APPENDIX I

LANDSCAPE PESTS

HEMLOCK WOOLLY ADELGID *(Adelges tsugae Annand)*

Hemlock Woolly Adelgid

A. tsugae is a small .03 cm (1/32 in) reddish-purple (aphid-like) insect that covers itself with a white fluffy secretion. *A. tsugae* was probably imported from Asia. The nymphs and adults have thread-like mouth parts (stylet) used to suck sap from young hemlock twigs. The needles may drop prematurely and defoliate the tree, resulting in death within several years. The adelgid may also inject a toxic saliva that disrupts the tree's growth hormones.

Female adult *A. tsugae* lay eggs hidden by the white fluffy secretion, protecting them from many pesticides. The eggs hatch and the adelgid crawlers move about and settle to feed on twigs or the base of needles. The white, fluffy wool secretion soon covers them completely. The female adelgid overwinters within the mass and may begin to lay eggs in February. Some nymphs may develop into a winged adult which then may fly to another hemlock to lay eggs or to an alternate host such as spruce. Dispersion is by wind, birds and mammals.

MANAGEMENT

A second generation may develop in early fall and over winter, which can be time to attempt management sprays with insecticidal soaps and horticultural oils. This combination reduces the adelgid population and has minimal effects on natural predators and parasites. Horticultural oils may damage hemlock during growing season. Specimen trees may require a soil drench with Merit™ (Imidicloprid) which is taken up by the tree roots and translocated throughout the branches and leaves to kill the adelgid. Predators or parasites that are effective are not yet available.

More information may be obtained at the USDA Forest Service, northeastern area (610-975-4186).

GYPSY MOTH

Gypsy Moth Caterpillar

Gypsy moth is a recent addition to the long list of insects that defoliate oak, aspen and other hardwood species in the United States. This exotic pest did not occur in North America until it was accidentally introduced into Massachusetts in 1869. Since then, gypsy moth populations have spread west and south.

Gypsy moth outbreaks can last one to five years. Outbreak populations then decline because of the buildup of disease, natural enemies and starvation. Low gypsy moth populations may be held in check by birds, insect predators and small mammals before the next outbreak occurs. In oak-dominated stands, gypsy moth outbreaks usually persist two to five years before collapsing. Populations then remain low for four to 12 years before increasing again. Outbreaks may build and decline faster in aspen dominated stands than in oak stands.

Effects of gypsy moth defoliation are usually most severe during the initial outbreak in a newly infested area. If more than 60% of the canopy is consumed by gypsy moth caterpillars, trees typically "refoliate," producing a second flush of leaves later in summer.

Gypsy Moth Egg Mass with Hatching Larvae

The amount of tree mortality and top kill sustained during a gypsy moth outbreak depends on the severity and frequency of defoliation and on tree health. Vigorous trees can often withstand severe defoliation for a few years. However, each refoliation stresses the tree, reducing its energy reserves. Subsequent stress, including additional defoliation, drought or frost injury, may kill the tree. Suppressed, diseased or low-vigor trees may be killed after one year of heavy defoliation. Severe gypsy moth defoliation, accompanied by an abundance of large hairy caterpillars and frass (fecal pellets), can be unsightly and may reduce the enjoyment of visitors at recreational areas.

Gypsy moth defoliation is primarily based on tree species composition. Stands dominated by oaks, aspen, birch, basswood, willow or other species preferred by gypsy moth will be at high risk of defoliation. Defoliation will be lower in stands dominated by tree species that are less preferred by gypsy moth, such as maples, ash and most conifers. Defoliation may also be higher

where many dead branches, bark flaps and stem wounds are present because these areas provide good hiding places for gypsy moth caterpillars and pupae.

Stand hazard is increased by factors that reduce stand vigor such as overmature trees, suppressed or diseased trees, compacted soil or severe competition. Hazard also increases when drought, late spring frosts, flooding or other stressful environmental conditions occur. Tree mortality has been observed primarily in oak-dominated stands where gypsy moth defoliation coincided with drought or late spring frosts.

MANAGEMENT OPTIONS

Appropriate strategies for gypsy moth management depend on the specific management objectives for each stand, and the quality of the site.

Release of the parasite (*Cotesia melanoscelus*) on gypsy moth larvae may be useful in reducing the population and thus reduce defoliation.

Remove suppressed and low-vigor trees that will be highly vulnerable to damage by gypsy moth and other pests. Leave healthy trees with large crowns that are likely to survive defoliation. Residual trees will require one to two years to recover from defoliation, drought or other stress and adjust to increased exposure.

Thinning to reduce stand density can increase vigor of residual trees and reduce stand risk and hazard. Thinning is most appropriate on medium- and high-quality sites, where costs are economically justified.

To reduce stand hazard, cut suppressed, wounded, diseased or low-vigor trees with poor canopies. Thin to levels appropriate for the species and the quality of the site. Prevent soil compaction, wounds and other injuries to residual trees. Anything that reduces vigor of the residual trees can increase stand hazard.

Selecting against tree species that are preferred hosts of gypsy moth will reduce long-term risk of defoliation. On fertile, mesic sites, altering the species mix can result in stands of high-quality hardwoods. Favoring ash, tulip poplar, maples or conifers in northern or mixed hardwood stands can help increase stand diversity while reducing the risk of defoliation. Increasing species diversity within stands may also reduce the long-term risks of damage by other forest pests.

High-value oak-dominated stands approaching economic or pathological rotation age can be protected with an aerial application of Bt (Bacillus thuringiensis var. kurstaki), a short-lived microbial insecticide that causes a bacterial disease in foliage-feeding caterpillars. Bt is not toxic to other insects or to fish, birds, humans or other animals. An alternative pesticide for killing gypsy month larvae is Dimilin (diflubenzuron) as an aerial application. It is applied at 1.7 g (0.06 oz). per acre and is effective. Other effective materials are Gypchek (gypsy moth neucleopolyhedrosis virus, NPV) and disparlure (Disrupt II) pheromone. The naturally occurring fungus *Entomophaga maimaiga* has also managed large gypsy moth populations in the environment.

Sometimes taking no action is the best alternative. Young, vigorously growing stands are likely to tolerate even severe defoliation for two to three years or longer. Stands with a mixture of species are less likely to sustain severe, repeated defoliation than are stands of nearly pure oak or aspen. No action may also be the best option when stands are at or near optimal levels, especially if vigorous non-host species are present.

Managing stands to provide wildlife habitat may result in greater numbers of natural enemies that feed on gypsy moth. Understory plants and shrubs, trees with cavities and fallen trees are important for maintaining populations of predatory and parasitic insects, insectivorous birds, rodents and other small mammals. When leaving trees for wildlife, select species that are not preferred by gypsy moth.

Avoid using Bt to protect foliage in stands managed primarily for wildlife. Bt can kill caterpillars of "non-target" butterfly and moth species that are present during spraying. However, high gypsy moth populations may also temporarily reduce diversity and abundance of some native insect species.

Recreational areas experiencing a gypsy moth outbreak can be unpleasant places for camping or picnics. The swarms of large caterpillars and frass are distasteful, and the hair on the caterpillars may trigger allergic reactions in some people.

Use burlap, sticky or Teflon-coated bands on the lower trunk of gypsy moth host trees in recreation areas. Use burlap and sticky bands to trap or destroy caterpillars as they move up and down tree stems. Use Teflon-coated bands to prevent caterpillars from crawling up into tree canopies to feed. Banding is economically viable for high-value ornamental or shade trees. Where practical, water defoliated trees during warm dry periods. Prevent soil compaction and wounds to gypsy moth host trees.

EASTERN TENT CATERPILLAR *Malacosoma americanum*

Eastern Tent Caterpillar

The eastern tent caterpillar is more a nuisance than a threat. While heavy infestations can cause serious defoliation, eastern tent caterpillars rarely kill trees except those already weakened by disease or climate and environmental stresses. Some studies indicate some defoliation strengthens trees and makes them hardier. These caterpillars get their name from the ugly tent-like nests that they spin in the crotches of host trees. They are native to North America east of the Rocky Mountains.

The preferred tree for these pests is the black cherry, but they will also infest other cherry trees as well as fruit trees such as apple and a variety of shade trees.

Eastern tent caterpillars are black and hairy with a white stripe and a series of blue dots along the length of the body. At maturity, they range from 5 – 7 cm (2 – 2 ½ in) in length. The moth is reddish in color with white bands on the forewings. Females can be double the size of the males with a wingspan of 7 cm (2 ½ in).

E. Tent Caterpillar Eggs

Eastern tent caterpillars survive the winter in masses of 100 to 300 eggs noticeable as shiny black bands encircling twigs. Eggs hatch in the spring at about the same time as the host tree comes into leaf. The young caterpillars then begin to consume leaves and spin the characteristic "tent" nest in the crotch of the tree. The nest continues to grow as long as the caterpillars keep feeding. When the caterpillars reach maturity, after about six weeks, they pupate in silken cocoons visible on trees, on the sides of buildings and on fences. Moths emerge in July to mate, lay eggs and then die.

MANAGEMENT

E. Tent Caterpillar Nest

Eastern tent caterpillar infestations rarely threaten the lives of trees, so management is generally for aesthetic purposes. Tents can be removed and destroyed at night after the caterpillars have returned from feeding.

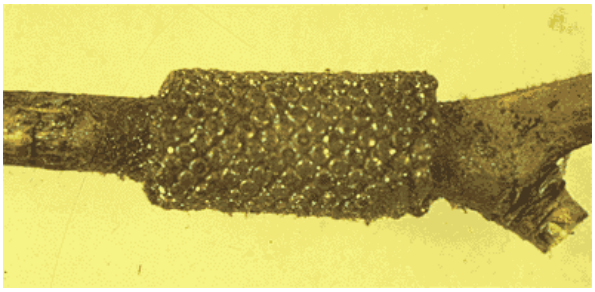
During winter after leaves have dropped from host trees, search for the black bands of eggs encircling twigs. Physically remove the egg mass or prune it out of the tree and destroy them. If a treatment becomes necessary because of large numbers of "tents," *Bacillis thuringiensis* Kurstaki is effective.

FOREST TENT CATERPILLAR *Malacosoma disstria*

Forest Tent Caterpillar

A cousin of the eastern tent caterpillar, the forest tent caterpillar prefers hardwoods like sugar maples and oaks. The term "tent" caterpillar is a little misleading as these insects don't construct large tent-nests in the crooks of trees. Instead they spin pad-like structures on trunks and on branches where they go to rest and to molt.

Other aspects of the forest tent caterpillar are similar to those of the eastern tent caterpillar. They may be ugly and unsightly, but their defoliation rarely kills host trees unless the trees are already diseased or under stress due to climatic or other environmental factors. Forest tent caterpillars have a brownish body with bluish lines along the side. With each molt, a line of white, footprint-shaped spots becomes visible. Mature caterpillars can reach 5 cm (2 in) in length. Moths are yellowish-brown and chunky with two dark lines on the forewings.



Forest Tent Caterpillar Egg Mass

Forest tent caterpillars start their lives as eggs laid in shiny brown bands of 100 to 300 around twigs. Caterpillars emerge as new leaves begin to appear and begin feeding and constructing their nests immediately. During the five or six weeks of the caterpillar stage, they go through four molts. After the last molt, the caterpillars spin yellowish cocoons in some sheltered place in which the final transformation to moth takes place. Moths emerge from the cocoons after about 10 days to mate, lay eggs and then die.

MANAGEMENT

Forest Tent Caterpillar Adult

If populations are large and widely distributed, the biological insecticide *Bacillis thuringiensis* Kurstaki is effective for forest tent caterpillars. The pad-like tents can be collected and destroyed at night when the caterpillars return. Egg bands can be pruned out or removed in winter when leaves have fallen (the bands become more visible).

DOGWOOD BORER *Synanthedon scitula* (Harris)

Dogwood Borer Adult

The Dogwood borer, a black, clearwing moth with yellow stripes, looks like a wasp and is a fast flyer. Unlike most moths, *S. scitula* is an active flyer during daylight hours. The adult emergence is related to the dogwood *(Cornus florida)* phenological development. When the last of the dogwood flower petals are ready to drop, the dogwood borers begin to emerge from the host. The flight of moths may continue until September. Eggs are laid on both smooth and rough bark, but usually on injured bark near wounds. Upon hatching, the larva searches for an entry point to the tree's inner bark. The larvae are phloem and cambium feeders and remain in the inner bark throughout development. The mature larva is white with a pale brown head.

Cultivated dogwood trees planted in sunny locations are usually more heavily infested than those in the woods. Loose bark is an early indication of attack. Dieback in the crown, scars on the trunk and limbs, and adventitious growth are signs of advanced damage. Woodpeckers prey on the larvae under the bark, and the adults are a food source for birds, dragonflies, bats and other insectivores. The Korean dogwood, *Cornus kousa,* may be resistant to the dogwood borer.

Management measures can include avoiding mechanical injury to the tree from mowers, string trimmers or other landscape equipment. Install mulch around trees or plant a ground cover to eliminate weeds and the need for mowing. Dogwood borer infested trees can be managed by a thorough liquid spray of the trunk and limbs with entomopathogenic nematodes. Provide the treatment in August or September; or in late April and in August or September for severe infestations. Chemical pesticides are NOT recommended. The nematode *Steinernema carpocapsae*, may be labeled for dogwood borer.

POISON IVY *Rhus toxicodendron*

Poison Ivy

Poison Ivy is a woody vine that is known for its ability to produce urushiol, a skin irritant that causes an itching rash for most people. The oil is in the leaves, vines and roots. Poison ivy grows throughout much of North America. It can grow as a shrub up to about 1.2 m (4 ft) tall, as a ground cover 10 – 25 cm (4 – 10 in) high, or as a climbing vine on various supports. Older vines on substantial supports send out lateral branches that may at first be mistaken for tree limbs. Poison ivy rarely grows at altitudes above 1,500 m (5,000 ft).

The leaves are compound with three almond-shaped leaflets. The berries are a grayish-white color and are a favorite winter food of some birds.

The color ranges from light green (usually the younger leaves) to dark green (mature leaves), and bright red in the fall. The leaf surface is smooth and has few or no teeth along the edges. The stem and vine are brown and woody.

Poison Ivy in the Fall

The reaction caused by poison ivy, urushiol-induced contact dermatitis, is an allergic reaction. For this reason, some people are immune to its effects. However, sensitivity can develop over time. If poison ivy is burned and the smoke then inhaled, this rash will appear on the lining of the lungs, causing extreme pain and possibly fatal respiratory difficulty. If poison ivy is eaten, the digestive tract and airways will be affected, in some cases causing death.

Due to the potential human risks from exposure to the urushiol in poison ivy, management of this native plant can be difficult. Wear gloves, dust mask, goggles and other skin protection. Small plants can be mowed (repeatedly) when it moves into turf areas. Herbicides can be used to kill poison ivy; however, the dead vines must be removed and bagged for disposal. Do NOT burn poison ivy. Provide signage to warn visitors of the presence of poison ivy along pathways or other areas where it is present.

WHITE-TAILED DEER - *Odocoileus virginianus*

White-Tailed Deer

The white-tailed deer is tan or brown in the summer and grayish brown in winter. It has white on its throat, around its eyes and nose, on its stomach and on the underside of its tail. The male has antlers. Males weigh between 150 and 300 pounds and females weigh between 90 and 200 pounds.

The white-tailed deer can be found in southern Canada and most of the United States, except for the Southwest, Alaska and Hawaii.

A deer's home range is usually less than a square mile. Deer collect in family groups of a mother and her fawns. When a doe has no fawns, she is usually solitary. Male bucks may live in groups consisting of three or four individuals, except in mating season, when they are solitary.

White-tailed Doe & Fawn

The white-tailed deer lives in wooded areas. In many areas, deer overpopulation is a problem. Gray wolves and mountain lions used to be predators of the white-tailed deer and helped keep their population under control.

Disease and parasites like lice, mites and roundworms can weaken or kill deer. Young deer and old deer often get sick and die, especially in the winter. Their long narrow legs and pointed hooves make it hard for them to move around in the snow and ice and it is easier for predators like dogs to catch them.

Deer and people are living closer to each other because of human development and growth in deer and human populations. Because humans and deer often share a habitat, there can be problems for both of them. When a deer's habitat becomes smaller because of human development, deer will often eat food from gardens.

The white-tailed deer is an herbivore or plant eater. It follows well-used trails to its feeding areas. It feeds in the early morning hours and in the late afternoon. A deer's diet changes depending on its habitat and the season. It eats green plants in the spring and summer. In the fall, it eats corn, acorns and other nuts. In the winter, it eats the buds and twigs of woody plants.

The white-tailed deer is a ruminant. Its stomach has four chambers for digesting food. This digestive system lets the white-tailed deer eat foods like woody plants that other animals can't digest! If deer have enough food, water and shelter, their population can grow very quickly.

White-tailed deer mate in November in the northern parts of their range and in January or February in the southern parts of their range. The female has one to three fawns about six months after mating. Fawns are reddish-brown at birth with white spots that help camouflage them. They can walk at birth and forage for food a couple of days later. They are weaned at about six weeks.

When a white-tailed deer is alarmed, it may stomp its hooves and snort to warn other deer. It may also "flag" or raise its tail and show its white underside. White-tailed deer are very good runners. They can run at speeds of up to 30 miles an hour. They are also good leapers and swimmers.

WOODCHUCK (GROUNDHOG) *Marmota monax*

The woodchuck, which inhabits most of North America, is sometimes known as a groundhog. This name is taken from the underground burrows that it digs and lives in. Each burrow consists of several rooms with sleeping areas located in the higher elevations and smaller chambers below which are used for hibernation or toilet facilities.

Woodchuck (Groundhog)

The woodchuck is large with a heavy body (45.72 – 67 cm [18 – 26 in]) atop short but powerful legs. Males are slightly larger than females. They have a coat of silver gray and brown with a lighter underneath side. The head is dark brown and the feet are so dark they appear black. Woodchuck incisors are ever-growing, and if not worn down properly in the course of chewing, they may continue to grow with fatal results. In both agricultural and garden areas, the burrows are hazardous to humans and animals alike. Typical woodchuck habitat includes rolling farmland, grassy pastures, small woodlots and fence lines. They prefer forest edges and openings where they are never far from cover, and are partial to loamy and sandy soils for burrowing.

Woodchucks are primarily herbivores, preferring the vegetative parts of plants. In the early spring when vegetation is sparse, they may eat the bark, buds and twigs of plants such as dogwood, sumac and fruit trees. They prefer to eat clover, grasses, forbs and herbs, as well as farm crops such as alfalfa, corn, fruits and vegetables. Females have a single littler of one to nine (average three to five), usually born in May. Young are weaned after approximately 45 days and dispersed when six months old. Woodchucks begin a true hibernation in October which ends in March or April. They live up to six years in the wild.

Woodchucks are prey for large predators (cougars, bobcats, wolves), and can be taken by coyotes or large hawks and owls. Modifying the habitat around woodchuck burrows may discourage them. Remove the cover around burrows and install objects that can move in the wind or randomly. Applying urine from large predators in the area of burrows may also encourage woodchucks to abandon the area. Burrows under structures can be modified with one-way doors to allow exit but not entry. Do not exclude woodchucks until after young have been weaned in late summer. Hardware cloth may need to be installed underground in an L shape to discourage digging new burrows under structures. Fasten hardware cloth to the bottom edge of the deck or structure, burying it 25.4 – 30.48 cm (10 – 12 in) underground with the bottom of the L-shaped angle leading outward.

EASTERN MOLE *Scalopus aquaticus*

Eastern Mole

The eastern mole is about 15.24 – 20.32 cm (6 – 8 in) in length and can weigh 84 – 168 gr (3 – 6 oz). Each year a mole can have one litter of two to six young, depending on the female's health. Gestation lasts about five to six weeks and the young are born between mid-April and mid-May. Young moles have less than a 50% chance of surviving long enough to reproduce.

Moles are insectivores whose primary food source is earthworms. They spend the majority of their life below the ground, and their activity can cause damage to lawns and turf. This damage is in the form of tunnels and/or mounds that can be unsightly and disturb root systems. Moles can quickly colonize and spread through adjacent properties. Because they need a well-established tunnel network to survive, management will be more difficult the longer they are allowed to tunnel and become established. In large areas, moles may move from one part of the property to another. This movement is affected by climate and ground moisture. They will also respond to changes in food supply as different insect larvae become available in different places and different times throughout the year. If disturbed, moles may temporarily leave an area, but will return. Even without disturbance, mole activity may only last a short time in a particular area.

Over-watering turf can bring soil invertebrates and moles closer to the surface making tunnels more visible. Reducing the amount and frequency of watering may help. Numerous home remedies have been used, but results are generally ineffective. Moles provide benefits to meadows and turf by turning soil, mixing soil nutrients, and improving soil aeration. Modifying the turf species to include native grass and forbs for an environmentally sound landscape can eliminate mowing and other manipulations.

If necessary, trapping is the most effective and practical method of managing moles. Trapping success tends to be greatest in the spring and fall, especially after rain. In the summer and winter, moles are active in deep soil and are more difficult to locate. To ensure safe and humane deployment, be sure to follow printed instructions. Traps should be set in active surface burrows. Two types of traps are available: harpoon traps and chokers. The harpoon trap consists of two prongs that straddle the mole tunnel and a set of spring-driven spikes. The spikes are raised above the tunnel and catch in the trigger release. When the mole triggers the trap, the prongs are released and driven through the sod, impaling and killing the mole. A choker trap consists of a cast-metal frame with two spring-retractable loops. Two slits are cut in the tunnel and the set loops are placed inside. When the mole triggers the trap, it is immediately crushed. When using traps, place a plastic pail with a warning sign over each trap. Set three to five traps per acre.

VOLES

Voles are compact rodents with stocky bodies, short legs and a short tail. Their eyes are small and their ears are partially hidden. Their fur is dense and usually brown or grey.

Meadow Vole

The meadow vole (*Microtus pennsylvanicus*) is the most widely distributed *Microtus* in the United States. The meadow vole is 14 – 19 cm (5 ½ - 7 ½ in) long with grey to yellow-brown fur and black-tipped hairs. Its underparts are grey and the tail is bicolored. It prefers damp meadows and grassland habitats.

The pine vole (*Microtus pinetorum*) or woodland vole is small, 10 – 15 cm (4 – 6 in) long. Its fur is brown with grey underparts. Its tail may be barely bicolored or unicolored. It prefers heavy ground cover in deciduous or pine forests, abandoned fields and orchards.

Voles are active day and night year around, and do not hibernate. Home range is usually 0.1 hectares (1/4 acre) or less. Voles construct many tunnels and surface runways with a number of burrow entrances. Voles have from one to five litters a year with an average of three to six young per litter. Population fluctuations are large and peak every two to six years. High vole densities may reach up to 1,250 per hectare (500 per acre). Life spans are short, ranging from two to 16 months.

Voles may cause extensive damage to orchards and forests by their girdling of seedling and mature trees. Voles are mostly herbaceous, feeding on a variety of grasses, herbaceous plants, bulbs and tubers, as well as bark and roots of trees; usually in the fall and winter. Voles are poor climbers and seldom enter buildings.

Managing voles involves exclusion and habitat modification. Exclude voles from orchard trees by enclosing each tree in .64 cm (1/4 in) hardware cloth, 30.48 cm (12 in) above soil level and buried 15.24 cm (6 in) deep. Modify the habitat by regular close mowing of the ground cover in the orchard (or other vole habitats) or tilling the areas with tunnels and burrows. Snap traps (with chunky peanut butter bait) placed in runways can also be effective in reducing the number of voles. The reproductive capability of voles may require a substantial number of traps.

TWO-SPOTTED SPIDER MITE *Tetranychus urticae* (Koch)

Two-Spotted Spider Mite

The two-spotted spider mite is widely distributed and a common pest of orchards and nursery plants. When environmental conditions are hot and dry, spider mites multiply rapidly and become a pest. Initial infestations tend to occur in areas bordering clover fields or grassy areas. Field perimeters and corners tend to exhibit the earliest symptoms of infestation. Dispersal over a wide area occurs when spider mites are carried on a balloon of their webbing by the wind.

Two-spotted spider mites feed on the underside of the foliage with sucking mouth parts and may be very destructive when abundant. Under hot and dry conditions, spider mites thrive on plants that are under stress. The juices which the mites obtain from stressed plants are rich in nutrients and the mites multiply rapidly.

Adult two-spotted spider mites are only about .35 mm (1/60 in) in length and have a black spot on each side of their bodies, which ranges in color from white to light red. The eggs of the mites appear like small clear or pale marbles when viewed through a hand lens.

Two-spotted spider mites overwinter as adult females. Egg laying begins in late April or May; the eggs hatch in five to eight days into the protonymph stage, which later molts to a deutonymph stage. These nymph stages have four legs. The time from egg to adult normally requires about three weeks, but may take less time under hot and dry conditions. Depending on the weather, five to ten generations may occur within a growing season. Spider mite reproduction and population multiplication will persist until cool weather of late summer leads to a reduction of population activity.

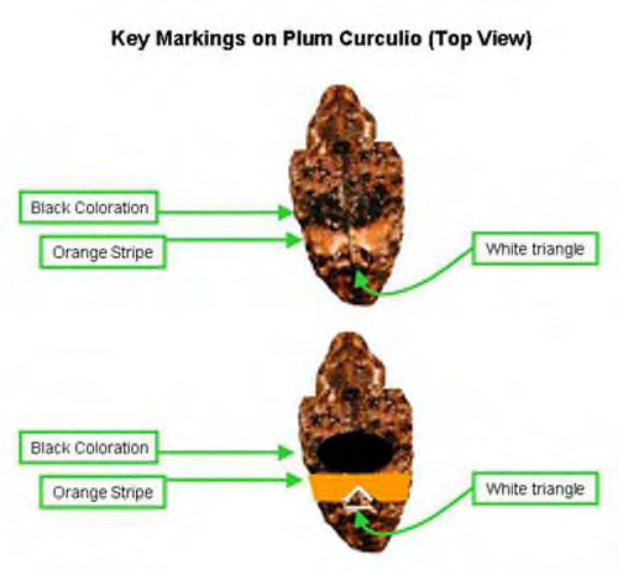
In assessing the degree of a spider mite infestation, it is important that one recognize the stippling or speckled effect on green foliage which is the early sign of mite feeding. It is essential to use a good hand lens to view the relative abundance of mites in egg, nymph and adult stages.

MANAGEMENT

When conditions are optimal for spider mite outbreaks, early detection facilitates timely and effective treatment. Since mite development is linked to host plant stress, cultural practices and varieties which limit plant stress in times of drought will also minimize the development of spider mites. Narrow-range oil sprays can provide effective management. Two-spotted spider mites are known to have developed resistance to miticides quite rapidly. Introduce predator mites *(Neoseiulus fallacis* or *Phytoseiulus persimilis)* to greatly reduce the mite population.

PLUM CURCULIO

The plum curculio, *Conotrachelus nenuphar* (Herbst), is widely distributed east of the Rocky Mountains and is a native insect. The name is somewhat misleading because this insect attacks not only plums, but also apples, peaches, pears, cherries, quince, and other wild and cultivated fruits. It can be very destructive. Injury to all hosts results first from the spring feeding of adult beetles, then from female egg punctures in the fruit, next from the feeding of larvae within the fruit, and finally from the early fall feeding of adult beetles.



Both the adult and larval stages injure fruits. In spring, adults feed on buds, blossoms, leaves and new fruits. Feeding scars appear as shallow cavities on the fruit surface. The major injury occurs from the laying of eggs by the curculios (weevils). A small cavity is made in the fruit for the egg; then a crescent-shaped cut is made adjacent to the egg pocket. Fuzz on peaches makes it difficult to see this egg scar. The early feeding and egg-laying punctures can cause marked scarring and malformation of the fruit. Early feeding on the surface of peaches often causes severely deformed fruits known as "cat-faced" peaches. The mechanical injury by adults in feeding and egg deposition can cause premature fruit drop. When the summer brood of adults appears, feeding cavities again can be found on the fruits.

The adult plum curculio is a small, hard-bodied, brownish-black snout beetle mottled with white and orange areas. It has four prominent black humps on its top surface. It is about 6 mm (.24 in) long, has a long snout, the end of which bears chewing mouthparts. The insect overwinters as an adult under debris in protected places in an orchard. In spring, shortly after peaches bloom or when apples are near the pink stage, the beetles come out of hibernation and begin to fly to fruit trees to feed.

Egg-laying begins as soon as the young fruits form and continues for three or four weeks. To lay eggs, the female first cuts a small, round cavity directly under the skin of the fruit with her mouthparts. Then she turns around and lays a single tiny white egg in the cavity, just under the skin of the fruit. After this, she cuts a crescent-shaped slit nearly halfway around the cavity, creating a dead flap in the surface of the fruit.

A single female lays about 60 to 150 eggs. Within seven days, larvae emerge from the egg and begin to eat their way through the flesh of the fruit. In stone fruits, the larva works its way toward the pit, around which it feeds extensively until it is fully grown. On apples, few if any of the young larvae survive if the apple continues to grow on the tree because the egg or larva is crushed by the firm, growing tissues of the fruit. If the apple drops prematurely or is picked

from the tree while the larva is still alive, or the variety is an early ripening one, the larva can complete its feeding and growth. The larva spends about 10 to 16 days feeding. On reaching completion of its development, the larva burrows out of the fruit by making an oval exit hole and enters the soil. At this stage, the larva is about 9 mm (.35 in) long and is a yellowish-white, legless grub with a brown head.

In the soil, the larva constructs a small cell 2.54 – 7.62 cm (1 – 3 in) deep, in which it transforms into a whitish pupa and then into an adult. The time between the entrance of the larva into the soil and the appearance of the new beetle above ground is about five weeks. Summer brood adults emerge in July and August. They do not lay eggs but instead feed on fruit, showing a preference for smooth-skinned fruits such as apples and plums.

In feeding on apples, the beetle makes a small hole in the skin of the fruit and then devours all the flesh of the fruit it can reach with its snout. This feeding takes place until the adults enter hibernation, which occurs from September through early November.

MANAGEMENT

Jarring the sluggish beetles from trees in the morning and capturing them on sheets is a physical management method. Natural control of the curculio results from winter mortality, attacks by birds and other predators, and from parasites. Pick up fallen fruit two to three times a week, put it in a plastic bag, tie it tightly and place it in the trash can. This will help keep larvae in fallen fruit from developing in the soil and, if done regularly, should lessen the damage done by this insect. Lightly tilling the soil (2.54 – 7.62 cm [1 – 3 in]) in the orchard in late June will reduce the numbers of pupating larvae.

EUROPEAN APPLE SAWFLY *Hoplocampa testudinea* (Klug)

European Apple Sawfly

The European apple sawfly is an introduced pest that was first noted in North America infesting crabapples on Long Island (Farmingdale, NY) and Vancouver Island during 1939 and 1940. Since then, it has spread into southern New Jersey, Vermont, New Hampshire and the southern tier of New York State. The pest is especially troublesome in the apple-growing regions of Massachusetts, Connecticut, Rhode Island and the Hudson Valley of New York. The pest is distributed over the entire continent of Europe but is most common in the north. The larvae feed on apple and crabapple varieties, but show a preference for early or long-blooming varieties with a heavy set of fruit. Sawflies are primitive hymenopterous insects and are related to bees, wasps and ants. Although two generations a year have been reported in England, only one occurs in North America.

The European apple sawfly overwinters as a mature larva in a cocoon a few inches below the surface of the soil. The larva pupates early in the spring and emerges as an adult wasp about the time apple trees come into bloom. Adults are 6 – 8 mm (.24 – .32 in) in length, with the male smaller than the female. The head is yellow with yellow antennae and black eyes. The wings are covered with tiny black hairs, giving them a dusky appearance. The body is brown; the upper surface appears almost black and shiny, and the lower surface lighter and orange to yellow. The males emerge first and, as the season progresses, both sexes can be found flying about the blossoming apple trees. When they alight, they move around rapidly vibrating their antennae. The adults feed on pollen and are most active when the sun is intense, usually around noon. The average adult life span is from one to two weeks.

The female sawfly lays her eggs in apple blossoms at the base of the stamens. She inserts her ovipositor (the saws) through the sepal. The egg is about .8 mm (.03 in) in length, oval, colorless and shiny. The eggs hatch within one to two weeks depending on temperatures.

The larva measures about 1.7 mm (.07 in) in length at hatch. It is light cream colored with a black head and caudal (rear) shield. The head and shield become lighter as the larva matures until they are pale brown in the mature fifth-instar stage. The larva increases in size during each instar so that when mature it is 9 – 11 mm (.35 – .43 in) long. There are seven pairs of prolegs on sawfly larvae but only five pairs on the larvae of lepidopterous pests. When mature, the sawfly larvae leave the fruit, enter the soil and construct cocoons in which they remain as pupae until the following spring. The cocoons are egg-shaped, parchment-like brown cases usually 4 x 8 mm (.16 x .31 in) in size.

The first larval instar commences feeding just below the skin of the fruit, creating a spiral path usually around the calyx end. Following this feeding, the larva usually molts and begins tunneling toward the seed cavity of the fruit or an adjacent fruit. The larva's feeding to the core usually causes the fruit to abort. As the larva feeds internally, it enlarges its exit hole which is made highly conspicuous by the mass of wet, reddish-brown frass. The secondary feeding activity of a single sawfly larva can injure all the fruit in a cluster, causing stress on that fruit to abort or drop during the traditional "June drop" period.

MONITORING AND MANAGEMENT

European apple sawfly adults are visually oriented toward apple blossoms. Field trials found sticky-coated, non-ultraviolet reflecting white rectangles to be the most effective trap for capturing and monitoring sawfly adult populations. The number of adults captured may determine the necessity for treatments directed at the pest. Before using chemical control measures, one should consult with the local Cooperative Extension or IPM specialist about the best materials and use patterns for the area. Disking or tilling the soil 6 – 10.16 cm (2 – 4 in) deep in the orchard over the winter can disrupt the pupating cocoons. Pick up dropped fruit in late June or early July and remove from the site.

Because the sawfly is an introduced pest, many of its natural enemies probably remained behind in Europe. The absence of such enemies may be a major reason for the pest's highly successful establishment in this country.

APPLE SCAB *Venturia inaequalis*

Apple Scab

Apple scab is of major economic importance in the mid-Atlantic region. If not managed, the disease can cause extensive losses (70% or greater) where humid, cool weather occurs during the spring months. Losses result directly from fruit or pedicel infections, or indirectly from repeated defoliation which can reduce tree growth and yield.

Apple scab can be observed on leaves, petioles, blossoms, sepals, fruit, pedicels, and less frequently, on young shoots and bud scales. The first lesions are often found on the lower surfaces of leaves as they emerge and are exposed to infection in the spring. Later, as the leaves unfold, both surfaces are exposed and can become infected. Young lesions are velvety brown to olive green and have feathery, indistinct margins. As an infected leaf ages, the leaf surface becomes deformed. Leaves may become curled, dwarfed, and distorted when infections are numerous. The number of lesions per leaf may range from one or two to more than a hundred. Young leaves with scab often shrivel and fall from the tree. Infections of petioles and pedicels result in premature abscission of leaves and fruit. In late summer or early fall, lesions may appear whitish due to the growth of a secondary fungus on the lesion surface.

Lesions on young fruit appear similar to those on leaves, but as the infected fruit enlarge, the lesions become brown and corky. Infections early in the season can cause fruit to develop unevenly as uninfected portions continue to grow. Cracks then appear in the skin and flesh or the fruit may become deformed. The entire fruit surface is susceptible to infection, but infections early in the season are generally clustered around the calyx end. Fruit infections that occur in late summer or early fall may not be visible until the fruit are in storage.

Although research has shown that the scab fungus can overwinter in trees as conidia on bud scales, the pathogen generally overwinters in leaves and fruit on the orchard floor. Ascospores are the major source of primary inoculum and are produced within pseudothecia that develop in leaves during the winter months. The first mature ascospores are capable of causing infections at about the time of bud break or soon thereafter. Ascospores continue to mature and are discharged over a period of five to nine weeks, with peak discharge during the pink to petal fall phenological stages. The length of time required for infection to occur depends on the number of hours of continuous wetness and the temperature during the wet period. Young leaves remain susceptible for five to eight days, but their lower surfaces may become infected in late summer. For fruit, the duration of the wet period required for infection increases with the age of the fruit, which remains susceptible until harvest.

Once the fungus is established in the leaf or fruit, conidia form on the surface of the lesion and become the source of secondary inoculum for the remainder of the season. Conidia are disseminated to developing leaves and fruit by splashing rain and wind.

Consult with regional Cooperative Extension Service personnel to determine the onset of ascospore maturity. An awareness of the scab inoculum situation during the previous year and in adjacent abandoned or commercial orchards may influence early-season scab management decisions. During the prebloom period, for both fresh and processing apples, determine apple scab infection periods by observing duration of leaf wetness and average temperatures during the wet period. Begin monitoring for first leaf symptoms by examining the upper and lower leaf surfaces on a minimum of ten leaf clusters on each sample tree. In monitoring, walk around the perimeter of the tree and examine at least two leaf clusters at each of the four compass directions. Record the total number of clusters with scab lesions. For fresh market production, more than one infected leaf cluster per tree represents potentially damaging levels of apple scab.

During summer and pre-harvest, continue monitoring for lesions on leaves of vegetative terminal shoots and on fruit. Record the total number of terminals and fruit with scab lesions. More than one infected fruit per tree is a potentially damaging level for the fresh market. After harvest, for both fresh and processing apples, determine the percent of leaves infected and number of lesions per infected leaf on six terminal shoots from each sample tree after harvest and before natural defoliation begins. Greater than 0.5% leaves infected with an average of one lesion per leaf represents significant risk of early scab infection next season.

MANAGEMENT

Management of apple scab is multifaceted, with resistant cultivars, sanitation, and fungicide all being used to some degree depending on the orchard system being used and the goals of the grower.

Most of the major apple cultivars are susceptible to the fungus.

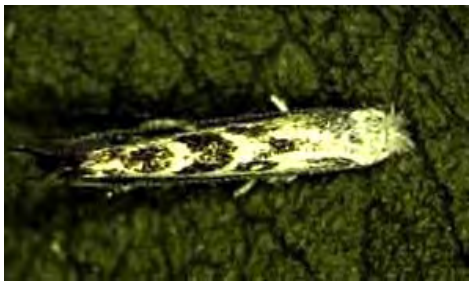
Prevention of pseudothecial formation in overwintering apple leaves would eliminate scab as a serious threat to apple production. Leaf and fruit pickup and destruction in late autumn can be employed. Flail mowing in late autumn to chop litter can help reduce numbers of pseudothecia. Applications of 5% urea to foliage in autumn can hasten leaf decomposition, thus reducing formation of pseudothecia. Applications should be made just prior to leaf fall to avoid stimulating tree growth and making the trees susceptible to winter injury.

Apple scab is treated primarily with fungicide sprays. Protectant fungicides prevent the spores from germinating or penetrating leaf tissue. To be effective, they must be applied to the surface of susceptible tissue before infection occurs. Occurrence of infection can be predicted with an accurate weather forecast.

Post-infection fungicides control the scab fungus inside leaves and fruit. The ability of these fungicides to stop infections is limited to a few hours, or up to few days, and often varies with temperatures during the first 24 to 48 hours after infection. Eradication of scab lesions after they appear does not occur. Good horticultural practices, such as proper site selection, tree spacing and annual pruning, facilitates scab management.

LEAFMINERS

The apple blotch leafminer *(Phyllonorycter crataegella* [Clemens]) and the spotted tentiform leafminer *(Phyllonorycter blancardella* [Fabricius]) are similar in biology, phenology and management.



Tentiform Leafminer

The moths are very small, light brown in color, appear shiny in flight and have white spots that look like bands when the wings are folded. The young are clear or pale yellow, flat and have no legs. The juveniles are darker yellow and cylinder shaped.

Leafminers overwinter as pupae within leaf mines from the previous fall. Adults emerge in April and May, mate and lay eggs. The larvae feed just above the leaf surface producing spotted mines. Pupation occurs in June followed by adult moth emergence.

Damage appears as densely spotted mined areas on the leaves. Heavy damage can affect fruit quality and quantity, resulting in a decrease in fruit size, early ripening, premature fruit drop, and reduced fruit set the following year.

Apple Leafminer

The apple leafminer *Lyonetia prunifoliella*) has begun to infest orchards during the past twenty years. The wandering linear mines of the apple leafminer widen to brown blotches, unlike the mines of the apple blotch and spotted tentiform leafminers which appear stippled. The apple leafminer constantly expel excrement on a silken thread from the mine. Just before pupating, the leafminer larvae spin cocoons which are suspended by threads and resemble a hammock. They have four to six generations per year and the larval damage seems confined to the youngest foliage. Severely damaged leaves tend to drop off prematurely, decreasing the number of most capable leaves. Fortunately, infestations are not known to cause premature fruit drop.

MONITORING

Sticky red visual traps can be stapled to tree trunks. Traps bated with pheromone can also be used. Beginning when petals fall, check fruit cluster leaves throughout the orchard for signs of mine development. Monitor for second generation populations in July.

MANAGEMENT

Flail mowing of leaf litter in the fall may reduce overwintering leafminer populations. There are parasitoids which decrease leafminer populations. The two most common are *Sympiesis marylandensis* and *Pholetesor omigis*. Both are wasps whose larvae feed on leafminer larvae in the tissue feeding stage.

POWDERY MILDEW

Powdery Mildew

There are numerous fungi that fall under the general description of a powdery mildew. Outdoors there are numerous plants that may be infected in any year; but lilac, phlox, some rose varieties and fruit trees seem to be infected most frequently. The actual injury to the plant varies greatly with the species and even the variety attacked. For instance, lilacs are typically infected late in the growing season and this does not usually cause serious injury to the plants. Lilacs are able to survive year after year in spite of the disease. On the other hand, begonia may be seriously injured by even a mild infection. The tissue under the fungal growth dies soon after infection resulting in leaf drop and poor plant growth. Thorough management practices must be implemented in this case. Among roses there are varieties that are more seriously affected than others. If powdery mildew has been a problem in the past, choose a variety that has some resistance to the disease.

Powdery mildew appears as a dusty white to grey coating over leaf surfaces or other plant parts. In most cases this fungal growth can be partially removed by rubbing the leaves. Powdery mildew will begin at discrete, usually circular, powdery white spots. As these spots expand they will coalesce, producing a continuous mat of mildew.

Symptoms usually appear late in the growing season on outdoor crops. The fungus is favored by periods of high relative humidity or site conditions that promote a more humid environment, such as close spacing of plants, densely growing plants or shade.

Injury due to powdery mildews includes stunting and distortion of leaves, buds, growing tips and fruit. The fungus may cause death of invaded tissue. Yellowing of leaves and death of tissue may result in premature leaf drop. Nutrients are removed from the plant by the fungus during infection and may result in a general decline in the growth and vigor of the plant. The seriousness of the disease will depend on the extent of the various types of injury.

The fungi which cause powdery mildew are spread by spores produced in the white patches. These spores are blown in the wind to other parts of the plant or to other plants during the growing season. Generally each species of fungus will be limited in the number of plant species that can be attacked. For example, the species of fungus infecting lilacs will not cause powdery mildew on apples.

During the winter the fungus survives on infected plant parts and in debris such as fallen leaves. It may produce resting structures known as cleistothecia, which resist harsh winter conditions. These will appear as small black dots within the white powdery patches. The next spring, sexual spores (ascospores) are released from the cleistothecia, shot up into the air, and carried by air

currents to leaves of plants where new infections will begin. During the growing season, the fungus produces asexual spores (conidia) that help the fungus to spread and the infection to build. This is the general cycle for most powdery mildews of outdoor plants.

MANAGEMENT

There are several effective fungicides available for different sites and plants, but use on plants varies with each product, and not all fungicides registered for use to treat powdery mildew may be used on all plants. Be certain the product you purchase is labeled for the intended use(s), and follow directions on that label.

For outdoor ornamental plants, gather up fallen leaves in autumn and destroy them. Where powdery mildew is a problem, resistant varieties (if available) should be grown. If needed during the growing season, begin fungicide applications when the first white patches are noticed. Repeat as indicated on the product label during cool humid weather. Some products with a broad range of applications for outdoor ornamentals include *Bacillus subtilis*, jojoba or neem oil, potassium bicarbonate, sulfur or lime sulfur. Some of these products may also be used to treat powdery mildew infections in the vegetable garden. Other products may also be available, so your local Cooperative Extension Office can be contacted for more information.

Management of powdery mildew on fruit trees should begin at the green tip bud stage for apples and may include some products containing the active ingredients *Bacillus subtilis*, neem oil or potassium bicarbonate.

Wettable sulfur is known to cause injury to some plants. Check labels for cautions about sensitive plants.

WHITEFLIES

Whiteflies

Whiteflies develop rapidly in warm weather and populations can build up quickly where natural enemies are destroyed. Whiteflies have a wide host range that includes many weeds and crops.

Whiteflies lay their eggs on the undersides of leaves. All stages feed by sucking plant juices from leaves and excreting excess liquid as honeydew as they feed.

As whiteflies suck phloem sap, large populations can cause leaves to turn yellow, appear dry and fall off plants. Like aphids, whiteflies excrete honeydew, so leaves may be covered with black sooty mold. The honeydew attracts ants, which interfere with the activities of natural enemies that may manage whiteflies and other pests. Exclude ants from plants (trees or shrubs) with a band of Tanglefoot around the base.

Management of heavy whitefly infestations is difficult as they are not well managed with insecticides. In many situations, natural enemies will provide adequate control of whiteflies. Avoid or remove plants that repeatedly host high populations of whiteflies. In ornamental plantings, populations in the early stages can be held to a minimum by removing infested leaves and hosing down with water sprays to dislodge adults.. Reflective mulches can repel whiteflies and sticky traps can be used to monitor or reduce numbers. If insecticides are used, insecticidal soaps or oils such as neem oil may reduce populations, but will not eliminate them.

Whiteflies have many natural enemies and outbreaks frequently occur when these natural enemies have been disturbed or destroyed by pesticides, dust buildup or other factors. Some predators include lacewings (*Chrysoperla carnea* or *C. rufilabris*), bigeyed bugs (*Geocoris punctipes*), and minute pirate bugs (*Orius tristicolor*). Several lady beetles and scale predators also feed on whiteflies. Whiteflies also have a number of naturally occurring parasites that can be very important in managing them (*Encarsia formosa* or *Eretmocerus californicus*). Avoiding the use insecticides that kill natural enemies is a very important aspect of whitefly management. Removing leaves by hand in heavily infested areas can reduce populations to levels that natural enemies can contain.

In ornamental plantings, yellow sticky traps can be posted around to trap adults. Such traps won't eliminate damaging populations but may reduce them as a component of an integrated management program relying on multiple tactics. Whiteflies do not fly far, so many traps may be needed.

SCALES

Scales

Scale insects can be serious pests on all types of woody plants and shrubs. Adult female scales and many immature forms do not move and are hidden under a waxy covering. They lack a separate head or other recognizable body parts. Scales have long, piercing mouthparts with which they can suck juices out of plants. They occur on twigs, leaves, branches or fruit. Severe infestations can cause overall decline and death of plants.

Armored scales, family *Diaspididae*, are less than .30 cm (1/8 in) in diameter and have a platelike cover. They are called armored scales because the scale cover is quite dense and provides protection from pesticides and parasites. They hatch from eggs, settle down and lose their legs, then form a hard cover that is separate from the body. Armored scales do not excrete honeydew.

Female soft scales, family *Coccidae*, may be smooth or cottony and have a diameter of .64 cm (1/4 in) or less. They are usually larger and more rounded than armored scales. Most immature soft scales retain their legs and antennae after settling and are able to move. Soft scales produce large quantities of honeydew that drips from their bodies.

Most armored scales have several generations a year, while most soft scales often have only a single generation. Eggs of both types are usually hidden under the adult female. Eggs hatch into tiny, usually yellow crawlers with legs. Crawlers walk over the plant surface, are blown by wind to other trees, and can be inadvertently moved by people or birds. Adult female scales are immobile and have a characteristic scale. Adult males are tiny winged insects that resemble parasitic wasps. They are rarely seen, do not feed, and live only a few hours.

Woody plants heavily infested with armored scales often look water stressed. Leaves may turn yellow and drop; twigs and limbs on trees may die, and bark may crack and produce gum. Many armored scales attack leaves or fruit as well, leaving blemishes and halos on fruit.

Soft scales also reduce tree health, but seldom kill trees. The major concern with these scales is their production of honeydew which gets on leaves and fruit, encouraging the growth of black, sooty mold. Honeydew also attracts ants which protect soft scales from natural enemies. Soft scales infest leaves and twigs, and do not attack fruit directly.

Scales are often well managed by natural enemies, especially when predator and parasite activities are not disrupted by ants or applications of broad-spectrum insecticides. Scale predators (*Cryptolaemus montrouzieri* and *Rhyzobius lophanthae*) and scale parasites (*Aphytis*

melinus, *Leptomastix dactylopii*, and *Metaphycus helvolus*) are available from commercial insectaries. In the case of soft scales, managing ants may be sufficient to bring about gradual control of scales. If not, well-timed sprays of oil applied either during the dormant season or when crawlers are active in the spring should provide management.

Monitor scales by inspecting plants for crawlers, mature females or ants. Dead scales from previous generations can remain on plants. Examine deciduous plants when leaves are off in the winter. Trees, bushes, twigs and branches heavily infested with scales may retain their leaves during winter and be easy to spot.

If possible, provide plants with appropriate irrigation so they are more resistant to scale damage. Prune off heavily infested twigs and branches to eliminate scales when infestations are on selective parts of the plant. Prune to open up tree canopies to increase heat exposure which increases scale mortality.

If large numbers of ants are climbing up trunks to tend scales, they should be managed. On ornamental plantings, deny ants access to plant canopies by pruning branches that provide a bridge between structures or the ground; and by applying a sticky material (such as Tanglefoot) to trunks. If trees are young or recently pruned, wrap the trunk first with a strip of fabric tree wrap, duct tape or other material which doesn't injure the tree.

Dormant season applications of specially refined oils or soap alone is usually adequate. Don't apply oils during the fog or rain. Horticultural oils can also be used in spring or summer against crawlers on deciduous plants. Use traps made of double-sided sticky tape to determine when crawlers are hatching. Change the tapes weekly and examine the tapes with a hand lens. Once eggs begin hatching, scale crawlers get stuck on the tapes and appear as yellow or orange specks.

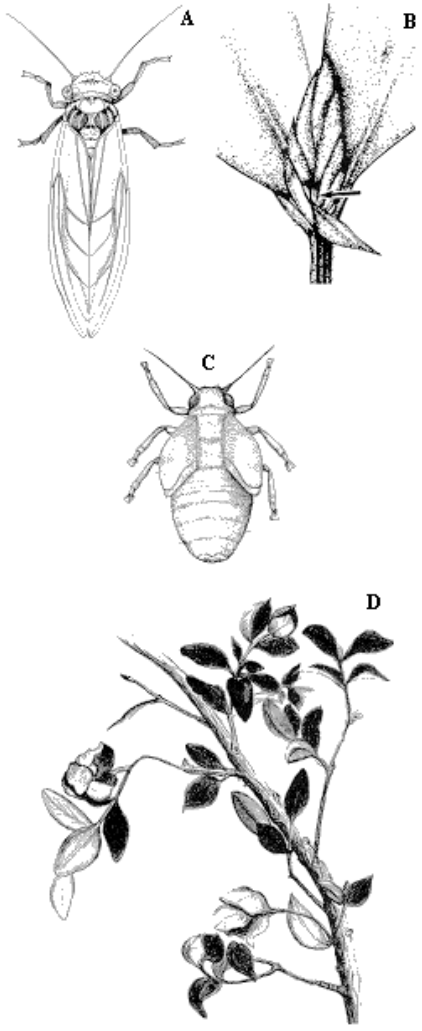
GREEN FRUIT WORM *Lithophane antennata* Walker

Green Fruit Worm

Green fruit worm larvae are pale green caterpillars with whitish stripes down each side of the body and a narrow stripe down the middle of the back. The adult is a grayish moth with a 2.54 cm (1 in) wingspan. Most species overwinter as adults and have one generation each year. Green fruit worms eat large holes in the young leaves and fruit of apple trees. Harvested apples are often found with large depressed areas of corky tissues, or with slightly raised spots. These symptoms may be accompanied by distortion of the fruit.

Monitor for green fruit worms from the beginning of bloom until after petal fall. Carefully check young leaves and shoots for the presence of larvae and leaf damage. Parasitic nematodes (*Heterorhabditis bacteriophora* or *Steinernema carpocapsae*) applied in a water spray (follow label directions) for early instar green fruitworm larvae can be effective. Monitor for egg hatch to be able to treat first instar larvae. Check green fruit for the presence of larvae. If damaging populations are present, prevent fruit damage by treating with *Bacillus thuringiensis* Kurstaki or Spinosad™. This formulation can be used during bloom and is effective on small larvae. Spot-treat localized infestations. Continue to monitor for the pest after treatment. If no more young larvae are found, no additional management action is necessary.

BOXWOOD PSYLLIDS *Psylla buxi* (Linnaeus)



Boxwood psylid. A, Adult. B, Overwintering nymph. C, Mature nymph. D, Boxwood leaves cupped by psylids.

Boxwood psyllid adults are small (3 mm [.12 in]) long, grayish-green sucking insects that have transparent wings and resemble a miniature cicada. The tiny, orange egg is spindle shaped. The nymph is flat, green and brown mottled, and is covered with white waxy filaments. The nymph is wingless and smaller than the adult.

Boxwood psyllids seem to occur wherever boxwoods are grown; however, they are most common in temperate areas. Boxwood is the only known host of this pest. Although both American and English varieties can be attacked, American boxwoods are more likely to be severely infested.

Psyllid nymphs extract sap from buds and young foliage. As a result, terminal leaves of infested plants become cupped and twig growth may be hampered. Since the boxwood psyllid completes its single annual generation early in the growing season, plants tend to outgrow their injury by midsummer.

Boxwood psyllids overwinter as nymphs within their orange egg shells. In spring as buds begin to grow and leaves unfold, the nymphs hatch. They immediately begin to suck sap from new leaves. As their feeding causes leaves to curl, the numphs become concealed and protected. Psyllid nymphs molt into adults in May and early June. The adults continue to feed; however, they are not as damaging as the nymphs. In July or August, females deposit one to seven eggs under each bud scale. Nymphs develop within the egg before winter, but do not emerge until spring. Once leaf cupping occurs, the nymphs are also somewhat protected from oil sprays and insecticidal soaps. Several chemical pesticides are labeled for this pest, however, none are recommended here. Injury is primarily aesthetic and, given the setting, no management intervention may be necessary.

WHITE GRUBS

Japanese Beetle Grub

White grubs are the C-shaped larvae of a large group of beetles called scarabs. Many species are found in the United States, and several attack turfgrass. The most important species are: Japanese beetle *(Popillia japonica* Newman), May or June beetles *(Phyllophaga* spp.), northern and southern masked chafers *(Cyclocephala* spp.), and black turfgrass ataenius *(Ataenius spretulus* [Haldeman]).

White grubs are perennial pests of the cool season and transition zone turf grasses. The species listed above are generally found east of the Mississippi River. White grubs eat organic matter including the roots of plants. Damage first appears to be drought stress. Heavily infested turf appears off color and wilts rapidly in the hot sun. Continued feeding will cause the turf to die in large patches. The tunneling of the larvae can cause the turf to feel spongy under foot. Grub populations may not cause observed turf injury, but predatory mammals such as skunks, raccoons, opossums and moles dig in the turf in search of a meal.

Scarabs have a complete life cycle with eggs, larvae, pupae and adults. Japanese and other beetles and chafers have annual life cycles. Most eggs are a creamy-white in color, about 1.5 mm (1/16 in) long and slightly oval when first laid in the soil. They absorb water from the soil, swell slightly and become more round. The C-shaped white grub larvae are thick bodied, creamy white with brown heads and short legs. The pupae are often slightly longer than the adults and are formed in chambers 1.27 – 2.54 cm (1 – 2 in) in the soil. The pupae are cream colored, then darken before the adults emerge. The adults are typical scarabs – robust, oval beetles with the antennae ending in a large club.

The adults are easily identified, but the grubs are the stage usually found in turf. White grubs seem to be periodic pests attacking turf areas irregularly from year to year. Soil moisture and rainfall are major factors which influence development. In general, years with normal or above normal rainfall see grub populations increase. Well maintained turf next to ornamental plants favored by the adults seems to be more commonly attacked.

MANAGEMENT

Modify host plants. Certain species of adults prefer specific host plants; i.e., where Japanese beetles are common, do not plant roses, grapes and lindens around high maintenance areas.

Practically all white grubs require moist soil for their eggs to hatch. The larvae are also susceptible to desiccation. In areas where the turf can tolerate moisture stress, do not water in July and early August when white grub eggs and larvae are present.

Several parasitic wasps, *Tiphia* spp. and scoliids, attack white grubs and may reduce populations in certain areas. These parasitic wasps, however, may take two to three years to build up effective populations.

Several strains of the bacteria, *Bacillus popilliae*, have been found that attack white grubs. The commercial preparation of this bacterium is extracted from Japanese beetle grubs and is most active against this species. The bacterium applied to the turf is picked up by feeding grubs and causes the body fluids to turn a milky-white before death. Fresh bacterial preparations should be used; three to five years are needed to establish lasting management.

Some insect parasitic nematodes are also used; however, available strains may not be effective from one season to another, and result in less than desirable control percentages.

Since white grub occurrence is sporadic, applying pesticides for management of anticipated grub populations is not recommended. Pheromones have been identified for Japanese beetles to monitor adult populations. White grub populations can be assessed when the grubs become large enough to be easily seen. Square foot samples can be taken in several places over the turf area. This is done by cutting through the turf on three sides and pealing back the turf. Inspect the thatch and upper portion of soil for grubs.

AZALEA LEAFMINER (LEAFROLLER) *Caloptilia azaleella* (Brunts)

Azalea Leafminer

The azalea leafminer is a leafminer for only the early larval stages of its life. The eggs of the azalea leafminer are white and land singly on the underside of a leaf along a midrib or vein. Hatching, the larva enters the leaf directly beneath its egg shell and feeds as a leafminer. The first instar larva feeds in a linear path which widens to blisterlike blotch mines which turn brown. The larva then crawls to the top surface of the leaf and, using silk, pulls the leaf over its body. It then feeds by chewing holes in the leaf. The mature larva selects a new leaf, rolls it up, and pupates inside.

The adult yellow moth is about 10 mm (.39 in) long and has a wingspan of 12 mm (.47 in). The adults tend to hide among the leaves of the host plant. There may be two generations each year. They overwinter as larva or pupa. Adults appear and eggs are laid when plants bloom in spring.

Do NOT use broad-spectrum insecticides that may kill natural predators and parasites. Neem oil products may be effective if applied as the adults first emerge. Pick and destroy rolled leaves or pinch them to kill larvae inside.

LACE BUGS

Lace Bug

Adult lace bugs are about .3 – .45 cm (1/8 – 3/16 in) long and have clear, ornamented wings that look like lace. There are several species that feed on trees and shrubs in the northeastern states. Most lace bugs have a limited host range. Nymphs are dark brown to black and are quite spiny. Eggs are inserted into the midrib or veins on the underside of leaves, or cemented to the leaf with a brown, crusty material. Brown patches or black droplets of excrement are an indication of lace bug feeding.

Lace bug damage to host plants is a result of feeding on the lower surface of leaves, sucking juices through slender, piercing mouth parts. Damage shows as yellow or white spots on the upper surface of the leaf. Lace bug damage is most common and severe on andromeda (*Pieris*), azalea, pyracantha and rhododendron. More damage on azalea and rhododendron occurs if the plants are in a sunny location. Azalea and rhododendrons are understory plants and do better in shady locations.

Lace bugs that attack evergreens overwinter in the egg stage. Those that attack deciduous plants overwinter as adults under bark or in leaf litter. Lace bugs have one to three generations per year, depending upon the species.

Management of lace bugs involves early spring monitoring of susceptible plants, looking at the underside of leaves for nymphs, adults and the black excrement spots. Leaf damage by the first generation will not disappear, even after the lace bugs are gone. Use a hard water spray to dislodge overwintering adults and new nymphs from the leaves. Encourage or release green lacewing larvae, predator mites or assassin bugs to keep lace bug populations down. Insecticidal soaps may be necessary to treat the underside of leaves to control the nymphs that have not been eaten by the predators. Be sure to monitor the plants for lace bug nymph populations as well as numbers of the predators at least monthly.

IRIS BORER *Macronoctua onusta*

Iris Borer Larvae

Iris borer caterpillars are the most destructive insect pests of iris. The pink caterpillars are 6 cm (2 in) long when full grown. Adult moths have brown front wings and lighter yellow-brown hind wings with wing span of up to 6 cm (2 in).

Iris borers spend the winter as eggs on old iris leaves and plant debris at the base of iris stalks. In early spring, they hatch into tiny caterpillars and climb up new foliage. They chew pin-sized holes and tunnel inside leaves as they continue down toward the rhizome. Their feeding causes tan streaks and later the tips of infested iris turn brown and appear to age prematurely although the entire plant seldom dies.

The caterpillar tunnels through the leaves reaching the rhizome by mid-summer. At this point the caterpillars have grown to about 3.8 – 6 cm (1 ½ – 2 in) long. Iris borers do severe damage to iris by consuming the rhizome.

In late July or early August, iris borers move into the soil where they pupate. They emerge as moths in late summer or fall. Female moths complete the life cycle by laying eggs on old iris plants where eggs remain until the following spring.

MANAGEMENT

Management of iris borers is difficult; however, there are several steps that can be taken to reduce their damage in gardens. Although all types of iris may be infested by iris borer, Siberian iris is more tolerant to iris borer attack. Proper sanitation is important. Check iris during early spring for caterpillars or evidence of chewing damage and streaks. If irises have been unaffected in the past, there is no need to use an insecticide to protect them. Maintain good sanitation practices to prevent problems and help detect an iris borer problem when it first begins.
If you discover iris borer damage early in the season, you can crush the insect while it is inside the leaf or remove the infested leaf. Beneficial nematodes can potentially be effective in reducing iris borer populations. Two species of nematodes, *Heterorhabditis* and *Steinemema*, have been shown to attack iris borer. Nematodes need a moist environment to survive and move. The best time to apply them is during a rain shower. Otherwise, water iris before and after applying nematodes. If an iris plant has above-ground symptoms in mid-summer, dig it up and examine the rhizomes. Discard any containing iris borer caterpillars. In the fall, remove and destroy old iris leaves, stems and any nearby plant debris. This removes and kills overwintering eggs, minimizing the risk of having the borers the following year. Clean up iris beds any time after a hard frost when female moths are no longer laying eggs.

JAPANESE BEETLES *Popillia japonica* Newman

Japanese Beetle Adults

The Japanese beetle is a major pest of urban ornamentals. The beetle occurs in much of the United States.

Adult beetles are .94 cm (3/8 in) long, metallic green, with hard copper-brown wing covers. Five small tufts project from under the wing covers on each side and a sixth pair at the tip of the abdomen. Adults emerge from the ground in late May or early June. Individual beetles live about 30 – 45 days with activity concentrated over a four to six week period. Beetle numbers begin to decline in late July.

Japanese beetles feed on about 300 species of plants, ranging from roses to poison ivy. Odor and location in direct sun are important in host plant selection. The beetles usually feed in groups, starting at the top of a plant and working down. While a single beetle doesn't eat much, group feeding causes severe damage. Adults feed on the upper surface of foliage chewing tissue between the veins. This gives leaves a skeletonized appearance. Japanese beetles can fly up to five miles, but one to two miles is average. They usually make only short flights as they move about to feed.

Management of the beetle grubs in turf grass is the most effective and efficient approach. The bacterium, *Bacillis* popilliae, is effective on Japanese beetle grubs in turf. It may take a few seasons to achieve lasting management. The use of parasitic nematodes (*Heterorhabdtitis bacteriophora*) in turf will also reduce grub populations. Apply nematodes while it is raining to get good penetration into the turf (see the Pest Profile on white grubs.). Direct spray applications of insecticidal soap kills adult Japanese beetles on contact, but does not provide any residual protection.

The hard body of the Japanese beetle may make them unattractive to many predators such as birds. Hand collecting can be a control option to protect valuable plants when beetle activity is low. When beetles are removed from a plant daily by hand, only about half as many are attracted to that plant compared to those on which beetles are allowed to accumulate.

Commercially available traps attract the beetles with two types of bait. One mimics the scent of female beetles and is only attractive to males. The other bait is a food lure that attracts both sexes. This is a powerful attractant that can draw thousands of beetles into traps in a day. If traps are used, place them near turf well away from gardens and landscape plants, and check (and empty) them daily.

BLACK SPOT OF ROSES

Black Spot of Roses

Black spot is the most important infectious disease of roses. It occurs only on roses (*Rosa* spp.) and is widespread among rose species and cultivars. Round to irregular black splotches with fringed margins are quite obvious, mostly on upper leaf surfaces. Leaf yellowing develops around these black spots with defoliation of these leaves common. Repeated defoliation weakens plants, leading to poor blooming and greater sensitivity to stress.

The fungus overwinters on fallen leaves and diseased canes. Spores are then splashed to newly emerged leaves and stem tissue in the spring. Under ideal conditions of leaf wetness, humidity and temperature, the spores can germinate and infect in one day, cause symptoms in four to five days, and produce new spores that can infect additional leaves, flowers and tissue within 10 to 11 days. Spores are spread to new locations by air currents.

MANAGEMENT

Cultural: Keep foliage dry. Roses can be planted in open locations to encourage drying after rains. Avoid sites with dense surrounding vegetation so good air movement will dry leaves. Black spot is most severe in summers with sustained rainy periods.

Sanitation: Remove all black spotted leaves from and around plants. This should be done throughout the season. Before winter, remove and clean up all diseased leaves and remove diseased canes where possible.

Fungicides are not successful if cultural and sanitation practices are not followed. For fungicides to work, applications must be made preventively, providing a protective barrier which kills germinating fungal spores that have landed on plants.

BLACK VINE WEEVIL *Otiorhynchus sulcatus* (Fabricius)

Black Vine Weevils

The black vine weevil was first detected in Connecticut in 1910; however, there is evidence that this species was actually seen in the 1830's. It was probably introduced from Europe through movement of ornamental plants. The weevil has now spread across much of North America. Adult black vine weevils feed on over 100 different kinds of plants including trees, shrubs, vines and flowers. The preferred hosts are yews, hemlock and rhododendrons.

Black vine weevils are oval shaped, about 1.27 cm (1/2 in) long and have a short, broad snout with elbow-shaped antennae. The body is grey to blackish-brown and the forewings have small pits and short hairs. Females emerge from soil pupation in late May to early June. These weevils feed on plant material for 21 – 45 days before they are ready to lay eggs. The females then place several eggs each day into the soil or leaf litter near host plants. The weevils hide during the day at the base of plants or in mulch or leaf litter. The adults may live 90 – 100 days and usually lay 200 eggs during this time. The eggs hatch in two to three weeks. The legless larvae feed on young tender roots of plants. If young roots become scarce or the soil becomes overly wet, the larvae will move to the larger roots near the base of the plant. Girdling around the plant may indicate large larval populations. By late fall, the larvae have matured and are about 1.57 cm (5/8 in) long. A single generation occurs each year.

The weevils cannot fly but are active walkers, and are easily transported in potted plats and soil root balls.

Inspection and Monitoring: Adult black vine weevils feed along leaf edges and produce crescent-shaped notches. Light to moderate notching has little effect on plant health. Careful searches should be made to try and locate specimens. Since several other weevils and some caterpillars produce similar notching, they may be difficult to distinguish.

Management: These weevils are difficult to manage once established because of their nocturnal behavior, the underground habits of the larvae, and the lack of natural predators or parasites. Habitat Modification: Egg and larval survival is helped when soil moisture is moderate to high in the summer. Mulches also help maintain moisture levels. Remove mulch layers and do not water plants unless absolutely necessary. Properly maintain downspouts and adequate soil drainage around plants. Biological Control: The *Steinernema* and *Heterorhabditis* spp. have been effective for controlling black vine weevil larvae in potted plants. Enough water must be used during application to wash the nematodes into the soil and root zone. Applications of nematodes in landscapes may have variable results.

NORWAY MAPLE *Acer platanoides*

Norway Maple Leaves

The Norway maple is a common tree throughout much of Europe, including Norway. An important commercial species in European timber markets, the Norway maple has similar uses in Europe as our sugar maple does here. Furniture and flooring are often made from the sawlogs, and the density of the wood makes it an excellent material for musical instrument soundboards.

Norway maples never grew in North America until they became recognized for two important landscaping attributes. The first is plasticity, for Norway maples have lent themselves to foliage color manipulations. The most popular variety has been the "Crimson King," a Norway maple with very dark red (nearly black) foliage. The second desirable quality has been the species' ability to withstand poor growing conditions, including infertile and compacted soils and atmospheric pollution. These two qualities quickly promoted the Norway maple to become overplanted in New England and can be found in virtually every town in this region.

But plasticity and aggressiveness are not without ecological shortcomings, particularly when a plant is non-native. Norway maples have "escaped" cultivation as they successfully germinate from seed. Norway maples are better competitors for light and nutrients than many of our native species, particularly in disturbed areas. The fact that Norway maples outcompete native species puts increasing pressure on native species. The solution is to become more informed about the invasiveness of the species that are planted.

Norway Maple Seedlings

MANAGEMENT

Hand-pulling of saplings (use weed wrenches) or mowing seedlings may be the most efficient means for management of Norway maple. Mature trees will continue to produce seeds, so must be removed. Cutting and removing the mature trees may involve the services of an arborist or commercial forester. Treating the cut stumps with Garlon 4 (Triclopyr) or Roundup (Glyphosate) is necessary to prevent resprouting. Large trees that cannot be removed can be girdled with an axe (cut into the cambium) encircling the base of the tree 15 cm (6 in) above ground level. Glyphosate or Triclopyr can be squirted into the cut to kill the tree and reduce resprouting. When trees, saplings or seedlings are removed, replant the area with desired native trees or desirable undergrowth vegetation.

ORIENTAL BITTERSWEET *Celastrus orbiculatus* Thunb.

Oriental Bittersweet

Oriental bittersweet, an invasive exotic plant, is a deciduous, woody, perennial vine which sometimes occurs as a trailing shrub. Also known as round-leaved and Asiatic bittersweet, stems of older plants sometimes grow to four inches in diameter. Leaves of oriental bittersweet are glossy, rounded, finely toothed and arranged alternately along the stem. Clusters of small greenish flowers emerge from leaf axils, allowing each plant to produce large numbers of seeds. At maturity, globular, green to yellow fruits split open to reveal three red-orange, fleshy arils that contain the seeds. These showy fruits have made oriental bittersweet very popular for use in floral arrangements. Since this plant is easily confused with our native climbing bittersweet vine (*Celastrus scandens*), which flowers at the tips rather than along the stems, it is imperative that correct identification be made before management is attempted.

Oriental bittersweet is an aggressive invader that threatens all vegetation levels of forested and open areas. It grows over other vegetation, completely covering it, and kills other plants by preventing photosynthesis, girdling, and uprooting by force of its massive weight. Oriental bittersweet appears to be displacing the native climbing bittersweet (*Celastrus scandens)*, which occurs in similar habitats, through competition and hybridization. Oriental bittersweet occurs from New York to North Carolina, and westward to Illinois.

Oriental bittersweet infests forest edges, woodlands, early successional fields, hedgerows, coastal areas and salt marsh edges, particularly those suffering some form of land disturbance. While often found in more open, sunny sites, its tolerance for shade allows oriental bittersweet to invade forested areas.

Oriental bittersweet reproduces prolifically by seed, which is readily dispersed to new areas by many species of birds. Its seeds germinate in late spring in partial to dense shade. It also expands vegetatively by stolons (above-ground stems), and rhizomes (underground stems), and through root suckering.

MANAGEMENT

Where hand labor is practical, vines can be pulled out by the roots and removed from the site, preferably before fruiting. If fruits are present, vines should be bagged and allowed to bake in the sun long enough to kill the seeds.

Systemic herbicides, such as glyphosate (e.g., Roundup) or triclopyr (e.g., Garlon), that are taken into the roots and kill the entire plant, have been used successfully in bittersweet management. This method is most effective if the stems are first cut by hand or mowed and herbicide is applied immediately to cut stem tissue. In areas where spring wildflowers or other native plants

occur, application of herbicides should be conducted prior to their emergence, delayed until after the last killing frost occurs, or carefully targeted. Herbicidal contact with desirable plants should always be avoided. No biological controls are currently known for oriental bittersweet.

A portion of this information was taken from a paper by Jil M. Swearingen, U.S. National Park Service, Washington, DC.

JAPANESE STILT GRASS *Microstegium vimineum*

Japanese Stilt Grass

Japanese stilt grass was first introduced into the United States in Tennessee around 1919 and likely escaped as a result of its use as a packing material for porcelain. It originated in Japan, Korea, China, Malaysia and India.

Japanese stilt grass is currently established in 16 eastern states, from New York to Florida. It occurs on stream banks, river bluffs, floodplains, emergent and forested wetlands, moist woodlands, early successional fields, uplands, thickets, roadside ditches, gas and power-line corridors, lawns and gardens. Japanese stilt grass threatens native understory vegetation in full sun to deep shade. Stilt grass readily invades disturbed shaded areas, like floodplains that are prone to natural scouring, and areas subject to mowing, tilling and other soil-disturbing activities including white-tailed deer traffic. It spreads opportunistically following soil disturbance to form dense patches, displacing native wetland and forest vegetation as the patch expands. Japanese stilt grass appears to be associated with moist, acidic to neutral soils that are high in nitrogen.

Japanese stilt grass is an annual in the grass family (*Poaceae*) resembling a small, delicate bamboo; mature plants are .62 – .91 m (2 – 3 ft) in height. Leaves are pale green, lance-shaped, asymmetrical, about 7.62 cm (3 in) in length, with a shiny midrib. Flowers are delicate spikes that emerge from slender tips in late summer and early fall. Fruits are produced shortly after flowering and then the entire plant dies. It spreads vegetatively by rooting at joints along the stem (a new plant can emerge from each node) and by seed. A single plant can produce 100 to 1,000 seeds that remain viable in the soil for at least three years, ensuring its persistence. Stilt grass seed germinates readily following soil disturbance. Although dispersal is not fully understood, seeds are probably transported by movement of water (e.g. surface runoff, streams, and floodwaters), soil, plants and on the feet of other animals including people. Virginia cutgrass (*Leersia virginica*), hairy jointgrass or small carpetgrass (*Arthraxon hispidus*), and possibly other delicate grasses and wildflowers like Pennsylvania knotweed (*Polygonum persicaria*) may be confused with Japanese stilt grass.

MANAGEMENT

Because it is similar in appearance to several native grasses, it is important to know how to recognize and differentiate stilt grass from look-alikes. The shiny midrib and asymmetrical leaves help to distinguish stilt grass. Early attention to new infestations should be a priority. Because it is shallow-rooted, stilt grass may be pulled by hand at any time. Flowering plants can be cut back using a mower or weed whip prior to seed production. For extensive infestations, contact and systemic herbicides may be more practical and effective.

Following disturbance to an area susceptible to stilt grass, stabilize with native vegetation suitable to site conditions.

JAPANESE BARBERRY *Berberis thunbergii*

Japanese Barberry Fruit

Japanese barberry is a dense, deciduous, spiny shrub that grows .61 – 2.44 m (2 – 8 ft) high. The branches are brown, deeply grooved, somewhat zig-zag in form and bear a single very sharp spine at each node. The leaves are small (1.27 – 3.81 cm [½ – 1 ½ in] long), oval to spatula-shaped, green, bluish-green, or dark reddish purple. Flowering occurs from mid-April to May in the northeastern U.S. Pale yellow flowers about 0.6 cm (¼ in) across hang in umbrella-shaped clusters of 2 – 4 flowers each along the length of the stem. The fruits are bright red berries about 1 cm (1/3 in) long that are borne on narrow stalks. They mature during late summer and fall and persist through the winter.

Japanese barberry may be confused with American barberry (*Berberis canadensis*), a native species of barberry in North America, and common or European barberry (*Berberis vulgaris*) which is an introduced, sometimes invasive plant.

Japanese Barberry

Japanese barberry forms dense stands in natural habitats including canopy forests, open woodlands, wetlands, pastures, and meadows and alters soil pH, nitrogen levels, and biological activity in the soil. Once established, barberry displaces native plants and reduces wildlife habitat and forage. White-tailed deer avoid browsing barberry, preferring to feed on native plants, giving barberry a competitive advantage. Japanese barberry has been found to raise soil pH (i.e., make it more basic) and reduce the depth of the litter layer in forests.

Japanese barberry has been reported to be invasive in twenty states and the District of Columbia. Due to its ornamental interest, barberry is still widely propagated and sold by nurseries for landscaping purposes in many parts of the U.S.

Barberry is shade tolerant, drought resistant, and adaptable to a variety of open and wooded habitats, wetlands and disturbed areas. It prefers to grow in full sun to part shade but will flower and fruit even in heavy shade.

Japanese barberry was introduced to the U.S. and New England as an ornamental plant in 1875 in the form of seeds sent from Russia to the Arnold Arboretum in Boston, Massachusetts. In 1896, barberry shrubs grown from these seeds were planted at the New York Botanic Garden. Japanese barberry was later promoted as a substitute for common barberry (*Berberis vulgaris*)

which was planted by settlers for hedgerows, dye and jam, and later found to be a host for the black stem grain rust. Because Japanese barberry has been cultivated for ornamental purposes for many years, a number of cultivars exist.

Japanese barberry spreads by seed and by vegetative expansion. Barberry produces large numbers of seeds which have a high germination rate, estimated as high as 90%. Barberry seed is transported to new locations with the help of birds (e.g., turkey and ruffed grouse) and small mammals which eat it. Birds frequently disperse seed while perched on power lines or on trees at forest edges. Vegetative spread is through branches touching the ground that can root to form new plants and root fragments remaining in the soil that can sprout to form new plants.

MANAGEMENT

Do not plant Japanese barberry. Because it is a prolific seed-producer with a high germination rate, prevention of seed production should be a management priority. Because barberry can resprout from root fragments remaining in soil, thorough removal of root portions is important. Manual control works well but may need to be combined with chemical in large or persistent infestations.

No biological control organisms are available for this plant.

Treatments using the systemic herbicides Glyphosate (e.g., Roundup) and Triclopyr (e.g., Garlon) have been effective in managing Japanese barberry infestations that are too large for hand pulling. This non-selective herbicide should be used with care to avoid impacting non-target native plants. However, application in late summer during fruiting may be most effective. Triclopyr or Glyphosate may be used on cut stumps or as a basal bark application.

Because Japanese barberry leafs out early, it is easy to identify and begin removal efforts in early spring. Small plants can be pulled by hand, using thick gloves to avoid injury from the spines. The root system is shallow making it easy to pull plants from the ground, and it is important to get the entire root system. The key is to pull when the soil is damp and loose. Young plants can be dug up individually using a hoe or shovel. Hand pulling and using a shovel to remove plants up to about .91 m (3 ft) high is effective if the root system is loosened up around the primary tap root first before digging out the whole plant.

Mechanical removal using a hoe or weed wrench can be very effective and may pose the least threat to non-target species and the general environment at the site. Tools like the weed wrench are helpful for uprooting larger or older shrubs. Shrubs can also be mowed or cut repeatedly. If time does not allow for complete removal of barberry plants at a site, mowing or cutting in late summer prior to seed production is advisable.

To prevent reinfestation by exotic invasive plants, there are many attractive native shrubs available that make great substitutes for Japanese barberry. A few examples include bayberry (*Myrica pensylvanica*), ink-berry (*Ilex glabra*), winterberry (*Ilex verticillata*), arrow-wood (*Viburnum dentatum*), mountain laurel (*Kalmia latifolia*), ninebark (*Physocarpus opulifolius*) and hearts-a-bustin' (*Euonymus americana*.

Some information in this section was taken from a paper by Jil M. Swearingen, U.S. National

Park Service, Center for Urban Ecology, Washington, DC.

SIEBOLD'S ARROWWOOD (*Viburnum sieboldii*)

Siebold's Viburnum

Also known as Siebold's Viburnum (an exotic, invasive plant from Eastern Asia and Japan), this plant is being propagated and sold as an ornamental plant by nurseries. Siebold's Arrowwood is a deciduous shrub growing to 4 – 6 m (15 – 20 ft), and 3 – 4 m (10 – 15 ft) wide. It produces flowers from May to June and has both male and female organs. The plant is not self-fertile. It grows in most soils but does best in moist areas. It prefers a deep, rich loamy soil in the sun or semi-shade. It grows from both seeds and cuttings. Seed may require more than 18 months in moist soil to germinate. Fruit ripens in September through October and is eaten by birds and other animals which may spread seed to other areas.

MANAGEMENT

Young plants may be pulled by hand or with a weed wrench. Older plants may need to have cut-stump or hack-and-squirt treatment. Glyphosate or Triclopyr can be used to treat the cut stump or the hack-and-squirt method.

As this plant is being sold for ornamental use in urban areas in the northeast U.S., the potential for its presence will be high. *V. sieboldii* is very easy to grow, is adaptable to a wide range of soil pH, and is tolerant of dry soils. Thus it is compatible to various environmental conditions.

Red Berries Ripen to Black

GARLIC MUSTARD *Alliaria petiolata* [Bieb] Cavara & Grande

Garlic Mustard Rosette

Garlic mustard (an invasive plant from Europe) is a cool season biennial herb with stalked, triangular to heart-shaped, coarsely toothed leaves that give off an odor of garlic when crushed. First-year plants appear as a rosette of green leaves close to the ground. Rosettes remain green through the winter and develop into mature flowering plants the following spring. Flowering plants of garlic mustard reach from .61 - .91 m (2 – 3 ½ ft) in height and produce buttonlike clusters of small white flowers, each with four petals in the shape of a cross.

Recognition of garlic mustard is critical. Several white-flowered native plants, including toothworts (*Dentaria*), sweet cicely (*Osmorhiza claytonii*), and early saxifrage (*Saxifraga virginica*), occur alongside garlic mustard and may be mistaken for it.

Beginning in May in the mid-Atlantic Coast Plain region, seeds are produced in erect, slender pods and become shiny black when mature. By late June, when most garlic mustard plants have died, they can be recognized only by the erect stalks of dry, pale brown seedpods that remain, and may hold viable seed, through the summer.

Garlic Mustard in Bloom

Garlic mustard poses a severe threat to native plants and animals in forest communities. Many native widlflowers that complete their life cycles in the springtime (e.g., spring beauty, wild ginger, bloodroot, Dutchman's breeches, hepatica, toothworts, and trilliums) occur in the same habitat as garlic mustard. Once introduced to an area, garlic mustard outcompetes native plants by aggressively monopolizing light, moisture, nutrients, soil and space. Wildlife species that depend on these early plants for their foliage, pollen, nectar, fruits, seeds and roots, are deprived of these essential food sources when garlic mustard replaces them.

Garlic mustard also poses a threat to one of our rare native insects, the West Virginia white butterfly (*Pieris virginiensis*). Several species of spring wildflowers known as "toothworts" (*Dentaria*), also in the mustard family, are the primary food source for the caterpillar stage of this butterfly. Garlic mustard is causing local extirpations of the toothworts, and chemicals in garlic mustard appear to be toxic to the eggs of the butterfly, as evidenced by their failure to hatch when laid on garlic mustard plants.

Garlic mustard is found from eastern Canada, south to Virginia and as far west as Kansas and Nebraska. Garlic mustard frequently occurs in moist, shaded soil of river floodplains, forests, roadsides, edges of woods, trails edges and forest openings. Disturbed areas are most susceptible to rapid invasion and dominance. Though invasive under a wide range of light and soil conditions, garlic mustard is associated with calcareous soils and does not tolerate high acidity.

After spending the first half of its two-year life cycle as a rosette of leaves, garlic mustard plants develop rapidly the following spring into mature plants that flower, produce seed and die by late June. Seeds are produced in erect, slender, four-sided pods, called siliques, beginning in May. Siliques become tan and papery as they mature and contain shiny black seeds in a row. By late June, most of the leaves have faded away and garlic mustard plants can be recognized only by the dead and dying stalks of dry, pale brown seedpods that may remain and hold viable seed throughout the summer.

Garlic Mustard Seed Pods

A single plant can produce thousands of seeds, which scatter as much as several meters from the parent plant. Garlic mustard flowers either self-fertilize or are cross-pollinated by a variety of insects. Self-fertilized seed is genetically identical to the parent plant, enhancing its ability to colonize an area. Although water may transport seeds of garlic mustard, they do not float well and are probably not carried far by wind. Long distance dispersal is most likely aided by human activities and wildlife. Additionally, because white-tailed deer prefer native plants to garlic mustard, large deer populations may help to expand it by removing competing native plants and exposing the soil and seedbed through trampling.

MANAGEMENT

Because the seeds of garlic can remain viable in the soil for five years or more, effective management requires a long term commitment. The goal is to prevent seed production until the stored seed is exhausted. Hand removal of plants is possible for light infestations and when desirable native species co-occur. Care must be taken to remove the plant with its entire root system because new plants can sprout from root fragments. This is best achieved when the soil is moist, by grasping low and firmly on the plant and tugging gently until the main root loosens from the soil and the entire plant pulls out. Pulled plants should be removed from site, especially if flowers are present.

For larger infestations of garlic mustard, or when hand-pulling is not practical, flowering stems can be cut at ground level or within several inches of the ground, to prevent seed production. If stems are cut too high, the plant may produce additional flowers at leaf axils. Once seedpods are present, but before the seeds have matured or scattered, the stalks can be clipped, bagged and removed from the site to help prevent continued buildup of seed stores. This can be done through much of the summer.

For very heavy infestations, where the risk to desirable plant species is minimal, application of the non-selective, systemic herbicide glyphosate (e.g., Roundup) is also effective. Herbicide may be applied at any time of year, including winter (to kill overwintering rosettes), as long as the temperature is above 10ºC (50ºF) and rain is not expected for about eight hours. Spray shields may be used to better direct herbicide and limit non-intentional drift.

Regardless of the management method employed, annual monitoring is necessary for a period of at least five years to ensure that seed stores of garlic mustard have been exhausted.

Researchers are investigating potential biological control agents for garlic mustard which may greatly improve management.

Portions of this document were taken from a paper done by Jil M. Swearingen, U.S. National Park Service, Washington, DC.

APPENDIX II

SAFETY

SAFETY

PESTICIDE SAFETY

Pesticides are insecticides, herbicides, fungicides, rodenticides and other chemicals used to control, prevent, destroy, repel or regulate pests. Pesticides have an EPA registration number on the label. This includes personal repellant products. As poisons, they can affect living organisms and usually may have adverse effects on other nontarget plants or animals, including humans. Because of their biological activity, pesticides can injure (or kill) adults, children, pets, livestock, wild animals, insects, birds, fish and plants. Pesticides must be carefully stored, handled and used to avoid exposure to nontargets.

Certification

Any person (park staff or contractor) who is involved in handling or applying pesticides should be trained in proper procedures. Protective equipment must be worn by the person handling, loading, mixing or applying any pesticide. Pesticides will only be applied by personnel who are properly trained and are supervised by a certified applicator or who are certified themselves. In New Jersey, certified applicators must receive training, pass a test and attend periodic updating continuing education workshops or training to keep their certification current. The IPM coordinator should be a state certified pesticide applicator.

Pesticide Information

Pesticide labels contain information on precautions for the safety of the pesticide applicator and cautions to be taken to protect or reduce exposure to other workers and/or visitors. The label is the law. Violating the label directions is a violation of FIFRA. Chemical (pesticide) labels on containers must not be removed or defaced. OSHA Hazard Communication Standard requires workers be trained and provided appropriate protective equipment and information (MSDS) on any hazardous material they might handle. Treated areas will be posted to provide the public (staff and visitors) with information on the pesticide used, the area treated, and the safe re-entry time (5 half lives). Keep an inventory of all pesticides used or stored in the park; copies of labels and MSDS should be stored with the products and also with the IPM Coordinator and the park safety officer.

Pesticide Storage

The pesticide storage facility should contain copies of labels, MSDS and inventory information. The pesticide storage structure must be properly posted with warning signs and securely locked. The structure must be fireproof and ventilated to the outside. Other materials such as cleaning fluids, paint, solvent, fuel oil, gasoline, kerosene or other chemicals should not be placed or stored in the pesticide storage structure because of the increased risk of fire or explosion. Different types of pesticides will be stored on separate shelves or compartments. The local Fire Department will be made aware of the storage location(s) and the types of pesticides stored so that a fire emergency plan is prepared.

Pesticide Disposal

The pesticide label has directions for procedures to follow to dispose of pesticide containers, pesticide and equipment rinsates. U.S. EPA and state regulations also address the disposal of hazardous substances. Limit the amount of material that needs to be disposed by:

- Purchasing only the amount needed for each treatment
- NPS policy limits the quantity of pesticide that can be purchased
- Mixing only the amount needed for the treatment
- Apply remaining mixed pesticide to the treated area according to label instructions
- Upon completion, triple rinse the spray equipment and apply the rinsate to the treated area (follow the label directions)
- Use single dose syringe applicator to apply gel baits
- Use containerized aerosol pesticides which can be reused until empty
- Use dust or granular pesticides that can be returned to the original container, if necessary, for storage

Excess unopened product can be considered to be "surplus property" and transferred to another agency in accordance with federal and state laws and regulations. Retain records of all donations of surplus pesticides.

Training

The IPM Coordinator should have attended the NPS IPM course, or be scheduled to take the course as soon as possible. Other key staff that have responsibilities related to pest management may also attend (forester, maintenance, natural resources, and supervisors). Pesticide applicators must take state certification classes and attend periodic updates. College or university courses on pesticide toxicology, wildlife management, botany, entomology and other life sciences can be useful.

The Curator will complete the basic NPS curatorial training course and, if possible, the NPS 40-hour IPM training course. The curator may also maintain state pesticide applicator certification. Staff performing inspections or monitoring should receive at least eight hours of documented IPM training that includes methods of inspecting structures. Staff involved in rodent management should receive at least 16 hours of instruction including inspection and monitoring techniques, disease prevention, rodent management methods, sanitation, safety; tuning, setting and recovery of snap traps; rodenticide use processes and risks. Staff required to manage stinging insects (hornets, honey bees, yellowjackets) will receive at least four hours of training including protective equipment, insect and colony removal procedures, bystander management and emergency first aid. The IPM Coordinator will maintain copies of all staff IPM training documents.

Notification

Areas on the park (structures, grounds, forests, etc.) that are scheduled to be treated with any pesticide should be posted at least 24 hours prior to the treatment with warning information (target pest, pesticide to be used, signal word, date of treatment, area of treatment, re-entry date,

information phone number). The posted notice should be of a material that will not deteriorate in weather, and should be removed on the re-entry date. The local fire, police and EMS units should also be made aware of the treatment information. Members of the staff and local neighbors who are known to suffer from environmental illness (EI) or multiple chemical sensitivity (MCS) must also be notified at least 48 hours before the treatment so they can leave the area or protect themselves. Please refer to the Pesticide Treated Area Posting Form at the end of this section.

Spills

Pesticide spills need more detailed attention than spills of other materials. The spilled pesticide may also present a long-term hazard at the spill site and to responding or present personnel. If a pesticide spill has occurred, immediate procedures must be taken. The first action is to protect yourself: put on protective clothing, gloves, boots, tyvek coveralls, goggles and respirator. The second action is to isolate the area: do not allow unauthorized and unprotected personnel into the area. Identify the material and determine the hazard. If an unprotected person is involved or has succumbed, perform the rescue and administer first aid, then decontaminate the victim. Contain the spill. For liquids or dusts, dike off the area, stop any leaks, and use absorbent material to soak up the spill. A small spill (one pint or less, or one-half pound or less) may be contained with absorbent cloths, sand, bagged clay, or diatomaceous earth. A larger spill may necessitate soil dikes, sand snakes, commercial bagged clay or other containment efforts. For large spills, the Fire Department or other emergency responders may be called. For large spills of highly toxic pesticides, CHEMTREC can be called for containment and cleanup information. CHEMTREC may call the Pesticide Safety Team Network (PSTN) if a large quantity of pesticide is involved. Removing and decontaminating the material may require special procedures. Exposed staff or other personnel may need to be taken to hospitals for examination and treatment. Additional tests may be necessary over time, depending upon the pesticide exposure. The lesson is to not have toxic pesticides on site, and, if at all possible, avoid spills. Develop procedures for handling pesticides to avoid spills.

Spill kits can be developed and placed at storage, mixing and application sites. The kit should have diking or absorbent material sufficient to contain the amount of pesticide that may be involved (storage areas may need more than mixing areas), protective clothing and equipment, and emergency phone numbers. Absorbent material can be bagged clay, activated charcoal, diatomaceous earth or other highly absorbent material. There are also absorbent pads now available for absorbing pesticides.

HUMAN HEALTH

Disease Concerns

Most arthropod, bird and mammal pests come into direct contact with soil, dead and rotting organic material, and other sources of disease organisms which may provide opportunity for transmission to humans. This potential adverse effect of disease transmission to humans (park staff and visitors) is an important reason for an aggressive pest management program.

The advent of Hantavirus illness and death from exposure to rodent urine, feces and saliva poses a real concern for the presence of rodents in structures. Anyone involved in rodent management

actions should be aware of the risks of exposure to the deadly Hantavirus, which may be present in rodent urine, feces and saliva. Minimal protection may be necessary when inspecting for rodent activity, monitoring or setting traps (dust mask, surgical gloves). Trapped rodents can be removed by placing a zip loc bag inside-out over your hand, grabbing the trap and captured (dead) rodent with the zip loc bag, then turning the bag right-side out over the trap and dead rodent, zipping the bag closed and placing it into another sealable bag for disposal. If a person is involved in cleaning rodent-infested, enclosed areas (inside a structure) or removing rodent urine, fecal droppings, nesting or other rodent debris, that person must wear approved protective equipment and follow Department of Health or CDC guidelines. Minimum protective equipment includes rubber gloves, goggles, coveralls, and a respirator with a HEPA filter. Other rodent-borne diseases associated with rodents are bubonic plague (flea transmitted), murine typhus, rat bite fever, hemorrhagic fever, and several others.

Other sources of human disease can be transmitted by ectoparasites on rodents, other mammals, birds and insects feeding on dead animals or other organic material. Allergies, asthma and other serious health effects can manifest from contact with exuviae, pheromones and cockroach and other insect body parts and droppings.

Wildlife Concerns

Mice often nest in, under and around structures, and are particularly fond of the cavities (and warmth) in stoves and other kitchen appliances and cupboards. Their gnawing (to keep their teeth worn down) on wiring and other electrical appliances has been the cause of many fires. Some migratory birds are implicated in harboring and transmitting Avian flu through contact with the fecal droppings.

Insect stings by ants, bees, wasps and yellowjackets can also be a concern for human safety, especially those who are sensitized to the stings. Managing these pests where there may be contact by visitors or staff is important. In some cases, notices to wear repellants may be necessary to attempt to ward off mosquitoes, black flies, ticks or other biting pests.

WARNING
PESTICIDE TREATED AREA

An application of a pesticide was deemed necessary to manage pests that are invading this area.

This notice is: a 24-hour a 48-hour a 72-hour an Emergency posting

Product Name: _____ Mfg. Name: _____

Active Ingredient: _____ USEPA Reg. No.: _____

Target Pest(s): _____

Date of Application: _____

Date Sign May Be Removed: _____ (No less than 72 hours from application)

Signal Word: Danger Warning Caution

If you have questions regarding this notification or require additional information, please contact the Park IPM Coordinator at 203-544-9829 x 11.

APPENDIX III

SUPPLIES

SUPPLIES

Inspection Tools

Inspection Tools

- Flashlight
- Hand lens, 16x or better
- Probe for testing wood for rot
- Spatula for checking cracks and crevices
- Notebook and pen
- Digital camera
- Moisture meter
- UV light for detecting rodent urine stains

Exclusion Materials

- **¼ in. hardware cloth** (stainless steel or galvanized). Used for excluding rodents, birds and larger pests
- **Stuf-Fit** (copper mesh – won't rust). Used for closing small holes, cracks, crevices and around pipes penetrating walls and ceilings. Easy to stuff into openings to prevent access by insects, rodents and other small pests. Compresses easily.
- **Stainless steel wool or scrubbies** (won't rust). Used for filling larger holes to prevent pest access. May be difficult to compress.
- **Dap Brand Caulk**. Many different sealants and fillers to cover cracks, crevices, small holes or openings filled with Stuf-Fit or stainless steel wool, and varied surfaces.
- **Door sweeps**. Metal framed with rubber or neoprene blade to prevent insects and mice from entering a structure under the door. Wooden thresholds may be installed on the floor below the door to close the gap if it is historic. Brush-type door sweeps do not exclude mice, large beetles or cockroaches.

Monitoring Materials

- **Unscented talc**. Used for tracking patches to determine runways of rats, mice or insects inside structures (non-toxic).
- **Lo-Line Crawling Insect Sticky Traps.** Used for monitoring and capturing crawling insects inside structures. Best designed trap on the market at this time.
- **Insects Limited Flying Insect Pheromone Traps.** Many different traps for monitoring presence and capturing flying and other insects. Traps are usually specific to species or groups of species.

Snap Traps

- **Victor Brand** mouse and rat snap traps. The oldest and best snap trap available today. Use only those with the metal trigger (the plastic ones are slower). The metal trigger can be fine-tuned (hair-triggered) with a file and minor adjustments. Must be checked each morning.
- **Rat Zapper** by AgriZap, Inc. An electronic trap that electrocutes rats and mice that enter the tunnel for the bait. Must be checked each morning.

Low-Risk Pesticides (for use in structures, museum and garden areas)

- **Avert Cockroach Bait Stations.** Abamectin bait station for cockroaches for use in and around structures.
- **Borid.** 99% Boric Acid powder which can be applied into cracks and crevices in structures to manage crawling insects.
- **Dekko Paks**. Borate based bait station designed for management of silverfish.
- **Drax Liquidator.** Boric Acid in sugar water bait for sweet-feeding ants. This slow-acting stomach poison is very effective for eliminating ant colonies. An excellent bait station for either inside or outdoor placement.
- **EcoEXEMPT IC.** An organic insecticide concentrate containing rosemary and other oils for use indoors and outdoors for crawling and flying insects.
- **Flea 'n Tick B Gone.** An enzyme treatment made from natural plant sources which has proven to effectively remove fleas, ticks, lice and other pests.
- **Hinder Deer & Rabbit Repellant.** Contains ammonium high fatty acid soaps to protect plants by forming a mild odor barrier. For use on vegetable, fruit and flower plants and shrubs.
- **Matran 2.** A FIFRA 25b exempt, non-selective, post-emergence herbicide which contains clove oil, water and lecithin. Can be used in and around all crop areas.
- **Max Force Roach Control System.** Contains Hydramethylnon to control cockroaches in structures.
- **Nisus Corporation. BoraCare.** DOT insecticide with solvent to aid wood penetration for wood-destroying organisms (WDOs). Solution can be mixed with water and applied as a spray.
- **Nisus Corporation. Jecta.** DOT in a gel to be injected into posts or wood in contact with soil to prevent or treat for termites, mold, fungi and wood rot; can be used for a spot treatment.
- **Nisus Corporation. Niban FG Bait.** Boric Acid for the control of ants, cockroaches, crickets and silverfish. Can be used both inside and outside.
- **Nisus Corporation. Niban Granular Bait C.** Boric Acid for the control of cockroaches and ants in structures.
- **Nisus Corporation. Nibor-D.** A borate powder used as a dust, liquid or mop solution to kill and prevent infestations of carpenter ants, silverfish and mildew. For both interior and exterior use.
- **Nisus Corporation. TimBor Professional.** Disodium Octaborate Tetrahydrate [DOT] insecticide. For use on insects in cracks and crevices, and treating wood to prevent (or treat) termites, wood-destroying insects, mold and fungi. A powder material for crawling insects that can also be mixed with water and applied as a spray; will penetrate into (and through) the raw wood member.
- **Perma-Guard Commercial Insecticide.** Diatomaceous Earth mixed with Pyrethrin and Piperonyl Butoxide which can be dusted into cracks and crevices to manage crawling insects such as cockroaches, ants and silverfish.
- **Perma-Guard Fossil Shell Flour.** Pure Diatomaceous Earth powder which can be used to manage museum pests such as Indian Meal Moth, grain weevils, etc.
- **Perma-Guard Garden and Plant Insecticide.** Diatomaceous Earth mixed with Pyrethrin and Piperonyl Butoxde. This is an effective material for insect management on field crops, yards and gardens.

- **Tri Die.** Pressurized Silica and Pyrethrin dust for management of museum pests and crawling insects in structures.
- **Victor Wasp and Hornet Spray.** Contains Mint Oil and Sodium Lauryl Sulfate for the management of wasps, hornets and yellow jackets.
- **WOODguard.** A petroleum oil and solvent with Copper 8-Quinolinolate which can be sprayed or brushed on raw wood surfaces to prevent fungus, mold, wood rot and mildew. Provides water repellency.
- **WOW (Without Weeds).** Contains Maize Gluten Meal for pre-emergent weed management for lawns and gardens.

APPENDIX IV

GLOSSARY

GLOSSARY

ABSORPTION-The process by which a chemical or fluid is taken into the systems of human beings, plants, and animals.

ACARICIDE-A pesticide used to kill mites and ticks. A miticide is an acaricide.

ACTIVE INGREDIENT-The chemical or chemicals in a pesticide responsible for killing, poisoning, or repelling the pest. (Listed separately in the ingredient statement.)

ACUTE TOXICITY-The ability of a pesticide to cause injury within twenty-four hours following exposure. LD_{50} and LC_{50} are common indicators of the degree of acute toxicity. (See also Chronic Toxicity.)

ADJUVANT-A substance added to a pesticide to improve its effectiveness or safety. Same as additive. Examples: penetrants, spreader-stickers, and wetting agents.

ADSORPTION-The process by which chemicals are held or bound to a surface by physical or chemical attraction. Clay and high-organic soils tend to adsorb pesticides.

AEROSOL-A material stored in a container under pressure. Fine droplets are produced when the material dissolved in a liquid carrier is released into the air from the pressurized container.

ALGAE-Simple aquatic plants that contain chlorophyll and are photosynthetic.

ALGICIDE-A pesticide used to kill or inhibit algae.

ANTI-SIPHONING DEVICE-A device attached to the filling hose that prevents backflow or backsiphoning from a spray tank into a water source.

ANTICOAGULANT-A chemical that prevents blood clotting. An active ingredient in some rodenticides.

ANTIDOTE-A treatment used to counteract the effects of pesticide poisoning or some other poison in the body.

ARACHNID-A wingless arthropod with two body regions and four pairs of jointed legs. Spiders, ticks, and mites are in the class Arachnida.

ARTHROPOD-An invertebrate animal characterized by jointed body and limbs. It is usually covered by a hard exoskeleton covering that is molted at intervals. For example, insects, mites, and crayfish are in the phylum Arthropoda.

ATTRACTANT-A substance or device that lures pests to a trap or poison bait.

AVICIDE-A pesticide used to repel or kill birds.

BACTERIA-Microscopic organisms, some of which are capable of producing diseases in people, plants and animals. Some bacteria are beneficial.

BACTERICIDE-Chemical used to kill bacteria.

BAIT-A food or other substance used to attract a pest to a pesticide or a trap.

BAND APPLICATION-Application of a pesticide in a strip alongside or around a structure, a portion of a structure, or any object.

BARRIER APPLICATION-See band application.

BENEFICIAL INSECT-An insect that is useful or helpful to people, such as insect parasites, predators, or pollinators.

BIOLOGICAL CONTROL-Management of pests using beneficial arthropods as predators, parasites, and disease-causing organisms which may occur naturally or are introduced to reduce pest populations.

BIOMAGNIFICATION-The process by which one organism accumulates chemical residues in higher concentration from other organisms which they have consumed.

BOTANICAL PESTICIDE-A pesticide produced from chemicals found in plants. Examples are nicotine, pyrethrins, and strychnine.

BRAND NAME-The name, or designation of a specific pesticide product or device made by a manufacturer or formulator. (A marketing name.)

CALIBRATE, CALIBRATION OF EQUIPMENT OR APPLICATION METHOD-Measurement and adjustment to control the output or rate of dispensing pesticides.

CARBAMATES-(N-Methyl Carbamates). A group of pesticides containing nitrogen, formulated as insecticides, fungicides, and herbicides. The N-Methyl Carbamates are insecticides and inhibit cholinesterase in animals.

CARCINOGENIC-The ability of a substance or agent to induce malignant tumors (cancer).

CARRIER-An inert liquid, solid, or gas added to an active ingredient for delivering a pesticide to the target effectively. A carrier is usually water, oil, or other solvent, used to dilute the formulated product for application.

CARRYING CAPACITY-The number of organisms for which a specific site can provide life support.

CERTIFIED APPLICATORS-Individuals who are certified by the state to use or supervise the use of restricted-use pesticides.

CHEMICAL NAME-The scientific name of active ingredients found in formulated products. This complex name is derived from the chemical structure of the active ingredient.

CHEMICAL CONTROL-Pesticide application to kill pests.

CHEMOSTERILANT-A chemical compound capable of preventing animal reproduction.

CHEMTREC-The Chemical Transportation Emergency Center which has a toll-free number (800-424-9300) for providing 24-hour information only for chemical emergencies such as a spill, leak, fire, or accident.

CHLORINATED HYDROCARBON-A pesticide containing chlorine, carbon, and hydrogen. Many are persistent in the environment, such as Chlordane and DDT. Only a few are registered for use in the U.S.

CHOLINESTERASE, ACETYLCHOLINESTERASE-An enzyme in animals that helps regulate nerve impulses. This enzyme is depressed by N-Methyl carbamate and organophosphate pesticides.

CHRONIC TOXICITY-The ability of a pesticide chemical to cause injury or illness (beyond 24 hours following exposure) when applied in small amounts repeatedly for a longer period of time. Chronic effects can also result from a single exposure. (See also Acute Toxicity.)

COMMERCIAL APPLICATOR-A state-certified applicator who for compensation uses or supervises the use of pesticides classified for restricted use for any purpose or on any property other than that producing an agricultural commodity.

COMMON NAME-A name given to a pesticide's active ingredient by a recognized committee on pesticide nomenclature. Many pesticides are known by a number of trade or brand names, but the active ingredient has only one recognized common name.

COMMUNITY-The different populations of animal or plant species that exist together in an ecosystem (See also Population and Ecosystem.)

COMPETENT-Individuals properly qualified to perform functions associated with pesticide application. The degree of competency (capability) required is directly related to the nature of the activity and the associated responsibility.

CONCENTRATION-Refers to the amount of active ingredient in a given volume or weight of formulated product.

CONTACT PESTICIDE-A pesticide that causes death or injury to pests when in contact with it. The chemical does not have to be ingested. It is often used to describe a spray applied directly on a pest.

CONTAMINATION-The presence of an unwanted substance (sometimes pesticides) in or on a plant, animal, soil, water, air, or structure.

CULTURAL CONTROL-A pest management method that includes changing human habits, such as sanitation, changing work practices, or cleaning or garbage pick-up schedules.

DECONTAMINATE-To remove or break down a pesticidal chemical from a surface or substance.

DEGRADATION-A process by which a chemical compound or pesticide is reduced to simpler compounds by the action of microorganisms, water, air, sunlight, or other agents. Degradation products are usually, but not always, less toxic than the original compound.

DEPOSIT-The amount of pesticide on a treated surface after application.

DERMAL TOXICITY-The ability of a pesticide to cause acute illness or injury to human beings or animals when absorbed through the skin (see Exposure Route.)

DESICCANT-A type of pesticide that draws moisture or fluid from a plant or arthropod pest, causing it to die. Certain desiccant dusts destroy the waxy outer coating that holds moisture within an insect's body.

DETOXIFY-To render a pesticide's active ingredient or other poisonous chemical harmless.

DIAGNOSIS-The positive identification of a problem and its cause.

DILUENT-Any liquid, gas or solid material used to dilute or weaken a concentrated pesticide.

DISINFECTANT-A chemical or other agent that kills or inactivates disease-producing microorganisms. Chemicals used to clean or surface-sterilize inanimate objects.

DOSE, DOSAGE-Quantity, amount, or rate of pesticide applied to a given area or target.

DRIFT-The airborne movement of a pesticide spray or dust beyond the intended target area.

DUST-A finely ground, dry pesticide formulation containing a small amount of active ingredient and a large amount of inert carrier or diluent such as clay or talc.

ECOSYSTEM-The pest-management unit. It includes a community (of populations) with the necessary physical (harborage, moisture, temperature), and biotic (food, hosts) supporting factors that allow a population of pests to persist.

EMULSIFIABLE CONCENTRATE (EC)-A pesticide formulation produced by mixing or suspending the active ingredient (the concentrate) and an emulsifying agent in a suitable carrier. When added to water, a milky emulsion is formed.

EMULSIFYING AGENT (EMULSIFIER)-A chemical that aids the suspension of a liquid in another that normally would not mix together.

EMULSION-A mixture of two liquids which are not soluble in one another. One is suspended as very small droplets in the other with the aid of an emulsifying agent.

ENCAPSULATED FORMULATION-A pesticide formulation with its active ingredient enclosed in tiny capsules of polyvinyl or other materials; principally used for slow release. The enclosed active ingredient moves out to the capsule surface as pesticide on the surface is removed (volatilizes, or rubs off).

ENDANGERED SPECIES-Individual plants or animals with a population that has been reduced to the extent that it is near extinction and that has been designated to be endangered by a federal agency.

ENTRY INTERVAL-See Re-entry Interval.

ENVIRONMENT-Air, land, water, plants, people, animals, and the interrelationships which exist among them.

EPA - ENVIRONMENTAL PROTECTION AGENCY-The federal agency responsible for ensuring the protection of people and the environment from potentially adverse effects of pesticides and other contaminants.

EPA ESTABLISHMENT NUMBER-A number assigned to each pesticide-production plant by the EPA. The number indicating the plant at which the pesticide product was produced must appear on all labels of that product.

EPA REGISTRATION NUMBER-An identification number assigned to a pesticide product when it is registered by the EPA for use. The number must appear on all labels of pesticide products.

ERADICATION-The complete elimination of a (pest) population from a designated area.

EXPOSURE ROUTE OR COMMON EXPOSURE ROUTE-The manner - dermal (through the skin), oral (through the mouth), or inhalation/respiratory - in which a pesticide may enter an organism.

FIFRA-The Federal Insecticide, Fungicide, and Rodenticide Act; a federal law and its amendments that controls pesticide registration and use.

FLOWABLE-A pesticide formulation in which very finely ground solid particles are suspended (not dissolved) in a liquid carrier.

FOG TREATMENT-A pesticide in aerosol-sized droplets (under 40 microns). Not a mist or gas. After propulsion, the fog droplets fall on exposed surfaces.

FORMULATION-The pesticide product as purchased, containing a mixture of one or more active ingredients, and carriers (inert ingredients), with other additives making it easy to store, dilute, and apply.

FUMIGANT-A pesticide formulation that volatilizes, forming a toxic vapor or gas that kills in the gaseous state, penetrating voids to kill pests.

FUNGICIDE-A chemical used to kill fungi.

FUNGUS (plural - fungi)-A group of small, often microscopic, organisms in the plant kingdom which cause rot, mold, and disease. Fungi need moisture or a damp environment (wood rots require at least 19%). Fungi are extremely important in the diet of many insects.

GENERAL USE (UNCLASSIFIED) PESTICIDE-A pesticide which can be purchased and used by the general public. (See also Restricted Use Pesticide.)

GRANULE-A dry pesticide formulation. An active ingredient is either mixed with or applied as a coating to an inert carrier to form a small, ready-to-use, low-concentrate chemical which normally does not present a drift hazard. Pellets differ from granules only in their precise uniformity, larger size, and shape.

GROUNDWATER-Water source located beneath the soil surface from which springs and well water are drawn (see also Surface Water.)

HABITAT MODIFICATION-Removing food, water, shelter, and other conditions that support pests, or excluding access by pests to the site.

HALF LIFE-The time required for half of something (i.e. pesticide) to undergo a specific process (chemical degradation), so that only one-half of the applied material is still active (i.e. half life of Chlordane in soil is about 75 years).

HANTAVIRUS-A deadly virus transmitted to humans through contact with rodent feces, urine and saliva resulting in acute respiratory failure.

HARBORAGE-Shelter that provides the basic needs, including a safe place for the pest population.

HAZARD-See Risk.

HERBICIDE-A pesticide used to kill or inhibit plant growth.

HIGH-RISK PERSON-A person who has some condition that may put him or her at risk from exposure to pesticides. Such persons include children, the elderly, pregnant women, newborns, asthmatics, the neurologically impaired, the environmentally ill (EI), and those with multiple chemical sensitivity (MCS).

HOST-Any animal or plant on or in which another lives for nourishment, development, or protection.

IGR, INSECT GROWTH REGULATOR JUVENOID-A pesticide which mimics insect hormones that control molting and the development of insect systems affecting the change from immature to adult (see Juvenile Hormone.)

INERT INGREDIENT-An inactive material without pesticidal activity in a pesticide formulation, but which may be hazardous for some other reason; i.e., petroleum derivatives.

INGREDIENT STATEMENT-A portion of the label on a pesticide container that gives the name and amount of each active ingredient and the total amount of inert ingredients in the formulation.

INHALATION-Taking a substance in through the lungs (breathing in). (See Exposure Route.)

INSECT GROWTH REGULATOR-See IGR.

INSECTICIDE-A pesticide used to manage or prevent damage caused by insects.

INSECTS, INSECTA-A class in the phylum Arthropoda characterized by a body composed of three segments and three pair of legs.

INSPECTION-A process for detecting pests, pest damage, and evidence of pest activity in a managed site. (See Monitoring.)

INTEGRATED PEST MANAGEMENT-See IPM.

IPM-Integrated pest management. The coordinated use of pest and environmental information with available pest management methods to prevent unacceptable levels of pest damage by the most economical means, and with the least possible hazard to people and the environment. IPM includes reducing pests to a tolerable level. Pesticide application is not the primary management method, but is an element of IPM, as are cultural and structural alterations. IPM programs stress communication, monitoring, inspection, and evaluation (keeping and using records).

JUVENILE HORMONE-A hormone produced by an insect that inhibits change or molting. As long as juvenile hormone is present the insect does not develop into an adult, but remains immature.

LABEL-All printed material attached to or on a pesticide container.

LABELING-The pesticide product label and other accompanying materials that contain directions for use that pesticide users are legally required to follow.

LARVA (plural - larvae)-The developmental stage of insects with complete metamorphosis that hatches from the egg. A mature larva becomes a pupa.

LC_{50}-Lethal concentration. The concentration of a pesticide, usually in air or water, that kills 50 percent of a test population of animals. LC_{50} is usually expressed in parts per million (ppm). The lower the LC_{50} value, the more acutely toxic the chemical.

LD_{50}-Lethal dose. The dose or amount of a pesticide that can kill 50 percent of the test population of animals when eaten or absorbed through the skin. LD_{50} is expressed in milligrams of chemical per kilogram of body weight of the test animal (mg/kg). The lower the LD_{50}, the more acutely toxic the pesticide.

LEACHING-The movement of a substance with water downward through soil.

LYME DISEASE-A debilitating disease mainly affecting joints that is transmitted to humans through the bite of ticks, especially the Deer Tick.

METAMORPHOSIS-A change in the shape or form of an animal. Usually used when referring to insect development.

MICROBIAL DEGRADATION-Breakdown of a chemical by microorganisms.

MICROBIAL PESTICIDE-Bacteria, viruses, fungi, and other microorganisms used to manage pests. Also called biorationals.

MICROORGANISM-An organism so small that it can be seen only with the aid of a microscope.

MITICIDE-A pesticide used to kill mites (see Acaricide.)

MODE OF ACTION-The way in which a pesticide exerts a toxic effect on the target plant or animal.

MOLLUSCICIDE-A chemical used to kill snails and slugs.

MONITORING-Ongoing surveillance. Monitoring includes periodic inspection and record-keeping. Monitoring records allow technicians to evaluate pest population suppression, identify infested or non-infested sites, and manage the progress of the pest-management program.

MSDS-Material Safety Data Sheet required by Department of Labor to be provided by manufacturers to those who request information on chemical substances. Included is data on flammability, eye hazards, protective equipment necessary, spill/clean-up instructions, and other hazard information.

NECROSIS-Death of plant or animal tissues which results in the formation of discolored, sunken, or necrotic (dead) areas.

NONTARGET ORGANISM-Any plant or animal other than the intended targets of pesticide application.

NYMPH-The developmental stage of insects with gradual metamorphosis that hatches from the egg. Nymphs become adults.

ORAL TOXICITY-The effect of a pesticide resulting in injury or acute illness when taken by mouth.

ORGANOPHOSPHATES-A large group of pesticides that contain phosphorus and inhibit cholinesterase in animals; i.e., Malathion and Diazinon.

PARASITE-A plant, animal, or microorganism living in, on, or with another living organism for the purpose of obtaining all or part of its food.

PATHOGEN-A disease-causing organism.

PERSONAL PROTECTIVE EQUIPMENT-Devices and clothing intended to protect a person from exposure to pesticides, including items like long-sleeved shirts, long trousers, coveralls, hats, gloves, shoes, respirators, and other safety items as needed.

PEST MANAGEMENT-See IPM.

PEST-An undesirable organism including any insect, rodent, nematode, fungus, weed, or some terrestrial and aquatic plants and animals, virus, bacteria, or micro-organism which the US EPA Administrator declares to be a pest under FIFRA, Section 25(c)(1).

PESTICIDE-A chemical or other agent used to kill, repel, or otherwise manage pests or to protect from a pest.

pH-A measure of acidity/alkalinity of a liquid: acid below pH7; basic or alkaline above pH7 (up to 14).

PHEROMONE-A substance emitted by an animal to influence the behavior of other animals of the same species. Some are synthetically produced for use in insect traps.

PHOTODEGRADATION-Breakdown of chemicals by the action of light.

PHYSICAL CONTROL-Habitat alteration or changing the infested physical structure, such as by caulking holes, cracks, tightening around doors, windows, moisture reduction, ventilation, and other means.

PHYSIOLOGICAL SENSITIVITIES-Human physiological reaction from exposure in the environment to perhaps minute amounts of chemicals that produce an adverse response.

PHYTOTOXICITY-Injury to plants caused by a chemical or other agent.

POINT OF RUNOFF-The point at which a spray starts to run or drip from the surface to which it is applied.

POISON CONTROL CENTER-A local agency, generally a hospital, which has current information on the proper first-aid techniques and antidotes for poisoning emergencies. Such centers are listed in telephone directories.

POPULATION-Individuals of the same species. The populations in an area make up a community (see Ecosystem.)

PORT-Small sealable hole that allows injection of pesticidal material into a wall or other void in a structure.

PRECIPITATE-A solid substance that forms in a liquid and settles to the bottom of a container; a material that no longer remains in suspension.

PREDATOR-An animal that attacks, kills, and feeds on other animals. Examples of predaceous animals are hawks, owls, snakes, spiders, lady-bird beetles and other insects.

PROFESSIONAL-One who is trained to conduct an efficient operation and able to make judgments based on training and experience.

PROPELLANT-The inert ingredient in pressurized containers that forces an active ingredient from the container.

PUPA (plural - pupae)-The developmental stage of insects with complete metamorphosis when major changes from larval to adult form occurs.

QUALIFIED APPLICATOR-An applicator who is certified (and licensed in some states) to apply restricted-use pesticides in the state. Qualification may also include training or experience.

RATE OF APPLICATION-The amount of pesticide applied to a plant, animal, unit area, or surface; usually measured per acre, per 1,000 square feet, per linear foot, or per cubic foot.

RE-ENTRY INTERVAL-The length of time following an application of a pesticide during which entry into the treated area is restricted. Also known as Entry Interval.

REGISTERED PESTICIDES-Pesticide products which have been registered by the Environmental Protection Agency for uses listed on the label.

REPELLENT-A compound that keeps insects, rodents, birds, or other pests away from plants, domestic animals, buildings, or other treated areas.

RESIDUAL PESTICIDE-A pesticide that continues to remain effective on a treated surface or area for an extended period following application.

RESIDUE-The pesticide active ingredient or its breakdown products which remain in or on the target after treatment.

RESTRICTED USE PESTICIDE-A pesticide that can be purchased and used only by certified applicators or persons under their direct supervision. A pesticide classified for restricted use under FIFRA, Section 3(d)(1)(C).

RISK-A probability that a given pesticide will have an adverse effect on people or the environment in a given situation.

RMSF-Rocky Mountain Spotted Fever is an acute infectious rickettsial disease transmitted to humans by the American dog tick.

RODENTICIDE-A pesticide used to kill rodents.

RUNOFF-The movement of water and associated materials on the soil surface. Runoff usually proceeds to bodies of surface water.

SANITATION-The practice of removing undesirable substances that support a pest or pest population (for instance, food or water).

SIGNAL WORDS-Required wording which appears on every pesticide label to denote the relative toxicity of the product. Signal words are DANGER-POISON, DANGER, WARNING, or CAUTION.

SITE-Areas of actual pest infestation. Each site should be treated specifically or individually.

SOIL INJECTION-The placement of a pesticide below the surface of the soil, a common application method for termiticides.

SOIL DRENCH-To soak or wet the ground surface with pesticide. Large volumes of pesticides are usually needed to saturate the soil to a sufficient depth.

SOIL INCORPORATION-The mechanical mixing of a pesticide product with soil.

SOLUTION-A mixture of one or more substances in another substance (usually a liquid) in which all the ingredients are dissolved. Example: sugar in water.

SOLVENT-A liquid which will dissolve another substance (solid, liquid, or gas) to form a solution.

SPACE SPRAY-A pesticide which is applied as a fine spray or mist to a confined area.

STOMACH POISON-A pesticide that must be eaten by an animal in order to be effective; it will not kill on contact.

SURFACE WATER-Water on the earth's surface such as rivers, lakes, ponds, and streams. (See Groundwater.)

SUSPENSION-A pesticide mixture consisting of fine particles dispersed or floating in a liquid, usually water or oil. Example: wettable powders in water.

TARGET-Plants, animals, structures, areas, or pests toward which the pesticide or other management method is directed.

TECHNICAL MATERIAL-Pesticide active ingredient in pure form, as it is manufactured by a chemical company. It is combined with inert ingredients or additives in formulations such as wettable powders, dusts, emulsifiable concentrates, or granules.

TOXIC-Poisonous to living organisms.

THRESHOLD-A level of pest density. The number of pests observed, trapped, or counted that can be tolerated without an economic loss or aesthetic injury. Thresholds in pest management may be site specific. For example, different numbers of flies may be tolerated at different sites (canoe warehouse and kitchen would have different thresholds).

TOLERABLE LEVELS OF PESTS-The presence of pests, at certain levels, is tolerable in many situations. Totally eliminating pests in certain areas is sometimes not achievable without major structural alterations, excessive control measures, unacceptable disruption, or unacceptable cost. The tolerable level in some situations will be near zero. Urban pest management programs may have lower tolerable levels of pests than rural programs.

TOXICANT-A poisonous substance such as the active ingredient in a pesticide formulation.

TOXICITY-The ability of a pesticide to cause harmful, acute, delayed, or allergic effects. (The degree or extent that a chemical or substance is poisonous.)

TOXIN-A naturally occurring poison produced by plants, animals, or microorganisms. Examples: the poison produced by the black widow spider, the venom produced by snakes, the botulism toxin.

UNCLASSIFIED PESTICIDE-See General-Use Pesticide.

USE-The performance of pesticide-related activities requiring certification including application, mixing, loading, transport, storage, or handling after the manufacturing seal is broken; care and maintenance of application and handling equipment; and disposal of pesticides and their

containers in accordance with label requirements. Uses not needing certification are long-distance transport, long-term storage, and ultimate disposal.

VAPOR PRESSURE-The property which causes a chemical to evaporate. The higher the vapor pressure, the more volatile the chemical or the more easily it will evaporate.

VECTOR-A carrier, an animal (such as an insect, nematode, mite) that can carry and transmit a pathogen from one host to another.

VERTEBRATE-Animal characterized by a segmented backbone or spinal column.

VIRUS-Ultramicroscopic parasites composed of proteins. Viruses can only multiply in living tissues, and they cause many animal and plant diseases.

VOID-Space inside walls or other inaccessible space that may harbor pests.

VOLATILITY-The degree to which a substance changes from a liquid or solid state to a gas at ordinary temperatures when exposed to air.

WATER TABLE-The upper level of the water-saturated zone in the ground.

WEST NILE VIRUS-A disease transmitted to humans and other animals by the bite of a mosquito. Birds (notably Corvids) act as a reservoir and may die as a result.

WETTABLE POWDER-A dry pesticide formulation in powder form that forms a suspension when added to water.

ZONE-The management unit, an area of potential pest infestation made up of infested sites. Zones will contain pest food, water, and harborage. A kitchen-bathroom arrangement in motel units might make up a zone; the canoe warehouse may make up another. Zones may also be established by eliminating areas with little likelihood of infestation and treating the remainder as a zone. A zone will be an ecosystem.

APPENDIX V

IPM INSPECTION FORMS

STRUCTURAL IPM INSPECTION FORM

Date_____ Inspector_____ Assisted by_____

Code Numbers for Problems on Form/Map:

1 = Roaches 2 = Flying Insects (flies, moths) 3 = Other Insects 4 = Rodent Sign 5 = Housekeeping
6 = Maintenance 7 = Bird Sign 8 = Squirrels 9 = WDOs 10 = Other

Abbreviations: PTW = Pressure Treated Wood FWJ = Floor Wall Junction

1. OUTSIDE - Curtilage:
Pests known present.....

Garbage/dumpster conditions.....
General area cleanliness.....
Dead trees/sod debris/termites.....
Pest harborage/debris on ground.....
Pest breeding (water, food, shelter).....
Paving/walk drainage problems.....
Wood too close to structure.....
Plants too close to building.....
General wood control.....
Hazardous trees/limbs.....
Shed/outbuilding problems.....
Rodent burrows/sign/holes.....
Pet/bird feeders/waterers.....
Insect evidence/harborage garden?.....
Vertebrate evidence/holes.....
.....

2. FOUNDATION - Exterior
Pests known present.....

A. Foundation:
Building corners square foundations.....
Foundation intact: dirt/wood contact?.....
Wood-concrete-soil contacts/PTW.....
Foundation cracks.....
36 in. clear area around structure (1 in. gravel).....
.....

B. Grade
Soil drainage characteristics.....
Grade from structure (6 in/10 ft.).....
Grade and water accumulations.....
.....

C. Siding/Building Exterior
Downspout drains splash on siding?.....
Splash blocks perforated pipe.....
Main siding peeling paint/buckling?.....
Water/air conditioner leaks.....
Rusty nails/wood streaking.....
Discolored/decayed wood siding.....
Wood pick test results.....
Wood moisture readings.....
Wood junctions caulked.....
Porch and soffit conditions.....
Tongue & groove flooring caulked.....
Door sweeps/good door closure.....
Metal kickplates on doors.....
Window frame conditions.....
Vents/exhaust/conduits screened.....
Cracks/holes around pipes/wires.....
Outside lights away from doors/on poles; high pressure sodium bulbs; covers clean.....
Trees touching/overhanging structure.....
Plants/plantings/planters/trellises.....
Trash/debris accumulations.....
Insect/vertebrate evidence/harborage.....
.....

D. Food Establishments
Loading docks/receiving areas clean.....
Garbage area removed from structure.....
Other outside storage/spills.....
Exterior wall/foundation cracks.....
.....

E. Structural Roof
Pests known present.....

Missing shingles/cracks in surface.....
Moss/lichen/algae/fungus on roof.....
Rusty iron nails in roofing.....
Shingles/roof intact.....
Shingle extension 1 ft. eave (12-24-30).....
Gutters clean, not clogged.....
Chimney/vents screened.....
Bird problems in eaves.....
Chimney flashing/construction tight.....
Dormer flashing/construction tight.....
Soffit flashing tight.....
Wires from roof pest-protected.....
Insect evidence/harborage.....
Fascia tight/painted (carpenter bees).....
.....

3. INSIDE - Crawlspace
Pests known present.....

Monitor (repair) structure twice a year (spring/fall) for moisture/ damage.....
Vents screened/open/in wells.....
Height of crawlspace (18 in.t joists).....
Wood/soil contact.....
Wood pick test results.....
Termite shields installed.....
Leaking pipes.....
Structural wood type.....
Wet areas? Why? Moisture readings.....
Mold/fungus/decay/insect damage.....
Wood debris present.....
Evident floor/wood shrinkage.....
Vapor barrier? Intact?.....
Pest access into structure thru floor.....
Active insect infestations?.....
Vertebrate sign?.....
Ventilation: 1 sf/150 sf; within 3 ft. of corner.....
Crawlspace access door clear.....

4. INSIDE - Structural
Pests known present.....

A. Basement
Walls dry/moisture readings.....
Storage condition/sanitation.....
Wood moisture in sill area.....
Floor drains clean/screened.....
Sticky trap monitoring.....
Trash collection practices.....
Insect evidence/harborage.....

B. Offices; Classrooms
Reception desk area.....
Exhibit area: general pest risks?.....
Exterior door conditions.....
Offices: neatness/problem areas.....
Eating/storing food at desks.....
Computers/elec equipment problems.....

Insect attracting items in building?.....
Insect evidence/harborage.....
Lunchroom/coffeemaking area.....
Vending machines.....
Trash collection practices.....
Decorative plants.....
General sanitation/lint.....
Cracks/holes in floor.....
Suspended ceilings/light fixtures.....

C. Service/Custodial Rooms
Custodial storage area.....
Wet mops/rags/sour drains.....
Electrical boxes/equipment.....
Drains cleaned/screened.....

D. Kitchens/Food Establishments
Countertops caulked/intact.....
Exhaust vents.....
Water leaks/pipe sweating/hot water heater.....
Drains clear/good condition.....
Food stored in cans/glass.....
Shelves clean/no shelf paper.....
Refrigerator pan/motor.....
Windows tight/insect presence.....
Condition of walls/grease/moisture.....
Storage 6 in. off floor.....
Dishwasher cleanliness/pests.....
Stove vent clean/screened.....
Stove/refrigerator doors clean.....
Hollow legs on tables/chairs/rails?.....
Equipment elevated on legs.....
Conditions under lowest drawers.....
Trash covered; out every night.....
Dishes kept in water until cleaned.....
Outside trash covered; cans cleaned weekly.....
Insect evidence/harborage.....
Dry storage areas.....
Areas behind false fronts on equipment.....
Loose floor tile/screened drains.....
Regularly emptied trash containers.....
Area around can opener/grease hoods.....
Condition of window frames.....
Employee lockers.....
Air doors/vanes positioned correctly.....
Door sweeps.....

E. Bathrooms
Water leaks at tub/shower/toilet; fungus.....
Floor strength near toilet.....
Water leaks under sink.....
Condition of window frames.....
Blistered ceiling/wall paint.....
Insect evidence/harborage.....

F. Structural/Attic
Sufficient ventilation.....
Insect/pest evidence/harborage.....
Vents screened.....
Temperature.....
Roof/wall junction tight seal.....
Rodent evidence.....
Exposed/chewed wiring.....
Appliance venting.....
Frozen condensation/ice dams.....
Bat presence.....

G. Additional notes

Floors:
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Walls:
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Windows/doors:
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Ceilings:
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Other:
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EQUIPMENT CHECKLIST - personal protective equipment

- 9 Hard hat
- 9 Insect repellant
- 9 Knee pads
- 9 Gloves, heavy/medical
- 9 Face shield/goggles
- 9 Dust mask/respirator
- 9 Overalls and/or bee suit
- 9 Bee veil
- 9 Smoker and fuel
- 9 Wasp Freeze
- 9 Fly swatter
- 9 .....

TOOLS FOR SITE INSPECTIONS

- 9 Clipboard/grid/paper
- 9 Inspection forms
- 9 Pencil/pen
- 9 Insect keys/info
- 9 Aspirator/collecting vials
- 9 Flashlight/headlamp
- 9 Flashlight batteries
- 9 Hand duster
- 9 Vials w/alcohol
- 9 Polaroid/digital camera
- 9 Belt/leatherman/knife
- 9 15x Hand lens/loupe
- 9 Film/flash
- 9 Caulk
- 9 Lo-line sticky traps
- 9 Screwdriver/phillips/slot
- 9 Crescent/general wrench
- 9 Forceps
- 9 Pocket tape recorder
- 9 Pliers
- 9 .....
- 9 .....
- 9 Masking/filament tape
- 9 Portable vacuum cleaner
- 9 Ladders/rope/carabiner
- 9 Sharp probe (wood awl)
- 9 White coveralls
- 9 Belt pouch for tools
- 9 Extendable mirror
- 9 Tape measure/6 in ruler
- 9 Plastic zip locs
- 9 Slide camera
- 9 Colored sticky labels
- 9 Binoculars
- 9 Moisture meter/thermometer
- 9 Small hand trowel
- 9 Knee/elbow pads
- 9 Spatula
- 9 Rechargeable drill
- 9 Stethoscope
- 9 Optivisor
- 9 Hand mirror
- 9 .....
- 9 .....

ADDITIONAL
COMMENTS.....
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LANDSCAPE IPM INSPECTION FORM

Site_____ Date_____ Inspector_____ Assisted by_____

PESTS PRESENT

VERTEBRATES	LOCATION	ACTION
INSECTS	LOCATION	ACTION
WEEDS	LOCATION	ACTION

INSECT PHEROMONE MONITORING TRAPS

SPECIES	COUNTS	LOCATION

OTHER OBSERVATIONS – i.e., Plants too Close to Structures, etc.

_____

_____

_____

_____

_____

APPENDIX VI

PEST SIGHTING LOGS

Weir Farm National Historic Site

Have you seen any pests lately? Please jot down your observations!

Pest Activity Log: Burlingham House

Report of Pest Sighting			
Date	Name/Phone	Location/Building	Pest/Problem Description

PLEASE RETAIN ORIGINAL FOR COPYING.

Weir Farm National Historic Site

Have you seen any pests lately? Please jot down your observations!

Pest Activity Log: Burlingham Barn

Report of Pest Sighting			
Date	Name/Phone	Location/Building	Pest/Problem Description

PLEASE RETAIN ORIGINAL FOR COPYING.

Weir Farm National Historic Site

Have you seen any pests lately? Please jot down your observations!

Pest Activity Log: Weir Barn

Report of Pest Sighting			
Date	Name/Phone	Location/Building	Pest/Problem Description

PLEASE RETAIN ORIGINAL FOR COPYING.

Weir Farm National Historic Site

Have you seen any pests lately? Please jot down your observations!

Pest Activity Log: Burlingham Landscape

Report of Pest Sighting			
Date	Name/Phone	Location/Building	Pest/Problem Description

PLEASE RETAIN ORIGINAL FOR COPYING.

Weir Farm National Historic Site

Have you seen any pests lately? Please jot down your observations!

Pest Activity Log: Young Studio

Report of Pest Sighting			
Date	Name/Phone	Location/Building	Pest/Problem Description

PLEASE RETAIN ORIGINAL FOR COPYING.

Weir Farm National Historic Site

Have you seen any pests lately? Please jot down your observations!

Pest Activity Log: Water Tower

Report of Pest Sighting			
Date	Name/Phone	Location/Building	Pest/Problem Description

PLEASE RETAIN ORIGINAL FOR COPYING.

Weir Farm National Historic Site

Have you seen any pests lately? Please jot down your observations!

Pest Activity Log: Lean-To

Report of Pest Sighting			
Date	Name/Phone	Location/Building	Pest/Problem Description

PLEASE RETAIN ORIGINAL FOR COPYING.

Weir Farm National Historic Site

Have you seen any pests lately? Please jot down your observations!

Pest Activity Log: Weir Studio

Report of Pest Sighting			
Date	Name/Phone	Location/Building	Pest/Problem Description

PLEASE RETAIN ORIGINAL FOR COPYING.

Weir Farm National Historic Site

Have you seen any pests lately? Please jot down your observations!

Pest Activity Log: Westervelt House

Report of Pest Sighting			
Date	Name/Phone	Location/Building	Pest/Problem Description

PLEASE RETAIN ORIGINAL FOR COPYING.

Weir Farm National Historic Site

Have you seen any pests lately? Please jot down your observations!

Pest Activity Log: The Shop

Report of Pest Sighting			
Date	Name/Phone	Location/Building	Pest/Problem Description

PLEASE RETAIN ORIGINAL FOR COPYING.

Weir Farm National Historic Site

Have you seen any pests lately? Please jot down your observations!

Pest Activity Log: Caretaker's House

Report of Pest Sighting			
Date	Name/Phone	Location/Building	Pest/Problem Description

PLEASE RETAIN ORIGINAL FOR COPYING.

Weir Farm National Historic Site

Have you seen any pests lately? Please jot down your observations!

Pest Activity Log: Weir House

Report of Pest Sighting			
Date	Name/Phone	Location/Building	Pest/Problem Description

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APPENDIX VII

BIBLIOGRAPHY

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APPENDIX VIII

PESTICIDE LABELS

THE FOLLOWING LOW-RISK PRODUCTS ARE SUGGESTED FOR USE AT

WEIR FARM NATIONAL HISTORIC SITE:

Avert Cockroach Bait Stations
Bora-Care Termiticide, Insecticide and Fungicide Concentrate
Borid
Drax Liquidator Ant Bait
EcoExempt IC Insecticide Concentrate
Flea ‘n Tick B Gone
Hinder Ready-To-Use Deer & Rabbit Repellent
Jecta Diffusible Boracide
Matran 2 Non-Selective, Post Emergence Herbicide
MaxForce Roach Control System
Niban-FG Fine Granular Bait
Niban Granular Bait C
Nibor-D Insecticide
Perma-Guard Commercial Insecticide
Perma-Guard Garden and Plant Insecticide
Perma-Guard Grain or Seed Storage Insecticide
Rejex-It Migrate Goose Repellent
Tim-bor Professional Insecticide and Fungicide
Tri-Die
Victor Poison-Free Wasp & Hornet Killer
WOODguard Exterior Wood Preservative and Finish
WOW (Without Weeds)

All of the above labels and material safety data sheets can be viewed separately in pdf format with the exception of Perma-Guard Garden and Plant Insecticide and WOW (which are in Word Perfect format).

APPENDIX IX

VENDORS

VENDORS

AGRIZAP, INC., 4535 McGrath Street, Building B, Ventura, CA 93003. 1-888-332-3728. www.ratzapper.com. Electronic rodent management device.

BENEFICIAL INSECTARY, 9664 Tanqueray Court, Redding, CA 96003. 1-800-477-3715. www.insectary.com. Provides beneficial critters for managing aphid, whitefly, mites and more.

BIOCONTROL NETWORK, 5116 Williamsburg Road, Brentwood, TN 37027. 1-800-441-2847. www.biconet.com. Provides an extensive list of low-risk pest control critters and products.

DO-IT-YOURSELF PEST CONTROL, INC., 2823 Chamblee-Tucker Road, Atlanta, GA 30341. 1-800-476-3368. www.doyourownpestcontrol.com. Provides Dekko Silverfish Paks (manufactured by Dekko Manufacturing, LLC) for control of silverfish and more.

GARDENS ALIVE!, 5100 Schenley Place, Lawrenceburg, IN 47025. 1-812-537-8650. www.gardens-alive.com. Informative catalog with a wide selection of many biological-based pest controls, including beneficial predators, parasites, beneficial nematodes, fertilizers and much more.

INSECTS LIMITED, INC., 16950 Westfield Park Road, Westfield, IN 46074. 1-317-896-9300. www.insectslimited.com. Provides pheromone traps for museum, stored product and other pests.

IPM LABORATORIES, Main Street, Locke, NY 13092-0099. 1-315-497-2063. www.ipmlabs.com. This company produces a very informative catalog and newsletter with helpful, expert information on using its many beneficial insects. Provides whitefly egg parasites and predators as well as a number of wasp parasites for aphid control, including the difficult to find *Aphelinus abdominalis* and *Aphidius ervi*. They always carry a quality product.

M&R DURANGO, INC., P.O. Box 886, Bayfield, CO 81122 aka The Good Bug Company, 970-259-3521. www.goodbug.com. Provides *Encarsia Formosa*, thrips predator, spider mite predator, green lacewing and more.

NEEM RESOURCES, THE AHIMSA ALTERNATIVE, INC., 5317 Whiting Avenue, Edina, MN 55439. 1-877-873-6336 or 1-405-538-0280. www.neemresource.com. Provides pure neem oil, karanja oil and other neem products for natural pest management.

PERMA-GUARD, INC., 625 East 2150 South, Bountiful, UT 84010. 1-877-801-2025. www.perma-guard.com. Supplier of diatomaceous earth product and pyrethrin and diatomaceous earth insecticides.

PEST CONTROL SUPPLIES, 1700 Liberty Street, Kansas City, MO 64102. 1-800-821-5689. www.pcspest.com. Termite and rodent control, herbicides, insect traps.

PRESERVATION PRODUCTS UNLIMITED, 6929 Seward Avenue, P.O. Box 29109, Lincoln, NE 68529. 1-800-648-7329.

RESIDEX, 8486-F Tyco Road, Vienna, VA 22182. 1-800-247-8528. www.residex.com. A source for pesticides, Lo-Line sticky monitoring traps, Victor snap traps and more.

RINCON-VITOVA INSECTARIES, INC., P.O. Box 1555, Ventura, CA 93002. 1-800-248-2847. www.rinconvitova.com. Provides a wide variety of pest management supplies and beneficial organisms.

TARGET SPECIALTY PRODUCTS, 15415 Marquardt Avenue, Santa Fe Springs, CA 90670. 1-562-802-2238. www.target-specialty.com. A source for pesticides, Lo-Line sticky monitoring traps, Victor snap traps and more.

UNIVAR USA. 65 Harristown Road, Glen Rock, NJ 07452. 1-201-670-1600. www.univarusa.com. A source for pesticides, Lo-Line sticky monitoring traps, Victor snap traps and more.

VICTOR PEST AND SAFER PEST CONTROL PRODUCTS. 1-800-800-1819. www.victorpest.com. Provides a full line of poison-free and low-risk pest management products. There is a search feature on pests, what they are, what diseases they may carry, and how to prevent infestations.

NOTE:

These suppliers are known to IPMI as providing high-quality products and services. There are hundreds of pest management product suppliers in the U.S. that may also provide high-quality products and services.

- Victor brand snap traps are the oldest manufactured traps, are widely available, and can be easily “fine-tuned” for reliable kills.
- Lo-Line monitoring (sticky) traps for crawling insects are the best designed, reliable products on the market to date.

As the nation's primary conservation agency, the Department of the Interior has responsibility for most of our nationally owned public land and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

NPS D-30 August 2006

ON THE BACK COVER
Weir House
Photograph by: William E. Currie, Consultant/Entomologist, International Pest Management Institute

National Park Service
U.S. Department of the Interior

Northeast Region
Natural Resource Stewardship and Science
15 State Street
Boston, Massachusetts 02109

http://www.nps.gov/nero/science/