**FINAL REPORT**
**WTFRC Project #** AE-01-37 **Organization Project #** 5352-22000-013-22T

**Project title:** Identification of extra-orchard host plants and habitats for key natural enemies of pome fruit pests suitable for manipulation or conservation

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**Objectives:**
1. Identify plant species in extra-orchard habitats that may be important to natural enemies of pear and apple pests as alternative feeding, mating, oviposition, or overwintering sites.
2. Determine if natural enemy densities within an orchard decrease as distance from extra-orchard habitat increases.
3. Survey plants in extra-orchard habitat for the presence of leafrolling caterpillars. Rear the caterpillars and associated parasitoids.
4. Determine the occurrence and phenology of the western flower thrips and its predators, particularly the minute pirate bug, Orius, on native and introduced plant species in extra-orchard habitat.

**Significant Findings:**

- Many species of plants found in extra-orchard habitat host beneficial arthropods (insects and spiders) including species found in adjacent orchards which are known or presumed to contribute to biocontrol. Beneficial arthropods were found on some plants for much of the season although their number and kind varied. Sagebrush, bitterbrush, oak, and ponderosa pine are examples. Beneficial arthropods in considerable number and variety were found on other species for a more limited time, particularly around flowering. Examples included gray and green rabbitbrush, tall buckwheat, and yarrow.

- Which beneficial arthropods present in an orchard also occur in adjacent extra-orchard habitat may depend on the type of habitat present. Some orchard beneficials also occurred on a variety of plants typical of central Washington's sagebrush steppe habitats. Others were rarely found in sagebrush habitats although they were found in other types of extra-orchard habitat such as woodland or riparian. The reverse situation also occurred as some species that are common in sagebrush habitats were rare in adjacent orchards.

- Natural enemy densities in some (although not all) orchards decreased as distance from extra-orchard habitat increased, consistent with the idea that extra-orchard habitat may serve as a source of colonists for the orchard.

- The western flower thrips occurred on many of the 126 species of plants that were sampled and was sometimes present in large numbers. Extra-orchard plants supporting thrips may act as a source of pest thrips moving into orchards. Thrips predators, especially minute pirate bugs and the young of several spider species, were found on many of the same plants and could be quite abundant.

- Caterpillars that exhibited leafrolling or leaf-tying behavior were found on 33 species of plants in extra-orchard habitat. Some of the moths reared from these caterpillars appear to be tortricids (ie., related to pest leafrollers) whereas others obviously represent different families. Many parasitoids were reared from the caterpillars although none appear to be the important leafroller parasitoid, Colpoclypeus florus. Lupines and alders were particularly heavily infested with leafroller type caterpillars.

**Methods:**

Orchard Sampling: Ten pear and 8 apple orchards were sampled in 2001 to determine if beneficial arthropod density decreased with distance from extra-orchard habitat. All were mating disruption or organic and each was divided into 2 or 3 sections at different distances from extra-orchard habitat depending on size: 0' - 200', 200' – 400', and > 400'. Twenty-six beat tray samples were taken in each section of an orchard once a month from May to October. All beneficial arthropods, except predatory mites, were collected and identified. Pest insects were noted on a presence/absence basis.

Extra-orchard habitat sampling: Fifty-one species of native and introduced plants in extra-orchard habitats near the 18 orchards were sampled in 2001. Each site was visited once a month from May to October. A species was sampled 1 to 6 times at a site. Ten to 20 beat trays were taken per sample. All beneficial arthropods were collected as was a sample of potential prey and host insects. Seven plant species were selected for more intensive sampling during 2002 based on their importance to beneficial arthropods as indicated by 2001 collection data. These plants were sampled at 1 – 2 week intervals, particularly during the pre-bloom, bloom, and post-bloom periods. Ten beat trays were taken per sample. Most species were sampled at more than 1 site.

Phenology and host plant utilization of western flower thrips and its predators: Samples of flowers and foliage were collected from 126 species of native and introduced plants in extra-orchard habitats to document the occurrence of flower thrips and its predators. For most species, samples were taken during the pre-bloom, bloom, and post-bloom periods. Thrips and other arthropods were extracted with Berlese funnels which employ heat from a light bulb to drive the organisms into a jar filled with 70% alcohol which in turn kills and preserves the specimens. Numbers of thrips, predators, and other organisms will be counted or estimated. Dry weights of the flower and foliage samples were obtained.

Survey of extra-orchard host plants for leafrolling caterpillars and their parasitoids: Plant species were visually inspected for the presence of leafrolling type caterpillars. Most plants were native species found in extra-orchard habitat near study orchards or at more distant locations. Most larvae were reared on foliage of the plants on which they were collected. Adult moths and any parasitoids obtained were frozen and mounted on pins or points. They will be sent to experts for identification.

**Results and Discussion:**

Orchard sampling: Raw collection data for some orchards indicated that natural enemy density decreased as distance from extra-orchard habitat increased. Such a trend was not apparent for all orchards, however. In some instances density of beneficial arthropods as a group decreased as distance from extra-orchard habitat increased while in other cases density of some subgroup of beneficials, or even a single species, showed the trend. We plan to analyze the distance data in greater detail this winter. Some data will be presented at the research review.

Extra-orchard habitat sampling: Beat tray samples were taken from 51 species of extra-orchard host plants during 2001. A complete list of the plants is given in Appendix 1. Occurrence of beneficial arthropods on several species of extra-orchard plants is summarized in the following table.

| | Green Lacewing | Brown Lacewing | Lady Beetle | Stethorus | Deraeocoris | Campylomma | Orius | Anthocoris | Damsel Bug | Big-eyed Bug | Aphid Parasitoid | Jumping Spider | Lynx Spider | Crab Spider | Dwarf Spider | Sac Spider | Anyphaena | Orb Weaver | * |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Big Sage | X | X | X | X | X | X | X | | X | X | X | X | X | X | X | | X | X | |
| Gray Rabbitbrush | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | X | X | X |
| Green Rabbitbrush | | X | X | X | X | | X | | X | X | X | X | X | X | X | | X | X | X |
| Yarrow | | | X | | | X | X | | X | X | X | X | | X | X | | X | | X |
| Balsamroot | | X | X | | | | X | | | | | X | X | X | | | | | X |
| Cusick's Sunflower | | | | | | | | | | | | X | X | X | | | X | | |
| Bitterbrush | X | | X | X | X | | X | X | X | X | X | X | X | X | X | | X | X | X |
| Tall Buckwheat | X | | | | | | X | | | X | X | X | X | X | X | | X | | X |
| Clematis | | X | X | | X | X | X | | | X | X | X | X | X | X | X | X | X | |
| Cottonwood | X | | X | X | | | X | X | | | | X | | X | X | X | X | X | X |
| Milkweed | | | X | | | X | X | | | | | X | | X | X | | | | |
| Oak | X | X | X | X | X | | | | | | | X | X | X | X | X | X | | X |
| Ponderosa Pine | X | | X | | X | | X | | | | | X | X | X | X | | | | X |
| Deerbrush | X | | | | X | | X | | X | | | X | X | X | X | X | X | | X |
| Snowberry | X | | | X | X | | X | | X | | | X | X | X | X | X | X | X | X |
| Douglas Fir | X | X | | | X | | X | | | | | X | | X | X | | | | X |
| Blackberry | X | | | | X | X | X | | X | | | X | X | X | X | | | X | X |
| Goatsbeard | X | | | | X | | | | X | | | X | X | X | X | | | | X |
| Diffuse Knapweed | X | | | | | | X | | X | X | | X | | | | | | | |
| Willow | X | | | X | X | X | X | X | X | | | X | X | X | | X | X | X | X |
| Tumbleweed | | | | | | | X | | X | X | | X | X | X | | | | X | |
| Yellow Star thistle | | | | | | | X | | X | X | | X | X | X | | | | | |
| Hoary Aster | | | | | | | X | | | X | | X | | X | | | | | |
| Oregon Grape | | X | | | | | | | | | | X | X | X | | X | | | X |
| Big-leaf Maple | X | X | | | | | | | | | | X | | X | X | | X | | X |
| Wild Rose | X | | | | X | | | | | | | X | X | X | X | | | | X |
| Ocean Spray | X | | | | | | | | | | | X | | X | X | | X | | X |

*Cobweb spiders

Beneficial arthropods listed in the table as occurring on an extra-orchard host plant are species (sometimes more than 1) that also occur in apple and pear orchards. Several species of lady beetles, for example, feed on pest aphids in orchards. Lady beetles are listed in the table as occurring on a plant only if 1 or more of the species that occur in orchards was also taken on the plant. Several other species of lady beetles were collected on various extra-orchard host plants but were not collected in orchards during the study. These species are not included in the table and if 1 or more of them were the only lady beetles taken on a plant, then an X does not appear in the table under lady beetles for that plant.

Some beneficials were represented by 2 or more species. Jumping spiders, for example, include several species in 3 common genera (Pelegrina, Phidippus, and Sassacus) and 2 less common genera (Phanias and Salticus) that have all been collected from orchards. One or more of these were taken on each of the host plants in the table. Other beneficials were represented by only a single species, the minute pirate bug Orius and the lynx spider Oxyopes scalaris, for example. Both species were taken on most plants listed in the table.

Sampling effort on the various plants was not equal. Some species, big sage and bitterbrush for example, were sampled far more frequently, and often at more than 1 location, than others

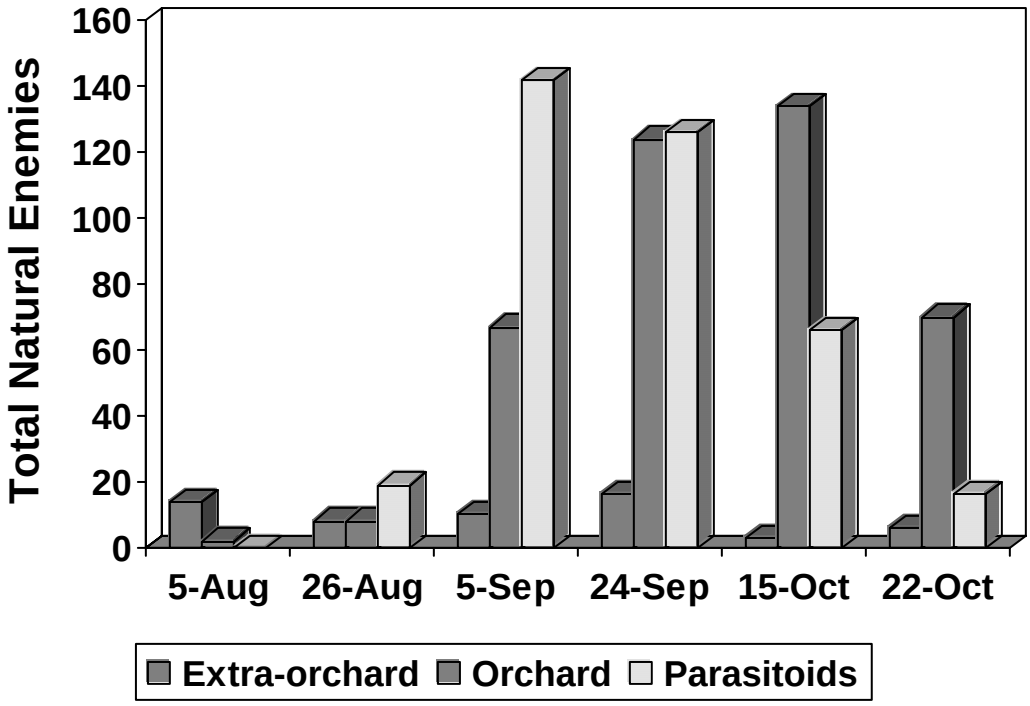
such as hoary aster and ocean spray. Additional sampling on the less frequently sampled species would undoubtedly fill in some of the gaps in the table.

The 7 species of extra-orchard host plants intensively sampled during 2002 are listed in the table below, along with some sampling parameters. All 7 are native and, with the exception of western clematis, are dry adapted and typical of the sagebrush steppe habitats most commonly found adjacent to central Washington orchards. Gray and green rabbitbrush are considered to be invasive increasers and are often more abundant in overgrazed or disturbed areas than in more pristine sagebrush steppe. Such situations often occur near orchards, as was the case with a number of our study sites. Western clematis generally seems to occur at sites where water is more abundant. Our samples were taken from a dense stand that grew along an irrigation canal that paralleled the eastern edge of an organic pear orchard. It also received water during orchard irrigations and the abundance of water may have been partly responsible for its lengthy flowering period at this site.

| **Plant Species** | **# of Sites** | **# of Samples/site** | **Sampling Period** |
|---|---|---|---|
| Gray Rabbitbrush | 3 | 12 – 15 | 7/10 – 10/24 |
| Green Rabbitbrush | 3 | 6 – 11 | 7/17 – 10/24 |
| Big Sagebrush (early) | 1 | 10 | 5/17 – 8/8 |
| Big Sagebrush (late) | 2 | 10 | 8/5 - 10/22 |
| Yarrow | 2 | 5 | 6/3 – 7/1 |
| Bitterbrush | 2 | 7, 8 | 5/17 – 7/30 |
| Tall Buckwheat | 2 | 13, 14 | 7/11 – 10/16 |
| Western Clematis | 1 | 12 | 6/17 – 9/26 |

The natural enemies found on extra-orchard host plants can be divided into 3 groups. One group consists of predatory insects and spiders that are rarely found in orchards. They are apparently adapted to the sagebrush steppe environment and rarely move out of it. Insects include certain lady beetles as well as snakeflies, assassin bugs, and ambush bugs (the latter 3 are occasionally taken in orchards but are far more common on extra-orchard plants). Spiders include jumpers like Pelegrina helenae and P. clemata. (Interestingly, Pelegrina aeneola was not found on sagebrush associated plants but it is often very abundant in organic orchards.) A second group of beneficial arthropods consists of predatory insects and spiders also commonly found in nearby orchards where they are known or presumed to contribute to orchard biocontrol. Insects in this group include Deraeocoris, minute pirate bugs, damsel bugs, green and brown lacewings, and certain lady beetles. Spiders include jumpers like Sassacus and several species of Phidippus, the lynx spider Oxyopes, some crab spiders in the genera Misumenops and Xysticus, and several others. The third group is the parasitoids, primarily small wasps. These can be very abundant on some extra-orchard host plants at certain times but few representatives of species important in orchard biocontrol were found in the beat tray samples. Figure 1 presents data for the 3 groups of natural enemies taken on gray rabbitbrush at 1 site during 2002.

Figure 1. Numbers of natural enemies in 3 groups taken in beat tray samples from gray rabbitbrush in 2002. Flowering began between 26 Aug and 5 Sept and ended by 22 Oct. Data for only 6 of 15 collections are shown for simplicity.




During the pre-bloom period of gray rabbitbrush (sampling actually began on 10 July) samples contained low numbers of parasitoids and orchard-associated predators. Moderate numbers of extra-orchard associated natural enemies were present during this period and numbers of natural enemies in this group remained quite stable throughout the sampling period. As gray rabbitbrush came into flower, however, parasitoids and orchard-associated predators increased markedly. Minute pirate bugs increased from 4 to 48 (all adults) between 26 Aug and 6 Sept and the crab spider, Misumenops lepidus, increased from 0 to 12 (small and medium sized immatures). These 2 species were the most abundant predators on gray rabbitbrush during bloom. Both fed on flower thrips which were very abundant during bloom as well. Pirate bugs reproduced on the plant as indicated by the presence of numerous nymphs during the middle bloom period: 19 immatures (57 adults) on 24 Sept and 44 immatures (48 adults) on 1 Oct. Immature numbers are actually too low because first and second stage nymphs were all but impossible to see on the beat tray. The parasitoid fauna during the flowering period was dominated by several species of tiny wasps in the family Platygastridae whose numbers increased from 18 to 126 between 26 Aug and 5 Sept. The host for these wasps is probably a species of small fly associated with the rabbitbrush.

This pattern of orchard-associated natural enemy abundance was also observed on gray rabbitbrush at the other 2 sample sites and, indeed, a generally similar pattern was seen on the other intensively sampled plants as well – that is a marked increase in the number of orchard-associated natural enemies during the bloom period.

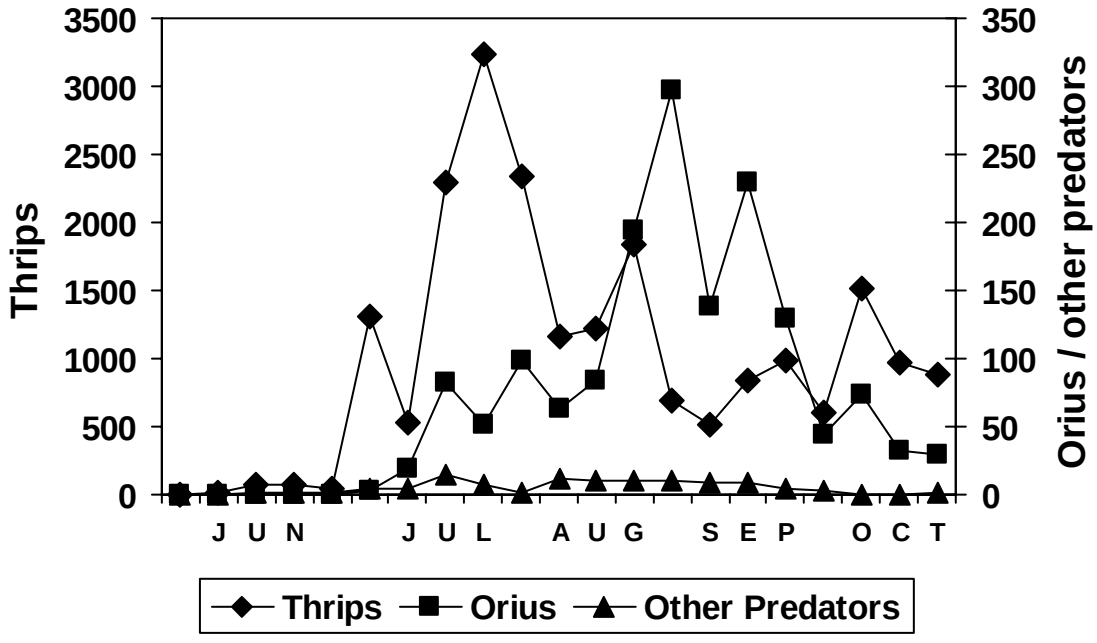
Phenology and hosts of western flower thrips and its predators: Flowers and foliage were collected from 126 species of native and introduced plants in extra-orchard habitats near our study orchards (see Appendix 2 for a complete list). Collections from many species were obtained during

the pre-bloom, bloom, and post-bloom periods for a total of more than 800 samples. Most of the samples will be processed this winter but data for tall buckwheat (Eriogonum elatum) will serve as an example.

Tall buckwheat was abundant at 2 study sites in the Cowiche-Tieton area where the extra-orchard habitat was little disturbed and the native flora very diverse. Population dynamics of thrips and their predators on tall buckwheat at 1 of the sites are shown in Figure 2.

Tall buckwheat proved to be a very interesting plant with a long flowering period. First bloom was noted on 10 June and the last flowers had not dried up until mid-October. Samples were collected at approximately weekly intervals throughout this period. Most thrips were Frankliniella, the western flower thrips, although some Thrips sp. were also present. Thrips numbers built up rapidly during late June and early July by which time the buckwheat was in good bloom. Immature thrips began to dominate the collections by early July and heavily outnumbered adults until early October, when their numbers fell below those of the adults. Minute pirate bug adults showed up in low numbers on 1 July and nymphs were present in the 11 July collection. Pirate bug numbers built to a peak on 27 August then gradually declined, but adults and a few last stage nymphs were still present on 15 October when the plant was all but out of bloom. Another important group of thrips predators were small immatures of several genera of spiders that were present in low numbers (at least relative to pirate bugs) throughout the flowering period of the plant. In beat tray samples from tall buckwheat and other plants these spiders were frequently observed with thrips as prey. In many cases there appeared to be few suitable alternative prey for these small, immature predators. Important species included the jumping spiders, Sassacus papenhoei and Phidippus spp., and the crab spiders, Misumenops lepidus and Xysticus cunctator, all of which are commonly found in apple and pear orchards. Population dynamics of thrips and their predators were similar on tall buckwheat at the second study site.

Figure 2. Numbers of thrips and thrips predators (the minute pirate bug, Orius, and others, primarily small, immature spiders) extracted via Berlese funnel from samples of tall buckwheat flowers at a site near Cowiche, WA in 2002.



Berlese funnel collections from the other plants that were sampled are currently being processed. For most species the number of samples was fewer than that collected from tall buckwheat as no other species flowered for such an extended period of time. A general impression, based on superficial examination of "alcoholized" samples that had been processed through the Berlese funnels, was that thrips occurred on most of the plant species that we sampled, sometimes in high numbers. Pirate bugs and other predators occurred on many species as well.

Survey of extra-orchard host plants for leafrolling caterpillars and their parasitoids: Approximately 400 larvae that exhibited some type of leafrolling or leaf-tying behavior were obtained from 33 species of plants in extra-orchard habitat either adjacent to or at some distance from orchards. To date more than 150 adult moths and about 100 parasitoids have been obtained with about 80 specimens still in rearing. Some of the moths appear to be in the family Tortricidae (as are the pandemis and oblique-banded leafrollers) whereas others represent other families. The vast majority of the parasitoids are small wasps (Hymenoptera) representing several families including Braconidae, Ichneumonidae, and Chalcidoidea. A few flies in the family Tachinidae have also been obtained. Several hyperparasitoids were apparently reared as well. It does not appear that Colpoclypeus florus, the most important leafroller parasitoid, was obtained. Moths and parasitoids will be sent to experts for identification.

Plants that were more heavily infested with leafrolling type caterpillars included various species of lupine (Lupinus), alder (Alnus), chokecherry (Prunus virginiana), tall buckwheat, Thompson's paintbrush (Castilleja thompsonii), and deerbrush (Ceanothus integerrimus).

An interesting additional bit of information that came to light as a result of the leafroller survey was the fact that alder was inhabited by quite high numbers of 2 species of sac spider (Clubionidae), Clubiona moesta and C. pacifica. These spiders were often associated with rolled alder leaves and were sometimes found in leafrolls. Clubiona species are in the same family as Cheiracanthium mildei which, observations have shown, may be a very efficient leafroller predator in orchards. Many of the rolled alder leaves showed evidence of predation reminiscent of C. mildei, particularly small holes (2-5 mm in diameter) cut in the leaves. C. mildei cut such holes when attacking leafrollers in their leafrolls during laboratory observations. It would be interesting to determine if the Clubiona species were in fact preying on the alder leafrollers and if they use some of the same specialized predatory behaviors employed by C. mildei, such as cutting holes in leafrolls.

In summary, this research has shown that many of the predatory insects and spiders found in orchards, where they are known or thought to contribute to control of certain orchard pests, also occur on a variety of plants in extra-orchard habitats. Outside the orchard, many of these beneficial arthropods appear to be exploiting alternative prey. Their numbers on some plants can be high, especially around flowering, and colonization of suitable plants by some species occurs rapidly. Presumably, movement from extra-orchard habitat into nearby orchards can occur rapidly as well, if conditions are favorable. Population increase can occur in extra-orchard habitat as some species reproduce on extra-orchard host plants. Since extra-orchard habitats are less subject to human disturbance than orchards, beneficial arthropod populations may be more stable and a principal benefit of extra-orchard habitat may be as a repository of these organisms from which the orchard can draw.

**BUDGET**
**Project Title:** Identification of extra-orchard host plants and habitats for key natural enemies of pome fruit pests suitable for manipulation or conservation
**PI:** Eugene Miliczky
**Project duration:** 2001-2002
**Project total (2 years):** $56,130

| **Year** | Year 1 (2001) | Year 2 (2002) |
|---|---|---|
| **Total** | 26,620 | 29,510 |

**Appendix 1:** Families and species of extra-orchard host plants sampled for natural enemies in 2001. n = native species, i = introduced species
**Sunflower family:** Big sage (n), Rigid sage (n), Canada thistle (i), Meadow goldenrod (n), Gray rabbitbrush (n), Green rabbitbrush (n), Annual sunflower (n), Yarrow (n), Spotted knapweed (i), Yellow starthistle (i), Balsamroot (n), Fleabane (Erigeron sp.)(n), Hoary aster (n)
**Rose family:** Bitterbrush (n), Wild rose (Rosa sp.)(n), Big-leaf maple (n), Ocean spray (n), Himalayan blackberry (i), Goatsbeard (n), Chokecherry (n), Bitter cherry (n)
**Mustard family:** Tumble mustard (i)
**Pea family:** White sweet clover (i), Lupine (n), Scotch broom (i), Vetch (i)
**Snapdragon family:** Common mullein (i), Common toadflax (i)
**Willow family:** Willow (n), Cottonwood (n)
**Milkweed family:** Showy milkweed (n)
**Goosefoot family:** Russian thistle (i), Hopsage (n)
**Buttercup family:** Western clematis (n)
**Honeysuckle family:** Snowberry (n), Blue elderberry (n)
**Barberry family:** Oregon grape (n)
**Buckthorn family:** Deerbrush (n)
**St. John's Wort family:** Common St. John's Wort (i)
**Buckwheat family:** Tall buckwheat (n), unidentified wild buckwheat (n), Curly dock (i)
**Dogbane family:** Flytrap dogbane (n)
**Evening primrose family:** Fireweed (n)
**Parsley family:** Desert parsley (n)
**Mint family:** Peppermint (n)
**Morning glory family:** Field bindweed (n)
**Currant family:** Golden currant (n)
**Beech family:** Oak (n)
**Pine family:** Ponderosa pine (n), Douglas fir (n)

**Appendix 2:** Families and species of extra-orchard host plants sampled for western flower thrips and its predators in 2002. n = native species, i = introduced species

**Sunflower family:** Linear-leaf daisy (n), Oregon sunshine (n), Shaggy daisy (n), Gray and Green rabbitbrush (n), Arrowleaf and Hooker's balsamroot (n), Yarrow (n), Western groundsel (n), Thread-leaf fleabane (n), Long-leaf and Western hawksbeard (n), Poverty sumpweed (n), Microseris troximoides (n), Rayless goldenweed (n), Bachelor's button (i), Wavyleaf thistle (n), Diffuse knapweed (n), Big sagebrush (n), Unidentified Artemisia (n), Chaenactis (n), Hoary aster (n), Cusick's sunflower (n), Prickly lettuce (i), Ragweed ? (n), Canada goldenrod (n), Canada thistle (i), Western salsify (i), Tidytips (n), False dandelion (n), Spotted knapweed (i)

**Rose family:** Cinquefoil (n), Bitterbrush (n), Saskatoon berry (n), Wild rose (n), Chokecherry (n), Bitter cherry (n), Ocean spray (n), Strawberry (n), Himalayan blackberry (i), Hawthorn (n)

**Mustard family:** Tumble mustard (i), Prairie rocket (n), Clasping pepperweed (i), Flixweed (i), Blue mustard (i), Dagger pod (n), Thick-leaf thelypody (n)

**Pea family:** Lupine (>1 species sampled)(n), White and Red clover (i), White and Yellow sweet clover (i), Alfalfa (i), Milkvetch (n), Scotch broom (i), Vetch (n?), Rabbit-foot clover (i)

**Snapdragon family:** Lowly penstemon (n), Thompson's paintbrush (n), Common mullein (i), Dalmatian toadflax (i), Small-flowered blue-eyed Mary (n)

**Willow family:** Slender willow (n)

**Milkweed family:** Showy milkweed (n)

**Goosefoot family:** Russian thistle (i), Lambsquarters (i), Kochia (i), Hopsage (n)

**Buttercup family:** Western clematis (n), Larkspur (n), Buttercup (n)

**Honeysuckle family:** Orange honeysuckle (n), Snowberry (n), Blue elderberry (n)

**Barberry family:** Oregon grape (n)

**Buckthorn family:** Deerbrush (n), unidentified Ceanothus (n), Cascara (n)

**St. John's Wort family:** Common St. John's wort (i)

**Buckwheat family:** Heart-leaf, Thyme-leaf, Strict, Parsnip-flowered, Snow, Tall, and Slenderbush buckwheat (all n), Curly dock (i)

**Dogbane family:** Flytrap dogbane (n)

**Evening primrose family:** Fireweed (n)

**Parsley family:** Columbia, Gray's, and Bare-stem desert parsley (all n), Queen Anne's lace (i)

**Mint family:** Peppermint (n), Purple sage (n)

**Currant family:** Squaw currant (n)

**Purslane family:** Miner's lettuce (n)

**Madder family:** Annual bedstraw (n)

**Lily family:** Cluster lily (n), Wild onion (n), Death camas (n), Mariposa lily (n)

**Waterleaf family:** Dwarf waterleaf (n), Silver-leaf and Thread-leaf phacelia (n)

**Maple family:** Big-leaf maple (n)

**Dogwood family:** Red osier dogwood (n)

**Mallow family:** Orange globe mallow (n), gooseberry-leaved globe mallow (n)

**Hydrangea family:** Mock orange (n)

**Borgage family:** Fiddleneck (n), Cryptantha (n), Popcorn flower (n), Bluebell (n), Puccoon (n), Great hound's tongue (n)

**Phlox family:** Collomia (n), Cushion, Showy, and Long-leaf Phlox (n), Scarlet gilia (n)

**Saxifrage family:** Alumroot (n), Prairie star flower (n)

**Sandalwood family:** Bastard toadflax (n)