

PAR BEE: FROM
HARMFUL TO HELPFUL.
GUIDELINES FOR A
SUSTAINABLE GOLF
COURSE THROUGH THE
PROMOTION OF BIODIVERSITY

SARAH GOLDSTEIN | MASTERS OF LANDSCAPE ARCHITECTURE | JUNE 2024

DEFINITIONS

- ① **TEE**
FLAT AREA WHERE GOLFERS TAKE THEIR FIRST SHOT, PLACING THEIR GOLF BALLS ON A TEEING BOX OR TEEING GROUND
- ② **FAIRWAY**
PATHWAY LEADING FROM THE TEEING BOX TO THE PUTTING GREEN. MAINTAINED AT A SHORT HEIGHT RANGING FROM 30 TO 50 YARDS WIDE
- ③ **ROUGH**
AREAS ALONGSIDE FAIRWAYS WHERE GRASS IS KEPT AT A LONGER LENGTH TO INCREASE DIFFICULTY OF THE GAME
- ④ **HAZARDS**
OTHER FEATURES ON THE COURSE TO INCREASE CHALLENGE, SUCH AS BUNKERS (SAND PIT) AND WATER HAZARDS (PONDS, LAKES, OCEANS)
- ⑤ **GREEN**
FINAL STRETCH OF THE PLAY AREA WHERE THE HOLE IS PLACED, AND CAN PROVIDE EXTRA CHALLENGES



IMAGE SOURCE: SUNRIVER RESORT

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION	
pollinators	8
golf courses	12
solution	16
CHAPTER 2: GOLF COURSES	
statistical information	20
maintenance	22
maintenance breakdown	24
CHAPTER 3: POLLINATORS	
introduction	34
threats	38
survival	40
CHAPTER 4: THE SITE: LAURELWOOD GOLF COURSE	
design statement	44
introduction to Laurelwood	46
design opportunities	54
CHAPTER 5: THE DESIGN	
recap	62
guidelines	66
plant selection factors	72
plant palettes	76
the design at Laurelwood	76
CHAPTER 6: MOVING FORWARD, WRAP UP, AND KEY TAKEAWAYS	
moving forward	102
adaptable framework	106
key takeaway	108

CHAPTER 1

INTRODUCTION

PERCEPTION



Source: Ocean Club

Golf courses are often seen as an oasis. A getaway. A reason for people to get outside, connect with loved ones, strengthen business relationships, and stay active. These landscapes are large plots of land with a lack of developed structures that users can visit for leisure and connection to the outdoors.

REALITY



Seneca Golf Course | Louisville, KY



Pine Ridge Golf Club | Springfield, OR



The National Golf Club | Kansas City, MO



The Golf Club at Landsdowne | Leesburg, VA



Pocono Manor Golf Course | Pocono Manor, PA



Royal County Down Golf Course | Northern Ireland



Thistle Dhu Putting Course | Pinehurst, NC



Royal Melbourne Golf Club | Melbourne, AU



Tiburon Golf Club | Omaha, NE



Tangle Ridge Golf Club | Cedar Hill, TX



Cobblestone Golf Course | Acworth, GA



Hillcrest Golf Club | Sun City West, AZ



Shingle Creek Golf Club | Orlando, FL



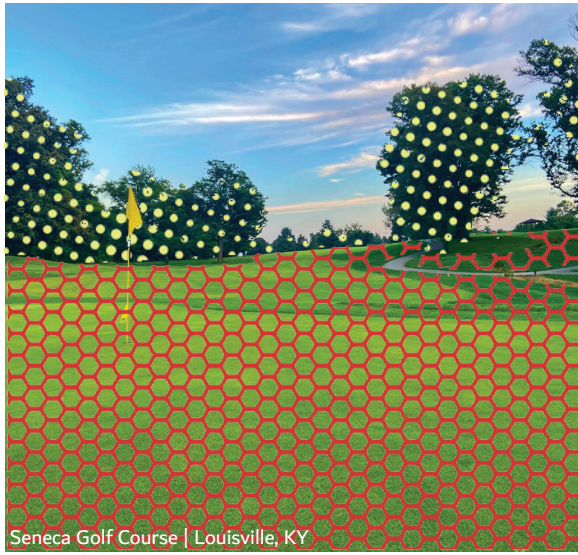
Sevierville Golf Club | Knoxville, TN



Sinaloa Golf Course | Simi Valley, CA

When searching “golf courses” on the internet, a compilation of images such as the ones you can see on screen appear. While some of these courses are referenced and regarded as the most beautiful golf courses, they hold many similarities to each other, regardless of their perceived status. These landscapes are highly engineered, constructed, and are resource heavy.

REALITY



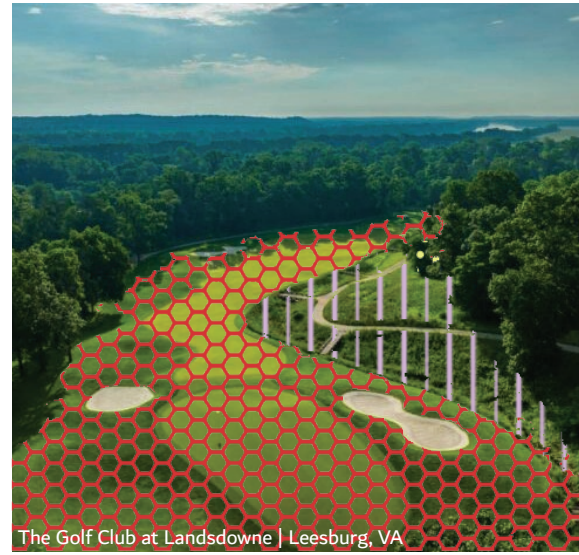
Seneca Golf Course | Louisville, KY



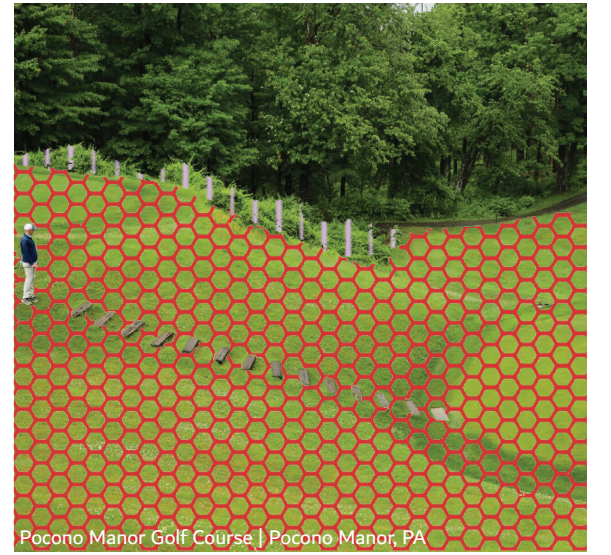
Pine Ridge Golf Club | Springfield, OR



The National Golf Club | Kansas City, MO



The Golf Club at Landsdowne | Leesburg, VA



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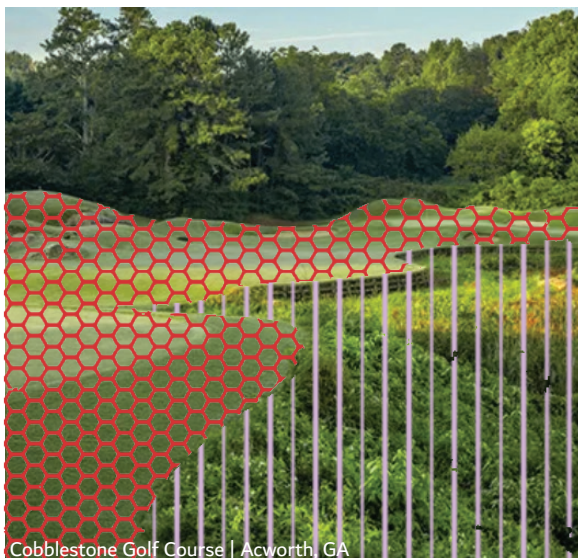
Royal Melbourne Golf Club | Melbourne, AU



Tiburon Golf Club | Omaha, NE



Tangle Ridge Golf Club | Cedar Hill, TX



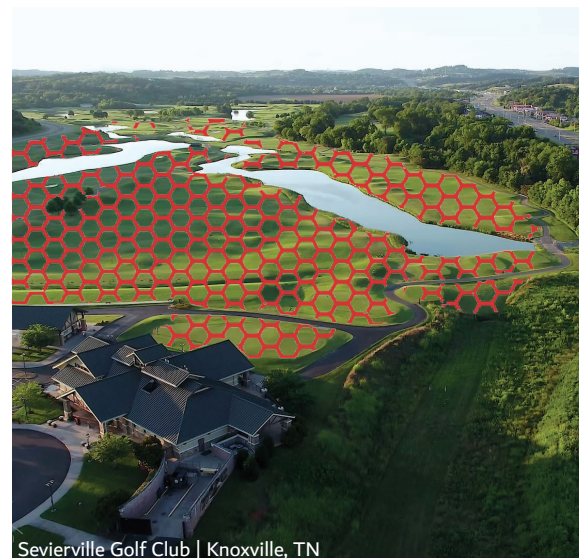
Cobblestone Golf Course | Acworth, GA



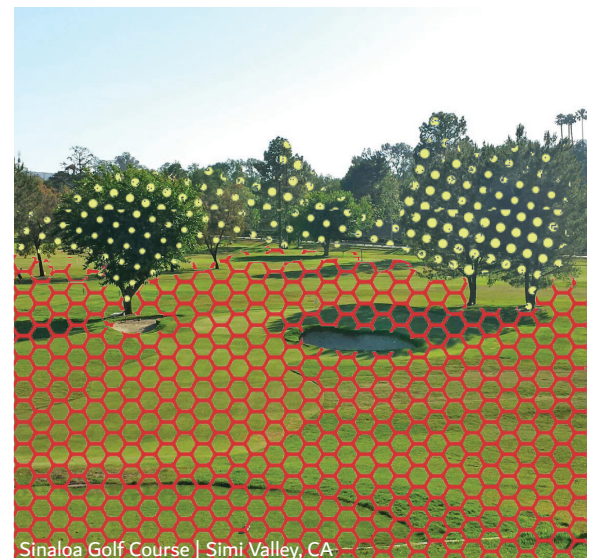
Hillcrest Golf Club | Sun City West, AZ



Shingle Creek Golf Club | Orlando, FL



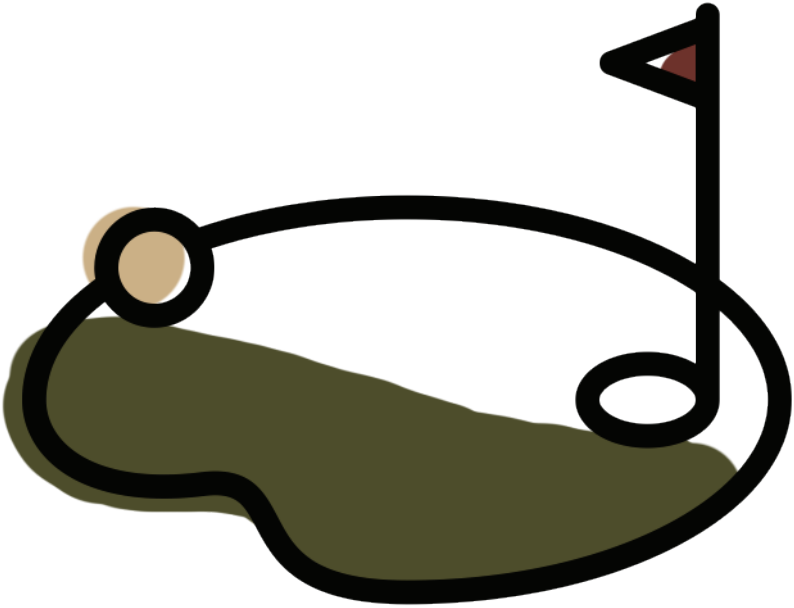
Sevierville Golf Club | Knoxville, TN



Sinaloa Golf Course | Simi Valley, CA

The ecological reality of a golf course is not quite as beautiful as its intriguing aesthetic. Similarities to note here include turfed green open space marked by the red hexagon pattern. Canopies of trees that appear to lack a progression of ecological communities, marked here by the yellow dots, and patches of bunch grasses - arguably rather uninteresting - can be spotted and marked by the vertical purple stripes. The scenery is often repetitive from course to course and appears to lack biodiversity.

SOLUTION



GOLF



BIODIVERSITY



CO-HABITATION

All of this is not to disparage golf courses, or a call to swear them off, but rather to open discussion about the opportunities available for enhancing an underutilized landscape to support wildlife. While golf courses are in fact highly engineered landscapes, their lack of built structures combined with acres of open space provides a place for more diverse habitat. By providing more land for pollinators to thrive in a space that does not currently provide much ecological value, the pairing has the potential to create a functional landscape for human and non-human species to cohabitate.

POLLINATOR FOCUSED



But why pollinators? Why should we care about the pollinating community? From the start of my project, I knew I wanted to focus on creating pollinator landscapes. For quite some time, I have also been drawn to the seeming lack of call for responsibility on golf courses as they continue to rely on environmentally harmful resources. So could this present a mutually beneficial opportunity?

INTRO TO POLLINATORS

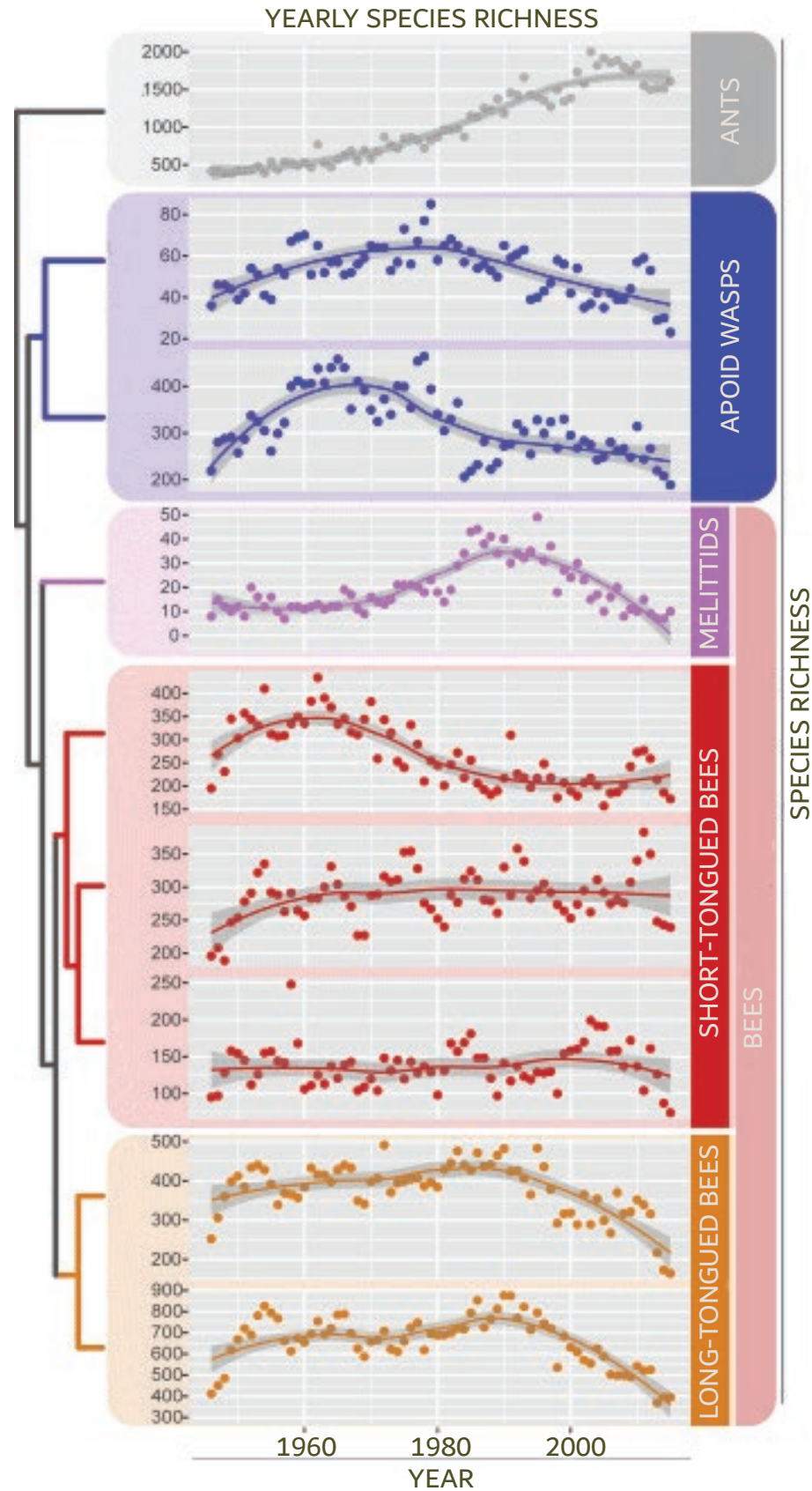


FIGURE 1.0 <https://www.sciencedirect.com/science/article/pii/S2590332220306515>

“WORLDWIDE OCCURRENCE RECORDS SUGGEST A GLOBAL DECLINE IN BEE SPECIES RICHNESS”

- EDUARDO E. ZATTARA // MARCELO A. AIZEN



Pollinators are working hard every day to provide sustenance in the world around us and provide beauty consequentially. Pollinators, both in their species abundance and richness, have been facing the harsh reality of population decline from as far back as the 1990s, as demonstrated in this graphic. Species richness refers to the number of different species in a community. This graphic shows that of all pollinating species observed in this study, ants were the only species to grow in richness on the global scale.

THREATS TO POLLINATORS



HABITAT LOSS



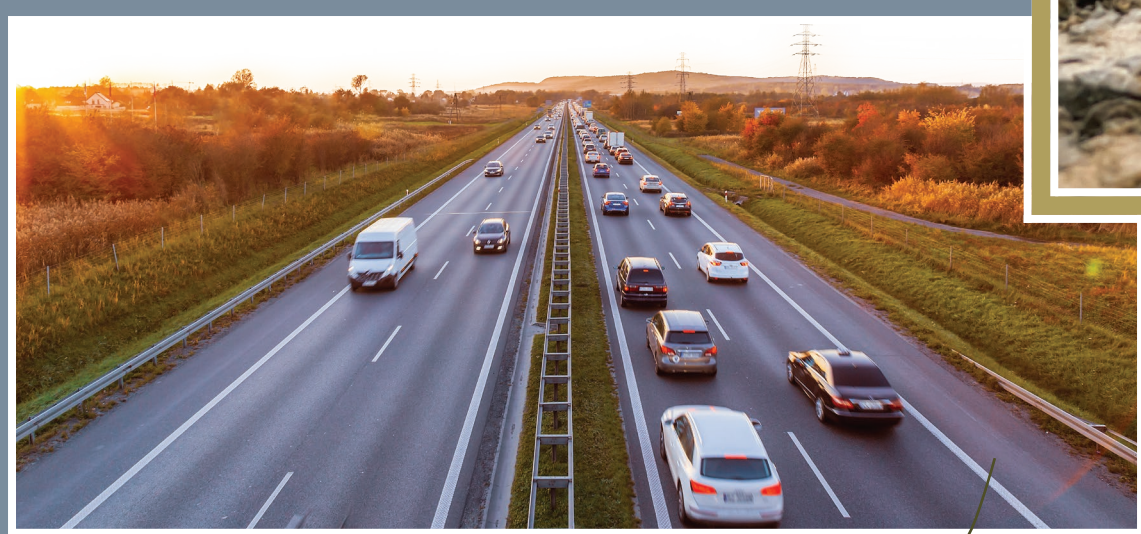
DEGRADATION



HABITAT CONVERSION



LOSS OF NATIVE HABITAT



FRAGMENTATION

Five of the main factors threatening the pollinating community are shown here, and include, in no particular order:

- Habitat Loss
- Habitat Conversion
- Land Fragmentation
- Land Degradation
- Loss of Native Habitat

The human population is constantly growing, while habitable space on Earth is finite. As the human population increases, so does urban sprawl. This means our towns and cities are getting larger and extending into the native habitat that surrounds the urban fabric. Converting land into urban communities reduces land available to non-human species, giving them less space to nest, reproduce, and forage by disjointing their access to resources and fragmenting their homes with no notable consideration as to how they might adjust.

SUBSEQUENT THREATS

2 THREAT CATEGORIES

① LAND DEVELOPMENT



ⓐ HABITAT LOSS



ⓑ HABITAT CONVERSION



ⓒ HABITAT FRAGMENTATION



ⓓ LAND DEGRADATION



ⓔ LOSS OF NATIVE HABITAT

② POOR LAND MANAGEMENT PRACTICES



ⓐ CHEMICAL APPLICATION



ⓑ REGULAR MOWING

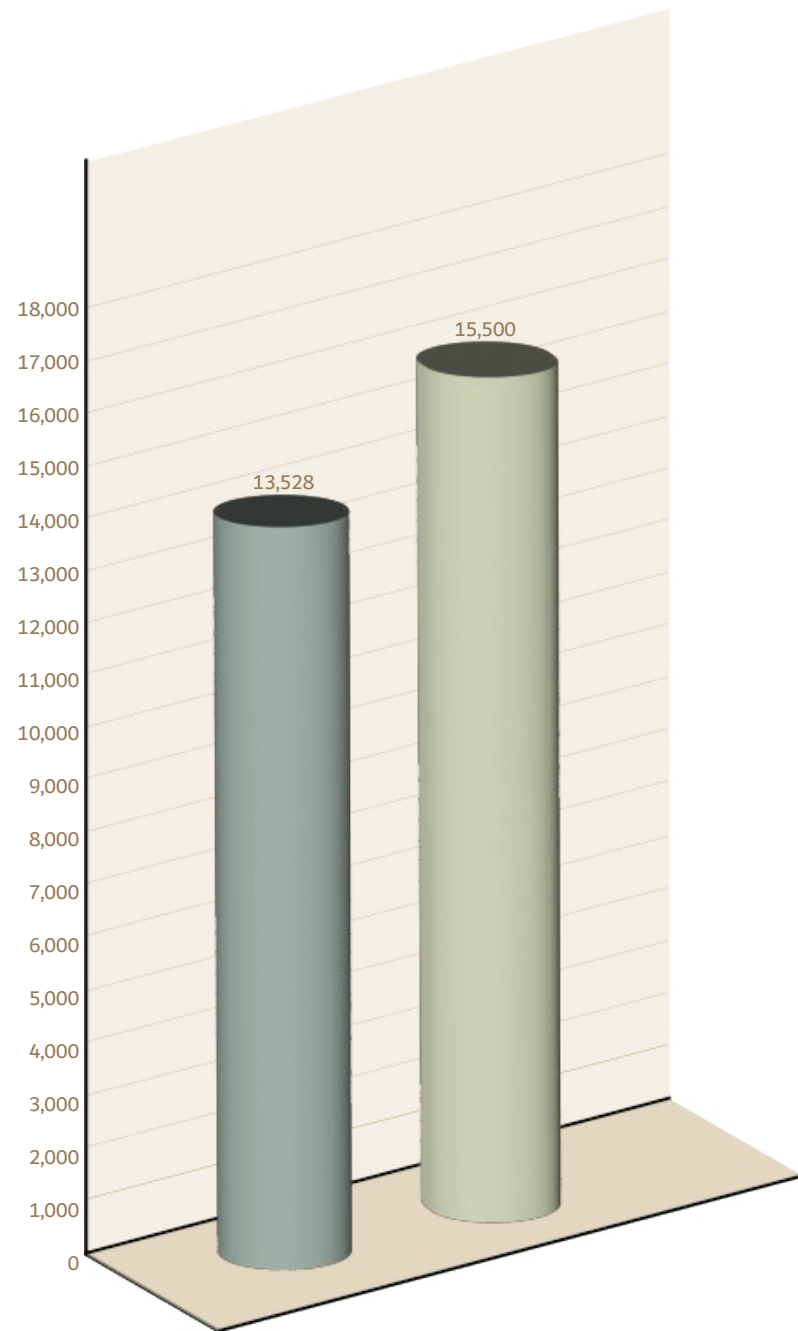
In addition to these land development related threats reiterated on the left, poor land management practices, seen on the right, subsequently affect pollinator health. Chemicals are being used in residential, agricultural, and commercial settings as a form of pest management. While these chemicals are often used to control uninvited pests, they are harming pollinators as a result. In addition, the modern day aesthetic standard to maintain a perfectly manicured lawn poses harm to pollinators. With regular mowing comes decreased floral abundance, and therefore less resources for pollinators.

Cumulatively, these factors have negative impacts on pollinator species richness and abundance as they face the reality of decreased resources for population growth and stability.

CHAPTER 2

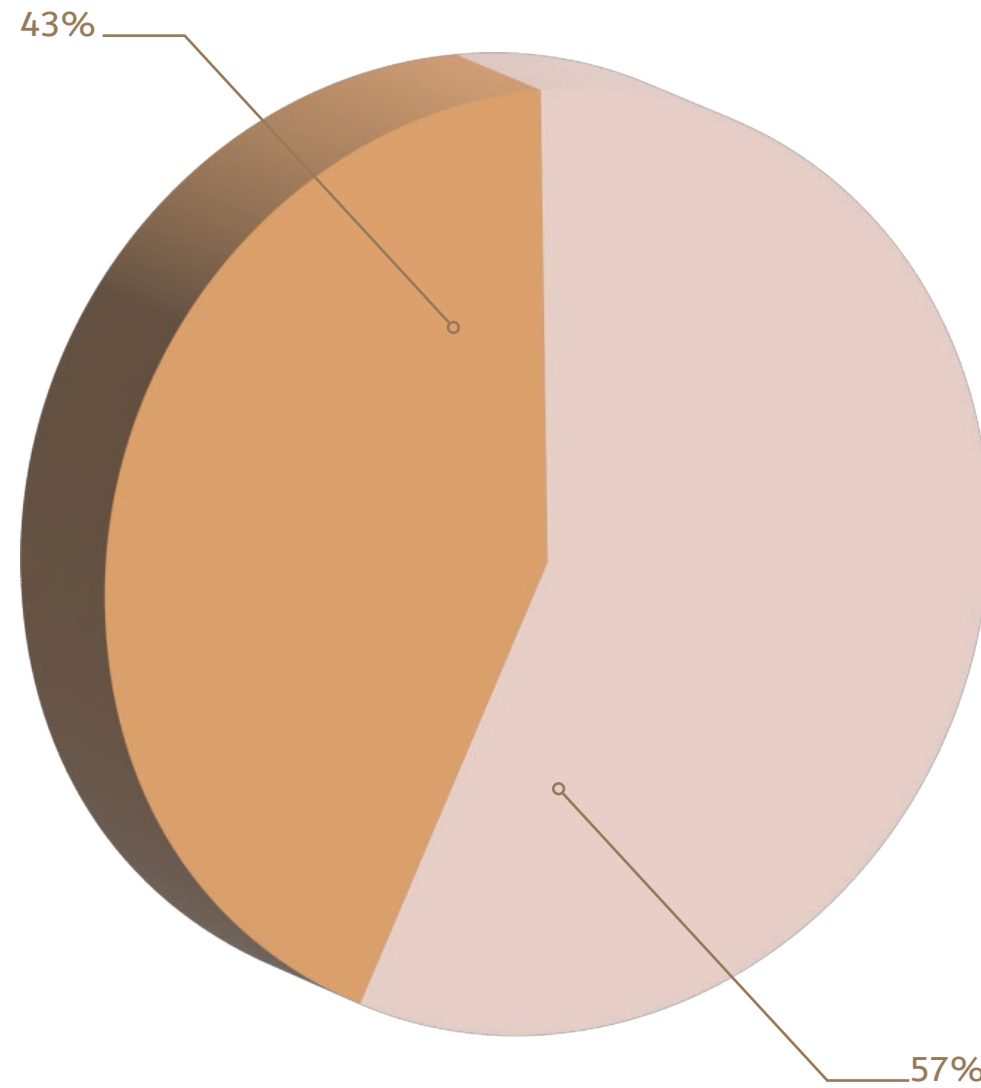
GOLF COURSES

THE PREVALENCE OF GOLF COURSES



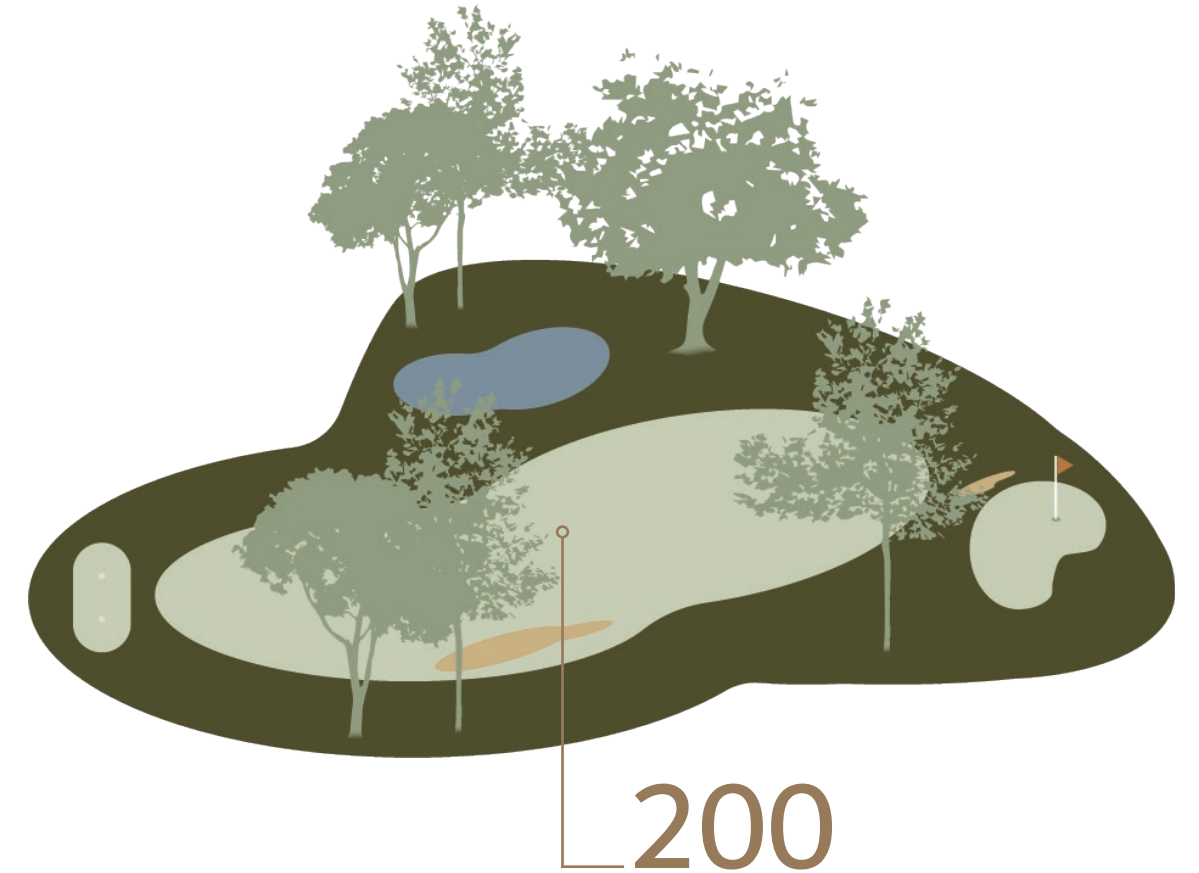
McDONALDS GOLF COURSES

NUMBER OF MCDONALDS VS. GOLF COURSES IN THE UNITED STATES



UNITED STATES INTERNATIONAL

PERCENTAGE OF GOLF COURSES DOMESTICALLY VS. INTERNATIONALLY



OREGON COURSES

NUMBER OF COURSES IN THE STATE OF OREGON

These stats are meant to provide a more digestible understanding of just how vast golf courses are. McDonalds is a chain that everyone is familiar with. It is not uncommon to see the infamous golden arches just about anywhere you travel. In the U.S., while there are 13,528 McDonalds, there are roughly 15,500 golf courses to give some perspective. The United States is home to nearly half of the world's golf courses at 43%, making it an even more pertinent topic locally. Lastly, of those roughly 15,500 U.S. courses, Oregon houses around 200.

MAINTENANCE REQUIREMENTS

PESTICIDES

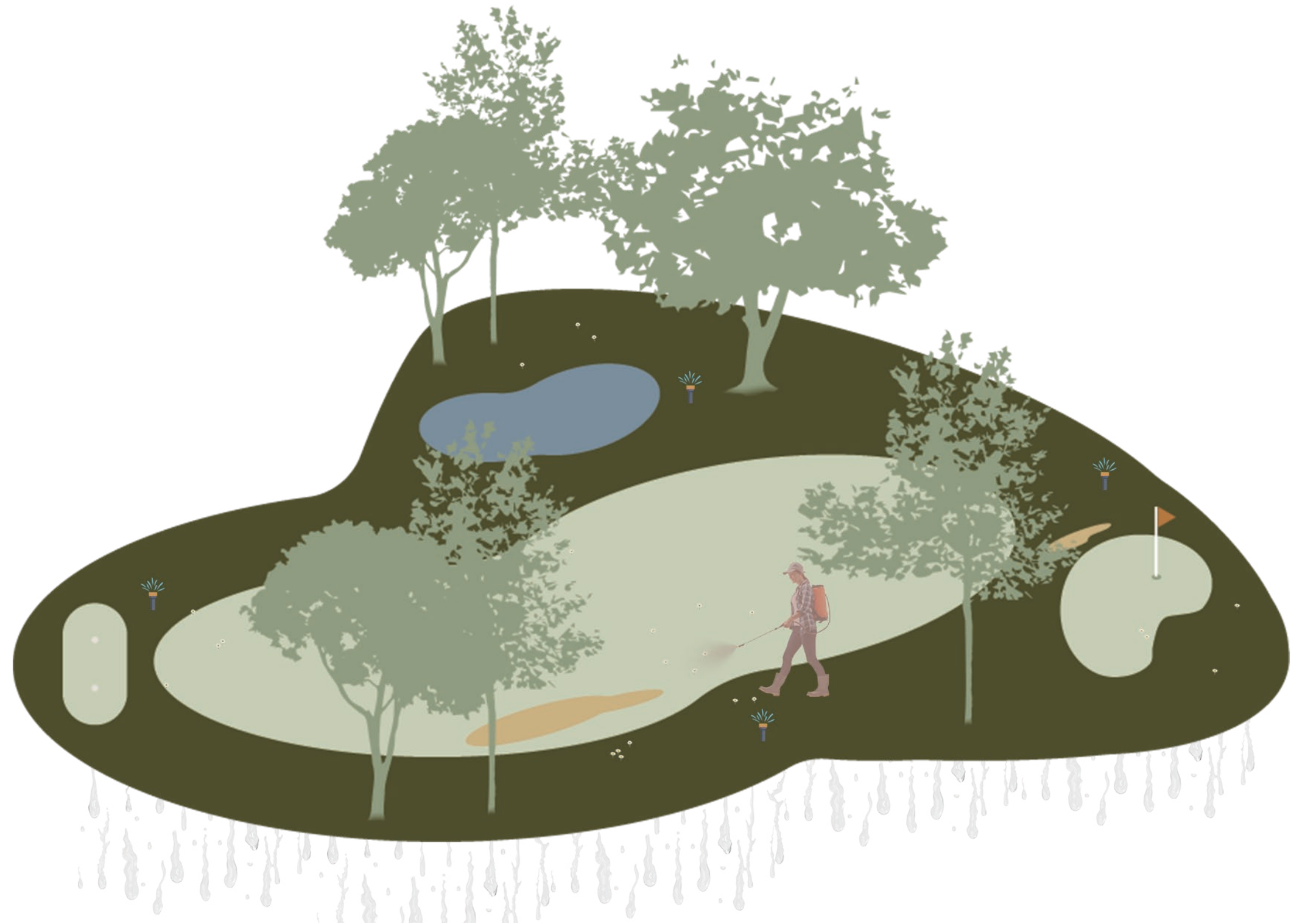
- KILL, REPEL, CONTROL UNWANTED PESTS
- HERBICIDES
- INSECTICIDES
- FUNGICIDES

FERTILIZERS

- PROVIDE NUTRIENTS
- PROMOTE HEALTH AND QUALITY
- PREVENT DISEASE
- CAN CAUSE WATER QUALITY ISSUES

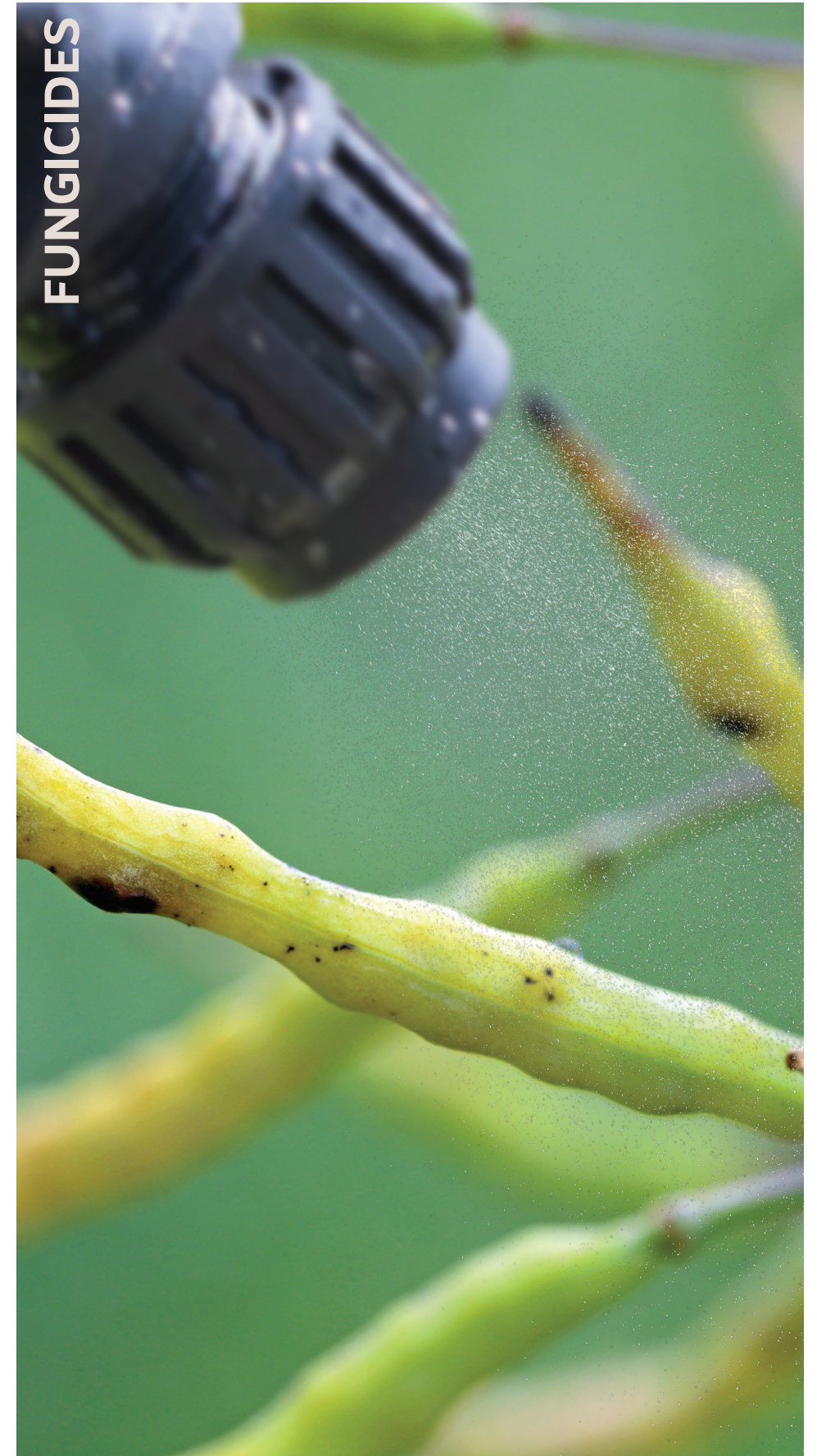
IRRIGATION

- MORE WATER FOR SHORTER TURF
- COSTLY
- 2.08 BILLION GALLONS PER DAY ACROSS U.S.



Golf courses are extremely resource heavy, often relying on pesticides, fertilizers, and substantial irrigation. Golf course superintendents depend on these mainstream maintenance practices to achieve the pristine manicured aesthetic that golfers are expecting upon arriving to play a round or practice their game at the driving range.

PESTICIDES

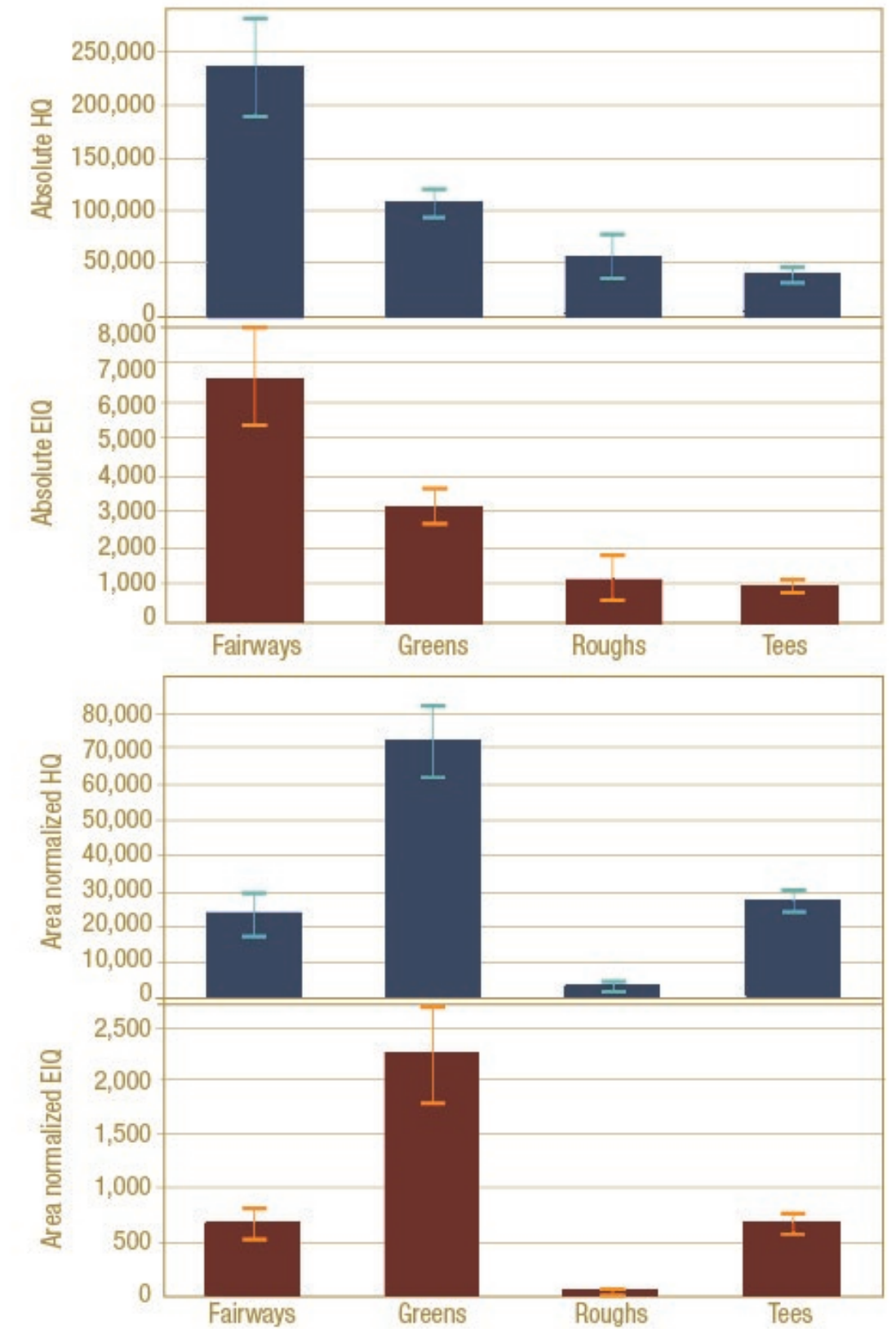


Starting with pesticides, pesticides are defined by the National Institute for Environmental Health Sciences as products that “... kill, repel, or control forms of animal and plant life considered to damage or be a nuisance in agriculture and domestic life” (Pesticides). These include herbicides, insecticides, and fungicides, which are used to rid the land of weeds and unwanted vegetation, insects, and fungi. While pesticides can control unwanted pests, they can also pose risks to human and non-human health when used in large quantities.

PESTICIDES



IMAGE SOURCE: SUNRIVER RESORT



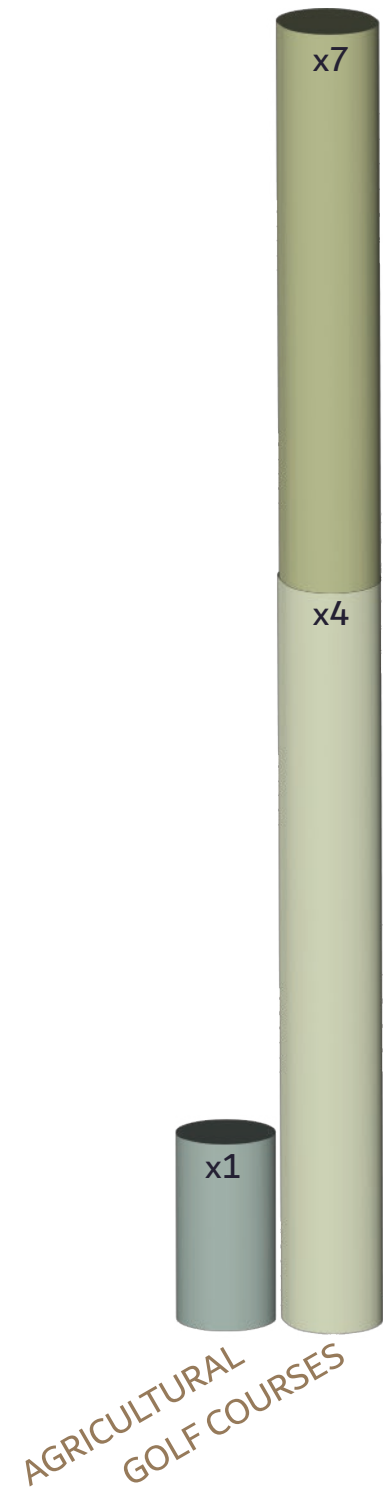
STUDY CONDUCTED IN NEW YORK AND WISCONSIN. ERROR BARS INDICATE VARIABILITY ACROSS GOLF COURSES.

<https://gcmonline.com/course/environment/news/pesticide-environmental-risk-golf-courses>


On golf courses, the amount of pesticides applied and their toxicity levels determine their risks. While golfers are at risk of exposure to pesticides that have not had enough time to disperse or degrade, studies have also found harmful pesticides applied on golf courses to be contaminating the groundwater and nearby aquatic sources.

The information on the right of the page shows results from a study conducted in New York and Wisconsin that highlights pesticide usage on golf courses, showing that the greatest hazards occur in the fairways and greens (Bekken et al., 2021) - the two most frequented parts of the course.

PESTICIDES: A CASE STUDY



PESTICIDE USAGE ON NY GOLF COURSES: POUNDS PER ACRE

 = 8,300 LBS

Although the exact quantity of pesticide usage on golf courses is not well-documented, one report published by the New York State Attorney General's office found that fifty-two Long Island golf courses used a collective 50,000 pounds of pesticides in one year (Feldman). The bar graph shows that this number is four to seven times more than the average agricultural usage on a pound per acre basis while the shipping containers give a weight representation, with the 6 containers weighing a total of roughly 50,000 pounds.

FERTILIZERS

NORMAL LEVEL OF FERTILIZER USAGE



EXCESSIVE LEVEL OF FERTILIZER USAGE



NO_3^- NITRATE

H_2O WATER

DO DISSOLVED OXYGEN

Next, fertilizers. Fertilizers provide nutrients, promoting plant health and quality. This includes turf grasses. They also have the ability to prevent disease and reduce pest problems. Many fertilizers contain nitrate, which is one of the components essential for healthy plant growth. However, when these fertilizers are used in excess, they can cause serious water quality issues due to increased salinity.

With the amounts of water used to irrigate golf course turf lawns, the nitrate can leach into groundwater and other nearby water sources. The high levels of salinity in these water sources can cause hypoxia, which means low levels of dissolved oxygen, which is harmful to animals that rely on these water sources for survival (Environmental Protection Agency, 2012).

IRRIGATION



Lastly, irrigation. Turf grasses typically require a lot of water, and an area such as the green that receives more traffic and is maintained at a shorter height could use two to three times more water than the same grass grown in the rough. Additionally, due to lawns being mown frequently, the roots grow at a shallower depth, making the lawn stressed and susceptible to pests. The United States Golf Association estimates that golf courses spend \$5,000 to \$108,000 annually on irrigation and has pulled information from the U.S. Geological Survey stating that U.S. courses average 2.08 billion gallons of water per day.

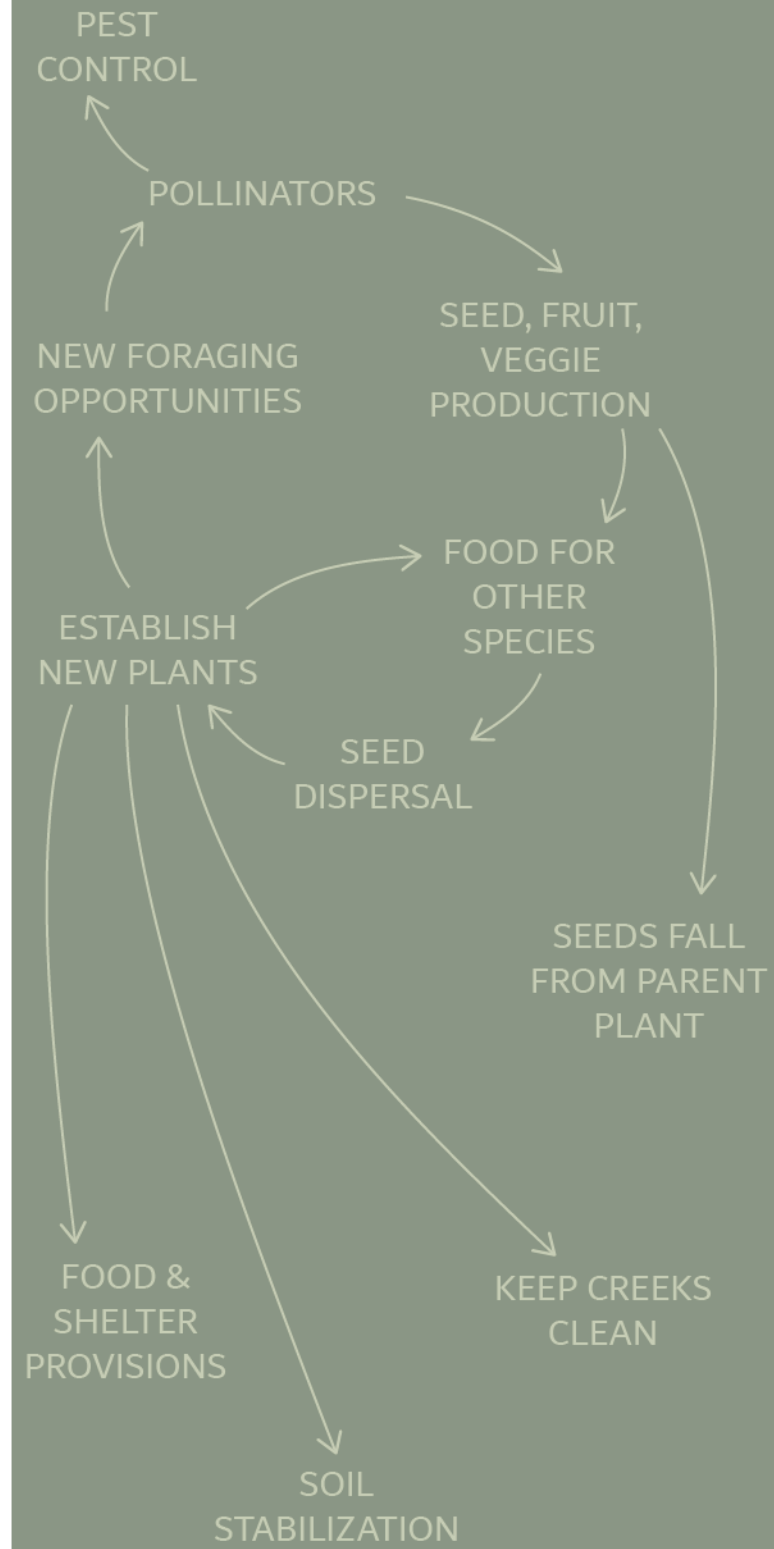
CHAPTER 3

POLLINATORS

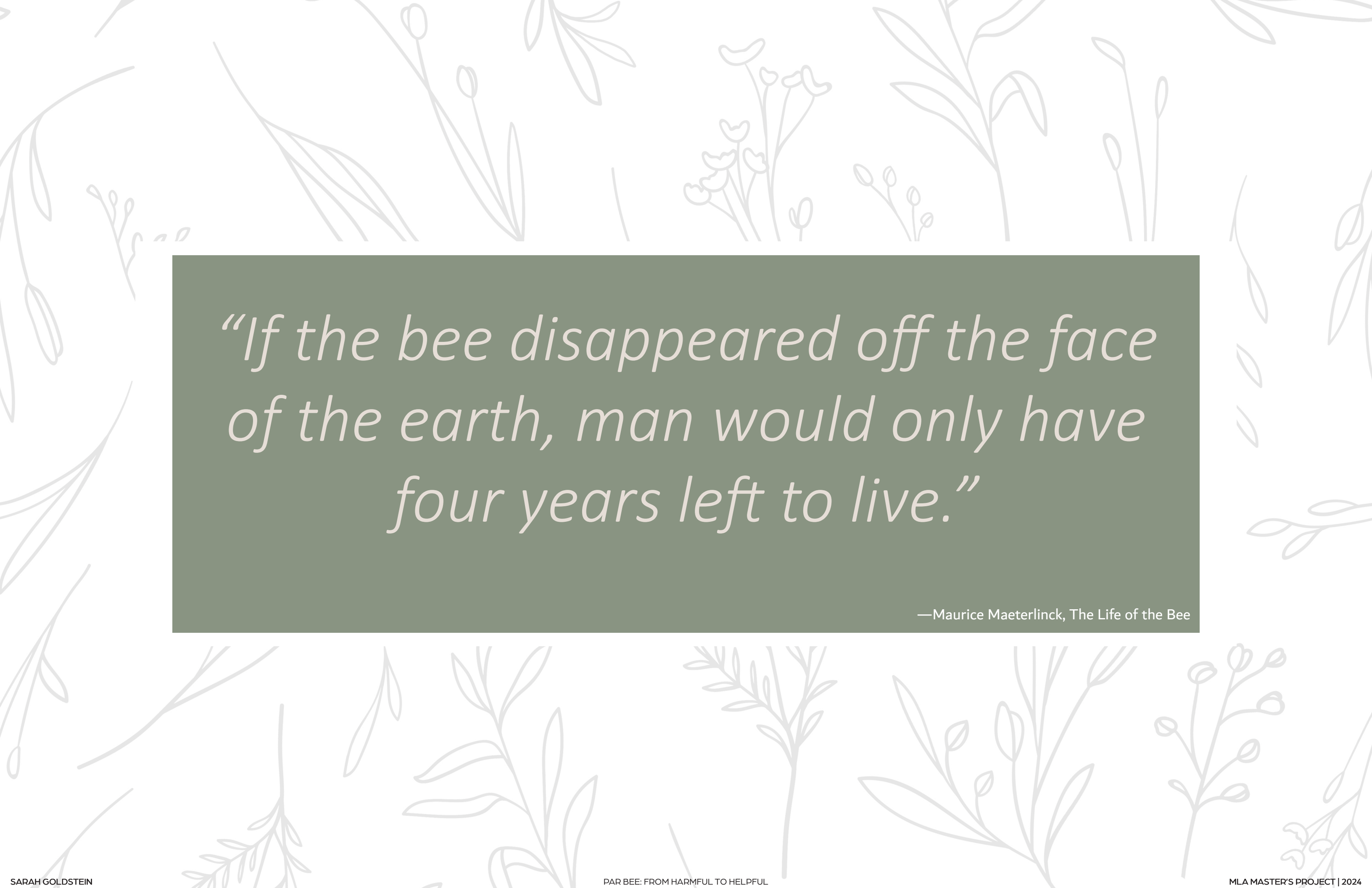
THE IMPORTANCE OF POLLINATORS



PLANTS ← → POLLINATORS



Pollinating species hold ecosystems together at a disproportionately large scale relative to their abundance. They provide services that allow habitats to function properly, including pollination, which aids in the production of seeds, fruits, and vegetables. Pollinating insects control pests, serve as an indicator of healthy streams and soils, and form the base of ecological food webs in all settings, including urban (Why We Need Insects, n.d.). In sum, they aid in the reproduction of 65% of the world's wild plants (Wratten et al., 2012), contribute to food security for human and non-human species, replenish and sustain vegetation, and are a part of a diverse ecosystem.














*“If the bee disappeared off the face
of the earth, man would only have
four years left to live.”*

—Maurice Maeterlinck, *The Life of the Bee*

In *The Life of the Bee*, Maurice Maeterlinck asserts that “If the bee disappeared off the face of the earth, man would have only four years left to live.” I found this quote to project a powerful message speaking to the necessity of bees, but also pollinators as a whole, to humanity and the environment.

POLLINATOR SURVIVAL NEEDS






















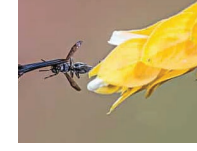


REPRODUCTION

-   TREES
-   BRANCH FORKS
-   HOST PLANTS
-   POLLEN
-   BARE SOIL
-   PROTECTED TWIGS

NESTING & OVERWINTERING

-   WOODY STEMS
-   MOSS & LICHEN
-   LEAF LITTER
-   BARE SOIL
-   SPIDER SILK
-   DEAD TREES/NURSE LOGS
-   CATKIN-BEARING SHRUBS
-   CATKIN-BEARING SHRUBS
-   BARK FISSURES/HOLLOW TREES

FORAGING

-   NECTAR
-   NECTAR
-   NECTAR
-   TREE SAP
-   TREE SAP
-   POLLEN
-   FLORAL ABUNDANCE
-   FLORAL ABUNDANCE
-   FLORAL ABUNDANCE
-   OVERRIPE FRUIT
-   INSECTS
-   CLOSE PROXIMITY

 BUTTERFLIES

 BEES

 HUMMINGBIRDS

In order to understand how to create a landscape that will promote and sustain pollinators, it is important to know what comprises a successful pollinator habitat. Although there are a wide variety of pollinators, such as moths, flies, and even certain small mammals, this project's primary focus is on bees, butterflies, and hummingbirds with the hopes of gaining more interest from the general public as they experience new habitats on the golf course.

The three main and most important components of these pollinator's lives are reproduction, nesting and overwintering, and foraging.

Each of these species has their own unique way of repopulating into the next generation. While some species may need bare soil to hibernate for the winter - ground nesting bees for example, others, such as butterflies, rely on bark fissures and hollow trees. Hummingbirds will even migrate to warmer climates until local weather conditions allow for a seasonal return. Lastly, food supply is essential for the survival of any species, whether that be pollen and nectar from plants, overripe fruit, or other insects.

CHAPTER 4

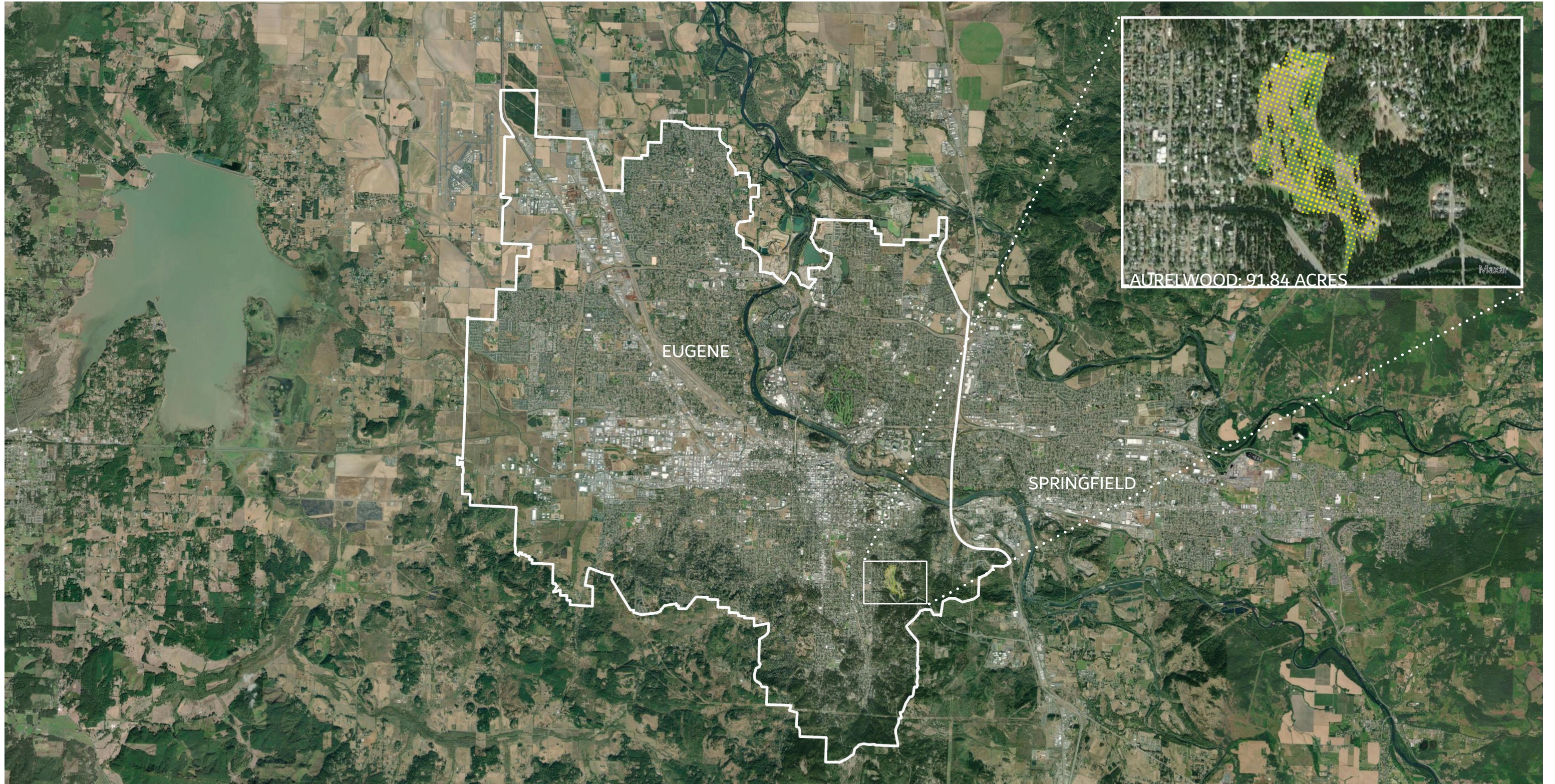
THE SITE: LAURELWOOD GOLF COURSE

HOW CAN I CREATE OPPORTUNITIES FOR BIODIVERSITY ON GOLF COURSES TO SUPPORT THE PROCREATION OF POLLINATORS?



All of this culminates to my question and design challenge, how can I create opportunities for biodiversity on golf courses to support the procreation of pollinators?

LAURELWOOD GOLF COURSE EUGENE, OR



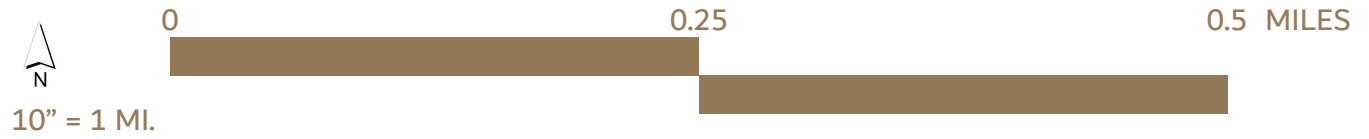
When choosing a site to ground my design for pollinator focused planting around the golf course, it made sense to stay local. This provided opportunities such as accessible site visits and the exploration of local flora and fauna in the design. Laurelwood Golf Course presented itself as a great site as they are already implementing sustainable practices - although it is important to note that they are not entirely organic. The course is situated at the periphery of Eugene's Urban Growth Boundary, bordered by residential neighborhoods to the north, west, and south, and forested landscapes to the east. The golf course's land, which is owned by the City of Eugene, measures out just under 92 acres

PLAN VIEW



LEGEND

-  COURSE ENTRANCE
-  DIRECTION OF PLAY
-  FAIRWAY
-  GREEN
-  TEE
-  OUT OF PLAY
-  DRIVING RANGE
-  PARKING LOT
-  CLUBHOUSE & PUB
- 1** HOLE NUMBER



This map shows Laurelwood in plan, providing an understanding of the layout of the game. The 9 hole game starts just south of Laurelwood's on-site restaurant, The Pub. As shown, there aren't too many trees as players move throughout the course until the property transitions into forested land to the east.

GETTING ACQUAINTED



- ① AREA OF PLAY
TEE
FAIRWAY
ROUGH
HAZARDS
GREEN
GOLF CART TRAILS
- ② DRIVING RANGE
PRACTICE AREA
- ③ PRIVATE HOUSING
RESIDENTIAL ZONE
- ④ WOODED BOUNDARY

In addition to the 9-hole game, Laurelwood offers a driving range for players to practice year-round. The course and the driving range can be seen from the back deck of the pub with forested hills encompassing the landscape and private homes peeking out through the surrounding trees

VISITATION RATES

WINTER

JAN FEB

SPRING

MAR APR MAY

SUMMER

JUN JUL AUG

FALL

SEPT OCT NOV

WINTER

DEC



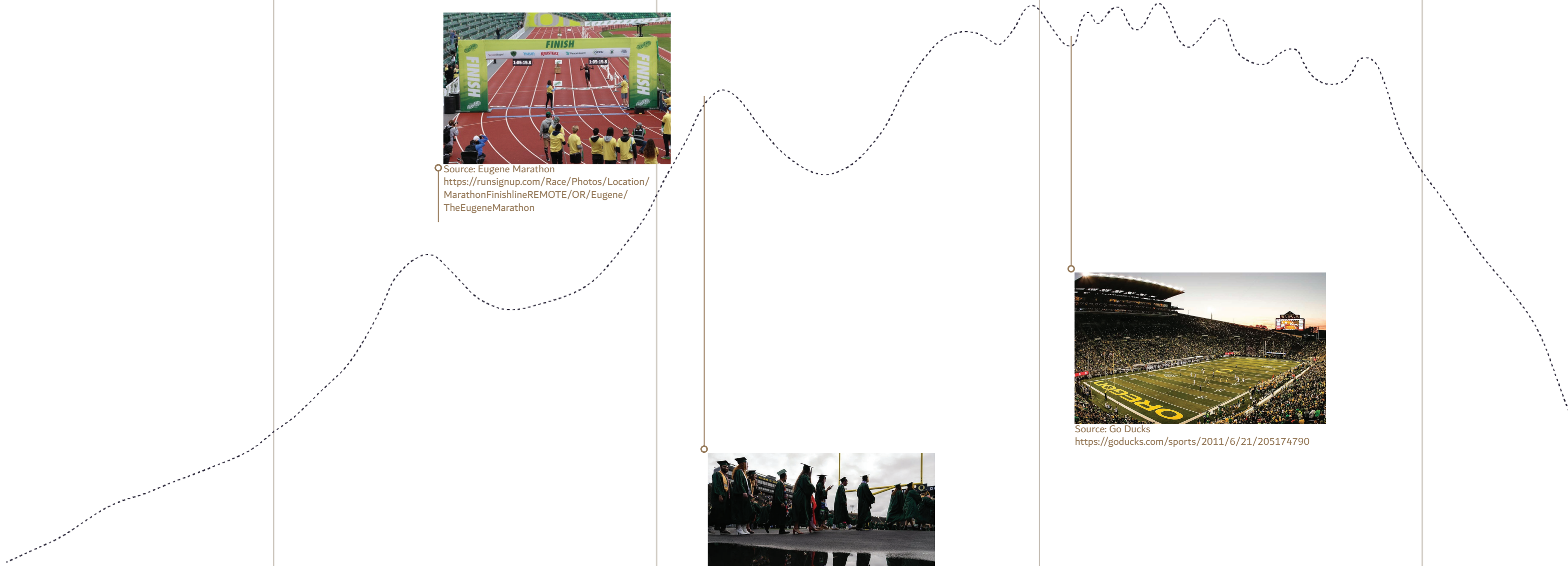
Source: Eugene Marathon
<https://runsignup.com/Race/Photos/Location/MarathonFinishlineREMOTE/OR/Eugene/TheEugeneMarathon>



Source: University of Oregon
<https://around.uoregon.edu/commencement-2022>



Source: Go Ducks
<https://goducks.com/sports/2011/6/21/205174790>



*this line is a suggestive representation and not an accurate portrayal of actual numbers

Will Benson, the superintendent of Laurelwood, deems the facility a “mom and pop course.” He estimates that they host 50-70,000 golfers per year. The course sees spikes in visitors during major track and field events, home football games, around graduation, and other large events. Outside of major events, the course experiences its busiest seasons in late spring through early fall, with visitation slowing in the winter.

LAURELWOOD GROUNDSKEEPING



The superintendent and employees of Laurelwood work to keep a tidy appearance, consisting of neatly mown lawns, the removal of weeds and debris, and healthy, green grass with sustainable practices in mind.

FIRST TAKES ON BIODIVERSITY AT LAURELWOOD



PURSUING BIODIVERSITY
ENTRY PLANTINGS



FIGHTING PESTS
ENGLISH DAISIES



As golfers arrive at the site, they are greeted by the course's pub, which Laurelwood has worked to make more attractive with various plantings, including Japanese pieris, Rosemary, and various evergreen shrubs. Although not all plantings here are native, it is a step toward improving biodiversity.

Additionally, Laurelwood has been taking an organic-focused approach for over ten years now. They have rid their course of herbicides, pesticides, and fungicides, however, they use Ammonium sulfate to fertilize their lawns to provide readily available nitrogen and sulfur, helping lawns to stay green.

The main issue Laurelwood faces is dealing with English Daisy. As pictured, the daisies pop up all over the property. The staff prioritizes removing the daisies on the tees, fairways, and greens, doing so by using a granular weed and feed, applying the product and removing the weeds by hand to target problem areas.

VINEYARD GOLF CLUB

MARTHA'S VINEYARD, EDGARDOWN, MA



Source: Vineyard Golf Club



Source: Vineyard Golf Club

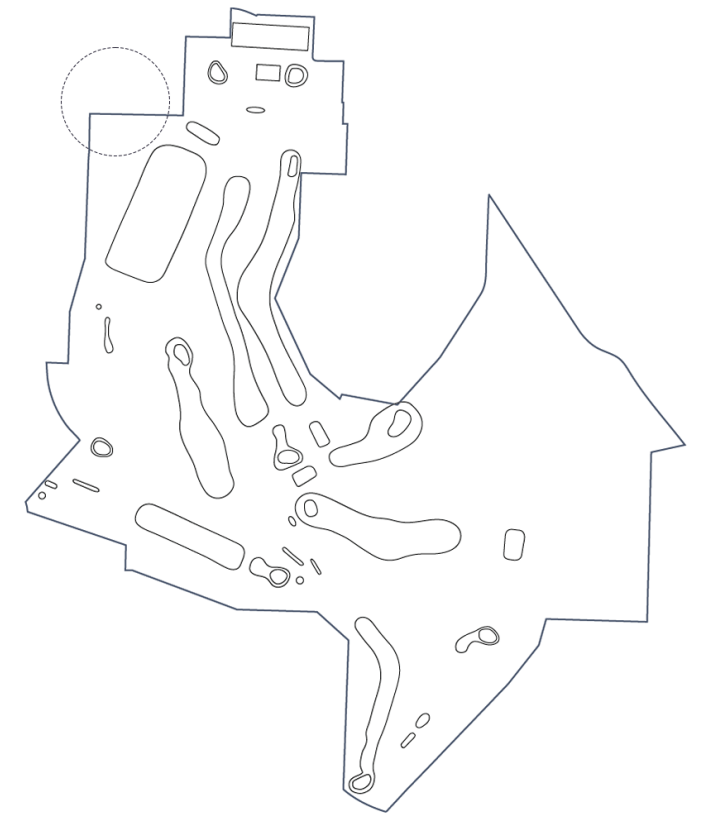


Source: Vineyard Golf Club

“ GLOBAL LEADER IN SUSTAINABLE GOLF ”

Laurelwood Golf Course is one of few golf courses implementing organic practices. The course no longer experiences the diseases they encountered pre-organics and has found success in restoring natural balance that the landscape seeks. However, Vineyard Golf Course located in Martha's Vineyard, MA, is the only 100% organic golf course in the United States. The Golf Course Superintendents Association of America (GCSAA) surveyed courses across the country and released results in 2012 which "indicated that 98% of average 18-hole golf facilities stored pesticides on site" (White, 2021).

POLLINATOR POCKET: THE BOG AT LAURELWOOD



Building on opportunity at Laurelwood, there already appears to be pursued interest in supporting pollinators on site. One homeowner, whose property abuts Laurelwood, has taken on a retirement project supporting local pollinators. Hidden away directly west of the driving range, there is a pocket pollinator garden.

Will Benson introduced me to this little pollinator oasis. He explained that the man who cares for and maintains this passion project has taken the time to create a garden full of native plants that he has sourced locally from Doak Creek Nursery. He has provided a variety of plants from perennials to shrubs to trees with a small stream to provide a water source for local pollinators.

This secret garden is open to all golf course visitors and provides opportunities for pollinator garden expansion and a potential means for welcoming more visitors to the golf course.

CHAPTER 5

THE DESIGN

OPPORTUNITY

EXPAND BIODIVERSITY

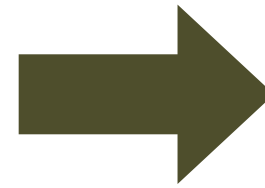
IMPROVED MAINTENANCE



To recap what has been covered so far, Laurelwood is a large site with a significant amount of open space. There are not many plantings outside of the trees scattered throughout the grounds. The open space can be capitalized on to enhance the desirability of the course while welcoming pollinators through native-focused habitat and increased biodiversity. Improved maintenance practices can further enhance the site, building on the organic approach Laurelwood already takes. These opportunities pair well with the ability to educate players on the improved landscape through educational signage, drawing more attention to the needs of pollinators.

GUIDELINES

**Audubon
International**



The Audubon International organization was referenced to inform this design. Audubon International aims to “help businesses identify and execute practices needed to achieve the highest standards in environmental sustainability” (2024). The Audubon Cooperative Sanctuary Program for Golf is uniquely tailored to golf courses to provide an “education and certification program that helps golf courses protect the environment and preserve the natural heritage of the game of golf” (ACSP for golf, 2024).

AUDUBON INTERNATIONAL

REQUIREMENTS

1 | ENVIRONMENTAL PLANNING

- DEVELOP MAP HIGHLIGHTING RELEVANT ZONES
- EVALUATE GOALS/OBJECTIVES ONCE PER YEAR
- TRAIN EMPLOYEES
- TRACK PROGRESS

2 | WILDLIFE HABITAT AND MANAGEMENT

- IDENTIFY CORE HABITATS
- IDENTIFY DOMINANT NATIVE PLANT COMMUNITIES
- TRACK BIRD + MAMMAL USE ON SITE
- MAINTAIN HABITAT IN AT LEAST 50% OF MINIMALLY USED LANDSCAPE
- CREATE NAVIGABLE ACCESS FOR WILDLIFE
- PLANT LAYERS AND TEXTURES
- LEAVE SNAGS WHERE THREAT IS NOT POSED
- MAINTAIN WATER SOURCE
- NATURALIZE >/= 50% OUT OF PLAY SHORELINES
- FLOWERS THAT PROVIDE NECTAR
- USE BUFFERS/SIGNS/FENCING FOR PROTECTION
- KEEP LANDSCAPE AT LEAST 80% NATIVE
- RESTORE DEGRADED HABITATS
- STEER HUMAN MOVEMENT AWAY FROM PLANTING ZONES

3 | CHEMICAL USE REDUCTION AND SAFETY

- BEST MANAGEMENT PRACTICES (BMP) + INTEGRATIVE PEST MANAGEMENT (IPM)
- EDUCATE STAFF
- INVENTORY SOIL TYPES
- IMPROVE SOIL HEALTH
- BASE FERTILIZER ON SOIL TEST
- USE OF PEST-RESISTANT/STRESS-TOLERANT CULTIVARS
- MAINTAIN RECORDS

4 | WATER CONSERVATION

- INSTALL MOST EFFICIENT IRRIGATION
- ELIMINATE NON-TARGET WATERING
- AVOID WATERING AT PEAK EVAPOTRANSPIRATION TIMES

5 | WATER QUALITY MANAGEMENT

- EVALUATE MANAGEMENT PRACTICES
- IDENTIFY ENTRY AND EXIT OF WATER TO AND FROM SITE
- ELIMINATE/MITIGATE EROSION TOWARD WATER BODIES
- USE SLOW-RELEASE FERTILIZERS
- FILTER DRAINAGE THROUGH VEGETATION
- REDUCE/ELIMINATE NEED FOR CHEMICAL ALGAE CONTROL

6 | OUTREACH AND EDUCATION

- COMMUNICATE GOALS/OBJECTIVES
- PROVIDE UPDATES
- INVITE EMPLOYEES/PATRONS/COMMUNITY TO HELP

■ SITE ANALYSIS

■ DESIGN

■ FOLLOW UP

■ DOES NOT PERTAIN

This chart outlines and analyzes the requirements that need to be met in order to achieve and receive certification. I have assigned a color to each category that I have designated for this project. The categories can be found at the bottom of the page: Site Analysis, Design, Follow Up, or Does Not Pertain. The six Audubon categories that are

being analyzed here are

- Analysis and Design
- Planting, Access, and Conservation
 - Water
 - Soil
- Chemicals and Fertilizer Use
- Continued Interest and Leadership

AUDUBON INFORMED GUIDELINES

BREAKDOWN

SITE ANALYSIS

- 1 DEVELOP MAP HIGHLIGHTING RELEVANT ZONES
- 2 IDENTIFY CORE HABITATS
- 2 IDENTIFY DOMINANT NATIVE PLANT COMMUNITIES
- 3 INVENTORY SOIL TYPES

DESIGN

- 2 MAINTAIN HABITAT IN AT LEAST 50% OF MINIMALLY USED LANDSCAPE
- 2 CREATE NAVIGABLE ACCESS FOR WILDLIFE
- 2 PLANT LAYERS AND TEXTURES
- 2 MAINTAIN WATER SOURCE
- 2 FLOWERS THAT PROVIDE NECTAR
- 2 USE BUFFERS/SIGNS/FENCING FOR PROTECTION
- 2 KEEP LANDSCAPE AT LEAST 80% NATIVE
- 2 STEER HUMAN MOVEMENT AWAY FROM PLANTING ZONES
- 3 IMPROVE SOIL HEALTH
- 3 USE OF PEST-RESISTANT/STRESS-TOLERANT CULTIVARS
- 6 COMMUNICATE GOALS/OBJECTIVES

FOLLOW UP

- 1 EVALUATE GOALS/OBJECTIVES ONCE PER YEAR
- 1 TRAIN EMPLOYEES
- 1 TRACK PROGRESS
- 3 BEST MANAGEMENT PRACTICES (BMP) + INTEGRATIVE PEST MANAGEMENT (IPM)
- 3 EDUCATE STAFF
- 3 BASE FERTILIZER ON SOIL TEST
- 3 MAINTAIN RECORDS
- 4 INSTALL MOST EFFICIENT IRRIGATION
- 4 ELIMINATE NON-TARGET WATERING
- 4 AVOID WATERING AT PEAK EVAPOTRANSPIRATION TIMES
- 5 USE SLOW-RELEASE FERTILIZERS
- 6 PROVIDE UPDATES
- 6 INVITE EMPLOYEES/PATRONS/COMMUNITY TO HELP

1 ENVIRONMENTAL PLANNING

2 WILDLIFE HABITAT AND MANAGEMENT

3 CHEMICAL USE REDUCTION AND SAFETY

4 WATER CONSERVATION

5 WATER QUALITY MANAGEMENT

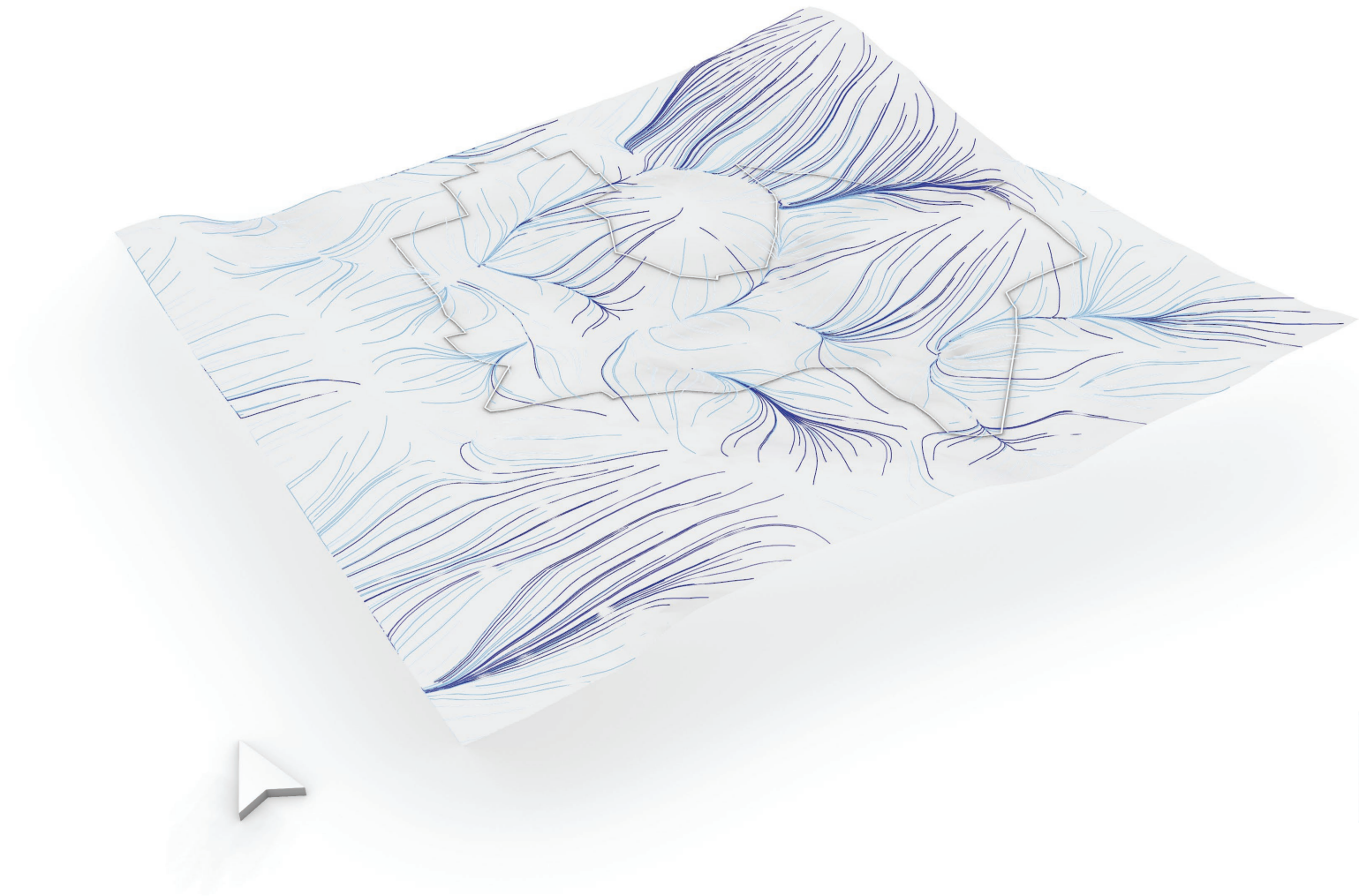
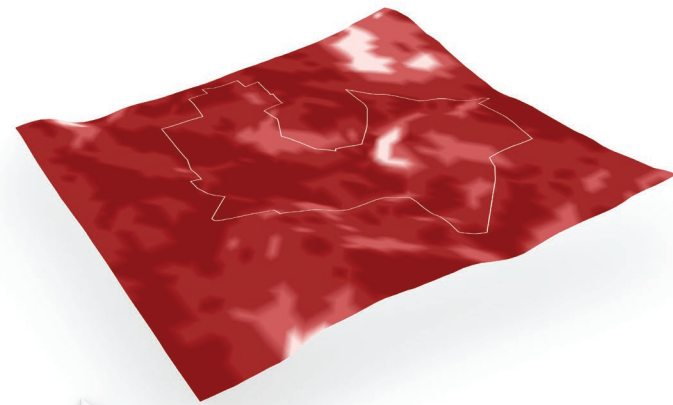
6 OUTREACH AND EDUCATION

Pictured here is a more legible breakdown of all of the factors necessary to create and maintain the proposed design. Pulling from the most important and relevant guidelines established by Audubon International, categorized requirements can be referenced for the design process, including before - Site Analysis, during - Design, and after - Follow Up. The numbers listed along the left hand side of each line item correspond to one of the six Audubon requirements for golf courses, which can be found again at the bottom of the page.

ENVIRONMENTAL CONDITIONS



WATER FLOW

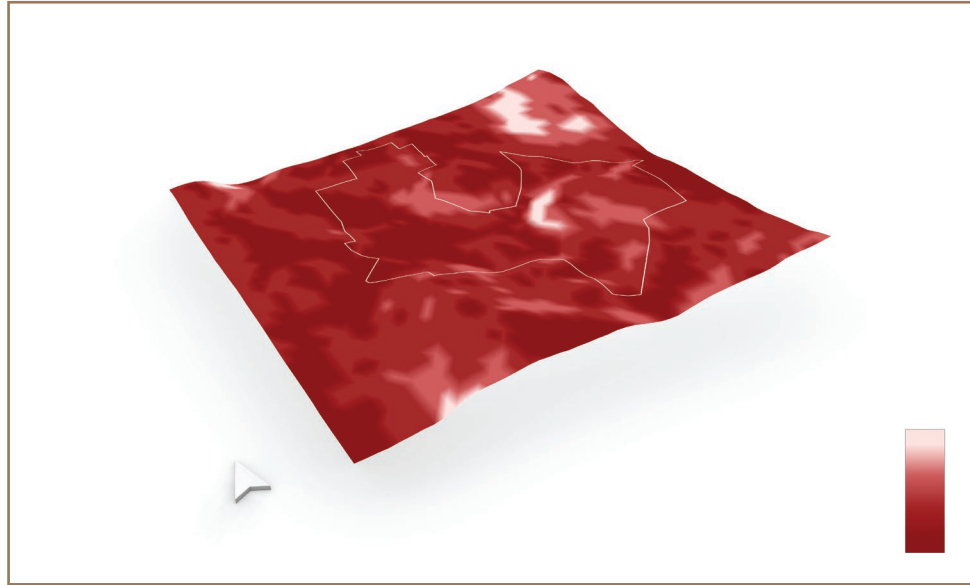
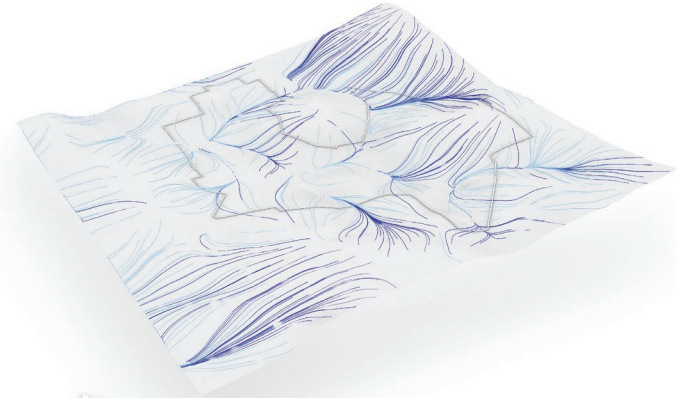


FLOW LENGTH

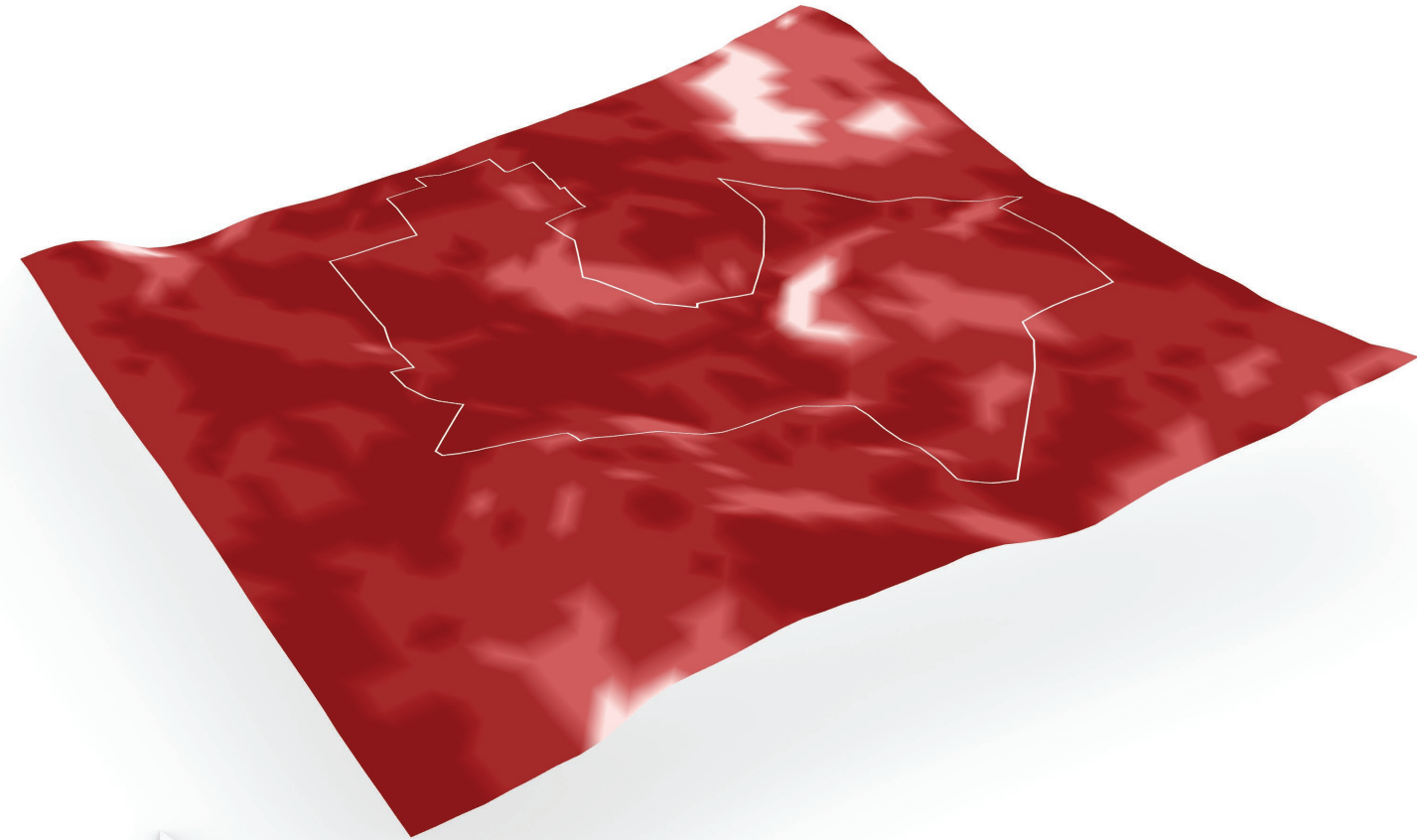
- SHORTEST
- LONGEST

To address the analysis portion of the Audubon informed guidelines, maps were developed to highlight suitable planting zones for pollinator habitat. Beginning with water flow, this analysis explains where the water is flowing to from the highest points on site while telling me the lengths of these flows, with darker lines representing longer flow paths.

ENVIRONMENTAL CONDITIONS



SLOPE

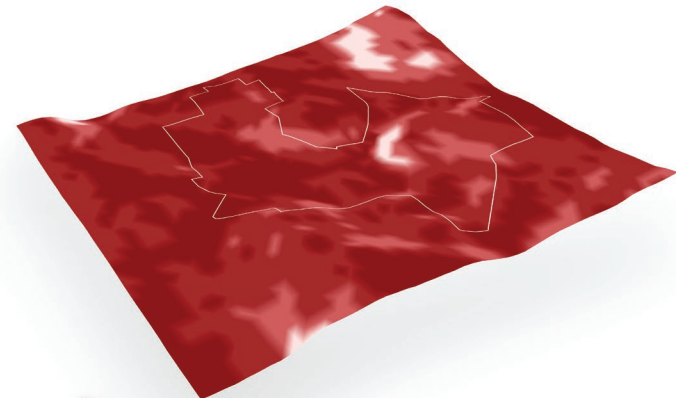
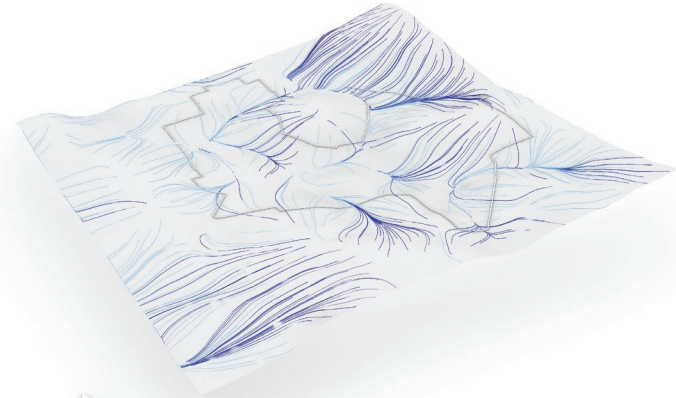


SLOPE

FLATTEST
STEEPEST

Next, slope ties into this as water flow correlates with the contours of the landscape, but it also helps to indicate where certain plants can assist with erosion control.

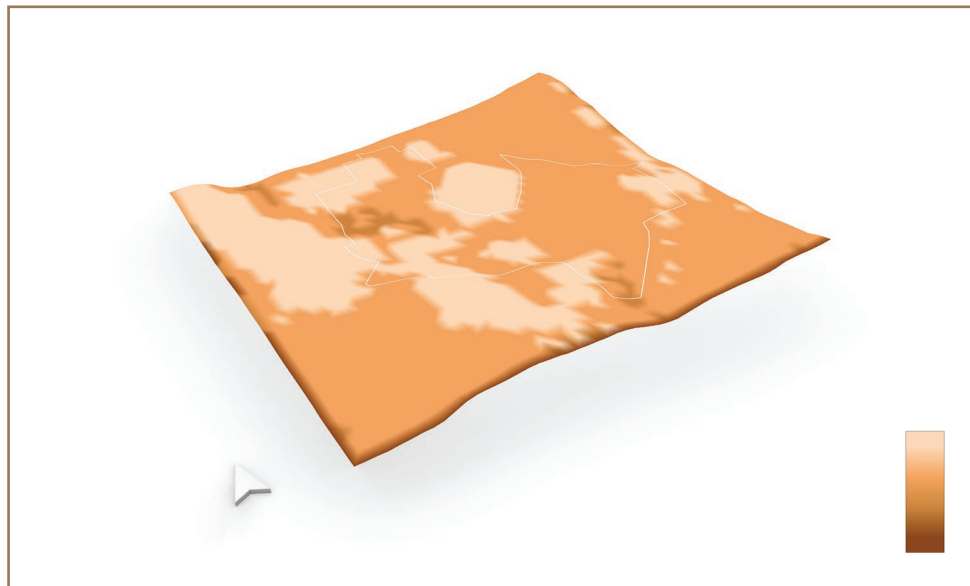
ENVIRONMENTAL CONDITIONS



SUN EXPOSURE

LEAST SUN

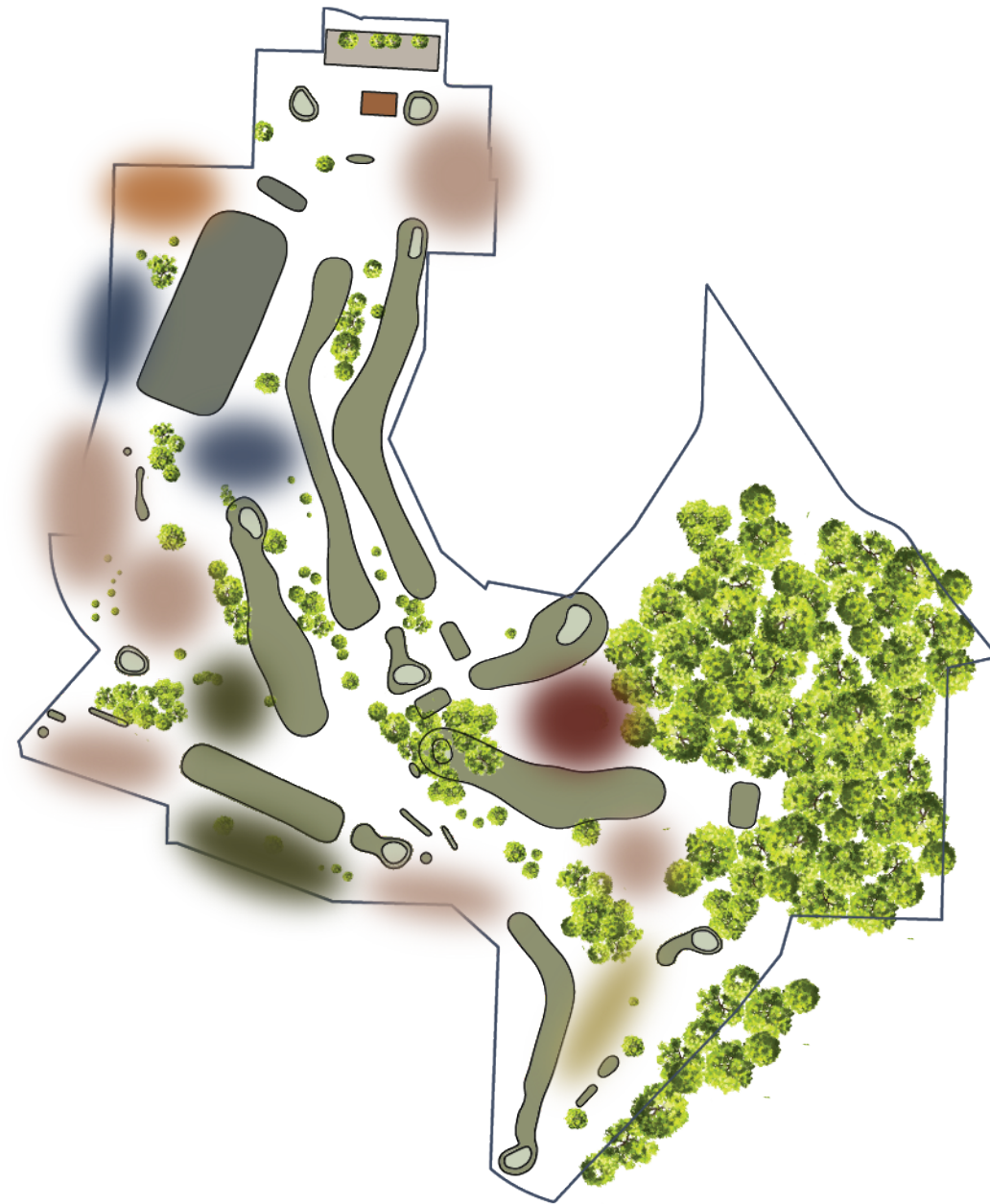
MOST SUN



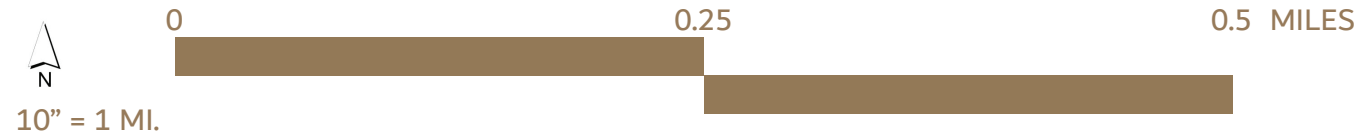
HELIOTROPE

Lastly, sunlight is one of the most important pieces for planting, as most pollinator friendly plants require partial to full sun exposure throughout the day.

PLANTING LOCATIONS



- MODERATE SUN, MODERATE WATER
- LEAST SUN, LEAST WATER
- MODERATE SUN, MOST WATER
- LEAST SUN, MODERATE WATER
- MOST SUN, MOST WATER
- MODERATE SUN, MOST WATER

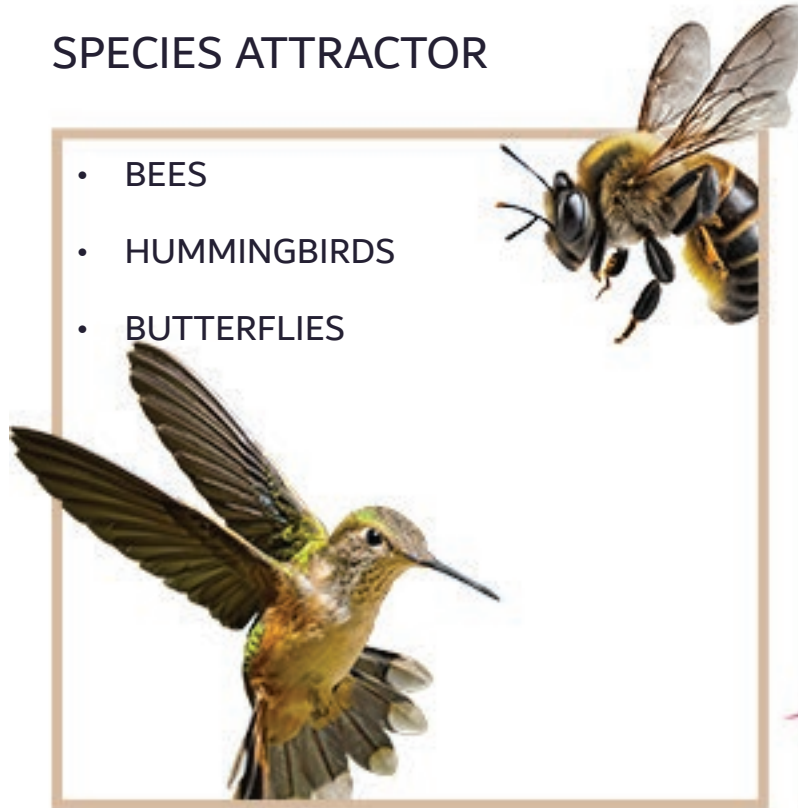


Highlighted on this plan are various planting areas that are out of the line of play. Through overlaying the assessed environmental factors, different planting conditions came to light, such as areas that have high sun exposure as well as high levels of water flow, areas that have low sun exposure and low water flow, and areas in between. The significance of this map will be revisited in just a little bit.

PLANT SELECTION

SPECIES ATTRACTOR

- BEES
- HUMMINGBIRDS
- BUTTERFLIES



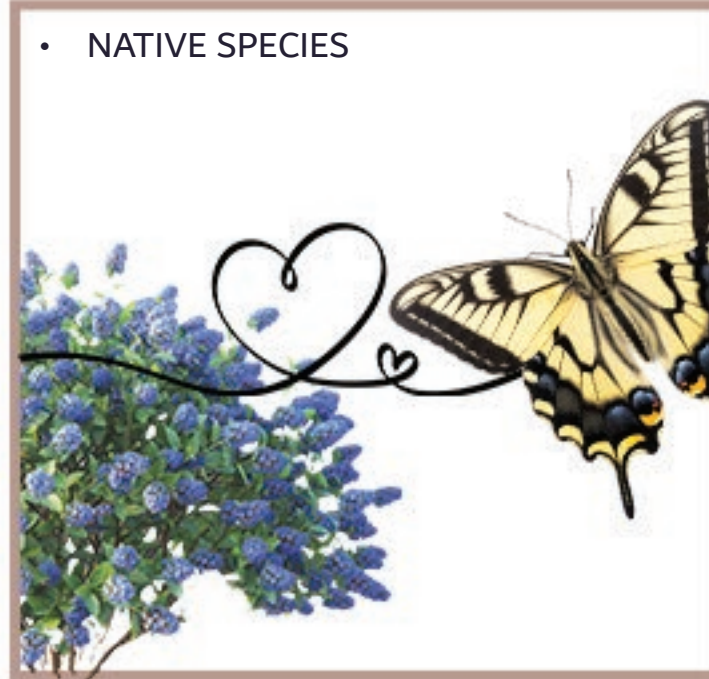
PLANT TYPE

- TREES
- SHRUBS
- PERENNIALS
- GRASSES



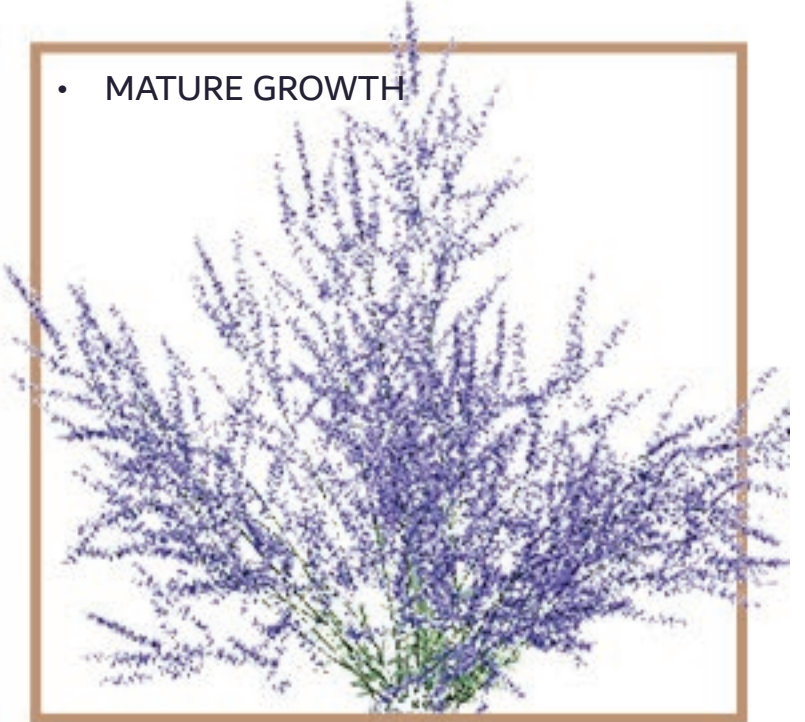
NATIVE STATUS

- NATIVE SPECIES



HEIGHT & SPREAD

- MATURE GROWTH



ENVIRONMENTAL NEEDS

- LIGHT
- SOIL
- WATER



FLOWERING PERIOD

- TIME OF YEAR
- SEED HEADS



POLLEN & NECTAR PRODUCTION

- NUTRITION
- PROVIDE FOR OFFSPRING



MAINTENANCE

- PRUNING
- WEEDING
- MOWING



Moving on to the design phase of the Audubon informed guidelines, plant palettes must be selected to create functional habitat for their targeted species. When choosing a plant palette, there are a lot of elements and factors that need to be taken into consideration. Since the focus of this project is on bees, butterflies, and hummingbirds, plants must be selected that appeal to these animals. It is necessary to provide a variety of plants to accommodate their needs, starting with plant types, ranging from trees to grasses. Selecting a palette that is focused on native plantings will ensure the gardens are suitable for native pollinators and allow anyone using this framework to meet the minimum Audubon requirement of 80% native plants. Understanding plant sizes contributes to spatial awareness of the planting design and offers more visual interest for human visitors. Choosing plants that flower through the seasons ensures that pollinators have access to pollen and nectar when necessary.

FROM GUIDELINES TO ACTUALIZATION

AUDUBON CRITERIA

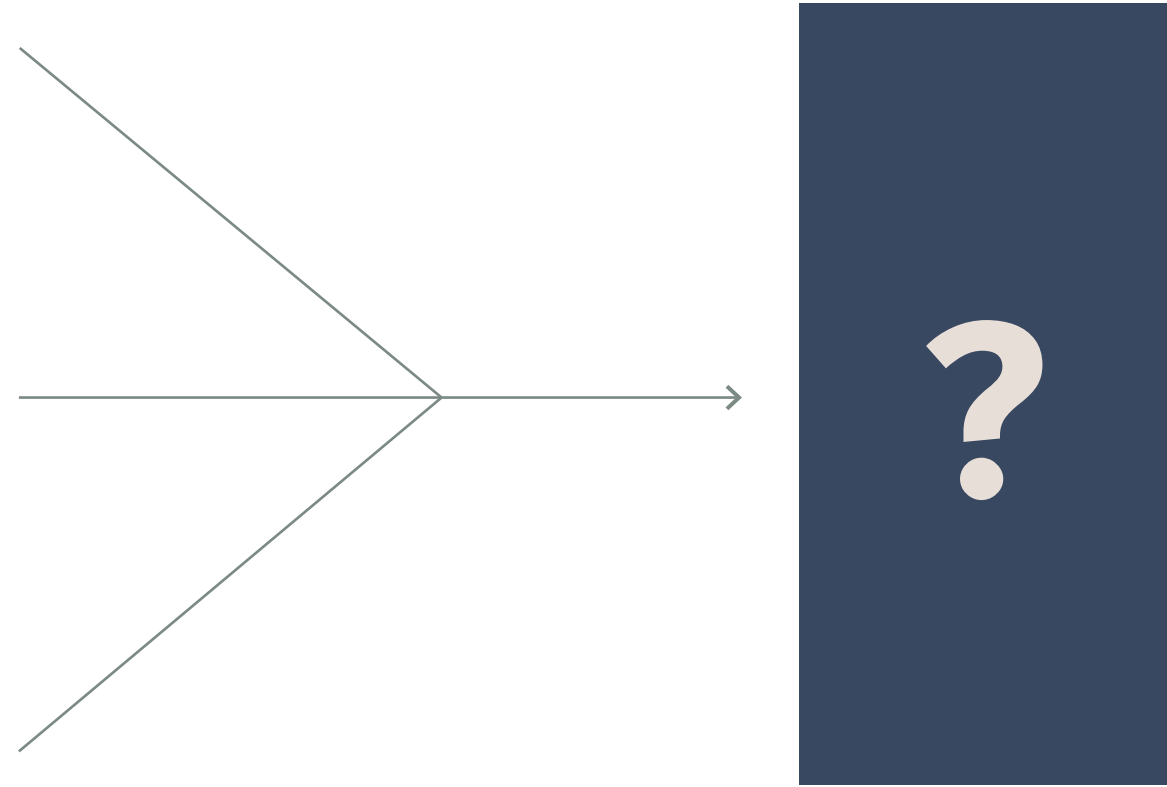
- SITE ANALYSIS
- DESIGN
- FOLLOW UP

ENVIRONMENTAL ANALYSIS

- WATER RUNOFF
- SLOPE
- SUN EXPOSURE

PLANT SELECTION

- SPECIES ATTRACTOR
- PLANT TYPE
- NATIVE STATUS
- HEIGHT & SPREAD
- ENVIRONMENTAL NEEDS
- FLOWERING PERIOD
- POLLEN & NECTAR PRODUCTION
- MAINTENANCE



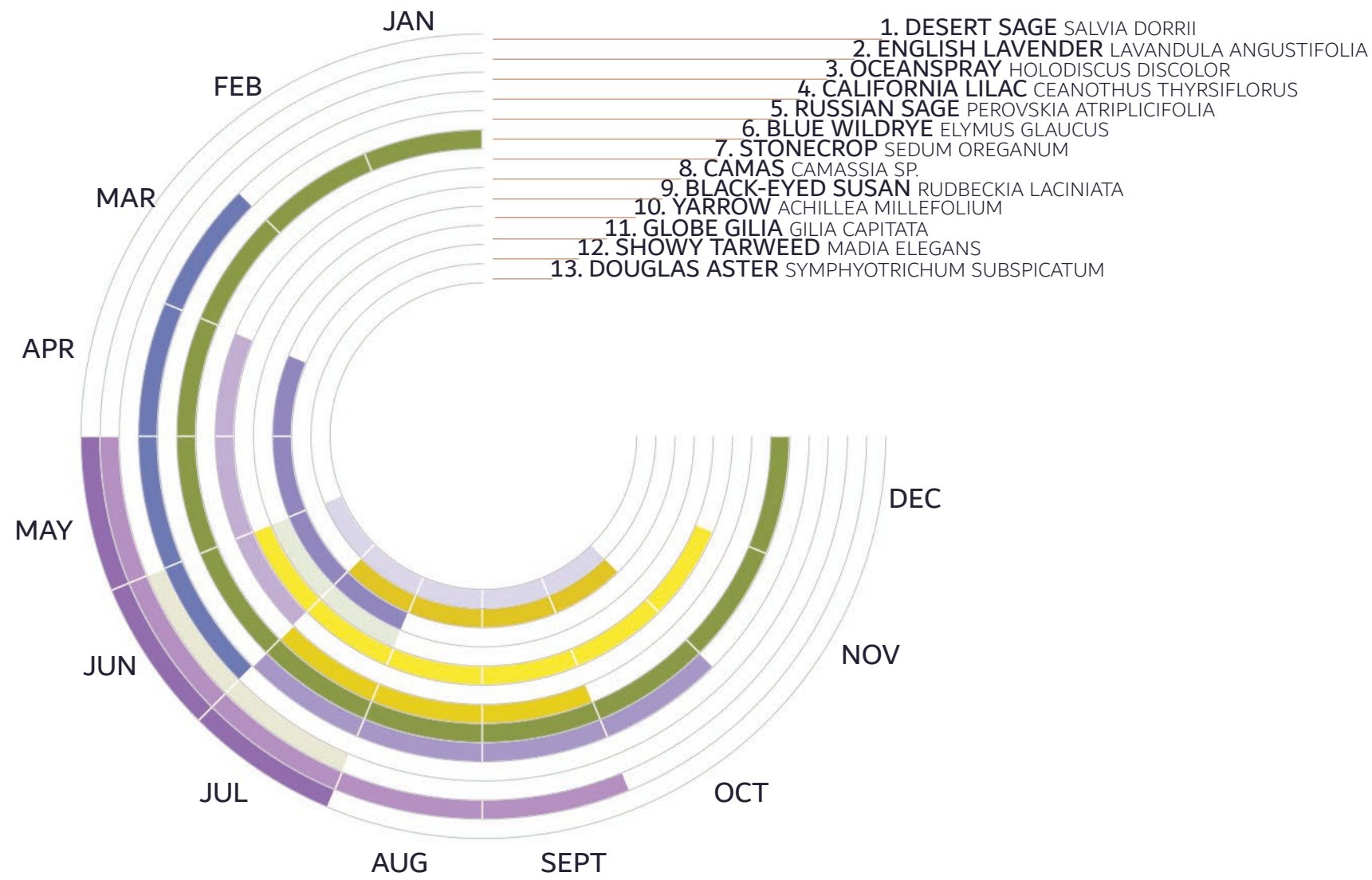
- PLANT CURATION
- SPECIES ATTRACTION
- ENVIRONMENTAL NEEDS

PLANT PALETTES



The Audubon guidelines, environmental analysis, and plant selection are all inputs that inform and provide information on ideal plant selections. While this project focuses on plants that could create pollinator habitat at Laurelwood Golf Course, these guidelines are transferable, which would allow others to create palettes for their respective locales. Sources such as Oregon State University Extension Service, Oregon State Beekeepers Association, the USDA provided information to curate a list of pollinator friendly plants before breaking them up into which plants attracted specific species, and then organizing them further into groups with similar environmental needs.

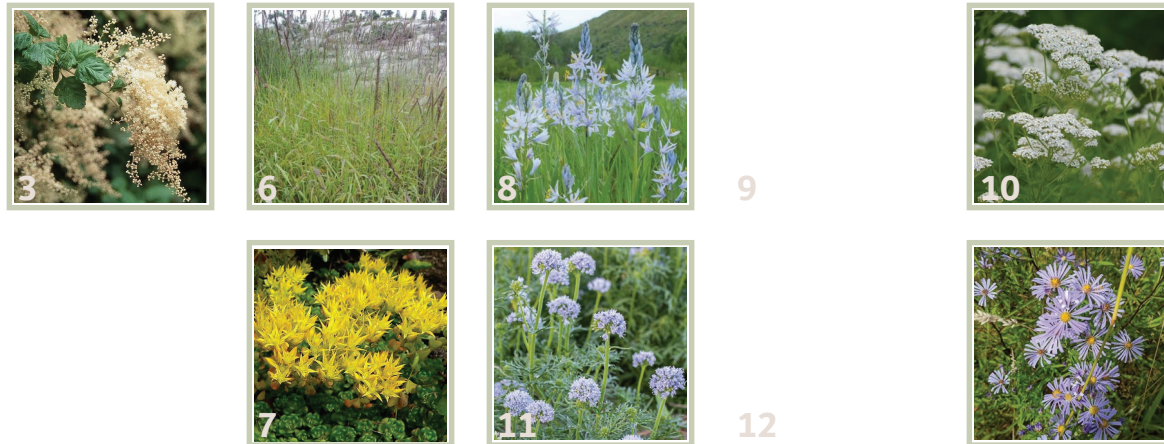
PLANT PALETTE: BEES - SUN & LOW WATER



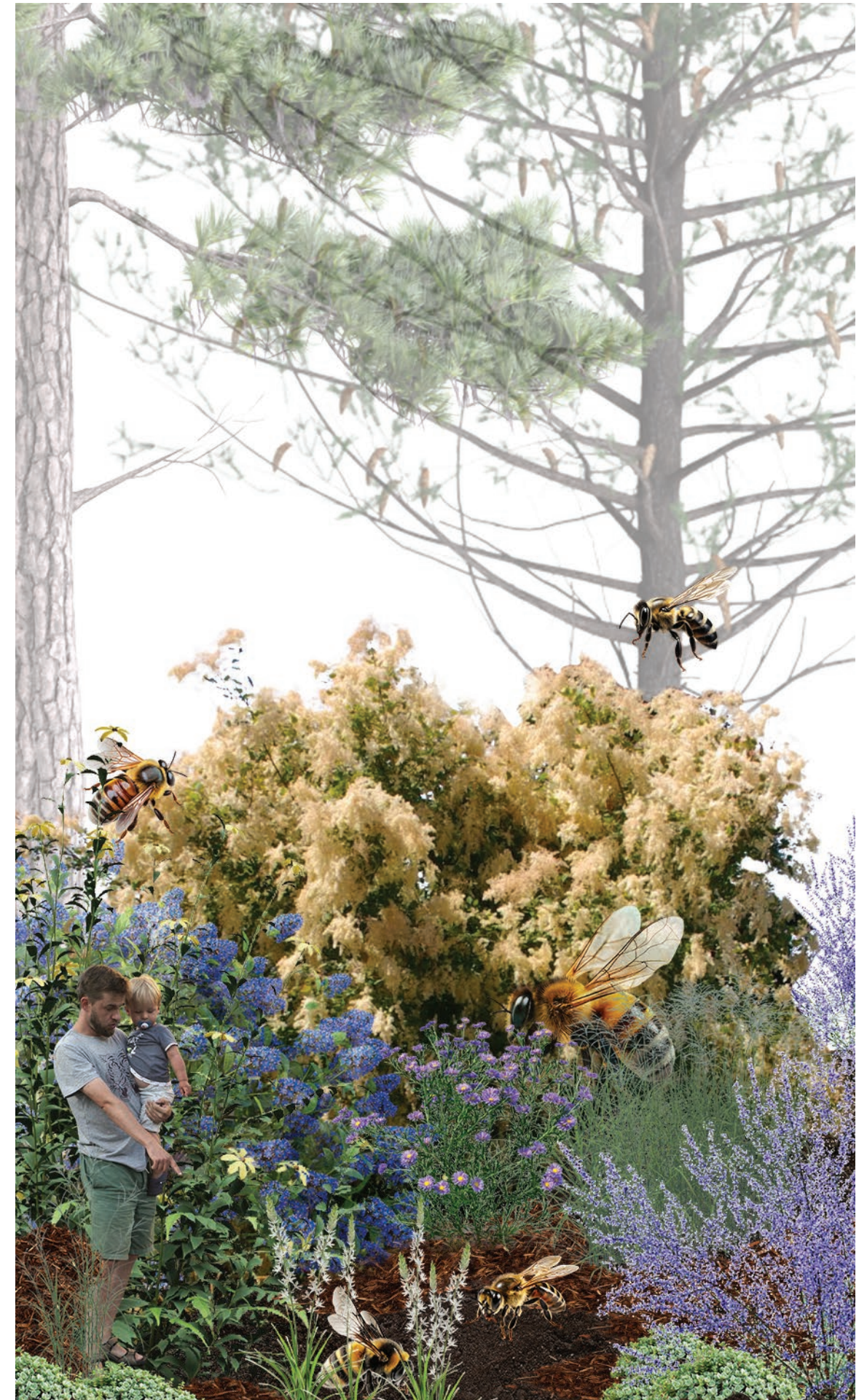
SHRUB



GROUNDCOVER PERENNIAL



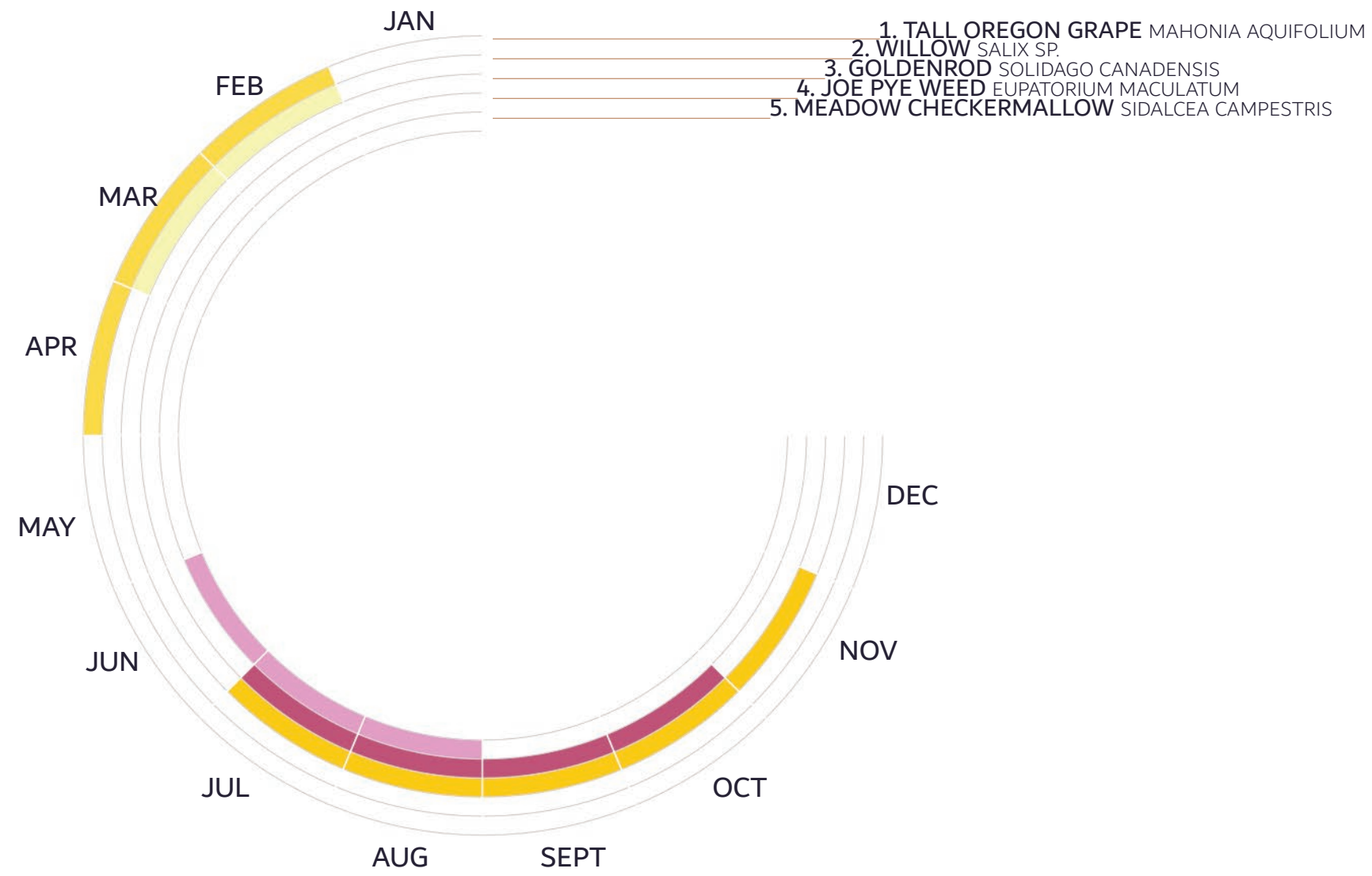
— = NATIVE



This plant palette was selected primarily for native bees. This palette, whose flowering seasonality can be ready counter clockwise from January to December, takes full sun to part shade and is the most drought tolerant of all plant palettes, requiring the least amount of water. Any combination of these plants should be planted in a location that receives at least four to six hours of sunlight a day on or near the top of a slope on site.

While these plants may attract additional pollinators, the palette is catered to bees through colors and shapes. Bees tend to be attracted to plants that produce white, yellow, purple and blue flat flowers. Limiting plant palettes to a set of colors increases visual interest for the human experience, as well.

PLANT PALETTE: BEES - SUN & AVERAGE WATER



SHRUB

PERENNIAL

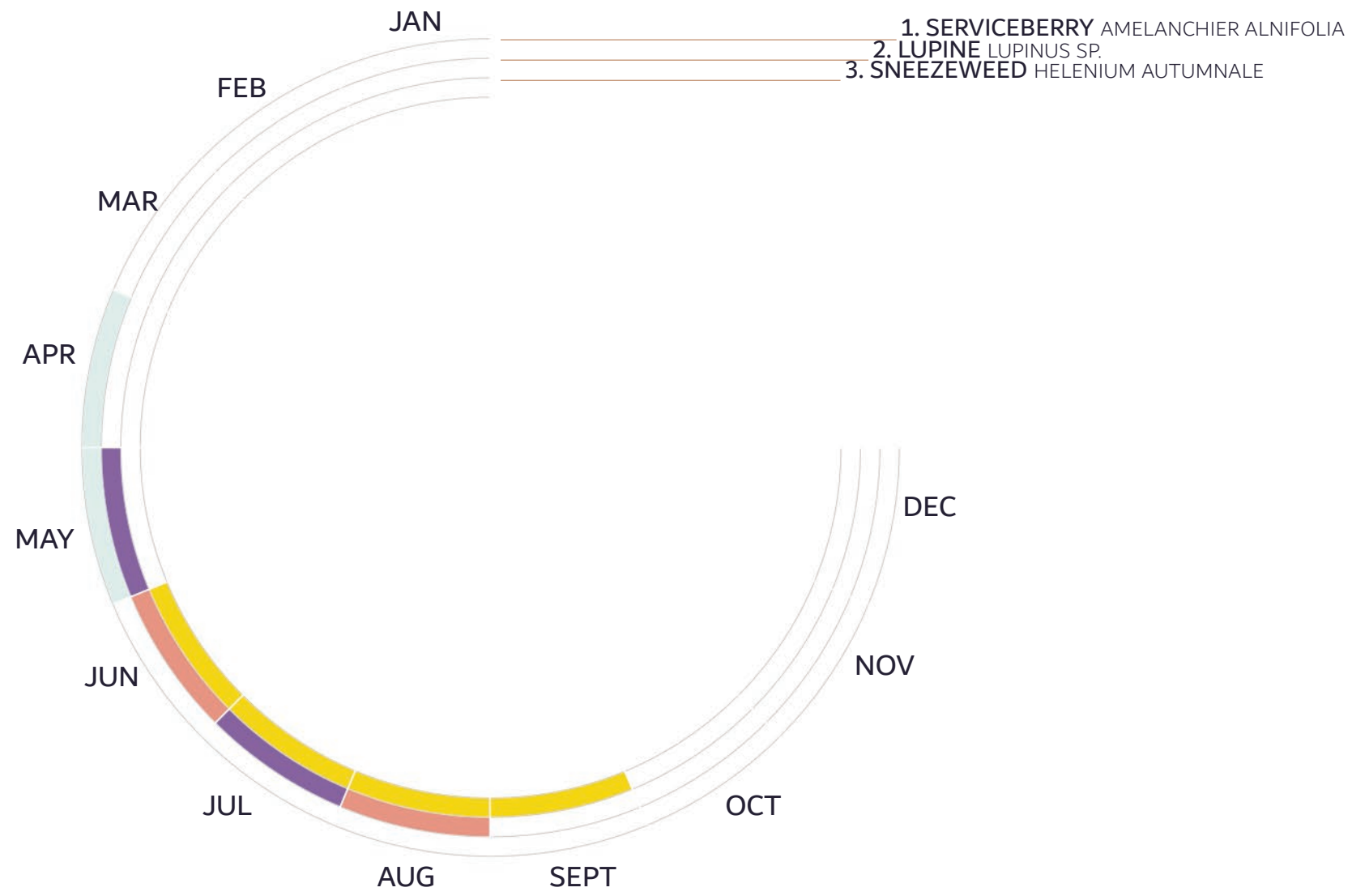


— = NATIVE



The second bee palette provides plants needing moderate amounts of water to survive. Bees go into hibernation in the winter, so prioritizing plants that flower from spring through fall is necessary to ensure they will have enough nectar to feed themselves and their offspring throughout their active seasons. The bees will hibernate near their food sources, so providing bare soil and leaving spent flower stalks throughout the winter will provide places for ground nesting and cavity nesting bees to take shelter in their dormant months. Spent flowers can provide another layer of visual interest for humans and have the added benefit of foraging opportunities for birds.

PLANT PALETTE: BEES - SUN & HIGH WATER



SHRUB



PERENNIAL

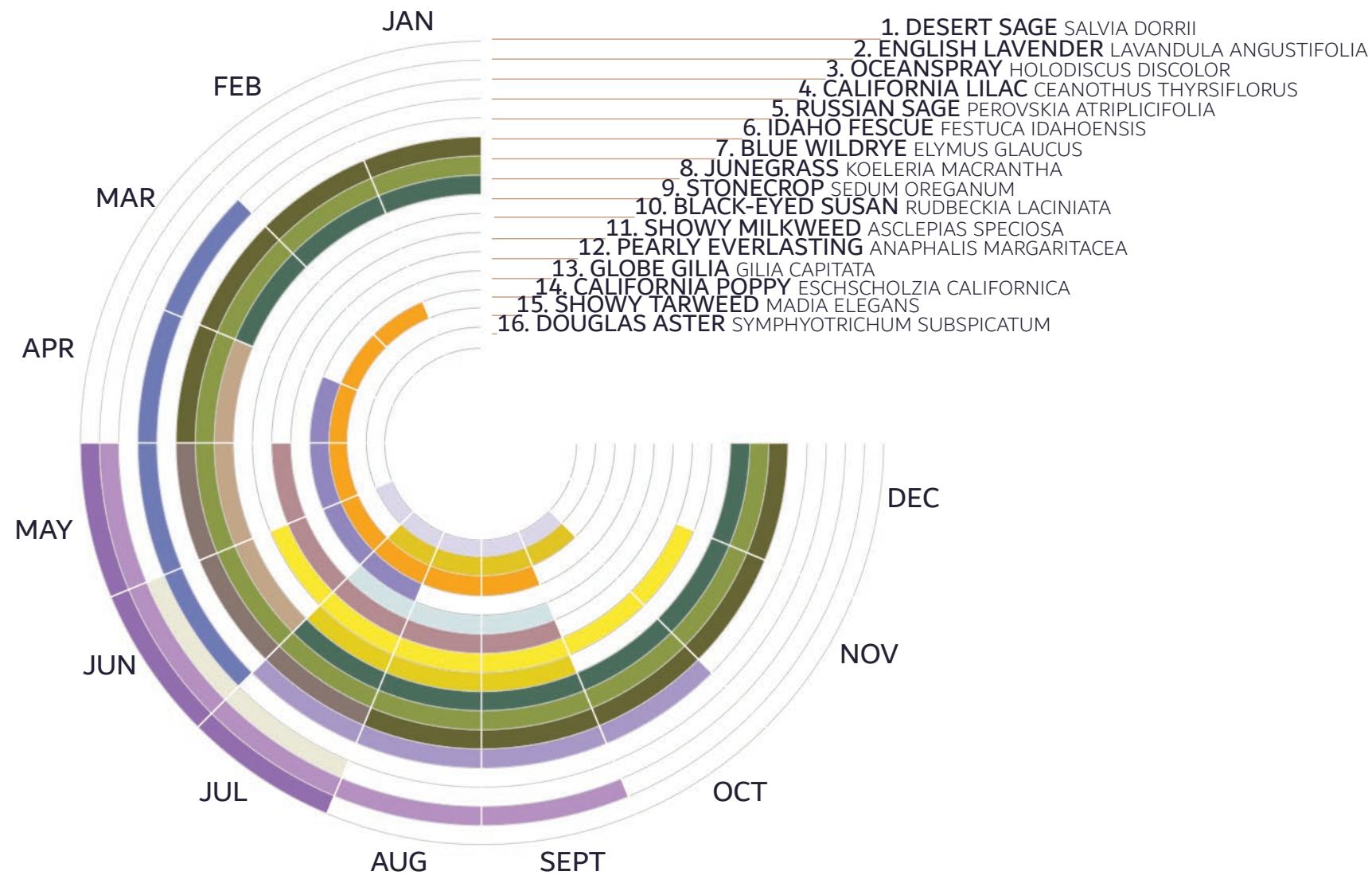


— = NATIVE



The final palette catered towards bees is for plants that have high water needs. These plants would succeed best in places that receive adequate sun where stormwater runoff collects. This palette is the most limited making it important to plant in mass to ensure bees can meet all of their needs from foraging capabilities to nesting and reproduction.

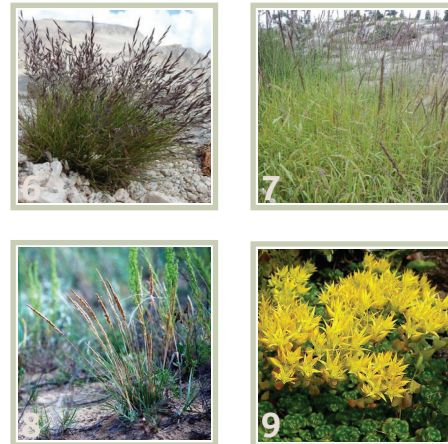
PLANT PALETTE: BUTTERFLIES - SUN & LOW WATER



SHRUB



GROUND COVER



PERENNIAL

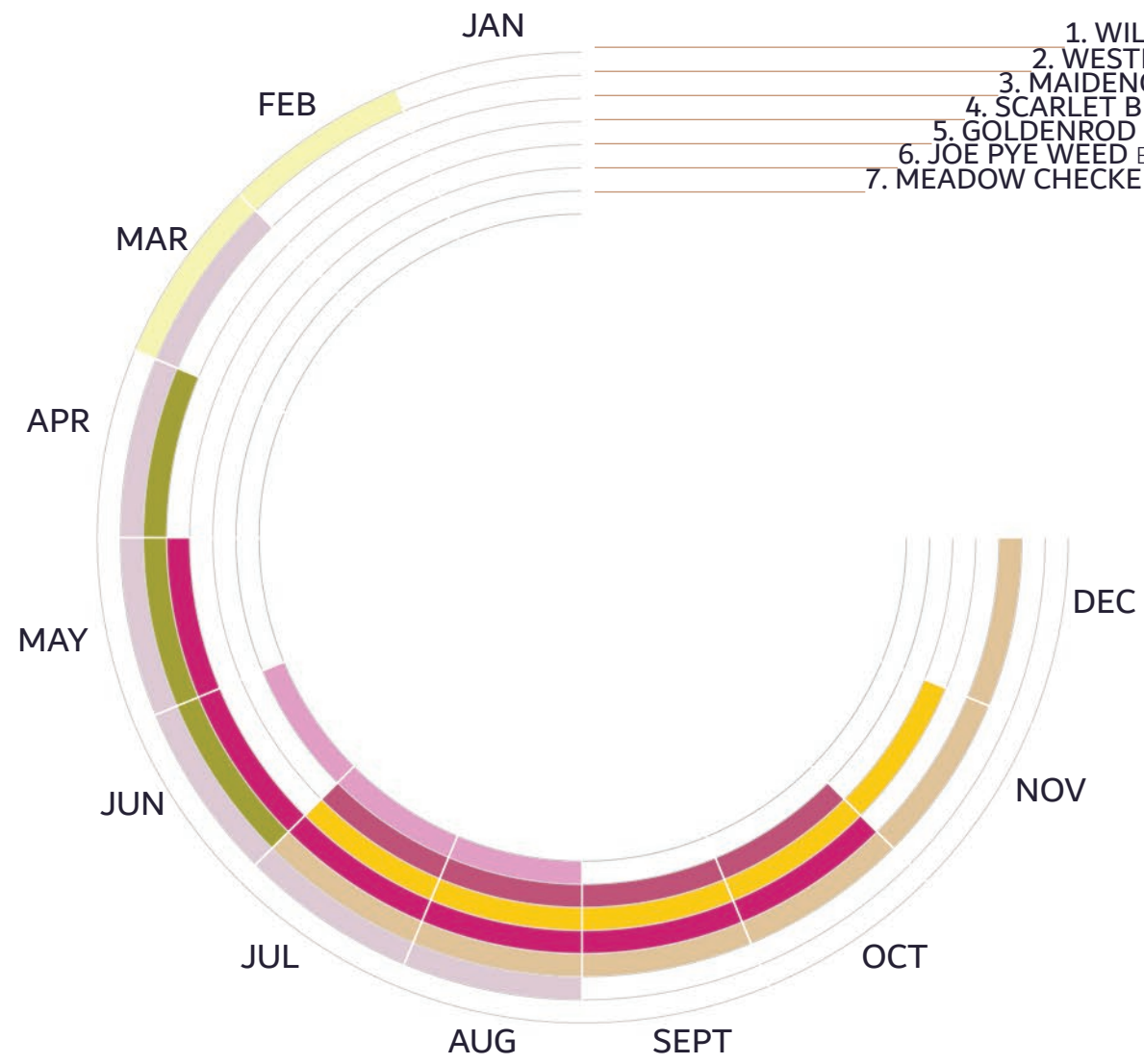


= NATIVE



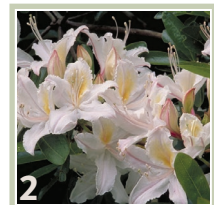
These next three palettes are catered towards butterflies, which are attracted to warmer tones - red, orange, yellow and purple flat flowers. When choosing plants for butterflies, in addition to nectar production, food sources for caterpillars, such as Showy Milkweed, must also be provided.

PLANT PALETTE: BUTTERFLIES - SUN & AVERAGE WATER



1. WILLOW *SALIX SP.*
2. WESTERN AZALEA *RHODODENDRON OCCIDENTALE*
3. MAIDENGRASS *MISCANTHUS SINENSIS*
4. SCARLET BEE BALM *MONARDA DIDYMA*
5. GOLDENROD *SOLIDAGO CANADENSIS*
6. JOE PYE WEED *EUPATORIUM MACULATUM*
7. MEADOW CHECKERMALLOW *SIDALCEA CAMPESTRIS*

SHRUB



GRASS



PERENNIAL

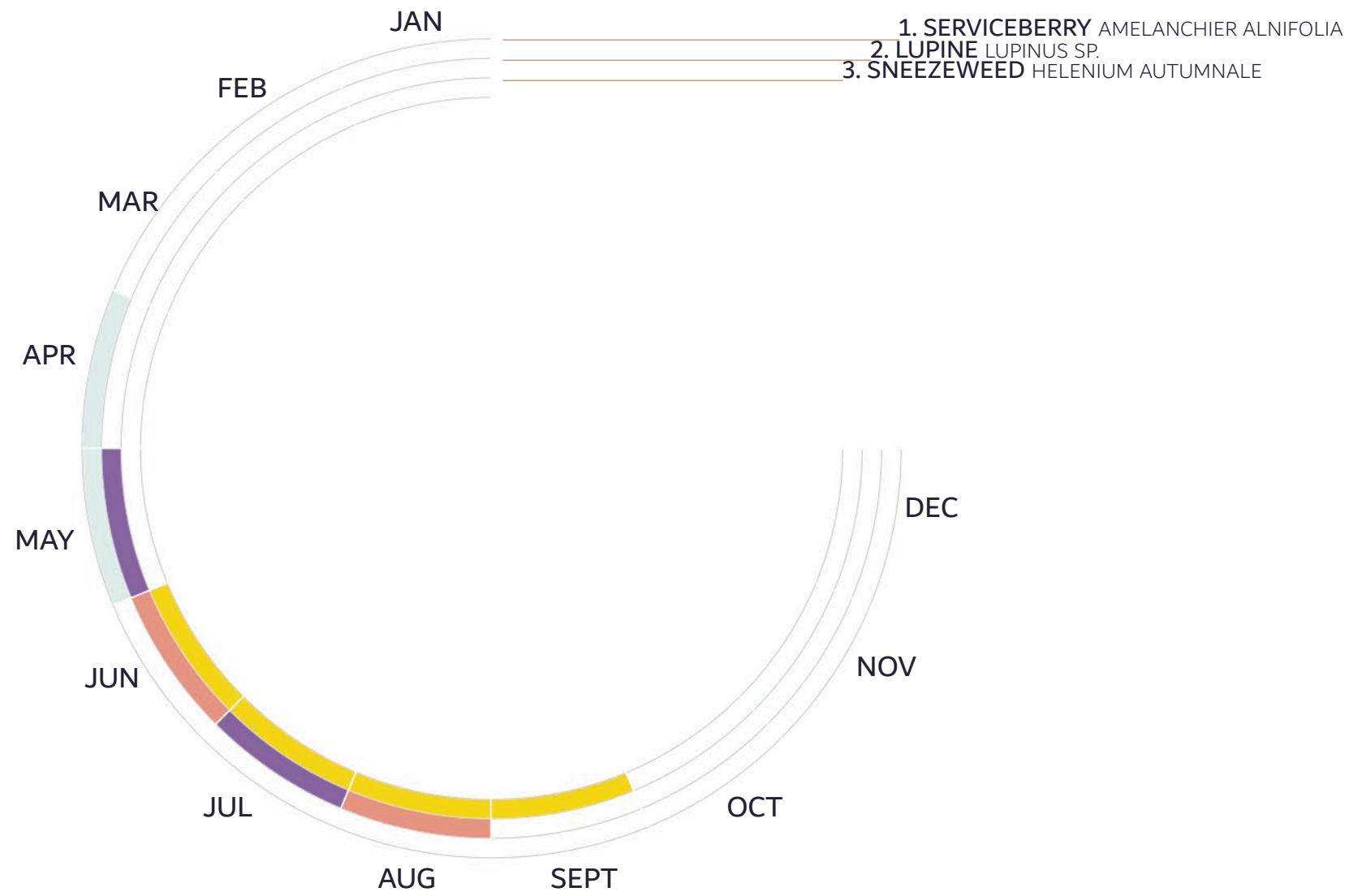


— = NATIVE



This butterfly palette requires adequate sun and moderate amounts of water. When establishing habitats for butterflies, logs and rocks should be placed into the landscape to provide resting opportunities for the busy critters. They will also seek shallow water sources, whether it be a flooded patch of land, a divet in a boulder that collects water, or a dedicated water feature.

PLANT PALETTE: BUTTERFLIES - SUN & HIGH WATER



SHRUB



1

PERENNIAL



2



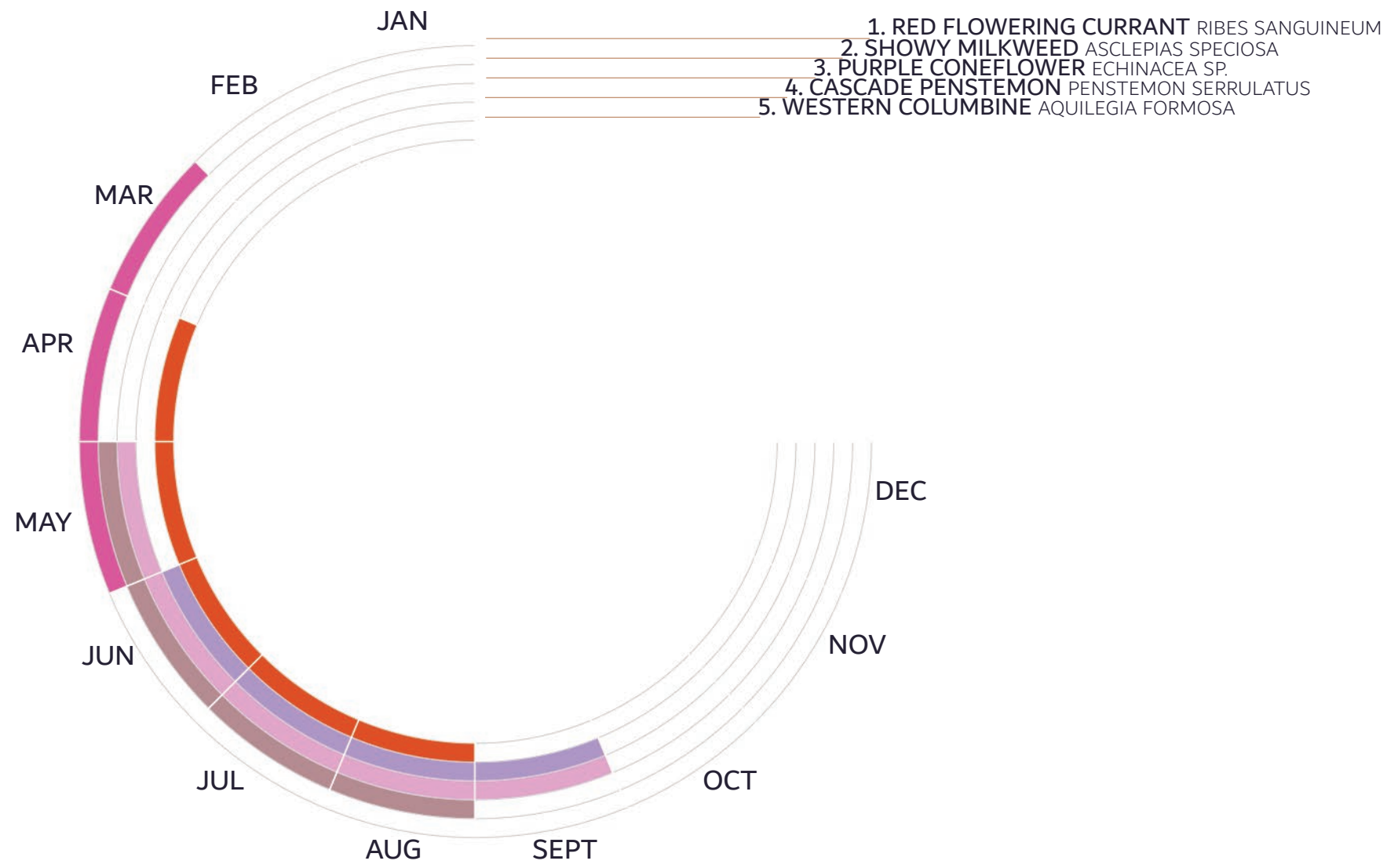
3

— = NATIVE



If this butterfly plant palette looks familiar to you, that is because it is the same palette provided for bees in sunny locations with high water requirements. This highlights how interwoven ecosystems are and the connection between flora and fauna. While palettes can be catered toward one species, many can benefit from the increased biodiversity. This palette would be ideal in an open sunny location at a lower elevation with amenities for both bees and butterflies, such as bare soil and logs and boulders.

PLANT PALETTE: HUMMINGBIRDS - SUN & LOW WATER

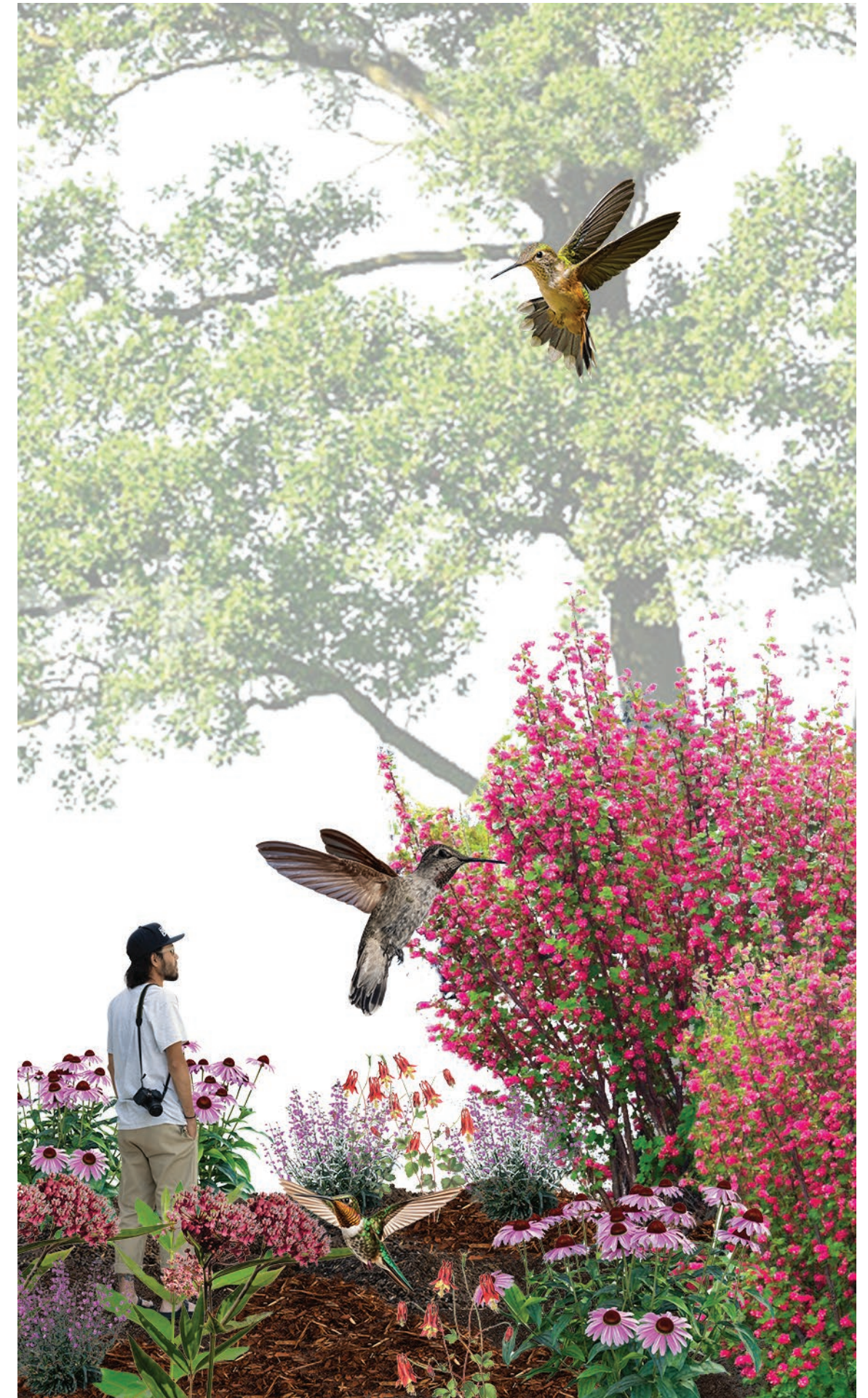


SHRUB

PERENNIAL



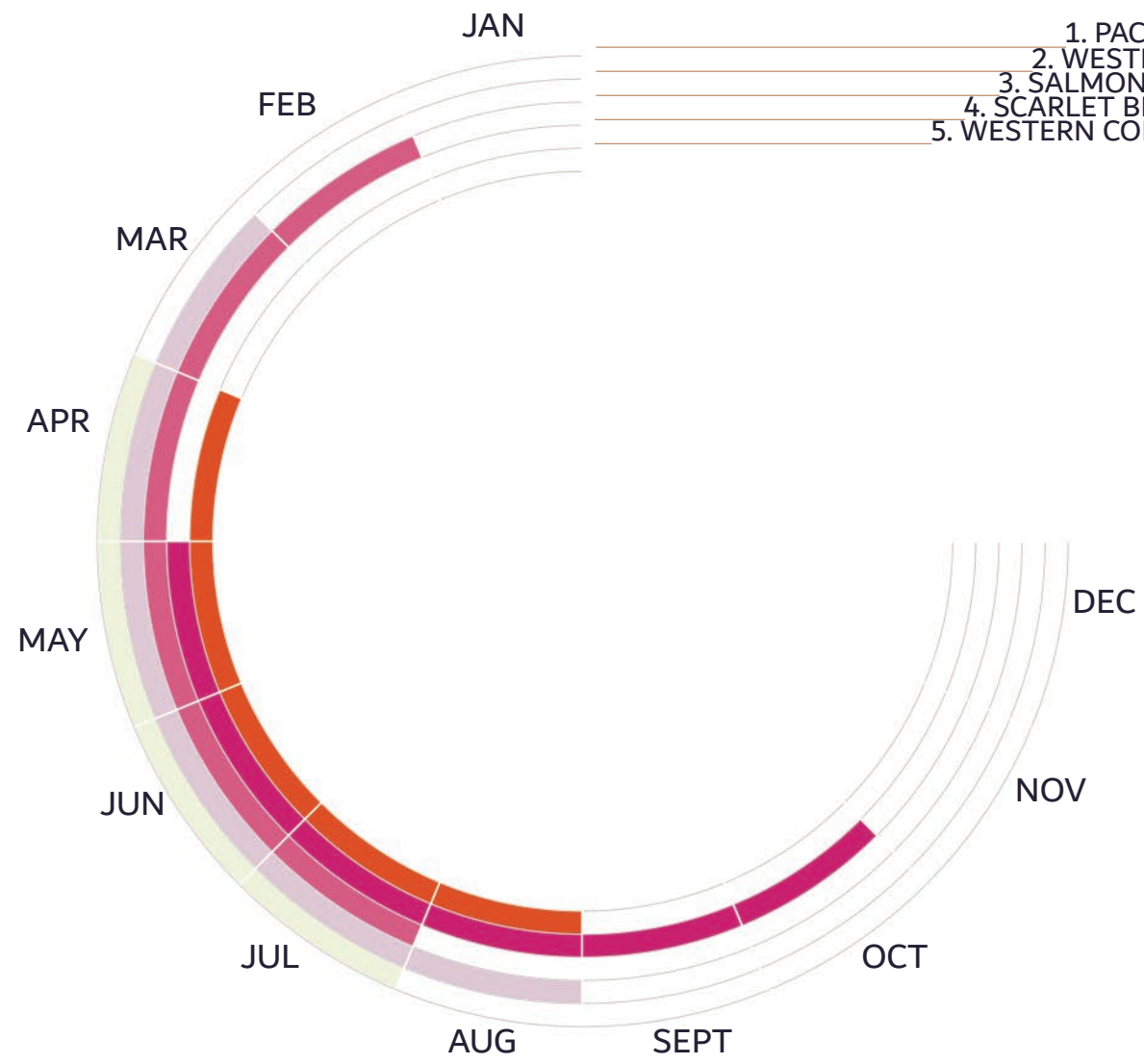
— = NATIVE



This last collection of palettes is focused on hummingbirds. Hummingbirds are not as concerned with fragrance, but rather they are stimulated by color and are attracted to red, pink and orange flowers, primarily tubular shaped. Most hummingbirds will migrate south for the winter, making spring and summer blooms the star of the show for these small birds.

This palette will succeed in sunny areas requiring little water. While planting these in mass, it is necessary to provide room for the hummingbirds to dive around the plants without hitting their wings as they maneuver through the landscape.

PLANT PALETTE: HUMMINGBIRDS - SUN & AVERAGE WATER



1. PACIFIC DOGWOOD *CORNUS NUTTALLII*
2. WESTERN AZALEA *RHODODENDRON OCCIDENTALE*
3. SALMONBERRY *RUBUS SPECTABILIS*
4. SCARLET BEE BALM *MONARDA DIDYMA*
5. WESTERN COLUMBINE *AQUILEGIA FORMOSA*

TREE



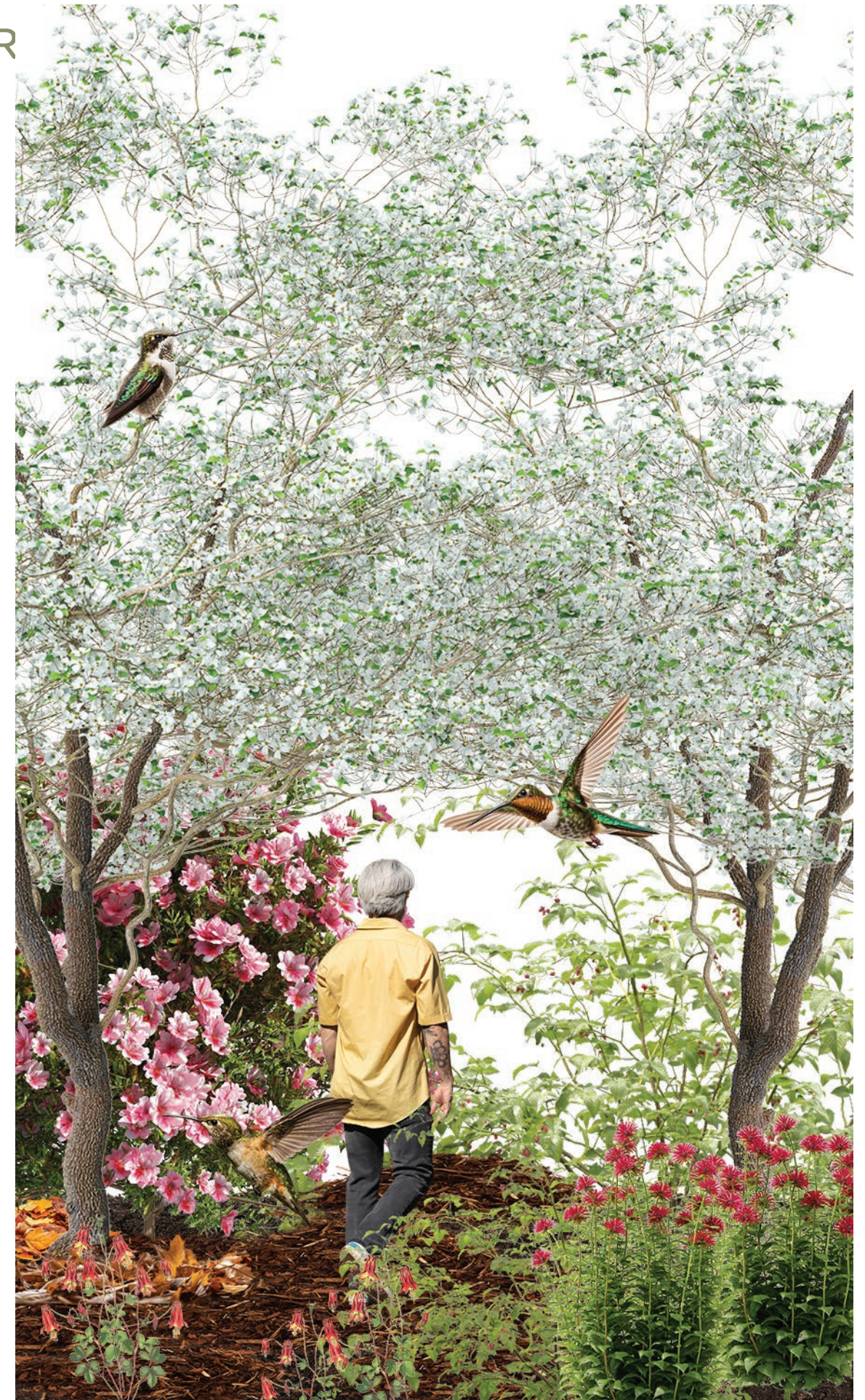
SHRUB



PERENNIAL

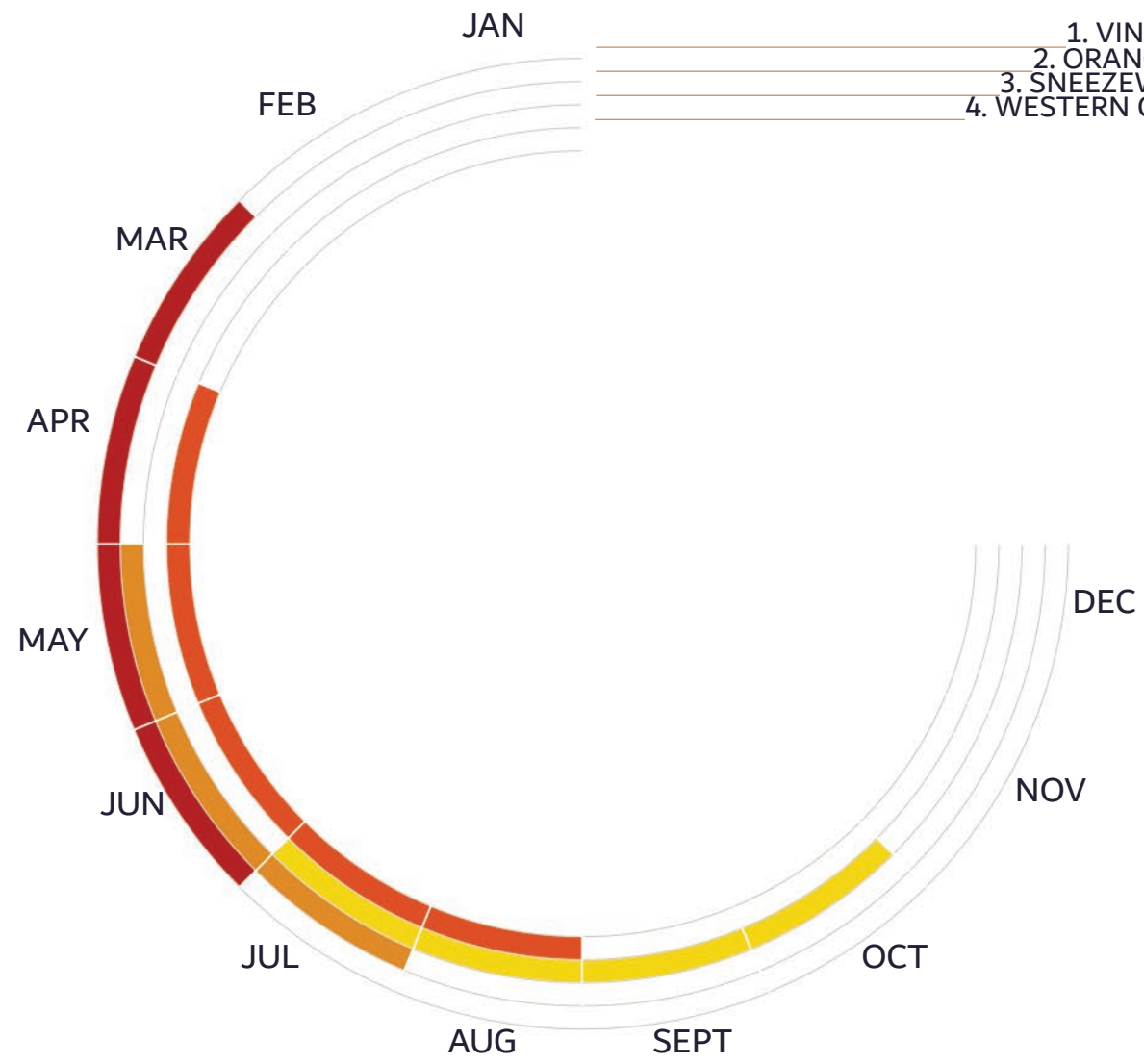


Light green line = NATIVE



This palette provides more diversity for hummingbirds to meet their survival needs. In addition to nectar from flowers, hummingbirds also feed on tree sap and the insects that accompany these trees. Trees will also provide pockets of space for hummingbirds to nest and perch on branches to rest and nurture their young.

PLANT PALETTE: HUMMINGBIRDS - SUN & HIGH WATER



SHRUB



1

VINE



2

PERENNIAL

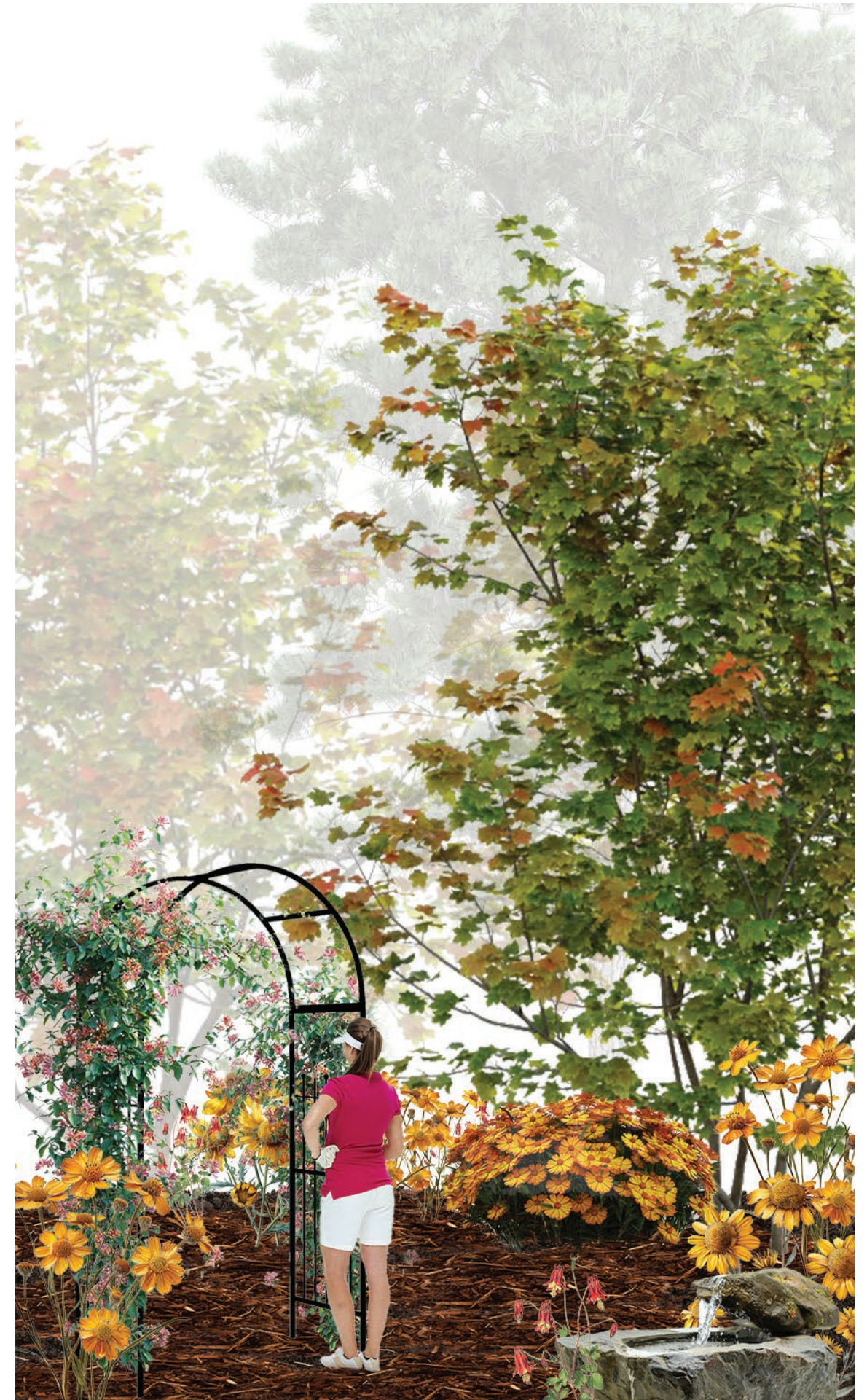


3



4

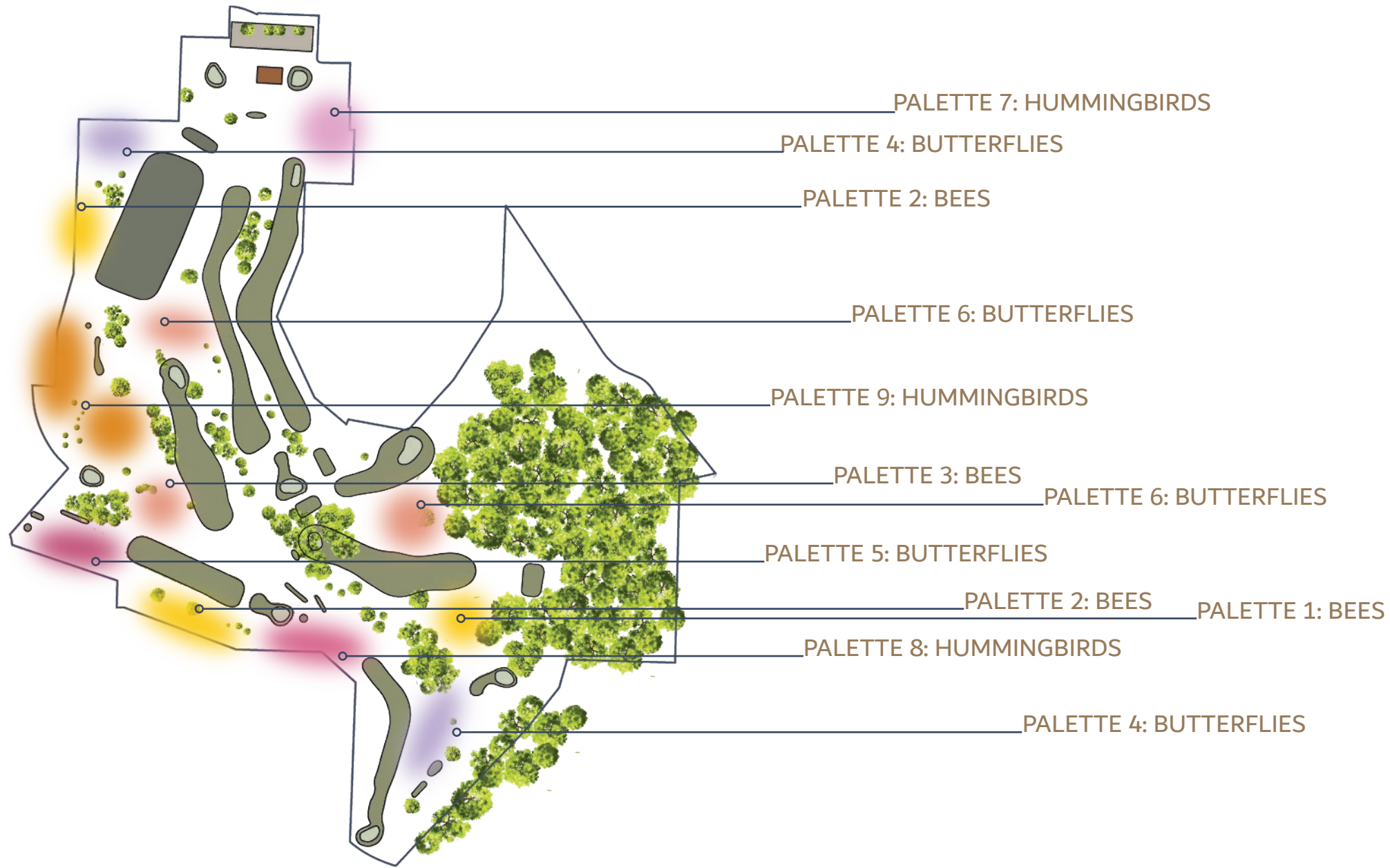
— = NATIVE



This last palette benefits hummingbirds through its flowers, branch perches, and sap production. Hummingbirds are also in need of a consistent water source, primarily for bathing. They meet most of their water needs through the consumption of nectar but enjoy a bath in shallow pools of water, no deeper than an inch and a half.

With all of these palettes, it is important to select a palette that is at least 80% native in keeping up with Audubon standards. This will also ensure that native pollinators are receiving the most nutritional value and are provided with adequate biodiversity that native ecosystems afford.

PLANTING LAYOUT



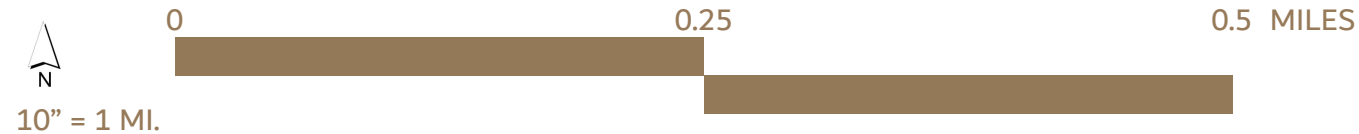
BEES: PALETTES 1, 2, 3



BUTTERFLIES: PALETTES 4, 5, 6



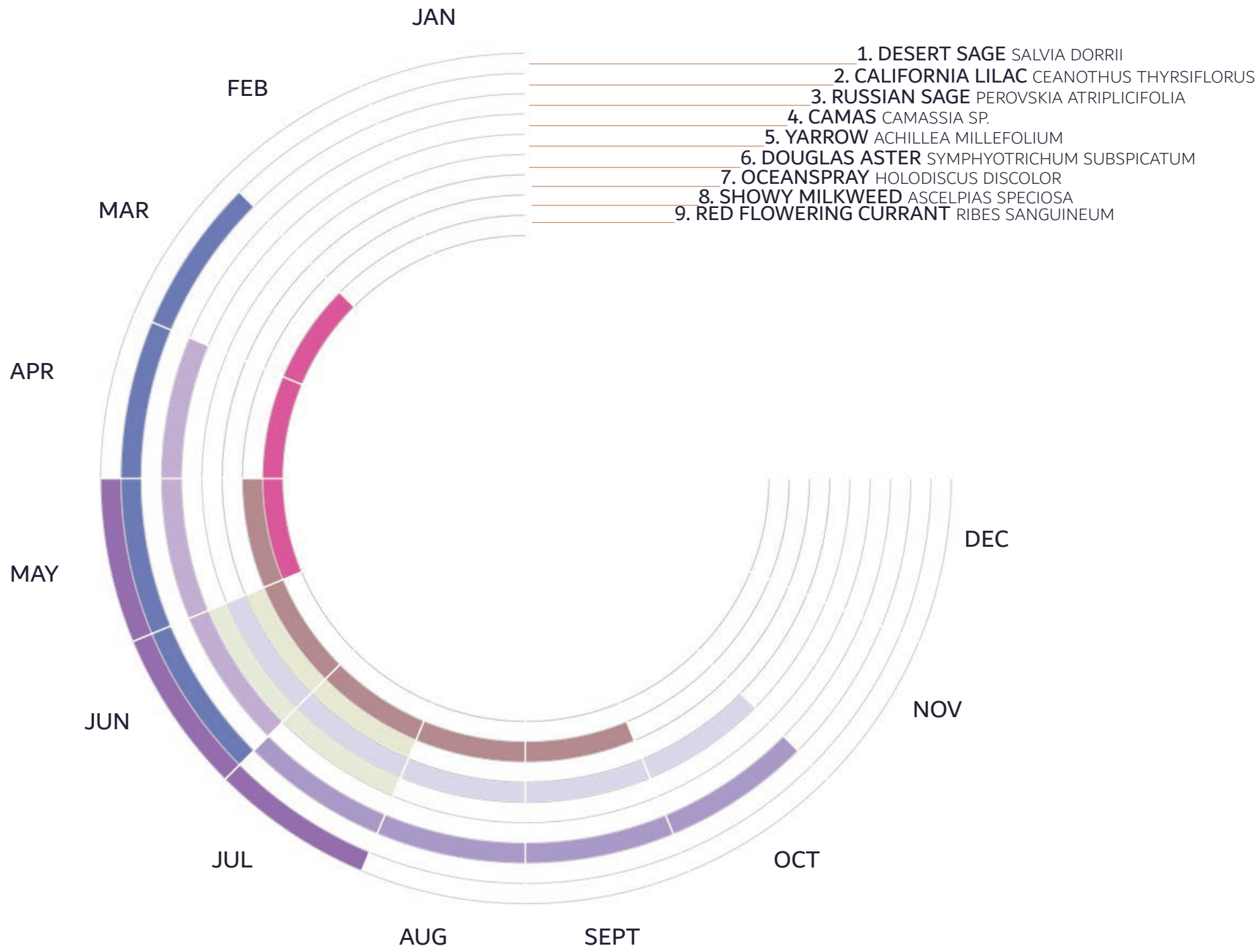
HUMMINGBIRDS: PALETTES 7, 8, 9



Returning to this map, Laurelwood ended up presenting itself as an adequate candidate for my focused palettes.

Most of the planting locations revealed themselves to have average to high amounts of sunlight, providing space for plants and ecosystems to succeed. As stated before, the plants on these palettes need a minimum of four to six hours of sunlight, which can be achieved on site, as Laurelwood is mostly open, with sporadic trees throughout the course. Due to this, palettes were located based on aesthetics, creating a gradient of color as visitors move through the site, learning about different species with each planted patch. One challenge to note that Laurelwood does face is its clay soils.

FLEXIBLE PALETTE CREATION




SHRUB



PERENNIAL



 = NATIVE

To compensate for these soils at Laurelwood, a palette of plants that will succeed in such soils was established as can be seen on this page. Point being, these palettes are flexible and can and should be adapted to each site that chooses to apply these design standards by considering local site conditions.

THE EXPERIENCE



Each of these palettes has had a render to exemplify and give palpability to this proposal, but here the reader can see what the experience might look like from the perspective of a golfer on site. As players move through the course, they will get to experience the beauty of the improved landscaping while pollinators have access to a more plentiful ecosystem in locations with the least amount of disturbance from the game, taking us back to the idea that golf courses and biodiversity can in fact cohabitate.

SIGNAGE

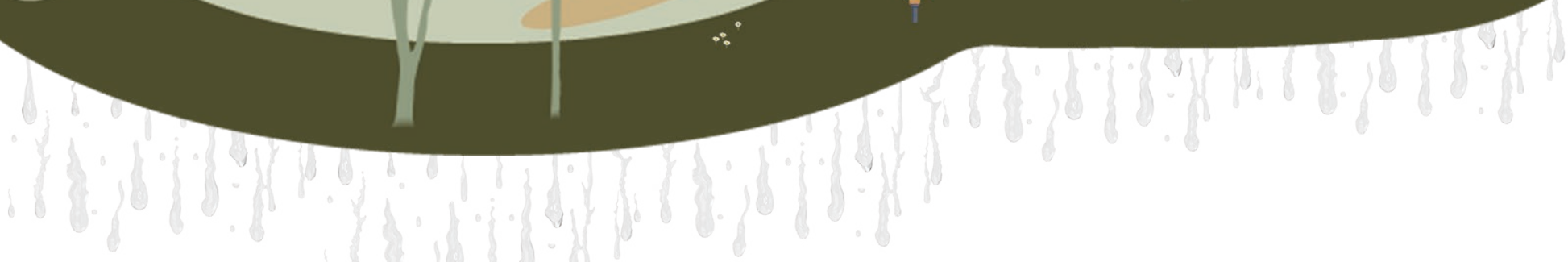


The signage will also provide an educational opportunity for visitors to learn about the new implementation of landscaping and how it is helping not only the local ecosystems, but humans as well. Educating them on reasons we must support pollinators, such as their responsibility for 85% percent of our food crop yields, 65% of the world's wild plants, and more.

CHAPTER 6

MOVING FORWARD, WRAPPING UP, AND KEY TAKEAWAYS

OBSTACLES



To start, if this project were to move forward, the first obstacle to overcome would be finding stakeholders to provide funding, as Laurelwood is a mom and pop course and would require funding from outside sources.

Secondly, finding maintenance staff to care for the new landscape would be a high priority, as this falls into the “Follow Up” section of the Audubon informed guidelines.

APPLICABLE AUDUBON STANDARDS

BREAKDOWN

SITE ANALYSIS

- 1 DEVELOP MAP HIGHLIGHTING RELEVANT ZONES
- 2 IDENTIFY CORE HABITATS
- 2 IDENTIFY DOMINANT NATIVE PLANT COMMUNITIES
- 3 INVENTORY SOIL TYPES

DESIGN

- 2 MAINTAIN HABITAT IN AT LEAST 50% OF MINIMALLY USED LANDSCAPE
- 2 CREATE NAVIGABLE ACCESS FOR WILDLIFE
- 2 PLANT LAYERS AND TEXTURES
- 2 MAINTAIN WATER SOURCE
- 2 FLOWERS THAT PROVIDE NECTAR
- 2 USE BUFFERS/SIGNS/FENCING FOR PROTECTION
- 2 KEEP LANDSCAPE AT LEAST 80% NATIVE
- 2 STEER HUMAN MOVEMENT AWAY FROM PLANTING ZONES
- 3 IMPROVE SOIL HEALTH
- 3 USE OF PEST-RESISTANT/STRESS-TOLERANT CULTIVARS
- 6 COMMUNICATE GOALS/OBJECTIVES

FOLLOW UP

- 1 EVALUATE GOALS/OBJECTIVES ONCE PER YEAR
- 1 TRAIN EMPLOYEES
- 1 TRACK PROGRESS
- 3 BEST MANAGEMENT PRACTICES (BMP) + INTEGRATIVE PEST MANAGEMENT (IPM)
- 3 EDUCATE STAFF
- 3 BASE FERTILIZER ON SOIL TEST
- 3 MAINTAIN RECORDS
- 4 INSTALL MOST EFFICIENT IRRIGATION
- 4 ELIMINATE NON-TARGET WATERING
- 4 AVOID WATERING AT PEAK EVAPOTRANSPIRATION TIMES
- 5 USE SLOW-RELEASE FERTILIZERS
- 6 PROVIDE UPDATES
- 6 INVITE EMPLOYEES/PATRONS/COMMUNITY TO HELP

1 ENVIRONMENTAL PLANNING

2 WILDLIFE HABITAT AND MANAGEMENT

3 CHEMICAL USE REDUCTION AND SAFETY

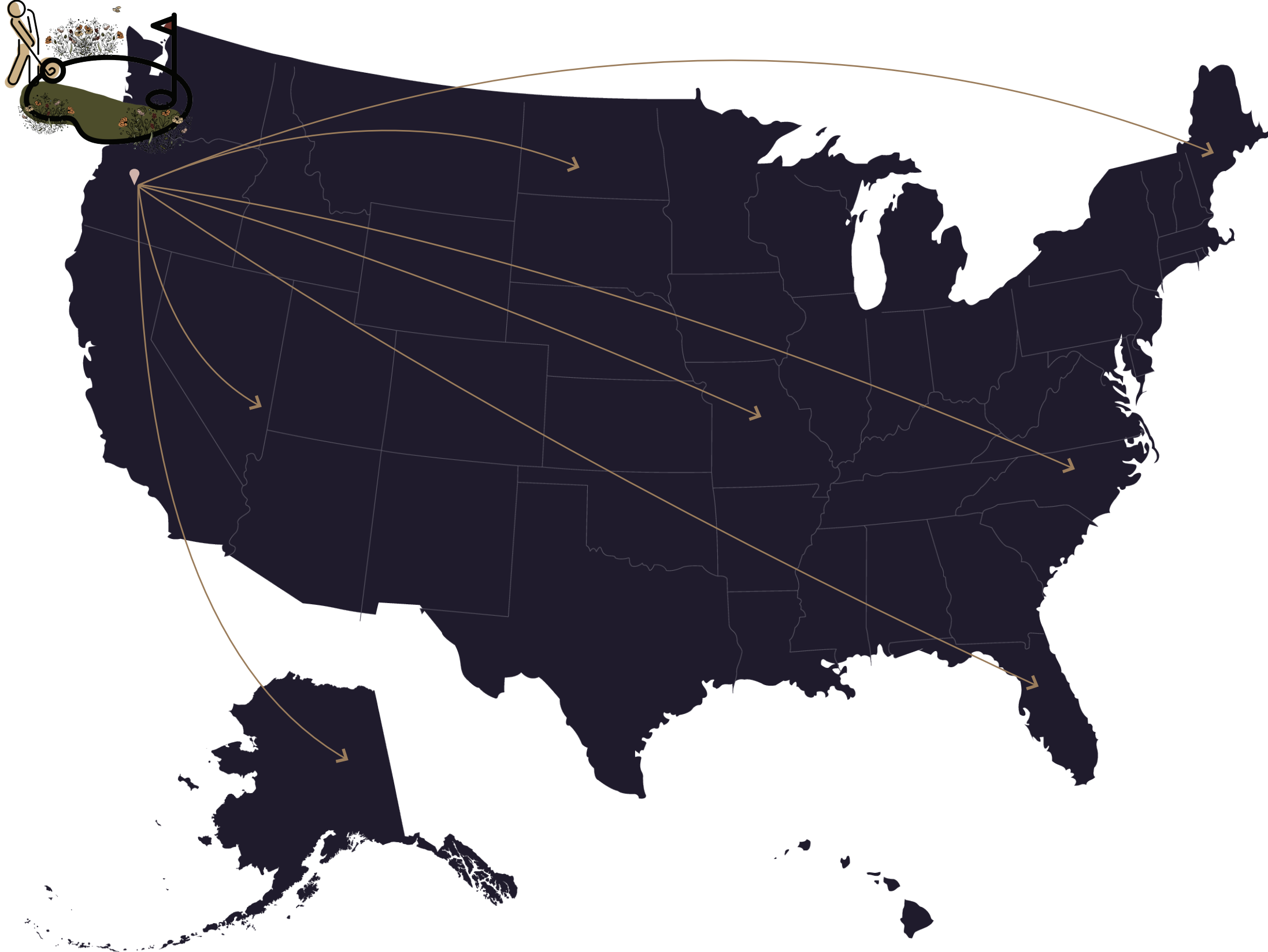
4 WATER CONSERVATION

5 WATER QUALITY MANAGEMENT

6 OUTREACH AND EDUCATION

Without proper maintenance, the landscape is bound to either fail or grow out of control. Currently, Laurelwood employs many high school or post high school students to tend to the grounds in addition to the superintendent. There would need to be training on proper care for each plant palette to increase chances of success. The “Follow Up” section provides a framework to create a plan for success, including evaluating progress, educating staff, improving irrigation, and more.

ADAPTABLE FRAMEWORK



While this project was grounded in a local site, the framework is adaptable and can be tailored to different golf courses. The plant palettes themselves are only transferable within the Willamette Valley, but it is the combination of the guidelines, analysis of local environmental conditions, and the plant selection criteria that will allow others to apply these principles to their native regions.

KEY TAKEAWAYS



As mentioned before, Vineyard Golf Course is the sole 100% organic golf course in the United States. While there are others, including Laurelwood Golf Course, working to implement organic practices, this fact speaks volumes of the amount of progress the golfing industry can make in sustainability. By taking advantage of these large, open landscapes that provide minimal ecological value and using them to provide for native pollinators, there is great potential to increase biodiversity and help pollinators while providing more beauty to the game of golf.

Our world's pollinators are losing access to resources and biodiversity to support the survival of their species. There are many ways to help our small friends. This proposal takes advantage of the large open spaces that golf courses provide and transforms them into pockets of sanctity that are full of abundance for foraging, nesting, overwintering, and reproduction.

The hope of this proposal is not only to leave the reader with an interest in improving golf course landscapes for the sake of biodiversity and the generational success of pollinators, but with a consideration for other species as Landscape Architects collaborate with other professionals to design for humans across landscapes, as well.

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PROJECT ADVISORS

YEKANG KO, ASSOCIATE PROFESSOR

KORY RUSSEL, ASSISTANT PROFESSOR

ELLE STAPLETON, VISITING ASSISTANT PROFESSOR

COHORT

JAKE BROTSIS

PHOEBE CHUANG

CAMERON CORONADO

TRESSA CUMMINGS

GIFFIN GLASTONBURY

KATHERINE HARRISON

CAITLIN JEFFS

BASIL KHALID

TRISTAN MATLOCK

MIKAYLA MCKONE

TED MYER

HOLLY PHARES

SARAH PHILLIPS

KATIE SINCLAIR

MOM, DAD, KENT, JENNA

LIAM

WILL BENSON, LAURELWOOD GOLF COURSE SUPERINTENDENT

AUGUST JACKSON, INTERPRETATION COORDINATOR, MOUNT PISGAH ARBORETUM

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