Invertebrate Soil Life

Get The Dirt:
Urban and Small Farm Soil Health Conference
16 October 2024

Stephanie Frischie,
Agronomist and Plant Ecologist

NORTH CENTRAL SARE
Sustainable Agriculture Research & Education

NRCS
Natural Resources Conservation Service

xerces.org

Photo: Jennifer Hopwood/The Xerces Society

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The Xerces Society

The Xerces Society for Invertebrate Conservation protects the natural world through the conservation of invertebrates and their habitats

Programs

Endangered Species

Pollinator Conservation (habitat with government and private sector partners)

Pesticide Reduction and Mitigation

Outreach and Education

Communications

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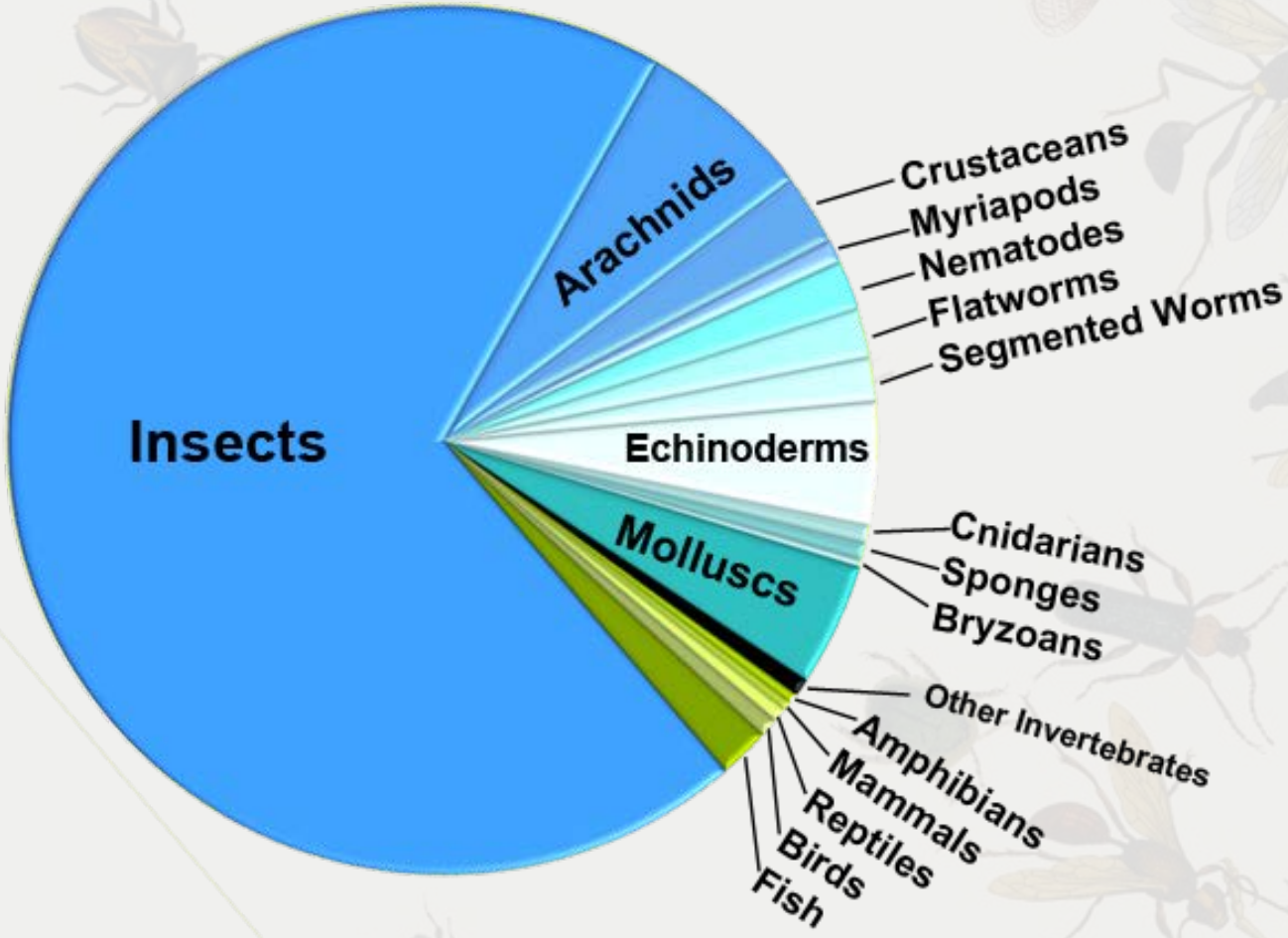
Invertebrate conservation is a priority!



There are about **2,130,000** described species on Earth (fungi, plants, invertebrates, vertebrates)

~ 70% of all described species are invertebrates (1,500,000 species)

95% of animal species are invertebrates

Graphic: Illinois Natural History Survey. Background illustration: The New York Times.

The fate of the world's insects is inseparable from our own

Soil health, pest control, ecological function, crop pollination…

Nutrient cycling and decomposition	Manage pest populations	Turn plants into food for other animals	Help plants reproduce
			

Photos: (left to right): Magnus Robinson; USDA ARS Scott Bauer; Marcel Holyoak via flickr; Sarah Foltz-Jordan / Xerces Society. Quote from NYT Editorial Insect Armageddon October 29, 2017

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Global disappearance of insects

Insect biomass declined by 76% in German nature reserves, between 1986 and 2016.

Hallmann, et al. 2017. More than 75 percent decline over 27 years in total flying insect biomass in protected areas. PLoSOne.https://doi.org/10.1371/journal.pone.0185809.

Photo: Alex Wild

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Image: “Subterranean Environment” by Charley Harper. The Giant Golden Book of Biology, 1961.

What about soil invertebrates?

“For instance, soil invertebrates and soil-dwelling larval stages of flying insects, which represent a major biodiversity pool in terrestrial ecosystems, have been woefully neglected in many biodiversity databases and assessments, as well as in conservation actions and policies.”

Eisenhauer *et al.* 2019. Recognizing the quiet extinction of invertebrates. Nat Commun 10:50.

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Image: “Subterranean Environment” by Charley Harper. The Giant Golden Book of Biology, 1961.

What about soil invertebrates?

“Given that a major fraction of invertebrates lives below the ground, and considering their significant functional role, biodiversity monitoring urgently needs to include soil organisms and functions.”

Eisenhauer *et al.* 2019. Recognizing the quiet extinction of invertebrates. Nat Commun 10:50.

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Connecting with soil invertebrates

Many insects that we see above-ground live in the soil for part of their life cycle

Fireflies, ground-nesting bees, and some beetle species

More on this later…

Photo: Stephanie Frischie/Xerces

Firefly larva. Photo by Jennifer Hopwood

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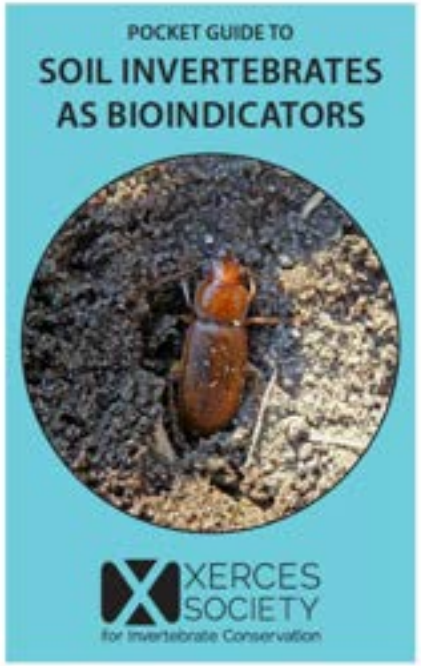
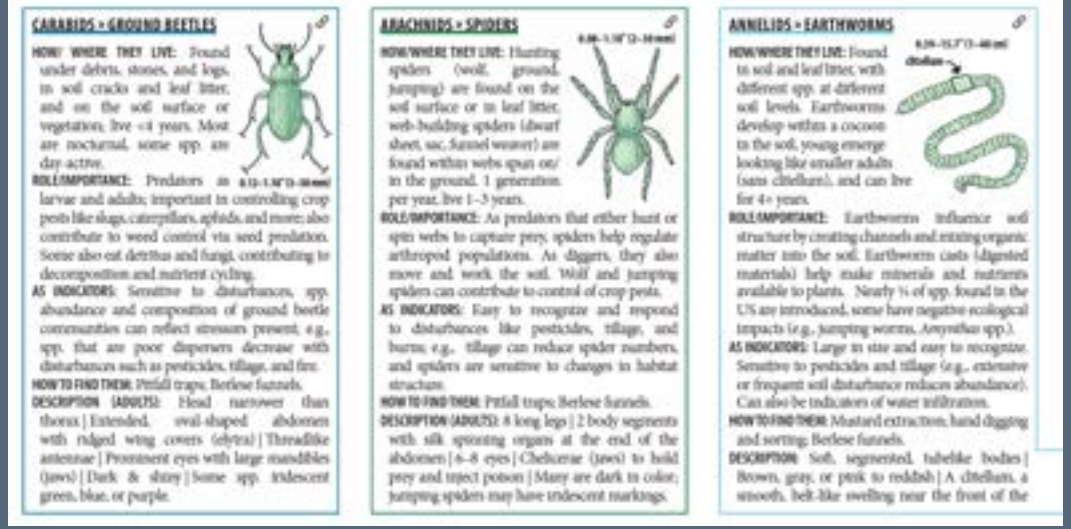
Soil Life Publications

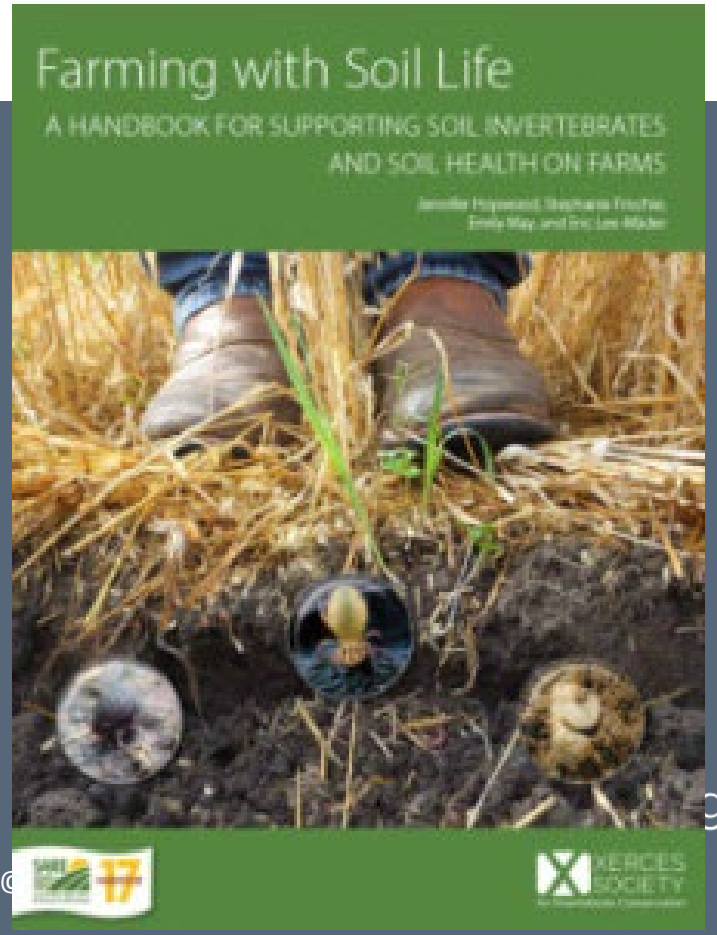


Xerces.org/soil life

Sare.org

Xerces YouTube Channel: Farming with Soil Life Online Short Course





Soil's Magnificence

Functions

Habitat for plants, microbes, animals	Water-supply regulation and filtration	Recycling and storage of organic matter (carbon)	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

Not soil

Soil: mineral particles, living plants and animals, dead plants and animals, structure, horizons, intact, in place

Soil material: disturbed, removed, ~isolated, less alive

dirt/debris, not alive

Soil profile: flickr/Soil Science (CC BY 2.0 DEED). Pile of top soil: Russel Wills (CC BY-SA 2.0 DEED). Dirt in dust pan: flickr/Lena (CC BY-SA 2.0 DEED)

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Soil is Full of Life

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

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

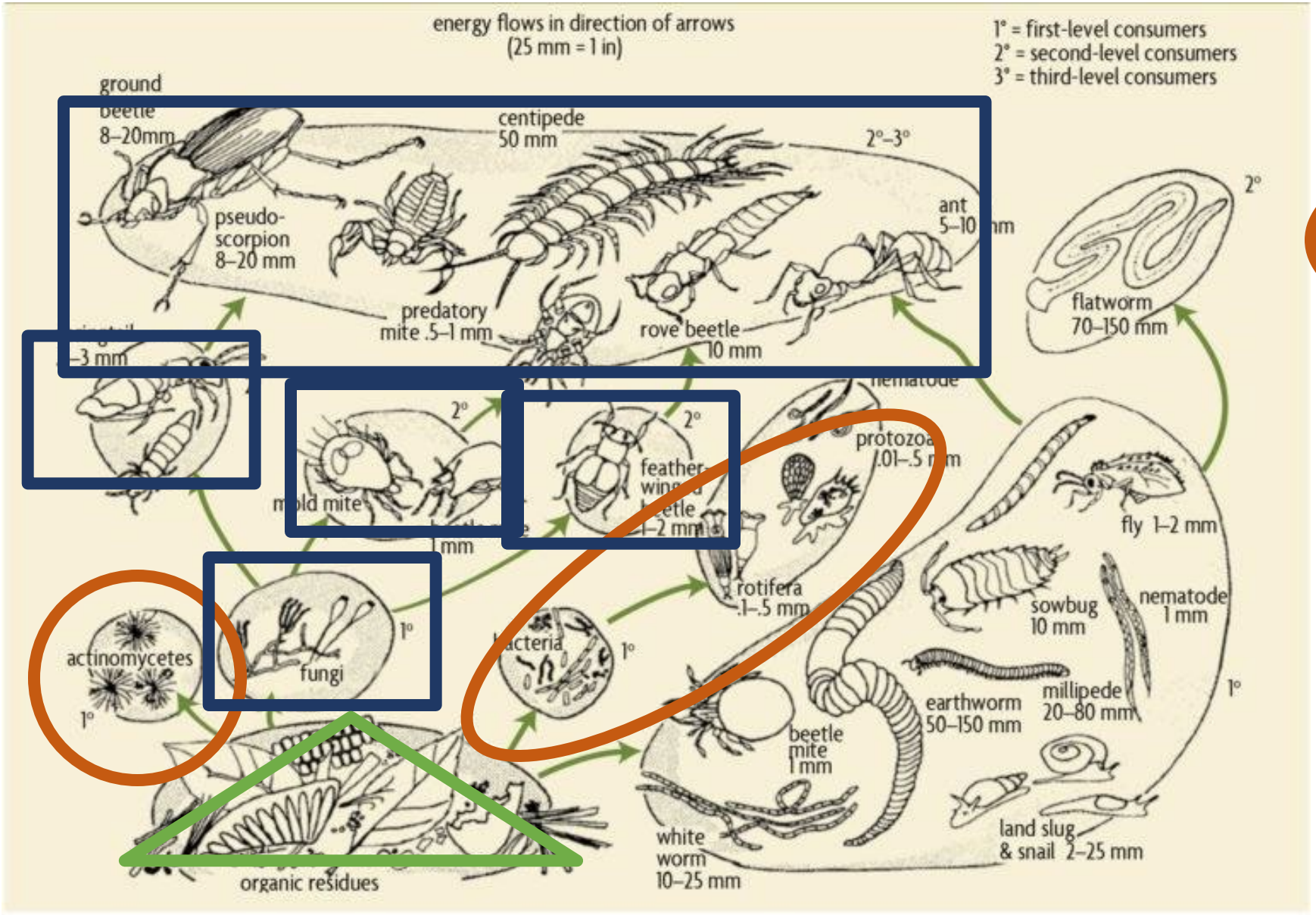

Figure 4.1. Soil organisms and their role in decomposing residues. Modified from D.L. Dindal (1972).

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Soil Formation (Pedogenesis)

Photo: cisc1970/flickr, CC

Five Factors

Parent material

Organisms

Climate

Topography

Time

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Soil Formation (Pedogenesis)

Six ~~Five~~ Factors

- Parent material
- Organisms
- Climate
- Topography
- Time
- Human influence

Photo: World Reference Base for Soil Resources (WRB), International Union of Soil Sciences (IUSS)

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Anthropogenic Soils: formed under human influence

Anthrosols

"human-altered" over 1000s-100s of years

- Hortic (garden)
- Irragric (water management)
- Plaggic (manure)

Technosols

"artefacts"

- Urbic (residential)
- Ekranic (sealed, paved)
- Isolatic (isolated – roof or container)
- Spolic (mine, rubble)

References: World Reference Base for Soil Resources (WRB), International Union of Soil Sciences (IUSS); Peter Schad (2018) Technosols in the World Reference Base for Soil Resources – history and definitions, Soil Science and Plant Nutrition, 64:2, 138-144, DOI: 10.1080/00380768.2018.1432973

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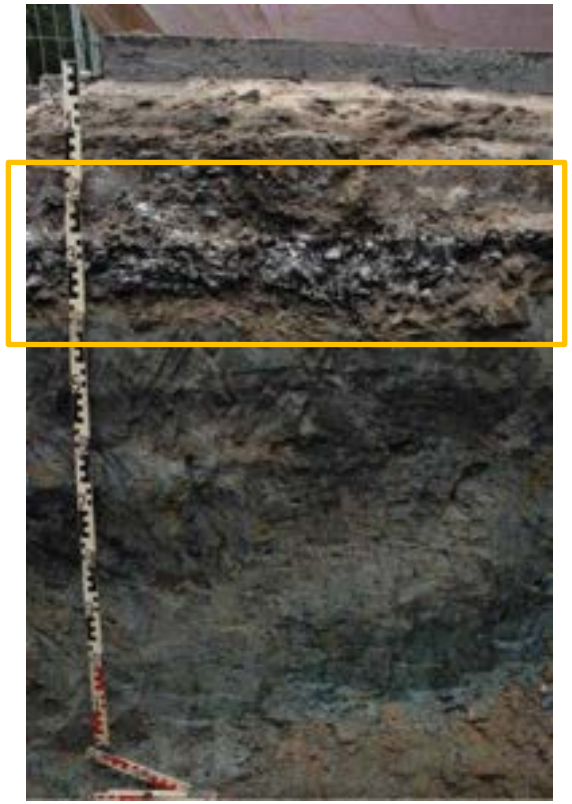
Technosols

Ekranic Technosol



Isolatic Technosol

Technosols

"artefacts" –anything human-made

- Urbic (residential)
- Ekranic (sealed, paved)
- Isolatic (isolated – roof or container)
- Spolic (mine, rubble)

References: World Reference Base for Soil Resources (WRB), International Union of Soil Sciences (IUSS); Peter Schad (2018) Technosols in the World Reference Base for Soil Resources – history and definitions, Soil Science and Plant Nutrition, 64:2, 138-144, DOI: 10.1080/00380768.2018.1432973
Photos: Ekranic Technosol: Peter Schad. Green roof and Isolatic Technosol: Bouzouidja, R., Rousseau, G., Galzin, V. *et al.* Green roof ageing or Isolatic Technosol's pedogenesis?. *J Soils Sediments* 18, 418–425 (2018). https://doi.org/10.1007/s11368-016-1513-3

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Urban Soils, natural or anthropogenic

Possible influences on soil life

- Contamination: heavy metals, PFAS, pesticides, microplastics, road salt
- Cultivated plant diversity: farms, food/flower gardens, pollinator plantings, turf, greenspaces
- Non-cultivated plant diversity: early-successional vegetation
- Soil amendments: media, fertilizers, compost
- Soil management: mulch, soil fabric, tillage, raised beds
- Water: Irrigation, altered hydrology, stormwater, flood plains
- Vertebrate animals: urban wildlife, pets, livestock
- Invertebrate animals: wild, pests, and introduced
- Invasive species (plants, animals)
- Edge effects
- ALAN (artificial light at night)

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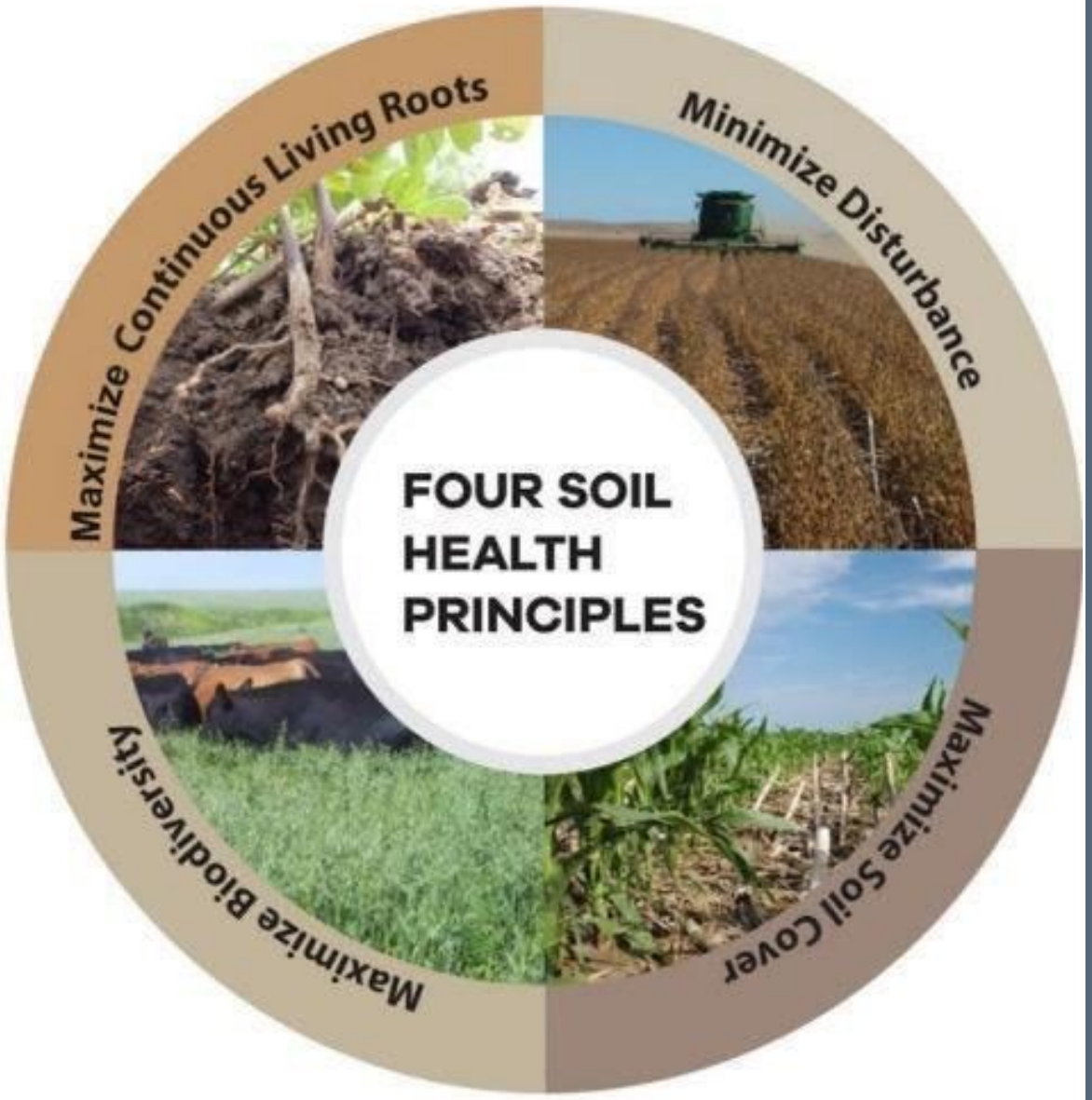

Figure: NRCS

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.

Healthy soil is living soil.

Protect the soil

- Minimize disturbance (physical and chemical)
- Maximize soil cover

Feed the life in soil

- Maximize continuous living roots
- Maximize biodiversity

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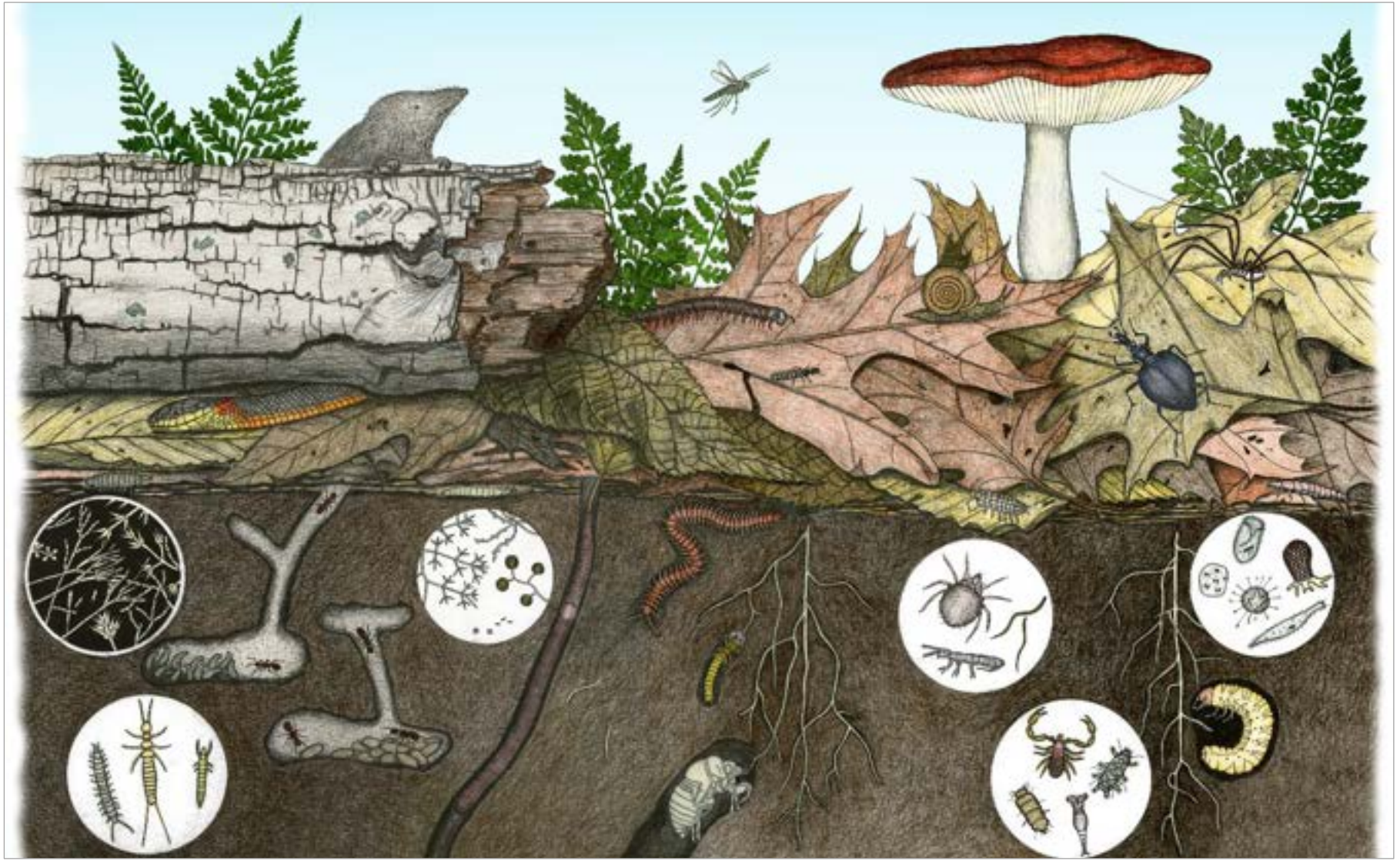
Soil is Full of Life



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

Illustration: Life in the Soil, Dr. Jim Nardi

Source: Decaëns et al. 2006

Ecological Roles of Soil Animals:
Decomposition

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

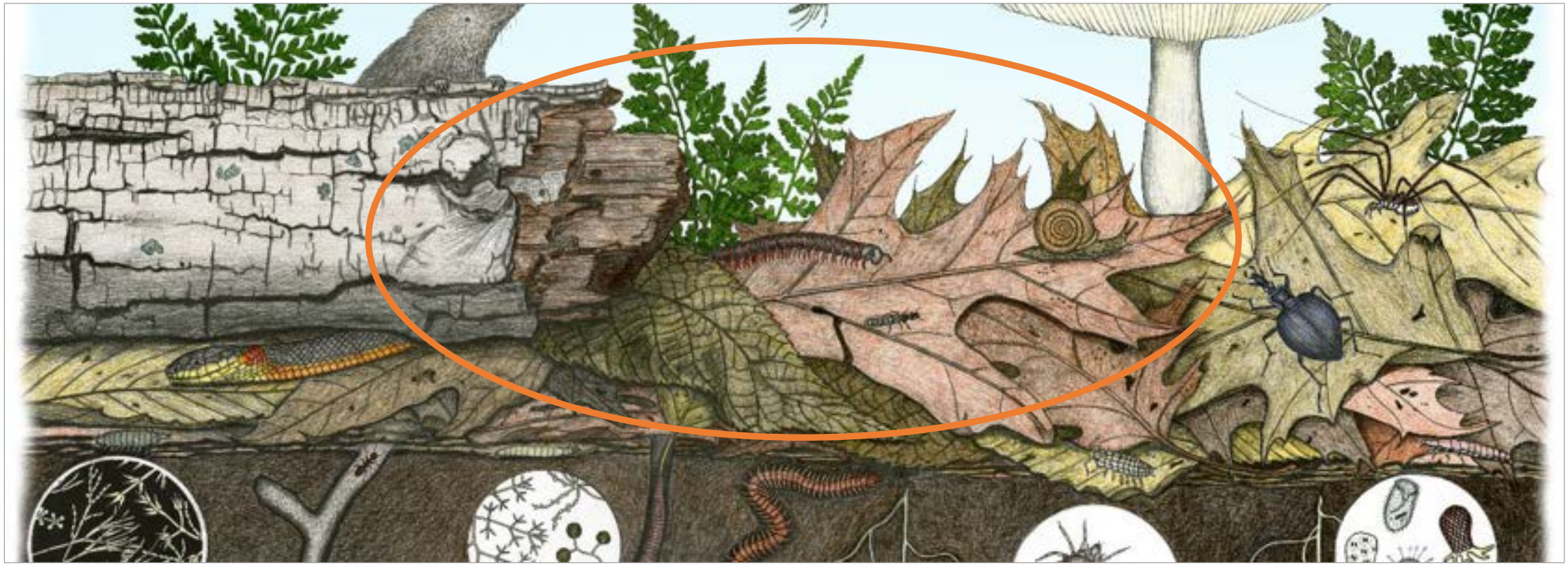


Illustration: Life in the Soil, Dr. Jim Nardi

Ecological Roles of Soil Animals:
Enrich soil

Enrich soil by integrating nutrients

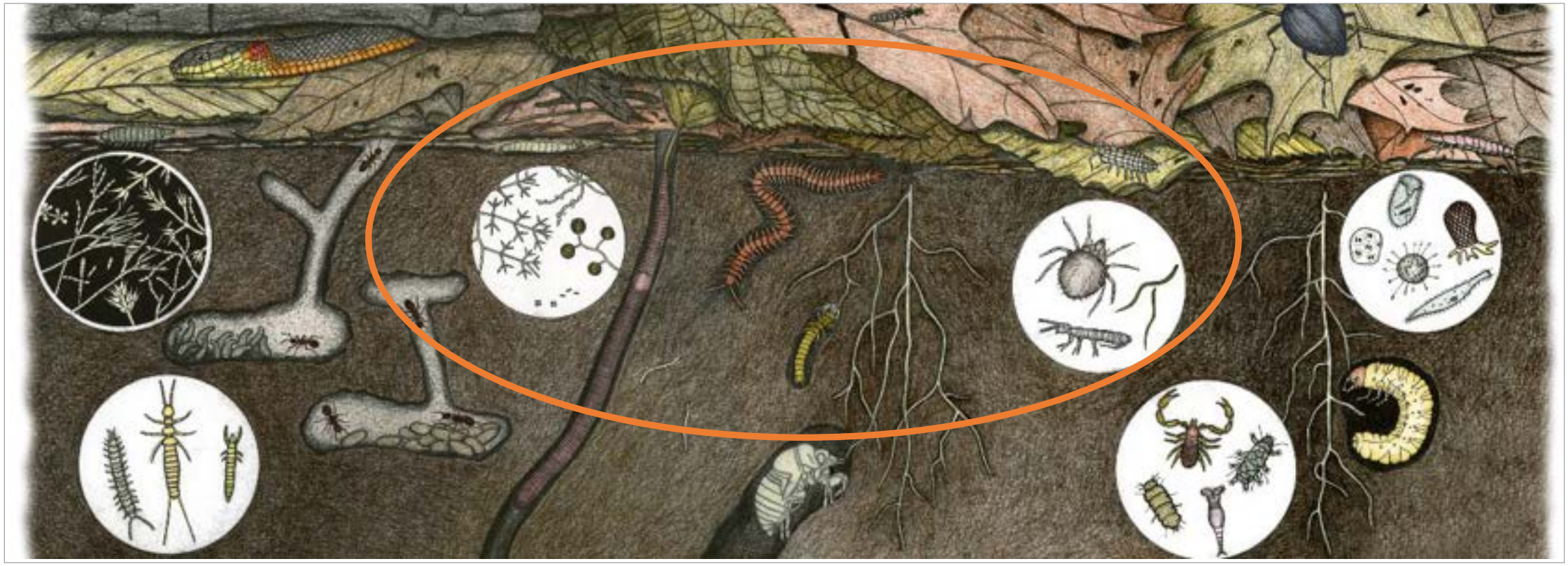


Illustration: Life in the Soil, Dr. Jim Nardi

Ecological Roles of Soil Animals:
Soil Engineers

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

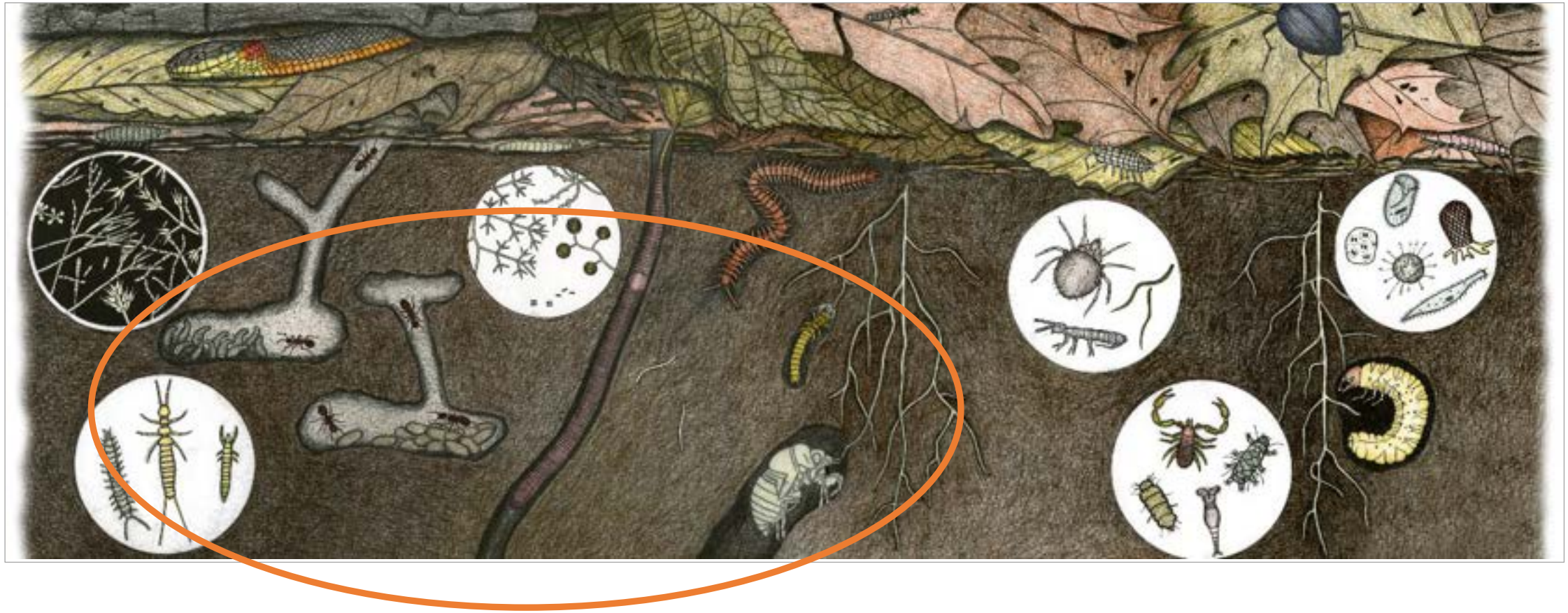


Illustration: Life in the Soil, Dr. Jim Nardi

Ecological Roles of Soil Animals:

Influencing Microbes

Disperse microbes throughout soil layers, make nutrients more accessible to microbes, alter microbe communities through predation

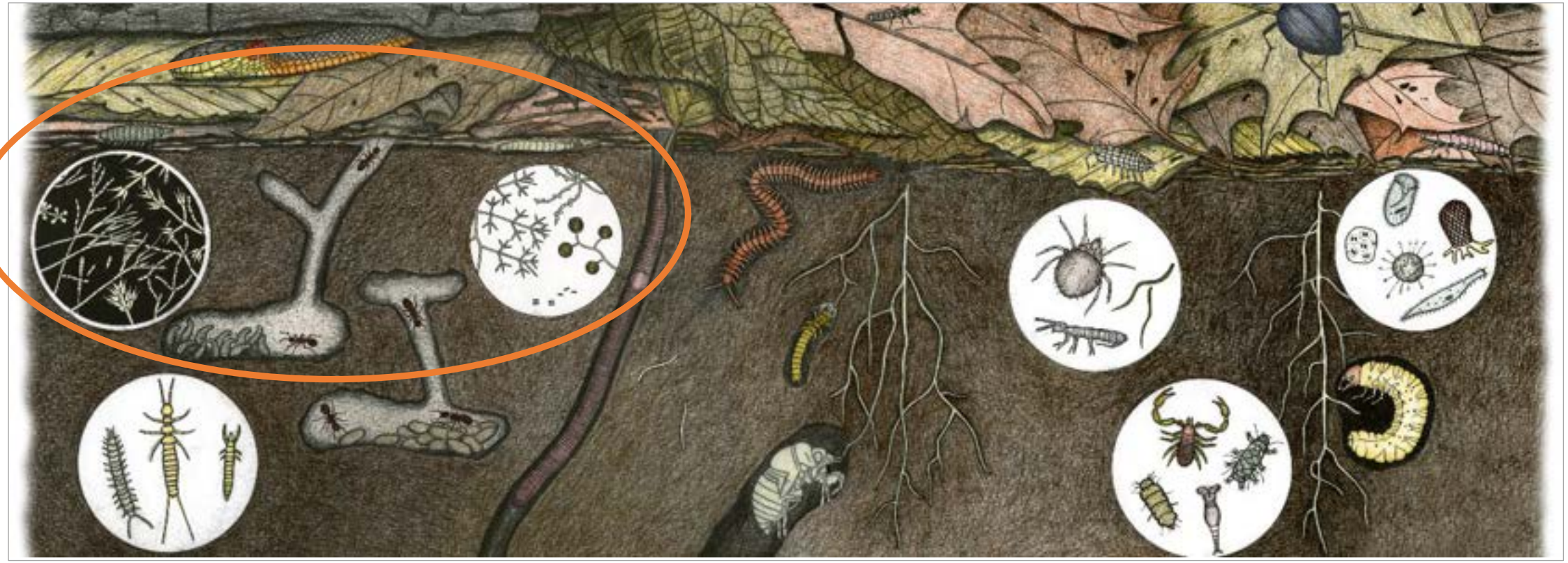
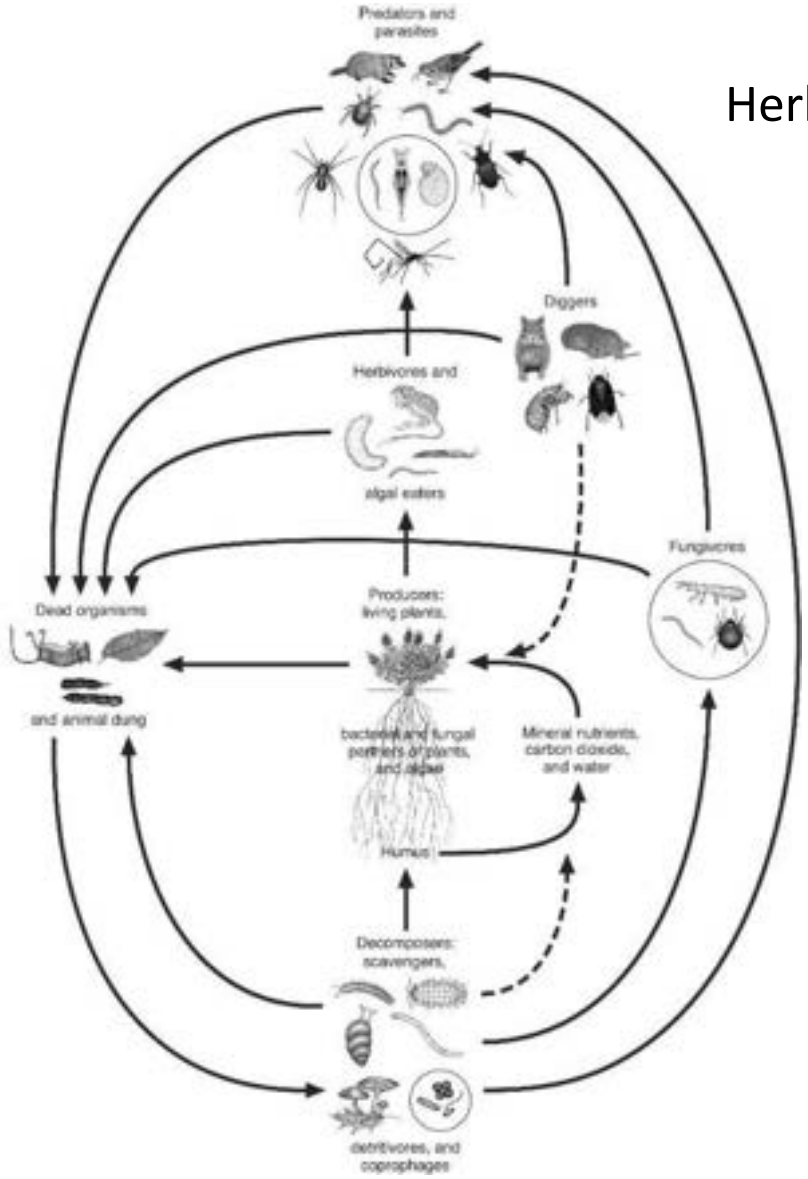


Illustration: Life in the Soil, Dr. Jim Nardi

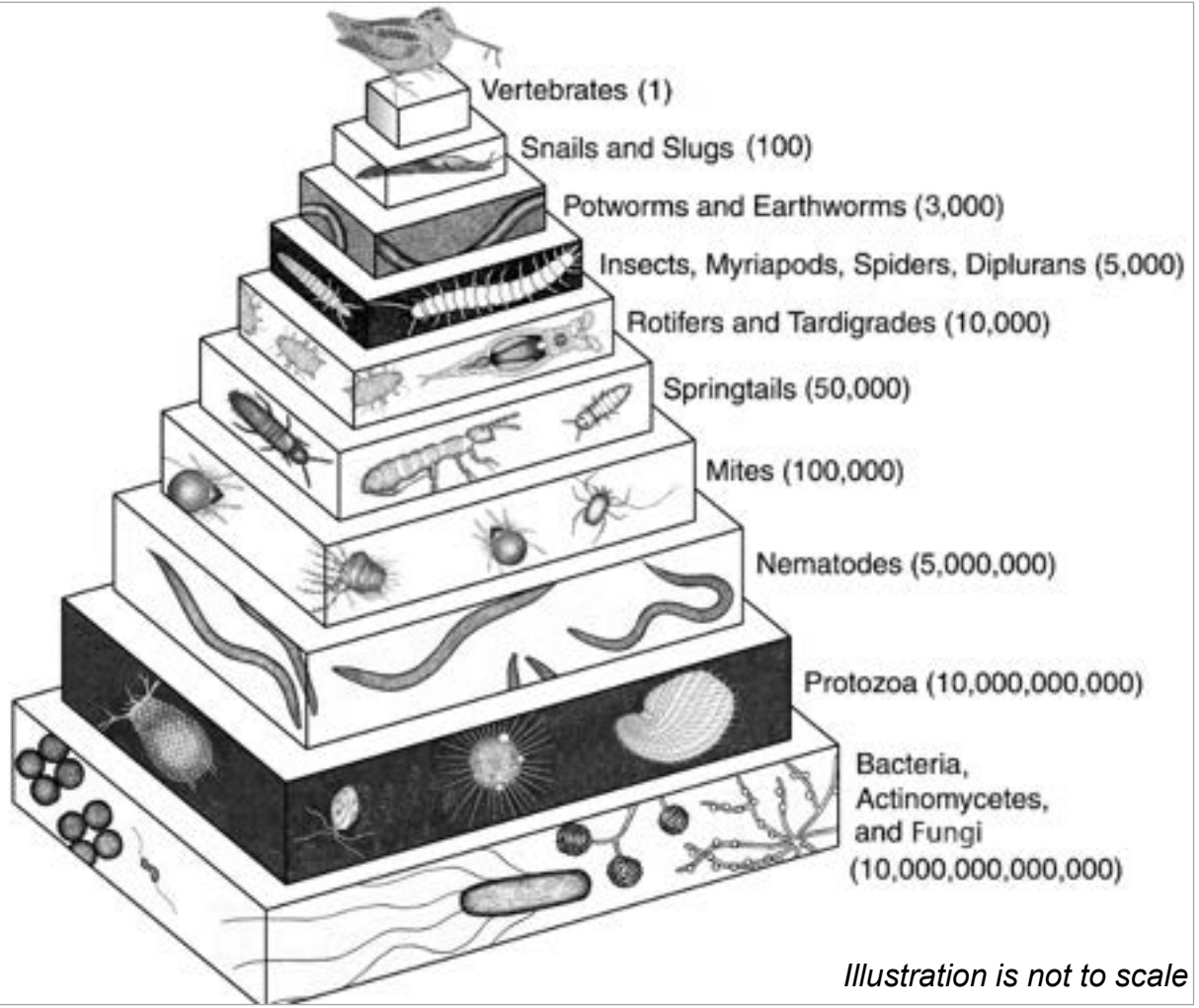
Ecological Roles of Soil Animals:
Food Webs



Herbivores, fungivores, bacterivores, predators, parasitoids, pollinators

Illustration: Life in the Soil, Dr. Jim Nardi; Photos: Jeff Gruber, Jennifer Hopwood, Sarah Foltz Jordan

Soil Life: Large and Small



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Conceptual illustration by Dr. James Nardi, Life in the Soil, Photos: Candy Thomas; Flickr/Specious Reasons; Flickr/Philippe Garcelon

Mites

Mesostigmata, Oribatida

Agricultural / Ecological role: Critical decomposers; some are predatory; help disperse bacteria and fungi

Where they live: Soil surface, within soil layers, and in deep soil

Of note: Mite communities vary with soil type; mites can travel by hitching rides on insects

Photos: Brenda Dobbs; Even Dancowitz

Springtails

Entomobryidae, Sminthuridae, more

Agricultural / Ecological role: Decomposers of decaying plants, fungi; some also eat bacteria, rotifers, nematodes, other springtails

Where they live: Leaf litter, decaying logs, fungi, soil surface; within soil layers

Of note: The rates at which springtails consume fungi or bacteria can stunt or stimulate microbial growth

Photos: Brenda Dobbs/Flickr; Andy Murray

Woodlice

Isopoda

Agricultural / Ecological role:

Decomposers of fresh plant debris and detritus

Where they live:

Soil surface, leaf litter, under logs and stones

How to distinguish:

- Pillbugs can roll into a ball, sowbugs have two appendages on end of body

Of note:

- Terrestrial crustaceans
- 1/3 of species in US are introduced; native species are most diverse in the south, along shores, in caves
- Accumulate heavy metals within their bodies

Photos: Charley Eiseman; Brenda Dobbs

Photos: Robert Lord Zimich; D.Fletcher/Flickr

Millipedes

Agricultural / Ecological role:

Decomposers, scavengers; particularly important in decaying plant decomposition

Where they live:

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

Of note:

- Powerful diggers, excavating deep tunnels
- Long lived

Ground Beetles
Carabidae

Agricultural / Ecological role: Predators of snails, slugs, caterpillars, grasshoppers, beetles, flies, more; important in biocontrol; some also decomposers or eat weed seeds

Where they live: Soil, leaf litter; overwinter in clumps of bunch grasses

Of note: One generation a year, live up to four years; guard their young
Ground beetle communities can be associated with plant communities

Photos: Sarah Foltz Jordan; Jean and Fred/Flickr

Spiders

Lycosidae, Salticidae, Gnaphosidae

Agricultural / Ecological role: Predators of other arthropods and can contribute to the control of crop pests; move and work the soil

Where they live: Soil surface, leaf litter; in webs; overwinter in permanent habitat

Of note: Hunting spiders are most visible but web builders are important too
Spiders can be long lived; can take some time to recover from disturbances


Jumping spider


Wolf spider


Ground spider

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

Earthworms

Agricultural / Ecological role:

- Alter soil properties by improving soil structure for better aeration, water intake, and water transmission; accelerate decomposition and improve nutrient availability to plants
- Some introduced species deplete leaf litter and do not mix nutrients within soil layers

Where they live:

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

Of note:

Earthworms native to North America are found in eastern states or Pacific coast states

Nightcrawler: *Lumbricus*

Red wiggler: *Eisenia foetida*

Photos: Schizoform/Flickr; kompostladen.de/Flickr

Annelida: Oligochaeta

Jumping worms (*Amynthas species)*

What to look for:

- Jumping worms have clitellum that encircles the whole body and is white/cream in color
- Behavior: jump or thrash wildly
- Grainy casts, soil like dried coffee grounds

Where found in the US now:

- Maine to Florida, west to eastern Nebraska, Oklahoma, Texas; recently reported in Washington, Oregon, California
- Use mustard extraction to sample

Prevention:

- Do not release worms used for bait or vermicomposting
- Be careful when sharing or moving compost and plants if you have JW
- Clean equipment, vehicles between sites to prevent spread

Photos: Schizoform/Flickr; Susan Day/UW Arboretum

Fireflies: Jewels of the Night

Photos: Jessica Lucia, Flickr; Jennifer Hopwood

Pollinators and Soil

Mace Vaughan; Betsy Betros; Whitney Cranshaw; Jim Cane; Jennifer Hopwood; Jonny Dell, Bugwood.org

Pitfall traps

DYI pitfall trap by Mnolf/Wikimedia Commons-CC.
Dung beetle pitfall traps by Combita et al. 2020. Experimental and Applied Acarology.

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Compare by season, vegetation, management

Photos: Sarah Foltz Jordan/The Xerces Society

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

SOIL SCOUTING WORKSHEET

XERCES SOCIETY for Invertebrate Conservation

Site Name: _____ **Observer:** _____

Date Trap Deployed: _____ / _____ / _____ **Time:** _____ AM / PM

Date Trap Emptied: _____ / _____ / _____ **Time:** _____ AM / PM

Visit #: _____ of _____ **Temperature:** _____ °F **Skies (circle one):** Clear / Partly Cloudy / Bright Overcast

DIRECTIONS:
Conduct monitoring twice per year from July-September, with survey dates separated by at least one month. Deploy traps in the early evening and empty them the following morning. Avoid rainy or unusually cold conditions. We recommend one or two pitfall traps per habitat feature of interest (e.g., native field border, cover crop field, beetle bank, etc.). Take care to place each trap so that the rim is perfectly level with the soil surface. See protocol for further details.

Trap Number	Habitat Type (field border, cover crop, hedgerow, etc.)	Microhabitat (sandy soil, straw mulch, wood chips, etc.)	# Ground Beetles	# Ground-Dwelling Spiders	# Tiger Beetles	Notes
Trap 1						
Trap 2						
Trap 3						
Trap 4						
Trap 5						
Trap 6						

(Expand data sheet if additional traps are used.)

ADDITIONAL OBSERVATIONS (Habitat area details, plant species in bloom, etc.):

SOIL SCOUTING WORKSHEET

XERCES SOCIETY for Invertebrate Conservation

Site Name: Armstrong Acres

Observer: S. Frischie

Date Trap Deployed: 9 / 19 / 2020

Time: 7:20 AM (PM)

Date Trap Emptied: 9 / 20 / 2020

Time: 8:10 (AM) PM

Visit #: 1 of 1

Temperature: 68 °F

Skies (circle one): (Clear) / Partly Cloudy / Bright Overcast

DIRECTIONS:

Conduct monitoring twice per year from July-September, with survey dates separated by at least one month. Deploy traps in the early evening and empty them the following morning. Avoid rainy or unusually cold conditions. We recommend one or two pitfall traps per habitat feature of interest (e.g., native field border, cover crop field, beetle bank, etc.). Take care to place each trap so that the rim is perfectly level with the soil surface. See protocol for further details.

Trap Number	Habitat Type (field border, cover crop, hedgerow, etc.)	Microhabitat (sandy soil, straw mulch, wood chips, etc.)	# Ground Beetles	# Ground-Dwelling Spiders	# Tiger Beetles	Notes
Trap 1	conventional corn field		0	0	0	mostly springtails, a few ants
Trap 2	perennial grass roadside		0	0	0	a few field crickets
Trap 3	perennial flowering pasture		0	0	0	more field crickets than roadside
Trap 4						
Trap 5						
Trap 6						

(Expand data sheet if additional traps are used.)

Food webs

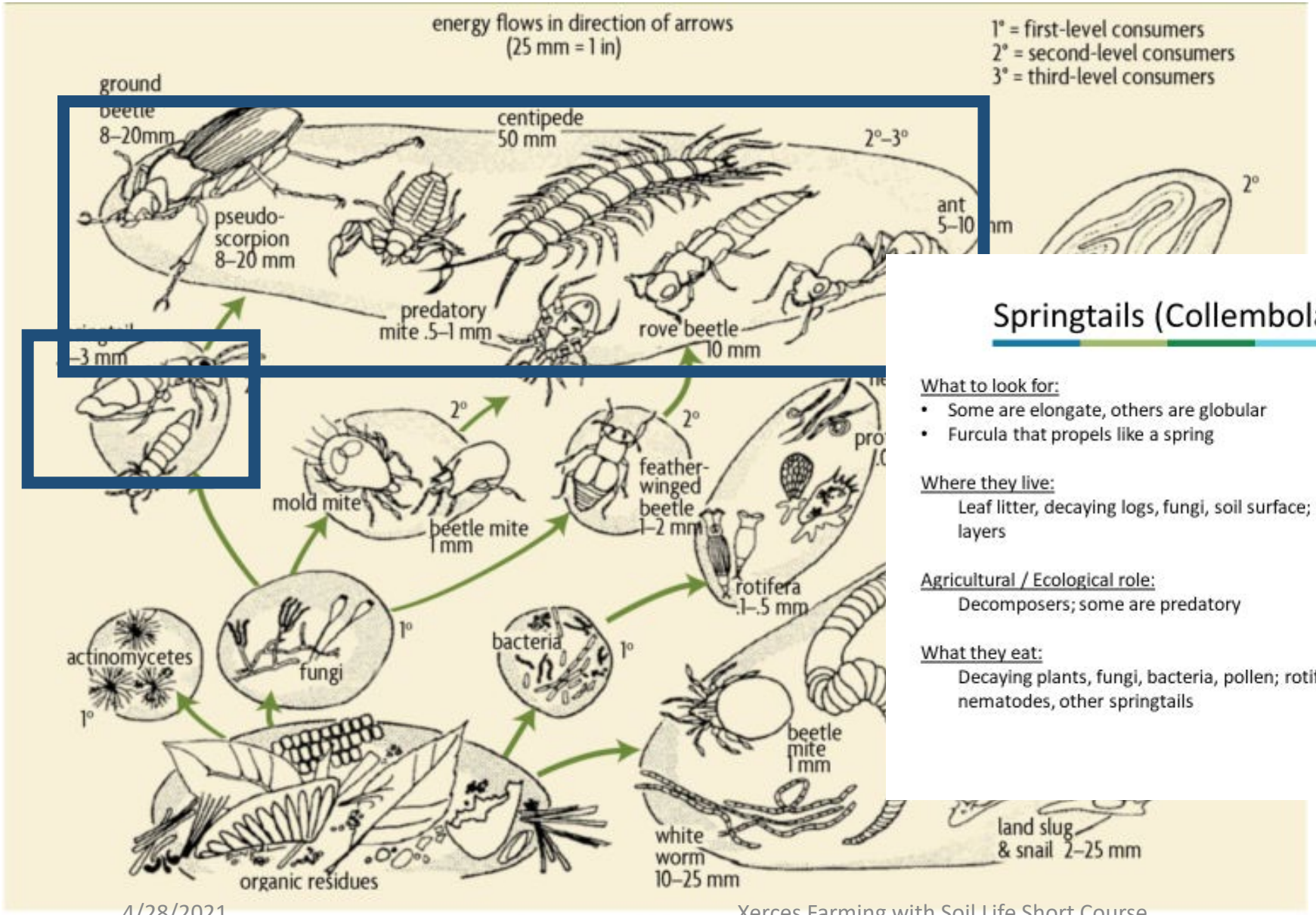

Figure 4.1. Soil organisms and their role in decomposing residues. Modified from D.L. Dindal (1972).

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

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Pitfall traps and Berlese funnel training examples

Photos: Jeff Gruber; Sarah Foltz Jordan

Soil Invertebrates in Urban Soils

Soil invertebrate communities can be diverse in urban soils

Communities are influenced by physical and chemical characteristics as well as past and present land use and management

Inverts are sensitive to:

- Soil disturbances
- Heavy metal contamination
- Pesticides
- Irrigation
- Fertilization
- Plant communities

Sources: Santorufa et al 2012; Bray and Wikings 2019

Factors influencing soil life in urban spaces

	← More soil life	Less soil life ->
Soil disturbances	Low disturbance	High disturbance
Pesticides	Low use	High use
Heavy metals	None or low levels	High levels
Irrigation	Variable	Variable
Fertilization	Organic	Inorganic
Plant communities	High diversity	Low diversity

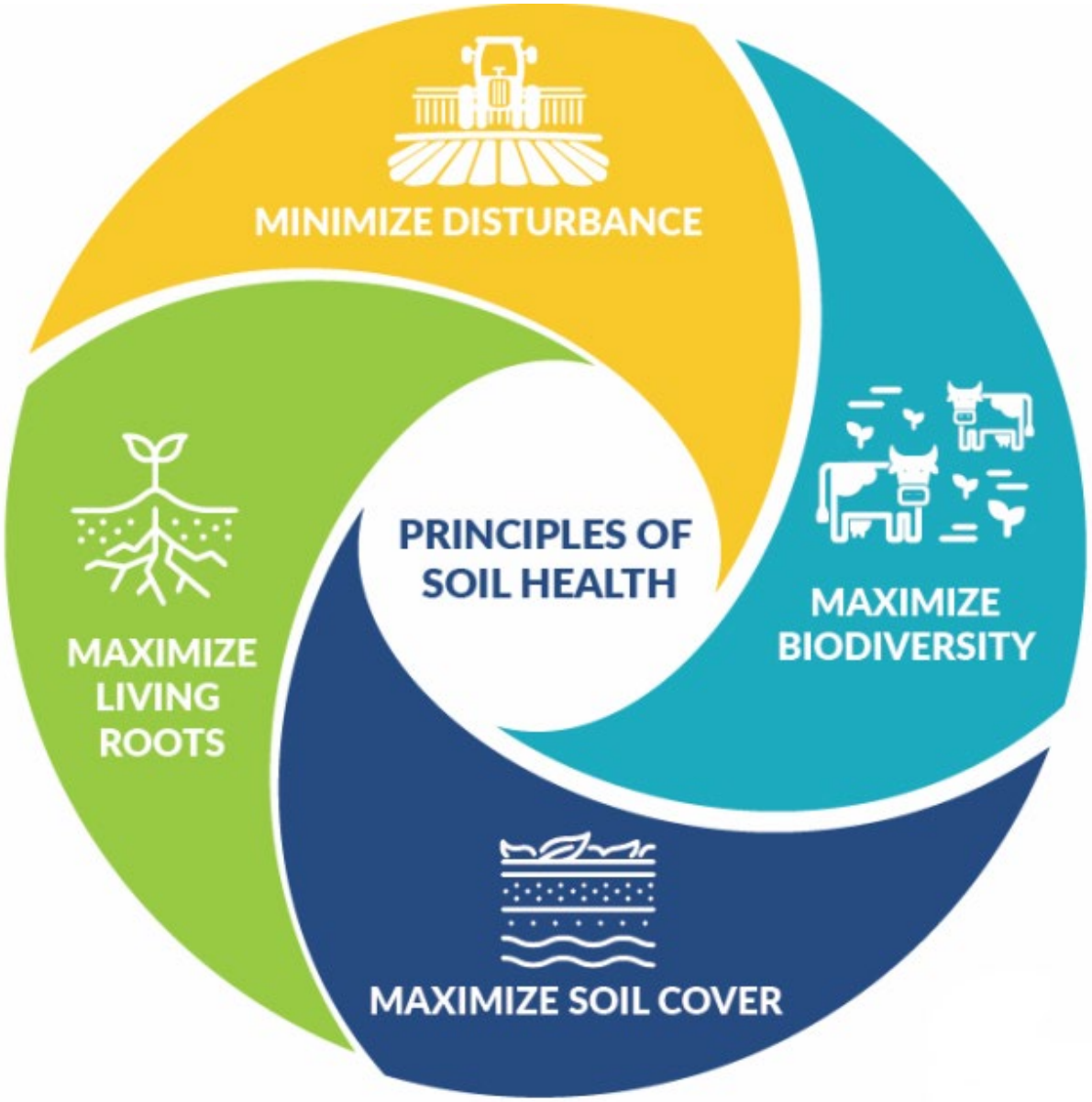

Figure: NRCS

Soil Health and Soil Life

Soil health practices support soil life, and soil life supports plant growth

Protect the soil

- Minimize physical and chemical disturbance
- Maximize soil cover

Feed the life in soil

- Maximize continuous living roots
- Maximize biodiversity

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Photos: Ruth Hartnap; Amy Wood

Minimize Disturbance

Limit physical soil disturbances

- Reduce tillage and other soil disturbances
- Rotate tilled areas

Pest Exclusion

Avoidance, resistant varieties

Trapping and Monitoring

Photo: Alina Harris, Xerces (floating row cover and resistant varieties); John Hayben

Minimize Disturbance

Limit chemical disturbances

- Non-pest species take much longer to recover from pesticides than do pests
- Can lead to secondary pest outbreaks

Reduce risks to nontarget soil invertebrates:

- Use Integrated Pest Management
  - Prevention
    - Pest exclusion (e.g. floating row covers)
    - Crop rotation, avoidance, resistant varieties
  - Trapping and monitoring
- Look for safest pest control measures

Strawberries in the garden beneath a cover crop cocktail

Mulch beneath plants can conserve water

Photos: Stephanie Frischie; Jennifer Hopwood

Maximize Cover

Keep the soil covered all the time

Living cover

Plant cover crops in garden beds to:

- Help build soil organic matter
- Help keep weeds at bay
- Hold and protect soil
- Provide habitat for some soil animals, pollinators, and more

Inert cover

Use organic mulch to conserve water, suppress weeds

Allow some crop residues to decompose

Maximize Continuous Living Roots

Golden crownbeard cover crop residue plus leaf mulch

Successional planting in food garden bed

Photos: Jennifer Hopwood

Keep living roots growing throughout the year

In garden beds:

- Reduce fallow periods with no living cover
- Grow long season crops
- Successional crop plantings
- Plant cover crops following crop plants
- Grow perennials


Rain garden


Flower garden

Photos: Stefanie Steele; Jennifer Hopwood

Maximize Biodiversity

Grow as many different species of plants as possible

Rotate crops, successional crops grow cover crops

Prioritize diverse permanent habitat with native plants

- Helps support soil life, pollinators, and more
- Helps to reduce exposure to lead contamination in soil

Maximize Biodiversity

Hedgerows

Rows of shrubs or large wildflowers that provide resources for pollinators and beautiful urban landscapes.

Photos: Nancy Lee Adamson/Xerces

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Beetle Banks

- Long term plantings in linear strips (2-6‘ wide) within/or adjacent to crops, or smaller clumps in gardens
- Provide shelter for ground beetles & beneficial inverts
- Native bunch grasses with optional wildflower component
- Planted on berm or flat ground

Photo: Sarah Nizzi (Xerces Society) (left); Scott Bauer, USDA-ARS (right)

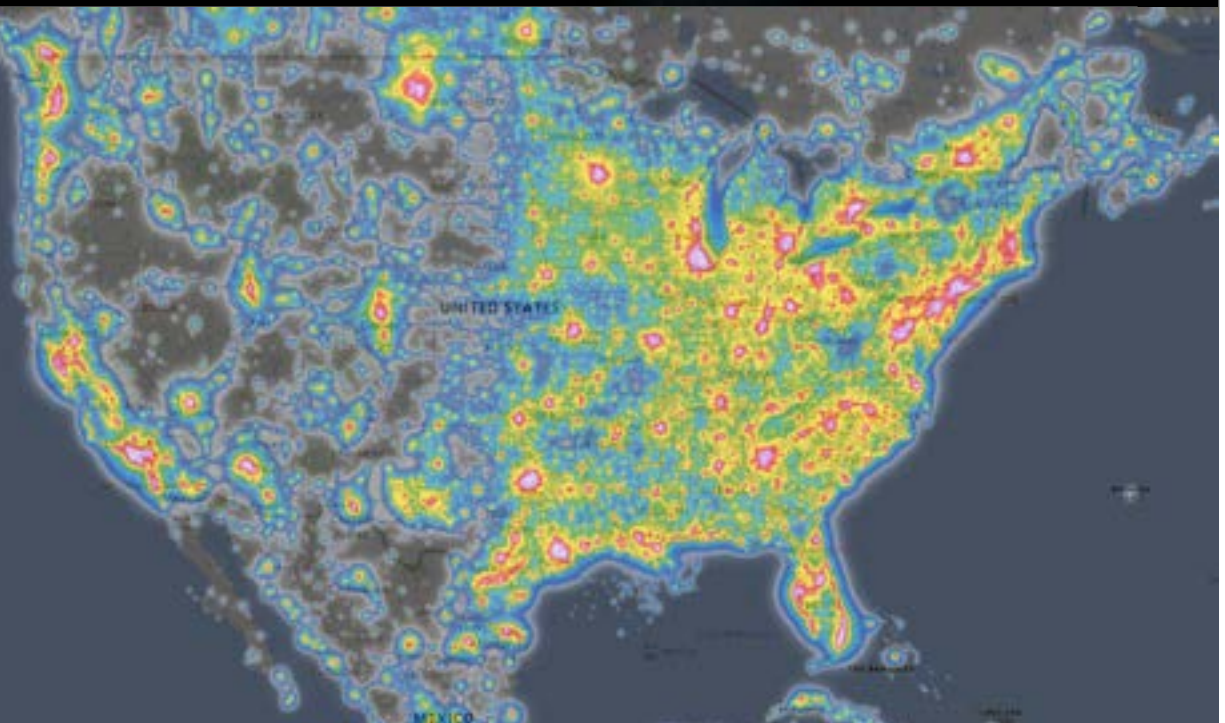


Photo: Richard Joyce; Map from Light Pollution Map

Managing Artificial Lights at Night

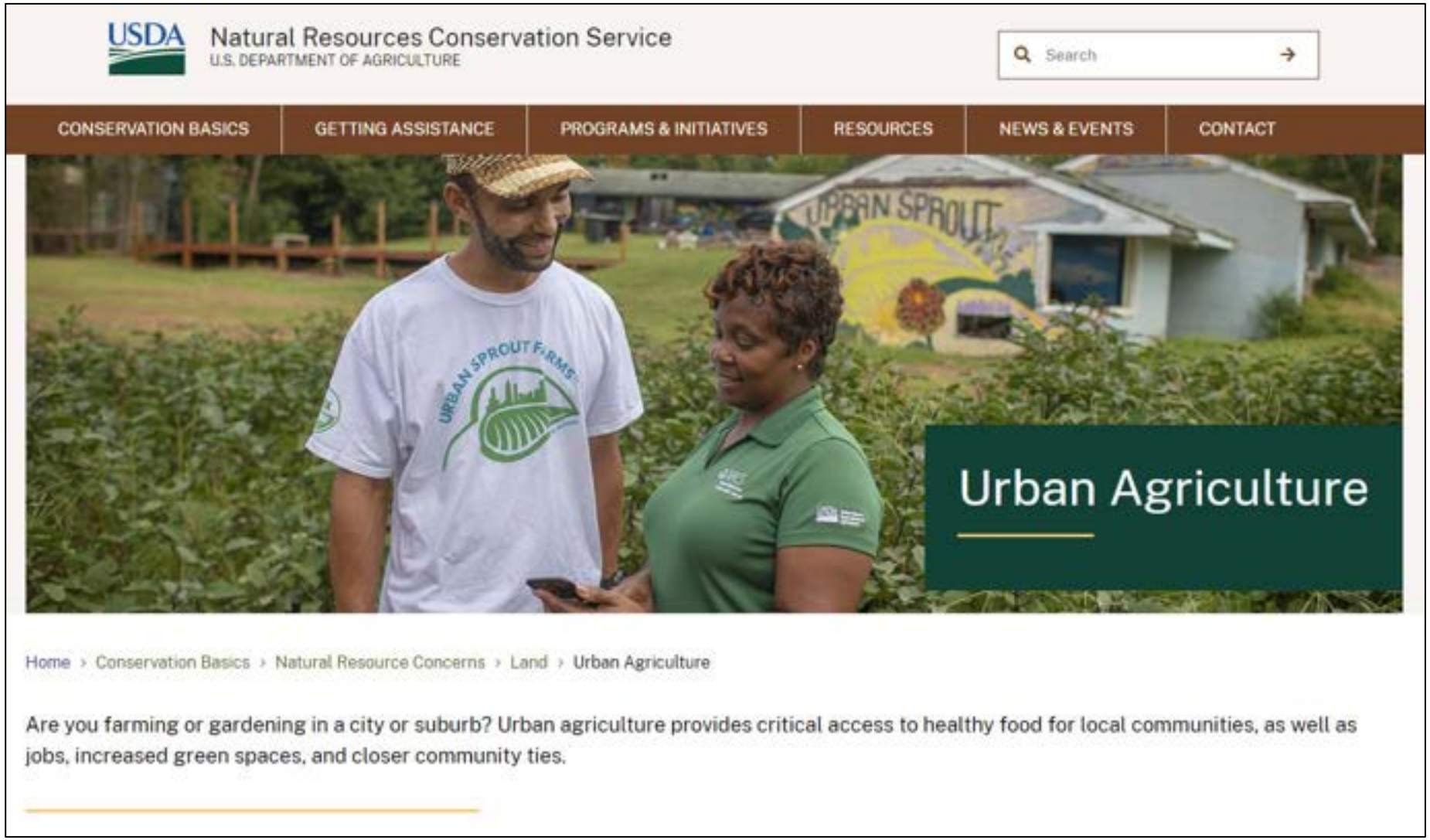
Artificial light can impact soil insects in multiple ways:

- Causes soil insects to move away from habitat and towards artificial light, which can be a hazard
- Reduces time for mating displays
- Can disrupt courtship communication

Recommended practices for using artificial light at night:

- Only where necessary
  - Consider shielding, placement, height
- Only when necessary
  - Use timers or motion detectors
- Use dim, red-filtered light

Resources: USDA-Natural Resources Conservation Service



NRCS Urban Ag Resources
https://www.nrcs.usda.gov/getting-assistance/other-topics/urban-agriculture

Contact local service center
https://www.nrcs.usda.gov/conservation-basics/conservation-by-state

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 Conservation Practices

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

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Xerces and NRCS

We can provide technical support and merge our activities with NRCS.

Here are some examples of useful NRCS practices in urban settings

Conservation Cover #327

"Pollinator Mix on Urban sites"

Cover Crop #340

"Multi-species Cover crop per 1000 square feet"

Field Border #386

"Small Scale Urban Field Border"

Conservation Crop Rotation #328

"Speciality Crop Rotations - Urban or Small Scale"

Photo credit: The Xerces Society / Kelly Gill, Karin Jokela, Kelly Gill, Kathryn Prince

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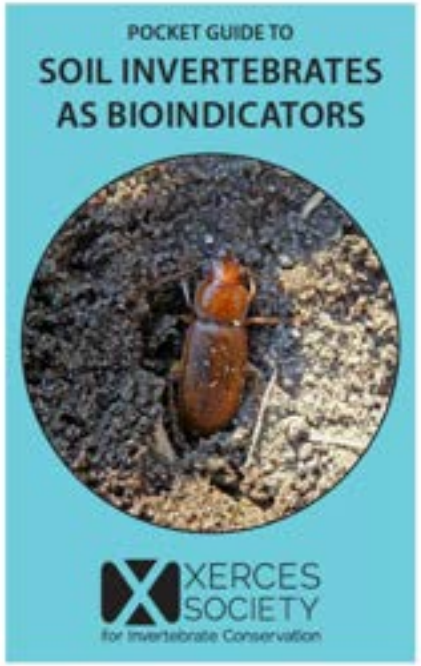
Resources: www.xerces.org

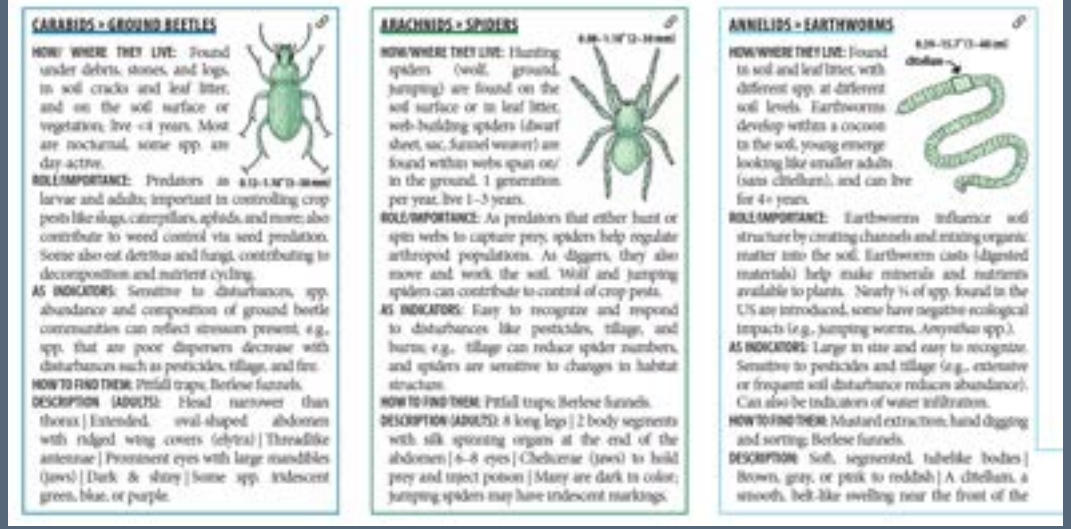
Soil Life Publications

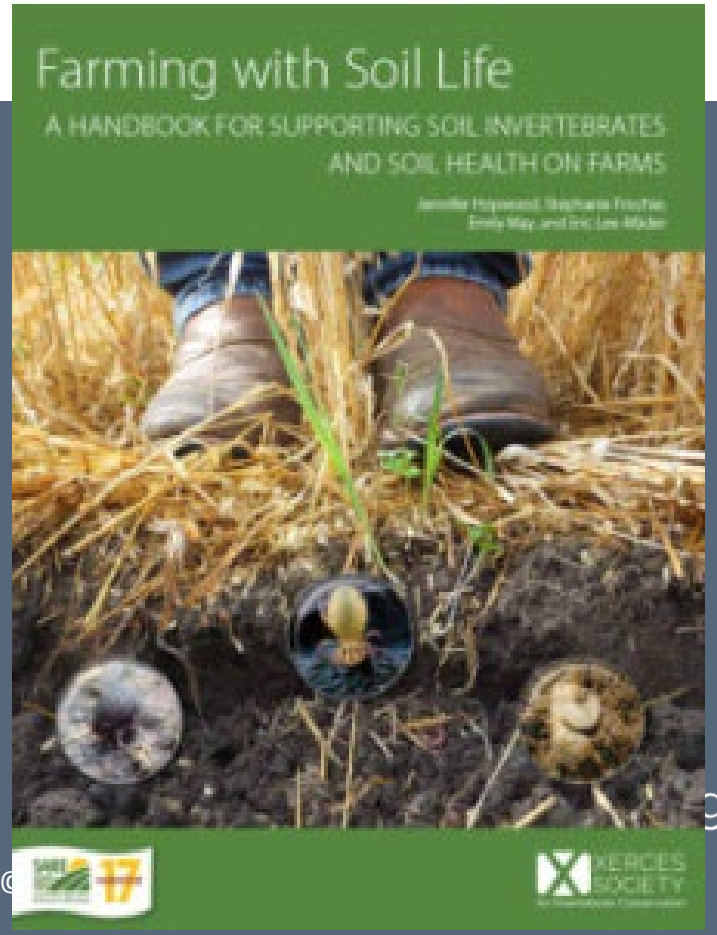


Xerces.org/soil life

Sare.org

Xerces YouTube Channel: Farming with Soil Life Online Short Course





Firefly Atlas (fireflyatlas.org)

Survey for fireflies/lightning bugs, especially imperiled and data-deficient species.

Photos: Richard Joyce/Xerces Society

Photo: Cypress firefly flash patterns by Radim Schreiber/FireflyExperience.org

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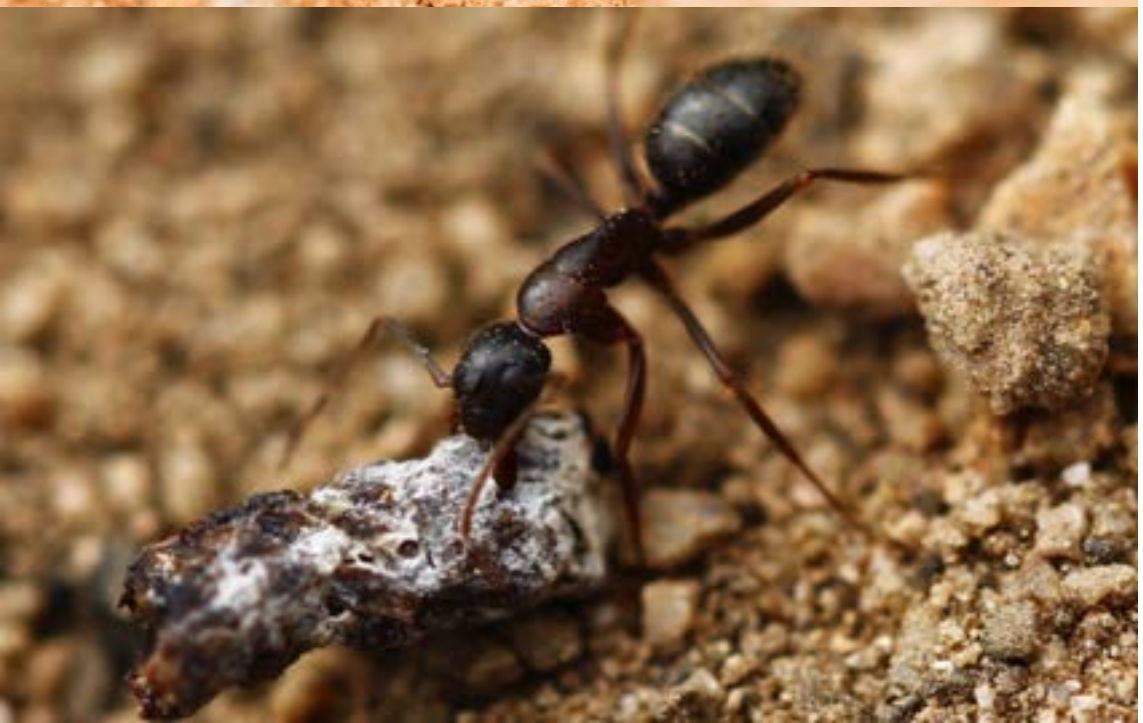
Questions? soils@xerces.org

Photo: TX Insects Unlocked_Flickr



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

Photos:; Walter Tschinkel; Uli Lorimer

Ants

Life Cycle:

- Mated queen finds nesting site, produces brood
- Workers care for colony
- Colonies are perennial, last for several years

Notes of Interest:

Mound building ants – earthworks 2-3 ft wide

A number of arthropods live within ant nests and benefit from the nest but do not harm the ants

There are over 40 introduced species, some are major pests

Dung Beetles

Scarabaeidae

Agricultural / Ecological role: Decomposers; reduce parasitic flies and reduce food pathogen spread; critical to grazing operations, worth more than $380 million/yr; diggers; seed dispersers.

Where they live: Larvae are within dung or within nests with dung; adults in many habitats; diversity is reduced in urban areas

Of note: Three strategies for reproducing in dung – eggs in pat, dig tunnel underneath dung under pat, roll dung away from pat into nearby tunnel

Photos: Susan Ellis / Bugwood; Deedee Soto

Photo: University of Minnesota Extension

Final Thoughts: 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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Final Thoughts:
What you do in your space is important!

Enhancing habitat and reducing pesticides has direct benefits to your space, and are a part of reversing larger insect declines.

Photo: Jennifer Hopwood

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

Soil Life: Pests

Where they live:

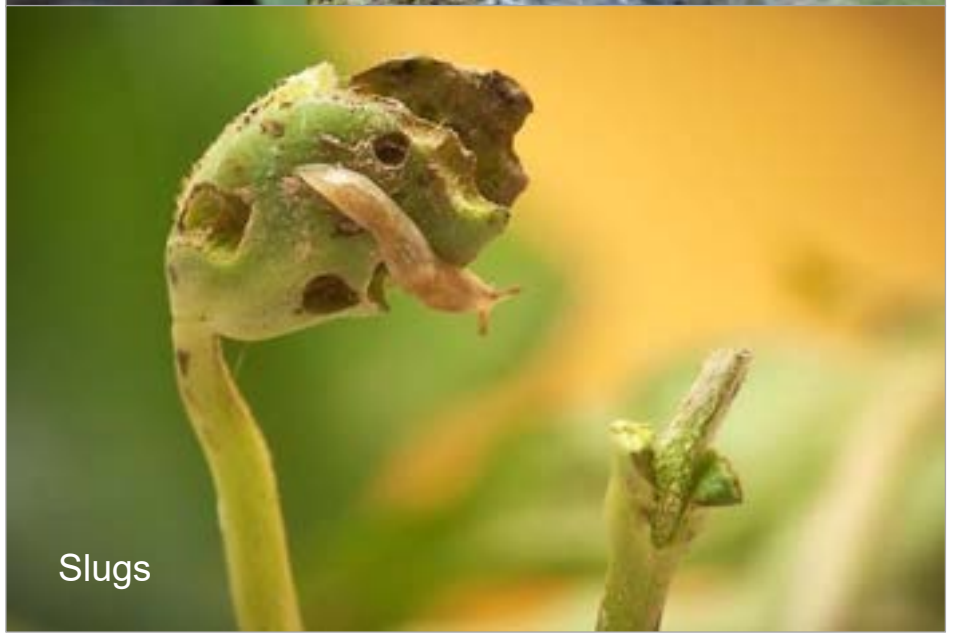
Soil surface, leaf litter

Agricultural / Ecological role:

Herbivores, decomposers; some are crop pests or ornamental plant pests; snails important in calcium cycling

What they eat:

Decaying plants, leaf litter, seedlings



Photos: Lithy/Flickr; Nick Sloff, Pennsylvania State University