Your yard, Your Microcosm: IPM Basics

Your yard or garden is a little world—a microcosm—filled with millions of living organisms large and small: macroorganisms and microorganisms. In a truly natural setting, barring any invasive species, this network of living components tends toward a balance of food, habitat, and predators that reduce the chance one organism will dominate another.

But your yard isn’t a natural setting. You want certain plants but not others. Only beneficial insects and few, if any, weeds. Certainly no plant diseases. Yard and garden success, without abundant chemical input, lies in making the most of natural principles and natural allies. You can’t control it all, but you can influence what’s invited in, what’s excluded, and which plants or creatures thrive. Your allies include helpful fungi and other invisible soil organisms, birds, toads, spiders, and beneficial insects. Include us as allies, too. Decades of research has provided a lot of knowledge.

Pest management starts with your whole system, the way you set up and maintain the yard, garden, or household. Knowledge helps you reduce pests rather than unintentionally encourage them.

Organic or IPM?

IPM practitioners and organic gardeners approach pest problems with the same tactics. Both begin with site and plant selection, use barriers, employ natural predators and physical pest controls. Both may even resort to certain pesticides to augment their problem-solving approach. Organic does not mean No Pesticides, but the use of specific products labeled for organic systems. Most organic pesticides are botanically derived or based on natural pathogens or minerals. Also, organic doesn’t mean non-toxic. In both IPM and organic gardening, pesticides are the last option, not the first.
Use Pesticides Only If

- you have identified and analyzed the situation;
- you have tried prevention and the other tactics we suggest;
- the problem exceeds your threshold of tolerance, meaning it’s become a serious issue, or
- your health is at stake.

All pesticides, including organic pesticides, must be used according to the label and at the timing and application rate for the greatest effectiveness. Anything less than following label instructions is not true IPM.

IPM Principles for Healthy Plants

Plant Health Comes First. Healthy plants are less vulnerable to pests than stressed plants, so begin with meeting your plants’ needs. This is the right plant, right place principle. Choose plants suitable for the soil, light, water, humidity, drainage, wind, salt, and reflected heat of your property, or find ways to augment these conditions.

“Prevent and Avoid” Is the Best Defense. Carefully inspect new plants for signs of disease or insect pests before planting. Anticipate and discourage predictable pests common in your area and the plants you have. With our guide and your increasing experience, you’ll know what to look for. Rotate annual flowers or vegetables to different spots each year. This helps reduce the build-up of soil-borne diseases and some insects. Mix and match different plants. Monoculture—planting too many of one plant in one place—eases the way for pests. Take special care to remove diseased plant parts, weeds, or debris. Learn about new, invasive pests and be on the alert for them.

Let Nature Work for You. Natural systems can solve many garden problems; you just need to help them along. The organisms in healthy soil provide nutrients and help prevent plant diseases. Add organic matter, especially compost, and you might never have to supplement with fertilizers.

Encourage the natural predators that routinely destroy many pests. And, when you can, avoid using pesticides (even least-toxic ones). They also harm beneficial insects and helpful fungi, upsetting the balance of predator-prey relationships.
Problems: You Can Solve Them

Let’s begin with what goes wrong with plants and what you need to know to form a diagnosis. Plant pests include insects, plant diseases, or weed competition, but problems may simply be cultural (abiotic)—overwatering, soil compaction, or too much shade.

Plant diseases are caused by pathogens: microscopic organisms such as fungi, bacteria, nematodes, phytoplasma, and viruses. We’ll help you identify the organism and treat it accordingly. Don’t be tempted to spray away the problem. It’s rarely a long-term solution. Often it’s the stressed plant, already in poor health, which becomes diseased. You can’t correct disease problems without addressing your plant’s growing conditions and health. Keep in mind: a host and a pathogen can inhabit the same environment, but if conditions aren’t right for the pathogen, it won’t cause disease.

Plant Diseases

Culturally speaking, a plant’s setting (insufficient air circulation, too much rain/overwatering, drought, unhealthy soil) may offer clues as to which disease agents infected your plant and what you can do to reduce a disease-friendly site.

**Fungi** are found everywhere and can cause diseases called rusts and smuts. Humidity and temperature affect how quickly they grow. Symptoms generally appear on leaves, and may include white or black moldy-looking spots. Fungi reproduce through tiny spores, sort of like primitive seeds. Microscopic (usually) and light as dust, spores can blow for miles on the wind—or travel via water (such as runoff from high land to low land or raindrops splashing up from soil to leaves); clothing (after you brush up against a plant, especially if it’s damp with rain or dew); animals (especially insects); and tools. Spores appear as black specks, pimples, or pink fluff (depending on which fungi, under what conditions).

Fungal diseases are often managed with cultural practices: choose resistant plant varieties, change watering habits, and clean up diseased plants. Fungicides—pesticides targeted at fungi—could help.

**Bacteria** are one-celled organisms causing many leaf spots, rots, and wilts. They are highly contagious and enter plants through wounds or natural openings in leaves: stomates and hydathodes. Symptoms include leaf spots or marginal burn; slimy or smelly tissue; wilting. Bacteria reproduce via cell division—or by spores when conditions don’t favor active growth. Good sanitation is pivotal in preventing their spread. Examples: sterilize pruners between cuts; rogue (remove and destroy) diseased plants. Look for resistant plant varieties when replacing.

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How Diseases Spread

- wind
- rain
- water runoff
- sprinklers
- garden tools
- shoes
- clothing
- baskets
- wheelbarrows
- tillers
- birds
- insects
- vectors
- wild animals
- people
- pets
- seeds
- plant pieces

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Fungi come first

Usually we list pests alphabetically. But here, where we’re introducing the main categories of disease, fungi come first. That’s because they cause the vast majority of plant diseases.

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Powdery Mildew, *Podosphaera fuliginea*, a fungus, on cucumber. Photo: Charles Averre, North Carolina State University, Bugwood.org
Phytoplasmas are tiny bacteria with no cell walls. Symptoms look virus-like, with yellowing, stunting, dieback. Typically, this shows up as bunchy shoot growth on shrubs and trees. There is no cure, so sanitation and purchasing healthy plants is important. It can infect both vegetables and garden ornamentals. Phytoplasmas need a vector—like a sap-sucking insect such as leafhoppers—to move from plant to plant.

Viruses cause problems for plants too. These bits of nucleic acid, surrounded by a protein coat, act as obligate parasites, multiplying inside a plant or insect vector. There is no cure, so prevention and resistant varieties are key. Symptoms include mottled or mosaic leaf patterns, stringy leaves, excessive branching, slow growth, and spotted or off-color leaves. Viruses are tricky to diagnose, yet rarely kill the host, since that would be self-eliminating. Although “wilt” is used in the names of some virus diseases (tomato spotted wilt, for example), you may not see wilting in infected plants. Some viruses, such as tobacco or tomato mosaic viruses (ToMV or TMV) survive in seeds or dead and dried out plant material for years. They spread by tools or hands; when a plant’s surface cells are damaged; sometimes in seeds or by cuttings; and by many insect species. Tobacco products could spread TMV to tomato and tobacco plants. Disinfecting pruners between cuts and removing diseased plants is pivotal in preventing their spread.

Viruses are often known by their initials: CMV cucumber mosaic virus; HVX hosta virus X; INSV impatiens necrotic spot virus; TSWV tomato spotted wilt virus; TMV tobacco and tomato mosaic viruses.

Nematodes are microscopic worms found in soil. While they are not a disease, and definitely not an insect, their damage is classified with diseases because some spread (vector) disease while feeding on roots or leaves. (Note: many nematodes are beneficial by feeding on grubs and other pests.) Most are microscopic, invisible even through a magnifier or loupe. They can spread with rain or water, from infested soil clods, clinging to roots of infected transplants. Root-feeding nematodes inject a toxin into roots and are serious pests. Infected plants struggle to take up water and nutrients. Foliar nematodes infect leaves and shoots, and can persist for years in dead leaves. They are less common in the northeast because our winters help knock them back.

Since most nematodes are invisible, you’ll be basing your diagnosis on how the plant looks. Call your county’s Cooperative Extension or a diagnostic lab for help.
The World of Insects

Throughout this book, and your life as a homeowner or gardener, insects keep popping up. So, let’s start with some basics. All adult insects have three body segments: head, thorax, abdomen, and six segmented legs.

Many insects go through complete metamorphosis, meaning four distinct stages. Let’s just say eggs come first. Eggs hatch into larvae, also known as grubs, caterpillars, maggots, borers, or “worms.” Larvae feed on plants or their products, such as flour or oatmeal, or other animals. They start out small and grow—some get really big. Then come pupae, a resting stage where larvae, protected in cocoons or pupal cases, change (pupate) into adults of all sorts: beetles, butterflies, flies, moths, sawflies, wasps, or weevils.

Other insects hatch from their eggs looking like tiny wingless adults. Those young adults are nymphs. Dragonflies, true bugs, aphids, mealybugs, crickets, grasshoppers all grow into adults in a process called gradual metamorphosis.

Whether they’re larvae or nymphs, all young insects molt several times, shedding their old skins so they can grow bigger.

Mites are different. They’re not insects—they’re arachnids, related to spiders, and have eight legs. Most are tiny—barely visible, sometimes even through a loupe. That’s why they’re called mites. They hatch looking like adults, just smaller, and go through gradual metamorphosis. But some species hatch into a six-legged form called larvae, and aren’t called nymphs until after their first molt when they will have eight legs.

Beneficial Organisms and Biodiversity

Most insects serve us in some way, often as predators or pollinators, or at least do us no harm. Fewer than five percent of all insects are considered true pests, endangering or damaging crops or natural habitat. Sometimes that’s because past landscaping or farming practices helped these pests succeed. How? By depleting and not rebuilding soil, by planting the same crop in the same place year after year, by using broadcast pesticides that lead to pesticide resistance.

Mites, spiders, nematodes, fungi and bacteria too numerous to count—these too serve our interests. Few are true pests.

In agriculture as well as in the yard and garden, biodiversity, the natural coexistence of many plant and animal species, tends to promote ecological health and reduce imbalances.

Natural enemies range across most orders and classes. Never kill a critter you haven’t identified … it could be a garden good guy.
**Incomplete Metamorphosis**, showing the life stages of the brown stink bug, *Euschistus servus*, shown at 2x actual size.

Drawn from photos by Herb Pilcher, USDA Agricultural Research Service, Bugwood.org.

**Eggs**

- First instar nymph
- Second instar nymph
- Third instar nymph
- Fourth instar nymph
- Fifth instar nymph
- Adult

**Complete Metamorphosis**, showing the life stages of the small cabbage white butterfly, *Pieris rapae*.

All illustrations on this page drawn by Karen English, NYSIPM.
**Beneficent Beetles**

**Fireflies, lightning bugs.** Long (to 1 inch) flat brown or black beetles with a light organ in their abdomens. Females flash as they crawl among plants, signaling to males as they flash and fly by. Larvae live in the soil, devouring slugs, snails, insect larvae, and other pests.

**Ground beetles** of many kinds. Shiny black, blue-green, or copper; sizes vary. Larvae are fierce hunters of cutworms, root maggots, aphids, spider mites, and many other pests. Some eat slugs or snails. Low-till or no-till gardening saves the lives of many soil-dwelling good guys.

**Lady beetles, also known as ladybugs or ladybird beetles.** Yellow, orange, or red adults with black spots; to ¼ inch. Other species are black with red spots. All have black legs and heads (though “neck shields” can have white-on-black patterns). Most species’ larvae (to 3/8 inch) are bristly and orange with black spots; Larvae and adults eat many pests, especially aphids, mites, thrips, and scale.

**Rove beetles** are sometimes mistaken for earwigs because of their short wings and exposed abdomen. They are not quite 1/8 inch, and move rapidly, holding their bodies high off the ground. Predators of many insect larvae, fly maggots, and soft-bodied insects.

**Soldier beetles** look like fireflies but don’t glow. Up to 1”, with long antennae—they are mostly tan, though some are bluish-gray. Adults and larvae eat insect eggs, caterpillars, maggots, and other insect larvae.

**Weevils, snout beetles.** Many weevils eat crops or stored foods like wheat or nuts. Others eat weeds. Some are so fussy about what weed they eat that scientists have turned them loose on invasive weeds such as mile-a-minute weed.

**Brazen Bugs**

**Ambush bugs** have pale yellowish bodies, ¼ inch, with a broad dark band on the lower half of their abdomens. Aggressive hunters of flies, moths, other bugs; even bees or butterflies, they seize prey with thick, muscular-looking front legs. Look for them on wild asters and Queen Anne’s lace.

**Assassin bug** adults are ½ – ¾ inch, and have sucking, downward-curving mouthparts useful on insect eggs, aphids, leafhoppers, beetle larvae, small caterpillars, flying insects and many others. Watch out. Assassin bugs can bite if you touch them. Eggs are found in clusters with little caps or lids on top of each. Nymphs are often bright red and have long, spidery legs (while their bodies grow, their legs don’t). They come in many
kinds and colors, but those in your flowers have long, thin heads and spiny front legs.

**Big-eyed bugs** are small, 1/8”, oval and generally black, tan, or white. They eat insect eggs, aphids, chinch bugs, leafhoppers and spider mites. Because they drop to the ground when disturbed, they’re often found in groundcover.

**Damsel bugs** are slender, dull gray or brown, ¼ – ½ inch, with curving, beak-like mouthparts. These fast-moving bugs dine on aphids, small caterpillars, leafhoppers, mites, plant bugs and more.

**Minute pirate bugs.** (Minute as in small, not sixty seconds!) The nymphs are pale with red eyes; the adults are oval, about 1/8 inch. Their black-and-white V-pattern mirrors itself. Thrips, spider mites, aphids, and eggs of many others comprise much of their food. They are found under flowering plants, clover, and groundcovers, and are apt to sample you with a bite.

**Spined soldier bugs** munch on Colorado potato beetles, Mexican bean beetles, aphids, and cabbageworms. Shield-shaped adults are ¾ inch, yellowish brown with fine black speckles. Their long snouts point straight forward. Pointy “shoulders” resemble a soldier’s dress uniform with shoulder epaulets. Don’t mistake it for the brown marmorated stinkbug, a pest with rounded shoulders.

**Two-spotted stink bug, conspicuous stink bug:** Adults: shield-shaped black body; 3/8 – 1/2 inch, with bright orange patterns on “shoulders” and back. This predator is common in vegetable and flower gardens, and eats eggs, larvae, and adults of many insect pests, such as Colorado potato beetles, Mexican bean beetles, and asparagus beetles; at times it eats foliage of some plants. The nymphs are red and black.

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**Will the real bug please stand up?**

Most insects aren’t really bugs to the people who study them. For entomologists, bugs are a certain type of insect (Order: Hemiptera)—an assassin bug, for example, or bed bug or lace bug—and many more. “True bugs”, the Hemiptera, are one of 31 orders of insects. For instance, in animal taxonomy terms this particular stink bug (*Hemiptera pentatomidae*) is:

Kingdom: Animalia  
Phylum: Arthropoda  
Class: Insecta  
Order: Hemiptera  
Family: Pentatomidae  

True bugs make their living by sucking nutrients out of leaves or stems or, if they’re a predatory bug, from another insect’s body. And some, like bed bugs, feed on blood. The main thing to remember about these true bugs is that they don’t chew or sting. They have sucking mouthparts.

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**Dragons and Damsels**

**Dragonflies and damselflies** catch and eat prey as they fly. Damselflies are thin, with bulging eyes set far apart. Dragonflies are heftier and their eyes almost touch. Four strong wings move independently. Some dragonflies even migrate like birds.
Friendly Flies

Most flies are good for your garden, pollinating flowers and eating pests. Midges, hoverflies, robber flies, tachinid flies—each of these groups includes several or many species of varying shapes and sizes. Keep an eye out for these helpful flies:

**Aphid midges.** Got a loupe? These tiny critters are just larger than a pencil point, and look like mini-mosquitoes. They overwinter under leaves or debris and lay eggs near aphids. Look for clusters of tiny orange eggs and bright colored larvae on leaves or stems. Midges thrive in temperatures between 60° and 80°F, and in high humidity, just when many plants are putting out the tender new growth aphids love.

**Hoverflies, flower flies, syrphid flies** look like ½-5/8” bees—and are great pollinators—but have two wings, not four. Larvae are pale greenish-brown, and only ¼ inch. These beneficiaals devour aphids, caterpillars, leafhoppers, mealybugs, and scale.

**Robber flies.** Some look like bumblebees or damselflies, and are good-sized at 1/2 – 1 ¼ inches. All have strong, stout legs and bearded faces. They feast on butterflies, bees, grasshoppers, wasps, and flies. Larvae live in soil and are rarely seen; they feed on grubs, root maggots, and insect eggs.

**Tachinid flies** are mottled black, gray, tan, or copper; stocky; 1/16 – 5/8 inch. Many have bristly abdomens. They lay eggs on bugs, caterpillars, and beetles—then the larvae eat their hosts. Good pollinators.

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**Buying Beneficials?**

Think Ahead. Placing an order for beneficial insects? Good. Instructions will come with your insects, but learning how to be a good host will increase their success—and encourage them to put up shop in your garden.

Generally, release your purchased beneficials in the late day or evening, after you’ve watered the garden. Try to sprinkle them around the garden, rather than dump them in a clump.

An optimal habitat means providing water and their favorite plants: carrot, caraway, dill, lovage, fennel, tansy, daisy, yarrow, goldenrod, black-eyed Susan, and asters.

And don’t expect them to stay around unless they’ve got food. In other words, if you don’t have a pest problem, they’ll go elsewhere. Provide habitat that promotes beneficials and they’ll visit when you have pests, then move on. Most importantly, don’t spray to kill your pests if you want to maintain or attract beneficials. Use pesticides only when absolutely necessary to stop a pest population from getting out of control.
**More Beneficials**

**Adult Lacewings** are lovely, and their larvae are fierce predators, eating lots of eggs, caterpillars, and soft-bodied insects like aphids, often camouflaging themselves with bits of leaves, twigs, or dirt. Adults sip nectar, so plant flowers in the composites family—daisies, mums, zinnias, and black-eyed Susan, goldenrod, asters, dandelions, and sunflowers.

**Mantids, praying mantises**, are fun to find. They are fast enough to catch mosquitoes and flies, and are the only insect predator that feeds at night on moths. Their egg cases, attached to plant stems, trees, fence posts, look like paper maché.

**Mites** are barely visible, eight-legged arachnids. Not insects! Predator mites attack pest mites (such as spider mites) and many soft-bodied insects—thrips, fungus gnats, fly larvae, and more. Often released in commercial greenhouses and orchards—you can buy them from labs that sell beneficials.

Mighty mites get bad press because of spider mites, well-known garden pests. But most of the world’s 30,000 species are beneficial. Predatory mites are quick on the draw when their prey are around, but pesticides kill them.

Try this if you have thrips and troublesome mites: Water plants well, since predatory mites thrive when it’s moist. A couple of days later, pull out your loupe and look. Spider mites and their kin will have settled down to dine, but those fast-moving dots are probably predatory mites attacking eggs, larvae, nymphs, or adults.
**Powerful Parasitoids**

Parasitoid wasps (no, they won’t sting you) are the reason we aren’t up to our ears in caterpillars. Their discreet habits and size—many are barely bigger than a comma—mean you’re unlikely to see them at work. Like predators, parasitoids live off something else, but in a more complicated way. They lay eggs in or on their host, and depending on which parasitoid, that host could be in any stage, from egg to adult. They eat their hosts inside out, finally killing them. While inside, they’re protected from other things that might eat them.

Watch them at work around an aphid colony. With good eyes or a magnifying lens you can spot tiny flying specks. You might even see them jabbing the aphids. They’re laying eggs. Look for aphid mummies—papery in color and texture—with holes where the new wasp exited. Aphids normally have soft bodies, but when parasitized their bodies harden a little, better protecting the growing wasp.

If you see wartlike growths on a caterpillar, that’s a likely sign of parasitoids at work. Leave them be. The helpful hatchlings will more than make up for the caterpillar’s feeding damage.

The variety and number of parasitoid species is amazing. About 5–10 percent of all the insects in your yard are parasitoids. Most are host-specific and choosy about the life stage they attack. The ichneumonid family includes about 40,000 species. Collectively they prey on caterpillars, spiders, larvae of beetles and sawflies, and so many more. The braconid family, also about 40,000 species, preys on caterpillars, flies, beetles, and wasps. And chalcid family wasps, 100,000 species strong, include many species of *Trichogramma* wasps and *Encarsia formosa* too. Some flies are also parasitoids, notably the tachinid flies.

**The Best of the Rest**

**Spiders** are not insects, but arachnids—they have eight legs. They’re predators of many garden pests and famous for spinning prey-trapping webs, but not all spiders spin webs. Some stalk their prey instead. Venomous spiders are rare in the Northeast.

**Wasps.** Yes. Hornets, paper wasps, yellow jackets are avid predators, bringing home caterpillars and other prey and feeding them to their young. By chance they also pollinate your plants!

The IPM approach values biodiversity. It teaches you how to protect and use beneficial insects, natural enemies, and other natural pest-control systems.
We Haven’t Forgotten Those Pesky Weeds

Weeds can out-compete veggies or flowers for nutrients, and even make apple and pear trees less productive. They can also host insect and disease pests. (On the balance side, they also could host natural enemies.)

Most of our favorite garden flowers have histories of being wild and free, and have cousins in the weed category. Weeds are survivors. They spread easily by runner or seeds, and many of those seeds can endure for years, waiting for the opportunity to sprout.

There are annual, perennial and biennial weeds and knowing the difference increases your chances of effective management. It’s said that more than half of home pesticide applications are herbicides used to kill weeds.

Some weeds pull out easily, some must be dug out to remove every trace of root. In the garden, bedstraw, bindweed, and curly dock may make you consider a new hobby. In the lawn, perennial weeds like dandelion, plantain and ground ivy tell you a lot about the health of your soil, but who wants to listen to a weed?

Can you outsmart weeds? Most of them. Because weeds might just be your number one pest, we have a full chapter devoted to them. We’ll talk about mulch in vegetable gardens and ornamental beds, and help you help your turfgrass to outcompete lawn weeds.

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Annual, Perennial, Biennial?

Generally speaking, annuals complete their life cycle in one season. They bloom and then they die.

Perennials grow and bloom, and then they rest or die back but will live for another few seasons; some live countless seasons.

Biennials need two seasons to complete their life cycle. Their growth form alternates from one year to the next as they produce seeds or propagate themselves. Note: they may live much longer than those two years.

Flowers in the compositae and asteraceae family of flowers are favorites of many beneficial insects. To encourage beneficial insects, plant a variety of compositae and cup-shaped flowers. “Composite” flowers are double. Besides the ray petals, the center is composed of tiny individual flowers. This is a huge family and includes yarrow (the pink flowers above), ageratum, aster, mums, marigolds, daisies, and more.
Vertebrate Pests—Inside and Out

Inside or out, mice and other animals such as groundhogs or pigeons can be noisy, destructive, or even carry diseases or parasites.

The best approach is to build them out and block them out. Animals enter homes for shelter and food, of course, but may just be exploring. What is normal behavior for them often causes damage for us: chewing through wires and insulation, and at times walls. In the garden, they dig up bulbs, mow through a mature crop, or get in your garbage. Some do little damage but having them as housemates or neighbors means noise, droppings and odor, not to mention the stress of hearing or seeing uninvited critters.

Relax. We have great resources for structural pests as well.

A Wish for Your Home and Garden

May your flowers bloom, your vegetables thrive, and your trees live for many decades. May your lawn grow green, your weeds grow small, and your family be surrounded by a healthy natural habitat with minimal pest visits inside your home. And may every pest you see be stalked by a beneficial organism!