Beyond Pollinator-Friendly

DESIGNING LANDSCAPES + CORRIDORS TO SUPPORT REGIONAL BIODIVERSITY

EVAN ABRAMSON, M.Sc.
Principal
LANDSCAPE | NTERACTIONS

"THE ESSENTIAL, INTERCONNECTED WEB OF LIFE ON EARTH IS GETTING SMALLER AND INCREASINGLY FRAYED. THIS LOSS IS A DIRECT RESULT OF HUMAN ACTIVITY."

Professor Josef Settele, Co-Chair, 2019 IPBES Global Assessment on Biodiversity and Ecosystem Services

Top: photograph by Lou Gold; bottom: photograph by Chris Jordan from the Midway series. Opposite: photographer unknown.

Playing with Fire

Humanity's impact on the Earth is now so profound that a new geological epoch has been declared.

The Age of the Anthropocene is defined by a striking acceleration of carbon dioxide emissions and sea level rise, the global mass extinction of species, and the transformation of land by deforestation and development.

As many as **30 to 50% of all species on the planet are heading toward extinction** by mid-century.

Ibid. and Thomas, et al. 2004. Extinction risk from climate change. Nature 427: 145–148. World is 'on notice' as major UN report shows one million species face extinction. UN News. (2019, May 6). Hance, J. "The Great Insect Dying." Mongabay Environmental News. (2019, July 18).

Collapse of Nature

One million species are threatened with extinction globally, including **more than half of the native bee species** in North America.

Insects essential for all ecosystems, as pollinators, food for other creatures and recyclers of nutrients.

Insects could vanish within a century at current rate of decline.

Habitat loss cited as the most pressing problem.

New classes of insecticides introduced in the last 20 years have also been especially damaging, particularly **neonicotinoids**.

"We are sleepwalking towards the edge of a cliff."

"Industrial-scale agriculture is killing the ecosystems...[we] need to restore the landscape by planting trees and hedges around fields, and flowers between crops."

Photo illustration by Matt Dorfman. Source photographs: Bridgeman Images.

Marshman J. & Knezevic I., (2021) "What's in a name? Challenging the commodification of pollination through the diverse economies of 'Bee Cities'", Journal of Political Ecology 28(1). p.124-145.

Carrington, D. 'Insect apocalypse' poses risk to all life on Earth, conservationists warn. Guardian News and Media. (2019, November 13).

Carrington, D. Humanity has wiped out 60% of animal populations since 1970, report finds. Guardian News and Media. (2018, October 29).

Sánchez-Bayo, F., Wyckhuys, K.A.G., Worldwide decline of the entomofauna: A review of its drivers, Biological Conservation. 232, 2019, 8–27.

Carrington, D. Plummeting Insect Numbers 'Threaten Collapse of Nature.' Guardian News and Media (2019, February 10).

J.-M. Bonmatin et al., Environmental fate and exposure; neonicotinoids and fipronil. Environ. Sci. Pollut. Res. Int. 22,35–67 (2015).

Crisis in North America

North America has lost 3 billion birds since 1970.

Over 1 in 4 birds in the past 50 years.

Habitat loss is the most direct cause.

Rosenberg, Kenneth V., et al. "Decline of the North American Avifauna." *Science, American Association for the Advancement of Science, 19 Sept. 2019.*

Artwork Chris Maynard

Five Biggest Threats to Biodiversity

According to the UN's Convention on Biological Diversity there are five main threats to global biodiversity:

1. Changes in Land and Sea Use

2. Exploitation of Natural Resources

3. Climate Change

4. Pollution

5. Invasive Species

IPBES (2019): Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 pages.

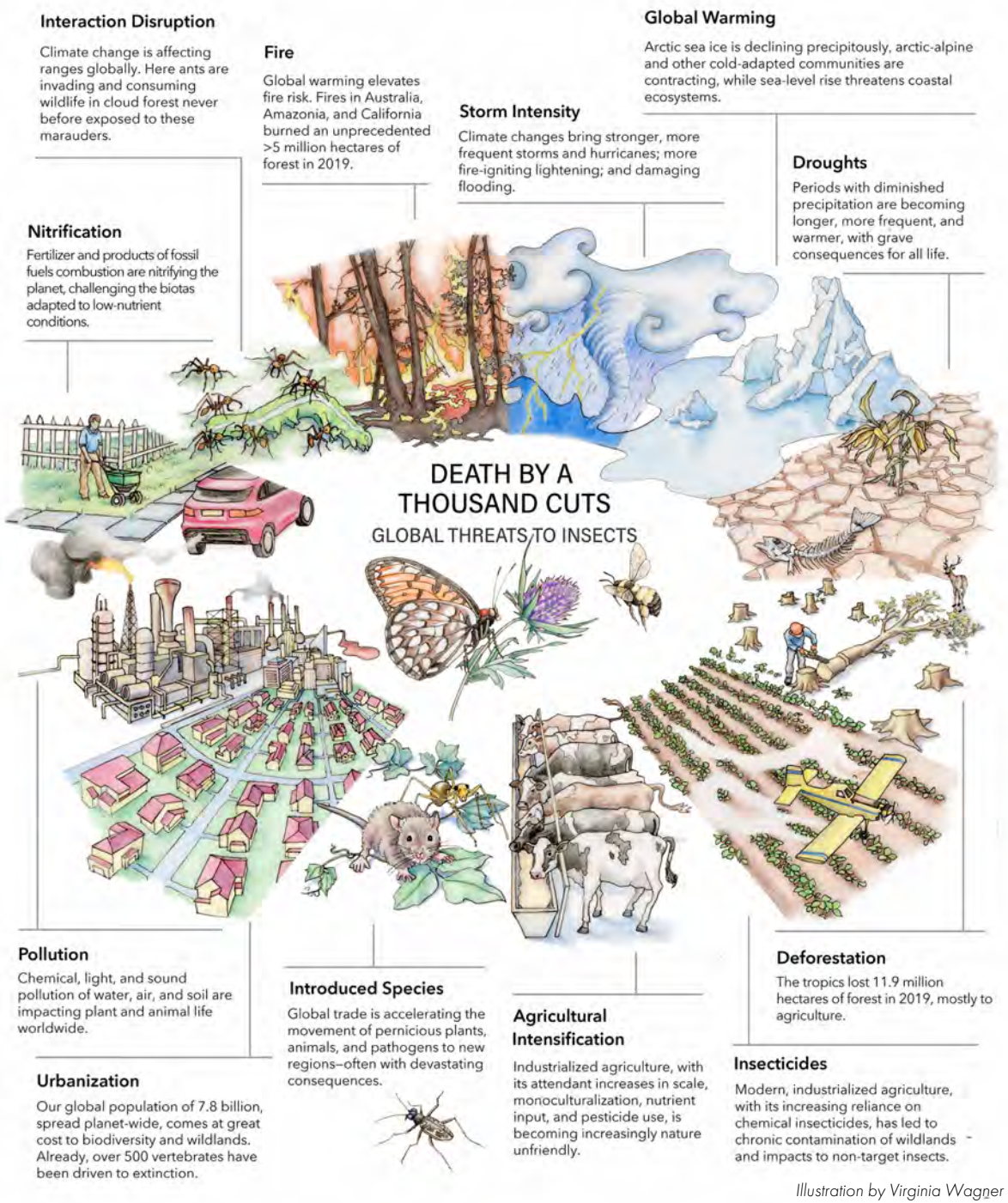


Illustration by Virginia Wagner

Climate + Biodiversity: Solve Both or Solve Neither

It's not just about climate change impacting biodiversity: it's about the loss of biodiversity deepening the climate crisis.

Connected, diverse and extensive ecosystems can help stabilize the climate and will have a better chance of thriving in a world permanently altered by rising emissions.

"Rather than being framed as a victim of climate change, biodiversity can be seen as a key ally in dealing with climate change."

Pettorelli, N., Graham, N. A. J., Seddon, N., Maria da Cunha Bustamante, M., Lowton, M. J., Sutherland, W. J., Koldewey, H. J., Prentice, H. C., & Barlow, J. (2021). Time to integrate global climate change and biodiversity science-policy agendas. Journal of Applied Ecology, 00, 1– 10.

Malhi, Y., Franklin, J., Seddon, N., Solan, M., Turner, M. G., Field, C. B., & Knowlton, N. (2020). Climate change and ecosystems: Threats, opportunities and solutions. Philosophical Transactions of the Royal Society B: Biological Sciences, 375(1794), 20190104.

Illustration by Charlotte Ager/The Guardian

Prairies, Pastures or Crops?

Grasslands hold 20% of global carbon stocks and a third of the world's land-based carbon.

U.S. agriculture accounts for more than 10% of the country's total emissions.

A 2019 study estimated that tillage for cropland expansion put as much carbon dioxide into the air annually as 31 million cars.

A 2018 study found that conserving grasslands in the U.S. could prevent almost **three times as much carbon emission as conserving forests.**

Half of all temperate grasslands worldwide have been lost, compared to less than 20% of the Amazon.

Grassland protection. Project Drawdown. (2020, February 12). Web.
Popkin, G. "How can the most endangered ecosystem in the world be saved?" Environment. National Geographic Online. September 17, 2021.

Photo: Michael Forsberg

Carbon Storage in Earth's Ecosystems

Achieving net-zero by 2050 depends on the Earth's natural carbon sinks.

Forests play a critical role in regulating the global climate. They absorb carbon from the atmosphere and then store it, acting as natural carbon sinks.

Where is Carbon Stored?

There are various carbon pools in a forest ecosystem.

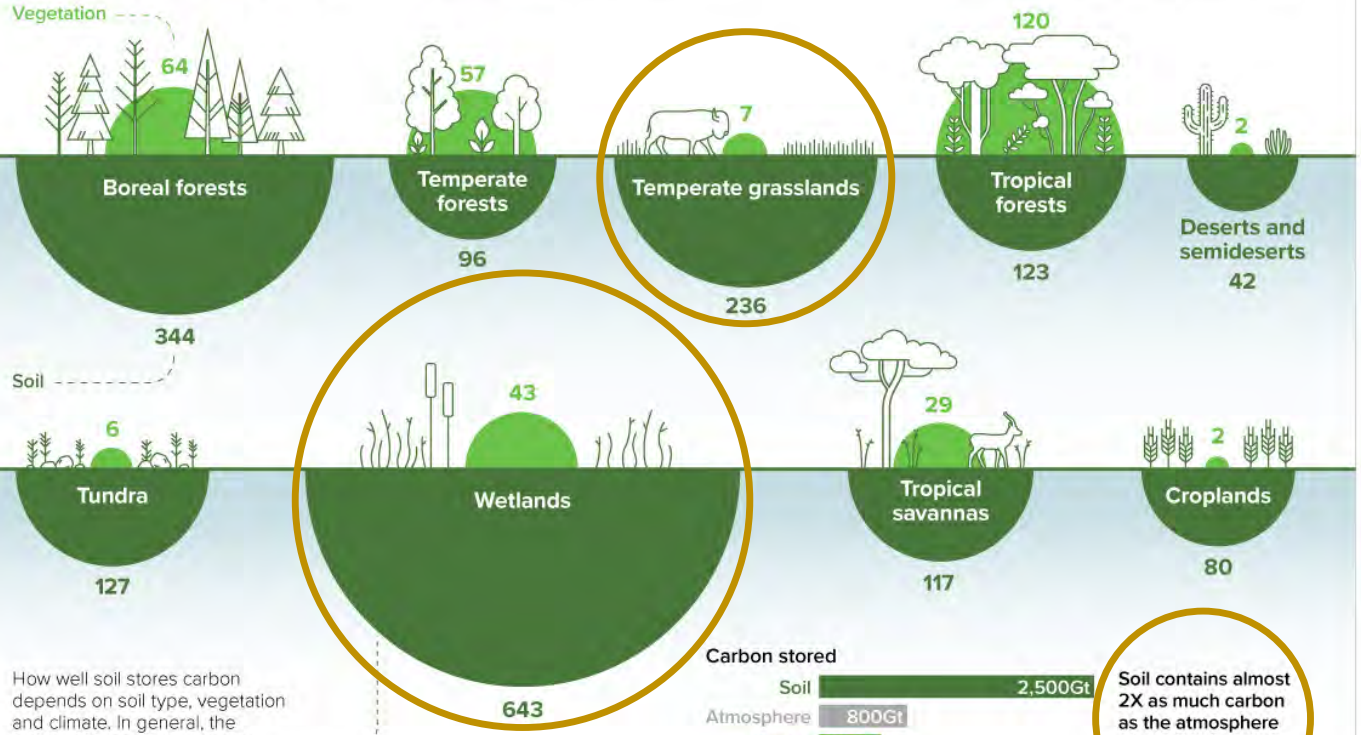
- **Living Biomass** — Leaves, twigs, roots of trees, trunk & branches
- **Dead Biomass** — Woody debris, leaf litter
- **Soil**

Carbon Storage

Tonnes of Carbon per Hectare*

The world's forests absorb around **15.6 gigatonnes** of CO_2 each year. That's around 3X the annual CO_2 emissions of the United States.

However, around **8.1 gigatonnes of CO_2 leaks back into the atmosphere** due to deforestation, fires and other disturbances.



How well soil stores carbon depends on soil type, vegetation and climate. In general, the **wetter and colder**, the better.

Soil contains almost 2X as much carbon as the atmosphere and living flora and animals combined.

*At a ground depth of one meter

Sources: IPCC, NASA

Graphic: Miranda Smith

More Reliable Carbon Sink Than Trees

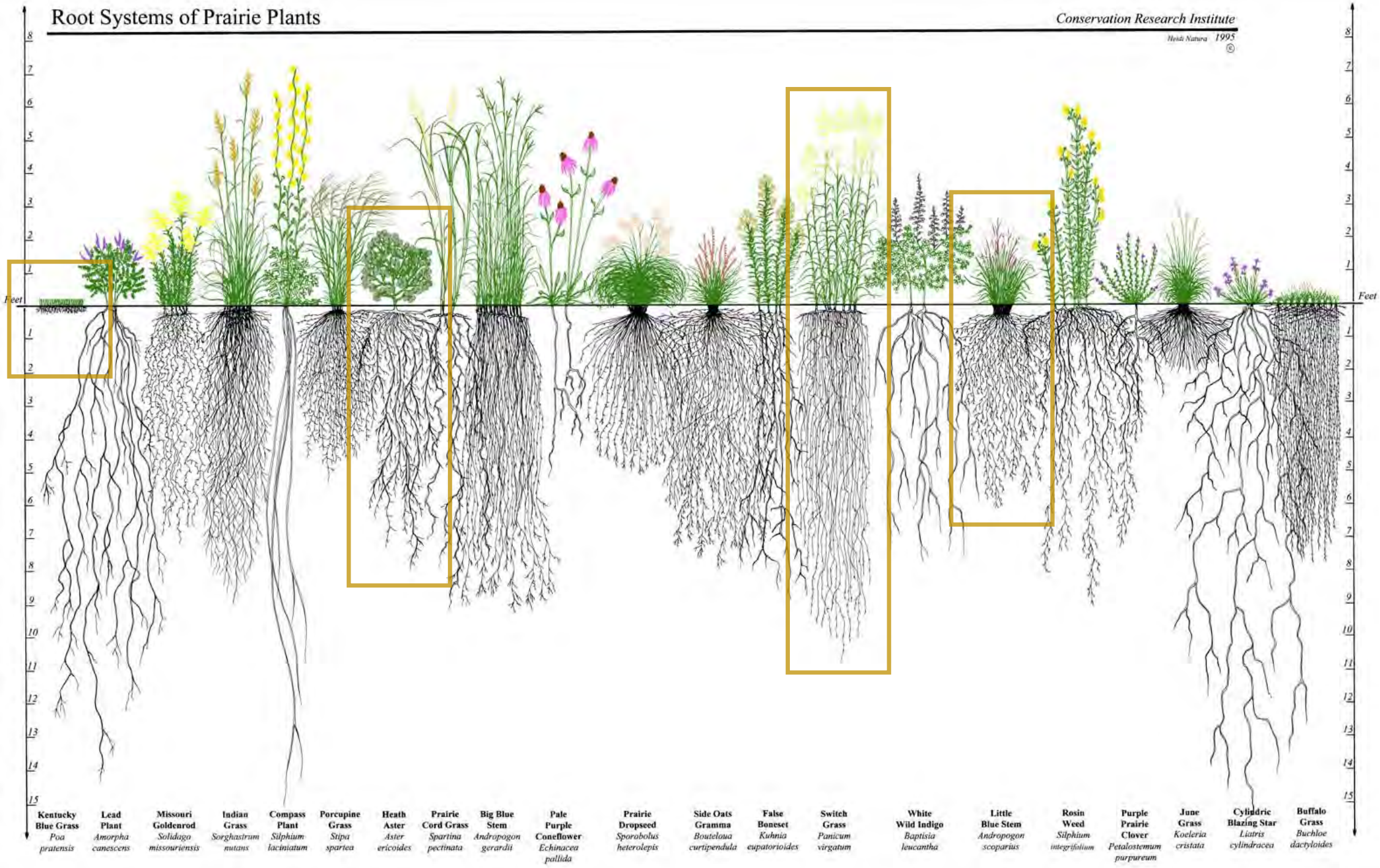
Unlike forests, grasslands sequester most of their carbon underground, while forests store it mostly in woody biomass and leaves.

When wildfires cause trees to go up in flames, the burned carbon they formerly stored is released back to the atmosphere. When fire burns grasslands, the carbon fixed underground tends to stay in the roots and soil, making them more adaptive to climate change.

"In a stable climate, trees store more carbon than grasslands. But in a vulnerable, warming, drought-likely future, we could lose some of the most productive carbon sinks on the planet."

Kerlin, K. "Grasslands more reliable carbon sink than trees." Science and Climate. 2020, August 6. Web.

Dr. Jerry Glover next to 14-foot tangle of Indian grass, compass plant and big bluestem. Photograph: Jim Richardson


Root Systems of Prairie Plants
Conservation Research Institute
Heidi Natura 1995 ©
Feet
Feet
Kentucky Blue Grass Poa pratensis
Lead Plant Amorpha canescens
Missouri Goldenrod Solidago missouriensis
Indian Grass Sorghastrum nutans
Compass Plant Silphium laciniatum
Porcupine Grass Stipa spartea
Heath Aster Aster ericoides
Prairie Cord Grass Spartina pectinata
Big Blue Stem Andropogon gerardii
Pale Purple Coneflower Echinacea pallida
Prairie Dropseed Sporobolus heterolepis
Side Oats Gramma Bouteloua curtipendula
False Boneset Kuhnia eupatorioides
Switch Grass Panicum virgatum
White Wild Indigo Baptisia leucantha
Little Blue Stem Andropogon scoparius
Rosin Weed Silphium integrifolium
Purple Prairie Clover Petalostemum purpureum
June Grass Koeleria cristata
Cylindric Blazing Star Liatris cylindracea
Buffalo Grass Buchloe dactyloides

It's Not Just About Carbon

When we move into a biodiversity space, many of the aboveground carbon models are too simplistic.

Restoration of late-successional grassland plant diversity accelerates annual carbon storage rates, with rates of soil C sequestration greatest at higher plant diversity, especially C4 grasses and legumes.

In a 22-year study conducted in Minnesota on abandoned farmland, by Year 13 **soil carbon storage rates were 200% greater in the highest plant diversity treatment** (16 species) than during natural succession at the site, and 70% greater than in grass monocultures planted.

"By maintaining a narrow focus on visible aboveground vegetation carbon stocks, we risk making ineffective management decisions to counteract biodiversity decline and climate change."

Yang, Y., Tilman, D., Furey, G., & Lehman, C. (2019). Soil carbon sequestration accelerated by restoration of grassland biodiversity. Nature Communications, 10(1).
Kristensen, J. A., Svenning, J.-C., Georgiou, K., & Malhi, Y. (2022). Can large herbivores enhance ecosystem carbon persistence? Trends in Ecology & Evolution, 37(2), 117–128.

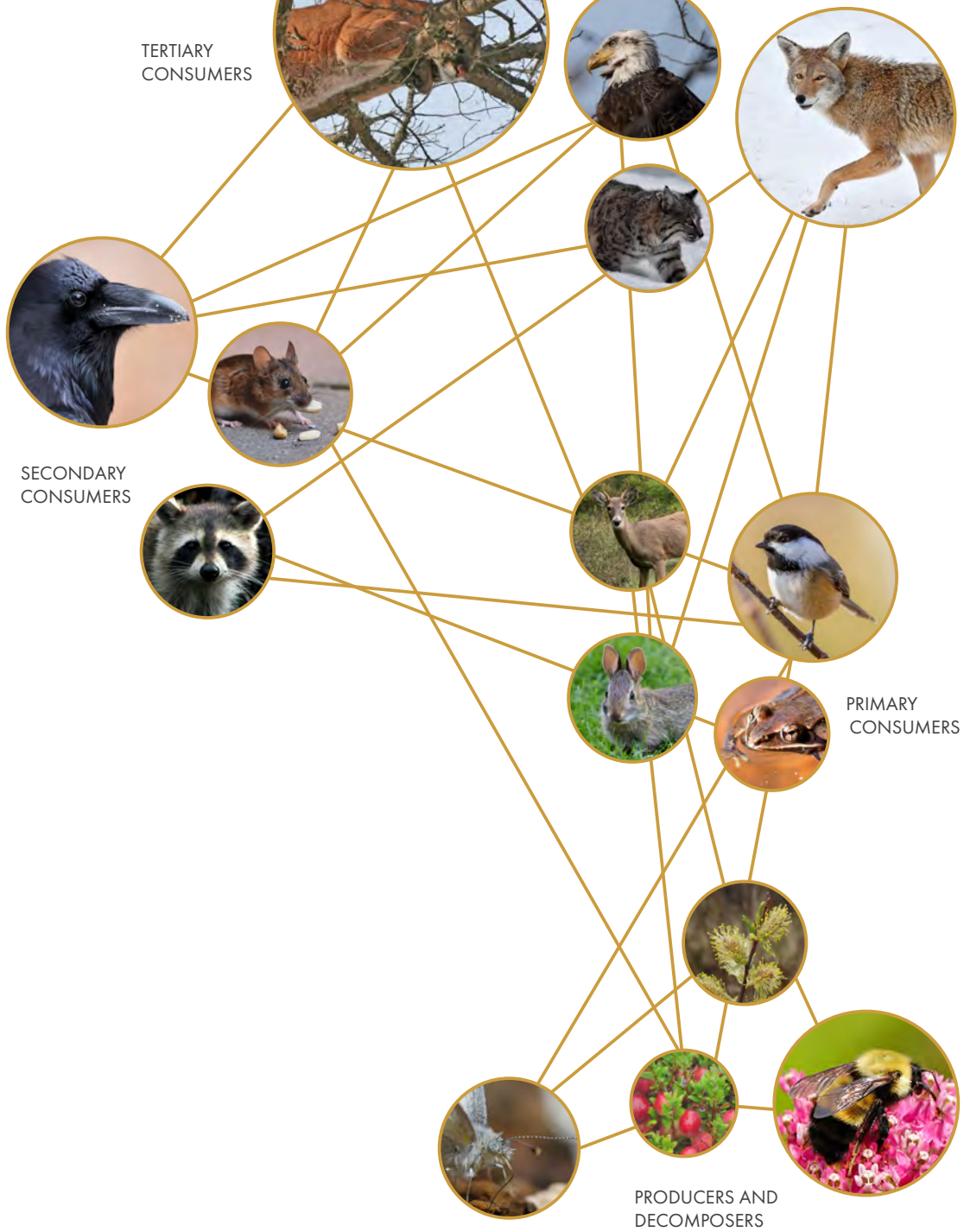
Graphic: Vox

Designing Nature in the Anthropocene

Farms, conservation lands, sub/urban greenways, rural communities and largescale solar arrays provide a wealth of opportunities for expanding regional biodiversity, climate change resilience, ecological health and food security through the implementation of native pollination systems corridors.

What happens (or doesn't happen) at the pollination scale has repercussions all the way up the food chain to the largest predators and humans.

"Ecological resilience may be the most important attribute for any natural system, especially in the face of rapid climate change, continuing loss and degradation of habitat, encroaching invasive species and other threats."



Helzer, C. Should We Manage for Rare Species or Species Diversity? The Prairie Ecologist. (2017, March 14). Retrieved January 18, 2021.

Why Pollinators?

Pollinators are primarily insects that fertilize plants, culminating in the production of seeds and fruit.

Pollinators are responsible for assisting over **80%** of the world's flowering plants.

Bees alone pollinate **45%** of the food crops grown in Massachusetts, and one-third of food grown in U.S.

Pollinators are vital to creating and maintaining the habitats and ecosystems that most animals rely on for food and shelter.

Some plants have a small guild of pollinators which coevolved with them to ensure their pollination.

Approximately 15% of northeastern native bee species are pollen specialists.

Jarrod Fowler "Specialist Bees of the Northeast: Host Plants and Habitat Conservation," Northeastern Naturalist 23(2), 305-320, (1 June 2016).

Bombus fervidus foraging on Monarda didyma (Scarlet bee balm). One of the most abundant bumblebee species in Massachusetts a few decades ago, it is now the second rarest bumblebee species in the state. Photograph by Norm Levey.

A Bee's Needs

Over 400 of the 4,000 native bee species in the U.S. live in the Northeast.

Native bees do the vast majority of pollination. In a global study of 41 crops in 600 fields across every populated continent, **wild pollinators were twice as effective as honeybees** in producing seeds and fruit.

The average native bee foraging range is 200 -1800 ft.

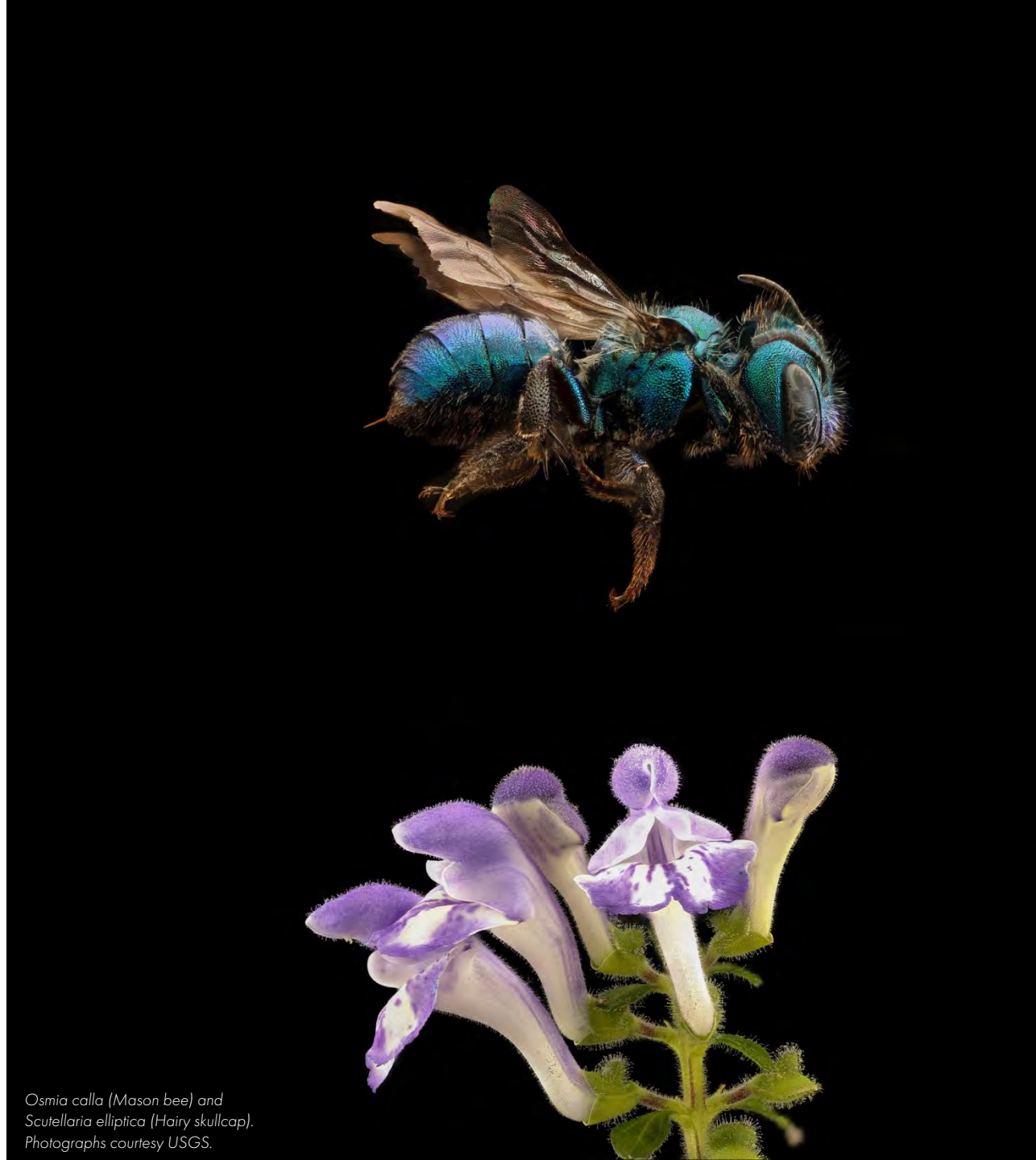
70% of bees are ground nesting.

Most are solitary.

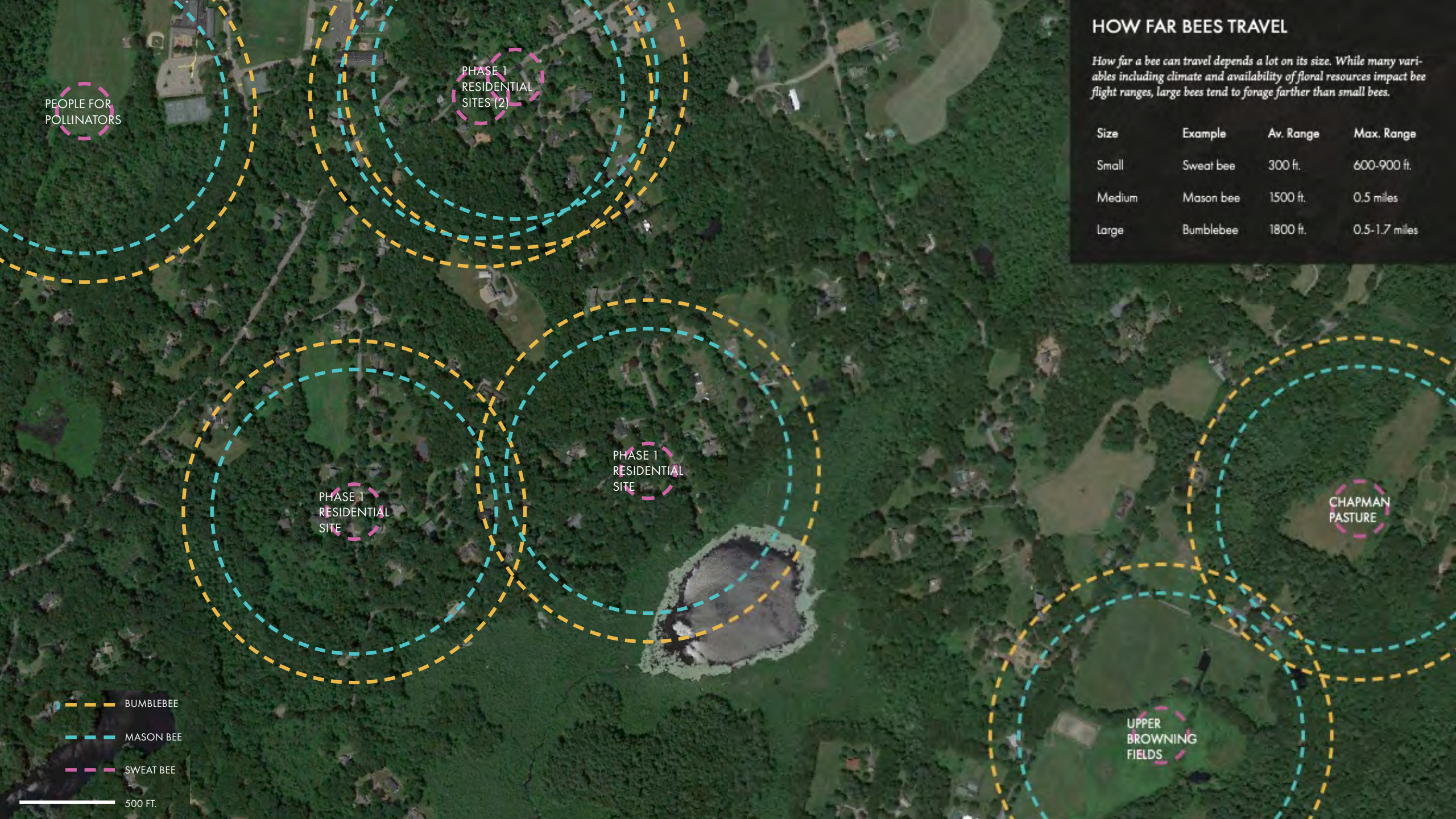
Habitats Include:

- Bare ground
- Soft-pithed twigs
- Abandoned rodent burrows
- Dead trees and snags

Garibaldi, Lucas A., et al. "Wild Pollinators Enhance Fruit Set of Crops Regardless of Honey Bee Abundance." Science, American Association for the Advancement of Science, 29 Mar. 2013.



Osmia calla (Mason bee) and Scutellaria elliptica (Hairy skullcap). Photographs courtesy USGS.



HOW FAR BEES TRAVEL

How far a bee can travel depends a lot on its size. While many variables including climate and availability of floral resources impact bee flight ranges, large bees tend to forage farther than small bees.

Size	Example	Av. Range	Max. Range
Small	Sweat bee	300 ft.	600-900 ft.
Medium	Mason bee	1500 ft.	0.5 miles
Large	Bumblebee	1800 ft.	0.5-1.7 miles

Other Significant Pollinators

Ruby-throated Hummingbird

As adept a pollinator as a honeybee
Trees, shrubs and vines for shelter; tubular flowers for forage
Not threatened

Aphrodite Fritillary

Spread pollen farther than bees
Only known host plants are native violets (Viola spp.)
Species of Conservation Concern in Massachusetts

Monarch Butterfly

Spread pollen farther than bees
Adults are generalists; caterpillars feed only on milkweed (Asclepias spp.)
81% population decline globally

Dion Skipper

Spread pollen farther than bees
Sedge wetlands, riparian marshes, wet meadows and shrub swamps
Threatened Species in Massachusetts

Pollinators in Peril

Not just honeybees are dying.
Pollinators worldwide are in decline due to:

Habitat Loss

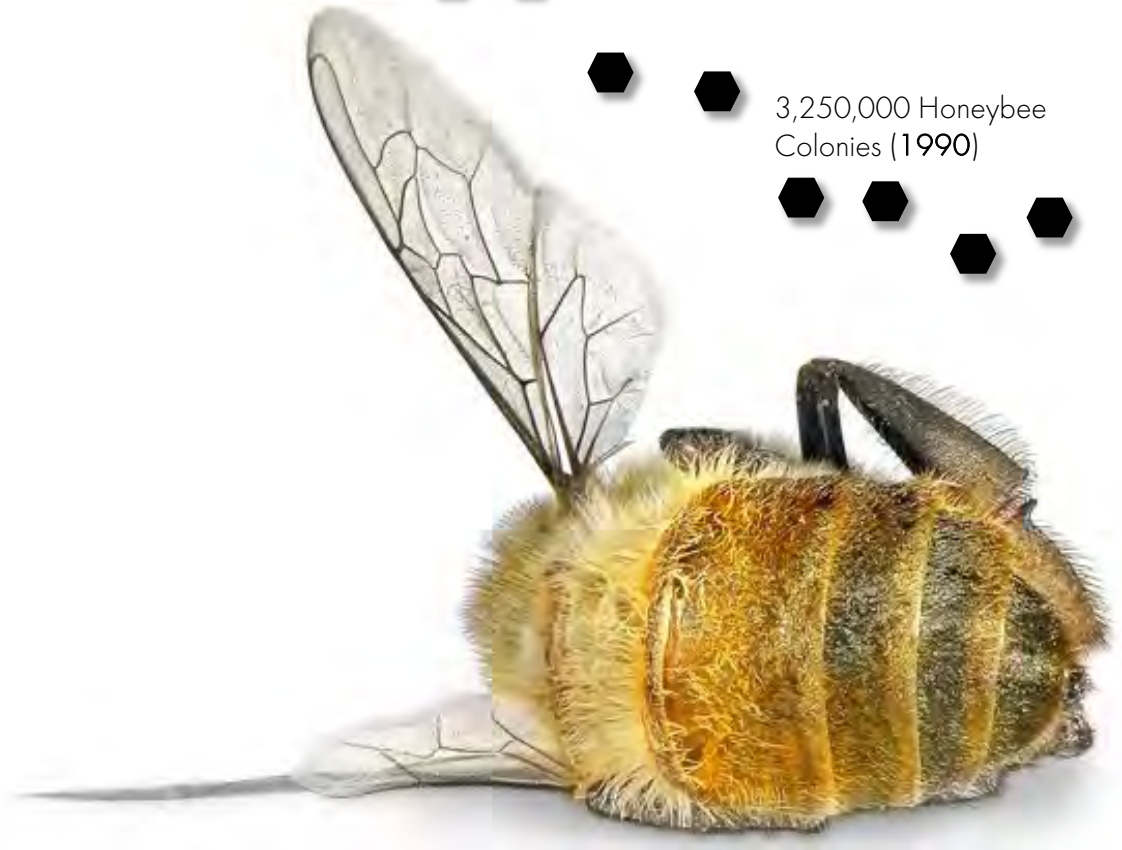
Pesticides

Climate Change

4,500,000 Honeybee Colonies (1980)

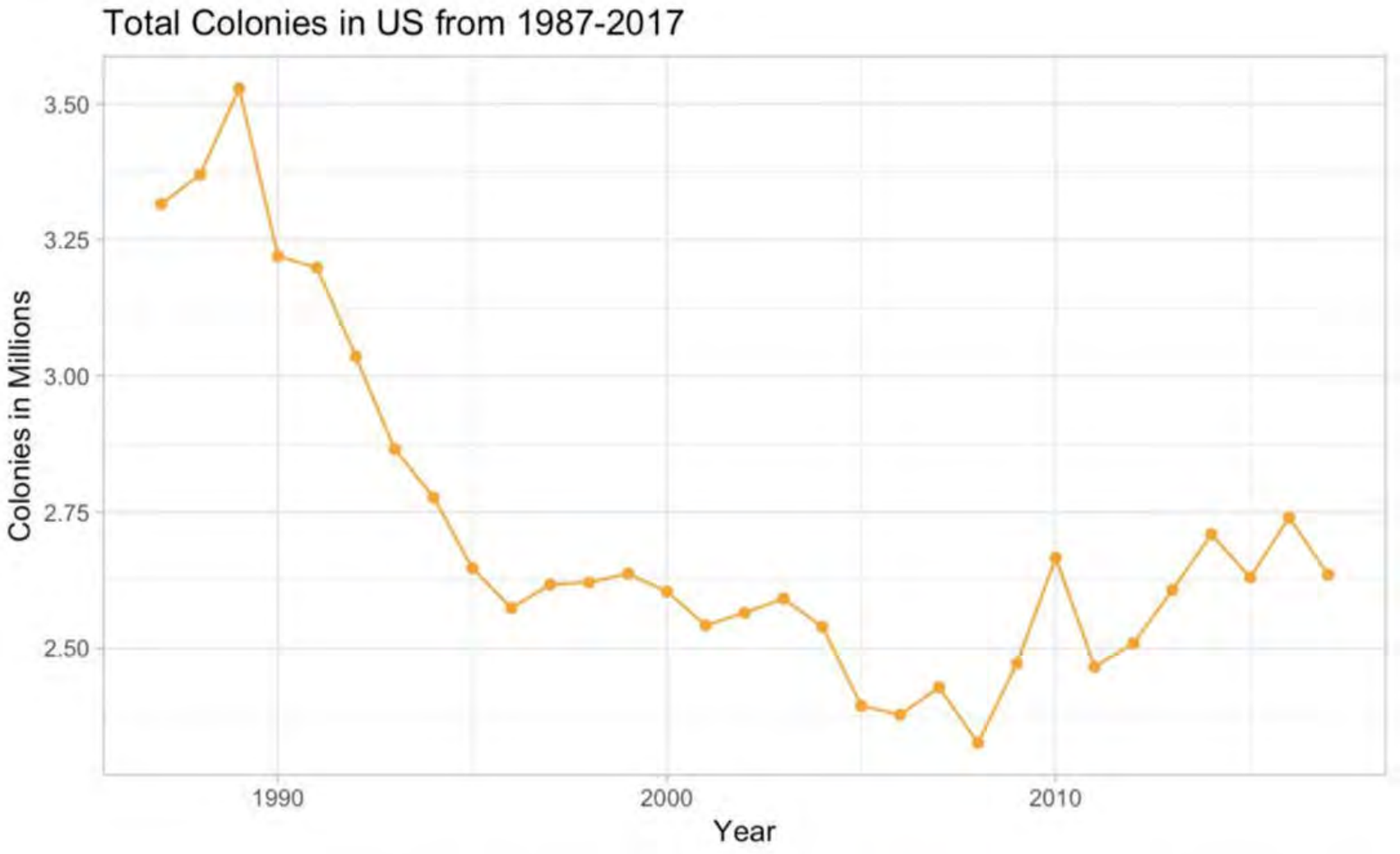
3,250,000 Honeybee Colonies (1990)

2,250,000 Honeybee Colonies (2005)



Graphic by Elan Bills. Honeybee statistics for continental United States.

Honeybee Trend Reversing

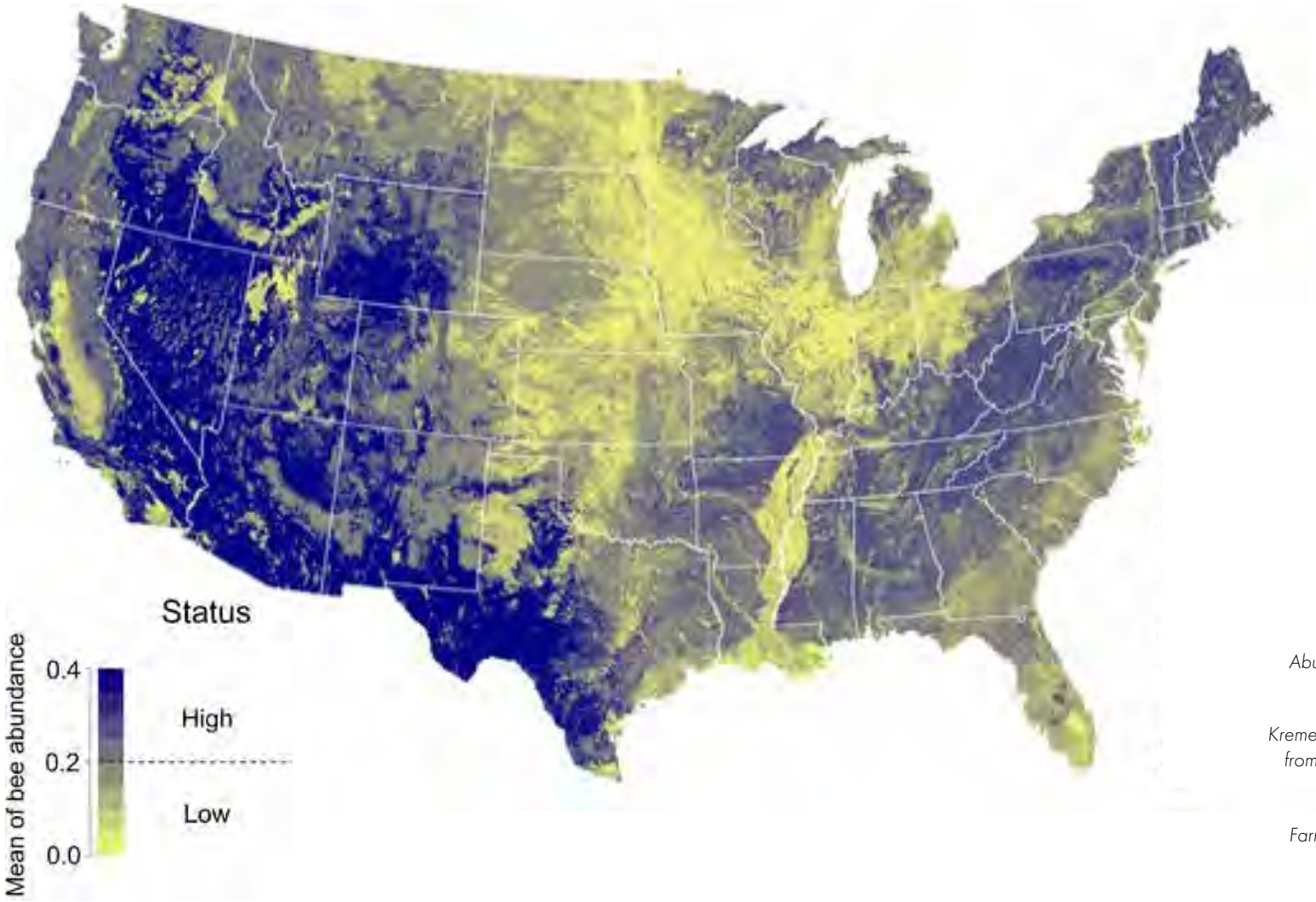


Since 2005, beehive populations in the U.S. have been relatively stable — and even increasing.

Graphic:
Abhi Motgi. "What's Buzzing with the Bees?" Medium, Towards Data Science, 24 June 2019.

Data:
Kaggle: Bee Colony Statistics
FRED: CPI data
NASA: Temperature anomalies from 1880-present

Wild Bees ↓ 23%



In the United States, wild bee abundance dropped by 23% in just five years.

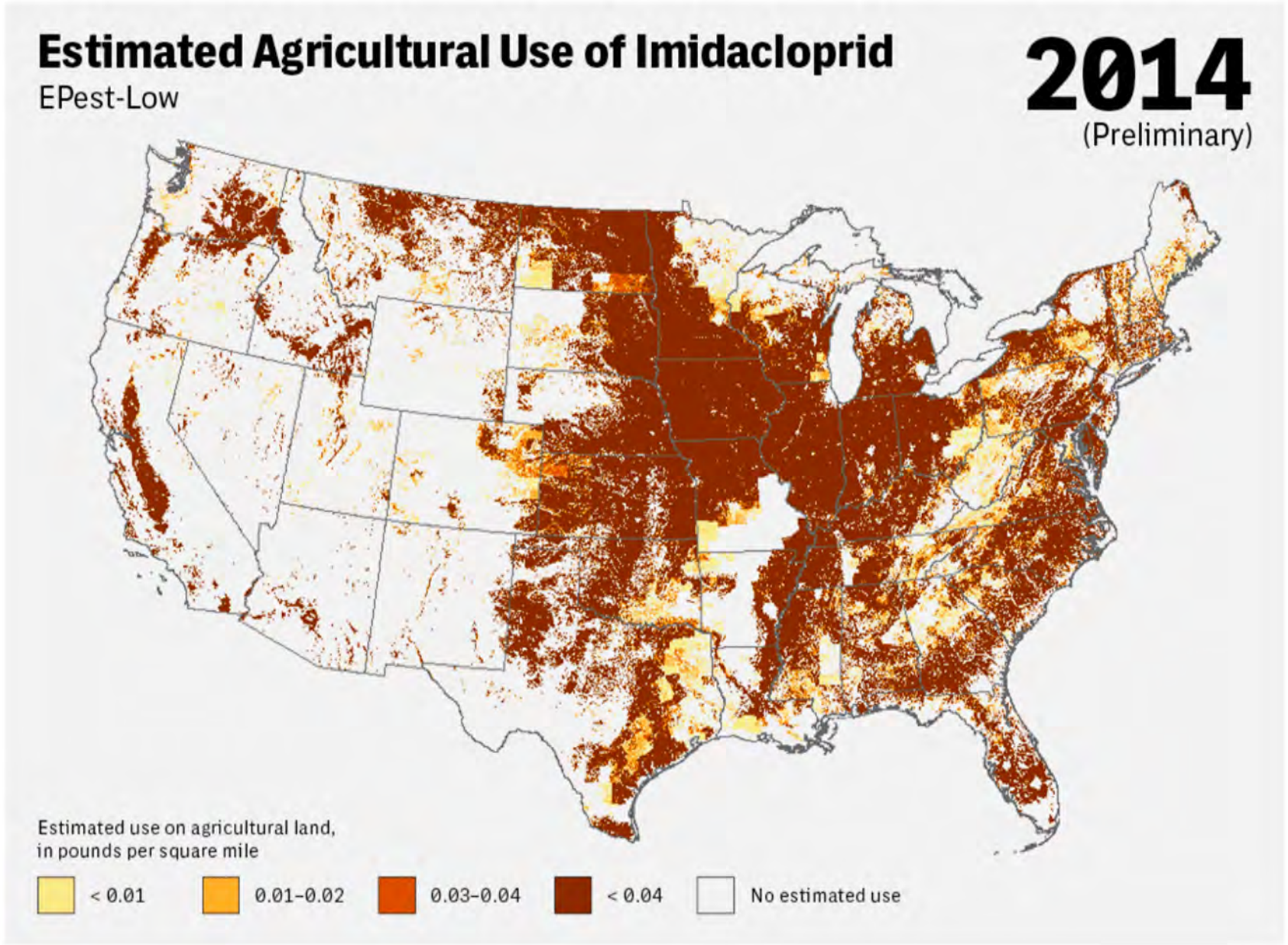
In New England, 22% of native plants are considered rare, in decline, endangered or extinct.

"A heterogeneous community of native species can help buffer against the decline of managed species."

Koh, Insu, et al. "Modeling the Status, Trends, and Impacts of Wild Bee Abundance in the United States." Proceedings of the National Academy of Sciences, vol. 113, no. 1, 2015, pp. 140–145.

Kremen C, Williams NM, Thorp RW. Crop pollination from native bees at risk from agricultural intensification. Proc Natl Acad Sci USA. 2002;99:16812–16816.

Farnsworth, Elizabeth. State of the Plants: Challenges and Opportunities for Conserving New England's Native Flora. Native Plant Trust, 2015.



In June 2022, the EPA confirmed that three widely used neonicotinoid insecticides (clothianidin, imidacloprid, thiamethoxam) likely harm roughly three-fourths of all endangered plants and animals.

Neonicotinoids, which are banned in the European Union, are the most popular insecticides in the United States.

Hundreds of studies have shown they play a major role in population-level declines of bees, birds, butterflies and freshwater invertebrates. More recent studies show significant harm to mammals.

Imidacloprid is also sold as a flea and tick prevention for pets.

Burd, Lori Ann. Center for Biological Diversity. June 16, 2022. Web.

Map: USGS National Water-Quality Assessment, The Intercept

Pollination Services Under Threat

Widespread use of pesticides in industrial agriculture causes more honeybees in the U.S. to die every year than all fish and animals raised for slaughter combined.

On organic farms near natural habitat, native bee communities can provide full pollination services without honeybees, even for a crop with heavy pollination requirements (watermelon).

All other types of farms studied experienced insufficient pollination services from native bees alone.

Conservation and restoration of native bee habitat are viable economic alternatives for reducing dependence on managed honeybees.

Kremen, C., Williams, N. M., & Thorp, R. W. (2002). Crop pollination from native bees at risk from agricultural intensification. Proceedings of the National Academy of Sciences, 99(26), 16812–16816.

McGivney, Annette. "'Like Sending Bees to War': the Deadly Truth behind Your Almond Milk Obsession." The Guardian, Guardian News and Media, 8 Jan. 2020.

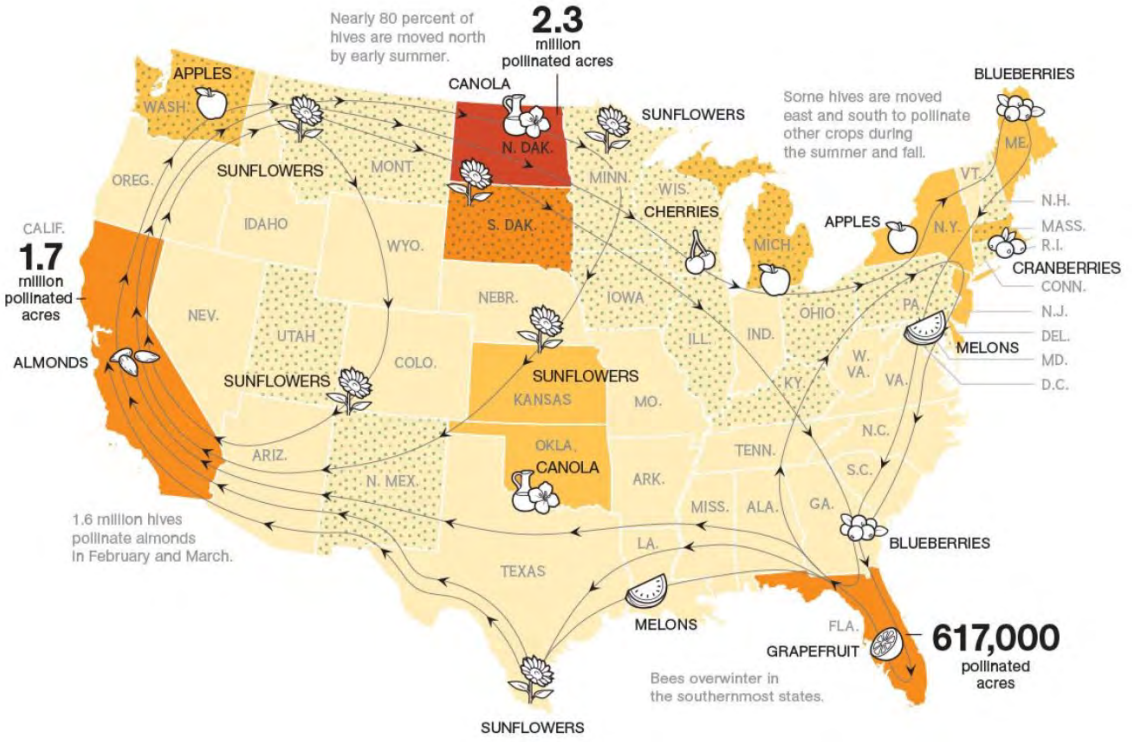


Photo: Caitlin O'Hara. Map: National Geographic (2014).

Wild Pollination

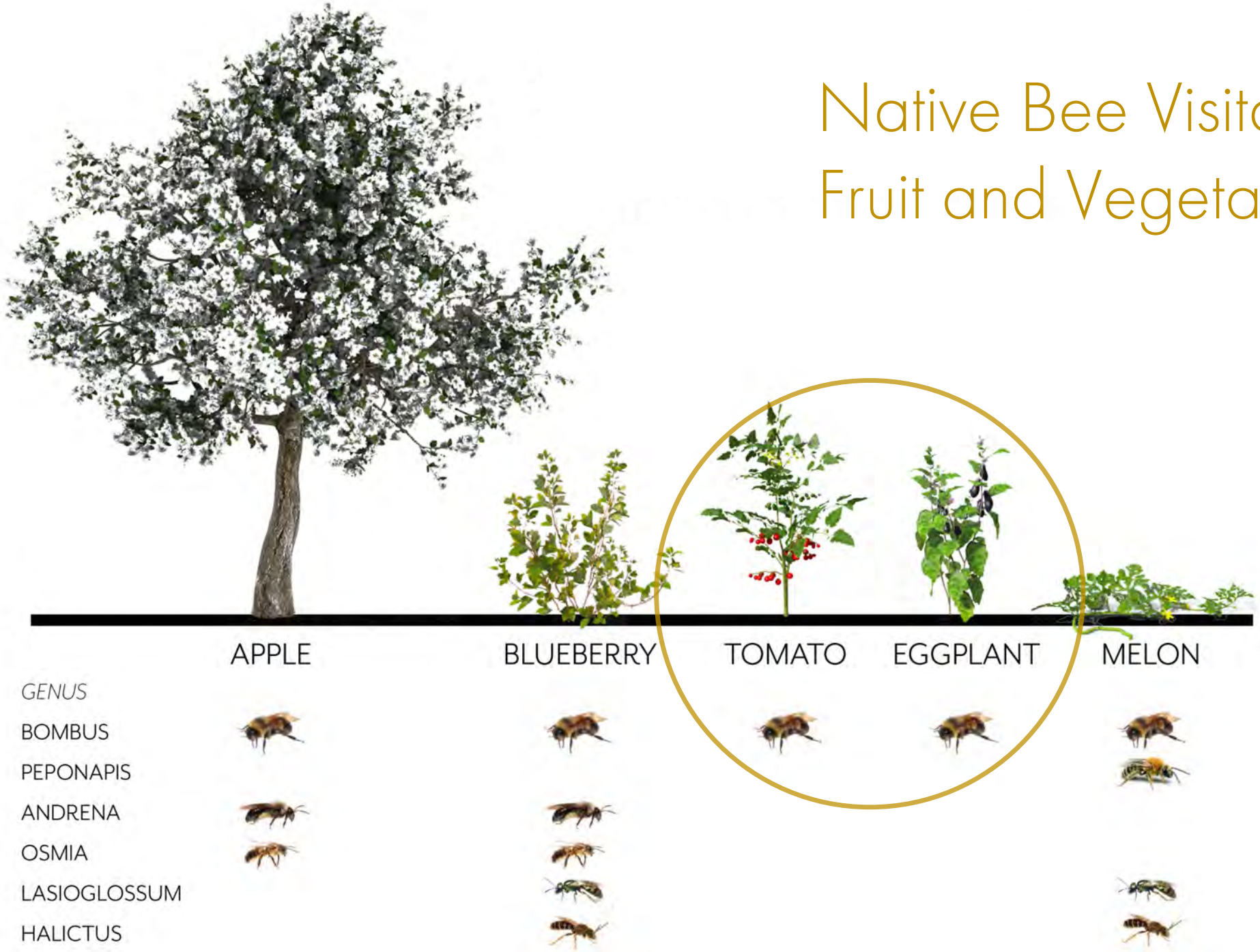
Michigan State University entomologists looked at blueberry farms over a four-year period. Farmers planted a one-acre patch of perennial wildflowers for about $700. The flowers, grown on fallow land next to 10-acre patches of blueberries, didn't make much difference in the first three years as plantings established. By year four, farms with flower patches had a 33% higher pollination rate than farms that relied on honeybees.

The fourth year was a terrible one for pollination. **Yet farms that relied on wild pollinators suffered much less than farms that relied on trucked-in honeybees.**

Beneficial insects also increased. One farmer added wildflowers throughout his farm and cut back from 10-12 insecticide applications a year to just 2-3, saving up to $6,000 a year.

Conniff, Richard. "How Attracting Wild Bees and Butterflies to Farms Can Save Farmers Money." TakePart, 14 Apr. 2014.

Native Bee Visitation to Fruit and Vegetable Crops



A Future Without Bees?

According to the UN's Food and Agriculture Organization (FAO), 90% of the world's food suppy comes from about 100 crop species.

71 of those crops rely on bees for pollination.

Around **270 species of wild bees do the bulk of this work**.

"A world where pollination is only available to those who can afford it."

Rowe, Mark. "From Gene Editing to Robotic Honey Bees: the Pollinator Crisis and New Technology." Geographical Magazine, 19 Jan. 2019.

Honeybees vs. Native Bees

"A 40-hive apiary residing on wildlands for 3 months collects the pollen equivalent of four million wild bees."

"Honeybees negatively affect abundance of both long and short tongued bumblebees, indicating that competition occurs."

"Local bumblebee decline linked to recovery of honeybees."

"Honeybee addition depresses the densities of wild insects (bumblebees, solitary bees, hoverflies, marchflies, other flies, and other flying and flower-visiting insects) even in a massive flower resource such as oilseed rape."

"Conserving honeybees does not help wildlife."

Cane, J. H. and V. J. Tepedino (2016). "Gauging the effect of honey bee pollen collection on native bee communities." Conservation Letters: n/a-n/a.

Geldmann, J. and J. P. Gonzalez-Varo (2018). "Conserving honey bees does not help wildlife." Science 359(6374): 392-393.

Goras, G., et al. (2016). "Impact of honeybee (Apis mellifera L) density on wild bee foraging behaviour." Journal of Apicultural Science. 60: 49.

Lindstrom, S. A. M., et al. (2016). "Experimental evidence that honeybees depress wild insect densities in a flowering crop." Proceedings of the Royal Society B: Biological Sciences 283(1843).

Magrach, A., et al. (2017). "Honeybee spillover reshuffles pollinator diets and affects plant reproductive success." Nature Ecology & Evolution 1(9): 1299-1307.

Mallinger, R. E., et al. (2017). "Do managed bees have negative effects on wild bees?: A systematic review of the literature." PLoS ONE 12(12): e0189268.

Miller, H. T. (2016). "Interaction between Bombus terrestris and honeybees in red clover fields reduces abundance of other bumblebees and red clover yield." Oslo, Norwegian University of Life Sciences M.Sc.

Nielsen, A., et al. (2017). "Effects of competition and climate on a crop pollinator community." Agriculture, Ecosystems & Environment 246: 253-260.

Thomson, D. M. (2016). "Local bumble bee decline linked to recovery of honey bees, drought effects on floral resources." Ecology Letters 19(10): 1247-1255.

Torne-Noguera, A., et al. (2016). "Collateral effects of beekeeping: Impacts on pollen-nectar resources and wild bee communities." Basic and Applied Ecology 17(3): 199-209.

Wojcik, V. A., et al. (2018). "Floral resource competition between honey bees and wild bees: Is there clear evidence and can we guide management and conservation?" Environ Entomol: nvy077-nvy077.


“Like raising chickens to save the birds.”

Beyond Pollinator-Friendly

Most efforts to restore pollination systems to date have focused on increasing the numbers of a few bee species based on their crop pollination abilities, rather than on the range of wild pollinator species needed for ecosystem health and resiliency.

A delicate balance exists between native plants and their pollinators, relationships that co-evolved over millions of years. For many specialists, once their "partner" is missing from the landscape, they cannot reproduce.

A major misconception about pollinator decline is that all species are declining at the same rate. "Seeing lots of bees" does not mean that your area is necessarily "pollinator-friendly."

Bombus vagans with Gentiana andrewsii Bottle Gentian. Video by Tom Lautzenheiser.

Diversity vs. Abundance

In Massachusetts, two out of 11 bumblebee species are extirpated and two others are expected to be gone within the next decade.

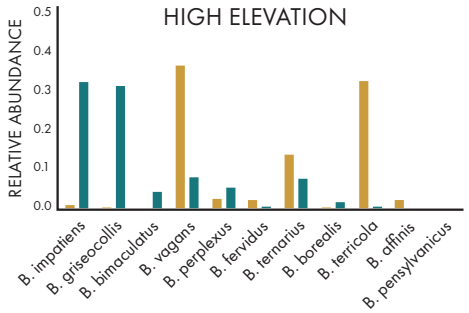
In New York, a recent statewide survey found 24% of native bee species to be at risk and 11% extirpated, as well as between 38% and 60% of native bees, flies, beetles and moths.

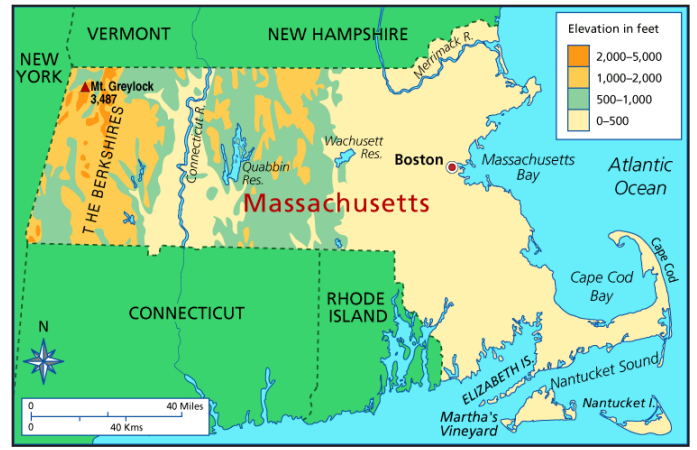
Lots of bees isn't always a good thing: While some species are declining or no longer found, others are more abundant now than historically. This is common throughout the Northeast.

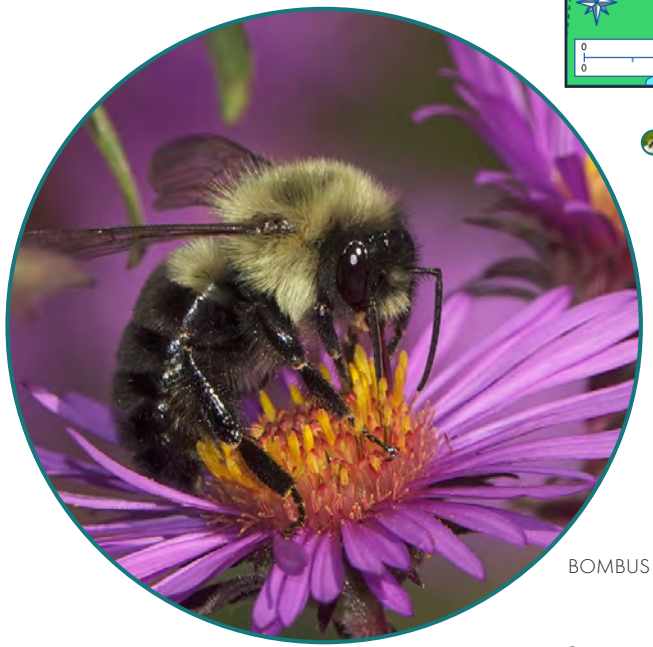
Short and medium-tongued bees are often targeted for conservation at the expense of long-tongued species. This puts plants that depend upon long-tongued bees for pollination at risk, as well as the wildlife that depends upon these plants.

What one bee wants or needs — be it for pollen, nectar or nesting — is not the same for every other bee species. MA lists 5 bees and 44 butterflies and moths as Species of Greatest Conservation Need.

STATUS OF BUMBLEBEE SPECIES IN MASSACHUSETTS (1960-2020)



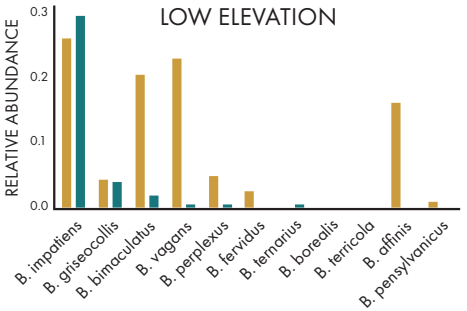




BOMBUS IMPATIENS

BOMBUS FERVIDUS

HISTORICAL
CURRENT



Contemporary data courtesy Dr. Robert Gegear. Historical records from Yale Peabody Museum. Photos by Norm Levey.

White, E.L., M. D. Schlesinger, and T.G. Howard. 2022. The Empire State Native Pollinator Survey (2017-2021). New York Natural Heritage Program, Albany, NY.

Native Plant Community Loss

At present, 22% of New England's native plant taxa are globally, regionally or locally imperiled or extirpated.

In a study of the native flora of Concord, Massachusetts which compared observations recorded primarily by Henry David Thoreau with observations recorded between 2003 and 2009, 27% of the species were no longer present, and a further 36% of formerly common species were now rare.

Many of these rare species existed only in small populations — in some cases, only a few individuals, or even just one plant.

Farnsworth, Elizabeth. State of the Plants: Challenges and Opportunities for Conserving New England's Native Flora. Native Plant Trust, 2015.

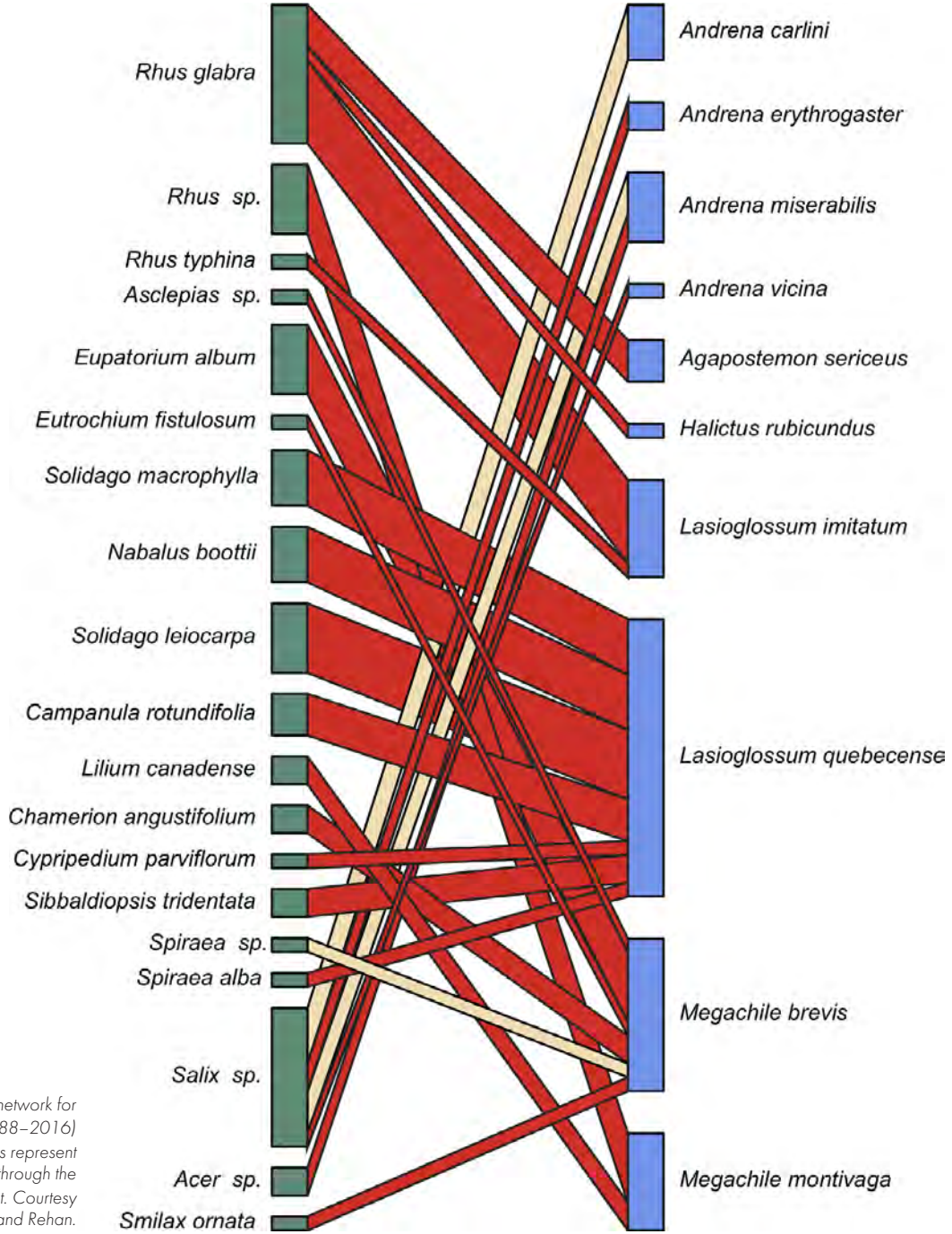
Primack, R. B. & Miller-Rushing, A. J. Uncovering, Collecting, and Analyzing Records to Investigate the Ecological Impacts of Climate Change: A Template from Thoreau's Concord. BioScience 62, 170–181 (2012).

Responding to Regional Trends

In a 2020 study, researchers determined that habitat loss from expanding agriculture and development as well as climate change were the primary drivers for a **94% loss of plant-pollinator networks** across northern New England over the past 125 years.

They concluded that conservation efforts **focused specifically on habitat restoration for declining wild bee and plant species** are fundamental to the preservation of regional biodiversity.

Mathiasson, M.E. and Rehan, S.M. (2020), Wild bee declines linked to plant-pollinator network changes and plant species introductions. Insect Conserv Divers, 13: 595-605.



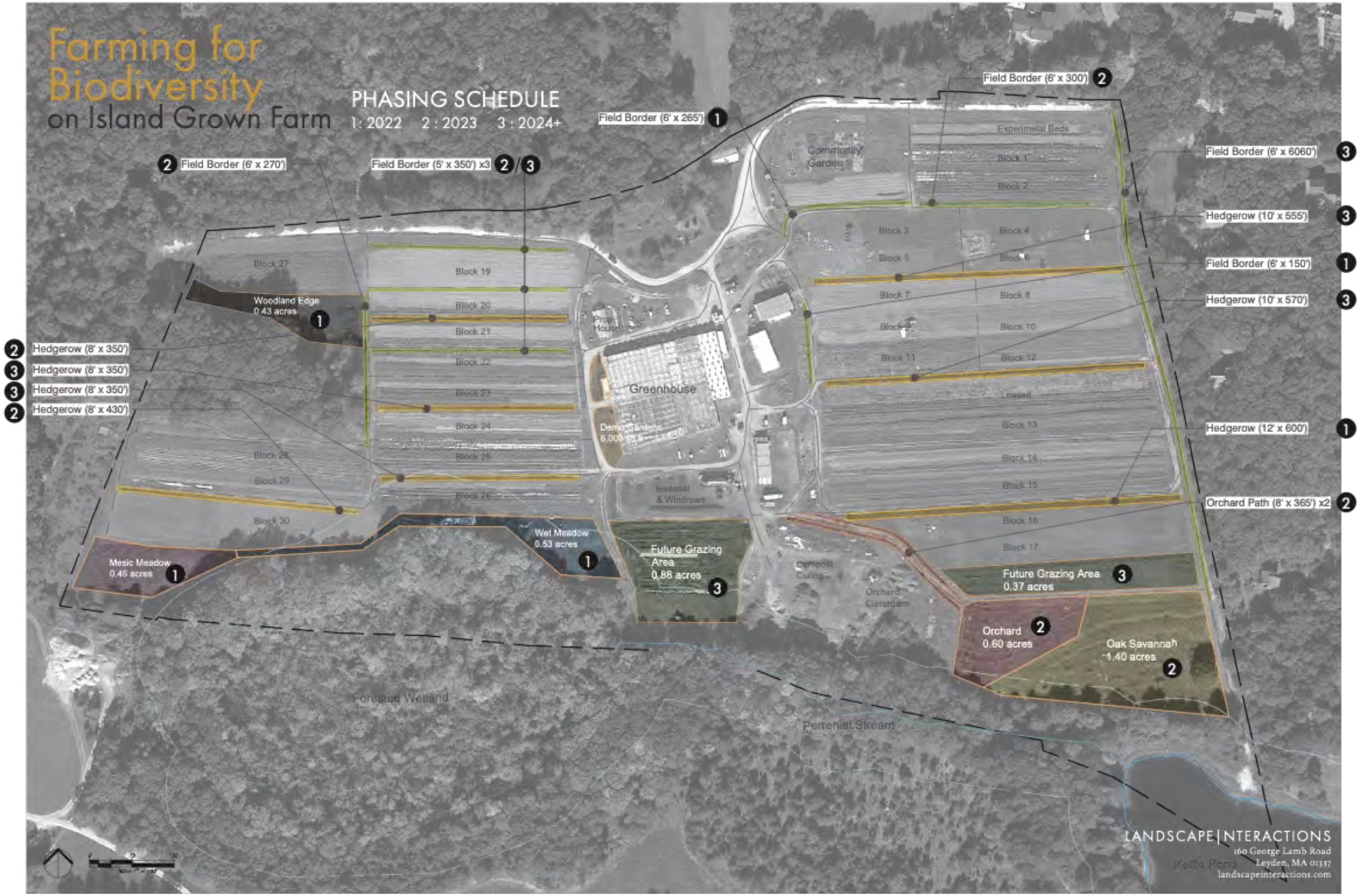
Historical (1891–1987) plant-pollinator interaction network for declining wild bee species and contemporary (1988–2016) presence or absence of these interactions. Yellow lines represent interactions that were maintained from the historical period through the present and red lines represent interactions that were lost. Courtesy Mathiasson and Rehan.

CASE STUDIES

Farming for Biodiversity
on Island Grown Farm

a project of
LANDSCAPE|NTERACTIONS

SCALABLE + REPLICABLE
FARMSCAPE HABITAT DESIGNS
TO SUPPORT POLLINATION SYSTEMS
AT RISK ON MARTHA'S VINEYARD


Farming for Biodiversity
on Island Grown Farm
PHASING SCHEDULE
1: 2022 2 : 2023 3 : 2024+
Field Border (6' x 265') 1
Field Border (6' x 300') 2
Field Border (6' x 270') 2
Field Border (5' x 350') x3 2/3
Field Border (6' x 6060') 3
Hedgerow (10' x 555') 3
Field Border (6' x 150') 1
Hedgerow (10' x 570') 3
Hedgerow (8' x 350') 2
Hedgerow (8' x 350') 3
Hedgerow (8' x 350') 3
Hedgerow (8' x 430') 2
Hedgerow (12' x 600') 1
Orchard Path (8' x 365') x2 2
Community Garden
Experimetal Beds
Block 1
Block 2
Block 3
Block 4
Block 5
Block 6
Block 7
Block 8
Block 9
Block 10
Block 11
Block 12
Leased
Block 13
Block 14
Block 15
Block 16
Block 17
Block 19
Block 20
Block 21
Block 22
Block 23
Block 24
Block 25
Block 26
Block 27
Block 28
Block 29
Block 30
Woodland Edge
0.43 acres 1
Prop House
Greenhouse
Demonstrations
6,000 sq ft
Invessel
& Windrows
Compost
Curing
Orchard
Classroom
Wet Meadow
0.53 acres 1
Mesic Meadow
0.45 acres 1
Future Grazing
Area
0.88 acres 3
Future Grazing Area
0.37 acres 3
Orchard 2
0.60 acres
Oak Savannah
1.40 acres 2
Forested Wetland
Perrenial Stream
Kettle Pond
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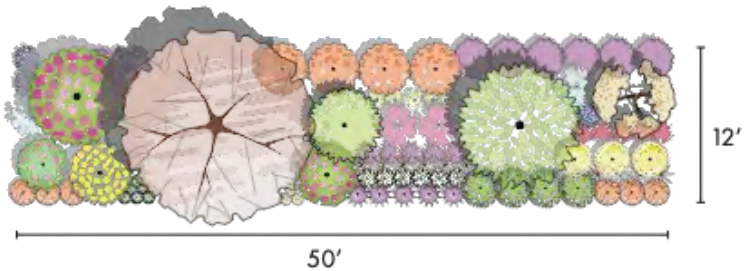
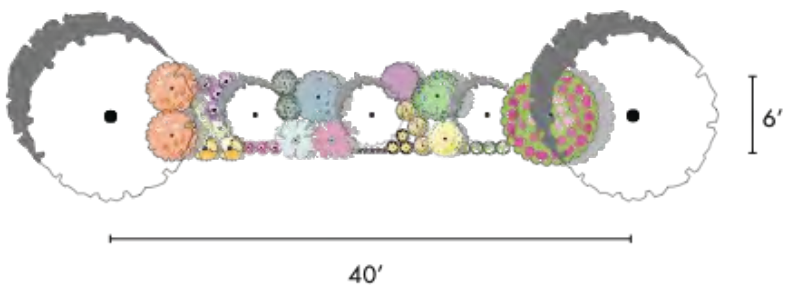
Farming for Biodiversity
on Island Grown Farm

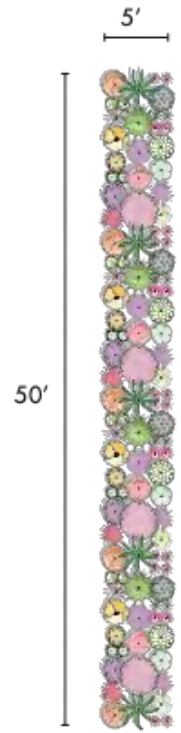
SCALABLE + REPLICABLE DESIGNS
FOR FARMSCAPE HABITAT SYSTEMS



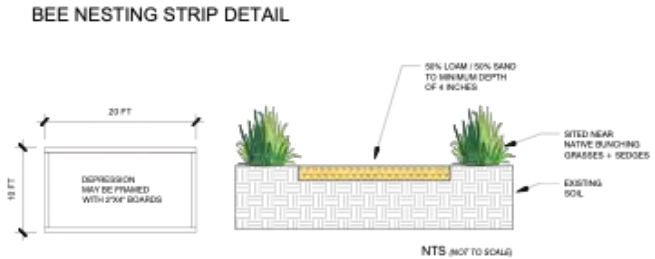
HEDGEROW
(12 FT. X 50 FT.)

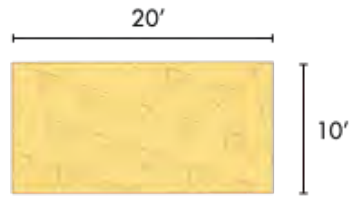


ORCHARD UNDERSTORY
(6 FT. X 40 FT.)



FIELD BORDER
(5 FT. X 50 FT.)





BEE NESTING STRIP
(10 FT. X 20 FT.)

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PLANT SCHEDULE HEDGEROW

TREES	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Prunus maritima	Beach Plum	1	6' wide spacing
	Quercus ilicifolia	Scrub Oak	1	15' wide spacing
	Salix humilis	Prairie Willow	1	6' wide spacing
	Salix petiolaris	Meadow Willow	1	10' wide spacing

SHRUBS	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Baptisia tinctoria	Yellow Wild Indigo	4	3' wide spacing
	Diervilla lonicera	Northern Bush-honeysuckle	4	4' wide spacing
	Hypericum prolificum	Shrubby St. John`s-wort	1	5' wide spacing
	Rosa carolina	Carolina Rose	1	4' wide spacing
	Rosa virginiana	Virginia Rose	1	5' wide spacing
	Rubus odoratus	Purple-flowering Raspberry	1	7' wide spacing
	Spiraea alba	Meadowsweet	2	3' wide spacing
	Spiraea tomentosa	Steeplebush	2	3' wide spacing
	Vaccinium angustifolium	Lowbush Blueberry	4	3' wide spacing

GRASSES	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Eragrostis spectabilis	Purple Lovegrass	5	2' wide spacing
	Schizachyrium scoparium	Little Bluestem	10	2' wide spacing

PERENNIALS	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Asclepias tuberosa	Butterfly Milkweed	6	2' wide spacing
	Eutrochium purpureum	Purple Joe-Pye Weed	6	3' wide spacing
	Lespedeza virginica	Slender Bush Clover	6	1' wide spacing
	Monarda didyma	Scarlet Bee Balm	5	2' wide spacing
	Monarda fistulosa	Wild Bergamot	5	2' wide spacing
	Penstemon digitalis	Foxglove Beardtongue	5	1.5' wide spacing
	Penstemon hirsutus	Northeastern Beardtongue	6	1.5' wide spacing
	Solidago bicolor	White Goldenrod	3	1' wide spacing
	Symphyotrichum novae-angliae	New England Aster	3	2' wide spacing
	Tephrosia virginiana	Goat's Rue	6	1.5' wide spacing

PLANT SCHEDULE FIELD BORDER

GRASSES	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Andropogon gerardii	Big Bluestem	5	3' wide spacing
	Carex pensylvanica	Pennsylvania Sedge	8	1' wide spacing
	Panicum virgatum	Switchgrass	4	3' wide spacing
	Schizachyrium scoparium	Little Bluestem	4	2' wide spacing

PERENNIALS	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Agastache scrophulariifolia	Purple Giant Hyssop	4	2' wide spacing
	Asclepias syriaca	Common Milkweed	4	2' wide spacing
	Asclepias tuberosa	Butterfly Milkweed	5	2' wide spacing
	Desmodium canadense	Showy Tick Trefoil	4	2' wide spacing
	Eurybia spectabilis	Purple Wood Aster	4	2' wide spacing
	Eutrochium fistulosum	Hollow Joe-Pye Weed	4	3' wide spacing
	Geranium maculatum	Spotted Crane`s-bill	8	1' wide spacing
	Lespedeza capitata	Round-headed Bush Clover	8	1' wide spacing
	Liatris novae-angliae	Northern Blazing Star	16	1` wide spacing
	Monarda didyma	Scarlet Bee Balm	4	2' wide spacing
	Monarda fistulosa	Wild Bergamot	4	2' wide spacing
	Penstemon digitalis	Foxglove Beardtongue	4	1.5' wide spacing
	Pycnanthemum muticum	Broad-leaved Mountain-mint	4	1.5' wide spacing
	Solidago sempervirens	Seaside Goldenrod	4	1.5' wide spacing
	Solidago speciosa	Showy Goldenrod	4	2' wide spacing
	Symphyotrichum lateriflorum	Calico Aster	4	2' wide spacing
	Zizia aurea	Golden Alexanders	8	1' wide spacing

PLANT SCHEDULE ORCHARD

SHRUBS	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Baptisia tinctoria	Yellow Wild Indigo	1	3' wide spacing
	Diervilla lonicera	Northern Bush-honeysuckle	2	4' wide spacing
	Rubus allegheniensis	Allegheny Blackberry	1	4' wide spacing
	Rubus odoratus	Purple-flowering Raspberry	1	7' wide spacing
	Rubus vermontanus	Vermont Blackberry	1	4' wide spacing
	Spiraea alba	Meadowsweet	1	3' wide spacing
	Spiraea tomentosa	Steeplebush	1	3' wide spacing

PERENNIALS	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Eurybia spectabilis	Purple Wood Aster	2	2' wide spacing
	Eutrochium purpureum	Purple Joe-Pye Weed	1	3' wide spacing
	Geranium maculatum	Spotted Crane`s-bill	3	1' wide spacing
	Hypericum punctatum	Spotted St. John`s-wort	3	1.5' wide spacing
	Penstemon digitalis	Foxglove Beardtongue	3	1.5' wide spacing
	Penstemon hirsutus	Northeastern Beardtongue	4	1.5' wide spacing
	Solidago juncea	Early Goldenrod	3	1' wide spacing
	Solidago speciosa	Showy Goldenrod	2	2' wide spacing
	Viola sororia	Common Blue Violet	6	0.5' wide spacing
	Zizia aurea	Golden Alexanders	4	1' wide spacing

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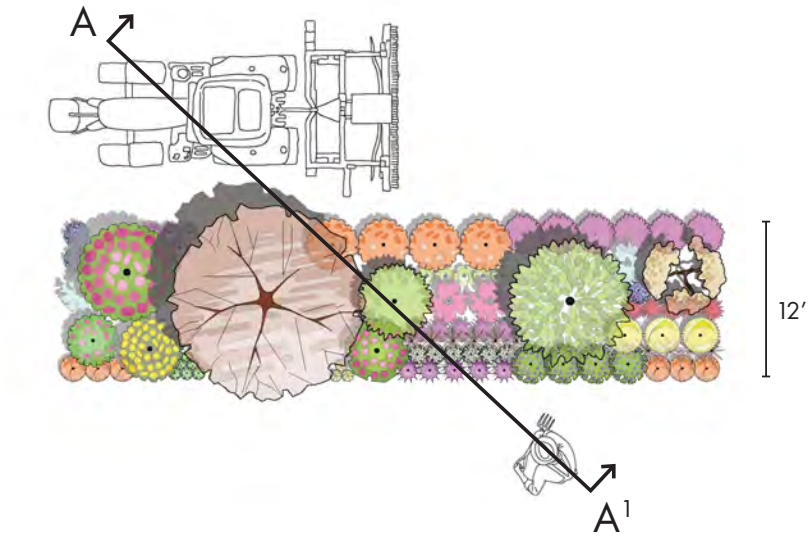

Section A - A1 of the hedgerow facing northeast. Scale of section below is three times the scale of design to the left.

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Conceptual rendering of field border between farm fields and walking path, with biodiverse grazing area on the right. Original photograph of IGI Farm courtesy Randi Baird.

Farmscape Typologies

Hedgerow 1

Diervilla lonicera
Quercus ilicifolia
Rosa virginiana
Salix petiolaris
Spiraea tomentosa

Meadow 2

Baptisia tinctoria
Hypericum prolificum
Lupinus perennis
Monarda didyma
Panicum virgatum
Schizachyrium scoparium
Solidago speciosa
Zizia aurea

Fallow Field 3

Asclepias syriaca
Carex pensylvanica
Cirsium discolor
Juniperus virginiana
Pedicularis canadensis
Symphyotrichum lateriflorum

Cover Crop 4

Chamaecrista fasciculata
Geranium carolinianum
Lobelia inflata
Monarda fistulosa
Nuttallanthus canadensis

Field Border 5

Agastache scrophulariaefolia
Andropogon gerardii
Desmodium canadense
Prunella vulgaris ssp. lanceolata

6 Edge Habitat

Cercis canadensis
Impatiens capensis
Geranium maculatum
Penstemon hirsutus
Rubus odoratus
Spiraea alba

7 Orchard

Asimina triloba
Prunus americana
Prunus maritima
Ribes spp.
Rubus allegheniensis

8 Pick Your Own

Vaccinium angustifolium
Gaylussacia baccata
Sambucus canadensis

9 Riparian Buffer

Acer rubrum
Asclepias incarnata
Carex stricta
Cephalanthus occidentalis
Eutrochium maculatum
Mimulus ringens
Pontederia cordata
Rosa palustris
Salix discolor
Salix lucida
Vaccinium corymbosum

10 Nesting Areas

Dead Trees, Snags
Standing Dead Stems
Mowing and Burning on Rotation
Bare, Exposed Ground

Lincoln Pollinator Action Plan

PLANTING FOR BIODIVERSITY AND CLIMATE RESILIENCE

Evan Abramson

The Lincoln Pollinator Action Plan is a comprehensive field guide for creating and maintaining habitat on a wide range of landscapes, to support threatened and at-risk pollinator species in the Northeast. While the designs, plant lists and management recommendations contained herein are based on the prevalent landscape conditions in Lincoln, Massachusetts, their applicability stretches far beyond town boundaries. The product of a year-and-a-half-long collaboration between scientists, designers, planners, conservation professionals and citizens, this Plan endeavors to make pollinator habitat conversion easy, exciting and aesthetically pleasing — and inspire landowners to view their properties as integral parts of a network of ecosystems that stretches into surrounding communities and across the wider region.

Commissioned by
the Lincoln Land Conservation Trust

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16 Center Street #426
Northampton, MA 01060
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a project of LANDSCAPE|NTERACTIONS

Science informs Design

Pollination Ecologist and Conservation Biologist Robert Gegear, Ph.D. has been studying the ecology, evolution and conservation of pollination systems native to eastern North America for over 25 years. An Assistant Professor of Biology at the University of Massachusetts-Dartmouth as well as Founder and Director of the New England Beecology Project, Dr. Gegear is a Scientific Consultant at Landscape Interactions whose research informs the plant selection and pollinator species targeted for each Toolkit in this plan. Dr. Gegear's research approach spans many boundaries, combining concepts and experimental techniques from behavioral ecology, neurobiology, experimental psychology, molecular biology, population and community ecology, evolutionary biology and computer science.

People for Pollinators, Chapman Pasture and Upper Browning Fields are being surveyed for pollinator species diversity and change over a three-year period by Dr. Robert Gegear. A classic "before and after" experiment, Year One (2020) involved observing and documenting pollinator and plant species interactions on the sites before any planting or landscape modifications took place. Years Two and Three (2021 and 2022) will document changes in species presence and interactions after the recommended plants, designs and management guidelines from the Toolkits have been implemented. **The Toolkits have been created to specifically target and support bee and butterfly species which are threatened or at risk in Northeastern Massachusetts.** The study format is based upon years of intensive field and lab observations by Dr. Gegear, which correlate at-risk bee and butterfly species with particular pollen, nectar and host plants, as well as nesting preferences. It is expected that populations of the at-risk bee and butterfly species targeted in this Plan will not only be observed, but sustained on each site in Years Two, Three and beyond.

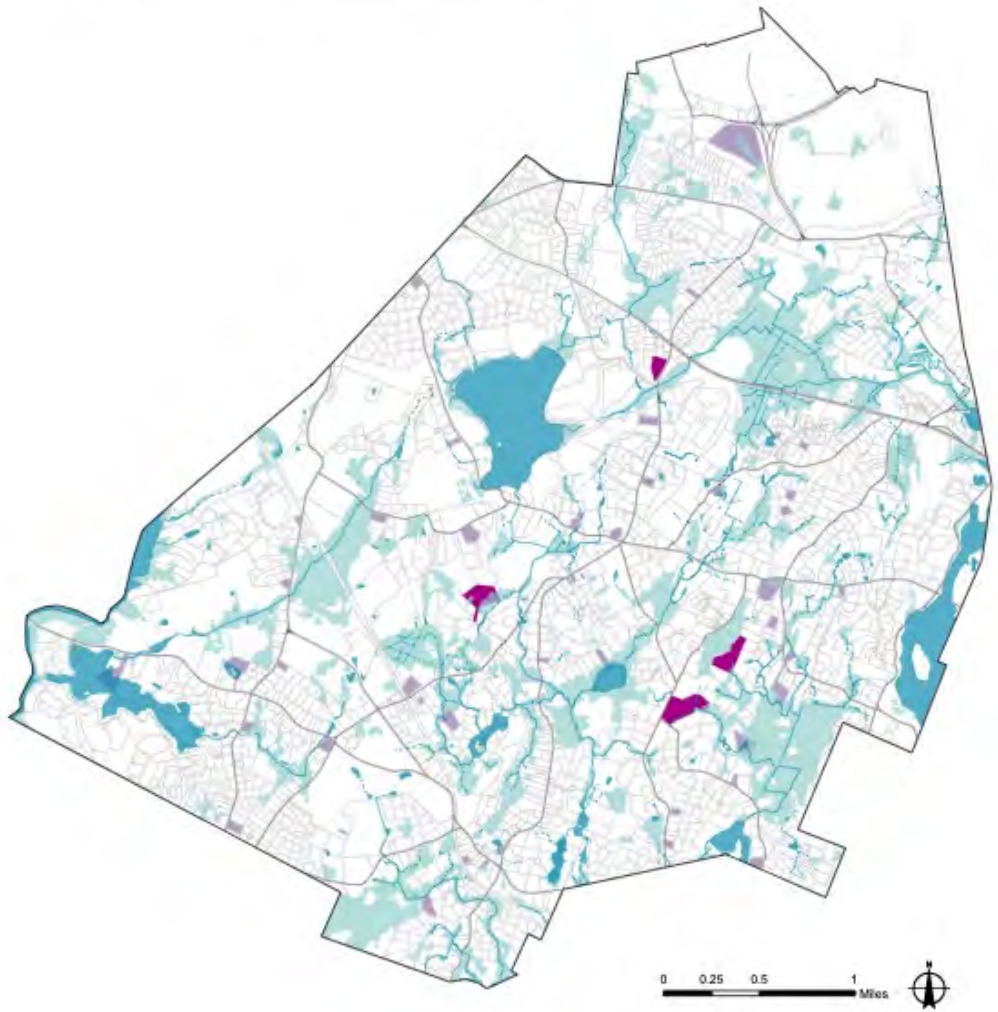
After kicking off Lincoln's Pollinator Action Plan programming with a public presentation in January 2020, Dr. Gegear offered workshops in Lincoln during the spring and summer, as well as an online tutorial, in order to recruit citizens to collect data on bumblebee species distributions in Lincoln using the **Beecology** app he created (https://beecology.wpi.edu). Videos and photographs of bumblebees on plants are taken on a smartphone or tablet and uploaded through the app. Dr. Gegear and members of his lab verify every bumblebee and plant ID before they are added to the database.

Another highly valuable visual resource for aspiring citizen scientists emerged in the summer of 2020, when renowned photographer, wildlife observer and Lincoln resident Norm Levey released **Bombus: The Bumblebees of Lincoln**, a bee ID video published in collaboration with Beecology and the Lincoln Land Conservation Trust. Billed as "a virtual walk in the People for Pollinators meadow and other locations in the town to meet the local bumblebees," the 13 minute video is an excellent tool for learning how to differentiate between seven different species of bumblebee presently abiding in Lincoln.

To become a Beecologist you can get started at: https://beecology.wpi.edu/website/participate#apps

This page: video stills from Bombus: The Bumblebees of Lincoln *filmed and produced by Norm Levey/The Natural World in Lincoln. https://theindwellingspider.wordpress.com/video/bombus-the-bumblebees-of-lincoln/ Opposite: Beecology workshop hosted by Dr. Gegear. Photographs by Bryn Gingrich, Outreach Director, Lincoln Land Conservation Trust.*

Toolkit sites seen in correlation to the 43 properties in Lincoln that installed plant kits based on the Birches School landscape design, which were sold through a plant sale by LLCT. The plants were selected to support at-risk bumblebee and butterfly species in Eastern Massachusetts specifically, rather than species whose populations are stable. A buffer of 500 feet was added to each property, representing the average foraging range of a native bee, in an attempt to depict opportunities for habitat connectivity across the town-wide landscape. While many solitary bee species forage limited distances from their nests, bumblebee species are known to forage much farther than 500 feet, as are many butterfly species.



POLLINATOR CORRIDOR PHASE 1 SITES

Toolkit sites and properties in Lincoln with pollinator habitat installed

- Toolkit Sites
- Properties in Lincoln with Toolkit Plants Installed
- Average Native Bee Foraging Range (500 ft.)
- Open Water
- Wetlands
- Perennial Stream
- Intermittent Stream
- Roads

Baseline
Survey Results

Across the Year One (2020) growing season, Dr. Gegear surveyed three of the Toolkit sites in Lincoln (People for Pollinators, Upper Browning Fields and Chapman Pasture) for bumblebee and butterfly species at risk in Northeastern Massachusetts. His observations were compared to historical data for pollinator species in the area, and inform the plant selection and habitat establishment recommendations for each site, outlined on the following pages.

This baseline data will be compared to subsequent surveys in 2021 and 2022 (Years Two and Three) after the planting designs and landscape management guidelines outlined in each site's Toolkit have been implemented. This will demonstrate the significance of species-level plant selection and in particular, of combining specific groups of plant species together on a site, to not only attract but sustain populations of pollinator species that are of the highest conservation priority. This science-based approach to landscape biodiversity design is at the core of the work that Landscape Interactions does.

INITIAL SURVEY REPORTS FOR BUMBLEBEE AND BUTTERFLY SPECIES AT RISK
(Year 1, 2020 season)

Robert J. Gegear

Historical records of bumblebee species relative abundance and distribution data were obtained from the Yale Peabody Museum for areas close to the study sites in Lincoln. Surveys of bumblebees and at-risk butterflies were taken in spring, summer and fall (one survey per time period). Bumblebee surveys included all species historically present in the area whereas butterfly surveys focused only on species at risk.

The following common bumblebee species were recorded at both People for Pollinators and Upper Browning Fields: *Bombus impatiens, B. griseocollis, B. perplexus* and *B. bimaculatus*. The at-risk *B. fervidus* and *B. vagans* were also observed at People for Pollinators and Upper Browning Fields. Chapman Pasture only had *B. impatiens* and one *B. fervidus* worker. *B. sandersoni*, which is a rare species with stable numbers, was not observed at any site.

It must be noted that Chapman Pasture had unusually low bee activity due to the lack of diverse floral resources (nesting habitat, however, seemed good for all species at Chapman Pasture).

A list of the target species expected to be at each site based on historical records is provided on the following page. I also provide an assessment below of the overall abundance and diversity of flower visitors (low, moderate, high) given site size.

Note: only at-risk butterflies were surveyed. None were found on any site.

SUMMARY FINDINGS:

People for Pollinators: High abundance, high diversity;
Upper Browning Fields: High abundance, moderate diversity;
Chapman Pasture: Low abundance, low diversity.

Left: Dr. Gegear surveying bumblebees in Lincoln. Photograph by Bryn Gingrich.

Photographs (clockwise from top): Aphrodite Fritillary by Andrea Janda; Bombus pensylvanicus by Matthew Beziat; Bog Coppers by Jim Brighton; Bombus affinis by Serina Jepsen (opposite page).

At-Risk Pollinators
Supported by this Plan

BEES:

- *Bombus affinis* Rusty patched bumblebee
- *Bombus fervidus* Golden northern bumblebee
- *Bombus pensylvanicus* American bumblebee
- *Bombus vagans* Half-black bumblebee

BUTTERFLIES:

- *Amblyscirtes hegon* Pepper and Salt Skipper
- *Callophrys gryneus* Juniper Hairstreak
- *Callophrys hesseli* Hessel's Hairstreak
- *Callophrys irus* Frosted Elfin
- *Carterocephalus palaemon* Arctic Skipper
- *Chlosyne harrisii* Harris' Checkerspot
- *Euphyes conspicua* Black Dash
- *Hesperia leonardus* Leonard's Skipper
- *Hesperia metea* Cobweb Skipper
- *Hesperia sassacus* Indian Skipper
- *Lycaena epixanthe* Bog Copper
- *Lycaena hyllus* Bronze Copper
- *Poanes massasoit* Mulberry Wing
- *Satyrium acadica* Acadian Hairstreak
- *Satyrium favonius* Oak Hairstreak
- *Speyeria aphrodite* Aphrodite Fritillary

BIGGEST THREATS FACING POLLINATORS

- Habitat Loss *(agriculture + human development)*
- Pesticides
- Climate Change







Recommended Plants
for Northeastern Massachusetts*

Latin Name	Common Name
Agastache scrophulariifolia	Purple giant hyssop
Andropogon gerardii	Big bluestem
Asclepias incarnata	Swamp milkweed
Asclepias syriaca	Common milkweed
Asclepias tuberosa	Butterfly milkweed
Baptisia tinctoria	Yellow wild indigo
Carex spp.	Sedges
Cephalanthus occidentalis	Buttonbush
Cercis canadensis	Redbud
Chamaecyparis thyoides	Atlantic white cedar
Cirsium discolor	Field thistle
Cirsium pumilum	Pasture thistle
Desmodium canadense	Showy tick-trefoil
Diervilla lonicera	Northern bush honeysuckle
Doellingeria umbellata	Tall white aster
Eutrochium dubium	Coastal plain Joe-Pye weed
Eutrochium fistulosum	Hollow Joe-Pye weed
Eutrochium maculatum	Spotted Joe-Pye weed
Eutrochium purpureum	Purple Joe-Pye weed
Geranium maculatum	Spotted crane's-bill
Hypericum ascyron	Great St. John's-wort
Hypericum prolificum	Shrubby St. John's-wort
Hypericum punctatum	Spotted St. John's-wort
Impatiens capensis	Spotted touch-me-not
Juniperus virginiana	Eastern red cedar
Lupinus perennis	Wild lupine
Mimulus alatus	Winged monkey flower
Mimulus ringens	Allegheny monkey flower

Latin Name	Common Name
Monarda didyma	Scarlet bee balm
Monarda fistulosa	Wild bergamot
Panicum virgatum	Switchgrass
Pedicularis canadensis	Canadian lousewort
Penstemon digitalis	Foxglove beardtongue
Penstemon hirsutus	Northeastern beardtongue
Prunella vulgaris ssp. lanceolata	Common selfheal
Prunus maritima	Beach plum
Quercus ilicifolia	Scrub oak
Quercus spp.	Oaks
Rosa carolina	Carolina rose
Rosa palustris	Swamp rose
Rosa virginiana	Virginia rose
Rubus allegheniensis	Common blackberry
Rubus odoratus	Purple-flowering raspberry
Rubus pensilvanicus	Pennsylvania blackberry
Rubus vermontanus	Vermont blackberry
Rumex altissimus	Pale dock
Rumex spp.	Water dock (native)
Salix bebbiana	Bebb's willow (male)
Salix discolor	Pussy willow (male)
Salix humilis	Prairie willow (male)
Salix lucida	Shining willow (male)
Salix petiolaris	Meadow willow (male)
Schizachyrium scoparium	Little bluestem
Scutellaria galericulata	Hooded skullcap
Scutellaria lateriflora	Mad dog skullcap
Solidago caesia	Axillary goldenrod

Plant recommendations are site-specific and based on landscape conditions at the Toolkit sites, however, the sites chosen represent a wide range of habitat types, land use, soils and hydrological conditions.

Opposite page, clockwise from bottom: Zizia aurea; Vaccinium angustifolium; Rubus odoratus; Ribes rubrum; Penstemon hirsutus; Bombus ternarius on Salix discolor; Spirea alba. This page, from top: Baptisia tinctoria; Carex stricta; Prunus maritima; Vaccinium macrocarpon; Schizachyrium scoparium; Scutellaria galericulata; Lupinus perennis.

Latin Name	Common Name
Solidago flexicaulis	Zig-zag goldenrod
Solidago juncea	Early goldenrod
Solidago odora	Sweet goldenrod
Solidago puberola	Downy goldenrod
Solidago sempervirens	Seaside goldenrod
Solidago speciosa	Showy goldenrod
Spiraea alba	White meadowsweet
Spiraea tomentosa	Steeplebush
Symphyotrichum laterifolium	Calico American-aster

Latin Name	Common Name
Vaccinium angustifolium	Lowbush blueberry
Vaccinium corymbosum	Highbush blueberry
Vaccinium macrocarpon	Large cranberry
Vaccinium oxycoccos	Small cranberry
Vaccinium pallidum	Hillside blueberry
Viola spp.	Violets (native)
Zizia aptera	Heart-leaved golden Alexanders
Zizia aurea	Common golden Alexanders





Toolkit
Sites

1. MEADOW & WOODLAND
   PEOPLE FOR POLLINATORS
2. OLD FIELD
   CHAPMAN PASTURE
3. WET MEADOW
   UPPER BROWNING FIELDS
4. GARDEN & LAWN
   BIRCHES SCHOOL

Conceptual rendering of the Chapman Pasture landscape design by Evan Abramson.

Meadow & Woodland Toolkit

PEOPLE FOR POLLINATORS

EXISTING CONDITIONS

People for Pollinators is a 8,700 sq.ft planted meadow surrounded by fencing, with a planted shrub layer on the south side of the fence, adjacent to woodland edges and open fields abutting the Lincoln Public Schools property. The site is situated on the northernmost portion of a 10.2-acre site owned and protected by LLCT. The soils are mesic and nearly all of the site is in full sun.

Since 2016, LLCT has managed the site for native pollinators by direct seeding and planting a variety of forbs, graminoids and shrubs. Approximately 25-35% of the fenced in meadow remains as non-native grasses and common weeds.

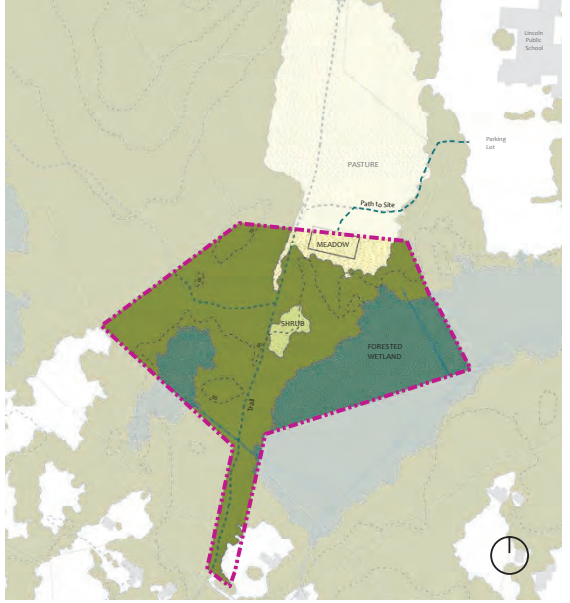
After an initial survey of plant species diversity on the site by Evan Abramson and Adam Kohl of Landscape Interactions in 2019, Dr. Gegear surveyed the site for bumblebees and at-risk butterflies multiple times in 2020. While pollinator populations at the site were categorized as "high abundance, high diversity" by Dr. Gegear, a lot of room remains for improvement, not only in native plant species diversity (early season pollen sources and host plants in particular) but also with regards to aesthetics and the visitor experience.

LLCT's goals for the site include expanding public education and programming; access to the location, therefore, needs to be more clear and welcoming. The meadow is currently surrounded by an 8 ft. tall chain link fence, with only one gate for entry, situated on the northern side. The fence was initially installed to prevent deer browse and to deter dog walkers from allowing their dogs off leash. The location is somewhat hard to find, although it is marked by a sign at the edge of the Lincoln Public Schools parking lot. A narrow path through woods and a field leads visitors to the site, with a mowed section of path branching off to the south and leading up to the fence.

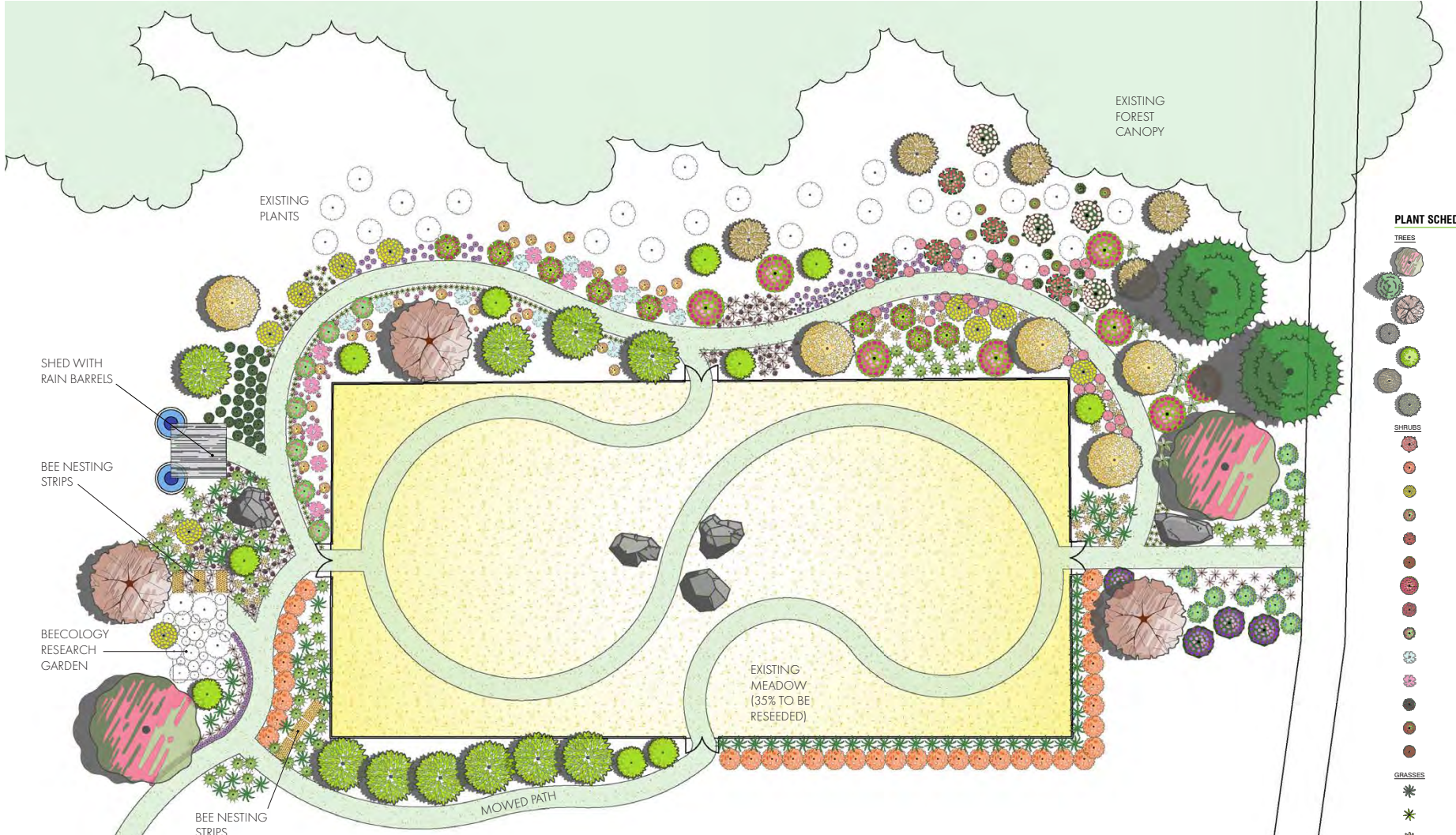
While LLCT has been actively stewarding People for Pollinators for several years, no permanent water source exists and establishing new plantings remains a challenge. Additionally, the shrubs planted between the fence and the surrounding woods are being pressured by invasive oriental bittersweet and weeds.

Paths within the meadow and shrub areas are not clearly defined or do not exist, and in order to access the shrubs visitors have to exit the meadow through the gate on the opposite side and walk around the fence. No seating or shade areas exist at the site, nor is there a gathering space for workshops.

After a number of site visits and conversations between designer Evan Abramson and LLCT staff, it was determined that a small gathering space should be added, with a slanted roof to allow for rainwater catchment. The fence will be reduced to a 2' height to deter dogs, with winding paths and gates connecting the various areas to each other. Plant species diversity on the site will be vastly widened per Dr. Gegear's recommendations in order to attract and sustain a long list of threatened and at risk species from early spring to late fall. Sitting areas will offer visitors the opportunity to take in the site's abundance and diversity at their own pace.



Composite panorama of field botanist Adam Kohl at People for Pollinators in 2019. Pollinator-supporting plants well established on the site include Asclepias incarnata, Eutrochium fistulosum, Monarda fistulosa, Penstemon digitalis, Salix lucida, S. petiolaris, Symphyotrichum novae-angliae, Vaccinium corymbosum and Zizia aurea. Opposite: sign at site entrance. Photographs by Evan Abramson.



Meadow & Woodland Toolkit

PEOPLE FOR POLLINATORS

LANDSCAPE|NTERACTIONS
16 Center Street #426
Northampton, MA 01060
landscapeinteractions.com

0 3 7.5 15 30

EXISTING
MOWED
PATH

SITE CONDITIONS

MEDIUM TO MOIST SOILS
FULL SUN TO PART-SHADE
MODERATE FOOT TRAFFIC
FORMER HAY FIELD

PLANT SCHEDULE

TREES	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Cercis canadensis	Eastern Redbud	2	20` wide spacing
	Chamaecyparis thyoides	Atlantic White Cedar	2	20` wide spacing
	Quercus ilicifolia	Scrub Oak	3	15` wide spacing
	Salix discolor	Pussy Willow	5	8` wide spacing
	Salix humilis	Prairie Willow	10	6` wide spacing
	Salix lucida	Shining Willow	5	10` wide spacing
	Salix petiolaris	Meadow Willow	10	10` wide spacing
SHRUBS	**BOTANICAL NAME**	**COMMON NAME**	**QTY**	**REMARKS**
	Cephalanthus occidentalis	Buttonbush	4	6` wide spacing
	Diervilla lonicera	Northern Bush-honeysuckle	36	4` wide spacing
	Hypericum prolificum	Shrubby St. John`s-wort	10	5` wide spacing
	Rosa carolina	Carolina Rose	7	4` wide spacing
	Rosa palustris	Swamp Rose	5	5` wide spacing
	Rosa virginiana	Virginia Rose	9	5` wide spacing
	Rubus odoratus	Purple-flowering Raspberry	8	7` wide spacing
	Rubus pensilvanicus	Pennsylvania Blackberry	4	6` wide spacing
	Rubus vermontanus	Vermont Blackberry	10	4` wide spacing
	Spiraea alba	Meadowsweet	10	3` wide spacing
	Spiraea tomentosa	Steeplebush	10	3` wide spacing
	Vaccinium macrocarpon	American Cranberry	7	2` wide spacing
	Vaccinium oxycoccos	Small Cranberry	7	2` wide spacing
	Vaccinium pallidum	Hillside Blueberry	30	2` wide spacing
GRASSES	**BOTANICAL NAME**	**COMMON NAME**	**QTY**	**REMARKS**
	Andropogon gerardii	Big Bluestem	75	3` wide spacing
	Carex pensylvanica	Pennsylvania Sedge	125	1` wide spacing
	Chasmanthium latifolium	River Oats	40	2` wide spacing
	Panicum virgatum	Switchgrass	70	3` wide spacing
	Schizachyrium scoparium	Little Bluestem	100	2` wide spacing
PERENNIALS	**BOTANICAL NAME**	**COMMON NAME**	**QTY**	**REMARKS**
	Cirsium pumilum	Pasture Thistle	50	1` wide spacing
	Eutrochium dubium	Coastal Plain Joe-Pye Weed	36	2` wide spacing
	Hypericum ascyron	Giant St. John`s-wort	26	2` wide spacing
	Pedicularis canadensis	Canadian Wood Betony	80	1` wide spacing
	Prunella vulgaris	Selfheal	116	1` wide spacing
	Rumex altissimus	Pale Dock	12	2` wide spacing
	Viola pedata	Bird`s-foot Violet	40	.5` wide spacing
GROUND COVERS	**BOTANICAL NAME**	**COMMON NAME**	**QTY**	**REMARKS**
	Dry Mix	Upland Meadow Seed Mix	8,714 sf	Seed 35% of total area

Refer to the following page for more information on the plants in the design.

Old Field Toolkit

CHAPMAN PASTURE

EXISTING CONDITIONS

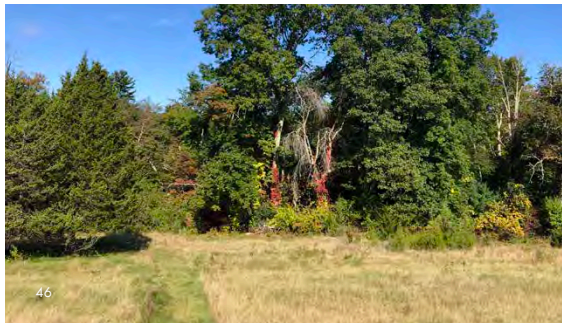
Chapman Pasture is a rolling 8-acre grassland that was grazed with sheep for over forty years. The property is unique in that its vegetation is relatively consistent: upland areas of the site are almost all non-native grasses that reach a mature height of less than 3 feet. The property forms part of a contiguous 95-acre corridor of protected land owned and managed by LLCT.

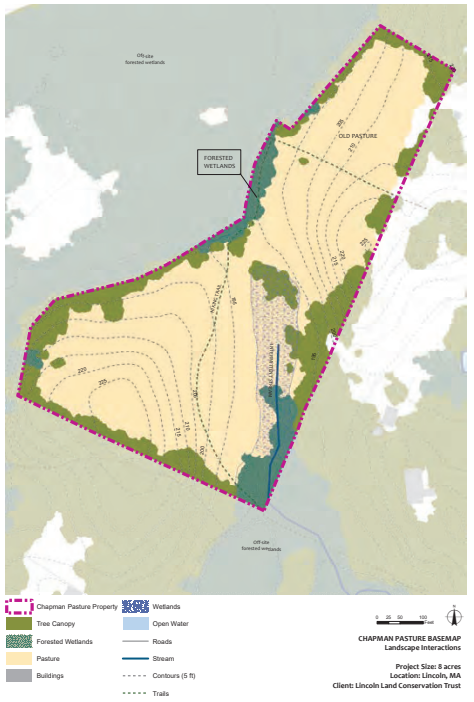
Forested wetlands border the site on both northwest and southeast sides, with an intermittent stream running northward through the center of the field from the southeast corner of the property. This stream, combined with the topography of the site, creates a low point in the center of the field, a wet swale which is comprised predominantly of native vegetation.

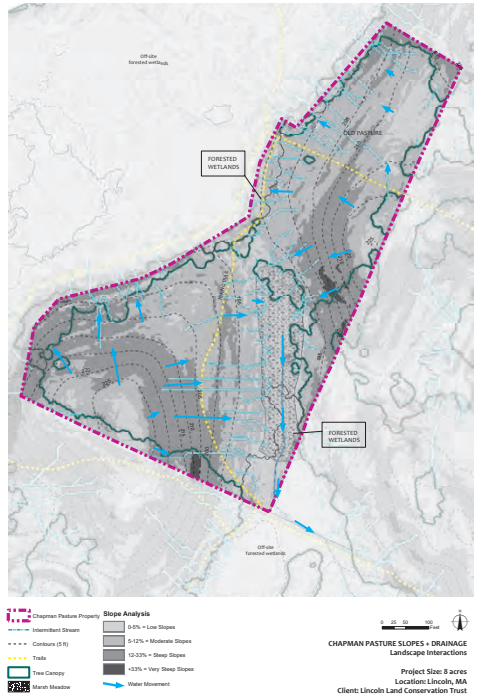
Whereas the upland two-thirds of the site are dominated by non-native grasses with small patches of early successional *Pinus strobus* (White pine) and *Juniperus virginiana* (Eastern red cedar), this wet swale contains a somewhat limited range of plants that support threatened pollinator species, including *Carex vulpinoidea* (Common fox sedge), *Asclepias incarnata* (Swamp milkweed), *Symphyotrichum nove-belgii* (New York American-aster) and *Solidago gigantea* (Smooth goldenrod). Field borders and forest edges contain significant portions of invasive *Celastrus orbiculatus* (Oriental bittersweet) as well as *Rosa multiflora* (Multiflora rose).

While Chapman Pasture is somewhat secluded, the site is open to the public and one point of access originates from another Toolkit site, Upper Browning Fields. LLCT is committed to converting the low habitat value of the grasses at Chapman Pasture to a diverse pollinator meadow with shrub areas. Seven bird boxes at Chapman Pasture are monitored for Eastern Bluebirds and Tree Swallows by a dedicated LLCT volunteer. Enhancements to the site will benefit these birds and wildlife at other trophic levels.

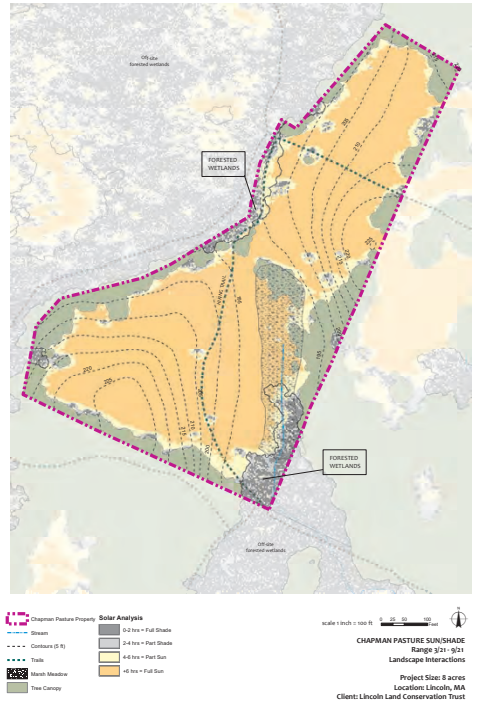
Due in large part to the dominance of the non-native grasses on the site, as well as the large scale of the property, Landscape Interactions proposed that prescribed fire be used to clear the site of existing vegetation and expose the soil for seeding. A proposal was prepared by LLCT and Landscape Interactions and sent to U.S. Fish & Wildlife Service. After visiting the site and learning more about LLCT's town-wide effort to target threatened pollinator species, USFWS agreed to fund a burn plan for the site, and to help find a team to execute the burn. USFWS will clear approximately one acre of field edges in preparation for the burn, which is scheduled for early spring 2021.







Above and right: some of the site analyses created to interpret the Chapman Pasture site and develop recommendations for habitat conversion and design. Clockwise from top left: Basemap, Slopes and Drainage, Sun and Shade. Below: existing conditions at the Chapman Pasture site in September, 2019. Opposite: Oriental bittersweet climbing a tree at the field edges.



SITE CONDITIONS

DRY SOILS & MOIST TO WET SOILS
FULL SUN & PART SHADE
NATURALIZED LANDSCAPE
OLD FIELD GRASSLAND

PLANT SCHEDULE

TREES	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Cercis canadensis	Eastern Redbud	4	20` wide spacing
	Quercus ilicifolia	Scrub Oak	6	15` wide spacing
	Salix bebbiana	Beaked Willow	6	20` wide spacing
	Salix discolor	Pussy Willow	12	8` wide spacing
	Salix humilis	Prairie Willow	10	6` wide spacing
	Salix lucida	Shining Willow	10	10` wide spacing
	Salix petiolaris	Meadow Willow	10	10` wide spacing
SHRUBS	**BOTANICAL NAME**	**COMMON NAME**	**QTY**	**REMARKS**
	Cephalanthus occidentalis	Buttonbush	10	6` wide spacing
	Diervilla lonicera	Northern Bush-honeysuckle	12	4` wide spacing
	Hypericum prolificum	Shrubby St. John`s-wort	10	5` wide spacing
	Rosa carolina	Carolina Rose	8	4` wide spacing
	Rosa palustris	Swamp Rose	8	5` wide spacing
	Rosa virginiana	Virginia Rose	8	5` wide spacing
	Rubus odoratus	Purple-flowering Raspberry	8	7` wide spacing
	Rubus pensilvanicus	Pennsylvania Blackberry	10	6` wide spacing
	Rubus vermontanus	Vermont Blackberry	10	4` wide spacing
	Spiraea alba	Meadowsweet	22	3` wide spacing
	Spiraea tomentosa	Steeplebush	22	3` wide spacing
	Vaccinium angustifolium	Lowbush Blueberry	36	3` wide spacing
	Vaccinium corymbosum	Highbush Blueberry	24	8` wide spacing
	Vaccinium macrocarpon	American Cranberry	24	2` wide spacing
	Vaccinium oxycoccos	Small Cranberry	24	2` wide spacing
	Vaccinium pallidum	Hillside Blueberry	100	2` wide spacing
PERENNIALS	**BOTANICAL NAME**	**COMMON NAME**	**QTY**	**REMARKS**
	Cirsium pumilum	Pasture Thistle	20	1` wide spacing
	Eutrochium dubium	Coastal Plain Joe-Pye Weed	30	2` wide spacing
	Hypericum ascyron	Giant St. John`s-wort	20	2` wide spacing
	Pedicularis canadensis	Canadian Wood Betony	40	1` wide spacing
	Viola pedata	Bird`s-foot Violet	40	.5` wide spacing
GROUND COVERS	**BOTANICAL NAME**	**COMMON NAME**	**QTY**	**REMARKS**
	Dry Mix	Upland Meadow Seed Mix	265,186 sf	Min. 110 PLS/sq.ft
	Wet Mix	Wet Meadow Seed Mix	23,789 sf	Min. 110 PLS/sq.ft

100 FT.

Refer to the following page for more information regarding plants in the design.

Old Field Toolkit

CHAPMAN PASTURE

LANDSCAPE|NTERACTIONS
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Northampton, MA 01060
landscapeinteractions.com

Old Field Toolkit

CHAPMAN PASTURE

MANAGEMENT GUIDELINES

SITE ESTABLISHMENT

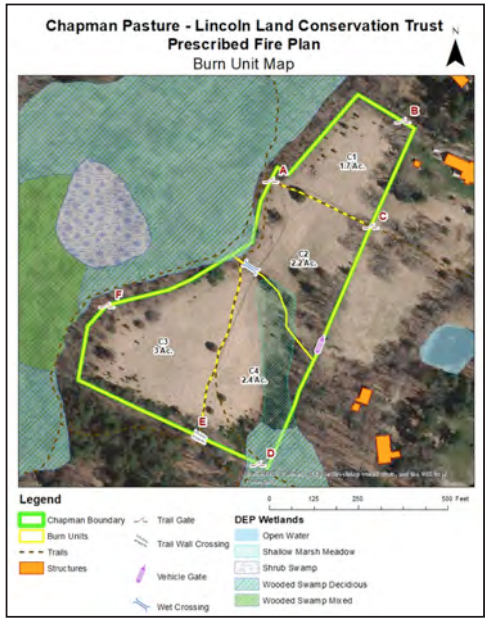
As mentioned, Chapman Pasture will be subject to prescribed fire in April 2021 as the initial method of site preparation for seeding. The burn will knock back non-native cool season grasses which dominate the site, expose the soil and encourage remnant native plant communities. As soon as 1 week following the burn, the wet swale can be planted with the recommended species depicted in the design. Additionally, exposed rocks and boulders on the site will be planted with the recommended arrangements of plants. Prescribed burns should continue on the site every 3-5 years as a primary method of vegetation management.

In late October or November 2021, the entire site should be mowed as close to the ground as possible, with the exception of those areas planted in the wet swale and in/around boulders in the field. If any emergent trees or invasives are found in the meadow during the 2021 growing season, they should be grubbed or pulled.

In November or December 2021, the wet and dry mixes should be seed drilled across the site, according to the areas outlined on the preceding page. If a seed drill is not available, the seed mixes may be broadcast; a harrow raking across the site may be required beforehand to ensure sufficient seed to soil contact (if drilling, no harrow raking is required). 100 lbs./acre of winter wheat cover crop should be added when fall seeding (if spring seeding, wild oats should be used instead). The plant lists for each seed mix are on the opposite page.

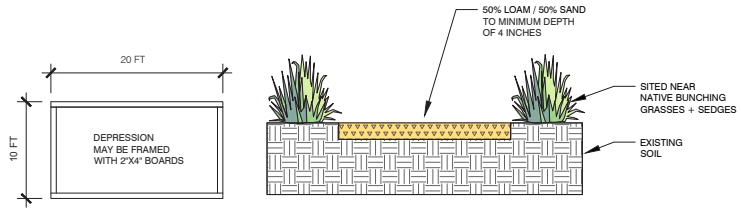
MOWING REGIMES

For the first growing season following seeding (2022), the entire site should be closely monitored for growth of vegetation. When the average height of vegetation in a given area is approximately 12 inches, the area should be brush hogged to a height of no less than 8 inches. This schedule should be continued throughout the first, and possibly second growing season.



Above: Map of burn unit areas from Chapman Pasture Prescribed Fire Plan courtesy Alex Entrup of Entrup Consulting. Left: Due in part to the scale and accessibility of the Chapman Pasture site, rather than having multiple 2'x4' nesting strips, it is recommended to create a single 10'x20' nesting location. Remove all vegetation and at least 4 inches of soil. 50% of the soil can be added back in mixed with 50% sand. The area should be well draining, in full sun and kept clear of weeds, grasses or other vegetation. Do not mulch.

BEE NESTING STRIP DETAIL



CHAPMAN PASTURE UPLAND MEADOW SEED MIX

Shrubs	
Spiraea alba	Meadowsweet
Spiraea tomentosa	Steeplebush
Forbs	
Agastache scrophulariifolia	Purple giant hyssop
Asclepias syriaca	Common milkweed
Asclepias tuberosa	Butterfly weed
Baptisia tinctoria	Yellow wild indigo
Cirsium discolor	Field thistle
Geranium maculatum	Spotted crane's-bill
Hypericum punctatum	Spotted St. John's-wort
Lupinus perennis	Wild lupine
Monarda fistulosa	Wild bergamot
Pedicularis canadensis	Canadian lousewort
Penstemon digitalis	Foxglove beardtongue
Penstemon hirsutus	Northeastern beardtongue
Prunella vulgaris ssp. lanceolata	Common selfheal
Solidago odora	Sweet goldenrod
Solidago speciosa	Showy goldenrod
Symphyotrichum lateriflorum	Calico American-aster
Zizia aptera	Heart-leaf golden Alexanders
Zizia aurea	Golden Alexanders
Graminoids	
Andropogon gerardii	Big bluestem
Carex blanda	Common wood sedge
Carex brevior	Plains oval sedge
Panicum virgatum	Switchgrass
Schizachyrium scoparium	Little bluestem

CHAPMAN PASTURE WET MEADOW SEED MIX

Forbs	
Asclepias incarnata	Swamp milkweed
Doellingeria umbellata	Tall white aster
Eutrochium fistulosum	Hollow Joe-Pye weed
Eutrochium maculatum	Spotted Joe-Pye weed
Eutrochium purpureum	Purple Joe-Pye weed
Impatiens capensis	Spotted touch-me-not
Mimulus alatus	Winged monkey flower
Mimulus ringens	Allegheny monkey flower
Rumex orbiculatus	Great Water Dock
Scutellaria galericulata	Hooded skullcap
Scutellaria lateriflora	Mad dog skullcap
Graminoids	
Andropogon gerardii	Big bluestem
Carex blanda	Common wood sedge
Carex brevior	Plains oval sedge
Panicum virgatum	Switchgrass

If during the second growing season, the majority of vegetation on the site or in a given area appears to remain non-native grasses, then continue mowing to keep the overall height of plants between 8-12 inches. This regime should be followed until the third growing season.

No-till seed drills such as the Flex by Truax pictured above are ideally suited for largescale native seeding without the need for raking. ***Sites should never be tilled before seeding native species, as doing so brings dormant weed seeds to the surface, increasing competition.***

In the second growing season (2023), the site should be periodically assessed by a botanist or other individual with vetted plant identification skills. If the majority of vegetation on the site or in a given area is native species from the mixes which were seeded, then the mowing schedule for the site or that area may be transitioned to a once-a-year mow. This should always occur during the dormant season (after November 15 or before April 1), after plants have gone to seed or before they begin next season's growth. Ideally, the site would be broken up into 2 or 3 sections, with each section being mowed once a year on a rotational basis. During this annual mow, vegetation should be cut to a height of 4-6 inches.

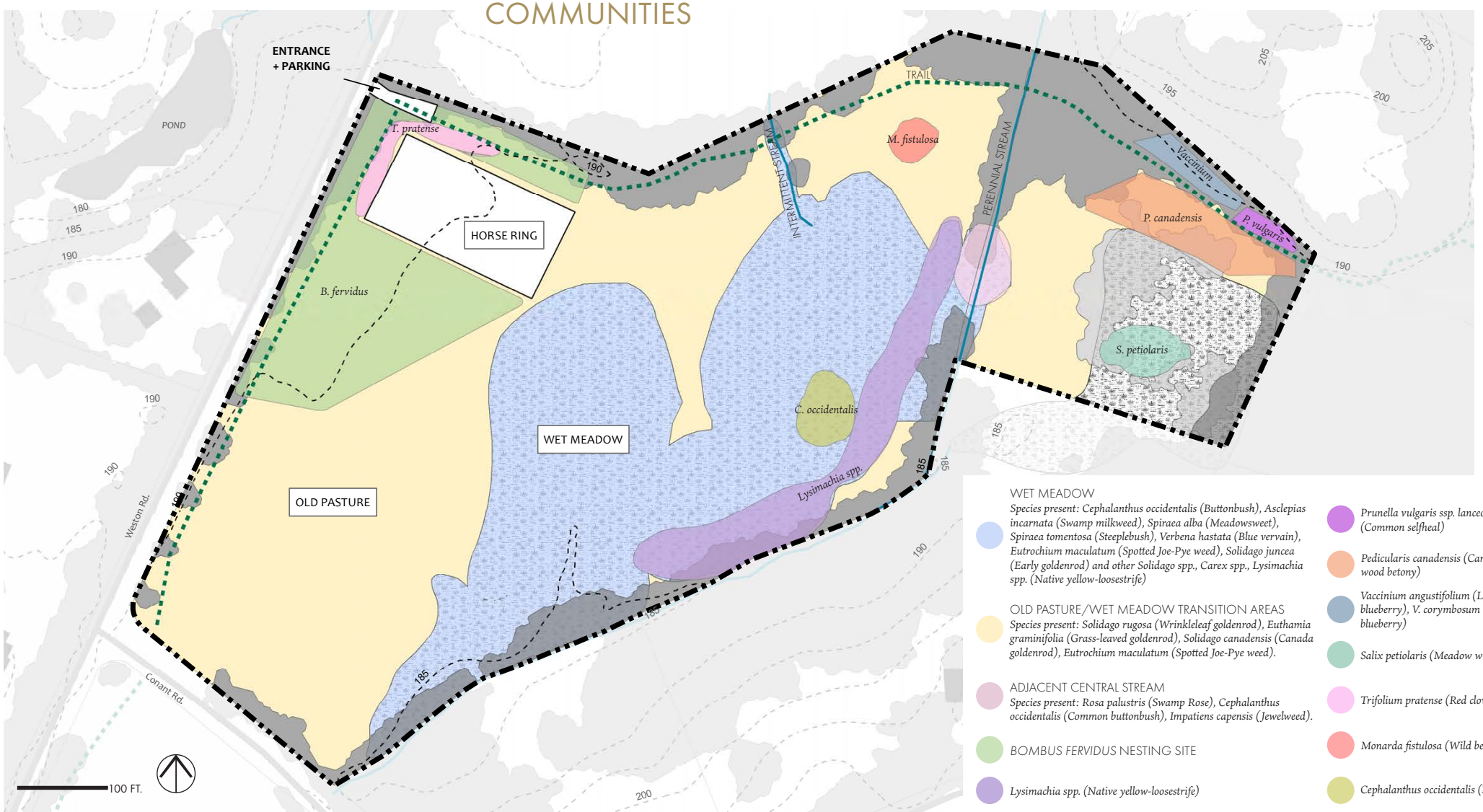
By the end of the third growing season (2024), the site should be ready for transition to an annual mow on a rotational basis. Invasive species and early successional trees in the open portions of the site should be closely monitored throughout, and either manually grubbed using a weed wrench ("Pullerbear" brand) or mechanically grubbed using a brush grubber ("Brush Grubber" brand) mounted on a tractor, ATV or pickup truck.

Wet Meadow Toolkit

UPPER BROWNING FIELDS

ECOLOGICAL COMMUNITIES

This map of plant species locations on Upper Browning Fields and the mowing/management guidelines presented in the map on the following pages were provided to Lincoln Conservation Department staff and LLCT in the early fall of 2020, to help interpret the varying ecosystems and plant communities present on the site, and understand the diverse management methods each unique area requires in order to better steward the landscape for at-risk pollinators.



WET MEADOW
Species present: Cephalanthus occidentalis (Buttonbush), Asclepias incarnata (Swamp milkweed), Spiraea alba (Meadowsweet), Spiraea tomentosa (Steeplebush), Verbena hastata (Blue vervain), Eutrochium maculatum (Spotted Joe-Pye weed), Solidago juncea (Early goldenrod) and other Solidago spp., Carex spp., Lysimachia spp. (Native yellow-loosestrife)

OLD PASTURE/WET MEADOW TRANSITION AREAS
Species present: Solidago rugosa (Wrinkleleaf goldenrod), Euthamia graminifolia (Grass-leaved goldenrod), Solidago canadensis (Canada goldenrod), Eutrochium maculatum (Spotted Joe-Pye weed).

ADJACENT CENTRAL STREAM
Species present: Rosa palustris (Swamp Rose), Cephalanthus occidentalis (Common buttonbush), Impatiens capensis (Jewelweed).

BOMBUS FERVIDUS NESTING SITE

Lysimachia spp. (Native yellow-loosestrife)

Prunella vulgaris ssp. lanceolata (Common selfheal)

Pedicularis canadensis (Canadian wood betony)

Vaccinium angustifolium (Lowbush blueberry), V. corymbosum (Highbush blueberry)

Salix petiolaris (Meadow willow)

Trifolium pratense (Red clover)

Monarda fistulosa (Wild bergamot)

Cephalanthus occidentalis (Buttonbush)

Wet Meadow Toolkit

UPPER BROWNING FIELDS

LANDSCAPE|NTERACTIONS
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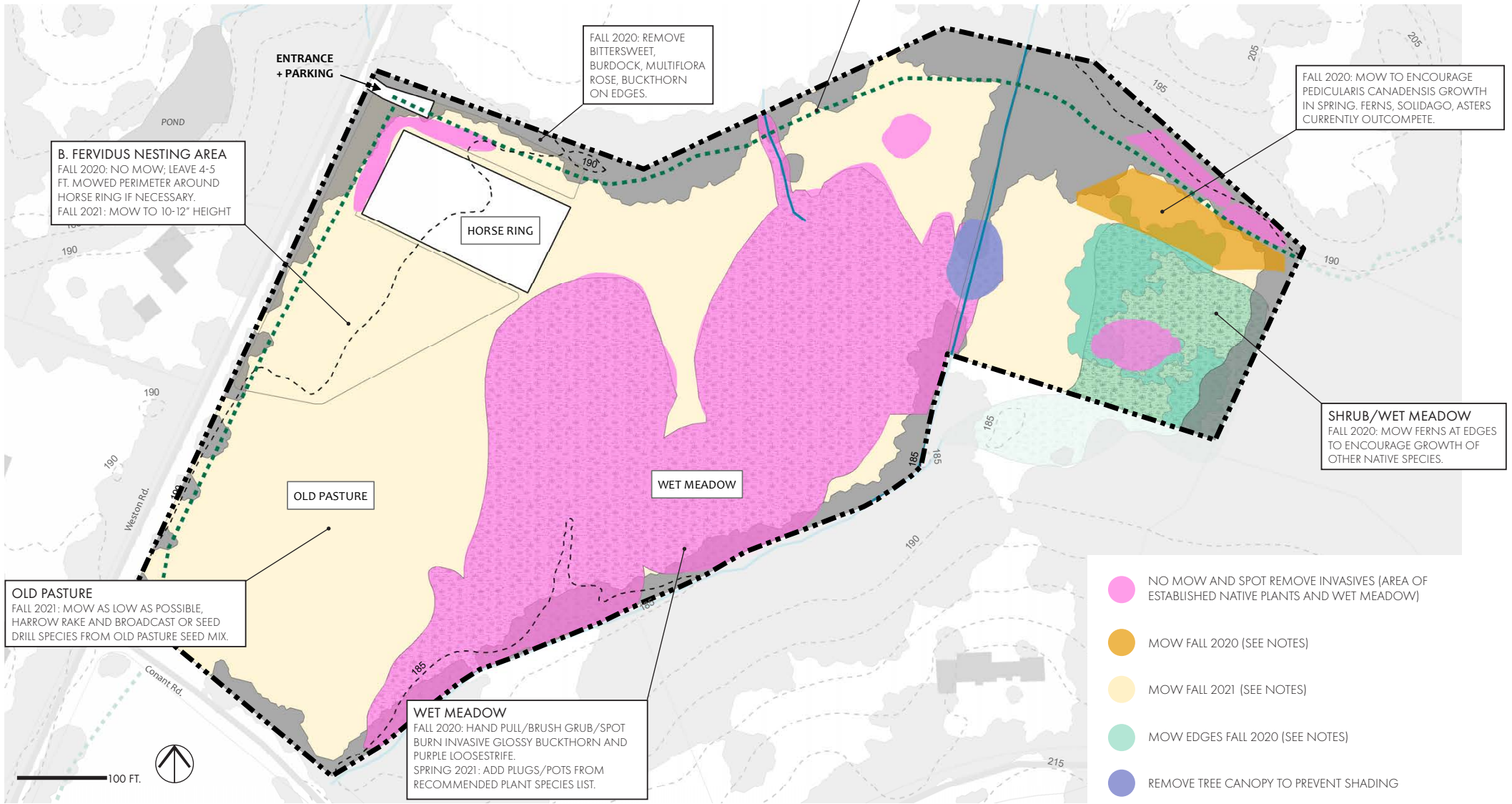
Northampton, MA 01060
landscapeinteractions.com

SITE CONDITIONS

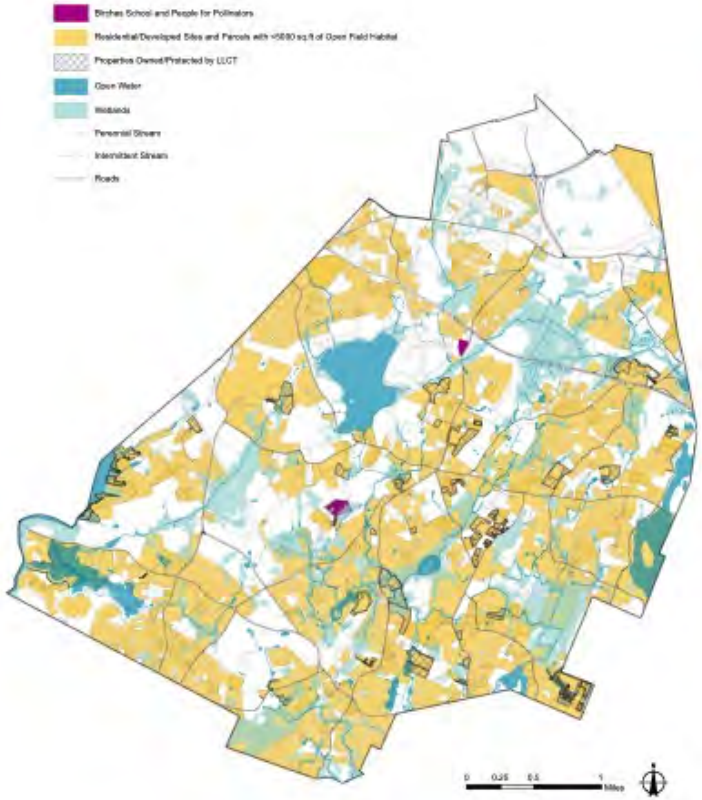
MEDIUM SOILS & WET SOILS
FULL SUN & PART SHADE
CONSERVATION HABITAT
WET MEADOW



Opportunities for Connectivity

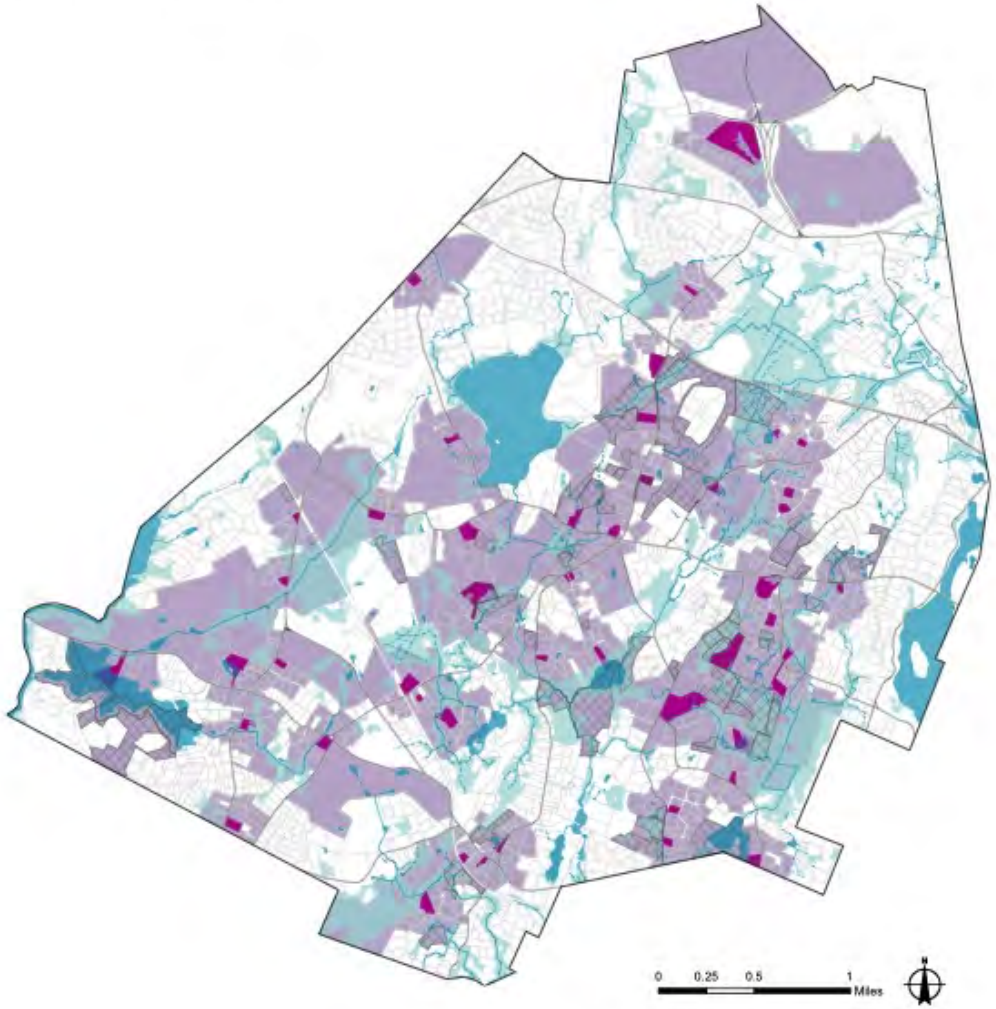
OPPORTUNITIES FOR BIRCHES SCHOOL AND PEOPLE FOR POLLINATORS TOOLKIT REPLICATION

Residential and developed properties in Lincoln and parcels with under 5000 sq.ft of open field habitat



Opportunities for replication of the Toolkit designs in Lincoln. Left: properties in yellow are zoned as residential or developed, or contain open field areas measuring less than 5000 sq.ft, similar conditions to the context in which the People for Pollinators and Birches School designs were created; center: properties in brown contain large areas of open grassland habitat, comparable to the Chapman Pasture site; right: properties in dark green contain wetlands, wet meadows or priority/estimated habitat of rare species, conditions which are analogous to the Upper Browning Fields site.

Properties that meet the replication criteria for one or more of the Toolkit designs based on their existing landscape typologies are seen in correlation to the Phase 1 Toolkit sites and properties with planting kits installed. All properties in lavender are within 500 feet of one or more of the Pollinator Corridor Phase 1 sites, and contain land use conditions or habitat features which are similar to one or more of the Toolkit sites. Right: with a 500 ft. buffer on every potential Phase 2 property, representing the average foraging range of a native bee species, a town-wide pollinator corridor in Lincoln is demonstrated, with overlapping flight ranges allowing for redundancy and further strengthening of the life stages of the target threatened species.



POLLINATOR CORRIDOR PHASE 2 SITES

Properties in Lincoln suitable for replication of Toolkit designs with maximum connectivity

- Toolkit Sites and Properties with Toolkit Plants Installed (Phase 1)
- Sites within 500 ft. of Phase 1 Sites That Meet Replication Criteria for One or More Toolkits
- Average Native Bee Foraging Range (500 ft.)
- Properties Owned/Protected by LLCT
- Open Water
- Wetlands
- Perennial Stream
- Intermittent Stream
- Roads


POLLINATOR

Pollinate Northampton

REPLICABLE AND SCALABLE
LANDSCAPE DESIGN TOOLKITS
TO SUPPORT POLLINATOR SPECIES AT RISK
IN THE CONNECTICUT RIVER VALLEY
OF MASSACHUSETTS

Evan Abramson, *Principal*
LANDSCAPE|NTERACTIONS

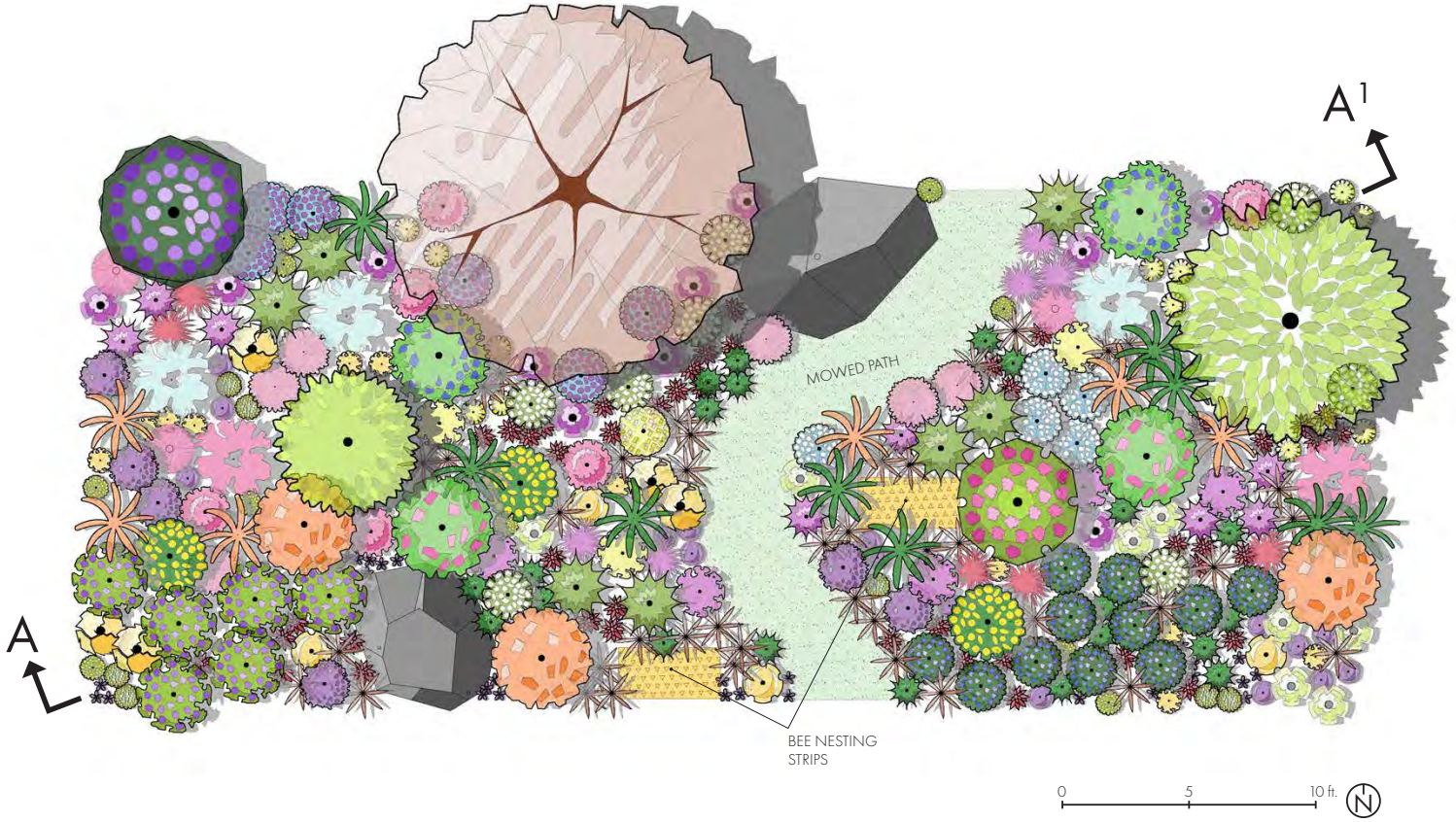
LANDSCAPE|NTERACTIONS 16 Center Street *426, Northampton, MA 01060 landscapeinteractions.com

Sun Garden Toolkit

NORTHAMPTON

LANDSCAPE|NTERACTIONS
16 Center Street #426
Northampton, MA 01060
landscapeinteractions.com

The plants in this design were selected for their propensity to thrive in full sun. Plants that are located north or beneath the canopy of taller plants are tolerant of part-shade. This design can easily be reworked to fit a range of layouts or conditions, including interspersing smaller groupings of plants within existing gardens and landscapes. Bee nesting strips can be created anywhere there is full sun and well-draining soils: remove at least 4 inches of existing vegetation and soil, and put back half the soil mixed with sand. Keep the area clear of plants at all times to allow ground nesting bees to access bare soil surface.



SITE CONDITIONS

DRY TO MEDIUM SOILS
FULL SUN
1000 SQ.FT

Sun Garden Toolkit

NORTHAMPTON

LANDSCAPE | INTERACTIONS
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Northampton, MA 01060
landscapeinteractions.com

PLANT SCHEDULE

TREES	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Quercus ilicifolia	Scrub Oak	1	15` wide spacing
	Salix humilis	Prairie Willow	1	6` wide spacing
	Salix petiolaris	Meadow Willow	1	10` wide spacing

SHRUBS	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Baptisia tinctoria	Yellow Wild Indigo	3	3` wide spacing
	Diervilla lonicera	Northern Bush-honeysuckle	3	4` wide spacing
	Rosa carolina	Carolina Rose	2	4` wide spacing
	Rosa virginiana	Virginia Rose	1	5` wide spacing
	Rubus pensilvanicus	Pennsylvania Blackberry	1	6` wide spacing
	Rubus vermontanus	Vermont Blackberry	2	4` wide spacing
	Spiraea alba	Meadowsweet	3	3` wide spacing
	Spiraea tomentosa	Steeplebush	2	3` wide spacing
	Vaccinium angustifolium	Lowbush Blueberry	6	3` wide spacing
	Vaccinium pallidum	Hillside Blueberry	11	2` wide spacing

BIENNIAL	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Cirsium pumilum	Pasture Thistle	3	2` wide spacing

GRASSES	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Andropogon gerardii	Big Bluestem	9	3` wide spacing
	Bromus kalmii	Prairie Brome	21	1` wide spacing
	Eragrostis spectabilis	Purple Love Grass	8	1-2` wide spacing
	Panicum virgatum	Switchgrass	7	3` wide spacing
	Schizachyrium scoparium	Little Bluestem	41	2` wide spacing
	Sorghastrum nutans	Indian Grass	6	2` wide spacing

PERENNIALS	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Agastache scrophulariifolia	Purple Giant Hyssop	6	2` wide spacing
	Asclepias syriaca	Common Milkweed	6	2` wide spacing
	Desmodium canadense	Showy Tick Trefoil	5	1-2` wide spacing
	Euthamia graminifolia	Grass-leaved Goldenrod	12	1` wide spacing
	Eutrochium dubium	Coastal Plain Joe-Pye Weed	6	2` wide spacing
	Hypericum ascyron	Giant St. John`s-wort	1	2` wide spacing
	Hypericum punctatum	Spotted St. John`s-wort	4	1` wide spacing
	Lupinus perennis	Wild Lupine	16	1` wide spacing
	Monarda didyma	Scarlet Bee Balm	5	2` wide spacing
	Monarda fistulosa	Wild Bergamot	5	2` wide spacing
	Pedicularis canadensis	Canadian Wood Betony	45	1` wide spacing
	Penstemon digitalis	Foxglove Beardtongue	8	1.5` wide spacing
	Penstemon hirsutus	Northeastern Beardtongue	11	1.5` wide spacing
	Solidago juncea	Early Goldenrod	11	1` wide spacing
	Solidago odora	Sweet Goldenrod	3	1-2` wide spacing
	Solidago speciosa	Showy Goldenrod	5	2` wide spacing
	Symphyotrichum laeve	Smooth Aster	5	1.5` wide spacing
	Symphyotrichum lateriflorum	Calico Aster	8	2` wide spacing
	Symphyotrichum novi-belgii	New York Aster	6	2` wide spacing
	Viola pedata	Bird`s-foot Violet	27	.5` wide spacing
	Zizia aptera	Heart-leaved Golden Alexanders	10	1` wide spacing
	Zizia aurea	Golden Alexanders	7	1` wide spacing

BEE NESTING STRIP DETAIL

Sidewalk Strip Toolkit

NORTHAMPTON

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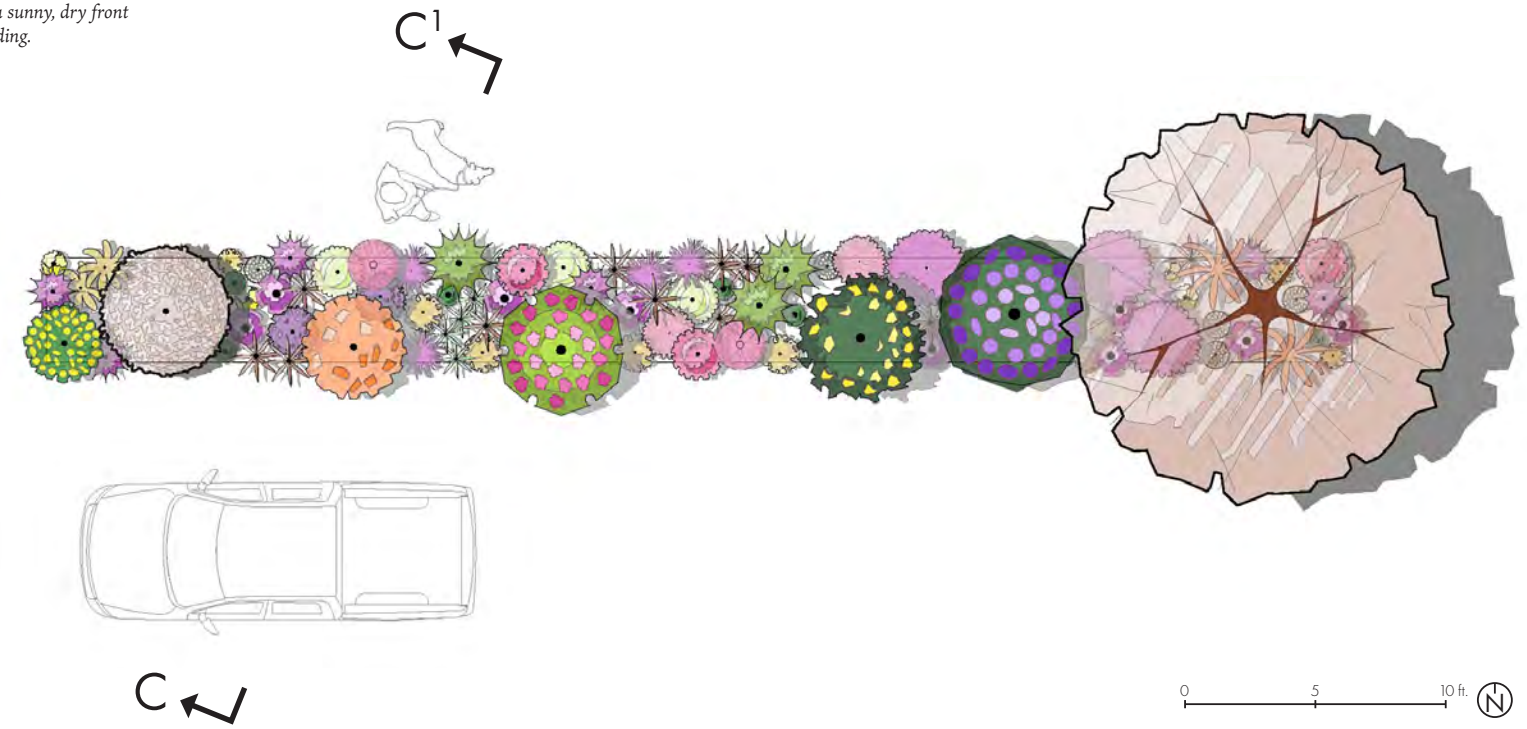
This assembly of hardy, salt and drought-tolerant plants survive the roughest of conditions. Many are less than 4' height or tolerate repeated cutting. The scrub oak and dwarf prairie willow are much shorter than most urban street trees and would fare well beneath power lines.

This design is also well suited for a sunny, dry front yard or south-facing side of a building.



SITE CONDITIONS

DRY SOILS
FULL SUN
200 SQ.FT

Wet Garden Toolkit

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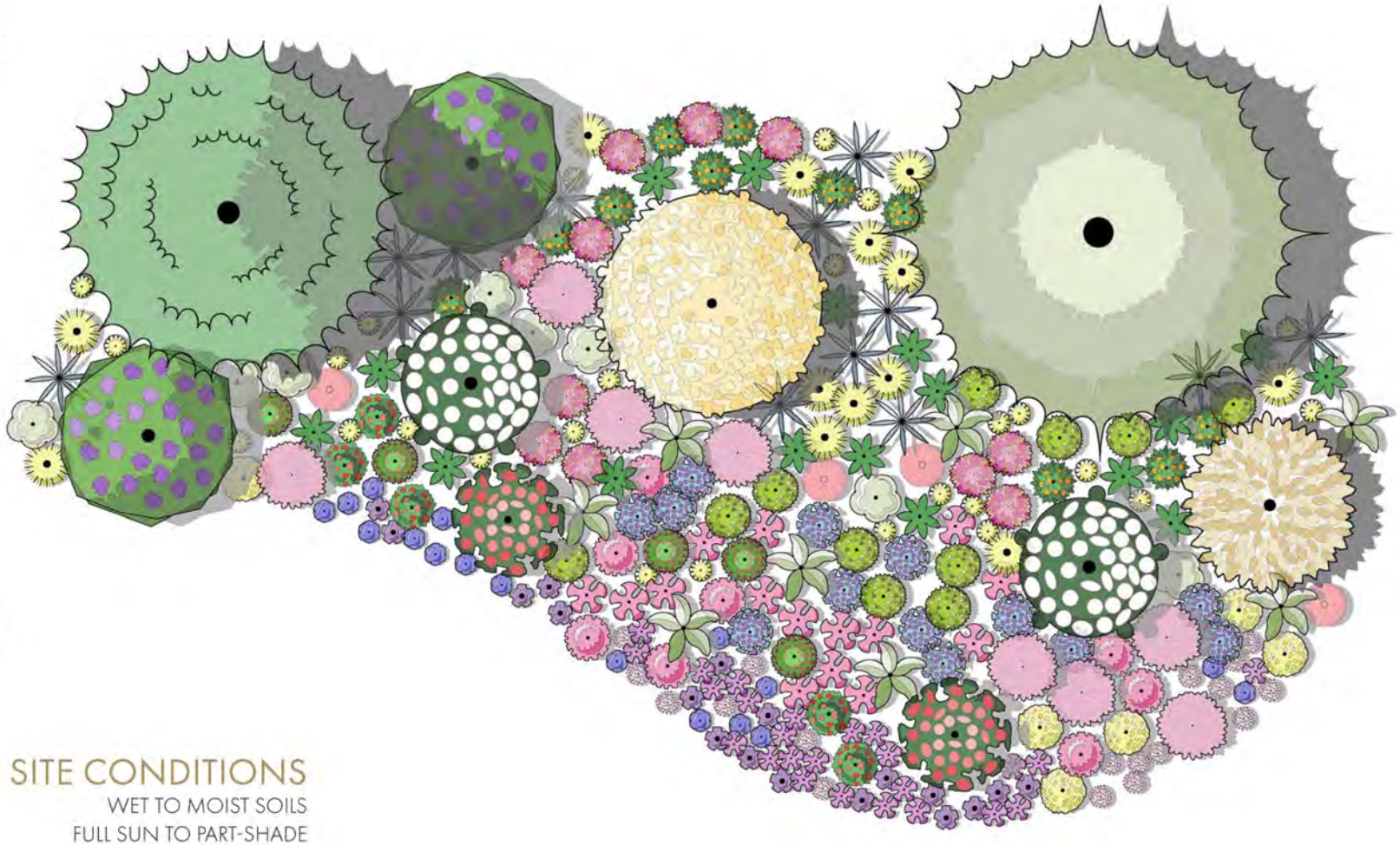

The plants here prefer soils that are wet. This design would work well for a moist spot in a lawn that doesn't dry up very often, or for a wet meadow/wetland restoration. Plants that are situated beneath the canopy of taller plants or directly north of them, are tolerant of the most shade.

SITE CONDITIONS

WET TO MOIST SOILS
FULL SUN TO PART-SHADE
1200 SQ.FT

0 5 10 ft. N

Wet Garden Toolkit

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PLANT SCHEDULE

TREES	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Chamaecyparis thyoides	Atlantic White Cedar	1	15` wide spacing
	Picea mariana	Black Spruce	1	20` wide spacing
	Salix discolor	Pussy Willow	1	8` wide spacing
	Salix lucida	Shining Willow	1	10` wide spacing

SHRUBS	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Cephalanthus occidentalis	Buttonbush	2	6` wide spacing
	Rosa palustris	Swamp Rose	2	5` wide spacing
	Vaccinium corymbosum	Highbush Blueberry	2	8` wide spacing
	Vaccinium macrocarpon	American Cranberry	5	2` wide spacing
	Vaccinium oxycoccos	Small Cranberry	5	2` wide spacing

ANNUALS	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Impatiens capensis	Spotted Jewelweed	11	2` wide spacing

BIENNIAL	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Cirsium muticum	Swamp Thistle	4	2` wide spacing

GRASSES	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Calamagrostis canadensis	Bluejoint Grass	13	2` wide spacing
	Carex stricta	Tussock Sedge	17	2` wide spacing

PERENNIALS	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Asclepias incarnata	Swamp Milkweed	11	2` wide spacing
	Doellingeria umbellata	Flat-topped Aster	13	2` wide spacing
	Eupatorium perfoliatum	Boneset	8	1-2` wide spacing
	Euthamia graminifolia	Grass-leaved Goldenrod	26	1` wide spacing
	Eutrochium fistulosum	Hollow Joe-Pye Weed	8	3` wide spacing
	Eutrochium maculatum	Spotted Joe Pye Weed	8	2` wide spacing
	Hypericum ascyron	Giant St. John`s-wort	6	2` wide spacing
	Lobelia siphilitica	Blue Lobelia	18	1` wide spacing
	Mimulus ringens	Monkeyflower	18	1` wide spacing
	Physostegia virginiana	Obedient Plant	15	1.5` wide spacing
	Pontederia cordata	Pickerelweed	17	1` wide spacing
	Rumex altissimus	Pale Dock	8	2` wide spacing
	Scutellaria lateriflora	Mad-dog Skullcap	25	1` wide spacing
	Symphyotrichum novae-angliae	New England Aster	13	2` wide spacing
	Symphyotrichum puniceum	Purple-stemmed Aster	11	2` wide spacing

McKeon Farm
Meadows & Hedgerows

TOOLKIT FOR LANDSCAPE DESIGN AND MANAGEMENT TO SUPPORT POLLINATOR SPECIES AT RISK IN WESTERN CONNECTICUT

EVAN ABRAMSON

Commissioned by the Norwalk River Watershed Association and the Ridgefield Conservation Commission

a project of
LANDSCAPE|NTERACTIONS

Design Overview

MCKEON FARM

McKeon Farm has been divided into four design areas. Each represents a distinct landscape typology commonly found in rural Western Connecticut and surrounding regions. For each area, a selection of plants has been arranged into a design that is appropriate for the ecological conditions of the site, as well as the aesthetics of the particular space, its present land use, and the surrounding landscape.

1 HEDGEROW

A 300 foot stone wall once dominated by invasive species is cleared without the use of chemicals by grubbing, cutting and pulling. A biodiverse selection of native trees, shrubs, forbs and sedges fills the newly opened niche before invasive species come back in, providing critical pollen, nectar, nesting and host sites for threatened pollinators, as well as a range of height, structure and color throughout the year.

2 UPPER MEADOW

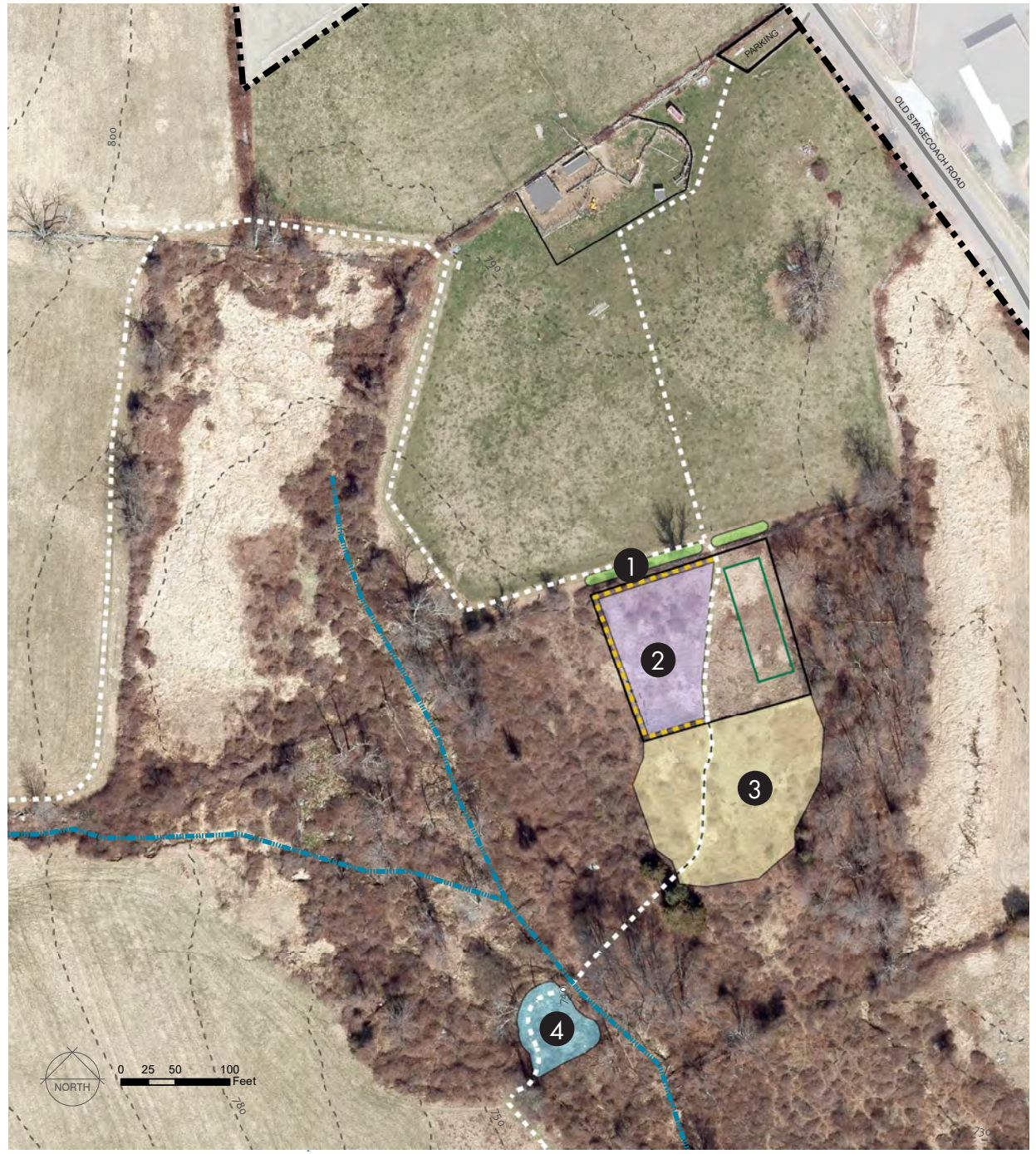
A sunlit field once dominated by non-native grasses, weeds, common flowers and invasive bittersweet is sod cut in the fall and direct seeded with a biodiverse mix of 30 forb and graminoid species.

3 LOWER MEADOW

An old farm field recolonized by late season flowers, non-native grasses and invasive bittersweet is mowed low and harrow raked in the fall and direct seeded.

4 WET MEADOW

A diverse array of wetland plants crucial for at-risk pollinators are inserted into full sun and part-shade areas of a wet meadow after invasive species have first been manually removed without the use of chemicals.

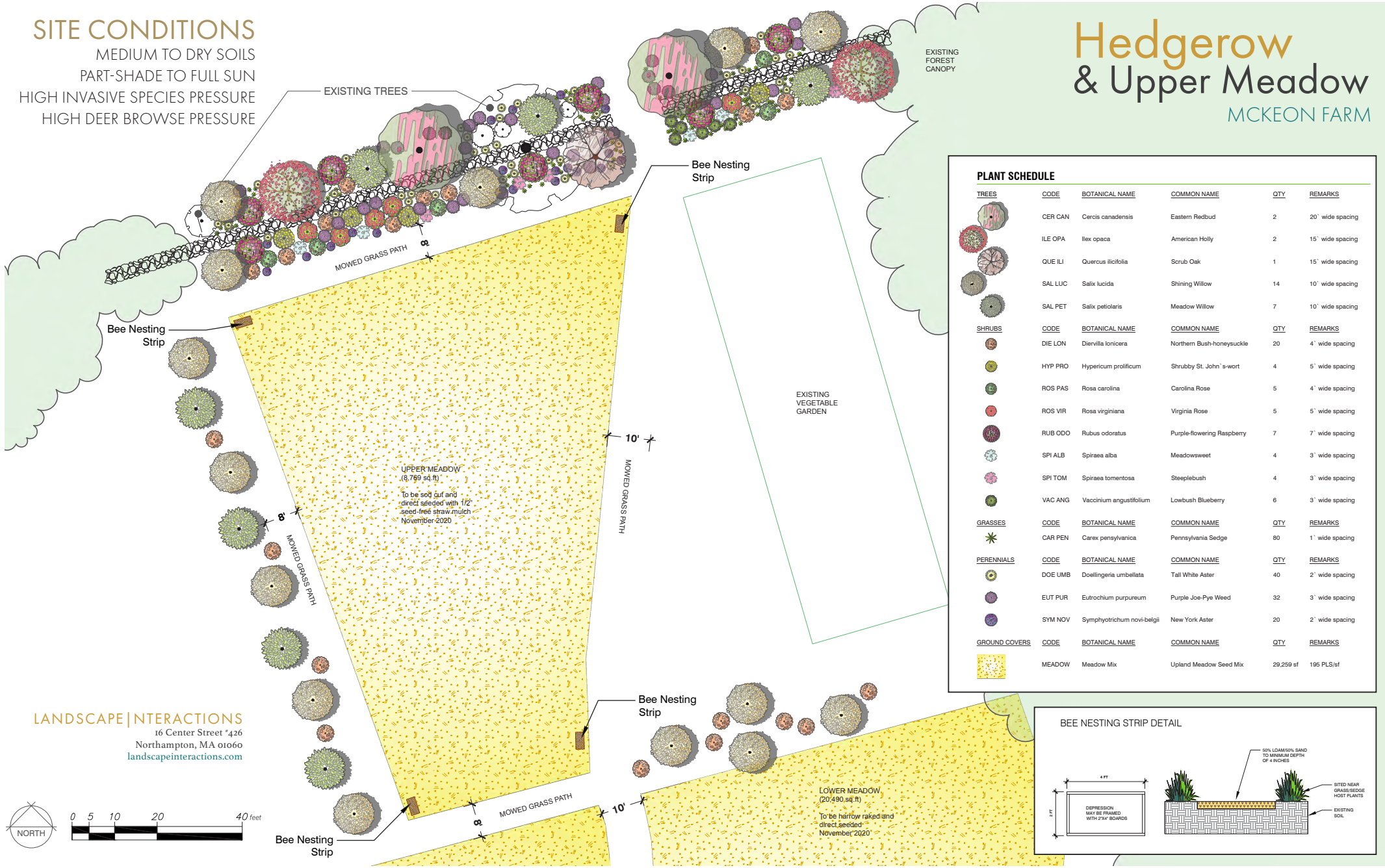


Hedgerow & Upper Meadow

MCKEON FARM

SITE CONDITIONS

MEDIUM TO DRY SOILS
PART-SHADE TO FULL SUN
HIGH INVASIVE SPECIES PRESSURE
HIGH DEER BROWSE PRESSURE



PLANT SCHEDULE

TREES	CODE	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	CER CAN	Cercis canadensis	Eastern Redbud	2	20` wide spacing
	ILE OPA	Ilex opaca	American Holly	2	15` wide spacing
	QUE ILI	Quercus ilicifolia	Scrub Oak	1	15` wide spacing
	SAL LUC	Salix lucida	Shining Willow	14	10` wide spacing
	SAL PET	Salix petiolaris	Meadow Willow	7	10` wide spacing
SHRUBS	**CODE**	**BOTANICAL NAME**	**COMMON NAME**	**QTY**	**REMARKS**
	DIE LON	Diervilla lonicera	Northern Bush-honeysuckle	20	4` wide spacing
	HYP PRO	Hypericum prolificum	Shrubby St. John`s-wort	4	5` wide spacing
	ROS PAS	Rosa carolina	Carolina Rose	5	4` wide spacing
	ROS VIR	Rosa virginiana	Virginia Rose	5	5` wide spacing
	RUB ODO	Rubus odoratus	Purple-flowering Raspberry	7	7` wide spacing
	SPI ALB	Spiraea alba	Meadowsweet	4	3` wide spacing
	SPI TOM	Spiraea tomentosa	Steeplebush	4	3` wide spacing
	VAC ANG	Vaccinium angustifolium	Lowbush Blueberry	6	3` wide spacing
GRASSES	**CODE**	**BOTANICAL NAME**	**COMMON NAME**	**QTY**	**REMARKS**
	CAR PEN	Carex pensylvanica	Pennsylvania Sedge	80	1` wide spacing
PERENNIALS	**CODE**	**BOTANICAL NAME**	**COMMON NAME**	**QTY**	**REMARKS**
	DOE UMB	Doellingeria umbellata	Tall White Aster	40	2` wide spacing
	EUT PUR	Eutrochium purpureum	Purple Joe-Pye Weed	32	3` wide spacing
	SYM NOV	Symphyotrichum novi-belgii	New York Aster	20	2` wide spacing
GROUND COVERS	**CODE**	**BOTANICAL NAME**	**COMMON NAME**	**QTY**	**REMARKS**
	MEADOW	Meadow Mix	Upland Meadow Seed Mix	29,259 sf	195 PLS/sf

BEE NESTING STRIP DETAIL

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Wet Meadow

MCKEON FARM

SITE CONDITIONS

MOIST TO WET SOILS
FULL SUN TO PART-SHADE
HIGH DEER BROWSE PRESSURE
FAIR INVASIVE SPECIES PRESSURE

VEGETATIVE ASSESSMENT

The wet meadow, bisected by a footpath and located to the southwest of a perennial stream flowing northwest to southeast, is largely a somewhat intact native plant community. Some invasives are beginning to encroach, including a number of large Multiflora rose (Rosa multiflora). Privet (Lingustrum spp.) are also present in low density throughout the meadow.

The dominant species within the open meadow are a mix of both native and non-native grasses and sedges. Native graminoids include Bottlebrush sedge (Carex comosa) and Big bluestem (Andropogon gerardii). Additionally, a number of goldenrods and asters are present, including Lance-leaved American-aster (Symphyotrichum lanceolatum), Tall goldenrod (Solidago altissima), Smooth goldenrod (Solidago gigantea), Common wrinkle-leaf goldenrod (Solidago rugosa), and Grass-leaved goldenrod (Euthamia graminifolia). Crooked-stemmed American-aster (Symphyotrichum prenanthoides) is sparsely present, found mainly along the trail. A wider variety of native forbs are also present in very low numbers, including approximately 3-4 Blue vervain (Verbena hastata); a single White vervain (Verbena urticifolia); and a single Swamp aster (Symphyotrichum puniceum). A single spotted St. John's-wort (Hypericum punctatum) was also found.

In the center of the wet meadow is a dense patch of rice cutgrass (Leersia oryzoides), which covers approximately 15% of the open section of the meadow. Although native, rice cutgrass can be somewhat weedy and aggressive and could threaten the establishment of new plantings.

A dense coverage of vines and shrubs exists on both western and eastern portions of the meadow, including native Wild grape (Vitis spp.) and Poison ivy (Toxicodendron radicans); as well as invasive Oriental bittersweet (Celastrus orbiculatus) and Porcelain berry (Amur peppervine).

To the north, the meadow transitions to woodland, with a stand of mature Gray willow (Salix cinerea) growing along the stream — an important source of early season pollen for threatened bees, as well as host plant for a number of at-risk lepidoptera. Along the edge of this willow, a dense coverage of invasives exists, including Privet, Multiflora rose and Oriental bittersweet; as well as native Virginia creeper (Parthenocissus quinquefolia), Poison ivy and Bramble (Rhus spp.). Black cherry (Prunus seritona) saplings are also present. Moving under forest cover, the willow gives way to mature Pignut hickory (Carya glabra) and Red maple (Acer rubrum). The shady understory along the stream is predominantly composed of Jewelweed (Impatiens pallida) — an important nectar source for at-risk bumblebees, as well as Common violet (Viola sororia), host plant for several threatened butterfly species. More invasives including Oriental bittersweet and Japanese barberry (Berberis thunbergii) are found in this moist shaded area. Traveling uphill toward the lower meadow, the understory consists of Pignut hickory, Red maple and Oak saplings, Wild grape as well as more invasives including Multiflora rose, Burning bush (Euonymus alatus), Japanese barberry, Garlic mustard (Alliaria petiolata) and Oriental bittersweet.

Above, the wet meadow at McKeon Farm is largely comprised of native plants. Below, Common violet (Viola sororia) growing alongside a footbridge crossing the perennial stream upslope.

PLANT SCHEDULE

		Quantity	Exposure	Size (HxW)	Spacing
Trees					
Salix discolor	Pussy Willow	4	Full Sun	15x8'	6-8'
Salix lucida	Shining Willow	4	Full Sun	20x10'	8-10'
Shrubs					
Cephalanthus occidentalis	Common Buttonbush	8	Full Sun, Part-Shade	8x6'	4-6'
Rosa Nitida	Shining Rose	6	Full Sun	3x5'	2-3'
Rosa Palustris	Swamp Rose	10	Full Sun	6x6'	4-6'
Vaccinium corymbosum	Highbush Blueberry	10	Full Sun, Part-Shade		
Forbs					
Asclepias incarnata	Swamp Milkweed	21	Full Sun, Part-Shade	5x2'	1-2'
Eutrochium dubium	Coastal Plain Joe-Pye Weed	20	Full Sun, Part-Shade	5x3'	2-3'
Mimulus ringens	Allegheny Monkey-flower	15	Full Sun, Part-Shade	3x2'	1-2'
Physostegia virginiana	Obedient False Dragonhead	10	Full Sun, Part-Shade	4x2.5'	1-2.5'
Pontederia cordata	Pickerelweed	10	Full Sun	4x2'	1-2'
Graminoids					
Carex stricta	Tussock Sedge	20	Full Sun	3x2'	1-2'
Rumex spp.	Water Dock (native)	20	Full Sun, Part-Shade	Varies	1-3'

PLANTING RECOMMENDATIONS

It is strongly recommended that all new planting areas in the wet meadow first be cleared with either a weed whacker or by manual pulling or grubbing. Dominant invasives such as Multiflora rose, Privet, Bittersweet and Barberry should be thoroughly cut back and roots dug out, in order to open space for the introduction of new plant species. The same can be said for the large patches of Rice cutgrass.

New plantings could be clustered in areas where invasives have been removed, in order to dissuade regrowth. All plantings should be flagged, staked and caged, in order to prevent deer browse and allow for future identification. New plants should be monitored closely for 1-2 growing seasons and weeded regularly, in order to ensure that they are not out-competed by existing, more well established plant species.

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BEST MANAGEMENT PRACTICES

1. NO CHEMICALS

Eliminate pesticide use, particularly those containing neonicotinoids. Herbicides and chemical lawn treatments can also be highly damaging to pollinators.

Avoid planting in areas previously contaminated by pesticides or without a spatial buffer from areas where pesticides are applied (at least 100 ft. wide forested buffer is recommended).

Ensure plants and seeds come from a clean, pesticide-free source. Many commercial nurseries treat their plants and seeds, oftentimes before retailers receive them. Some pesticides and most neonicotinoids persist in plants and soil for months to years.

2. DIVERSE NATIVE PLANTS

Plant straight native plant species. Cultivars and exotic plants largely do not support the pollen and nectar preferences of threatened pollinators and tend to be visited by common pollinator species whose populations are stable.

Include a range of plant types (trees, shrubs, forbs, grasses, sedges) with varying bloom times, to ensure pollen, nectar and host plants are available across the entire growing season.

3. CREATE NESTING OPPORTUNITIES

Seventy percent of native bee species are ground nesting. Mulch using compost or natural materials (e.g. chopped leaves, seed-free hay, composted wood chips) and leave bare areas of well-drained soil in sunny locations.

Thirty percent of native bees are cavity nesting. Allow dead trees, snags and pithy stemmed plants such as raspberries to remain standing.

To benefit bumblebees, maintain small brush piles. This will provide cover for rodents that will in turn create nesting habitat for bumblebees. Where possible, leave leaf litter in gardens and allow it to build up over time. This provides cover for overwintering queens. Barns with unbaled hay or a dry, protected cavity containing hay, straw, clumps of moss or grass located above or below ground are also ideal.

As with other ground nesting bees, limiting or eliminating tillage practices will limit the potential of harming bumblebees.

4. BE MESSY

Skip the fall clean up, allowing dead stems, leaves and seed heads to stand over winter, and wait until evening temperatures consistently reach 50 degrees before raking in the spring.

Don't be overzealous when it comes to tidying up. Some weeds act as host plants for caterpillars, such as lambsquarters *(Chenopodium album)* for Common Sootywing *(Pholisora catullus)* and Queen Anne's lace *(Daucus carota)* for Black Swallowtail *(Papilio polyxenes)*.

5. IT DOESN'T STOP WITH PLANTING

That being said, with new plantings, water and weed regularly for the first two years.

To deter deer and rodents until plants fully establish, it may be helpful to construct temporary fencing or set up netting. Natural repellent sprays such as *Plantskydd* can be effective when applied regularly. Thorny plants such as roses can also deter deer browse and function as natural fences for more vulnerable plants.

6. LAST BUT NOT LEAST

Put something in place to catch rainwater, with a dirt base to simulate a puddle, providing pollinators necessary minerals. Make it last between rainy days.

Keep night skies dark for moths and other nocturnal insects: motion-detecting lights or lamps facing down instead of spotlights on all night.

Some plant species establish best by direct seeding: while late fall or early winter is the best time to sow, early spring seeding is also possible, although some species may not germinate until the following year.

Green Corridor Pollinator Toolkit

GARDEN
LAWN
MEADOW
WOODLAND
WETLAND

LANDSCAPE DESIGN TO SUPPORT POLLINATOR SPECIES AT RISK IN SOUTHWEST CONNECTICUT

EVAN ABRAMSON

Commissioned by

Aspetuck Land Trust
Westport Fairfield Weston Easton

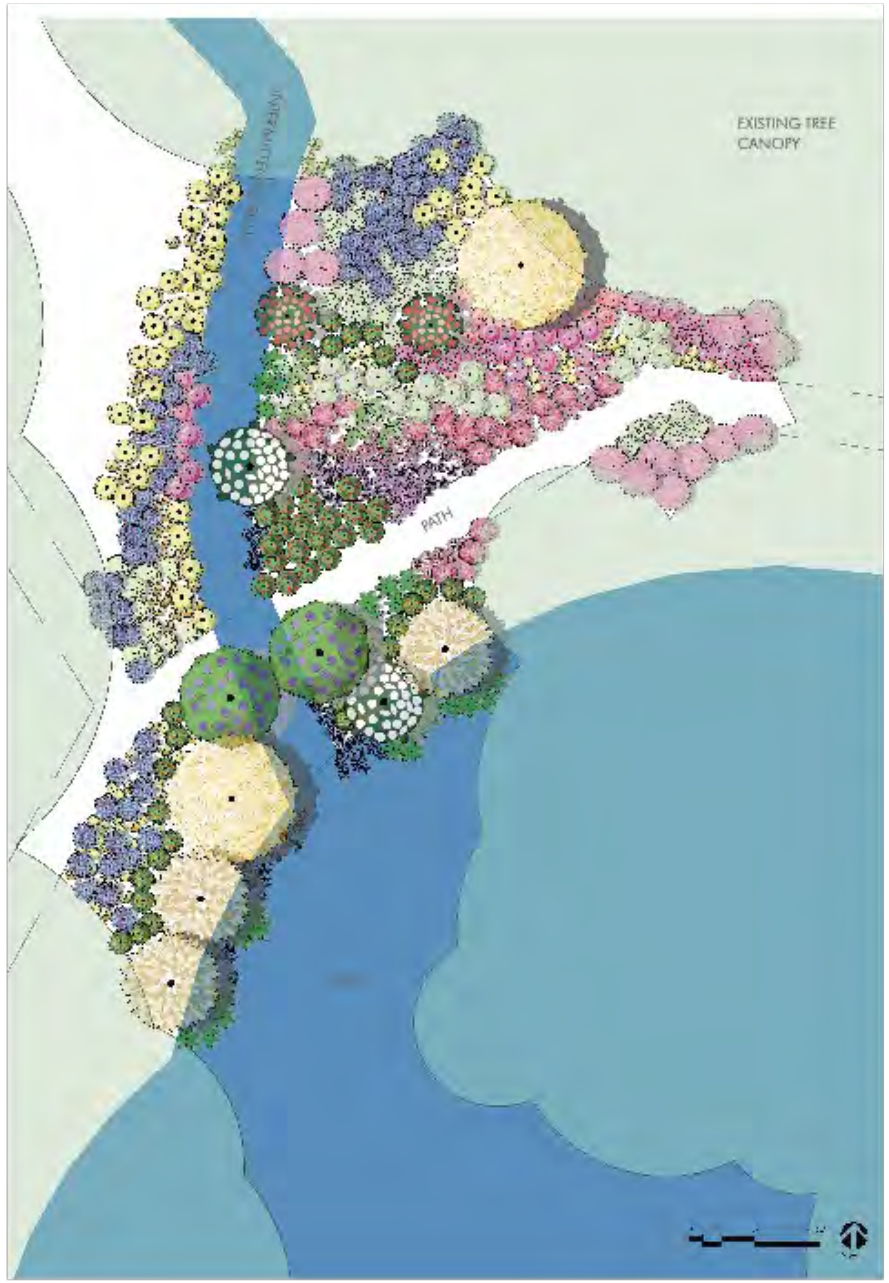
Project Site
Haskins Preserve
Westport, CT

Pond + Stream Crossing

HASKINS PRESERVE

SITE CONDITIONS

MOIST TO WET SOILS
FULL SUN
HIGH DEER BROWSE PRESSURE
AGING AQUATIC INFRASTRUCTURE



PLANT SCHEDULE

TREES	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	Salix discolor	Pussy Willow	3	8' wide spacing
	Salix lucida	Shining Willow	2	10' wide spacing
SHRUBS	**BOTANICAL NAME**	**COMMON NAME**	**QTY**	**REMARKS**
	Cephalanthus occidentalis	Buttonbush	2	6' wide spacing
	Rosa palustris	Swamp Rose	2	5' wide spacing
	Vaccinium corymbosum	Highbush Blueberry	2	8' wide spacing
	Vaccinium macrocarpon	American Cranberry	20	2' wide spacing
ANNUALS	**BOTANICAL NAME**	**COMMON NAME**	**QTY**	**REMARKS**
	Impatiens capensis	Spotted Jewelweed	28	2' wide spacing
BIENNIAL	**BOTANICAL NAME**	**COMMON NAME**	**QTY**	**REMARKS**
	Cirsium muticum	Swamp Thistle	7	2' wide spacing
GRASSES	**BOTANICAL NAME**	**COMMON NAME**	**QTY**	**REMARKS**
	Carex stricta	Tussock Sedge	26	2' wide spacing
PERENNIALS	**BOTANICAL NAME**	**COMMON NAME**	**QTY**	**REMARKS**
	Asclepias exaltata	Poke Milkweed	10	2' wide spacing
	Asclepias incarnata	Swamp Milkweed	27	2' wide spacing
	Doellingeria umbellata	Flat-topped Aster	40	2' wide spacing
	Eupatorium perfoliatum	Boneset	16	1-2' wide spacing
	Euthamia graminifolia	Grass-leaved Goldenrod	55	1' wide spacing
	Eutrochium fistulosum	Hollow Joe-Pye Weed	14	3' wide spacing
	Eutrochium maculatum	Spotted Joe Pye Weed	19	2' wide spacing
	Lobelia siphilitica	Blue Lobelia	32	1' wide spacing
	Mimulus ringens	Monkeyflower	30	1' wide spacing
	Physostegia virginiana	Obedient Plant	34	1.5' wide spacing
	Pontederia cordata	Pickerelweed	45	1' wide spacing
	Rumex altissimus	Pale Dock	5	2' wide spacing
	Scutellaria lateriflora	Mad-dog Skullcap	21	1' wide spacing
	Solidago flexicaulis	Zigzag Goldenrod	63	1' wide spacing
	Symphyotrichum novae-angliae	New England Aster	76	2' wide spacing
	Symphyotrichum puniceum	Purple-stemmed Aster	23	2' wide spacing

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Grazing for Biodiversity

Grazing for Biodiversity

Grazing for Biodiversity

2021 Baseline Results

With the right timing and intensity, rotational grazing and native floral diversity is possible in the same field.

Feeding livestock and pollinators simultaneously.

Building soil carbon, improving nutrient flow and water retention.

2022: Direct seeding 60+ additional species.

Species supported includes:

Achillea millefolium
Asclepias syriaca
Carex pensylvanica
Eurybia divaricata
Euthamia graminifolia
Fragaria virginiana
Hypericum sp.
Prunella vulgaris
Potentilla simplex
Rubus allegheniensis
Rubus flagellaris
Rubus occidentalis
Salix spp.
Schizachyrium scoparium
Solidago altissima
Solidago bicolor
Solidago canadensis
Solidago gigantea
Solidago juncea
Solidago nemoralis
Solidago rugosa
Sorghastrum nutans
Spiraea alba
Spiraea tomentosa
Symphyotrichum latifolium
Symphyotrichum racemosum
Symphyotrichum undulatum
Vaccinium angustifolium

2021 Site Prep

2022 Seeding

2022 Seeding

2022 Growing Season

Measuring Success

Functional diversity improved over time.

Native bumblebee and butterfly species diversity as a metric of success (or failure).

Plant selection supports species richness across functional traits, trophic levels and animal groups (bee, butterfly, moth, bird).

Three-year study period.

Science informs the design process, plant selection and measures the results.

Every project has a maintenance plan and management regimes.

Clockwise from top left: Bombus vagans, B. perplexus, B. fervidus, B. ternarius. Photographs by Norm Levey.

WE ARE BEECOLOGY

Protecting our native pollinators through the power of citizen science.

ABOUT THE BEECOLOGY PROJECT

Collect

Help our databases grow using our apps.

Visualize

See the power of citizen science with our database visualization tools.

Simulate

Explore environmental effects in a virtual bee world.

Landscape | nteractions

Biodiversity through Pollination Science

We specialize in designing landscapes and planning corridors that build biodiversity and strengthen ecological resilience to a changing climate at the ecosystems level.

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