

Beneficial Insectary Design



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Winter 2018 Internship Project
SER-UW Native Plant Nursery

Table of Contents

Introduction	2
Project Goals	2
Integrated Pest Management	3
Table 1: Observed nursery pests & their natural enemies	4
Plant Selection	5
Table 2: Bloom period of selected insectary plants	6
Insectary Design	9
Figure 1: Species composition	9
Cost Estimation	10
Table 3: Cost Estimation	10
Maintenance and Monitoring	11
Sources	12

Introduction

Beneficial insectaries are a form of integrated pest management that uses biological control. Insectaries are designed to attract and create habitat for the natural enemies of pests, which then predate nursery pests. The reduced pest populations result in better overall plant health and reduced pesticide usage. In addition to the benefit of biological pest control, the insectary will attract pollinators, as many beneficial insects are also pollinators at some point in their lifecycle. The construction of an insectary at the SER-UW Nursery will provide an opportunity for research and help to inform future pest management. This research will not only help the nursery, but the UW Farm, UW Botanic Gardens, and other related organizations as well.

Goals

The installment of a beneficial insectary is projected to reduce the need for pesticides at SER-UW Nursery and create a stronger integrated pest management plan. This will be accomplished by building 4-5 wooden container gardens, containing a mixture of perennial native species. The species selected will provide habitat for beneficial insects, winter structure, and flowers throughout the growing season to provide food sources, since many beneficial insects are also pollinators. In the future, research will be conducted to determine what beneficial insects appear, population sizes, foraging patterns, etc.



Image: Hoverfly larva eating an aphid



Image: Parasitized beetle filled with wasp larvae

Integrated Pest Management

Beneficial insectaries use biological control to manage pests. There are a few basic principles to follow when constructing one:

- Determine which species are most likely to be helpful
- Know and map existing habitat
- Manage and create habitat to attract natural enemies to your area

In the case of SER-UW Nursery, helpful insect species have been determined by looking at past pest monitoring records (Table 1). There is existing habitat for beneficials in the nursery stock and surrounding Union Bay Natural Area, but there are few centralized year-round habitat and food sources. By constructing a beneficial insectary, habitat will be created to provide food throughout the growing season and shelter all year.

A beneficial insectary helps control insect pests on its own, but works best when it is part of an integrated pest management (IPM) plan. IPM focuses on long-term prevention of pest damage through ecosystem management, using a variety of methods. Beneficial insectaries focus on biological control, but there is also mechanical control (e.g. bird screens), cultural control (reducing pest establishment), and chemical control.



Image: Wasp parasitizes aphid

Chemical control, or the application of pesticides, is known to be harmful to beneficial insects and other creatures, and should only be used when economically necessary. Beneficial insectaries require some tolerance of pests, because predators follow pests (their food source). Most beneficial insects have lower birth rates than pests, so if pesticides are applied, pests will almost always repopulate first. It is best to wait for beneficial insects to predate before applying pesticides, unless the infestation is large or in the winter.

Establishing a timeline for pesticide application is an important part of IPM. Generally, if the pest problem has not been abated by beneficial insects in 3 weeks, pesticide application could be considered, but it is up to the Nursery Manager. To

reduce the negative impact, use the most specific pesticides possible (general pest sprays also kill pollinators and beneficials), and try to mainly use bait traps. If spraying is necessary, spot-spray the most problematic plants. Pesticides should *never* be applied to the beneficial insectary. Rather, the insectary should provide shelter for beneficials during pesticide application.

Table 1: Observed nursery pests & their natural enemies

Observed Pest:	Natural Predators:
Fungus Gnat	<i>Hypoaspis miles</i> (predatory mite), <i>Steinernema feltiae</i> (entomopathogenic nematode)
Thrip	Endoparasitic Wasps,
Caterpillar	Green Lacewing
Aphid	Green Lacewing, Endoparasitic Wasps, Hoverfly, Ladybugs, Aphid midge
Leafhoppers	Hoverfly, Anagrus spp., spiders
Roseslugs	Parasitic Wasps, Predatory Beetles (Ladybugs, Carabidae, soldier beetles) Parasitic Flies

Not included on this list are Eastern Cottontail Rabbits. They are the nursery's largest pest, and since coyotes have had a decreased presence in the area, there is little biological control to keep their population in check. Some ways to deter rabbit predation on nursery plants is to use scent deterrents. Rabbits navigate primarily by smell, so surrounding the nursery in scents they dislike (pepper, onion, etc.) it can keep the rabbits away from nursery stock. This can be done by spreading pepper along the ground, surrounding outdoor stock with onion plants, or any number of ways.

Plant Selection

Selected insectary plants are “grown to attract, feed, and shelter insect parasites (parasitoids) and predators to enhance biological pest control” (UC-IPM). Many beneficial insects require nectar and pollen in addition to pests, so the most important factor for plant selection is the timing and duration of flowering. Natural enemies to nursery pests like birds, parasitic wasps, and hoverflies are also pollinators. Even if pests are abundant, having available nectar and pollen will increase the abundance and lifespan of beneficials, since insects have different feeding requirements at various stage of development. Selected plants should provide well-structured habitat all year, as well as provide flowers throughout the growing seasons. Structured habitat helps attract non-pollinating natural enemies, like spiders and ground beetles, and provides winter shelter. Shaded areas are also important for egg-laying. Perennial species are the best, as it reduces the cost and labor associated with maintaining the beneficial insectary. Native species are also preferred, because native insects are more well-adapted to them and they can be easily sourced.



Image: Parasitic wasp foraging on a Yarrow flower

The chosen plant species must be suited to growing conditions in the containers. The containers will be stationed around the nursery, an area with high insolation. Since the containers must be able to be transported, the containers can't have an open bottom like a raised bed would. This means the plants won't be able to access nutrients or water other than what is available inside the container. During the summer the containers will need to be watered, since no groundwater will be available to the plants and precipitation is low. Precipitation should be sufficient to water plants from fall to spring.

Table 2: Bloom period of selected insectary plants

Common Name	Scientific name	Value to Insects	Early		Middle			Late	
			April	May	June	July	Aug.	Sept.	Oct.
Common Camas	<i>Camassia quamash</i>	Attracts hoverflies, ladybugs, beetles, and bees.	*	*	*				
Common Lomatium, Spring Gold	<i>Lomatium utriculatum</i>	Attracts native bees, syrphid flies, beetles, moths, and butterflies.	*	*	*				
Kinnikinnick	<i>Arctostaphylos uva-ursi</i>	Provides woody habitat structure; late summer berries provide bird forage; Hosts butterflies	*	*	*				
Harsh Indian Paintbrush	<i>Castilleja hispida</i>	Attracts hummingbirds, bees, beetles, and butterflies.		*	*	*	*		
Broadleaf Lupine	<i>Lupinus latifolius</i>	Attracts pollinators, mainly native bees; Old growth provides habitat structure		*	*	*			
Woolly Sunflower	<i>Eriophyllum lanatum</i>	Attracts beetles, syrphid flies, bees, moths, and butterflies.		*	*	*			
Yarrow	<i>Achillea millefolium</i>	Attracts a wide range, particularly parasitic wasps and hoverflies		*	*	*	*		
Nodding Onion	<i>Allium cernuum</i>	Attracts native bees, butterflies, and predatory beneficials. Scent is known to repel rabbits.			*	*	*		
Slender Cinquefoil	<i>Potentilla gracilis</i>	Attracts bees, butterflies, birds, and other beneficials. Host plant for certain butterfly species..			*	*	*	*	
Pearly Everlasting	<i>Anaphalis margaritacea</i>	Attracts a wide range; Host plant for painted lady butterfly.			*	*	*	*	*
Canadian Goldenrod	<i>Solidago canadensis</i>	Attracts a wide range, including parasitic wasps, bees, and hoverflies.				*	*	*	*

***Solidago canadensis* (Canadian Goldenrod):** *S. canadensis* provides nectar and pollen late into summer, attracting many beneficial insects. It is a hardy perennial wildflower that grows well in full sun in a range of soil conditions. It should grow well in a container, where its rhizomatous spreading is limited, but it does have a weedy habit so it should be monitored to make sure it does not take over the container.

***Achillea millefolium* (Common Yarrow):** A perennial herb that grows well in full sun and dry, well drained soil. Its flowers attract beneficial insects, and provide habitat structure. Its small flowers are known for attracting endoparasitic wasps and other tiny flies. Similarly to *S. canadensis*, it has a weedy habit and care should be taken to make sure it doesn't take over the container.

***Potentilla gracilis* (Slender Cinquefoil):** Serves as a nectar and pollen source for many beneficial insects and is a possible host plant for the purplish copper (*Lycaena helloides*) and two-banded checkered skipper (*Pyrgus ruralis*) butterflies. It has golden flowers over the summer, and has seed-heads that attract birds. A hardy perennial wildflower, it grows in full sun to light shade in dry to moist soil.

***Anaphalis margaritacea* (Pearly Everlasting):** A perennial wildflower known as a food plant for Painted Lady butterflies, it also attracts a host of other beneficial insects. It has a long bloom time, and grows in full sun to part shade in dry soil.

***Lupinus latifolius* (Broadleaf Lupine):** Provides nectar and pollen to beneficial insects, in particular native bees. It has early season blooms, and old growth provides habitat structure. Grows well in full sun with dry to moist soil.

***Arctostaphylos uva-ursi* (Kinnikinnick):** Provides low woody habitat all year round, has early blooms, attracts pollinators (bees, birds, butterflies)

***Allium cernuum* (Nodding Onion):** Attracts native bees, butterflies, and predatory/parasitic beneficial insects. Its scent is also known to repel rodents (Rabbits such as the Eastern Cottontail hate the smell of onion). This species self-sows easily, so flowers should be removed at the end of the season to prevent it taking over. The bulb should be divided about every 3 years, or when it reaches 8-10 plants. *A. cernuum* is a drought-tolerant prairie plant.

***Lomatium utriculatum* (Common Lomatium):** Its small yellow flowers are perfect for small beneficials like parasitic wasps and hoverflies. It grows well in drier, sunny open areas.

***Camassia quamash* (Common Camas):** Attracts native bees and other beneficials. Provides pollen source early in season. Grows in moist soil that is dry by early spring, in open sunny areas.

***Eriophyllum lanatum* (Woolly Sunflower):** A drought-tolerant plant that grows well in many conditions, it is best to plant in groups and prune the dead branches. The small flowers provide food for many beneficial insects, and it is known to be especially attractive to butterflies.

***Castilleja hispida* (Harsh Indian Paintbrush):** Grows well in sunny areas with moist to dry soil. It's small, tube-like flowers mainly attract bees and butterflies, but some beneficials will eat through the flower to access pollen. Should be monitored for use by beneficial insect species.

***Festuca idahoensis* (Idaho Fescue):** Drought-tolerant bunchgrass that will provide winter habitat structure for spiders, beetles, and various other beneficials.

***Elymus glaucus* (Blue Wildrye):** a native bunchgrass that tolerates a wide range of conditions. Provides habitat for spiders, beetles, and other beneficials.

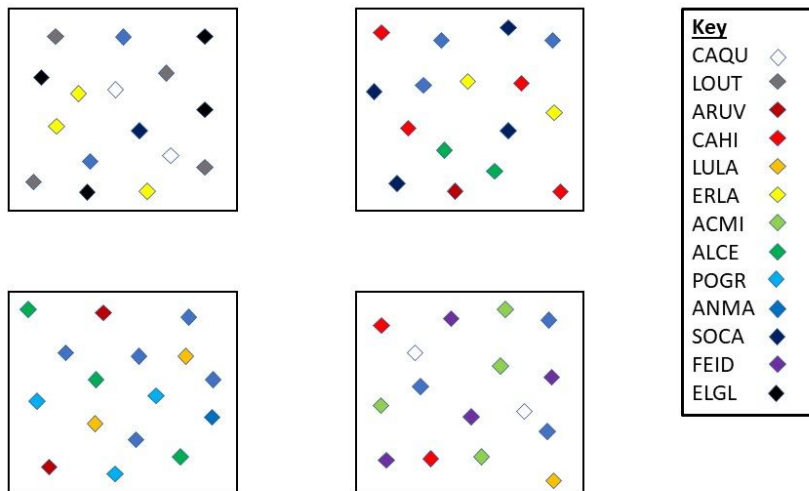
Insectary Design

The beneficial insectary will consist of 4 moveable container gardens. The beds will be 4'x4' and constructed out of 2X6 planks of treated wood. 4x4 is the minimum effective habitat size for an insectary. The bottom of the container will be made out of metal garden mesh, with wood planks spaced across. The mesh will allow adequate drainage for the plants.

Materials Needed (One Box):

- 10 2X6 treated boards (4 ft length)
- 1 4X4 piece of metal garden mesh
- 4 2x2 treated boards (1 ft length)
- ~40 screws

According to Sound Native Plants' plant quantity calculator, each box would have 16 4-inch container plants or plugs installed to create dense habitat. Based on this, each plant would have 1 square foot of space to spread. More plants can be added to the containers, and it is expected that many of the selected species will disperse seeds, 16 is simply the bare minimum amount of plants needed. With 4 boxes, a grand total of 64 plants are required.



The above figure shows potential species compositions for each box, taking into account structure and bloom period. The composition is subject to change as the insectary

matures. The boxes will be placed around the nursery. Two will be on the south side of the hoop house, 2 near the plants in the outside area. Since the containers can be moved, the placement can easily be changed.

Cost Estimation

Constructing a beneficial insectary will be a relatively low cost project, and will be paid for by the UW Botanic Gardens' gift fund. The plant species selected can all be sourced from the SER-UW nursery, so the cost will lie in purchasing soil and construction materials. For 4 containers, approx. 2.5 cubic yards of soil will be needed. Pacific Topsoil has a minimum 6 yards for delivery, and the supreme mix would cost \$258. To save money, soil could be picked up at \$26 per cubic yard, cutting costs significantly to \$78. The other main cost for this project is construction material. 13 12-ft 2x6 planks of treated wood costs \$130 from Home Depot. A roll of mesh is about \$25, and the leftovers can be used to fence out rabbits. The 2x2's and nails will be around \$20, putting the total cost of this project around \$251. Cost is variable depending on where and how materials are sourced.

Table 3: Cost Estimation

Material	Amount	Cost
Pacific Topsoil: Supreme Mix	3 cubic yds.	\$76
2x6 Treated wood planks (12 ft)	13	\$130
Metal Mesh	64 sq. ft.	\$25
2x2's, nails, misc.		\$20
	Total Cost:	\$251

Maintenance & Monitoring

Though the majority of plants selected are drought-tolerant, semi-regular watering of the insectary beds will be needed in the summer months, since the plants won't have access to groundwater. Weeding can be done by volunteers, however some weedy species such as Queen Anne's Lace actually provide great habitat for beneficial insects. Weeds should only be removed if they are outcompeting or otherwise degrading the habitat. The chosen plants are native perennials, so there will be little need for new plants every year.

Some of the insectary plants will need pruning at the end of the season to prevent their spread of seeds. Nodding Onion, Yarrow, Canadian Goldenrod, and Slender Cinquefoil should all have their flowers heads cut off at the end of their blooming period. These species can become weedy and take over the insectary beds if their seeds are not prevented from spreading. Nodding Onion bulbs should be divided every few years, once it has become 8-10 plants.

If there is little initial activity or to replace a beneficial insect population after pesticide usage, insects could potentially be purchased from local gardening stores. This is not the best option because ideally the insectary will attract native insects from the surrounding area. Store-bought insects are generally non-native and can potentially carry diseases.

The creation of the insectary provides a great opportunity for research. Regularly monitoring what insect species visit each plant could provide data on the effectiveness of the insectary. The nursery should also continue monitoring which pest species are present, and any evidence found of predation, such as "aphid mummies". Overtime, we can learn more about what plant compositions are best for attracting beneficial insects, and how an insectary impacts the pest population.

Sources

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