GCSAA

Photos by Larry Stowell

Golf Course Environmental Profile

Phase II, Volume III
Pest Management Practices on U.S. Golf Courses

EIFG GCSAA USGA

Funded by the USGA through the Environmental Institute for Golf, the philanthropic organization of the GCSAA.

Golf Course Superintendents Association of America

Golf Course Environmental Profile

Phase II, Volume III

Pest Management Practices on U.S. Golf Courses

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

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Foreword

Survey documents changes in pest management practices

Results from our latest survey, Pest Management Practices on U.S. Golf Courses — part of the groundbreaking, multiphase Golf Course Environmental Profile — show an increase in non-pesticide practices, while traditional pest management activity has remained at about the same levels as in 2007.

Funded by the USGA through the Environmental Institute for Golf, the Golf Course Environmental Profile provides critical information for the golf course management profession and assists efforts to advocate for superintendents and the entire industry. By comparing data from this latest study with results from the first pest management practices survey in 2007, GCSAA is able to measure our industry's progress and communicate superintendents' ongoing efforts toward resource conservation and environmental protection.

GCSAA members are stewards of every golf facility's greatest asset, the course itself. Study after study has demonstrated our dedication to the continual advancement of sustainable practices. The results from this latest pest management survey are no different. Since 2007 golf course superintendents have increased their reliance on cultural practices and plant growth regulators to complement their traditional pest management practices.

We have been entrusted with a small piece of this Earth, and it is our responsibility to educate others about the many benefits of golf's professionally managed land and the game itself. Just as you continue to communicate these points to your golfers and in your communities, GCSAA will use the data collected through the Profile surveys to advocate for our profession and the golf industry as a whole.

On behalf of your board of directors, I thank all the superintendents who took the time to take part in this study.

Peter J. Grass, CGCS
2016 GCSAA President

Executive Summary

Objectives

Pest management practices on U.S. golf courses were documented for the first time in a 2007 survey conducted by the Golf Course Superintendents Association of America. The objectives of the second Pest Management Practices Survey were to compare results from 2015 to those from 2007 to document national and regional trends in:

- Types of pest management practices
- Pest management decision-making
- Impact of regulations on pest management practices
- Use of written pest management plans
- Approaches to pesticide handling (storage, mixing and loading)

Key results

Pest management practices

- Over the past several years, U.S. golf courses have increased their reliance on non-pesticide pest control practices such as cultural control, plant growth regulators and biological control.
- In contrast, reliance on conventional chemistries such as fungicides, herbicides, insecticides and nematicides has either decreased or showed little change.
- The data suggests that turf managers are using non-pesticide control practices in conjunction with conventional chemistries, rather than as substitutes for them.

Pest management decision-making

The most important/influential sources of information on pest management were, in decreasing order: personal interactions, websites and print publications.

Impact of pest management regulations

- Since 2007, the degree to which superintendents felt that pesticide restrictions influenced their pest management programs has declined significantly.
- Pest management activities that are regulated by local authorities have remained at roughly the same level as in 2007. However, the types of activities that are most heavily regulated have changed.
- The number of Certified Pesticide Applicators at each facility has remained relatively unchanged since 2007, with an average of roughly one certified applicator for every nine holes on the golf course.
- A new regulatory program, the National Pollutant Discharge Elimination System (NPDES), was modified to cover aquatic pesticide applications to "Waters of the United States" in 2011 (8). In the 2015 survey, 4% of superintendents said that they were required to physically obtain an NPDES permit.

Gray leaf spot can devastate large swaths of ryegrass, kikuyugrass and St. Augustinegrass during the warm, humid summer months.

Written pest management plans

- Development of written integrated pest management (IPM) plans and pesticide application plans was a voluntary activity for the large majority (85%) of facilities who reported using them.
- In 2015, there was a decrease in the number of facilities reporting use of written IPM and pesticide application plans, possibly because of the economic impact of the recession.
- In contrast, the use of written pesticide emergency response plans has increased slightly since 2007.

Pesticide handling

Only small changes have occurred in the attributes of mixing and loading areas and pesticide storage areas since 2007.

Impact of budget and facility size

- Facilities with larger budgets and/or more holes are more likely to possess state-of-the-art pesticide storage and mixing/loading stations.
- These types of facilities with are also more likely to invest time and labor in the development of written pest management plans.

Introduction
Why do we need a golf course environmental profile?

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

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

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

In fall 2014, the second phase of the Golf Course Environmental Profile began, with a follow-up set of surveys that mirrors the previous series. The surveys are to be conducted by the GCSAA through the EIFG and funded by the United States Golf Association (USGA). The third survey to be released in the second phase focuses on pest management practices, and explores trends, changes and progress that have been made since the initial survey was conducted in 2007.

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

The objectives of the second Pest Management Practices Survey were to compare results from 2015 to those from 2007, in order to document national and regional trends in:

- Types of pest management practices
- Pest management decision-making
- Impact of regulations on pest management practices
- Use of written pest management plans
- Approaches to pesticide handling (storage, mixing and loading)

RESULTS
National Trends
Pest Management Practices

When asked how their reliance on different forms of pest control had changed over the past several years, respondents reported increased reliance on non-pesticide pest control practices such as cultural control, plant growth regulators (PGRs) and biological control. In contrast, reliance on conventional chemistries such as fungicides, herbicides, insecticides and nematicides either decreased or showed little change during that same time period (Figure 1).

Cultural, monitoring and biological practices

Since 2007, reliance on the use of cultural practices has increased by 66% (Figure 1). These practices also were used by more than 90% of facilities with nine, 18 and 27+ holes in both 2007 and 2015 (Table 1). Cultural practices focus on modifying the pest's environment or habitat in such a way that pest numbers or pest damage is reduced. Increased mowing heights, salinity management, fertilizer management and improving plant health are commonly used cultural practices on golf courses.

Other frequently used non-pesticide practices in both 2007 and 2015 (Table 1) include monitoring weather, scouting for pests, recording outbreaks, and tolerating higher levels of plant damage. In addition, pesticide resistance management, spot treatment with pesticides and encouragement of improved turf health were reported by a large majority of respondents in 2015; questions on these practices were not included in the 2007 survey, however.

The use of sensors is the practice that has showed the greatest increase since 2007. Sensors are hand-held or machine-mounted devices that gather information on soil or plant characteristics, and they allow superintendents to better manage turf health and, therefore, improve resilience against pest attack. The likely reason for increased sensor use is that the technology is relatively new

(2) and, therefore, is still in the early, rapid adoption phase.

Facilities with nine, 18 and 27+ holes demonstrated similar trends over time in adoption of these practices, though nine-hole facilities were less likely to use these techniques than larger courses (Table 1).

Significant applied research on the development and use of cultural practices in pest management (Table 2) in recent years may have played a role in the large increase in adoption of these strategies.

Plant growth regulators

Reliance on PGRs has increased by 44% since 2007 (Figure 1). These products are generally assigned the lowest toxicity classification by the U.S. Environmental Protection Agency (21). They are used to improve turf quality and stress tolerance, and to suppress the growth of certain weeds and diseases (11,16). Although PGRs have been available for several decades, recent advances in technology have resulted in improved scheduling of these products as well as the introduction of newer products that have reduced the risk of phytotoxicity associated with some of the early PGRs (12).

Change in reliance on various pest management practices

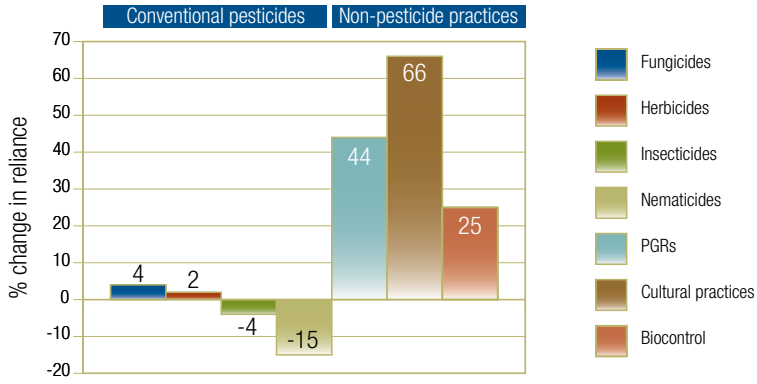


Figure 1. Percent change in reliance by all facilities on various pest management practices over the past several years. Values were determined by subtracting the percentage reporting decreased reliance from the percentage reporting increased reliance on each pest management practice.

% facilities using various cultural, biological and monitoring practices

	Facility type					
	9 holes		18 holes		27+ holes	
	% of facilities					
Practices	2007	2015	2007	2015	2007	2015
Sensors	10*	20	19*	41	20*	42
Traps	31	34	26*	35	28	34
Biocontrol	48	32*	46	47	48	40
Predictive models	47	36*	60	58	65	65
Pest-tolerant turf	51	39*	66	60*	63	59
Higher damage tolerance	69	67	70	72	68	68
Record outbreaks	74	72	86	78*	88	85
Scouting	93	89	96*	97	98	97
Monitoring weather	94	91	97	97	98	99
Cultural practices	90	95	96	97	97	96
Mapping pest damage	NA†	39	NA	56	NA	61
Photos (aerial or regular)	NA	28	NA	39	NA	49
Spot treatment	NA	88	NA	94	NA	93
Pesticide-resistance management strategies	NA	82	NA	95	NA	96
Increased pest tolerance through improved turf health	NA	95	NA	97	NA	95
Pest ID by university or independent lab	NA	45	NA	52	NA	63
Monitoring weather conditions conducive to pest outbreaks	NA	88	NA	95	NA	95

†NA, Practices were surveyed only in 2015.
*Significant difference ($P < 0.10$) between 2007 and 2015.

Table 1. Percentage of facilities using various cultural, biological and monitoring practices "sometimes" or "frequently." For each golf course size (nine, 18 and 27+ holes), practices in 2007 were compared with those in 2015.

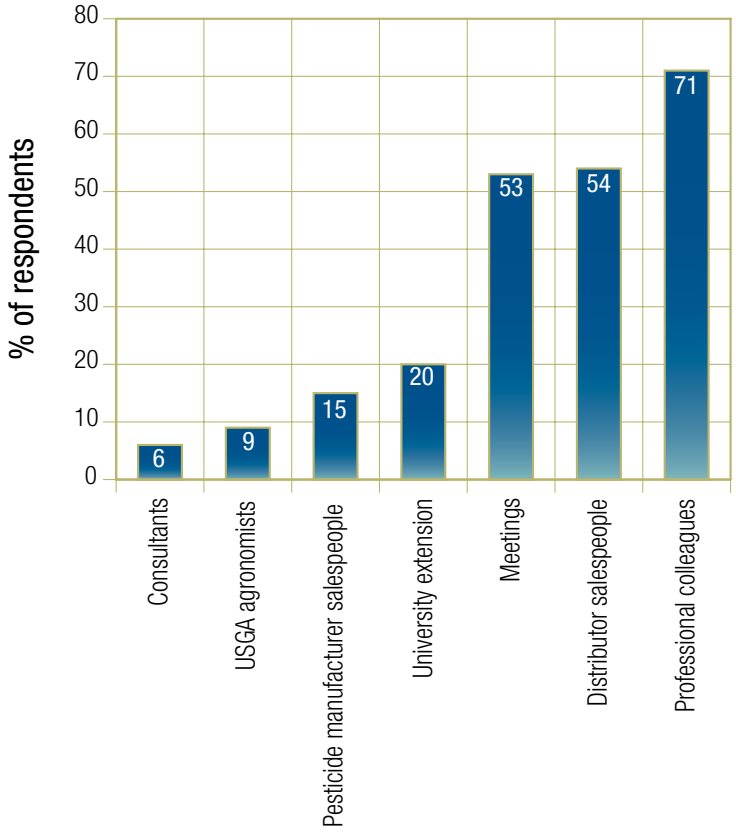
Advances in cultural practices for turf pest management

Practice	Effect	Reference†
Decrease potassium rates	decreased pink and gray snow mold	13,22
Manganese applications	decreased take-all patch (*Gaeumannomyces graminis*)	10
Decrease nitrogen rates	decreased silvery thread moss (*Bryum argenteum*)	20,24
Manage organic matter	decreased earthworm infestation	17
Mowrah meal and related saponins	decreased earthworm infestation	17
Sand topdressing	decreased silvery-thread moss (*B. argenteum*)	20
Increase mowing heights	decreased silvery-thread moss (*B. argenteum*)	20
Decrease phosphorus fertilizer rates	decreased *Poa annua* invasion	18
Sand topdressing	reduced anthracnose damage (*Colletotrichum cereal*)	15
Appropriate nitrogen fertility	reduced anthracnose damage *(C. cereale)*	15
Increase mowing height	reduced anthracnose damage *(C. cereale)*	16
Use potassium nitrate rather than other nitrogen sources	reduced anthracnose damage *(C. cereale)*	14
Iron sulfate	decreased *Poa annua* growth	19
Increase nitrogen fertility	reduced brown ring patch (*Waitea circinata* var. *circinata*)	26
Reduce soil salinity	reduced rapid blight (*Labyrinthula terrestris*) severity	23
Phosphite fertilizers	reduced Pythium blight severity	7

†Numbers indicate references in the Literature Cited section.

Table 2. Recent research advances in the use of cultural practices for turf pest management.

Influences on pest management decision-making
2A. Importance of different types of personal interactions



Biological controls

The use of biological controls has increased by 25% since the first survey in 2007 (Figure 1). These products and practices rely on the use of a naturally occurring predator, parasite or pathogen to control pests. The recent introduction of effective biopesticide products based on active ingredients such as polyoxin-D (derived from the microbe *Streptomyces*) and phosphites/phosphonates (based on salts and esters of phosphorous acid) has very likely contributed to this increased reliance on biocontrols (3,4).

Conventional pest control practices

Of the conventional pesticides, nematicides had the largest decrease in use since 2007 (Figure 1). This drop is very likely due to the Environmental Protection Agency's 2008 prohibition of the sale and distribution of the nematicide fenamiphos (1), which had been widely used in the golf course industry. Reliance on fungicides, herbicides and insecticides changed very little between 2007 and 2015.

Pest Management Decision-Making

The most important/influential sources of information on pest management strategies in 2015 (Figure 2) were, in decreasing order: personal interactions, websites and print publica-

tions. Because this set of questions was asked for the first time in 2015, the data presented here serves as a baseline for future survey analyses.

Personal interactions

Almost all (98%) respondents indicated that one or more types of personal interactions were in the top five of their most influential information sources on pest management. Of these sources, individuals or organizations with whom superintendents interact most frequently (professional colleagues, distributor salespeople and people at meetings) appear to have the greatest influence (Figure 2A).

Websites

Websites were the second most popular general information source, with 87% of respondents listing one or more websites as highly influential. The most frequently cited websites were sponsored by GCSAA and state university extension organizations (Figure 2B).

Print publications

One or more print publications were cited by 79% of respondents as highly influential. The most frequently cited publications were sponsored by GCSAA, university extension and the USGA (Figure 2C).

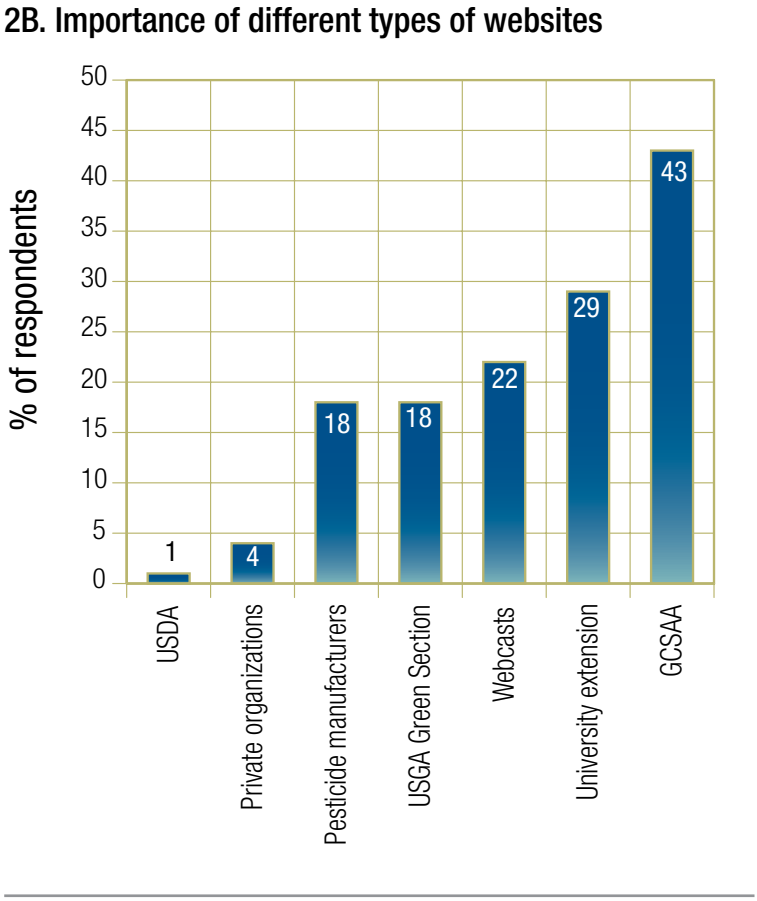
IMPACT OF PEST MANAGEMENT REGULATIONS

In both 2007 and 2015, superintendents reported that, in general, restrictions on pest management programs had a relatively low impact. However, the degree to which superintendents feel that pesticide restrictions influence their pest management programs has declined significantly since 2007, particularly in the North Central, Northeast, Southeast and Transition regions (Figure 3).

The greater availability of lower-risk and/or non-pesticide pest management products — which are regulated less stringently — is likely responsible for the perception that regulations and restrictions had less impact in 2015 than in 2007.

State and local regulations

Federal regulations (including pesticide labeling) cover almost all aspects of pesticide operations and applications. In some locations, however, additional pesticide regulations are issued by local governments (state, city/town, county, tribe, etc.).



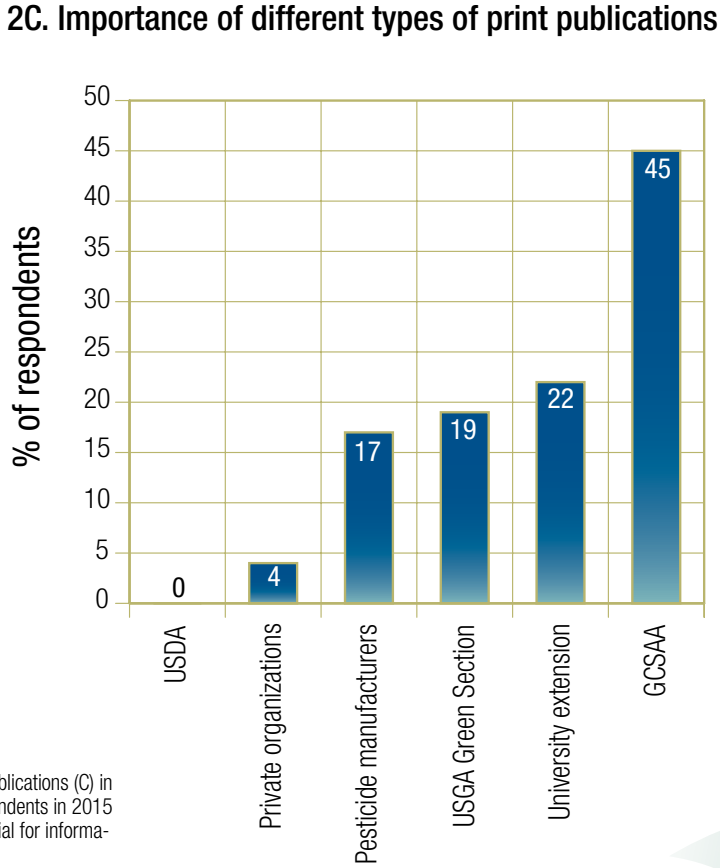


Figure 2. Role of personal interactions (A), websites (B) and print publications (C) in pest management-decision making for all facilities. Percent of respondents in 2015 who viewed each information source as one of the five most influential for information on pest management strategies.

Change in perceived impact of regulations, 2007-2015

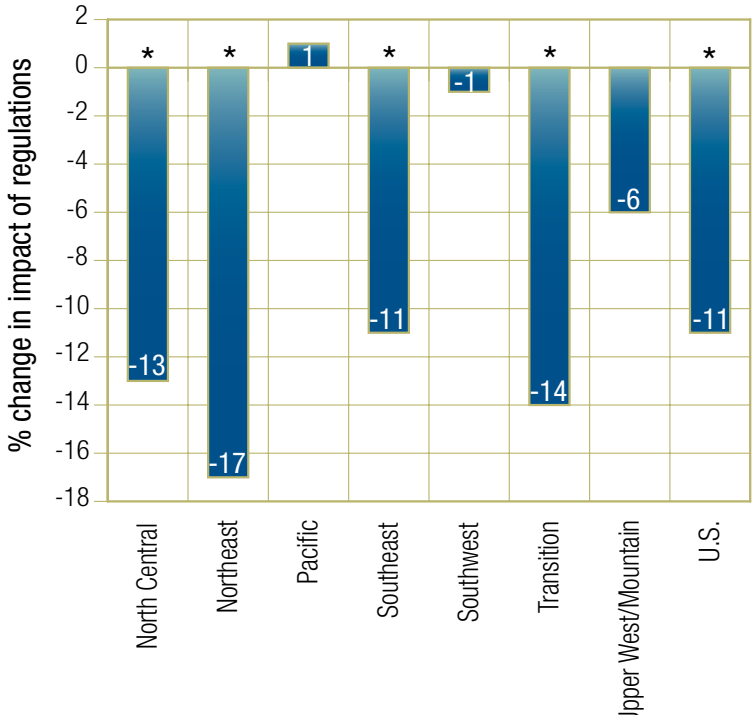


Figure 3. Percent change in perceived impact of regulations, from 2007 to 2015, for 18-hole facilities. For each region, an asterisk indicates a significant difference ($P < 0.10$) between 2007 and 2015.

Respondents were asked which pesticide-related activities are regulated by local governments above and beyond the federal regulations. The biggest changes since 2007 were increases in product bans, restrictions on amounts of some products and requirements for buffer strips, no-apply zones and date restrictions (Table 3).

Pesticide applicator certifications

Federal law requires any person who applies or supervises the use of restricted-use pesticides to be certified in accordance with federal EPA regulations as well as any appropriate state, territorial and tribal laws. Restricted-use products have been deemed by the EPA to have the potential to cause adverse effects on the environment and/or injury to applicators or bystanders without added restrictions (5).

The number of Certified Pesticide Applicators at each facility has remained relatively unchanged since 2007, with roughly one certified applicator for every nine holes on the golf course. The average number of applicators was 1.2 for nine-hole facilities, 2.1 for 18 holes and 3.6 for 27+ holes. However, states are now moving to certify all applicators on golf courses, regardless of whether restricted-use pesticides are used.

% 18-hole facilities reporting local government regulation of pest management

	Agronomic region†													
	NC		NE		PAC		SE		SW		TR		UW	
	% of facilities reporting local government regulation													
Regulations	**2007**	**2015**	**2007**	**2015**	**2007**	**2015**	**2007**	**2015**	**2007**	**2015**	**2007**	**2015**	**2007**	**2015**
Date restrictions	2*	6	3*	20	11*	23	5*	18	8*	19	3*	12	5*	18
No-apply zones	5*	12	14*	34	15*	34	12*	23	16	19	6*	14	11	18
Required buffer strips	7*	21	13*	38	18*	44	13*	27	16	19	7*	21	10*	21
Re-entry restrictions	NA‡	24	NA	26	NA	29	NA	33	NA	40	NA	24	NA	27
Restricted amount/application	12*	24	19*	36	19	23	15*	32	25*	38	11*	21	11*	24
Mixing/loading	50	39*	29	19*	51	33*	45	33*	74	54*	43	23*	37	28
Application procedure	51	31*	56	30*	64	38*	58	41*	75	52*	54	27*	52	33*
Restricted total amount	15*	30	25*	47	30	33	17*	36	31*	46	15*	27	13*	28
Banned products	11*	27	24*	49	40*	62	17*	40	38	47	10*	22	21*	37
Posting/notification	62	50*	69	60*	78	68	55	44*	77	55*	59	42*	58	46*
Storage	54	48	52	47	69	58	64	57*	84	69*	69	54*	55	55
Record keeping	72	70	79	84	86	82	78	77	89	83	81	78	75	69

†Agronomic regions: NC, North Central; NE, Northeast; PAC, Pacific; SE, Southeast; SW, Southwest; TR, Transition; and UW, UpperWest/Mountain.
‡NA, Practices were surveyed only in 2015.
*Significant difference ($P < 0.10$) between 2007 and 2015.

Table 3. Percentage of 18-hole facilities reporting local government regulation (above and beyond federal regulations) of various pest management activities. For each region, regulations in 2007 were compared with those in 2015.

National Pollutant Discharge Elimination System

The National Pollutant Discharge Elimination System (NPDES) program is a hybrid federal/state program that requires a permit placing limits on the discharge of potential point source pollutants to "Waters of the United States" (WOTUS). In 2011, aquatic pesticide applications to WOTUS were included in this program. The permitting is administered by state governments in 44 states, and the U.S. Environmental Protection Agency retains oversight responsibilities in six states (6). In the 2015 survey, 4% of respondents (data not shown) said they had been required to physically obtain an NPDES pesticide general permit. Automatic permit coverage is provided in most states and with the EPA if aquatic pesticide applications fall under a threshold level.

WRITTEN PLANS

Written plans covering pesticide use include pesticide emergency response plans, integrated pest management (IPM) plans and pesticide application plans. These plans are adopted for the purposes of planning, communication, coordination and safety. Written plans need to be regularly updated in order to be considered viable. For this reason, it is helpful to understand how the use of written plans has changed since the 2007 survey.

Written integrated pest management plans

An IPM plan is a written, comprehensive document that contains the strategies and tactics that will be implemented to manage pests on the golf course. Golf course superintendents have several resources available when developing a written IPM plan, from those provided at a national level (9), to those provided by state university/extension programs or environmental organizations. IPM strategies and tactics include:

- Integration of cultural, biological and chemical controls as a means of minimizing hazards to humans and the environment
- Pest monitoring
- Pest identification
- Pest damage thresholds

The number of nine-hole and 18-hole facilities reporting the use of an IPM plan decreased significantly in 2015 (Table 4). Participation rates were 23% for facilities with nine holes, 34% for those with 18 holes and 43% for those with 27+ holes. This trend toward fewer IPM plans was observed in both public and private facilities, as well as in most agronomic regions (data not shown).

Of those reporting the use of written IPM plans, the majority (85%) of the plans were voluntary projects, either initiated by the superintendent or carried out in cooperation with a non-regulatory organization (such as a watershed protection or environmental organization).

What is responsible for the decrease in development of IPM plans? One possible cause is the downward shift in the U.S. economy that occurred after the 2007 survey was completed, and the concomitant downsizing of golf course maintenance budgets, which would have resulted in less time and fewer resources available for development of such plans. It is also the case that research, education and promotion of golf course turf IPM — by both universities and private organizations — has decreased since the 2007 survey, and as a result, less information and support are available for superintendents interested in this process. For example, a search of articles (in both peer-reviewed journals and trade publications) with "golf" and "IPM" or "golf" and "integrated pest management" in the titles revealed a 32% decrease in such articles appearing from 2000

% facilities with various written plans

	Facility type					
	9 holes		18 holes		27+ holes	
	% of facilities					
Plan type	2007	2015	2007	2015	2007	2015
IPM plan	34	23*	41	34*	39	43
Pesticide application plan	57	52	63	58*	67	74
Pesticide emergency response plan	36	44	50*	53	62	45
Either IPM plan or pesticide application plan	63	57	72	68*	76	81

*Significant difference ($P < 0.10$) between 2007 and 2015.

Table 4. Percentage of facilities with various written plans. For each golf course size (nine, 18 and 27+ holes), plan types in 2007 were compared with those in 2015.

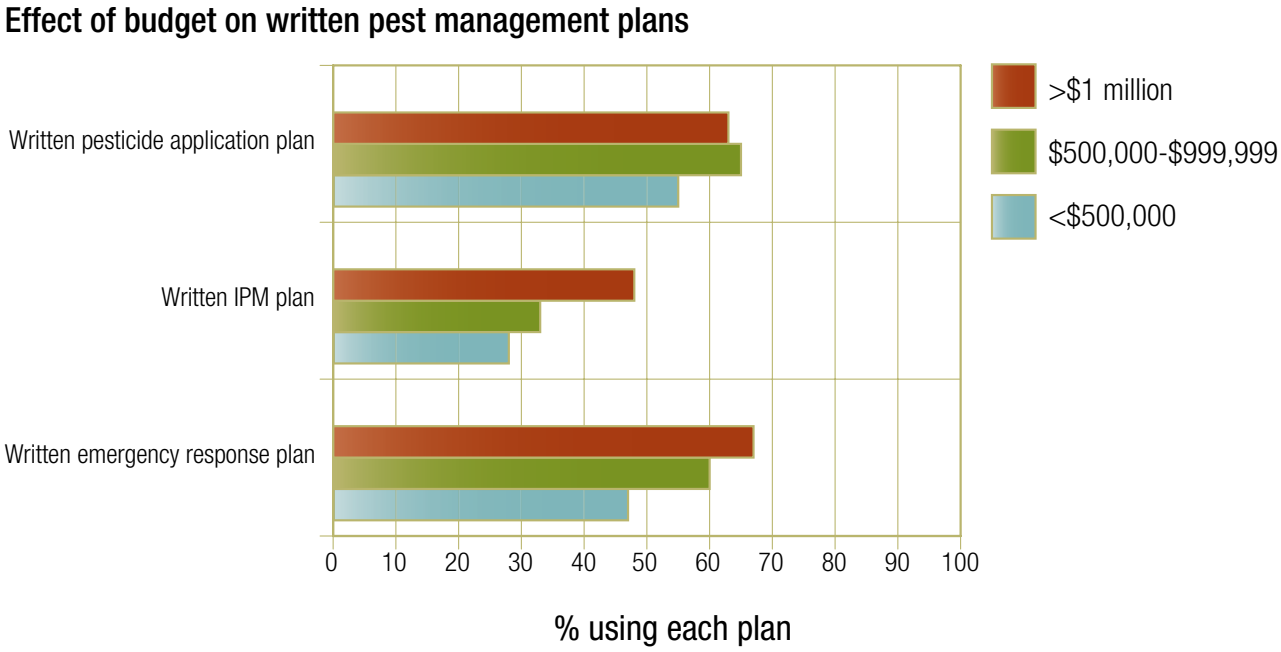


Figure 4. Effect of golf facility annual budget on the development of written pest management plans for all golf facilities, 2015.

to 2007 (221 articles) versus 2008 to 2015 (150 articles) (25).

Written pesticide application plans

Pesticide application plans are written documents that list all pesticide applications (and may include nutrient and plant growth regular applications as well) planned for the year. These plans are used by superintendents for multiple purposes, including the development of budgets, staffing plans and product ordering. A golf facility may have a written pesticide application plan that works in conjunction with a written IPM plan. Although these facilities may develop and use both types of plans, some may use one or the other, or neither. The percentage of facilities with either an IPM Plan or a Pesticide Application Plan was 57%, 68% and 81%, for facilities with nine, 18 and 27+ holes, respectively.

Pesticide application plans were the most frequently used written plan, with 52% of facilities with nine holes, 58% of those with 18 holes and 74% of those with 27+ holes having a written pesticide application plan. The decline in their use at nine- and 18-hole facilities since 2007 (Table 4) may be due to the same economic and educational factors discussed previously for IPM plans. The reasons given for development of these plans were similar to those provided for IPM plans, with voluntary projects comprising 85% of all reported plans.

Written pesticide emergency response plans

Written pesticide emergency response plans are designed to prepare the staff to effectively respond if an accident should occur within the pesticide operation or the pesticide storage area. The use of these plans did not change significantly from 2007 to 2015 (Table 4), with 44% participation for facilities with nine holes, 53% for those with 18 holes, and 45% for those with 27+ holes.

Role of budget and facility size

In general, golf courses with larger budgets and/or more holes were more likely to have written pest management plans of all types than those with lower budgets or smaller courses (Figure 4, Table 4). This is likely due to the added labor involved in developing and administering the plan and keeping it up-to-date.

PESTICIDE HANDLING

Pesticide mixing and loading

A mixing and loading station is a dedicated area where pesticides are measured, mixed and loaded into application equipment. These stations should be designed with safety features that protect humans from exposure during mixing and loading, and protect the environment from potential contamination. Although specific regulatory requirements for mixing and loading areas vary from state to state, some of the most commonly recommended features include floors or pads with impervious surfaces and overhead enclosures to prevent the spread of pesticide residue through rainfall.

% facilities with each property of mixing and loading areas

	Facility size					
	9 holes		18 holes		27+ holes	
	% of facilities					
Properties	2007	2015	2007	2015	2007	2015
Stand-alone pesticide mixing tank	12	8	14*	17	17	14
Collection of pesticide rinsate	11	16	26	27	35	27
Roof to protect from weather	22	18	29	30	35	36
Floor contains liquid spills	27	26	35	33	50	54
Water fill capacity > 50 gallons/minute	13	18	35	33	37	38
Emergency shut-off valve	23*	32	44	39*	44	44
Recycle pesticide containers	32	34	36*	39	42	43
Impervious floor	27	26	44	41*	50	54
Anti-siphon device on water line	44	47	56	54	56	53
Spill kit near mix/load area	37	39	60*	64	69	69

*Significant difference ($P < 0.10$) between 2007 and 2015.

Table 5. Percent of facilities with each property of mixing and loading areas. For each golf course size (nine, 18 and 27+ holes), mixing/loading properties in 2007 were compared with those in 2015.

Effect of budget on properties of pesticide mixing/loading areas

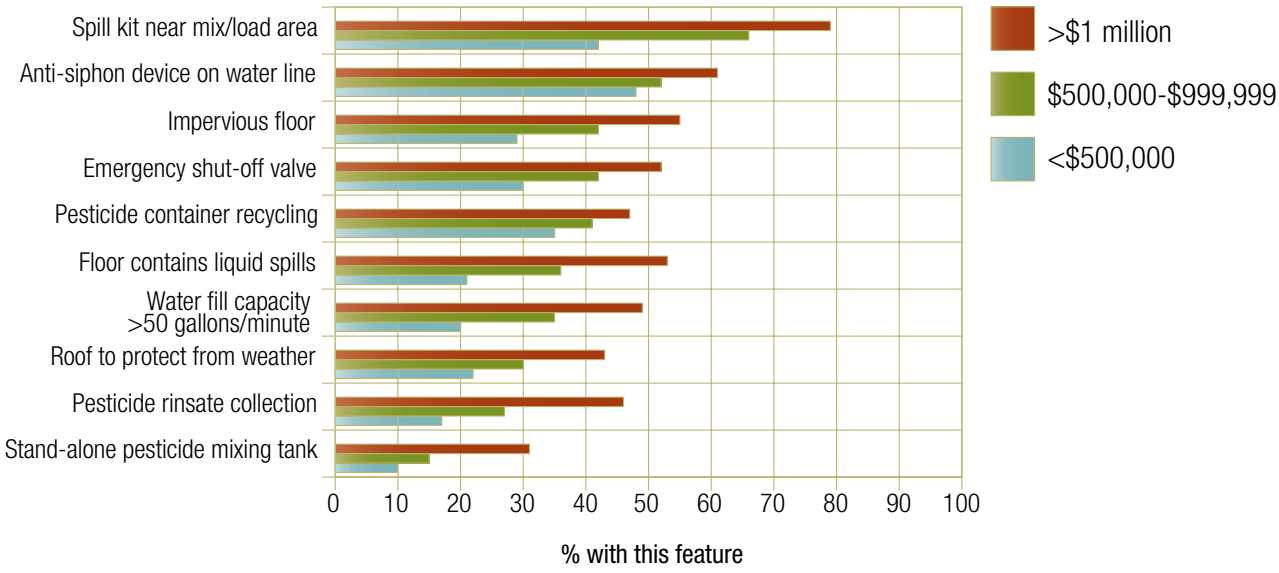


Figure 5. Effect of golf facility annual budget on the properties of pesticide mixing and loading areas for all golf facilities, 2015.

Only small changes in the attributes of mixing and loading areas have occurred since 2007 (Table 5). The most common features were anti-siphoning devices on the water line and the nearby location of spill kits. Anti-siphon functions can also be filled via air gaps between the fill line and the mixing or spray tank. This option wasn't provided to respondents, however. For this reason, the actual percentage of facilities with anti-siphoning functions is probably higher than the values shown in Table 5. For the future, the industry should focus on increasing the number of facilities with a roof or overhead enclosure and with floors that are either impervious or contain liquid spills.

% facilities with each property of pesticide storage facilities

	Facility size					
	9 holes		18 holes		27+ holes	
	% of facilities					
Properties	2007	2015	2007	2015	2007	2015
Explosion proof fixtures	13	12	31	29	37	35
Impervious shelving	32	29	51	46*	53	52
Passive venting	57	45	57	48*	59	55
Powered venting	20	24	50	52	54	59
Separate, dedicated building	33	37	53	55	53	57
Floor contains liquid spills	43	39	63	63	67	71
Impervious floor	55	45*	67	64*	76	71
Spill kit nearby	41	42	67	69	76	77
Emergency shower/eyewash nearby	47	49	73	71	78	75
Sign indicating pesticide storage	64	61	84*	87	89	90
Locked or restricted access	82	85	93	92	96	93

*Significant difference ($P < 0.10$) between 2007 and 2015.

Table 6. Percentage of facilities with each property of pesticide storage facilities. For each golf course size nine, 18 and 27+ holes), storage facility properties in 2007 were compared with those for 2015.

Role of budget and golf course size in the properties of mixing and loading areas

Larger facilities consistently reported greater use of mixing and loading features (Table 5). A golf facility's annual budget was also clearly and directly related to the attributes of its mixing and loading stations (Figure 5). For example, fewer than 30% of facilities with annual budgets below $500,000 had some of the most basic safety requirements, such as overhead enclosures and floors with impervious surfaces. In contrast, among facilities with annual budgets greater than $1 million, 55% had floors with impervious surfaces and 43% had overhead enclosures. This data indicates that facilities with smaller golf courses and/or lower budgets will continue to be inhibited from adopting many of these attributes.

Pesticide storage facilities

The large majority of respondents in both 2007 (97%) and 2015 (99%) stored pesticides on-site. The most common features reported in both years were, in descending order: locked or restricted access; signage indicating pesticides are stored inside; emergency shower or eyewash located nearby; spill kit near storage area; impervious floor or flooring that contains liquid spills; use of a separate, dedicated building; and use of powered venting (Table 6).

The primary purpose of pesticide storage facilities is to contain pesticide products in case of accidents, so that both humans and the environment are protected. Such facilities should be secure, dry, well lit, well ventilated and protected from extreme weather. Although specific regulatory requirements for pesticide storage vary from one state to another, some of the most commonly recommended features include impervious shelving and flooring, locked or restricted access and easy access to emergency eyewash and spill kits. Because these features should be present in all pesticide storage facilities, improvements are needed in the number of facilities that adopt these features.

Since 2007 the frequency of adoption of most storage features has increased only slightly (Table 6). This may be a function of the recession in the years since 2007, and the concomitant lack of investment in high-cost features when new facilities were being built.

Role of budget and golf course size in the properties of pesticide storage facilities

As seen for mixing and loading features, greater use of storage features is consistently reported for larger facilities (Table 6). The attributes of a facility's pesticide storage facilities were also clearly and directly related to its annual budget. Some of the largest discrepancies between facilities with large budgets and those with smaller budgets were in the use of a separate, dedicated building for pesticide storage, impervious shelving, powered venting, and the use of explosion-proof fixtures (Figure 6). These trends suggest that facilities with smaller golf courses and/or lower budgets will continue to be inhibited from adopting many of these attributes.

Effect of budget on properties of pesticide storage facilities

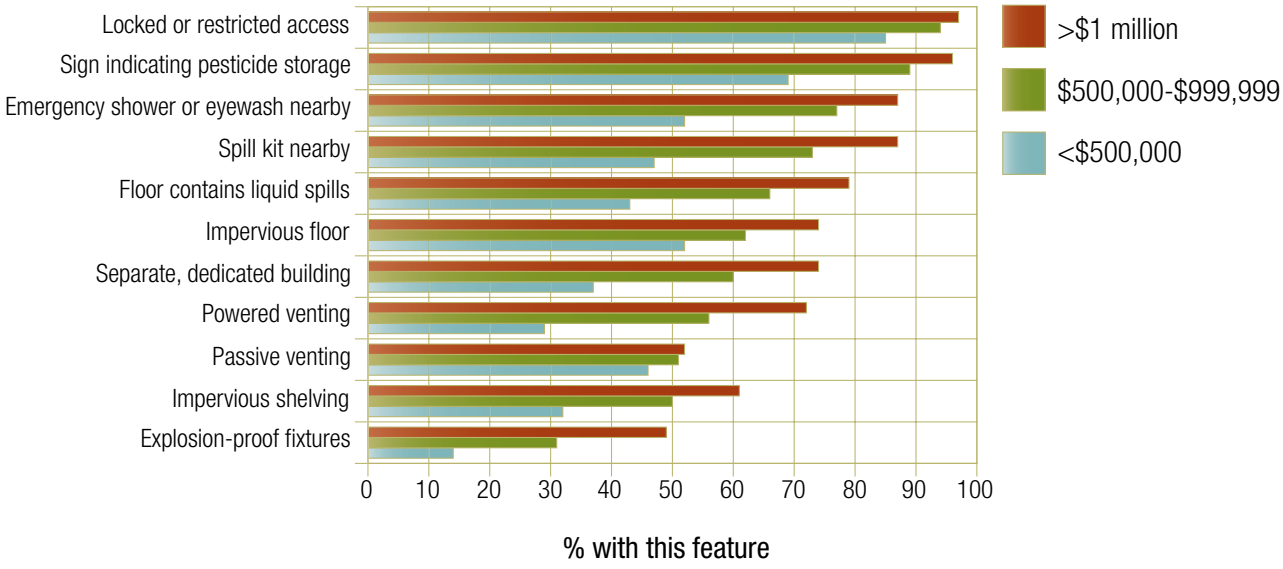


Figure 6. Effect of golf facility annual budget on properties of pesticide storage facilities, for all golf facilities, 2015.

North Central region: Change in reliance on various pesticide practices

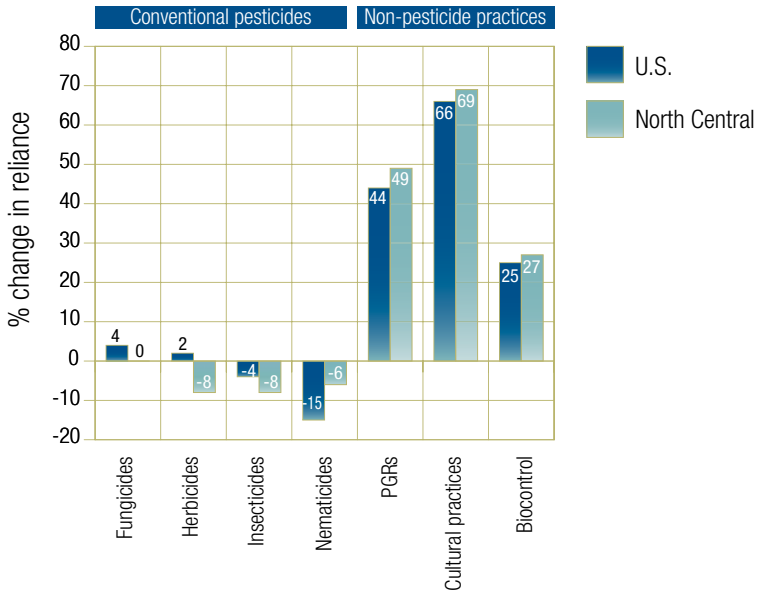


Figure 7. Percent change in reliance by 18-hole facilities in the North Central region on various pest management practices over the past several years. Values were determined by subtracting the percentage reporting decreased reliance from the percentage reporting increased reliance on each pest management practice.

Regional Trends

North Central region

Changes in pest management strategies

Changes in reliance on different pest management strategies in the North Central region were similar to those seen in the U.S. overall (Figure 7). Dependence on conventional pesticides slightly decreased over the past several years, while use of non-pesticide practices increased dramatically.

State and local government regulation

Golf facilities in the North Central region reported fewer state and local regulations than those in the U.S. as a whole. The most heavily regulated activities included record keeping, posting/notification and pesticide storage (Figure 8).

Storage facilities

Golf facilities in the North Central region tended to incorporate fewer attributes of pesticide storage facilities than those in the U.S. overall. The most frequently cited attributes used included locked/restricted access, signs indicating pesticides are stored inside, and an emergency shower or eyewash (Figure 9).

North Central region: Local government regulation

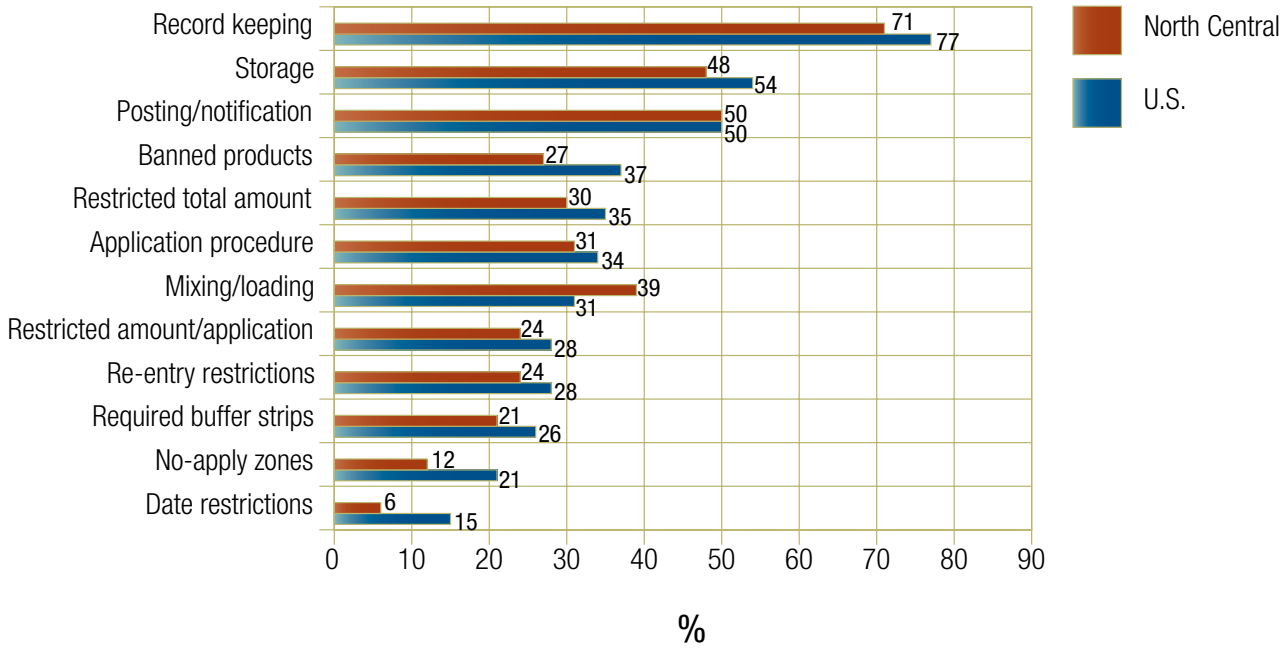


Figure 8. Percentage of 18-hole facilities in the North Central region reporting local government regulation (above and beyond federal regulations) of various pest management activities in 2015.

Pesticide mixing and loading stations

Golf facilities in the North Central region tended to incorporate more attributes of mixing and loading stations than those in the U.S. as a whole. The most frequently cited attributes included spill kits near the mixing and loading area, anti-siphon devices on the water line, and impervious floors (Figure 10).

North Central region: Properties of pesticide storage facilities

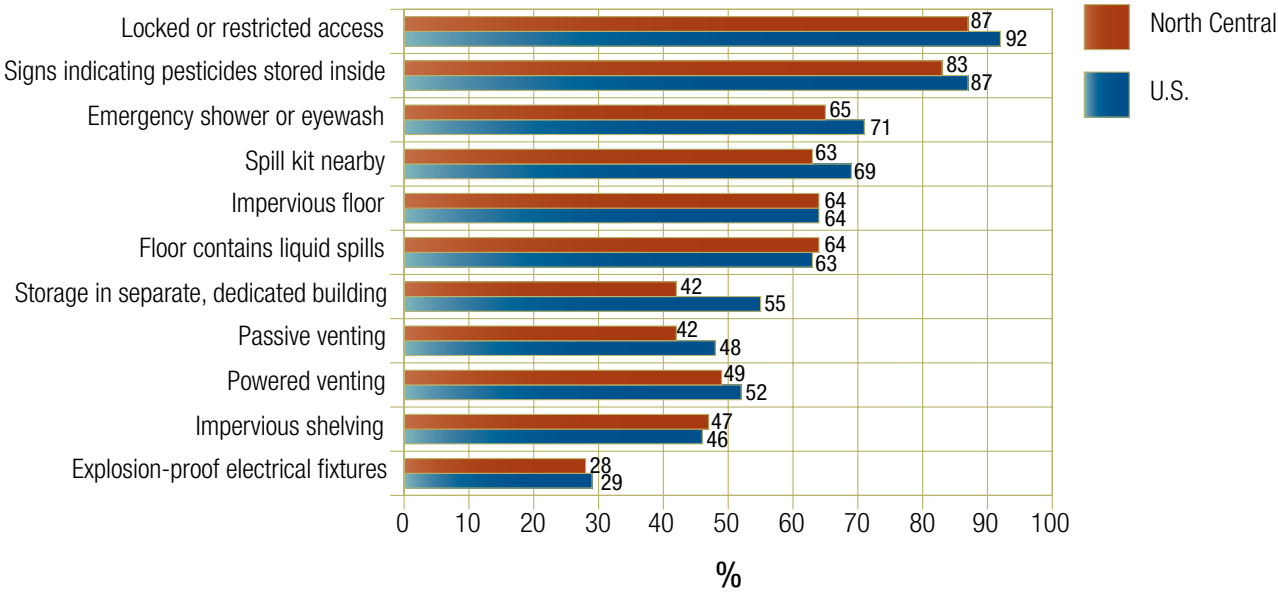


Figure 9. Percentage of 18-hole golf facilities in the North Central region that have each of the properties of pesticide storage facilities.

North Central region: Properties of mixing/loading areas

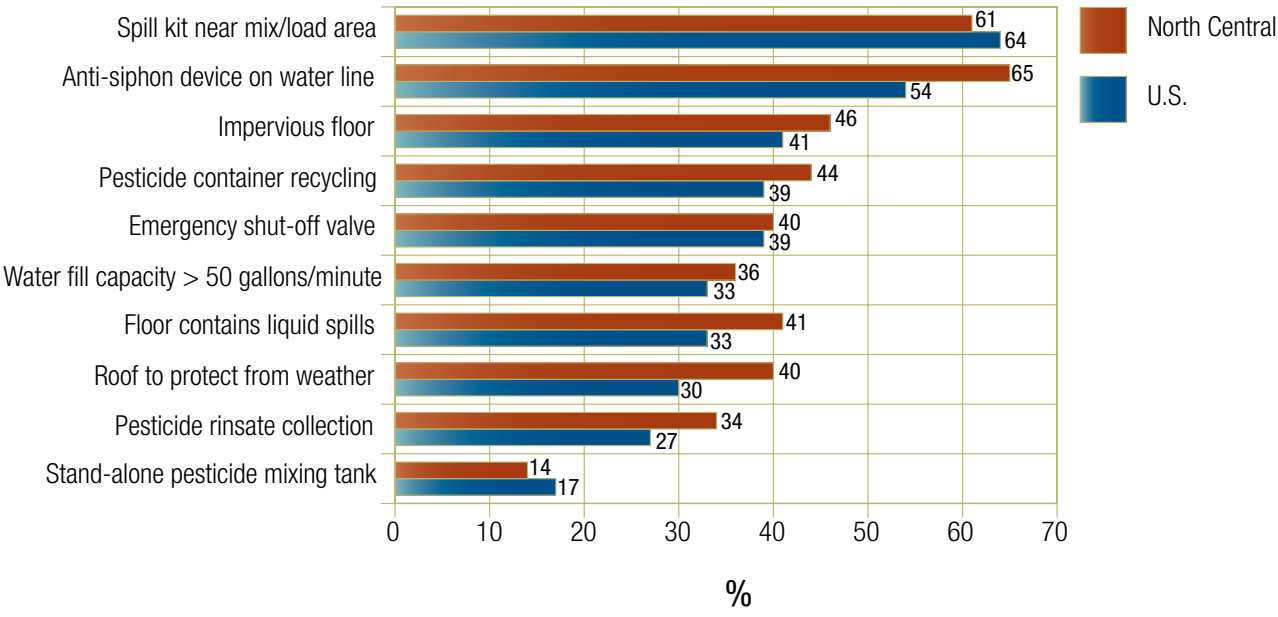


Figure 10. Percentage of 18-hole facilities in the North Central region with each property of mixing and loading areas.

Northeast region: Change in reliance on various pesticide practices

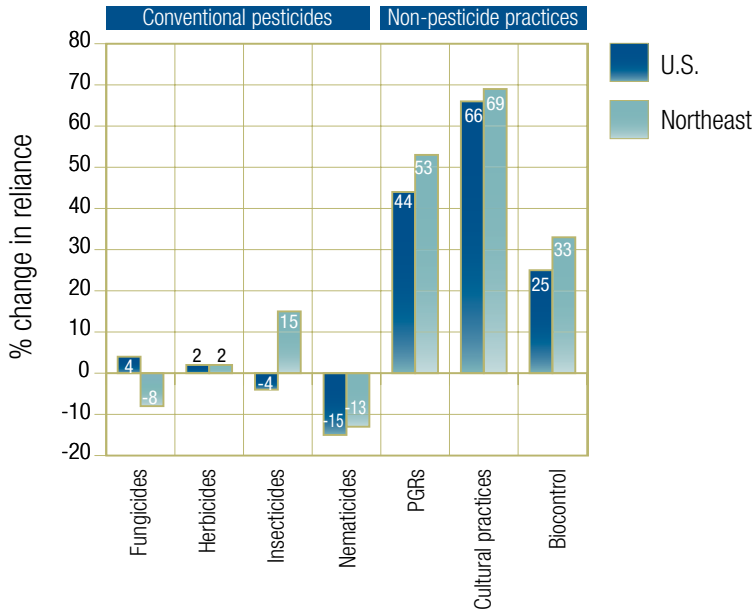


Figure 11. Percent change in reliance by 18-hole facilities in the Northeast region on various pest management practices over the past several years. Values were determined by subtracting the percentage reporting decreased reliance from the percentage reporting increased reliance on each pest management practice.

Northeast region

Changes in pest management strategies

Changes in reliance on different pest management strategies in the Northeast region were somewhat different than elsewhere (Figure 11). For conventional pesticides, Northeast region facilities reported the largest reduction in reliance on fungicides, but also the largest increase in reliance on insecticides, when compared to the U.S. as a whole and to all other regions. For non-pesticide practices, the Northeast region showed the greatest increase in use of biological control and PGRs when compared to all other regions.

State and local government regulation

Golf facilities in the Northeast region reported a higher frequency of state and local regulations than those in the U.S. overall. The most heavily regulated activities included record keeping, posting/notification and banning of products (Figure 12).

Storage facilities

Golf facilities in the Northeast region tended to incorporate more attributes of pesticide storage facilities than those in the U.S. overall. The most frequently reported attributes were: locked/restricted access, signs indicating pesticides are stored inside, spill kit nearby, and a floor that contains liquid spills (Figure 13).

Northeast region: Local government regulation

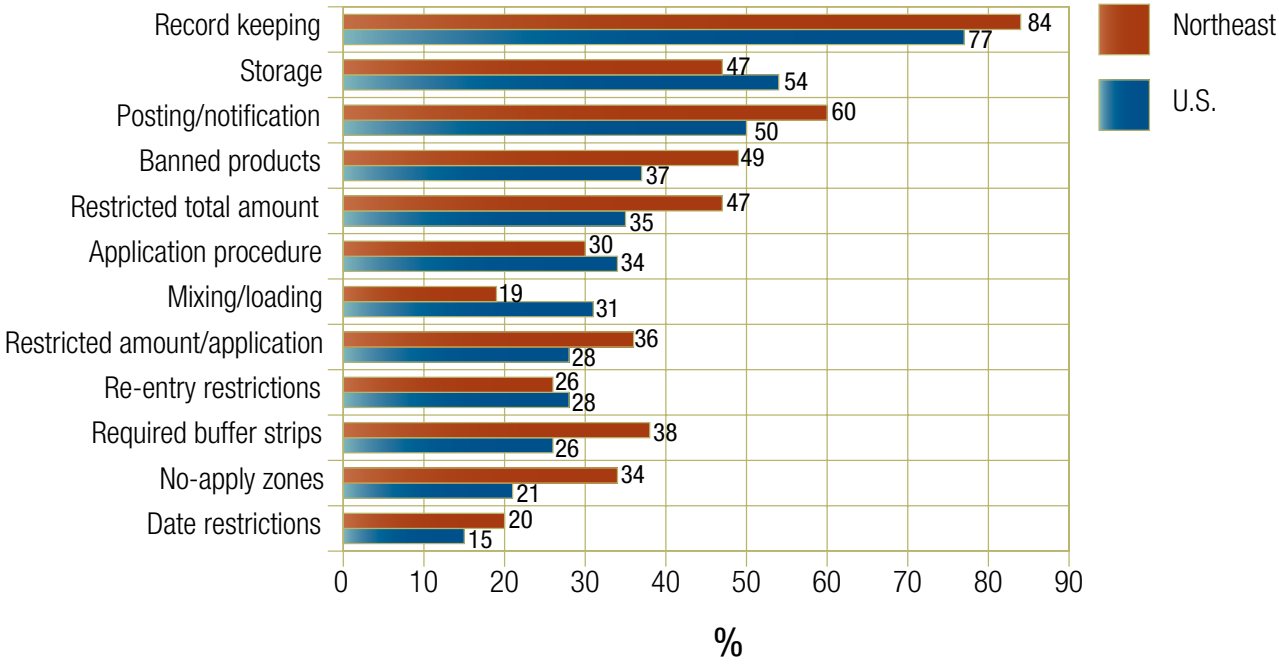


Figure 12. Percentage of 18-hole facilities in the Northeast region reporting local government regulation (above and beyond federal regulations) of various pest management activities in 2015.

Pesticide mixing and loading stations

Golf facilities in the Northeast region tended to incorporate roughly the same types of attributes of mixing and loading stations as those in the U.S. as a whole. The most frequently cited attributes were: spill kits near the mixing and loading area, anti-siphon devices on the water line, and emergency shut-off valves (Figure 14).

Northeast region: Properties of pesticide storage facilities

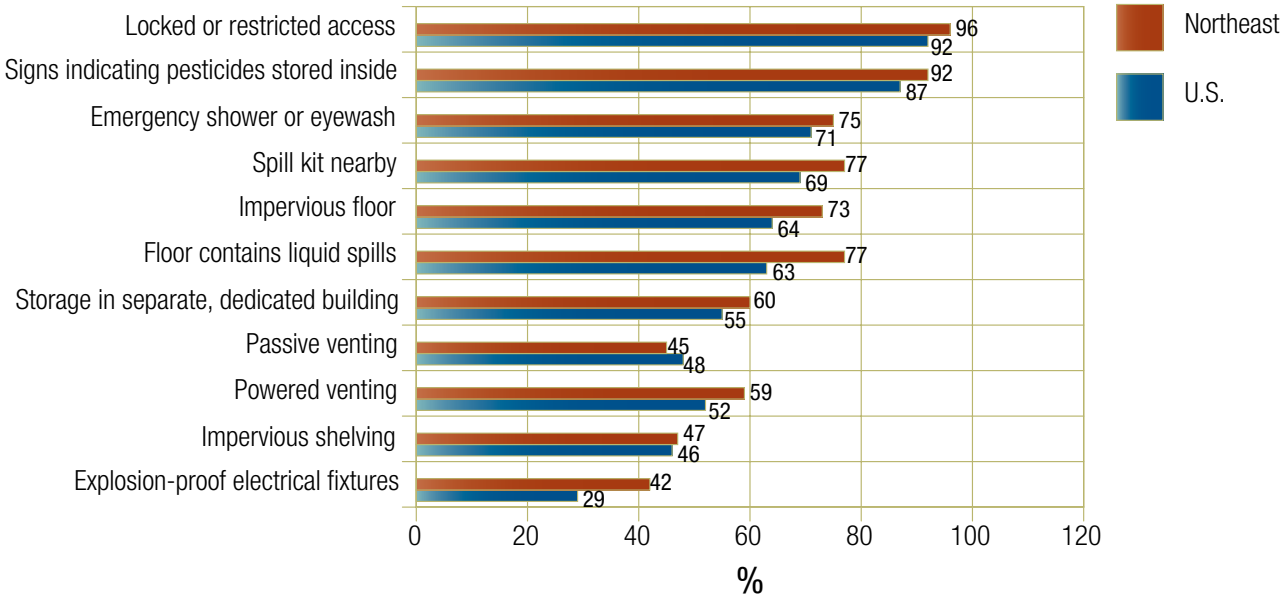


Figure 13. Percent of 18-hole golf facilities in the Northeast region with each property of pesticide storage facilities.

Northeast region: Properties of mixing and loading areas

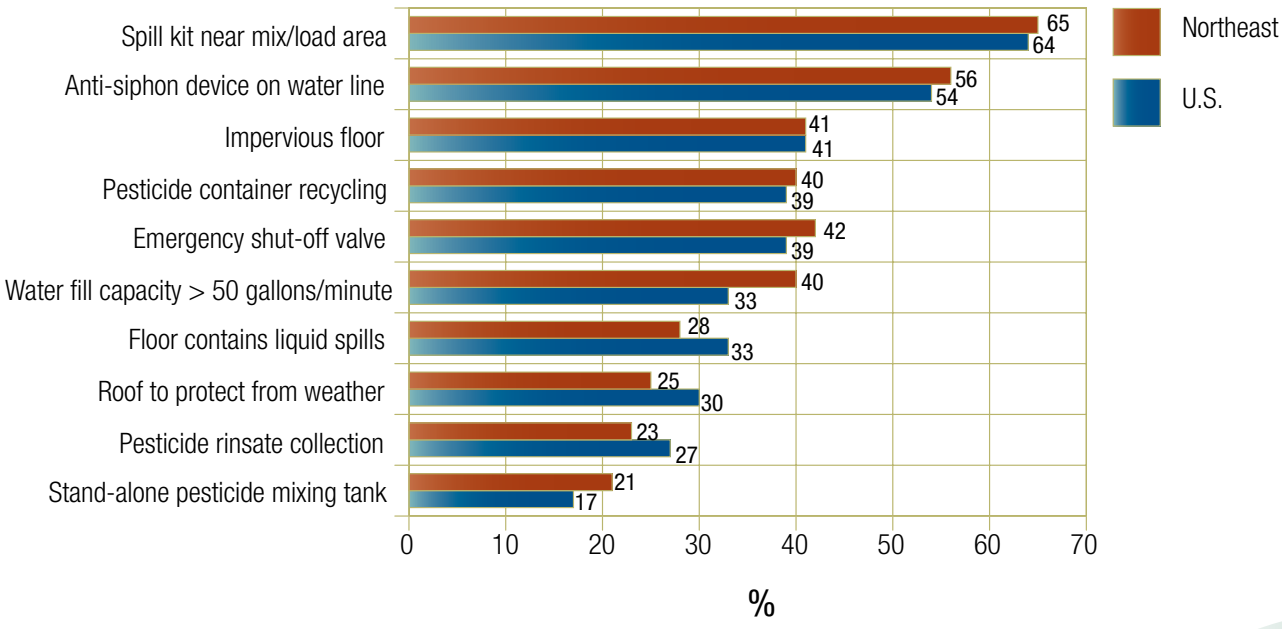


Figure 14. Percent of 18-hole facilities in the Northeast region with each property of mixing and loading areas.

Pacific region:
Change in reliance on various pesticide practices

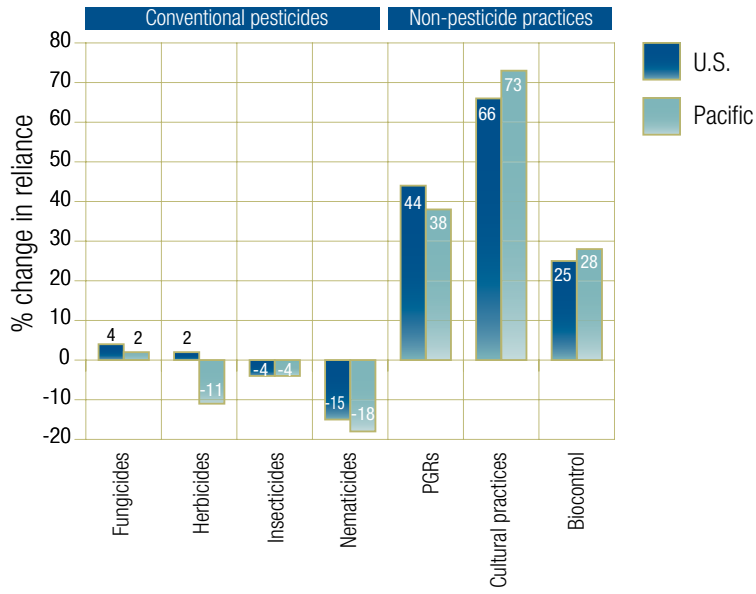


Figure 15. Percent change in reliance by 18-hole facilities in the Pacific region on various pest management practices over the past several years. Values were determined by subtracting the percentage reporting decreased reliance from the percentage reporting increased reliance on each pest management practice.

Pacific region

Changes in pest management strategies

Changes in reliance on pest management strategies in the Pacific region were somewhat different than those seen in the U.S. overall (Figure 15). For conventional pesticides, Pacific region facilities indicated the greatest decrease in reliance on herbicides and nematicides when compared to all other regions. And for non-pesticide practices, the Pacific region cited the greatest increase in use of cultural control practices when compared to all other regions.

State and local government regulation

Golf facilities in the Pacific and Southwest regions reported the highest frequencies of state and local regulations compared to other regions. The most heavily regulated activities in the Pacific region included record keeping, posting/notification, and banned products (Figure 16).

Storage facilities

Golf facilities in the Pacific region tended to incorporate more attributes of pesticide storage facilities than those in the U.S. as a whole. The most frequently cited attributes were: locked/restricted access, signs indicating pesticides are stored inside, and emergency shower or eyewash (Figure 17).

Pacific region: Local government regulation

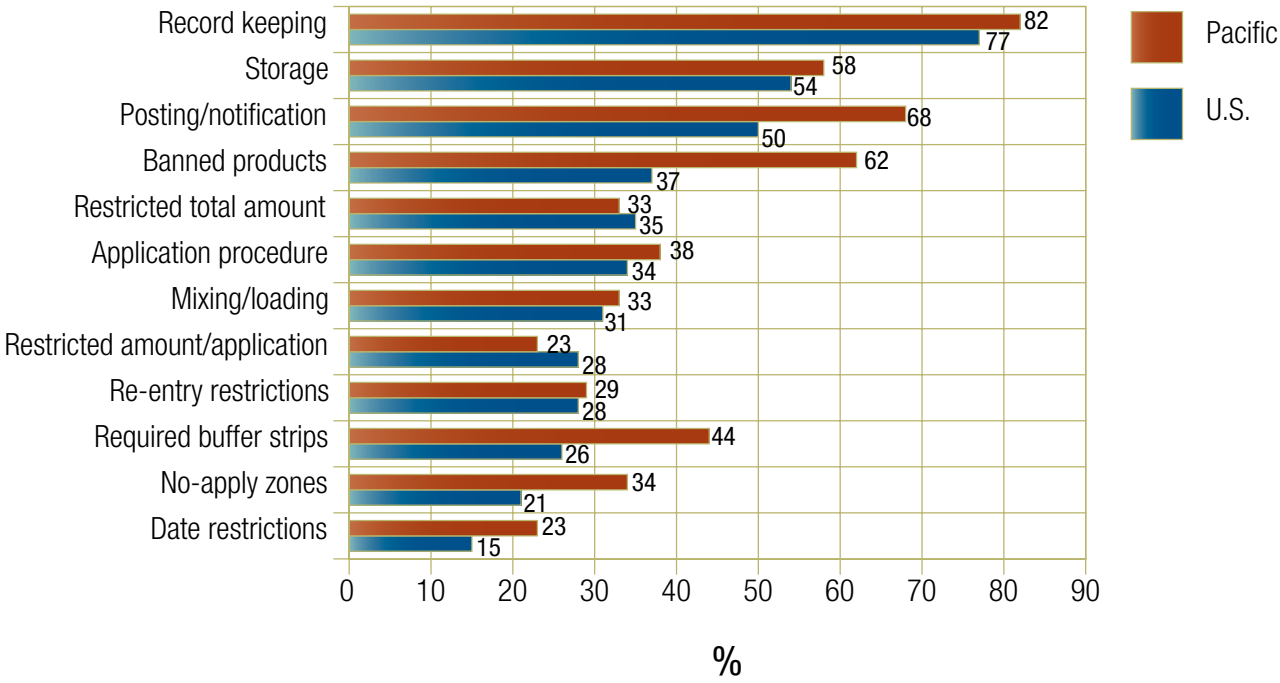


Figure 16. Percentage of 18-hole facilities in the Pacific region reporting local government regulation (above and beyond federal regulations) of various pest management activities in 2015

Pesticide mixing and loading stations

Golf facilities in the Pacific region incorporated spill kits near the mixing and loading area and recycling of pesticide containers at much higher frequencies than facilities in other regions. In most other respects, the Pacific region golf facilities mirrored those in the rest of the country. (Figure 18).

Pacific region: Properties of pesticide storage facilities

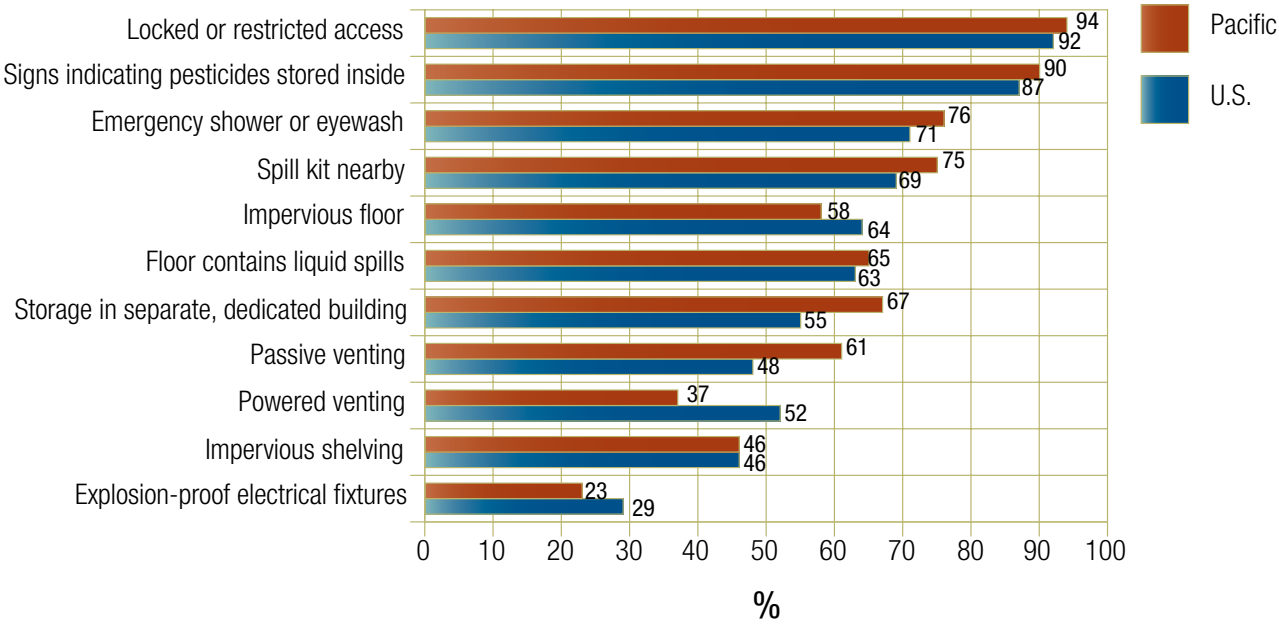


Figure 17. Percentage of 18-hole golf facilities in the Pacific region with each property of pesticide storage facilities.

Pacific region: Properties of mixing and loading areas

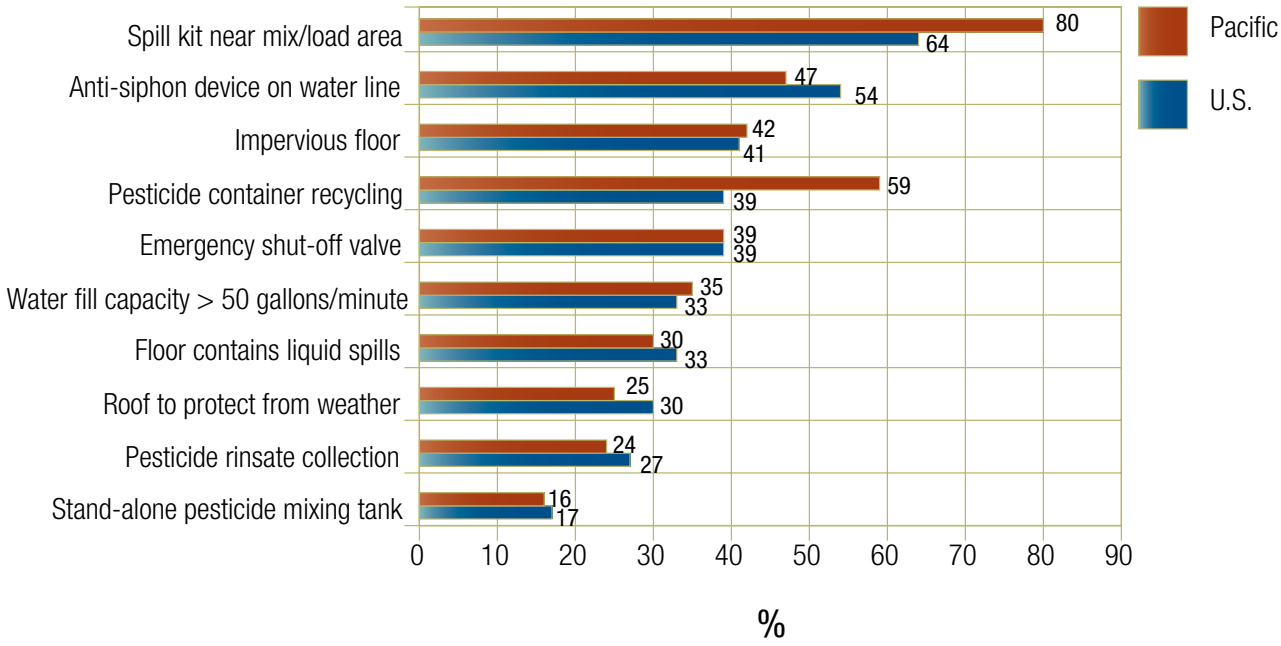


Figure 18. Percentage of 18-hole facilities in the Pacific region with each property of mixing and loading areas.

Southeast region: Change in reliance on various pesticide practices

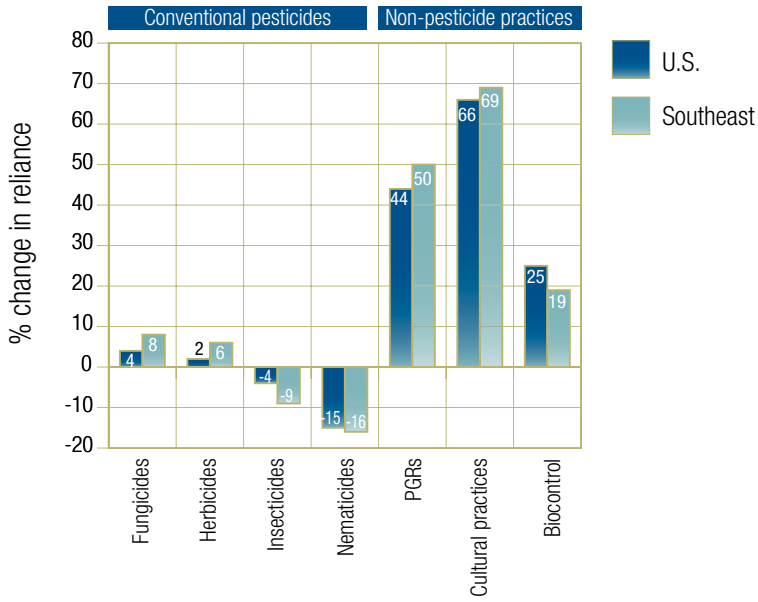


Figure 19. Percent change in reliance by 18-hole facilities in the Southeast region on various pest management practices over the past several years. Values were determined by subtracting the percentage reporting decreased reliance from the percentage reporting increased reliance on each pest management practice.

Southeast region

Changes in pest management strategies

The Southeast region reported less use of insecticides than the U.S. overall, but otherwise closely mirrored the nation, with large reductions in nematicide use and large increases in the use of cultural practices and PGRs (Figure 19).

State and local government regulation

Frequency of state and local regulations in the Southeast region were reported to be similar to that of the U.S. as a whole. The most heavily regulated activities included record keeping, storage, and posting/notification (Figure 20).

Storage facilities

Golf facilities in the Southeast region tended to incorporate more attributes of pesticide storage facilities compared to the country overall. The most frequently cited attributes used included locked/restricted access, signs indicating pesticides are stored inside, and emergency shower or eyewash (Figure 21).

Southeast region: Local government regulation

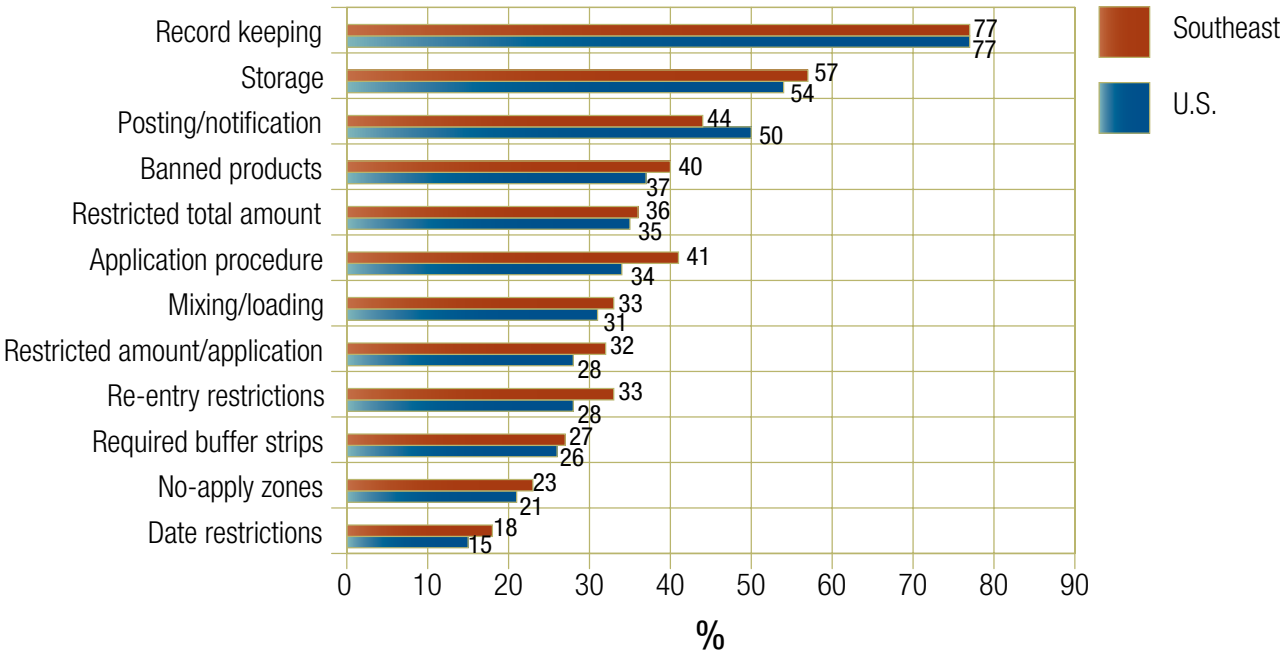


Figure 20. Percentage of 18-hole facilities in the Southeast region reporting local government regulation (above and beyond federal regulations) of various pest management activities in 2015.

Pesticide mixing and loading stations

Golf facilities in the Southeast region tended to incorporate more attributes of mixing and loading than those in the U.S. overall. The most frequently cited attributes were: spill kits near the mixing and loading area, anti-siphon devices on the water line, and emergency shut-off valves (Figure 22).

Southeast region: Properties of pesticide storage facilities

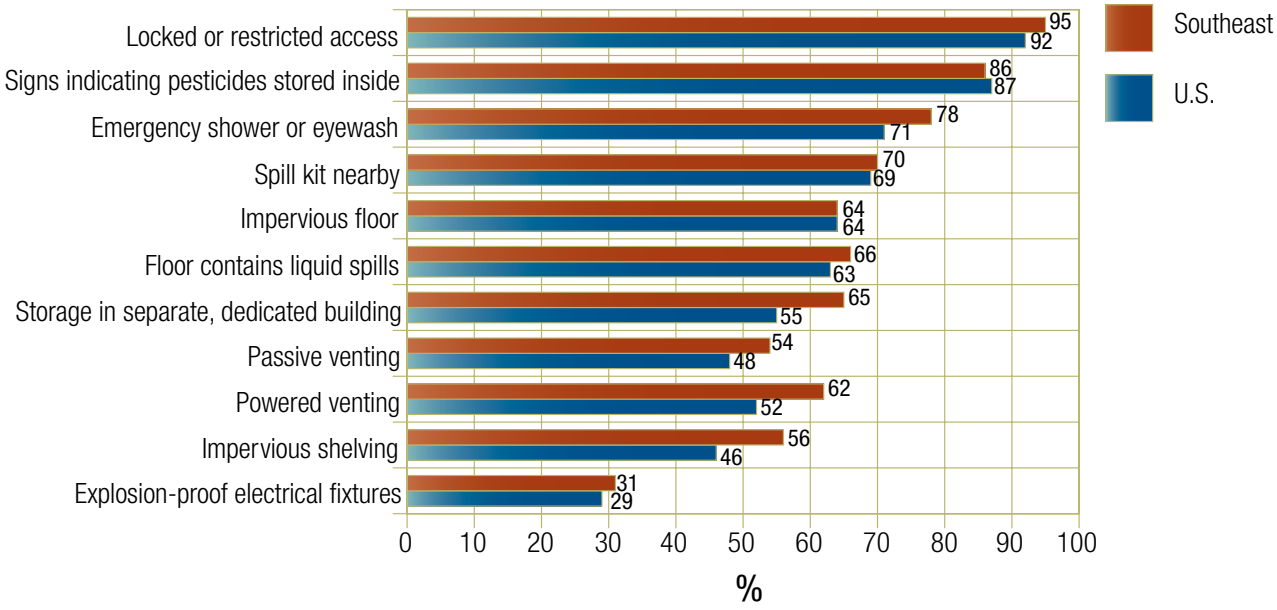


Figure 21. Percentage of 18-hole golf facilities in the Southeast region with each property of pesticide storage facilities.

Southeast region: Properties of mixing and loading areas

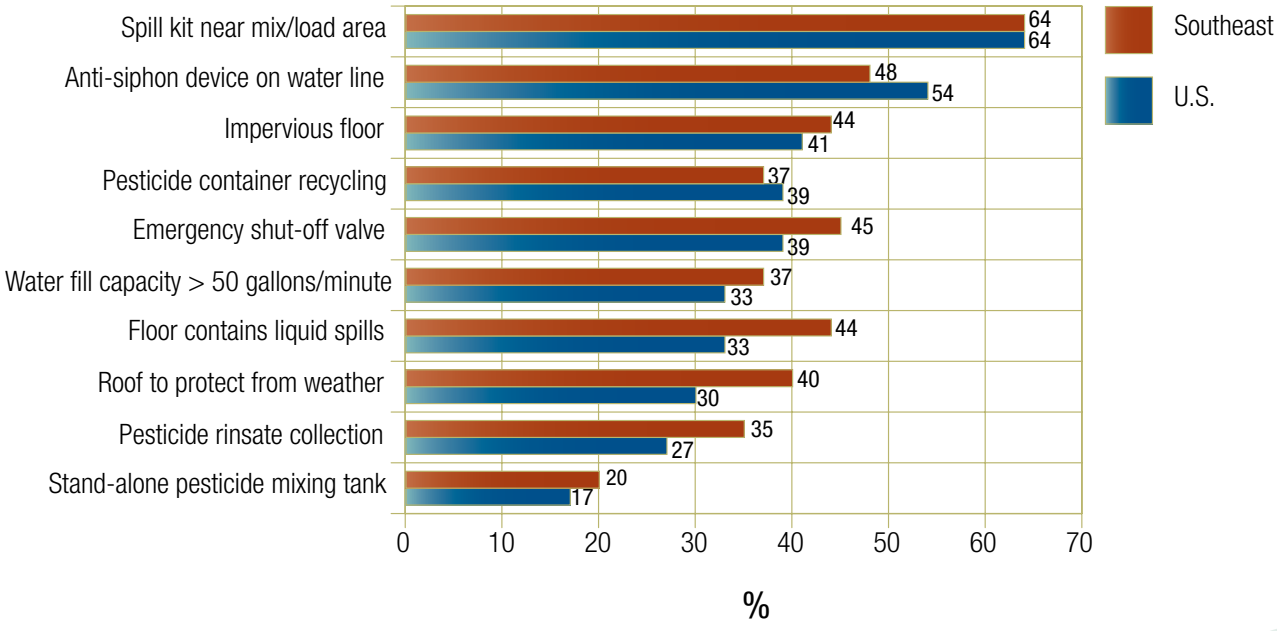


Figure 22. Percentage of 18-hole facilities in the Southeast region with each property of mixing and loading areas.

Southwest region: Change in reliance on various pesticide practices

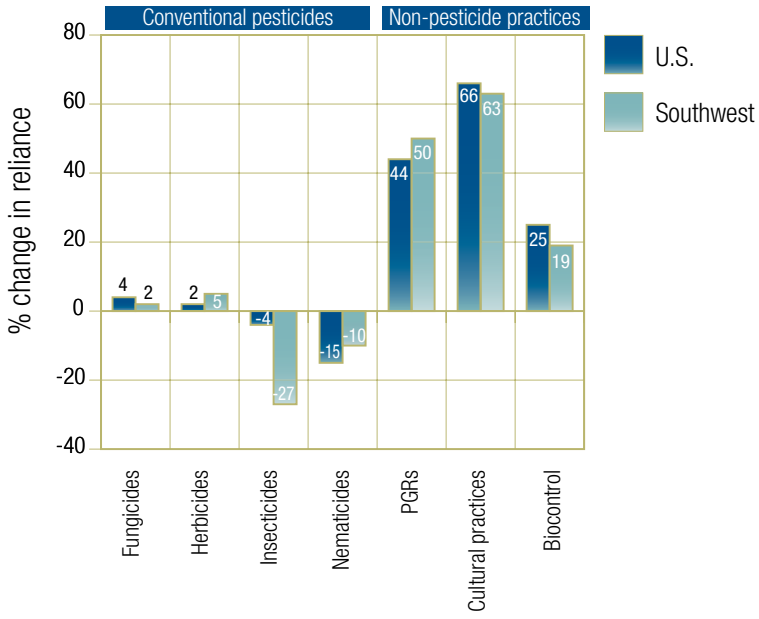


Figure 23. Percent change in reliance by 18-hole facilities in the Southwest region on various pest management practices over the past several years. Values were determined by subtracting the percentage reporting decreased reliance from the percentage reporting increased reliance on each pest management practice.

Southwest region

Changes in pest management strategies

Changes in reliance on different pest management strategies in the Southwest region closely mirrored those in the U.S. overall (Figure 23), with one exception. A marked decrease in reliance on insecticides in the region was the greatest reduction in use of these products nationwide.

State and local government regulation

Golf facilities in the Southwest and Pacific regions reported more state and local regulations than the other regions. The most heavily regulated activities for the Southwest included record keeping, storage, and posting/notification (Figure 24).

Storage facilities

Golf facilities in the Southwest region tended to incorporate more attributes of pesticide storage facilities than those in the U.S. as a whole. The most frequently cited attributes were: locked/restricted access, signs indicating pesticides are stored inside, and emergency shower or eyewash (Figure 25).

Southwest region: Local government regulation

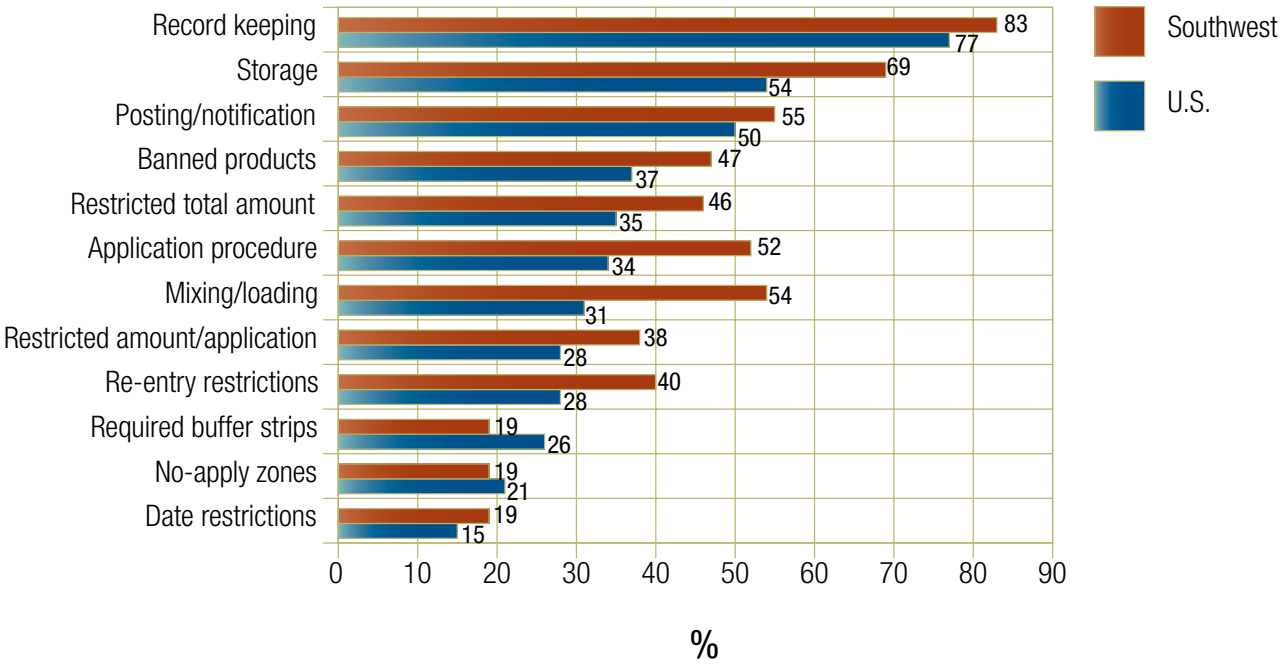


Figure 24. Percentage of 18-hole golf facilities in the Southwest region reporting local government regulation (above and beyond federal regulations) of various pest management activities in 2015.

Pesticide mixing and loading stations

In the Southwest region, golf facilities tended to incorporate more attributes of mixing and loading stations than those in the U.S. overall. The most frequently reported attributes were: spill kits near the mixing and loading area, anti-siphon devices on the water line, and emergency shut-off valves (Figure 26).

Southwest region: Properties of pesticide storage facilities

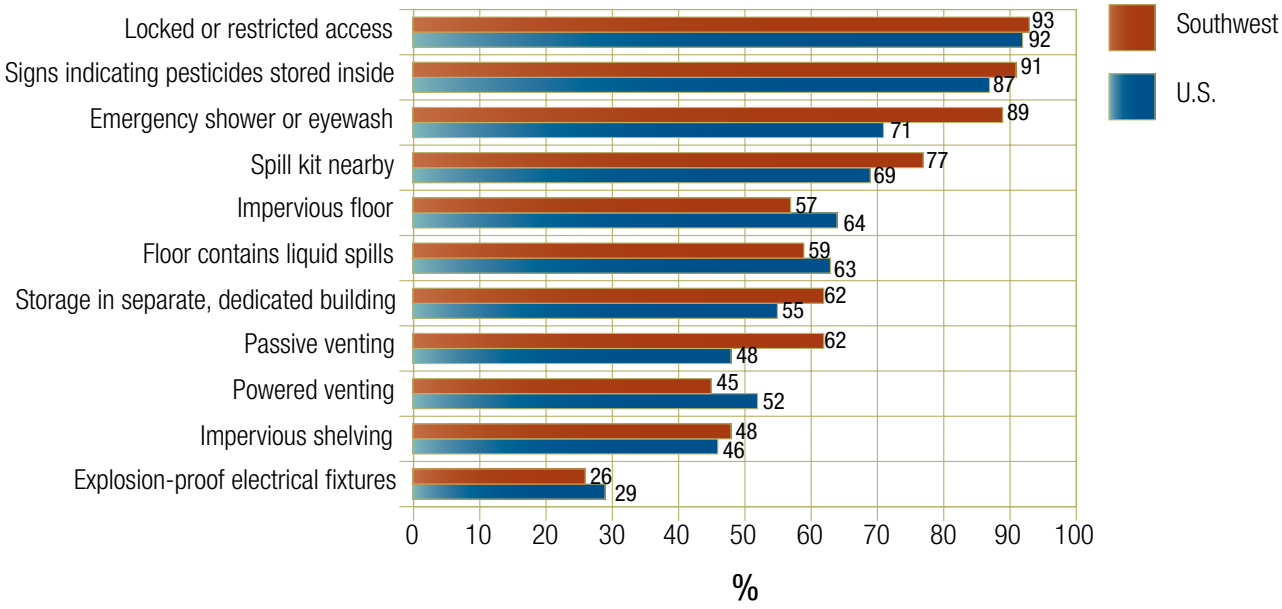


Figure 25. Percentage of 18-hole golf facilities in the Southwest region with each property of pesticide storage facilities.

Southwest region: Properties of mixing and loading areas

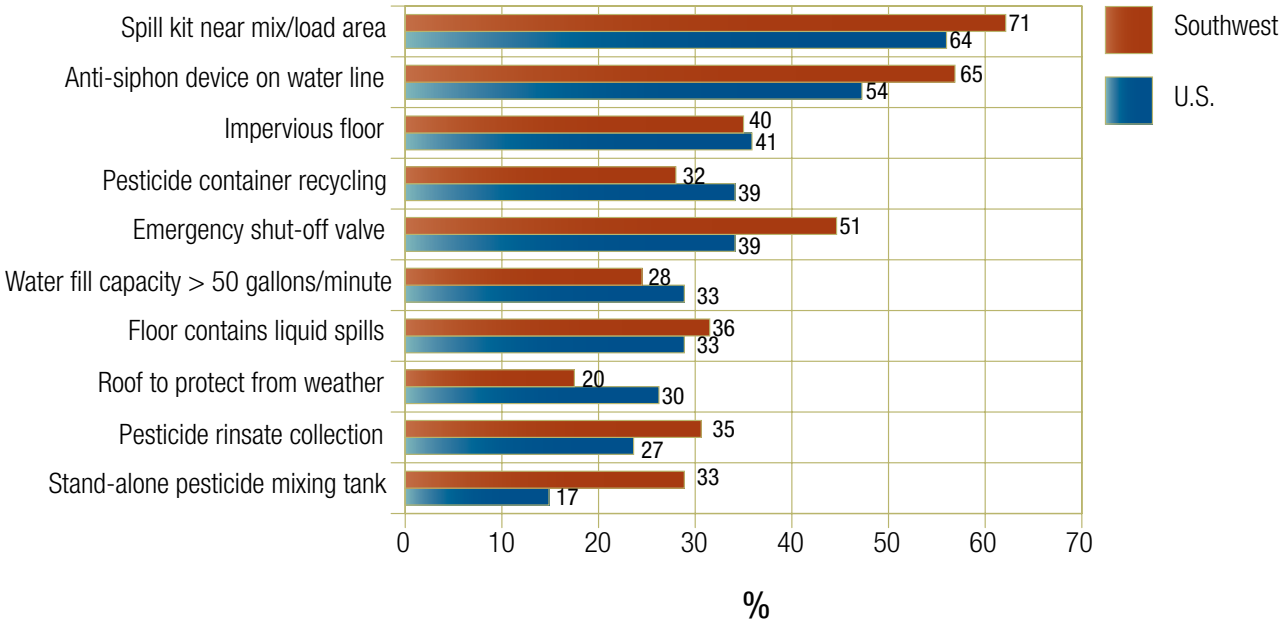


Figure 26. Percentage of 18-hole golf facilities in the Southwest region with each property of mixing and loading areas.

Transition region: Change in reliance on various pesticide practices

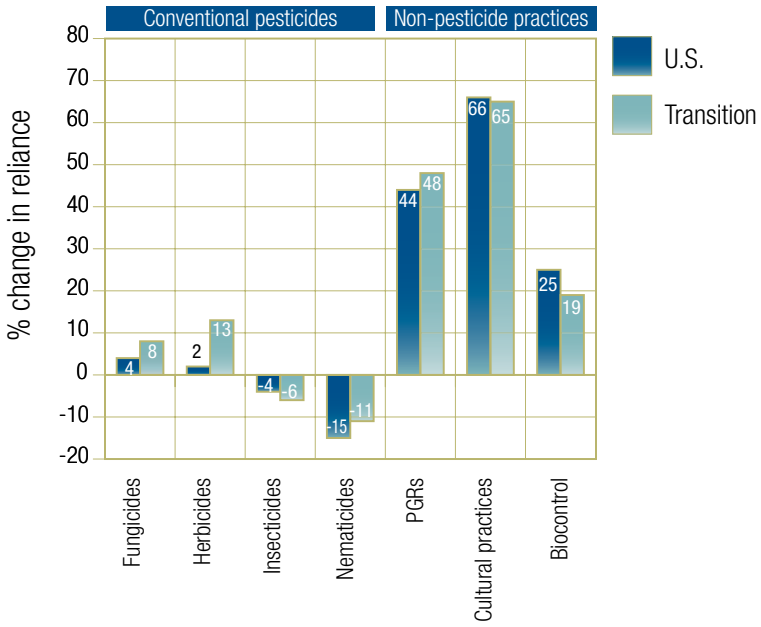


Figure 27. Percent change in reliance by 18-hole facilities in the Transition region on various pest management practices over the past several years. Values were determined by subtracting the percentage reporting decreased reliance from the percentage reporting increased reliance on each pest management practice.

Transition region

Changes in pest management strategies

Changes in reliance on different pest management strategies in the Transition region closely mirrored those in the U.S. overall (Figure 27), with one exception. The Transition region cited a greater increase in herbicide use than all the other regions.

State and local government regulation

Golf facilities in the Transition region reported the lowest frequency of state and local regulations compared to other regions. The most heavily regulated activities included record keeping, storage, and posting/notification (Figure 28).

Storage facilities

Golf facilities in the Transition region tended to incorporate fewer attributes of pesticide storage facilities than those in the U.S. overall. The most frequently cited attributes included locked/restricted access, signs indicating pesticides are stored inside, and spill kits located nearby (Figure 29).

Transition region: Local government regulation

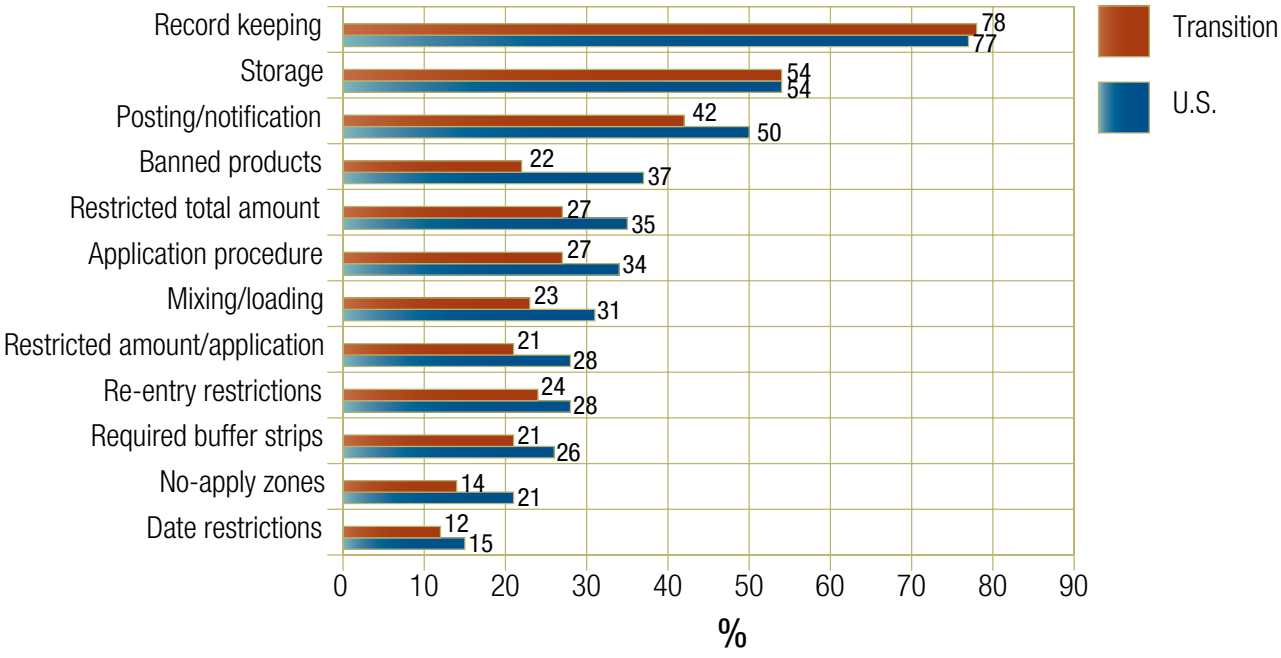


Figure 28. Percentage of 18-hole facilities in the Transition region reporting local government regulation (above and beyond federal regulations) of various pest management activities in 2015.

Pesticide mixing and loading stations

Golf facilities in the Transition region tended to incorporate fewer attributes of mixing and loading stations than those in the U.S. as a whole. The most frequently reported attributes were: spill kits near the mixing and loading area and anti-siphon devices on the water line (Figure 30).

Transition region: Properties of pesticide storage facilities

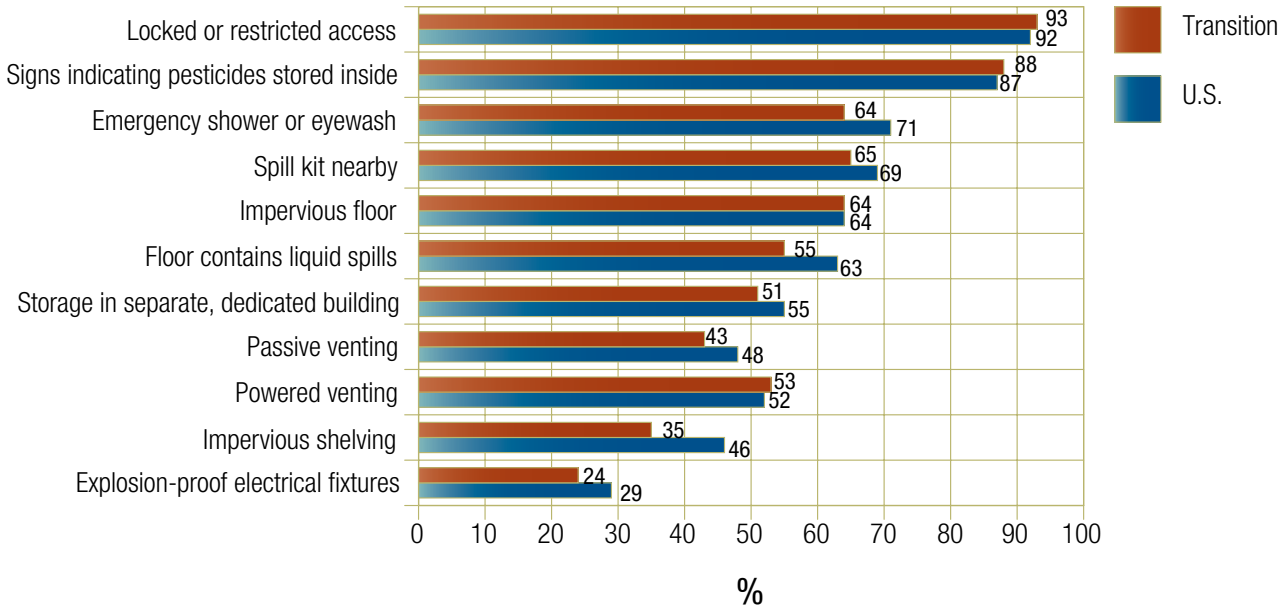


Figure 29. Percentage of 18-hole golf facilities in the Transition region with each property of pesticide storage facilities.

Transition region: Properties of mixing and loading areas

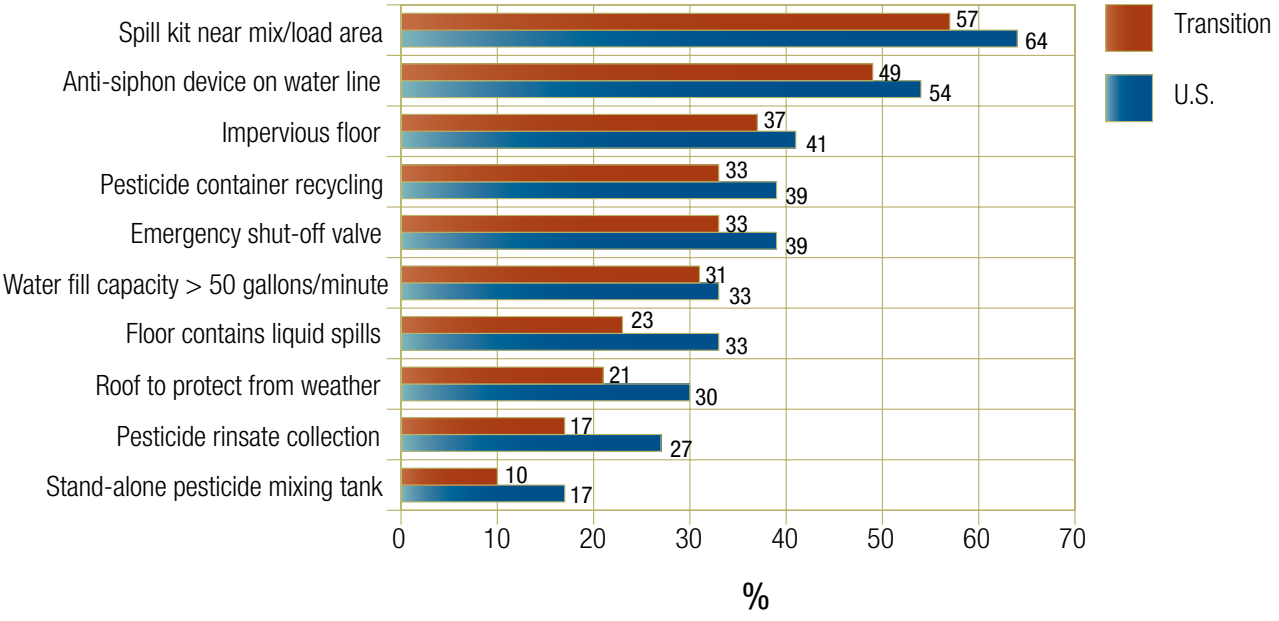


Figure 30. Percentage of 18-hole facilities in the Transition region with each property of mixing and loading areas.

Upper West/Mountain region: Change in reliance on various pesticide practices

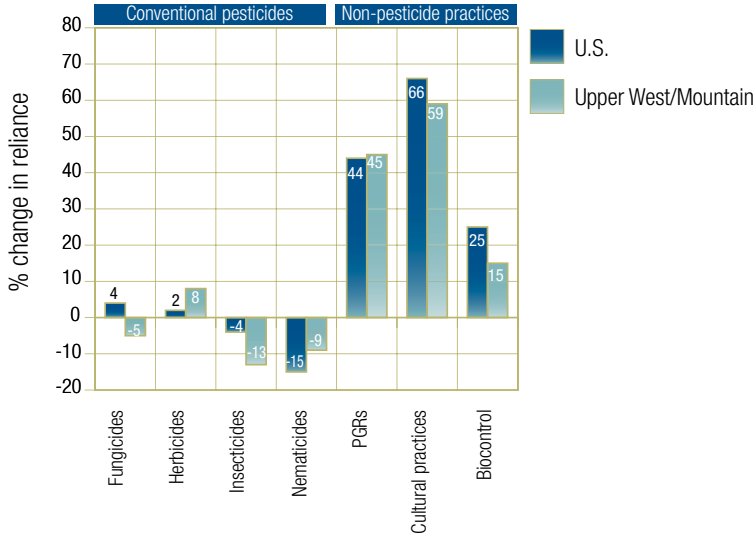


Figure 31. Percent change in reliance by 18-hole facilities in the Upper West/Mountain region on various pest management practices over the past several years. Values were determined by subtracting the percentage reporting decreased reliance from the percentage reporting increased reliance on each pest management practice.

Upper West/Mountain region

Changes in pest management strategies

The Upper West/Mountain region had greater decreases in dependence on fungicides and insecticides than elsewhere (Figure 31), but lagged slightly behind the nation in adoption of cultural practices and biological control.

State and local government regulation

Golf facilities in the Upper West/Mountain region reported a lower frequency of state and local government regulation than that in the U.S. overall. The most heavily regulated activities included record keeping, storage, and posting/notification (Figure 32).

Storage facilities

Golf facilities in the Upper West/Mountain region tended to incorporate fewer attributes of pesticide storage facilities than those in the country as a whole. The most frequently cited attributes used included locked/restricted access, signs indicating pesticides are stored inside, and emergency shower or eyewash (Figure 33).

Upper West/Mountain region: Local government regulation

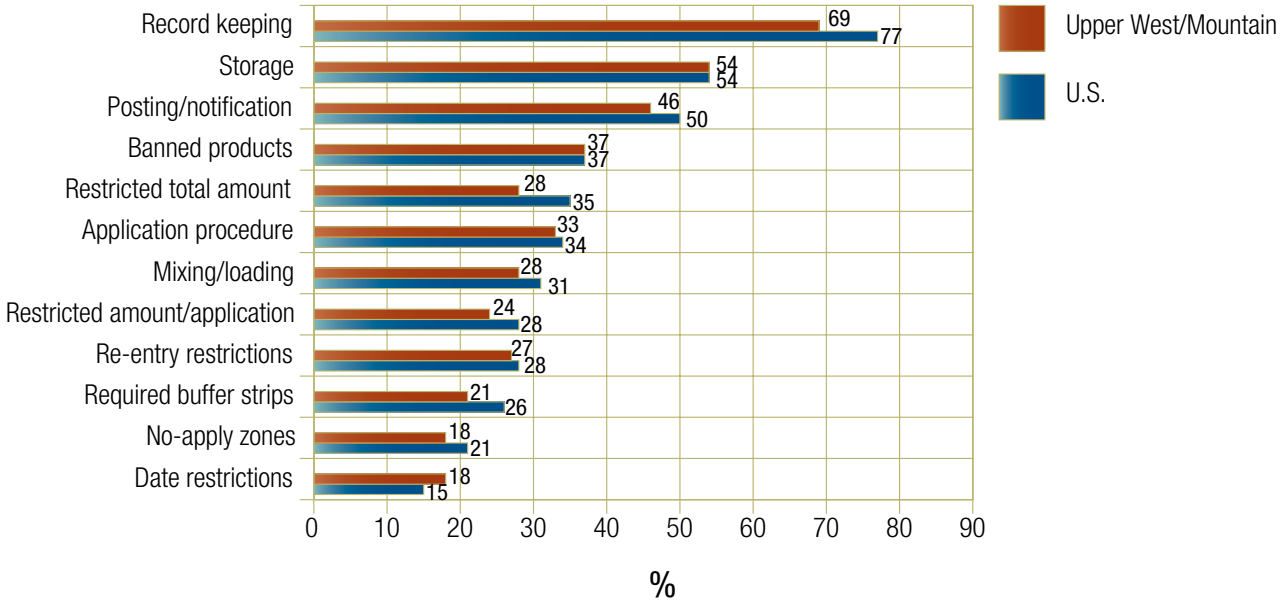


Figure 32. Percentage of 18-hole facilities in the Upper West/Mountain region reporting local government regulation (above and beyond federal regulations) of various pest management activities in 2015.

Pesticide mixing and loading stations

In the Upper West/Mountain region, golf facilities tended to incorporate fewer attributes of mixing and loading stations than facilities in the U.S. overall. The most frequently cited attributes were: spill kits near the mixing and loading area and anti-siphon devices on the water line (Figure 34).

Upper West/Mountain: Properties of pesticide storage facilities

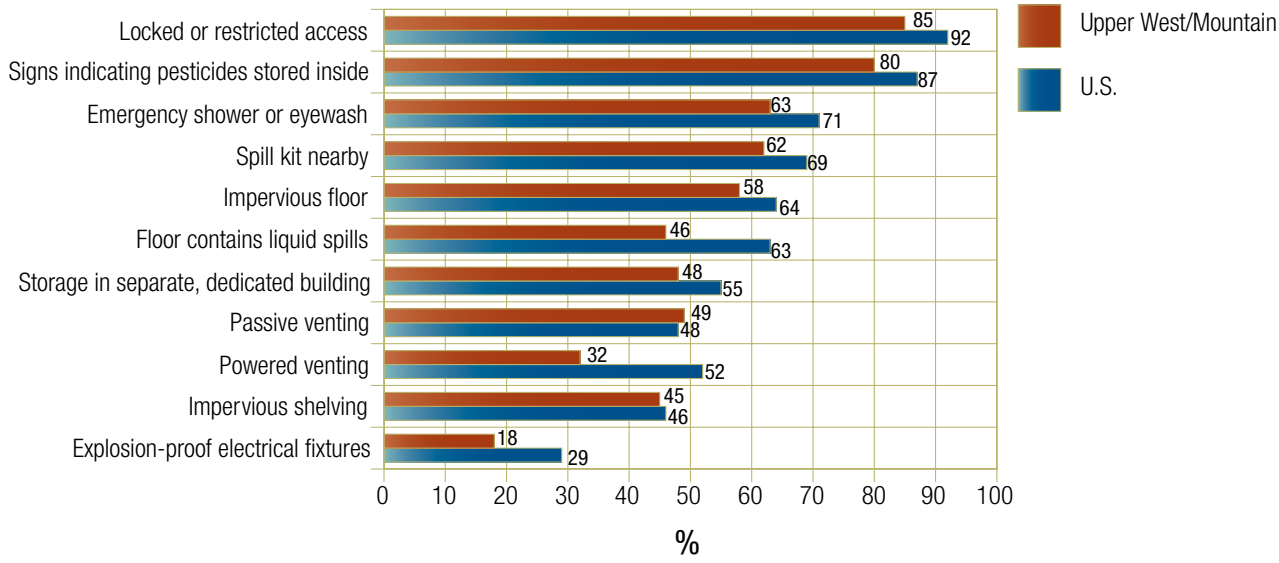


Figure 33. Percentage of 18-hole golf facilities in the Upper West/Mountain region with each property of pesticide storage facilities.

Upper West/Mountain region: Properties of mixing/loading areas

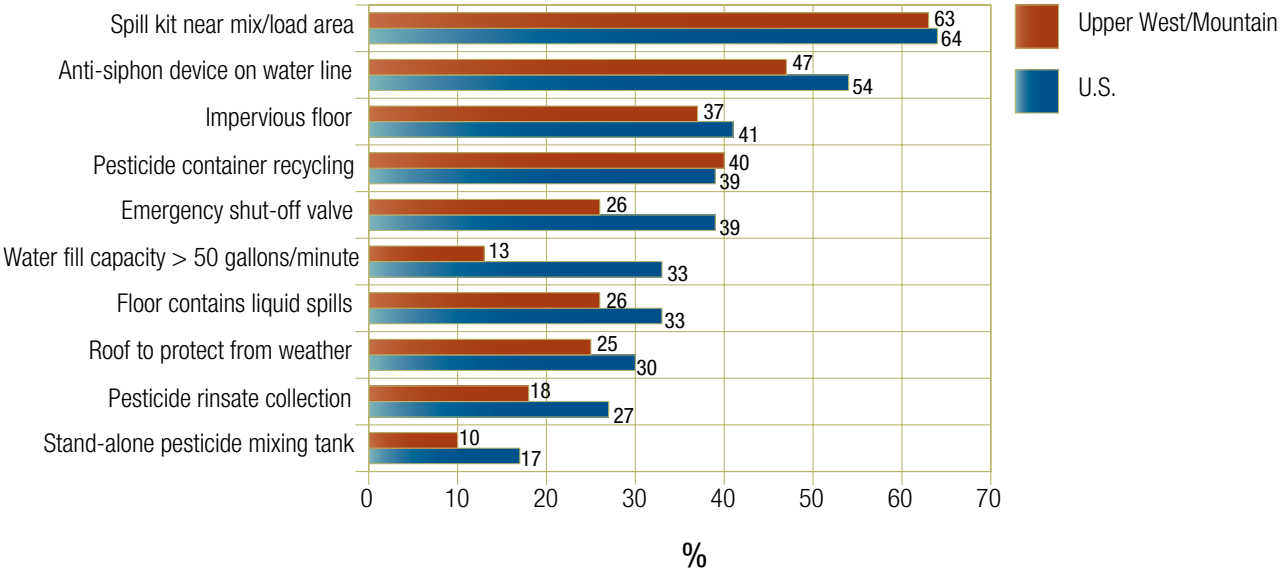


Figure 34. Percentage of 18-hole facilities in the Upper West/Mountain region with each property of mixing and loading areas.

CONCLUSIONS, RECOMMENDATIONS AND METHODOLOGY

Conclusions and recommendations

- Increased awareness, research, education and availability of new cultural, biological and chemical pest management practices has led to:
  - o greater reliance on non-pesticide pest management practices over the past several years
  - o decreased impact of regulatory restrictions on pest management programs
- Reliance on conventional pesticides has remained relatively stable over the past few years, with the exception of nematicides, for which there was a 15% decrease in use.
- Non-chemical pest management practices continue to be employed at high frequencies, especially weather monitoring, scouting and recording of pest outbreaks.
- Personal interactions are the most influential sources of pest management information, followed by (in decreasing order) websites and print publications.
- Costly improvements in pesticide storage facilities, pesticide mixing and loading stations, and adoption of pesticide written plans have decreased since the initial 2007 survey. This is likely a result of the downward shift in the economy that took place after the 2007 survey was completed.
- As the economy recovers, greater emphasis should be placed on golf facilities to improve the safety features of pesticide storage and mixing/loading areas, and to incorporate IPM plans and other written pest management plans into their programs.
- Development of written pest management plans (IPM plans and pesticide application plans) was largely a voluntary effort, with less than 15% initiated because of regulatory requirements.
- Facilities with larger budgets and/or larger golf courses are more likely to possess state-of-the-art pesticide storage and mixing/loading stations, and are also more likely to invest time and labor in the development of written pest management plans.
- Further improvements in pest management efficacy and safety will rely on greater investment by golf courses in staff education and safety-related facility improvements; by universities and superintendent associations in research, outreach and education on new pest management strategies; and by companies in continued development of new, environmentally compatible and efficacious pest management products.

Methodology and survey response

Survey questions adhered as closely as possible to those in the 2007 survey. However, input from golf, environmental, academic and regulatory sources was integrated into the 2015 survey in order to clarify questions or to integrate information on new technologies and issues in golf course management.

PACE Turf was contracted to provide technical oversight of the survey, to analyze and summarize the data, and to prepare reports for publication in peer-reviewed scientific journals, as well as in GCSAA publications and websites.

The National Golf Foundation (NGF) was contracted to refine and format the survey instrument for online use, conduct the survey, manage the recruitment of participants, collate the data and complete the analysis in collaboration with GCSAA and PACE Turf.

Of the 15,372 golf facilities in the U.S. at the time the survey was completed, 13,652 U.S. golf courses managed by superintendents with available email addresses were identified by integrating GCSAA and NGF databases. An initial email invitation, which included a link to the online survey, was sent to prospective participants in October 2015, followed by three follow-up email reminders sent in November 2015. A total of 1,946 completed surveys were received, which represents a 12.6% response coverage (Table A1). This is somewhat lower than the 20.8% response coverage from the earlier survey, which also included a mail survey campaign. While both surveys targeted the same population, respondents in 2015 were not identical to those in 2007.

To gain insights into survey data, respondents were stratified by agronomic region (Figure A1, Table A1), as well as by golf course type, number of holes and green fees.

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

Plant growth regulators, such as ethephon and trinexapac-ethyl, have been used as replacements for herbicides in management of annual bluegrass on putting greens. A green infested with *Poa annua* is shown on the left, and a plot on the same green treated with a PGR is pictured on the right.

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APPENDIX

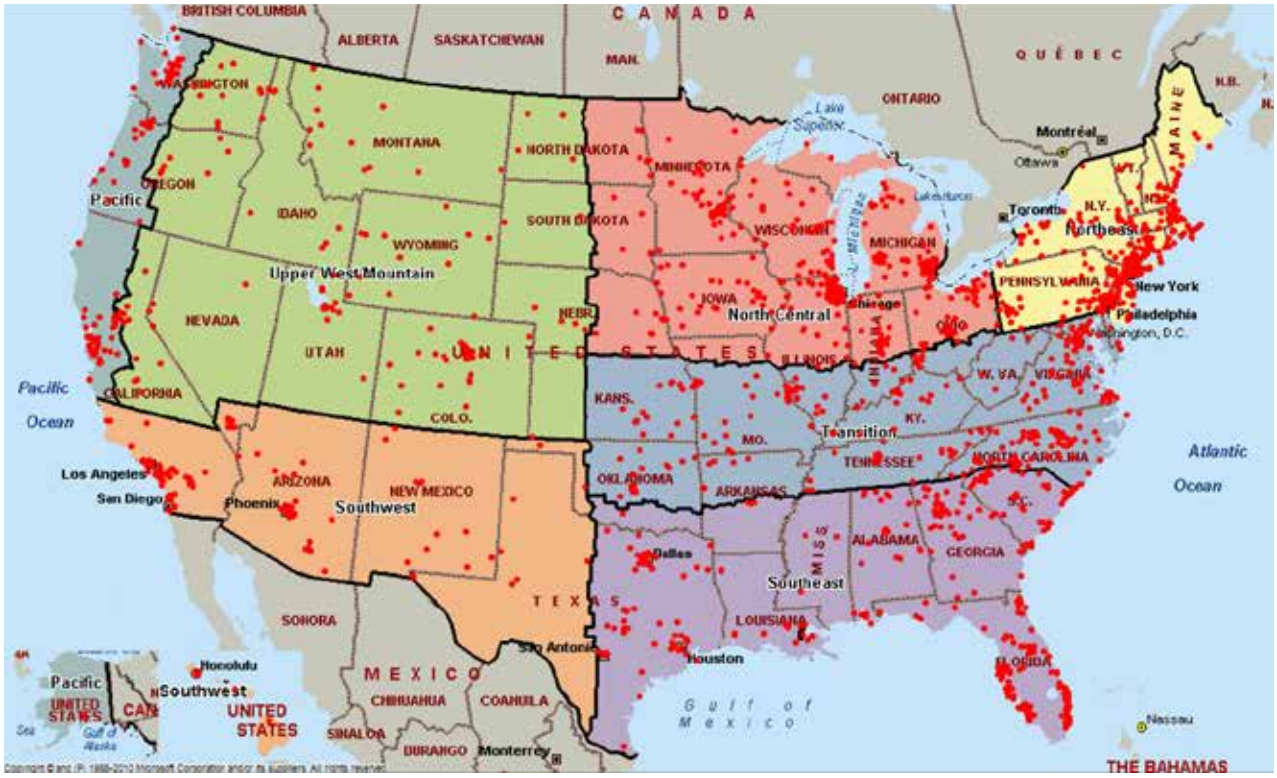

Figure A1. Distribution of 2015 survey responses received in seven different agronomic regions.

APPENDIX

2015 and 2007 pest management survey responses and weighting factors

Facility description				2015 U.S. golf facilities		2015 survey response		
Region	No. of holes	Type	Green fees	No.	% of total	No. of responses	% response	Weight factor
Northeast	9	all	all	737	4.8	41	2.1	2.287
Northeast	18	public	<$55	642	4.2	38	2	2.090
Northeast	18	public	>$55	507	3.3	62	3.2	1.032
Northeast	18	private	all	606	3.9	157	8.1	0.488
Northeast	27+	all	all	198	1.3	48	2.5	0.516
North Central	9	all	all	1,292	8.4	36	1.8	4.678
North Central	18	public	<$55	1,461	9.5	107	5.5	1.731
North Central	18	public	>$55	343	2.2	64	3.3	0.677
North Central	18	private	all	490	3.2	126	6.5	0.491
North Central	27+	all	all	334	2.2	64	3.3	0.659
Transition	9	all	all	716	4.7	16	0.8	5.832
Transition	18	public	<$55	1,020	6.6	91	4.7	1.414
Transition	18	public	>$55	309	2.0	67	3.4	0.592
Transition	18	private	all	553	3.6	116	6	0.601
Transition	27+	all	all	195	1.3	55	2.8	0.454
Southeast	9	all	all	532	3.5	7	0.4	8.666
Southeast	18	public	<$55	976	6.3	83	4.3	1.478
Southeast	18	public	>$55	426	2.8	76	3.9	0.712
Southeast	18	private	all	699	4.5	155	8	0.569
Southeast	27+	all	all	387	2.5	103	5.3	0.476
Southwest	9	all	all	261	1.7	8	0.4	4.259
Southwest	18	public	<$55	238	1.6	22	1.1	1.412
Southwest	18	public	>$55	304	2.0	45	2.3	0.860
Southwest	18	private	all	230	1.5	31	1.6	0.938
Southwest	27+	all	all	174	1.1	36	1.8	0.630
Upper West/Mtn	9	all	all	430	2.8	22	1.1	2.550
Upper West/Mtn	18	public	<$55	254	1.7	44	2.3	0.721
Upper West/Mtn	18	public	>$55	219	1.4	53	2.7	0.529
Upper West/Mtn	18	private	all	146	0.9	32	1.6	0.594
Upper West/Mtn	27+	all	all	75	0.5	38	2	0.246
Pacific	9	all	all	184	1.2	9	0.5	2.398
Pacific	18	public	<$55	101	0.7	21	1.1	0.596
Pacific	18	public	>$55	154	1.0	33	1.7	0.590
Pacific	18	private	all	117	0.8	29	1.5	0.507
Pacific	27+	all	all	60	0.4	11	0.6	0.655
Total				15,372	100	1,946	100	

Table A1. 2015 and 2007 pest management survey responses and weighting factors characterized by agronomic region, golf facility type, number of holes and green fees. To compensate for under- or over-representation when compared to the U.S. golf course proportions, data was weighted. Facilities refer to a business location where golf can be played on one or more golf courses.

Table A1 (continued)

Facility description				2007 U.S. golf facilities		2007 survey response		
Region	No. of holes	Type	Green fees	No.	% of total	No. of responses	% response	Weight factor
Northeast	9	all	all	762	4.8	59	1.8	2.687
Northeast	18	public	<$55	737	4.8	93	2.8	1.723
Northeast	18	public	>$55	384	2.2	111	3.3	0.659
Northeast	18	private	all	653	4.0	246	7.4	0.547
Northeast	27+	all	all	197	1.3	36	1.1	1.162
North Central	9	all	all	1,396	8.8	82	2.5	3.521
North Central	18	public	<$55	1,537	9.6	275	8.3	1.165
North Central	18	public	>$55	290	1.7	125	3.8	0.453
North Central	18	private	all	543	3.4	207	6.2	0.557
North Central	27+	all	all	352	2.2	76	2.3	0.951
Transition	9	all	all	787	5.1	40	1.2	4.229
Transition	18	public	<$55	1,043	6.6	167	5	1.324
Transition	18	public	>$55	285	1.6	124	3.7	0.435
Transition	18	private	all	626	3.9	236	7.1	0.548
Transition	27+	all	all	203	1.3	47	1.4	0.922
Southeast	9	all	all	623	3.9	20	0.6	6.568
Southeast	18	public	<$55	968	6.3	132	4	1.584
Southeast	18	public	>$55	398	2.4	160	4.8	0.505
Southeast	18	private	all	784	4.8	302	9.1	0.527
Southeast	27+	all	all	417	2.6	80	2.4	1.104
Southwest	9	all	all	270	1.7	10	0.3	5.722
Southwest	18	public	<$55	261	1.7	46	1.4	1.190
Southwest	18	public	>$55	257	1.6	91	2.7	0.582
Southwest	18	private	all	259	1.6	80	2.4	0.660
Southwest	27+	all	all	178	1.1	28	0.8	1.386
Upper West/Mtn	9	all	all	432	2.8	27	0.8	3.524
Upper West/Mtn	18	public	<$55	289	1.9	82	2.5	0.777
Upper West/Mtn	18	public	>$55	157	0.9	78	2.3	0.370
Upper West/Mtn	18	private	all	151	0.9	77	2.3	0.398
Upper West/Mtn	27+	all	all	70	0.4	29	0.9	0.480
Pacific	9	all	all	217	1.3	19	0.6	2.088
Pacific	18	public	<$55	134	0.8	37	1.1	0.758
Pacific	18	public	>$55	119	0.7	44	1.3	0.511
Pacific	18	private	all	126	0.8	47	1.4	0.564
Pacific	27+	all	all	65	0.4	12	0.4	1.002
Total				15,970	100	3,325	100	

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