May 19, 2025

Public Comments Processing
Attn: FWS-R3-ES-2024-0137
U.S. Fish and Wildlife Service
MS: PRB/3W
5275 Leesburg Pike
Falls Church, VA 22041-3803

Re: Comments from the Golf Course Superintendents Association of America (GCSAA) regarding the Draft Endangered and Threatened Species: Species Status with Section 4(d) Rule for Monarch Butterfly and Designation of Critical Habitat Proposed Rule (Docket No. FWS-R3-ES-2024-0137)

Dear Ms. Barbara Hosler,

The Golf Course Superintendents Association of America (GCSAA) is pleased to offer comments in response to the U.S. Fish and Wildlife Service (USFWS) issuing the Draft Endangered and Threatened Species: Species Status with Section 4(d) Rule for Monarch Butterfly and Designation of Critical Habitat Proposed Rule (Docket ID: FWS-R3-ES-2024-0137-0001).

As USFWS considers the listing of the monarch butterfly under the Endangered Species Act (ESA), it is crucial to recognize the unique role that golf courses play in both environmental stewardship and community recreation. The golf course industry is dedicated to conserving pollinators, including monarch butterflies, and GCSAA believes there is ample, credible support to except golf course management activities, including pesticide use, under Section 4(d). This exception would allow golf courses to continue their essential conservation efforts without hindering effective pest management. Without it, golf course management could face significant challenges.

In this letter, GCSAA responds to USFWS's request for public comment by providing an overview of GCSAA and information on how:

- GCSAA routinely educates members about the importance of pollinator conservation;
- Golf course design provides opportunities to balance land use objectives with pollinator conservation, including directly through the provision of habitat to monarchs; and,
- GCSAA has developed golf course pest management Best Management Practice (BMP) programs that rely heavily on Integrated Pest Management (IPM) and include reasonable and feasible protective measures that (in GCSAA's view) effectively minimize pesticide exposure to monarchs.

The GCSAA believes there is sufficient, credible evidence to **include golf course management activities, including pesticide use in accordance with the EPA-approved label, and consistent with the approach EPA and the USFWS are taking to ESA compliance with regards to all other listed species, as an incidental take exception under Section 4(d) should the monarch be listed under the ESA.** Golf course

superintendent's standard approaches to pest management, enshrined in BMPs developed by GCSAA, already include reasonable and feasible protective measures that effectively minimize pesticide exposure to monarch. These include applying pesticides sparingly, always making targeted applications with equipment that minimizes potential exposure and employing IPM-based pest management programs that allow for maintenance of habitat and contribute positively to monarch conservation. Excepting pest management activities on golf courses from the proposed listing of the monarch butterfly under the ESA would allow these managed landscapes to continue contributing to monarch conservation efforts while maintaining their economic and recreational functions. Excepting golf courses from additional restrictions under the proposed ESA listing – in GCSAA's view – would not compromise the protection of monarch butterflies but would instead support ongoing responsible management practices and active planting of monarch habitat on golf course properties.

Thank you for allowing GCSAA to submit these comments on the proposed listing of the monarch to USFWS. We look forward to working with USFWS on monarch recovery and conservation while ensuring our mutual goals to protect species and habitat. GCSAA welcomes the opportunity to discuss with the agency additional opportunities to increase or enhance monarch habitat around the country. Golf courses establish and maintain valuable pollinator habitat that we believe will be integral to the success of the species. Please contact me at (800) 472-7878, ext. 3619 or cmckeel@gcsaa.org if you have additional questions or if you need additional information.

Sincerely,

Chava E. McKeel
GCSAA Director, Government Affairs

Contents

1. Background on GCSAA and Golf in the U.S.

GCSAA is the professional association for the men and women who manage and maintain the game's most valuable resource — the golf course. The golf industry recognizes the association as a key contributor in elevating the game and business. Since 1926, with a focus on golf course management, GCSAA has been the top professional association in the United States (U.S.) and worldwide. With headquarters located in Lawrence, Kansas, GCSAA provides education, information, and representation of nearly 22,000 members in more than 72 countries. Its mission is to serve its members, advance the profession, and improve communities through the enjoyment, growth, and vitality of the game of golf.

The U.S. golf course industry provides a high benefit to the national economy and public wellbeing. According to data compiled by the American Golf Industry Coalition (https://www.golfcoalition.org):

- $226.5 Billion: Total economic impact of golf in America, including direct, indirect and induced impacts in 2022
- $101.7 Billion: Total size of the golf economy nationally
- $80 Billion: Total wage income from about 1.65 million U.S. jobs
- $4.6 Billion: Charitable contributions
- 15,000+: Approximate number of U.S. golf facilities

The game of golf provides recreation and enjoyment for millions of Americans. Beyond its health and wellness value, golf generates jobs, commerce, economic development and tax revenues in communities across the country. It brings visitors to states, drives new construction and residential development, generates retail sales and creates demand for a myriad of goods and services. In short, golf impacts nearly two million Americans whose livelihoods directly or indirectly depend on it.

The golf industry is committed to environmental responsibility in the design, construction and management of golf courses. The game's leading organizations have invested considerable resources in this effort and are now driving the game toward sustainability. GCSAA supports these initiatives, which include research, education, and innovative practices that are dedicated to providing long-term benefits to the communities where golf courses are located. With a shared goal of elevating golf's environmental consciousness, golf course superintendents and developers around the country are committed to continually improving their efforts to conserve water, protect water quality, preserve natural habitats, save energy, and reduce pollution.

Golf has a longstanding history of giving back. It starts with the values of sportsmanship, respect and integrity inherent to the game, and continues with the billions of dollars raised annually for charities across the country. Whether supporting men and women in uniform, promoting scholastic achievement or providing fundraising opportunities for worthy charities, the golf industry is finding ways for all Americans to benefit from the game.

Golf delivers value in ways beyond jobs, revenue, taxes, and multiplier effects. Golf is a lifestyle, a

community asset, and a positive contributor to physical, mental and social wellness. Recent research highlights the game's critical role in helping people to escape their everyday stressors – especially 35- to 49-year-olds, who are much more likely than other age groups to say they play golf to recover from stress and mentally recharge. Surveys reveal that virtually every U.S. golf facility (97%) organized at least one recreational program or initiative in 2024 to expand golf's local reach and impact, in turn elevating the quality of life within their communities.

2. Golf Course Design and Pollinator Conservation

2.1 Opportunities to Balance Land Uses

As USFWS considers the listing of the monarch butterfly under the Endangered Species Act (ESA), it is crucial to recognize the unique role that golf courses play in environmental stewardship and in providing habitat for the monarch. Golf courses are not merely recreational spaces, they are managed landscapes that include natural areas that can contribute positively to local ecosystems. An average 18-hole golf facility spans 146 acres, of which almost one third consists of natural areas and water features (**Figure 1**).[1]

Nationally in 2021, land-use of an 18-hole golf facility was allocated as follows:

- 95 acres of maintained turfgrass
  - 49 acres of roughs
  - 27.1 acres of fairways
  - 5.9 acres of practice areas
  - 3.3 acres of greens
  - 3.1 acres of tees
  - 1.7 acres of clubhouse grounds
  - 0.8 acres of turfgrass nursery
- 23.3 acres of natural areas
- 5.7 acres of water features
- 2.2 acres of parking lots
- 2.2 acres of bunkers
- 2.1 acres of building

Figure 1. Average acres by land-use on golf courses

The typical layout of golf course components provides opportunities to adapt these areas to different land uses and various functions (**Figure 2**). These features, or physical components of golf courses, include:

- Tees: the starting point for each hole
- Bunkers: sand areas designed to challenge players
- Greens: the area where the hole or "cup" is located
- Fairways: the main playing area between the tee box and the green
- Roughs: the areas surrounding the fairway, often with longer grass
- Water hazards: water bodies that function as irrigation supply and storm water control and designed to challenge players
- Natural areas: naturalized areas

[1] Golf Course Environmental Profile: Land-use and energy practices on U.S. golf facilities can be found here: https://www.gcsaa.org/docs/default-source/environment/gcep-property-report-phase-3-final-update-6-27.pdf?sfvrsn=4517cf3e_0.

Figure 1. Defined physical components of a typical U.S. golf course.

According to the most recent Golf Course Environmental Profile survey on land use published in both the HortTechnology[2] journal and on GCSAA's website,[3] an average 18-hole 146-acre golf course only contains about 6.4 acres of greens and tees, which require the most maintenance and inputs. Fairways, which represent about 27 acres of a typical golf course, require the next highest levels of maintenance and (generally infrequent) pest management. Additionally, due to playing surface quality requirements, plantings in these areas are managed so they do not produce flowers and so do not pose a threat to pollinators by direct application. Golf course roughs, driving ranges, practice areas and nurseries are about 58 acres, and about 12 acres are water, bunkers, parking lots, buildings, and clubhouse grounds.

Table 1 summarizes management activities and overlap with potential resources for monarchs for each golf course feature. Golf course features are illustrated in **Figure 2**.

Table 1. Summary of Management Activities and Potential Overlap with Monarch Resource by Golf Course Feature

Golf Course Feature	Total Area of 18-hole Course (Acres)[1]	Physical Maintenance	Chemical Maintenance	Potential Monarch Resource – Adults (nectar)	Potential Monarch Resource - Larvae (milkweed)
Bunkers	2.2	Raking, sand replacement	Not Typical	No	No
Tees	3.1	Regular leveling and repair	Yes, Commonly Spot Treatment	No	No
Greens	3.3	Frequent mowing and	Yes, Commonly	No	No

[2] *Land-use and Energy Practices on US Golf Courses* by Travis W. Shaddox, J. Bryan Unruh, Mark E. Johnson, Clark D. Brown, and Greg Stacey.

[3] Golf Course Environmental Profile: Land-use and energy practices on U.S. golf facilities: https://www.gcsaa.org/docs/default-source/environment/gcep-property-report-phase-3-final-update-6-27.pdf?sfvrsn=4517cf3e_0.

Golf Course Feature	Total Area of 18-hole Course (Acres)[1]	Physical Maintenance	Chemical Maintenance	Potential Monarch Resource – Adults (nectar)	Potential Monarch Resource - Larvae (milkweed)
		rolling	Spot Treatment		
Water hazards	5.7	NA	Not Typical	No	No
Fairways	27.1	Regular mowing	Moderate	No	No
Roughs	49	Occasional mowing	Minimal	Some	Some
Natural areas	23.3	Occasional mowing	Minimal	Yes	Yes

[1]Golf Course Environmental Profile: Land-use and energy practices on U.S. golf facilities: https://www.gcsaa.org/docs/default-source/environment/gcep-property-report-phase-3-final-update-6-27.pdf?sfvrsn=4517cf3e_0

Pollinator conservation works very well with typical golf course design practices as golf courses provide patches of habitat throughout the facility in natural areas. This works well for monarchs as there is evidence that monarchs prefer smaller and medium sized patches as opposed to large contiguous areas, so planting milkweed in several patches distributed across an area is recommended.[4] In addition, golf course design easily provides space for sanctuaries for birds and other wildlife and the opportunity for habitats that are beneficial to pollinators, including monarch butterflies.

The Wine Valley Golf Club in Walla Walla, Washington provides a key example of how golf courses can adapt to complex landscapes. The club is surrounded by agricultural production and even supports alfalfa seed production within the property (circled red in **Figure 3**). Alfalfa seed production utilizes alkali bees for pollination services. The coexistence of managed turfgrass with these native pollinators and surrounding agricultural systems exemplifies both careful pest management within golf course settings and the ability in these landscapes to balance multiple land use objectives.

[4] 2025 Mid-Atlantic HK Planting Guide.pdf.

Figure 2. Aerial image of Wine Valley golf course in Walla Walla, Washington. Red circle denotes alkali bee bed within alfalfa seed fields operating within the golf course facility.

2.2 Golf Courses Provide Habitat to Support Monarchs

GCSAA and golf facilities around the United States are deeply invested in monarch butterfly conservation and require special consideration under the ESA. In addition to previously mentioned societal values, golf courses provide habitat for monarchs that would not otherwise be available, often the only habitat for miles. Without the 4(d) exception, golf courses would not be able to effectively treat the managed portions of their course for pest infestation, the quality of the playing surfaces of courses would denigrate which would lead to reduced rounds of play, negatively impacting the viability of the business plan for the golf courses. Golf courses would be forced to close, leaving the land (including monarch habitat) for developers, or completely unmanaged. This would result in the net loss of monarch habitat. Thus, golf courses require special consideration under the ESA to continue to support migrating monarchs.

GCSAA's environmental Best Management Practices Program (BMPs), education, and other resources help golf course superintendents to manage golf courses while also protecting monarchs and creating valuable habitat. **Figure 4** provides an example of monarch habitat flourishing on a golf course in Colorado where milkweed plantings thrive adjacent to well-maintained golf course features. The resources provided by GCSAA to golf course superintendents allow golf courses to be managed in ways

that can also support the monarch butterfly.

Figure 3. Example of monarch habitat existing with managed areas on Saddle Rock Golf Course in Aurora, Colorado. Golf course is managed to simultaneously support playability and monarch butterfly habitat.

Supporting Overwintering Monarchs – California

Many golf courses provide landscapes that support overwintering activities of monarchs and provide educational opportunities for the public either directly on the golf course or by supporting efforts adjacent to golf courses (**Figure 5**).

Additionally, some courses operate under management plans specific to monarch conservation, such as The Monarch Bay Golf Course in San Leandro, California, a golf course in the proposed designated critical habitat area. This golf course is owned by

Figure 4. Monarch Grove Sanctuary, a 2.4 acre park that is one of largest overwintering sites in the West, about one mile from Pacific Grove Golf Links. Both the Sanctuary and the Golf Links are managed by the City of Pacific Grove.

the City of San Leandro and managed by the American Golf Corporation. Monarch butterflies have been overwintering at this golf course for decades and the city hosts monarch tours for public education at the facility. Management recommendations aimed at conservation of overwintering monarch for this course are included in the "Assessment of Overwintering Monarch Habitat at Monarch Bay, San Leandro, CA" published in December 2023. This document outlines 11 main management actions to "maintain and enhance wind shelter with new tree plantings and provide early season nectar sources" for monarch conservation. This document also includes maps with specific monarch location notations and additional proactive mitigation recommendations that are followed by the golf course superintendent. Examples of proactive mitigation recommendations implemented at the Monarch Bay Golf Course include minimal maintenance and disturbance of habitat between the months of March and September (periodic mowing is conducted when necessary for habitat management), and no pesticides used in proximity to the habitat. The recommendations outlined in this document are consistent with the Monarch Overwintering Grove Management Plan Template that USFWS has made available on the docket (FWS-R3-ES-2024-0137).

Another example of a golf course providing a landscape that supports the overwintering activities of monarchs and operates under management plans specific to monarch conservation is at Morro Bay Golf Course in Morro Bay, CA. Morro Bay Golf Course is one of California's most important overwintering sites for western monarch butterflies. After consulting with California Poly San Luis Obispo professor emeritus Kingston Leong, the golf course superintendent replanted a total of 130 Monterey Cypress trees at the course over the last decade to help support monarch conservation. Morro Bay Golf Course has many owl boxes and a bluebird house trail. The course enlisted the help of the First Tee youth development program and local schoolchildren to organize the planting of hundreds of Monterey cypress trees to help shelter the monarch grove from the northwest winds that sweep down the coast. The trees, which are resistant to pitch canker, have grown enough to have some buffering effect. The eucalyptus trees are trimmed to permit just the right amount of sunlight, and that the course uses minimal pesticides that might affect the monarchs. You can learn more about the monarch conservation efforts at Morrow Bay Golf Course in *Golf Course Management* magazine here - https://gcmonline.com/course/environment/news/butterfly-conservation.

Supporting Early Migrating Monarchs - Texas

Texas is a critical conservation area for the eastern population of the monarch and many golf course facilities in Texas are committed to monarch conservation. For example, Tierra Verde Golf Club in Arlington, Texas was the first golf course in Texas, and the first municipal golf course in the world, to be certified as an Audubon Signature Sanctuary in 2001. The public golf course encompasses 263 total acres with 90 acres of managed turf. Over the last 24 years, Tierra Verde has continued to develop their wildlife and pollinator programs and now has Monarch Watch waystations on property. Golf Course Superintendent Mark Claburn won an environmental award last year for his skill in communicating and sharing his environmental efforts with his peers and his community.

TPC San Antonio, located in San Antonio, Texas, is committed to supporting pollinators through sustainable landscaping and habitat enhancement. TPC San Antonio has been a Certified Audubon Sanctuary for Golf since 2012. TPC San Antonio sits on 400 acres of native Texas Hill Country. The golf

courses are regulated by the Environmental Management plan that only 150 acres can be utilized for the golf course as managed area. The remaining 250 acres are to remain as natural as possible. Native vegetation includes cactus, pasture grasses, natural scrub, trees (oaks and cedars), and desert willows. Twenty-five acres of on-course area surrounding the large capture pond on the Canyons course has been designated as pollinator habitat, providing pollinator species with ideal accessibility to water and forage resources.

Supporting Breeding and Migrating Monarchs

GCSAA works with many other organizations to help superintendents be successful in the establishment and maintenance of monarch habitat areas. These programs include golf-specific programs like Operation Pollinator and Monarchs in the Rough as well as additional resources available to our industry from Syngenta, Bayer, BASF, and CropLife International (see Appendix 1 – for a complete list of monarch and pollinator conservation programs that GCSAA participates in or references). Monarchs in the Rough aims to increase the area on golf courses that can support monarchs beyond the natural areas. Participants in the program guarantee to set aside at least one acre to plant locally appropriate milkweed seeds provided by Audubon International. Areas planted to milkweed are required to be at least 100 feet away from any portions of the property that are playable or are treated with pesticides. As of May 2025, over 800 golf properties were participating in the program, and Audubon International received a $25,000 grant at the beginning of 2025 to facilitate the participation of another 120 golf properties.[5] One participant in the program, Elmwood Golf Course in Michigan, even goes so far as to provide protected monarch roost sites for fall migrating adults.[6]

Golf course properties can also participate in several programs offered by Audubon International that not only promote conservation and environmental sustainability, but specifically focus on the use of chemicals, including pesticides. The Audubon Cooperative Sanctuary Program for Golf (ACSP) is an environmental education and certification program through which golf courses can get technical assistance on site assessment and environmental planting, chemical use reduction, and wildlife habitat management (https://www.audubonintenational.org/audubon-cooperative-sanctuary-program). There are approximately 2,000 golf courses in the U.S. that currently participate in the ACSP. Courses that want to go even further can participate in Audubon's Signature Sanctuary Certification, which involves site visits by Audubon technical experts, development of a Natural Resources Management Plan with course staff (https://www.audubonintenational.org/signature-sanctuary-certification). Courses that are certified as Signature Sanctuaries are also required to report chemical (including pesticides) use to Audubon and conduct routine water quality tests.

Golf courses represent unique conservation opportunities for monarch butterflies, providing critical resources for both adults and larvae across the country. These areas offer refuge and can establish connectivity of resources for monarchs and many other species in low-diversity landscapes. The GCSAA and its members understand the conservation potential of golf courses and can provide the USFWS with numerous case studies demonstrating thriving wildlife populations and monarch habitat due to the presence of golf courses. GCSAA is committed to

[5] https://Monarchsintherough.org/golf-courses-surpass-initial-goal-for-butterfly-protection/
[6] https://Monarchsintherough.org/Monarchs-in-the-trees/

contributing to the recovery of the monarch butterfly by continuing to educate its members on pollinator and monarch habitat importance and providing additional resources. GCSAA welcomes the opportunity to discuss with the agency additional opportunities to increase or enhance monarch habitat around the country.

3. GCSAA Educates Members about the Importance of Pollinator Conservation

GCSAA recognizes the importance of native pollinators in our ecosystem and their significant contribution to our quality of life. GCSAA is aware of and concerned about the issue of pollinator decline, and supports expedited review of the many potential factors that contribute to pollinator issues. GCSAA will continue to support use of best management practices that provide habitat through native areas as well as the professional use of inputs through training and education and the use of IPM practices. There are golf facilities providing apiaries that provide a great education platform to create awareness of pollinator issues Americans face.

In 2020, GCSAA added a comprehensive pollinator resources section to www.gcsaa.org. This section provides a comprehensive listing of the association's work toward pollinator protection including articles, webinars, case studies, videos, pollinator habitat and conversation guides, and information on beekeeping and apiaries. You can find the resources here: Pollinator Resources | GCSAA. The pollinator resources section includes information on environmental stewardship programs such as Operation Pollinator and Monarchs in the Rough which many golf course superintendents participate in.

Additionally, GCSAA offers educational materials, webinars, and develops case studies to inform golf course superintendents and their staff about pollinator conservation. The association facilitates access for members to information on guides that help support pollinator and habitat conservation from organizations such as the United States Golf Association, Xerces Society, North American Pollinator Protection Campaign, Environmental Protection Agency and the North Central IPM Center. A network of GCSAA field staff across the country and the team at the headquarters office are always ready to help superintendents with questions about their BMPs, how to get started with native and pollinator plantings, and how to provide valuable wildlife habitat.

GCSAA also offers seminars at our annual conference as well as both live and on-demand webinars for members to learn about pollinator biology, protection, and establishing and maintaining habitat. Seminars and webinars taught by experts from all over help members learn and get the best advice on environmental conservation including:

- "Creating Habitats for Monarch Butterflies and Pollinators on Golf Courses"[7] Chip Taylor, Ph.D. of Monarch Watch,
- "A Greener Golf Course" by Jay McCurdy, Ph.D., [8]
- "Managing Native and Out of Play Areas with BMPs to Ensure Success"[9] co-presented by a scientist and superintendents sharing their own experiences with pollinator habitat.

[7] *Creating Habitats for Monarch Butterflies and Pollinators on Golf Courses* by Chip Taylor, Ph.D.
[8] *A Greener Golf Course* by Jay McCurdy, Ph.D.
[9] *Managing Native and Out of Play Areas with BMPs to Ensure Success* by J. Bryan Unruh, Ph.D; Matt Ceplo, CGCS; Jay Randolph, CGCS; and Kyle D. Sweet, CGCS

Lastly, GCSAA hosts Facility Learning Tours at golf courses near the annual GCSAA Conference and Trade Show so superintendents can see on-the-ground examples of how their peers protect and provide for pollinators. Additional examples of this educational material can be found on the GCSAA website pollinator resources page.[10]

GCSAA is committed to teaching youth and adults about the importance of pollinator protection. GCSAA's First Green program is a science, technology, engineering, arts and math (STEAM) environmental outreach program that uses the golf course as a living laboratory. K-12 students participate in hands-on, outdoor learning stations that include lessons on wildlife habitat, soil science, environmental sustainability, mathematics, water conservation, water quality, career exploration and much more. There can be specific stations devoted to: Plants and the Environment and Wildlife and Habitat Management. More can be found here - https://www.thefirstgreen.org/. GCSAA has had a total of 21,379 students participate in field trips since the summer of 2018; the association has conducted field trips in 44 states. Our total count of field trips is 375.

4. Golf Course Management

Golf course management requires a unique approach compared to other land uses because it requires balancing aesthetic, environmental, and economic considerations. Golf courses are often located in urban environments and so are under public scrutiny, face heightened attention from concerned citizens, media, and environmental activist groups regarding the use of inputs like water and pesticides. However, as we've already described, golf courses can also play a critical role in conservation through habitat establishment and maintenance. It is essential for the golf industry to constantly implement sustainable land and pest management methods.

4.1 Golf Course Superintendents Lead Golf Course Management

The management of golf courses is led by superintendents, the professional responsible for the golf course landscape. Today's golf course superintendents are educated professionals who prioritize environmental quality and the protection of wildlife, pollinators, and at-risk species. They possess extensive knowledge in pesticide stewardship and Integrated Pest Management (IPM) due to state certification requirements and certification and training programs offered by GCSAA and other organizations such as Audubon International. The Certified Golf Course Superintendent (CGCS) designation, conferred by GCSAA, is the highest professional level in the golf industry. While not all GCSAA members are CGCS, most superintendents hold college degrees and engage in substantial continuing education, making them leading practitioners of IPM. According to the *Golf Course Environmental Profile: A continued investigation into pest management practices on U.S. golf courses* (Phase III, Volume III), in 2021, superintendents at 71% of U.S. golf facilities have an IPM or pesticide application plan.[11]

[10] Pollinator Resources | GCSAA

[11] Golf Course Environmental Profile: A continued investigation into pest management practices on U.S. Golf Courses report can be found online here: https://www.gcsaa.org/docs/default-source/environment/phase-3-pest-management-report-final.pdf?sfvrsn=2a81cd3e_2.

GCSAA Class A membership puts a focus on IPM. Members earn Class A status through a combination of formal education, experience as a golf course superintendent, continuing education and providing proof of a valid pesticide license or passing the GCSAA IPM Exam. Class A membership demonstrates a personal commitment to lifelong learning, environmental stewardship and elevating the golf course management profession. It also shows employers that achievements and competencies are documented and validated.

The pesticide license requirement of Class A membership demonstrates a commitment to environmental stewardship. While not every golf course superintendent applies chemicals, all Class A members have a basic understanding of the concepts related to this competency, and this requirement can be fulfilled in one of two ways:

1. provide proof of a valid state/country pesticide license/certification with your current license number, date of expiration and the state, province or country that issued the license, or

2. successfully complete the GCSAA IPM exam, which tests the basic principles of safe pesticide storage, disposal and application. This exam is designed to be used in place of a pesticide license to meet Class A or CGCS requirements.

The Certified Golf Course Superintendent (CGCS) designation is bestowed upon those who have demonstrated a high degree of knowledge in their profession. The CGCS designation is the most widely recognized in the golf industry and the highest recognition that can be achieved by golf course superintendents. What does it take to become certified?

- Be currently employed as a golf course superintendent;
- meet GCSAA Class A requirements;
- meet application requirements and apply online; and
- successfully complete:
    1) proctored online exam;
    2) communication and Leadership requirement; and
    3) attesting of the golf course.

The certification exam must be successfully taken within a one-year applicant period, which begins when your application is approved. An independent online proctoring service is used to monitor during the closed-book exam. The exam is made up of three parts (Agronomy; Business; Environmental Management) and contains multiple-choice questions. Each part of the exam is timed.

To fulfill the attesting requirement, you must have your golf course operation evaluated by two certified golf course superintendents. This evaluation is conducted during your course's growing season and covers four major divisions:

1. **Course conditions**: This area includes putting greens, golf course tees, fairways, roughs, bunkers, car or cart paths, ponds and waterways, driving range and general grounds.

2. **Maintenance facility:** This section covers office areas, shop area, pesticide storage area, equipment storage area, fuel storage area, equipment wash area, safety equipment and

employee areas.

3. **Record-keeping:** In this section, the attestors will review your financial records, employee records, chemical applications, employee training, storage tanks and wildlife inventory.

4. **Communication skills:** This section will cover professionalism, management skill statements and communication with management, members/players, staff and the community.

GCSAA also recognizes and honors its members who focus on environmental leadership and sustainability. In 2018, the Environmental Leadership in Golf Awards were updated to recognize more superintendents in more focused areas of environmental sustainability. The ELGAs are based on the environmental best management practices that GCSAA recommends all courses utilize. There are four ELGAs available:

- **Natural Resource Conservation Award** - This award recognizes individuals who employ effective strategies for water conservation, energy conservation, and sound wildlife management. This one focused on wildlife management.
    - In 2024, Jim Pavonetti, CGCS of Fairview Country Club in Greenwich, Connecticut won this award for his multi-faceted conservation efforts on every part of his facility including efforts to take care of wildlife include adding/expanding native areas, monarch butterfly areas, pollinator areas, bluebird and bat boxes, nesting areas, buffer zones around water and creating no-spray/fertilizer areas.

- **Healthy Land Stewardship Award** - This award recognizes individuals who employ effective strategies for efficient use of pesticides and nutrients as well as pollution prevention. This one focused on IPM.
    - In 2021, Cortland Winkle of TPC Four Seasons Golf and Sports Club in Irving, Texas won this award for their impressive integrated pest management program and native area management. The facility is home to native mesquite groves, 42 acres of native grass and 128 documented species of wildlife. The facility has a sophisticated IPM program, with an on-site “war room” that includes microscopes, diagnostic tools and other resources. The maintenance department uses environmentally friendly products and practices, such as worm casting teas, biosolid organic fertilizers and micro-rate fungicide treatments.

- **Communications and Outreach Award** - This award recognizes individuals who effectively communicate conservation strategies with facility employees and others as well as share their efforts with golfers and other members of their community.
    - In 2021, Jay Randolph, CGCS of Ben Geren Golf Course in Forth Smith, Arkansas won this award for the huge amount of outreach and education he does in his local community and beyond. Among his efforts are teaching many local groups about the importance of native plantings to pollinators and hosting annual butterfly walks and other educational events for Western Arkansas Master Naturalists.

- **Innovative Conservation Award** - This award recognizes individuals who utilize or invent unique and innovative strategies for conservation at their facility. Some are doing a pollinator area.
    - In 2022, Russell F. Young, CGCS of Palm Tree Golf Course on Guam won this award for finding a unique and pesticide-free way of dealing with the rhinoceros beetle which is

devasting the Coconut Palm Trees on Guam. He created traps by using infected trees that the beetles could not escape from, then after the trees began to break down naturally, he finished composting them to use around the property. He worked with Colorado State University to monitor the effectiveness of the innovation and with the University of Guam to identify and plant trees less susceptible to the beetle.

4.2 Golf Course Best Management Practices in 50 States

GCSAA's Golf Course best management practices (BMPs) offer guidelines for superintendents to manage their facilities in an efficient and environmentally sound manner. BMP manuals document all of the science-based practices and professional course management strategies that superintendents employ. These practices benefit golf courses, golfers, and everyone in the community that a golf course serves. The GCSAA BMP National Template contains twelve chapters (though many states have added more to better serve superintendents in their state) with one chapter specifically dedicated to Pollinator Protection (Figure 6) and others include IPM with sections specific to pollinators (see Section 7 of the National Template), and Pesticide Management. [12]

BMP

GCSAA

Section 9 Pollinator Protection

Most flowering plants need pollination to reproduce and grow fruit. While some plants are pollinated by wind, many require assistance from insects and other animals. In the absence of pollinators, many plant species, including the fruits and vegetables we eat, would fail to survive.

The western honey bee (*Apis mellifera*) is one of the most important pollinators in the United States. Hundreds of other bee species, including the bumble bee (*Bombus* spp.), also serve as important pollinator species. Protecting bees and other pollinators is important to the sustainability of agriculture.

Pesticides are products designed to control pests (for example, insects, diseases, weeds, nematodes, etc.). Pesticides and other plant growth products, including plant growth regulators, surfactants, biostimulants, etc., are used in golf course management. The non-target effect of products used in golf course management is of increasing concern; therefore, pesticide applicators, including those on golf courses, need to be mindful of the impact that pesticides have on pollinator species and their habitat.

Regulatory Considerations

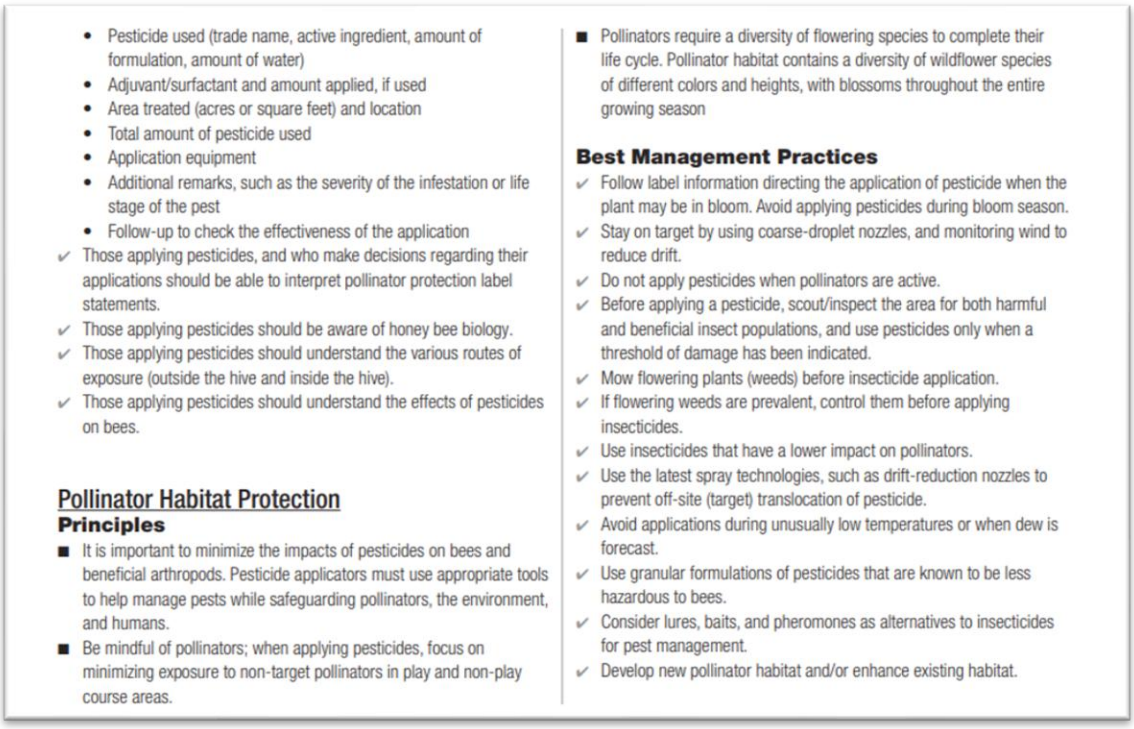
Principles

- Pollinator-protection language is a label requirement found on pesticide labels; follow the label, it is the law.
- Pesticide applicators must be aware of honey bee toxicity groups and able to understand precautionary statements.
- Recordkeeping may be required by law in order to use some products. IPM principles suggest that you keep records of all pest control activity so that you may refer to information on past infestations or other problems to select the best course of action in the future.

Best Management Practices

- ✓ Proper records of all pesticide applications should be kept according to local, state, or federal requirements.
- ✓ Use records to establish proof of use and follow-up investigation of standard protocols regarding:
  - Date and time of application
  - Name of applicator
  - Person directing or authorizing the application
  - Weather conditions at the time of application
  - Target pest

[12] GCSAA's BMP National Template planning guide is available online at: BMP Planning Guide | GCSAA.



- Pesticide used (trade name, active ingredient, amount of formulation, amount of water)
- Adjuvant/surfactant and amount applied, if used
- Area treated (acres or square feet) and location
- Total amount of pesticide used
- Application equipment
- Additional remarks, such as the severity of the infestation or life stage of the pest
- Follow-up to check the effectiveness of the application

✓ Those applying pesticides, and who make decisions regarding their applications should be able to interpret pollinator protection label statements.
✓ Those applying pesticides should be aware of honey bee biology.
✓ Those applying pesticides should understand the various routes of exposure (outside the hive and inside the hive).
✓ Those applying pesticides should understand the effects of pesticides on bees.

Pollinator Habitat Protection

Principles

■ It is important to minimize the impacts of pesticides on bees and beneficial arthropods. Pesticide applicators must use appropriate tools to help manage pests while safeguarding pollinators, the environment, and humans.
■ Be mindful of pollinators; when applying pesticides, focus on minimizing exposure to non-target pollinators in play and non-play course areas.
■ Pollinators require a diversity of flowering species to complete their life cycle. Pollinator habitat contains a diversity of wildflower species of different colors and heights, with blossoms throughout the entire growing season

Best Management Practices

✓ Follow label information directing the application of pesticide when the plant may be in bloom. Avoid applying pesticides during bloom season.
✓ Stay on target by using coarse-droplet nozzles, and monitoring wind to reduce drift.
✓ Do not apply pesticides when pollinators are active.
✓ Before applying a pesticide, scout/inspect the area for both harmful and beneficial insect populations, and use pesticides only when a threshold of damage has been indicated.
✓ Mow flowering plants (weeds) before insecticide application.
✓ If flowering weeds are prevalent, control them before applying insecticides.
✓ Use insecticides that have a lower impact on pollinators.
✓ Use the latest spray technologies, such as drift-reduction nozzles to prevent off-site (target) translocation of pesticide.
✓ Avoid applications during unusually low temperatures or when dew is forecast.
✓ Use granular formulations of pesticides that are known to be less hazardous to bees.
✓ Consider lures, baits, and pheromones as alternatives to insecticides for pest management.
✓ Develop new pollinator habitat and/or enhance existing habitat.

Figure 5. Excerpts from Chapter 9: Pollinator Protection from the GCSAA BMP National Template

GCSAA's BMP National Template provides guidance that is specific to the protection of sensitive species including those that are federally listed under the ESA, including:

Planning Design and Construction (Chapter 1)

- Regulatory Issues: Identify any rare, protected, endangered, or threatened plant or animal species on the site.
- Wildlife Considerations: Identify species on the site that are considered threatened or endangered by the federal or state government, including species the state deems "of special concern."

Irrigation (Chapter 2)

- Non-Play and Landscape Areas: Map any environmentally sensitive areas such as sinkholes, wetlands, or flood-prone areas, and identify species classified as endangered or threatened by federal and state governments, and state species of special concern.

Pesticide Management (Chapter 8)

- Environmental Fate and Transport: Environmental characteristics of a pesticide can often be determined by the environmental hazards statement found on pesticide product labels. The environmental hazards statement (referred to as "Environmental Hazards" on the label and found under the general heading "Precautionary Statements") provides the precautionary language advising the user of the potential hazards to the environment from the use of the product. The environmental hazards generally fall into three categories: (1) general environmental hazards, (2) non-target toxicity, and (3) endangered

species protection. Select pesticides with reduced impact on pollinators. Select pesticides that, when applied according to the label, have no known effect on endangered species present on the facility

GCSAA recognizes the need for state-level BMP programs and golf facility-written BMP plans for nutrient, drought, water management, and IPM. GCSAA has implemented national IPM and BMP guidance, setting voluntary standards that guide superintendents in using the most sustainable practices to steward the environment.

By 2020, GCSAA aimed to have comprehensive BMP programs in all 50 states, supported by a How-To Guide for BMP Planning. The BMP Planning Guide and National Template is an online resource for developing state-level golf course BMP programs and has made it easy for superintendents to develop state BMP programs.[13] GCSAA met its 2020 goal, and now comprehensive agronomic and environmental BMP manuals are available in all 50 states and can be accessed on the GCSAA website (State BMP Guides | GCSAA). Some states, like New York (Case Studies - Best Management Practices for New York State Golf Courses) have conducted case studies to follow effectiveness, including many case studies on IPM approaches and pollinator habitat projects.

Many of the state BMP guides include specific sections on sensitive and federally listed species protections, establishing management plans for both state and federally listed species onsite, training crew members to recognize these species, and contributing to species conservation efforts. Some specific BMP examples relevant for key monarch stopover/overwintering/breeding sites are highlighted below:

- Texas (texas-bmps.pdf): includes discussion of pesticide selection and use around habitat, includes establishment of habitat and education efforts for ESA species
- California (california-bmps.pdf): contains specific monarch conservation activities, chapter 15 is specific to ESA protections including specific pesticide practices, highlights EPA's Bulletins Live! Two and California specific ESA protections
- Iowa (iowa-bmps.pdf): pollinator practices include controlling flowering weeds before insecticide applications and using coarse droplet sizes to minimize drift, endangered species and critical habitat conservation activities to preserve habitat and migration corridors
- Florida (florida-bmps-update.pdf): endangered species protections and species-specific BMPs (ex: aquatic protections for manatees), highlights ESA Bulletins and participation in safe harbor agreements
- Wisconsin (wisconsin-bmps.pdf) and Delaware (delaware-bmps.pdf): includes specific recommendations for monarch butterfly conservation

Now that each state in the US has a state-specific BMP plan, GCSAA is now focused on phase two of the BMP initiative, working towards producing an individual golf facility BMP manual.

[13] GCSAA's State BMP planning guide is available online at: State BMP Guides | GCSAA.

4.3 Integrated Pest Management Practices in Golf

Integrated Pest Management (IPM) is integral to golf course operations all over the United States. GCSAA supports IPM efforts through the BMPs, education, resources and providing a step-by-step IPM planning guide. As noted above, Class A members and Certified Golf Course Superintendents need to obtain a pesticide applicator license or pass an IPM exam as part of their requirements for those designations.

An entire chapter (Section 7) of the GCSAA BMP National Template is dedicated to IPM principles, many of which are specific to pollinator protection, including:

Integrated Pest Management (Chapter 7)

- Pollinator Principles
    - It is important to minimize the impacts on bees and beneficial arthropods. Pesticide applicators must use appropriate tools to help manage pests while safeguarding pollinators, the environment, and humans.
    - Pollinator-protection language is a label requirement found on pesticide labels.
    - Be mindful of pollinators; when applying pesticides, focus on minimizing exposure to non-target pollinators in play and non-play course areas.
    - Pollinators may be negatively impacted when pesticide applications are made based on insufficient information and/or made without regard to the safety of pollinators.
- Pollinator Best Management Practices
    - When using pesticides, minimize injury and damage by following label directions.
    - Follow label information concerning the application of pesticides when plants may be in bloom. Avoid applying pesticides during bloom season.
    - Stay on target by using coarse-droplet nozzles and monitor wind to reduce drift.
    - Do not apply pesticides when pollinators are active.
    - Before applying a pesticide, scout/inspect area for both harmful and beneficial insect populations, and apply only when the indicated threshold of damage has been reached.
    - Mow flowering plants (weeds) before insecticide application.
    - If flowering weeds are prevalent, control them before applying insecticides.
    - Use insecticides that have a lower impact on pollinators.
    - Use the latest spray technologies, such as drift-reduction nozzles to prevent off-site (target) translocation of pesticide.
    - Avoid applications during unusually low temperatures or when dew is forecasted.
    - Use granular formulations of pesticides that are known to be less hazardous to bees.
    - Consider lures, baits, and pheromones as alternatives to insecticides for pest management.

GCSAA also has additional IPM resources located on the Association's website. These resources include fact sheets, key references, industry articles including cases studies and helpful reference texts.[14] This webpage also includes a step-by-step IPM planning guide developed by turf scientists and entomologists to aid members.

[14] https://www.gcsaa.org/environment/environmental-by-topic/ipm-resources

GCSAA assembled resources by partnering with Wendy Gelernter, Ph.D., and Larry Stowell, Ph.D., turfgrass and entomology researchers and founders of PACE Turf, and worked to bring together a comprehensive IPM guide with Pat Vittum, Ph.D., renowned turf entomologist who has worked with University of Massachusetts since 1980. The IPM Planning Guide takes you step by step through the process of building a comprehensive integrated pest management (IPM) plan specific to each golf course facility. You start with setting your goals and end with a complete plan that includes management practices, schedule, and even a related budget.

GCSAA is dedicated to helping golf course superintendents with thoughtful IPM practices. GCSAA provides hundreds of hours in on-demand online education as well as many seminars and sessions at the annual conference in support of this goal. This education includes scouting and monitoring pest populations, utilizing cultural, biological, and mechanical control methods, and using chemical controls responsibly. GCSAA also provides a study guide and an IPM exam for free to members and non-members alike. Both are used by hundreds of professionals annually.

GCSAA invests heavily in making sure golf course superintendents have access to the latest research on IPM and pesticides. GCSAA's magazine, *Golf Course Management,* highlights new and emerging technologies and shares stories of superintendents using them. GCSAA also has a research grant program which offers competitive research grants to researchers working to improve IPM practices for the overall benefit of the environment and community among other topics significant to golf course management. Results of these studies are published in peer review journals and *GCM* magazine. Pest management research funded by GCSAA since 2020 is provided in Table 2.

Table 2. Pest Management Research that GCSAA has funded since 2020

Year	Research title	University	Director
2025	Chemical and biological control of Cyanobacteria (blue-green algae) on golf course putting green surfaces	Rutgers University	Ming-Yi Chou, Ph.D.
2025	Impact of Soil Properties on Plant-parasitic Nematode Populations	Oregon State University	Alec Kowalewski, Ph.D.
2024	Implementation of a continuous soil surfactant program and implications for pre-emergence herbicide persistence on golf courses	University of Tennessee	Becky Grubbs Bowling, Ph.D.
2024	Nematode resistance management on golf course turf	University of Florida	William T. Crow, Ph.D.
2023	Suppressing dollar spot through adjustment of leaf surface pH	University of Wisconsin-Madison	Paul Koch, Ph.D.
2023	Effects of Moisture Management on Annual Bluegrass Weevil Movement, Oviposition, Larval Survival, and Turfgrass Damage	Pennsylvania State University	Benjamin McGraw, Ph.D.
2022	Evaluating alternative effective action thresholds for lance (*Hoplolaimus galeatus*) nematodes in creeping bentgrass putting greens	Virginia Tech	David McCall, Ph.D.
2022	Improving our Understanding of US Fall Armyworm Populations that Originate in Florida to	University of Florida	Silvana Vieira de Paula Moraes, Ph.D.

Year	Research title	University	Director
	Aid in Improving Golf Course IPM Recommendations		
2021	Optimizing the use of annual bluegrass weevil to control annual bluegrass in creeping bentgrass fairways	Rutgers University	Albrecht Koppenhofer, Ph.D.

Bekken et al. (2021) also identified three practices to reduce risk that are incorporated into many IPM and BMP programs deployed on golf courses throughout the US: reducing the number of pesticide applications, spot treatment, and product selection. These practices are utilized in current IPM and BMP programs as evidenced above and through a compilation of typical pesticide application information from superintendents across the US.

4.4 Overview of Golf Course Pest Management Activities

Proper planning, documentation, and review of pest control practices, along with all cultural practices that ensure healthy turfgrass and surrounding areas, are essential to course operations. Golf courses use both cool-season and warm-season turfgrass species, depending on geographic and climatic suitability and the intended purpose of each golf course feature (tee, fairway, rough, etc.). Bermudagrass, Kentucky bluegrass, and annual bluegrass are the most common types of turfgrass used on golf courses in the US.[15] The quality and playability of the turfgrass, which significantly influences the golf game and overall experience, must be protected from damage caused by weeds, diseases, and insects.

Pests on golf courses vary by location and season, but the most common pests are those in turfgrass and in surrounding trees:

- Common pests in turfgrass
  - Weeds: crabgrass
  - Fungal diseases: dollar spot and pink snow mold
  - Insects feeding on turf: various grubs, Annual Bluegrass weevils, and cinch bugs, and ants that can create mounds on greens and fairways
- Common pests in trees surrounding turfgrass
  - Insects: Emerald ash borers and Zimmerman pine moths, white flies, and spider mites

Pesticides are included as a component of pest management toolboxes on many, but not all, golf courses. Golf course superintendents try to avoid spraying pesticides unless necessary to protect key playing surfaces. When pesticides are needed to address specific pest management concerns in golf courses (decisions informed by scouting), superintendents are committed to responsible pesticide use on their golf courses. Superintendents understand that pesticide application on golf

[15] Golf Course Environmental Profile: Land-use and energy practices on U.S. golf facilities: https://www.gcsaa.org/docs/default-source/environment/gcep-property-report-phase-3-final-update-6-27.pdf?sfvrsn=4517cf3e_0

courses requires skill, knowledge, and training, and involves the use of the most selective possible pesticide to target the specific problem pest.

Pesticide use on golf courses meet – or in many cases exceed – all federal, state, and local regulations related to pesticide application and use, storage, and record keeping. Pesticides on golf courses are applied by licensed personnel and while pesticide license requirements vary by state, the Environmental Protection Agency (EPA) establishes minimum certification criteria for private and commercial applicators that ensure pesticide label comprehension through certification exams.[16] Recertification is required and continuing education credits for recertification are stipulated by each state to ensure applicators stay up to date on pesticide regulatory changes. State-specific pesticide regulatory information including licensing and certification requirements can be found on the National Pesticide Information Center website: https://npic.orst.edu/reg/state_agencies.html. Some states such as Kentucky require detailed record keeping of each application and notification requirements that are specific to golf courses requiring markers to be posted prior to certain applications.[17]

Different pesticides are applied to golf course features requiring management at different intervals and times depending on geographic location, weather, disease pressure, and pest outbreaks. Bekken et al. (2021) derived a framework for quantifying pesticide environmental risk on golf courses using data from 22 golf courses in the northeastern and north-central US and found that pesticide usage is not uniform across different areas and that golf courses show a distinct pattern in how pesticides are applied compared to other land uses.[18] In fact, there are some areas of golf courses that may receive routine pesticide inputs, such as greens, but much of the land that encompasses golf courses receive few, if any, pesticide applications. Additionally, pesticides are applied on golf courses using various methods, several of which USFWS determined are unlikely to result in pesticide exposure to monarch, including spot spraying, granular applications, and soil injection. Many golf courses also employ sophisticated technology such as GPS guidance, auto steering, and ultrasonic sensors on application equipment to help ensure targeted applications of pesticides and minimization of off-site movement.

4.5 Pest Management Activities Vary Across the Golf Course

Different portions of an average golf course require both diverse and highly tailored management practices due to: the diversity of turf types used on specific portions of a given golf course; the fact that golf courses experience heavy foot traffic and mechanical wear from mowing and maintenance equipment (which can make turf more susceptible to pests); and, varying features on golf courses such as water bodies, sand traps, golf cart tracks, etc. Proper management of golf courses is imperative to maintain a course's aesthetic appeal and functionality. In the context of IPM-based pest management this means a reliance on pest scouting (which relies on knowledge

[16] USEPA Federal Certification Standards for Pesticide Applicators; https://www.epa.gov/pesticide-worker-safety/federal-certification-standards-pesticide-applicators

[17] See https://www.uky.edu/Ag/Entomology/PSEP/1lawsandregs2.html#records for more information about Kentucky's pesticide regulations.

[18] Bekken, M.A., Schimenti, C.S., Soldat, D.J., and F.S. Rossi. 2021. *Analyzing pesticide environmental risk on golf courses*. In Golf Course Management: Pesticides. Available online at: https://gcmonline.com/course/environment/news/pesticide-environmental-risk-golf-courses.

and training to make proper pest identifications), and when necessary active management with a priority given to cultural methods.

Regardless of location, the most common time that pesticides are applied is in the early morning before golf play begins and when weather is more favorable for application because there are low winds (< 5 mph). Because monarchs are most active during late morning and early afternoon, the timing of pesticide applications on golf courses in the early morning reduces exposure to active adults and feeding larvae. Management details by golf course feature, with an emphasis on pest control and focus on interactions with monarchs and their resources, are provided below.

<u>Bunkers and Water Hazards</u>

Bunkers ('2' in **Figure 7**) and water hazards ('3' in **Figure 7**) are by nature not suitable habitat for monarchs and therefore management practices within these features are unlikely to affect adult and larval butterflies. Bunkers (~2% of an average golf course by area) are comprised entirely of sand, a substrate that does not support milkweed or other pollinator-attractive flowering plants and are not managed with pesticides. While water hazards (6% of an average golf course by area) may be treated to manage aquatic weeds and algae, these water features are not attractive to monarchs. Adult monarch butterflies do not forage for water directly from ponds and instead collect water through "puddling" behavior, visiting small puddles for water instead of larger bodies of water like golf course water hazards.[19] Mechanical and biological control options are also normally utilized first to manage nuisance vegetation in water hazards. Given the small overall area of bunkers and water hazards, and the highly limited interactions of monarchs with these portions of golf courses, management practices on these two golf features are unlikely to impact monarch butterflies.

Figure 6. Defined physical components of a typical U.S. golf course.

[19] https://www.nwf.org/-/media/Documents/PDFs/Garden-for-Wildlife/Tip-Sheets/Water-Butterfly-Gardens

Tees and Greens

Tees ('1' in **Figure 8**) and greens ('4' in **Figure 8**) make up less than 5% of the average golf course property. Because the tee box is the starting place for the hole and the green is the end of the hole, there is distance between the two, varying from ~130 to ~550 yards depending on the type of hole (par 5 holes are longer than par 3 holes). Tees and greens consist of a variety of turf grass species and typically receive the highest intensity of management, including regular mowing and chemical control of weeds and other pests that affect the playability of these surfaces. Tees and greens are mowed intensively to maintain grass heights <0.125 inches. These areas do not provide suitable habitat for monarch adults or larvae due to the grass height and lack of floristic resources. Therefore, management activities in these areas are unlikely to impact monarch butterflies.

Figure 7. Defined physical components of a typical U.S. golf course.

Examples of common pest threats on golf course tees and greens in different regions of the U.S. include:

Desert Southwest

- Annual bluegrass (*Poa annua*) is a common pest problem on tees and greens in this region and is generally controlled using appropriate herbicides applied 1-2 days prior to overseeding using a handheld or mounted boom sprayer. Applications to control Annual bluegrass strictly adhere to all herbicide label requirements, including implementation of buffer strips near water, avoiding spraying during adverse weather conditions (including when it is windy).

Great Lakes

- Algae and mosses are a common pest problem on greens in this region, and they are generally controlled using cultural controls (e.g., mowing and rolling), and if necessary, appropriate algaecides and herbicides. When pesticides are used to control these pests, pesticides are generally applied using handheld or mounted boom sprayers. Applications to control these pests strictly adhere to all pesticide label requirements, including use of appropriate adjuvants, utilizing the coarsest effective droplet size, and avoiding spraying during adverse weather conditions (including when it is windy).

Florida

- Dollar and leaf spots are common pests on tees and greens in this region, and are generally controlled using cultural controls (e.g., maintaining proper fertility levels and careful irrigation and thatch management), and if necessary, appropriate fungicides. Treatments of these pests follow IPM principles, and pesticides are only used when established thresholds are exceeded. When pesticides are determined to be necessary to

control these pests, pesticides are applied using handheld or mounted boom sprayers. Applications to control these pests strictly adhere to all pesticide label requirements, including use of boom skirts, utilizing the coarsest effective droplet size, and avoiding spraying during adverse weather conditions (including when it is windy).

Central Plains

- Crabgrass (*Digitaria* spp.) and goosegrass (*Eleusine* spp.) are common pest problems on tees and greens in this region, and are generally controlled using cultural controls (e.g., consistent aerification, light and frequent topdressing, overseeding, and reducing traffic), and if necessary, appropriate herbicides. When herbicides are used to control these pests, pesticides are generally applied using backpack sprayers, or handheld or mounted boom sprayers. Applications to control these weeds strictly adhere to all pesticide label requirements including avoiding spraying during adverse weather conditions (including when it is windy) and use of appropriate adjuvants (i.e., spray stickers).

When pesticides are applied to these tees and greens, the size of the application area would be classified as either spot spraying (areas of <1,000 ft^2) or small area applications (>1/10 acre or 4,356 ft^2) per the U.S. Environmental Protection Agency's (EPA) ESA Mitigation Menu website.[20] USFWS has also identified spot spraying as an application method not likely to impact the monarch.

Fairways

Fairways ('6' in **Figure 9**) represent a large portion of the golf course area, making up nearly a third of all turfgrass areas. Fairways are mowed less regularly than greens to maintain ~0.5-inch-tall grass but similarly require routine management to support playable terrain.

Figure 8. Defined physical components of a typical U.S. golf course.

When pesticides are applied over larger areas of turf on fairways, broadcast spraying with boom sprayers is common. This application method consists of a boom rig pulled by a tractor or other vehicle such as an all-terrain vehicle (ATV). The spray equipment is carefully set up so that the height of the boom on standard equipment is 18 inches or less from the ground. This boom height is predicted to result in decreased off-site drift and deposition and is the preferred method for minimizing environmental impact. This is consistent with what is considered "low boom" applications

[20] https://www.epa.gov/pesticides/mitigation-menu

that the Environmental Protection Agency (EPA) models in AgDRIFT.[21]

Examples of common pest threats on golf course fairways in different regions of the U.S. include:

Desert Southwest

- Annual bluegrass, crabgrass, dallisgrass (*Paspalum diliatatum*) and goosegrass are common pest problems on fairways in this region and are generally controlled using appropriate herbicides applied in the spring and fall using a mounted boom sprayer. Applications to control these weeds strictly adhere to all herbicide label requirements, including implementation of buffer strips near water, using the lowest possible boom height, and avoiding spraying during adverse weather conditions (including when it is windy).

Great Lakes

- Clover species are common pest problems on fairways in this region and are generally controlled using either regular mowing or appropriate herbicides applied using a handheld or mounted boom sprayer. Treatments can be either pre-emergent (to the weed) and made in the late fall or early spring, or post-emergent and made during summer. Applications to control these weeds strictly adhere to all herbicide label requirements, including the use of required adjuvants, using the coarsest effective droplet size, and avoiding spraying during adverse weather conditions (including when it is windy).

Florida

- Crabgrass and goosegrass are common pest problems on fairways in this region and are generally controlled using cultural controls (e.g., following turf best management practices such as maintaining optimal soil fertility, careful irrigation, removal of grass clippings and thatch management), and when necessary appropriate herbicides applied pre-emergence (to the weed) in the early spring or during the summer using a handheld or mounted boom sprayer. Applications to control these weeds strictly adhere to all herbicide label requirements, including use of boom skirts, using the coarsest effective possible droplet size, and avoiding spraying during adverse weather conditions (including when it is windy).

Northwest

- Dollar and leaf spots are common pests on fairways in this region and are generally controlled primarily using cultural controls (e.g., maintaining proper fertility levels and careful irrigation and thatch management), and if necessary, appropriate fungicides. Treatments of these pests follow IPM principles, and pesticides are only used when established thresholds are exceeded. When pesticides are determined to be necessary to control these pests, pesticides are applied using handheld or mounted boom sprayers. Applications to control these pests strictly adhere to all pesticide label requirements, including use of boom skirts, utilizing the coarsest effective droplet size, and avoiding spraying during adverse weather conditions (including when it is windy).

[21] Information about the AgDRIFT model can be found on EPA's website: https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment.

Management activities in fairways control for weed species and many pesticide products require blooming weed management to reduce potential exposure to pollinators. Given the lack of non-turfgrass species present in these areas, management activities are unlikely to impact monarch butterflies.

Roughs

Roughs ('5' in **Figure 10**) represent roughly half of the managed turf grass area on a typical golf course. Given the size of a typical rough, significant efforts have been made by superintendents to minimize maintenance of these areas to save on costs. When these areas are less intensively managed, nectar producing plants and milkweed species may emerge. While management is still needed within these areas, novel solutions are being adopted for more targeted inputs for achieving multiple benefits from these areas, like the Monarchs in the Rough program (see section 2.2 for more information about how roughs can serve as managed monarch habitat).

Figure 9. Defined physical components of a typical U.S. golf course.

Natural Areas

Natural areas ('7' in **Figure 10**) are inherently excluded from intensive turfgrass management programs. However, just like any habitat restoration site or conservation reserve area, these areas do still require some management to maintain biodiversity and maximize benefits of these areas. In golf course settings, natural areas must be balanced with aesthetics so "at the very least, most naturalized areas require annual mowing in the fall or spring, but many courses perform additional mowing throughout the year in areas where playability and aesthetics are a concern."[22] If pest issues arise in trees around the golf course in natural areas, pesticide injections are a common application method which would have no impact on monarch butterflies. As an example, the Director of Golf Operations with San Luis Obispo County Parks and Recreation who oversees three different golf courses notes that there are many eucalyptus trees on the properties. While they have been fortunate to not experience many pest issues in these trees, if issues did arise, the course of action would be to wait until all monarch activity is gone (monarchs typically arrive in late September and are gone by the middle of February) and cultural activities would be attempted first before resorting to chemical control. Tree injections would be used for pest control within the trees and spraying would only occur outside of the monarch activity season.

[22] USGA Naturalized Areas on the Golf Course, https://www.usga.org/content/usga/home-page/articles/2019/04/3-things-naturalized-areas-golf.html.

4.6 Typical Pesticide Application Regimes in Relation to Monarchs

Below are examples from across the country of typical pesticide application regimes on golf courses in relation to monarchs. These examples illustrate industry-wide standards and best practices for pesticide use on golf courses effectively mitigate pesticide exposure to monarchs. Moreover, these examples provide further illustrations that many golf courses go out of their way to create and maintain optimal habitat for monarchs to support the conservation of this important species. Additional information can be provided by GCSAA if of interest to USFWS.

SOUTH DAKOTA CASE STUDY			
Question	***Insecticides***	***Herbicides***	***Fungicides***
Where on the course are you applying pesticides?	Greens, tees, fairways, and spot treatments on roughs.	All areas of the course, as needed.	Greens, tees, and fairways.
From March - August, how frequently are you applying?	One application in March to greens, tees, fairways for grubs.	Spot sprays are used as needed in the summer.	Fairways and tees are treated once in June.
What time of the day are applications typically made?	Early morning.	Throughout the day as needed.	Morning.
What application equipment do you use for these applications? (ex: gator, backpack/handheld)?	Toro multi pro 1750.	Toro multi pro 1750, spot sprays are done using a vehicle-mounted 25 gallon sprayer.	Toro multi pro 1750.
What measures do you commonly take to protect monarch butterflies?	In roughs with native plants such as milkweeds herbicides are sprayed only in October, insecticides are not applied at all in these portions of the course. We have pollinator plots on the golf course and plant milkweed varieties; we also provide milkweed seeds for other groups to start pollinator plots.		
Are there measures you take to avoid/minimize pesticide exposure and impact to pollinators?	No insecticide applications to native pollinator plots and we only treat weeds and mow in our pollinator plots in the late fall.		

WASHINGTON STATE CASE STUDY			
Question	***Insecticides***	***Herbicides***	***Fungicides***
Where on the course are you applying pesticides?	N/A	Fairways, tee boxes, primary rough, native rough.	Putting greens.
From March - August, how frequently are you applying?	N/A	Once per season.	1-2 times per season.
What time of the day are applications typically made?	N/A	2 hours before sunset until dark.	At first light.

What application equipment do you use for these applications? (ex: gator, backpack/handheld)?	N/A	150-gallon sprayer with a 20 ft-wide boom, gator' with a 4 ft-wide boom, or for spot treatments either a backpack sprayer or a vehicle-mounted 20-gallon sprayer with a hand wand.	150-gallon sprayer with a 20 ft-wide boom.
What measures do you take to protect monarch butterflies?	Enhancing and promoting populations of milkweed, lupine, western yarrow, fern leaf biscuitroot in out-of-play native areas. Collecting milkweed seeds to germinate and plant new areas. Actively participate in monarchs in the Rough through Audubon International to plant pollinator habitat including milkweed.		
Are there measures you take to avoid/minimize pesticide exposure and impact to pollinators?	Spot spray when possible. Make applications prior to bloom. Control weeds with mechanical mowing when feasible. Make applications in the evening behind play. Minimize drift.		

4.7 Mitigating Measures in Golf Reducing Pesticide Exposure

The EPA recently released an ecological mitigation menu website that provides conservation measures for addressing potential pesticide runoff and erosion from pesticide applications in agricultural lands.[23] These ecological mitigations are part of EPA's larger workplan to improve protection for species listed under the ESA and for EPA to meet their obligations when registering and re-registering pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).[24] While pesticide use in golf courses differs from those in agricultural lands, there are golf course features and inherent golf course design elements that arguably function to reduce pesticide runoff/erosion in similar ways to many of the mitigation measures on EPA's mitigation menu website. In GCSAA's view these include, but are not limited to:

- Cover crops - turfgrass on golf courses is functionally analogous to cover crops in agricultural landscapes with regards to mitigating pesticide movement off the application site. In EPA's ESA Mitigation Menu, cover crops are identified as a measure that is effective at mitigating pesticide runoff and erosion. Like cover crops, turfgrass on golf courses helps prevent soil erosion by providing continuous ground cover, can contribute to soil health by adding organic matter through grass clipping and root turnover, and can help manage water by improving soil structure and increasing infiltration.
- Vegetative filter strips - turfgrass and other vegetation in the roughs on golf courses serve a similar function to vegetative filter strips in agricultural landscapes with regards to mitigating pesticide runoff and erosion. Golf course greens are typically surrounded by turfgrass that is

[23] https://www.epa.gov/pesticides/mitigation-menu
[24] EPA's ESA Workplan Update is located at: https://www.epa.gov/system/files/documents/2022-11/esa-workplan-update.pdf

higher in height than the green and also function as a filter strip.

- Pesticide applications that meet the definition of spot spraying and small area application.

Similarly, spray drift mitigation measures that EPA identified in the Final Herbicide Strategy (Docket EPA-HQ-OPP-2023-0365) and Final Insecticide Strategy (Docket EPA-HQ-OPP-2024-0299) as ways to reduce spray drift buffer distances required for non-target species protection are always employed when broadcast applications of pesticides are made on golf courses. Specifically, the typical boom height on spray rigs used on golf courses would qualify as "low boom" under EPA's ESA strategies and provide a 75% reduction in the buffer distance required. In other words, the equipment used to apply broadcast applications of pesticides on golf courses inherently mitigates the potential spray drift of pesticides off the application site.

GCSAA compiled a list of practices from the GCSAA BMP National Template and information from management regimes across the country for mitigating pesticide spray drift and runoff/erosion which has been submitted to the EPA for consideration when implementing EPA's ESA Workplan during the FIFRA registration process. A copy of what was transmitted to EPA is provided in Attachment 2.

5. Aligning with EPA's FIFRA Registration Process and Incidental Take Exception Under 4(d) for Golf Course Management

The pesticide Registration and Registration Review process conducted by the EPA under the auspices of FIFRA ensures that pesticide registrations do not cause undue harm to humans or the environment. Pesticide applications made on golf courses adhere to FIFRA-approved labels and will inherently protect monarch butterflies. The GCSAA believes that golf courses play a key role in monarch conservation through habitat establishment, maintenance, and education and that EPA-approved pesticide use on golf courses as part of responsible pest management regimes does not pose a threat to the continued existence of monarch butterflies. As EPA starts to implement their ESA Workplan and approve future pesticide labels, the list of practices compiled by GCSAA for mitigating pesticide spray drift and runoff/erosion, submitted to the EPA as referenced above, can be considered by EPA (Appendix 2). GCSAA recognizes that EPA's ESA Workplan and implementation will continue to be refined and revised to reflect the best available data and GCSAA welcomes the opportunity to work with EPA as this process progresses for future pesticide actions.

The GCSAA reiterates that golf courses require special consideration under the ESA to continue to support migrating monarchs. **There is credible support to include golf course management activities, including pesticide use in accordance with the EPA-approved label, and consistent with the approach EPA and the Service are taking to ESA compliance with regards to all other listed species, as an incidental take exception under Section 4(d) should the monarch be listed under the ESA.** This approach, for both the monarch and other species listed in the future, will provide regulatory efficiency, a coordinated and consistent compliance approach for golf course superintendents, and help support faster and more consistent protections for all listed species. Without this exception, golf courses would not be able to play their important role in monarch conservation, the economy, and for their communities. GCSAA supports flexibility to allow for adaptive management practices that can be adjusted based on new research and monitoring data related to monarch conservation and golf course

management.

6. Conclusion

Thank you for allowing GCSAA to submit the above comments to the agency. We look forward to working with USFWS on monarch recovery and conservation while ensuring our mutual goals to protect habitat and species. GCSAA welcomes the opportunity to discuss with the agency additional opportunities to increase or enhance monarch habitat around the country. Golf courses establish and maintain valuable pollinator habitat that we believe will be integral to the success of the species. Golf courses provide habitat for monarchs that would not otherwise be available, often the only habitat for miles. Under Section 4(d) of the ESA, we propose an incidental take exception for pesticide use and for normal golf course management practices. Without the 4(d) exception, golf courses would not be able to effectively treat the managed portions of their course for pest infestation, the quality of the playing surfaces of courses would denigrate which would lead to reduced rounds of play, negatively impacting the viability of the business plan for the golf courses. Golf courses would be forced to close, leaving the land (including monarch habitat) for developers, or completely unmanaged. This would result in the net loss of monarch habitat. Thus, golf courses require special consideration under the ESA to continue to support migrating monarchs.

We are committed to being part of the recovery of the monarch butterfly. Please contact me at (800) 472-7878, ext. 3619 or cmckeel@gcsaa.org if you have additional questions or if you need additional information.

Appendix I. Resources that GCSAA shares with members to help with Pollinator Conservation

Golf specific programs:

- Operation Pollinator - Operation Pollinator provides golf course managers agronomic information to successfully establish and manage attractive wildflower habitat for bumblebees and other pollinators. Additionally, managers can use provided communication tools to help explain how Operation Pollinator supports pollinators while also enhancing the visual appearance of the course and the overall playing experience. Syngenta collaborates with Applewood Seed Company in Arvada, Colo. to provide a golf course with custom-blended wildflower mixes native to your geographic region. Over 250+ golf courses have participated in the program.
- Monarchs in the Rough - Monarchs in the Rough is an environmental initiative led by Audubon International aimed at protecting and restoring habitats for monarch butterflies and other pollinators. The program involves hundreds of participating golf courses across North America, which help create breeding grounds for monarchs along their migration routes. This initiative is a collaborative effort with the Environmental Defense Fund to establish crucial pollinator habitats, addressing the decline in monarch populations by providing necessary resources like milkweed and wildflower seeds.

General resources:

- USDA Forest Service - The U.S. Forest Service manages 193 million acres of public lands for native plants and pollinators, research on pollinating species, restoration of habitat post-fire, and public-friendly outreach materials print and online, including the Celebrating Wildflowers website, Pollinator-Friendly Ecoregional Planting Guides, Bumble Bees of the Eastern and Western United States books, Bee Basics book, and Attracting Pollinators to Your Garden brochures (co-produced with Pollinator Partnership), and the Conservation and Management of Monarch Butterflies manual.
- U.S. Fish and Wildlife Service - This national center is a place for land managers, decision and policy makers, scientists, program leaders and others to explore, coordinate and share best practices and approaches to protecting monarch butterflies.
- Pesticide Environmental Stewardship - Development of The Pesticide Stewardship Website is funded by the NSF-Founded Center for Integrated Pest Management. The goals of the Web site are to summarize general principles of pesticide stewardship and to direct users to key resources (including state-specific regulations) by stewardship topic.
- Pollinator Partnership - Pollinator Partnership's mission is to promote the health of pollinators, critical to food and ecosystems, through conservation, education, and research. Signature initiatives include the NAPPC (North American Pollinator Protection Campaign), National Pollinator Week, and the Ecoregional Planting Guides.
- North American Pollinator Protection Campaign - The North American Pollinator Protection Campaign (NAPPC) is a tri-national collaboration of diverse partners working to protect pollinators and raise the profile of pollinator issues. The organization has nearly 140 entities working together to promote awareness and scientific understanding of pollinators, gather and disseminate information about pollinators, provide a forum to identify and discuss pollinator issues, and promote projects, initiatives and activities that enhance pollinators.
- The Xerces Society - The Xerces Society, a conservation organization focused on invertebrates, works with golf courses to improve pollinator habitat and promote biodiversity. They provide resources and guidance on creating pollinator-friendly spaces on golf

courses, which can be valuable for wildlife in urban and suburban areas, according to the Xerces Society.

Pollinator information by green industry associations and industry partners:

- PollinatorHealth.org by the National Pest Management Association (NPMA)
- Debug the Myths: Pollinator Protection by RISE (Responsible Industry for a Sound Environment)
- Pollinator Protection Resources by CropLife International
- The Importance of Pollinators by BASF
- Bee Health by Bayer
- Pollinator Information by Bayer
- Bee Health by Syngenta

Appendix 2. GCSAA Mitigation List for Spray Drift and Runoff

Provided by GCSAA to U.S. EPA to Inform Spray Drift and Runoff/Erosion Mitigation Measures for Golf Courses, December 15, 2023

BMP CATEGORY	BEST MANAGEMENT PRACTICE – DESCRIPTION	REFERENCE(S)	BMP CLASSIFICATION
BUFFER AREAS	Use turf and native plantings to enhance buffer areas. Increase height of cut in the riparian zone to filter and buffer nutrient movement to the water. Recognition also that turf is a vegetative filter strip.		Run-off & erosion
	A 1.5-inch-tall buffer strip reduced runoff of 2,4-D to 8% of that from turfgrass without a buffer strip. Similar reductions were documented for dicamba, mecoprop, chlorpyrifos, NH^4-N, and PO^4-P.	(Cole et al. 1997)	
	A gradual increase in the buffer strip height-of-cut resulted in 19% less runoff volume than a single height-of-cut, which also result in a further 17% and 11% reduction of N and P runoff, respectively, compared to a single buffer strip.	(Moss et al. 2005)	
	Blue flag Iris (*Iris versicolor*) resulted in 76% and 48% of chlorpyrifos and pendimethalin, respectively, being removed from soil compared to 46% and 8% from the unvegetated control.	(Smith et al. 2008)	
	Water volume, nitrate and phosphate concentration in runoff from simulated crop lands were reduced by as much as 70 – 90% when using turfgrass as a buffer strip.	(Saleh et al. 2018)	
COVER CROP	Maintain turfgrass or other vegetation suitable for the areas to prevent bare soils and implement sprigs, seedings, etc. for weak turfgrass areas in order to maintain adequate ground cover. (Turf is not a row crop and provides ground cover.)		Run-off & erosion
	Leaching of metalaxyl decreased as bentgrass density increased.	(Petrovic et al. 1996)	
	The half-life of mefenoxam and propiconazole were reduced between 25% and 49%, respectively, when applied to creeping bentgrass compared to bare soil.	(Gardner and Branham 2001)	

BMP CATEGORY	BEST MANAGEMENT PRACTICE – DESCRIPTION	REFERENCE(S)	BMP CLASSIFICATION
	The half-life of cyproconazole was 129 days when applied to bare soil but declined to 12 days when applied to creeping bentgrass. The amount of cyproconazole detected in soil under turfgrass was 1% of that detected in bare soil 4 days after application.	(Gardner et al. 2000)	
	Pendimethalin remained in the turfgrass system with none detected in soil and ≤0.003 ppm detected in leachate.	(Stahnke et al. 1991)	
	Kentucky bluegrass leaves and thatch were found to be strong sorbents of pesticides.	(Lickfeldt and Branham 1995)	
	Nitrogen and phosphorus runoff from established tall fescue/Kentucky bluegrass was 1% and 8% of that from cultivated tobacco from the same plots in prior years.	(Gross et al. 1990)	
DRAINAGE MANAGEMENT	Maintain berms, waterways, grassed features, wetlands, etc. to manage drainage, runoff treatment train, etc.		Run-off & erosion
	Following storm events on a golf course in Indiana, an artificially constructed wetland resulted in reductions of NO3-N and phosphorus exiting the golf course of 97% and 74%, respectively.	(Kohler et al. 2004)	
	A constructed wetland resulted in a reduction of approximately 88% of nitrogen, 81% of chemical oxygen demand, 85% of heavy metals, and 60% of the total suspended solids prior to discharge	(Kao et al. 2001)	
	In North Carolina, a wetland resulted in a reduction of more than 80% nitrogen, 91% of total suspended solids, 59% of total phosphorus, and 66% of chemical oxygen demand following a storm event.	(Kao and Wu 2001)	
	St. Augustinegrass and mulch resulted in >50% reduction of cumulative runoff volume compared to xeriscape over two years in Texas.	(Chang et al. 2021)	
	Pervious surfaces one-half the size of impervious surface resulted in a 50% reduction in drainage water volume.	(Steinke et al. 2009)	
MANAGEMENT ZONES	Establish a special management zone around surface waters.		Run-off & erosion

BMP CATEGORY	BEST MANAGEMENT PRACTICE – DESCRIPTION	REFERENCE(S)	BMP CLASSIFICATION
	Soil loss via runoff from vegetated plots was 35 lbs acre^{-1} yr^{-1} which was increased by 40-fold on bare soil.	(Chirino et al. 2006)	
	Vegetative cover reduced relative soil loss and relative runoff to 10% and 25%, respectively, compared to bare soil.	(Elwell and Stocking 1976; Moreno-de las Heras et al. 2009)	
CRITICAL HABITAT	Preserve critical habitat.		Offset
	Naturalized areas, which may consist of tall grasses or a mixture of grasses, forbs, and other plants, can provide ecosystem services by helping support urban wildlife, pollinators, and other beneficial insects. Naturalized golf course roughs may shelter a reservoir of natural enemies when insecticides are applied to fairways, tees, or greens, allowing them to recolonize once residues have waned.	(Dobbs and Potter 2016)	
	Birds and insect (ground beetles and bumblebees) showed higher species richness and higher abundance on golf course habitat compared to nearby farmland. Golf course supported a greater diversity of tree species which was positively related to increases in bird diversity.	(Tanner and Gange 2005)	
IDENTIFY SPECIES	Identify species on the site that are considered threatened or endangered by the federal or state government, including species the state deems "of special concern."	(U.S. Fish & Wildlife Services 2023a; 2023b; United States Golf Association 2006)	Education & Stewardship
IPM	Use IPM principles to limit excess use of pesticides.		Education & Stewardship
	Mapping diseased areas using digital imagery from unmanned aerial vehicles and making fungicide applications guided by disease-incidence maps, required 51 – 65% less fungicide.	(Booth et al. 2021)	
	IPM and biologically-based strategies using alternative cultural practices reduced the environmental impact by 50-95% while maintaining acceptable turfgrass quality and meeting golfer satisfaction.	(Rossi and Grant 2009)	

BMP CATEGORY	BEST MANAGEMENT PRACTICE – DESCRIPTION	REFERENCE(S)	BMP CLASSIFICATION
	Pesticide programs utilizing reduced risk products were as effective in controlling dollar spot disease as a conventional program while reducing pesticide risk by ~50–80% depending on the pesticide risk indicator used.	(Bekken et al. 2022)	
IPM	Always follow the directions on the label. These directions have been developed after extensive research and field studies on the chemistry, biological effects, and environmental fate of the pesticide. The label is the single most important document in the use of a pesticide. State and federal pesticide laws require following label directions!		Education & Stewardship
	Survey results indicate that nearly 100% of turfgrass professionals appear to be well informed of their responsibilities for legal and safe use of pesticides. Also, those green industry practitioners have incorporated this information into their daily routine to use pesticides safely and correctly to be environmentally responsive.	(Fidanza et al. 2009b)	
IPM	Use preventive chemical applications only when your professional judgment indicates that properly timed preventive applications are likely to control the target pest effectively while minimizing the economic and environmental costs.		Education & Stewardship
	Preventive fungicide applications are a standard control strategy for many soilborne turfgrass diseases.	(Couch 1995)	
	Results indicate that preventive low-rate applications of the DMI fungicides triadimefon, triticonazole, tebuconazole, metconazole, or myclobutanil are effective tools in the suppression of fairy ring on putting greens caused by either *Bovista dermoxantha* (Vittad.) De Toni, (= *Lycoperdon dermoxanthum* Vittad.), and *Vascellum curtisii* (Berk.) Kreisel (= *L.curtisii* Berk.).	(Miller et al. 2012)	

BMP CATEGORY	BEST MANAGEMENT PRACTICE – DESCRIPTION	REFERENCE(S)	BMP CLASSIFICATION
	The loss of many insecticides for curative white grub control owing to the implementation of the Food Quality Protection Act of 1996 (FQPA) and the introduction of new chemistries (e.g., halofenozide, neonicotinoids) with long residual activity and optimal performance against young larvae have led to the wide adoption of preventive applications against white grubs. As they are usually applied over large areas, preventive applications of these new compounds are expensive, increase the chances of resistance development or enhanced microbial degradation and, by depriving endemic natural enemies of host/prey, may ultimately increase dependency on chemical control.	(Koppenhöfer and Fuzy 2008)	
	Fungicide labels usually provide a range of application rates and intervals. Fungicides can be used on a preventive basis (usually at lower rates and/or at longer intervals between applications) when a disease outbreak has not yet occurred but when weather favorable for disease is expected. Conversely, fungicides may be used on a curative basis (often at higher rates and/or at shorter intervals) after an outbreak has occurred and disease pressure is high.	(Clarke et al. 2020)	
PESTICIDE SELECTION	Select pesticides that have a low runoff and leaching potential.		Run-off & erosion
	Following application to putting greens, chemicals lost as a percent of applied increased in the order prothioconazole < trifloxystrobin < pyraclostrobin < boscalid < fludioxonil. Chemicals with a low half-life and high sorption coefficient tended to leach less than those with high half-lives and low sorption coefficients.	(Aamlid et al. 2020)	
	Leaching of isazophos, isofenphos, and ethoprop through a putting green was low (<0.3% of applied) but differed slightly among pesticides. The low leaching and differences were attributed to the differences in biodegradation that likely occurred in the thatch layer.	(Cisar and Snyder 1996)	
	The lowest maximum concentration of fungicide found in leachate occurred from the fungicide with the highest sorption coefficient (propiconazole)	(Larsbo et al. 2008)	

BMP CATEGORY	BEST MANAGEMENT PRACTICE – DESCRIPTION	REFERENCE(S)	BMP CLASSIFICATION
PROPERLY CONFIGURED APPLICATION EQUIPMENT	Minimize off-target movement by using properly configured application equipment.		Run-off & erosion
	Spray droplet size increased by as much as 10-fold when air pressure decreased from 84 to 14 kPa.	(Hanks 1995)	
	Spray adjuvants effectively increased spray droplet size when air pressure was 14 kPa but failed to influence droplet size when air pressure was 84 kPa.	(Hanks 1995)	
	Spray drift increased from 14% to 37% between correct and incorrectly adjusted equipment.	(Nordby and Skuterud 1974)	
SPRAY VOLUME	Use recommended spray volumes for the targeted pest to maximize efficacy.		Run-off & erosion
	Anthracnose declined by 35% as the carrier volume of fludioxonil was increased from 43 to 87 gallons per acre.	(Fidanza et al. 2009a)	
	Chlorothalonil applied to creeping bentgrass in a carrier volume of 50 gallons per acre resulted in a 65% greater reduction of dollar spot disease compared to a carrier volume of 110 gallons per acre.	(McDonald et al. 2006)	
	2,4-D applied in a carrier volume of 80 gallons per acre compared to 20 gallons per acre resulted in greater movement of the chemical through the turfgrass canopy and resulted in a reduction of dislodgeable residue from the leaf surface.	(Jefferies et al. 2017)	
NOZZLE SIZE	Use the latest spray technologies, such as drift- reduction nozzles to prevent off-site (target) translocation of pesticide.		Drift reduction
	Nozzles that provided nearly complete coverage resulted in greater dollar spot control on fairways and greens than low-drift nozzles on 9 of 62 dates whereas low-drift nozzles provided better control on 0 of 62 dates ($\alpha=0.05$).	(Vincelli and Dixon 2007)	
	Spray drift from flat-fan nozzles increased from 2% to 22% of applied as nozzle size decreased from 10 to 1, respectively.	(Miller et al. 2011)	

BMP CATEGORY	BEST MANAGEMENT PRACTICE – DESCRIPTION	REFERENCE(S)	BMP CLASSIFICATION
NOZZLE SIZE – SPRAY IMPACT AREA	Stay on target by using coarse-droplet nozzles.		Drift reduction
	Fine droplet size resulted in a downwind drift of 34% (normalized percent of applied rate) compared to 7% from the ultra-course droplet size at 20 feet downwind.	(Foster et al. 2018)	
WIND SPEED	Monitor wind speed to reduce drift.		Drift reduction
	Measured 40 feet from the nozzle, dicamba drift increased from 0.2% to 13.5% when wind increased from 2 to 11 miles per hour.	(Sousa Alves et al. 2017)	
WEATHER MONITORING AND SITE ASSESSMENT	Before applying a pesticide, evaluate the impact of site-specific characteristics (for example, proximity to surface water, water table, and well-heads; soil type; prevailing wind; etc.) and pesticide-specific characteristics (for example, half-lives and partition coefficients).		Drift reduction
	The half-life of mefenoxam and propiconazole were reduced between 25% and 49%, respectively, when applied to creeping bentgrass compared to bare soil.	(Gardner and Branham 2001)	
	The half-life of cyproconazole was 129 days when applied to bare soil but declined to 12 days when applied to creeping bentgrass. The amount of cyproconazole detected in soil under turfgrass was 1% of that detected in bare soil 4 days after application.	(Gardner et al. 2000)	
	Measured 40 feet from the nozzle, dicamba drift increased from 0.2% to 13.5% when wind increased from 2 to 11 miles per hour.	(Sousa Alves et al. 2017)	
BOOM HEIGHT	Utilize boom height 24” or under.		Drift reduction
	Spray drift from flat-fan 110° nozzles increased from 2 to 27 microliters when boom height was increased to 13 to 33 inches.	(Miller et al. 2011)	
	Increasing the boom height from 15 to 30 inches increased spray drift from 1% to 32%.	(Nordby and Skuterud 1974)	
DRIFT AND DEPOSITION AIDS	When applicable, use drift and deposition aids with pesticide applications to reduce off-target movement.		Drift reduction
	Drift reduction agents resulted in ~45-55% reduction in spray drift depending on boom and nozzle type.	(Vieira et al. 2021)	
	Including 0.125% spray adjuvant resulted in spray droplets <105 µm decreasing from 35% to 16%.	(Hanks 1995)	

BMP CATEGORY	BEST MANAGEMENT PRACTICE – DESCRIPTION	REFERENCE(S)	BMP CLASSIFICATION
FOG AND TEMP INVERSIONS	Avoid spraying during foggy conditions or temperature inversions.		Drift reduction
	Temperature inversions tend to occur at night and often begin forming between 5:00 pm and 8:00 pm.	(Bish et al. 2019)	
	Air pollutant concentrations peaked during hours when air mixing was lowest, which was at 8:00 pm.	(Yassin et al. 2018)	
	Dicamba drift was primarily influenced by the interaction of temperature and humidity. Long periods of stable atmospheric conditions after applications resulted in greater dicamba flux.	(Kruger et al. 2023)	
MIX AND LOAD	Store, mix, and load pesticides away from sites that directly link to surface water or groundwater.		Education & Stewardship
	Inadequately stored pesticides and improper chemical mixing and loading practices can present a potential risk to worker health and to environment.	(Vogt 2009)	
	The maintenance area is where pesticides are loaded into application equipment, mowers and other pieces of equipment are serviced, and pesticides, fuel, fertilizer, and cleaning solvents are stored. This is where pollution of soil, surface water, or ground water is most likely to occur.	(Florida Department of Environmental Protection 1995)	
DEFLECTOR SHIELD	Use a deflector shield to prevent fertilizer and pesticide spills from contacting surface waters.		Run-off & erosion
	A deflector shield effectively reduced fertilizer spread beyond the deflector.	(Parish 2003)	
	From 140 to 350 yards downwind, glyphosate drift was reduced by 50% using a hooded sprayer compared with no hood.	(Foster et al. 2018)	
	Spray hoods resulted in a reduction of spray drift between 33%-65% compared with no hoods.	(Vieira et al. 2021)	
TIMING OF PESTICIDE APPLICATIONS	Decide which pest management practice(s) are appropriate and carry out corrective actions. Direct control where the pest lives or feeds. Use properly timed preventive chemical applications only when your professional judgement indicates they are likely to control the target pest effectively, while minimizing the economic and environmental costs.		Education & Stewardship

BMP CATEGORY	BEST MANAGEMENT PRACTICE – DESCRIPTION	REFERENCE(S)	BMP CLASSIFICATION
RECORD KEEPING	Use records to establish proof of use and follow-up investigation of standard protocols regarding date and time of application; name of applicator; person directing or authorizing the application; weather conditions at the time of application; target pest; pesticide used.		Education & Stewardship
WELL PROTECTION	Properly plug abandoned or flowing wells.		Run-off & erosion
	Many wells around homes, farms, industrial sites, and urban areas (possibly even on golf courses) may have been abandoned without being properly plugged. This creates risk to humans, animals, and the water supply.	(Lesikar and Mechell 2010)	
	An abandoned water well is a well that has been permanently discontinued, is in such disrepair that its continued use for the purpose of obtaining groundwater is impractical, has been left uncompleted, is a threat to groundwater resources, or may be a health or safety hazard.	(Michigan Legislature 1978)	
	Unplugged abandoned wells are potentially a threat to the environment and human wellbeing.	(Environmental Assistance Center 2020)	
GRASS CLIPPINGS	Dispose of grass clippings where runoff will not carry them back to surface waters.		Run-off & erosion
	Depending upon numerous factors, turfgrass clippings can contain 2-5% nitrogen and 0.1-0.5% phosphorus.	(Kussow et al. 2012)	
	Pesticide residue was removed with the turfgrass clippings.	(Cisar and Snyder 1996)	
	2,4-D residue was removed from turfgrass foliage following ball roll.	(Jefferies et al. 2017)	
POLLINATOR PROTECTION	Those applying pesticides, and who make decisions regarding their applications should be able to interpret pollinator protection label statements.	(Dobbs and Potter 2015)	Education & Stewardship

BMP CATEGORY	BEST MANAGEMENT PRACTICE – DESCRIPTION	REFERENCE(S)	BMP CLASSIFICATION
	Results validate EPA label precautionary statements not to apply neonicotinoids insecticides to blooming nectar-producing plants if bees may visit the treatment area. Direct hazard from insecticides can be mitigated by adhering to label precautions, or if blooms inadvertently are contaminated, by mowing to remove them. Chlorantraniliprole usage on lawns appears non- hazardous to bumble bees.	(Larson et al. 2013)	
ENV STEWARDSHIP PROGRAMS	Participation in recognized stewardship program		Education & Stewardship
	In a survey of university-affiliated golf course superintendents participating in the Audubon Cooperative Sanctuary Program, better water quality and decreased long-term maintenance costs were ranked as the most beneficial aspects of the program.	(Kuban 2015)	

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