Conserving Urban Insects:

A Toolkit for Landscape Professionals in the Intermountain West

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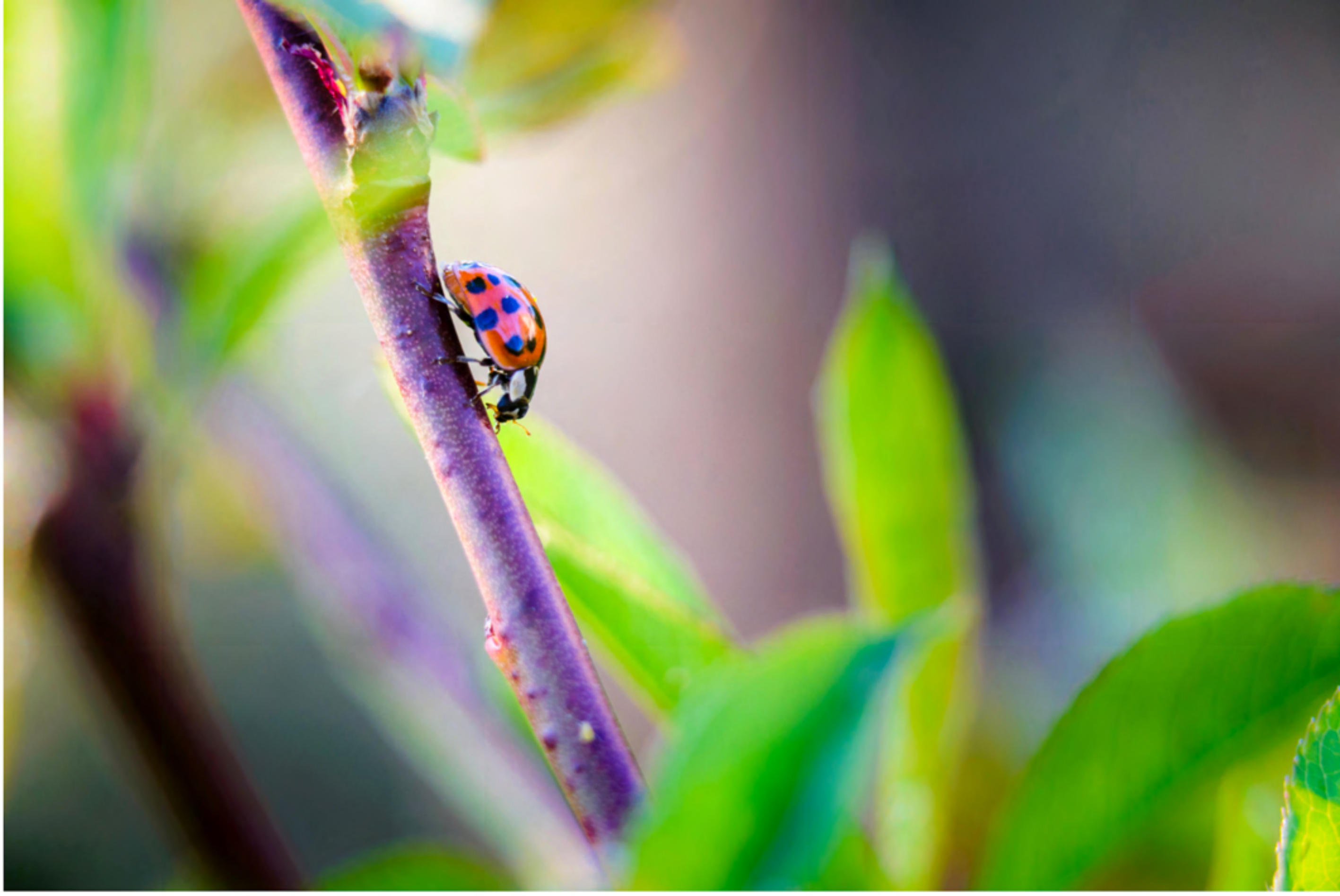
"Biological diversity is the key to the maintenance of the world as we know it."

~ E.O. Wilson



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Introduction

Purpose of this Toolkit
This toolkit is a resource for landscapers, landscape architects and designers, urban foresters, growers, staff in public gardens, parks, nurseries and other **ornamental horticulture professionals**. It is intended for those interested in conserving nonpest insects in urban and suburban environments.

Why urban and suburban areas?
Insects are critical not only to natural and agricultural ecosystems, but also to urban ecosystems. Urban environments are characterized by a patchwork of habitat "islands" including home gardens, university campuses, urban parks and farms, vacant lots, cemeteries, arboreta, and botanical gardens [1]. These habitat islands are the focus of this toolkit.

Suburbs often have a wider range of plant species [2] than urban centers or rural outskirts, which presents an opportunity for landscape professionals to encourage insect and bird diversity. Some wildlife including birds [3], bumblebees, butterflies, and gall moths [4] have been found in higher numbers in the suburbs than in rural areas.

Arming industry professionals with the know-how to support insects benefits both biodiversity and people. **Landscapes can be designed to preserve both valuable habitat and aesthetic value** [5].

Conservation In The Intermountain West
The Intermountain West is a unique region with a rapidly growing population. **Much of the population growth of the US in the last 10 years occurred in Utah, Idaho and Nevada** [6]. Despite this growth, the Intermountain West is largely overlooked by national horticulture and entomology outlets. Its arid, shrub-steppe ecosystem isn't found anywhere else in the country. Expanding human populations in the Intermountain West present a challenge and an opportunity for insect conservation.

*"If we cannot act as responsible stewards of **our own backyards**, the long-term prospects for biological diversity in the rest of the planet are grim indeed."*

— Dr. Dennis D. Murphy, 1988

Insects Matter, Everywhere

"The Little Things That Run the World"
Over half of known living species are insects [7]. They outnumber mammals by a factor of 20:1. There are over 1.2 million known insect species, and an estimated 3-5 million more are waiting to be discovered [8]. It may surprise many horticulturists to learn that **only 1% of insects are considered pests** [9].

The value of biodiversity
Biodiversity — the number of species in a given place — is critical to functioning ecosystems. The more biodiverse an ecosystem is, the more resilient it is in the face of threats like climate change, emerging invasive species, and extinction. Insects represent the vast majority of biodiversity in every land ecosystem. Insects are critical to ecological stability.

Plants need insects, and so do we
140 million years before dinosaurs roamed the planet, the six-legged creatures we now know as insects began to evolve. Insects and land plants co-evolved. As insects developed strategies to eat plants, plants responded by developing defense strategies in a chaotic dance of evolution.

85% of plants are pollinated by animals [10], most of which are insects. **The diversity of land plants we have is, in large part, because of their relationship to insects**.

What happens without insects?
Distinguished biologist, E.O. Wilson described what would befall humanity if invertebrates (including insects) were to die off:

"...if invertebrates were to disappear, I doubt that the human species would last more than a few months.

"Most of the fishes, amphibians, birds and mammals would crash into extinction about the same time.

"Next would go the bulk of flowering plants and with them the physical structure of the majority of forests and other terrestrial habitats of the world.

"The earth would rot. As dead vegetation piled up and dried out, narrowing and closing the channels of the nutrient cycles, other complex forms of vegetation would die off, and with them the last remnants of the vertebrates.

"The remaining fungi, after enjoying a stupendous explosion in population, would also perish.

"Within a few decades, the world would return to a state of a billion years ago, composed primarily of bacteria, algae, and a few other very simple multicellular plants.

E.O. Wilson, 1987
The Little Things That Run the World
(The Importance and Conservation of Invertebrates)

Left: Leaf beetle (Chrysomelidae)

Figure 1. How insects benefit urban ecosystems

A) Decomposition. Insects break organic matter down into plant-accesssible nutrients [11].

B) Weed control. Insects eat weeds and impede their spread [12].

C) Pollination. Insects pollinate vegetable gardens, fruit trees, and native plants.

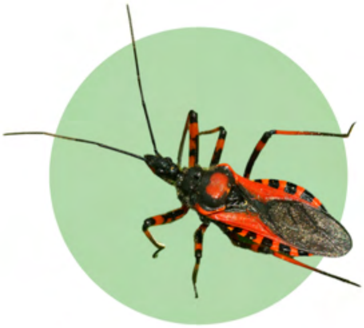
D) Pest control. Carnivorous beneficial insects eat pests. The US would spend an estimated $4.5 billion annually on pest control without beneficial insects [13].

E) Soil improvement. Insects are soil bioturbators, creating pockets for air and water to flow through and preventing soil compaction [14].

F) Wildlife Food. Insects are the major food source for urban and peri-urban bird populations [15].

Common Beneficial Insects

Gardens host a complex community of insects. These include **generalist** insects, which can feed on a broad range of plants or insects, and **specialist** insects, which have species-specific forage needs. Many beneficial insects are carnivorous and prey upon pest insects. These "**natural enemies**" are our first line of defense against plant damage. **Pest outbreaks often begin because the landscape has not been managed to attract or support populations of predatory or parasitoid insects.**



Assassin Bug **Family: Reduviidae**

What to look for: Fast-moving, predatory true bugs.
Prey: True bugs, aphids, caterpillars (including fall army worms), sawfly larvae, beetle larvae (including locust borers).
How to support: Mature tree bark, stumps, debris, leaf litter. Provide a layer of fallen leaves in garden beds over winter.

Green Lacewing (adult, eggs, larva) **Family: Chrysopidae**

What to look for: Eggs are laid on silky stalks, often near prey.
Prey: Soft-boded insects like aphids, mealybugs, and thrips.
How to support: Adults need pollen and nectar. Plant a variety of flowers including flowering herbs, borage, and composite flowers like sunflowers.

Ladybeetle (pupae and larvae) **Family: Coccinellidae**

What to look for: Larvae have orange-black coloration.
Prey: Many are specialists of aphids, or scale larvae.
How to support: Adults need pollen and nectar sources. Plant flowers in the sunflower or carrot families, including common fennel. Provide tall bunch grasses for overwintering.

Leafcutter Bee ***Megachile* spp.**

What to look for: Circular cuts in leaves are used for nests.
Prey: None. Leafcutter bees are pollinators.
How to support: Tolerate leaf chewing; leaves are used to line nests and protect larvae. Provide old stems for overwintering. Plant evening primrose and sunflower for specialist *Megachile*.

Minute Pirate Bug ***Orius* spp.**

What to look for: Tiny (3 mm) black and white true bugs.
Prey: Insect eggs, aphids, spider mites, and thrips.
How to support: Attract with composite flowers like zinnia and sunflower. Reduce use of broad-spectrum pesticides and consider alternatives like *Bacillus thuringiensis* (Bt) pesticides.

Parasitoid Wasp **Multiple Families**

What to look for: Highly varied. Many are gnat-sized and black.
Prey: Many specialize on aphids, whiteflies and other insects.
How to support: Avoid use of neonicotinoids. Plant woody perennials, and plan for continuous blooms. Attract with flowering herbs, salvias, and moon carrot.

Predatory Mite **Family: Phytoseiidae**

What to look for: Tiny (0.3mm), orange and fast-moving dots.
Prey: Spider mites, thrips, mealybugs and whiteflies.
How to support: Avoid use of broad-spectrum insecticides, especially permethrin. Loss of predatory mite populations can cause outbreaks of spider mites or thrips.

Rove Beetle **Family: Staphylinidae**

What to look for: Highly varied. May look similar to earwigs.
Prey: Insect eggs and larvae, slugs, and spider mites.
How to support: Provide bunch grasses and leaf litter for overwintering, Limit tillage and plant wildflower meadows.

Syrphid / Hover Fly **Family: Syrphidae**

What to look for: Bee-mimics with buggy eyes.
Prey: Aphids, mealybugs, scales, and thrips.
How to support: Plan landscapes for continuous bloom. Attract with calendula, rose, aster, fennel, and yarrow. Provide leaf litter for overwintering.

Tachinid Fly **Family: Tachnididae**

What to look for: Flies with bristly abdomens.
Prey: Squash bugs, sawlies, beetles, grasshoppers and more.
How to support: Attract with *Tithonia*, *Agastache*, and carrot family plants. Provide leaf litter for pupal stages.

Plant Selection

Above: The **Idaho Firewise Demonstration Garden** uses plant shapes, layering, and diversity in a way that shows habitat landscapes can be visually appealing, insect-friendly, and firewise, a key consideration in the Intermountain West.

Key Takeaways

- **Plant densely and diversely**
- **Incorporate native plants**
- **Plan "four-season forage"**

Insect forage needs

The insect diet is as variable and complex as insects themselves. Fortunately, insects can find plenty of food in a small area. Suburbs can offer a more diverse buffet of plants than hyper-urban or rural areas [11], making home gardens and landscapes a prime resource for insect conservation.

It shouldn't come as a surprise that more flowers correlate with higher numbers of pollinators like bees and hoverflies [12], but the diversity of flowers available also impacts the diversity of those pollinators [13]. The takeaway: **horticulture professionals should install large numbers of different flowering plants.** But which plants are best?

Native or introduced?

A growing body of research shows the value of native plants to specialist insects, like many moths and butterflies [19-21]. A study of Los Angeles gardens found that **the presence of native or xeric plants corresponded to 30% higher insect diversity** [22]. However, native cultivars, called "nativars" vary in their ability to attract insects [23].

Some introduced plants can support native insects, especially generalists (see pp. 12-13). As author and entomologist Doug Tallamy said in a 2018 interview, "If their mouthparts work, they don't care if it's native or non-native... It's not as simple as plant natives and save the world." [24]

Green industry professionals should strive to grow and incorporate native and xeric plants into urban and suburban landscapes. Many of these plants are attractive, high performers in a garden setting (see pp. 12-13).

Don't forget specialist insects

Many pollinator plant studies have focused on the European honeybee, which is not native to North America and is an example of a generalist insect. Generalist insects can feed on a broader range of plants than their specialist counterparts.

There is a spectrum between generalists and specialists, with some insects (like bumblebees) foraging on multiple plant families, while others feed their young on a specific plant genus (like the globemallow bee or monarch butterfly). **Gardens should feature plants for both insect types, which requires knowledge of local specialist insects.**

Forgive plant-feeders

Around half of all insects are herbivores and need leaves, stems, woody plants, or pollen to survive. And an estimated half of insect herbivores are specialists [25]!

Plants can survive with a surprising amount of leaf damage, and not all leaf-feeding insects are pests. **More tolerance of chewed leaves in the landscape industry is needed in acknowledgment of the insects that provide significant benefits to our gardens.** Aesthetic considerations can change to reflect the value of plants as habitat. The role that insects play in gardens and landscapes has benefits that can outweigh aesthetic injury (see pp. 5-6).

Table 1. Examples of Specialist Insects	
Insect	**Host plant**
Alexandra's Sulfur *Colias alexandra*	Pea-family plants (Lupins, etc.)
Blue Copper Butterfly *Lycaena heteronea*	Wild Buckwheat *Eriogonum* spp.
California Tortoiseshell *Nymphalis californica*	Wild Lilac *Ceanothus* spp.
Field Crescent *Phyciodes pulchella*	Various *Aster* and *Machaeranthera*
Globemallow Bee *Diadasia diminuta*	Globemallow *Sphaeralcea* spp.
Prickly Pear Bee *Melissodes opuntiellus*	Prickly Pear *Opuntia* spp.
Sunflower Andrena *Andrena helianthi*	Sunflower *Helianthus* spp.
Unnamed Pollen Wasp *Pseudomasaris zonalis*	Beefriend *Phacelia* spp.
Western Monarch *Danaus plexippus*	Regional Milkweeds *Asclepias* spp.

Table 1. Examples of specialist insects native to the Intermountain West.

Four-season forage

Insects also emerge at different times, even within the same genus. **Gardens should provide flowering plants from snow melt to the first snow fall** to provide resources to as many pollinators as possible.

Below: The globemallow bee (*Diadasia diminuta*) is an example of a specialist insect, only feeding its young pollen from the globemallow plant (*Sphaeralcea* spp.).

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Figure 2. Density and diversity of plant shapes
Planting density and structural diversity within gardens can encourage many beneficial insects [26]. One way to accomplish this is by grouping diverse herbaceous perennials to mimic a meadow (above) with a cottage garden aesthetic. Another strategy is to mimic Intermountain desert landscapes with semi-herbaceous and woody perennials and light mulch between plants. Incorporate multiple floral shapes from single flower, composite flowers, umbels, and spikes and different canopy layers, from shrubs to tall trees.

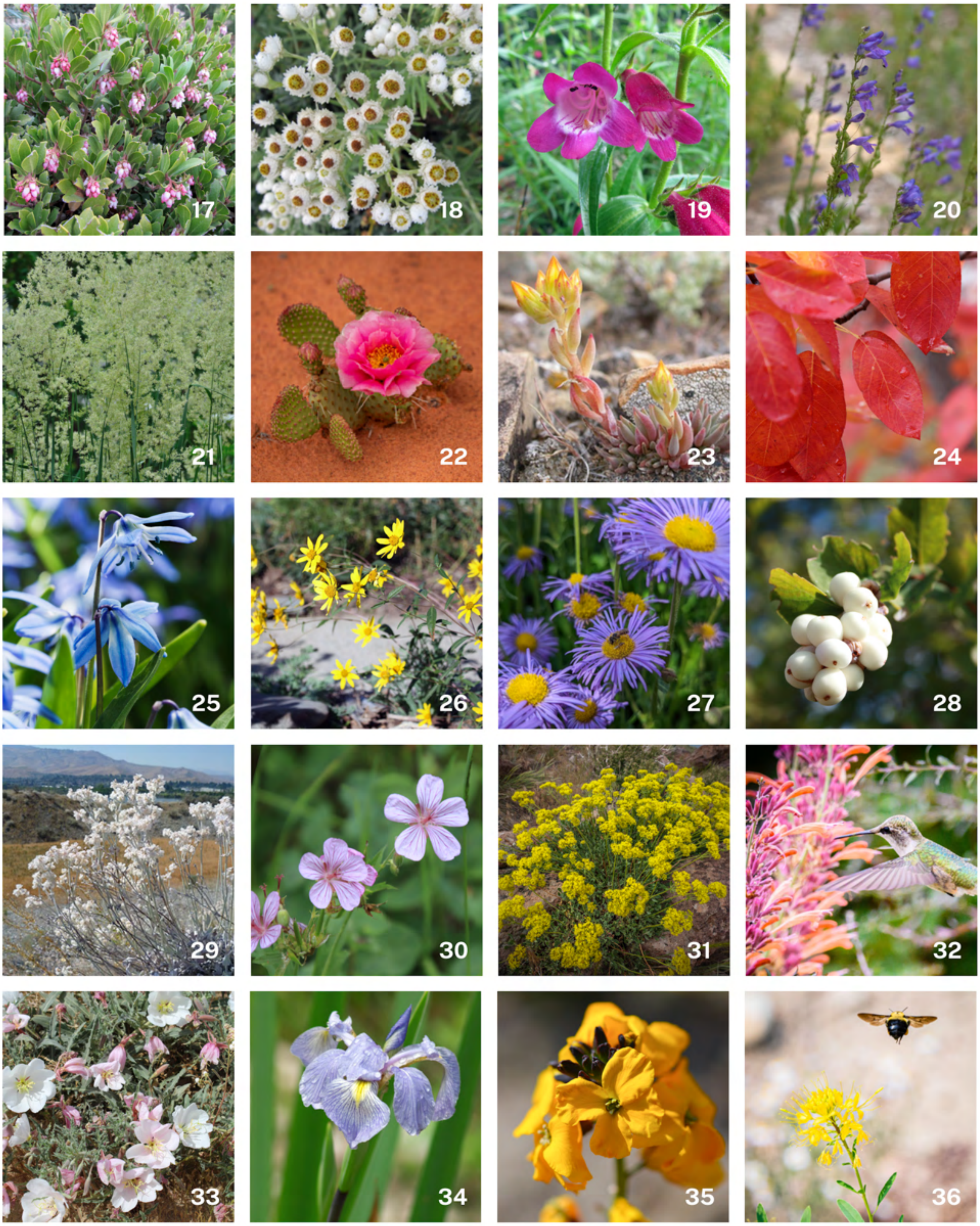
Plant Stratification: The vertical layering of habitat from ground cover, herbaceous layer, shrub layer, to low, mid, and high tree canopies.

Recommended Plants

The plants below were chosen for their attractiveness, ease of management, drought tolerance, adaptability to urban environments, and their value to native insects. [27-30]

Recommended Insectary Plants for Intermountain West Landscapes

1. Apache Plume (*Fallugia paradoxa*) **2.** Beefriend (*Phacelia* spp.) **3.** Redstem Ceanothus (*Ceanothus sanguineus*) **4.** Chocolate Flower (*Berlandiera lyrata*) **5.** Curl-leaf Mountain Mahogany (*Cercocarpus ledifolius*) **6.** Fernbush (Chamaebatieria millefolium) **7.** Fireworks Goldenrod (*Solidago rugosa* 'Fireworks') **8.** Desert Sage (*Salvia pachyphylla*) **9.** Desert Willow (*Chilopsis linearis*) **10.** Desert Yellow Fleabane (*Erigeron linearis*) **11.** Douglas' Aster (*Symphyotrichum subspicatum*) **12.** Globemallow (*Sphaeralcea* spp.) **13.** Goldhill Golden-aster (*Heterotheca jonesii* x *villosa* 'Goldhill') **14.** Gray Rabbitbrush (*Ericameria nauseosa*) **15.** Idaho Blue-Eyed Grass (*Sysirinchium idahoense*) **16.** Moon Carrot (*Seseli gummiferum*)



17. Panchito Manzanita (*Arctostaphylos* x *coloradensis* 'Panchito') **18.** Pearly Everlasting (*Anaphalis margaritacea*) **19.** *Penstemon* x *mexicali* **20.** Rocky Mountain Penstemon (*Penstemon strictus*) **21.** Prairie Junegrass (*Koeleria macrantha*) **22.** Prickly Pear (*Opuntia aurea* Purple Form) **23.** Spearleaf Stonecrop (*Sedum lanceolatum*) **24.** Western Serviceberry (*Amelanchier alnifolia*) **25.** *Scilla* spp. **26.** Showy Goldeneye (*Heliomeris multiflora*) **27.** Showy Fleabane (*Erigeron speciosus*) **28.** Snowberry (*Symphoricarpos albus*) **29.** Snow Buckwheat (*Eriogonum niveum*) **30.** Sticky Geranium (*Geranium viscosissimum*) **31.** Sulfur Buckwheat (*Eriogonum umbellatum*) **32.** Threadleaf Giant Hyssop (*Agastache rupestris*) **33.** Tufted Evening Primrose (*Oenothera caespitosa*) **34.** Western Blue Flag Iris (*Iris missouriensis*) **35.** Western Wallflower (*Erysimum capitatum*) **36.** Yellow Bee Plant (*Cleome lutea*)

Plant Alternatives

Some plants have less value to Intermountain West native insects than others. The following examples include substitutes that have better insectary value and desireable qualities for landscaping purposes.

1) Russian sage (*Salvia yangii*) (left) is a rhizomatous plant that has been noted to primarily provide resources to European honeybees. Desert sage (*Salvia pachyphylla*) (right) is a powerhouse plant that attracts parasitoid wasps and flies, native bees and beyond.

2) Butterfly bush (*Buddleja* spp.) (left) is listed as a noxious weed in multiple states, while desert willow (*Chilopsis linearis*) (right) attracts bumblebees, carpenter bees and butterflies.

3) Japanese lilac tree (*Syringa reticulata*) (left) has low pollen and nectar availability, whereas *Ceanothus* (right) is the larval host plant of many butterflies, including the pale Swallowtail (*Papilio eurymedon*).

4) *Forsythia* (left) notably provide no pollen or nectar, while golden currant (*Ribes aureum*) (right) is an important early blooming shrub for mining bees (*Andrena* spp.).

5) The nectar- and pollen-providing parts of double-flowered plants, like this marigold, have been bred into showy petals and provide no resources to pollinators. Consider globemallow (*Sphaeralcea* spp.) — host plant of the specialist globemallow bee — as a pop of summer color instead.

Tips for Plant Selection

- **Incorporate native plants into landscape designs and installs**
- **Plan for blooming flowers from snowmelt to the first snow fall**
- **Choose a wide range of plant shapes and structures**
- **Plant densely for maximum pollinator appeal**
- **Include plants for specialist insects (see Table 2, p. 10)**

Right: Ant lion adults are both pollinators and predators, feeding on pollen, nectar and other insects.

Pesticides & Non-Targets

Key Takeaways

- **Avoid neonicotinoid use as much as possible**
- **If use is necessary, apply soil drenches of imidacloprid <u>after</u> flowering**
- **Treat weeds early on, well before their flowering phase**

"Imidacloprid breaks down into more and more toxic parts over time, with toxicity peaking at 3 years."

The majority of pesticides dissolved in urban streams across the US have been attributed to just 16 compounds [31]. Of these, **imidacloprid** is the most toxic to insects and therefore of most concern to conservation, second to **organophosphates**. Imidacloprid belongs to the pesticide class **neonicotinoids**, which gained popularity in the 1990s and are now the most commonly used insecticide [32].

How neonicotinoids work

The factors that make neonicotinoids appealing also make them ecologically detrimental. **Plants absorb neonicotinoids into their vascular system, sending it into every leaf, shoot, flower and root** [33]. In the case of imidacloprid, the compound breaks down into more and more toxic parts, with toxicity peaking at 3 years and remaining for up to 6 years [33]. **This means that a flowering tree treated 3 years ago with a soil drench may have nectar today that is even more toxic to pollinators.** While neonicotinoids are less toxic to humans than other insecticides like **carbamates**, they are much more potent to insects than previous controversial insecticides like DDT [34].

Effects on non-targets

Native bees and beneficial parasitoid wasps are especially susceptible to neonicotinoids [35]. Harmful effects from these neurotoxins have also been observed in aquatic insects, earthworms [36] and even vertebrates like quail [37].

Multiple studies have found that bumblebee colonies produce 85% fewer new queens when exposed to canola fields treated with neonicotinoids [34], and blue orchard mason bees had 44% fewer offspring when exposed over multiple generations [38]. Just one-third of the lethal dose given to honeybees hampers their navigation, and studies have observed other sublethal effects like impairment to bee immune systems, learning, and memory [34]. Evidence is emerging that a newer insecticide class, diamides, may have similar effects on ecosystems [42].

Mitigating harmful effects

Few studies have looked at the effects of woody plant neonicotinoid treatments on non-target insects. One study by Mach *et al.* published in 2018 found that the timing of soil drench applications of imidacloprid were critical to residual toxicity in nectar. When ap-

Left: Native bees are more susceptible to neonicotinoid toxicity than European honeybees.

plied at label rates in fall and spring, the plants' floral nectar had lethal toxicity to bees. However, when applied in summer, the following spring's blooms were much less toxic. This suggests that **if treatment with imidacloprid is absolutely necessary, treating soon after flowering may provide control of pests** like aphids, scales or leaf beetles **while reducing risk to pollinators.** As noted by the authors, warnings on pesticide labels prohibiting the use of neonicotinoids during flowering does not actually mitigate risk to pollinators (Mach *et al*, 2018).

Are fungicides safe for insects?

Many applicators assume that fungicides and herbicides do not impact insects. After all, they aren't typically designed to do so. Recent research shows otherwise. Not only do applications of the fungicide chlorothalonil appear to decrease bumblebee workers and produce smaller queens, their use is the leading predictor of pathogens in US bumblebee colonies.

Herbicides and pollinators

Harmful effects of the herbicide glyphosate (brand name: RoundUp) observed in bees include disruption of gut bacteria, and impair both homing and foraging abilities [34]. This is unfortunate because applying glyphosate to flowering weeds is not recommended [42] or very effectual. **Flowering weeds can still go to seed after the application of glyphosate** [43].

Connection to plant health

Many studies have shown a relationship between plant stress and insect pests [44][45][46]. **Plants that experience stress from drought, mineral deficiencies, or physical damage can give off signals that attract insect pests** and may not be able to provide a strong defense response. Choosing plants for their acclimatization to regional climates and soils is critical. Planting at the proper depth and removal of girdling roots in trees can help to prevent secondary pest outbreaks.

Tips for Reducing Pesticide Use

- **Plant responsibly. Don't install or recommend plants (including trees) that are doomed to struggle with pests.**
- **Don't apply pesticides (including fungicides or herbicides) to blooming flowers.**
- **Avoid the use of long-lasting pesticide classes like neonicotinoids and diamides.**
- **Stay up to date on emerging pesticide research through trade organizations like the International Society of Arboriculture and the Ecological Landscape Alliance.**

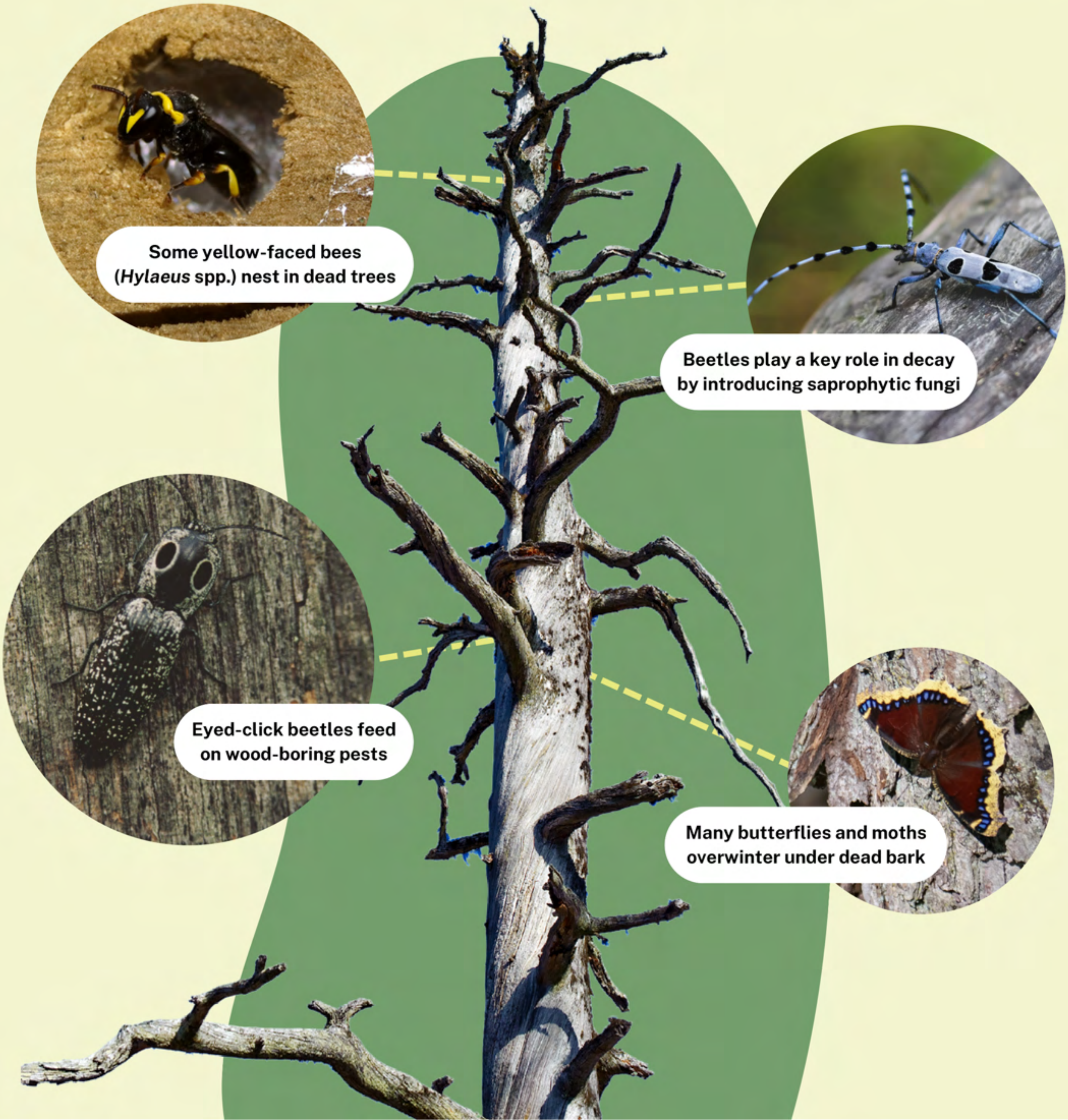
Below: Bombus griseocollis foraging on red horsechesnut. Insectary trees should be carefully managed to protect pollinators from pesticide harm.

The Importance of Leaving Snags

From woodpeckers to salamanders, certain wildlife thrive on dead and dying trees. “Snags” have been promoted as wildlife havens since the 1960s [47], but little attention has been brought to their importance as insect habitat. In some cases, urban snags actually have higher levels of insect activity than forest snags [48]. **Insects perform arguably the most important functions in snag ecology**:

1) introducing fungal decay organisms;
2) breaking down the dead wood themselves;
3) serving as forage for a plethora of bird species [49]

Without insects, our world would be buried in preserved logs and limbs with no one there to catalyze the decay process. **Urban foresters should consider leaving snags as habitat when it is safe to do so.** *See Additional Resources (p. 22) for more info.*



Protecting Insects During Maintenance

Key Takeaways

- **Leave leaf litter wherever possible**
- **Cut down hollow stems to 6-8"**
- **Mulch some areas lightly**

Conserving insects doesn't stop at growing flowers and using pesticides wisely. Insects need space for nesting and overwintering. Disruptions to leaf litter, plant stems, or soil may kill overwintering insects. This is often at odds with traditional garden aesthetics, but **homeowners are increasingly aware that some "messy" appearance is a part of habitat landscaping** [34]. Any concessions that landscapers or clients are willing to make can support critical insect needs.

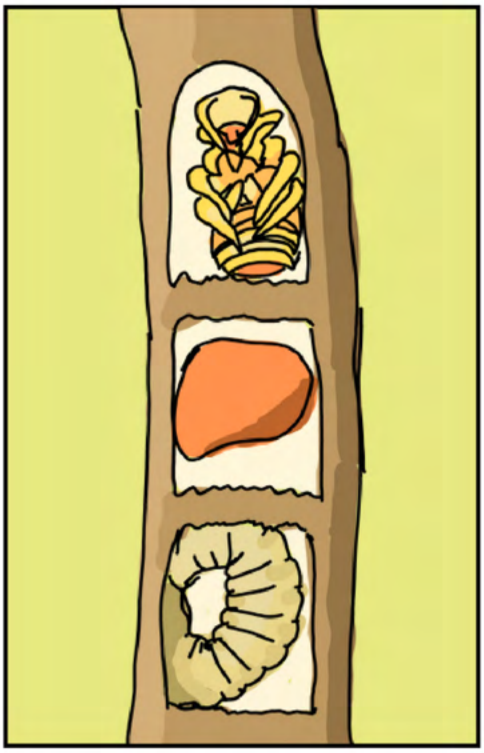


Figure 2. Drawing of bees developing inside a plant stem. From top to bottom: a bee pupa, pollen and larva.

Home sweet stem

Many different insects nest in hollow plant stems, including leafcutter bees, solitary wasps, tortricid moths and some beetles [50]. To provide nest sites for these insects, leave floral stems and seed heads, which also function as winter interest. **Cut stems down to 6-8" in late spring.** It is important to provide old, hollow stems year-round, because insect emergence times vary. Some insects, like the blue orchard bee, don't emerge until July!

Effects of urban soils

Compaction in urban soils is a problem for both plants and insects. **70% of bees nest and live underground, as do a vast number of other beneficial insects.** Ground beetles (family: Carabidae), nutrient recyclers like ants, and pollinators like moths and butterflies all live in the soil at some point in their lifecycle. Insects need loose soil to burrow, scavenge, and hunt.

Landscapers and urban foresters can avoid practices that cause compaction, and act as advocates for soil health during construction and turf installation. Reduce heavy vehicle traffic on soils and use a light layer of wood-based mulch to prevent compaction. Compacted soils exacerbate flooding and affect soil water content. Removing topsoil is a damaging practice that can set garden growth back and hurt urban insect populations [51]. Landscape fabric not only limits soil access to beneficial insects, but ultimately makes weed management more difficult.

Tips for Soil Management

- **Avoid using landscape fabric**
- **Reduce vehicle and foot traffic**
- **Use a light (1-2") layer of wood mulch**

Figure 3. Insect overwintering habitat types. Garden insects overwinter in a variety of locations: **1)** Beneath leaf litter; **2)** Above-ground on or insider of plants; or **3)** Underground [54]

Leave the leaves

Leaf mulch not only improves soil, but provides a home for many insects. Important predatory insects like assassin bugs, rove beetles and syrphid flies take shelter in leaf litter [52]. Leaves protect vulnerable bumblebee queens, wooly bear caterpillars and California tortoiseshells over winter. Wintertime is already challenging for insects, and many die during the season [50]. A layer of leaves can slow down snowmelt [53], which can provide critical insulation for some overwintering insects [50]. This is especially important in areas where the "urban heat island" effect can prematurely melt snow.

Mulch and ground nesters

While many ground-nesting insects prefer bare ground with loose, sandy soil, not all need naked soil. Some sweat bees (*Halictus* spp.) and bumblebees have been known to nest in soils lightly covered (1-2") with rock or wood mulch. Shallow mulch isn't enough to deter weed germination, but it can help prevent erosion and reduce soil moisture loss.

Tips for Fall Cleanup

- **Blow or rake leaves into beds, pile up to 6 inches of leaf litter onto plants [54].**
- **Mow small amounts of leaves into turf to reduce soil compaction.**
- **Leave as many plant stems as clientele will allow. Cut back fallen stems and seed heads for aesthetics. At a minimum, leave 6-8" of stems, including grasses.**
- **Don't shred or vacuum leaves unless there is an excess and they will be disposed of.**

Below: Leaving plant stems not only provides nesting sites for bees, but places for butterflies to pupate over winter.

Additional Resources

Organizations & Databases

American Public Gardens Association
Ecological Landscaping Alliance
International Society of Arboriculture
Lady Bird Johnson Wildflower Center Native Plant Database
Northwest Center for Alternatives to Pesticides
UC IPM: Bee Precaution Pesticide Ratings Database
Xerces Society for Invertebrate Conservation

Insectary Plant & Seed Sources

Draggin' Wing Farm
Fourth Corner Nurseries
Grand Prismatic Seed
High Country Gardens
Klamath-Siskiyou Native Seeds
Prairie Moon Nursery
Plants of the Wild
Snake River Seed Cooperative
Theodore Payne Foundation Store
Western Native Seed

Recommended Reading

Planting in a Post-Wild World by Thomas Rainer & Claudia West
Pollinators and Pollination by Jeff Ollerton
Silent Earth: Averting the Insect Apocalypse by Dave Goulson
The Bees in Your Backyard by Joseph S. Wilson & Claudia Messinger Carril
The Living Landscape by Doug Tallamy & Rick Darke

Below: 70% of bees nest underground. Watch for bees flying low or in figure eights near the ground. Mark and protect entrances.

Citations

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