

Attracting Beneficial Insects to Reduce Pests Naturally

Promoting Ecological Biodiversity
Above and Below the Ground



Cat Buxton
Grow More, Waste Less
Food Systems Consulting LLC, Sharon, Vermont
www.growmorewasteless.com



Beneficial insects are natural enemies of pests



PREDATORS:

both young and adults feed directly on other insects.



PARASITOIDS:

develop on or in one host insect, emerge as adult, eventually killing host.



POLLINATORS:

Bees, other insects: pollinate flowers while collecting nectar and pollen; increase crop yields.

PREDATOR: Ground beetle



common ground beetle_introduced_Bio Images UK / Malcom Storey.jpg

General predator. One of many 'common ground beetles'. introduced from Europe and widespread. There are thousands of Carabid (ground) beetles in N. America. They eat all three life stages (larvae, pupae, adults) of spotted cucumber beetle, striped cucumber beetle and squash bugs.

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PREDATOR: Syrphid Fly

Photo copyright Bruce Marlin - <http://www.cirrusimage.com/>

Body is just over $\frac{1}{2}$ inch long



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Pest: aphid

Predators: lady beetles, parasitic wasp, bigeyed bug, damsel bugs, lacewings, minute pirate bugs, syrphid fly, fungal diseases



Pea Aphid

Whitney Cranshaw

Colorado State University Bugwood.org

Predator: Lady beetle

Lady beetles eat about 5,000 Aphids and other soft-bodied pests during their one-year lifetime. *Coccinella novemnotata*, the nine-spotted ladybug, is one native.



Prey:

Adults: Feed on pollen and nectar, mealy bugs and small insects.

Larva: Feed on aphids, thrips, leafhoppers and other soft-bodied caterpillars.

Predator: Syrphid fly



Syrphid fly

Whitney Cranshaw, Colorado State University, Bugwood.org



Syrphid fly larva feeding on aphids

Clemson University - USDA Cooperative Extension

Pest: cucumber beetle

Predators:

Larva: entomopathogenic fungi and nematodes.

Adults: soldier beetles, hunting spiders, web-weaving spiders, carabid ground beetles, tachinid flies, braconid wasps, bats



Predator: soldier beetles

Prey: Adults: grasshopper eggs, cucumber beetles, caterpillars



Spiny s. beetle

John Ruberson, Kansas State University,
Bugwood.org.



Pest: Tomato Hornworm

Predators

larva: braconid wasp, paper wasp

egg and small larva: lady beetles, green lacewings



Predator: Parasitic Wasps

(braconid, chalcid, ichneumon)



Braconid wasp

David Cappae University,
Michigan State,
Bugwood.org

Prey

Larva: caterpillars and aphids

In the photo, a tomato hornworm is covered with cocoons of pupating braconid wasps.



parasitized hornworm by Braconid wasps David Cappae,
Michigan State University, Bugwood.org

Pest: Japanese beetles

Japanese beetle
Roger Schmidt, University of
Wisconsin-Madison Bugwood.org

Beetle larva: John A. Weidhass, Virginia
Polytechnic Institute and State University,
Bugwood.org

Predator:
Adults
Tachnid fly

Larva
nematodes



Predator: nematodes

tachnid fly parasitizing Japanese
beetle Copyright_2004 Vincent J
Hickey bugguige.net

Nematodes (HB -
Heterorhabditis Bacteriophora)
Nematodes can suppress larvae
and pupae in the soil while the
others will attack adults, eggs
and larvae on plants or on the
soil surface.



Thousands of nematodes in a wax moth casing.
Peggy Greb, USDA Agricultural Research Service,
Bugwood.org

Pest: cabbage worm

RIGHT
cabbage worm
Whitney Cranshaw,
Colorado State
University



cabbage looper larva Clemson
University - USDA Cooperative
Extension

LEFT
Cabbage white moth
(worm) Whitney
Cranshaw, Colorado
State University,
Bugwood.org



Predators

larva: (looper) parasitic wasps, (worm) shield bugs, ambush bugs, and vespid wasps

egg and small larva: tachnid fly, syrphid fly

Predator: tachnid fly

Tachnid fly
David Cappae University,
Michigan State, Bugwood.org

TachnidFly parasitizes hornworm
John A Weidhass
Virginia Polytechnic Institute and
State University Bugwood.org

Prey:

Larva: caterpillars, beetles, sawflies, borers, and green stink bugs, cutworms, codling moths, tent caterpillars, cabbage loopers, and gypsy moth larvae.



Pest: leaf hopper

Predators: spiders, lacewings, minute pirate bugs, lady beetles, spiders, assassin bugs, wasps, robber flies, and predaceous mites. important food source for birds and lizards.



Leafhopper
Susan Ellis,
Bugwood.org



Leafhopper,
G. Oldfield, USDA,
Bugwood.org

Predator: lacewing

www.growmorewasteless.com



Lacewing larva feeding on leafhopper
ucce.ucdavis.edu/



Lacewing eggs ohiohistory.org

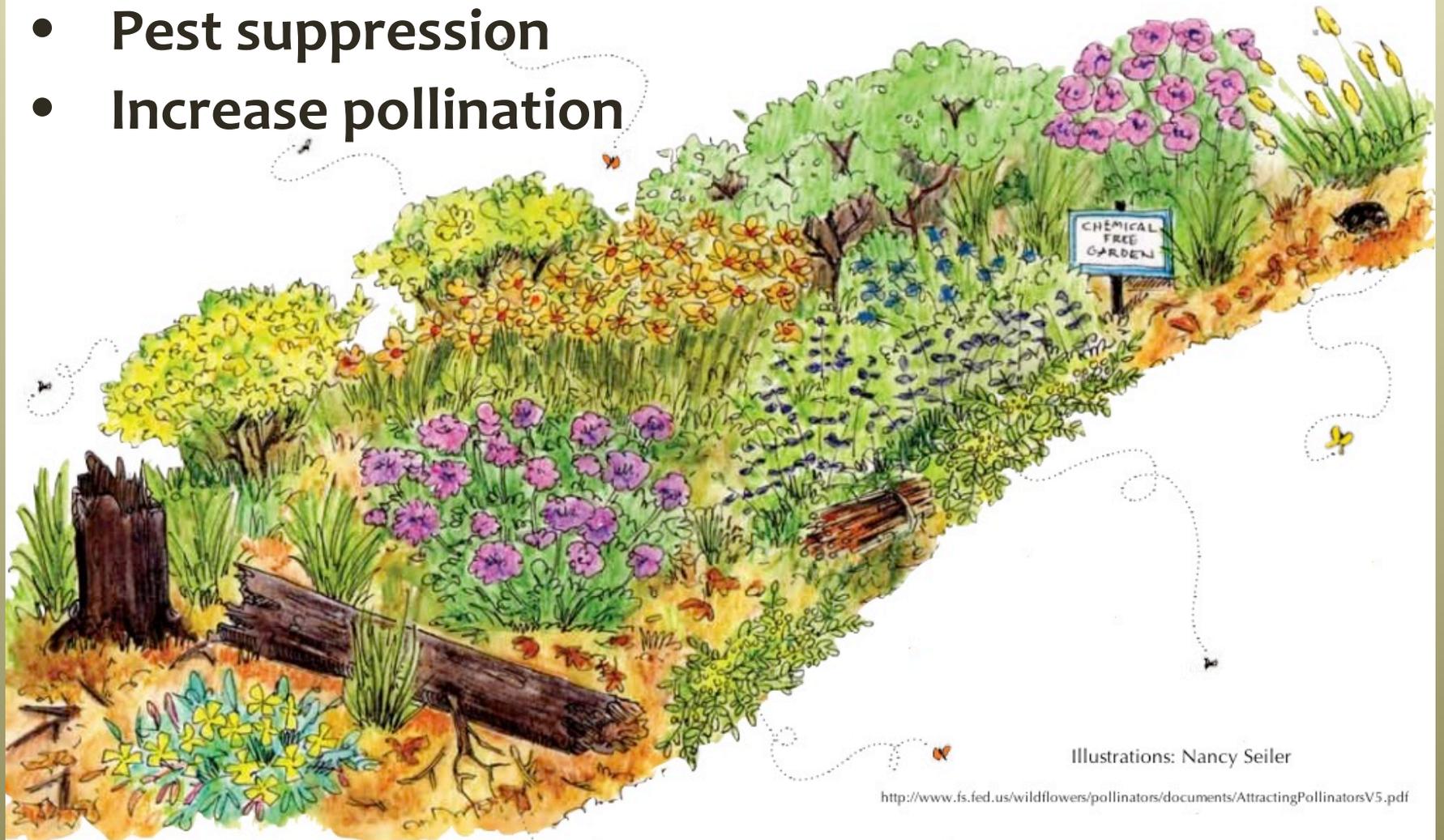


Lacewing fcps.edu

Prey: Adults: primarily nectar, pollen, and aphid honeydew
Larva: Aka aphid lion. aphids, caterpillars, mealy bugs, small beetles and some beetle larvae, scale insects, leafhoppers, thrips, spider mites, whitefly, eggs and caterpillars of butterflies and moths.

Why attract them to your yard?

- Promote biodiversity
- Pest suppression
- Increase pollination

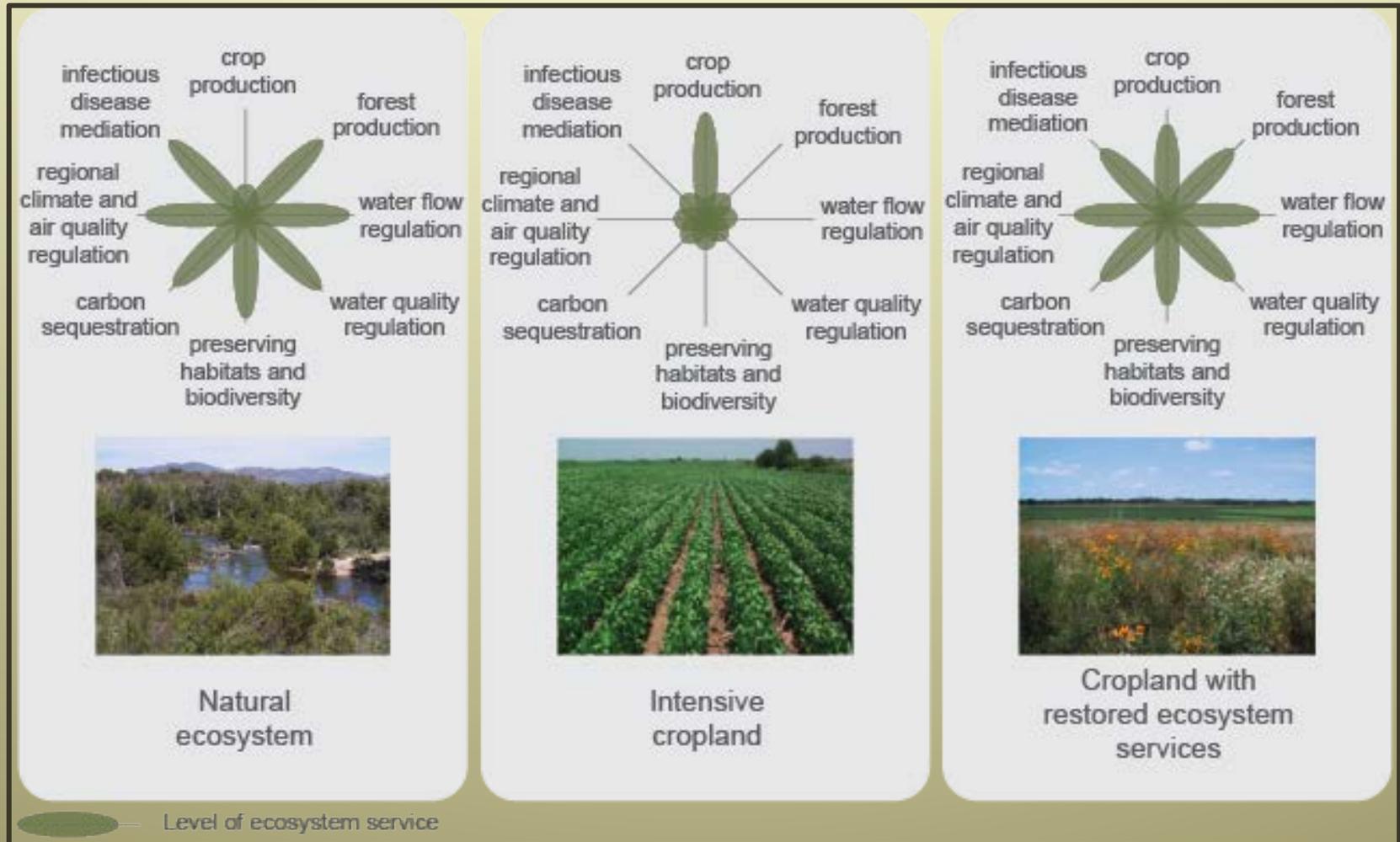


Illustrations: Nancy Seiler

<http://www.fs.fed.us/wildflowers/pollinators/documents/AttractingPollinatorsV5.pdf>

Provide Ecosystem Services

Growing more, maximizing diversity, nurturing photosynthesis



Maximize diversity

About 900,000 insect species identified.

- At least twice that to be discovered.
- 1% are known to be harmful to humans.
- A sliver of those are agricultural pests.

It's estimated that there are 1750 beneficial insects to every 1 "pest".

There are more than 900,000 identified insects in the world and disagreement as to whether there are 1 or 2 million more that have yet to be known!

Only 1% of ALL insects known are harmful to humans and just a sliver of those are agricultural pests.

The more chemicals you use to "control" these "pests" the more "pests" you end up with because you kill all the good guys too!

TAKE CARE – Don't kill them!

Avoid using chemical fertilizers and pesticides:

- Broad spectrum insecticides kill all insects (including beneficials).
- Herbicides kill all plants (and destroy habitats).
- Ingredients can tie up nutrients and minerals in the soil.
- Even organic salt-based fertilizers tie up water and nutrients.
- Are toxic to mycorrhizal fungus and soil microbes.
- Nitrogen fertilizer creates a mono-crop of microorganisms, greatly diminishing soil health, ultimately resulting in polluted waterways and ocean dead-zones.

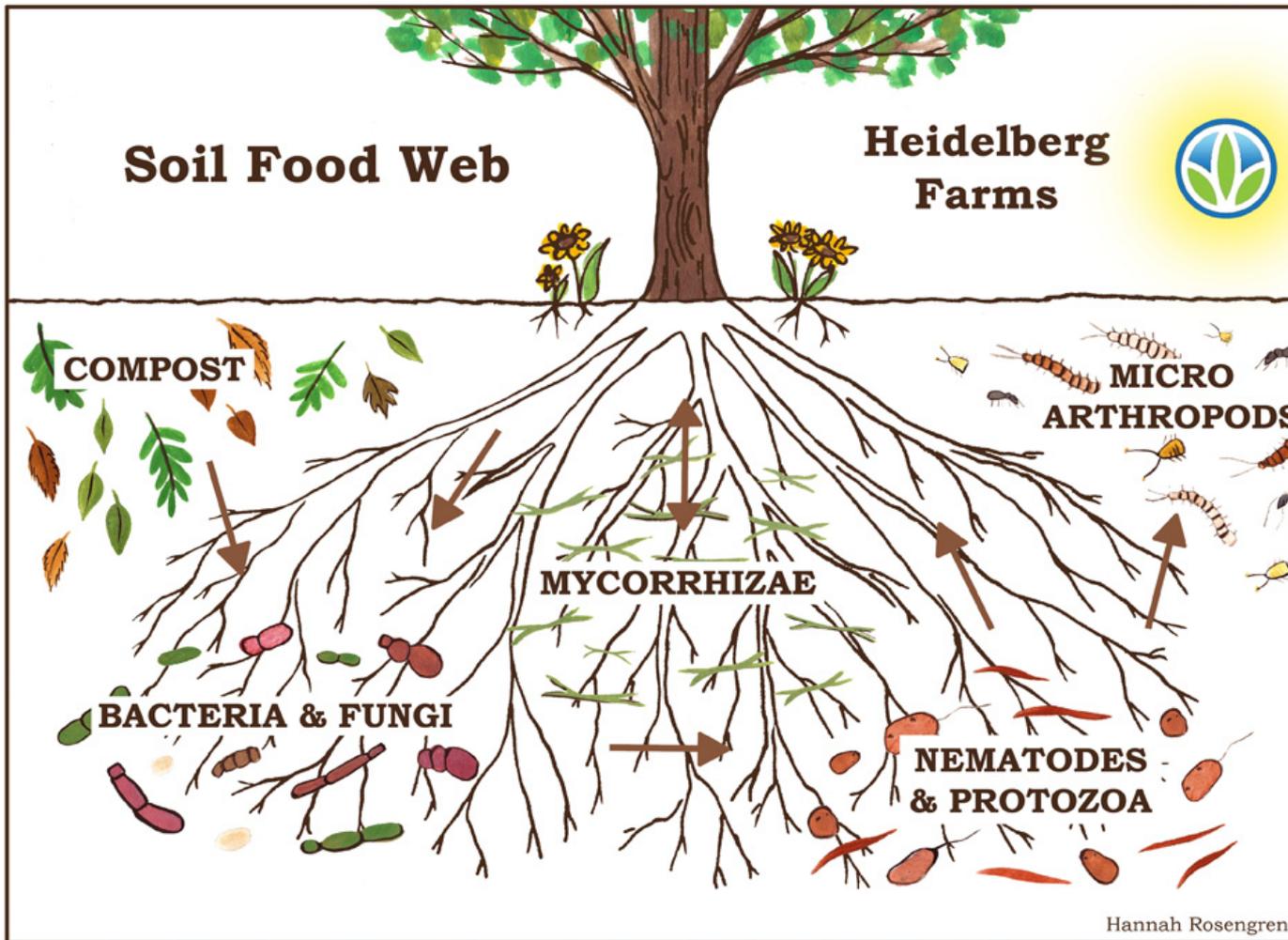
Manage pests naturally

- **Preventative tactics/tools:** soil management, diverse plantings, crop rotation, trap crops, companion planting, time crops with insect cycles, succession plantings, barriers: floating row covers, mulch, reflective plastic.
- **Actions:** Build the soil carbon sponge. Scout often for eggs & larvae, hand picking, hose-off, vacuum, ...
- **Caution:** natural sprays and sticky traps. *Biological controls.*



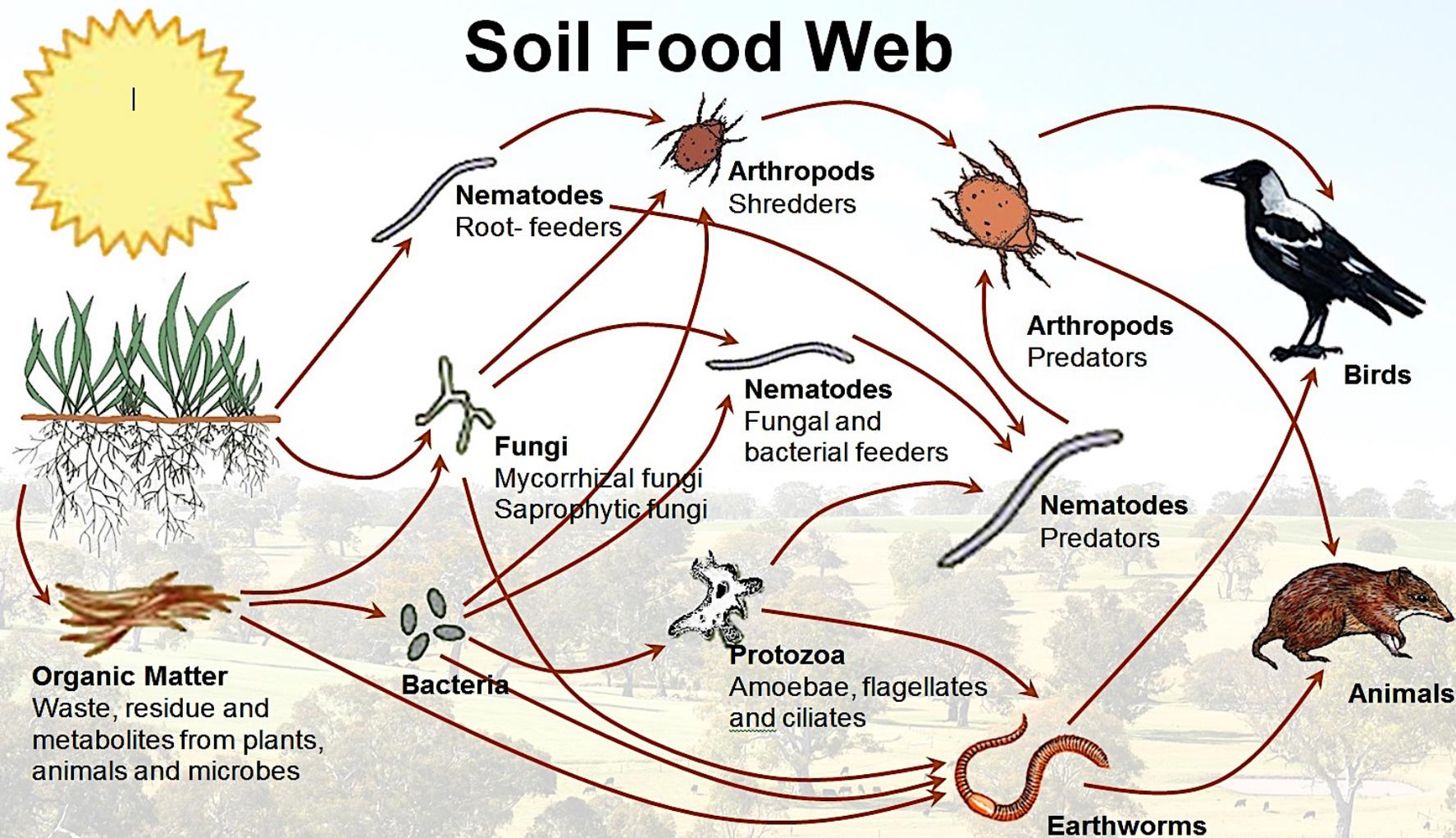
BUILD COMMUNITY

Work from the Ground Up



- Know your soil
- Build soil life
- Add organic matter
- Minimize soil disturbance
- Choose complimentary root structures (perennials)
- Rotate crops (annuals)
- Mulch

Soil Food Web



First trophic level	Second trophic level	Third trophic level	Fourth trophic level	Fifth trophic level
Photo synthesisers	Decomposing Mutualists, Pathogens, Parasites, Root-feeders	Shredders Predators Grazers	High level predators	Higher level predators

Soil Crust Microbes

Spider

Microfungi on leaf surface

Millipede

Ground Beetle

Ant

Bacteria

Earthworm

Fungal hyphae in soil

Mite

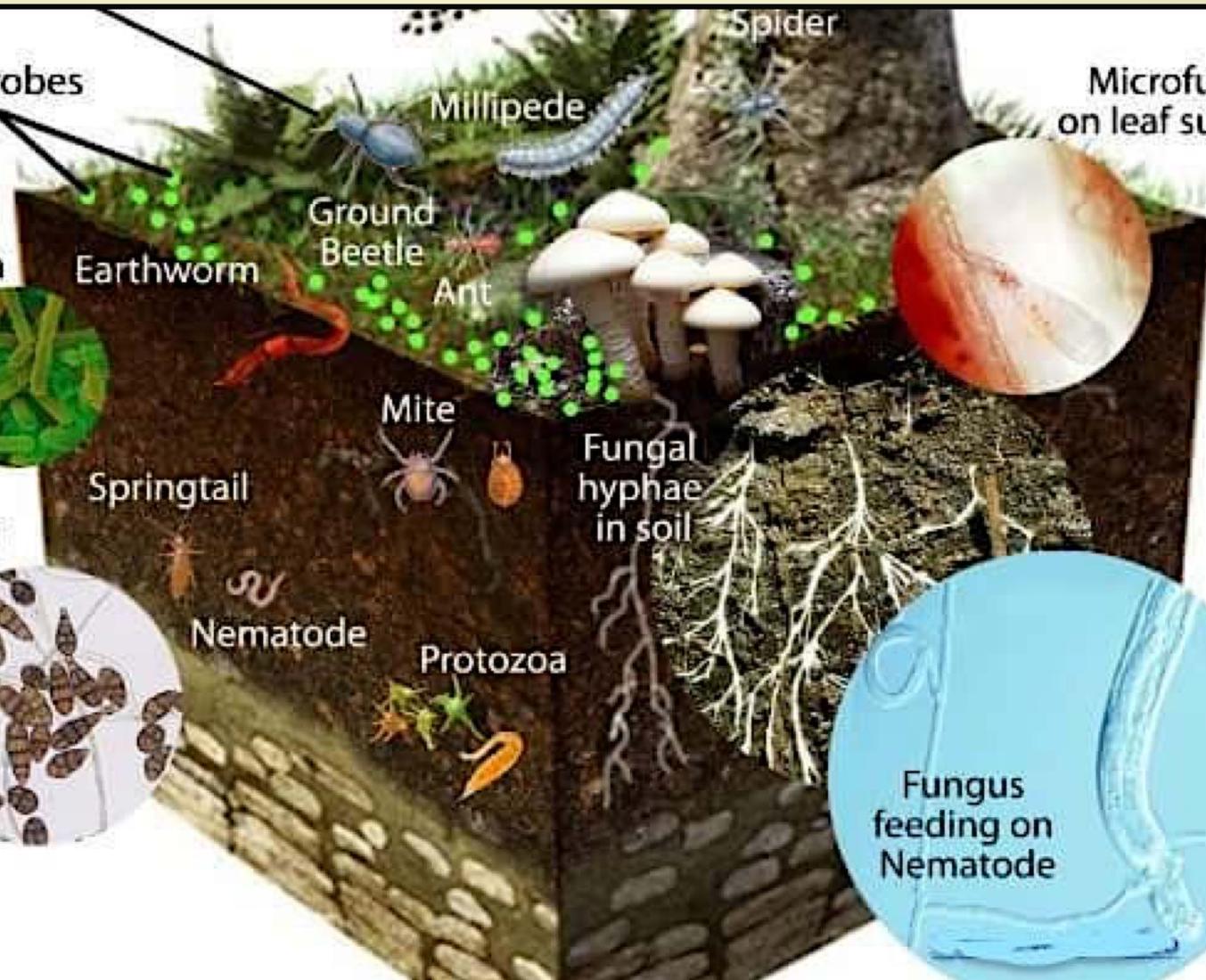
Springtail

Microfungi in soil

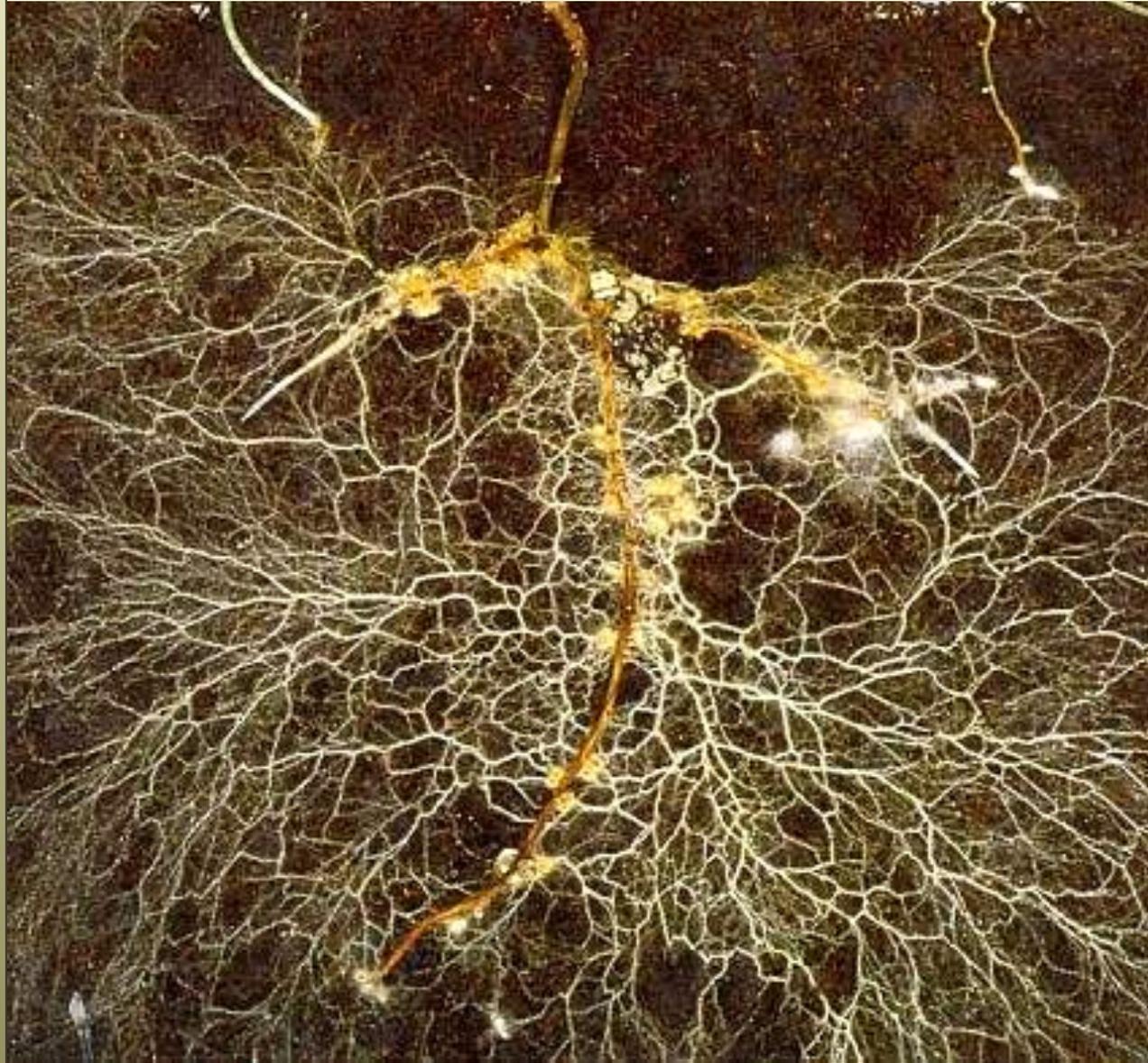
Nematode

Protozoa

Fungus feeding on Nematode

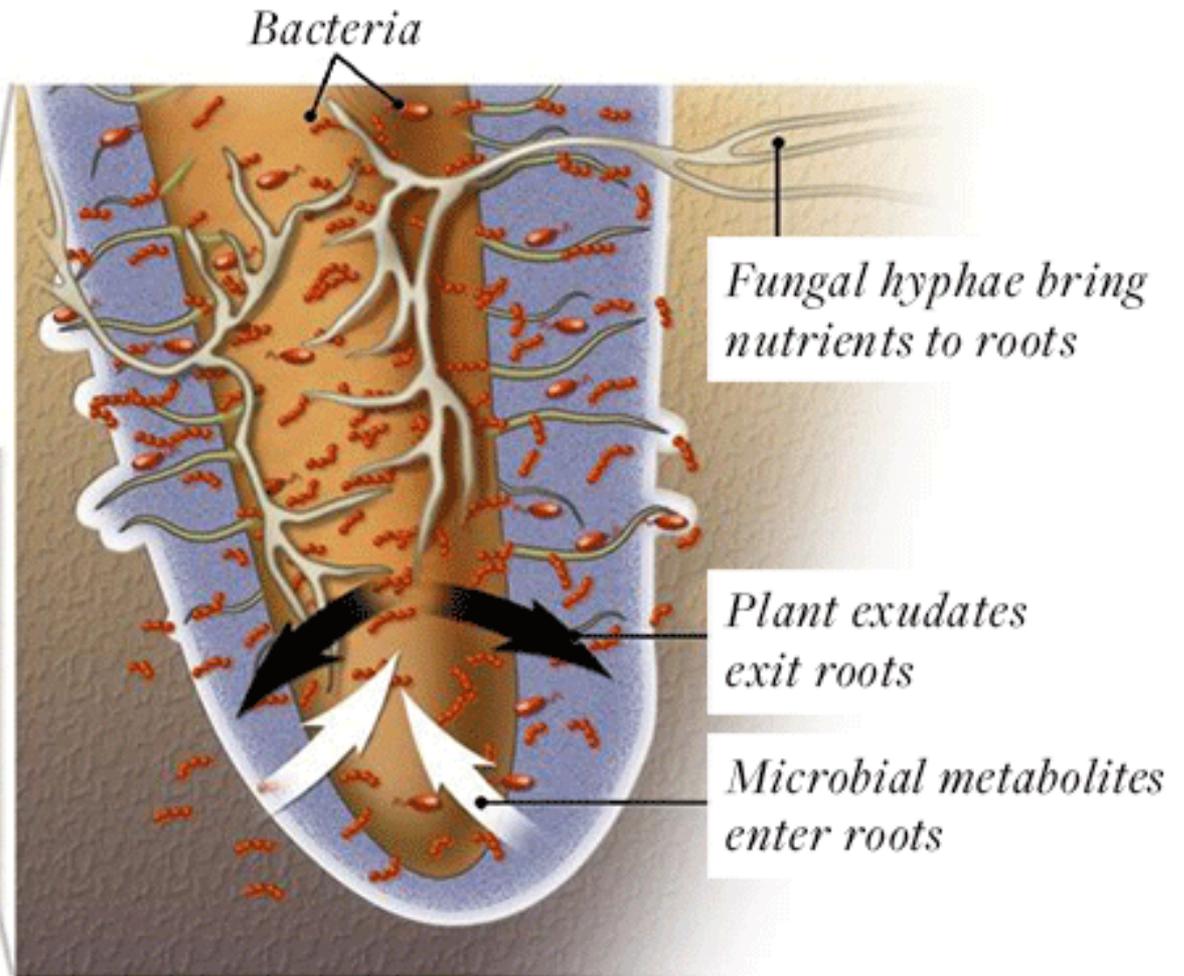
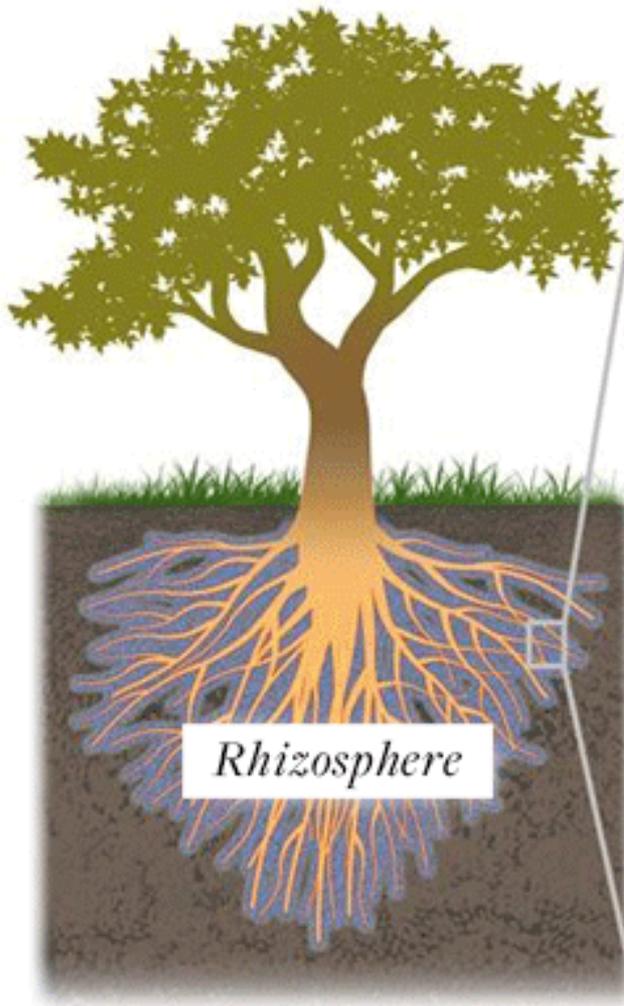


mycorrhizal fungus



Mycorrhizas are the symbiotic relationships between soil fungus and plant roots, that are primarily responsible for nutrient transfer.

We know very little about mycorrhizae.



The rhizosphere can be vast!

Soil organisms need water and stability.

And, by the way creating conditions for them to thrive could cool the planet, quickly!

- One teaspoon of healthy soil can hold over one billion bacteria, several yards of fungal filaments, several thousand protozoa, and scores of nematodes.
- A 1% increase of organic matter in the top inch of soil per acre can hold 20,000 gallons of water.
- Living soil can absorb and store greenhouse gases AND retain water.
- The first meter of soil contains three times as much carbon (in SOM) as is found in either the atmosphere or in living plants.

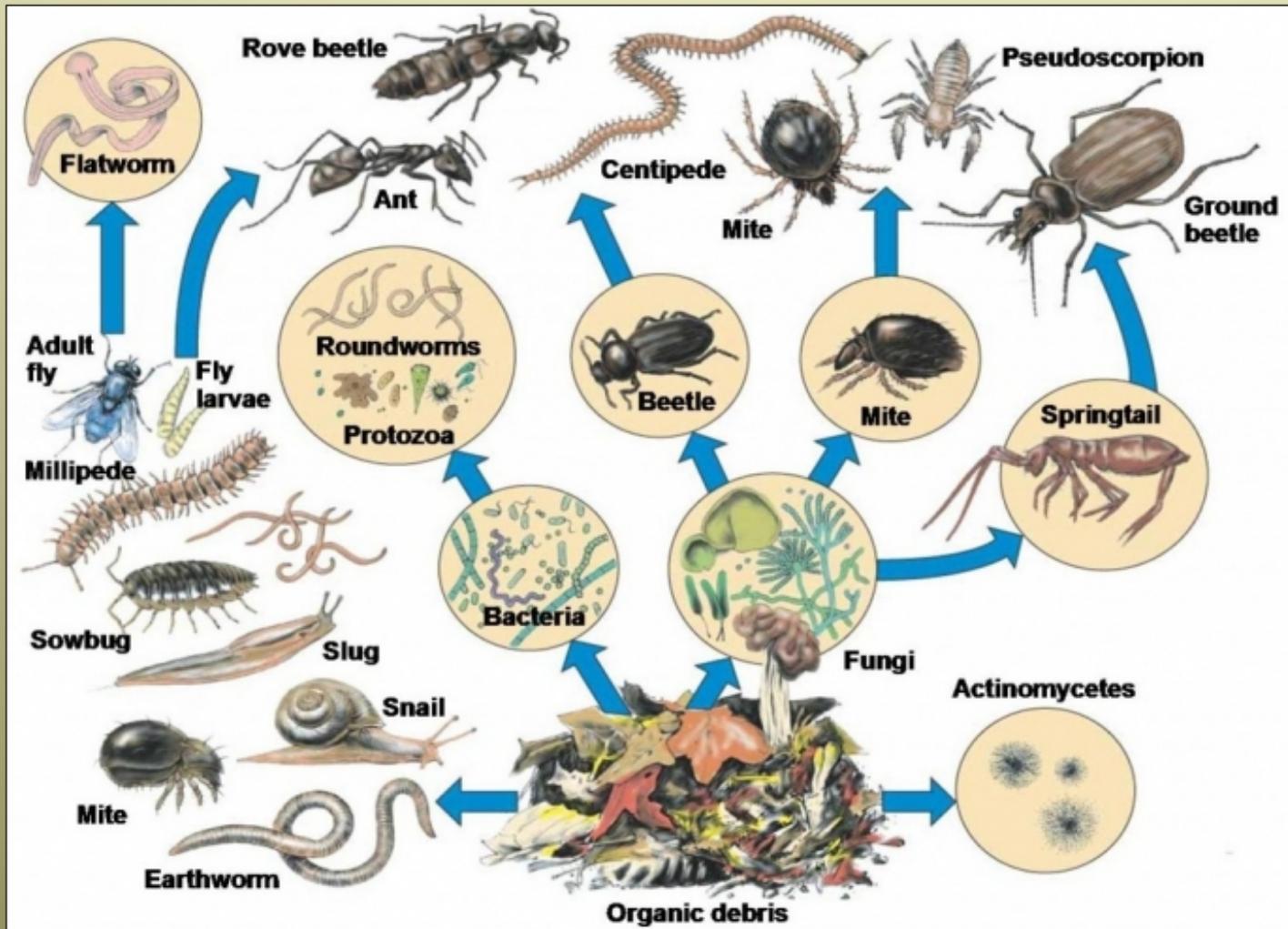


Soil Health Principles

1. Living roots In the ground
2. Maximize diversity
3. Minimize disturbance
4. No bare soil
5. Animal contact with soil

SUPPORT THE UNDERGROUND

Healthy soil = diverse soil life = healthy plants = healthy insect populations



Healthy and diverse populations of soil organisms allow for maximum nutrient uptake by plants.

How to keep zillions of insects around

Diverse communities provide shelter and nutrients for a variety of life forms



PROVIDE CONDITIONS:

- Stability: food, water & shelter
- Healthy soil
- Species diversity
- Structural diversity
- Continuous blooms
- Living roots in the ground, year-round.

BUILD COMMUNITY

work from the top down

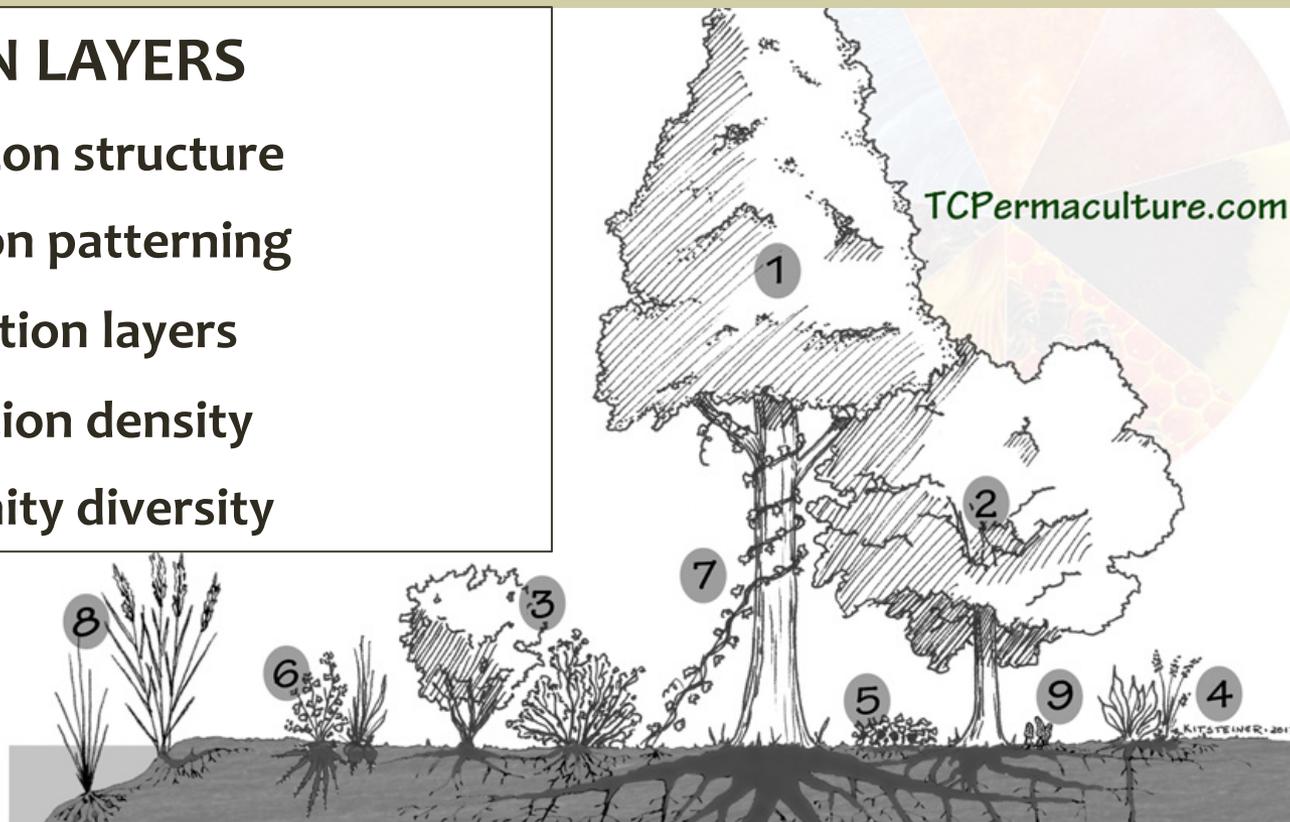
THINK IN LAYERS

- soil horizon structure
- vegetation patterning
 - vegetation layers
 - vegetation density
- community diversity

Plant attributes lend to soil support.

CONSIDER

- root structure
- symbiotic relationships
- Nutrient exchange
- water exchange



Nine Layers of the Edible Forest Garden

- | | |
|---------------------------------|---------------------------|
| 1. Canopy/Tall Tree Layer | 6. Underground Layer |
| 2. Sub-Canopy/Large Shrub Layer | 7. Vertical/Climber Layer |
| 3. Shrub Layer | 8. Aquatic/Wetland Layer |
| 4. Herbaceous Layer | 9. Mycelial/Fungal Layer |
| 5. Groundcover/Creeper Layer | |

About 20% of the Sun's energy is absorbed by ozone, clouds, and atmospheric gases.

About 25% of the Sun's energy is scattered and reflected by clouds and air.

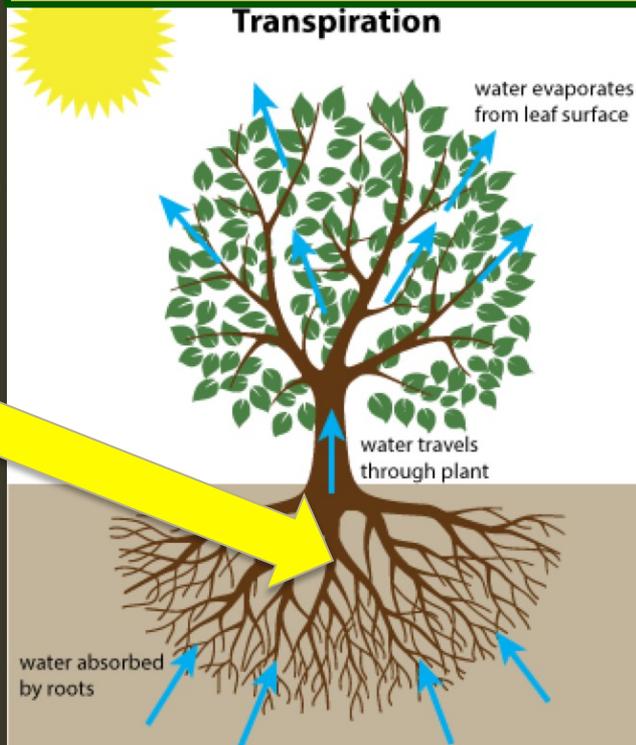
About 5% of the Sun's energy is reflected by the Earth's surface.

About 50% of the Sun's energy is absorbed by the Earth's surface.

SUNLIGHT ENERGY

- 25% reflected back to space
- 50% absorbed by earth to feed the underground zoo
 - Need biomass, plants, algae...
- 20% absorbed by atmosphere
 - Need clouds
- 5% reflected by earth surface
 - Radiative cooling

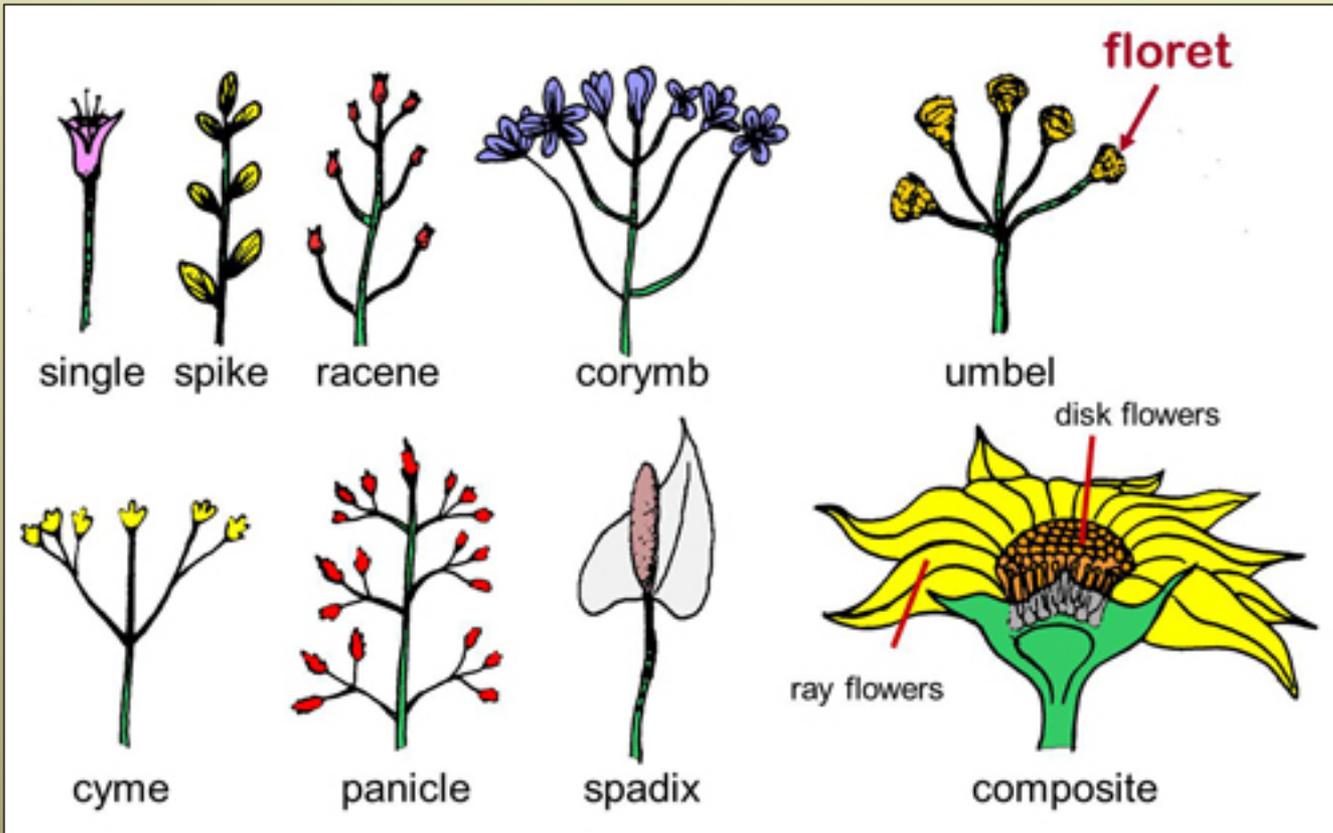
Transpiration



 Biodiversity
photosynthesis 

Structural & color variety

It's beautiful AND it matters to insects!



Some insects are specialist feeders



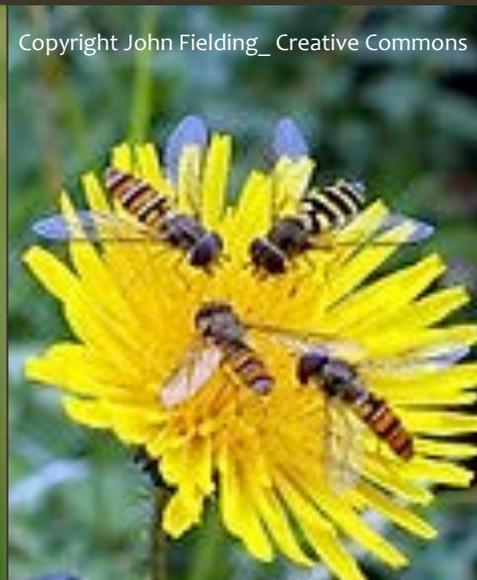
Some insects require plenty of good places to rest, or to hunt from.

Blossom color and shape preferences

Pollinator Syndrome Traits Table

Trait	<u>Bats</u>	<u>Bees</u>	<u>Beetles</u>	<u>Birds</u>	<u>Butterflies</u>	<u>Flies</u>	<u>Moths</u>	<u>Wind</u>
Color	Dull white, green or purple	Bright white, yellow, blue, or UV	Dull white or green	Scarlet, orange, red or white	Bright, including red and purple	Pale and dull to dark brown or purple; flecked with translucent patches	Pale and dull red, purple, pink or white	Dull green, brown, or colorless; petals absent or reduced
Flower Shape	Regular; bowl shaped – closed during day	Shallow; have landing platform; tubular, c day	Large bowl-like, Magnolia	Large funnel like; cups, strong perch support	Narrow tube with spur; wide landing pad	Shallow; funnel like or complex and trap-like	Regular; tubular without a lip	Regular: small and stigmas exerted

http://www.fs.fed.us/wildflowers/pollinators/What_is_Pollination/syndromes.shtml



Native plants:

Choose exotics
with caution

- Enhance native biodiversity
- Re-create natural habitats
- Less likely to be invasive
- Adapted to local climate
- Less resource intensive
- Habitat permanency



VERMONT NATIVE PLANTS THAT ATTRACT BENEFICIAL INSECTS, BY BLOOM

2015 CAT BUXTON www.catbuxton.com

LIKES SHADE (if shaded)		be=bees bn=beneficial bf=butterflies or hummingbirds										!! = aggressive ↓										Attracts									
common name (aka)	scientific name	Bloom time										bloom color										!!	be	bn	bf						
		Mch	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	R	Pk	O	Y	G	B	Pp	B	W												
geranium, wild (crane's bill)	geranium maculatum	X	X	X	X	X									Pk								Pp		W		x	x			
false solomon's seal	maianthemum racemosum	X	X	X	X																					W		x	x		
viola, birdsfoot	viola pedata	X	X	X	X																			Bl	Pp			x	x	x	
baptisia (false Indigo)	baptisia australis, b. tinctoria		X	X	X	X																			Pp			x			
cinquefoil, dwarf	potentilla canadensis		X	X	X	X											O											x		x	
columbine	aquilegia canadensis		X	X	X	X								R				Y										x		x	
coreopsis (tickseed)	coreopsis lanceolata		X	X	X													Y										x	x	x	
phlox	phlox divaricata		X	X	X																			Bl	Pp		W		x	x	x
yarrow	achillea millefolium		X	X	X	X	X	X																		W	X	x	x	x	
golden alexander	Zizia aurea		X	X	X	X	X											Y										x	x	x	
woodsorrel	oxalis dillenii			X	X	X	X	X	X	X								Y										x		x	
bee balm, wild bergamot	monarda citriodora, m. fistulosa			X	X	X	X	X	X						Pk										Pp		W	X	x	x	
butterfly weed	asclepias tuberosa			X	X	X	X	X							Pk	O												x	x	x	
fleabane (daisy fleabane)	erigeron annuus			X	X	X	X	X																		W		x	x	x	
heal-all (selfheal)	prunella vulgaris			X	X	X	X	X							Pk										Pp			x		x	
prarie coneflower	ratibida pinnata, rudbeckia pinnata			X	X	X	X	X										Y										x	x	x	
dogbane (Indian hemp)	apocynum cannabinum			X	X	X	X																			W	X	x	x	x	
groundsel (ragwort)	senecio obovatus				X	X	X											Y										x		x	
black-eyed susan	rudbeckia hirta				X	X	X	X	X									Y										x	x	x	
figwort	scrophularia marilandica				X	X	X	X	X											G						Br			x	x	x
goldenrod	solidago nemoralis (many sp.)				X	X	X	X	X									Y										X	x	x	x
milkweed, swamp	asclepias incarnata				X	X	X	X	X						Pk										Pp				x	x	x
jewelweed (touch-me-not)	Impatiens capensis				X	X	X	X									O	Y										X	x		x
blanket flower	gaillardia aristata, gaillardia pulchella					X	X	X	X	X				R	Pk	O													x		x
aster	various spp						X	X	X	X					Pk										Pp		W		x	x	x
helianthus	helianthus decapetalus						X	X	X	X								Y										X	x	x	
jerusalem artichoke	helianthus tuberosus						X	X	X	X																					

CHOOSE THE RIGHT PLANTS TO INCREASE BENEFICIAL INSECT POPULATIONS

Look for:

- ◆ Diversity in species
- ◆ Diverse structures, above and below the ground
- ◆ Successional growth and bloom times
- ◆ Hardiness and other tolerances and preferences
 - ◆ Temperatures, water, soil type, nutrient demands.
- ◆ Native habitat – Where is it from?
- ◆ Plant habits – How will it perform here?
 - ◆ Some non-natives can be very aggressive once taken out of their symbiotic ecology. Some won't survive at all.
- ◆ Function: human uses and ecological functions

In remembrance of Nina Swaim

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Syrphid Fly - Cornell U. Cooperative Extension

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