McKeon Farm

Meadows & Hedgerows

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

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

a project of

LANDSCAPE | NTERACTIONS

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Norwalk River Watershed Association
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WHAT IS A TOOLKIT?

Replicable landscape designs and habitat management strategies based on common landscape scenarios and specific selections and arrangements of plants.

The Toolkit on the following pages was designed by Evan Abramson, Principal at Landscape Interactions, based on years of scientific study by Dr. Robert Gegear of UMass-Dartmouth and the Beecology Project. The featured designs, plant lists and landscape management guidelines have been developed specifically to support bee and butterfly species that are of the greatest conservation priority in Western Connecticut, and represent common landscape typologies found in rural Fairfield County and neighboring regions.

WHAT MAKES THESE DESIGNS DIFFERENT?

Most pollinator plantings have focused on overall abundance – "seeing lots of bees" — rather than on the wide range of wild pollinators found in a biodiverse and resilient ecosystem. The same problem arises from habitats planted with generic pollinator seed packets. While we see lots of flowers, those flowers are often providing resources for only a few common species of pollinators, and don't satisfy the full pollen, nectar and nesting requirements of a functionally diverse ecosystem.

HOW SHOULD THIS TOOLKIT BE USED?

The three design areas in this Toolkit were selected because they represent common landscape "situations" in rural Connecticut. It is our hope and intention for them to be replicated on properties and in communities throughout the region. The designs were created to increase biodiversity and climate resiliency by attracting and sustaining the widest possible range of pollinator species, and in particular, species of the greatest conservation priority in Western Connecticut. Each area targets a particular type of landscape or ecological condition: the plant arrangements and lists can therefore be applied to any similar landscape. By replicating the Toolkit across Western Connecticut and neighboring counties and states, the building blocks for a regional pollinator corridor will be strengthened, and hopefully, many of these at-risk species will not only be attracted to your landscapes, but sustained.

Section of the Hedgerow design area at McKeon Farm. Refer to page 11 for the complete landscape design and plant list.

Plants Matter

A truly “pollinator-friendly” landscape is highly diverse in both plant and animal species composition and includes a wide range of native plant types, ensuring that pollen and nectar are available throughout the growing season; and that nesting habitat and host plants are available throughout the year. The focus of this Toolkit is to provide the recommended plants and landscape management strategies to support native pollinator species that are at risk in rural Western Connecticut. The loss of these pollinator-plant interactions, or pollination systems, can have catastrophic consequences on the biodiversity of the state, and the region as a whole. But it’s not too late to start planting.

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

Why Pollinators?

Native pollinators are vital to creating and maintaining the habitats and ecosystems that most animals rely on for food and shelter — including humans. What happens (or doesn't happen) at the pollination scale has repercussions all the way up the food chain. Over 80% of the flowering plants on Earth depend upon insect-mediated pollination; bees alone pollinate one-third of the food grown in the United States. In a global study of more than 40 crops in 600 fields across every populated continent, scientists found that wild pollinators were twice as effective as honeybees in producing seeds and fruit (Garibaldi et al.). In the United States, wild bee pollination services were estimated to be worth $3.07 billion in 2006 (Losey & Vaughan). This estimate is a conservative approximation of wild bee pollination's contemporary value, considering the increase in pollinator-dependent crop plants over the past decade (Russo et al.; Mathiasson & Rehan).

As **keystone species**, wild pollinators provide food, shelter and nest sites to wildlife at other trophic levels through their interactions with native flowering plants. Protecting diversity of native pollination systems is therefore critical for maintaining healthy and diverse ecosystems. Pollination systems include bees, butterflies and moths, birds, beetles and flies, and represent over 80% of plant species worldwide.

Just like humans, pollinators need nutrient-dense food, shelter, and successful reproduction to thrive. But not all species require the same thing. A delicate balance exists between native plants and their pollinators, relationships that evolved over millions of years. Some plants have a small guild of species which coevolved with them to ensure their pollination. Similarly, approximately 15% of northeastern native bees are considered pollen specialists (Fowler). For many specialists, once their "partner" is missing from the landscape, they cannot reproduce – and thus risk becoming extirpated, endangered (and eventually, extinct).

A major misconception about pollinator decline is that all species are declining at the same rate. In fact, many species are actually increasing in abundance and geographic distribution as a direct result of human disturbance. "Seeing lots of bees" does not necessarily mean that your landscape is pollinator-friendly. Unfortunately, most efforts to restore pollination systems to date have resulted in increasing the numbers of a few common bee, butterfly and moth species, rather than on the range of wild pollinator species needed for ecosystem health and resiliency.

Above (left to right): View of the Upper Meadow at McKeon Farm in May 2020 from the corner of the hedgerow looking southwest; view of the invasives-dominated hedgerow from the corner of Stagecoach Pasture 2 looking west (same date); view of the hedgerow looking east after invasives had been removed in October 2020, days before design installation. Below: Analysis of solar exposure at McKeon Farm across the growing season (March 21-September 21). Photograph of hedgerow after removal by Kitsey Snow, all others by Evan Abramson.

Project Context

McKeon Farm is a 43-acre permanently protected property 800 feet above sea level, owned and managed by the Ridgefield Conservation Commission. Once part of the 135-acre Arigideen Farm of Daniel and Louise McKeon, early proponents of organic agriculture, the site consists of rolling pastures, upland meadows and deciduous forest draining into a wet meadow shrubland bisected by a perennial stream in the center of the site. Pastures are leased out to a livestock farmer, who grazes sheep, goats and llama on rotation. A hedgerow running west to east along an old stone wall divides the pastures from two meadows (Upper and Lower) which are managed by the Conservation Commission along with the majority of the southern half of the site (see map at right).

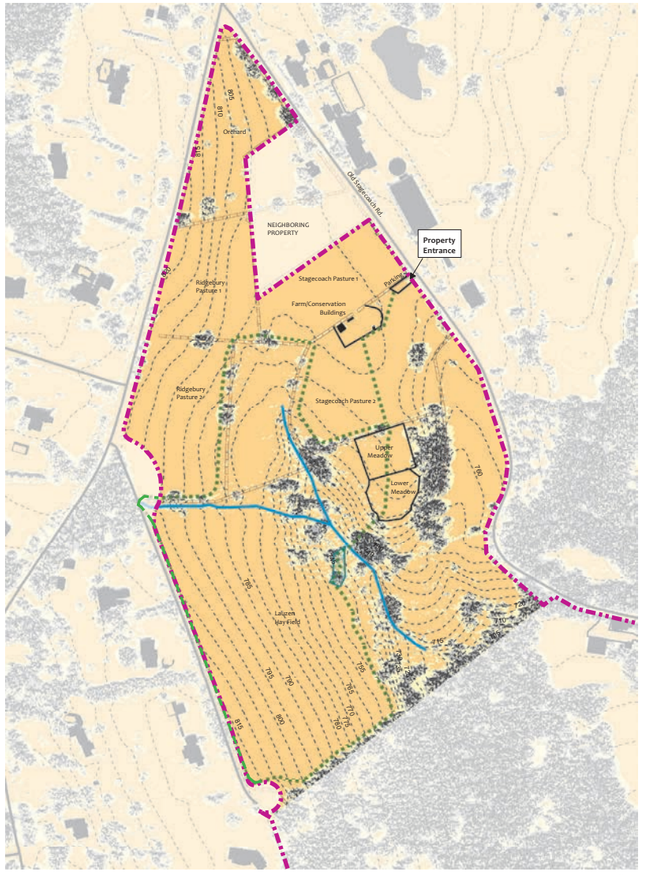
In spring of 2020, Evan Abramson of Landscape Interactions was contracted by the Norwalk River Watershed Association on behalf of the Ridgefield Conservation Commission, to create a series of design and habitat management strategies at McKeon Farm to support pollinator species at risk, and serve as a model for neighboring properties and communities. By demonstrating a range of design interventions and approaches to landscape conversion, the vision is for McKeon Farm to serve as a model for biodiverse, ecologically resilient landscape design and management across the region.

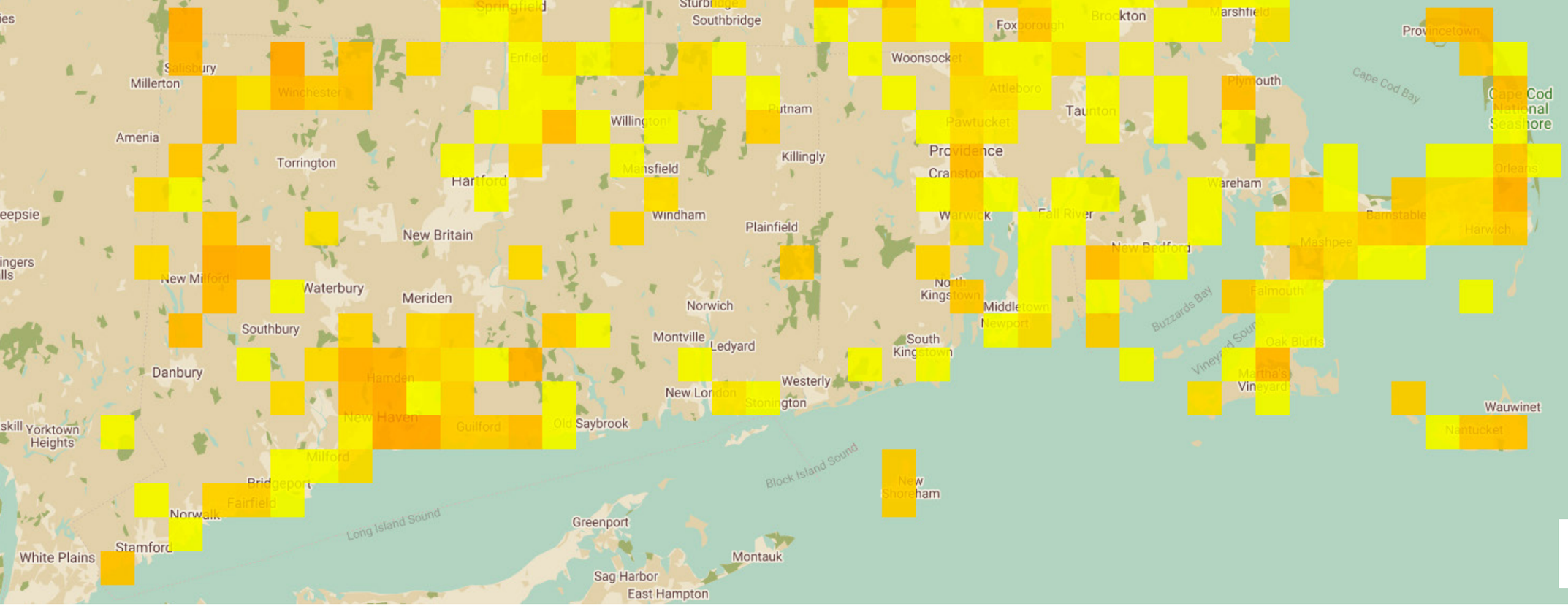
At the start of the project period, significant portions of the property were overtaken by invasive species. The hedgerow was dominated by Oriental bittersweet (Celastrus occidentalis), Japanese barberry (Berberis thunbergii), Morrow's honeysuckle (Lonicera morrowii) and autumn olive (Elaeagnus umbellata). The same invasive species, and in particular Oriental bittersweet, were dominant along the other sides of the Upper Meadow, growing densely along an old metal fence.

The eastern portion of the Upper Meadow consists of a vegetable garden run by Cornerstone Home and Gardens, a non-profit supporting individuals with autism. Across a wide mowed path, approximately 5,000 sq. ft were seeded with a pollinator seed mix in 2019. Black-eyed Susan (Rudbeckia hirta), Purple coneflower (Echinacea purpurea), Wild bee balm (Monarda fistulosa), Awl American-aster (Symphyotrichum pilosum), Creeping thistle (Cirsium arvense), Common evening-primrose (Oenothera biennis), Partridge pea (Chamaecrista fasciculata) and Purple vetch (Vicia benghalensis) were all present among grasses and weeds. The rest of the Upper Meadow was predominantly mowed turf grass.

The Lower Meadow, also divided by a mowed path, was approximately two-thirds native and non-native grasses and sedges. The other third consisted of patches of goldenrods and asters, including Wrinkle-leaf goldenrod (Solidago rugosa), Flat-top goldenrod (Euthamia graminifolia), Awl American-aster (Symphyotrichum pilosum) and Lance-leaved American-aster (Symphyotrichum lanceolatum). Common milkweed (Asclepias syriaca) was peppered throughout the eastern half, with a high abundance of Oriental bittersweet along the woodland edge. Following the path downhill, forest opens up into a wet meadow after crossing a stream (see page 13 for a complete summary of the Wet Meadow area).

After walking the site with Ridgefield Conservation Commission members Kitsey Snow and Dave Cronin as well as Louise Washer, President of the Norwalk River Watershed Association, it was determined that all of the invasives in the hedgerow and around the Upper Meadow would be removed and replaced with a new hedgerow design consisting of pollen, nectar and host plants to attract and sustain at-risk bee and butterfly species (see page 9 for a complete list). While some plants previously seeded in the Upper Meadow support at-risk pollinators, the majority favor common, abundant species. It was agreed that both Upper and Lower Meadows would be prepped and seeded in the fall with a new custom seed mix. The wet meadow area would be diversified to include a wide range of pollen, nectar and host plants suitable for wet conditions which were currently missing from the site (see page 13).





Above: portion of map depicting 8,049 observations of bumblebees in New England based on range of species diversity, 1864-2020. Courtesy the Beecology Project. Below: Dr. Gegear surveys bumblebees during a Beecology citizen scientist training. Photograph by Evan Abramson.

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 in this Toolkit. 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.

McKeon Farm is being surveyed for pollinator species diversity and change over a three-year period by Dr. Gegear. A classic "before and after" experiment, Year One (2020) involved observing and documenting pollinator and plant species interactions on the site before any planting or landscape modifications took place. Years Two and Three (2022 and 2023) will document changes in species presence and interactions after the recommended plants, designs and management guidelines from the Toolkit have been implemented. **This Toolkit has been created to specifically target and support bee and butterfly species which are threatened or at risk in Western Connecticut.** 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 Toolkit will not only be observed, but sustained on each site in Years Two, Three and beyond.

Using the **Beecology** app that Dr. Gegear created, citizen scientists can contribute to species observations at McKeon Farm, as well as throughout the region, by uploading videos and photographs of bumblebees on plants. Dr. Gegear and members of his lab verify every bumblebee and plant ID before they are added to the database.

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

Measuring Success

While the subject of pollinator decline is understood by many to be highly significant, few pollinator habitat projects target the range of species at risk in a given geographic area. This is ironic since it is due to the decline of so many pollinator species that we are aware of the pollinator crisis in the first place. **Shouldn't pollinator habitat projects therefore target the species that merit conservation and protection, rather than common or abundant species whose populations are stable?**

Many of the species whose numbers have fallen so sharply in recent decades possess more specialized habitat requirements. With respect to pollinators, this usually involves foraging and/or nesting preferences among particular groups of plants. The same can be said among certain plant taxa, with many of the species experiencing steep declines associated with a limited group of insects for their reproductive needs. Yet **few pollinator habitat design or restoration projects collect data before, during or after recommended plantings and strategies have been implemented.** Limited research based on first-hand field observations exists, in order to demonstrate the efficacy (or inefficacy) of particular plant species or landscape management regimes in promoting the abundance and diversity of those species that are the most in need of conservation.

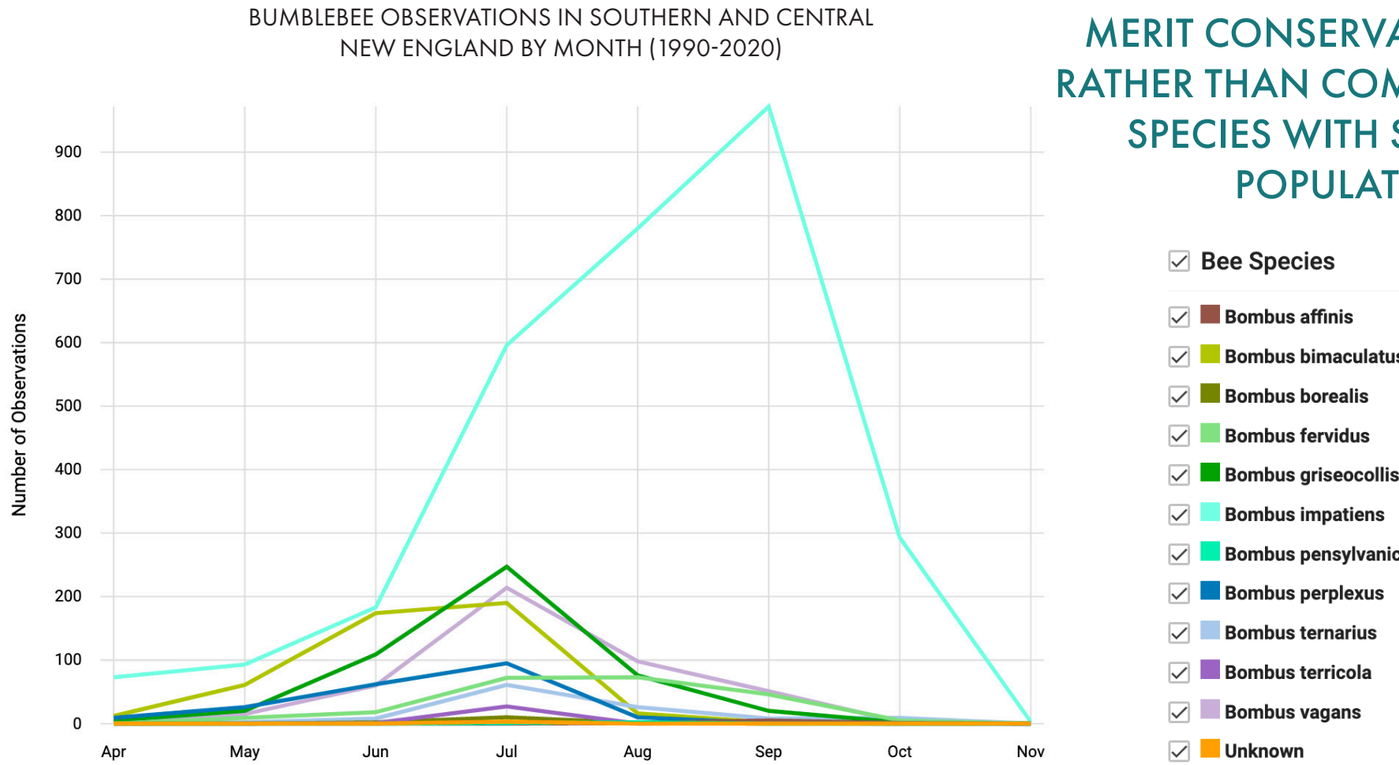
For McKeon Farm, field observations of bumblebee and butterfly species at risk in Western Connecticut have been collected by Dr. Gegear throughout the 2020 growing season. To measure the success (or failure) of the Toolkit in attracting and sustaining at-risk pollinator species on the site, the following criteria will be measured over a three-year period (2020-2022):

» NATIVE BUMBLEBEE AND BUTTERFLY SPECIES DIVERSITY SUSTAINED *(not just one sighting of a particular species)*

» PLANT SELECTION SUPPORTS SPECIES RICHNESS ACROSS FUNCTIONAL TRAITS, TROPHIC LEVELS AND ANIMAL GROUPS *(bee, butterfly, moth, bird)*

» FUNCTIONAL DIVERSITY IMPROVED OVER TIME

In other words, which bumblebee and butterfly species were on the site before and after the design and habitat modifications were implemented? Which plant species were added? What management changes worked? And how were animals further up the food web affected?



Historical data courtesy Yale Peabody Museum, contemporary data courtesy Dr. Robert Gegear. Total of 4,966 observations depicted. Graph courtesy the Beecology Project.

SHOULDN'T POLLINATOR HABITAT PROJECTS TARGET SPECIES THAT MERIT CONSERVATION, RATHER THAN COMMON SPECIES WITH STABLE POPULATIONS?

Baseline Survey Results

During the 2020 growing season, Dr. Gegear surveyed McKeon Farm for bumblebee and butterfly species at risk in Western Connecticut. His observations were compared to historical data for pollinator species in the area. This baseline data will be compared to subsequent surveys in 2021 and 2022 following the implementation of the landscape design and management guidelines outlined in this Toolkit in fall of 2020. 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 REPORT FOR MCKEON FARM (2020)

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 site in Ridgefield. Surveys of bumblebees and at-risk butterflies were taken in spring and summer (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 McKeon Farm in 2020: *Bombus impatiens, B. griseocollis, B. perplexus* and *B. bimaculatus.* Additionally, the following at-risk bee species were observed: *B. fervidus* and *B. vagans*, both of which are targets for this project's conservation efforts. A complete list of the target pollinator species expected to be at the site based on historical records is provided on the following page.

Summary Assessment of Flower Visitors at McKeon Farm *(based on site size)*: Moderate abundance, moderate diversity.

At-Risk Pollinators
Supported by this Toolkit

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
- » *Amblyscirtes vialis* Common Roadside Skipper
- » *Boloria bellona* Meadow Fritillary
- » *Callophrys irus* Frosted Elfin
- » *Carterocephalus palaemon* Arctic Skipper
- » *Chlosyne harrisii* Harris' Checkerspot
- » *Erora laeta* Early Hairstreak
- » *Euphyes bimacula* Two-spotted Skipper
- » *Euphyes conspicua* Black Dash
- » *Euphyes dion* Dion Skipper
- » *Hesperia leonardus* Leonard's Skipper
- » *Hesperia metea* Cobweb Skipper
- » *Hesperia sassacus* Indian Skipper
- » *Lycaena epixanthe* Bog Copper
- » *Lycaena hyllus* Bronze Copper
- » *Pieris oleracea* Mustard White
- » *Pieris virginiensis* West Virginia White
- » *Poanes massasoit* Mulberry Wing
- » *Polygonia progne* Gray Comma
- » *Satyrium acadica* Acadian Hairstreak
- » *Satyrium favonius* Oak Hairstreak
- » *Speyeria aphrodite* Aphrodite Fritillary
- » *Speyeria atlantis* Atlantis Fritillary

BIGGEST THREATS FACING POLLINATORS

- » HABITAT LOSS *(AGRICULTURE + HUMAN DEVELOPMENT)*
- » PESTICIDES
- » CLIMATE CHANGE

Photographs (clockwise from top left): Bombus vagans by Peter Gorman; West Virginia White by M. Silver; Bombus affinis by Serina Jepsen; Bog Coppers by Jim Brighton; Harris' Checkerspots mating by Tom Halliwell.

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

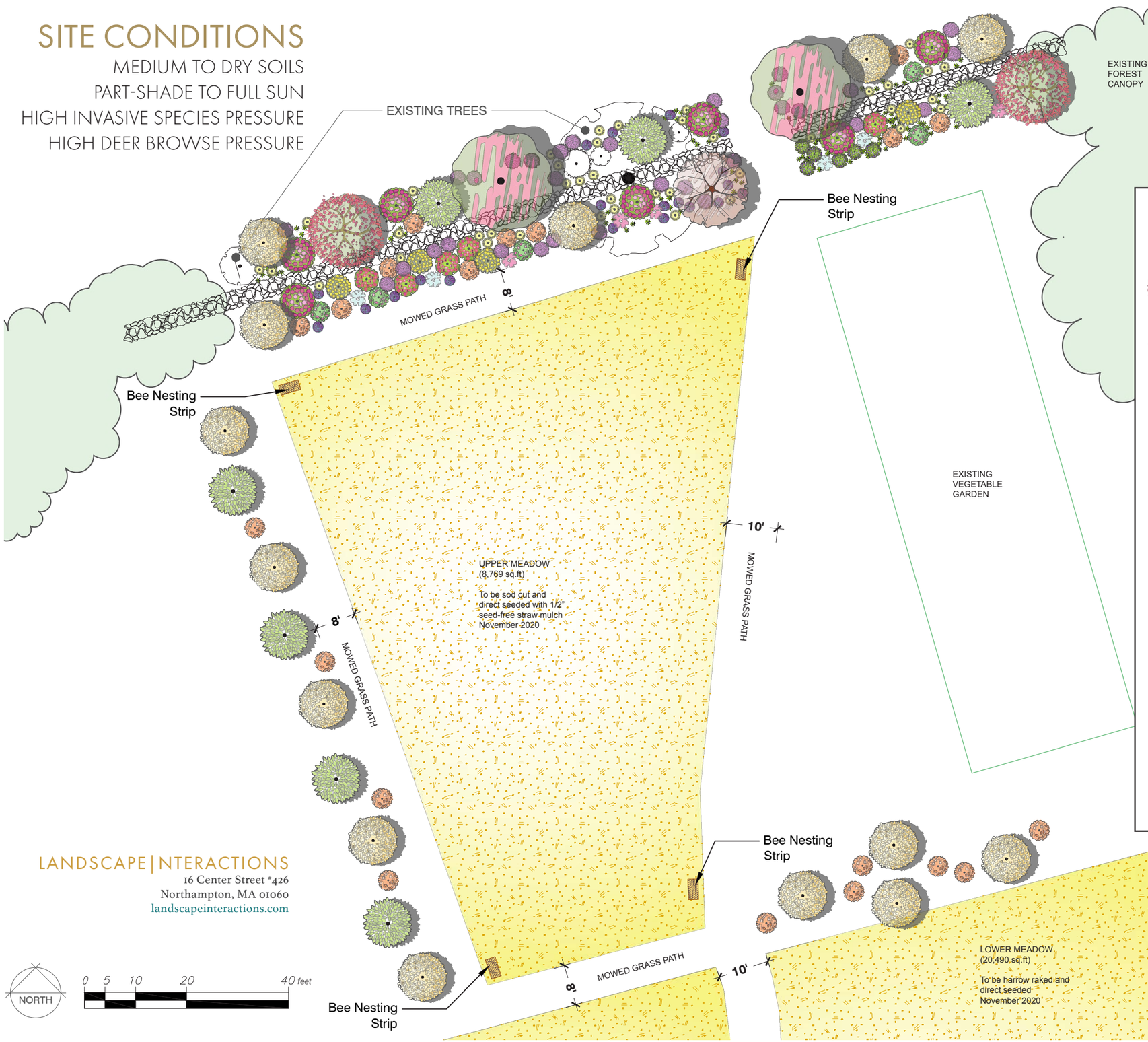
A diverse array of wetland plants crucial for at-risk pollinators are inserted into full sun and part-shade areas of a wet meadow after invasive species have first been manually removed without the use of chemicals.

SITE CONDITIONS

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

Hedgerow & Upper Meadow

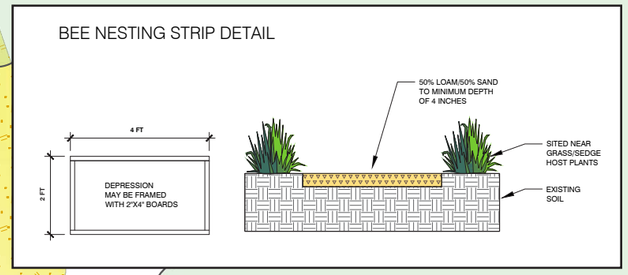
MCKEON FARM



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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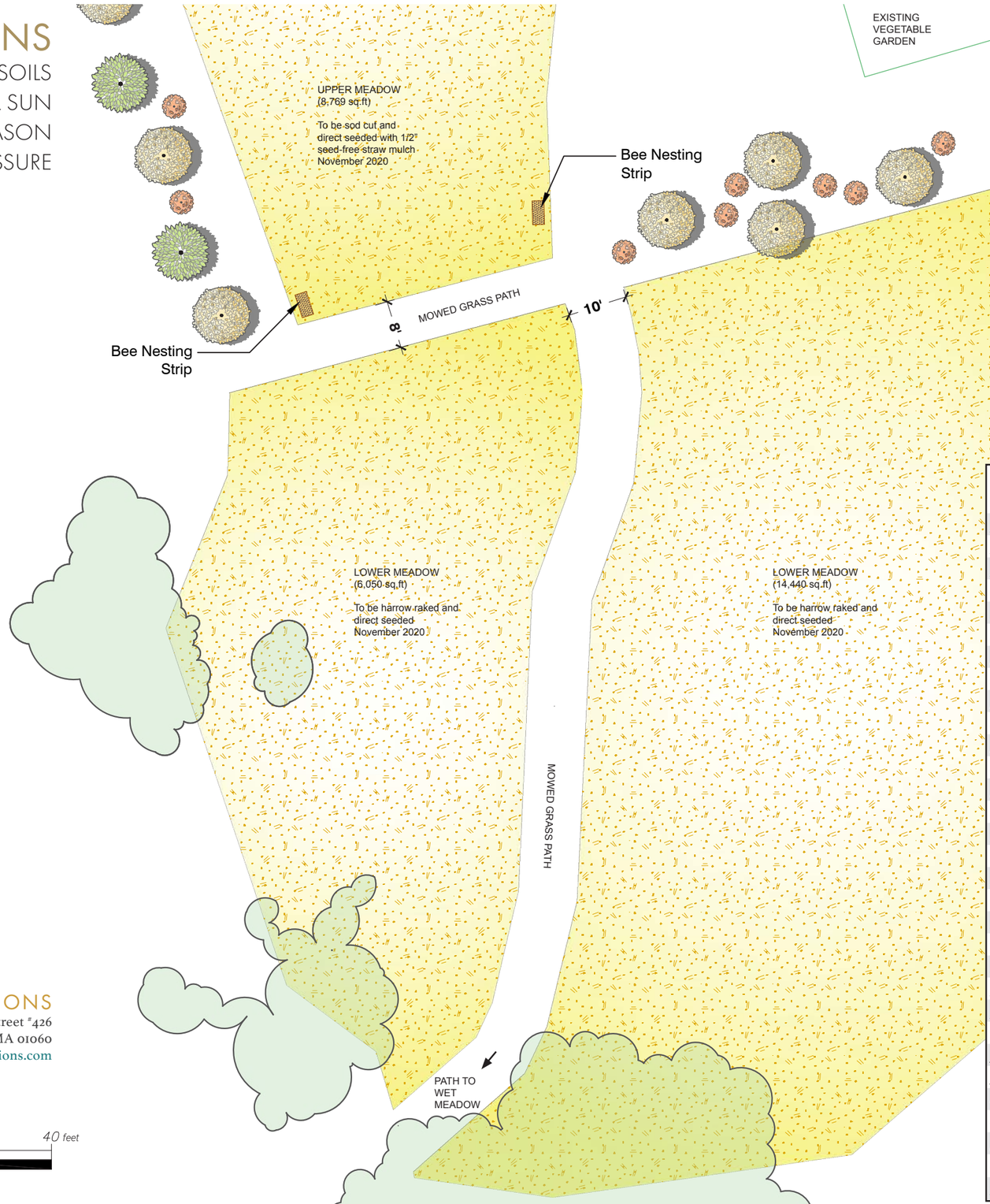
SITE CONDITIONS

MEDIUM TO DRY SOILS
FULL SUN
HIGH COOL SEASON
GRASS PRESSURE

Lower Meadow

MCKEON FARM



MEADOW SEED MIX

Forbs		% Count	% Weight
Agastache scrophulariaefolia	Purple Giant Hyssop	2.19	1.87
Asclepias syriaca	Common Milkweed	0.19	3.73
Asclepias tuberosa	Butterfly Weed	0.30	5.60
Cirsium discolor	Pasture Thistle	0.15	1.87
Doellingeria umbellata	Tall White Aster	1.57	1.87
Euthamia graminifolia	Grass-leaved Goldenrod	4.28	0.97
Eutrochium purpureum	Purple Joe-Pye Weed	1.97	3.73
Geranium maculatum	Spotted Crane's-bill	0.12	1.87
Hypericum punctatum	Dotted St. John's-wort	13.63	1.87
Lupinus perennis	Wild Lupine	0.16	11.20
Monarda fistulosa	Wild Bergamot	3.29	3.73
Monarda punctata	Spotted Bee Balm	4.23	3.73
Penstemon digitalis	Foxglove Beardtongue	3.05	1.87
Penstemon hirsutus	Northeastern Beardtongue	5.83	1.87
Solidago juncea	Early Goldenrod	6.81	1.87
Solidago nemoralis	Old Field Goldenrod	14.10	3.73
Solidago speciosa	Showy Goldenrod	4.46	3.73
Symphyotrichum laeve	Smooth American-aster	1.29	1.87
Symphyotrichum novae-angliae	New England American-aster	1.55	1.87
Symphyotrichum pilosum	Awl American-aster	1.71	0.97
Symphyotrichum prenanthoides	Crooked-stemmed American-aster	5.64	3.73
Zizia aptera	Heart-leaf Golden Alexanders	0.85	5.60
Zizia aurea	Golden Alexanders	0.52	3.73
Graminoids			
Agrostis perennans	Upland Bent Grass	6.11	0.97
Andropogon gerardii	Big Bluestem	0.47	3.73
Carex brevior	Plains Oval Sedge	1.36	3.73
Danthonia spicata	Poverty Oat Grass	1.17	3.73
Eragrostis spectabilis	Purple Lovegrass	10.76	3.05
Panicum virgatum	Switchgrass	0.17	0.97
Schizachyrium scoparium	Little Bluestem	2.07	10.95

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NORTH

0 5 10 20 40 feet

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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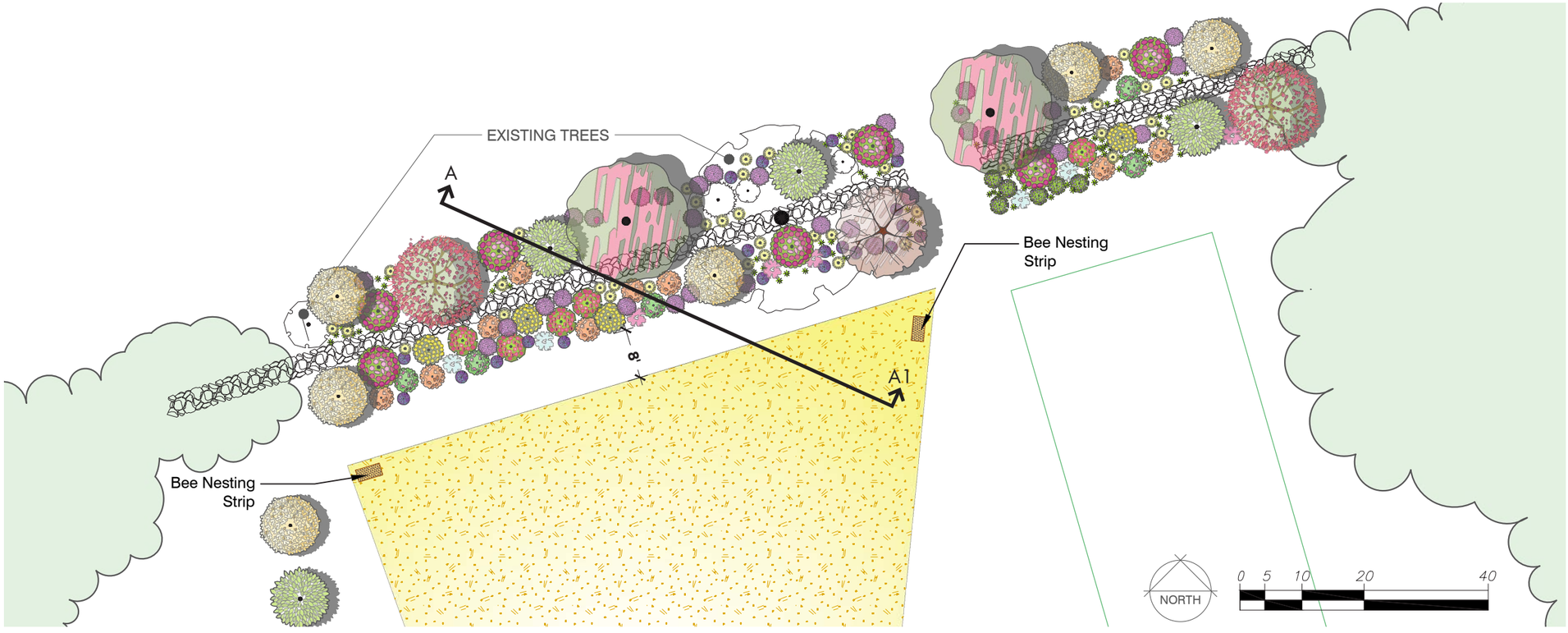
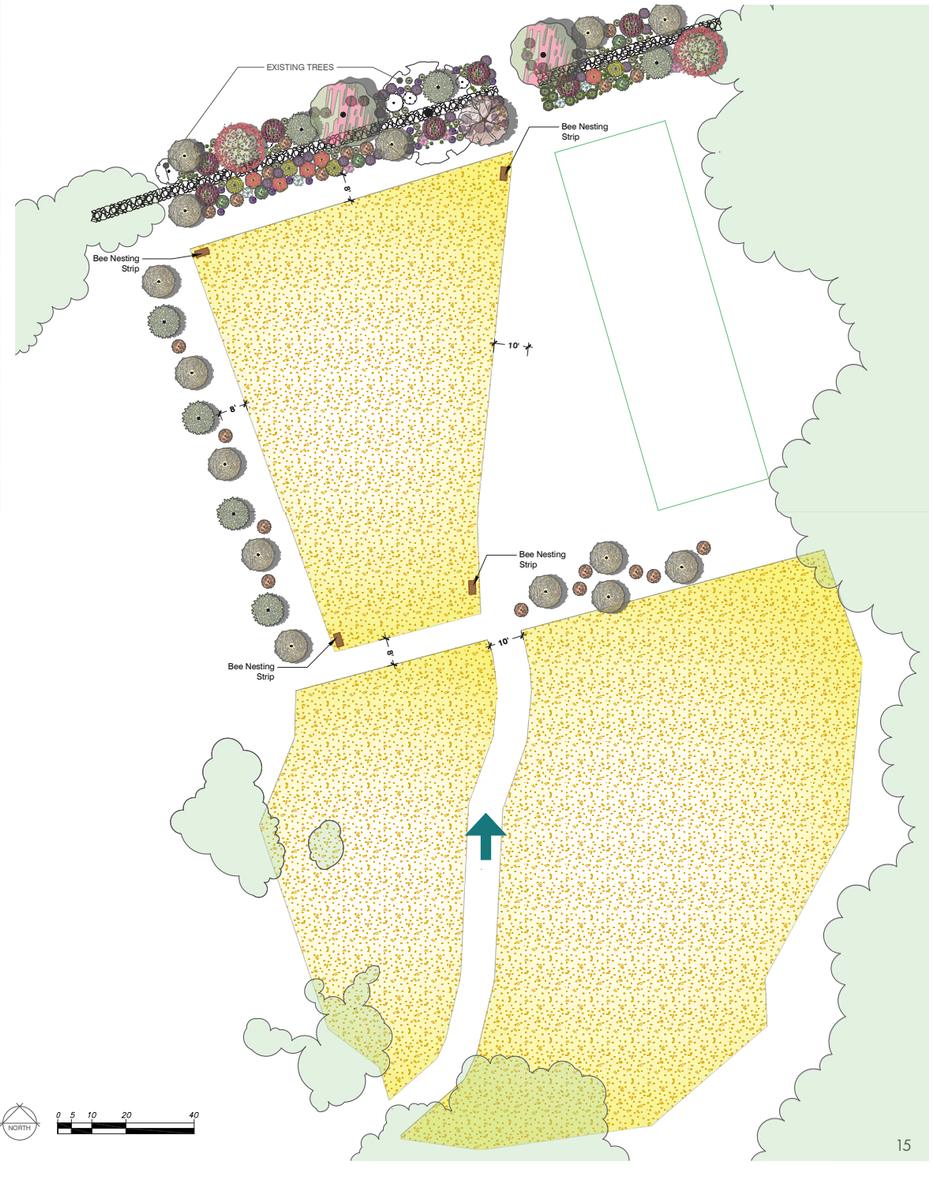


Section A - A1 of the hedgerow facing northeast. Scale of section below is four times the scale of design to the right.

A

A1

Conceptual rendering of the Lower Meadow facing north from the center of the mowed path.



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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.

MEADOW ESTABLISHMENT AND MAINTENANCE

SITE PREPARATION

The Upper Meadow at McKeon Farm was installed by first removing existing turf grass and plants using a walk behind gas-powered sod cutter. It is recommended to first mow as low as possible, and to sod cut when there has not been a lot of rain, as it makes the soil easier to lift. The Lower Meadow, representing a much larger area, was mowed low and harrow raked with a tractor before seeding. A seed drill can be used in lieu of raking, and is the ideal equipment for native meadow seeding on a large scale.

After all of the sod was rolled up and removed, the meadow seed mix listed on page 12 was hand broadcast equally across all areas of exposed soil. The seeds were mixed in a 5 gallon bucket with slightly dampened coarse sand. Four to six gallons of sand should be used for every 1,000 sq. ft to be seeded (sawdust may also be used instead of sand). The same method was used for seeding the Lower Meadow.

Late fall or winter are the best times to direct seed most native plant species, although early spring is also possible. If there is not adequate precipitation, areas recently seeded or planted should be watered. A cover crop should also be included: winter wheat *(Triticum aestivum)* for fall or winter seedings, and wild oats *(Avena sativa)* for spring seedings, either one at 100 lbs/acre.

Alternatively, small to medium-sized areas may be smothered with black plastic or sheet mulched in lieu of sod cutting as a method of vegetation removal.

MOWING REGIME

For the first growing season following seeding (2021), all seeded areas should be closely monitored for growth. When the average height of vegetation is between 10-12 inches, the area should be brush hogged or weed whacked or to a height of no less than 6-8 inches. This schedule should continue throughout the first, and possibly second growing season.

In the second growing season (2022), the seeded areas should be periodically assessed by a botanist or individual with vetted plant identification skills. **If the majority of vegetation in a given area is native species from the seed mixes**, then the mowing schedule for that area should transition to a once-a-year mow. This should always occur during the dormant season (between November 15 and April 1), after plants have gone to seed or before next season's growth. Ideally, the site would be broken up into 2 or 3 sections, with each section cut once a year on a rotational basis. During this annual mow, vegetation should be cut to a height of 6-8 inches. If during the second growing season, **the majority of vegetation in a given area appears to remain non-native grasses and/or weeds**, then continue mowing as described above to keep the overall height of plants always between 6-12 inches. This regime should be followed until the third growing season.

By the third growing season (2023), the site should be ready for transition to an annual mow on a rotational basis as described above. Invasive species and early successional trees should be closely monitored throughout the 3-5 year establishment period, and either manually pulled using a weed wrench or mechanically grubbed using a brush grubber mounted on a tractor, ATV or truck.

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WHY POLLINATORS?

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