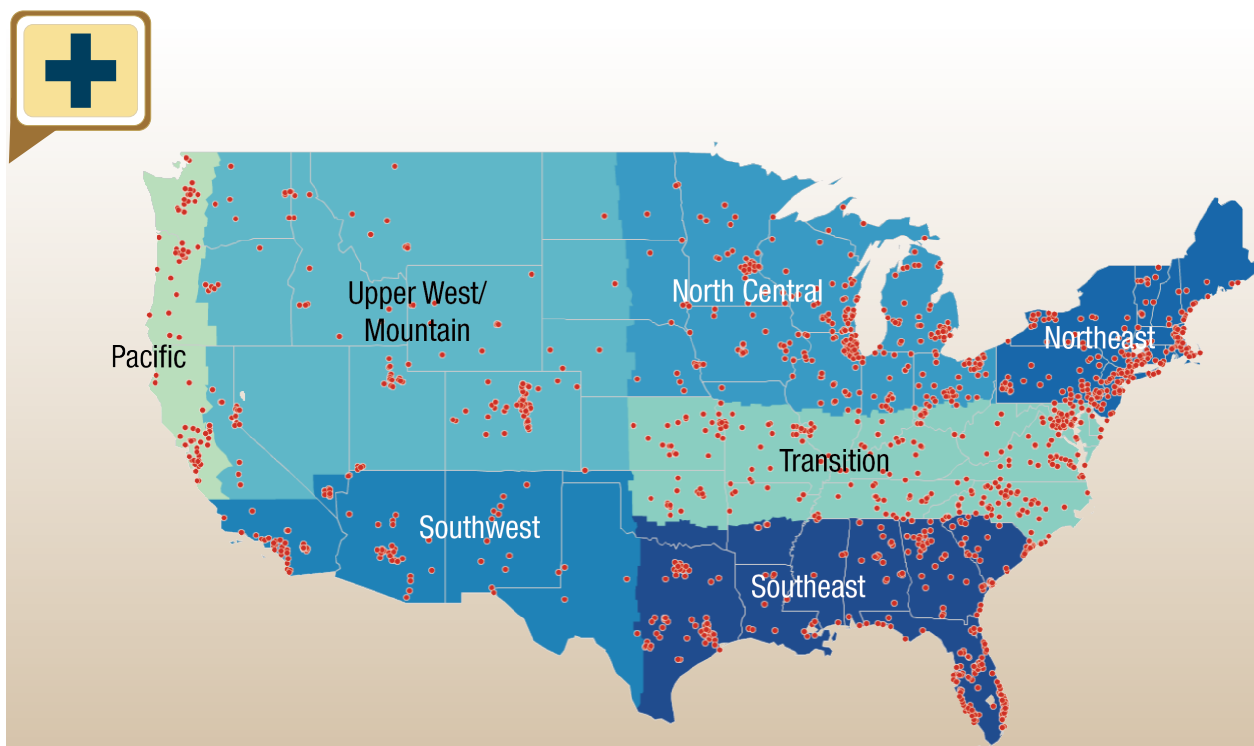


Figure 15. Distribution of the 2024 survey and the seven agronomic regions.

Results

National

Nationally, nutrient use on U.S. golf courses has declined substantially since 2006, reflecting changes in application rates, fertilized acreage, and the number of operational facilities. Total projected applications of N, P₂O₅, and K₂O decreased by 41%, 59%, and 53%, respectively. These reductions were accompanied by declines in fertilized acreage, with N-, P₂O₅-, and K₂O-treated areas decreasing by 23%, 50%, and 30%, respectively, and the number of operational facilities decreasing by 13%.

Since the initial 2006 survey, application rates also declined across all nutrients, with N decreasing by 26%, P₂O₅ by 75%, and K₂O by 47%. Phosphorus experienced the greatest reduction both in total use and rate, resulting in a shift in the overall nutrient ratio towards less P₂O₅ and K₂O relative to N. While most facilities continue to apply N, fewer

facilities reported applying P₂O₅ and K₂O compared to previous years.

Management practices have also changed over time. The proportion of facilities using soil testing and written nutrient management plans declined modestly, while the use of plant growth models increased. Facilities that tested soil were associated with greater nutrient application rates across most course features. The frequency of fertilizer applications increased, particularly on greens, while the percentage of applications made with calibrated equipment remained near 50%.

Overall, these findings indicate a continued reduction in nutrient inputs alongside evolving management practices, suggesting increased efficiency in some areas while highlighting opportunities for improvement in others.

Nutrient Use

- Total projected applied N, P₂O₅, and K₂O declined by 41%, 59%, and 53%, respectively, since 2006 (**Figure 1**).

Fertilized Acres

- Acres fertilized with N, P₂O₅, and K₂O declined by 23%, 50%, and 30% since 2006, respectively (**Figure 2**).
- Acres fertilized with N, P₂O₅, and K₂O declined within each agronomic region (**Table 12**).
- More than 97% of facilities reported applying N to greens and tees (**Table 1**).
- The least common features to receive N were grounds (50%) and natural areas (4%) (**Table 1**).
- The proportion of facilities that reported applying P₂O₅ has declined since 2006 for each course feature (**Table 1** and **Figure 6**).
- The proportion of facilities that

Table 1. Frequency of U.S. golf facilities that reported applications of nitrogen (N), available phosphorus (P₂O₅), and soluble potash (K₂O) to each golf facility feature in 2006, 2014, 2021, and 2024.

Year	Greens	Tees	Fairways	Roughs	Practice Areas	Natural Areas	Grounds
Golf Facilities (%)							
N							
2006	99.9 a ⁱ	98.1 a	96.2 a	73.2 a	59.6 a	8.0 a	56.5 ab
2014	99.3 b	96.8 ab	91.7 c	65.2 b	59.6 a	3.9 b	58.0 a
2021	99.5 b	96.5 b	92.7 bc	64.8 b	60.4 a	3.8 b	54.1 a
2024	99.4 b	97.7 ab	94.6 ab	70.0 a	59.4 a	4.1 b	49.6 b
P ₂ O ₅							
2006	92.4 a	88.7 a	82.1 a	61.1 a	51.8 a	6.1 a	48.6 a
2014	80.5 b	65.2 b	51.4 b	32.2 c	35.7 b	1.7 b	30.1 b
2021	74.9 c	59.4 c	49.5 b	31.1 c	35.7 b	1.8 b	26.1 c
2024	81.6 b	63.9 b	52.2 b	37.3 b	38.4 b	2.3 b	25.8 c
K ₂ O							
2006	96.8 a	94.8 a	92.3 a	69.3 a	57.2 a	8.3 a	54.5 a
2014	95.0 ab	89.0 b	83.0 b	56.4 bc	53.3 b	3.3 b	52.0 a
2021	92.8 b	86.3 b	80.1 b	54.9 c	53.4 ab	3.2 b	46.0 b
2024	94.1 b	88.4 b	82.8 b	60.4 b	51.6 b	3.3 b	42.0 b

ⁱ Within columns, values followed by a common letter are not significantly different according to the χ^2 test at the 10% significance level.

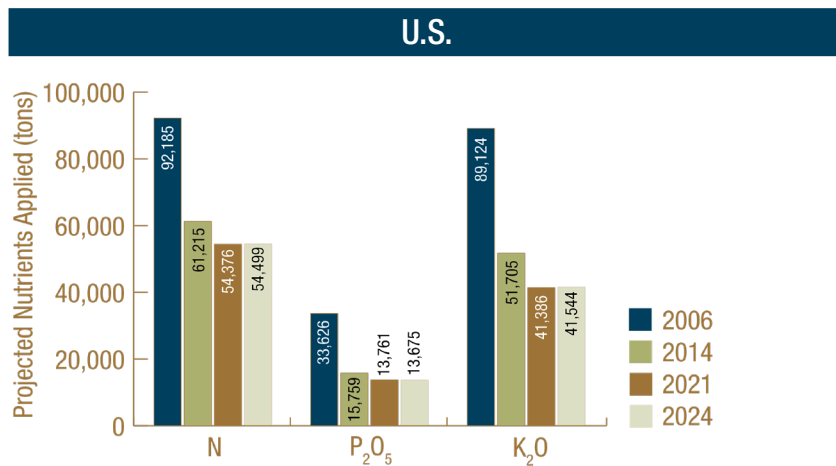


Figure 1. Projected tons of N, P₂O₅, and K₂O applied on U.S. golf facilities in 2006, 2014, 2021, and 2024.

reported applying K₂O has declined since 2006 for each course feature (Table 1 and Figure 6).

- Median fertilized acres declined since 2006 by 16% (Table 13).

Operational Facilities

- Operational golf facilities declined by 13% since 2006 (Table 14).

Application Rates

- Nitrogen application rates have declined 26% from 2.3 lbs. per 1,000 ft² in 2006 to 1.7 lbs. per 1,000 ft² in 2024 (Table 2).
- P₂O₅ application rates declined by 75% since 2006 (Table 2).
- K₂O application rates declined by 47% since 2006 (Table 2).
- The greatest application rates of N, P₂O₅, and K₂O were on greens, fol-

Table 2. Nitrogen (N), available phosphorus (P₂O₅), and soluble potash (K₂O) use rates on golf facilities within the U.S. and regions (Fig. 15) in 2006, 2014, 2021, and 2024.

Year	U.S.	NC ⁱ	NE	Pac.	SE	SW	Trans.	UWM
N (lbs. per 1,000 ft²)								
2006	2.3 a ⁱⁱ	1.8 a	1.9 a	2.3 a	3.6 a	3.8 a	2.0 a	2.3 a
2014	1.7 b	1.3 b	1.6 ab	1.7 a	2.7 b	2.5 ab	1.6 ab	1.7 ab
2021	1.6 b	1.3 b	1.5 ab	2.4 a	2.2 b	1.2 b	1.4 b	1.3 b
2024	1.7 b	1.1 b	1.2 b	2.4 a	2.6 b	2.6 a	1.5 b	1.6 ab
P₂O₅ (lbs. per 1,000 ft²)								
2006	0.8 a	0.6 a	0.7 a	1.0 a	0.9 a	2.2 a	0.9 a	0.9 a
2014	0.3 b	0.1 b	0.2 b	0.4 a	0.8 ab	0.6 b	0.3 b	0.4 ab
2021	0.3 b	0.1 b	0.4 b	0.6 a	0.5 b	0.9 b	0.2 b	0.3 b
2024	0.2 b	0.1 b	0.3 b	0.6 a	0.4 b	1.4 ab	0.3 b	0.2 b
K₂O (lbs. per 1,000 ft²)								
2006	1.9 a	1.4 a	1.6 a	1.9 a	3.3 a	3.2 a	1.9 a	1.8 a
2014	1.2 b	0.7 b	1.1 b	1.2 a	2.7 ab	1.2 b	1.2 b	1.1 ab
2021	1.1 b	0.6 bc	1.1 b	1.3 a	1.9 b	1.5 b	0.8 b	0.6 b
2024	1.0 b	0.5 c	0.8 b	1.2 a	2.0 b	1.5 b	1.1 b	0.7 b

ⁱ NC, North Central; NE, Northeast; Pac., Pacific; SE, Southeast; SW, Southwest; Trans., Transition; UWM, Upper West/Mountain.

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

lowed by tees and practice areas (**Figure 3**).

- Approximately 1 lb. of P_2O_5 was applied to each course feature (**Figure 3**).
- Median tons of N, P_2O_5 , and K_2O declined by 41%, 69%, and 60%, respectively, since 2006, to 3.4, 0.5, and 2.0 tons per facility (**Table 15**).
- Overseeding was associated with greater application rates of N, P_2O_5 , and K_2O on each course feature, except K_2O on greens (**Figure 4**).
- Application rates of N, P_2O_5 , and K_2O were similar among 9, 18, and 27+-hole facilities (**Table 25**). Private facilities applied rates 18%, 33%, and 33% higher than public facilities for N, P_2O_5 , and K_2O , respectively.

Nutrient Sources

- The percentage of facilities that used natural organic N sources declined from 64% in 2006 to 56% in 2024 (**Table 26**).
- Within facilities that used natural organic N sources, the most common sources were animal waste (73%), followed by biosolids (31%), crop products (18%), and food waste (17%) (**Table 27**).
- Among facilities that used natural organic N, the use of biosolids and food waste declined to 31% and 17% of facilities, whereas facilities using animal waste increased, and crop products remained unchanged from 2006 to 2024.
- The percentage of slow-release N applied reduced from 65% in 2006 to 62% in 2024 (**Table 28**).
- Inversely, the percentage of quick-release N increased from 31% in 2006 to 34% in 2024 (**Table 28**).
- The frequency of facilities applying soil amendments increased for all soil amendments except limestone and calcium chloride (**Table 29**).
- 83% of facilities applied at least one soil amendment, with the most common amendments being humic materials (60%), followed by amino acids/proteins (52%) (**Table 29**).

U.S.

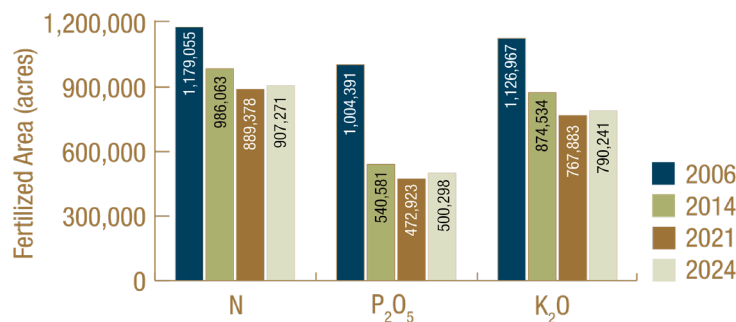


Figure 2. Projected acres fertilized with N, P_2O_5 , and K_2O of U.S. golf facilities in 2006, 2014, 2021, and 2024.

U.S. Median Nutrient Applied per Course Feature

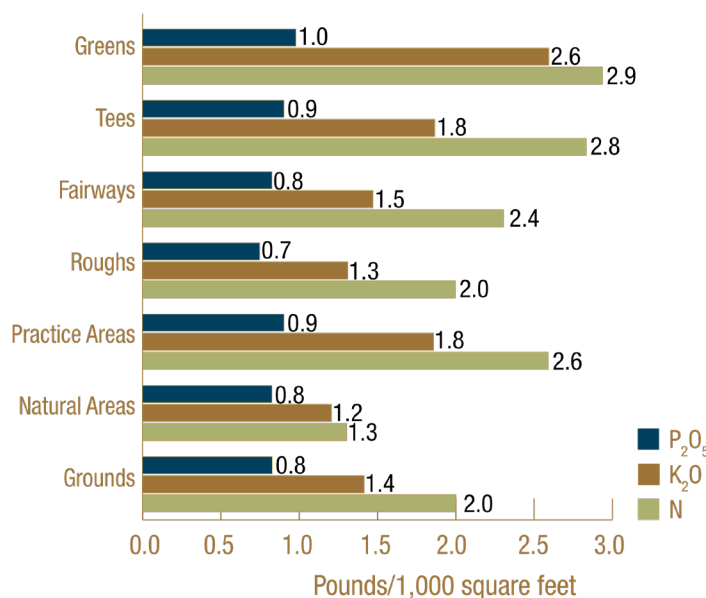


Figure 3. Application rates of N, P_2O_5 , and K_2O on U.S. golf facilities by course feature in 2024.

Nutrient Ratios

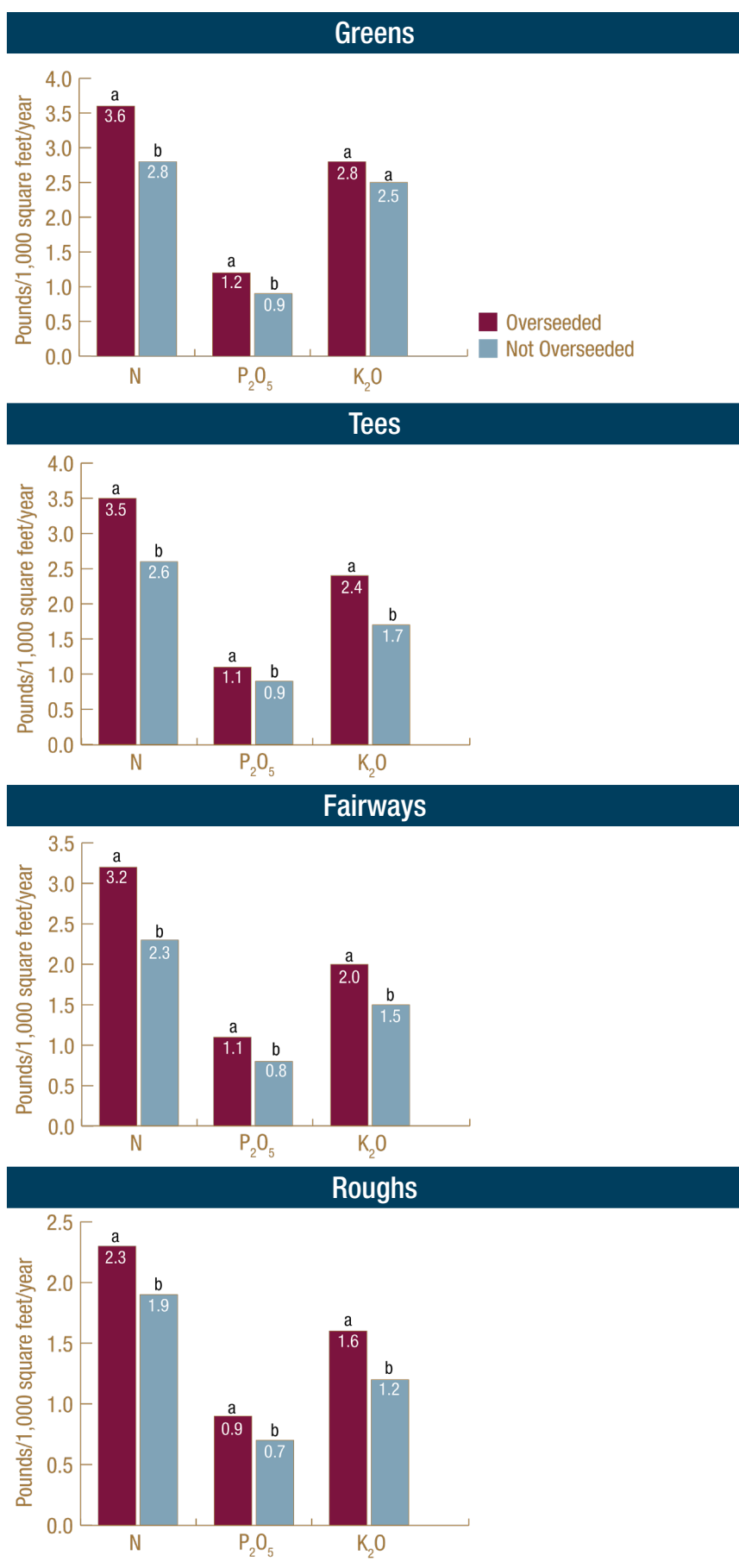
- The ratio of N to P_2O_5 to K_2O increased from 5.0 to 1 to 2.8, pooled across course features since 2006. The ratio increased since 2006 for total nutrients and nutrients applied to greens and tees (**Table 19**). The increase was likely due to reduced amounts of applied P_2O_5 .

Nutrient Restrictions and Management Plans

- Facilities experiencing any type of

nutrient restriction increased, relative to 2006, to 16% but declined since 2014 (**Table 3**).

- The yearly amount and/or amount of P_2O_5 per application was the most common restriction (12%), but has declined since 2014 and 2021 (**Table 3**).
- Federal, state, tribal, or local nutrient restrictions were associated with reductions of 12%, 33%, and 30% in N, P_2O_5 , and K_2O application rates, respectively (**Figure 5**).
- The percentage of facilities that used a



written nutrient management plan fell from 47% in 2006 to 42% in 2024 (Table 24).

Soil Testing

- The percentage of facilities that soil tested greens, which was the most commonly tested, declined from 92% to 85% since 2006 (Table 21).
- Fairways (60%) were the second most common feature soil tested, followed by tees (59%) and practice areas (26%).
- Facilities that soil tested were associated with greater quantities of N applied to each course feature, except greens (Figure 17). Facilities that soil tested applied approximately 22% more N than facilities that did not soil test when pooled across all course features.
- Facilities that soil tested were associated with greater quantities of P₂O₅ applied to practice areas, ground, tees, and roughs, and were equivalent to facilities that did not soil test on all remaining course features (Figure 17). Facilities that soil tested applied approximately 14% more P₂O₅ than facilities that did not soil test when pooled across all course features.
- Facilities that soil tested were associated with greater quantities of K₂O applied to each course feature, except natural areas (Figure 17). Facilities that soil tested applied approximately 32% more K₂O than facilities that did not soil test when pooled across all course features.
- The most common soil test extractant used for phosphorus was Mehlich-3, which increased from 33% to 38% of facilities between 2021 and 2024. (Figure 18).
- The importance of using soil analysis for nutrient application decisions

Figure 4. Application rates of N, P₂O₅, and K₂O on U.S. golf facilities by course feature associated with overseeding in 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level.

Table 3. Frequency of federal, state, local government, or tribal authority restrictions on nutrient applications on U.S. golf facilities in 2006, 2014, 2021, and 2024.

Restriction Type	2006	2014	2021	2024
Nutrient restriction of any type	7 c ¹	23 a	18 b	16 b
Phosphate (total yearly amount or amount per application)	5 d	20 a	15 b	12 c
Date restrictions for applications	2 b	8 a	7 a	8 a
Required buffer strips	0 c	7 a	7 a	5 b
Nitrogen (total yearly amount or amount per application)	2 b	5 a	4 a	5 a
Regional / state stormwater management plan	1 c	6 a	3 b	5 a
No-apply zones	1 b	4 a	4 a	4 a
Potash (total yearly amount or amount per application)	1 b	1 b	2 ab	2 a

¹Within rows, values followed by a common letter are not significantly different according to the χ^2 test at the 10% significance level.

declined since 2006 and 2014, but remains one of the top five most important factors (Table 22).

- The percentage of facilities that used soil test results with the intent of reducing reliance on fertilizers declined from 55% to 45% since 2014 (Figure 16).
- Using soil test results to reduce reliance upon fertilizers was associated with increased amounts of applied N (26%) and K₂O (35%) (Table 23).

Fertilizer Application and Storage

- The percentage of nutrient applications made with calibrated equipment declined across each course feature, yet remained at approximately 50% of applications (Table 30).
- The median number of nutrient applications per year increased on each course feature (Table 31). Greens continue to account for 2-3 times as many applications as other course features (tees and fairways), and outnumber applications on roughs by more than 5-fold.
- The percentage of facilities that used a nutrient storage facility increased from 51% in 2006 to 68% in 2024 (Table 32).

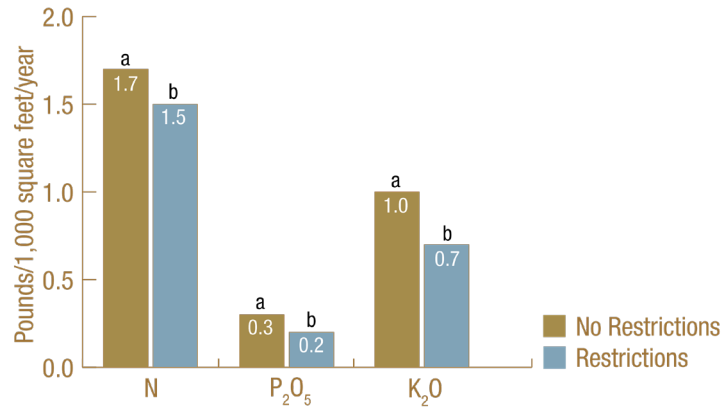


Figure 5. Application rates of N, P₂O₅, and K₂O on U.S. golf facilities associated with federal, state, tribal, or local nutrient restrictions in 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level.

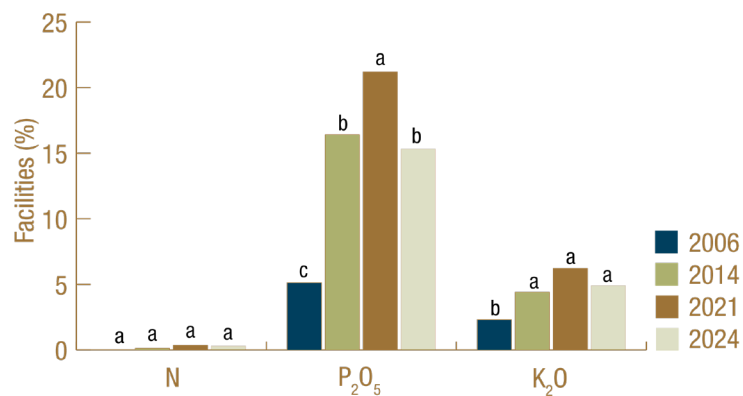


Figure 6. Frequency of U.S. golf facilities that reported no applications of nitrogen (N), available phosphorus (P₂O₅), or soluble potash (K₂O) in 2006, 2014, 2021, and 2024. Bars with a common letter are not significantly different according to the χ^2 test at the 10% significance level.

Regional

Across agronomic regions, nutrient use declined consistently since 2006, although the magnitude of change varied. Total applications of nitrogen, P_2O_5 , and K_2O decreased in every region, generally ranging from 37–45% for N, 45–70% for P_2O_5 , and 47–59% for K_2O . Fertilized acreage also declined across all regions, typically by 18–29%, reflecting both reductions in managed turf areas and broader industry contraction via facility closures. The number of operational facilities decreased across all regions, ranging from 3% to 16%, contributing to overall reductions in nutrient use.

Application rates declined in most regions, particularly for P_2O_5 and K_2O , although some regions (e.g., Pacific and Southwest) reported little change in certain nutrient rates. Nitrogen rates declined in most regions but remained unchanged in others. Despite these differences, the general trend across regions was toward reduced nutrient inputs.

The Southeast accounted for the greatest proportion of total nutrient use nationally, reflecting both climatic and management differences. Median fertilized acreage declined in some regions (e.g., North Central and Southwest) but remained stable in others, indicating regional variability.

Soil testing of greens declined in several regions, while remaining stable in others, and continued to be most common on greens, followed by fairways and tees. The use of written nutrient management plans remained largely unchanged across regions.

Overall, regional trends mirror national patterns, with widespread reductions in nutrient use alongside variability in application rates, management practices, and facility characteristics.

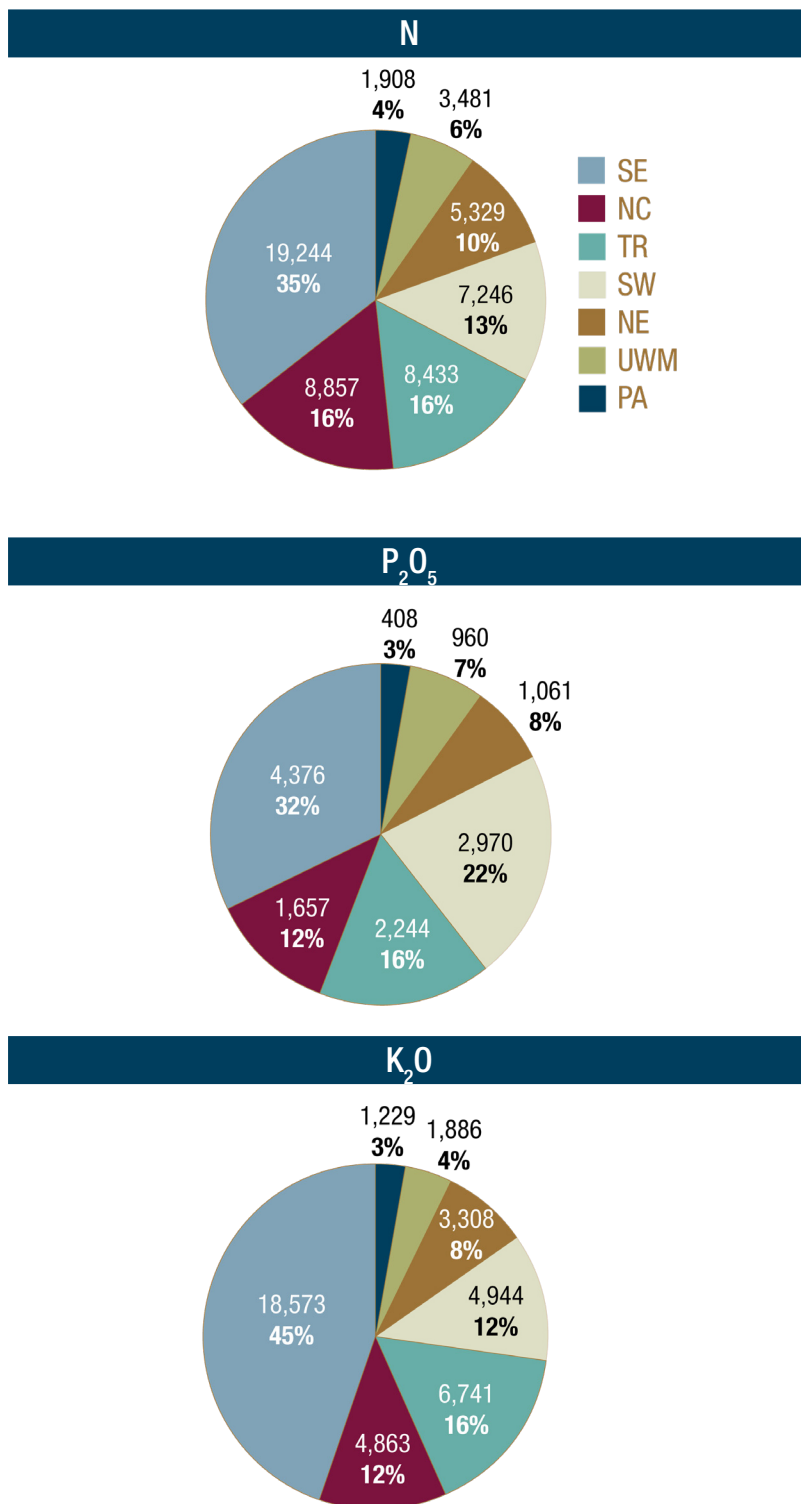


Figure 7. Projected tons and percent nutrient use on U.S. golf facilities by agronomic region in 2024.

Nutrient Use

- Total projected N, P₂O₅, and K₂O declined within each agronomic region (**Table 11**). Nitrogen on the order of 37-45%, P₂O₅ roughly 45-70%, and K₂O between 47-59%.
- The Southeast region used the greatest quantity and percentage of the total N, P₂O₅, and K₂O applied in the U.S (**Figure 7**).

Fertilized Acres

- Acres fertilized with N declined within each agronomic region by 18-29% (**Table 12**).
- Acres fertilized with P₂O₅ declined within each agronomic region by 28-66% (**Table 12**).
- Acres fertilized with K₂O declined within each agronomic region by 21-42% (**Table 12**).
- Facilities that reported P₂O₅ applied declined from 2006 to 2021, but increased since 2021 (**Figure 6**). The increase appears to be on greens, tees, and roughs (**Table 1**).
- Since 2006, median fertilized acres declined in the North Central (18%) and Southwest (52%) and remained unchanged in all other regions (**Table 13**).

Number of Facilities

- Operational golf facilities declined between 3% and 16%, depending on the region (**Table 14**).

Application Rates

- The median N application rate declined in the North Central, Northeast, Southeast, and Transition regions since 2006. The median N application rate remained unchanged in the Pacific, Southwest, and Upper West/Mountain regions since 2006 (**Table 2**).
- P₂O₅ application rates declined within each region except the Pacific and Southwest (**Table 2**).
- K₂O application rates declined within each agronomic region except the Pacific (**Table 2**).
- The highest application rates of N,

P₂O₅, and K₂O were on greens, followed by tees and practice areas (**Figure 3**).

- Approximately 1 lb. of P₂O₅ per 1,000 ft² was applied to each course feature (**Figure 3**).
- Median tons of N applied per facility per year declined since 2006 in each region except the Pacific region, where median tons were equivalent to those applied in 2006. The greatest magnitude reduction was reported in the Southwest, where the 12.8 tons applied in 2006 were reduced to 3.9 tons in 2024 (**Table 15**).
- Median tons of P₂O₅ declined in each region since 2006, with six regions applying 0.9 tons of P₂O₅ or less in 2024 (**Table 15**).
- Median K₂O declined in each region since 2006. The greatest reduction in applied K₂O occurred in the Southwest region, where facilities reported they reduced the 10.6 tons applied in 2006 to 2.1 tons in 2024 (**Table 15**).

Nutrient Management Plans

- The percentage of facilities within each region that used a written nutrient management plan remained unchanged since 2006, except in the Pacific region, which reported a decrease to 29% in 2024 (**Table 24**).

Soil Testing

- The percentage of facilities that soil tested greens declined in the North Central, Northeast, Pacific, and Upper West/Mountain regions, and remained unchanged in the remaining regions since 2006 (**Table 21**).
- Within regions, the percentage of facilities that soil tested greens ranged from 66% in the North Central to 99% in the Southeast (**Table 21**).
- Within each region, fairways were the second most common soil feature tested, followed by tees and practice areas (**Table 21**).

North Central

Nutrient Use

- N, P₂O₅, and K₂O use in the North Central region declined by 41%, 64%, and 59%, respectively, since 2006 (**Table 4, Table 11**).
- The application rates (per 1,000 ft²) of N, P₂O₅, and K₂O were 39%, 74%, and 68% less than those of 2006 (**Table 4, Figure 8**).
- Since 2006, N rates were reduced on each course feature except roughs and natural areas (**Table 16**).
- Since 2006, P₂O₅ rate reductions were reported on greens, tees, fairways, and grounds, but did not change on roughs, practice areas, or natural areas (**Table 17**).
- Since 2006, K₂O rate reductions were reported for each course feature except natural areas (**Table 18**).
- Median tons of N, P₂O₅, and K₂O applied per facility in the North Central region declined by 50%, 85%, and 77% since 2006 (**Table 15**).
- The percentage of facilities that used a written nutrient management plan remained unchanged at 45% since 2006 (**Table 24**).
- The percentage of facilities that used natural organic N sources declined from 56% to 41% since 2006 (**Table 26**).
- The percentage of facilities that used slow-release N sources declined from 69% to 64% since 2006 (**Table 28**).

Nutrient Storage and Application

- The percentage of nutrient applications made with calibrated equipment declined on each course feature since 2006 (**Table 30**).
- The number of nutrient applications made per year increased on greens and remained unchanged on tees, fairways, and roughs (**Table 31**).
- The percentage of facilities that used storage suitable for fertilizer increased from 43% to 68% since 2006 (**Table 32**).

Fertilized Acres

- The number of acres fertilized with N, P₂O₅, or K₂O were 29%, 66%, and 35% less than those reported in 2006 (**Table 4, Figure 8**).

Table 4. Projected nutrient use, fertilized area, and nutrient application rate in the North Central region and the U.S. in 2006, 2014, 2021, and 2024.

Year	U.S.	NC	U.S.	NC	U.S.	NC
	Projected Use (tons)		Projected Area (acres)		Nutrient Applied (lbs. per 1,000 ft²)	
	N					
2006	92,185	15,047	1,179,055	279,185	2.3	1.8
2014	61,215	10,612	986,063	230,025	1.7	1.3
2021	54,376	8,711	889,378	206,284	1.6	1.4
2024	54,499	8,857	907,271	199,457	1.7	1.1
Δ '06 to '24 (%)	-41	-41	-23	-29	-26	-39
	P ₂ O ₅					
2006	33,626	4,657	1,004,391	222,890	0.8	0.6
2014	15,759	1,421	540,581	87,951	0.2	0.1
2021	13,761	1,242	472,923	66,723	0.3	0.1
2024	13,675	1,657	500,298	75,912	0.3	0.1
Δ'06 to '24 (%)	-59	-64	-50	-66	-59	-74
	K ₂ O					
2006	89,124	11,960	1,126,967	264,087	1.9	1.4
2014	51,705	7,142	874,534	199,216	1.2	0.7
2021	41,386	4,496	767,883	166,854	1.1	0.6
2024	41,544	4,863	790,241	170,856	1.0	0.5
Δ'06 to '24 (%)	-53	-59	-30	-35	-49	-68

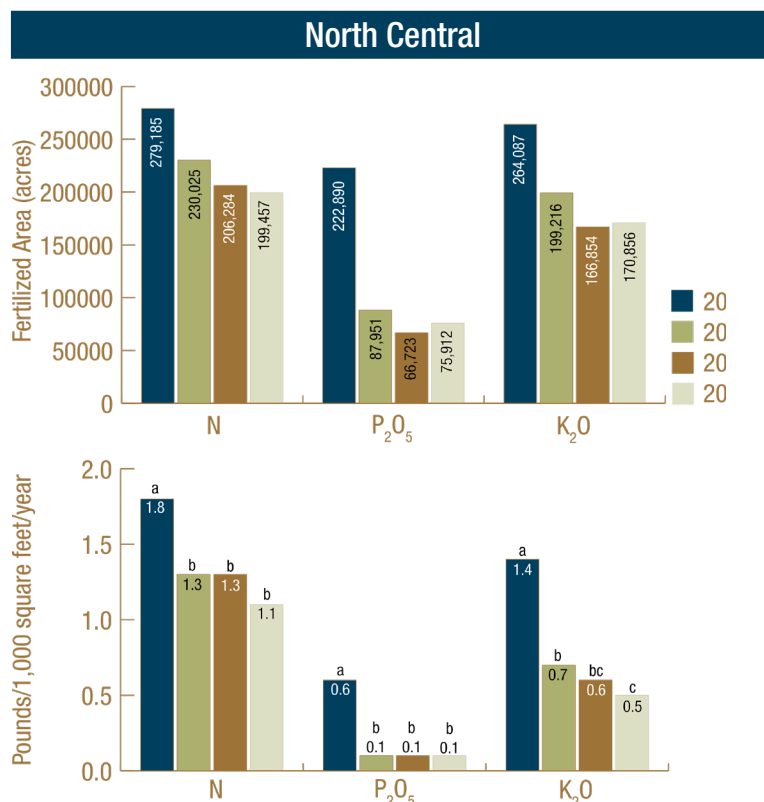


Figure 8. Fertilized acres and application rates of N, P₂O₅, and K₂O on golf facilities in the North Central region in 2006, 2014, 2021, and 2024.

- Median fertilized acres in the North Central declined from 125 in 2006 to 102 in 2024 (**Table 13**). Median fertilized acres of natural areas were equivalent to those in 2006. However, median fertilized acres of roughs, fairways, practice areas, and grounds declined since 2006. Median fertilized acres of greens and tees both increased by about 0.4 acres since 2006.

Overseed

- The percentage of facilities that overseeded declined since 2021 and was equivalent to 2014 (**Table 20**). Concomitantly, the percentage of facilities that did not overseed any course feature increased from 79% to 88% since 2021.

Soil Testing

- The percentage of facilities that soil tested putting greens declined to 66% since 2006, which was 20 points lower than the baseline year of 2006 (**Table 21**).

Operational Facilities

- The number of operational facilities in the North Central region declined by 585 facilities or 14% since 2006 (**Table 14**).
- Changes in operational facilities resulted in reduced use of N, P₂O₅, and K₂O (**Table 14**).

Northeast

Nutrient Use

- N, P₂O₅, and K₂O use in the Northeast region declined by 42%, 70%, and 59%, respectively, since 2006 (**Table 5, Table 11**).
- The application rates of N, P₂O₅, and K₂O were 35%, 63%, and 52% less than those of 2006 (**Table 5, Figure 9**).
- Since 2006, N rates were reduced on each course feature except nature areas (**Table 16**).
- Since 2006, P₂O₅ rate reductions were reported on greens, tees, and fairways, but no change on the remaining course features (**Table 17**).
- Since 2006, K₂O rate reductions were reported on each course feature except natural areas (**Table 18**).
- Median tons of N, P₂O₅, and K₂O applied per facility in the Northeast region declined by 38%, 64%, and 55% since 2006 (**Table 15**).
- The percentage of facilities that used

a written nutrient management plan remained unchanged at 34% since 2006 (**Table 24**).

- The percentage of facilities that used natural organic N sources declined from 75% to 62% since 2006 (**Table 26**).
- The percentage of facilities that used slow-release N sources was equivalent to 2006 (65%) (**Table 28**).

Nutrient Storage and Application

- The percentage of nutrient applications made with calibrated equipment remained unchanged since 2006 on each course feature (**Table 30**).
- The number of nutrient applications per year increased on each course feature except roughs, with the greatest number (11.4) on greens (**Table 31**).
- The percentage of facilities that used storage suitable for fertilizer increased from 49% to 61% since 2006 (**Table 32**).

Fertilized Acres

- The number of acres fertilized with N, P₂O₅, or K₂O were 24%, 61%, and 38% less than those reported in 2006 (**Table 5, Figure 9**).
- Median fertilized acres in the Northeast were equivalent to those reported in 2006 and were ranked third lowest among regions at 86.1 acres (**Table 13**). Median fertilized acres of roughs, natural areas, and tees were also equivalent to 2006. However, the median number of fertilized acres of fairways, practice areas, and grounds has declined since 2006. Median fertilized acres of greens increased 20% since 2006.

Overseed

- The percentage of facilities that stopped overseeding was equivalent to 2014 at <1% (**Table 20**). The percentage of facilities that overseeded greens

Table 5. Projected nutrient use, fertilized area, and nutrient application rate in the Northeast region and U.S. in 2006, 2014, 2021, and 2024.

Year	U.S.	NE	U.S.	NE	U.S.	NE
	Projected Use (tons)		Projected Area (acres)		Nutrient Applied (lbs. per 1,000 ft²)	
	N					
2006	92,185	9,139	1,179,055	161,846	2.3	1.9
2014	61,215	6,560	986,063	134,774	1.7	1.6
2021	54,376	5,656	889,378	125,551	1.6	1.5
2024	54,499	5,329	907,271	123,695	1.7	1.2
Δ '06 to '24 (%)	-41	-42	-23	-24	-26	-35
	P ₂ O ₅					
2006	33,626	3,483	1,004,391	143,916	0.8	0.7
2014	15,759	1,152	540,581	57,360	0.2	0.2
2021	13,761	1,351	472,923	50,298	0.3	0.4
2024	13,675	1,061	500,298	55,490	0.3	0.3
Δ'06 to '24 (%)	-59	-70	-50	-61	-59	-63
	K ₂ O					
2006	89,124	8,090	1,126,967	157,981	1.9	1.6
2014	51,705	4,719	874,534	121,645	1.2	1.1
2021	41,386	4,145	767,883	110,601	1.1	1.1
2024	41,544	3,308	790,241	97,762	1.0	0.8
Δ'06 to '24 (%)	-53	-59	-30	-38	-49	-52

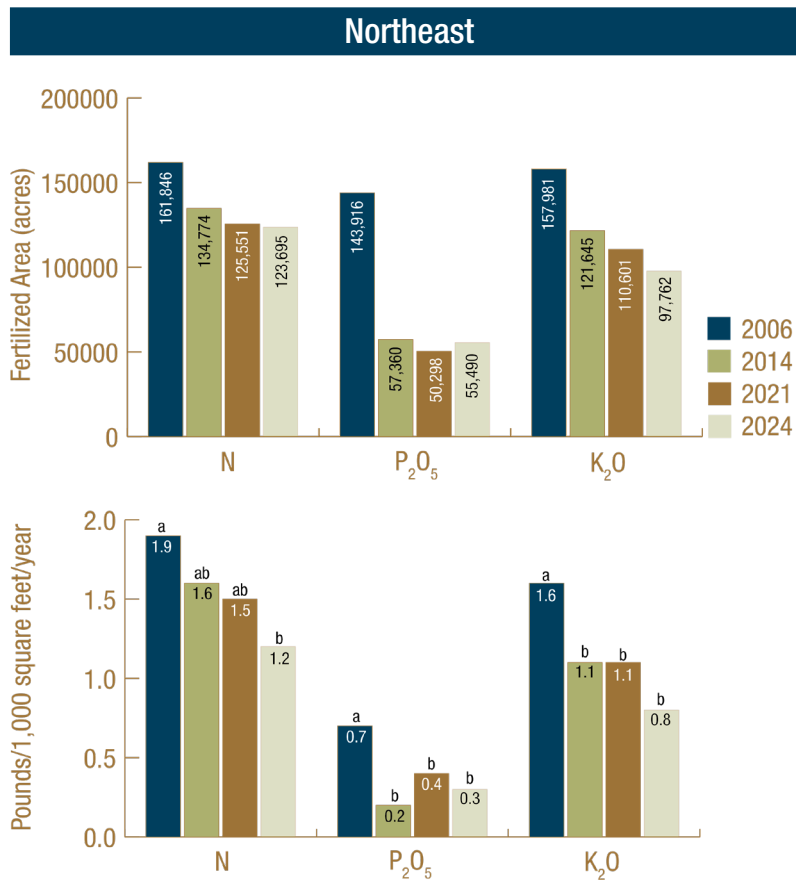


Figure 9. Fertilized acres and application rates of N, P₂O₅, and K₂O on golf facilities in the Northeast region in 2006, 2014, 2021, and 2024.

declined to 12% in 2024, whereas the percentage of facilities that did not overseed any course feature rose to 78%.

Soil Testing

- The percentage of facilities that soil tested declined since 2006 for greens, tees, fairways, and roughs, and remained unchanged for other course features (**Table 21**).

Operational Facilities

- The number of operational facilities in the Northeast region declined by 285 facilities, or 10%, since 2006 (**Table 14**).
- Changes in operational facilities resulted in reduced use of N, P₂O₅, and K₂O (**Table 14**).

Pacific

Nutrient Use

- N, P₂O₅, and K₂O use in the Pacific region declined by 39%, 64%, and 54%, respectively, since 2006 (**Table 6**, **Table 11**).
- The application rates of N, P₂O₅, and K₂O did not change since 2006 (**Table 6**, **Figure 10**).
- Although the overall N rate did not change since 2006, N rates were reduced on greens, tees, and grounds (**Table 16**).
- Although the overall P₂O₅ rate did not change since 2006, P₂O₅ rates were reduced on greens, tees, fairways, roughs, and grounds areas (**Table 17**).
- Although the overall K₂O rate did not change since 2006, K₂O rates were reduced on greens, tees, fairways, roughs, and grounds areas (**Table 18**).
- Median tons of N applied per facility did not change since 2006, but median tons of P₂O₅ and K₂O applied per facility declined by 67% and 65% since 2006 (**Table 15**).
- The percentage of facilities that used a written nutrient management plan declined from 47% in 2006 to 29% in 2024 (**Table 24**).
- The percentage of facilities that used natural organic N sources remained unchanged at 57% since 2006 (**Table 26**).
- The percentage of facilities that used slow-release N sources remained unchanged at 66% since 2006 (**Table 28**).

Nutrient Storage and Application

- The percentage of nutrient applications made with calibrated equipment remained unchanged on each course feature since 2006 (**Table 30**).
- The number of nutrient applications per year increased from 16.1 to 20.7 on greens since 2006, but remained unchanged on other course features (**Table 31**).
- The percentage of facilities that used storage suitable for fertilizer remained unchanged at 72% since 2006 (**Table 32**).

Fertilized Acres

- The number of acres fertilized with N, P₂O₅, or K₂O were 29%, 52%, and 42% less than those reported in 2006 (**Table 6**, **Figure 10**).
- Median fertilized acres in the Pacific remained unchanged since 2006 at 73.4, which was the second lowest region (**Table 13**). However, median fertilized acres of

Table 6. Projected nutrient use, fertilized area, and nutrient application rate in the Pacific region and the U.S. in 2006, 2014, 2021, and 2024.

Year	U.S.	Pacific	U.S.	Pacific	U.S.	Pacific
	Projected Use (tons)		Projected Area (acres)		Nutrient Applied (lbs. per 1,000 ft²)	
	N					
2006	92,185	3,110	1,179,055	42,969	2.3	2.3
2014	61,215	2,124	986,063	34,707	1.7	1.7
2021	54,376	2,052	889,378	33,458	1.6	2.4
2024	54,499	1,908	907,271	30,422	1.7	2.4
Δ '06 to '24 (%)	-41	-39	-23	-29	-26	5
	P ₂ O ₅					
2006	33,626	1,123	1,004,391	41,553	0.8	1.0
2014	15,759	966	540,581	27,546	0.2	0.4
2021	13,761	444	472,923	20,789	0.3	0.6
2024	13,675	408	500,298	20,096	0.3	0.6
Δ'06 to '24 (%)	-59	-64	-50	-52	-59	-40
	K ₂ O					
2006	89,124	2,697	1,126,967	42,467	1.9	1.9
2014	51,705	1,949	874,534	31,495	1.2	1.2
2021	41,386	1,188	767,883	28,117	1.1	1.3
2024	41,544	1,229	790,241	24,726	1.0	1.2
Δ'06 to '24 (%)	-53	-54	-30	-42	-49	-40

roughs and fairways declined since 2006 to 20.3 and 21.7, respectively (Table 13).

Overseed

- The percentage of facilities that stopped overseeding was 4%, which was equivalent to 2014 (Table 20). The percentage of facilities that overseeded each course feature has not changed since 2014. The percentage of facilities that did not overseed any course feature remained at 57%, the same as in 2014.

Soil Testing

- The percentage of facilities that soil tested greens, tees, or fairways declined to 80%, 53%, and 60%, respectively, in 2024 (Table 21).

Operational Facilities

- Since 2006, the number of operational facilities in the Pacific region has declined by 69, to 560 in 2024 (Table 14).
- Changes in operational facilities resulted in reduced use of N, P₂O₅, and K₂O (Table 14).

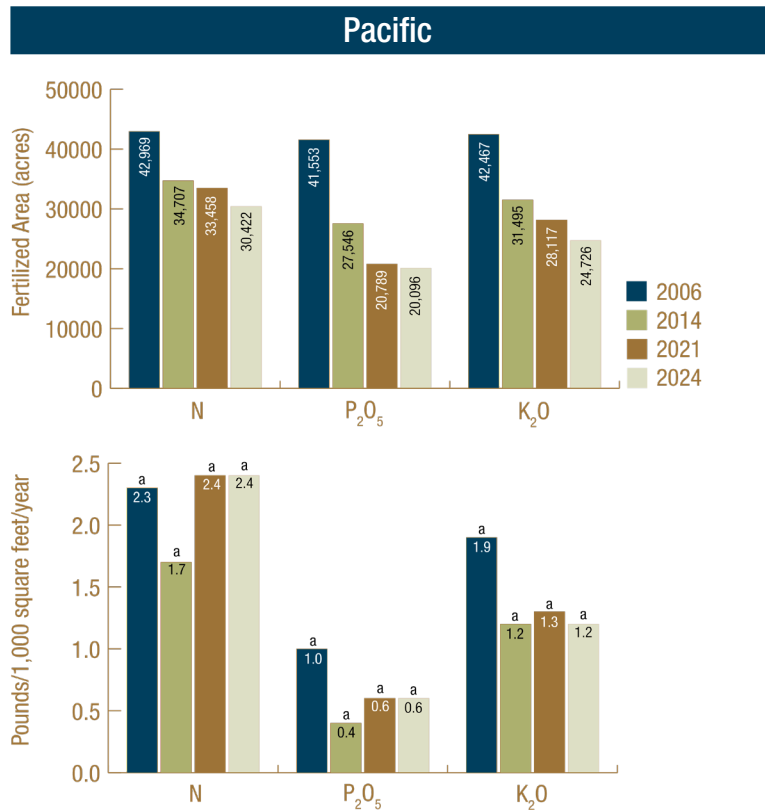


Figure 10. Fertilized acres and application rates of N, P₂O₅, and K₂O on golf facilities in the Pacific region in 2006, 2014, 2021, and 2024.

Southeast

Nutrient Use

- N, P₂O₅, and K₂O use in the Southeast region declined by 41%, 61%, and 50%, respectively, since 2006 (**Table 7, Table 11**).
- The application rates of N, P₂O₅, and K₂O were 27%, 51%, and 39% less than those of 2006 (**Table 7, Figure 11**).
- Since 2006, N rates have been reduced on each course feature except natural areas (**Table 16**).
- Since 2006, P₂O₅ rate reductions have been reported for each course feature except natural areas (**Table 17**).
- Since 2006, K₂O rate reductions have been reported for each course feature except natural areas (**Table 18**).
- Median tons of N, P₂O₅, and K₂O applied per facility in the Southeast region declined by 32%, 59%, and 45% since 2006 (**Table 15**).
- The percentage of facilities that used

a written nutrient management plan remained unchanged at 47% since 2006 (**Table 24**).

- The percentage of facilities that used natural organic N sources remained unchanged at 65% since 2006 (**Table 26**).
- The percentage of facilities that used slow-release N sources declined from 65% to 60% since 2006 (**Table 28**).

Nutrient Storage and Application

- The percentage of nutrient applications made with calibrated equipment declined on each course feature since 2006 (**Table 30**).
- The number of nutrient applications per year increased on each course feature, with the greatest applications occurring on greens (29.5) (**Table 31**).
- The percentage of facilities that used storage suitable for fertilizer increased from 59% to 71% since 2006 (**Table 32**).

Fertilized Acres

- The number of acres fertilized with N, P₂O₅, or K₂O were 18%, 41%, and 21% less than those reported in 2006 (**Table 7, Figure 11**).
- Median fertilized acres in the Southeast were the same as in 2006 at 120.3 acres (**Table 13**). Median fertilized acres of greens and tees increased to 2.9 and 3.3 acres, respectively. Median fertilized acres of fairways and grounds were moderately reduced compared to 2006.

Overseed

- The percentage of facilities that stopped overseeding was similar to 2014 at 16% (**Table 20**). The percentage of facilities that overseeded greens, tees, and fairways declined since 2014, and the percentage of facilities that did not overseed any

Table 7. Projected nutrient use, fertilized area, and nutrient application rate in the Southeast region and the U.S. in 2006, 2014, 2021, and 2024.

Year	U.S.	SE	U.S.	SE	U.S.	SE
	Projected Use (tons)		Projected Area (acres)		Nutrient Applied (lbs. per 1,000 ft²)	
	N					
2006	92,185	32,532	1,179,055	280,685	2.3	3.6
2014	61,215	18,894	986,063	234,015	1.7	2.7
2021	54,376	19,302	889,378	213,414	1.6	2.2
2024	54,499	19,244	907,271	229,886	1.7	2.6
Δ '06 to '24 (%)	-41	-41	-23	-18	-26	-27
	P ₂ O ₅					
2006	33,626	11,114	1,004,391	237,648	0.8	0.9
2014	15,759	5,144	540,581	138,002	0.2	0.8
2021	13,761	4,780	472,923	134,054	0.3	0.5
2024	13,675	4,376	500,298	141,095	0.3	0.4
Δ '06 to '24 (%)	-59	-61	-50	-41	-59	-51
	K ₂ O					
2006	89,124	37,246	1,126,967	268,337	1.9	3.3
2014	51,705	20,478	874,534	219,974	1.2	2.7
2021	41,386	18,362	767,883	194,550	1.1	1.9
2024	41,544	18,573	790,241	210,700	1.0	2.0
Δ '06 to '24 (%)	-53	-50	-30	-21	-49	-39

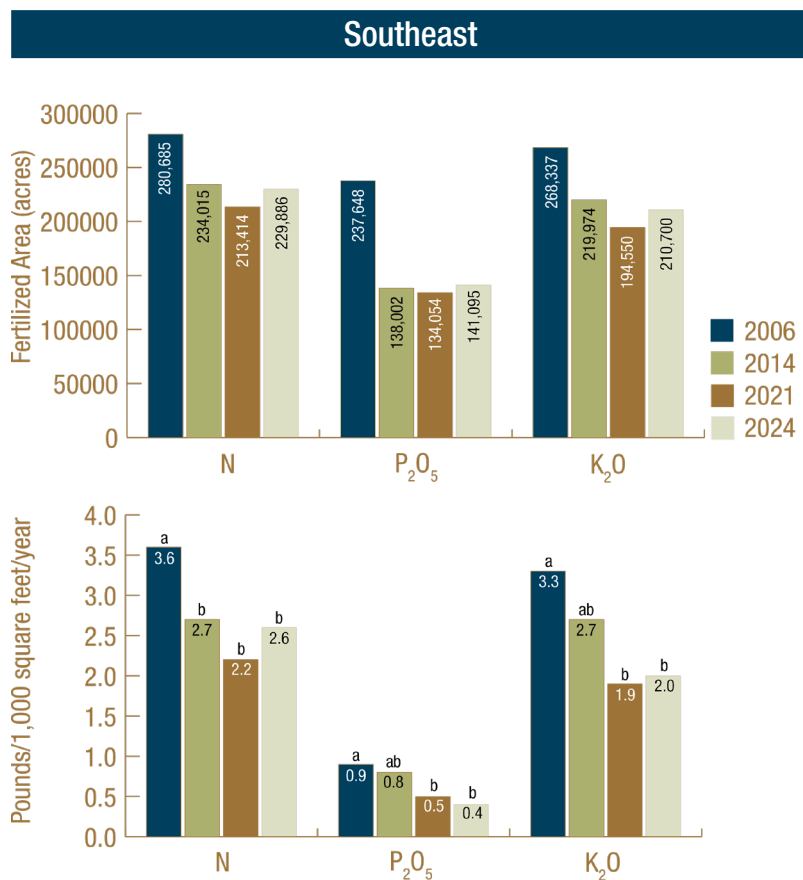


Figure 11. Fertilized acres and application rates of N, P₂O₅, and K₂O on golf facilities in the Southeast region in 2006, 2014, 2021, and 2024.

course feature increased from 37% to 52%.

Soil Testing

- The percentage of facilities that soil tested putting greens, tees, fairways, and natural areas remained unchanged since 2006, but declined for practice areas, roughs, and grounds (Table 21).

Operational Facilities

- The number of operational facilities in the Southeast region declined by 512 facilities since 2006, to 2,704 in 2024 (Table 14).
- Changes in operational facilities resulted in reduced use of N, P₂O₅, and K₂O (Table 14).

Southwest

Nutrient Use

- N, P₂O₅, and K₂O use in the Southwest region declined by 45%, 45%, and 59%, respectively, since 2006 (Table 8, Table 11).
- The K₂O application rate was 54% less than that of 2006, whereas N and K₂O application rates, which had declined in 2021, rose in 2024 to levels equivalent to those reported in 2006 (Table 8, Figure 12).
- Total N rates declined through 2021 but increased in 2024 (Table 16).
- Since 2006, N rates have been reduced on greens, tees, and practice areas and have remained unchanged on other course features (Table 16).
- Although the total rate of P₂O₅ was equivalent to that reported in 2006, a 31% reduction was reported on grounds (Table 17).
- Since 2006, K₂O rate reductions were reported on every course feature except natural areas, which were equivalent to 2006 (Table 18).
- Median tons of N, P₂O₅, and K₂O applied per facility in the Southwest region declined by 70%, 69%, and 80% since 2006 (Table 15). The reduction in tons of N, P₂O₅, and K₂O was the greatest among all regions.
- The percentage of facilities that used a written nutrient management plan remained unchanged at 45% since 2006 (Table 24).
- The percentage of facilities that used natural organic N sources remained unchanged at 63% since 2006 (Table 26).
- The percentage of facilities that used slow-release N sources remained unchanged at 60% since 2006 (Table 28).

Nutrient Storage and Application

- The percentage of nutrient applications made with calibrated equipment in 2024 remained unchanged on each course feature compared to 2006 (Table 30).
- The number of nutrient applications per year increased on each course feature, with the most applications

Table 8. Projected nutrient use, fertilized area, and nutrient application rate in the Southwest region and the U.S. in 2006, 2014, 2021, and 2024.

Year	U.S.	SW	U.S.	SW	U.S.	SW
	Projected Use (tons)		Projected Area (acres)		Nutrient Applied (lbs. per 1,000 ft²)	
	N					
2006	92,185	13,247	1,179,055	118,683	2.3	3.8
2014	61,215	8,986	986,063	93,383	1.7	2.5
2021	54,376	7,209	889,378	80,850	1.6	1.1
2024	54,499	7,246	907,271	86,061	1.7	2.6
Δ '06 to '24 (%)	-41	-45	-23	-27	-26	-31
	P ₂ O ₅					
2006	33,626	5,408	1,004,391	99,658	0.8	2.1
2014	15,759	3,053	540,581	75,983	0.2	0.6
2021	13,761	3,254	472,923	63,323	0.3	0.9
2024	13,675	2,970	500,298	71,691	0.3	1.4
Δ'06 to '24 (%)	-59	-45	-50	-28	-59	-35
	K ₂ O					
2006	89,124	12,127	1,126,967	113,167	1.9	3.2
2014	51,705	6,397	874,534	81,642	1.2	1.2
2021	41,386	4,733	767,883	67,637	1.1	1.5
2024	41,544	4,944	790,241	81,737	1.0	1.5
Δ'06 to '24 (%)	-53	-59	-30	-28	-49	-54

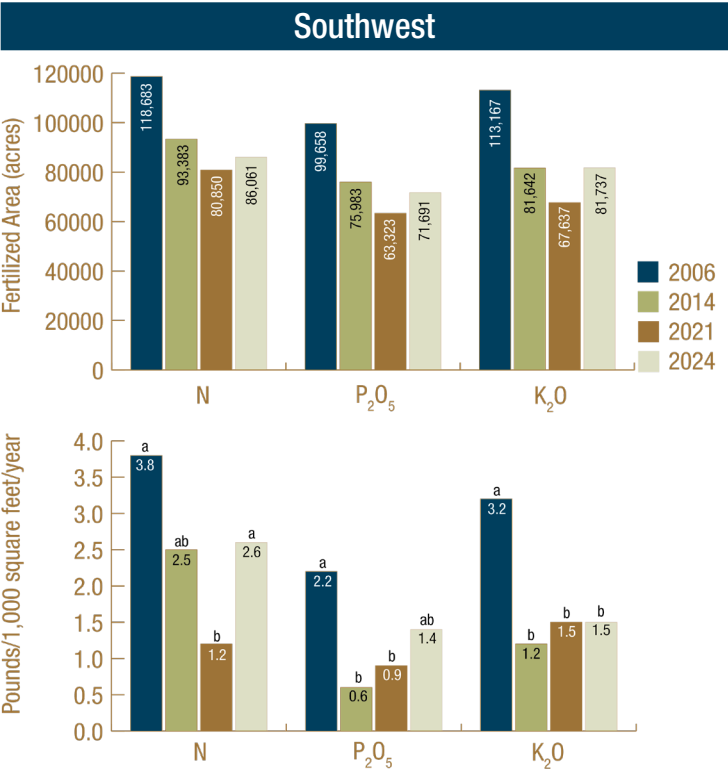


Figure 12. Fertilized acres and application rates of N, P₂O₅, and K₂O on golf facilities in the Southwest region in 2006, 2014, 2021, and 2024.

reported on greens (22.9) (Table 31).

- The percentage of facilities that used storage suitable for fertilizer remained unchanged to 70% since 2006 (Table 32).

Fertilized Acres

- The number of acres fertilized with N, P₂O₅, or K₂O were 27%, 28%, and 28% less than those reported in 2006 (Table 8, Figure 12).
- Median fertilized acres in the Southwest declined since 2006 from 148.4 to 71.4 acres (Table 13). Median fertilized acres of fairways, practice areas, greens, tees, and grounds were equivalent to those in 2006. Median fertilized acres of roughs and natural areas declined since 2006.

Overseed

- The percentage of facilities that stopped overseeding was the same as in 2014 (Table 20). The percentage of facilities that overseeded each course feature remained unchanged since 2014. The percentage of facilities that did not overseed any course feature has remained unchanged at 41% since 2014.

Transition

Soil Testing

- The percentage of facilities that soil tested remained unchanged since 2006 (**Table 21**).

Operational Facilities

- The number of operational facilities in the Southwest region declined by 88 facilities since 2006, to 1,133 facilities in 2024 (**Table 14**).
- Changes in operational facilities resulted in reduced use of N, P₂O₅, and K₂O (**Table 14**).

Nutrient Use

- N, P₂O₅, and K₂O use in the Transition region declined by 38%, 62%, and 47%, respectively, since 2006 (**Table 9, Table 11**).
- The application rates of N, P₂O₅, and K₂O were 26%, 68%, and 40% less than those of 2006 (**Table 9, Figure 13**).
- Since 2006, N, P₂O₅, and K₂O rates have been reduced on each course feature, except natural areas (**Table 16, Table 17, Table 18**).
- Median tons of N, P₂O₅, and K₂O applied per facility in the Transition region declined by 25%, 67%, and 40% since 2006 (**Table 15**).
- The percentage of facilities that used a written nutrient management plan remained unchanged at 42% since 2006 (**Table 24**).
- The percentage of facilities in 2024 that used natural organic N sources was equivalent to those in 2006 (**Table 26**).
- The percentage of facilities that used slow-release N sources declined to 57% since 2006 (**Table 28**).

Nutrient Storage and Application

- The percentage of nutrient applications made with calibrated equipment remained unchanged since 2006 and was ≥60% for each course feature (**Table 30**).
- The number of nutrient applications per year increased on greens and fairways since 2006, but remained unchanged on other course features (**Table 31**).
- The percentage of facilities that used storage suitable for fertilizer increased from 49% to 74% since 2006 (**Table 32**).

Fertilized Acres

- The number of acres fertilized with N, P₂O₅, or K₂O were 20%, 52%, and 26% less than those reported in 2006 (**Table 9, Figure 13**).
- Median fertilized acres in the Transition region, which had declined in 2021 from 119.9 to 103.5 acres, returned to the initial 2006 levels and

were 124.6 acres (**Table 13**). Median fertilized acres of roughs and fairways were also equivalent to 2006. However, the median number of fertilized acres in practice areas and grounds declined since 2006. Median fertilized acres of natural areas, greens, and tees increased since 2006.

Overseed

- The percentage of facilities that overseeded roughs has increased from 6% to 14% since 2014 (**Table 20**). The percentage of facilities that stopped overseeding or did not overseed any course feature remained unchanged since 2014 at 10% and 68%, respectively.

Soil Testing

- The percentage of facilities that soil tested was equivalent to that in 2006, except in natural areas, which declined from 5% in 2006 to 2% in 2024 (**Table 21**).

Operational Facilities

- The number of operational facilities in the Transition region declined by 461 facilities, to 2,490 in 2006 (**Table 14**).
- Changes in operational facilities resulted in reduced use of N, P₂O₅, and K₂O (**Table 14**).

Table 9. Projected nutrient use, fertilized area, and nutrient application rate in the Transition region and the U.S. in 2006, 2014, 2021, and 2024.

Year	U.S.	Trans	U.S.	Trans	U.S.	Trans
	Projected Use (tons)		Projected Area (acres)		Nutrient Applied (lbs. per 1,000 ft²)	
	N					
2006	92,185	13,600	1,179,055	210,663	2.3	2.0
2014	61,215	9,688	986,063	178,741	1.7	1.6
2021	54,376	7,982	889,378	162,981	1.6	1.4
2024	54,499	8,433	907,271	169,420	1.7	1.5
Δ '06 to '24 (%)	-41	-38	-23	-20	-26	-26
	P ₂ O ₅					
2006	33,626	5,876	1,004,391	189,959	0.8	0.9
2014	15,759	3,064	540,581	101,034	0.2	0.3
2021	13,761	1,924	472,923	89,916	0.3	0.3
2024	13,675	2,244	500,298	91,460	0.3	0.3
Δ'06 to '24 (%)	-59	-62	-50	-52	-59	-68
	K ₂ O					
2006	89,124	12,670	1,126,967	204,407	1.9	1.9
2014	51,705	8,354	874,534	155,772	1.2	1.2
2021	41,386	6,383	767,883	144,707	1.1	0.8
2024	41,544	6,741	790,241	151,168	1.0	1.1
Δ'06 to '24 (%)	-53	-47	-30	-26	-49	-40

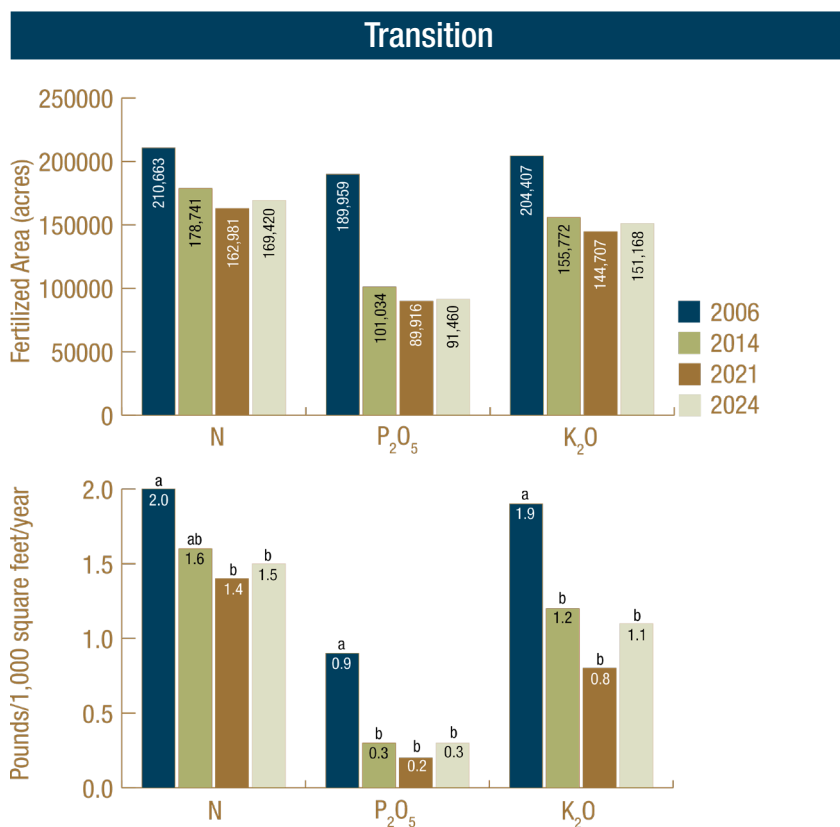


Figure 13. Fertilized acres and application rates of N, P₂O₅, and K₂O on golf facilities in the Transition region in 2006, 2014, 2021, and 2024.

Upper West/ Mountain

Nutrient Use

- N, P₂O₅, and K₂O use in the Upper West/Mountain region declined by 37%, 51%, and 56%, respectively, since 2006 (**Table 10, Table 11**).
- The application rates of N in 2024 were equivalent to those of 2006, whereas rates of P₂O₅ and K₂O were 82% and 63% less than those of 2006 (**Table 10, Figure 14**).
- Since 2006, N rates were reduced on greens, tees, fairways, and practice areas, increased on natural areas, and remained unchanged on grounds (**Table 16**).
- Since 2006, P₂O₅ rate reductions have been reported on greens, tees, and grounds, and have remained unchanged on other course features (**Table 17**).
- Since 2006, K₂O rate reductions have

been reported for each course feature, except natural areas, where the K₂O rate increased from 0.8 to 2.0 lbs. per 1,000 ft² per year (**Table 18**).

- Median tons of N, P₂O₅, and K₂O applied per facility in the Upper West/Mountain region declined by 48%, 83%, and 72% since 2006 (**Table 15**).
- The percentage of facilities that used a written nutrient management plan remained unchanged at 39% since 2006 (**Table 24**).
- The percentage of facilities that used natural organic N sources remained unchanged at 51% since 2006 (**Table 26**).
- The percentage of facilities that used slow-release N sources remained unchanged at 63% since 2006 (**Table 28**).

Nutrient Storage and Application

- The percentage of nutrient applications made with calibrated equipment declined on fairways and roughs since 2006 (**Table 30**).
- The number of nutrient applications made per year increased on each course feature except tees and roughs (**Table 31**).
- The percentage of facilities that used storage suitable for fertilizer increased from 41% to 63% since 2006 (**Table 32**).

Fertilized Acres

- The number of acres fertilized with N, P₂O₅, or K₂O were 20%, 35%, and 30% less than those reported in 2006 (**Table 10, Figure 14**).
- Median fertilized acres in the Upper West/Mountain were equivalent to

Table 10. Projected nutrient use, fertilized area, and nutrient application rate in the Upper West/Mountain region and the U.S. in 2006, 2014, 2021, and 2024.

Year	U.S.	UWM	U.S.	UWM	U.S.	UWM
	Projected Use (tons)		Projected Area (acres)		Nutrient Applied (lbs. per 1,000 ft²)	
	N					
2006	92,185	5,510	1,179,055	85,023	2.3	2.3
2014	61,215	4,350	986,063	80,419	1.7	1.7
2021	54,376	3,466	889,378	66,840	1.6	1.3
2024	54,499	3,481	907,271	68,331	1.7	1.6
Δ '06 to '24 (%)	-41	-37	-23	-20	-26	-28
	P ₂ O ₅					
2006	33,626	1,965	1,004,391	68,766	0.8	0.9
2014	15,759	960	540,581	52,704	0.2	0.4
2021	13,761	766	472,923	47,819	0.3	0.3
2024	13,675	960	500,298	44,553	0.3	0.2
Δ'06 to '24 (%)	-59	-51	-50	-35	-59	-82
	K ₂ O					
2006	89,124	4,334	1,126,967	76,520	1.9	1.8
2014	51,705	2,666	874,534	64,791	1.2	1.1
2021	41,386	2,079	767,883	55,417	1.1	0.6
2024	41,544	1,886	790,241	53,291	1.0	0.7
Δ'06 to '24 (%)	-53	-56	-30	-30	-49	-63

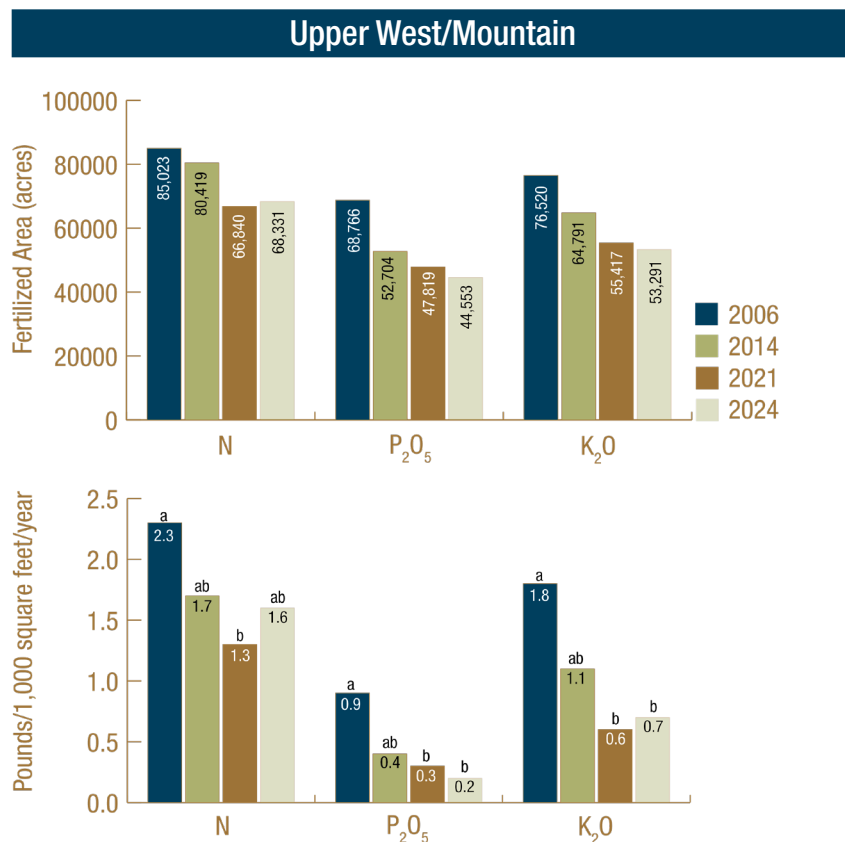


Figure 14. Fertilized acres and application rates of N, P₂O₅, and K₂O on golf facilities in the Upper West/Mountain region in 2006, 2014, 2021, and 2024.

those reported in 2006 at 95.2 (**Table 13**). Median fertilized acres of roughs, fairways, and natural areas were also equivalent to 2006. However, median fertilized acres of practice areas and grounds declined since 2006, while median fertilized acres of greens and tees increased.

Overseed

- The percentage of facilities that overseeded fairways decreased since 2014 (**Table 20**). The percentage of facilities that did not overseed any course feature remained unchanged at 84% since 2014.

Soil Testing

- The percentage of facilities that soil tested remained unchanged on tees and fairways since 2006, but declined on other course features (**Table 21**).

Operational Facilities

- The number of operational facilities in the Upper West/Mountain region declined by 38 facilities since 2006 to 1,073 facilities (**Table 14**).
- Changes in operational facilities resulted in reduced use of N, P₂O₅, and K₂O (**Table 14**).

Conclusion and Recommendations

- The continued reduction in applied N, P₂O₅, and K₂O since 2006 appears to be driven by a combination of lower application rates, fewer fertilized acres, and fewer operational facilities. Reductions in fertilized acreage occurred across all nutrients and regions, while facility closures may have contributed as much as 13% to these reductions.
- The most substantial reduction in nutrient use continues to be associated with P₂O₅, which declined by 59% overall and 75% in application rate since 2006. While nutrient restrictions remain a contributing factor, their prevalence has declined since prior survey years. Despite this, the proportion of facilities applying P₂O₅ remains lower than historical levels, indicating a sustained shift in phosphorus management. Given

phosphorus's role in environmental impairment and its association with increased weed populations, facilities are encouraged to continue limiting applications and only apply P₂O₅ when justified by soil tests or observed turfgrass response.

- Nitrogen application rates declined by 26% and remain the primary driver of turfgrass response. Potassium application rates declined by 47%, yet the relative proportion of K₂O applied remains high compared to the expected turfgrass response, particularly where soil K is sufficient. While potassium is not considered an environmental contaminant, excessive applications represent unnecessary costs and may increase disease risk on cool-season grasses. Facilities should evaluate potassium use based on their site-specific needs.

- The N:P₂O₅:K₂O ratio has shifted to 5.0:1:2.8, largely due to reduced phosphorus applications. This widening ratio suggests that nutrient programs are relying more on N. While this aligns with plant demand, it reinforces the importance of critically evaluating non-N inputs to ensure they are justified agronomically rather than applied by default.
- The use of soil testing declined across multiple course features, and its perceived importance in decision-making has also decreased. However, soil testing remains one of the most commonly used tools. Notably, facilities that soil test were consistently associated with higher applications of N, P₂O₅, and K₂O. This relationship does not imply causation but raises concerns regarding how soil test results are interpreted and implemented. It

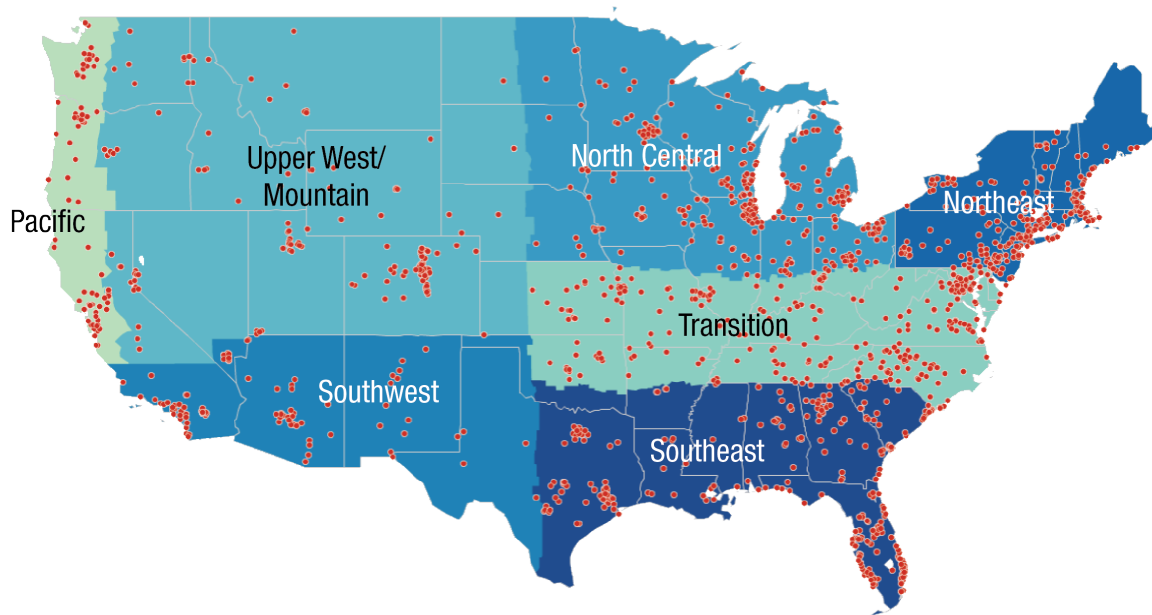


Figure 15. Distribution of the 2024 survey and the seven agronomic regions.

is recommended that facilities ensure soil testing programs are aligned with evidence-based guidelines and are used to optimize nutrient inputs.

- The use of written nutrient management plans has declined slightly since 2006 and is utilized by less than half of facilities. Given the complexity of modern nutrient management and regulatory environments, facilities are encouraged to adopt or maintain written plans to improve consistency, documentation, and decision-making.
- The frequency of fertilizer applications increased across all course features, particularly on greens, while overall nutrient rates declined. This suggests a shift toward smaller, more frequent applications. While this approach may improve nutrient use efficiency, it also increases the importance of accurate application practices and equipment calibration.
- The use of natural organic N sources declined overall, as did the proportion of slow-release N, while quick-release N increased slightly. These trends suggest a shift toward more readily available nutrient sources. Facilities should

evaluate N source selection based on agronomic effectiveness, cost, and environmental considerations. This movement towards soluble N sources may reduce costs but requires greater accuracy and caution due to the risk of turfgrass burn and off-site movement.

- The use of soil amendments increased substantially, with 83% of facilities applying at least one amendment, most commonly humic materials and amino acids. Given the widespread adoption of these products, facilities are recommended to critically evaluate their efficacy and return on investment under their specific conditions. Without specific conditions, the value of some humic products and amino acids is questionable and can greatly increase costs.
- The percentage of facilities with proper fertilizer storage has increased substantially since 2006, indicating improved awareness of environmental risk and regulatory compliance. Proper storage reduces the potential for point-source pollution and should remain a priority for all facilities.

- The adoption of plant growth models increased, suggesting a growing interest in data-driven decision-making. Continued development and use of these tools may further improve nutrient management efficiency when integrated with sound agronomic principles.

Appendix

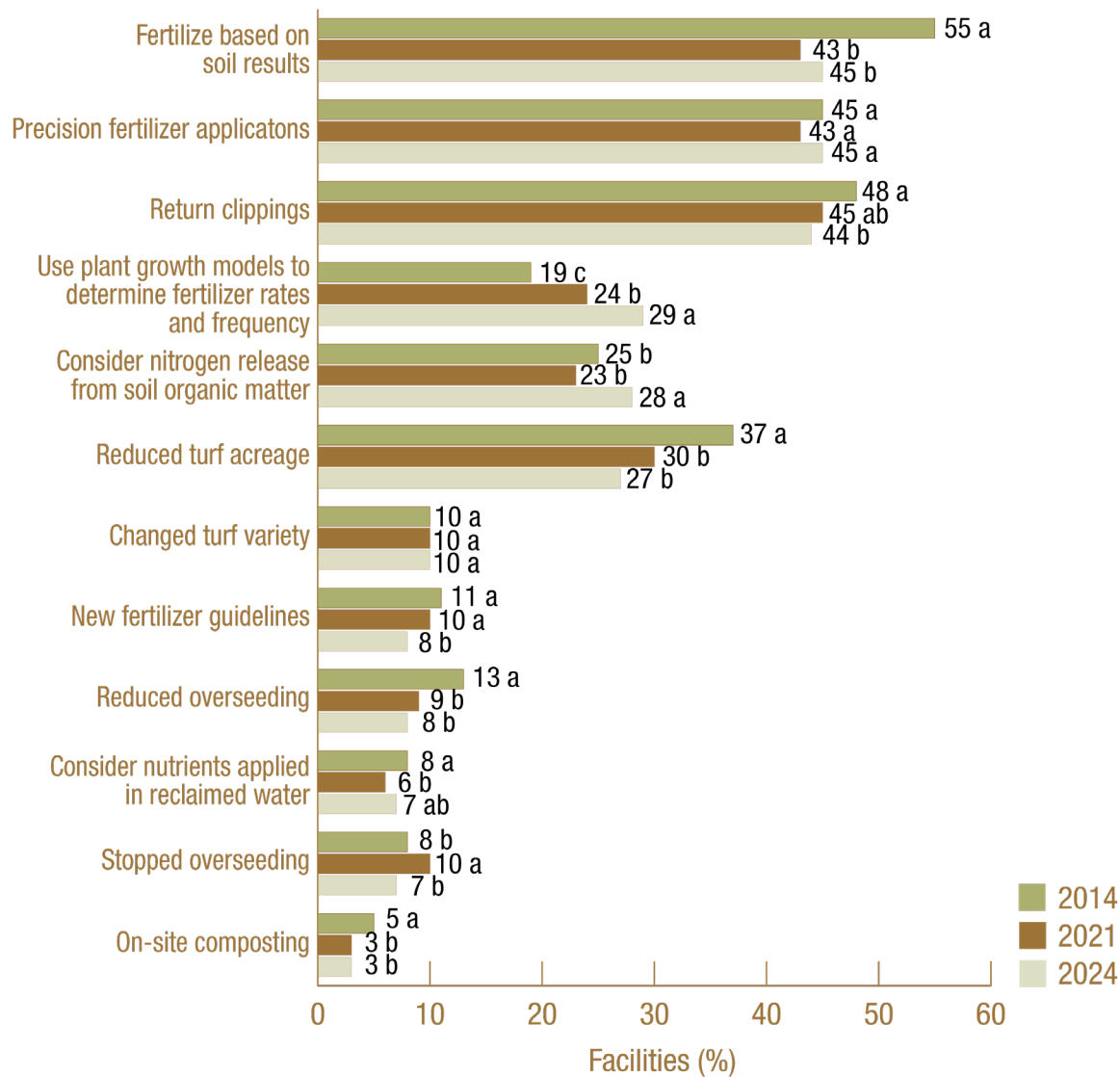


Figure 16. Frequency of management practices used on U.S. golf facilities with the intent of reducing reliance on applied nutrients in 2014, 2021, and 2024. Bars with a common letter are not significantly different according to the χ^2 test at the 10% significance level.

Table 11. Projected nitrogen (N), available phosphorus (P_2O_5), and soluble potash (K_2O) applied to golf courses within the U.S. and regions (**Fig. 15**) in 2006, 2014, 2021, and 2024.

Region	2006	2014	2021	2024	2006-2024
	Tons				Δ%
	N				
U.S.	92,185	61,215	54,376	54,499	-41
North Central	15,047	10,612	8,711	8,857	-41
Northeast	9,139	6,560	5,656	5,329	-42
Pacific	3,110	2,124	2,052	1,908	-39
Southeast	32,532	18,894	19,302	19,244	-41
Southwest	13,247	8,986	7,209	7,246	-45
Transition	13,600	9,688	7,982	8,433	-38
Upper West/Mountain	5,510	4,350	3,466	3,481	-37
	P_2O_5				
U.S.	33,626	15,759	13,761	13,675	-59
North Central	4,657	1,421	1,242	1,657	-64
Northeast	3,483	1,152	1,351	1,061	-70
Pacific	1,123	966	444	408	-64
Southeast	11,114	5,144	4,780	4,376	-61
Southwest	5,408	3,053	3,254	2,970	-45
Transition	5,876	3,064	1,924	2,244	-62
Upper West/Mountain	1,965	960	766	960	-51
	K_2O				
U.S.	89,124	51,705	41,386	41,544	-53
North Central	11,960	7,142	4,496	4,863	-59
Northeast	8,090	4,719	4,145	3,308	-59
Pacific	2,697	1,949	1,188	1,229	-54
Southeast	37,246	20,478	18,362	18,573	-50
Southwest	12,127	6,397	4,733	4,944	-59
Transition	12,670	8,354	6,383	6,741	-47
Upper West/Mountain	4,334	2,666	2,079	1,886	-56

Table 12. Projected acres fertilized with nitrogen (N), available phosphorus (P_2O_5), and soluble potash (K_2O) on golf facilities within the U.S. and regions (**Fig. 15**) in 2006, 2014, 2021, and 2024.

Region	2006	2014	2021	2024	2006-2024
	Area (acres)				Δ%
	N				
U.S.	1,179,055	986,063	889,378	907,271	-23
North Central	279,185	230,025	206,284	199,457	-29
Northeast	161,846	134,774	125,551	123,695	-24
Pacific	42,969	34,707	33,458	30,422	-29
Southeast	280,685	234,015	213,414	229,886	-18
Southwest	118,683	93,383	80,850	86,061	-27
Transition	210,663	178,741	162,981	169,420	-20
Upper West/Mountain	85,023	80,419	66,840	68,331	-20
	P_2O_5				
U.S.	1,004,391	540,581	472,923	500,298	-50
North Central	222,890	87,951	66,723	75,912	-66
Northeast	143,916	57,360	50,298	55,490	-61
Pacific	41,553	27,546	20,789	20,096	-52
Southeast	237,648	138,002	134,054	141,095	-41
Southwest	99,658	75,983	63,323	71,691	-28
Transition	189,959	101,034	89,916	91,460	-52
Upper West/Mountain	68,766	52,704	47,819	44,553	-35
	K_2O				
U.S.	1,126,967	874,534	767,883	790,241	-30
North Central	264,087	199,216	166,854	170,856	-35
Northeast	157,981	121,645	110,601	97,762	-38
Pacific	42,467	31,495	28,117	24,726	-42
Southeast	268,337	219,974	194,550	210,700	-21
Southwest	113,167	81,642	67,637	81,737	-28
Transition	204,407	155,772	144,707	151,168	-26
Upper West/Mountain	76,520	64,791	55,417	53,291	-30

Table 13. Median fertilized acres on golf facilities within the U.S. and regions (**Fig. 15**) in 2006, 2014, 2021, and 2024.

Year	U.S.	NC ⁱ	NE	Pac.	SE	SW	Trans.	UWM
	Area (acres)							
	Total							
2006	120.4 a ⁱⁱ	125.2 a	88.6 a	123.7 ab	130.8 a	148.4 a	119.9 ab	124.2 ab
2014	114.3 ab	107.0 b	106.4 a	125.3 a	107.3 b	171.1 a	124.2 ab	137.5 a
2021	104.1 bc	117.8 ab	90.1 a	79.2 ab	107.7 b	89.6 b	103.5 b	115.1 ab
2024	100.5 c	102.1 b	86.1 a	73.4 b	120.3 ab	71.4 b	124.6 a	95.2 b
Roughs								
2006	40.8 a	45.4 a	33.0 a	31.0 a	42.3 ab	41.1 a	45.4 a	35.9 a
2014	38.8 a	38.8 b	28.9 a	45.2 a	41.6 b	47.8 a	41.6 a	35.4 a
2021	40.6 a	42.7 ab	29.5 a	26.7 ab	47.1 ab	40.6 ab	47.7 a	32.0 a
2024	38.4 a	38.6 b	30.2 a	20.3 b	48.3 a	33.0 b	46.3 a	32.8 a
Fairways								
2006	25.6 a	23.6 a	21.3 a	27.8 a	31.2 a	31.1 a	24.8 a	26.5 ab
2014	23.8 b	21.9 ab	21.3 ab	26.1 ab	27.1 b	31.5 a	21.8 b	27.0 a
2021	23.4 b	20.9 b	21.3 ab	26.6 ab	27.5 b	28.4 a	22.9 ab	22.9 ab
2024	23.1 b	21.3 b	19.3 b	21.7 b	27.7 b	27.0 a	24.2 ab	22.4 b
Natural Areas								
2006	13.9 b	13.4 b	9.6 a	17.8 a	15.0 a	29.2 a	12.4 bc	18.6 a
2014	12.2 b	13.6 b	9.8 a	11.7 a	10.9 a	31.3 a	9.2 c	25.2 a
2021	17.3 a	26.9 a	14.2 a	8.9 a	16.0 a	16.7 ab	17.5 ab	17.5 a
2024	12.9 b	10.9 b	10.4 a	12.9 a	15.9 a	11.2 b	19.3 a	11.7 a
Practice Areas								
2006	4.9 a	4.0 a	3.6 a	4.0 a	6.1 a	5.1 ab	5.6 a	5.5 a
2014	4.6 a	4.0 a	3.1 ab	4.0 a	5.0 a	6.4 a	5.8 a	4.8 ab
2021	3.6 b	2.1 b	2.7 bc	3.1 a	5.3 a	4.5 ab	3.8 b	4.0 ab
2024	3.6 b	2.6 b	2.0 c	3.5 a	6.0 a	4.4 b	3.9 b	3.1 b
Greens								
2006	2.4 b	2.4 b	2.5 c	2.2 a	2.7 b	2.3 b	2.5 c	1.9 b
2014	2.5 b	2.6 ab	2.6 bc	2.5 a	2.6 ab	2.8 a	2.4 bc	2.2 ab
2021	2.7 a	2.6 ab	2.8 ab	2.4 a	2.8 ab	2.7 a	2.7 ab	2.3 a
2024	2.8 a	2.8 a	3.0 a	2.6 a	2.9 a	2.7 ab	2.8 a	2.3 a
Tees								
2006	2.2 c	2.0 b	1.9 a	1.8 a	3.0 bc	2.3 b	2.3 b	1.7 b
2014	2.3 bc	2.2 ab	2.0 a	2.2 a	2.7 c	3.1 a	2.3 b	1.9 ab
2021	2.4 ab	2.1 ab	2.1 a	2.0 a	3.0 ab	2.7 ab	2.6 a	2.0 ab
2024	2.5 a	2.3 a	2.0 a	2.2 a	3.3 a	2.6 ab	2.7 a	2.2 a
Grounds								
2006	1.7 a	1.6 a	1.7 a	1.0 a	2.0 a	1.6 a	1.7 a	1.5 a
2014	1.4 b	1.4 a	1.4 ab	1.5 a	1.4 b	1.2 ab	1.4 ab	1.2 ab
2021	1.1 c	0.9 b	1.2 b	0.8 a	1.5 b	0.9 b	1.1 bc	0.9 b
2024	1.1 c	1.0 b	0.9 c	1.0 a	1.3 b	1.7 a	1.0 c	0.9 b

ⁱ NC, North Central; NE, Northeast; Pac., Pacific; SE, Southeast; SW, Southwest; Trans., Transition; UWM, Upper West/Mountain.

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

Table 14. Number of golf facilities within the U.S. and regions (**Fig. 15**) in 2006, 2014, 2021, and 2024 and the resulting projected change in nutrient use.

Region	Golf Facilities				Projected Nutrient Applied ⁱ		
	2006	2014	2021	2024	N	P ₂ O ₅	K ₂ O
	No.				Change 2006-24 (tons)		
U.S.	15,990	15,372	14,033	13,952	-7,830	-1,956	-6,555
North Central	4,123	3,920	3,555	3,538	-1,422	-274	-804
Northeast	2,739	2,690	2,470	2,454	-584	-123	-384
Pacific	629	615	565	560	-218	-50	-151
Southeast	3,216	3,020	2,737	2,704	-3,409	-829	-3,517
Southwest	1,221	1,208	1,138	1,133	-531	-231	-384
Transition	2,951	2,793	2,509	2,490	-1,497	-415	-1,248
Upper West/Mountain	1,111	1,125	1,059	1,073	-169	-34	-67

ⁱ Determined by multiplying the change in golf facilities from 2006 to 2024 by the average amount of N, P₂O₅, or K₂O applied.

Table 15. Median nitrogen (N), available phosphorus (P₂O₅), and soluble potash (K₂O) use per golf facility, within the U.S. and regions (**Fig. 15**) in 2006, 2014, 2021, and 2024.

Year	U.S.	NC ⁱ	NE	Pac.	SE	SW	Trans.	UWM
	Nutrients Applied (tons/year per facility)							
	N							
2006	5.8 a ⁱⁱ	4.8 a	3.4 a	5.9 a	10.0 a	12.8 a	5.1 a	6.2 a
2014	4.0 b	2.6 bc	3.4 a	4.5 a	6.0 b	8.8 ab	4.1 ab	5.2 ab
2021	3.5 b	3.3 b	2.8 ab	3.7 a	5.5 b	2.3 c	2.9 c	3.8 bc
2024	3.4 b	2.4 c	2.1 b	3.6 a	6.8 b	3.9 bc	3.8 bc	3.2 c
	P ₂ O ₅							
2006	1.6 a	1.3 a	1.1 a	2.1 a	2.2 a	4.9 a	1.8 a	1.8 a
2014	0.5 b	0.2 b	0.4 b	0.9 ab	1.7 ab	1.3 b	0.6 b	0.9 ab
2021	0.5 b	0.2 b	0.6 ab	0.7 b	0.8 c	1.3 b	0.4 b	0.5 b
2024	0.5 b	0.2 b	0.4 b	0.7 b	0.9 bc	1.5 b	0.6 b	0.3 b
	K ₂ O							
2006	5.0 a	3.9 a	2.9 a	4.9 a	9.7 a	10.6 a	4.7 a	4.7 a
2014	2.9 b	1.5 bc	2.3 ab	3.4 ab	6.2 b	4.0 ab	3.1 ab	3.3 ab
2021	2.3 bc	1.6 b	2.0 b	1.8 b	4.7 b	3.0 b	1.6 c	1.8 bc
2024	2.0 c	0.9 c	1.3 c	1.7 b	5.3 b	2.1 b	2.8 b	1.3 c

ⁱ NC, North Central; NE, Northeast; Pac., Pacific; SE, Southeast; SW, Southwest; Trans., Transition; UWM, Upper West/Mountain.

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

Table 16. Nitrogen (N) use rates on golf facilities within the U.S. and regions (**Fig. 15**) in 2006, 2014, 2021, and 2024.

Year	U.S.	NC ⁱ	NE	Pac.	SE	SW	Trans.	UWM
	N (lbs./1,000 ft ² per year)							
	Total							
2006	2.3 a ⁱⁱ	1.8 a	1.9 a	2.3 a	3.6 a	3.8 a	2.0 a	2.3 a
2014	1.7 b	1.3 b	1.6 ab	1.7 a	2.7 b	2.5 ab	1.6 ab	1.7 ab
2021	1.6 b	1.3 b	1.5 ab	2.4 a	2.2 b	1.2 b	1.4 b	1.3 b
2024	1.7 b	1.1 b	1.2 b	2.4 a	2.6 b	2.6 a	1.5 b	1.6 ab
Greens								
2006	4.3 a	3.4 a	3.6 a	5.1 a	7.7 a	5.1 a	4.2 a	3.9 a
2014	3.8 b	2.8 b	3.2 b	4.0 b	5.9 b	5.1 a	4.0 a	3.5 a
2021	3.1 c	2.4 c	2.5 c	3.8 b	5.5 b	3.8 b	3.2 b	2.8 b
2024	2.9 d	2.2 d	2.4 c	3.5 b	4.8 c	4.2 b	2.9 c	2.3 c
Tees								
2006	3.9 a	3.4 a	3.6 a	4.6 a	5.8 a	4.9 a	3.4 a	3.4 a
2014	3.1 b	2.7 b	3.0 b	3.5 b	4.1 b	4.8 ab	2.7 b	2.9 b
2021	2.9 c	2.6 b	2.5 c	3.9 ab	4.0 b	4.0 bc	2.5 b	2.9 bc
2024	2.8 c	2.3 c	2.6 c	3.3 b	4.0 b	4.0 c	2.5 b	2.5 c
Fairways								
2006	3.1 a	2.7 a	2.8 a	3.4 a	4.5 a	4.1 a	2.9 a	2.8 a
2014	2.6 b	2.1 b	2.3 b	2.8 ab	3.5 b	4.3 a	2.6 b	2.4 b
2021	2.4 c	2.0 bc	1.9 c	2.7 b	3.5 b	3.7 a	2.3 bc	2.4 b
2024	2.4 c	1.9 c	2.0 c	2.8 ab	3.5 b	3.7 a	2.3 c	2.3 b
Roughs								
2006	2.4 a	1.7 a	1.9 a	2.6 a	4.0 a	3.2 a	2.1 a	2.3 a
2014	1.9 b	1.4 bc	1.5 b	1.9 b	2.7 b	3.3 a	1.7 b	1.9 b
2021	1.8 b	1.3 c	1.4 b	2.0 b	2.6 b	2.8 a	1.7 b	2.1 ab
2024	2.0 b	1.5 ab	1.4 b	2.1 ab	2.8 b	2.8 a	1.8 b	2.1 ab
Practice Areas								
2006	3.3 a	2.7 a	2.6 a	3.2 a	5.1 a	4.4 a	3.0 a	2.9 a
2014	2.8 b	2.5 ab	2.2 b	2.8 a	3.6 b	4.6 a	2.5 b	2.5 ab
2021	2.7 bc	2.3 b	2.1 b	2.8 a	3.8 b	3.1 b	2.5 b	2.4 b
2024	2.6 c	2.0 c	2.1 b	3.1 a	3.7 b	3.5 b	2.4 b	2.1 b
Natural Areas								
2006	1.3 a	1.2 a	1.0 a	1.2 a	1.4 a	2.2 a	1.3 a	1.2 b
2014	1.3 a	0.8 ab	0.7 a	1.0 a	1.3 a	1.6 a	0.9 a	1.4 b
2021	1.1 a	0.7 b	1.2 a	1.1 a	1.3 a	1.4 a	0.9 a	0.8 b
2024	1.1 a	1.0 ab	0.8 a	1.3 a	1.8 a	1.0 a	1.1 a	2.3 a
Grounds								
2006	2.6 a	2.3 a	2.2 a	3.4 a	3.8 a	3.1 ab	2.4 a	2.5 a
2014	2.2 b	2.0 b	1.9 ab	2.9 ab	2.8 b	3.8 a	1.8 b	2.4 a
2021	2.0 c	1.8 c	1.8 b	2.8 ab	2.5 b	2.7 b	1.9 b	2.1 a
2024	2.0 c	1.7 c	1.8 b	2.5 b	2.7 b	2.5 b	1.9 b	2.1 a

ⁱ NC, North Central; NE, Northeast; Pac., Pacific; SE, Southeast; SW, Southwest; Trans., Transition; UWM, Upper West/Mountain.

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

Table 17. Available phosphorus (P_2O_5) use rates on golf facilities within the U.S. and regions (**Fig. 15**) in 2006, 2014, 2021, and 2024.

Year	U.S.	NC ⁱ	NE	Pac.	SE	SW	Trans.	UWM
	P_2O_5 (lbs./1,000 ft ² per year)							
	Total							
2006	0.8 a ⁱⁱ	0.6 a	0.7 a	1.0 a	0.9 a	2.2 a	0.9 a	0.9 a
2014	0.3 b	0.1 b	0.2 b	0.4 a	0.8 ab	0.6 b	0.3 b	0.4 ab
2021	0.3 b	0.1 b	0.4 b	0.6 a	0.5 b	0.9 b	0.2 b	0.3 b
2024	0.2 b	0.1 b	0.3 b	0.6 a	0.4 b	1.4 ab	0.3 b	0.2 b
Greens								
2006	1.5 a	1.0 a	1.2 a	1.7 a	2.2 a	2.1 a	1.6 a	1.3 a
2014	1.1 b	0.7 b	0.8 b	1.1 b	1.7 b	1.8 a	1.4 b	0.9 b
2021	1.0 c	0.6 b	0.8 b	1.0 b	1.8 b	1.7 a	1.0 c	0.7 b
2024	1.0 c	0.7 b	0.8 b	0.9 b	1.4 c	1.8 a	0.9 c	0.7 b
Tees								
2006	1.3 a	1.0 a	1.3 a	1.4 a	1.7 a	1.8 a	1.3 a	1.0 a
2014	1.0 b	0.7 bc	0.9 b	1.1 ab	1.3 b	1.5 a	1.0 b	0.8 ab
2021	0.9 b	0.6 c	0.8 b	1.2 a	1.4 ab	1.7 a	0.9 b	0.6 b
2024	0.9 b	0.8 b	0.9 b	0.7 b	1.2 b	1.6 a	0.9 b	0.7 b
Fairways								
2006	1.1 a	0.8 a	0.9 a	1.0 a	1.5 a	1.6 a	1.1 a	0.9 a
2014	0.9 b	0.5 b	0.6 b	0.9 ab	1.2 bc	1.4 a	1.0 ab	0.7 ab
2021	0.8 b	0.5 b	0.7 ab	0.9 ab	1.2 b	1.6 a	0.7 c	0.5 b
2024	0.8 b	0.6 b	0.6 b	0.6 b	1.0 c	1.6 a	0.8 bc	0.7 ab
Roughs								
2006	0.9 a	0.5 a	0.7 ab	0.8 a	1.4 a	1.5 a	0.9 a	0.8 a
2014	0.8 ab	0.4 b	0.7 a	0.6 ab	1.2 ab	1.3 a	0.8 ab	0.7 ab
2021	0.8 b	0.4 ab	0.5 b	0.6 ab	1.1 bc	1.3 a	0.6 b	0.5 b
2024	0.7 b	0.5 ab	0.6 ab	0.4 b	0.9 c	1.2 a	0.8 ab	0.6 ab
Practice Areas								
2006	1.2 a	0.8 ab	1.0 a	1.0 a	1.6 a	1.8 a	1.2 a	1.0 a
2014	1.0 b	0.8 ab	0.6 b	0.9 a	1.1 b	1.6 a	1.0 b	0.8 ab
2021	1.0 b	0.9 a	1.0 a	0.9 a	1.3 ab	1.4 a	0.9 b	0.6 b
2024	0.9 b	0.7 b	0.8 ab	0.9 a	1.1 b	1.4 a	0.9 b	0.8 ab
Natural Areas								
2006	0.7 a	0.7 a	0.6 a	1.0 a	1.1 a	1.3 a	0.7 a	0.4 a
2014	0.7 a	0.0 ⁱⁱⁱ	0.5 a	0.8 ab	0.6 a	1.1 a	0.6 a	0.6 a
2021	0.8 a	0.3 a	1.8 a	0.4 b	0.7 a	1.6 a	0.8 a	0.3 a
2024	0.8 a	0.9 a	0.7 a	0.5 ab	0.9 a	0.4 a	1.1 a	0.7 a
Grounds								
2006	1.0 a	0.7 a	0.9 a	1.1 a	1.3 a	1.6 a	1.1 a	0.9 a
2014	0.8 b	0.6 ab	0.8 a	1.0 ab	1.1 ab	1.5 ab	0.8 b	0.7 b
2021	0.8 b	0.5 ab	0.8 a	0.8 ab	1.0 b	1.2 ab	0.8 b	0.7 b
2024	0.8 b	0.4 b	0.7 a	0.5 b	1.0 b	1.1 b	0.7 b	0.5 b

ⁱ NC, North Central; NE, Northeast; Pac., Pacific; SE, Southeast; SW, Southwest; Trans., Transition; UWM, Upper West/Mountain.

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

ⁱⁱⁱ Values without variability were not analyzed.

Table 18. Soluble potash (K₂O) use rates on U.S. golf facilities within the U.S. and regions (**Fig. 15**) in 2006, 2014, 2021, and 2024.

Year	U.S.	NC ⁱ	NE	Pac.	SE	SW	Trans.	UWM
	K ₂ O (lbs./1,000 ft ² per year)							
	Total							
2006	1.9 a ⁱⁱ	1.4 a	1.6 a	1.9 a	3.3 a	3.2 a	1.9 a	1.8 a
2014	1.2 b	0.7 b	1.1 b	1.2 a	2.7 ab	1.2 b	1.2 b	1.1 ab
2021	1.1 b	0.6 bc	1.1 b	1.3 a	1.9 b	1.5 b	0.8 b	0.6 b
2024	1.0 b	0.5 c	0.8 b	1.2 a	2.0 b	1.5 b	1.1 b	0.7 b
Greens								
2006	4.5 a	3.4 a	3.4 a	4.6 a	9.9 a	6.6 a	4.3 a	3.2 a
2014	3.6 b	2.4 b	2.7 b	3.2 b	7.8 b	5.0 b	4.2 a	3.0 a
2021	2.9 c	1.9 c	2.1 c	3.1 b	6.8 b	3.6 c	3.1 b	2.2 b
2024	2.6 d	1.6 d	2.1 c	2.4 b	5.8 c	3.5 c	2.7 c	1.8 b
Tees								
2006	3.3 a	2.8 a	3.1 a	3.6 a	5.8 a	4.0 a	2.9 a	2.2 a
2014	2.4 b	2.0 b	2.2 b	2.6 b	3.8 b	3.4 ab	2.3 b	2.0 ab
2021	2.0 c	1.6 c	1.6 c	2.3 bc	3.8 b	2.9 b	1.8 c	1.7 bc
2024	1.8 d	1.2 d	1.7 c	1.7 c	3.3 b	2.6 b	1.7 c	1.5 c
Fairways								
2006	2.6 a	2.1 a	2.3 a	2.6 a	4.6 a	3.0 a	2.5 a	1.9 a
2014	1.9 b	1.4 b	1.5 b	2.0 ab	3.3 b	2.8 ab	2.0 b	1.6 ab
2021	1.6 c	1.1 c	1.3 b	1.7 b	3.1 b	2.4 ab	1.6 c	1.4 b
2024	1.5 c	1.0 c	1.3 b	1.4 b	2.9 b	2.2 b	1.6 c	1.4 b
Roughs								
2006	1.9 a	1.2 a	1.5 a	2.0 a	4.1 a	2.3 a	1.8 a	1.7 a
2014	1.5 b	0.8 b	1.1 b	1.3 ab	2.7 b	2.2 a	1.5 b	1.3 ab
2021	1.2 c	0.6 c	0.9 b	1.1 b	2.6 b	1.8 ab	1.2 c	1.2 b
2024	1.3 c	0.7 bc	0.9 b	1.1 b	2.5 b	1.6 b	1.3 bc	1.2 b
Practice Areas								
2006	2.9 a	2.1 a	2.3 a	2.4 a	5.2 a	3.6 a	2.6 a	2.3 a
2014	2.2 b	1.8 a	1.6 b	1.9 a	3.4 b	2.9 ab	2.1 b	1.7 b
2021	1.8 c	1.2 b	1.6 b	1.7 a	3.2 b	2.2 bc	1.6 c	1.3 b
2024	1.8 c	1.2 b	1.5 b	2.1 a	3.0 b	2.0 c	1.7 bc	1.4 b
Natural Areas								
2006	1.1 a	1.0 a	0.9 a	1.2 a	1.7 a	1.2 a	1.1 a	0.8 b
2014	1.1 a	0.9 a	0.7 a	1.1 a	1.5 a	1.6 a	0.9 a	1.2 ab
2021	1.0 a	0.6 a	0.8 a	1.1 a	1.7 a	1.4 a	0.9 a	0.6 b
2024	1.2 a	1.2 a	0.9 a	1.5 a	1.1 a	0.7 a	1.2 a	2.0 a
Grounds								
2006	2.2 a	1.8 a	1.8 a	2.5 a	3.5 a	2.3 a	2.0 a	1.9 a
2014	1.6 b	1.3 b	1.3 b	2.2 ab	2.5 b	2.5 a	1.5 b	1.6 ab
2021	1.5 c	0.9 c	1.2 b	1.7 ab	2.6 b	2.3 ab	1.5 b	1.3 bc
2024	1.4 c	1.0 c	1.1 b	1.5 b	2.4 b	1.5 b	1.4 b	1.1 c

ⁱ NC, North Central; NE, Northeast; Pac., Pacific; SE, Southeast; SW, Southwest; Trans., Transition; UWM, Upper West/Mountain.

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

Table 19. Ratios of applied nitrogen (N), available phosphorus (P_2O_5), and soluble potash (K_2O) on U.S. golf facilities in 2006, 2014, 2021, and 2024.

Year	N	P_2O_5	K_2O
	Total		
2006	2.7 b ⁱ	1	2.3 c
2014	5.7 a	1	3.9 a
2021	4.9 a	1	3.1 ab
2024	5.0 a	1	2.8 b
	Greens		
2006	3.0 c	1	3.0 b
2014	3.6 a	1	3.4 a
2021	3.3 ab	1	2.9 b
2024	3.2 b	1	2.7 c
	Tees		
2006	3.0 b	1	2.5 a
2014	3.4 a	1	2.5 a
2021	3.4 a	1	2.3 b
2024	3.1 b	1	2.1 c
	Fairways		
2006	3.1 b	1	2.5 a
2014	3.3 a	1	2.5 a
2021	3.3 a	1	2.3 b
2024	3.3 ab	1	2.2 b
	Roughs		
2006	2.8 a	1	2.3 a
2014	2.9 a	1	2.3 ab
2021	3.0 a	1	2.2 ab
2024	3.0 a	1	2.1 b
	Practice		
2006	2.9 b	1	2.4 a
2014	3.3 a	1	2.4 a
2021	3.0 ab	1	2.1 b
2024	3.1 a	1	2.1 b
	Natural Areas		
2006	2.0 a	1	1.6 a
2014	1.7 a	1	1.9 a
2021	1.4 a	1	1.5 a
2024	1.7 a	1	1.6 a
	Grounds		
2006	2.8 b	1	2.2 a
2014	3.1 a	1	2.3 a
2021	2.9 ab	1	2.1 a
2024	3 ab	1	2.2 a

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

Table 20. Frequency of overseeding practices on golf facilities within the U.S. and regions (**Fig. 15**) in 2014, 2021, and 2024.

Year	U.S.	NC ⁱ	NE	Pac.	SE	SW	Trans.	UWM
Golf Facilities (%)								
Stopped Overseeding								
2014	8 b ⁱⁱ	1 a	<1 b	6 a	20 b	10 a	11 a	2 a
2021	10 a	1 a	2 a	8 a	30 a	13 a	10 a	1 ab
2024	7 b	<1 b	<1 b	4 a	16 b	19 a	10 a	<1 b
Reduced Overseeding								
2014	13 a	1 a	5 a	7 a	24 a	33 a	20 a	5 a
2021	9 b	<1 a	5 a	11 a	19 a	33 a	8 b	4 a
2024	8 b	1 a	5 a	12 a	20 a	18 b	7 b	2 a
Overseeded Greens								
2014	17 a	7 b	20 a	16 a	28 a	41 a	6 a	14 a
2021	13 b	13 a	17 ab	4 b	9 b	35 a	7 a	6 b
2024	12 b	8 ab	12 b	21 a	9 b	36 a	6 a	9 ab
Overseeded Tees								
2014	31 a	7 b	24 a	30 a	58 a	69 a	33 a	17 a
2021	24 b	13 a	17 a	35 a	36 c	58 a	23 ab	9 b
2024	25 b	9 b	17 a	40 a	46 b	56 a	22 b	11 ab
Overseeded Fairways								
2014	14 a	4 b	15 a	11 a	20 a	43 a	8 b	11 a
2021	13 a	9 a	10 a	15 a	12 b	34 a	18 a	7 ab
2024	13 a	7 b	12 a	16 a	10 b	45 a	11 ab	6 b
Overseeded Roughs								
2014	6 b	2 ab	7 ab	4 b	3 a	30 a	6 b	3 a
2021	6 b	4 a	5 b	11 a	4 a	17 b	9 ab	3 a
2024	8 a	2 b	10 a	7 ab	5 a	31 a	14 a	2 a
Did Not Overseed Any Feature								
2014	65 b	89 a	71 b	68 a	37 c	30 a	62 a	80 b
2021	70 a	79 b	79 a	62 a	63 a	40 a	64 a	88 a
2024	70 a	88 a	78 ab	57 a	52 b	41 a	68 a	84 ab

ⁱ NC, North Central; NE, Northeast; Pac., Pacific; SE, Southeast; SW, Southwest; Trans., Transition; UWM, Upper West/Mountain.

ⁱⁱ Within columns, values followed by a common letter are not significantly different according to the χ^2 test at the 10% significance level.

Table 21. Frequency of golf facilities within the U.S. and regions (**Fig. 15**) that soil tested course features in 2006, 2014, 2021, and 2024.

Year	U.S.	NC ⁱ	NE	Pac.	SE	SW	Trans.	UWM
Golf Facilities (%)								
Greens								
2006	92 a ⁱⁱ	86 a	96 a	94 a	96 a	91 a	95 a	92 a
2014	91 a	85 a	91 b	92 ab	98 a	93 a	88 bc	91 ab
2021	85 b	74 b	88 b	97 a	98 a	86 a	79 c	85 ab
2024	85 b	66 b	91 b	80 b	99 a	92 a	92 ab	81 b
Tees								
2006	70 a	62 a	77 a	74 a	81 a	64 a	68 a	62 a
2014	64 b	56 a	73 ab	60 ab	72 b	63 a	63 ab	52 a
2021	58 c	45 b	60 c	65 ab	77 ab	60 a	53 b	50 a
2024	59 c	40 b	63 bc	53 b	77 ab	66 a	63 a	50 a
Fairways								
2006	75 a	66 a	79 a	77 a	83 a	83 a	71 a	75 a
2014	67 b	58 b	69 b	69 ab	75 a	70 a	66 ab	68 a
2021	62 c	49 c	61 b	68 ab	79 a	67 a	56 b	62 a
2024	60 c	40 c	63 b	60 b	80 a	62 a	64 ab	62 a
Practice Areas								
2006	31 a	18 a	28 a	26 a	52 a	31 a	33 a	32 a
2014	27 b	18 a	27 ab	17 a	38 b	32 a	30 ab	19 b
2021	22 c	10 b	21 b	19 a	35 b	31 a	25 b	17 b
2024	26 b	11 b	25 ab	25 a	42 b	36 a	30 ab	21 b
Roughs								
2006	22 a	10 a	21 a	16 a	35 a	30 a	26 a	21 a
2014	19 b	10 a	17 ab	14 a	25 b	26 ab	23 a	20 a
2021	15 c	4 b	16 ab	5 b	22 b	18 b	22 a	9 b
2024	16 bc	3 b	14 b	9 ab	24 b	25 ab	28 a	9 b
Grounds								
2006	13 a	8 a	13 a	8 a	20 a	10 a	15 a	12 a
2014	12 a	9 a	13 a	6 ab	19 a	9 a	14 a	6 a
2021	7 b	2 b	9 a	3 b	10 b	7 a	12 a	6 ab
2024	8 b	2 b	10 a	8 ab	12 b	15 a	11 a	2 b
Natural Areas								
2006	4 a	2 a	3 a	2 a	5 a	4 a	5 a	5 a
2014	3 ab	1 ab	4 a	2 a	2 b	4 a	4 ab	1 b
2021	1 c	1 ab	3 a	2 a	0 c	2 a	2 b	2 ab
2024	2 bc	1 b	3 a	- ⁱⁱⁱ	3 ab	2 a	2 b	1 b

ⁱ NC, North Central; NE, Northeast; Pac., Pacific; SE, Southeast; SW, Southwest; Trans., Transition; UWM, Upper West/Mountain.

ⁱⁱ Within columns, values followed by a common letter are not significantly different according to the χ^2 test at the 10% significance level.

ⁱⁱⁱ Insufficient responses to calculate a value.

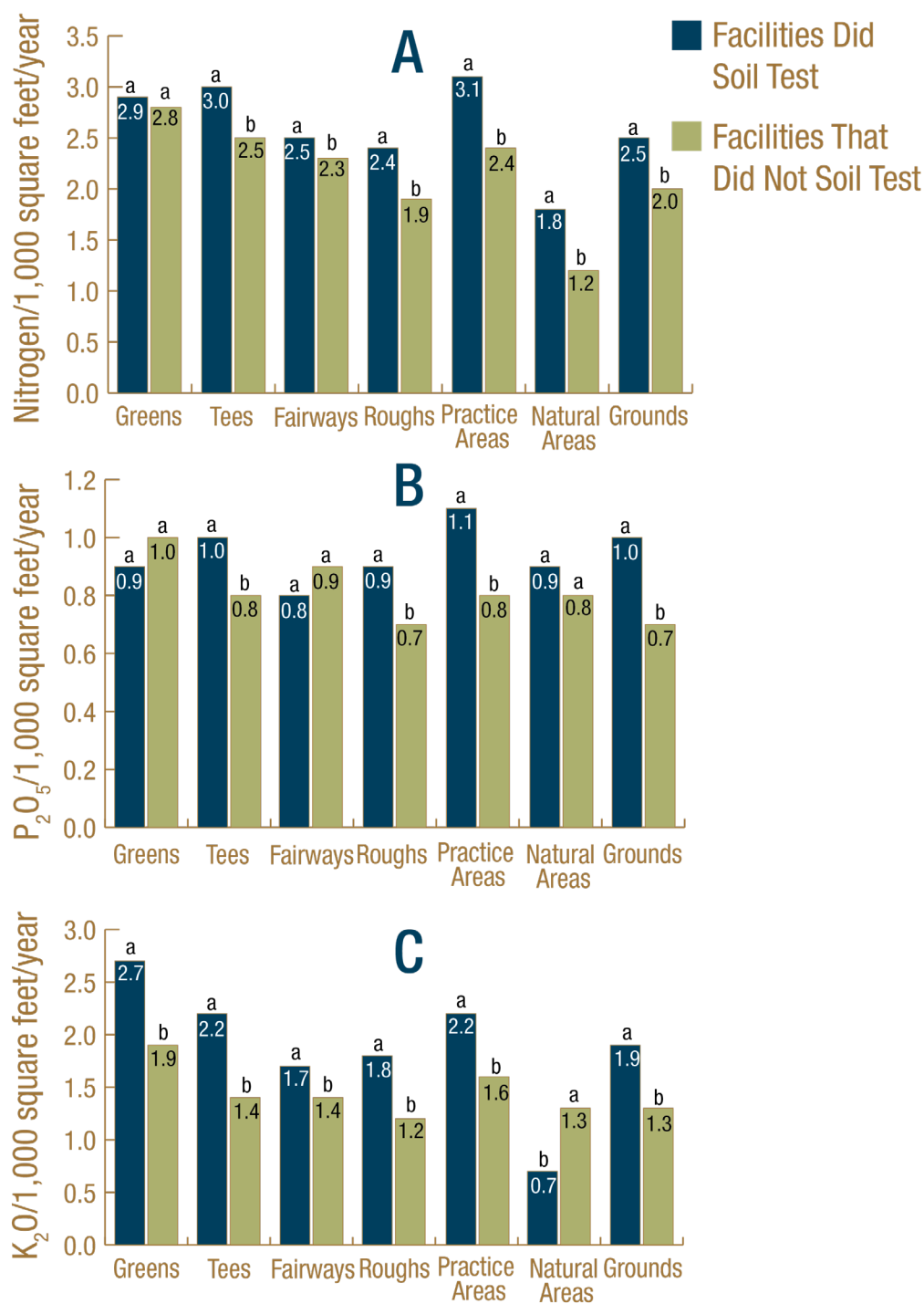


Figure 17. Use rates of A.) Nitrogen, B.) available phosphorus (P₂O₅), C.) and soluble potash (K₂O) on U.S. golf facilities that did or did not soil test in 2024. Bars with a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level.

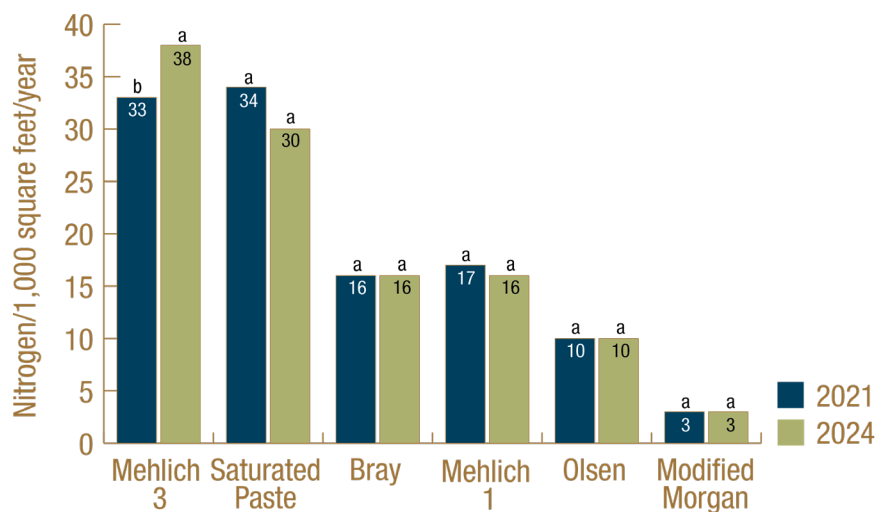


Figure 18. Frequency of soil extractant used for phosphorus analysis on U.S. golf facilities in 2024.

Table 22. Importance of factors when making nutrient application decisions on U.S. golf facilities in 2006, 2014, 2021, and 2024.

Decision Factor	2006	2014	2021	2024
	Importance (1 to 5) ⁱ			
Visual observation / scouting	4.1 a ⁱⁱ	4.1 a	4.0 b	4.1 ab
Precipitation / temperature / weather	4.1 a	4.1 a	4.0 b	4.0 b
Traffic / wear	3.8 c	3.9 b	3.9 ab	4.0 a
Previous product performance on your established turf	4.1 a	4.1 a	4.0 b	3.9 c
Disease problems / pressure	4.1 a	4.0 b	3.9 c	3.9 c
Soils / soil analysis	4.1 a	4.0 b	3.9 c	3.9 c
Golfers' expectations for turf performance	3.8 b	3.8 ab	3.7 b	3.9 a
Turf species	4.0 a	3.9 b	3.9 b	3.8 b
Length of growing season	3.8 a	3.7 ab	3.6 c	3.7 bc
Cost of fertilizer	3.6 c	3.8 a	3.7 b	3.5 d
Clipping production	3.4 b	3.4 b	3.4 b	3.5 a
Reduction of environmental impact	- ⁱⁱⁱ	3.6 a	3.4 b	3.4 b
Golf events calendar	3.5 a	3.5 a	3.3 c	3.4 b
Regulatory requirements	2.7 c	3.0 a	2.9 b	3.0 ab
Turf growth prediction models	2.8 c	2.8 bc	2.9 b	3.0 a
Manufacturer recommendations	2.8 a	2.9 a	2.8 a	2.8 a
University recommendations	2.7 b	2.9 a	2.7 b	2.6 b
Consultant / service provider recommendations	2.6 a	2.5 ab	2.5 bc	2.4 c
Tissue analysis	2.5 a	2.4 ab	2.4 b	2.4 b
Nutrient content of effluent water source	2.0 bc	1.9 c	2.0 ab	2.1 a
Adjacent property owner's maintenance standards	1.8 c	2.0 a	1.8 bc	1.9 ab
Overseeding warm season grasses with cool-season grasses	- ⁱⁱⁱ	1.3 a	1.3 a	1.3 a

ⁱ Respondents rated factors on a 1–5 scale, where 1 = not important at all, and 5 = extremely important.

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

ⁱⁱⁱ Not asked in 2006.

Table 23. Association between management practice used with the intent of reducing reliance upon applied nutrients and median nitrogen (N), available phosphorus (P_2O_5), and soluble potash (K_2O) applied on U.S. golf facilities in 2024.

Management Practice	Was management practice used?					
	Yes	No	Yes	No	Yes	No
	N (tons/year)		P_2O_5 (tons/year)		K_2O (tons/year)	
Fertilize based on soil test results	3.9 a ⁱ	3.1 b	0.4 a	0.6 a	2.3 a	1.7 b
Return clippings	3.4 a	3.5 a	0.4 a	0.6 a	1.9 a	2.0 a
Use precision fertilizer applications	3.6 a	3.3 a	0.5 a	0.6 a	2.0 a	2.0 a
Reduce turf acreage	3.0 b	3.6 a	0.4 b	0.6 a	1.8 a	2.1 a
Consider nitrogen release from soil organic matter	2.8 b	3.8 a	0.5 a	0.5 a	1.7 b	2.2 a
Use plant growth models to determine fertilizer rates and frequency	3.1 a	3.6 a	0.3 b	0.6 a	1.7 b	2.2 a
Reduce overseeding	4.9 a	3.3 b	0.9 a	0.5 b	2.6 a	1.9 a
Use new fertilizer guidelines	3.8 a	3.4 a	0.4 a	0.5 a	2.0 a	2.0 a
Change turf variety	3.6 a	3.4 a	0.4 a	0.5 a	2.1 a	2.0 a
Consider nutrients applied in reclaimed water	4.4 a	3.4 b	0.4 a	0.5 a	2.6 a	1.9 a
Stop overseeding	4.2 a	3.4 a	1.0 a	0.5 b	2.6 a	1.9 a
Compost on-site	3.7 a	3.4 a	0.8 a	0.5 a	2.2 a	2.0 a

ⁱWithin rows and nutrient, values followed by a common letter are not significantly different according to the Tukey-Kramer test at the 10% significance level.

Table 24. Frequency of golf facilities within the U.S. and regions (**Fig. 15**) with a written nutrient management plan in 2024.

Year	U.S.	NC ⁱ	NE	Pac.	SE	SW	Trans.	UWM
Golf Facilities (%)								
2006	47 a ⁱⁱ	52 a	41 a	47 a	48 a	50 a	42 a	44 a
2014	44 ab	52 a	41 a	31 b	43 a	45 a	41 a	46 a
2021	43 ab	52 a	35 a	38 a	41 a	46 a	43 a	36 a
2024	42 b	45 a	34 a	29 b	47 a	45 a	42 a	39 a

ⁱNC, North Central; NE, Northeast; Pac., Pacific; SE, Southeast; SW, Southwest; Trans., Transition; UWM, Upper West/Mountain.

ⁱⁱWithin columns, values followed by a common letter are not significantly different according to the χ^2 test at the 10% significance level.

Table 25. Nitrogen (N), available phosphorus (P_2O_5), and soluble potash (K_2O) use rates on U.S. golf facilities by golf holes and facility type in 2024.

	N	P_2O_5	K_2O
Golf Holes	(lbs./1,000 ft ² per year)		
9	1.6 a ⁱ	0.4 a	0.8 a
18	1.7 a	0.3 a	1.0 a
27+	1.9 a	0.3 a	1.2 a
Facility Type			
Public	1.6 b	0.3 b	0.9 b
Private	1.9 a	0.4 a	1.2 a

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

Table 26. Frequency of natural organic nitrogen use on golf facilities within the U.S. and regions (**Fig. 15**) in 2006, 2014, 2021, and 2024.

Year	U.S.	NC ⁱ	NE	Pac.	SE	SW	Trans.	UWM
	Golf Facilities (%)							
2006	64 a ⁱⁱ	56 a	75 a	66 a	67 a	56 a	65 a	57 a
2014	61 a	51 ab	74 a	61 a	64 a	67 a	64 ab	53 a
2021	54 b	47 b	56 b	56 a	62 a	36 b	55 b	62 a
2024	56 b	41 b	62 b	57 a	65 a	63 a	57 ab	51 a

ⁱ NC, North Central; NE, Northeast; Pac., Pacific; SE, Southeast; SW, Southwest; Trans., Transition; UWM, Upper West/Mountain.

ⁱⁱ Within columns, values followed by a common letter are not significantly different according to the χ^2 test at the 10% significance level.

Table 27. Frequency (percentage) of natural organic sources used by U.S. golf facilities that used natural organic products in 2006, 2014, 2021, and 2024.

Year	Biosolid	Animal Waste	Crop products	Food waste
	Golf Facilities (%)			
2006	47 a ⁱ	64 c	15 ab	24 a
2014	39 b	65 bc	14 ab	13 b
2021	39 b	68 ab	14 b	13 b
2024	31 c	73 a	18 a	17 b

ⁱ Within columns, values followed by a common letter are not significantly different according to the χ^2 test at the 10% significance level.

Table 28. Percentage of slow and quick-release nitrogen applied on golf facilities within the U.S. and regions (**Fig. 15**) in 2006, 2014, 2021, and 2024.

Year	U.S.	NC ⁱ	NE	Pac.	SE	SW	Trans.	UWM
	Slow-Release Nitrogen (%)							
2006	65 a ⁱⁱ	69 a	69 ab	59 ab	65 a	57 ab	62 a	65 a
2014	65 a	69 a	71 a	59 ab	62 ab	49 b	61 ab	68 a
2021	61 b	66 ab	62 c	54 b	60 b	48 b	61 ab	67 a
2024	62 b	64 b	65 bc	66 a	60 b	60 a	57 b	63 a
Year	Quick-Release Nitrogen (%)							
2006	31 b	28 c	29 bc	35 ab	31 b	42 ab	34 a	33 a
2014	32 b	29 bc	28 c	38 ab	33 ab	49 a	36 a	29 a
2021	35 a	32 ab	35 a	42 a	36 a	49 a	35 a	30 a
2024	34 a	32 a	33 ab	31 b	36 a	38 b	37 a	33 a

ⁱ NC, North Central; NE, Northeast; Pac., Pacific; SE, Southeast; SW, Southwest; Trans., Transition; UWM, Upper West/Mountain.

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

Table 29. Frequency of soil amendment and supplement use on U.S. golf courses in 2006, 2014, 2021, and 2024.

Soil Amendment	2006	2014	2021	2024
	Golf Facilities (%)			
Used at least one amendment	76 b ⁱ	83 a	84 a	83 a
Humic materials	41 c	53 b	58 a	60 a
Amino acids/proteins	38 b	49 a	50 a	52 a
Biostimulants	43 b	48 a	50 a	49 a
Gypsum	34 c	49 a	44 b	43 b
Sulfur	8 b	27 a	25 a	26 a
Sugars	14 c	18 b	18 b	22 a
Microbial inoculants	14 b	20 a	18 a	21 a
Limestone	22 b	26 a	22 b	20 b
Compost	13 b	14 b	16 a	19 a
Biocontrol agents	6 b	8 a	10 a	9 a
Calcium chloride	5 b	9 a	8 b	8 b
Compost teas	3 c	8 a	6 b	4 b

ⁱ Within rows, values followed by a common letter are not significantly different according to the χ^2 test at the 10% significance level.

Table 30. Percentage of nutrient applications made using calibrated equipment on golf facilities within the U.S. and regions (**Fig. 15**) in 2006, 2014, 2021, and 2024.

Year	U.S.	NC'	NE	Pac.	SE	SW	Trans.	UWM
	Nutrient Applications (%)							
	Greens							
2006	56 a ⁱⁱ	51 a	60 a	51 a	58 a	55 a	63 a	50 a
2014	53 a	50 a	55 a	28 b	55 ab	59 a	60 a	50 a
2021	46 b	39 b	50 a	37 ab	52 ab	47 a	56 a	28 b
2024	48 b	37 b	55 a	41 ab	48 b	55 a	60 a	40 ab
	Tees							
2006	57 a	49 a	60 a	51 a	60 a	59 a	64 a	58 a
2014	54 a	47 ab	57 a	28 b	58 a	54 a	62 a	64 a
2021	49 b	41 b	54 a	47 ab	55 ab	45 a	58 a	39 b
2024	49 b	41 b	52 a	45 ab	46 b	53 a	64 a	46 ab
	Fairways							
2006	67 a	62 a	69 a	57 a	71 a	59 a	70 a	73 a
2014	61 b	54 a	67 a	37 a	64 ab	55 ab	64 a	70 a
2021	51 c	43 b	54 b	49 a	54 bc	44 b	62 a	44 b
2024	53 c	43 b	60 ab	42 a	51 c	55 ab	64 a	49 b
	Roughs							
2006	71 a	70 a	76 a	55 a	72 a	54 a	77 a	74 a
2014	66 ab	67 ab	75 a	49 a	68 a	58 a	63 b	65 ab
2021	60 bc	53 b	67 a	71 a	61 ab	51 a	64 ab	54 ab
2024	58 c	53 b	69 a	48 a	54 b	55 a	67 ab	51 b

ⁱ NC, North Central; NE, Northeast; Pac., Pacific; SE, Southeast; SW, Southwest; Trans., Transition; UWM, Upper West/Mountain.

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

Table 31. Number of nutrient applications made annually on golf facilities within the U.S. and regions (**Fig. 15**) in 2006, 2014, 2021, and 2024.

Year	U.S.	NC ⁱ	NE	Pac.	SE	SW	Trans.	UWM
	Nutrient Applications (no./year)							
	Greens							
2006	11.9 c ⁱⁱ	8.9 b	9.3 c	16.1 b	20.0 b	17.2 b	12.1 b	9.5 b
2014	14.4 b	9.7 ab	10.6 bc	20.7 a	30.3 a	22.2 a	14.2 a	13.7 a
2021	16.3 a	11.0 a	13.7 a	22.2 a	31.8 a	23.5 a	15.6 a	16.3 a
2024	15.7 a	10.4 a	11.4 ab	20.7 a	29.5 a	22.9 a	16.7 a	14.5 a
	Tees							
2006	5.4 b	5.3 ab	5.7 b	6.7 a	6.5 b	5.9 c	4.7 a	3.8 a
2014	5.5 b	5.1 b	5.4 b	7.2 a	7.7 a	8.8 b	4.3 a	4.3 a
2021	6.2 a	5.8 a	7.1 a	7.5 a	7.7 a	7.7 b	4.6 a	4.6 a
2024	6.3 a	5.0 b	6.6 a	7.2 a	8.5 a	12.0 a	4.8 a	4.4 a
	Fairways							
2006	3.5 c	3.3 b	3.1 b	4.0 a	4.4 c	5.0 c	3.4 b	2.6 c
2014	4.1 b	3.5 ab	3.5 b	5.3 a	5.7 b	6.3 bc	3.9 ab	3.0 bc
2021	4.6 a	3.9 a	4.6 a	4.5 a	6.5 ab	7.9 ab	3.6 ab	4.2 a
2024	4.9 a	3.6 ab	4.9 a	5.1 a	7.4 a	10.4 a	4.0 a	3.7 ab
	Roughs							
2006	2.6 b	1.8 a	2.0 a	3.0 a	3.9 b	4.4 b	2.4 a	2.1 a
2014	2.5 b	1.9 a	2.1 a	2.4 a	3.7 b	4.8 ab	2.3 a	2.1 a
2021	2.6 ab	2.0 a	2.2 a	2.8 a	3.9 ab	4.5 ab	2.2 a	2.5 a
2024	2.8 a	2.0 a	2.0 a	2.8 a	4.6 a	5.9 a	2.5 a	2.6 a

ⁱ NC, North Central; NE, Northeast; Pac., Pacific; SE, Southeast; SW, Southwest; Trans., Transition; UWM, Upper West/Mountain.

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

Table 32. Frequency of golf facilities within the U.S. and regions (Fig. 15) that used fertilizer storage that, at a minimum, had an impervious floor and roof, ventilation, security (locked with access restricted), and containment features to prevent loss to the environment and/or contamination from run off in 2006, 2014, 2021, and 2024.

Year	U.S.	NC ⁱ	NE	Pac.	SE	SW	Trans.	UWM
	Golf Facilities (%)							
2006	51 c ⁱⁱ	43 c	49 b	62 b	59 b	65 a	49 c	41 b
2014	63 b	59 ab	64 a	72 ab	66 ab	72 a	58 bc	66 a
2021	64 b	58 b	65 a	81 a	72 a	48 b	64 b	66 a
2024	68 a	68 a	61 a	72 ab	71 a	70 a	74 a	63 a

ⁱ NC, North Central; NE, Northeast; Pac., Pacific; SE, Southeast; SW, Southwest; Trans., Transition; UWM, Upper West/Mountain.

ⁱⁱ Within columns, values followed by a common letter are not significantly different according to the χ^2 test at the 10% significance level.

Table 33. 2024 nutrient and pest survey responses and weighting factors categorized by region (**Fig. 15**), facility type, number of holes, and green fee.

Region	Facility Type	Holes	Green Fee	Golf Facilities		Survey Responses		Weight
		(No.)	(\$)	(No.)	(%)	(No.)	(%)	
Northeast	All	9	All	652	4.7	18	1.2	3.892
Northeast	Public	18	<\$55	402	2.9	10	0.7	4.319
Northeast	Public	18	\$55+	639	4.6	71	4.7	0.967
Northeast	Private	18	All	585	4.2	109	7.3	0.577
Northeast	All	27+	All	176	1.3	17	1.1	1.112
North Central	All	9	All	1135	8.1	19	1.3	6.418
North Central	Public	18	<\$55	901	6.5	45	3.0	2.151
North Central	Public	18	\$55+	753	5.4	109	7.3	0.742
North Central	Private	18	All	448	3.2	110	7.3	0.438
North Central	All	27+	All	301	2.2	31	2.1	1.043
Transition	All	9	All	641	4.6	20	1.3	3.443
Transition	Public	18	<\$55	635	4.6	41	2.7	1.664
Transition	Public	18	\$55+	514	3.7	85	5.7	0.650
Transition	Private	18	All	520	3.7	117	7.8	0.478
Transition	All	27+	All	180	1.3	28	1.9	0.691
Southeast	All	9	All	444	3.2	9	0.6	5.300
Southeast	Public	18	<\$55	541	3.9	41	2.7	1.418
Southeast	Public	18	\$55+	669	4.8	87	5.8	0.826
Southeast	Private	18	All	685	4.9	119	7.9	0.618
Southeast	All	27+	All	365	2.6	61	4.1	0.643
Southwest	All	9	All	240	1.7	2	0.1	12.893
Southwest	Public	18	<\$55	120	0.9	8	0.5	1.612
Southwest	Public	18	\$55+	379	2.7	40	2.7	1.018
Southwest	Private	18	All	228	1.6	45	3.0	0.544
Southwest	All	27+	All	166	1.2	23	1.5	0.775
Upper West/Mountain	All	9	All	389	2.8	11	0.7	3.799
Upper West/Mountain	Public	18	<\$55	80	0.6	14	0.9	0.614
Upper West/Mountain	Public	18	\$55+	369	2.6	72	4.8	0.551
Upper West/Mountain	Private	18	All	154	1.1	46	3.1	0.360
Upper West/Mountain	All	27+	All	81	0.6	12	0.8	0.725
Pacific	All	9	All	157	1.1	5	0.3	3.374
Pacific	Public	18	<\$55	28	0.2	2	0.1	1.504
Pacific	Public	18	\$55+	205	1.5	42	2.8	0.524
Pacific	Private	18	All	116	0.8	23	1.5	0.542
Pacific	All	27+	All	54	0.4	7	0.5	0.829



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