Bees & Golf: An Unlikely Yet Impactful Partnership

By

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Parker Anderson, Greener Golf

Executive Summary

Protecting Pollinators and Changing an Industry

With over 200,000 diverse species, pollinators are keystone organisms in nearly every ecosystem. They provide essential ecosystem services that provide direct and indirect benefits, including pollinating 35% of our food crops and 94% of flowering plants. Despite their contributions to the environment and humans, pollinator populations are declining worldwide due to various anthropogenic causes like land use change and pesticide use. A multi-faceted approach must be taken in order to reverse this decline and maintain the valuable diversity and services provided by pollinators.

Golf courses represent an enormous green space land cover (2 million acres in the United State alone) that already provides important natural retreats and ecosystem services, especially in urbanized landscapes, but have a largely untapped potential to support pollinators. Many courses are beginning to move from resource-intense management toward more sustainable practices, but key challenges to improve habitats for pollinators on golf courses remain. There is a lack of awareness surrounding the myriad of ecological and socioeconomic benefits of supporting honeybees and other pollinators on golf courses, and insufficient guidance on where and how to actually implement pollinator habitat. In order to protect, promote, and propagate pollinators on golf courses, we address these challenges directly through three interrelated approaches:

1) Document the history and shift in golf course practices and provide golf course managers with actionable rationale and strategies to identify and convert underutilized managed areas into lower maintenance areas, as a step towards more sustainable land use, potential pollinator habitat, and even cost reduction.

2) Describe the menu of pollinator habitat options on a golf course (from honey-producing apiaries to formal and informal gardens), with guidance on how to recognize and assess the ecological and social benefits that these provide and easy ways to communicate and celebrate these benefits.

3) Design and build a multifunctional demonstration pollinator garden on a golf course, documenting every step in the process in a way that it can be applied at any site.

1) Identify Underutilized Areas on Golf Courses

Our review of the history and current practices on golf courses makes it clear that high-intensity maintenance does not need to be the norm. Golf has a long-standing connection with nature, but many factors, from war chemicals to televising the sport, has led to the intensification of management. We provide evidence through both quantitative research across courses and case studies outlining golf courses that are now part of a shift toward more sustainable practices. To provide specific guidance on how a course can become a part of this shift, we focus on one relatively simple management action: converting managed underutilized areas on a golf course into lower maintenance areas. There are two main methods to identify underutilized areas on a course that we outline in detail:

1. Observing the course and recording where people regularly go, and

2. Utilizing the DEACON tool from The United States Golf Association (USGA) to map golfers and cart routes.

We demonstrate how using the DEACON tool can also allow managers to actually quantify the benefits of reducing the maintenance level of underutilized areas. These include reducing both water and chemical (fertilizer and pesticide usage), which lowers maintenance and labor costs and has the potential to provide safe ecosystem services and habitat for wildlife and pollinators.

2) Choose from a Menu of Pollinator Habitat Options for Golf Courses and Recognize and Share their Benefits

Depending on how they are managed, the different components and acreage of golf courses can serve as safe havens for pollinator species, providing them with resources such as food, water, and shelter. We developed a menu of options for implementing pollinator habitat on courses that allow facilities to choose from a suite of interventions that best suit their specific wants, needs, and individual circumstances:

1. Mixed Species Rough
2. Unmowed Naturalized Area With Wildflowers
3. Formalized Native Pollinator Garden, and
4. Apiaries in Naturalized Areas.

We further document that creating any type of pollinator habitat on golf courses is not only key to sustaining healthy pollinator populations, but can also provide numerous additional benefits for the golf course and local community, including:

- Improved On-Site Safety
- Reduced Maintenance Costs and Labor
- Unique Branding and Sales
- Positive Player Experience and Health
- Community Engagement and Educational Opportunities
- Large-Scale Impact on Food and Water Systems

3) Design and Implement a Pollinator Garden

To provide both actionable guidance and a specific demonstration of how a golf course can incorporate pollinator habitat we developed a set-by-step guide for designing and implementing a multifunctional pollinator garden that equally meets the needs of key end users. Based on scientific research and previous knowledge, we outline the process in terms of the following steps:

1. Establishing Project Goals and Parameters - key visions or desired outcomes, plus any budget or timeline needs
2. Site Analysis - assess physical site features that will affect design
3. Choosing Design Style and Aesthetic - such as a formal or informal garden design
4. Develop a Multifunctional Plant Palette and Design - choose the plants and layout that simultaneously meet the needs of three key end users:
    - Pollinators
    - Golfers and visitors

    - Management and maintenance staff
5. Design Within a Budget - strategies for designing within different budgets
6. Communicate the Design - using visuals to communicate ideas
7. Implement the Garden - planning for the day, organizing volunteer events and follow up after the garden has been completed

We then apply all the steps to illustrate a real-world case of designing and implementing a high-quality multifunctional pollinator garden in Goat Hill Park golf course in Oceanside, California.

We recommend that all the knowledge and guidance we have gathered be used to inform golf courses on why and how they can become valuable pollinator habitat sites, while also improving golfer experience and overall function and longevity of their course.

Acknowledgments

This project was able to be successfully completed with the support and guidance of our faculty advisor, graduate student instructors, clients, and partners. We would like to give a sincere thank you to our project advisor, Dr. Sheila Schueller, for her extraordinary support throughout every stage of this project and helping us grow as individuals and professionals within our fields. We would also like to acknowledge Lisa DuRussel for her thoughtful guidance and assistance during the design development process for our pollinator garden as well as our graduate student instructors Kat Cameron and Michal Russo for being amazing resources throughout the entire project. A special thank you to our client, Parker Anderson, for giving us this unique opportunity to help the game of golf grow in a sustainable way alongside pollinators.

Thank you John and Tam Ashworth along with the entire Goat Hill team for showing us amazing hospitality and allowing us to conduct meaningful research on their course. A big shout out to the rest of the Goat Hill community, volunteers, and The Fire Pit Collective who helped us showcase and implement our pollinator garden. We also want to thank Rusty Spencer for the photography and videos taken during the garden implementation process.

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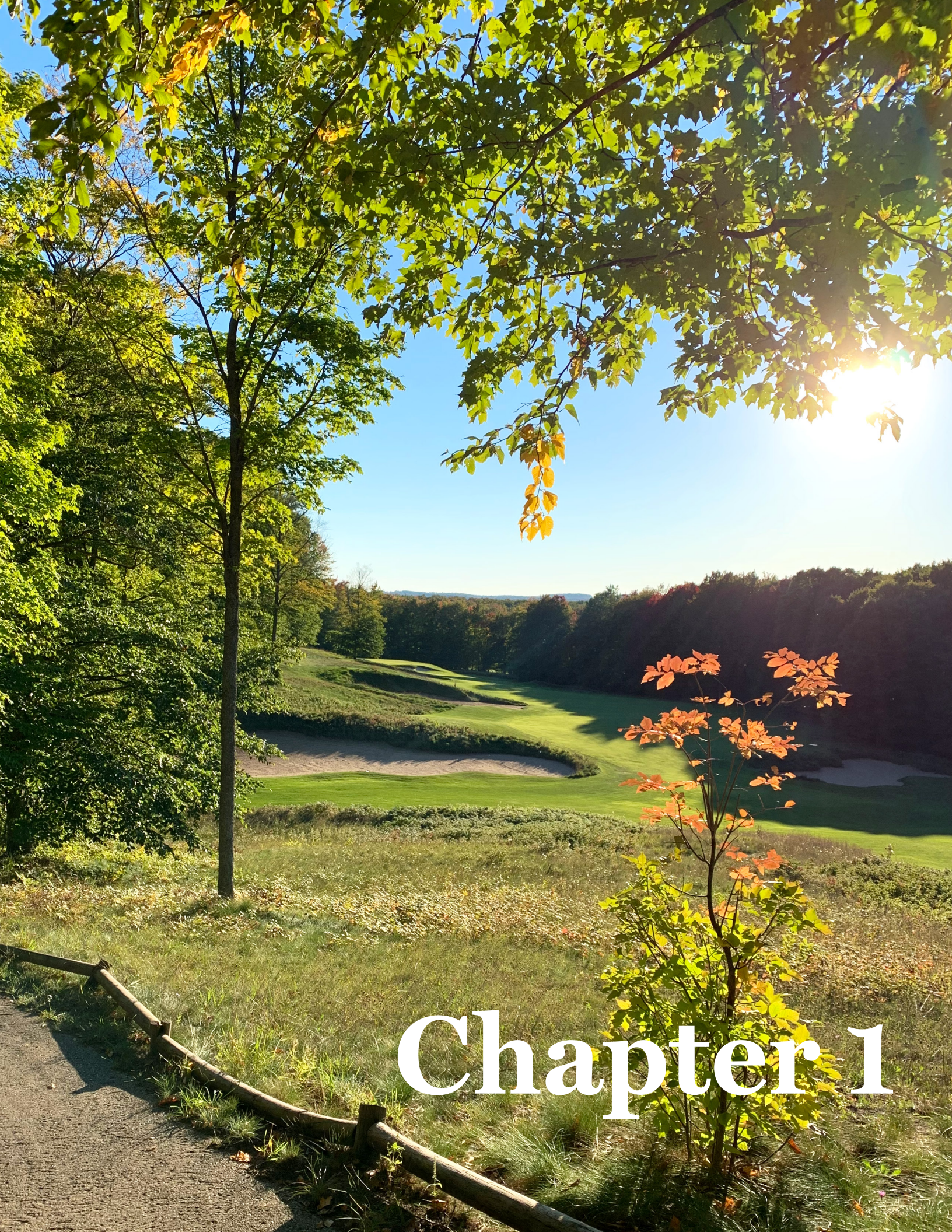

Chapter 1

Golf Courses and Their Potential to Support Pollinators

Pollinators in Crisis

With over 200,000 species native to North America (Marks, 2005), pollinators are keystone species in nearly every ecosystem. They provide a wide array of ecosystem services to plants and humans, pollinating around 94% of flowering plants and 35% of the world's food crops (Vanbergen, 2013). With one in three bites of food being dependent on these organisms, pollinators serve as the backbone of the world's agricultural industry, contributing between $235 billion and $577 billion (US) in annual global food production value (Lumpur, 2016). Naturalized honey bees (Apis mellifera) often act as a key pollinator in agricultural systems. They are valued for honey production and can even serve as indicator species, reflecting the health of the ecosystem around them (Celli and Maccagnani, 2003).

Despite their essential role in ecosystems, almost all pollinator species are experiencing critical losses worldwide due to increased environmental pressures such as land-use change, fragmentation, and pesticide exposure (Ramaswamy, 2017; Table 1.1). This includes honeybees, whose future is threatened by Colony Collapse Disorder (CCD), which is worsened by environmental factors (Elias, 2021). There is a critical need to support pollinators in novel ways, not just in natural areas, but on working and used landscapes, such as cropland (Kremen and Merenlender, 2018), residential areas (Xerces Society, 2019), campuses (Bliss et al., 2021), and even golf courses.

Table 1.1 Significant threats pollinators are facing directly contributing to declining populations worldwide.

HABITAT LOSS	PESTICIDES	CLIMATE CHANGE	DISEASES & PATHOGENS
• Loss of food, native vegetation, & resting sites • **Known**: Increased fragmentation is a special concern for migratory species - has population scale implications	• Bees recover slowly from insecticides - can take up to 4 years for populations to recover (FWS.gov) • Weed killers & insecticides are swept away with runoff impacting water quality	• **Known**: Phenological & distributional shifts (Scaven 2013) • **Unknown**: Physiological response & affect on P-P interactions (Scaven 2013)	• Microbial pathogens (viruses, bacteria, and fungi), parasitic mites, DMV • **Known:** Resistance determined by exposure to other stressors **Unknown:** Colony Collapse Disorder & how disease affects different species

The Golf Industry

The golf industry has a massive impact and influence on people and landscapes. In the United States, the approximate 16,300 golf courses cover about 2 million acres of land with an average of 150 acres for an 18-hole course, accounting for $84 billion in economic impact, 2 million careers, and 25.6 million golfers annually (NGF, 2022). Because of continuing development and suburban sprawl, golf courses can often be some of the few remaining large green spaces in urban areas with the ability to contribute to valuable ecosystem services, including reducing the urban heat island effect, increasing sequestration of greenhouse gasses, propagating pollinator habitat and health, and providing stormwater catchment capacity (Colding & Folke, 2009, Tanner & Gange, 2005 & Bartlett & James, 2011). Golf courses can also provide users with the opportunity to be immersed in nature, supporting educational and mental health benefits (Stanberg, 2011).

Despite the existing positive impact and potential of golf courses, there remains much room for improvement of multifunctional sustainability practices. Even though maintained turf (greens, fairways, roughs, mown areas, etc.) makes up on average 63%, or 95 acres of the 150 acres (GCSAA, 2015), much of the remaining area provides an opportunity for multifunctional habitat. These include natural areas (forest/woodland, native, unmown, etc.), water features, and non-landscaped areas (parking lots, paths, buildings). The potential for golf courses to serve as valuable habitat for species like pollinators is largely untapped. A major barrier to providing better habitat and improving sustainable practices on golf courses is a significant lack of data that identifies the economic, social and environmental benefits of these naturalized areas and additional sustainability practices. Furthermore, there is a lack of knowledge on how to effectively implement sustainability practices on golf courses and this makes any movement toward sustainability within the golf industry slow and inefficient. It supports perceptions that golf courses are only detrimental to the environment and that they have no environmental value for their surrounding ecosystems.

Client and Research Sites

Project Client

Greener Golf is a design and management consulting firm founded in 2019 and led by Parker Anderson, a University of Michigan alumnus (MS/MLA '15). What started as an interest in golf as well as bees led to the formation of Greener Golf. Parker partners with golf facilities to help golf managers optimize their resources. Using systems thinking and biomimicry, Greener Golf partners with nature to increase gross margin and increase positive golfer experience for partner facilities. Saving water, promoting pollinators, and minimizing costs are some of the services offered through Greener Golf. Parker recognizes the often underutilized potential of a golf facility and can objectively demonstrate the economic, environmental, and community value a golf facility can provide (Anderson, 2020). By incorporating pollinators on golf courses, Greener Golf educates, consults, and assists superintendents on best management practices that can have significant environmental, social, and economic impact on golf courses and surrounding communities. Through education, interpretive signage, and community engagement, Greener Golf instills sustainable lifestyles in golf course visitors and raises awareness around the existing threat towards pollinators.

Greener Golf has worked with several golf courses around the United States and Mexico to improve efforts towards sustainable pollinator-friendly management. Two clients in particular are of special interest for our project: Radrick Farms Golf Course and Goat Hill Park Golf Course (further described below).

Research Sites

Goat Hill Park Golf Course (goathillpark.com; Figure 1.1), a long time client of Greener Golf, sits on 75 acres located in Oceanside, California and is known for their relaxed and welcoming environment and progressive eco-friendly ownership. The golf course has been a pillar within the Oceanside community providing year-round recreation and community activities that are both affordable and accessible with a motto of "World Class/ Working Class" (Strege, 2017). Established in 1952 as Center City Golf Course, a 9-hole course, and was later redesigned into an 18-hole short course by Ludwig Keehn in the early 90's. The death of Ludwig Keehn in 2004 led to years of mismanagement, followed by a community effort that made national headlines to halt the course's redevelopment. Co-founders of Linksoul (a golf apparel brand), John Ashworth and Geoff Cunningham, took over Goat Hill Park in 2014 (Goat Hill Park, n.d.). Since their takeover they have reinvigorated the space with sustainable management efforts that have since "planted seeds" in the minds of conservationists and the golf course industry of the potential golf courses can have in the worlds of sustainability and wildlife conservation.

Not only has Goat Hill hired Greener Golf to improve, implement, and promote sustainable pollinator-friendly best practices, they also have a vibrant and excited community eager to participate and engage in improvement efforts. Additionally, Goat Hill Park has mentioned interest in continuing the course's development towards pollinator-friendly practices and furthering the education of its golfers and visitors. We used Goat Hill Park as our primary location for our research and development, demonstration garden, and as the case study (Chapter 4: Best Practices for Implementing a Multifunctional Pollinator Garden at a Golf Course) to showcase how golf courses can promote, protect and propagate pollinators.

Radrick Farms Golf Course, a private golf course owned by the University of Michigan, is located in Ann Arbor, Michigan. It is a 275-acre, championship caliber, 18-hole course with nearly four miles of fairway (Alumni Association at University of Michigan) and was an early design by golf course architects Pete and Alice Dye. This golf course has made

Figure 1.1 Aerial image of Goat Hill Park located in Oceanside, CA - @photobyrusty (top), apiaries on hole twelve at Goat Hill Park (bottom left), and a naturalized area with pollinators present (bottom right).

significant efforts in the way of sustainable pollinator-friendly practices, including in 2016 when they installed apiaries (Figure 1.2) to support bees. In order to care for their apiaries Radrick Farms has a dedicated beekeeper on staff as well as wildflower and no-mow spaces scattered throughout the golf course. Additionally, they have placed interpretive signage (Figure 1.2) in these areas to celebrate pollinators and as a way to educate visitors to what is happening. While the main focus of our work was on Goat Hill Park, we utilized Radrick Farms for field data collection as well as a resource for inspiration and to see what has worked for them when it comes to sustainability efforts and supporting bees on a golf course.

Project Goals and Approach

Despite the work of Greener Golf and its golf course partners, the golf industry's environmental and social potential to support pollinators remains unknown. This is primarily due to a lack of awareness about the myriad of ecological and socioeconomic benefits of

Figure 1.2 Aerial image of Radrick Farms Golf Course located in Ann Arbor, MI (top), apiaries on Radrick Farms property (bottom left) and a sign explaining pollinator related efforts happening at Radrick Farms (bottom right).

supporting honeybees and other pollinators on golf courses, as well as a lack of guidance on how to implement such changes on site. What is needed is solid documentation of the benefits - from biodiversity to cost savings - and clear guides and demonstration sites to support and promote feasible implementation. The overall goal of this project is to address these challenges in order to protect, promote, and propagate pollinators on golf courses. This helps to mitigate world-wide threats to pollinators and ecosystem services and helps to encourage golf courses to become more sustainable and multifunctional. This was accomplished through a series of strategies listed below:

1. Identify and quantify the benefits of converting underutilized managed areas that could support multifunctional pollinator habitat.

This included using observations and the use of industry tools to collect data and identify underutilized areas on golf courses and then provide informative and visual alternative uses that are evidence-based (informed by above research), logistically and financially feasible,

stack functions, and meet sustainability goals while also providing potential pollinator habitat.

2. Documented the benefits of existing pollinator-related efforts at multiple sites.

To meet the identified lack of awareness about the reasons to support pollinators on golf courses, we gathered and organized information about the potential benefits of promoting pollinators on golf courses, so that it can be used to inform and motivate change in the golf industry. We sought out information from a variety of sources and measures to document the direct and indirect benefits of two pollinator-support efforts in particular: 1) wildflower plantings and 2) honeybee apiaries and beekeeping programs.

3. Collaboratively implemented a multifunctional pollinator garden demonstration site at Goat Hill Park Golf Course.

This provides a valuable and complete case study of the whole process of promoting pollinators on golf courses, including landscape design and planning around out-of-play areas and apiaries, sourcing and gathering planting materials, community engagement through events and volunteering opportunities, and educational materials to ensure the success of the site.

4. Effectively shared our results and recommendations for adoption of pollinator programs to the golf industry.

To broaden the impact of our data gathering and demonstration site, we produced easily accessible materials that can be shared digitally and physically, and featured our demonstration site in interviews and on social media platforms. Additionally, we created a website for this report to be easily accessed and revisited (https://seas.umich.edu/research-impact/student-research/masters-projects/bees-golf-unlikely-yet-impactful-partnership).

Chapter Overview

For our project we developed a menu of options for supporting pollinators that is based on research, synthesis, and implementation to inform the golf industry of the possibility to make effective changes that will benefit both the environment and future business. Specifically Chapter 2: A Move Towards Sustainability: Identifying and Quantifying the Benefits of Converting Underutilized Managed Areas on Golf Courses and Chapter 3: What Are the Menu of Options to Support Pollinators on Golf Courses and What Are Their Benefits?, both discuss key questions and strategies related to the management of golf courses and the inclusion of pollinator habitat on golf courses. Within chapter 2, we first discuss the history of golf and what led to the intense management practices seen today before reviewing current sustainability trends. Based on our review of current practices we lay out ways in which golf courses can identify and quantify underutilized areas and how we used an industry tool developed by The United States Golf Association (USGA) called DEACON to help us identify underutilized areas. We review how to access this tool and the data that was produced. Chapter 3 takes a look at the different ways golf courses can support pollinators and what the benefits are to implementing these recommendations based on our review of literature. This chapter provides a menu of options for adding pollinator habitat on a golf course. Additionally we provide recommendations on how golf courses can share and promote the work they are doing to encourage further pollinator conservation and environmental stewardship.

Chapter 4: Best Practices for Implementing a Multifunctional Pollinator Garden at a Golf Course takes what we learned from our site assessment and available pollinator habitat options for golf courses from the previous chapters to provide a step-by-step process on how to design and implement a multifunctional pollinator garden from establishing a client to installing a new garden. Finally, we describe how we applied the

steps outlined in this chapter to design and implement a demonstration pollinator garden for a golf course that provides high quality habitat for their established apiaries as well as other pollinators. Through a combination of scientific research and real world application we present a simple how-to guide that can be applied within golf courses and similar urban settings to further promote pollinator conservation.

Project Significance

This project has significant economic, environmental, and social impact at local, national, and global scales. For our client, Greener Golf, not only does our project further support their ultimate mission of promoting, propagating, and protecting pollinators on golf courses, it will also work to further spread pollinator awareness and the multifunctional capabilities that golf courses present. Beyond our client, golf course members and visitors will be exposed to what sustainable management practices have the potential to change, in addition to changing the behaviors and perceptions associated with sustainability and the golf course industry. With nearly 15,000 golf courses in the U.S. alone, this project has the potential to have a significant environmental impact. Utilizing golf courses as safe havens for pollinators that promote healthy populations of bees is a win-win scenario for golf courses and their communities. By developing and outlining new sustainable maintenance practices for golf courses that reduce pesticide and insecticide use, reduce irrigation use and chemical runoff, and implement pollinator protected naturalized areas, golf courses are more than capable of being viable and productive habitats for wildlife.

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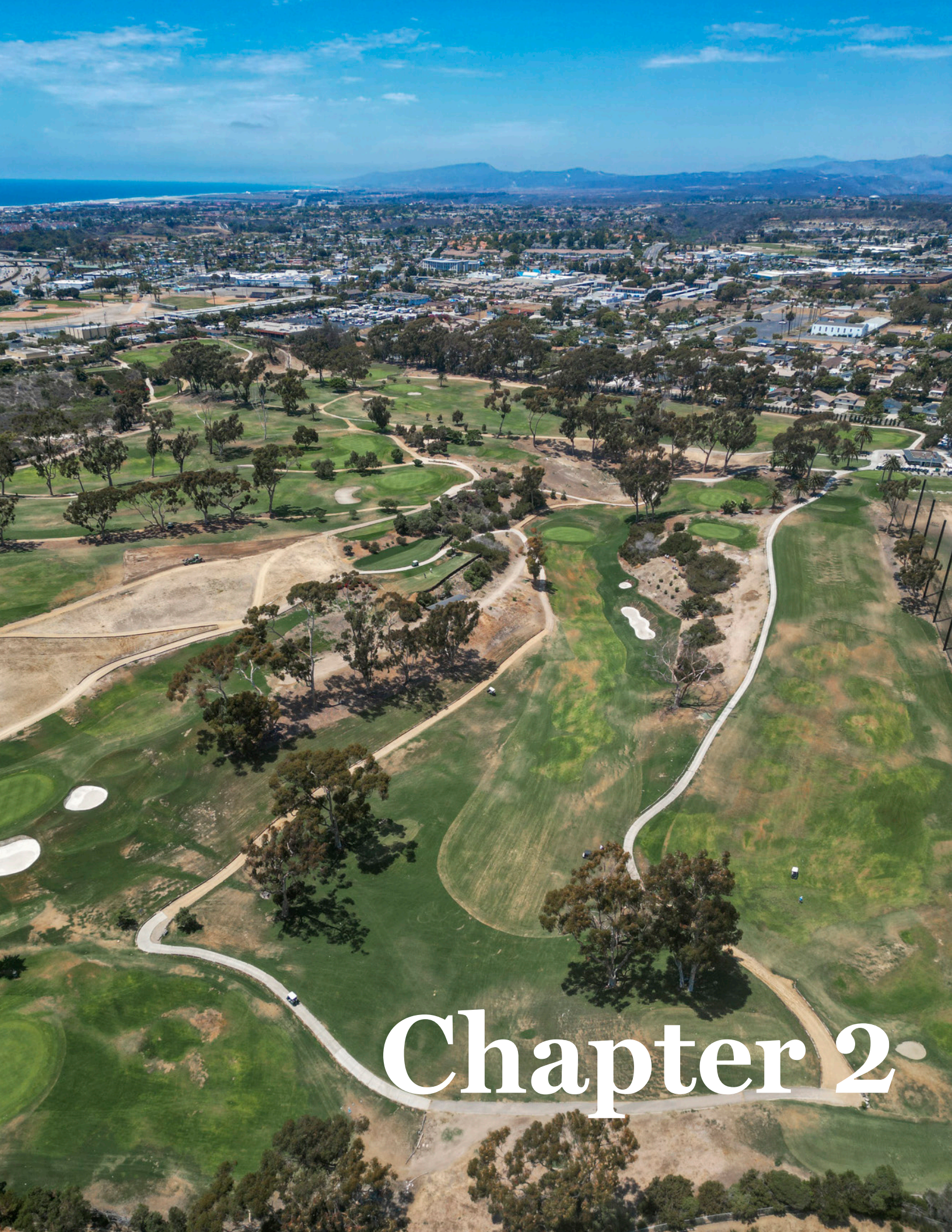

Chapter 2

A Move Towards Sustainability: Identifying and Quantifying the Benefits of Converting Underutilized Managed Areas on Golf Courses

Purpose and Audience

The golf industry is currently in a state of transition. Historically, golf courses have used large amounts of water, pesticides, and energy to keep the facility as green and pristine as possible. With the onset of regulations, environmental movements, and negative public perception, the industry has begun shifting towards a more sustainable future. Instead of maintaining a highly-managed, pristine golf course at the expense of the site and its surrounding environment, many golf courses are now making an effort to work alongside nature. Today, not only can golf courses take action to reduce and limit their negative ecological impact, but they can also choose management practices that increase biodiversity and enhance ecosystem services.

Despite some noteworthy success stories, the golf industry's transition to a more environmentally friendly future has been challenging due to a lack of quantitative data that shows golf course superintendents why sustainable management practices are a valuable investment, as well as limited guidance on how to feasibly implement sustainable practices at a facility. To address these problems we first provide context to understand: 1) what historical factors led to intense management, and 2) how and why golf course maintenance trends are changing. These inform our compilation of the significant environmental, economic, and social benefits of one relatively simple management action: **converting managed underutilized areas on a golf course into lower maintenance areas.** We then present specific guidance on different ways to identify these underutilized

areas on a course, including a real-world example using the United States Golf Association's (USGA) DEACON tool at Goat Hill Park Golf Course in Oceanside, California. Overall, our aim is to provide both golf course managers and superintendents with actionable rationale and strategies for identifying and converting underutilized managed areas as a low-stakes step towards more sustainable land use with the potential to support pollinators - keystone species that are facing a critical habitat shortage.

Golf: A Sport With but Against Nature?

From its inception, golf has been a beloved recreational pastime and continues to prosper today. Golf originated as a sport in Scotland in the 15th century and made its way to the United States (U.S.) in the 17th century. The United States Golf Association (USGA) was founded in 1894, creating a structured association to help grow the sport (Shefter, 2014). Within a year, the USGA catapulted the sport by launching the U.S. Amateur Championship, U.S. Open, and the U.S. Women's Amateur. This introduced the sport of golf to a wide range of spectators and players, significantly increasing golf popularity. According to the National Golf Foundation (2022), in the U.S., "106 million, one out of every three Americans age 6+, has played golf, followed golf on television or online, read about the game, or listened to a golf-related podcast in 2021".

Golf is inextricably linked with nature around the world. When playing golf, the golfer's experience is within a natural or semi-natural setting. The sport is interconnected with some of the world's most scenic environmental settings and it "has been argued that no other sport promotes the magical, zen-like tonic of a walk in pristine natural surroundings in a way that golf does. The relationship between golf and nature is long-standing, as courses are so often integrated with the surrounding landscapes, wildlife and vegetation" (Wheeler et al., 2006, p. 427). Few sports in the world foster a deeper connection to the natural environment in the same manner as golf. Although golf courses provide connection to nature, a combination of historic events, new technology, and social norms have led the industry towards intense maintenance practices that are often at the expense of the surrounding environment. Understanding both the historical roots of intense maintenance practices and the current evidence of change on golf courses makes it clear that high-intensity maintenance does not need to be the norm. By following a series of best practices and time-tested strategies, some of which are outlined in the following report, more golf courses can transition toward sustainable practices and shift the industry norm to ecological stewardship.

Understanding both the historical roots of intense maintenance practices and the current evidence of change on golf courses makes it clear that high-intensity maintenance does not need to be the norm.

Factors Leading to Intense Management on Golf Courses

The post World War II (WWII) era in the United States (U.S.) gave rise to new technology and chemicals, resulting in the intensification of golf course management (Millington et al., 2016). Further equipment development of heavy machinery, like bulldozers and lawn mowers, shifted to higher mechanization and efficiency (Richardson, 1953), creating the focus from working with the existing landscape to moving, altering, and ultimately destroying the existing environment as management desired. Post WWII, synthetic chemicals used during the war were repurposed for agriculture, where they were intended to mitigate pests and enhance soil fertility. Pesticide and fertilizer use seemed to increase management efficiency in agriculture, which led golf courses to follow suit. Maintenance

practices based on high use of chemicals lead to habitat loss, deforestation, and a significant disruption of existing natural processes (Wheeler et al., 2006).

The advent of color television had a major impact on golf course management as it set a global aesthetic standard for how a golf course should look. Golf was first broadcasted in 1948, in black-and-white, with few cameras stationed at a single hole (Nenno, 2020). As broadcasting and technology evolved, additional cameras were added, enhancing the viewing experience. These advancements launched golf to popularity, making it a high spectator sport. However, when the first color telecast of a major championship was nationally broadcasted in 1965, the aesthetic of the sport was changed forever (Nenno, 2020). Widespread viewers were, for the first time, seeing the highly-managed, pristine conditions of televised tournament golf. This had a global impact on golf course management and the industry as a whole, as course managers were now expected to produce the pristine conditions as seen on television. This, of course, increased the demand on maintenance resources, like water consumption and chemical usage. Television and society had decided the aesthetic standard, and golf courses were expected to meet them, no matter the cost.

The U.S. environmental movement in the 1960s brought public awareness and criticism of the negative impacts of the golf industry, resulting in regulations that affected golf course management practices. Efforts to protect and preserve natural resources like water, air, and land from pollution and overconsumption lead to the adoption of a variety of environmental laws to regulate impacts on these natural resources. Most notable are the Land and Water Conservation Act of 1964, the Clean Water Act of 1970 and the Endangered Species Act of 1973. While golf courses changed their practices to fit these regulations, there was not yet a drive to go beyond meeting minimum requirements.

Although the environmental movement helped reduce some of the intense management of natural areas on golf courses, in the next section we discuss current trends in golf showing a stronger shift toward a more sustainable relationship with nature. Golf courses needed to keep up with more intense environmental regulations, as well as shed their unsustainable image, but even beyond that, golf courses are now more motivated to take major steps to lower their overall inputs and reinstate their connection with nature.

Current Trends Towards Sustainability in Golf Management Practices

Golf Course Environmental Profile
Recent research across many golf courses confirms that significant strides towards more sustainable management practices are being made. Until recently, national data tracking these efforts had not been recorded, advertised, or easily accessible. That changed with the creation of the Golf Course Environmental Profile created by the Golf Course Superintendent Association of America (GCSAA) and the Environmental Institute for Golf (EIFG). This effort collected data on golf course management practices in 2005 and again in 2015, allowing for quantification of a ten year change in practices across a range of U.S. golf courses on five topics: energy use, land use characteristics, pest management, nutrient use, and water use. Within the land use characteristics profile, environmental stewardship is one of the measures surveyed. Phase three of data collection began in early 2021 and based on the GCSAA's early reports the trends towards more sustainable practices in golf course management has continued. In this section, we detail the changes in practices that have been documented, including specific cases, and their implications for pollinators as well as the golf course industry.

Turf Acreage

The amount of turf acerage, the most managed and resource-heavy zones on golf courses, is

decreasing. Between 2005 and 2015, there was a significant decrease in maintained turf acreage for both 9-hole and 18-hole facilities, particularly for public courses, while private courses still saw a reduction but at a lower rate (GCSAA, 2017). All areas on golf courses, other than greens, saw a decrease in maintained acreage. In addition to turf reduction, approximately 46% of facilities have increased their acreage of natural, or unmowed areas, since 2005 (Gelernter & Stowell, 2017). Maintained turf requires extensive amounts of time, equipment, and money, while unmowed areas are less demanding and are able to provide forage opportunities for pollinators and help increase plant diversity on golf course properties. Most notably, the reduction in turf also indicates a decrease in use of other resources such as water, fertilizer, and pesticides.

One way that golf courses are reducing maintained turf acreage is by increasing the amount of naturalized areas that are present. For some golf courses like Brickyard Crossing in Indianapolis, Indiana, this meant simply taking a hands-off approach and allowing the turf to grow unmanaged through the growing season and only cut back once a year. Other courses like Fawn Lake Country Club in Spotsylvania, Virginia (Figure 2.1) and Fowler's Mill Golf Course in Chesterland, Ohio are removing turf and replacing it with native perennials and wildflowers to help decrease maintenance costs and provide wildlife habitat (Audubon International, 2007).

Water Usage

In the past two decades, golf courses nationwide have reduced their water usage. It is estimated that roughly 14,000 golf courses across the U.S. require irrigation in some form. National water usage across all golf facilities has had an average reduction of 29% from 2005 to 2020 (GCSAA, 2022). The Southeast region experienced the largest reduction in water usage, while the Southwest and Upper West had the smallest reduction. This variability is due to the fact that the areas with the smallest reductions typically have low rainfall and/or high temperatures, thus face relatively higher difficulty in reducing their water consumption. Significant factors

Figure 2.1 Aerial image of naturalized area on the first hole of Fawn Lake Country Club in Spotsylvania, VA. Photo courtesy of Fawn Lake Country Club (fawnlakecc.com).

causing water reduction included irrigating less frequently, using more drought-tolerant turfgrass, and increasing no-mow acreage.

Forest Highlands Golf Club in Flagstaff, Arizona and Mountain Vista Golf Club in Palm Desert, California are just two of the many courses that have worked towards reducing their water consumption. Forest Highlands laid out a three phase project to meet their goal of reducing water usage, including discontinuing the irrigation of native areas and reducing the irrigation of the driving range, roughs and common areas throughout the course (Audubon International, 2007). Meanwhile at Mountain Vista they are taking advantage of technology to help monitor water usage and to control when, where and for how long any one area on the course is being watered. They are also using soil wetting agents to help get water down to the roots instead of sitting on the surface (Bohannan, 2022). Both of these courses have also made improvements to their irrigation systems, replacing aging lines and sprinkler heads and monitoring for any leaks that may occur to minimize unintentional water loss.

Chemical Use

Chemical use for turfgrass fertilization and pest treatments continue to be used, but better management practices have changed how they are being applied and at what rates. Results from surveys have shown a significant reduction in fertilizer applications (GCSAA, 2015a). The GCSAA reports nutrient use as the application of the most commonly used fertilizers of nitrogen, phosphate and potash. Of the three nutrients, phosphate saw the largest decrease in use. In 2006, courses applied 33,626 tons of phosphate, by 2014 that number had been reduced by 53% to 15,759 tons of phosphate. Nitrogen and potash saw a decrease of 34% (92,185 tons to 61,215 tons) and 42% (89,124 tons to 51,705 tons), respectively. The two biggest factors contributing to a decrease in nutrient usage were reduction of fertilized areas and adoption of conservation efforts such as avoiding overseeding, fertilizing based on soil tests, and the use of precision fertilization applications. Meanwhile, pest management has not seen decreases as significant as many of the other management practices surveyed. However, there has been some reduction in use of chemical applications and golf facilities are starting to use non-chemical pest control in conjunction with the more common chemical solutions (GCSAA, 2015b).

Courses that have begun to reduce their chemical applications include Colonial Acres golf course in Glenmont, New York. Colonial Acres started with the goal to reduce synthetic fertilizer and pesticide use by 50% and use organic and biological controls to maintain the quality of the course. With the initial success of this reduction they further reduced their chemical use to a 30:70 ratio of chemical to organic applications throughout the course. In addition to these changes, they shared their practices with golfers, some of whom were interested in using the organic and biological methods at their own homes (Audubon International, 2007).

Environmental Stewardship Participation

Although there are a number of environmental stewardship programs to partner with, engagement between golf courses and these programs is still relatively low. As a part of the surveys sent out, the GCSAA asked facilities if they participated in a variety of environmental stewardship programs such as state-specific Best Management Practices (BMPs) and the Audubon Cooperative Sanctuary Program. Between 2005 and 2015, little has changed in terms of participation within these listed programs. The majority of facilities responded that they were not involved in any of the listed programs, with the top reasons being lack of funds (41%), lack of time (39%), and practices already in place (40%) (GCSAA, 2017). Besides the programs listed in the Environmental Profile report, there are other programs such as Monarchs in the Rough and the Xerces Society that golf courses can partner with to show their commitment to becoming

environmental stewards. Participation with these organizations requires golf course managers to be intentional when it comes to maintenance and providing space for wildlife. The benefits of partnerships between golf courses and environmental programs can be seen at The Sanctuary Golf Club on Sanibel Island in Florida (Figure 2.2) which has been a Audubon Cooperative Sanctuary certified golf course since 2003 (Mickey, 2019). In compliance with Audubon International, The Sanctuary Golf Club has developed a list of maintenance practices that help sustain wildlife habitats, migratory routes, nesting sites, and food sources for local wildlife populations. With the course bordering the J.N. "Ding" Darling National Wildlife Refuge, The Sanctuary Golf Club is dedicated to creating space where members and wildlife can coexist. Over the years, management has replaced over 8,000 square feet of turf with pollinator habitat as well as removing roughly one and half miles of cement cart paths and replacing them with permeable material to help with water runoff from irrigation. With close communication between golf facilities and environmental stewardship programs, managers can become educated on the best management practices for sustainable golf courses.

A Move Towards Sustainability: Methods to Identify and Quantify Underutilized Managed Areas

It is clear that sustainable practices on golf courses are increasing, and it is becoming more feasible for other golf courses to join

Figure 2.2 Wildflowers and native tall grasses near a tee box at The Sanctuary Golf Club on Sanibel Island in Sanibel, FL (main) and a Gopher Tortoise, frequently found on the golf course (top left). Photos courtesy of The Sanctuary Golf Club.

the movement and become models for their communities and other courses. New technology, resources, and BMP case studies have given golf courses the opportunity to deviate from outdated unsustainable practices to managing their facilities in a way that is safer for the environment and works with nature. One relatively simple and effective way to start this journey towards more sustainable practices is to identify underutilized managed areas and reduce the maintenance of these areas that are not actively in play. Here we describe both the methods to identify underutilized managed areas and to assess the potential benefits of their conversion to lower maintenance natural landscapes. Underutilized areas are any maintained parts of the course with minimal golfer and golf cart traffic, and there are two main options to identify them.

Option 1: Observe and Monitor

Spending time observing how the course is used is the most cost effective option to identify underutilized areas, requiring no tools or equipment, and can efficiently reveal the potential areas that can be converted into alternative landscape scenarios. Spending time on each hole allows one to observe and monitor golfer and cart traffic, resulting in recognition and awareness of areas that may be underutilized. Doing this creates avenues for management and superintendents to interact with golfers of all skill levels, allowing them to build relationships, open up dialogues, and better understand how the course is being used. Due to the nature of the various tasks maintenance teams are responsible for, they are inherently spending the most time out on the course. Superintendents can teach these staff members to look out for details of where they see underutilized areas and report back to management. While observing on the course, it is key to include monitoring traffic of golfers and carts, use of bunkers (or not), paths of the ball, and identifying areas that are managed for play but not often used during play of the course.

Option 2: The United States Golf Association (USGA) DEACON Tool

An alternative option to visual monitoring is to utilize spatial data collected by the DEACON tool produced by the USGA. DEACON, named after the late Deacon Palmer (father of legendary golfer Arnold Palmer), is a suite of tools designed to help golf course superintendents and facility managers acquire a better understanding of the different aspects of their course like resource consumption, pace of play, and tracking how golfers and golf carts circulate through the course. To learn more about how to use the Deacon Tool, see https://usga-facilities.zendesk.com/hc/en-us/categories/360001973893-Getting-Started.

An Overview of the DEACON Tool

In order to customize the DEACON gadgets to the needs of each course, superintendents are able to select what kind of demographic data they would like recorded with the gadgets, choosing from variables including gender, sex, age, dates used, the player ability, and/or if they are walking or taking a golf cart. Before a round, the GPS logging devices are assigned to a golfer and the selected data are recorded. The gadgets are then placed in the player's pocket or clipped on their belt loop and while playing, the gadget pings off of satellites to collect location data. Once the player is finished, the devices are collected, returned to the USGA, and the data is uploaded into the online DEACON portal. Each golf course receives its own profile on the DEACON online portal where maps are stored and data points can be examined and manipulated. Superintendents can then meet with a DEACON team to discuss how to best utilize the various maps and maintenance data for their specific needs.

Using satellite imagery, a surface map shows where the roughs, fairways, greens, tee boxes, bunkers, and hazards are located on the course. Each of these surfaces are polygons, or delineated areas on the map, that can be

manipulated or deleted and some of them, like fairways and bunkers, have maintenance costs associated with them. These surfaces help create a profile that shows the total cost of maintenance based on 2017 national unit price averages collected from golf courses across the country. Golf courses can choose to use the cost estimates provided by the DEACON tool or they can input their own financial data to obtain a more accurate breakdown of their maintenance costs. DEACON breaks down costs into four resource categories: labor, material, energy, and equipment. Within each of these categories, costs are further broken down into various sub-resource categories like mow, irrigation, fertilizer, and clean debris, giving management the ability to see how their money is being spent. Management can then adjust the surfaces to see what a reduction in turf in different areas will do in terms of maintenance costs and labor.

The DEACON tool, although a more costly investment than simply spending time on the course, requires less resources in terms of time and labor, is more accurate, and records more manipulatable data and information about the course. For the GPS mapping service alone DEACON costs $1,400 though there are additional services that can be purchased as well. This investment into better understanding the course has the capacity to show superintendents where underutilized areas are, how maintenance costs can be reduced, and what information about pace of play is most important. The money spent on the DEACON tool is small compared to the amount of money and time this option will save the course in the long run.

GPS Mapping: A Case Study at Goat Hill Park

In order to identify underutilized managed areas on golf courses, we applied the USGA DEACON gadgets to study golfer and cart movements at Goat Hill Park in Oceanside California (Chapter 1: Golf Courses and Their Potential to Support Pollinators). On July 1st, 2022, our team traveled to the 79-acre municipal golf course to host a Bee Benefit where 142 golfers were voluntarily tracked as they golfed. The goal of this event was to record the step-by-step process of using the gadgets successfully, as well as providing Goat Hill Park with the data and our findings. Here we describe both the process for administration and our results. We then discuss our findings and how we used them to assess opportunities for reducing managed areas and increased pollinator habitat throughout the course.

Preliminary Steps

How to Access DEACON Devices

To receive the USGA DEACON devices, our client, Parker Anderson of Greener Golf, contacted USGA Green Section assistants to put in a request for 200 gadgets. You may also go to gsshop.usga.org/ to contact the USGA and put in a request to receive gadgets for your golf facility. Different DEACON packages allow users to track different data points such as pace of play reports, detailed heatmaps, and hole location features. Once our request was accepted, we were required to have a meeting with USGA DEACON assistants who prepped us on the logistics of how the devices worked, how to hand them out, the on-the-ground data we needed to collect from golfers during the event, and finally how to send them back to the USGA.

Administration and Golfer Participation

When and where you administer the gadgets is an important consideration. Ideally, intercepting golfers before they are on the first tee box is best, as your data is a comprehensive record of the entire round and you are not interrupting the pace of play. During the Bee Benefit, we handed out the gadgets as the golfers were checked in and before they approached the first tee box. When administering the GPS gadgets, it is important to let the golfers know what the devices do, what data they are collecting, and who is receiving the data. We found that it was important to let each golfer know that

participating in our event was completely voluntary and anonymous. We did this by creating a DEACON Gadget poster (Appendix A) for golfers to read and having team members answer questions. For the purpose of our study, we focused on collecting data related to golfer and golf cart movements throughout their game. However, Deacon also allows users to collect information like gender, tee time, and skill level. This information aided in our analysis once we received the DEACON satellite data, discussed in more detail in the following section.

Approaching each golfer at the end of their round and thanking them for participating was the best method for collecting the GPS devices afterwards but found that a collection drop box at both the 9th and 18th green were helpful in collecting the devices as well. It is worth noting that the DEACON devices are small and are susceptible to being lost during the round or taken home. We found that checking off the GPS gadget's ID number as they were returned was a great way to know which devices were missing. Once the devices were returned, we sent them back to the USGA where they compiled the data for us. Finally, we met with a USGA DEACON assistant to help understand the various ways to manipulate and analyze the data we collected at the Bee Benefit.

Mapping Tools

Setting Up the DEACON Profile

The first step our team took after receiving access to the Goat Hill Park DEACON profile was to reconfigure, delete, and label the defaulted land-use polygons created by the DEACON team to create a basemap that represented the various existing maintained surface types on the course (green, bunkers, fairway etc.) (Figure 2.3). Due to the defaulted polygons being made based off of an outdated satellite image coupled with Goat Hill Park's dry conditions blurring the lines between out-of-play and fairway, significant adjustments to the polygons were needed. Having accurate and appropriately sized polygons is an essential component to understanding your site because these polygons directly impact the total turf acreage of the course as well as the total cost of maintenance. Because there are different costs associated with different surface types, the size and surface type are key factors determining which alternative land use options would be used, the economic implications they could have, and how its conversion would impact playability. Once satisfied with the adjustments of our base map, we created multiple 'Facility Views' of the course. This essentially meant having multiple copies of our base map but allowed us to further modify and add new polygons with different analysis goals being accomplished with each Facility View. These different versions derived from the same map allowed us to compare and contrast specific metrics like the impact of different resource prices on annual costs, different out-of-play area groupings, and maintained area sizes.

The modifications made to the land-use polygons increased the accuracy of our results and allowed us to break down Goat Hill Park into seven different surface components: green, rough, fairway, tee boxes, clubhouse grounds, out-of-play, and bunkers (Figure 2.4). From this we could see that the rough accounted for the highest amount of land use at 38% (16.07 acres), while fairways and out-of-play areas both accounted for 20% (8.46 acres) of the property.

Pro Tip: Setting Up the DEACON Profile

Be sure to **modify, add, & delete** the defaulted surface polygons so that they accurately represent the surface coverage of the course at the time of data collection. For example, the surface polygons we received had fairway & rough surface polygons stacked on top of one another. This made the surface's overall square footage & cost estimates inaccurate.

Figure 2.3 Current locations of maintained turfgrass, holes, and bunkers at Goat Hill Park.

Understanding Traffic Routes, Densities and Maintenance Costs

When trying to understand and identify how the golf course is used by golfers and golf carts, the DEACON tool provides multiple mapping tools and layers to aid the analysis. Users have the ability to turn any of these layers on or off at any time to assist with analyzing their data. The 'Heatmap' and 'Tracks' layers generated from the DEACON gadgets provide clear and communicable visual representations of high traffic and underutilized areas.

Heatmap

The Heatmap (Figure 2.5) provided a visual representation of low, mid, and high density areas as determined by 142 gadgets. Areas in red represent high density, areas in green were mid, and areas in blue were low level. DEACON does not provide ranges associated with these numbers. We were not surprised that results showed the tee boxes, greens, and pathways had the highest densities, fairways were high to mid-level, and that the out-of-play, rough, and naturalized areas had the lowest densities. What was valuable about the Heatmap feature was it allowed us to identify and compare how frequently an area was visited and using the Heatmap in conjunction with the Surfaces layer added context to those traffic densities. This information furthered our understanding of underutilized

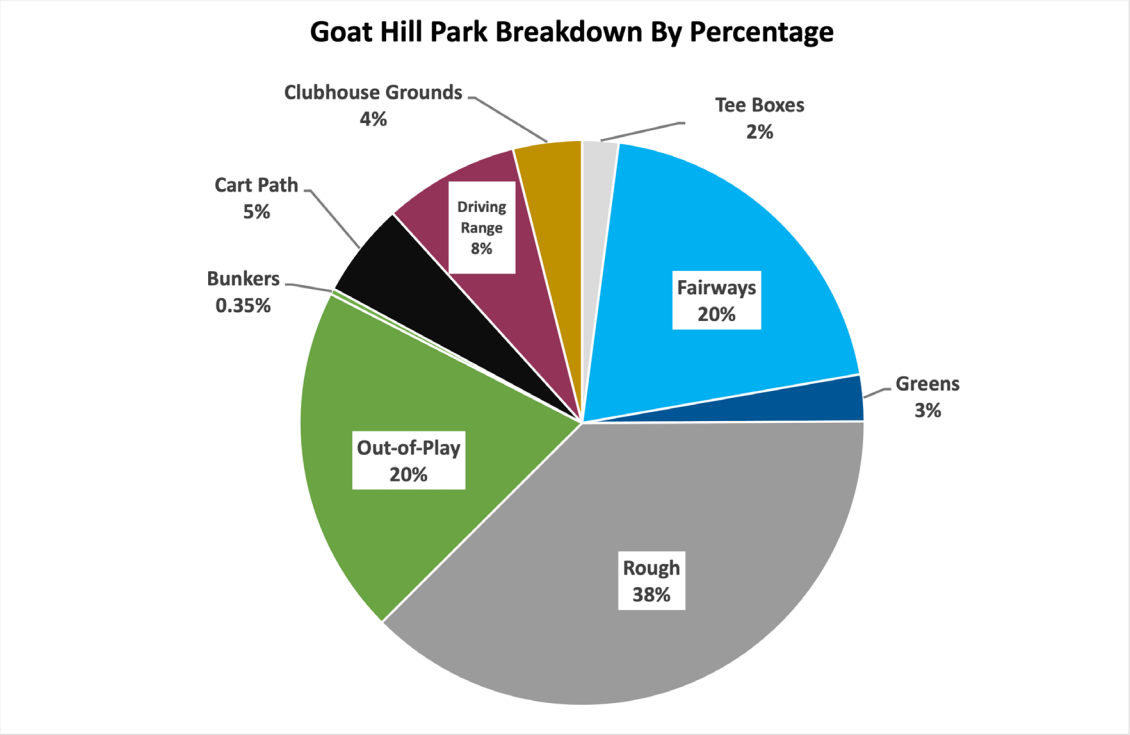

Figure 2.4 Pie chart showing the allocation of maintained turf and other features at Goat Hill Park.

areas on the course and in the Park and will be useful information for informing the form of alternative land use prescribed.

Tracks

Using the Tracks feature provided the clearest and most accurate depiction of where golfers (64 tracks) and golf carts (78 tracks) were circulating through the course. With skill level (handicap) and gender and age being beyond the scope of our study, we selected 'Both Genders', 'All Ages' and a handicap scale of 0-36.0 (all skill levels) to create our comprehensive Tracker map (Figure 2.6). The choice to combine golfer (walking) tracks and cart tracks in our map was due to the DEACON profile only providing data for the 'With Cart' and 'All' (with cart and without cart) layers. Therefore, in order for us to graphically represent and compare cart (blue tracks) versus walker (pink tracks) movements, both layers were overlaid at the same time. We used the void space, Surfaces layer, and differences in tracker colors to identify and analyze the differences in movements. Although we did not anticipate this parameter, it did not significantly impact our overall goal and ability to deduce golfer and cart movements. However, with access to this data, we would have been able to go deeper into our analysis, determine if there were differences between the type of managed space utilized, and would have allowed us to appropriately prescribe management and/or land use changes.

Pro Tip: Tracks

The DEACON tool uses satellites to track golfer and cart movements throughout the course. In some cases, the signal between the gadgets & the satellites can get thrown off creating **'shoot outs'.** These 'shoot outs,' or tracker anomalies, can be seen when making your tracker maps & should be ignored.

Cost Estimate of Existing Managed Areas

One of key features of the DEACON tool is the Course Totals page. The purpose of this feature is to understand the overall

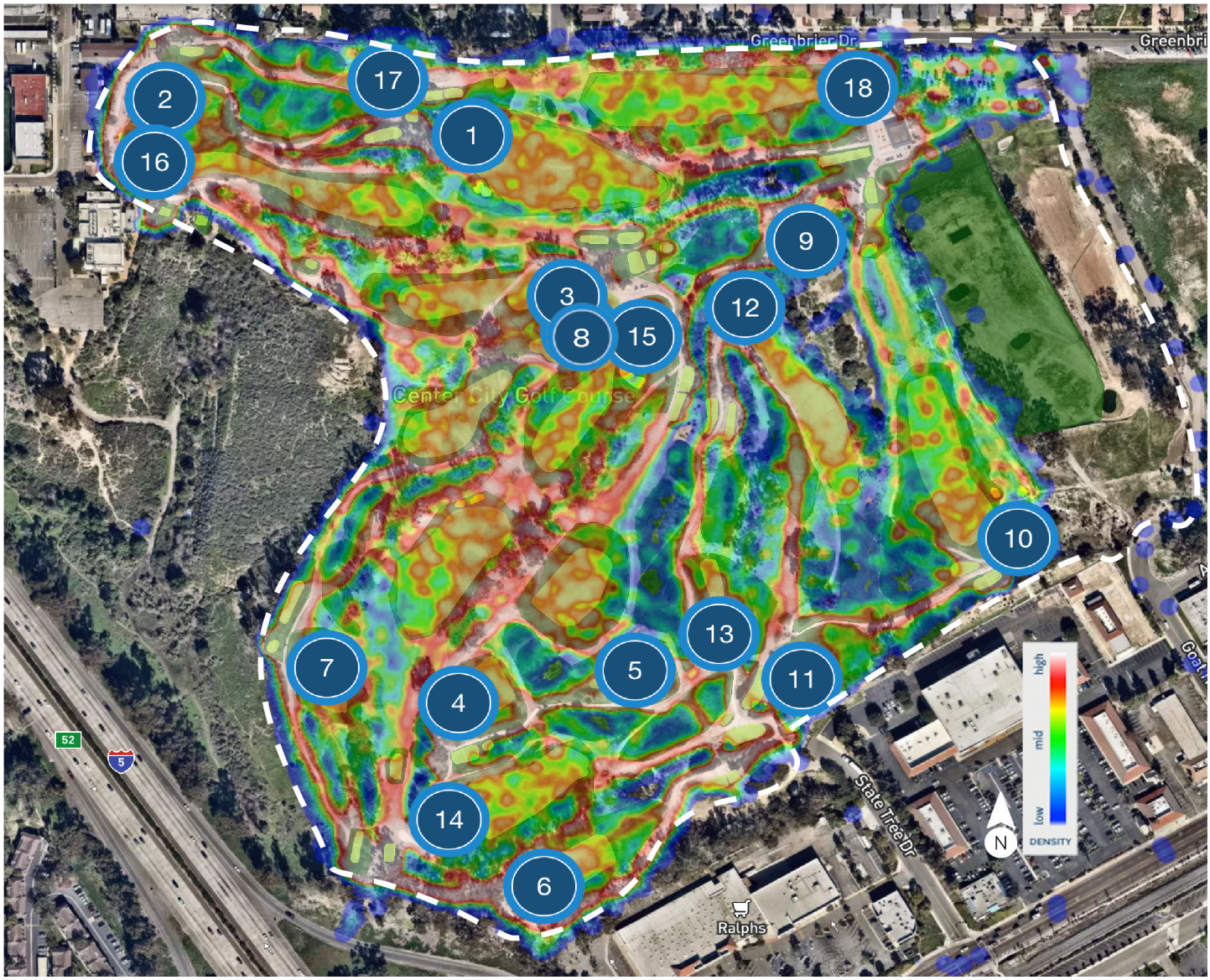

Figure 2.5 Heatmap depicting golfer and golf cart traffic from low (blue) to high (red) densities throughout Goat Hill Park.

maintenance costs of the course but more importantly, the costs associated with maintaining each surface type as well as the breakdown of key resources (Figure 2.7). With the ability to completely customize the resources used (and costs associated) to maintain your course (energy, labor, materials, equipment) and the ability to filter by surface and resource, superintendents are able to identify their most costly inputs and surfaces. This knowledge can encourage a reduction in surfaces with highly intensive resource inputs and can encourage more financially and environmentally sustainable alternatives. Due to not having access to the appropriate data for this feature, our goal for presenting it here, with hypothetical estimates, is to demonstrate and explain how the feature can be used and the benefits it can provide. To use this feature accurately, we recommend meeting with the course superintendent to get accurate data to calculate a representative number for your course. However, if this information is not readily available or accessible, we recommend researching your state's current average prices and visiting federal statistic sites.

The current cost of maintaining Goat Hill Park (based on DEACON's default estimates, California averages, and federal statistics sites) is estimated to be $238,797.95 at 42.3

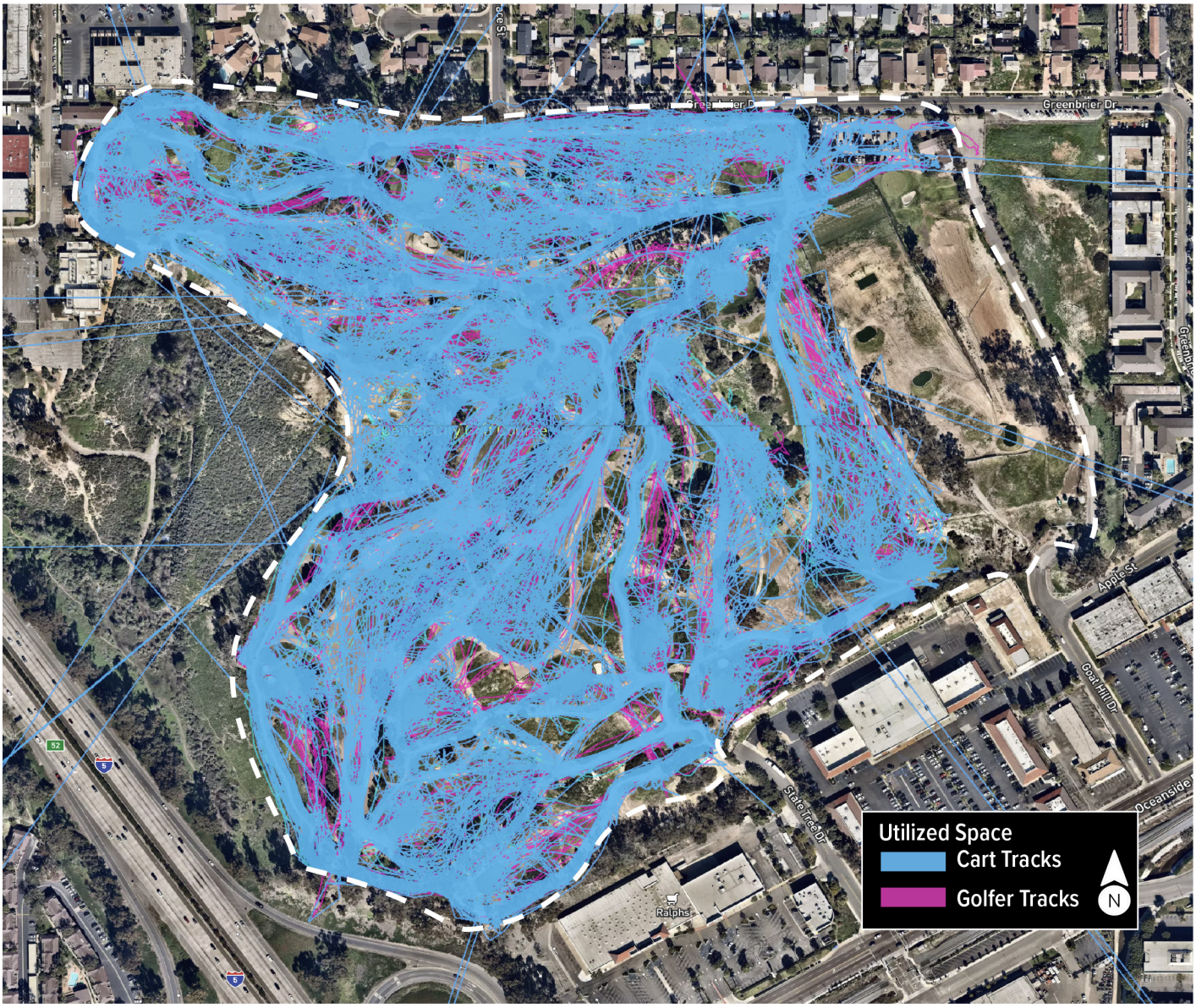

Figure 2.6 Golfer tracks (walking) and golf cart tracks throughout the course at Goat Hill Park.

acres. We adjusted the resource subtypes and unit costs of labor and energy to better represent the current costs and salaries of maintaining a golf course in California (not specific to Goat Hill). For energy, we adjusted the prices of diesel, electricity, propane, and unleaded to California current average prices. These unit prices were pulled from federal statistics sites. For labor, we have two levels of employees, level 1 at $17.00 USD/hr and level 2 at $15.00 USD/hr. Goat Hill Park does not have a water feature, hence the $0.00 cost for that surface type.

Pro Tip: Cost Estimate of Existing Managed Areas

Modify, add, & delete any resource inputs in the Material Cost Estimate feature that are not relevant or accurate for your course. This may require meeting with superintendents or maintenance staff.

The USGA provides a cost per unit price that defaults to the **national average** & does not consider regional price differences, varying maintenance regimes, & today's current inflation rates.

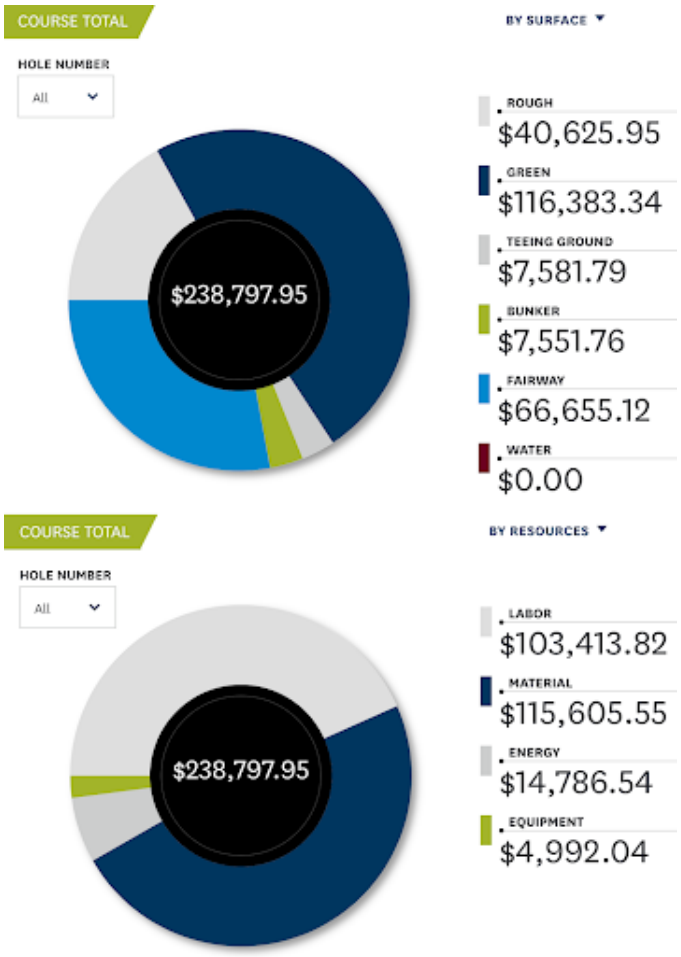

Figure 2.7 Example of Deacon's online profile for resource use. The cost of maintaining Goat Hill Park by resource type (bottom). The cost of maintaining Goat Hill Park by surface type (top). Note: The metrics presented here are hypothetical estimates based on California averages and federal statistics data and may not be representative of the maintenance costs and resources used at Goat Hill Park.

Economic Impact of Converting Underutilized Managed Areas

Identification of Target Areas

With our project's ultimate goal of identifying underutilized managed space on golf courses for alternative land use, one of the key steps to finding these diverse spaces was to revisit the tracker data presented in Figure 2.6.

Instead of comparing the mode in which the two different colored tracks were traveling (cart or walking), we combined the tracks and measured the void space between them (Figure 2.8). This information, coupled with the Surfaces layer allowed our team to reveal the locations of underutilized areas that would not be easily identified on or off the course as well as the costs associated with their current maintenance. The implications of this highly valuable data has the potential to reveal major cost reduction opportunities for superintendents. In order to determine what our team regarded as "underutilized", we decided that managed areas (greens, roughs, fairways, bunkers) with less than ten tracks (>10 Tracks) were deemed underutilized.

Of the 27 diverse managed areas that we identified as underutilized, one was a bunker (Area D), three areas were part fairway and part rough (Areas E, I, and W), and twenty-three were only roughs. Underutilized areas were typically located on the Eastern side of the course around the perimeter of fairways and along existing paths. Understanding the location and surrounding context of each area is important in determining the type of naturalized area it can become.

Pro Tip: Identification of Target Areas

When using the DEACON tool & its online mapping features, be sure to **note the accuracy** of the satellite imagery used for the basemap. Imagery can be outdated & will impact your analysis, the accuracy of the defaulted surface polygons, & more.

Quantifying Underutilized Managed Areas

To quantify the benefits of identifying underutilized managed areas at Goat Hill Park, we considered three key criterias: surface type, size, and maintenance cost (Table 2.1). The area code seen in Table 2.1 is associated with the codes in Figure 2.8. Areas range in size from 780 square feet (Area D) to 38,431 square feet (Area V) with the average size being 8,365 square feet. Areas with the largest square footage (Areas V, R, 2A) had above average maintenance costs (< $425.00

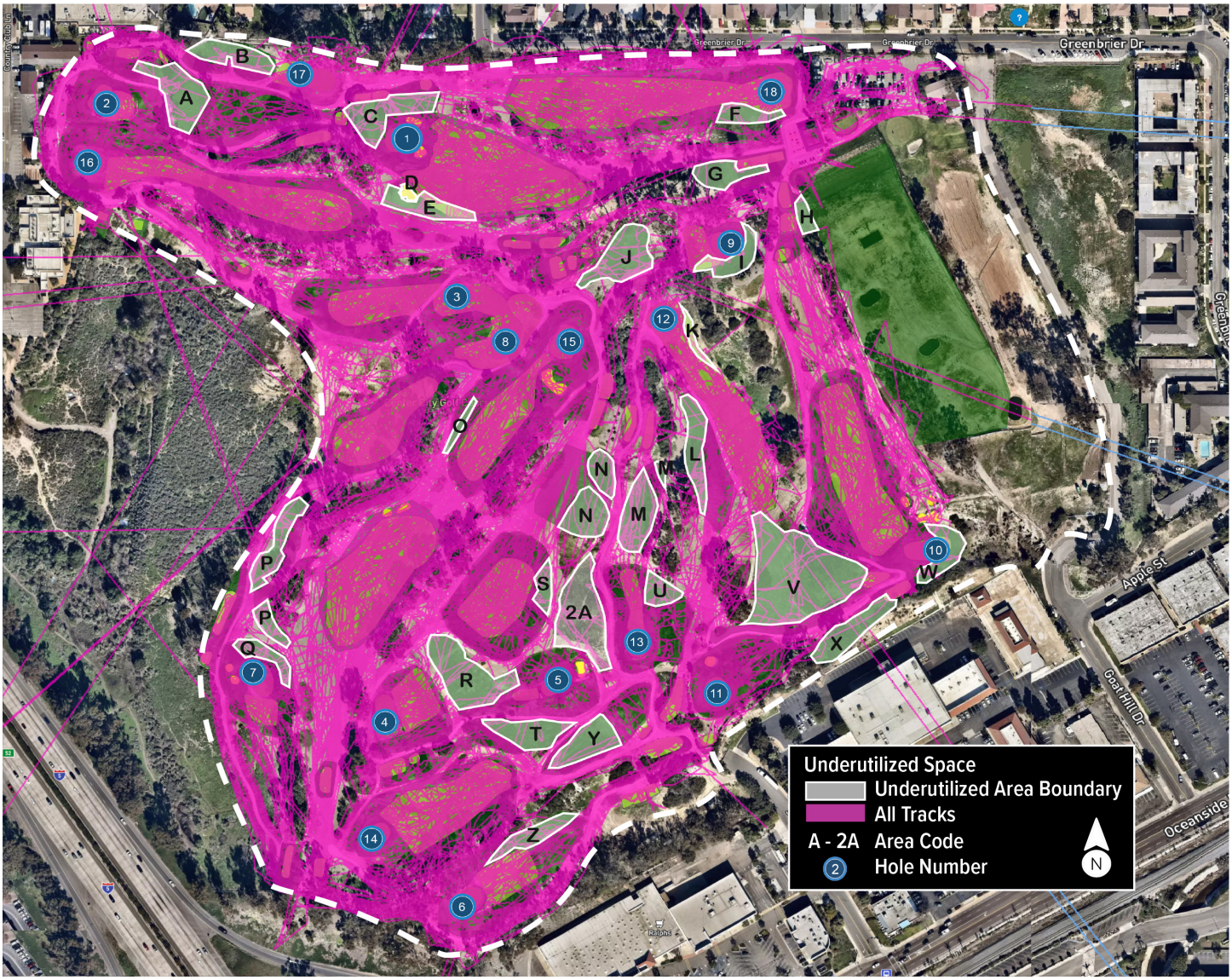

Figure 2.8 Underutilized areas (white polygons) at Goat Hill Park that are currently being managed and maintained. The pink tracks (utilized areas) represent the combination of golfer (walking) and golf cart movements.

annually), yet areas with the smallest square footage did not always have the lowest maintenance cost. Area D, the 780 square foot bunker, costs $893.00 to maintain, nearly double the average maintenance costs. Finding this reinforced the importance of accurately recording area types in DEACON as each area has different maintenance costs and needs associated with them. We found that the total amount of underutilized managed land is 232,219 square feet (approximately 5.3 acres) and Goat Hill Park is currently paying an annual price of $11,701 to maintain it.

What our findings tell us is that if Goat Hill Park chooses to convert the 27 underutilized areas (approximately 5.3 acres) to lower maintenance land, they would reduce their annual maintenance costs by 5% and the amount of managed land by 12.5%. This kind of cost and labor reduction can have a significant impact on how golf courses are managed, especially for those that have restricted financial resources. For golf courses that are unable or uninterested in converting all identified areas, our team pulled information associated with each area (Table 2.1) as criteria for which areas golf courses could prioritize. The goal is to identify the areas that will have the largest

Table 2.1 Identified underutilized areas that are currently managed broken down by surface type, size, and maintenance cost. Rows highlighted in red are recommended as priority areas for conversion.

Underutilized Managed Areas at Goat Hill Park			
Area Code	**Area Type**	**Size (Square Feet)**	**Maintenance Cost ($)**
A	rough	10,648	462
B	rough	7,593	329
C	rough	10,557	458
D	Bunker	780	893
E	rough + fairway	6,561	474
F	rough	4,095	177
G	rough	6,084	264
H	rough	2,660	115
I	rough + fairway	4,771	340
J	rough	12,482	541
K	rough	2,368	390
L	rough	9,340	405
M	rough	10,841	470
N	rough	12,488	541
O	rough	2,343	101
P	rough	10,035	435
Q	rough	5,053	219
R	rough	13,240	574
S	rough	2,838	123
T	rough	8,576	372
U	rough	4,532	196
V	rough	38,431	1,668
W	rough + fairway	7,413	485
X	rough	9,109	395
Y	rough	9,207	399
Z	rough	5,433	235
2A	rough	14,741	640
Total		**232,219**	**$11,701**

economic and environmental impact as finding ways to reduce maintenance and labor costs allows for more time and money to be put towards improving the golfer and pollinator experience.

Recommending Areas for Conversion

Of the 27 areas our team identified, there were three that presented special opportunities (Figure 2.9) for more specialized interventions. Areas V, 2A, and R were ranked (in this order) by the current cost of maintenance, size, and by their location and proximity to fairways and greens (Table 2.1). Focusing on areas with the highest cost of maintenance was one of the most important criterias we prioritized as these spaces would have the greatest cost reduction and are most likely to improve environmental sustainability given the input reductions such as mowing, irrigation, and fertilization. By converting these three areas, Goat Hill Park would reduce maintenance costs by 1.2%. We favored larger underutilized areas because of their ability to act as more productive patches for wildlife and their recorded above average maintenance costs. The total acreage of reduced maintained area would be 1.5 acres. We considered the location and proximity to fairways and circulation routes of these spaces as this would impact what these areas could be converted to and how they are accessed. Finally, we considered viewpoints and locations that would offer the highest aesthetic value. Additionally, we did not want areas nearest fairways or greens, as balls could potentially harm wildlife and pollinator habitats. The three areas we identified are currently roughs and have high traffic edges and low traffic edges. They are also surrounded by nodes of circulation, equaling high visibility and a healthy distance from fairways and greens. Based on the criteria our team has chosen, areas V, 2A, and R would have the greatest financial and environmental impact. Converting these areas would reduce total maintenance costs by 1.2% and total maintained area by 1.5 acres. Area V, the

Figure 2.9 Recommended maintained areas for conversion. Areas R, 2a, and V were chosen for their relative size, above average maintenance costs, and their location and proximity to greens and fairways.

largest area identified, includes the landing zone for Hole 11 and a forward tee for Hole 12. Additionally, area V has one of the lowest elevations of the surrounding area and during big weather events becomes an informal water catchment zone. This area and its current uses present several exciting opportunities for conversion that can improve its productivity. It would be beneficial to partially convert the area used by golfers to a bee lawn and the remaining zone to be a wildflower mix and/or planting area consisting of plants with high infiltration rates. Understanding the existing uses of your underutilized area can help inform the type of intervention most appropriate and effective for your course.

Implications of Increasing Low Maintenance on a Golf Course

To summarize, there are 5.3 acres of managed surface at Goat Hill Park that are viable options to convert to lower maintenance space. If converted, the course will save a minimum of 5% ($11,701) of their annual costs and reduce maintained areas by 12.5%. This money can be reinvested into the course, its programming, and the golfer experience. To have the strongest maintenance cost reduction, we recommended prioritizing underutilized areas V, R, and 2A. This is due to their relative location, their size, and their current cost of maintenance. Considerations were also made towards their aesthetic value, visibility, and impact on circulation.

Converting these maintained areas to lower maintenance areas will have a positive environmental and economic impact for the course and the larger community. Simply reducing chemical and natural resource consumption can save tens of thousands of dollars annually, reduce contaminated runoff, and provide safe habitat for wildlife. Furthermore, if efforts by golf course superintendents and their maintenance staff are able to be more intentional and strategic with their plans for converted areas, they have the potential to provide the course with year-round aesthetic value, enhanced multifunctional ecological services and benefits, and improved sustainability initiatives for the future.

Pollinator gardens are one of the many sustainable and beneficial ways to convert underutilized space. Our team, in collaboration with Greener Golf and Goat Hill Park, converted a 9,500 square foot plot of rough near the 12th hole into a multifunctional space that will now be a focal point for the course and help promote and protect pollinators. The garden is designed to not only provide pollinators with a highly productive habitat and refuge for resident and migratory species, but also to stabilize the steep slope, retain water, provide year-round visual interest to guests, and educate visitors on pollinators and their important services to the environment (Chapter 4: Best Practices for Implementing a Multifunctional Pollinator Garden at a Golf Course).

Conclusion and Next Steps

This chapter documents how golf courses are changing in their practices to become more sustainable and how golf course managers can become a part of that movement by identifying and converting underutilized maintained areas to areas that are lower maintenance, less costly, and more beneficial to pollinators and other wildlife. Facilities management can identify these areas through the use of the DEACON tool, which is customizable and easy to use, or simply by observing and spending time out of the course. By taking this first step to find and reduce maintained turf, golf courses will also reduce water usage and cut back on fertilizer and pesticide use further working towards being environmentally friendly. For more guidance on the kinds of land uses that can be incorporated within lower maintenance areas that best support pollinators, and why supporting pollinators is a worthwhile endeavor, see the following chapter, Chapter 3: What Are the Menu of Options to Support Pollinators on Golf Courses and What Are Their Benefits?

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Chapter 3

What Are the Menu of Options to Support Pollinators on Golf Courses and What Are Their Benefits?

Purpose and Audience

With their extensive amount of greenspace, golf courses have a large potential to provide high quality habitat to pollinators. Pollinators are essential for the reproduction of the crops and plants that are the foundation of landscape diversity and human well-being, but pollinator species are declining worldwide due to land-use change, habitat fragmentation, and climate change. A standard 150-acre golf course has approximately 55 acres of land that it can manage in a way that supports local pollinator populations, providing resources such as food, water, and shelter. At the same time, the creation of pollinator habitat on a course can have numerous benefits beyond the pollinators, from reduced maintenance costs to increased player experience. However, the potential for golf courses to provide pollinator habitat remains largely untapped, because of a lack of knowledge of options or their benefits. In this chapter we provide golf course superintendents, owners, landscapers and designers, community members, and environmental advocates with:

1. a variety of feasible and impactful options to implement pollinator habitat within a golf course,

2. guidance on how to recognize and assess the ecological and social benefits that these pollinator habitats provide, and

3. easy ways to communicate and celebrate these benefits with the golfers and wider community.

What Are Options for Supporting Pollinators Within the Different Components of a Golf Course?

Golf Course Components

The first step to add the ecological and social value of pollinator habitat on a golf course is to recognize the distinct components of a golf course landscape that have the potential to contribute to that value. The typical golf course can be split into two major components: **maintained turfgrass areas**, where golf is played, and **naturalized areas**, including areas such as native grasslands, savannas, shrublands, forested areas, and wetlands that are incorporated outside of and within the field of play (Figure 3.1). Maintained turfgrass areas consist of four distinct parts: the tee box, fairway, green, and rough. By maintaining these four parts differently (i.e., different levels of mowing, irrigating, and pesticide and fertilizer application), each area provides a different style of play for the golfer, making each stroke different than the one before.

What differentiates maintained turfgrass areas from naturalized areas is the level of maintenance that is devoted to it throughout the year. Maintained turfgrass is typically cut multiple times per week, irrigated daily, and has chemical fertilizer and pesticides applied to it once every one to two weeks (Vavrek, 2018). In contrast, naturalized areas such as hillsides, wooded areas, and the spaces in between holes do not get mowed, irrigated, or sprayed as frequently as maintained turfgrass areas. Instead, these areas may get cut back once a year, weeded, or have trees trimmed. Even within the category of maintained turfgrass, there can be substantial differences among golf courses, from turf that is thoroughly maintained, uniform, and absent of any other species, to turf that is maintained less intensely, containing multiple species. High-end golf clubs, for example, may invest more in intense maintenance of their facilities compared to municipal golf courses.

Green

Greens are where the pins (the flagsticks) are located that golfers are shooting towards. Each green area averages between five to six thousand square feet, making up 3% (3.2 acres) of the maintained turfgrass on a course (GCSAA, 2017). As the most important feature on any golf course, greens are the most manicured turf type on the course,

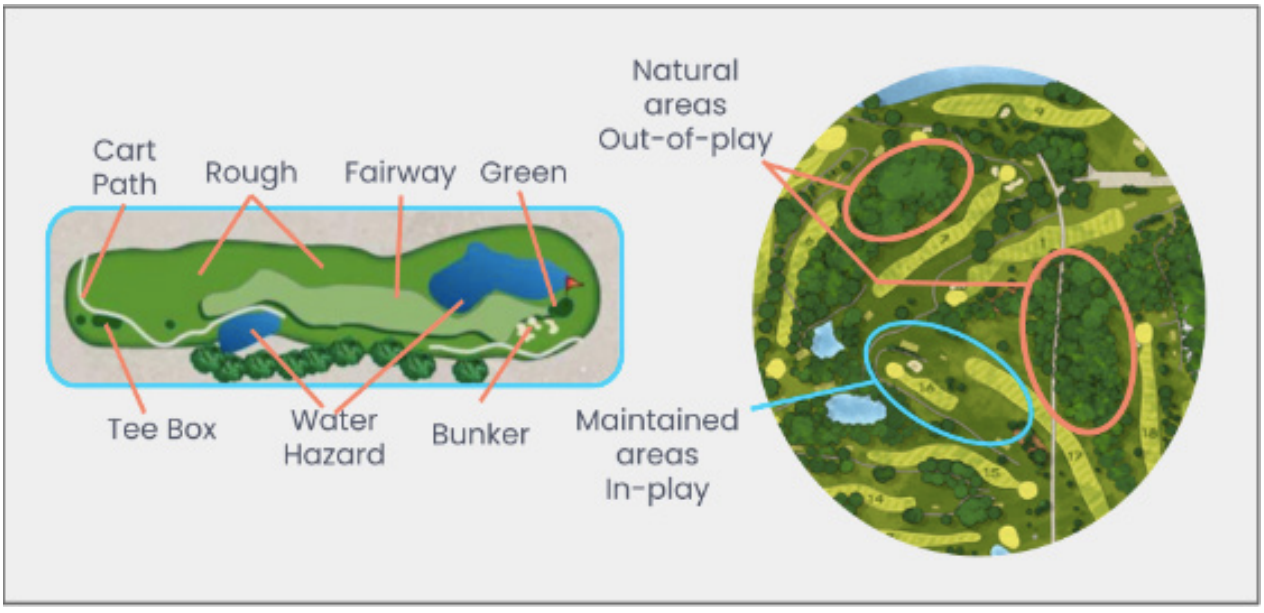

Figure 3.1 Key components of a golf course.

being irrigated, sprayed with fertilizer and pesticides, and mowed daily to 0.125 inches or lower (Figure 3.2a). Coupled with a very high foot traffic, the health of the greens are highly prioritized by superintendents, which is why they are on average twice as costly to maintain compared to fairways and rough (see Figure 2.7 in Chapter 2).

Fairway

Fairways typically stretch the length of the hole between the tee box and green making up about 29% (28 acres) of the maintained turf on the golf course (GCSAA, 2017). Fairways are mowed three to four times a week at 0.5 inches facilitating faster playing conditions, which allows the ball to move further on its surface (Lowe, 2013).

Rough

The rough makes up the biggest component of maintained turfgrass on the golf course, taking up approximately 51% (48 acres) of the total maintained turf area (GCSAA, 2017). The turfgrass within the rough is kept much longer (1.5 to 2 inches) compared to the other turfed areas (Lowe, 2013; Figure 3.2b). Since most roughs are not actively irrigated or fertilized and tend to grow in more challenging environments (i.e. under trees, on roots, in shade, drainage paths) compared to other turf types, it is not abnormal to see patchiness, dried out areas, standing water and a mixture of grass species present as grasses from naturalized areas can creep their way into the rough (Nicoludis, 2021). The level of consistency within a course's rough depends on the amount of money and other resources put into it as well as golfer expectations.

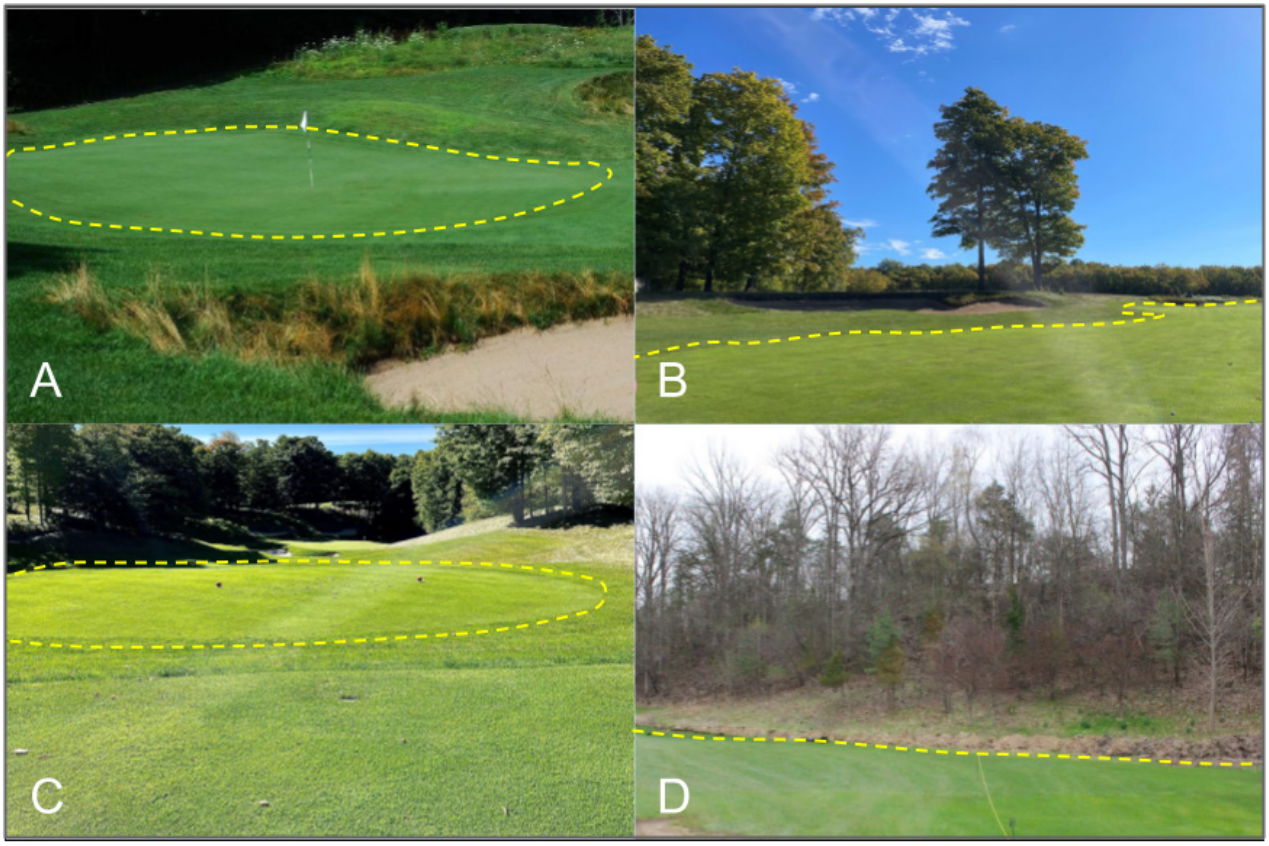

Figure 3.2 Comparison between the different major golf course components A: Green at Calderone Golf Club. B: Tee box at the Smith Signature course at Treetops Resort. C: Edge of fairway and rough at the Smith Signature course at Treetops Resort. Notice the clear contrast between fairways (light green grass) and rough (dark green grass along the woodland). D: naturalized tall grass and woodland area at Radrick Farms Golf Course.

Tee Box

Tee boxes make up approximately 3% of a golf course's maintained turfgrass (~3.1 acres). It marks the beginning of each hole and as the name suggests, this is where tees are located (GCSAA, 2017; Figure 3.2c). Holes typically have one to five tee boxes that are spaced out based upon the design of the course. This allows golfers of different skill levels to choose the tee box that best fits their handicap. In terms of their maintenance, tee boxes are typically mowed to a length between 0.250 to 0.500 inches, depending on the grass species that is used (Florida Department of Environmental Protection, 2007). The amount of irrigation will depend on the type of species used, soil type, and the climatic location of the golf course (Murphy, 2002). Due to high amounts of foot traffic, tee boxes typically need consistent maintenance throughout the year.

Naturalized Areas

Naturalized areas can reside in or outside the designed playing area, often being incorporated into the overall design of the course. Roughly 21.4% (32.2 acres) of the golf course grounds are naturalized areas (GCSAA, 2017). Naturalized areas can be composed of water features, clubhouse grounds, and other materials as seen in Figure 3.2d. Naturalized areas can serve numerous functions such as water catchment systems (i.e., ponds), important wildlife habitats, and vegetative buffers that reduce runoff (Davis and Park, 2022). As the areas are not actively being used by golfers, they are generally managed significantly less than maintained turfgrass on the course. General maintenance usually consists of cutting down vegetation once a year, trimming branches, and removing any invasive species found within the site. Given the large amount of space naturalized areas occupy on golf courses, there are a wide variety of options available to superintendents on how best to manage them.

Pollinator Habitat Options on Golf Courses

Pollinators and golf may seem like an unlikely pairing, but viewing the different golf course components we just described as potential habitat for pollinators is a way for courses to be a part of the current movement toward golf course sustainability (Chapter 2: A Move Towards Sustainability: Identifying and Quantifying the Benefits of Converting Underutilized Managed Areas on Golf Courses), while meeting a critical ecological need. Pollinator species are in a critical state of population decline largely in part due to a loss of high-quality habitat and the lack of adequate resources such as food and shelter (Dicks et al., 2021; Rhodes, 2018; Potts et al., 2010). Depending on how they are managed, the different components and acreage of

Terminology: Golf Course Components

Maintained Turfgrass Areas: Regularly (weekly to daily) maintained turfed areas that act as the playing surface for golfers. The four major turfgrass areas on a golf course includes:

Tee Box: The starting position for each hole where the golfer hits his first shot.
Fairway: Stretch of shortly cut turf between the tee box & green.
Green: Areas on the course where the pins are located that the golfers are shooting towards.
Rough: Longer-cut turf grass that surrounds the tee boxes, fairways, & greens.

Hazards: Obstacles such as water bodies, sand bunkers, & naturalized areas that each golfer tries to avoid as they approach the green.

Naturalized Areas: All inclusive term that includes everything on the course that is not maintained turfgrass (i.e. water bodies, open grasslands, scrubland,& woodlands). Naturalized areas can be found outside of & within the field of play (as natural hazards). They do not receive the same level of maintenance relative to maintained turfgrass areas.

golf courses can serve as safe havens for pollinator species especially within urban and agricultural settings. Beyond the ecological benefits, investing in pollinator habitat has the potential to provide numerous social and economic benefits as well, creating a win-win situation for pollinators and the golf facility. Due to the spectrum of available resources and space at golf courses, we developed a menu of options for implementing pollinator habitat on courses that allow facilities to choose from a suite of interventions that best suit their specific wants, needs, and individual circumstances. The effort and maintenance required to implement pollinator habitat within golf course settings occur along a spectrum from options that require low effort to options that require much more labor, time, and equipment (Figure 3.4). Important to note, all of the options we present are feasible at different scales, which can influence effort to establish and maintain them. First we will lay out these options, some of which may already be in place on a course, and then share the known ecological and social benefits of applying them.

Mixed Species Rough

Incorporating a spectrum of flowering plants into rough turfgrass areas, known as a 'bee lawn', is an easy and highly beneficial way to support pollinators while still maintaining the natural function and playing ability of a rough (Figure 3.3; Figure 3.4, upper left). The environmental services of single-species turf grass are limited, because it does not provide any feeding, nesting, or breeding sites for pollinators. Converting rough into bee lawns, simply by mixing low flowering perennials with the turfgrass, creates a pollinator haven that provides pollinators with nectar and pollen, protection from predators, and nesting sites (Rihn, 2022). Bee lawns have a documented higher ecological value than typical roughs because they are managed using low-input methods such as less chemical applications, and can attract over 50 species of native bees (Moncada et al., 2021). Since many plants do not tolerate being mowed short like turfgrass, requirements for bee lawn flowers include being adapted to be mowed short, flowering at low heights, being tolerant of foot traffic, having a moderately competitive nature, and having a perennial life cycle. Popular flowering plants in bee lawns include

Figure 3.3 Examples of 'bee lawns' that occur naturally in the rough at Tanglewood Golf Course (left) and Radrick Farms Golf Course (right). Each photo shows patches of Dutch white clover growing in their maintained rough.

Dutch white clover (Trifolium repens), self-heal (Prunella vulgaris), and creeping thyme (Thymus serpyllum). Creating a bee lawn in the rough requires relatively low effort as you do not need to tear out existing turfgrass and only need to seed the areas you want to convert. Even easier, refraining from broad-leaf herbicide application in the rough can allow for bee lawns to occur naturally, without the input of any seed mixes.

Even easier, refraining from broad-leaf herbicide application in the rough can allow for bee lawns to occur naturally, without the input of any seed mixes.

Unmowed Naturalized Area With Wildflowers

Not mowing certain naturalized areas around a golf course can help establish native wildflowers in a habitat that would have otherwise been left underutilized. Based on the goals of the golf facility, this option can range from simply not mowing selected areas, to prepping a site to establish a simple wildflower meadow with seed mixes. Based on pilot observations of pollinators across four different golf courses, we found that low-effort unmowed naturalized areas have the potential to attract just as many and as diverse pollinators as maintained formalized pollinator gardens (Appendix B). Areas such as woodlands or woodland edges provide great space for this option. Proper management of woodland areas such as thinning and coppicing can encourage the natural growth of woodland wildflowers (Bumblebee Conservation Trust, 2021). If a facility chooses to establish a native wildflower meadow, a little more time and preparation will be needed compared to the no-mow option. Successfully establishing a naturalized pollinator meadow from seed is on average a three-year process, with the first year being devoted to site preparation (Neal, 2019), and subsequent years allowing for establishment and growth. Fall (September through December) is a great time to sow wildflower seeds as germination will be enhanced by cooler temperatures and wetter soil conditions. For a detailed step by step process on the best practices for establishing a native wildflower meadow with seed mixes, refer to "Planting for Pollinators: Establishing a Wildflower Meadow from Seed" (2019). If a more rapid establishment is desired and budget allows, planting perennial plugs instead of using seeds can result in a flowering wildflower meadow in the first growing season, with increased diversity and blooming in subsequent years (Weatherford, n.d.).

Formalized Native Pollinator Garden

Creating formalized native pollinator gardens throughout golf course naturalized areas directly increases average pollinator abundance fourfold compared to turfgrass habitats such as fairways and roughs (Nestle et al., 2021). To maximize the ecological benefits of formalized pollinator gardens, designers should try to include a diverse assortment of native species as the number of native species that are included in the garden significantly impacts the abundance of pollinators present (Dale et al. 2020). Implementing formalized pollinator gardens are a great addition to golf courses as they are specifically designed to increase the ecological services and aesthetic value of an area. This can also provide a great opportunity for facilities to locate underutilized areas on their course and convert them into high-functioning habitats. The high amounts of planning that goes into garden design, flower species selection, garden preparation work, plant sourcing, and general maintenance post planting makes this the most time and resource intensive option. In Chapter 4: Best Practices for Implementing a Multifunctional Pollinator Garden at a Golf Course: A Case Study at Goat Hill Park, we provide detailed best practices for implementing high-quality and multifunctional formalized native pollinator gardens on golf courses.

Apiaries in Naturalized areas

Establishing apiaries on a golf course is a great way to not only provide safe areas for bee colonies to live, but also to minimize human-bee contact. Whether golf facilities know it or not, bees occur naturally on golf courses and can often reside in not-so-ideal locations such as irrigation boxes, tool sheds, gutters, clubhouses, and more. By putting swarm traps in trees around the course, maintenance crews can transfer wild honey bees into apiaries that are placed in a safe, naturalized area. Honey bees can serve multiple purposes on golf courses, the most notable being that they act as indicator species in their ecosystems. By establishing apiaries on golf courses, managers can use the health of the honey bee colonies as an indicator of the overall ecological health of the golf course itself. Courses such as Cantigny Golf in Wheaton, Illinois and The Sanctuary on Sanibel Island, Florida already use this method of ecosystem health assessment, each having over five

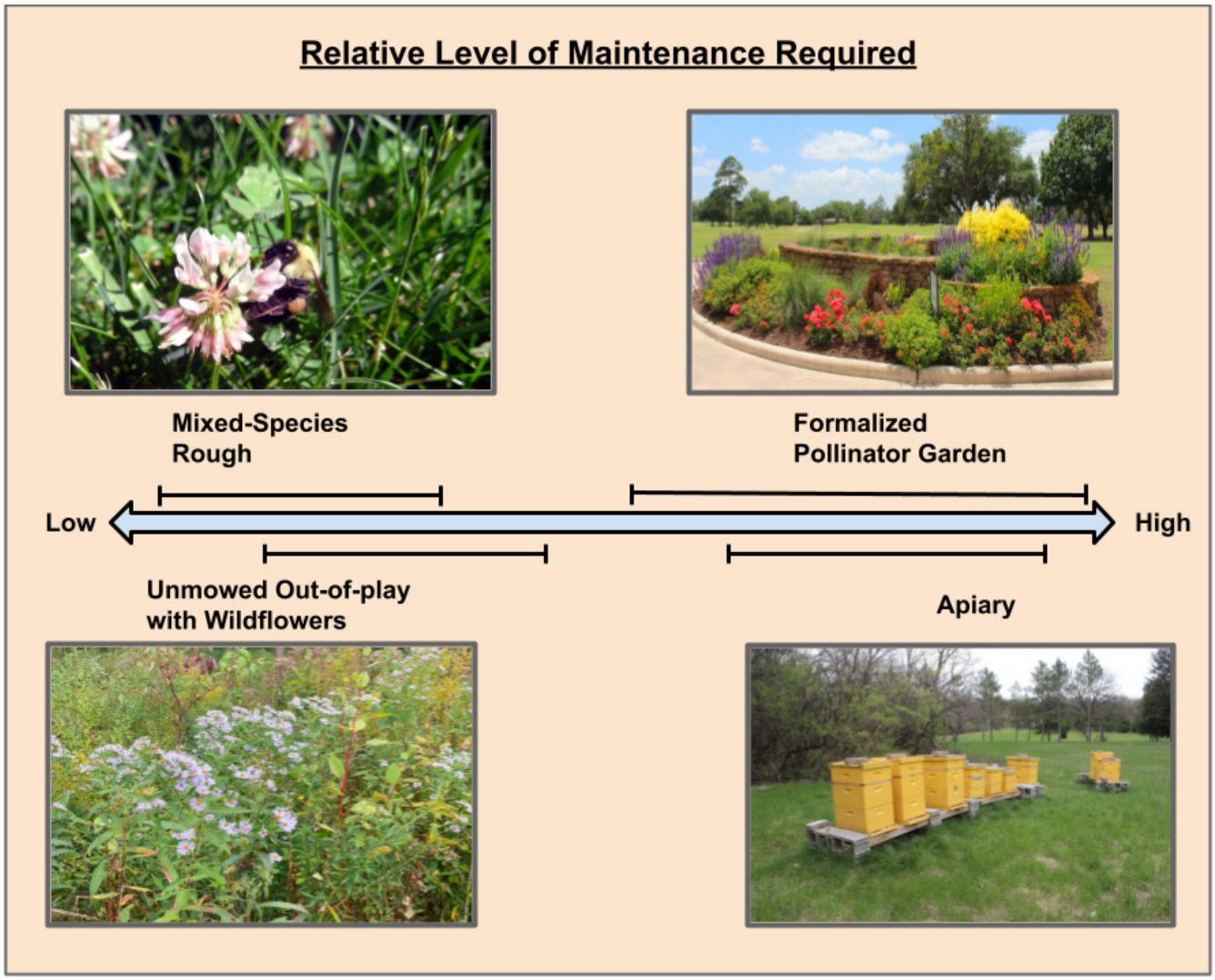

Figure 3.4 Relative level of maintenance (i.e. labor, time, equipment) required for implementing and maintaining different pollinator habitat options. It is important to note that the level of maintenance of any of these four options can vary significantly depending on the golf course's wants and needs. The type of maintenance is also an important factor when choosing a pollinator habitat option. For instance, while a formalized pollinator garden will typically require more time investment compared to an apiary, an apiary will require more tools, materials, and resources to construct and maintain.

apiaries in their naturalized areas (Mickey, 2019). Although apiaries generate many new benefits for golf courses, they do require continual maintenance from an experienced beekeeper to remain healthy. This will require facilities to train or hire specialized staff or develop a partnership with local beekeepers or organizations. Radrick Farms Golf Course has a total of nine apiaries that are tended to by a full time beekeeper who maintains colony health and harvests honey that is sold in the clubhouse.

The Benefits of Adding Pollinator Habitat on Golf Courses

Creating diverse pollinator habitat on golf courses is not only key to sustaining healthy pollinator populations, but also provides numerous additional benefits for the golf course and local community. Through the incorporation of pollinator habitats on golf courses, bees and other pollinators gain access to critical nutrients such as pollen and nectar, while golf facilities and golfers receive the benefit of reduced input costs, additional income revenue streams, educational opportunities, and positive public image. This "win-win" scenario between sustainable improvements and economic benefits of pollinator habitat negates the longstanding notion within the golfing industry that golf facilities will be harmed economically if they incorporate sustainability within their maintenance plan.

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Improved On-Site Safety

Naturalized habitat or space allocated to pollinators on a golf course helps improve the safety of golfers, staff and the pollinators themselves. Bees are likely to be on any golf course to some extent, due to water and even minimal forage availability. However, by providing quality habitat designed for pollinators that are outside of high-traffic play areas, pollinator-human interactions are likely to be reduced. More specifically, providing out-of-play apiaries as home base for honeybees, both reduces aggressive behavior and the likelihood that they colonize irrigation boxes (P. Anderson, pers. comm.).

Because pollinator habitats require little to no chemical fertilizer or pesticide use (there are organic alternatives), course maintenance teams, golfers, pollinators, and the surrounding community would have reduced exposure to potentially harmful chemicals due to a reduction in their storage, handling, and application. In addition to a reduction in chemical usage, naturalized areas generally require less frequent and intensive maintenance (i.e. only having to mow down two or three times a year), therefore maintenance could be completed when fewer golfers are present (i.e. early mornings and/or during off-seasons), instead of putting crew at risk of potential injuries from stray golf balls.

Improved On-Site Safety

Bees are less likely to colonize in irrigation boxes & other places around a golf course if they have **designated pollinator habitats** available. This also reduces bee's aggressive behavior, resulting in less negative human-bee interactions.

Reduced Maintenance Costs and Labor

Identifying and converting underutilized managed areas on golf courses into pollinator habitats can generate significant cost benefits within the maintenance budget, specifically with materials and labor efforts. When a

golf course converts underutilized managed areas into pollinator habitats there is less turfgrass to manage, leading to a reduction in maintenance costs. Unlike turfgrass, pollinator habitats do not require significant resources or equipment to be a presentable feature on the course. Reduced expenses can be reflected by less frequent use of water and chemical fertilizers and pesticides, which can have high annual costs (Chapter 2: A Move Towards Sustainability: Identifying and Quantifying the Benefits of Converting Underutilized Managed Areas on Golf Courses). Less frequent use of equipment can be seen by operating less energy-consuming machinery such as lawn mowers and weed whackers. This creates less wear and tear on the equipment and produces cost savings with gas or diesel. In regard to reduction in chemical fertilizers and pesticides, pollinator habitats support not only bees and other pollinators, but predatory and parasitic insects. These beneficial insects are known as biological control agents, a sustainable and low cost approach to pest management commonly used in agriculture. If provided a habitat that allows populations to grow year round, beneficial insects can "reduce common pest populations of moths, aphids, mites and bugs by 20 to 40%" (Jones, 2015, p. 1). By reducing the abundance of turfgrass pests on golf courses through strategic planting, predatory and parasitic insects can directly lower the need for pesticide applications.

Depending on the pollinator habitat chosen, there will be different maintenance plans, still requiring labor, but less regular, intense maintenance. For example, a naturalized area may require a cut back once a year, whereas a formalized garden bed would require weeding, deadheading and potentially weekly watering. As labor is currently the highest expense of a golf course (S. States, pers. comm.), managing labor efforts will help ensure the effectiveness of a maintenance team. With less time required to be spent on turf maintenance, labor efforts can be reallocated to other areas of a course requiring attention, creating more efficient labor performance for the golf course to improve the golf experience (Audubon International, 2007).

Unique Branding and Sales

Enhancing naturalized areas and environmental performance on a golf course may enrich customer satisfaction, improve the golf course's image and reputation, and allow the golf course to differentiate themselves from others. Having increased naturalized areas and pollinator habitats can provide beneficial impacts to a golf course, such as enrichment of land use, an increase of positive reputation, and an increased number of sustainability initiatives. With these beneficial impacts, there is also the potential for a golf course to establish a leadership model towards sustainability for the golf industry as a whole. Customer satisfaction can increase if a course makes efforts in preserving the heritage of the game in regard to the unique, scenic environment this sport is known for (Audubon International, 2007). Additionally, customers are becoming more aware of sustainability initiatives, as 78% of global customers feel environmental sustainability is important, 68% have made modest to significant changes to their purchasing behaviors, and 50% rank sustainability as a top five value driver in purchasing decisions (Simon-Kucher & Partners, 2021). This information paired with the golf market growing in demand (Straits Research, 2022), suggest that upholding environmental considerations and performance will help golf courses differentiate themselves by having unique sustainability values, giving golf courses an opportunity to attract new customers.

One lesser known economic benefit to having pollinator habitats is the opportunity to produce and sell honey. Producing honey necessitates the integration of an apiary and beekeeping program on the golf course property, adding an unique value to the course. In the United States (U.S.), a hive can produce about 55 pounds of honey per year but could range between 0-100 pounds (National Agricultural Statistics Service, 2020). Honey

produced by a golf course's apiary makes for a desirable novelty product. When golfers are able to see and taste the course-produced honey, they are able to connect on another level with the course and pollinators. From experience, Parker Anderson has come to understand the intangible, emotional value of course-produced honey, no matter how small the jar or how rarely it is available. Although there may be an economic benefit with producing honey, the main focus and understanding should be on the many other benefits and values the apiary/beekeeping program has to offer.

Positive Player Experience and Health

Golfers and visitors can gain meaningful mental and emotional health benefits from being in, and around, more natural areas such as pollinator habitats on golf courses. Natural environments have long been proven to help with regulating moods, reducing stress, anxiety and depression, and improving mental and emotional health (Kaplan, 1995). Stephen and Rachel Kaplan invented the Attention Restoration Theory (ART), where they explain how humans' attention fatigues unconsciously, leading to stress, irritation, depression and more negative effects. They emphasize the need to practice restoring one's directed attention fatigue by immersing in nature, which can be attainable on golf courses with notable nature characteristics. Additionally, exercising in natural environments is associated with greater self-reported feelings of revitalization and positive engagement, decreases in tension, confusion, anger, and depression, and increased energy (Coon, 2011). Therefore, contact with nature provided by golf courses promotes an effective, population-wide strategy in prevention of mental illness health, as well as personal and interpersonal health (Maller et al., 2005). Golf courses naturalized areas provide opportunity for attention restoration and improved cognitive function. Beyond the health benefits, maximizing naturalized areas paired with positive experiences in natural environments has a strong indication of people adopting ecological behavior (Hartig et al., 2001). Because golf is interconnected with some of the most scenic environmental settings (Wheeler et al., 2006), this supports the idea that golf can promote ecological behavior. Pollinator habitats in particular - with their multicolor flowers, active wildlife, and diverse vegetative forms - can be critical not only to promoting ecological behavior, but also to achieve the health benefits of immersion in natural environments. Psychological restoration level has been linked to the abundance of flowers in a greenscape (Lindal & Hartig, 2015).

Incorporating pollinator habitats into the design of golf courses can also enhance the existing aesthetic and golfers' experience. Three components should be taken into consideration while designing and improving a golf course: the setting, the beauty, and the challenge (MacKellar, 2009). The beauty component can depend on how managed areas are integrated with the surrounding natural or semi-natural habitat (Dobbs, 2015), and the challenge component can present a golf course with a visual, and physical, challenge to golfers, creating added degrees of difficulty to the course (Landschoot, 2019). Therefore, a well-designed and improved course may have influence on customers' purchasing power, as aesthetically pleasing visuals that present challenges for the players could sway a customer's decision on which golf course to play.

Pollinator habitats that incorporate a diverse selection of forbs, with multiple flower colors, have a stronger perceived perception of higher biodiversity, more attractiveness, and connections with wellbeing (Ramer et al., 2019). Color diversity in plantings is seen as an important factor in public perception of biodiversity and is extremely attractive and stimulating (Hoyle et al., 2017). Public perception of flowering lawns, compared to just green lawns, are 'aesthetically pleasing' or 'are beautiful', with 96.5% strongly or moderately agreeing with the statement "I like the way flowering lawns look" (Ramer

et al., 2019). This supports the idea that pollinator habitats with a similar mix of flowers and appearances would sustain these beliefs. Also, there is belief in connections between aesthetics and individual and community wellbeing. People feel happy when there is an increase in the beauty around them and believe aesthetic benefits would reach beyond themselves, demonstrating interest in caring for their neighborhood (Ramer et al., 2019). Golfers may be pleased with the beautification of the pollinator habitats in naturalized areas, as it enhances the aesthetic, experience, and value of the golf course.

Positive Player Experience & Health

The **Attention Restoration Theory (ART)** proposes that exposure to nature is not only enjoyable but can also help improve focus, mental fatigue & one's ability to concentrate, therefore giving golf courses a major opportunity to have significant positive human health effects, such as regulating moods, reducing stress, anxiety & depression, & enhancing feelings of revitalization & positive engagement.

Community Engagement and Educational Opportunities

Establishing pollinator habitats will benefit the golf course by offering educational and engagement opportunities. Courses with the unique features of apiaries, wildflower meadows, or pollinator gardens can foster member support, loyalty, and a sense of connection and community based on the way these features of the course reinforce shared environmental values. Having pollinators present on a golf course can also inspire, encourage, and educate communities on environmental stewardship and sustainable practices, with opportunities for engaged and accessible outreach and educational activities. Golf courses that develop educational programming on these topics and practices allow for more marketing on their positive sustainability narratives (Appendix A). Because of the unique nature of these golf courses, sharing and enhancing the sustainability narratives and practices can create an important, yet often overlooked, tool for influencing the industry towards a sustainable future. These educational and engagement informational sharing programs and tools can measure the impact these initiatives bring to their community and evaluate the value of golf courses to help guide the industry towards a sustainable and prosperous future.

Larger-Scale Impact on Water and Food Systems

Naturalized areas within golf courses have the ability to protect water quality and supply. Developed urbanized areas are largely impermeable surfaces, preventing the infiltration of rain and runoff. The majority of these areas have replaced the once valuable rural open land and high quality vegetation that provided important ecosystem services. Urban regions experience warmer temperatures than their rural counterparts and their impermeable surfaces overburden municipal stormwater infrastructure (United States Environmental Protection Agency, 2022). Golf course greenspace can ameliorate the increased temperatures of concrete urban areas, and pollinator habits in particular can provide higher infiltration value. Replacing shallow-rooted turfgrass with more deeply rooted plants of pollinator habitats can help protect water quality and quantity by increasing infiltration and reducing stormwater run-off into waterways. These habitats can play a significant role in reducing the overall amount of water resources used, reducing contaminated runoff, and improving overall water quality (de Groot et al., 2010). By acting as vegetative buffers surrounding water bodies and at times, as rain gardens, wildflower habitats have the ability to retain water, recharge groundwater tables, and act as a natural filtration system.

Golf courses with healthy pollinator populations year-round can also support our food system. All types of bees pollinate

approximately 75% of fruits, nuts, and vegetables grown in the United States, pollinating crops like apples, blueberries, carrots, avocadoes, tomatoes, strawberries, melons, peaches, potatoes, almonds, and coffee (United States Geological Survey, 2015). Bee pollination is responsible for more than $15 billion in increased crop value each year (U.S. Department of Agriculture, 2022), with some scientists estimating that one out of every three bites of food we eat exists because of animal pollinators like bees, butterflies and moths, birds and bats, and beetles and other insects (U.S. Department of Agriculture, n.d.). Golf courses often occur within a landscape mosaic of development and agriculture, so they have the potential to support pollinators that also visit crops.

Larger-Scale Impact on Food Systems

Pollinators, especially honey bees, are responsible for pollinating around **35% of the world's food crops**, contributing up to $577 billion in annual food production value. This makes one out of every three bites of food dependent on pollinators!

How Can Pollinator Habitat Benefits be Shared and Communicated to Support Pollinator Stewardship?

Effective communication of the benefits of high-quality wildflower habitat on golf courses is needed to shift golf's environmentally harming narrative and practices, and demonstrate how golf courses can indeed enhance the ecosystem services of the local ecosystem (Appendix D). In this chapter we have compiled the forefront literature on the range of options and benefits of supporting pollinators on golf courses, and here we detail how to effectively communicate these benefits to a wider audience through community engagement that leads to increased pollinator stewardship. Specifically, in this section we describe how to use surveys to simultaneously educate and assess your community, how to engage your community by hosting an effective Bee Benefit event that educates golfers on the environmental and social benefits of golf, as well as how to use social media to promote benefits to a much larger audience.

Survey

Surveying is a great tool to educate golfers on the idea of having and promoting bees and other pollinators on golf courses. Including questions about pollinators on "end-of-season" feedback surveys can allow golf course managers to assess the current understanding that golfers have about pollinators on their course so that they figure out what to prioritize during a potential pollinator-promotion event. Having pollinator-related questions on annual feedback surveys also allows golfers to input their voice and ideas to show golf course managers what they like, what they dislike, and also what they think future pollinator activities should include. For a list of pollinator and sustainability related sample questions (Appendix C) where we have provided ways to assess golfer's current knowledge, awareness, and support of pollinator efforts on golf courses.

Pollinator-Related Event

Hosting a pollinator-related event on golf courses allows managers and outside organizations to directly communicate with the community on why bees and other pollinators are vital to the ecosystem and how golf courses have helped sustain their populations. It is also a great way for golf courses participating in pollinator endeavors to showcase their progress, promote future community pollinator events, and even advertise their collected honey for sale. At a Bee-Benefit hosted at Goat Hill Park Golf Course (Chapter 1: Golf Courses and Their Potential to Support Pollinators) in Oceanside, California on July 1st, 2022, golfers were able to learn about how golf courses can act as a safe haven for local pollinator populations, hear about the specific activities Goat Hill Park has been doing to promote pollinator health,

and even sell honey produced right there on the course (Appendix A).

Social Media

Social media can serve as an effective and easy way to promote the idea of pollinators on golf courses. Being easy to utilize, social media can allow golf courses to visually showcase their pollinator activities and projects to a much larger audience compared to other forms of customer communication. With social media platforms being the preferred source of information for teens and younger adults, utilizing social media to promote the idea of pollinators can be an effective way to portray the benefits and importance of golf courses to younger generations (Vogels et al., 2022). The Goat Hill Park Instagram page ("goathillpark") was one of the ways in which our team was able to promote our bee-benefit event. Their Instagram page was able to not only give details on the event itself but also provide critical information on how their golf course protects, promotes, and propagates pollinator species onsite.

Sharing the Benefits of Pollinators on Golf Courses to Support Pollinator Stewardship

Survey: Feedback surveys give golf course managers the opportunity to assess golfer's current understanding of pollinators & what to prioritize on their course. Asking for golfer's inputs & ideas & engaging in environmental stewardship is a great way to build relationships.

Event: Pollinator-related events teach golfers about how golf courses can act as safe havens for local pollinators, why pollinators are so important, & different ways to incorporate sustainable best management practices into their own gardens.

Social Media: Social media is so popular these days, it would be a mistake to not utilize it. It's an easy way for golf courses to visually showcase pollinator activities & projects to a much wider audience.

Conclusion and Next Steps

The implementation of high-quality pollinator habitat on golf courses has a number of ecological justifications such as increasing the overall health of local pollinator populations through its provisioning of food, shelter, and reproductive sites. High-quality pollinator habitat also provides golf facilities with economic and social benefits through reduced maintenance costs, honey sales, increased educational opportunities, higher aesthetic qualities around the course, increasing golfer's mental health, and greater community wellbeing. Since golf courses vary dramatically in their financial, labor, and equipment resources, we presented here a menu of options facilities can implement to best fit their overall goals and vision. These options are meant to increase the overall quantity and quality of pollinator habitat on golf courses to maximize the benefits to both pollinators and people.

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Chapter 4

Best Practices for Implementing a Multifunctional Pollinator Garden on a Golf Course

Purpose and Audience

Implementing a high-functioning and intentionally designed pollinator garden on a golf course can significantly increase the health and abundance of local pollinator species, as well as create a space that adds to the aesthetic and ecosystem service value of the golf course. Allocating resources towards a pollinator garden can be a win-win for golf facilities and local ecosystems as it creates food, habitat, and reproductive sites for pollinator communities in addition to increasing the beauty of the course, promoting golfer experience, and lowering long-term maintenance costs. Even if these benefits are recognized, it is still a relatively new idea to include as part of the operation of golf courses and there are not many precedents readily available to show how it can be done. Due to this fact, this type of work is not included in most job descriptions or as part of the overall maintenance plan for many golf courses so while there may be an interest in including spaces for pollinators or other wildlife it is not required. This may lead golf facilities to either forgo including pollinator gardens or limiting pollinator habitat to already established gardens.

This chapter presents the step-by-step process of designing and implementing a multifunctional pollinator garden. Specifically, this chapter provides details on site analysis, determining garden style and aesthetic, which suitability factors and physical plant traits to consider, future maintenance considerations, communicating garden designs to clients or co-partners, budgeting, garden installation, and post-installation management. We then

apply all the steps to illustrate a real-world case of designing and implementing a high-quality pollinator garden on a golf course in southern California. *Golf course managers, local environmental groups, landscape designers and consultants, or anyone else interested in improving their landscape* can use this step-by-step guide and sample case to effectively implement their own pollinator garden.

Key Steps to Design and Implement a Multifunctional Golf Course Pollinator Garden

Anyone who has decided they want to add value to a golf course with a well-designed pollinator garden needs to have a course in mind and, if needed, establish the client contact. For those who are not currently involved with a golf course, or are not a golf course manager, you will need to reach out to golf courses you are interested in working with and see if they are interested in installing pollinator gardens. Some courses may not be interested without knowledge of the benefits of including pollinator habitat (Chapter 3: What Are the Menu of Options to Support Pollinators on Golf Courses and What Are Their Benefits?) or might not know where to place the garden on the course (Chapter 2: A Move Towards Sustainability: Identifying and Quantifying the Benefits of Converting Underutilized Managed Areas on Golf Courses), or whether they have the budget for a pollinator garden (which can be clarified in step one). Establishing a site and willingness can take time, but opening up lines of communication and creating contacts can lead to future opportunities. Once a project has been established, a series of steps should be taken to create a successful pollinator garden.

Step 1: Establishing Project Goals and Parameters

The initial meeting should be used to establish project goals and to set some parameters on how the work will be accomplished. This is the time to sit down with all interested parties and find out if there is a vision for the garden(s) and if the space(s) will function as more than just pollinator habitat. The myriad of ecological and socioeconomic benefits of pollinator gardens can be reviewed (Chapter 3) to determine which benefits are most desired. To clarify any specific pollinator goals, it will be helpful to remember that pollinators include honeybees, many species of native bees, wasps, butterflies, moths, flies, beetles, and hummingbirds. The goal of the garden might be to support pollinators generally, or to focus on a particular issue, such as honeybee or monarch butterfly decline, or to attract primarily showy pollinators, such as butterflies and hummingbirds. Though pollinators differ in their needs, there are many overlaps that would also allow a single garden, well-designed, to attract a wide variety of pollinators and enhance site diversity (Holm, 2014).

This meeting should also be used to start to get an idea of how the garden may look and the types of plants and materials that will be used. Are there any must-have plants, colors or materials, or definitely-not plants or features? Because the main focus of the garden will be to provide sustainable habitat for pollinators, it should be agreed upon that any garden design would be pesticide-free, not require high water or fertilizer inputs, and avoid disruptive maintenance or upkeep. Nevertheless, the new garden will still need some level of maintenance, therefore take some time to decide on how much time the golf course is willing or able to dedicate to the space.

A rough budget and timeline are the other issues to discuss at this point with your client and/or co-partners. A ballpark budget (to be refined later) will guide decision making when it comes to plant selection, number of plants purchased, size of plants selected, container sizes purchased, and possibly even the size of the garden itself. Knowing the expected timeline is important to find out since designing, planning and purchasing takes time, and there are more optimal times

to plant related to seasons. As you will see throughout these steps, communication is important at every step of the project. Early and clear communication can prevent misunderstandings and delays. Once you have spent some time establishing the goals and parameters of the project it is time to move on to the next step.

Because the main focus of the garden will be to provide sustainable habitat for pollinators, it should be agreed upon that any garden design would be pesticide-free, not require high water or fertilizer inputs, and avoid disruptive maintenance or upkeep.

Step 2: Site Analysis

Before the actual design process begins, it is key to complete a site analysis of the area in the golf course where the garden will be located. Site analysis involves recording all the features that will inform the design, including slope, sun exposure, soil conditions, existing plants, and the surrounding features - all of these affect what types of plants and materials will be suited for a site. Soil conditions can be assessed on site (e.g., sandy vs. clay soil), or samples can be sent to a local lab to obtain more specific information on nutrient availability. Site analysis also includes noting regional climate and plant hardiness zones. Plants have known zones in which they grow well in, and others where they will not survive (Figure 4.1). A plant's ability to withstand a geographical region's winter conditions is determined by its hardiness zone and is a key criterion for plant selection, no matter the

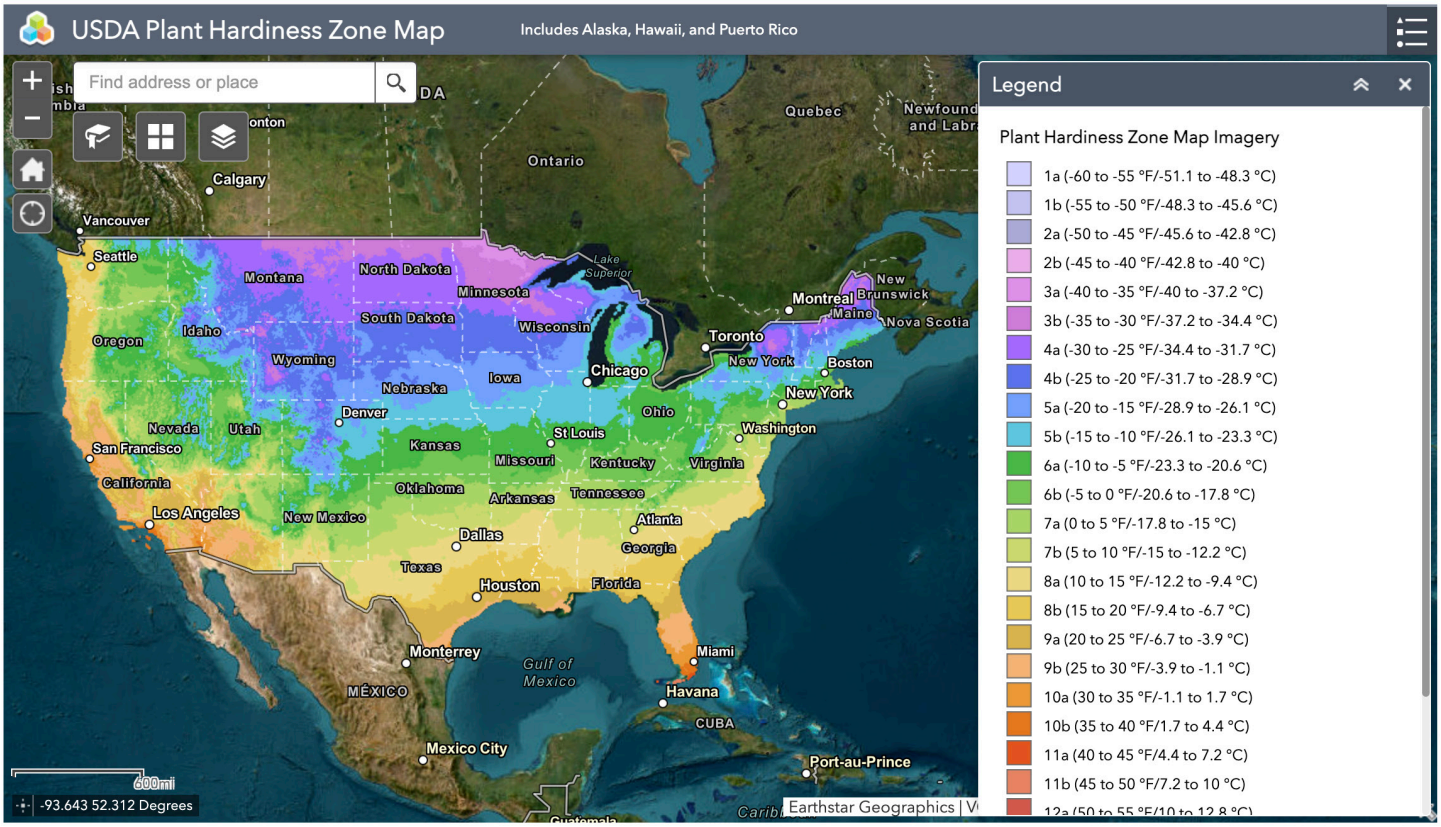

Figure 4.1 USDA hardiness zones interactive map. https://planthardiness.ars.usda.gov/

site's geographic region. Many plants may be considered perennials in certain regions, but due to their hardiness can only be grown as annuals in other regions. Site analysis information can come from many sources, including on the ground observations, those with site knowledge, a clinometer app (Clinometer + Bubble Level by plaincode), and research on the region.

Site analysis also includes noting aspects of the surrounding infrastructure, such as water lines, sprinkler heads and irrigation boxes. If there is no irrigation on the proposed site, you will need to think about how the new garden will be watered - manually, using portable or temporary irrigation lines or by installing new irrigation lines. Ideally the garden should be designed for the climate and weather patterns of the region it is located in. For designers, it is important to recognize the restrictions and/or potential advantages the existing site conditions present. Knowing this will assist in determining the garden design's complexity, plant palette, irrigation system, long-term maintenance plan and the various ecological services/benefits your plant selection could or should provide. It can be useful to draw a simple map showing important features, site lines, proximity to playable areas, and cart paths. This same map could be used to mark the locations of any new infrastructure that will be placed on the site as well as defining the boundaries of the garden beds. Bring this map with you when you sit down to talk with your client and/or co-planners, as you can then sketch out initial thoughts and ideas that come up in conversation. They might also point out things you may have missed or that they feel are important to note.

Step 3: Choosing Design Style and Aesthetic

When designing aesthetically pleasing pollinator gardens, plants are your most important tools. From their multifunctional traits to their aesthetic influence, each plant and garden is unique, possessing their own special qualities that attract and resonate with different users. Aesthetics and style are components that can directly inform a garden's acceptance and likeability to humans, influence the amount of inputs they require, and can affect the garden's attractiveness to pollinators. No matter where the garden will be planted on a golf course, from out-of-play areas to the clubhouse or entryway, ensuring its likeability and aesthetic appeal begins with understanding how it fits within its context.

Determining Style and Aesthetic

Determining a garden's style and aesthetic is a decision that will influence everything from the look and feel, the layout, the plants, its ecological value, to its long-term upkeep and acceptance. This is because "people's appreciation [and receptiveness] of a garden is, to a large extent, determined by its visual appearance, which, in turn, is strongly influenced by the style of its design" (Van den Berg & Van Winsum-Westra, 2010, p.179). When not explicitly determined by your client and/or co-partners, one of the best ways

Life Span Categories: Annual, Biennial, & Perennial

1. **Annuals:** Survive for a single growing season & typically need to be replaced yearly depending on their seed dispersal. They work best in pots or for pops of color.
2. **Perennials:** Grow back each year. Perennials ensure their long-term success as they spend the first two years after planting getting established & strengthening their root system. Two main types of perennils: hardy & woody.
3. **Biennials:** Take two years to complete their life cycle. The first year is spent getting established & the second year is spent flowering & releasing seeds. These plants are the least reliable & consistent. Many do not survive their full life cycle & others have been known to live longer than two years.

to develop a culturally relevant garden is to draw style and aesthetic cues from your site's surrounding context. A successful use of style and aesthetic seamlessly blends artificial spaces with nature (or the existing aesthetic) and incorporates, accentuates, enhances and preserves the best attributes of the site (ASGCA, 2021). Effective style choice balances the ability to connect distinct spaces through shared stylistic elements, while simultaneously creating an eye-catching focal point within the landscape.

In order to accurately mimic natural and artificial design cues drawn from your site's surrounding context, begin with identifying and noting the existing landscape design principles that are defining the site's overall aesthetic. Key design principles are elements like unity, scale, balance, simplicity, variety, emphasis, and sequence (Whiting & de Jong, 2014) and together, they play a key role informing a garden's visual complexity and ability to evoke feeling and sense of connectedness. From investigating these elements, your search will most often lead you to one of two seemingly distinct garden styles: formal or informal gardens. At a distance, these two styles seem polarizing, one emphasizing over-manicuring plants, symmetry, and hard edges, while the other encourages asymmetry, soft edges, and low maintenance. However, it should be noted that within these two umbrella categories, there are a spectrum of subcategories that are not always distinct from each other. Design

Figure 4.2 Example images of common formal garden styles.

is fluid and can pull from and incorporate one or many different stylistic and aesthetic elements to meet the designer's vision.

Formal Gardens. Formal gardens lean towards a neat and manicured look, paired with straight lines, orderly frames, hard edges, and a repetitive rhythm of repeated block plantings. They can range from minimalist with few components or more traditional with a diverse variety of showy, yet always orderly arranged plants (Van den Berg & Van Winsum-Westra, 2010). Garden styles that fall within this category are Hampton Style, modern, classical, Persian, and French Renaissance gardens, to name a few (Figure 4.2). The aesthetic or taste that exudes from this style is structural, clean and uniform - everything has its place.

Informal Gardens. Informal gardens have a natural appearance and typically incorporate a low-impact maintenance strategy, though that is not always the case. The most well-known informal garden styles include naturalistic, new perennialism, xeriscape, and English cottage (Figure 4.3). Their aesthetic or feeling is wild, organic, and free with an increased reliance on intermingling or matrix plant massings. Matrix planting highlights a dominant plant species, such as clusters of grasses or other structural plants, and then incorporates ornamental species sprinkled in (e.g. New Perennialism; Figure 4.4). The style mimics the softness and romantic feel of wildflower meadows and alludes to a complex natural environment.

Although your site's context and visibility

Figure 4.3 Example images of common informal garden styles.

within the golf course should be the predominant drivers of your style choice, like many things, there are advantages and challenges associated with both options that may influence your decision. The importance of garden and plant maintenance should not be underestimated. Maintenance is a critical and inherent component of gardens and plants, no matter the strategy or level of intervention. In order to maintain a particular visual standard, form, and lifespan, different garden styles may better align with the goals and resources available to dedicate to your garden. For example, although both formal and informal gardens can range from high-to-low maintenance inputs and can both be highly valuable for pollinators, when choosing your style and aesthetic with sustainability and pollinator habitat in mind, informal gardens are the more effective and efficient choice. The challenge with informal gardens, although becoming much more popular today, is the often noted 'overgrown' look, as maintenance strategies promote allowing plants to gracefully (and without intervention) evolve through their lifecycle. This is an appropriate choice when a more seamless transition between naturalized areas and gardens is desired. If the goal instead is to highlight a focal point or cultural features, or introduce a certain identity or sophistication to a space, then formal gardens may be a better choice. However, highly manicured formal gardens will likely require gaining additional knowledge on pruning techniques and implementing routine maintenance.

Pro Tip: Determining Style & Aesthetic

Native plants & their aesthetic value change from geographical region to region as well as their **cultural significance & preference**. They are typically incorporated in informal, naturalistic planting designs because of their 'wild' appearance, but can be just as impactful & suitable in formal gardens as well.

Step 4: Develop a Multifunctional Plant Palette and Design

Due to "landscape aesthetics being a powerful cultural driver of a greenspace's success and long-term sustainability" (Bliss et al., 2021, p.28), it is critically important that pollinator habitats on golf courses be strategically designed to simultaneously maximize aesthetic quality, elevate course functionality, and support habitat longevity (Dale et al. 2010). Successful garden design and its social programming (i.e. seating, pathways, signage) should be drawn from the diverse needs and desires of your end users including pollinators, golfers and visitors, and maintenance staff. By doing so, designers are able to rule out particular styles and aesthetics, plants with particular maintenance needs, and can design-in critical habitat criteria and site specific ecological elements for future climatic resiliency needs. Here we outline the specific and interrelated design considerations for each of the main garden end users: 1) pollinators, 2) golfers and visitors, and 3) course management, maintenance staff, and garden consultants.

It is critically important that pollinator habitats on golf courses be strategically designed to simultaneously maximize aesthetic quality, elevate course functionality, and support habitat longevity.

Pollinators

To achieve the ultimate goal of promoting and protecting pollinators on a golf course, certain habitat criteria must be met to sustain populations and increase recruitment. In general terms, habitat criteria calls for nesting, resting, breeding, and feeding elements in order to attract and retain pollinators.

Food Resources. One of the most important elements for promoting pollinators

in a golf course setting is including high floral diversity and abundance (Dale et al. 2010; Bliss et al. 2021, Sakai 2022), because that ultimately attracts and provides food for more pollinators. Choosing native plants when possible, instead of just ornamental or cultivated plants, can have a strong, positive impact on pollinator recruitment and even reduce garden maintenance. Although pollinators can be attracted to certain non native ornamental plants (Erickson et al., 2020; Pardee & Philpott, 2014), native plants tend to support a higher abundance and diversity of pollinators (Dylewski et al., 2019; Fukase, 2016; Tonietto et al., 2011).

Choosing certain flower types and arrangements can also influence which pollinators are attracted to a pollinator garden. Planting en masse, that is in large single-species clusters, is especially important to attract pollinators, like honeybees and some butterflies, that like to collect pollen and nectar from a single flower species when foraging (flower constancy; Grüter, 2011). Flower features (flower color, shape, smell), referred to as "pollination syndromes", have evolved over time to attract a distinct set of pollinator types, therefore planting with all of these features will support a broader range of pollinators (Table 4.1). For example, a diverse color range is important because bees can see ultraviolet light but not red, thus bees will inherently be more attracted to yellow instead of red flowers. Birds on the other hand can see red and the plants they forage on have evolved to hold more nectar to attract them. More pollinators can also be attracted by choosing flowers with nectar guides, also known as the patterns or shading on leaf petals, that direct pollinators to the pollen or nectar source within the plant (Xerces Society, 2016). Selecting plants for their floral features and planting en masse can do much of the work when it comes to attracting pollinators, especially when time of bloom is also considered.

Additional Habitat Needs. Beyond providing floral resources, it is critical to dedicate space within your garden to the essential habitat needs of pollinators that will provide shelter, nesting, and overwintering opportunities. Shelter depends on your target pollinator species, but the majority rely on leaf litter, stems and branches (brush piles), undisturbed ground, bare ground, dead wood, and rock piles. In order to account for all of these different styles of nesting and overwintering, consider plant spacing as a design choice to free up more open soil for ground nesters. Leaving dead plant material throughout the winter season (not cutting it back in fall) can provide cavity nesters with protection, as well as nesting material for other wildlife, like birds. This also provides maintenance relief to staff by reducing work loads. Incorporating host plants, like milkweed plants for monarch butterflies, simultaneously acts as forage, shelter, and rearing habitat for more specialist pollinators, like caterpillars and moths. Physical structures like 'bee hotels' can be a nesting and breeding resource, however this is not recommended for courses looking for low maintenance strategies. Bee hotels must be regularly cleaned and monitored in

Table 4.1 Key features of flowering plants for attracting different pollinators (and their key habitat requirements). Pollinator Syndrome resource: https://www.fs.usda.gov/wildflowers/pollinators/What_is_Pollination/syndromes.shtml

Pollinator	Plant Attractions	Flower Shape Preference	Essential Habitat Needs
Bees	Pink, Purple, or Blue	Shallow, Landing Platform, Tubular	Nest Materials; Open Soil; Water
Butterflies & Moths	Bright Colors - Red and Purple	Wide Landing Pad; Narrow Tube	Sun; Mud Puddle; Host Plants
Flies	Pale, Dark Browns & Purple; Fragrant	Shallow; Funnel-Like	Moisture/Humidity; Orangic Material
Beetles	White, Cream, or Green; Fragrant	Large; Bowl-Like	Decaying Organic Matter
Hummingbirds	Bright Colors - Red	Tubular	Shade; Water Source

order to mitigate the spread of diseases and infections. Overall, when designing-in nesting and overwintering habitats, most of the needed materials, like brush piles and woody debris, are already existing naturally on your site, or can be introduced through restoration work. Adjusting maintenance strategies and allowing gardens to run through their life cycle naturally can tick many of those boxes.

Choosing the right plant palette and materials to support feeding, nesting, resting, and breeding activities can be complex, however, there are many online resources from credible organizations, like Xerces Society and Pollinator Partnership, to assist in making these choices. Additionally, these organizations provide helpful tools when deciding which plants to incorporate into your pollinator garden. They provide pollinator-friendly plant lists organized by state and additional information on planting for success, pollinator safe management, and more (Appendix E). See https://xerces.org/pollinator-conservation/pollinator-friendly-plant-lists to find the best plants for your state.

Golfers and Visitors

Popular golf courses successfully balance challenging playing conditions with picturesque views and rolling landscapes, and visitors can expect that the spaces adjacent to the course, whether it be clubhouses, pollinator gardens, or cart paths, meet the same functional and aesthetic standards as the course. A pollinator garden that does not impede the course's playability and is equally as aesthetically pleasing as it is sustainable, may look very different from course to course. However, what remains constant is the design of these spaces has the potential to create transformative experiences, elevate the game, and can even attract new audiences.

Functional Requirements. In golf course design, "the most important characteristic to consider is how a course plays" (Brandon Johnson in ASGCA, 2021, p.18). Therefore, it is critical that the designed garden meets the functional needs of the game and does not inappropriately interfere with play. Studying the surrounding context, noting traffic patterns, the garden's visibility, its proximity to where golf is being played, and the transition spaces around your site, will not only reveal some of the functional requirements of your design, but also inform some of the key aesthetic expectations that will lead to its success. Design strategies that work to avoid interfering or hindering the game include wide plant spacing, considering the garden's 360-degree visibility, determining a maximum plant height, and being conscious of where you place your apiary or pollinator structures, if applicable. You can reduce exposure to potentially harmful interactions between the garden and players, and maintain a high-quality appearance by being intentional with your plant palette, for example avoiding plants with sharp needles or fragile stems if players will be close to the plants.

Aesthetically Pleasing. The gardens and sweeping landscapes of world-renowned golf courses have designed their spaces with an understanding that meeting the functional needs of the game is simply a fundamental starting point of design. What makes their courses truly successful and able to attract golfers and visitors from all over the world is their understanding that "beauty and aesthetic appeal ultimately play a vital role in how a course is received by golfers'' (Brandon Johnson in ASGCA, 2021 p.18), and are what will likely cause them to return and share their experiences with others. Therefore, when building a pollinator attracting plant palette that appeases the aesthetic and stylistic needs of golfers and visitors, identifying the desired external features and phenological traits of individual plants will assist you in achieving your goals. The following recommendations for developing the aesthetics of your plant palette are made with the assumption that the designer has already: 1) drawn stylistic cues from the surrounding context, 2) identified the suitability conditions and hardiness of your site, and finally, 3) considered the

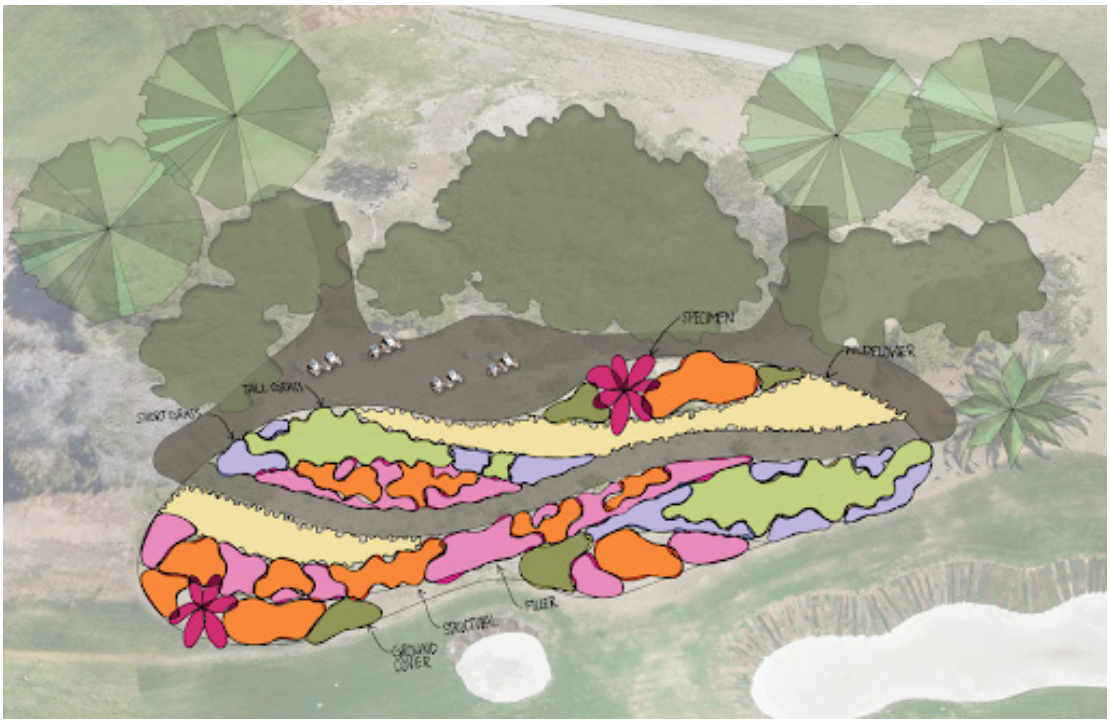

Figure 4.4 An example of how to incorporate planting layers

habitat requirements of pollinators and the associated floral features for attracting them. The external features (flower color, floral pattern, texture, fragrance) of individual plants are among the first, and likely most important, features that contribute to the overall aesthetic of a garden. When selected properly, these features can create eye-catching moments, and can be equally as effective in being attractive to people as they are to pollinators. Defining a color palette can assist in refining your options, while elements like fragrance, have the ability to elicit certain responses from visitors and elevate their experience.

When investigating the external features of plants, it is equally important to consider each plant's appearance individually, as it is to visualize them within the entire garden structure. A plant's individual structural characteristics, or habit (mounding, trailing, upright, climbing and more), are most often used to inform how they will be incorporated into the garden's design. Within the context of the entire garden, the habit of a plant often becomes associated with a planting layer. These layers are commonly referred to as filler plants (mid-height, typically mounding, adds volume), ground cover (low and trailing, often along borders), structural plants (upright and central), and specimen plants (focal plants, eye-catching, larger). How these layers are organized (Figure 4.4), whether intermingled, planted en masse, or in drifts (groupings of odd numbers) begins with understanding your site's surrounding context and understanding the design principles (repetition, flow, depth, and scale) associated with your garden style. Defining planting layers early on can assist in the organization, hierarchy, complexity, and overall visual impact of the garden and can be done without specific plants in mind.

One of the benefits of being intentional about your planting layers is the ability to maintain year-round visual interest. When selecting plants, being cognizant of a plant's blooms schedule and leaf phenology will ensure there will be multiple plants blooming or leafed out (having leaves) at a time. Leaf phenology refers to the time and season in which the plant retains green leaves and this can be broken into two categories: evergreen and deciduous. Evergreen plants maintain year-round green leaves, while deciduous plants

drop all of their leaves during the winter, or its dormancy period. A flowering schedule relates to the period of time a particular species is in bloom (winter, spring, summer, fall) and varies by species and geographical region/hardiness. Similarly, there are fruiting seasons for fruit-bearing plants. Having year-round visual interest by interspersing planting layers with both evergreen and deciduous perennials, as well as multiple plants blooming throughout each season, will enhance the sensory experience for visitors and add visual complexity. Each time you visit the site throughout a bloom season the garden will look and feel different, adding a sense of mystery and excitement to the garden.

Transformative Experience. Beyond functional and aesthetic considerations, a truly well-designed garden has the potential to transform, expand, and elevate the viewer's knowledge of the landscape and wildlife, its natural systems, and can even positively influence behavior and attitudes towards sustainability. Tying your design to local culture and place, while being thoughtful about how you frame and celebrate the course's natural landscape, are powerful tools for reconnecting visitors with nature, creating new communities, and promoting sustainability.

Consideration for how you integrate social programming elements like seating areas, circulation, and lookout points are key strategies for influencing the way people interact and connect with a garden. Designers enable visitors to create memorable and meaningful experiences through the creation of intimate spaces, varying viewpoints and perspectives, and manners in which people can spend time in the garden. Furthermore, by highlighting and accentuating the course's unique landscape views and making transitions between spaces seamless, beautiful, and believable and using culturally significant plants and materials (i.e., local materials and familiar and recognizable plants), designers strengthen a visitor's connection to their native landscape and introduce sustainability in a way that is equally beautiful as it is meaningful.

By artfully balancing less-known natives with locally recognized plants in your naturalistic design (understanding that the aesthetic value, significance, and preference of native plants vary from geographical region to region), you are creating an opportunity for native plants more widely accepted and seen for their aesthetic value, not just their sometimes wild reputation.
This balance teaches people about their local landscape and gives visitors a sense of place and newfound appreciation for regional and natural resources. This intentional and thoughtful way to incorporate native plants and landscapes into your design can create new communities, strengthening ties between people and their environment, as

Design Elements

Unity - Quality of oneness, organizes view into orderly groups
Line - Connects & defines the space (ex. Sweeping, bold lines & curves rather than zig zag)
Form - The 3D mass (ex. Horizontal & spreading, rounded, vase shaped, & pyramidal)
Texture - Relationship between foliage, size, & plant mass (fine/coarse, heavy/light, thin/dense, light/shade)
Color - Creates mood & feeling, gives the greatest appeal & evokes the greatest response
Scale - Comparative value of landscape elements to a fixed structure (relative scale, high scale, low scale)
Balance - Repeats the same; symmetry, gives stability, stateliness, & dignity. Is equilibrium (formal & informal)
Simplicity & Variety - Work together to balance each other
Simplicity is a degree of repetition rather than constant change, creating unity
Variety is diversity & contrast in form, texture, & color preventing monotony
Emphasis - Dominance & subordination of various elements

well as creating opportunities for positive social interaction.

When designing a garden that incorporates any number of cultural, ecological, or sustainable elements, whether it be through native plants, pollinator habitat, green infrastructure, recycled materials and more, a spectrum of educational and environmental stewardship opportunities become available. These design features and metrics should be highlighted and shared with visitors through social and educational programming, as they expose people to the beauty and possibilities of sustainable design, give visitors the tools and knowledge to make sustainable behavioral changes, and ideally, change the way they think about sustainability. The incorporation of educational programming, like interpretive signage that highlights your garden's various environmental components, such as its pollinator attracting elements, can provide visitors with the language to investigate further, deepening the educational impact of the design. Signage can teach people about the benefits of particular design choices, their native landscape, and ideally, will influence visitors to make similar choices for their own gardens. This approach to design, one that emphasizes nature and supports natural systems, can be a strategic way to access a new audience of environmental consumers and introduce a greener identity into the golf industry. As environmental stewards in the industry, new grant funding, outreach, and collaboration opportunities with local environmental organizations can also become feasible.

Golf Course Management and Maintenance Staff

When designing a high-functioning and long-lasting pollinator garden, it is equally as important to understand the capabilities and needs of management and maintenance staff as it is to consider the habitat criteria of pollinators, aesthetic, and functional needs of golfers and visitors. Low maintenance, multifunctional plant palettes are economically and environmentally sustainable, they reduce resource inputs, and support long-term garden resiliency. Together, these plant characteristics ease labor burdens, minimize maintenance costs, improve the quality of the surrounding ecosystem, and improve the marketable reputation and sustainability impact of the course. Management, maintenance staff, and/or hired garden consultants should be prepared for the short-term investments that will ensure the garden's long-term success and benefits once established. Being thoughtful and intentional upfront with your design and maintenance choices can ensure a new transformative experience that is educational and natural. Short term investments range from dedicating resources that will identify the site specific conditions influencing the garden's overall productivity, to dedicating resources to make informed decisions on plant selection criteria like life history traits (lifespan type, hardiness, and dispersal habits).

Low Maintenance and Longevity. There are several features to consider when choosing a plant palette and design that will make a garden easier to care for long term, including nativity, regional climate, competitiveness, and lifespan. Native plants have evolved a suitability to the physical conditions of their native ecosystems (light, soil, and moisture conditions), allowing them to be self-sustaining, growing and reproducing successfully without human interference for centuries. Incorporating these highly adapted plants, without being routinely cut back, pruned, or mown, can directly contribute to a reduction in the labor and financial inputs going into the garden's upkeep. Choosing to incorporate perennials, instead of annuals and biennials, can ensure both yearly visual interest as well as an increase in the garden's longevity with less inputs and disturbance. This no-to-low maintenance strategy reduces the amount of landscape waste generated and deters habitat loss for wildlife, with no loss to the aesthetic and stylistic standards of the design.

Although native plants are most often associated with low maintenance strategies due to their intrinsic suitability to their natural habitat, when selected correctly, non native and ornamental plants can also be effective in sustainable, low maintenance planting design. However, in order to maintain a reduction of labor, costs, and resource inputs when considering ornamental plants, look for species that are native to a similar climate and hardiness zone as your site (see Site Analysis above). This climactic information will inform various requirements like moisture and sunlight. If a plant and its habitat are not compatible, it can quickly become high maintenance and short lived, eventually needing replacement. Whether native or non native, plants have different competitive behaviors, or growth rates, associated with them. Their suitability to the area can either hinder their growth or enhance it. It is particularly important to understand your plant's competitive nature when combining native plants with non natives because those planted in close proximity to each other can either facilitate each other (providing, for example shade from hot, dry conditions) or compete for resources like water, nutrients, and sunlight. Natives tend to have deep root systems and their suitability to their ecosystem allows them to perform efficiently, often quickly outgrowing and out-competing their non native neighbors. Therefore, planting companion plants can increase establishment success, and avoiding pairs where one plant is much more competitive than the other can reduce the need to constantly prune back overgrown plants or replace lost plants.

Adding plants with specific resistances and tolerances will also increase the longevity and sustainability of the garden. Some of these features include drought tolerance and even tolerances of harsh weather conditions like heat, frost, wind, and salt, reducing plant loss and the need for inputs in these conditions. Additionally, many plants have evolved resistance or defense to pests like deer, rabbits, and insects. This resistance to herbivorous pests assists in maintaining the overall quality, health, and appearance of your garden without the use of chemical pesticides.

Pro Tip: Low Maintenance Plants

Low maintenance plants should be suitable for local **hardiness zone**, tolerate local **summer climate**, withstand typical **precipitation** of the area & require the garden's **sun exposure** levels. Additional criteria can include being pest resistant, not needing to be pruned or split often, don't spread rapidly, & don't require supplemental fertilizer (Shinn, 2012).

Ecosystem Service Value. Some of the exciting benefits of incorporating native vegetation into your plant palette have already been mentioned throughout this report, like their attractiveness to pollinators, aesthetic and educational value, and suitability. But they can also provide key ecosystem services that significantly elevate the functions and services provided by a garden. Relative to shallow-rooted non native cultivars, the deeper root systems of perennial native plants increases water infiltration, which in turns reduces run-off (and loss of inputs), soil erosion, and even flooding (de Groot et al., 2010). Furthermore, by being more adapted to local climates, many native plants are more efficient in their water use and tolerance of local soils, thus reducing water and fertilizer inputs as well as reducing human and wildlife exposure to harmful chemicals.

Another key ecosystem service value of native plants that will simultaneously improve habitat quality for pollinators and lead to reduced inputs is their role in ecological pest management. Native plant gardens, especially in agroecosystems, are dubbed 'beneficial insectary strips' as they provide critical habitat for beneficial insects, otherwise known as parasites or parasitoids, that target unwanted pests and reduce the spread of diseases (Rex Dufour, 2000). By attracting and providing habitat for these beneficial

insects, maintenance staff can reduce or even eliminate the use of insecticides and pesticides from their regimen as well as protect their pollinators from predators.

Step 5: Designing Within a Budget

When it comes to creating a pollinator garden there are a few considerations to keep in mind, a large consideration is the budget. Ideally, a budget has already been discussed and agreed upon before any sort of design work has started. If the budget is not set or known, it is better to design with a low budget in mind or to create options that range in cost. Keep in mind that overall maintenance should be factored into budget discussions, as maintenance can involve ongoing cost in labor, resources and money.

A great option for courses with limited funds is to have a fundraiser for a future garden. Many golf courses have a membership program and can be close-knit communities that care about the business. Holding some kind of fundraising event is also a great way to get to know the community better, and as a way to promote the project, which can build excitement for these new changes. In the case study at the end of this chapter, we discuss what a fundraising event can look like and our experience with hosting one.

Options for a Range of Budgets

Since golf courses can range from low cost municipal/public courses to high-end, private courses, there will be differences in how much money each individual course is willing or able to spend on adding new pollinator friendly spaces. A golf course may even have the funds to install a high-cost, large-scale formal pollinator garden. By contrast, a golf course may choose no or low additional cost options to create pollinator habitat, such as converting some of their maintained turf into no mow areas, or allowing low growing flowers to grow in the rough and elsewhere (Chapter 3: What Are the Menu of Options to Support Pollinators on Golf Courses and What Are Their Benefits?). In many cases, it may even be a cost and labor saving to simply convert underutilized rough into low maintenance habitats that are more pollinator-friendly (Chapter 2: A Move Towards Sustainability: Identifying and Quantifying the Benefits of Converting Underutilized Managed Areas on Golf Courses) by reducing irrigation and labor to those areas. Whichever option is chosen, it needs to match the funds available to that course.

Working With a Limited Budget. A course desiring a lower budget designed garden may require being a little more creative, especially when working with a large space, but can be just as successful and beautiful as projects with large budgets. One of the easiest ways to stretch the budget is to work with what is already there. See if there are plants at the golf course, either at the site or elsewhere on the course, that can be transplanted or split. However, make sure that any plants you plan on keeping are not considered invasive or aggressive, otherwise they could quickly take over.

Plant selection, spacing, and phasing options can also be used to significantly reduce cost. Tightly spaced plants or plants that do not have much spread both require higher quantities to fill the space. Increasing the spacing between plants and choosing plants that have a larger spread can help to fill up a space, while also reducing the quantity of plants needed. Another option to reduce cost is to purchase less mature plants which typically come in smaller pot sizes (e.g. 4” pot vs. 1 gal. pot). Using seed instead of plants is another lower cost option for larger spaces or more naturalistic gardens. Increasing the spacing, purchasing smaller pot sizes, and/or using seed will result in the garden appearing more sparse early on, but will continue to grow in over time. A few accent plants can help with that transition, by creating a space that has some visual impact from the start. Alternatively, up front costs can be reduced by planting in phases. By breaking up the garden into smaller spaces that are planted

over time, a lower quantity of plants is needed each time, and the overall cost can be spread throughout the entirety of the project.

Working With Moderate to Large Budgets. Projects with moderate or large budgets have more opportunities than those with limited budgets, but clients and co-planners may appreciate a more affordable design, even if they were prepared to spend a large amount of money on the project. A more cost effective garden design may leave room in the budget for pollinator-friendly improvements elsewhere on the golf course, such as replacing or enhancing existing planting beds. Any excess money can go towards acquiring apiaries that can be located either in the garden or elsewhere on the property. By using some of the strategies listed above in the design process you can open up your budget to being able to purchase more expensive materials or uncommon plants to enhance the aesthetics of the garden.

Step 6: Communicating your Design

It is essential to appropriately and effectively communicate your design to your client and/or co-partners. Being prepared to explain and justify your choices in a concise and organized manner can make all the difference when presenting to someone who may not be familiar with the site, project goals, or even garden design itself. As mentioned before, communication is key at all stages of design, as is having a detailed and thoughtful understanding and even documentation of why you made certain design decisions. For example, you can refer back to your site analysis when justifying your design. Often visuals can communicate design better than words and allow others to imagine themselves in the space. Using a wide range of graphics and imagery from various perspectives and detail levels can also be tweaked to be used for advertisements, social media campaigns, and more.

Visual Communication Tools

There are several types of visual communication tools that can be employed to assist in communicating your design, vision, inspiration and more. These tools range in detail, time spent developing them, skill level/experience required, drawing tools and software needed, and are typically most impactful when presenting multiple iterations, perspectives, and graphic styles at a time. Utilizing strategic labeling and keywords embedded in your graphics can also assist in avoiding confusion or misunderstanding. Some of the most common visual communication tools one can use throughout the design development process are hand drawings, master plans, construction documents, bloom schedules, perspective renders, and character imagery for communicating aesthetic goals and plant palettes. Bloom schedules refer to a specific type of chart (technical or illustrative) that visually represents the bloom time or appearance of the plants in your palette year round. A perspective render is an illustrative visual communication tool that allows viewers to get a realistic impression of the character and setting of specific feature of the design. This type of rendering is a two-dimensional representation of three-dimensional space and is most often from the viewpoint of the observer (line of sight). Although many high quality visuals require software like ArcGIS, AutoCAD, and Photoshop, it should be noted that more accessible alternatives, such as site photos, hand drawings, strategic Google Imagery and labeling, can be equally successful in communicating your design and its story.

The final tool to consider incorporating into your communication process is the schematic design packet (Appendix F.1). This packet, useful for all phases of design, is a strategy for presenting your work, inspirations, and vision in a professional, concise, one-stop-shop manner. Their ultimate purpose is to store and organize information used to support and inform your design decisions to share with clients and/or co-partners. Schematic design

packets and their content can, and should, evolve throughout the development process, highlighting different features or design elements when necessary. Common pages within the schematic design packet include site analysis and inventory, surrounding context imagery and notes, planting inspiration, style and aesthetic inspiration, social programming inspiration, and of course, the planting design. Strategic and clear labeling, captions, precedent and plant names, and concise explanations are important to include for clients and/or co-partners to research and understand reasoning on their own time.

Pro Tip: Visual Communication Tools

Constant communication or regular design meetings with a client are not always possible. If this is the case, be sure to discuss & determine a clear scope of services, design goals, & style/aesthetic vision **early on in the process**. It can be very helpful to engage outside resources like advisors &/or practitioners to assist in more complex design questions.

Phasing Visual Communication Throughout the Design Process

It is helpful, and to the designer's advantage, to share the garden's design development multiple times before the final proposal and/or its implementation. Plans are adjusted many times before being implemented, and visuals can help identify successful elements of the design that achieve the project's vision, and those that need to be changed. Being strategic about which type of visual communication techniques to utilize during various different phases of the design development process can help save time, effort, and improve design meetings between your team and your client. For example, it is important not to overwhelm partners with highly detailed master plans, renders, and graphics early on in development phases, because this can lead to conversations getting stuck on explaining small irrelevant details. Low-detail hand drawings, quick sketches, and character imagery from Google are a very successful and less time consuming way to manage the high level of feedback and

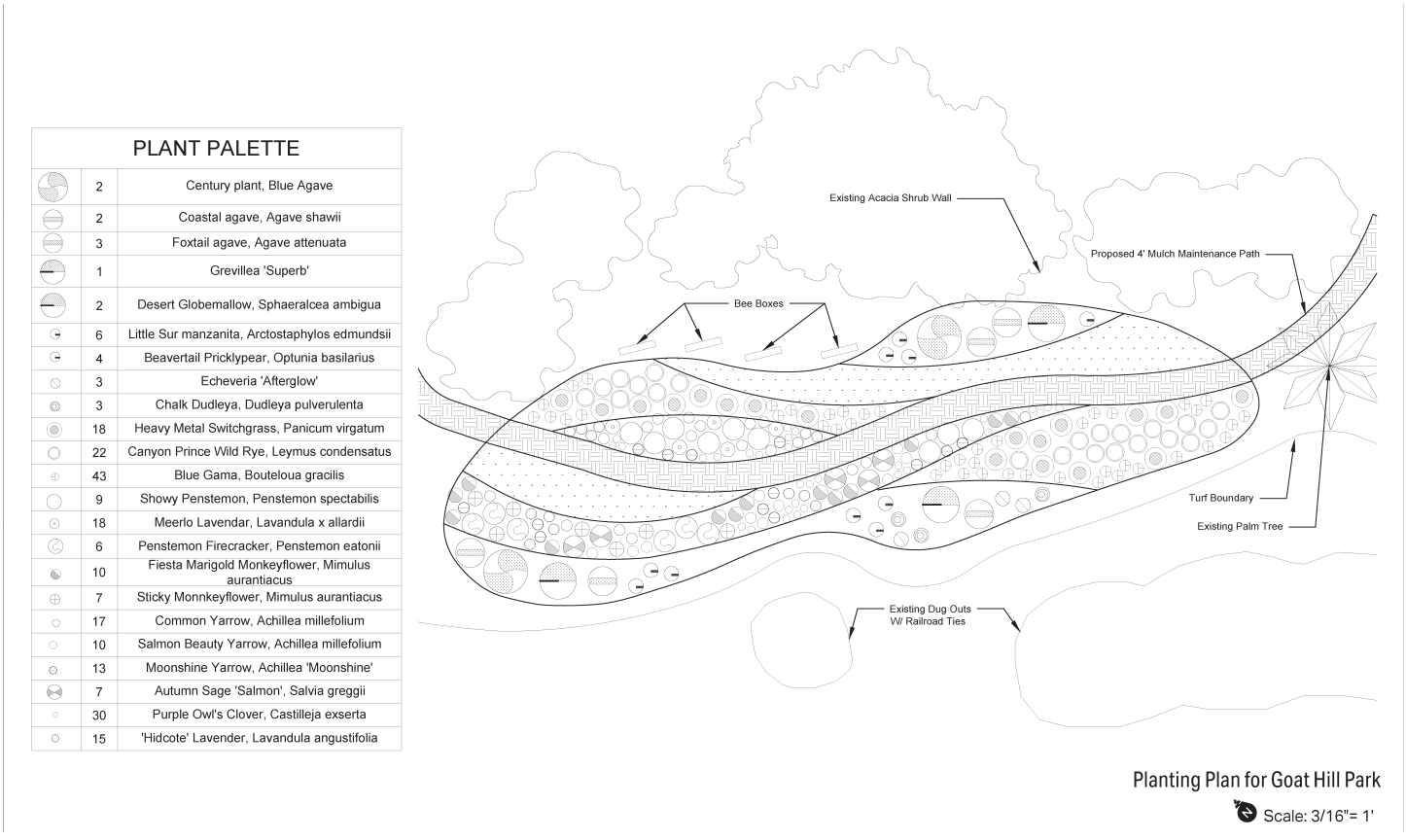

Figure 4.5 An example of a scaled planting plan from a construction document set (not to scale).

critiques in the early stages of design.

As the design development process progresses and more parties become involved in the garden's implementation, like contractors, nurseries and maintenance staff, begin to create more technical to-scale visuals that incorporate measurable and legible details that assist in visualizing the garden and its spatial layout. Scaled drawings from construction documents include overall master plans, construction details, and planting plans (Figure 4.5). Having scaled plans is one of the best tools to inform how designed elements fit within the site and can even include essential information like plant spacing, counts, and material quantities (top soil, decomposed granite, mulch), and can provide important insight for irrigation design and developing maintenance plans. In the later phases of planning, once designs are proposed, adjusted, and approved, you can advertise your design to a larger audience to communicate vision to contractors using perspective renderings and illustrative site plans. Perspectives are illustrative, stylistic, and aesthetically pleasing to share, however they are not essential graphics for the garden's implementation.

Step 7: Implement the Garden

All the work that has to be done to plan out a sustainable and attractive pollinator garden culminates in the actual implementation of the garden. In order for this to happen, plants will need to be purchased and site preparation will need to occur. Spend some time comparing nurseries to find a reputable one(s) and find out what their current inventory contains to make sure they have the plants you are looking to purchase. Typically plants are ordered in advance; the sooner you can order plants the better. Nurseries only grow and/or purchase a certain amount of plants each year. Ordering early allows the nurseries to hold the plants instead of selling them to another party, and gives nurseries time to source plants that they may not currently stock.

The site should be prepared before the plants arrive. Third party contractors or golf course staff may be brought in to clear out brush or complete more difficult earthworks tasks, like flattening out or building up the space. Whether you hire contractors, utilize volunteers, or rely on maintenance staff to prepare the site, once the site preparation is complete, the plants can be staged and placed in the ground. If it is possible, consider setting up a volunteer event to install the new garden spaces. This gives community members a chance to help improve the golf course they visit and will give you a chance to talk about why a pollinator garden is being implemented. It may also encourage community members to think about adding pollinator friendly plants to their own gardens or to learn more about how to help improve pollinator habitat in their area.

Planning a Community Planting Event

Organizing a community planting event to implement your garden is a great way to engage local community members and showcase the ways in which your course is helping promote the long-term health of pollinators on site. The goal of this type of event is not only to get additional help from volunteers, but to give volunteers practical gardening experience, showcase the many ecological and social benefits of formalized pollinator gardens or apiaries to local community members, as well as to create buzz within the broader golfing community. Below, we provide pre and post-event guidance to run an effective volunteer garden planting event.

Pro Tip: Planning a Community Planting Event

Hosting a community planting event allows participants to **learn from & engage** in the installation of a high functioning pollinator garden - a **community building** opportunity that enables a sense of **personal ownership**, gets people **connecting with nature**, & **learning about pollinators**!

Pre-Event Steps. To make sure all of the plants will be in the ground once the event has ended, advertising at least a month before the scheduled event is key to acquiring enough volunteers. If a lot of additional help is needed, sending out promotional materials early should be prioritized. Promotional fliers should include the date and time of the event, where it is located, what will be provided, the overall goals of the event, a sign-up sheet, and a waiver form, if necessary. Promotional materials can be displayed in the clubhouse and/or pro shop at the golf course and can be included in a newsletter or mailing list to reach the larger community. Social media is another great way to promote the event and to connect with people who may not be interested in golf, but are interested in helping pollinators.

The week of the event, plants should be on site and either placed next to the garden, or set exactly where they need to be planted. Getting plants sourced and on site at least a week before the event will give adequate time for delayed deliveries and allow for you to switch out any unexpected plants that were shipped. To help volunteers visualize and stick to the intended layout plan of the garden, outline the different floral beds within the formalized garden with a spray paint can or flags. Having pre-assigned roles for the group can help the event run smoothly and efficiently. Some roles you can assign group members include: plant placement and spacing, spreading compost and mulch, digging and planting, and taking photos.

Pro Tip: Pre-Event Steps

Advertising at least **one month in advance** can assist in ensuring enough volunteer help for the event. Great ways to advertise: hanging fliers in the clubhouse, providing details in the course's newsletter, & showcasing the event on the course's social media pages.

During-Event Steps. During the start of the event, it is important to thank the volunteers for coming out and to explain the environmental, social, and economical benefits that this garden will produce. This will allow volunteers to understand the goals and long-term benefits associated with the garden they are about to implement. Food, drinks, and shelter should be provided for breaks and any inclement weather. A shelter can also be where personal belongings or tools are stored. If rain is in the forecast, building berms and trenches within and around the garden is crucial to properly direct excess rainwater away from the garden. If planting on a sloped terrain, the accumulation of excess rainwater may wash out loose topsoil and newly planted plants.

Post-Event Steps. When the garden is completed, there are still some tasks that should be taken into consideration. To begin, clean-up is essential to ensure the beautification of the garden and to make sure nothing is misplaced. Once clean-up is completed and before volunteers start to pack up and leave, it is best to again, thank your volunteers for their time and effort. The event most likely could not have been completed nearly as well or on time without the volunteers' help. With that, a group picture is a great idea to help volunteers feel valued and document the memories of the community coming together to support pollinators. Volunteers that feel their work was valued will likely help out during future volunteer events hosted at the golf course.

Case Study: Designing a Pollinator Garden for Goat Hill Park Golf Course

Goat Hill Park Golf Course is an 18-hole short course with rolling hills and ocean views, located in Oceanside, a small coastal town in Southern California (Chapter 1: Golf Courses and Their Potential to Support Pollinators). Goat Hill Park expressed an interest in supporting existing honey bee apiaries and to continue their work towards being a more

sustainable and environmentally-friendly course. Together, with Parker Anderson of Greener Golf, they contacted our team to help design and implement a new pollinator garden. For a little over a year, from January 2022 to March 2023, we worked with John Ashworth, the owner of Goat Hill Park, and his team to design and build a garden that combined ecological benefits with golf aesthetics that would last for years to come. Below we share our experience and the key lessons learned while working through the garden design steps outlined in this chapter at Goat Hill Park.

Step 1: Establishing Project Goals and Parameters

We started this project with a golf course and client contact already established, so we simply needed to be introduced to John and begin to build our relationship with him. The first meeting was primarily to get to know each other, though we did ask John a handful of questions regarding the project and site. We learned that John is always looking for ways to make Goat Hill Park a better place, both for the environment and its community and when Parker approached him with the project proposal, he happily agreed to the idea. While John did not have a clear vision for the garden in our first meeting, keeping maintenance to a minimum was a priority for him, but otherwise he was open to seeing our ideas. He explained some of the recent changes taken to make Goat Hill Park more sustainable: a reduction in turf, using recycled water for irrigation, planting pollinator-friendly plants near the entrance of the course, and setting up apiaries on the course. Unfortunately, in this meeting we did not discuss certain parameters like budget and timeline, which we only clarified at a later date. This was a good lesson in how important it is to discuss these parameters early on, as it raised some challenges during the design phase.

Step 2: Site Analysis

We utilized a combination of satellite and drone imagery, online resources, site visits, and John's knowledge to perform an initial site analysis for our project remotely. From this information, we gathered data on the regional climate and local ecosystems, took various measurements, recorded our observations and started to think about what changes could be made on the site. We had access to drone imagery which we used to create our original sketches that included our proposed garden boundary and the surrounding features (bunkers, car paths, fairway, trees, etc.) near the site (Appendix F.1). Once we could visit the site we saw just how steep the hillside was and saw what visitors would see from the nearby fairway. We made notes from our observations and talked to John to clarify any questions we had about the current conditions. We compiled all of the information to identify key design challenges and opportunities.

Our site analysis showed us that based on current conditions (loose soil and steep slope) the hillside was susceptible to erosion (Appendix F.2). Moving through the site was challenging due to the loose top layer of soil and could pose a safety risk. Additionally, the underlying soil is somewhat compacted, dry, and clay heavy which could make it difficult to plant in without watering deeply to soften the ground. Finally, there are several existing citrus trees, half of which were in good condition, that we would either need to incorporate into our design or remove. Throughout the design process, we referred back to our site analysis to help inform our decisions.

Step 3: Choose Design Style and Aesthetic

We determined that Goat Hill Park resonated with informal, low maintenance styles and incorporated stylistic and aesthetic elements resembling naturalistic, xeriscape, and coastal prairie gardens. We learned that visitors and golfers celebrated and appreciated the course's relaxed, organic, and soft aesthetic.

Step 4: Develop a Multifunctional Plant Palette and Design

Because the goals of our end users were so distinct from each other, we researched and investigated their needs individually, and then came together to develop a list of must-haves and must-nots. First and foremost, this is a pollinator garden, thus our biggest focus was on providing high-quality habitat for pollinators. Second, we decided to use primarily native plants and cultivars of native plants for our design, though a few non native plants were included as well. This was based on our knowledge that native plants tend to provide more benefits and some native pollinator species need native plants to survive. Although we aimed to support as many local and migratory pollinators as possible, we held special consideration for the habitat needs of honeybees, as our project's site at Goat Hill Park has existing apiaries along the northern edge of the garden. Even though the main focus of our design was on pollinators, we also needed to make sure the garden was visually appealing to those visiting and playing the golf course.

To achieve this, our plant palette balanced natives with familiar, broadly socially accepted, and legible plants to the general public (Bliss et al. 2021), even if that meant including non native cultivars. Due to our site's location in southern California, we understood that people and pollinators would be visiting and using the site year-round. Therefore, providing year-round visual interest through a balance of evergreen plants and the development of a strategic bloom schedule was important. At the same time, we needed to consider the surrounding context of the site and the overall aesthetics of Goat Hill Park to ensure our design did not feel out of place compared to the rest of the golf course. We knew that the garden's highly visible location, proximity to the fairway and multiple cart paths, and its south facing location on the 12th hole's hill, the site has the unique potential to become a focal point.

Finally, a key part of our design strategy was based around creating a space that did not require high levels of maintenance. The golf course we worked with had a small grounds crew that was already busy with the general maintenance associated with managing a golf course. Our client was concerned with the extra workload that would be placed on his staff with the implementation of the new garden. We also wanted to make sure that any plants we chose would be drought tolerant, since our project site was located in Southern California, which is regularly subjected to drought conditions and we were not sure if the golf course would have to deal with water restrictions. Coming up with a plant list to meet all our various needs was an iterative process and we revised our list multiple times before we finalized our plant list. This gave us the chance to tailor our selections to better fit both our budget and the maintenance requirements given to us.

Step 5: Design Within a Budget

Due to the fact that our project did not have a defined budget in the beginning, we decided to create a handful of options that ranged in cost. Doing this also allowed us to explore a variety of styles and layout options for different budgets and work through the challenges the site presented. Once we sat down with John to discuss the different options, we were able to extract the parts from each design that he liked and combine them together to create the final design that kept costs down, fit with the aesthetic of the golf course and, most importantly, would provide forage and habitat for pollinators. In retrospect, it would have been better to have a clear understanding of what the budget was before we started generating ideas, to have better tailored our early design options.

Ultimately, our project ended up somewhere in the moderate to large budget category, but we opted to use some design strategies for more limited budgets to help stretch our budget and to manage the large space we needed to plant out. For example, we made the decision to purchase one gallon plants instead of five gallon plants to cut down on overall costs. For specimen plants, slow growing plants

and certain shrubs, we decided to order them in five gallon pots. This helped break up our space and would create visually interesting zones throughout the garden, even before the smaller plants grew out. In order to give the garden a more naturalistic look, we varied the spacing of our different beds, which again helped lower the cost.

Step 6: Communicate the Design

Some of the visual communication tools we utilized throughout our garden's design development process were hand drawings, multiple iterations of master plans, perspective renders, and character imagery for aesthetic goals and plant palettes. Although our team had the resources to develop high level renders and master plans, we used hand drawings paired with strategic Google imagery and labeling to communicate our design ideas with John. For certain, more complex design questions, we reached out to faculty and practitioners to assist us in graphically representing our solutions. Throughout this process, we learned how important it is to be strategic about which type of visual communication techniques are utilized during various phases of the design development process.

With the majority of our client meetings being held virtually, our team found that being able to visually communicate our design significantly helped our client better understand the vision, aesthetic, and the final site plan. We learned that using character imagery and hand drawings was usually enough for John to understand our ideas during the initial design phases. This allowed us to save time by only creating a full render if requested. We paired this offer with character imagery, pictures of the site's existing condition, and plant palette inspiration pictures to develop a final design proposal packet (Appendix F.1)

Additionally, we held a benefit event to help raise money to build out the pollinator garden we were designing. This event allowed us to get to know the community a little better and to share our project plan with them. We created excitement around the pollinator garden and apiaries that were already on site through a 'Coming Soon' poster (Appendix A) and conversations. In our experience, the members were willing and happy to support our fundraiser because it would help improve the golf course and the bees. In the end, we did not end up needing the additional funds for the planting, thus all proceeds went to the beekeeping program at Goat Hill Park and will be used to care for the bees and pollinator garden.

Step 7: Implement the Garden

To implement our roughly 8,500 square foot formalized pollinator garden at Goat Hill Park, our team hosted an onsite community garden planting event on January 14th, 2023. Being such a large garden, we had John create and advertise a promotional flier just under two months before the event, to gain enough volunteers. The promotional flier, along with a sign-up sheet, was displayed within the Goat Hill clubhouse and also sent out through their email newsletter. Additionally, the Goat Hill Golf Course Instagram page was used to take pictures of the site to promote our upcoming event to a broader audience.

A total of 252 plants were ordered from various California nurseries two weeks prior to our community planting event. Due to inclement weather in California during this time, almost half of the plants ordered did not arrive, and there were some unexpected plants delivered. We utilized local nurseries to buy the plants that were not shipped and to replace the plants that were delivered, but not included in our garden design plan. It is important to note that complications like these are not uncommon when sourcing many plants for large-scale gardens and that a pre-made contingency plan can help troubleshoot these issues, if they arise. A contingency plan can help you make replacement decisions for plants that were not delivered, allowing you to order replacement plants that stay within the specific plant palette and design agreed upon

in step 4. Always be sure to double check plants if they are dropped off from the nursery on site.

The final few days leading up to the community planting event were spent finalizing any of the remaining pre-event steps. Last-second weeding of the entire garden site was done to ensure the hill was prepped for volunteers on their arrival. Distinct garden beds were outlined using white spray paint to help volunteers visualize the different floristic areas of the garden.

During the event, plants were staged exactly where they needed to be planted, resulting in volunteers not accidentally planting in the wrong floral bed. With heavy rain in the forecast, our group, along with the volunteers, were tasked with building berms to stabilize the slope of the garden and help prevent any plants or seed mix from washing out to the bottom of the hill, onto the golf course. Lots of pictures and videos were taken to document the experience and share with volunteers after the event. Drone footage was also captured to provide aerial shots of the garden site during the implementation of the garden, as well as to take a group photo. Once the event ended, we thanked all of the volunteers who helped.

With the heavy rain we experienced at the event, some post-garden implementation was needed to make sure the planting was successful. A 1-to-2 inch layer of mulch and compost was spread out on top of the garden to not only keep moisture within the soil, but also to help prevent any further washouts from rain. Once this was finished, all the tools were gathered and washed and given back to the maintenance team.

Conclusion

The steps to design and implement a multifunctional pollinator garden that we have outlined in this chapter are completely adaptable to any golf course. They can be applied to any type of underutilized area, any budget, and any style or aesthetic. These design decisions contribute to telling a space's story and character, all while having multiple aesthetic, environmental, and even economic and maintenance benefits for the course. Following the guidelines outlined here is an excellent way to contribute to a golf course's sustainability initiatives, but the values extend beyond that. Our implementation of a pollinator garden at Goat Hill Park illustrates how the process may play out to not only improve a course, but even build a sense of joint purpose and community.

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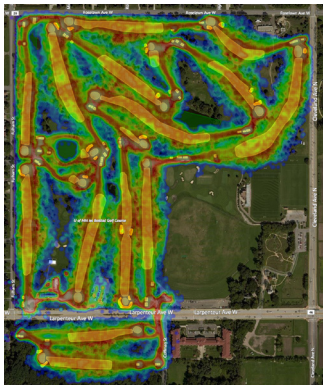
Appendix A

USGA's New "Deacon" Tool

Making Golf More Sustainable and Enjoyable

Our team is using the USGA's Deacon tool to help us better understand the many different spaces on golf courses through the use of GPS logging devices.



Deacon's GPS service helps to map where golfers are going and where they aren't going during a round.

The service could also help find areas that could be converted into pollinator habitat or simply more naturalized spaces.

This will help Goat Hill staff make more efficient, data-driven decisions to increase the quality of play for golfers while lowering maintenance costs.

For best results simply place the logger in a pocket or hooked to a belt loop and go out and play your round. Once you're done playing return the logging device and your part is done.

Thank you for participating in this project.

USGA

1952 GOAT HILL PARK

GREENER GOLF

M SEAS SCHOOL FOR ENVIRONMENT AND SUSTAINABILITY UNIVERSITY OF MICHIGAN


COMING SOON TO HOLE 12...
GOAT HILL PARK & THE BEE TEAM PRESENT:
FORE POLLINATORS,
A FLOWER BUFFET!

Appendix B

Pollinator Monitoring Protocol

Goal

The goal of this pollinator monitoring protocol is to provide details on how to efficiently and quantitatively document pollinator diversity and abundance in pollinator habitats in order to assess overall site biodiversity and habitat quality.

When to go

The climate you live in will determine the best time of year to go out and sample for pollinators. If you live in the southwest, you can survey between May and July while individuals living in the Midwest should wait until June and survey through August. Pollinators are most active when the weather conditions are warm, sunny and calm. Temperatures should be around 60°F or above with skies clear to partly cloudy and wind speeds ideally under 8 mph. It is best to survey early afternoon, with bee activity being highest between noon and 5pm. Staying out of the shade is important to record accurate pollinator data.

Collecting Data

Study sites can be any area of interest that you want quantitative data on. Typical study sites include meadows, backyard gardens, and along walking trails. To capture pollinator abundance data, calculate the number of visits per flower per hour in a study plot. Map out a 2x2m square with a rope or flags within your pollinator patch. The size of the square can be adjusted to fit your needs but too large of a study plot will increase the chance of miscounting pollinators. Count the number of inflorescence (number of flowering heads) on each flower within the 2x2m plot. Then, set a timer for 5 minutes and count the number of times a pollinator (even the same one) lands on a flower head (inflorescence). To capture pollinator diversity during the 5 minute survey, tally up the number of different pollinator species and number per species. Once the initial 5 minutes are up, you can move your 2x2m study plot around the study site to obtain more abundance and diversity data. You can design your own data table to record pollinator data or copy the provided data table below.

Additional Resources

- Survey 123:
  - The University of Michigan has created a “Pollinator Habitat Assessment” tool using Survey 123.
  - Download the app and use this QR code to access it →
  - For additional information and help using the survey, email schuel@umich.edu

- WiBee App:
  - Another pollinator habitat assessment app created by the University of WIsconsin
  - For more details go to https://pollinators.wisc.edu/wibee/how-to-collect-data/

Date & Time: Notes:
Weather:
Observer Estimated # of pollinator touches ___ / 5 x 60 = **___ pollinator touches per hour**

Site ID	Honey Bee	Bumble Bee	HoverFly	Butterfly/Moth	Wasp	Carpenter bee	Beetle	Tiny dark bee	Metallic Green Sweat Bee	Other:	Other:

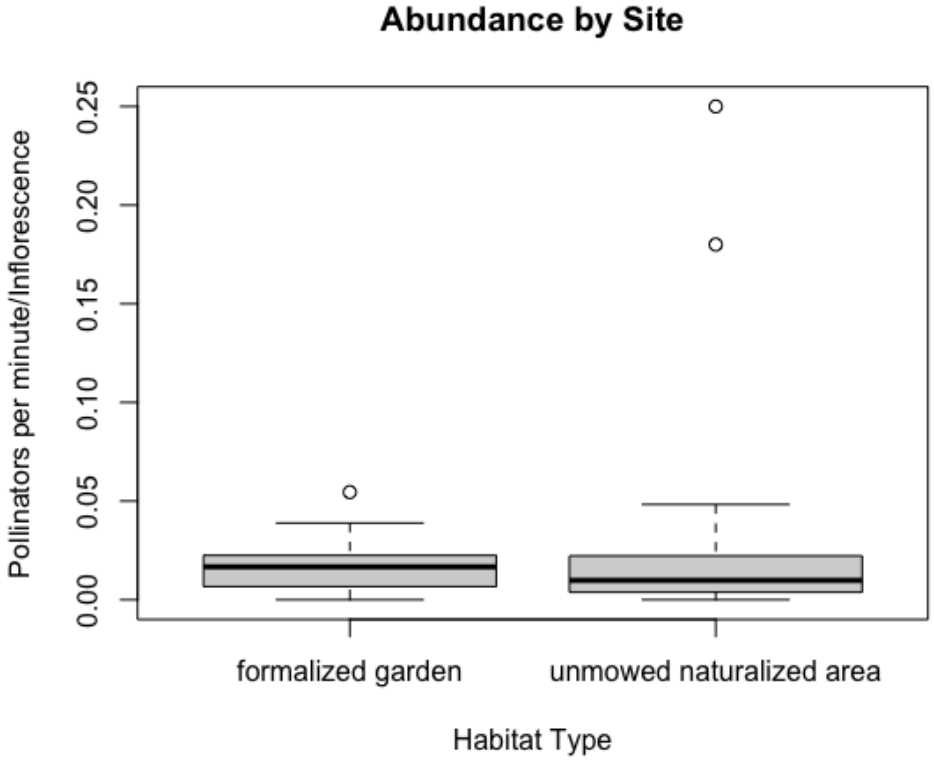
Date & Time: Notes:
Weather:
Observer: Estimated # of pollinator touches ___ / 5 x 60 = **___ pollinator touches per hour**

Site ID	Honey Bee	Bumble Bee	HoverFly	Butterfly/Moth	Wasp	Carpenter bee	Beetle	Tiny dark bee	Metallic Green Sweat Bee	Other:	Other:

Pollinator Survey Pilot Results

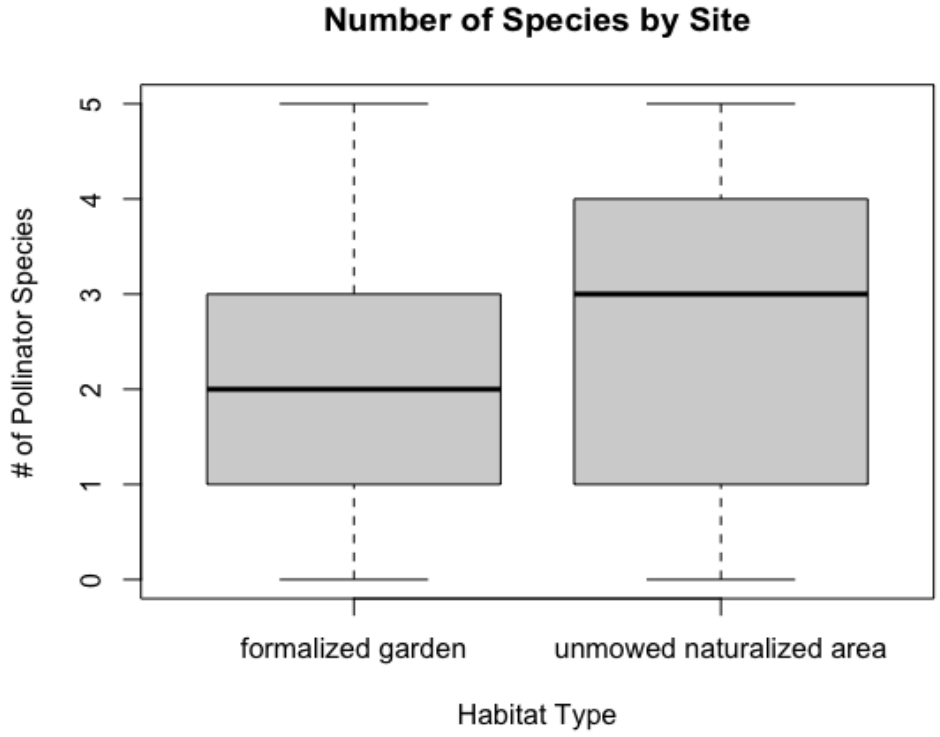
Pollinator Abundance by Habitat Site

Pollinator abundance by habitat type results were calculated by taking the number of pollinators recorded during the survey period and dividing by the survey period time (5 minutes) to get pollinators per minute for a site. Pollinators per minute was then divided by the number of inflorescence counted at each site to account for differences in floral density between sites. Sample sizes were 18 for formalized gardens and 22 for unmowed naturalized areas. Pollinator abundance averages were 0.017 for formalized gardens and 0.031 for unmowed naturalized areas. There was no statistically significant difference between the abundance of pollinators between the two habitat sites (P = .298).



Number of species observed by site

Number of species by site represents the number of different species observed during survey periods. The number of species observed while surveying formalized gardens varied between zero and five species with an average number of 2.23 species observed per survey period. The number of species observed while surveying unmowed naturalized areas also varied between zero and five species with an average number of 2.59 species observed per survey period. There was no statistically significant difference in the number of species observed between sites (P = .474).



Means:
Formalized garden: 2.23 species per observation period
Unmowed OOP: 2.59

Sampling Sites at Radrick Farms Golf Course

Appendix C

Please complete this survey BEFORE golfing.

Please take a minute to complete these questions for a University of Michigan study about golfing practices that will inform site efforts at Goat Hill. Your responses are voluntary and anonymous. **Responders must be 18+ years of age. Respondents get a prize at the end :)**

1. Age Range
- a. 18 - 29
- b. 30 - 49
- c. 50 - 69
- d. 70 & over

2. Years of Goat Hill Membership
- a. Less than 1 year
- b. 1-10
- c. 10+

3. Years Golfing
- a. Less than 1 year
- b. 1-10
- c. 10+

4. To what extent do you agree with the following statement: Golf courses have an environmental responsibility to include sustainability practices on the course (reduced water/chemical use, native plantings, etc.).
- a. Strongly disagree
- b. Disagree
- c. Neither agree nor disagree
- d. Agree
- e. Strongly agree

5. How aware are you about the services pollinators provide humans and the environment?
- a. Not at all aware
- b. Slightly aware
- c. Moderately aware
- d. Very aware
- e. Extremely aware

6. How aware are you about the ways that golf courses can support pollinators?
- a. Not at all aware
- b. Slightly aware
- c. Moderately aware
- d. Very aware
- e. Extremely aware

7. How aware are you about the pollinator conservation efforts at Goat Hill (e.g., beekeeping program)?
- a. Not at all aware
- b. Slightly aware
- c. Moderately aware
- d. Very aware
- e. Extremely aware

Please complete this survey AFTER golfing.

Please take a minute to complete these questions for a University of Michigan study about golfing practices that will inform site efforts at Goat Hill. Your responses are voluntary and anonymous. **Responders must be 18+ years of age. Respondents get a prize at the end :)**

1. Age Range
- a. 18 - 29
- b. 30 - 49
- c. 50 - 69
- d. 70 & over

2. Years of Goat Hill Membership
- a. Less than 1 year
- b. 1-10
- c. 10+

3. Years Golfing
- a. Less than 1 year
- b. 1-10
- c. 10+

4. How aware are you about the ways that golf courses can support pollinators?
- a. Not at all aware
- b. Slightly aware
- c. Moderately aware
- d. Very aware
- e. Extremely aware

5. Now that you've heard about the pollinator conservation efforts at Goat Hill, to what extent do you support additional pollinator-related efforts?
- a. Strongly do not support
- b. Do not support
- c. Neutral
- d. Support
- e. Strongly support

6. To what extent do pollinator conservation efforts affect your golfing experience?
- a. Very negatively
- b. Negatively
- c. Neutral
- d. Positively
- e. Very positively

7. Additional questions, concerns, comments…

For additional comments, questions, concerns please contact:
Parker Anderson (Parker@greener.golf) or University of Michigan's Student Team (forepollinators22@umich.edu)

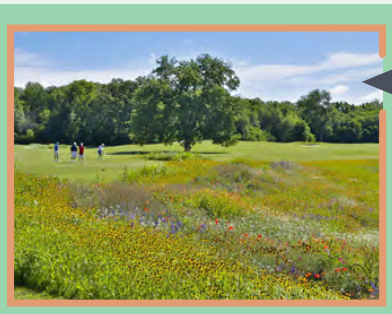
HABITAT OPTIONS FOR POLLINATORS ON GOLF COURSES

INTERVENTIONS BASED ON LEVELS OF MAINTENANCE FOR A VARIETY OF SCALES

MIXED SPECIES ROUGH / "BEE LAWNS"

Bee Lawns are an easy way to provide **benefits to pollinators** without changing the look or playability of an area. Bee Lawns are as **simple** as adding **low-growing flower seeds** in with existing turf. Better yet they can **occur naturally** in places where **herbicide is not used.**

Popular flowering plants used:
Dutch White Clover (*Trifolium repens*)
Self-heal (*Prunella vulgaris*)
Creeping Thyme (*Thymus serpyllum*)



NO-MOW + WILDFLOWERS

Similar to Bee Lawns but utilized in areas **not typically used** by golfers. Simply **not mowing** certain areas is a **low effort** way to **naturalize** a space. Another option is to **clear** an area and **sow** a mix of **native wildflower seeds**.

POLLINATOR GARDENS

Thoughtfully designed gardens can be a great way to **benefit pollinators** and still fit in with the **visual aesthetics** of a course. More time and effort will be needed but there is **more control** over the **look and feel** of the garden.

SHELTER STRUCTURES

Many golf courses have started to include shelter structures for pollinators and other wildlife. **Apiaries** placed in naturalized areas or among garden beds is **one such option** for providing shelter. As a bonus the honey can be harvested and **shared with the community**.

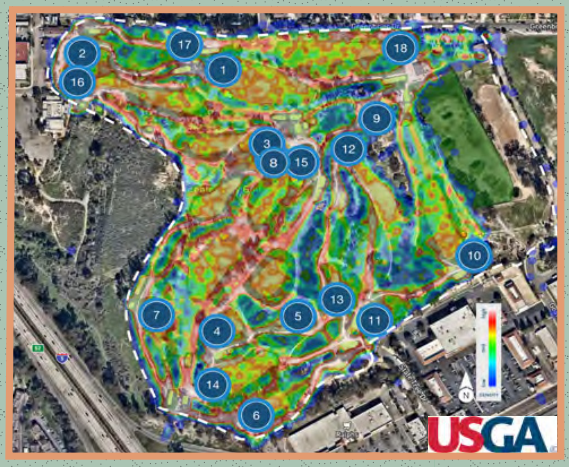
FINDING SPACE FOR POLLINATOR HABITAT

OBSERVE & DOCUMENT

OBSERVE	Spend time watching people play on the course
DOCUMENT	Record where people go and don't go most often
REPEAT	Do this a least a few times to get the best results

GPS AIDED MAPPING

CONTACT	USGA offers a tool called DEACON which can utilized
COLLECT	DEACON uses GPS devices to map player traffic
ANALYZE	Review the maps created to find opportunity areas



POLLINATOR GARDEN DESIGN ON GOLF COURSES

CRITERIA FOR DESIGNING HIGH ECOLOGICAL VALUE GARDENS FOR GOLF COURSE END USERS...

When it comes to designing **high ecological value** pollintaor habitats on golf courses, there is a spectrum of **aesthetic, functional, & suitability** criteria & experctations to consider. **Your site's surrounding context, the overall functional goals and vision of your design, & the needs of your garden's end users** will assist in revealing just that! Here we outline key design & habitat criteria for the most common end users of pollinator gardens on golf courses.

PERFORMING SITE ANALYSIS

CHOOSING A STYLE & AESTHETIC

DESIGN CRITERIA FOR END USERS

- POLLINATORS
- GOLFERS & VISITORS
- MANAGEMENT & MAINTENANCE STAFF

SEAS SCHOOL FOR ENVIRONMENT AND SUSTAINABILITY UNIVERSITY OF MICHIGAN

CAITLIN BATES, CADE SCHAFER, REMINGTON GERST, KAITLYN VREEKEN

STYLE & AESTHETIC

Your style choice will influence everything from your design's **look & feel**, the **layout**, the **plant palette**, its **ecological value**, & its **long-term upkeep** & **acceptance**.

FORMAL

- SYMMETRICAL
- GEOMETRIC
- STRAIGHT LINED
- UNIFORM

COMMON STYLE

- FRENCH RENAISSANCE
- HAMPTON STYLE
- CONTEMPORARY

INFORMAL

- ASYMMETRICAL
- FREE-FLOWING
- CURVED
- INTERMINGLING

COMMON STYLE

- NEW PERENNIALISM
- ENGLISH COTTAGE
- NATURALISTIC

DESIGNING FOR POLLINATORS

PRIORITY DESIGN ELEMENTS: NESTING, BREEDING, RESTING, FEEDING

POLLINATOR	FLORAL FEATURES
BEES	
BUTTERFLIES	
FLIES	
BEETLES	
HUMMINGBIRDS	

Flower features (flower color, shape, & smell) referred to as **'pollination syndromes'** have evolved over time to attract a distinct set of pollinator types & so planting with all of these features will support a broader range of pollinators.

- **HIGH FLORAL DIVERSITY & ABUNDANCE**
- **PLANT NATIVES EN MASSE**
- **PROVIDE DIVERSE SHELTER TYPES**
- **YEAR-ROUND FORAGE OPPORTUNITIES**

DESIGNING FOR GOLFERS & GOLF COURSE VISITORS

Function, beauty, & aesthetic **define how a course is received by users** and whether or not they return. That is why it is critically important for pollinator gardens to simultaneously maximize aesthetic quality & meet functional requirements of the game.

PRIORITY DESIGN ELEMENTS: FUNCTIONAL NEEDS OF GOLF, BEAUTY & AESTHETIC APPEAL

- **ACCENTUATE LANDSCAPE VIEWS**
- **YEAR-ROUND VISUAL INTEREST**
- **PLANT SPACING FOR BALL ACCESS**
- **PLANT HEIGHT FOR UNOBSTRUCTED LINE OF SIGHT**

DESIGNING FOR MANAGEMENT & MAINTENANCE STAFF

PRIORITY DESIGN ELEMENTS: GARDEN LONGEVITY, REDUCE INPUTS, MULTIFUNCTIONALITY

- **PLANT SUITABILITY**
- **SUPPORT ECOSYSTEM SERVICES**
- **LOW MAINTENANCE NATIVE PLANTS**
- **TOLERANCE OF PHYSICAL CONDITIONS**

Appendix E

Resources for Developing a Pollinator Plant Palette		
Organization	**Title**	**Website**
Pollinator Partnership	Ecoregional Planting Guides	https://pollinator.org/guides
Xerces Society	Plants For Pollinators	https://xerces.org/node/574
USDA	USDA Plants Database	https://plants.usda.gov/home/plantProfile
USDA	Pollinator Syndromes	https://www.fs.usda.gov/wildflowers/pollinators/What_is_Pollination/syndromes.shtml
Designing for Pollinators (Habitat + Design)		
Organization	**Title**	**Website**
ASLA	Applying Ecological Design: Supporting Pollinators	https://www.asla.org/residentialpollinators.aspx
Xerces Society	Nesting Resources	https://xerces.org/pollinator-conservation/nesting-resources
Xerces Society	Pollinator Habitat Evaluation Form	https://xerces.org/publications/hags/pollinator-habitat-evaluation-form
Xerces Society	Habitat Restoration	https://xerces.org/pollinator-conservation/habitat-restoration
Xerces Society	Habitat Assessment Guides	https://xerces.org/pollinator-conservation/habitat-assessment-guides
US Forest Service	Gardening for Pollinators	https://www.fs.usda.gov/wildflowers/pollinators/gardening.shtml
Maintenance Strategies for Pollinator Gardens		
Organization	**Title**	**Website**
American Horticulture Society	Sustainable Gardening	https://ahsgardening.org/gardening-resources/sustainable-gardening/
Missouri Botanical Garden	Sustainable Gardening	https://www.missouribotanicalgarden.org/gardens-gardening/your-garden/help-for-the-home-gardener/sustainable-gardening
Chesapeake Bay Landscape Professional	Sustainable Landscape Maintenance Manual	https://cblpro.org/downloads/CBLPMaintenanceManual.pdf
Calscape	Calscape California Native Plant Gardening Guide	https://calscape.org/planting-guide.php

Appendix F

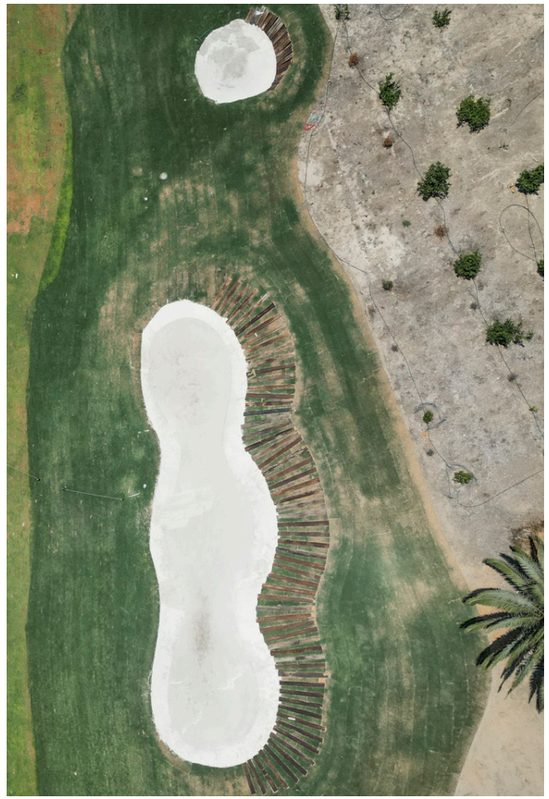
Appendix F.1

Goat Hill Park Pollinator Garden // **Schematic Design Package**

Bees & Golf: An unlikely yet Impactful Partnership Oceanside, CA August 2022

Existing Vegetation

Existing Apiary



View from Top of Slope

Site Slope

Immediate Context

Acacia along Northern Boundary

Goat Hill Park Pollinator Garden // **Existing Site Conditions**

Bees & Golf: An unlikely yet Impactful Partnership Oceanside, CA August 2022

Goat Hill Park Pollinator Garden // **Existing Site Conditions**

Bees & Golf: An unlikely yet Impactful Partnership Oceanside, CA August 2022

Goat Hill Park Pollinator Garden // **Character Images**

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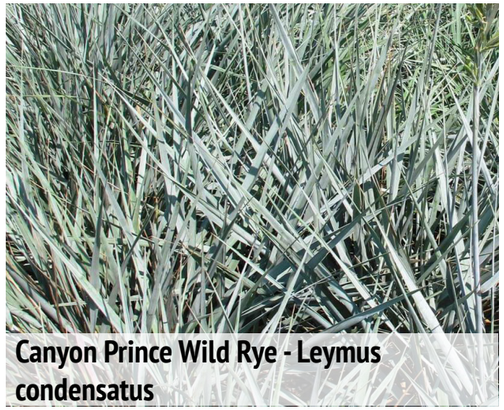
Autumn Sage ‘Salmon’ - Salvia greggii

Common Sun Rose - Crocanthemum scorparium

Butterfly Weed - Asclepias tuberosa

Bee Bliss Sage - Salvia X Bees Bliss



Canyon Prince Wild Rye - Leymus condensatus

Maiden Grass - Gracillimus Miscanthus

Deer Grass - Muhlenbergia rigens

Pink Muhly - Muhlenbergia capillaris

Shaw’s (Coastal) Agave - Agave shawii

Sticks on Fire - Eurphorbia tirucalli

Sticks on Fire - Eurphorbia tirucalli

Sticks on Fire - Eurphorbia tirucalli

Goat Hill Park Pollinator Garden // **Proposed Plant Palette**

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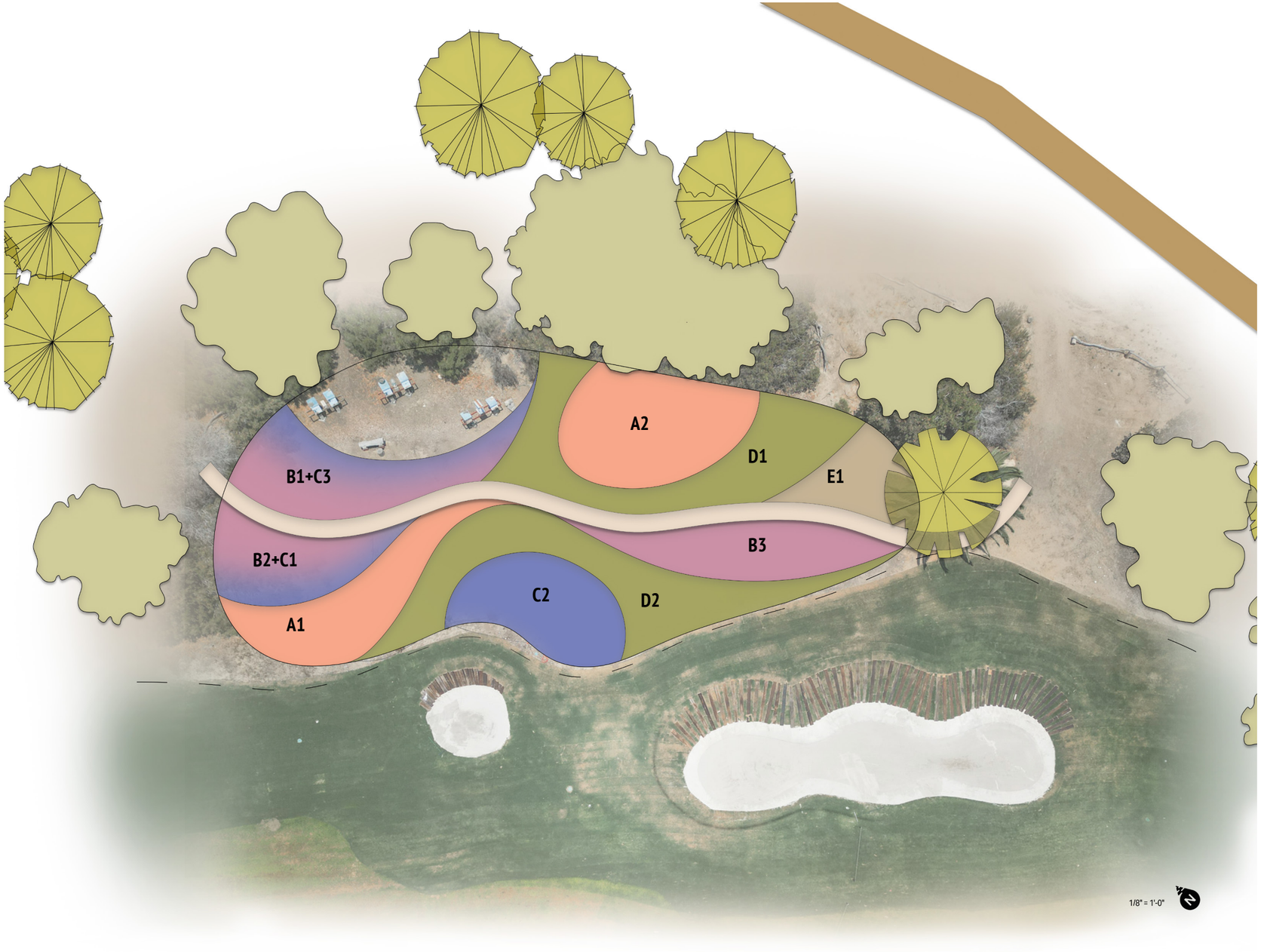


Goat Hill Park's Pollinator Garden Proposal

This garden features six planting bed types: xeriscape, flowering perennials, ground covers, mixed perennials and ground covers, grasses native and ornamental, and rock garden.

The variety of plant types is both visually appealing and beneficial for the environment by increasing the site's biodiversity. This mix of plant types will create habitat and become a food source for pollinators and other wildlife in and around Goat Hill.

The bed shapes flow organically and mimic the hilly topography of Goat Hill. The various beds work with the hillside and steep grade and will help to provide stability.

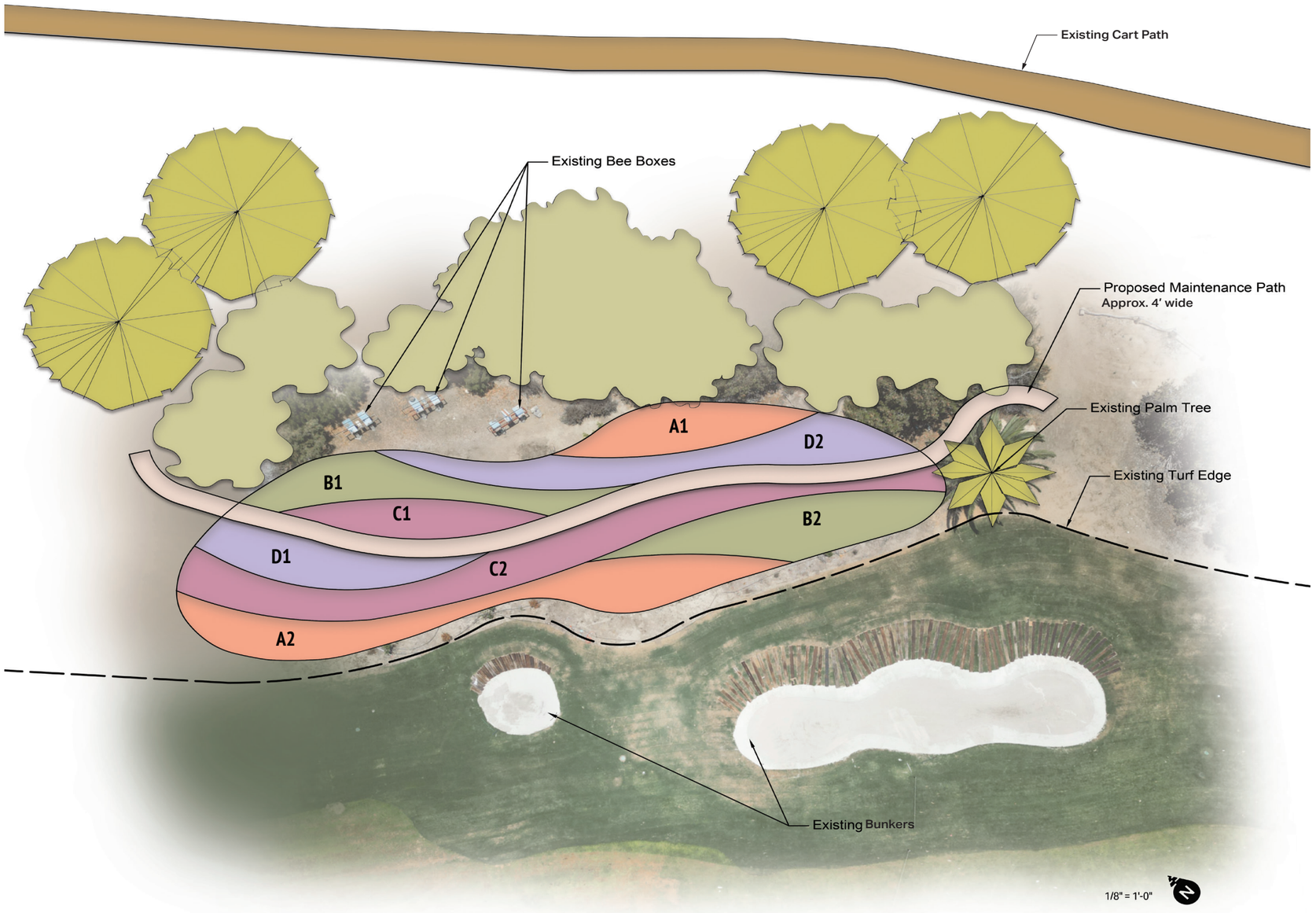
By choosing mostly natives plants this garden bed will be low maintenance once established. Most of these plants only need minimal watering, many are evergreen, bloom throughout the year, and need minimal pruning/cutting back.

PLANT BED LEGEND

Bed A - Xeriscape
Bed B - Flowering Perennials
Bed C - Ground cover
Bed D - Native & Ornamental Grasses
Bed E: Rock garden

Goat Hill Park Pollinator Garden // **Scenario 1 Overall Plan**

Bees & Golf: An Unlikely yet Impactful Partnership Oceanside, CA August 2022



Goat Hill Park's Pollinator Garden Proposal

Four planting bed types: xeriscape, native and ornamental grasses, flowering and evergreen perennials, and a native seed mix.

The highly diverse palette of plants provide ample food and habitat for visitng pollinators, the apiary and wildlife throughout the seasons. The site's location will maximize visibility and provide year-round visual interest for the visitors of Goat Hill Park.

The bed shapes flow organically in horizontal lines in order to work with the grade, reduce water loss, increase stabiliazation, and improve the overall longevity of the garden.

The plants selected for this garden are low maintenance but may require weekly - bi-weekly watering before established. Grass beds and perennials can benefit from being cutback once a year.

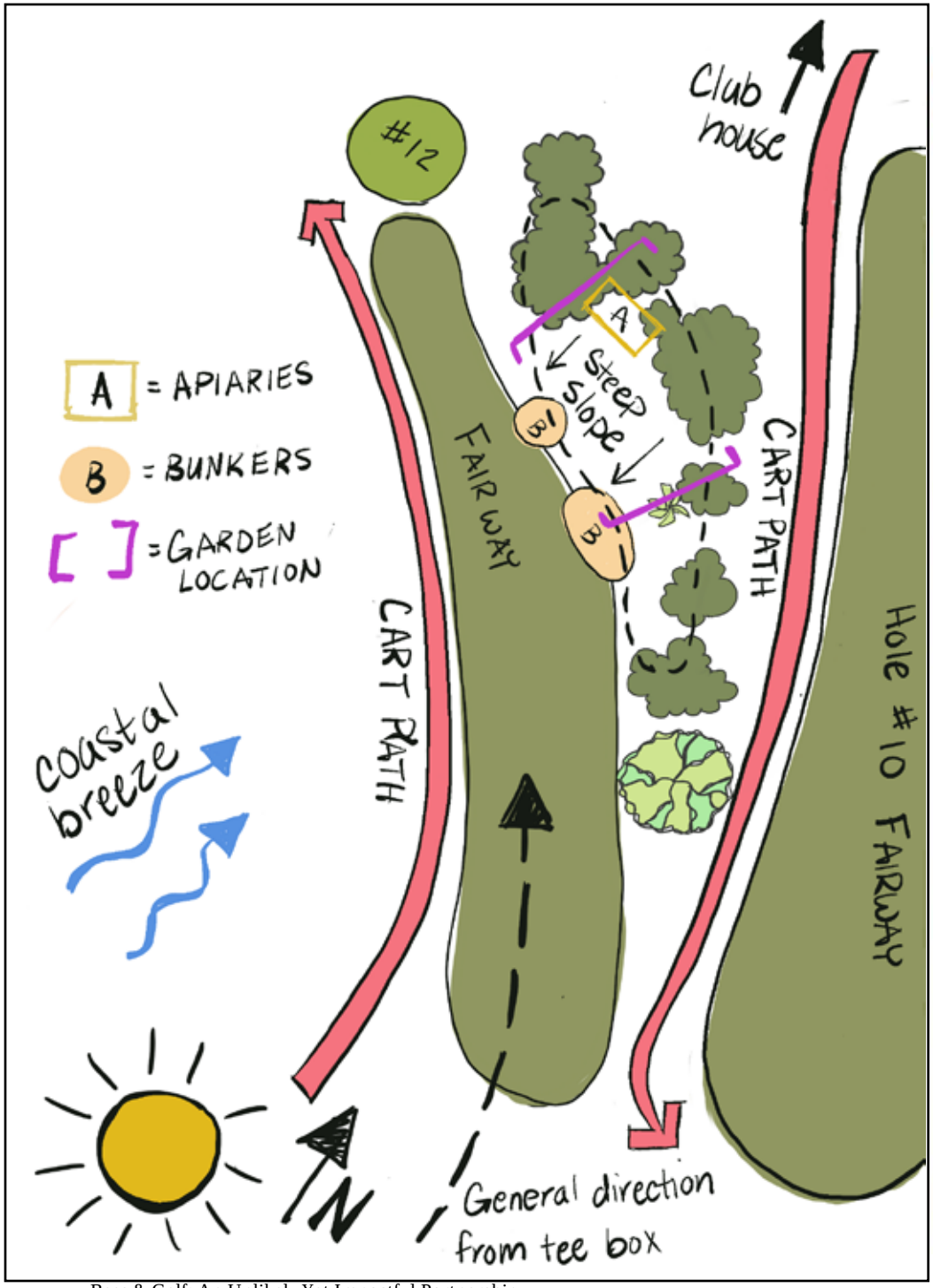
PLANT BED LEGEND

Bed A - Xeriscape
Bed B - Native and Ornamental Grasses
Bed C - Flowering & Evergreen Perennials
Bed D - Native Seed Mix

Goat Hill Park Pollinator Garden // **Overall Plan**

Bees & Golf: An Unlikely yet Impactful Partnership Oceanside, CA August 2022

Appendix F.2

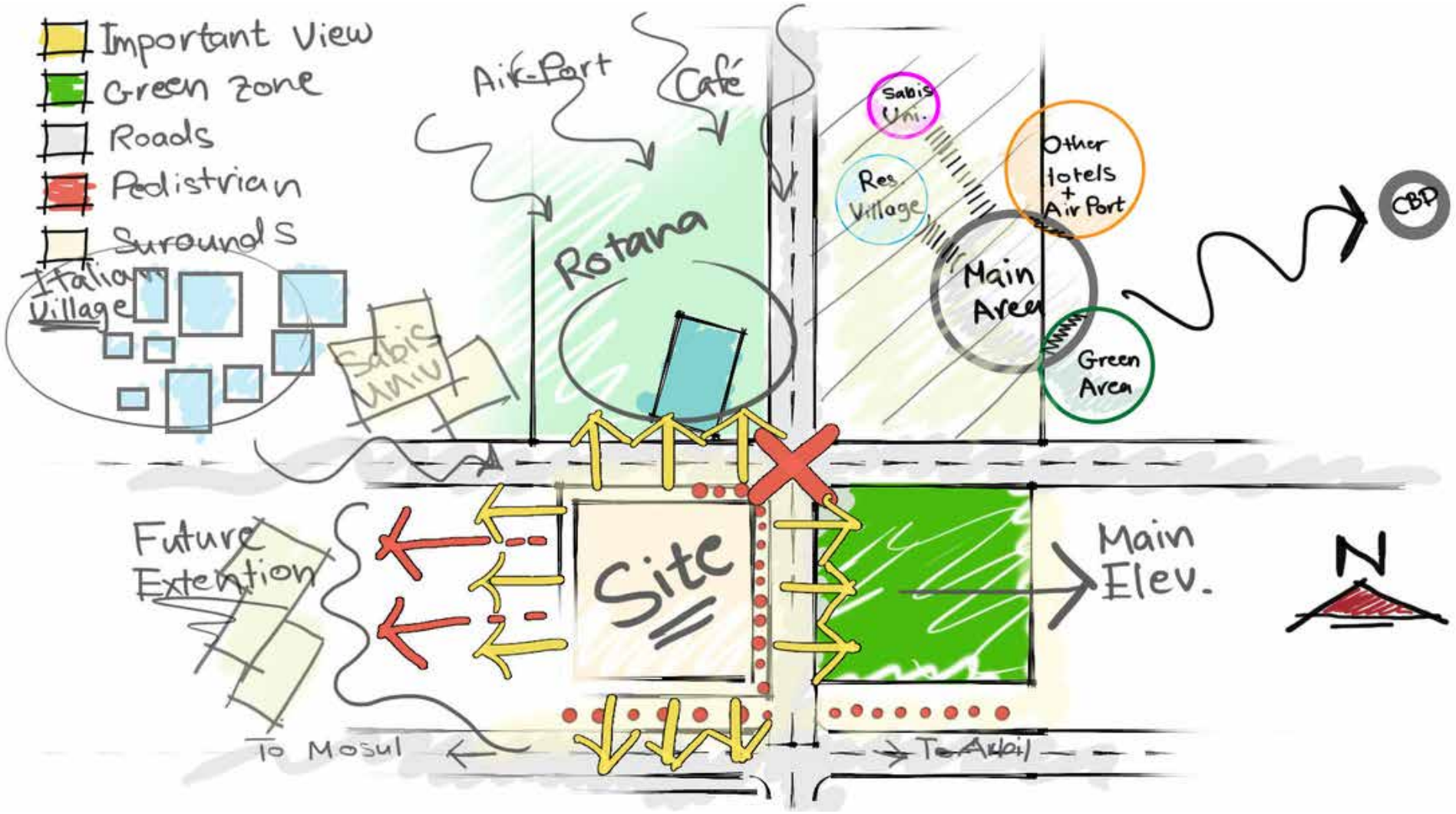

#12
Club house
A = APIARIES
B = BUNKERS
[ ] = GARDEN LOCATION
A
Steep Slope
B1
B
FAIR WAY
CART PATH
CART PATH
Hole #10 FAIRWAY
coastal breeze
N
General direction from tee box


Cart Path
Bunkers


Existing Vegetation


Slope


Apiary



https://trinitys1design.weebly.com/site-analysis.html

Additional example of site analysis diagram