The Xerces Society
for Invertebrate Conservation

Conservation Biological Control

Beneficial Insect Habitat

Assessment Form and Guide

FARMS AND AGRICULTURAL LANDSCAPES

June 2015

The Xerces Society for
Invertebrate Conservation

www.xerces.org

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Cover Photographs
Above: Native perennial insectary strip on Montana grain farm, photograph by Jennifer Hopwood, The Xerces Society; *left*: native ladybird beetle (*Hippodamia convergens*) consuming aphids on soybean, photograph by Thelma Heidel-Baker, The Xerces Society; *right:* braconid wasp on lovage flower, photograph by Sarah Foltz Jordan, The Xerces Society.

Photographs
We are grateful to the photographers for allowing us to use their wonderful photographs. Nancy Lee Adamson, The Xerces Society: 12c, 12d. Jessa Kay Cruz, The Xerces Society: 8, 9a. Gwendolyn Ellen, Oregon State University: 6b. Sarah Foltz Jordan, The Xerces Society: 2, 3, 5, 7e, 9b, 9d–h, 11a–c. Thelma Heidel-Baker, The Xerces Society: 7d. Don Keirstead, New Hampshire NRCS: 10c. Eric Lee-Mäder, The Xerces Society: 7b, 7c. Debbie Roos, North Carolina State University Extension Service: 10b. Matthew Shepherd, The Xerces Society: 9c. Steven Severinghaus, flickr.com: 7f. Anne Stine, The Xerces Society: 6a, 12a, 12b. Elijah Talamas, USDA Systematic Entomology Laboratory: 7g. Mace Vaughan, The Xerces Society: 7a. South Dakota NRCS: 10d. U.S. Department of Agriculture: 6c. Lesław Zimny, Wikimedia Commons: 10a.The copyright for all photographs is retained by the photographers. None of the photographs may be reproduced without permission from the photographer. If you wish to contact a photographer, please contact the Xerces Society at the address below.

Adult hover fly (Syrphidae: *Sphaerophoria*) feeding on golden Alexanders (*Zizia aurea*), a native plant in the carrot family. The larval stage of many hover flies are important predators of aphids.

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Regional offices in California, Minnesota, Nebraska, New Jersey, North Carolina, Texas, Vermont, and Wisconsin.

The Xerces Society for Invertebrate Conservation is a nonprofit organization that protects wildlife through the conservation of invertebrates and their habitat. Established in 1971, the Society is at the forefront of invertebrate protection, harnessing the knowledge of scientists and enthusiasm of citizens to implement conservation programs worldwide. The Society uses advocacy, education, and applied research to promote invertebrate conservation.

Beneficial Insect Conservation

Habitat Assessment Form and Guide

Beneficial insects provide a variety of services on farms, including pollination, decomposition, and natural pest control. The term "beneficial insects" throughout this document refers to those insects and other arthropods that prey upon or parasitize crop pests. There are numerous groups of beneficial insects, including certain types of flies, wasps, beetles, true bugs, lacewings, spiders, and mites (see more detailed list, below). These wild insects contribute significantly to natural pest control on farms, and their populations can be increased by a variety of habitat improvements and other strategies.

Purpose

This tool is meant to help educate farmers and conservation planners, prioritize conservation actions, and quantify habitat or management improvements on a single farm. The goal of this tool is not to compare one farm with another, or to rank farms in any way. Rather, it is intended to help incorporate beneficial insect conservation into a management plan and then document improvements in habitat resulting from specific actions and management practices. As with any tool of this nature, the evaluation and scoring practice is a subjective process, and the usefulness of the tool is dependent upon the consistency of the evaluator. While the goal is to implement changes that will result in an increased final score, there may not always be a viable treatment for individual variables. The scoring goals outlined in the instructions are general guidelines, but the capacity to reach or exceed these goals varies widely in different landscapes and may be refined by state USDA–NRCS offices and other conservation agencies for a more regionally-specific habitat assessment guide.

Instructions

- This habitat assessment form and guide is focused on beneficial insects for conservation biological control on farms and agricultural landscapes, such as orchards or field crop settings. If you are interested in pollinator habitat assessment, see *Habitat Assessment Reference Materials* (page 12).
- An assessment should be done twice, once during the conservation planning process (before project implementation), and once after the plan has been implemented.
- Prior to conducting an assessment, print out aerial photos to help with site and landscape questions.
- The accompanying photos and notes will help you identify and assess some specific habitat features.
- Each item in the assessment should be given a score of 0 if not present or the appropriate value from the "Score" column.
- Add up the scores to calculate a subtotal for each subsection (e.g., 5b. Insecticide use).
- Next, add up subsection subtotals to get a total for each section. Transfer these figures into the summary table on page 3 to generate the overall score.
- To maximize the potential for natural pest control, a post-implementation score of at least 110 points, with an improvement of at least 40 points, is ideal. If this is not possible for your region, talk to your area biologist, regional ecologist, or planner for guidance.

Beneficial Insects: Pest Control On Farms

There are many groups of beneficial insects that target crop pests. The most common groups will be familiar to most landowners/managers:

- Flies (hover flies, tachinid flies, robber flies, and dance flies)
- Wasps (paper wasps, sand wasps, trichogramma wasps, chalcid wasps, scelionids, braconids, ichneumonids, vespids, sphecids, scoliids, tiphiids)
- Beetles (ladybird beetles, ground beetles, tiger beetles, rove beetles, fireflies, soldier beetles, checkered beetles)
- True bugs (damsel bugs, pirate bugs, assassin bugs, big-eyed bugs, predatory stink bugs)
- Lacewings
- Spiders and predatory mites

Please note that this list is not exhaustive and may not apply to all areas.

Lacewing larvae are such voracious predators that they can consume up to 400 aphids each week, earning them the name "aphid lions".

Site Summary

Farm/Farmer:	Planner:	
Address:		County:
Dates	Assessment score before implementation (existing habitat):	
	Assessment score after implementation:	
Define and describe the project area (attach annotated maps; include soil classification, if known):		

Total Score for Habitat Assessment

The figures entered into this summary table will be calculated during completion of the assessment.

	BEFORE	AFTER
Section 1: Landscape Features *(max score 20)*		
Section 2: Farmscape Features *(max score 40)*		
Section 3: Foraging Habitat *(max score 40)*		
Section 4: Shelter & Overwintering Habitat *(max score 40)*		
Section 5: Management Practices *(max score 80)*		
OVERALL SCORE *(max score 220)*		

Section 1: Landscape Features

Complex landscapes with smaller field sizes and natural field borders have greater potential for natural pest control by beneficial insects. Natural areas in the landscape can also increase the speed at which new habitat is colonized by beneficials. Native plants are important, since beneficial insects are generally much more dependent on these plants than are pest insects.

Section 1: Landscape Features

1a. Percentage of natural or semi-natural vegetation within ½ mile of farm; e.g., prairie, shrub lands, woodlands, grasslands, riparian habitat, and wetlands. It does NOT include lawn grass, cropland, weedy areas, or heavily grazed pasture.

Max score of 10.

SELECT ONLY ONE	Score	Before	After	Treatment to increase score (no treatment if off-site)
>30%	10			
20%–30%	7			
5%–20%	3			
<5%	0			
Subtotal (1a)				

(1a)

The photos below illustrate the specified percentages of cover.

1b. Dominant vegetation in non-cropped area within ½ mile of farm.

Max score of 10.

SELECT ONLY ONE	Score	Before	After	Treatment to increase score (no treatment if off-site)
Native plants	10			
Mix of native and naturalized (non-invasive) plants	7			
Naturalized flowering species (e.g., clover)	5			
Mix of native, naturalized, and weedy/ invasive species	3			
Invasive flowering weeds or sod-forming grasses	0			
Subtotal (1b)				

(1b)

Landscape Features Total

(1a + 1b)

Section 2: Farmscape Features

On-farm natural areas and other features have a significant influence on the abundance and diversity of beneficial insects.

2a. Percentage of farm that is in natural or semi-natural habitat (see 1a for examples).
Max score of 10.

SELECT ONLY ONE	Score	Before	After	Treatment to increase score
>10%	10			
6–9%	7			
3–5%	5			
1–2%	3			
0%	0			
Subtotal (2a)				

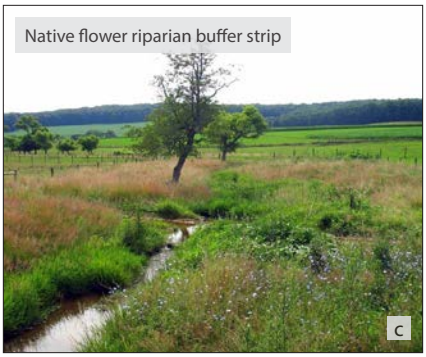
(2a)

2b. Additional farm features that are present. See below for examples. *Note 'n/a' if option is not applicable to the farm.*
Max score of 30.

SCORE ALL OPTIONS THAT APPLY	Score	Before	After	Treatment to increase score
Permanent meadows, field borders, or perennial insectary strips with diverse native wildflowers allowed to bloom	5			
Woodlands, hedgerows, or brushy areas adjacent to cropped areas, and composed of diverse, primarily native trees and shrubs	5			
Beetle banks or other areas of undisturbed perennial native grasses within fields or adjacent to cropped areas	5			
Annual flowering insectary strips; bolting crops allowed to bloom; flowering cover crops allowed to bloom	4			
Pasture with >30% non-invasive flowering plants (e.g., red clover, alfalfa, etc.) allowed to bloom	4			
Windbreak to reduce high winds, dust, and pesticide drift. If drift is an issue, windbreak should be composed of coniferous trees or shrubs that will not attract beneficials	3			
Riparian buffers or filter strips present, ideally including native flowering plants	4			
Subtotal (2b)				

(2b)

The photos below illustrate some habitats used by beneficial insects for shelter, egg-laying, and overwintering.



Farmscape Features Total

(2a + 2b)

Section 3: Foraging Habitat

Many predators and parasitoids use floral resources as supplemental food, or during certain stages of their life cycle. Season-long bloom also supplies alternate prey to keep beneficials on the farm before and after crop pests are present.

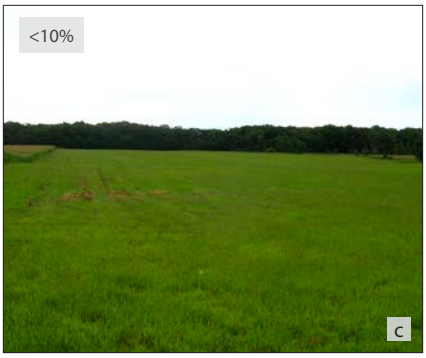
3a. Percentage of vegetative cover (non-crop area) that is wildflowers, flowering shrubs, or flowering trees on farm. *This does not include invasive or noxious species (e.g., knapweed, purple loosestrife, Canada thistle, yellow star thistle, etc.).*

Max score of 10.

SELECT ONLY ONE	Score	Before	After	Treatment to increase score
>50% cover	10			
30%–50% cover	7			
20%–30% cover	5			
10%–20% cover	3			
<10% cover	1			
Subtotal (3a)				

(3a)

The photos below illustrate some categories. See regional technical notes (listed on page 12) for lists of preferred plants and other information.



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Beneficial Insects: Predators & Parasitoids

Insects that contribute to pest control, or biological control, can be divided into two groups: predators and parasitoids. Predators—such as syrphid fly larvae, shown eating soybean aphids (*d*), and ground beetles (*e*)—are insects that hunt, kill, and consume pests. Parasitoids are specialist parasites that use other insects, including crop pests, as hosts on which their larvae feed and eventually kill. Examples of parasitoids include *Archytas apicifer* (*f*), a tachinid fly that targets many species of pest caterpillars, and *Gryon pennsylvanicum*, a scelionid wasp, shown emerging from a squash bug egg (*g*).

Section 3: Foraging Habitat *continued*

Section 3: Foraging Habitat

3b. Number of species of wildflowers, flowering shrubs, or flowering trees on farm that bloom in **spring** and support beneficial insects. *This includes some crops and cover crops, but does not include invasive or noxious species (see references section for examples).*

Max score of 10.

SELECT ONLY ONE	Score	Before	After	Treatment to increase score
7+ species	10			
4–6 species	6			
1–3 species	3			
0 species	0			
Subtotal (3b)				→ (3b)

3c. Number of species of wildflowers, flowering shrubs, or flowering trees on farm that bloom in **summer** and support beneficial insects. *This includes some crops and cover crops, but does not include invasive or noxious species (see references section for examples).*

Max score of 10.

SELECT ONLY ONE	Score	Before	After	Treatment to increase score
7+ species	10			
4–6 species	6			
1–3 species	3			
0 species	0			
Subtotal (3c)				→ (3c)

3d. Number of species of wildflowers, flowering shrubs, or flowering trees on farm that bloom in **fall** and support beneficial insects. *This includes some crops and cover crops, but does not include invasive or noxious species (see references section for examples).*

Max score of 10.

SELECT ONLY ONE	Score	Before	After	Treatment to increase score
5+ species	10			
3–4 species	6			
1–2 species	3			
0 species	0			
Subtotal (3d)				→ (3d)
Foraging Habitat Total				← (3a + 3b + 3c + 3d)

(3a)

Section 4: Nesting Habitat (Shelter, Egg-laying, and Overwintering)

Beneficial insects have a variety of habitat requirements for shelter, egg-laying, and overwintering. Since many beneficials have at least one life stage in the soil, reduced tillage systems are more supportive of these insects. Hedgerows, woodlands, and strips of perennial native plants adjacent to (or nested within) cropped areas provide important shelter and alternative hunting sites.

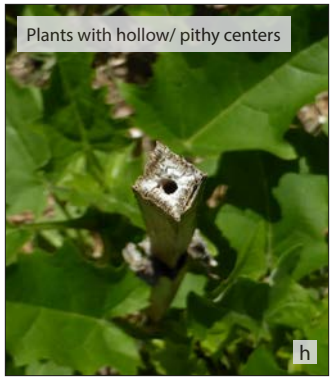
4. Beneficial insect shelter, egg-laying, and overwintering habitat.

*Score as follows: Abundant=5, Moderate=3, Scarce=1, Lacking=0

Max score of 40.

SCORE ALL OPTIONS THAT APPLY	Score	Before	After	Treatment to increase score
1 point for every 10% of area untilled on site	0–10			
Areas of undisturbed native bunch grasses (clump-forming) in the vicinity of cropped areas	0–5*			
Undisturbed ground covered in mulch or leaf-litter adjacent to cropped areas	0–5*			
Areas with untilled, uncompacted, well-drained ground, either bare or with sparse vegetation	0–5*			
Dead wood, snags, or brush piles in the vicinity of cropped areas	0–5*			
Rock piles, rock borders, or rock walls in the vicinity of cropped areas	0–5*			
Shrubs/ woody plant species with hollow/ pithy stalks (e.g., elderberry, cane fruit, etc.) or large, sturdy prairie plants with hollow/ pithy centers (e.g., cup plant, goldenrod, etc.).	0–5*			
	Total (4)			

The photos below illustrate some habitats used by beneficial insects for shelter, egg-laying, and overwintering.



Nesting Habitat Total

Section 5: Management Practices

Pesticide use and other crop management practices on farms have a significant influence on beneficial insect populations.

5a. Non-chemical crop and pest management techniques used on the farm. *Note 'n/a' if option is not applicable.*
Max score of 20.

SCORE ALL OPTIONS THAT APPLY	Score	Before	After	Treatment to increase score
Farm exhibits high crop diversity and/ or whole-farm diversity, naturally limiting pest outbreaks	3			
Plants are provided with growing conditions to optimize plant health, limit plant stress, and improve pest resistance	2			
Resistant crops and varieties are selected	2			
Crop rotation is used to break pest and disease cycles and improve plant health	2			
Altered planting times are used to reduce overlap between major pests and plants in their most sensitive stages (requires knowledge of plant and pest phenology)	2			
Sanitation is practised (e.g., removing or destroying infested fruit or plants)	2			
Cover cropping is used for building soil health and providing food and habitat for beneficial insects	2			
Intercropping with insectary plants is used to attract beneficial insects to crops most in need of pest control	2			
Low levels of pests are tolerated in recognition that these insects are important food for building populations of wild predators and parasitoids	3			
Subtotal (5a)				

(5a)

The photos below illustrate some habitats used by beneficial insects for shelter, egg-laying, and overwintering.

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Section 5: Management Practices *continued*

5b. Insecticide use. *Max score of 60.*				
SCORE ALL OPTIONS THAT APPLY	**Score**	**Before**	**After**	**Treatment to increase score**
No use of insecticides (including organic-approved products). Pests are not an issue, or issues are addressed by hand-picking, spraying with water, protecting with row-cover, plant collars, pheromone traps, mating disrupters, or other non-chemical controls. (*Proceed to Subtotal 5b.*)	60			
If pesticides are used:				
Most pest issues are addressed by non-chemical methods (see above question for examples)	3			
No soil fumigation	3			
Buffer of at least 30′ between any insecticide application and habitat areas	5			
Insecticides with lowest toxicity to beneficial insects are prioritized	5			
Applications occur only when pest pressure warrants, based on scouting program and economic threshold	5			
Application only occurs outside of crop bloom period	5			
Mowing is used to reduce bloom in any adjacent or understory habitat subject to drift	5			
Spraying occurs only in calm conditions, between 2–9 mph winds.	5			
Spraying only occurs at night	3			
Specialized spray equipment is used to reduce drift (e.g., electrostatic or hooded sprayers)	3			
Spray equipment is calibrated regularly	3			
Subtotal (5b)				
Management Practices Total				

(5a)

(5b)

(5a + 5b)

Beneficial Habitat: Placement & Proximity

Habitat should be placed adjacent to crops or areas of the farm where beneficial insects are most needed for pest control. While certain predators may travel a considerable distance to colonize agricultural fields, some—many parasitic wasps, for instance—will only travel a few hundred feet or less.

On the right, a *Polistes* spp. paper wasp is shown bundling up potato beetle larvae to bring back to its nest to feed its young (*a*, *b*). This same wasp was followed back to its nest in row of gooseberry bushes less than 50′ from the crop field (*c*).

Although paper wasps can fly much greater distances for food when necessary, a shorter distance between habitat and prey is more efficient for these insects and enables better pest control. As such, habitat for beneficial insects should be created as close to the target crop as possible, provided it remains protected from pesticide drift. For more information on installing beneficial insect habitat, see the *Reference Materials* (page 12).

Habitat Assessment Reference Materials

Beneficial Insect Conservation

Conservation Biological Control Resource Center
The Conservation Biological Control Resource Center includes regional information on beneficial insect profiles, beneficial insect management strategies, and more.
www.xerces.org/cbc/

Farming with Native Beneficial Insects. Mader et al. 2014.
This comprehensive guide by the Xerces Society describes how to recognize beneficial insects and their habitat, as well as how to evaluate, design, and improve habitat for them. Includes close-up photography and in-depth profiles of more than 20 beneficial insect families and their kin.
www.xerces.org/farming-with-native-beneficial-insects

Natural Enemies Handbook: The illustrated guide to biological pest control. Flint et al. 1998.
Developed by the University of California–Davis, this book covers the identification and use of both wild and released natural enemies to control pests in agriculture.
www.ipm.ucdavis.edu/IPMPROJECT/ADS/manual_naturalenemies.html

SARE Whole Farm Approach To Managing Pests
This 20-page bulletin outlines the ecological principles that help guide pest management on farms.
www.sare.org/Learning-Center/Bulletins/A-Whole-Farm-Approach-to-Managing-Pests

Biological control of insects and mites: An introduction to beneficial natural enemies and their use in pest management. Mahr et al. 2008.
This book (available as a free pdf) covers recognition of important natural enemy groups as well as information on habitat needs of these insects, and how to maximize their effectiveness for successful biological control.
http://learningstore.uwex.edu/assets/pdfs/A3842.pdf

Manage Insects on Your Farm: A Guide to Ecological Strategies. Altieri et al. 2005.
This book (available as a free pdf) provides ecological strategies that improve your farm's natural defenses and encourage beneficial insects to attack your worst pests.
www.northcentralsare.org/Educational-Resources/Books/Manage-Insects-on-Your-Farm

A pocket guide to common natural enemies to crop and garden pests in the Pacific Northwest. Oregon State University Extension.
This free printable pocket guide is designed to help the user quickly recognize the main groups of natural enemies and their predacious activity, with observation tips. Includes photos of the most common species in the Pacific Northwest, many of which are also found throughout the country.
www.ipmnet.org/Posters_and_Presentations/Pocket_Guide_Natural_Enemies.pdf

Pesticide Impacts & Risk Reduction

Beyond the Birds and the Bees: Effects of Neonicotinoid Insecticides on Agriculturally Important Beneficial Insects
A report released by the Xerces Society moving the spotlight from the risks neonicotinoids pose to bees to the impacts of neonicotinoids on other invertebrates, such as earthworms or lady beetles.
www.xerces.org/beyond-the-birds-and-the-bees/

University of California–Davis IPM Natural Enemies Gallery
Developed by the University of California–Davis, this online gallery allows users to find natural enemies by order and family name, scientific name, or targeted crop pest.
www.ipm.ucdavis.edu/PMG/NE/index.html

Inside Agroforestry–Windbreaks
An article about using windbreaks to capture pesticide drift.
http://nac.unl.edu/documents/insideagroforestry/vol20issue1.pdf

Habitat Installation & Assessment

Installation Guides for Pollinator & Beneficial Insect Habitat
Regional guidelines provide in-depth practical guidance on how to install and maintain habitat for pollinators and other beneficial insects, along with region-specific plant recommendations.
www.xerces.org/pollinator-conservation/agriculture/pollinator-habitat-installation-guides

Michigan State University Natural Enemies and Native Plants
Includes an overview of the reasons to choose native plants; a chart of native plants that provide season-long bloom for beneficials; and links to additional resources.
http://nativeplants.msu.edu/about/biological_control/natural_enemies

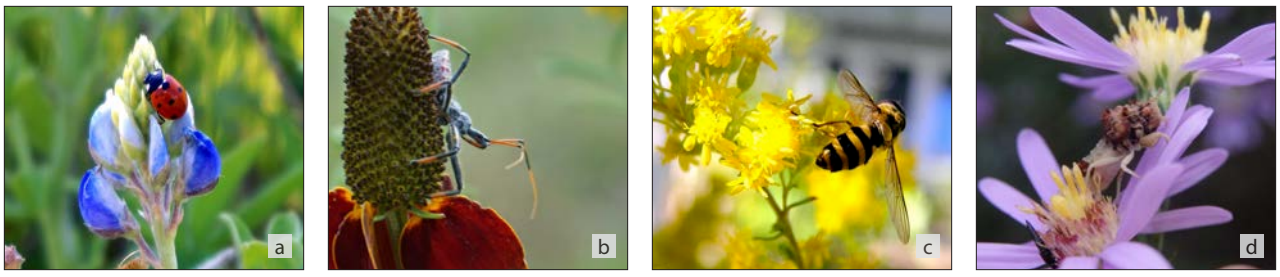
Introduced, Invasive, and Noxious Plants
Federal and state noxious weed lists, invasive plant lists, and introduced plant lists, with links to more information.
https://plants.usda.gov/java/noxiousDriver

Pollinator Habitat Assessment Form and Guide
These pollinator habitat assessment guides are designed to help educate conservation planners and landowners, prioritize conservation actions, and quantify habitat or land management improvements for pollinators on a single site. The guidelines include step-by-step instructions and photographic examples of important habitat features.

- *Farms and Agricultural Landscapes*
  www.xerces.org/pollinatorhabitatassessment_agriculture
- *Natural Areas and Rangelands*
  www.xerces.org/pollinatorhabitatassessment_naturalareasrangelands

Pollinator Habitat & Beneficial Insects

Many native wildflowers used in pollinator habitat also attract beneficial insects looking for foraging or nesting habitat. Below, from left to right: ladybird beetle on Texas bluebonnet (*Lupinus texensis*); assassin bug on Mexican hat (*Ratibida columnifera*), syrphid fly on wreath goldenrod (*Solidago caesia*), and ambush bug on smooth aster (*Symphyotrichum laeve*).



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