UNIVERSITY OF GEORGIA
EXTENSION

The *Eco-Friendly* Garden:

Attracting Pollinators, Beneficial Insects, and Other Natural Predators

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Introduction

Why attract insects to your landscape? Although insects supply valuable services to landscapes and ecosystems, they are often perceived negatively. In actuality, insect pollinators are necessary for crop production **and** for the viability of wild plant species. Insects also help in the regulation of pests that destroy agricultural crops and in decomposition, helping to aerate the soil. These ecological services are referred to as **arthropod-mediated ecosystem services (AMES)**. Because insects are so necessary and beneficial to the landscape, the use of plant species that support these insects is important.

Recent studies in ecology (the interactions between organisms, their environment, and each other) have found that the way people choose to landscape in urban areas can affect the biodiversity of that area. **Biodiversity** is the variety among and within plant and animal species. Higher biodiversity in a landscape makes for a healthier ecological environment. With the use of native ornamental plants, gardeners and landscapers can help improve their local environment.

"Habitat management" refers to the use of insect-attracting plant species in order to intentionally draw insects to garden areas and urban landscapes. These plants provide a refuge for the insects during winter as well as nectar and pollen resources. Landscape arrangement directly affects beneficial insect populations, those insects that can provide ecological benefits such as biodiversity and natural pest control. This concept of habitat management can lead to potential increases in pollinating and other beneficial insect populations. An increase in these populations in landscapes will contribute to improved pollination of plants and biological pest control and reduce the need for pesticides. A pollinator-friendly and ecologically sustainable garden is both beautiful **and** able to attract and sustain beneficial insects.

What Kinds of Insects are Common Visitors in a Garden?

Three types of insects are commonly found in an ornamental garden. There are pollinators (Figure 1), plant-eating insects, and beneficial insects. Pollinators aid in the pollination of plant species by carrying pollen from one plant to another or within one plant. This process guarantees that the plant will produce fruit and seeds. Spiders also are considered beneficial (because they feed on many plant-feeding insects); however, they are not considered insects by entomologists; one difference being that the true insects have six legs while spiders have eight. For our purposes, we will include spiders in the 'beneficial insect' group. Beneficial insects are, simply put, 'good bugs' that eat 'bad bugs.' They are those insects that naturally prey on pests found in gardens and ornamental landscapes.

Figure 1. Bees are an important pollinator species that contribute greatly to the world's food production. However, evidence suggests that pollinator insect populations are declining worldwide.

What Were the Research Goals?

We studied habitat management in order to provide detailed information on the attractiveness of a wide selection of ornamental floral resources to pollinators, natural enemies, and plant-eating insects, as well as to determine the effects of various plant attributes on insect visitations.

Our overarching goal is to foster biodiversity in residential and commercial landscapes. We studied which plants and plant attributes are best able to attract ecologically important insects most often. By increasing the use of such plants, we can begin to improve ecological health and increase biodiversity in the landscape. A garden that provides suitable foraging sites with adequate and diversified nectar sources (such as shrubs, trees, and flowers) can increase viable populations of insects that will in turn help the garden to thrive. Just as important is understanding the relationships that bring about biodiversity, for example, flowers attract not only butterflies but also plant-feeding insects, which in turn attract natural predators who feed on them (Figure 2).

Figure 2. The plant whirling butterfly *(Gaura)* is highly attractive to pollinators and also aphids. The ladybug is a natural predator who feeds on the aphids.

Attracting insects to landscapes through the use of native and flowering plants can lead to increases in agricultural production and limitations of pesticide inputs.

How Was the Research Done?

The research was conducted at the University of Georgia campus in Griffin, Georgia. The Butterfly and Conservation Garden was established in the fall of 2012 and contains approximately 70, mostly perennial species, many of which are native plant species (Figures 3A, 3B, 4A, 4B, and 4C; Table 1).

Figure 3A. The Butterfly and Conservation Garden in October 2012 at installation.

Figure 3B. The Butterfly and Conservation Garden in July 2013.

Figure 4A.
A variety of foliar textures and colors were mixed with flowering plants to ensure not only that plants are attractive to insects but provide aesthetic appeal as well.
Hibiscus 'Mahagony Splendor' and *Curcuma* 'Emperor' bold foliage complement the yellow flowers of tri-leafed coneflower, *Lantana* 'Mozelle,' and the pink blossoms of Eupatorium 'Gateway.'

Figure 4B.
Colocasia 'Black Stem' (center) and butterfly ginger's (top left) upright habit provide height and bold foliage complementing the flowers of salvia 'Mystic Spires' and smooth aster 'Bluebird' as well as the fine-textured foliage of blue star (photo taken in October 2014, when foliage was starting to turn yellow).

Figure 4C.
Shrubs planted included top left: naturalized senna (*Senna* x *floribunda*), bottom left: native buttonbush, top right: non-native glossy abelia 'Raspberry Profusion,' and bottom right: variegated hidden ginger (*Curcuma* 'Emperor').

Table 1. Complete list of perennial plants trialed at the gardens.

Abelia 'Raspberry Profusion'	*Foeniculum vulgare*
Achillea 'Sunny Seduction,' 'Coronation Gold'	*Gaura lindheimeri* 'Passionate Blush'
Agastache 'Acapulco,' 'Black Adder' †'Raspberry Nectar'	*Hedichium coronarium*
Amsonia hubrichtii	*Hedichium coccineum*
Asclepias incarnata	*Heliopsis scabra* 'Summer Sun'
Asclepias physocarpa	*Hibiscus* 'Mahogony Splendor'*
Asclepias tuberosa 'Hello Yellow'	*Lantana camara* 'Mozelle,' 'Miss Huff'
Aster dumosus 'Wood's Pink'	*Lonicera sempervirens* 'Major Wheeler'
Aster laevis 'Bluebird'	*Lysimachia* 'Firecracker'
Aster tataricum 'Jindai'	*Melissa officinalis*
Astilbe 'Visions in Pink'	*Monarda didyma* 'Raspberry Wine'
Belamcanda chinensis	*Nepeta* x *faassenii* 'Walker's Low'
Buddleia 'White Profusion'	*Passiflora incarnata*
Caryopteris x *clandonensis* 'First Choice'	*Petroselinum crispum*
Cassia x *floribunda*	*Petunia* x *hybrida* 'Fuseables'
*Celosia spicata**	*Phlox paniculata* 'Robert Poore'
Ceratostigma plumbaginoides	*Rudbeckia triloba*
Cephalanthus occidentalis	*Rudbeckia* 'Indian Summer,' 'Goldstrum'
Clethra alnifolia 'Hummingbird'	*Ruellia brittoniana* 'Purple Showers,' 'Katie White'
Colocasia 'Black Stem,' 'Pink China'	*Salvia microphylla* 'Hot Lips'
Coreopsis 'Big Bang Cosmic Eye,' 'Red Shift'	*Salvia* x *hybrida* 'Wendy's Wish'
Coreopsis auriculata 'Snowberry'	*Salvia leucantha* 'Santa Barbara'
Curcuma petiolata 'Emperor"	*Salvia* 'Mystic Spires'
Dendranthema 'Cambodian Queen'	*Senna* x *floribunda*
Dianthus 'Coconut Surprise,' 'Cheddar Pink'	*Solenostemon scutellarioides* 'Fuseables'
Dicliptera suberecta	*Stachys byzantina*
Digitalis purpurea 'Alba,' 'Excelsior Hybrid'	*Thunbergia alata*
Echinacea purpurea 'Magnus'	*Verbena bonariensis*
Eupatorium rugosum 'Chocolate'	*Verbena canadensis* 'Taylortown Red'
Eupatorium purpureum 'Gateway'	*Zinnia linearis* 'Starbright' *

**annual species*

† *In Georgia, some Agastache hybrids are more suitable when grown as annuals and replanted each year.*

The plants used in the garden were selected based on their attractiveness to pollinators and beneficial insects, their horticultural attributes, current availability in the trade, and their adaptability to a Southeastern growing environment. Pollinator-friendly garden plants can provide not only nectar and pollen, but also food — in the form of foliage for immature butterflies. For example, fennel, parsley, lemon balm, and passion flower were incorporated in the planting to serve as food source for the larval stages of various insect species. No pesticides were used for pest control throughout the study.

Our study focused primarily on pollinators visiting the garden, which included bees, wasps, flies, butterflies, moths, and beetles. Other considerations included: interesting foliage, extended blooming (spring to fall for seasonal interest), and low-maintenance (Figures 4A, 4B, and 4C; Table 1). Most of the plants we used require full-sun growing conditions, while a few species are better adapted to some shade. In addition to different color blooms, an aesthetically pleasing landscape incorporates a variety of the following:

- blossom size – many small flowers on an inflorescence to few large ones
- foliar textures – fine to coarse
- foliar colors – chartreuse to purple
- plant height – groundcovers to bushes

In order to assess the many insects that visited the garden, we used several methods. Insect activity, abundance, and diversity were evaluated through visual observations and sweep net (sampling of the plants through an aerial net), color pan, and sticky card trappings (Figure 5). The color pan trapping involved the use of colored plastic cups and bowls filled with soapy solutions, which served as traps for the insects. The sticky card trapping was used to monitor flying insect species that might not have been observed through the other methods. Yellow sticky trap cards were placed on utility posts at heights of 2 feet and 4 feet.

Figure 5. Insects were captured with an aerial net (left), sticky cards (right), and color pan traps (center).

What Were the Results?

Insect Types

We observed the following groups of insects: pollinators, beneficial insects (including spider species), and plant-feeding insects throughout the trial. Common pollinator species included: bumble bee (two species) (Figure 6), honey bee, carpenter bee (one species), small bee (13 species), paper and potter wasps, thread-waisted wasps, mud daubers, syrphid flies, other flies, and long-legged flies (Figure 7). The two types of pollinators seen in larger numbers were bees and flies, followed by wasps (Figure 8).

Common lepidopteran species (butterflies and moths) that visited the garden included various skipper

Figure 6. Left to right: small bee, bumble bee, and other bees (two on the right).

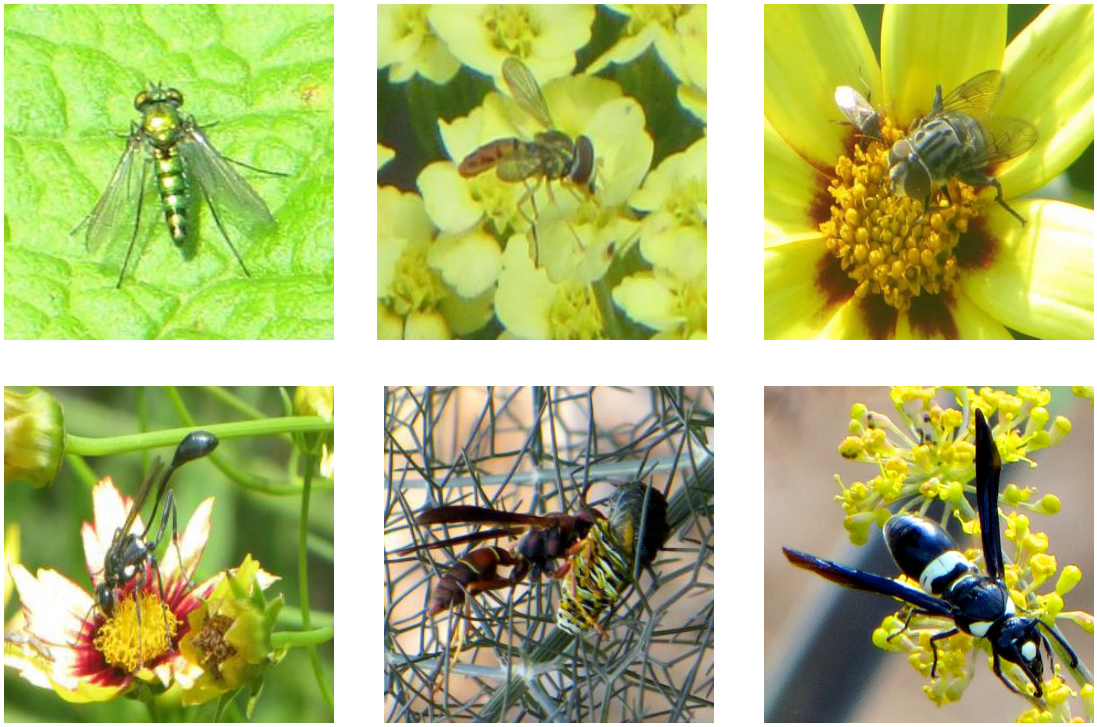


Figure 7. Top row: long-legged fly, syrphid fly and other fly. Bottom row: wasps.

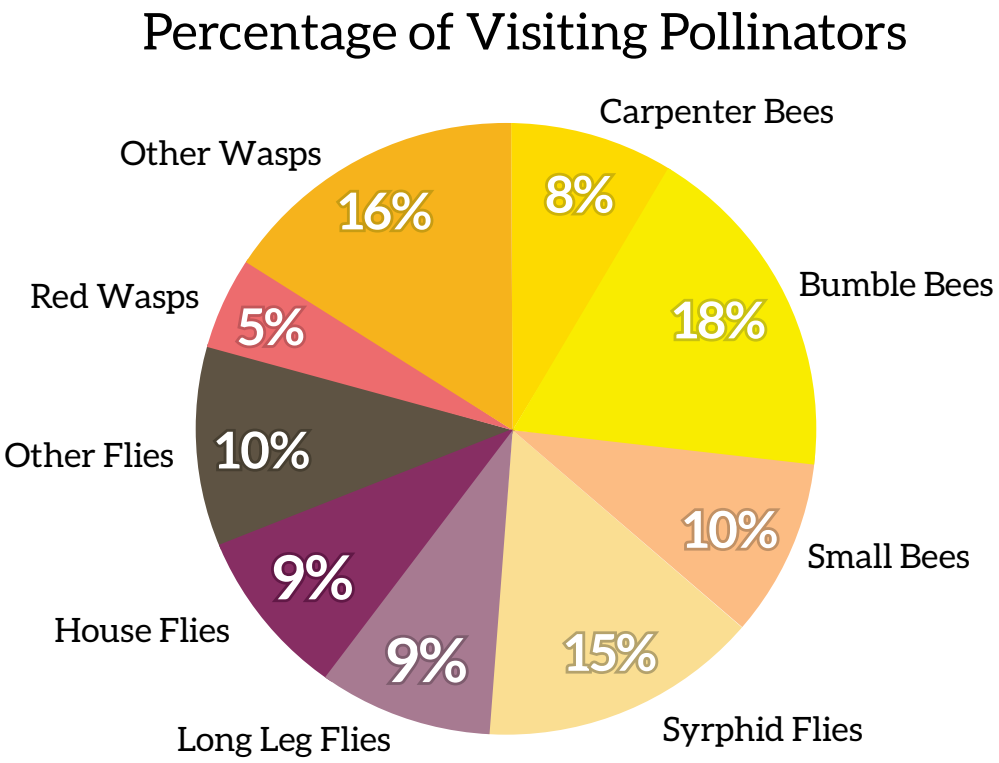


Figure 8. Insects as a percentage of the total amount of visiting pollinators; the two most common types of pollinator visitors were bees and flies, followed by different species of wasps.

butterflies, Eastern swallowtail butterflies, sulphur butterflies, cabbage white butterflies, variegated and Gulf fritillary butterflies, common buckeye butterflies, American/painted lady butterflies, Eastern blue butterflies, and hummingbird moths (Figures 9A, 9B, and 9C). The most common types of butterfly visitors were skippers, followed by American/painted ladies and swallowtails (Figure 10).
In addition to pollinators, other visitors to the garden included plant-feeding insects, such as leafhoppers/

Figure 9A. From left to right: common buckeye, sulphur, fritillary, American/painted lady.

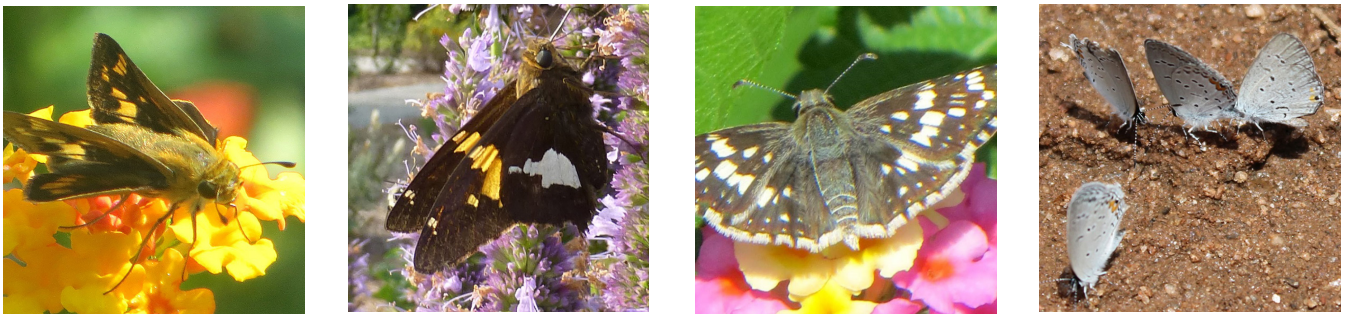


Figure 9B. From left to right: fiery skipper, silver-spotted skipper, checkered skipper, Eastern blue butterfly.

Figure 9C. From left to right: Eastern swallowtail, hummingbird moth, tiger swallowtail.

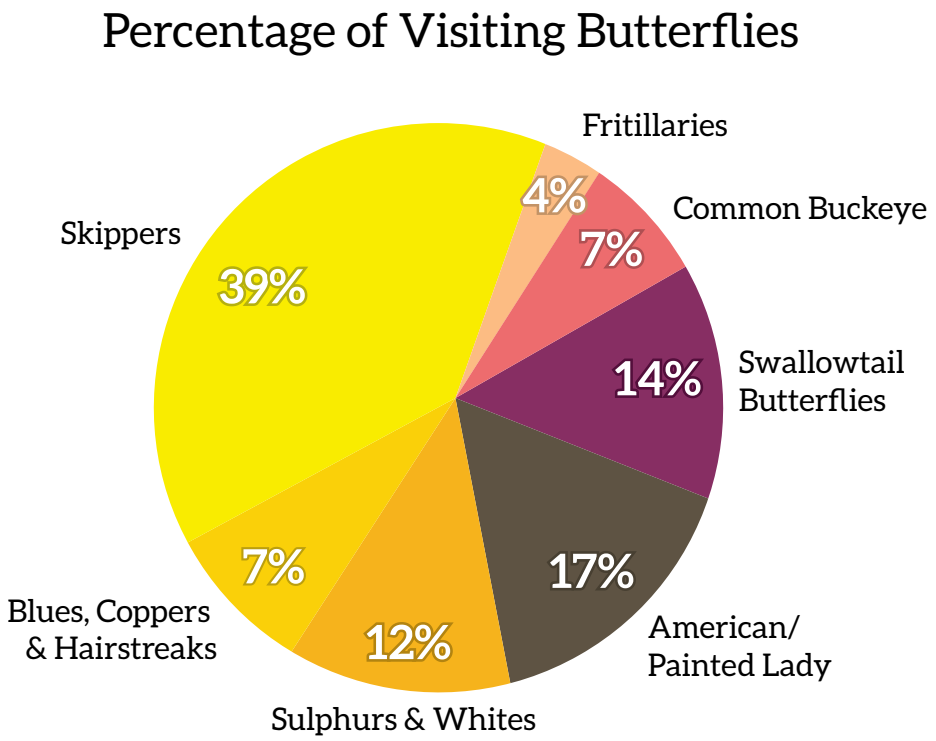


Figure 10. Percentage of visiting butterflies; most common were Skipper Butterflies, followed by American/Painted Lady, Swallowtails, and Common Buckeye.

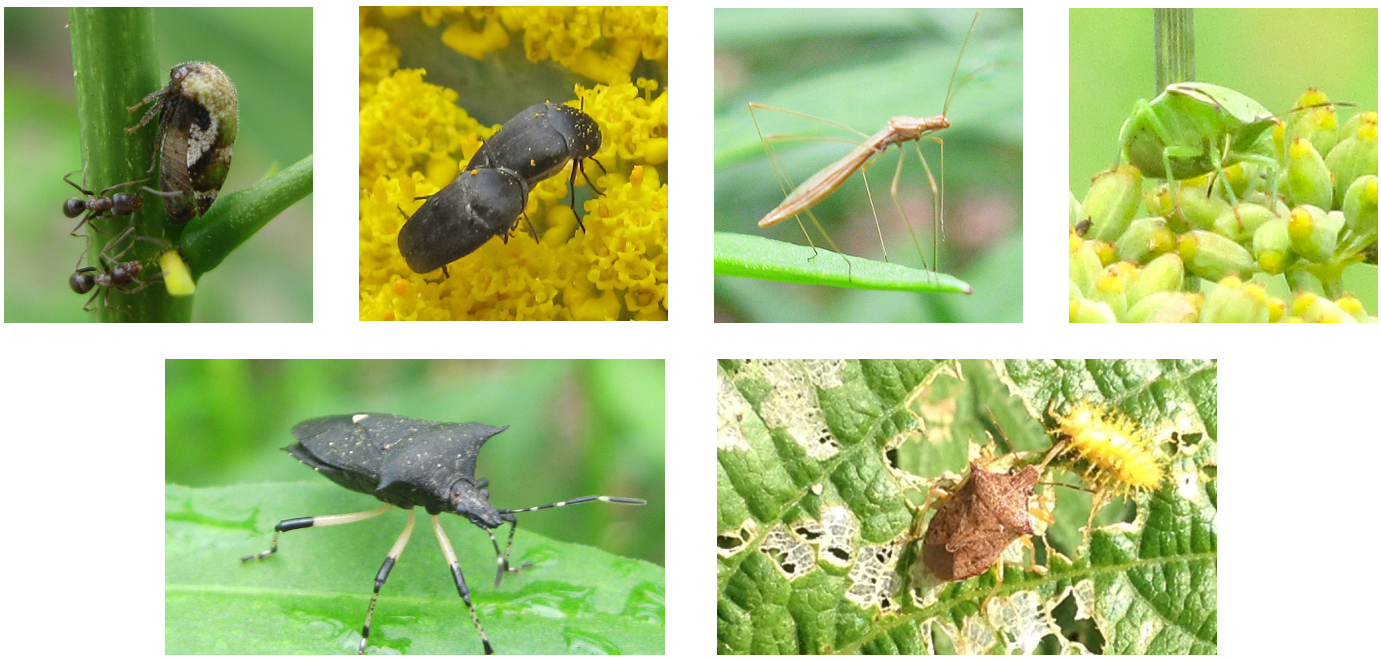


Figure 11. Top row: plant-feeding insects. From left to right: buffalo treehopper, tumbling flower beetle, green stink bug, stilt bug. Bottom row: predaceous stink bugs. From left to right: black stink bug, *Proxys punctulatus* (Palisot), and brown spined-soldier stink bug, *Podisus maculiventris* (Say). The pointy shoulders of the predaceous stink bugs can be one of the distinguishing features between 'good' stink bugs (i.e., those that eat pests), and 'bad' stink bugs (i.e., those that eat plants). The other distinguishing feature is the mouth parts, slender in the herbaceous type and thicker in the predaceous type.

treehoppers, stink bugs, flea and leaf beetles, tumbling flower beetles, and stilt bugs (although some species of stilt bugs can also be predators feeding on aphids) (Figure 11).
Leafhoppers/treehoppers and stink bugs feed on plant sap, while the insects listed feed on pollen and other flower parts. The following species of leafhoppers were observed: buffalo treehopper, glassy-winged sharpshooter, and red-banded leafhopper. These insects were often seen by March or April and visited the garden throughout the summer and early fall. Stink-bug species fall into two categories — predaceous stink bug and plant-feeding stink bug. Predaceous stink bugs feed on beetle larvae, caterpillars, and other insects. Plant-feeding stink bugs feed on plant sap.

We also observed spider predators, such as green lynx spiders, white-banded crab spiders, wolf spiders, daddy long-legs spiders, golden silk spiders, and orb-weaver spiders (Figure 12).

Both beneficial insects/spiders and plant-feeding insects were seen in approximately equal numbers (Figure 13).

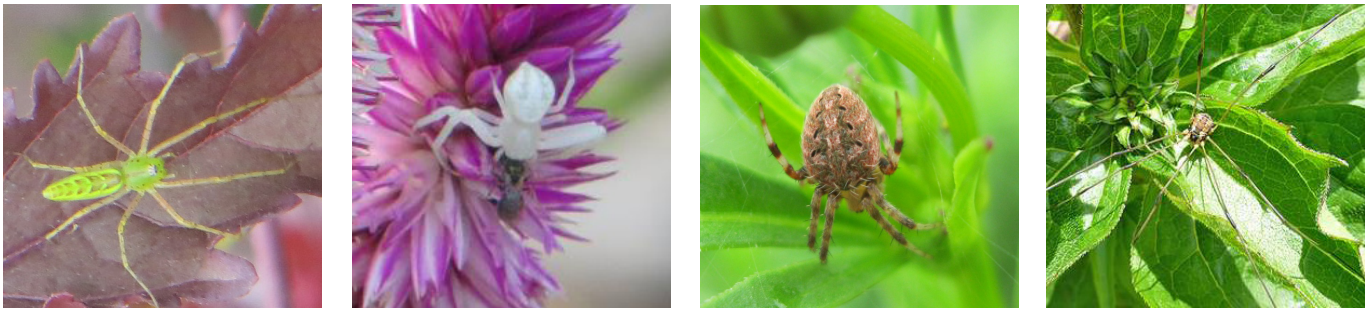


Figure 12. Spiders species encountered in the garden. From left to right: green lynx spider, white-banded crab spider, wolf spider, daddy long-legs spider.

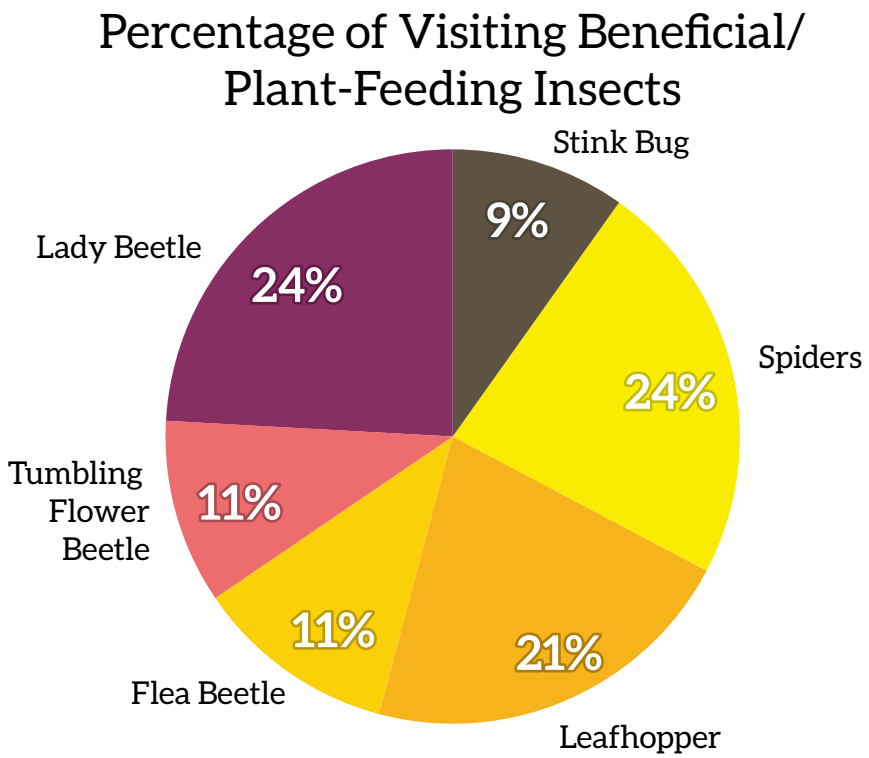


Figure 13. Types of beneficial/plant-feeding insects observed in the garden by percentage of total visiting beneficial/plant-feeding insects.

Plant Characteristics and Insect Preference

Insects and flower characteristics are linked directly through evolution. Plants develop certain characteristics in order to attract insects, especially pollinating and beneficial insects. Research suggests that flower appearance can directly influence a pollinator's preference and behavior toward that flower. Factors that contribute to plant attractiveness for pollinating, plant feeding, and beneficial insects include: plant color, plant height, flower shape, and flower type.

Butterflies and bees have innate flower color preferences. Many pollinators are able to see ultraviolet (UV) rays that humans cannot detect. These colors can be detected on brightly colored flowers by bees and other pollinators. In our research, we found that flower color was pivotal in determining how attracted to a flower a pollinator was. We found that bumble bees preferred purple flowers (Figure 14).

Flower shapes that include many small flowers, rather than one solitary flower, are thought to be more attractive and highly visible from afar. This concept can also be true for plant height. In our research, we found that leafhoppers and sharpshooters preferred multiple flower shapes (Figure 15). Umbel and solitary shapes were identified as ideal flower types for the assassin bug (Figure 16). Beneficial, pollinating, and plant-feeding insects preferred flower colors in addition to yellow and the flower shapes urceolate, bowl, cruciform, funnelform, and salverform.

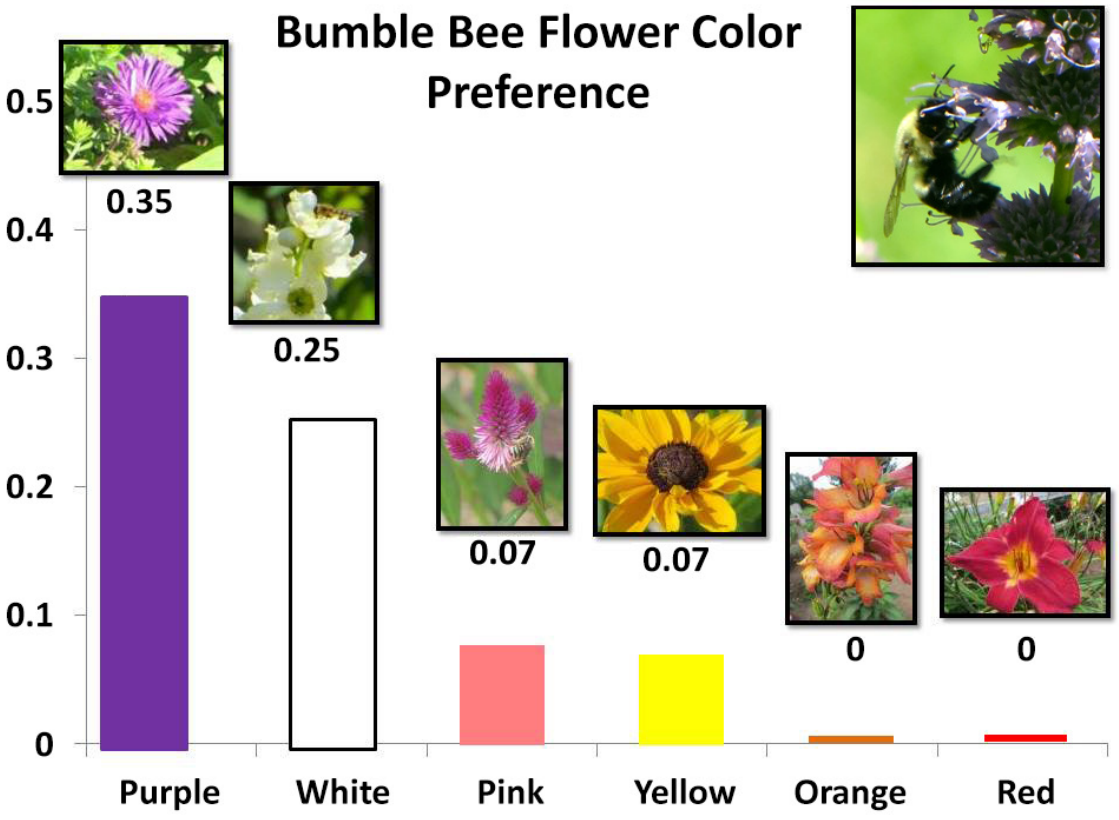


Figure 14. Purple flowers were preferred by bumble bees.

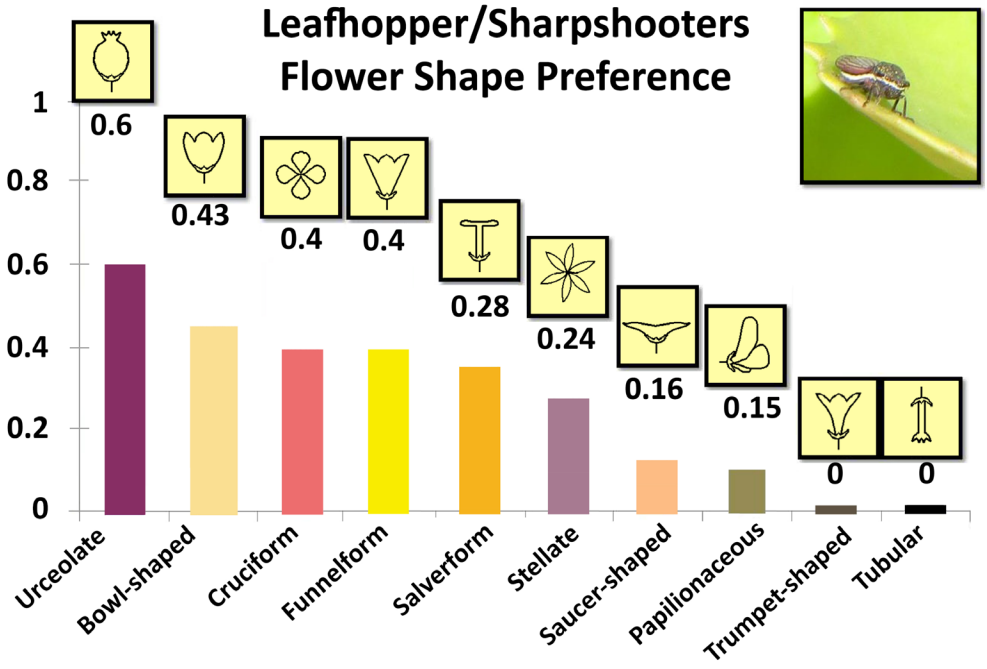


Figure 15. Leafhoppers and sharpshooters preferred multiple flower shapes.

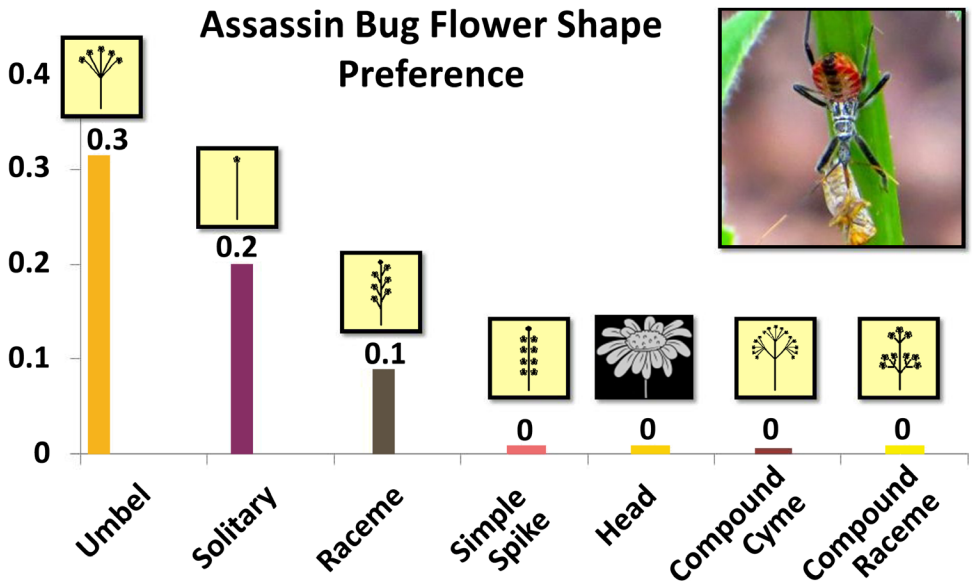


Figure 16. Umbel and solitary shapes were identified as ideal flower types for the assassin bug, a natural predator.

Which Plants Were Most Attractive to Bugs?

All plant species in the garden were attractive to pollinators and/or beneficials to various degrees (for complete list refer to Table 1). Our results are summarized by which plants were top attractors for pollinators (Table 2) and beneficials (Table 3). The plants that were most attractive to all insect and spiders were: hyssop, whirling butterflies, buttonbush, black-eyed Susan (*Rudbeckia*), yarrow, tickseed, Joe-Pye weed, and salvia.

How Can You Apply This in Your Garden?

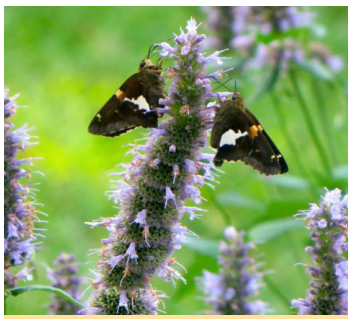
A garden that is both beautiful and able to attract and sustain beneficial insects, thereby reducing the need for pesticides, will be pollinator friendly and ecologically sustainable. Increasing the use of perennial, annual, and native plant species that attract pollinators, beneficials, and plant-eating insects can help you to naturally control pests in your landscape and increase biodiversity.

Table 2. Top plant species for attracting pollinators.

Glossy abelia
Abelia x *grandiflora*
'Raspberry Profusion'

Yarrow
Achillea filipendula
'Coronation Gold'

Yarrow
Achillea millefolium
'Sunny Seduction'

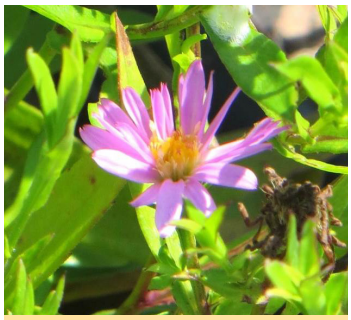


Hyssop
Agastache 'Black Adder'

Hyssop
Agastache 'Raspberry Nectar'

Hyssop
Agastache mexicana
'Acapulco'

Bluestar
Amsonia hubrichtii



Hardy Aster
Aster dumosus 'Wood's Pink'

Smooth aster
Aster laevis 'Bluebird'

Chinese astilbe
Astilbe chinensis
'Visions in Pink'

Blackberry lily
Belamcanda chinensis

Butterfly bush
Buddleia x *davidii*

Wheat celosia
Celosia spicata

Elephant ear
Colocasia esculenta
'Black Stem'

Tickseed
Coreopsis auriculata
'Red Shift'

Variegated hidden ginger
Curcuma petiolata 'Emperor'

Hummingbird plant
Dicliptera suberecta

Coneflower
Echinacea purpurea
'Magnus'

Fennel
Foeniculum vulgare

Whirling butterflies
Gaura lindheimeri
'Passionate Blush'

Hardy lantana
Lantana camara 'Mozelle'

Hardy lantana
Lantana camara 'Ms. Huff'

Honeysuckle
Lonicera sempervirens
'Major Wheeler'

Hairy Loosestrife
Lysimachia 'Firecracker'

Catmint
Nepeta x faassenji
'Walker's Low'

Orange Coneflower
Rudbeckia fulgida
'Goldsturm'

Black-eyed Susan
Rudbeckia hirta
'Indian Summer'

Three-leaved coneflower
Rudbeckia triloba

Salvia
Salvia 'Mystic Spires'

Baby sage
Salvia microphylla 'Hot Lips'

Coleus
Solenostemon scutellariodes
'Fuseables'

Black-eyed Susan vine
Thunbergia alata

Table 3. Top plant species for attracting beneficials.

Glossy abelia
Abelia x *grandiflora*
'Raspberry Profusion'

Yarrow
Achillea filipendula
'Coronation Gold'

Yarrow
Achillea millefolium
'Sunny Seduction'

Bluestar
Amsonia hubrichtii

Butterfly bush
Buddleia x *davidii*

Bluebeard
Caryopteris x *clandonensis*
'First Choice'

Wheat celosia
Celosia spicata

Tickseed
Coreopsis
'Big Bang Cosmic Eye'

Tickseed
Coreopsis auriculata
'Red Shift'

Tickseed
Coreopsis auriculata
'Snowberry'

Variegated hidden ginger
Curcuma petiolata 'Emperor'

Joe-Pye Weed
Eupatorium purpureum
'Gateway'

Fennel
Foeniculum vulgare

Whirling butterflies
Gaura lindheimeri
'Passionate Blush'

Honeysuckle
Lonicera sempervirens
'Major Wheeler'

Lemon Balm
Melissa officinalis

Catmint
Nepeta x faassenji
'Walker's Low'

Black-eyed Susan
Rudbeckia hirta
'Indian Summer'

Three-leaved coneflower
Rudbeckia triloba

Baby sage
Salvia microphylla 'Hot Lips'

Senna floribunda
Senna x *floribunda*

Coleus
Solenostemon scutellariodes
'Fuseables'

Lamb's ear
Stachys byzantina

Some plant-feeding insects can be tolerated because they will help keep the presence of natural enemies of insects in the garden. If we eliminate all pests, the natural enemies will leave the area in search of food. To have a successful habitat management site, it is crucial to increase pest suppression by providing adequate resources for the natural enemies of those pests. One way of achieving this is by choosing the appropriate plants for the managed area. Some criteria used to determine which plants to choose for habitat management of insects included:

- attractiveness to natural enemies
- rich production of pollen and nectar
- seed accessibility
- availability of floral resources

Choose plants with sweet, pungent, highly fragrant flowers; red, purple, orange, yellow, or pink flower colors; and simple, open flowers. Native annual and perennial plants are preferred because they adapt locally, increase native plant diversity of the region, minimize recurring costs, and help with habitat permanency. Often, native plants have reduced water, nutrient, and sometimes pest control requirements because of their adaptation to the local climate.

If you want to have a large and viable population of active butterflies, your garden must provide more than just a source of nectar. Suitable habitat for over-wintering, storm protection, and overnight staging must also be provided. In order to attract butterflies all summer, you not only need nectar producing plants, but also larval food plants and a shallow pool of water (e.g., flat rocks that can hold water). You must also include salt sources, resting areas, and roaming areas in your garden. Many grasses and wildflowers native to Georgia provide suitable food for larvae. Establishing a pesticide-free habitat through the use of natural enemies of pests in place of chemical pesticides will also help you increase the population of active butterflies in your landscape.

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