**Crop Pests** Caterpillars Mealybug Aphids **Cabbage Looper** Vegetable **Thrips** Scale Cutworm Grasshoppers Whiteflies Spider **Filbert** Slugs **Filbert Brown** Cucumber & White Butterfy Leafminer Weevils Mites **Beetles** Marmorated Worms and Their Important Stink Bugs **Natural Enemies Field Chart** moth larva **Natural Enemies** White butterfly larva **Assassin Bugs** Early instar X **Big-Eyed Bugs** X **Damsel Bugs** Small Caterpillars **Green Lacewings - Brown Lacewings** Small Caterpillars **Ground Beetles** Λ **Lady Beetles Rove Beetles** X X **Soldier Beetles** eggs X **Tachinid Flies** X **Hover Flies / Syrphid Flies** Larvae attacking aphids **Minute Pirate Bugs** Small Eggs and early larvae Caterpillars X **Parasitic Wasps** X OSU is monitoring a f) Parasitic wasp - eggs population found in on caterpillar Portland Spiders Orb Weaver Photo Credits: a) Susan Ellis bugwood.org, b) Joseph Berger, Bugwood.org, c) Seastone, L. and B. Parks, Museum Collections Heteroptera, USDA APHIS ITP, Bugwood.org, e) Phil Sloderbeck, Kansas State University, Bugwood.org, f) David Cappaert, Bugwood.org, g) Whitney



Pest- Beneficial Insect Chart.indd 1





Cranshaw, Colorado State University, Bugwood.org, **r**) Polic State Unive

#### **Native Plant Field Border**

Strips of native grasses and wildflowers planted along field edges, farm roads, underneath power lines, or in the corner areas of center-pivot irrigated fields.

Longevity of Planting: Permanent or temporary, depending on the types of plants.

**Degree of Difficulty:** High

**Time/Money Investment:** Low cost, high time investment

Plant Establishment: Establish borders from seed by hand broadcast seeding, mechanical spreaders and seeders, either till or no-till.

**Weed Control During Plant Establishment:** Will need some degree of weed control. This can be done by hand weeding, spot-spraying, or mowing/string trimming.

**Maintenance:** Protect from insecticide and herbicide drift. Hand weed and mow to control weeds. Ideally, no more than 30% of field border should be mowed each year to ensure enough undisturbed food and shelter for beneficial insects. Can inter-plant if needed.

**Considerations for Plant Selection:** Consider soil type, sun or shade exposure, drainage, local native plant distribution.

**Benefits:** Can reduce movement of Eurasian weeds into crops by occupying ground that might otherwise be dominated by those weeds. May reduce the stunting effect that sometimes occurs along the edges of row crops. Provides a buffer that catches runoff from fields.





## **Pollinator Hedgerow**

Linear rows of flowering shrubs, trees, perennial wildflowers, and grasses in the understory. Located along property boundaries, fence lines, roads, and as barriers to separate crop fields. **Longevity of Planting: Permanent** 

**Degree of Difficulty:** Low

Time/Money Investment: Medium

Plant Establishment: Transplants or live-stake cuttings. May need supplemental irrigation for first two years. **Weed Control During Plant Establishment:** Mulch around plants after planting to discourage weeds. During the first and second years weeds may need to be mowed, hand pulled, or spot sprayed.

**Maintenance:** Remove weeds as needed. Cut back large shrubs or trees that shade other hedgerow plants. Mulch around plants for weed control and moisture retention.

Watering will be minimal if planted with species native to the west side of the Cascades. Where water is scarcer, water for first two years only.

**Considerations for Plant Selection:** Shrubs and small trees. Can also include flowering vines, grasses, and wildflowers. The inclusion of perennial wildflower transplants can significantly boost the benefits to pollinators and other beneficial insects while shrubs and small trees are getting established. Consider shade tolerant species for north-facing sides of hedgerow. Noninvasive exotic plants can also be used if needed. Consider future mature size of hedgerow plants.

**Benefits:** Provides habitat for pollinators and other wildlife. Captures runoff from crop fields. Provides sources of firewood, fruits, and herbs. Can reduce gravel dust from roads. Stabilizes soil along irrigation ditches. Also, may be designed to shield crops from wind and pesticide drift from wind and pesticide drift from nearby cropland. If serving as a pesticide drift barrier, choose small-needled evergreen shrubs that will not attract pollinators.





#### Streamside Buffer

Multi-level native vegetation maintained along streams, creeks, and rivers.

**Longevity of Planting: Permanent** 

**Degree of Difficulty:** High. A lot of effort goes into getting plants established, but once they are 'free to grow', maintenance should be minimal.

**Time/Money Investment:** High

**Plant Establishment:** Plant bare root plants or live stakes in winter. Plant containers in spring.

**Weed Control During Plant Establishment:** Requires intensive weed control for first few years until plants are able to out-compete the weeds.

**Maintenance:** Exclude livestock. Once plants are 'free to grow', little maintenance is needed. As the plants grow taller, they will be better at shading out the weeds.

**Considerations for Plant Selection:** Choose native plants that will grow tall enough to shade the stream and fill in with shrubs to provide the greatest weed control and habitat benefit. Native plants will require the least amount of maintenance and will yield the greatest wildlife habitat.

**Benefits:** Protects surface and underground water quality by filtering pesticide and nutrient runoff. Drains standing water from crop fields. Shades the water, reducing water temperature for fish and other aquatic wildlife. Stabilizes stream banks, reduces erosion and downstream siltation, and provides corridors for





## **Beetle Bank**

Grassed elevated berm that provides shelter and overwintering habitat for predatory ground beetles. Planted next to or through the center of crop fields. **Longevity of Planting: Permanent** 

Degree of Difficulty: High. Difficulty lies in establishing grasses amidst pressure from cropland weeds. Time/Money Investment: High

**Preparing the Site:** Plow two reverse furrows side by side to create an embankment roughly 2-6 feet wide and at least 1 foot high. Make sure weeds have been removed from the area.

Plant Establishment: Seed the bank in early fall (just before rains) or plant bunch grass plugs after fall rains

start. If irrigation is available, transplants may be planted and mulched in the spring. **Weed Control During Plant Establishment:** Mow or string trim routinely the first year after planting to

suppress annual weeds that may shade and compete with newly established bunch grasses. **Maintenance:** Once grass is established, you may have to control woody weeds with spot-spray or handpulling. As the grasses mature, they should be fairly effective at preventing weed encroachment.

**Considerations for Plant Selection:** Plant berm with perennial native bunch grasses. Grass can be combined with small patches of native wildflowers for the benefit of other beneficial insects. If crop field is large, you may need multiple beetle banks positioned at regular intervals to account for the dispersal distance of ground beetles and other beneficial insects.

**Benefits:** Provides undisturbed overwintering habitat for predatory ground beetles. Promotes quick movement by beetles back into crop fields when warm weather returns the next year. Various ground beetles also feed on weed seed, which will help suppress crop weeds.







## **Cover Crops/ Alley Crops**

Temporary or permanent plantings of ground cover on fallow crop fields, between rows of berry crops or nursery stock, or in the understory of vineyards and orchards.

Longevity of Planting: Single-season unless planted on fallow fields, between rows of more permanent crops, or in the understory of vineyards and orchards.

**Degree of Difficulty:** Easy

Time/Money Investment: Low cost per acre

**Plant Establishment:** Seed crops like crimson clover and phacelia directly into soil surface just before fall rains to encourage fast germination. Buckwheat is better sown in late spring. Check with your seed provider for best planting time. May also plant with a no-till drill after mowing. Allow flowers to bloom before tilling or mowing for biocontrol benefit.

Weed Control During Plant Establishment: Minimal weed control is needed since plantings are usually

Maintenance: Make a plan for terminating the cover crop when it reaches desired maturity. Methods include tilling, mowing, spraying with herbicide, or a roller-crimper to flatten the plant and leave on the field as

Considerations for Plant Selection: Consider other objectives of cover crops. Legumes contribute to soil fertility by fixing nitrogen. Grasses can capture excess soil nutrients, prevent weed growth, and reduce erosion. Brassicas are often used to absorb excess nutrients, reduce soil compaction, and suppress soil pests. Benefits: Improve soil fertility, prevent weed growth, reduce erosion, interrupt pest and disease cycles, and





### **Insectary Strip**

Strips of pollen and nectar sources planted between crop rows.

**Longevity of Planting:** Temporary - life of crop planted.

**Degree of Difficulty:** Easy

**Time/Money Investment:** Low cost

**Plant Establishment:** For annuals, seed in spring after danger of frost. For perennials, plant in late fall, at or just below the soil surface. Hand scatter seeds or use vegetable seed drill.

**Weed Control During Plant Establishment:** Minimal weed is needed control since plantings are usually

**Maintenance:** To avoid damage to beneficial insects, this practice is best for operations where insecticides aren't being used. Requires less routine weeding than permanent plantings. Annuals will require irrigation. Considerations for Plant Selection: Because plantings are usually temporary and will be worked up at the end of the season to make room for a new crop, low-cost, rapid-blooming annual flowers are often used. Perennials can also be used for longer-term plantings.

Benefits: When combined with permanent native grass and wildflower field borders, insectary plantings can draw the beneficial insects directly in to the crop from the field edges, enhancing pest control throughout entire field. Due to its temporary nature, they do not provide shelter or overwintering habitat for insects.





## Preparing Your Site: What Are Your Options?

Site preparation is key to successful habitat creation. The more time you spend eliminating weeds from your site before planting, the less time and money you will spend on future maintenance and upkeep. Your plants are also more likely to survive with less competition from weeds for water and space. The most effective strategy is often to combine a few of these methods.

#### Solarization

**How it works:** Laying clear plastic on the ground to create high temperatures capable of killing weed seeds and plants.

**Uses:** This is a good option for organic farmers. It works best east of the Cascades where there is more sun and higher summertime temperatures It is most effective in the full sun and on south facing gentle slopes.

**Timing:** Begin in mid-late spring and seed in the fall

#### Steps:

- 1. Prepare the area in the spring by mowing or tilling. Be sure to remove remaining stems or branches that might tear the plastic.
- 2. Lay UV-stabilized plastic over the planting area, shovel soil to bury the edges of the plastic, preventing airflow and trapping in heat. Weigh down the center if necessary.
- 3. Repair tears with greenhouse plastic repair tape as they happen. 4. Remove plastic in late summer and seed in to the soil surface.
- 5. Spot spray with herbicide or hand-pull weeds as necessary.

**Benefits:** Doesn't use herbicide. An opportunity to reuse high-tunnel plastic if it is in good condition. **Drawbacks:** Can harm the biotic community in the top inch of soil, may be ineffective in areas where summer temperatures are not high or where

any shade hits the plastic, has relatively high preparation costs, and once

complete there is a large sheet of plastic to disposed of.

#### Herbicide

How it works: Spraying the leaves of the plant will cause the plant to draw the herbicide down into the roots of the weeds, killing them. **Uses:** Can be used on farms that are not organically certified. Should be

used on sites that have a low risk of erosion. Timing: Give at least 6 months to allow for multiple treatments, starting in early spring and finishing up before planting in fall.

#### Steps:

- 1. Mow existing vegetation.
- 2. Spray weeds again as they re-sprout to 4 6" tall throughout the spring, summer, and early fall.
- 3. Plant in the fall, waiting at least 72 hours after the last herbicide treatment (ensure that you are using an herbicide with a short residual
- toxicity). **Benefits:** Less labor intensive than manual removal methods. **Drawbacks:** Can't be used on an organic farm. Can have negative effects

on beneficial insects. **Note:** Always read and follow the label when using herbicides.

#### Sheet mulching

**How it works:** Eliminates grasses or herbaceous weeds by smothering them, eliminating access to sunlight.

**Uses:** Effective on herbaceous plants and grasses. Will not work on woody weeds such as blackberry and Scot's broom. Woody vegetation must be

**Timing:** Lay down mulch 6 – 8 weeks before planting. Mulch with wood chips in the spring for fall planting, and mulch in the fall if you plan on planting in the spring. Planting too soon after mulching will result in weeds growing out of planting of holes.

#### Steps:

- 1. Mow weeds and grasses as short as possible. 2. Water thoroughly. This will accelerate the composting process.
- 3. Place layers of newspaper or cardboard on the future planting area. Remove staples and tape from cardboard before laying it down. If using newspaper, place 15-20 layers down. Only use black and white print, no gloss inserts. Make sure the cardboard or newspaper overlaps
- Water again once the cardboard or newspaper is down, making sure to

at least 6" for complete coverage. Minimize foot traffic on the mulched

- saturate the materials. 5. Lay 4 – 6" of mulch on top of the cardboard or newspaper.
- 6. Plant through the cardboard and mulch and into underlying soil. 7. Mulch will need to be replenished every year or two as desired until

plants are free to grow. **Benefits:** This process is low-cost and fairly easy to do on your own. It leaves a lot of organic matter in place causes virtually no disruption to the soil, creates home for many beneficial insects, improves soil structure and

adds organic matter. **Drawbacks:** Can be time consuming depending on the size of the project.





Solarization in progress (left), sheet mulching in progress (right)

#### Tillage

How it works: Using tillage equipment (e.g., disc, harrow, rototiller) to cultivate the planting area, just as one would prep a planting site for crops.

Most effective for cover crops and insectary strips that are planted directly **Timing:** Right before planting, although one or more preliminary passes

consistently for several years and as a result has collected little weed seed.

might be necessary if there is extensive grass or other weeds. **Steps:** Till planting area just like you would till any other field to prepare for planting.

**Uses:** Best if used on land that has been cropped, grazed, or mowed

Benefits: Quick, low cost.

**Drawbacks:** Can stir up dormant weed seed, degrade soil structure, increase erosion, and disturb the life in the soil.

### Mowing

**How it works:** Knocks grass or weeds back enough to get new plants

**Uses:** Mowing can be effective when planting woody plants, such as a hedgerow, into ground dominated by grasses and/or herbaceous plants. For clearing woodier plants such as blackberry, you can use a rotary mower, string trimmer, or even a chain saw. Mowing for site preparation is not usually recommended for installing forbs and other grasses. Even woody plants will need to be heavily mulched afterwards to prevent competition from existing herbaceous plants.

**Timing:** Mow directly before planting and then mow around plantings as needed until grass and weeds become dormant.

disturbance.

1. If you've got mostly grasses, you can mow right before planting and maintain for the first few years after until plants are 'free to grow'.

3. Scrape the vegetation off the ground in a 2 foot radius around planting

- If you have larger, woodier vegetation, it may require multiple mowings over a couple of years before the site is clear of weeds. Digging out roots of woody vegetation will be best option for removal.
- area before digging a hole for planting. 4. Mulching with wood chips around installed plants is critical to reduce competing vegetation directly around plants and to conserve water. **Benefits:** Complies with organic practices. Creates minimal soil

**Drawbacks:** Can be very time consuming for larger weeds. Won't be very effective for grasses and forbs.





#### **General Planting Considerations**

- 1. Consider blooming time of flowers so that they build up beneficial insect population before seasonal
- 2. Make sure that the bloom time of flowers don't interfere with the bloom time of your crops in order to reduce competition for pollinator services.
- 3. Use plants that are not hosts for diseases to which your crop is susceptible.

#### Additional Resources

Willamette Valley Farmscaping for Beneficials Resource List

http://ipmnet.org/Posters\_and\_Presentations/Gwen/Willamette%20Valley%20Farmscaping%20 Resource%20List.pdf **Managing Insects on Your Farm** 

**Building Soils for Better Crops – Sustainable Soil Management** www.sare.org/content/download/841/6675/Building\_Soils\_For\_Better\_Crops.pdf?...1

**Managing Cover Crops Profitably** http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition

www.sare.org/content/download/29731/.../Manage\_Insects\_on\_Your\_Farm.pdf?...1

# **Xerces Society**

http://xerces.org/fact-sheets/

**Habitat Planning for Beneficial Insects** 

http://xerces.org/habitat-planning-for-beneficial-insects/ **Maritime Northwest Plant list** 

http://www.xerces.org/wp-content/uploads/2014/09/MaritimeNorthwestPlantList\_web.pdf A Guide to Multi-functional Hedgerows in Western Oregon

https://tilth.org/app/uploads/2013/06/Conservation-Buffers-in-Organic-Systems.pdf

#### http://extension.oregonstate.edu/umatilla/mf/sites/default/files/em8721.pdf **Conservation Buffers in Organic Systems**

Acknowledgements

Creation of this publication was a collaborative effort between Clackamas Soil and Water Conservation

District, Lisa Kilders and East Multnomah Soil and Water Conservation District, Chelsea White-Brainard. Special thanks to Mace Vaughan for editing. Thank you to Xerces Society and the authors of Farming with Native Beneficial Insects, on which we relied heavily as a resource. Authors include Eric Lee-Mäder, Co-Director, Pollinator Program, The Xerces Society; Jennifer Hopwood, Pollinator Conservation Specialist, The Xerces Society; Lora Morandin, Morandin Ecological Consulting; Mace Vaughan, Co-Director, Pollinator Program The Xerces Society; Scott Hoffman Black, Executive Director, The Xerces Society.

Editorial thanks to Joshua Vlach, Oregon Dept. of Agriculture, entomologist; David Lowenstein, Oregon State

University Extension, entomologist; Rowan Steele, Headwaters Farm Program Manager, East Multnomah Soil and Water Conservation District; Lucas Nipp, Senior Conservationist, East Multnomah Soil and Water **Conservation District** 

Photo credits: Chelsea Rutherford; East Multnomah Soil and Water Conservation District; Gwendolyn Ellen, Agricultural Biodiversity Consulting