Beneficial Invertebrates in Our Soil

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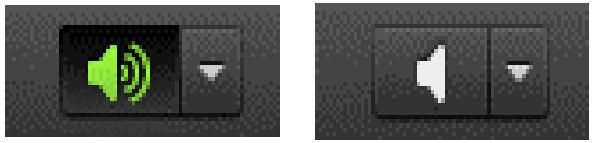
Photo: Jennifer Hopwood/The Xerces Society

Logistics

Computer Speaker Status



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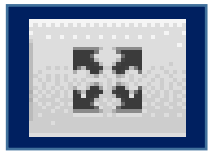
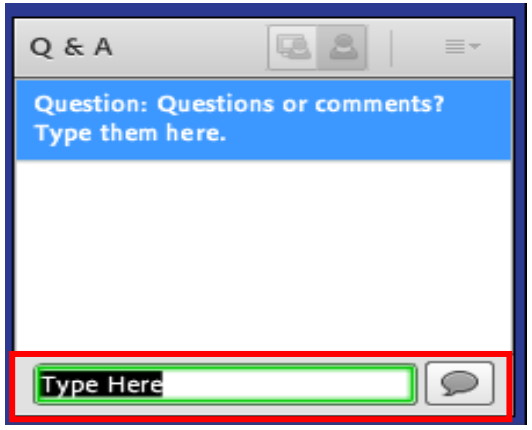
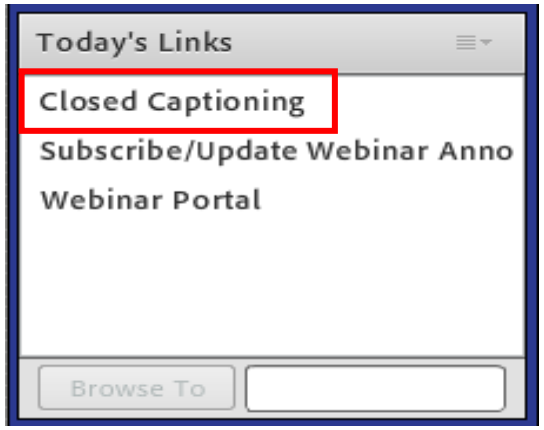


Q&A Pod



Today's Links



Today's Handouts

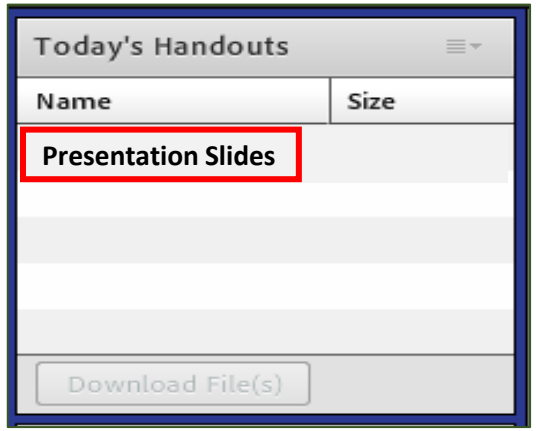


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Photo: Jennifer Hopwood/The Xerces Society

Our Living Soil: An Introduction

Photo: Stephanie Frischie/The Xerces Society

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Soil's Magnificence

Functions

A medium for plant growth and habitat for wildlife	Water-supply regulation and filtration	Recycling and storage of organic matter	Construction




Photos: ground beetle: Sarah Foltz-Jordan/The Xerces Society; filtration demonstration: Logan Jackson/Curators of the University of Missouri; organic soil: Luke McGuff/flickr; construction and soil: Virginia National Guard/flickr

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Soil Characteristics and Classification

Physical: texture, aggregate stability, density

Chemical: pH, cation exchange capacity, fertility

Biological: respiration, microbial diversity and abundance

Other: color, age, Orders

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Figure: NRCS

Soil Health Basics

Soil health is the continued capacity of a soil to function as a vital, living ecosystem that sustains plants, animals, and humans.

Protect the soil

- Minimize disturbance
- Maximize soil cover

Feed the life in soil

- Maximize continuous living roots
- Maximize biodiversity

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Soil is Full of Life

Illustration: Life in the Soil, Dr. Jim Nardi, 2007.

Soil is Full of Life

One teaspoon of soil contains more living organisms than there are people in the world!

Photo: Jennifer Hopwood

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Fungi and Bacteria

Bacteria

- Most abundant soil organism (biomass)
- Feed on carbon, contribute to decomposition, are eaten by micro- and mesofauna
- Transform atmospheric N_2 to forms that are available to plants

Fungi

- Very abundant
- Decompose plant residue
- Regulate pathogens
- Multiply the capacity of roots to absorb water, nutrients and tolerate drought

Background image: FAO, ITPS, GSBI, SCBD, and EC. 2020. *State of knowledge of soil biodiversity - Status, challenges and potentialities, Report 2020.* Rome, FAO.

Fungi and Bacteria

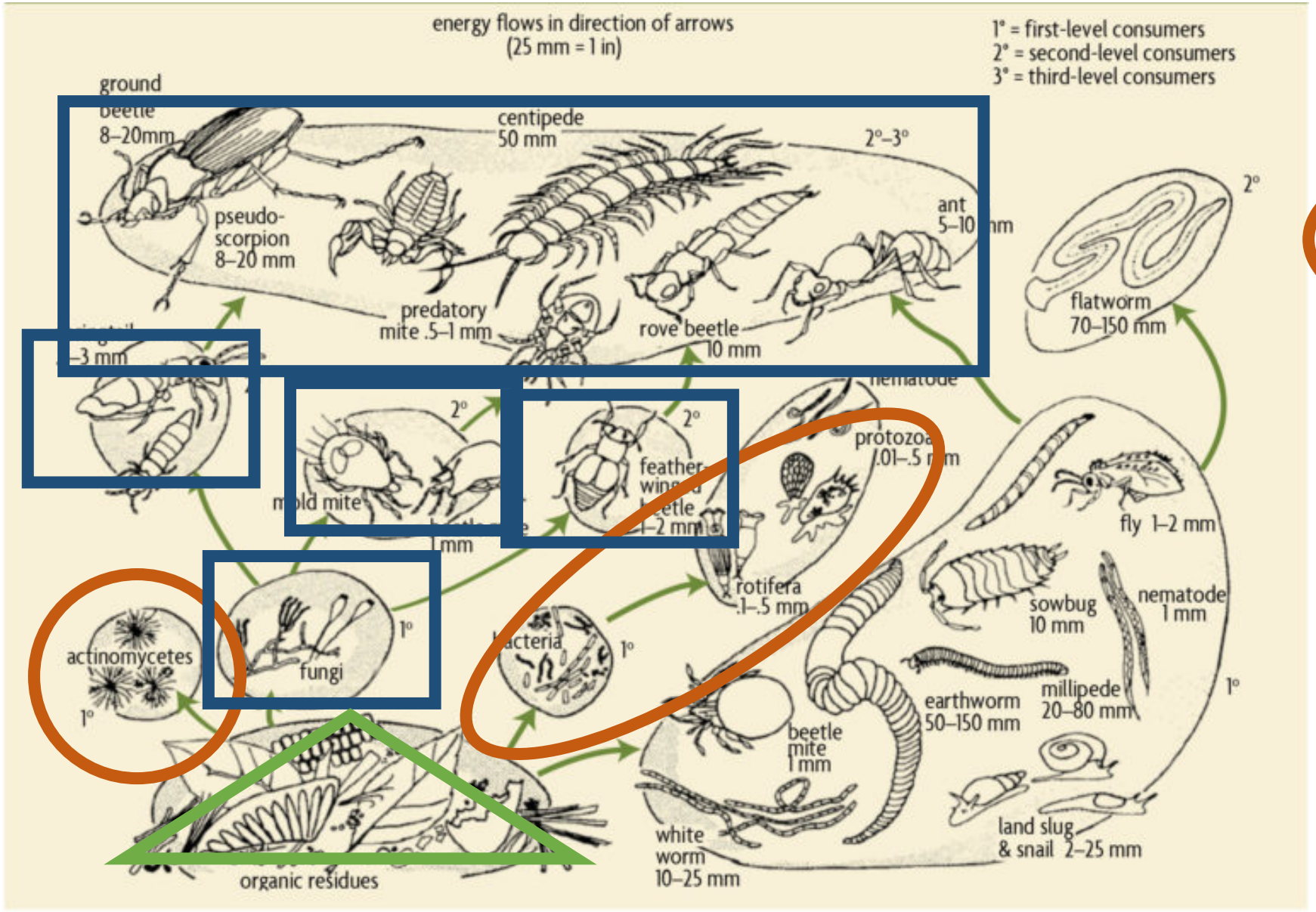

Figure 4.1. Soil organisms and their role in decomposing residues. Modified from D.L. Dindal (1972).

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Relative Abundance of Soil Life

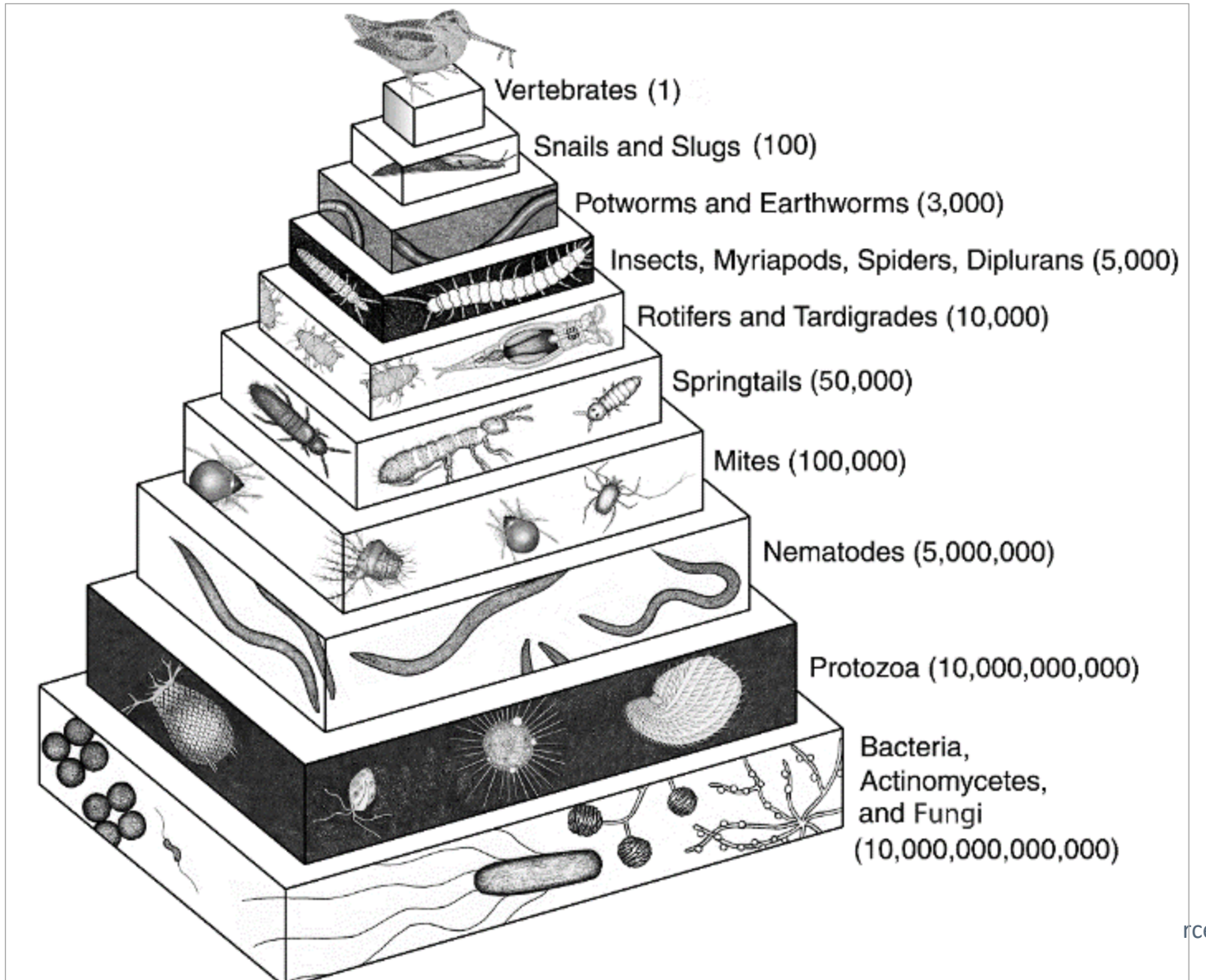

Image by Dr. James Nardi, Life in the Soil

Illustration is not to scale

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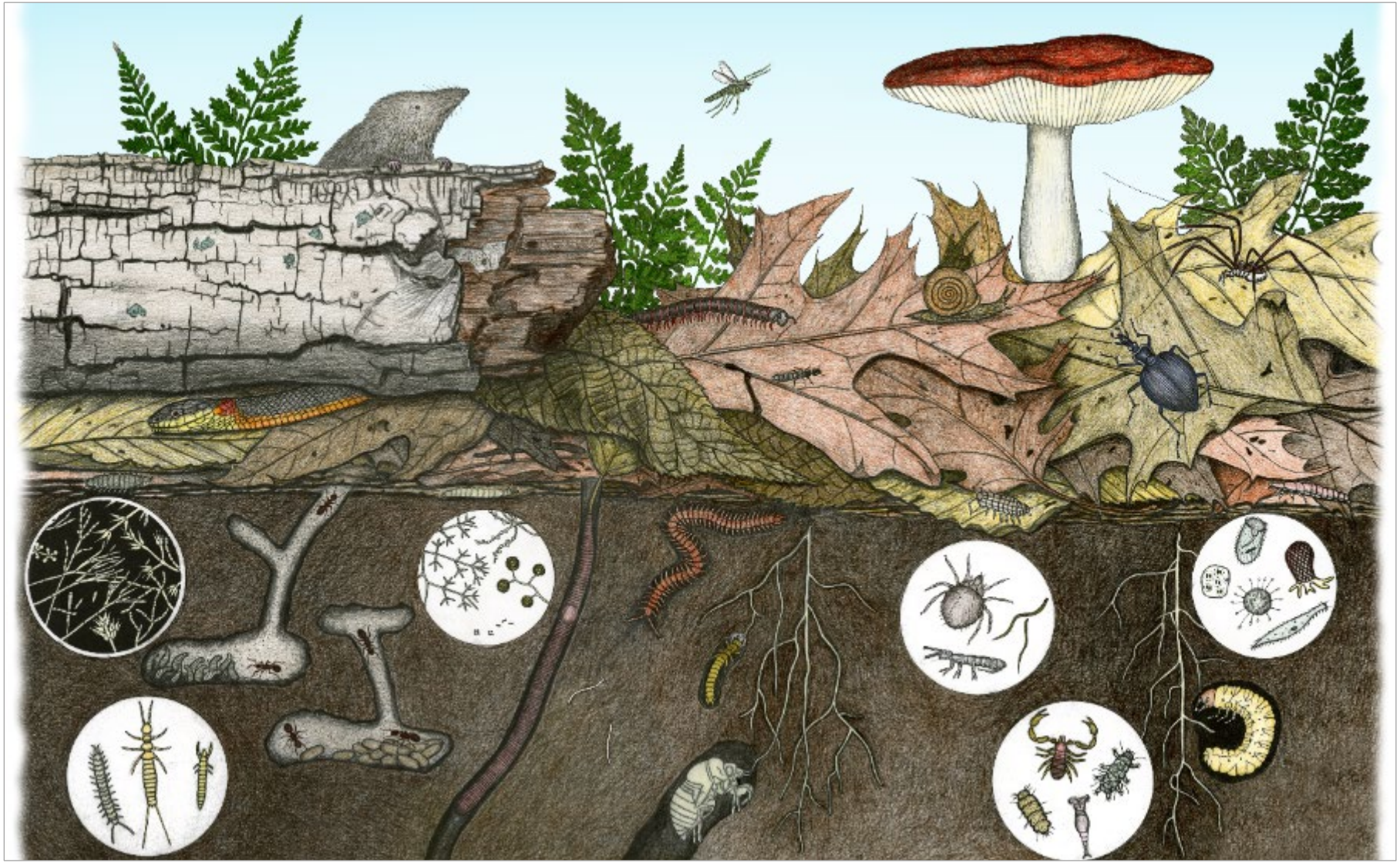
Soil is Full of Life



Soil animals represent nearly 25% of the total diversity of all known living organisms.

Illustration: Life in the Soil, Dr. Jim Nardi

Source: Decaëns et al. 2006

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Photo: Magnus Robinson

Ecological Roles of Soil Animals

Decomposers

- Break down plant and animal matter into pieces bacteria and fungi can use

Enrich soil

- Integrate nutrients

Soil engineers

- Tunnel into soil, bring subsoil to surface, help hydrate and aerate soil

Roles in food webs:

- Herbivores, fungivores, bacterivores, predators, parasitoids, pollinators

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Protozoa

What to look for:

Amoebae: cytoplasm extensions

Testate amoebae: shell-like test

Ciliates: use cilia to sense or move

Flagellates: use whiplike organs to propel

Where they live:

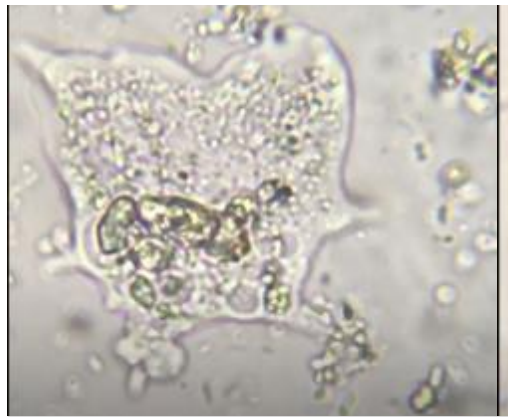
In water films, shallow and deep soil

Agricultural / Ecological role:

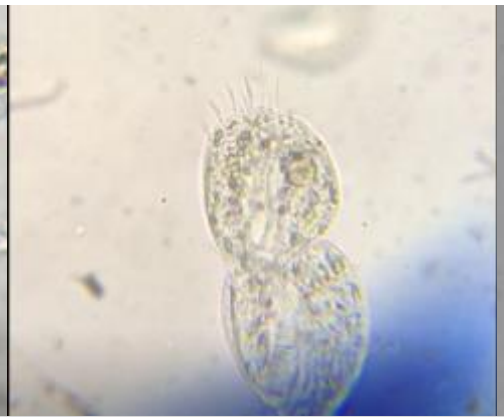
Important in nutrient cycling: predators, decomposers

What they eat:

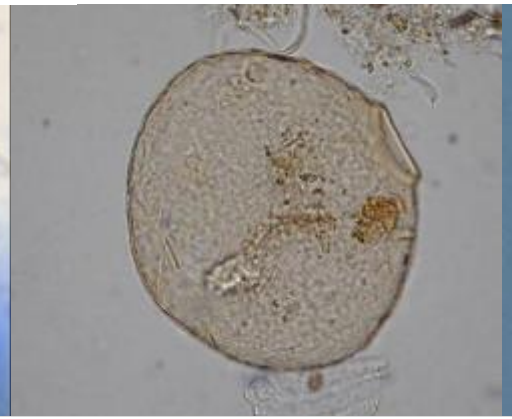
Bacteria, algae, fungus



Amoebae



Ciliate



Testate amoebae

Flagellate

Photos: Candy Thomas

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Rotifers and Tardigrades

What to look for:

- Rotifers: crowns of cilia for vortex feeding
- Tardigrades: eight stubby legs with claws, piercing mouthparts

Where they live:

In water films within the soil, leaf litter

Agricultural / Ecological role:

Predators, scavengers

What they eat:

Bacteria, protozoa, nematodes, fungi, plants, algae

Photos: Flickr/Specious Reasons

Nematodes

What to look for:

- Unsegmented transparent worms with tapered ends
- Specialized mouthparts for food sources

Where they live:

In water films or pores within soil

Agricultural / Ecological role:

Predators, omnivores, plant parasites

Move bacteria through soil layers

What they eat:

Protozoa, tardigrades, rotifers, other nematodes; bacteria; fungi; plants

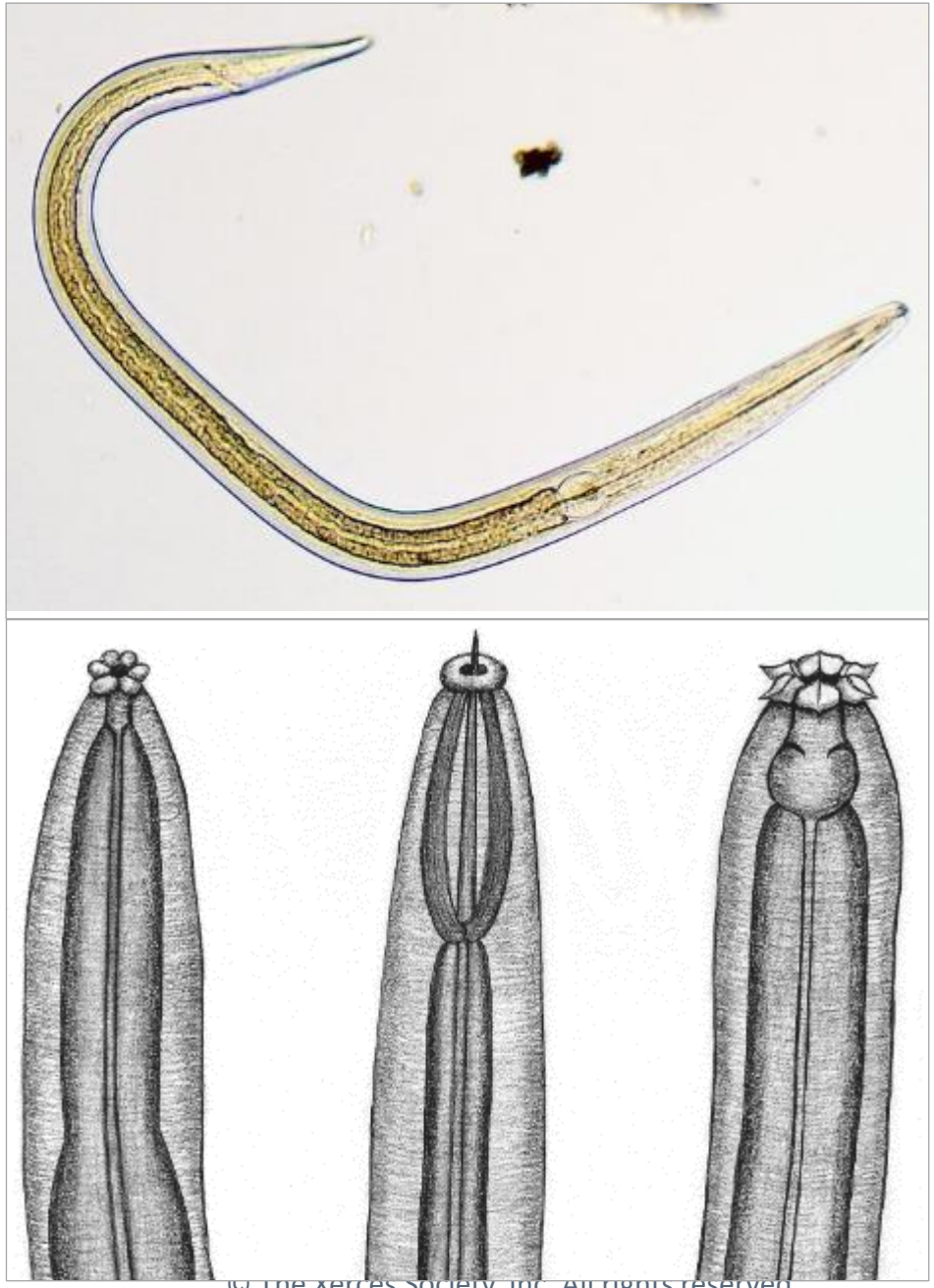

Photo: Flickr/Philippe Garcelon; Illustration: Jim Nardi, Life in the Soil

Potworms

What to look for:

White segmented worms, smaller than earthworms

Where they live:

In upper soil layer

Agricultural / Ecological role:

Ecosystem engineers, integrating organic matter and minerals; decomposers, consumers

What they eat:

Fungi, bacteria, decaying organic material; also ingest soil particles

Photos: Flickr/anneke1998; Andy Murray

Earthworms

What to look for:

- Tubelike segmented bodies
- Clitellum closer to the head

Where they live:

Soil surface and leaf litter; within soil layers, and in deep soil

Agricultural / Ecological role:

- Impact soil structure through burrowing and mixing; make some nutrients accessible to plants
- Some introduced species deplete leaf litter and do not mix nutrients within soil layers

What they eat:

Leaf litter and soil (organic matter as well as minerals)

Photos: Schizoform/Flickr; (Armando L. Sanchez / Chicago Tribune

Arthropods, Metamorphosis and Diet

Figure 36: Clockwise from top left: assassin bugs do not pupate. Females lay eggs in clutches on branches or leaves; after hatching, nymphs go through numerous instars until they are fully mature.

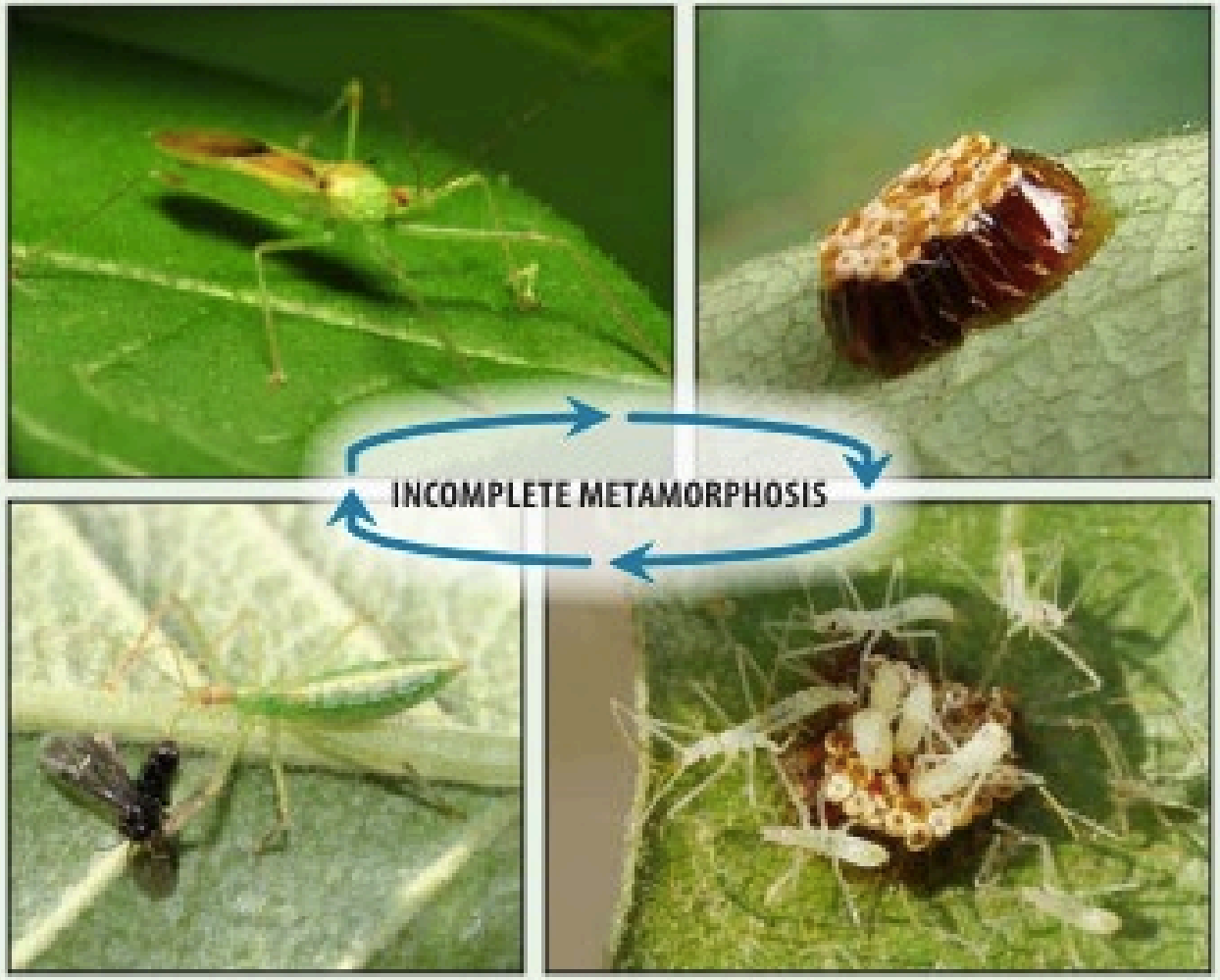

Figure 37: Clockwise from top left: lady beetles oviposit clusters of eggs; after hatching, larvae go through several instars before becoming pupae, when they develop into adults.

Mites

What to look for:

- Pear shaped, dark bodies
- Adults with eight legs

Where they live:

Soil surface, within soil layers, and in deep soil

Agricultural / Ecological role:

Critical decomposers; some are predatory

Help disperse bacteria and fungi

What they eat:

Bacteria, decaying organic material, fungi; springtails, nematodes, insect eggs and larvae

Photos: Christophe Quintin/Flickr; Bob Webster/BugGuide

Springtails (Collembola)

What to look for:

- Some are elongate, others are globular
- Furcula that propels like a spring

Where they live:

Leaf litter, decaying logs, fungi, soil surface; within soil layers

Agricultural / Ecological role:

Decomposers; some are predatory

What they eat:

Decaying plants, fungi, bacteria, pollen; rotifers, nematodes, other springtails

Photos: Brenda Dobbs/Flickr

Photos: Robert Lord Zimich; D.Fletcher/Flickr

Millipedes

What to look for:

- Elongated, segmented body with two pairs of legs per segment
- One pair of antennae, chewing mouthparts

Where they live:

Leaf litter, upper soil layer; under logs, stones; a few in deep soil layers

Agricultural / Ecological role:

Decomposers, scavengers; particularly important in plant decomposition

What they eat:

Decaying vegetation, fungi

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Photos: Troy Bartlett

Centipedes

What to look for:

- Segmented bodies, often flattened, with one pair of legs per segment
- First pair of legs modified to inject venom

Where they live:

Soil layers shallow and deep; under logs, bark, stones

Agricultural / Ecological role:

Predators; some are detritivores

What they eat:

Earthworms, arthropods; may also eat small reptiles or mammals

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Jumping spider

Wolf spider

Spiders

What to look for:

- Two body regions, eight legs, multiple eyes
- Chelicerae for injecting or digging

Where they live:

Soil surface, leaf litter; in webs

Agricultural / Ecological role:

Predators; move and work the soil

What they eat:

Other arthropods

Photos: Bryan Reynolds; Jennifer Hopwood; David Stephens; Josephe Berger; Ian Marsman

Ground spider

Wolf spider

OPEN QUESTION #1, please reply in the CHAT

Have you thought or wondered about soil invertebrates before today?
If yes, how?

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Soil Insects

Barbara Thurlow; Daniel R. Suiter University of Georgia_Bugwood; Even Dankowicz, Jessica Louque-Smithers/Bugwood; David Cappaert/Bugwood; David Jones,Univ of Georgia/Bugwood

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Flies as Decomposers

A number of flies are important decomposers of plant material

Whitney Cranshaw, Colorado State Univ, Bugwood.org; K. Schiender; David Cappeart, bugwood.org; Susan Eillis, bugwood.org

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Photos: Mace Vaughan; Mario Ambrosino

Flower Flies

What to look for:

- Adults have coloration that mimic bees or wasps
- Larvae are gray-green, are legless

Where they live:

Larvae live within leaf litter or rotting wood, or on plants.

Agricultural / Ecological role:

Decomposers, predators, pollinators

What they eat:

Larvae eat decaying vegetation or soil insects; Adults eat nectar, sometimes pollen

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Photos: Adult soldier beetles mating, by Debbie Roos; Karen Loughrey Richard

Soldier Beetles

What to look for:

- Adults with leathery wing covers
- Larvae are dark with sickle-shaped jaws

Where they live:

Soil, leaf litter, under stones; adults on flowers

Agricultural / Ecological role:

Predators important in biocontrol, pollinators

What they eat:

Insect eggs, larvae; aphids, snails, slugs

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Photos: Jennifer Hopwood

Fireflies

What to look for:

- Adults with leathery wing covers
- Luminous segments in adults and larvae

Where they live:

Leaf litter, under bark; adults in tall grass

Agricultural / Ecological role:

Predators

What they eat:

Snails, slugs, earthworms, caterpillars

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Photos: Jsarah Foltz Jordan; Jean and Fred/Flickr

Ground Beetles

What to look for:

- Adults with brown, black color and ridged wing covers
- Larvae with sickle-like jaws

Where they live:

Soil, leaf litter

Agricultural / Ecological role:

Predators important in biocontrol; some also decomposers or eat weed seeds

What they eat:

Snails, slugs, caterpillars, grasshoppers, beetles, flies, more

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Photos: Susan Ellis/Bugwood; Jeff Gruber

Rove Beetles

What to look for:

- Adults with short wing covers
- Elevated tip of abdomen

Where they live:

Soil (some in deeper layers), leaf litter, mulch, nests

Agricultural / Ecological role:

Predators, decomposers, mix soil

What they eat:

Insect eggs or larvae, slugs, mites; dead plant or animal matter

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Burying beetle


Carrion beetle

Photos: Susan Ellis / Bugwood

Burying Beetles

What to look for:

- Burying beetles: red, orange and black
- Carrion beetles: oval bodies, black with yellow or orange

Where they live:

Within or below carrion

Agricultural / Ecological role:

Decomposition of animal carcasses

What they eat:

Carrion

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Photos: Susan Ellis / Bugwood; Jay Cosey

Dung Beetles

What to look for:

- Adults have oval bodies, clubbed antennae and scalloped legs
- Larvae are c-shaped

Where they live:

Larvae are within dung or within nests with dung; adults in many habitats

Agricultural / Ecological role:

Decomposers; critical to grazing operations, worth more than $380 million/yr; diggers; seed dispersers.

What they eat:

Dung, particularly herbivorous mammals

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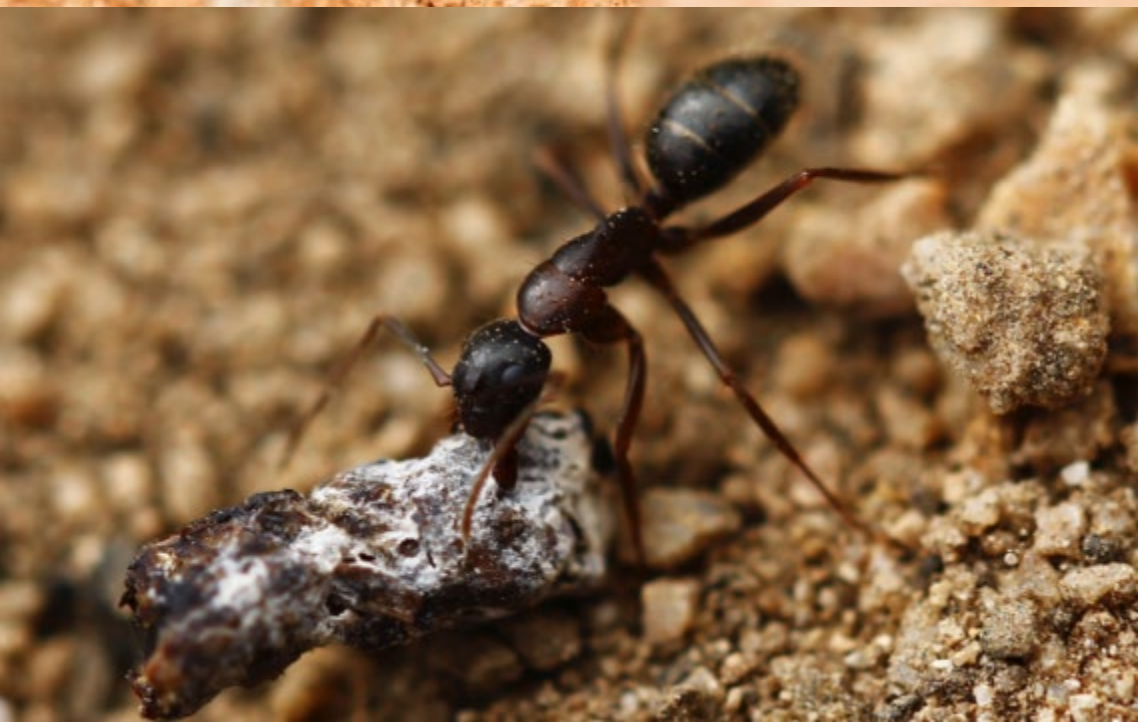

Ants

What they look like:

- Red, brown, black
- Constricted “waist” with lobes
- Elbowed antennae

Where they live:

Underground in nests; leaf litter

Agricultural / Ecological role:

Ecosystem engineers, predators, decomposers, seed dispersers

What they eat:

Small arthropods; dead animals; plants, fungi, sap

Photos:; Elizabeth Cash ASU; Magnus Robinson; Walter Tschinkel

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Ground nesting bees

What to look for:

- Adults with constricted waist, often hairy, pollen-carrying structures

Where they live:

Larvae in nests in the soil, adults are found on flowers

Agricultural / Ecological role:

Pollinators of crops, wild plants; diggers

What they eat:

Pollen, nectar

Photos: Nancy Lee Adamson; Sara Morris; Betsy Betros; Hillary Sardinas;


Great golden digger wasp


Sand wasp

Ground Nesting Predatory Wasps

What to look for:

- Constricted waist
- No pollen-carrying structures, not hairy

Where they live:

Larvae in nests in the soil, adults on flowers

Agricultural / Ecological role:

Predators important in biocontrol; pollinators, diggers

What they eat:

Arthropods,
Nectar


Cicada-killer wasp

Photos: Nancy Lee-Adamson; Whitney Cranshaw/Bugwood; ©

Soil Life: Pests

Scarab beetle grubs

Wireworms

Soil-dwelling caterpillars

Adult moths

Where they live:

Soil among plant roots

Agricultural / Ecological role:

Herbivores, decomposers; some are crop pests or ornamental plant pests

What they eat:

Roots, decaying plants and wood

Photos: J. Obermeyer/Purdue University; Jennifer Hopwood; Whitney Cranshaw/Bugwood; Paolo Mazzei/Bugwood

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Photo: University of Minnesota Extension

What Soil Animals Do for Us

Soil animals have a huge influence on life above ground:

- Nutrient cycling
- Maintain soil structure
- Improve water infiltration and storage
- Enhance plant productivity
  - Supporting the provision of food, shelter, and fuel for people
- Climate regulation
- Biocontrol of other organisms
- Pollination
- Food source for wildlife

Sources: Lavelle et al. 2006; Daecens et al. 2006; Culliney 2013; FAO et al. 2020.

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Farming practices and soil life

	← More soil life		Less soil life →
Tillage	no-till	minimal	conventional
Fertilizers	organic		inorganic
Pesticides	lower		higher
Above-ground diversity	higher		lower

Photo: Nick Sloff/Penn State University

Some Effects of Tillage, Fertilizer and Pesticides

Desiccation; breakage of fungal hyphae; destruction of tunnels, burrows or nest sites

Spikes and loss

Direct and indirect effects

Photos: United Soybean Board, Thirteen of Clubs/flickr, Kevin Wood/flickr

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Springtails, a few ants

Fewer crickets

More crickets

BENEFICIAL INSECTS FOR NATURAL PEST CONTROL:

Soil Scouting

PURPOSE

Beneficial insects like predatory ground beetles and spiders can provide important natural pest control in a farm or garden setting. This guide and worksheet is designed to help you assess the presence of predatory organisms that hunt and rest on soils. Using catch-and-release pitfall traps, you will be able to easily detect and count these soil-surface predators. Use this guide along with our flower and foliage scouting guides to gain a better understanding of the beneficial insect community on your farm.

WHAT YOU NEED	• Clipboard , worksheet copy, and pen/pencil • Small spade or trowel • Containers for pitfall traps (e.g., plastic drinking cups or large yogurt containers, ideally with lids) • Flags or stakes (to mark trap locations)
WHERE TO USE	Undisturbed habitats adjacent to crops (e.g. field borders, hedgerows, woodland edges) or within crops (e.g. cover crops, beetle banks, insectary strips). Scouted habitat areas should be located in full sun and protected from pesticide applications.
WHEN TO USE	Twice per year, July-September • Visits separated by at least 1 month • Deploy pitfall traps in early evening • Empty traps as soon as possible the next morning Warm conditions with daytime temperatures >60 °F (15.5 °C) Avoid sampling in rainy conditions that may flood traps

HOW TO SCOUT

You will be setting out catch-and-release pitfall traps (see photo, right) to observe and record soil-surface predators. The number of traps you will set out is dependent on the number of habitat areas you are interested in monitoring. We recommend one or two pitfall traps per habitat feature of interest, placed at least 50 ft. apart (further apart in larger habitat areas).

- **Select habitat area(s) you want to monitor.**
- **Deploy traps in late afternoon or early evening.** Dig an appropriate-sized hole in each location you wish to survey. Place container (lidded if possible) inside the hole so that its rim is level with the soil surface. (Using lid prevents dirt from spilling into bottom of the trap, and a dirt-free container makes trap evaluation easier the next morning.) Once the container is well-positioned, fill dirt in around the container and carefully remove the lid.
- **Use flags or stakes to mark trap locations.** Mark trap locations to ensure you can find traps again the next morning.
- **Revisit traps the following morning.** Use provided worksheet to record any predators in traps. Use photos at right for guidance on commonly caught predators.
- **Remove trap, or place lid on the trap (if reusing).** The stake/flagging should be left in place for the next survey date. Traps can be left in place, but must be covered to prevent further captures during the interim period. If farm practices (like mowing) prevent use of physical markers in some habitat areas, then a detailed description of trap locations is needed.

Acknowledgments: Guide created by Thelma Heidel-Baker, Sarah Foltz Jordan, Jarrod Fowler, and Eric Lee-Mader of The Xerces Society. All photos taken by Sarah Foltz Jordan.

XERCES SOCIETY for Invertebrate Conservation

20 September 2020
West Lafayette IN

Photo: Jennifer Hopwood

Soil Animal Resource Concerns

Soil organism habitat loss or degradation

Objective: Improve habitat for beneficial soil organisms.

Terrestrial habitat for wildlife and invertebrates

Objective: Improve quantity and quality of habitat to meet requirements of identified terrestrial wildlife or invertebrate species.

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Table 1. NRCS Conservation Practices That Can Be Used to Support Soil Organisms *continued*

CONSERVATION PRACTICE	CODE	DEFINITION	PURPOSE. Each practice is applied to support one or more of the following purposes:
Filter Strip	393	A strip or area of herbaceous vegetation that removes contaminants from overland flow.	• Reduce suspended solids and associated contaminants in runoff and excessive sediment in surface waters • Reduce dissolved contaminant loadings in runoff • Reduce suspended solids and associated contaminants in irrigation tailwater and excessive sediment in surface waters.
Forage Harvest Management	511	The timely cutting and removal of forages as hay, green chop, or ensilage.	This practice is used to accomplish one or more of the following purposes: • Optimize quantity and quality of forage at the desired levels while promoting vigorous plant regrowth • Manage the species composition to enhance desirable species • Reduce excess soil nutrients • Reduce pest pressure (insects, disease, weeds, invasive plants or plant toxins) • Improve or protect wildlife and their habitat • Optimize soil microbial life and aggregate stability • Reduce soil compaction
Forest Stand Improvement	666	The manipulation of forest species composition, stand structure, or stand density by cutting or killing selected trees and understory vegetation to achieve desired forest conditions or obtain ecosystem services.	• Improve and sustain forest health and productivity • Reduce damage from pests and moisture stress • Initiate forest stand regeneration • Reduce fire risk and hazard and facilitate prescribed burning • Restore or maintain natural plant communities • Improve wildlife and pollinator habitat • Alter quantity, quality, and timing of water yield • Increase or maintain carbon storage.
Grassed Waterway	412	A shaped or graded channel that is established with suitable vegetation to convey surface water at a non-erosive velocity using a broad and shallow cross-section to a stable outlet.	This practice is used to accomplish one or more of the following purposes: • Convey runoff from terraces, diversions, or other water concentrations without causing erosion or flooding • Prevent gully formation • Protect/improve water quality.
Hedgerow Planting	422	Establishment of dense vegetation in a linear design to achieve a natural resource conservation purpose.	Providing at least one of the following conservation functions: • Habitat, including food, cover, and corridors for terrestrial wildlife. • To enhance pollen, nectar, and nesting habitat for pollinators. • Food, cover, and shade for aquatic organisms that live in adjacent streams or watercourses. • To provide substrate for predaceous and beneficial invertebrates as a component of integrated pest management. • To intercept airborne particulate matter. • To reduce chemical drift and odor movement. • Screens and barriers to noise and dust • To increase carbon storage in biomass and soils. • Living fences • Boundary delineation and contour guidelines
Herbaceous Weed Treatment	315	The removal or control of herbaceous weeds including invasive, noxious, prohibited, or undesirable plants.	This practice is used to accomplish one or more of the following purposes: • Enhance accessibility, quantity, and/or quality of forage and/or browse • Restore or release native or desired plant communities for wildlife habitat • Protect soils and control erosion • Reduce fine fuel loads and wildfire hazard • Control pervasive plant species to a desired level of treatment.

Table of Practices

Farming with Soil Life handbook lists 35 NRCS practices that support soil organisms

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USDA-NRCS Conservation Practices for Soil Invertebrates

Residue and Tillage Management, Reduced Tillage (345)
Residue and Tillage Management, No Till (329)
CSP Enhancement (E329106Z)

Photo: Tim McCabe, Arkansas NRCS

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USDA-NRCS Conservation Practices for Soil Invertebrates

Conservation Cover (327)

Photo: Don Keirstead, New Hamshire NRCS

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NRCS practices

Wildlife Habitat Planting (420)

Establishing wildlife habitat by planting herbaceous vegetation or shrubs

Photo: Sarah Foltz Jordan/The Xerces Society. Wisconsin.

NRCS practices

Cover Crop (340)

Grasses, legumes, and forbs planted for seasonal vegetative cover

Photo: Tracy Robillard/NRCS Oregon

USDA-NRCS Conservation Practices for Soil Invertebrates

Field Border (386)

Photo: Jennifer Hopwood/Xerces Society

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USDA-NRCS Conservation Practices for Soil Invertebrates

Pest Management Conservation System (595), CSP Enhancement 595137Z

Photos: David Biddinger, Penn State University; John Pearson

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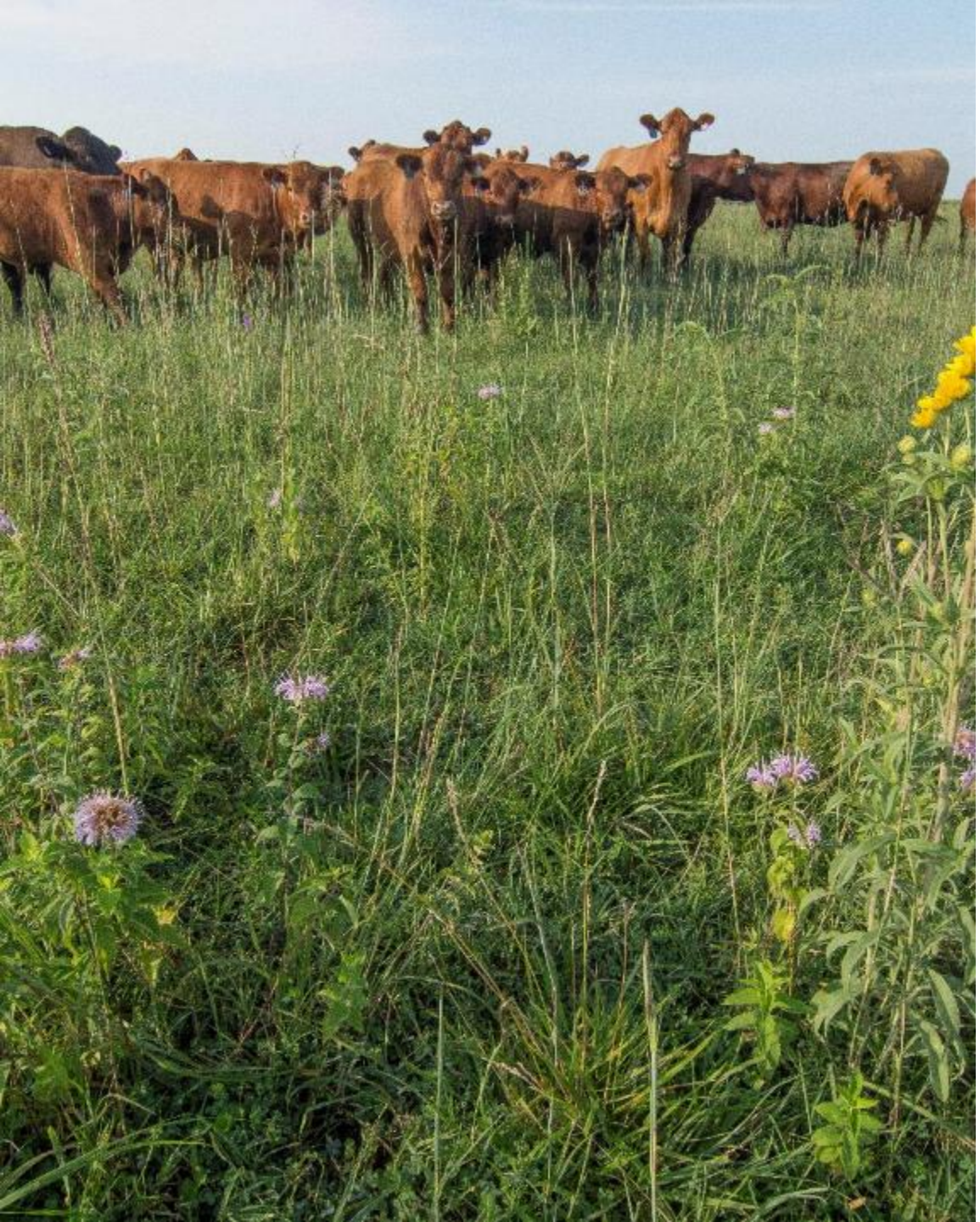

Photo: Chris Helzer

Other Associated Practices

Additional NRCS practices that support soil invertebrates:

- Forest Stand Improvement (666)
- Tree and Shrub Planting (612)
- Windbreak / Shelterbelt Establishment (380)
- Alley Cropping (311)
- Prescribed Burning (338)
- Prescribed Grazing (528)
- Forage Harvest Management (511)
- Restoration and Management of Rare and Declining Habitats (643)

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Case Study: Sogn Valley Farm, Cannon Falls, MN

Photo: Sogn Valley Farm / Dana and Karin Jokela

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Case Study: Sogn Valley Farm

Cover crop mulch system

Interseeded cover crops

Photos: Sogn Valley Farm / Dana and Karin Jokela

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Case Study: Sogn Valley Farm

Perennial native plant field borders on the farm

Photo: Sogn Valley Farm / Dana and Karin Jokela

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Flowering Cover Crop Trials

Agua Gorda Cooperative, Central Minnesota

Flowering cover crops integrated into crop rotation

Casey Bailey Farm, Fort Benton, MT 8,000 acres dryland grains & range Photos: Sarah Foltz Jordan

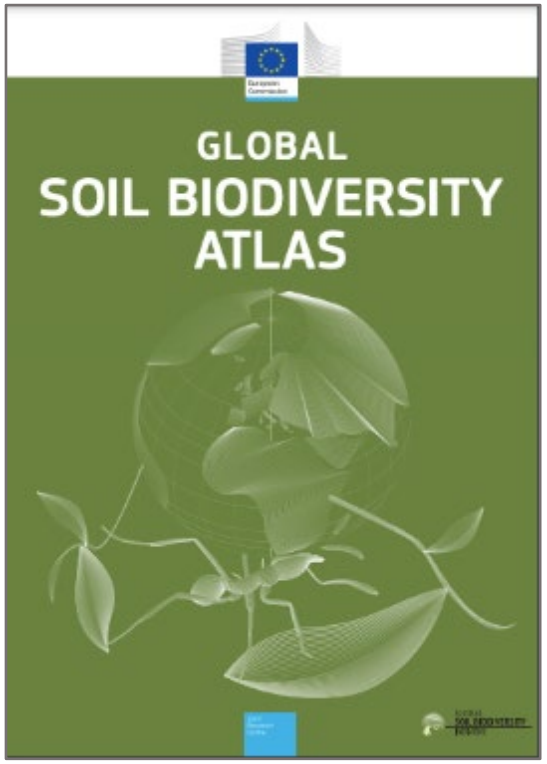
Clark Land and Cattle

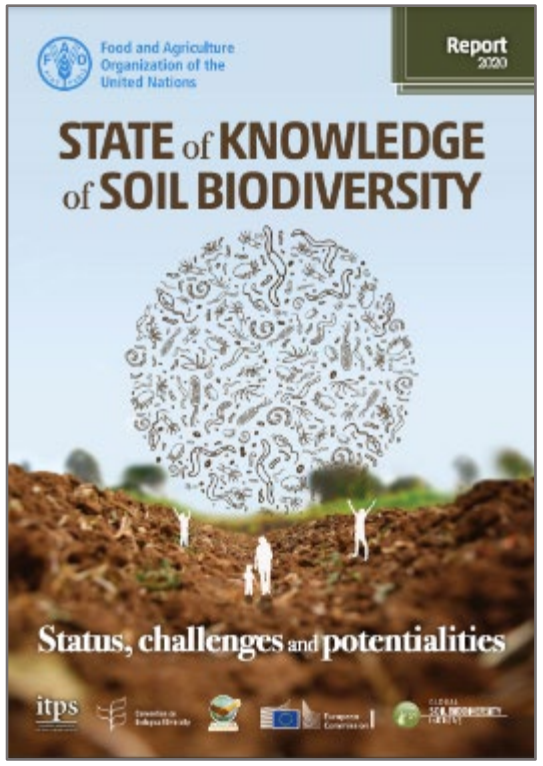
West Central Indiana

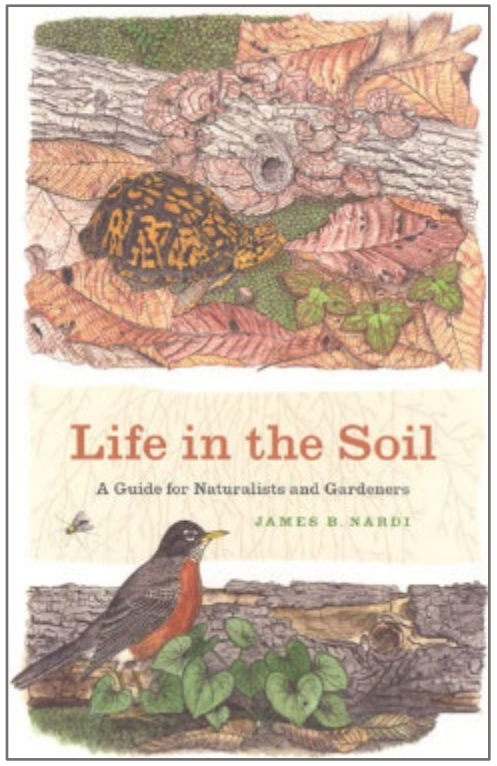
- 6 crop system / plus 1
- 1200 acres certified organic, remainder of acres in transition
- No starter fertilizer
- No fungicide, no seed treatment, no insecticide
- No P, K or ag lime applied in 7 years
- No Nitrogen applied in 2 years (that includes manure)
- Everything is done naturally
- Organic with no tillage

Photos; Rick Clark

Other resources







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The Xerces Society for Invertebrate Conservation

The Xerces Society is a science-based nonprofit organization that engages in education, outreach, applied research, policy, and restoration to protect invertebrates and their habitats.

Xerces blue butterfly (*Glaucopsyche xerces*), the first U.S. butterfly to go extinct due to human activities

Photos: 2018 Xerces staff by Matthew Shepherd/Xerces Society. Blue butterfly by Dana Ross.

Main Office: Portland, Oregon

Regional Offices: California, Connecticut, Idaho, Indiana, Iowa, Maine, Minnesota, Nebraska, New Hampshire, New Jersey, New Mexico, North Carolina, North Dakota, Oklahoma, Washington, Wisconsin

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Xerces Society - Protecting the Life that Sustains Us

- **Pollinator conservation**
- **Agricultural biodiversity**
- **Endangered species**
- **Aquatic invertebrates**
- **Pesticide management**
- **Urban conservation**
- **Policy & advocacy**

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Resources from Xerces Society

www.xerces.org

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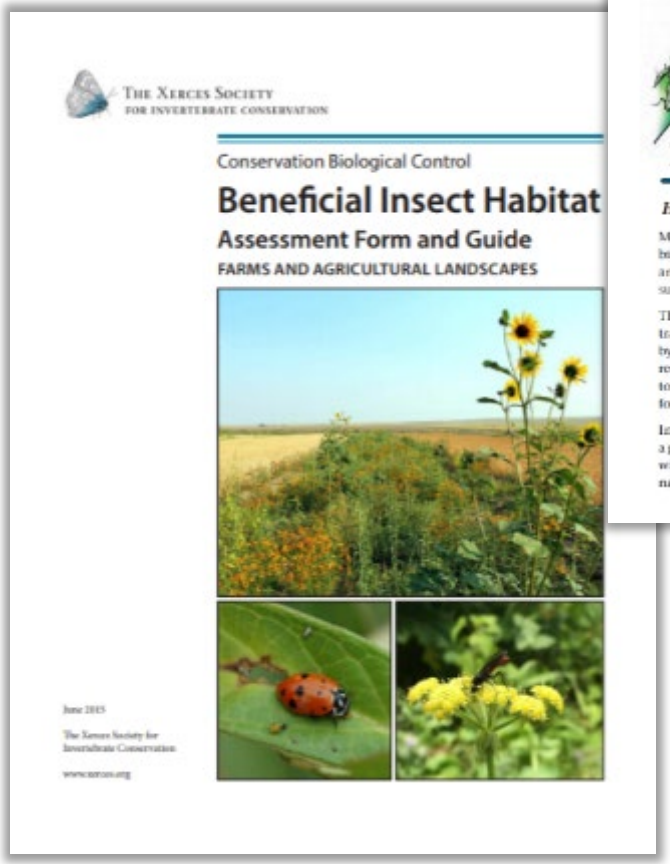
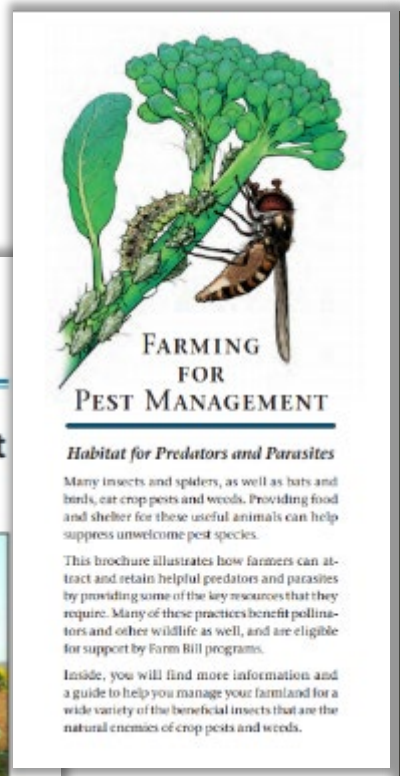
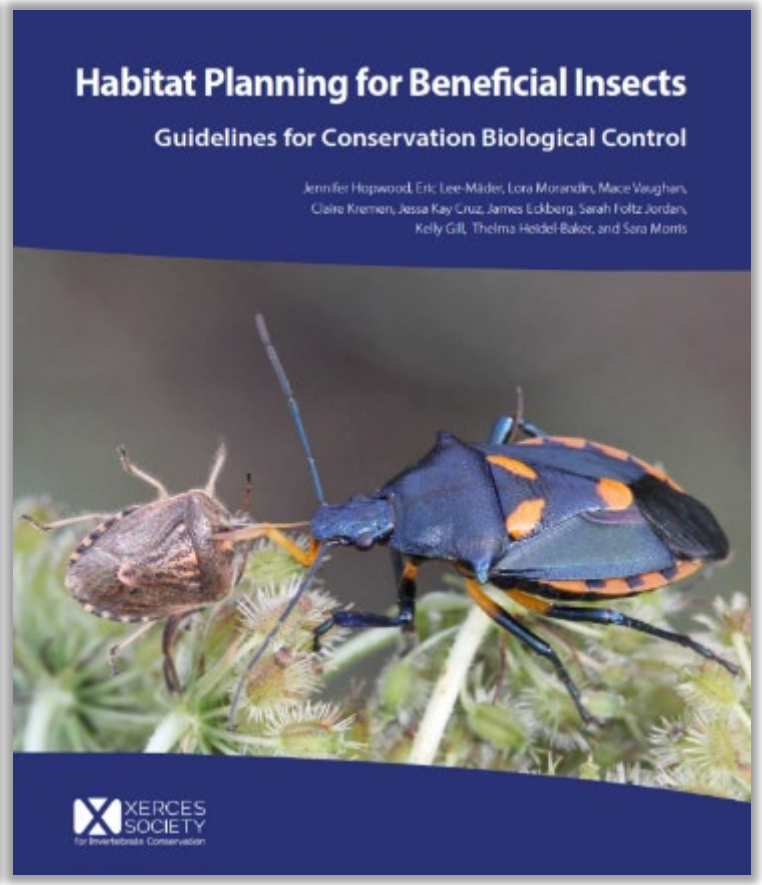
Resources from Xerces Society







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Beneficial insect scouting guides

BENEFICIAL INSECTS FOR NATURAL PEST CONTROL:

Soil Scouting

PURPOSE

Beneficial insects like predatory ground beetles and spiders can provide important natural pest control in a farm or garden setting. This guide and worksheet is designed to help you assess the presence of predatory organisms that hunt and rest on soils. Using catch-and-release pitfall traps, you will be able to easily detect and count these soil-surface predators. Use this guide along with our flower and foliage scouting guides to gain a better understanding of the beneficial insect community on your farm.

WHAT YOU NEED	• Clipboard , worksheet copy, and pen/pencil • Small spade or trowel • Containers for pitfall traps (e.g., plastic drinking cups or large yogurt containers, ideally with lids) • Flags or stakes (to mark trap locations)
WHERE TO USE	Undisturbed habitats adjacent to crops (e.g. field borders, hedgerows, woodland edges) or within crops (e.g. cover crops, beetle banks, insectary strips). Scouted habitat areas should be located in full sun and protected from pesticide applications.
WHEN TO USE	Twice per year, July-September • Visits separated by at least 1 month • Deploy pitfall traps in early evening • Empty traps as soon as possible the next morning Warm conditions with daytime temperatures >60 °F (15.5 °C) Avoid sampling in rainy conditions that may flood traps

HOW TO SCOUT

You will be setting out catch-and-release pitfall traps (see photo, right) to observe and record soil-surface predators. The number of traps you will set out is dependent on the number of habitat areas you are interested in monitoring. We recommend one or two pitfall traps per habitat feature of interest, placed at least 50 ft. apart (further apart in larger habitat areas).

- **Select habitat area(s) you want to monitor.**
- **Deploy traps in late afternoon or early evening.** Dig an appropriate-sized hole in each location you wish to survey. Place container (lidded if possible) inside the hole so that its rim is level with the soil surface. (Using lid prevents dirt from spilling into bottom of the trap, and a dirt-free container makes trap evaluation easier the next morning.) Once the container is well-positioned, fill dirt in around the container and carefully remove the lid.
- **Use flags or stakes to mark trap locations.** Mark trap locations to ensure you can find traps again the next morning.
- **Revisit traps the following morning.** Use provided worksheet to record any predators in traps. Use photos at right for guidance on commonly caught predators.
- **Remove trap, or place lid on the trap (if reusing).** The stake/flagging should be left in place for the next survey date. Traps can be left in place, but must be covered to prevent further captures during the interim period. If farm practices (like mowing) prevent use of physical markers in some habitat areas, then a detailed description of trap locations is needed.

Acknowledgments: Guide created by Thelma Heidel-Baker, Sarah Foltz Jordan, Jarrod Fowler, and Eric Lee-Mader of The Xerces Society. All photos taken by Sarah Foltz Jordan.

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BENEFICIAL INSECTS FOR NATURAL PEST CONTROL:

Foliage Scouting

PURPOSE

Beneficial insects like lady beetles, damsel bugs, and lacewing larvae can provide important natural pest control in a farm or garden setting. This guide and worksheet is designed to help you assess the beneficial insects present - though not always readily visible - in plant vegetation. Many beneficial insects hunt and rest in plant vegetation. Using a simple tool called a beat sheet, you will be able to count the foliage-dwelling predatory insects in habitat adjacent to crops. Use this guide along with our flower and soil scouting guides to gain a better understanding of the beneficial insect community on your farm.

WHAT YOU NEED	• Beat sheet (blank sheet of paper) • Clipboard (for beat sheet and worksheet) and pen/pencil • Timer • Measuring tape (100-ft. preferred, shorter ok) • Flags or stakes (to mark transect lines) • Thermometer (or means to collect weather info) • Hand lens (optional)
WHERE TO USE	Undisturbed habitats adjacent to crops (e.g. field borders, hedgerows, woodland edges) or within crops (e.g. cover crops, beetle banks, insectary strips). Scouted habitat areas should be located in full sun and protected from pesticide applications.
WHEN TO USE	Twice per year, June-September • Visits separated by at least 2 to 3 weeks • Visits between 10:00 AM and 3:00 PM Warm and calm conditions • Temperatures >60 °F (15.5 °C) • Skies sunny to partly cloudy or bright, but overcast

HOW TO SCOUT

You will use an insect beat sheet (see image, right) to observe beneficial insects on plant foliage along two 100 ft.-length transect lines (scouting paths). Observations will occur for 7.5 minutes along each 100 ft. transect. Smaller habitat areas may require a transect line to be divided into shorter lengths.

- Select the habitat area(s) you want to monitor, and lay out the measuring tape to define your transect lines. Use flags to mark the transects if needed.
- Set your timer for 7.5 minutes and ready your beat sheet and worksheet. Begin your timer and slowly move along the transect line, using the beat sheet as you go.
- To use the beat sheet, choose a handful of stems near the top of herbaceous plants or ends of branches on woody plants then carefully bend the plant material over the insect beat sheet. Smartly tap the plant material onto the beat sheet several times to shake insects out of the vegetation.
- Quickly and briefly observe insects on the sheet. Record observations of beneficial insects onto the worksheet. Use images to the right as a starting point for common beneficial insects you may observe.
- Only plants within 3 ft. of the transect line should be sampled.
- Try to pace all transect walks to end simultaneous with the timer. If timer ends before you complete a transect, quickly assess the remaining transect left.

Acknowledgments: Guide created by Thelma Heidel-Baker, Sarah Foltz Jordan, Jarrod Fowler, and Eric Lee-Mader of The Xerces Society. All photos taken by Thelma Heidel-Baker.

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BENEFICIAL INSECTS FOR NATURAL PEST CONTROL:

Flower Scouting

PURPOSE

Beneficial insects like flower flies, soldier beetles and predatory wasps can provide important natural pest control in a farm or garden setting. This guide and worksheet is designed to help you assess the presence of beneficial insects visiting flowers in a farmscape. Many predatory and parasitoid insects use flowers for food. With this guide, you will be able to count these flower-visiting beneficial insects in habitat adjacent to crops. Use this guide along with our foliage and soil scouting guides to gain a better understanding of the beneficial insect community on your farm.

WHAT YOU NEED	• Clipboard, worksheet copy, and pen/pencil • Timer • Measuring tape (100-ft. preferred, shorter ok) • Thermometer (or means to collect weather info) • Flags or stakes (to mark transect lines) • Hand lens (optional)
WHERE TO USE	Flowering habitats adjacent to crops (e.g. field borders, hedgerows) or within crops (e.g. cover crops, beetle banks, insectary strips). Scouted habitat areas should be located in full sun and protected from pesticide applications.
WHEN TO USE	Twice per year , May – August • Visits separated by at least 2 to 3 weeks • Visits between 10:00 AM and 3:00 PM Warm, sunny, and calm conditions • Temperatures >60 °F (15.5 °C) • Skies sunny to partly cloudy or bright but overcast

HOW TO SCOUT

You will be conducting visual observations of insects on flowers along two 100 ft.-length transect lines (scouting paths) for 7.5 minutes per transect line. A transect line may be divided into shorter lengths for small habitat areas (see worksheet for more info). Before scouting, assess habitat area(s) to ensure that flowers are present to scout.

- Lay out measuring tape to define your transect lines. Use flags to mark them if needed.
- Set your timer for 7.5 minutes and ready your clipboard and worksheet.
- Begin your timer and slowly walk the designated transect line, observing and recording foraging flower visitors. Focus on beneficial insects listed (see photos to right). Record only those beneficial insects observed within a 3 ft. distance from the transect line.
- Walk slowly while scouting for insects. Avoid sudden movements and visual interference from your shadow that may scare off insects.
- Pace all transect walks to end simultaneous with the timer. If timer ends before you complete the entire transect distance, quickly assess the remaining length.
- *Consistency is key for good scouting!* When scouting between transects and scouting dates, try to use the same methods as much as possible.

Acknowledgments: Guide created by Thelma Heidel-Baker, Sarah Foltz Jordan, Jarrod Fowler, and Eric Lee-Mader of The Xerces Society. Photos by Sarah Foltz Jordan (1, 2, 4) and Thelma Heidel-Baker (3, 5).

Adapted from: Ward, K., D. Carlevaro, E. May, M. Foxwell, N. Vaughan, N. Williams, R. Winfree, R. Isaacs, and K. Gill. 2014. Streamlined bee monitoring protocol for assessing pollinator habitat. 15 pp. Portland, OR: The Xerces Society.

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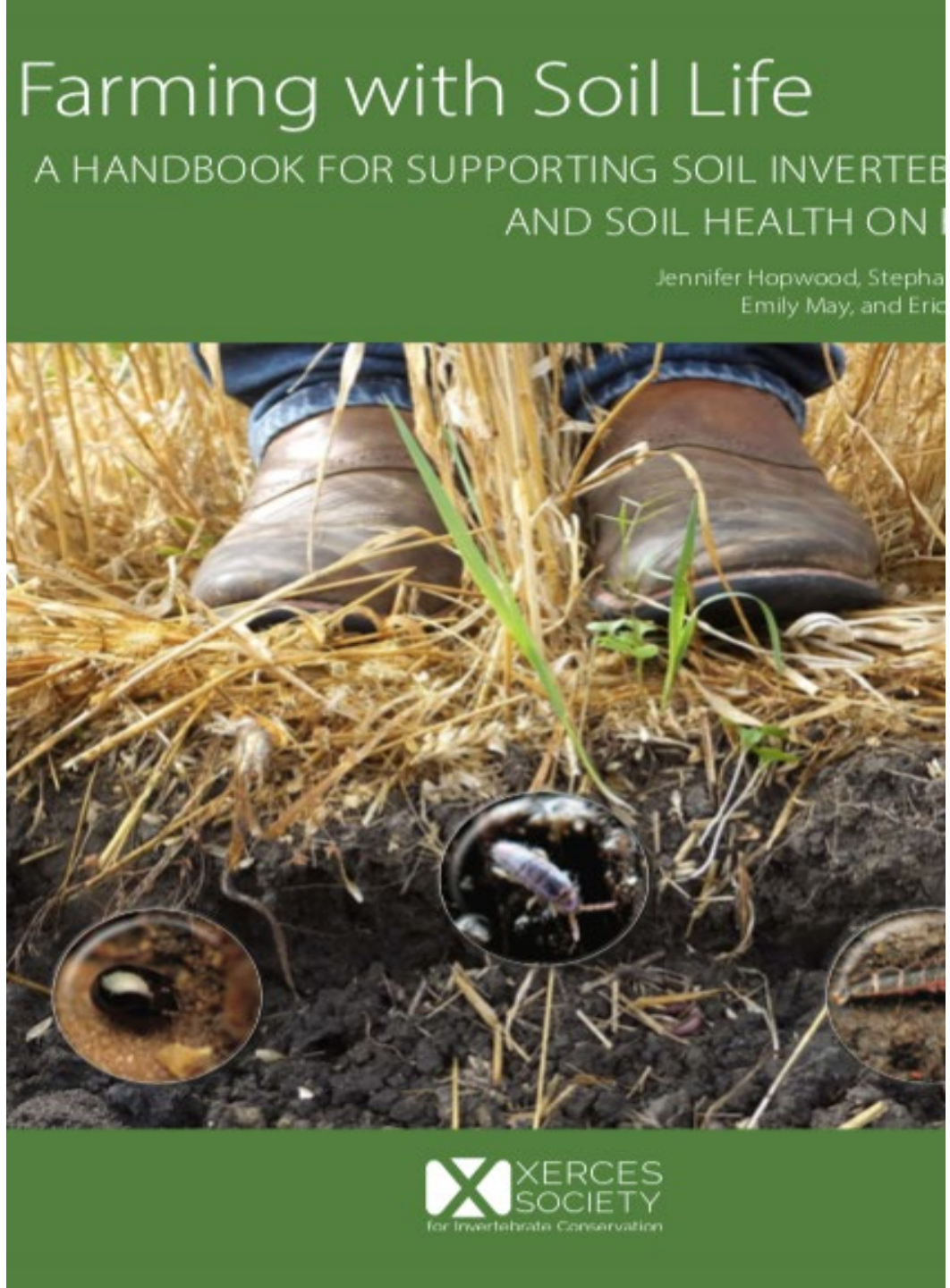

Farming with Soil Life

Handbook

https://xerces.org/publications/guidelines/farming-with-soil-life

Online short courses starting in April 2021

https://www.xerces.org/events

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Photo: Rusty patched bumble bee, © Clay Bolt

Acknowledgements

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Photo: J. Wheeler

Final Thoughts

“Essentially, all life depends on the soil ... There can be no life without soil and no soil without life; they have evolved together. ”— Charles E. Kellogg, USDA Yearbook of Agriculture, 1938

Photo: Scarab-hunting wasp, Jennifer Hopwood

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OPEN QUESTION #2, please reply in the CHAT

What particular practices have you implemented or seen implemented to support soil life?

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Spotlight on Soil Life

Photo: Andy Murray

"The soils of our yards, gardens, and fields swarm with thousands of kinds of minute animals and plants of which we know little or nothing. We depend on the soil for our very existence, yet…this soil we daily tread under foot is almost a veritable terra incognita."

NA Cobb, 1914 Yearbook of Department of Agriculture

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