

Move to Reference Manual August 25, 2014 meeting

File: EBAB-R

Westfield Public Schools

December 14, 2001

Integrated Pest Management

Policy Statement

Structural and landscape pests can pose significant problems for people and property. Pesticides can pose risk to people, property, and the environment. It is therefore the policy of the Westfield Public Schools to incorporate Integrated Pest Management (IPM) procedures for control of structural and landscape pests. The object of this program is to provide necessary pest control while minimizing pesticide use.

Goals

Reduce any potential human health hazard or threat to public safety.

Prevent loss or damage to school structures or property.

Prevent pest from spreading into community, or to plant and animal populations beyond the site.

Enhance the quality of life for students, staff, and others.

Section 1 – Rats and Mice

The Norway rat, house mouse and deer mouse are the most common rodent problems in Massachusetts. Proper identification is needed before control is started because of pest management program will differ for each species.

Any sign of rodent activity should be reported to the IPM coordinator in the school. This includes live or dead animals, feces or gnaw marks.

Monitoring

Light Talcum powder or chalk dust can be used on suspected harborage, runs or entry points. Footprints or tail marks will indicate activity.

Vacuum or sweep up pellets or gnawing debris and re-inspect for new sign.

Non toxic blocks can be used for monitoring.

Glue boards are excellent ongoing monitoring tool, not only do they catch mice, but they also aid in detecting possible activity.

Cultural Control

Good sanitation to reduce water, shelter, and food. Food should be out of lockers overnight. (For rats a control program should be started before too much disturbance is done).

Store all food in rodent proof structures. All food should be drained and sealed in plastic bags. Clean trash containers regularly and make sure containers have tight fitting lids.

Ultrasonic devices are not effective.

Identify and seal all points of entry. Mortar, sheet metal or hardware cloth can be used around pipes, sewer outlets and small openings.

Trim bushes, grass and vines so a 12-18 inch vegetation barrier form the foundation of buildings, or provide a soil sterilizations control area 12-18 inches away from the building.

Traps

A trapping program should be in place in all schools as a preventative/monitoring program in critical storage and food handling areas. Traps should be checked at least once a month.

Glue boards, and live traps such as catch all traps can be placed in areas away from foot traffic are most effective when placed in areas along walls and runways.

When using bait, bait should be tamper-proof bait station and in areas that are not accessible to children.

Snap traps and glue board as can be placed inside bait stations to keep them away from children.

The Norway rat, house mouse, and deer mouse are the most common rodent problems in Massachusetts. Proper identification is needed before control is started because the pest management program will differ for each species. Native Massachusetts mice as the deer mice presents only seasonal problem in the fall and winter while the house mouse and Norway rat are year round – round pests with potential for serious damage/infestation.

In general, Norway rats are large, robust rodents with small blunt muzzle, small eyes, and short, round ears. Coloration is grizzled reddish to grayish brown with gray to yellowish-white belly. They may range in size from 7-18 ounces and reach 11 inches at maturity. Their tails are hairless and shorter than their head and body.

The house mouse is smaller and more slender than the Norway rat. Its eyes are small and ears are quite prominent. The muzzle is pointed. The average size of a house mouse is 3 inches and weight 1 ounce or less. House mice are light brown to dark gray in color with a lighter color belly. Its tail is as long as its head and body.

The deer mouse is approximately the same size as the house mouse but it is bicolor which easily distinguishes it from the house mouse. Deer mice have large eyes, which also distinguish them from house mice.

Rats and mice cause damage by gnawing, urinating, defecating, and nesting. The damage to food is much greater as a result of contamination than it is from actual loss from feeding. Deer mice are also capable of transmitting the Hantavirus, a serious, often fatal, human respiratory disease.

Any sign of rodent activity should be reported to the IPM coordinator in the school. This includes live or dead animals, feces, or gnaw marks.

The use of light talcum powder or chalk dust can determine harborage, runs, or entry points. Footprints or tail marks in dust will indicate activity. Vacuuming or sweeping of pellets or gnawing debris and monitoring for signs will also indicate continued activity. Non – toxic food blocks can be used to monitor activity as well. Glue boards can be used not only to catch mice but as a monitoring tool to detect possible activity.

Good sanitation is essential in rodent control. Eliminate all water, shelter, and food. Store food in rodent –proof containers or structures. No food should be stored in lockers overnight. All food should be drained and sealed in plastic bags. Clean trash containers regularly and make sure containers have tight fitting lids.

Identify and seal all entry points. Mortar, sheet metal, or hardware cloth can be used around pipes, sewer outlets and small openings.

Trim shrubs, grass and vines so that 12 -18 inch vegetation barrier is maintained adjacent to the foundation of buildings. An alternative is to provide a soil sterilization control area in this location.

A trapping program should be in place in critical storage and food handling areas in all schools as a preventative/monitoring program. Traps should be checked at least once a month. Glue boards and live traps such as catch-all traps can be placed in areas away from foot traffic and are most effective when placed in areas along walls and runways.

There are several rodenticides available. They should be used with caution in and around schools. Place bait in tamper – proof bait stations in areas that are not accessible to children. Snap traps and glue boards can be placed inside bait stations as well to keep away from children.

Section 2 – Ants

Sanitation

Eliminate food sources

1. Store all food (pet food included) in glass or plastic containers with a tight sealing lid.
2. Clean all spilled food or drink.
3. Ask that food not be kept overnight in lockers, desks, or drawers.

Trash receptacles

1. Remove trash that contains food at least daily.
2. Wash all trash receptacles regularly.

Use ant trails

1. Find food sources and eliminate them.
2. Find entrance points and eliminate them by chalking cracks and improving structures.

Control options

1. Spraying ants with sopping water will kill them.
2. Ants can be vacuumed up.

Pesticide use (if necessary)

1. Baits are preferred (they will kill a colony, otherwise ants will return).
2. If a colony can be found it can be treated with a spray or dust. If you can't find the colony, these pesticides are of little use.

There are three reasons why ants can become a problem

1. Worker ants coming inside for food or water.
2. Winged re-productives (the swarmers) emerge inside.
3. Ants colonize and nest in walls or structures within the building.

Different species of ants feed on sugar, fat, or protein. Most species nest outside. Winged ants are “swarmers” the kings and queens. Large numbers of winged ants indoors indicate an indoor infestation.

Common ants in Massachusetts include pavement and carpenter ants. Ant problems in winter indicate an indoor colony. Proper identification will help in finding the nesting site. Most ant problems do not require professional pest control help.

Non-chemical control

General sanitation. Eliminate food sources. If an ant finds food they recruit hundreds more as long as food is available. If the food is removed, ants will be forced to look elsewhere and should stop the habit of coming indoors.

1. Seal all food, especially sugar containing products in tight fitting glass or plastic containers.
2. Wash trash containers, recycling items, clean up all spills.
3. Chalk entrance and points of entry to keep ants outdoors.
4. Winged ants can be cleaned up with a vacuum.

Chemical control

Special considerations – Ants live in colonies that may have thousands of individuals. Only the queen can lay eggs. To control ants you must find the nest and kill the queen. This can be done as a spot treatment or with baits that are taken back to the colony.

1. Soapy water will knock down the workers that are present. Individuals can be then wiped up.
2. Ant baits are preferred in schools. Workers will take the poison back to the nest and feed it to the young and queen. Some ant baits are for sweet feeding ants, some for protein feeding ants, and some are for both types.

Active ingredients will include less toxic products such as boric acid, sulfuramid, abamectin, hydramethylnon and fipronil. Baits come in plastic stations, gels and pelleted baits. Different treatment sites will require different formulations.

Larger Yellow ants

Give off a pleasant citronella or lemon smell when crushed. Workers are yellow or reddish yellow and 3/16 inch long. Swarmer are 6/16" and darker red in color. These ants feed on honeydew from aphids and normally nest under stones, patio blocks and along foundations. Workers do not seem to be interested in coming indoors. Yellow ants can swarm from April to August, but most calls are associated with ant nests under heated concrete slabs or along foundations. They are often mistaken for termites. Because the swarming only lasts for a few days per year, treatment is not always necessary. These ants will not accept bait. The best control is to seal cracks or other entrances or to inject insecticides into the nest.

Pharaoh ants

Are strictly an indoor problem – primarily in hospitals, nursing homes and apartments. The ants are yellow to red and only 1/16 inch long. They differ from grease ants because they have three segments to their antennal club. Pharaoh ants eat a variety of foods including soap, toothpaste, fats, grease, sweets, and dead insects. Treating the problem with insecticide sprays often force the ant to bud into multiple colonies and will make the infestation worse over time. Baits made specifically for pharaoh ants are the best treatment. Pharaoh ants have multiple queens in a colony and do not swarm.

Thief ants

Are commonly called grease ants and are the smallest ants 1/20 inch found indoors. They usually nest outdoors and forage in well defined trails during mid to late summer. Preferred foods include grease, meat, cheese, and peanut butter. Nests are very difficult to find, and these ants should be baited. Barrier treatments will slow the migrations indoors and often force the ants into foraging patterns. These can be difficult to separate from Pharaoh ants but only have 2 segments on the antenna club.

Pavement ants

They are 1/8 inch reddish brown to black ants with two nodes, sculptured furrows on the head, and a pair of spines on the thorax. These ants feed on greasy foods including pet food and on sweets. Nests are often under driveways or in other concealed sites. Workers can be found in the kitchen. When

swarms appear inside, the nest may be under a slab or similar location. Indoor colonies swarm at any time. If the nest cannot be found, baiting with protein – based bait is most successful. Barrier treatments will give seasonal control from outdoor colonies.

Cornfield ants

Are the common small mound – building ants in the yard. They are small 1/10 inch red to dark brown ants that feed on sweets and honeydew from other insects. There can be hundreds of colonies in a lawn, most indoor problems are associated with concrete slabs or brickwork built on light soils. Workers will occasionally come in for food and are found feeding on sweets and honeydew from insects infesting on houseplants. Swarming is on sunny late afternoons during August and early September when thousands of winged ants can be seen bubbling from the nest or in the air.

Field ants

Look similar to carpenter ants but do not nest or forage indoors very often. They construct large mound type nests in the soil, with some species constructing very large mounds. If baits are tried for control, use one that contains sweets or dead insects. Spot treating the individual nests more common approach.

Section 3 - Flies

There are many species of flies that can cause problems in buildings. Controlling and fly problems rely on eliminating and cleaning their breeding site. Different species have different breeding sites, so catching some problem flies and having them identified is essential.

Common fly breeding sites

1. Fermenting organic material
2. Trash containers
3. Recycle bins
4. Compost
5. Sour mops
6. Floor drains
7. Sink overflows
8. Unused urinals
9. Sump pumps
10. Sewers
11. Animal waste
12. Potting soil
13. Moist organic matter

Sanitation of breeding sites

1. When problem areas are found, a thorough cleaning is needed.
2. After the area is cleaned, maintain it more often (e.g. empty trash more often, rinse out recyclables before putting them in the recycling bin, clean drains more often).
3. Wash trash receptacles regularly.
4. Keep garbage in sealed trash bags.

Exclusion

1. Screen all windows that will be opened.
2. Maintain screening.

3. Have all exterior doors be self-closing and keep them closed when not being used.

Chemical Control

1. Aerosol sprays will knock down adults, but not solve the problem.
2. Problems will likely resurface within a few days if breeding sites are not cleaned.

There are four or five species of flies that can be found breeding indoors. If fly problems are seasonal or reoccurring the source may be outside. Proper identification will help lead to breeding source and type of sanitation needed to control the fly problem. Flies can breed quickly and go through a generation in 10-14 days. Fruit flies breed in yeast associated with moist, fermenting organic material in trashcans, recycling bins, compost and sour mops.

Drain flies breed in floor drains, sink over-flowers, and in unused urinals, sump pumps and sewers.

Filth flies such as household flies and blowflies breed in garbage and animal waste. They do have public health concern, as they are capable of mechanically transmitting a number of diseases.

Fungus gnats breed in potting soil of indoor plants and in moist organic matter.

Cluster flies seek shelter in buildings during the fall.

Non Chemical Control

1. Cleaning up the breeding sites (sanitation) is the most important control (for any fly problems).
2. Indoor electric fly traps can be used in food or stage areas. Traps work better in dark corners, false ceilings and other sites away from light.
3. Flypaper and fly swatters can be used for individual flies.
4. Keep trash containers upwind of school, dump once or twice a week, and keep clean. Sour milk is very attractive to house flies.
5. Flush floor drains on a regular basis and repair plumbing leaks and seepage.
6. Keep all garbage in sealed trash bags and take out daily.
7. Traps can be used but different flies use different attractants and some traps only attract flies from outside. Traps only capture individuals and will not replace identifying and cleaning the breeding sites.

Chemical control

1. Chemicals only kill adult flies and doesn't deal with the source of the problem.
2. Aerosols containing pyrethrum or synthetic prethroids will give quick knock down. These products are toxic to fish so be careful in classroom settings. Sprays should used only when children are not present.
3. Fungus gnats that are breeding in potting soil can be controlled with bacteria (*Bacillus thuringensis isranesis*) sold as Gnatrol that is watered onto the soil.

All flies are not created equal. There are over 16,000 species in North America. Understanding the specific biological and environmental requirements will be important for control. Adult flies are very mobile and are not always directly associated with the source of the problem. Most fly problems can be traced to isolated breeding sites. The worm-like maggots are less mobile and can be found crawling in or near food source. If these can be found and eliminated the problem should clear up in a few days. If the source cannot be found, short-term control using aerosol knock down insecticide will adult flies but will have to be repeated every 3-5 days.

Cluster or attic flies (*Polinia rudis*) migrate indoors during the mild September and October. They are similar to, but slightly larger than, houseflies, and under magnification will have yellowish or golden hairs on the thorax. Cluster flies breed during the summer on earthworms. Adults seek sheltered sites in the fall and often crawl into attics, steeples, wall voids, door and window casing, and other openings that lead to protected sites. On sunny days from October to April flies filter into living spaces and sluggishly buzz around windows. People often believe cluster flies are breeding in walls, but they are only seeing adult flies that entered during the fall. Most problems will be in buildings and homes in exposed, semi-rural areas. Homes in wooded sites and urban areas attract fewer flies. Flies can migrate ½ mile or more.

The best control is to identify points. Attic, roof and overhang vents should be screened with fine mesh screen. Openings in siding, overhangs and around windows, sky lights, and doors should be chalked or stuffed with copper wool. If you can keep the flies from entering a second problem will be solved.

Dead cluster flies in walls and attics will be a food source and breed numbers of carpet and beetles that can cause problems later on.

There are a number of species of vinegar flies also known as pomace or fruit flies that breed indoors. Adults are 1/16 to 1/8 inch, light brown and often have red or maroon eyes. They are found hovering around overripe fruit or fermenting material such as beer or soft drinks. Breeding sites contain decomposing material that contains yeast and other microorganisms associated with fermentation. Overly ripe fruit and vegetables, fermenting liquids in recycling bottles and cans. Unused garbage disposals, caked organic matter in trash containers, soured mops, organic seepage under sinks and drains, and slimy drain pans in coolers and refrigerators are all breeding sources. Generation times can be 10-14 days. Adult vinegar flies can be killed with pyrethrin sprays, but the source must be found and eliminated for control.

Drain flies

Also called moth or sewer flies are found in the slime layer in floor drains, sewers, overflows on sinks and pools and other damp organic matter. Adults are small, hairy, adult, weak flying gnats that often congregate in sinks and bathrooms. They rest with wings flat on the back and have a triangular or delta shape. Adults are often found some distance from the source. Hot water, drain cleaners or other flushing materials that eliminate the slime should solve the problem.

Blow flies

Blowflies are metallic green, blue or shiny black flies about the size of houseflies. They breed on dead, decaying animals animal waste and high protein garbage. Infestations are usually intense but short lived and come from adult flies being present, or ½" cream colored maggots wandering into the living space. Check chimneys, attics, vents, crawl spaces and accessible wall voids for food sources. Small animals like mice or birds can only support a limited number of flies. Small animals will usually give off an odor and may produce flies for months. It is usually not appropriate to tear walls apart, but if the location of the source is known, drilling and treating the void can give relief.

True houseflies are most always associated with human generated source. They breed a generation within 14-30 days on garbage, human and animal waste, wet animal feed, and rotting fruits and vegetables. Houseflies have mechanically transmitted a number of human pathogens, and their presence is a public health concern. Sanitation and elimination of food should always be the first line of defense. In summer the potential of an outside source of flies requires various elimination practices

including caulking, proper screening, air doors, and other barriers. Light traps or windscreens can be placed near entries to capture invading flies. Surface sprays applied to resting sites will knock down adults and there are commercial fly baits that can be used in some situations. These should only be used in a last resort in the schools.

Humpback flies

There are three or four fruit fly sized flies that are associated with wet organic matter or animal waste. Adults are found congregating around garbage cans, sinks, drains, or windows. A common source is broken sewage pipes that leak wet organic matter under concrete slabs or within walls. Long term control relies on repair and source reduction. Proper identification of the type of fly involved will give clues to the breeding site.

Fungus gnats

Fungus gnats are 1/10" long; dark colored flies with many-segmented antenna. Adults create a nuisance indoors and larvae are associated with damp decaying vegetable matter, high organic plant potting soil or fungus growing within walls. Look for small white or clear, dark headed maggots in potting soil to confirm the breeding site in plants. If plants are the source, it is best to remove the plants and leave treatment of the pots to plant care people to avoid plant chemical injury problems. Adults can be knocked down with various pyrethrum or prethroid sprays. In new construction fungus gnat problems have been traced to damp hay associated with foundations and hearing ducts.

Section 4 – Silverfish and Firebrats

The most common sources of silverfish and firebrat problems are closets, storage rooms, and boiler rooms Silverfish. Silverfish may be found throughout the school, but only treatment of the source will be effective.

1. Monitor silverfish populations with sticky traps and jar traps
Reduce moisture and clutter in problem areas.

Silverfish and firebrats are slender, carrot shaped, wingless insects that are covered with scales. Adults are 1/3 to 1/2" long. Silverfish are shiny or pearly gray; firebrats are mottled gray and brown. Both have two long antennae on the head and three long tails at the tip of the abdomen. Aside from the color, silverfish and firebrats look very similar and are often just called silverfish. They eat foods and materials that are high in protein, sugar, or starch – such as cereals, flour, fabrics, starch in clothing, and paste or glue on wallpaper and book bindings.

Both silverfish and firebrats dislike light and are active at night. They run with a characteristic darting movement and you will seldom see them during the day unless their hiding place is disturbed and they dart out to seek another hiding place. Silverfish live in damp, cool places such as basements. Large numbers are sometimes found in new buildings where walls are still damp. Firebrats prefer hot, dark areas around furnaces and fireplaces, and insulation around hot water or heating pipes. To find food, these do considerable traveling throughout a building, often along walls, baseboards, pipelines, and heating ducts. Firebrats and Silverfish are also commonly found in bookcases, closets, window frames, and behind baseboards.

Non-chemical control

1. Reduce moisture and humidity, dry out damp areas.
2. Vacuum cracks and crevices and where possible seal or patch harborage sites.

3. Remove old papers, cardboard boxes, and other clutter.
4. Small articles containing silverfish can be frozen or heated above 120 degrees.
5. Silica gel and diatomaceous earth can be used as desiccants in cracks and voids.
6. Capture and monitor silverfish and firebrat populations. Two possible traps are
 - sticky board type traps
 - small glass jars with ramps to the rim or taped on the outside. Silverfish cannot crawl vertically out of a glass jar.

Chemical control

Common sources of silverfish problems in schools are closets, storage rooms, and boiler rooms. Though silverfish will wander into classrooms and other areas for food, silverfish must reach the source of the problem or it will be ineffective. Pyrethroid flushing agents may be used to aid silverfish inspections. Sticky and jar traps are also useful monitoring tools that will aid inspection. When large silverfish populations are found, chemical treatment may be necessary.

Chemical treatment options include:

1. Baits with starch and boric acid. These products should be used only in rooms where children do not have access.
2. Synthetic pyrethroid products that are labeled for silverfish. Spot or crack and crevice treatment is preferred. Possible treatment sites include baseboards, doors and window casings, closets, and places where pipes go through walls and floors.

Section 5 – Head lice

PESTICIDES SHOULD NEVER BE USED ANYWHERE IN SCHOOLS TO CONTROL LICE.

Lice will die within 48 hours without a human host. The following measures are precautionary for school buildings.

Control measures at school:

1. Sleeping mats, pillows, rugs, and clothing can be placed in the freezer overnight (this will kill any lice present).
 2. Vacuum furniture, carpeting, and rugs thoroughly.
 3. Isolate children's clothing from each other in plastic bags.
- Washing clothing/cloths in hot water and hot dryer will also kill lice.

Head lice only survive and breed on people. They are a medical problem and treatment should be left to parents and medical staff. Head lice cannot survive off their human host more than 48 hours. Because of increased resistance to prescription treatments head lice have become more difficult to control, leading to more pressures on schools to provide treatments.

SCHOOLS SHOULD NOT BE SPRAYED TO CONTROL HEAD LICE.

Treatments in classrooms

1. Sleeping mats, rugs and personal items hats, cloths can be placed into a freezer overnight to kill lice.
2. Vacuum furniture and floor rugs thoroughly.
3. Clothing can be isolated in individual plastic bags for each student.
4. Bagged articles can be placed in the freezer overnight or items can be left isolated for 21 days.
5. Washing of clothing in hot water and hot dryer will kill lice.

Personal treatments

1. Because treatments do not kill 100% of the eggs it is important to retreat within 10-14 days for control.
2. Nit combs are constructed to remove lice and eggs from hair and are very effective if used properly.
3. The use of oils such as olive oil and coconut oil if left on the hair for at least 8 hours.
4. All members of the family need to be checked for lice activity.

When problems are discovered in a classroom, all children should be inspected for active lice.

Chemical control

CHEMICALS SHOULD NOT BE USED ANYWHERE IN SCHOOLS TO CONTROL LICE.

Infestations are most likely from personal contact or sharing infested articles such as combs, brushes and hats.

Section 6 – Spiders

Exclusion

1. Check door sweeps
2. Seal electrical openings
3. Screen vents and seal area around them
4. Regularly vacuum carpeting
5. Keep vegetation away from school walls
6. Keep lighting away from school building or use sodium vapor lighting

Chemical Control

GENERAL INSECTICIDE SPRAYS ARE NOT EFFECTIVE AGAINST SPIDERS, DON'T USE THEM.

1. Vacuuming often or physically removing is the most effective method. Spiders eat insects. Larger number of spiders and spider webs mean there are many insects available for food. Schools near lakes often attract large number of flying insects to night-lights, as does general security lighting on buildings. Spiders will build webs under eaves, in corners or on shrubbery. Spider populations will fluctuate from year to year, but will be highest in late summer. Indoors, the highest numbers will be in storerooms, crawl spaces, and basements. Because there is so little food available indoors, spider populations will be limited unless they have an easy time migrating from outdoors. Poisonous spiders are very rare in Massachusetts.

Non-chemical Control

1. If hunting spiders are found inside in large numbers, check door sweeps. Electrical openings, vents and other areas on the outside of the building seal up these access points.
2. Keep vegetation along the foundation to a minimum, preferably a 24" band that is vegetation free.
3. Vacuum indoors to remove webs and egg cases.
4. For indoor nesting species, remove clutter in storage rooms. Keep boxes away from walls.

5. Promote good ventilation in storerooms will help eliminate insects that spiders feed on.
6. Use glue board traps to follow spider activity and problem areas.

Chemical sprays

1. General surface sprays are not very effective and therefore should not be used.
2. Individual spiders can be controlled with non residual aerosols containing pyrethrin, resmethrin or sumithrin.
3. In the few cases where large numbers of spiders and spider webs disfigure the building, spot treat areas around doors, windows and other openings on the outside of building before the fall term. Use a wettable powder or microencapsulated synthetic pyrethroid.
4. Dust treatment can be used in crawl spaces or as crack and crevice treatment in storeroom.
5. Power washing or brushing of walls may be needed to remove debris and may be effective as spraying.

Section 7 – Small Mammals

Moles

Chunky stout-bodied animals 6-8 inches long with very short tails. They have tiny, barely visible eyes and sensitive pink snout. Huge, flattened, space like front feet. Fur is sleek, soft, and gray. The animal itself is rarely seen alive or dead, but its damage can be very conspicuous.

Chipmunks

Rat-sized mammal with 2 sets of black and white stripes which fade out on a rusty brown rump. Always found near rocks, wood, debris.

Shrews

Short-tailed shrews are 3-4 inches long and sleek. Silvery gray in color. Face (muzzle) is pointed rather than blunt and teeth are not typical paired, often yellow, incisors. Eyes are very tiny.

Rats

Rats are large, robust rodents with hairless tails. Grizzled reddish to grayish brown in color with gray to yellowish-white belly.

Mice

Small slender rodent with pointed snout (muzzle) about 2-4 inches long. Light brown to dark gray in color with lighter colored belly.

Section 8 – Skunks

1. Areas inhabited by skunks can be screened with ½" wire mesh once the skunks leave the area.
2. Removing brush, wood piles, stacks of building material, or debris will deter skunks from the area.
3. Fencing around a small area like an athletic field will keep skunks out of the area if there are fence gates that are kept closed.
4. Skunks can be trapped and removed.

Striped skunks are members of the weasel family. They are generally considered beneficial because of their diet that primarily consist of insects such as crickets, grasshoppers, beetles, cutworms and other insect larvae. Skunks will also feed on small mammals such as mice, rats, moles, ground squirrels as well as garden vegetables and fruits and bird eggs.

Skunks are about the size of a large domestic cat. Their jet-black coat easily identifies them with white strips that run from the top of their head down their back. They are primarily nocturnal and are for the most active from early evening through most of the night. Although they don't hibernate, skunks are less active during the winter. Litters are born early spring with 4-6 young per litter. The young venture out on their own in the fall.

Habitat modifications that will deter skunks from school properties include removal of brush, woodpiles, stacks of building material, or debris. Fencing where practical such as around athletic fields, will also keep skunks out of an area. Gates must remain closed at all times to prevent skunks from entering a fenced area.

When necessary, skunks can be trapped and removed from areas where they are unwanted. A live baited trap with fish, fish-flavored cat food, chicken parts, bacon, or peanut butter on bread works well. Traps should be 9" x 9" x 24" or smaller. Smaller traps will reduce the chances of being sprayed. Wrapping the trap with tarp may entice the skunk to enter the trap.

Other traps such as foothold or body traps are available but are not recommended for use on school grounds.

There are no biological agents available for skunk control.

There are non-chemicals registered to control skunks. If problems result from digging activity of skunks in turf to access grubs and other insects, the use of a least toxic insecticide to control the insect problem will likely eliminate the skunk-digging problem as well.

There are chemicals to mask skunk odors. Neutrolem alpha is available and may be used as a deodorant for humans, pets, and surfaces. Several home remedies such as bleach, vinegar, tomato juice, ammonia are also used in reducing skunk odors. A combination of one quart 3% hydrogen peroxide and ¼ cup baking soda with one teaspoon of liquid soap is effective in neutralizing skunk odors in pets. Bathe the pet in this mixture, taking care around eyes, ears, and mouth and rinse well with tap water.

Section 9 – Centipedes

Centipedes usually live outdoors in damp areas such as under leaves, stones, boards, tree bark, or in mulch around outdoor plantings. When these centipede habitats are near a home's foundation, centipedes will wander inside where they may be found at floor level almost anywhere. If accidentally injured, larger centipedes may bite, causing some pain and slight swelling. Actually, their jaws or mouthparts do not cause their "bites" but by the front legs which are modified to look and function like jaws and contain venom glands. Smaller species are not large enough to penetrate human skin. Centipede bites are usually not serious, but an antiseptic should be used on the wound and a physician consulted in all cases where the skin is punctured.

Centipedes are usually brownish, flattened, and elongated animals, which have many body segments. One pair of legs is attached to most of these body segments. They differ from millipedes in that millipedes have two pairs of legs on most segments and bodies, which are not flattened. Centipedes range in length from 1 to 6 inches and can run very rapidly.

Section 10 - Pigeons

Nuisance Pigeons can ruin the looks of a building as well as pose a health threat to students, employees, and guests. Pigeon droppings contain uric acid that actually eats into the surface it drops on. Painted surfaces, canvas awnings, signs and other similar surfaces post the most risk. Dried bird droppings can contain many fungal and viral diseases that can represent a serious liability to the school district. Histoplasmosis, Encephalitis, Meningitis, St. Louis Encephalitis and Salmonella are just a few of the common viral and bacterial diseases that have been associated with bird droppings. Fleas, Ticks, Mites, and Lice are just a few of the parasites that have been associated with Pigeons.

Wild Feral Pigeons or rock doves are a direct descendant of the ancient Roman Homing Pigeons. Feral Pigeons are non-migratory meaning that they are often born, lie, and die in the same place. Once a building becomes home to pigeons, they are there for life. As a descendant of homing pigeons, feral pigeons are good flyers sometimes flying at speeds of up to 80 MPH. Trapping and relocation may seem like a good idea, but once you travel out in the country somewhere to let them go, they will fly right back. They have an excellent sense of direction and can find their way home from many, many miles away.

Histoplasmosis is a common respiratory infection that is associated with Pigeon droppings. Humans inhaling fungal spores that have cultivated on pigeon droppings cause histoplasmosis. It has flue like symptoms that can persist for several weeks and that even some doctors can't diagnose. Fleas, ticks and other parasites are also known to be spread by pigeons especially near water sources where they clean themselves and pick the parasites off and drop them on the ground or eat them.

Cultural Control

1. Screen vents, eaves and windows or use plastic or nylon netting to discourage roosting and nesting sites.
2. Changing the angle to over 45 degrees or more can discourage roosting on ledges.
3. Porcupine wire or other materials can be used to discourage landing. Eliminate food supply if possible (e.g. do not feed the pigeons).
4. Five Cage Traps can be very effective tool to reduce populations of pigeons roosting or nesting on undesirable sites.

Chemical Control

1. Contract services with a certified pest control that specializes in bird control.

Section 11 – Crickets

House Crickets

The house cricket and the field cricket commonly invade homes. Camel crickets and mole crickets are also occasional pests indoors, especially in damp and dark basements which have a partial dirt floor. When present in large numbers, crickets are considerable annoyance and can cause damage to some fabrics such as linens, rayon, and furs. They will attack paper, all kinds of foods, and even rubber. However, unless large numbers occur, such damage is usually minor.

Crickets are rather closely related to cockroaches, so have a gradual metamorphosis. The young, or nymphs, look like adults, except that their wings and genitalia are not developed fully. The house picket lives outdoors but may invade houses in great numbers. Adults are about $\frac{3}{4}$ inch long with 3 dark bands on the head and long thin antennae. The body is light yellowish-brown. This cricket is active at night,

usually remaining hidden during the day. They are omnivorous, eating or drinking almost anything that is available. In households, they may chew on or damage silk, woolens, paper, fruits, and vegetables.

Field Crickets

The field cricket is widely distributed over the United States. It is larger than the house cricket and has wings extending beyond the wing covers. They are usually dark brown to gray or blackish. Field crickets frequently invade houses and may feed on just soil or a wide variety of other materials. Smaller field crickets of the genus *Nembius* may also invade homes in late summer. Field crickets prefer to live outdoors where they feed on soft plant parts, but will move inside when grasses dry up or environmental conditions outdoors become unfavorable (excess heat, cold or rainfall).

Field crickets are often attracted to lighted areas at night. Thus, turning off these lights during periods when crickets are numerous, or at least manipulating lights so the crickets are less bothersome can lessen problems with crickets. Otherwise, exclusion techniques should be applied to keep crickets from entering structures as much as possible.

Satisfactory control of crickets frequently involves treatment of both inside and outside the structure, as well as removal of breeding and feeding sites outdoors and use of tight-fitting screens and doors. Any opening to the building near ground level should be properly sealed. Sprays are recommended for chemical control. Wettable powders such as Demon WP and microencapsulated formulations such as Demand will give superior residual action on outdoor surfaces. Non-residual sprays such as CB80 can be very useful when applied as a fog to attics, ceiling voids, crawl spaces or other areas when fast knockdown and kill are required. Dust formulations of Drione or borid 1 may be preferred in some circumstances, such as for treatment of crawl spaces, wall voids, or attics.

Chemical Control

1. Various bait formulations such as Larva Lur, Niban and Baygon 2% are available which are particularly effective when scattered around the foundation outdoors, or when applied above drop ceilings or in attics indoors.

Insecticide spray or bait applications to damp areas of the basement and ground level floors are recommended for field crickets. Other areas may have been treated for house crickets or seasonal swarms of field crickets, which may be found almost anywhere in a structure. Application outdoors to foundations, window wells, around doors, and windows, crawl spaces, under garbage cans, flowerbed, and weep holes in brick facings are necessary. If heavy infestations are encountered, a 5 to 20 foot band around the structure should also be treated with either a residual spray or bait.

Section 12 – Crickets

Mole Crickets

Mole Crickets are about 1 ½ inches long, are golden to chocolate brown in color and are covered with fine “velvety hairs”. They are endowed with strong front legs equipped for digging. Their small winding burrows of loosened soil reveal their presence. They are nocturnal feeders and may tunnel as much as 10 to 20 feet a night.

Northern Mole Cricket

Those meandering surface ridges that suddenly appear on your lawn indicate the presence of mole crickets. The next symptom is will be dead or damaged plants. Two common mole cricket species

attack plants – the Northern Mole Cricket and Southern Mole Cricket. Vegetable crops may be damaged by the mole crickets.

Treatments for mole crickets usually include a thorough treatment of the infested area with a residual insecticide such as Talstar. After treatment, a thorough watering usually helps residual insecticides to penetrate the soil.

Carmel Crickets

Also called stone or cave crickets, camel crickets are not true crickets, are wingless, and are otherwise distinctive in appearance because of their arched backs. They are active at night, are not attracted to light and have no “song”.

Jerusalem Crickets

Jerusalem Crickets are sometimes called “children of the earth”. They have large, round, naked heads with two bead like black eyes that may give them a fancied resemblance to a miniature child. They burrow into loose soil, are active at night and are seldom seen. They are useful predators, feeding on other insects and spiders. Although fierce looking, Jerusalem Crickets are harmless, but their powerful mandibles could inflict a minor, non-venomous wound if handled carelessly.

Section 13 Cockroaches

Cockroaches are among the most common insects on earth. Based on fossil evidence, roaches are known to have been present on Earth for over 300 million years. Their sizes vary considerably; some species are up to several inches long. Some biologists consider insects to be one of the most successful groups of animals to ever inhabit this planet, and cockroaches are one of the most adaptable and successful insect groups. They have been able to survive many changing environments over millions of years. There are approximately 3500 species of cockroaches worldwide about 60 species found in the United States. Their presence in nearly every part of the world and wide range of habitats demonstrate that cockroaches are truly an outstanding success story in nature. Unfortunately, many of the same outstanding biological characteristics, which make them so successful, also make them one of the most difficult pest to manage. Cockroaches, especially the German cockroach, are the most commonly encountered and important household insect pests in much of the US. Only a few of the cockroach species found in the United States routinely enter and infest our dwellings. The most common of these are the German cockroach, American cockroach, Oriental cockroach, Brown-banded cockroach, Smoky brown cockroach, Australian cockroach, Brown cockroach, Woods cockroach, Field cockroach, and the Asian cockroach. Of these eight species, the first five represent 95% of all cockroach management in and around buildings. In some parts of the US, one species may be more important than another may. Certain other species may infest homes or other buildings, but will generally be found in very localized situations or under other unusual circumstances.

GENERAL BIOLOGY AND BEHAVIOR OF COCKROACHES

Most cockroaches are tropical and sub-tropical in origin, generally living outdoors. They are mostly active at night, during which time they forage for food, water and mates. They may be seen in the daytime, particularly when a heavy population is present or when some other forms of stress is placed on the population (such as lack of food or water). Cockroaches ordinarily prefer a moist environment, and many species also prefer a relatively high degree of warmth. Some tropical roaches feed only on vegetation. However, cockroaches which live in buildings are mostly scavengers and feed on a wide variety of food. They are especially fond of starches, seeds, grease, and meat products; but will also eat

a great variety of materials such as cheese, beer, leather, bakery products, starch in book bindings, glue, hair flakes of dried skin, dead animals, and plant materials.

Cockroaches usually choose to live in protected cracks and crevices which provide a warm and humid environment. Some species, such as the American and oriental cockroach, gather in large groups on open walls in protected places or in open areas outside. While they are often found in groups in their daytime hiding or resting areas (called "harborage") and can be found feeding in groups at night, cockroaches are not social insects as are the ants and wasps. Cockroaches generally forage individually for food and otherwise behave in a largely individualistic or non-social manner. Even though cockroaches are not social insects, they do often form aggregates.

The general shape of a cockroach is familiar to everyone. They are oval and flat-bodied, which enables them to squeeze into all types of cracks and crevices. A pronotum (a shield-like covering) projects forward over the head; their mouthparts are of the chewing type and are oriented downward slightly toward the rear of their body. With their long spiny legs, they can run rapidly over most surfaces. Specialized pads in their tarsi allow them to easily scale glass windows or walk on a ceiling. Besides their ability to move around inside and outside, and the fact that some species are good flyers, cockroaches are well known for moving to new areas via "hitchhiking." Because they prefer to hide in cracks and crevices in the daytime, they are frequently moved about by individual people or in products shipped around cities or the country. Careful inspection of furniture, clothing, or other goods coming into a home or other facility may reveal cockroaches hiding in these items.

Cockroaches develop by a gradual metamorphosis that consists of three stages: egg, nymph, and adult. The female produces a purse shaped egg capsule, called an ootheca, which has two rows of eggs in it. Nymphs hatch out of the egg capsule by working together to break a seam along the top of the egg case. When the seam splits open, the tiny nymphs emerge to begin their life. The nymphs generally resemble the adult in appearance and behavior, but are smaller, do not have wings or wing pads, and frequently have a somewhat different color. Newly molted nymphs are white, but will darken to the normal color within a few hours. Some people mistakenly think these molting individuals are "albino cockroaches".

Nymphs undergo a series of molts; with the last molt, the wings are fully formed and the sexes are easily distinguished from each other. Wings of the adults may be long and functional or short to almost nonexistent. In some species males are winged, but females have only small wing pads. Adults may or may not fly depending on the species and upon environmental factors. The length of time required for the eggs to hatch, for nymphs to develop and the life span of the adults will also vary (even within each species) due to temperature, humidity, the quality of their diet, and other environmental conditions.

German Cockroach

The German cockroach is the most economically important urban pest. It is the most common cockroach species in house, apartments, restaurants, hotels and other institutions throughout the United States. In some southern areas, larger cockroach species such as the smoky-brown cockroach can be more of a problem. The oriental cockroach or some other species may also be more common in certain situations especially infesting around or under the premises and frequently moving indoors. However, the German cockroach is by far the most common and important species infesting our homes and institutions. In some areas it may still be referred to as the "croton bug".

Adults are plan to medium brown and about ½ to 5/8 inches long. German cockroaches can be distinguished from other roaches by the two dark stripes on the back of their head. German cockroach

nymphs resemble the adults except that they are smaller, wingless and darker in color, often being nearly black. A single light stripe running down the middle of the back is the most prominent marking on the young cockroach. The female carries her egg capsule protruding from the rear of her abdomen until the eggs are ready to hatch. Females that are carrying egg capsules are called "gravid". The egg capsule is slender, about 1/3 inch long and tan in color. The nymphs may break open the capsule while it is still attached to the female, or she may deposit the capsule in some protected place where they young will be able to find food and harborage when they emerge. The German cockroach is the only common house infesting species, which carries the egg capsule for such an extended period. Capsules removed from the female more than a couple of days before the normal hatching time are unlikely to hatch unless they remain under conditions of very high humidity. This is also true for gravid females which may be killed by an insecticide within several hours, to one day or more, from the time the egg capsule would normally have hatched. The embryos in the egg capsule require a responsibly steady flow of water, usually from the adult female, to prevent death from desiccation or drying out. Again, if humidity is very high, desiccation may not occur, and the egg capsule can survive for a few hours or longer after premature dropping, or death of the female. Adult females will usually produce from 4-8 egg capsules in their lifetime. Each capsule contains 30-48 eggs. It usually takes 28 days from the time of initial formation of the egg capsule until it hatches. Formation of the next egg capsule usually begins within a couple of weeks. There are 6 or 7 nymphal stages, called instars, before they molt into the adult stage. The number of nymphal instars may increase under certain environmental conditions or if appendages such as legs or antennae are lost during the earlier nymphal instars. In the later case, extra instars will occur to allow regeneration of these missing body parts. Completion of the nymphal stage under room conditions requires 40-125 days, depending on environmental conditions and other factors such as favorable diet. Adult German cockroaches can live up to one year, but most will die from various causes long before that time. Nymphs have habits similar to those of adults. They are active mostly at night and hide in dark crevices during the day.

If German cockroaches are seen during the day, the population is probably so large that the available harborage is already full, or food and moisture are in such short supply that daytime foraging is necessary. Such behavior indicates that the population is under considerable stress. This species usually hides in areas close to moisture and food, which means they are generally, found in kitchens and other food areas. They prefer to rest on wood rather than on metal or other smooth surfaces. Large infestations do occur on metal surfaces when there are few other surfaces available. Examples would be on ships, or in large modern food processing plants and kitchens with stainless steel equipment and wall panels.

The German cockroach is a general feeder, but is particularly attracted to fermented foods and beverage residues (e.g. beer spills). If water is present, adults can live about a month without food, but young nymphs will die of starvation within 10 days. Without food or water, the adults die in less than two weeks. Most stages become very stressed if deprived of food or water for more than a couple of days. Stressed cockroaches tend to wander or forage for resources aggressively, even during abnormal periods such as the daytime. Infestations are sometimes found in areas not generally suspected of German cockroaches; for example, dresser drawers in bedrooms. When German cockroaches are found scattered through non-food areas of a home or building, it is usually caused by a very heavy infestation or by the repellent effects of insecticide applications. Cockroaches in these areas will find food scarce, but can feed on scattered crumbs, soiled clothing, and the flue on dresser drawers or on some cosmetic products. German cockroaches can also be found outdoors during warm months, often associated with garbage receptacles. This, too, is usually due to a heavy infestation indoors.

Why the German Cockroach is so Successful

As mentioned, the German cockroach is the most commonly encountered of the house infesting species in the United States. It is also generally the most persistent and difficult to manage. The reasons for this are somewhat complex, but an understanding of some of the factors involved is basic to the practice of pest management. First, the German cockroach has a larger number of eggs per capsule than the other species that infest structures. Second, it also has the shortest period to develop from hatching until sexual maturity; thus, populations of German cockroaches will build up faster than other species. These factors combine to produce what entomologists call a “high reproductive potential.” Third, German cockroach nymphs have a better chance of surviving than do other species because the female carries the egg capsule during the entire time that the embryos are developing within the eggs. This results in the nymphs avoiding the many hazards of the environment, which may affect eggs that remain, detached and isolated. Thus, more nymphs are likely to hatch and a higher reproductive potential is likely. Fourth, German cockroach nymphs are smaller than most other cockroaches; thus, they are able to conceal themselves in many places that are inaccessible to individuals of the larger species. In fact, in a commercial kitchen, there may be literally thousands of cracks and crevices young cockroaches can hide in and remain protected. German cockroach nymphs also tend to stay close to mother, often close to the female at the time of hatching, creating a tendency for a high local population density. They also have aggregation pheromones associated with their feces, which have the effect of increasing the level of aggregation or clumping individuals in the population. These biological factors, combined with its very adaptive feeding habits and other behaviors, give the German cockroach advantages toward increased chances for survival and persistently maintaining high cockroach. The “high reproductive potential” of this species can significantly affect its ability to develop resistance to insecticides. During the late 1950s and the 1960s, insecticides such as DDT and chlordane were widely used to control German cockroaches. In many cases, some individuals of German cockroach populations exposed to these insecticides survived. And because these cockroaches reproduce so quickly, survivors were able to pass the ability to survive exposure to DDT and chlordane to following generations. Over many generations, large portions of populations can then become resistant to insecticides. It is possible within a single town or city to find both populations of cockroaches that are resistant to a particular insecticide and others that are susceptible to the same insecticide. Each population’s history of insecticide exposure over many generations will determine the level of resistance to various insecticides.

Some of these uncommon patterns of infestation are more understandable in the light of recent research on the normal movement patterns of German cockroaches within and between urban apartments. Detailed field research has shown that they can be quite mobile within structures. Up to 10% (or more) of the adult German cockroaches in a moderately to heavily infested apartment can move into or out of the kitchen area within a week’s time. Similar rates of movement have also been measured between adjacent apartments. This latter movement usually does not occur unless the two adjacent apartments share common plumbing. Thus, exclusion of German cockroach movement into the wall voids which house plumbing connections or careful treatment of those areas with insecticides (e.g. dust formulations), will greatly aid in maintaining adequate control in multi-family dwellings and other large, complex structures such as hospitals and motels. The German cockroach is a relatively active species, moving around readily within structures. They travel from one location to another and can pass through very small openings. They are also regularly carried from place to place in such things as bagged potatoes and onions, beverage cartons, grocery bags, food cans, other food packages, handbags, and the folds of clothing. The pest management professional must look very closely to find all the places in which cockroaches may be living and try to determine how cockroaches might be transported into the premises. It may not be possible to eliminate all the German cockroaches in a structure at any one time if a steady flow of cockroaches is carried into the premises via people, food

shipments or other routes. Further, the use of insecticides may scatter cockroaches widely throughout a building. If all of the scattered or “satellite” populations are not found and treated re-infestation of treated areas will occur.

German Cockroach Management

Much of the discussion on where cockroaches will harbor was written particularly with the German cockroach in mind. This species is most commonly found near sources of food, water, and warmth. This is particularly true of the small nymphs. The larger nymphs and adult males are known to range more widely inside infested buildings. Adult females forage for food and water in a manner similar to males, except during the few days before the egg capsule hatches. During this time they will forage very little. When inspecting for German cockroaches, thoroughness is the golden rule. Check places such as cracks and crevices, under tops of tables, behind and under sinks, in cabinets, the motor compartments of refrigerators and soft drink dispensing machines, underneath the bases of kitchen equipment or pallets which are set on the floor, in switchboxes and fuse boxes, underneath cafeteria counters and soda fountains, in food carts, in cash registers and telephones, in vegetable bins, around meat counters and check-out stands, under meat cutting blocks, and almost anywhere else conditions are favorable. It is impossible to list all the places where German cockroaches may live and hide, so you must inspect thoroughly and use judgment and roach “thinking” to find all of the harborages.

American Cockroach

The American cockroach is known as the water bug, flying water bug, and in some areas of the South, the palmetto bug. It is the largest of the common species, growing to 1.5 inches or more in length. It is reddish-brown, with a pale brown or yellow border on the upper surface. Both the male and female are fully winged. The wings of male extend slightly beyond the tip of the abdomen, while those of the female are about the same length as the abdomen. The female drops her egg capsule within a day after it is formed. Sometimes it is dropped in a suitable location, such as near a food source, or in a protected area. In the South, this may be outdoors in moist and decaying wood. At other times it may be glued to some surface with secretions from the female’s mouth. Egg capsules are formed at the rate of about one per week until from 15 to 90 capsules have been produced. Each capsule contains 14-16 eggs. At room temperature, nymphs will hatch out in 50-55 days. In the process of hatching, nymphs will molt and leave their first cast skins in the egg case. Young nymphs are grayish-brown and each will molt 9-13 times before reaching maturity. After the first few molts, nymphs become more reddish brown in color. The time required to complete the nymphal stage vary from 160-197 days. Under ideal conditions, an adult female can live up to 14-15 months; males for somewhat shorter period. However, in natural populations many factors reduce their life span.

When indoors, the nymphs and adults are usually found in dark, moist areas of basements and crawl spaces as well as in and around bathtubs, clothes hampers, floor drains, pipe chases, and sewers. In basements they are usually found in corner areas high on the walls. In the North, this roach is commonly associated with steam heat tunnels. In northern areas where steam heat tunnels are not found, the American cockroach will be restricted primarily to large institutional buildings. The American cockroach is also common around the manholes of sewers, and on the underside of metal covers of large sump pumps in boiler rooms. American cockroaches have also been observed migrating from one building to another during warm months in the North.

In the South, this roach is abundant in alleyways, yards, hollow trees and palm trees. Recent studies in Florida have shown that American cockroaches and other outdoor roaches are generally associated with trees and woodpiles in landscapes. They especially prefer moist, shady areas. Sometimes they are

found under roof shingles or flashing, or even in the attic. Similar studies in Texas have shown that American and smoky-brown cockroaches often prefer moist, shady areas of ground cover, which are often found around foundations and near swimming pools. The presence of automatic sprinkler systems for irrigating these areas of turf and ground cover will provide particularly attractive and favorable living conditions for cockroach populations. When conditions are unfavorable, American cockroaches and other outdoor species may move indoors. American cockroaches feed on a variety of foods, but decaying organic matter seems to be preferred. When conditions are unfavorable, American cockroaches and other outdoor species may move indoors. American cockroaches feed on a variety of foods, but decaying organic matter seems to be preferred. They also feed upon book bindings, manuscripts, clothing and glossy paper with starch sizing. Syrup and other sweets are also attractive. The adults can survive two or three months without food, but only about a month without water. The adults have well-developed wings, but seldom fly. They are capable of gliding long distances and will cover considerable distances if they take off from a tree or rooftop. In the South, and as far north as Kentucky, American cockroaches have been reported to fly short distances.

American Cockroach Management

In larger urban buildings American cockroaches are found in dark, damp and warm places. They frequently congregate in-groups in more or less open spaces, rather than in cracks and crevices. They are often found near steam pipes, in sewers, grease traps, floor drains, pipe chases, damp basements and similar places. They are also common in the sanitary and storm sewers of most cities. As with German cockroach management, it is important to do a thorough inspection. A trap survey may be necessary in difficult or special situations before any management procedures are attempted. This includes infestations which are originating in the landscape outdoors.

In the South, American cockroaches are commonly found in the landscape along with other larger species, and can readily move inside during nighttime foraging. Movement in doors often increases during periods of cold, extreme hot and dry weather, or excessive rainfall. In these cases, it is important to treat all outdoor areas where the cockroach populations are focused. Perimeter or "barrier" treatments using residue insecticide formulations to prevent cockroach entry into buildings are helpful. Identify where the cockroaches are harboring and moving around in the landscape, and focus insecticide applications in those areas. One important note: do not treat firewood piles with residual sprays. Instead, use baits in these areas or have the customer remove the wood. Exclusion techniques such as caulking or sealing various cockroach entry points are effective at reducing the problem indoors. To prevent cockroaches from entering through weep holes in exterior brick façade, insert small squares of window screening into the holes using a putty knife. This prevents insect entry, yet still allows for air exchange for which the weep holes are intended. Excessive and widespread insecticide applications in the landscape are not usually necessary. American cockroaches can be controlled by the use of sprays, dust or baits. Residual insecticides sprays applied into infested areas will control American roaches slowly, but effectively. Indoor surfaces are most effectively treated with wettable powder or flowable microencapsulated formulations. This is especially true for basement and other utility areas, where bare concrete or other porous surfaces are present. Be sure to treat around floor drains where American cockroaches are harboring, and try to use window screening or some other method to physically prevent them from entering the building from these sources. Insecticidal dusts are very effective.

Dust applications should be made to voids and other harborage areas, which will remain dry. Do not apply dusts to wet or damp areas. In some situations, American cockroaches can be killed by the use of non-residual, quick-knockdown insecticides. Non-residuals are usually applied either with aerosols, ULV sprayers, or foggers. American cockroaches will also feed upon commercially available baits such as

Maxforce, Seige and Avert. It is important to remember that sufficient numbers of bait locations should be used. When insecticide applications to plants such as trees, ground covers or grassy areas are necessary outdoors, only use formulations which are safe for use on plants. In these situations, either wettable powder, microencapsulated or emulsifiable concentrate sprays of the residual materials listed above are generally appropriate. For applications to the sides of houses, door and window-jams, and other exterior surfaces, microencapsulated formulations of wettable powders are preferred.

Oriental Cockroach

The oriental cockroach is also referred to as the waterbug, black beetle or shad roach. It is found in all parts of the United States. Total length of this cockroach is about 1.25 inches for the female and 1 inch for the male. The female has small, functionless rudimentary wings called wing pads. The male's wings cover about $\frac{3}{4}$ of the abdomen. Neither the male nor the female can fly. Adults are very dark brown or nearly black, and usually have a somewhat greasy sheen to their body. Females are broader and heavier looking than males. An egg capsule is formed by the female for about 30 hours, after which it is either dropped or attached to a protected surface near a food supply. Females will produce an average of 8 capsules, each containing 16 eggs which will hatch in about 60 days under room conditions. Nymphs molt from 7-10 times and the nymphal stage usually takes several months to one year to complete.

Unlike the other house infesting species, the oriental cockroach generally has a seasonal developmental cycle. The peak number of adults usually appears in late spring or early summer. The number of adults in the population is generally quite low by late summer and early fall, due to natural mortality and the hatching of nymphs. Few live adults are usually found in the population throughout the year, but if nymphs have not reached maturity by late fall or early winter, their development seems to slow considerably and maturity is not reached until spring. The nymphs and adults have similar habits and are found associated with decaying organic matter indoors and out. They can be found in yards, beneath leaves, in dumps, in crawl spaces and in the mulch of flower beds. They are also common in high moisture situations such as sewers, drains and dark, damp basements. Both the nymphs and adults are sluggish and are usually located at or below ground level indoors. They are seldom found on walls, in high cupboards or in the upper floors of buildings.

Oriental cockroaches feed on all kinds of filth, rubbish and other decaying organic matter. They seem especially fond of garbage and the contents of discarded tin cans. If water is available, they can live for a month without food, but die within two weeks without water. In many areas oriental cockroaches are generally found outdoors during warm weather. In periods of drought there may be considerable movement into structures, apparently in relation to humidity gradients. As cold weather approaches, or sometimes during unseasonably cool periods, a similar migration indoors may occur. There may be considerable group movement within heated structures during cold weather, particularly if areas of a building are maintained at warmer temperatures than other areas.

Oriental Cockroach Management

Indoors, Oriental cockroaches prefer dark moist areas such as under porches, crawl spaces, basements and floor drains. They may be found outdoors in abandoned cisterns, water valve pits, in bark mulch under shrubs and around the foundation, in stone walls, and in garbage and trash dumps. Oriental cockroaches are often found in cooler places than is typical for the other large species of cockroaches. For example, they can survive over winter in protected landscape areas of cold regions of the United States.

Oriental cockroaches can be controlled with the same types of insecticide sprays and baits as those used for the American cockroach. However, the moist situations in which this cockroach is normally found will typically decrease long term effectiveness of residual insecticides, cause baits to mold (reducing their effectiveness), and often prevent the successful use of dusts.

Section 13 Cockroaches

Because Oriental cockroaches often move into dwellings in large numbers, a perimeter or barrier treatment is recommended when cockroaches are found living outside. Recent research on the movement of Oriental cockroaches under, and around and into homes from harborage in crawl spaces and cinder block foundations has shown that these cockroaches frequently move into the home along plumbing (e.g. up through the floor from the crawl space underneath) and under door or window jams. Thus, carefully treat these areas with insecticides, and/or physically prevent such invasion by caulking or screening.

Brown-banded Cockroach

This is one of the smaller cockroaches, rarely being more than ½ inch long. It is light brown and can be readily distinguished from the German cockroach by the presence of two lighter, transverse bands running from one side to the other across the base of the wings and abdomen in adults, and in the same position on the nymphs. These bands may be somewhat irregular or broken and are more apparent on the young and the females than on the males. The female has a broader body than the male. Both male and female are quite active and the adult males fly readily when disturbed. Both adults and nymphs may jump when attempting to escape. They frequently occur in the same buildings as the German cockroach. One must be very careful to identify this species correctly, as control techniques are different for the two species because of their different behaviors. A female brown-banded cockroach carries her egg capsule for a day or two, and then attaches it to a protected surface. The egg case is purse-shaped, light brown in color and is cemented in place, usually to the side or under surfaces of infested objects. Females will produce about 14 egg capsules during their adult life, each containing about 18 eggs. These hatch in 50-75 days, depending on temperature. Under room conditions, nymphs mature in about 160 days. Adults may live up to 10 months. Nymphs and adults are generally found on ceilings, high walls, behind picture frames and light fixtures, or near motors of refrigerators and other appliances. They are also found in light switches, closets and furniture. They do not require as close an association with moisture sources as the German cockroach. This helps explain why they are so commonly found in rooms other than the kitchen or bathroom. These cockroaches dislike light and are not normally seen during the day. The brown-banded cockroach prefers feeding on starchy materials. However, they can be found feeding on almost anything, and have been known to chew on such non-food materials as nylon stockings (presumably for the residues of body oils and skin flakes).

When making an inspection for brown-banded cockroaches, look beneath tables and chairs, dressers and chests. Look also behind pictures, along picture moldings, on rough plaster walls and ceilings, and most especially on the ceilings and upper walls of cabinets, pantries and closets. No room should be left uninspected, nor should any piece of furniture (wood, metal or upholstered) if its construction provides shelter. Look for tiny black droppings, attached egg capsules, or cast skins where they have fallen from above onto shelves or ledges. These cockroaches are more often found in homes, apartments, hotels and hospital rooms than in stores, restaurants and kitchens. They are frequently transported in furniture, and will rapidly spread throughout an entire building. They have long been abundant in the southern states, but will rapidly spread throughout an entire building. They have long been abundant in the southern states, but are now found as far north as Canada. In the cooler northern states, they are generally found in the warmer parts of buildings.

Brown-banded Cockroach Management

Brown-banded cockroaches prefer warm places and are usually found widely dispersed throughout houses or other buildings. Unless a control program is thorough, these roaches can be difficult to manage because they live as individuals and small groups in such widely scattered locations. A thorough inspection of the premises is a must for brown-banded cockroach management. Sprays or dusts (e.g. of products recommended for German cockroach control) should be thoroughly applied to such places as inside bureaus, shelves in clothes closets, ceiling light fixtures, and valances above windows. Professionals must learn the hiding places of this cockroach.

Smoky-Brown Cockroach

Smoky-brown cockroaches are closely related to the American cockroach but are distinguished by their smaller size, being slightly more than 1-inch long and uniform mahogany brown colored. They do not have any lighter coloration around the edge of their pronotum, as does the adult American cockroach. They do not have any lighter coloration around the edge of their pronotum, as does the adult American cockroach. Both males and females have wings longer than their bodies (see Figure 61*). Young nymphs have long antennae that are white at the tip. Females lay a dark-brown to black egg capsule, which contains 24 eggs. The capsules are firmly attached to some object, although occasionally they may be found lying loosely on the ground or floor. Each female produces about 17 capsules. Their life cycle is similar to other *Periplaneta* species, except that the average adult life span is less than the American cockroach. In a protected area, the smoky-brown cockroach will live for about 200 days at room temperature. This cockroach is restricted in its distribution within the U.S. It is common throughout central Texas and eastward, along the Gulf Coast, throughout Florida and up the eastern seaboard. It is the most common species of cockroach encountered in some parts of the South, and is now known to be present in some areas of southern California. It is not generally found in the North except when accidentally brought in. Normally, this cockroach feeds on plant material, but it can feed on almost anything that other cockroach species feed on once inside a dwelling. It is commonly found living in wood shingle roofs and in gutters where it feeds on decaying organic matter. In attics, they are typically found living at the roofline. Nymphs and adults enter buildings in a number of ways. They can be brought into the house with firewood or anything else that is stored outside, in garages or other storage areas. They can enter around doors and windows, through ventilation ports under the eaves of a house or any other small cracks or crevices, which lead inside. Many homes with brick facades are built with regularly spaced "weep holes" in the brickwork. Cockroaches and many other insects can enter wall voids via these "weep hole" accesses. They can also move onto roofs and gutters and eventually into the structure. Smoky-brown cockroaches move in and out of buildings to forage more than American cockroaches and most other outdoor species.

Smoky-brown Cockroach Management

This cockroach can be controlled with the residual sprays and baits recommended for American cockroaches. However, the extent and thoroughness of treatments must be often greater since this cockroach is typically more active in its movements and will usually be found living in and around the inside and outside of a building. Individuals or groups of smoky-brown cockroaches may be found in almost any room of a building as well as in crawl spaces, garages, attics, flower beds, in and around trees, shrubs, trash or garbage receptacles, woodpiles and just about any other place where they can hide. They move about readily going in and out of buildings. It is often necessary to treat outside areas with power sprayers to get thorough coverage of the areas in which they hide. Dusts are effective in attics and crawl spaces, and may be applied with power dusters. When treating exterior surfaces of the home or building, use wettable powders in order to obtain the most effective residual performance on these difficult porous surfaces. In addition, it is often necessary to dust cracks on the outside of the

building and to dust in the cracks of wood shingle roofs. Also, check the rain gutters for the possibility that smoky-brown cockroaches are living in debris trapped in the gutter. There are various insecticide baits available for use against other outdoor cockroaches, crickets, millipedes and other crawling insects. These can also be useful to control the smoky-brown cockroach. In general, successful smoky-brown cockroach management requires planning and thoroughness. It also requires use of more different types of applications than any other type of cockroach management. Fortunately, once adequate results have been achieved in and around a home, the reproductive potential of this species is low enough (compared to the German cockroach) that their numbers will not rebound very quickly. However, if one or more groups of smoky-brown cockroaches left untouched by the effort, or if they cannot be eliminated for the adjacent property, adequate control and customer satisfaction may be difficult to obtain. In many areas of the South, smoky-brown cockroach management is very frustrating in heavily wooded neighborhoods, because of the many cockroach population reservoirs that are present, but difficult to find or treat.

Woods Cockroach

The term woods cockroach covers a number of cockroach species, usually of the same genus and having similar habits. The species most generally described is the Pennsylvania woods cockroach. Woods cockroaches are small, usually not more than 2/3 inch long. Adults are dark brown with the sides of the thorax and the front half of the wings margined with yellow. In the male, the wings are longer than the body, while those of the female cover only 1/3 to 2/3 of the abdomen. The males are generally strong fliers, whereas the females do not fly. The Pennsylvania woods cockroach is widely distributed in the eastern, southern, and Midwestern states, up to Canada. Egg capsules are produced during the warm months and are deposited loosely behind the loose bark of dead trees, fallen logs or stumps. The woods cockroach rarely breeds indoors. The nymphs and adults are usually found outdoors beneath loose bark in wood pile stumps and hollow trees. These cockroaches often become a problem when infested firewood is brought indoors. They will wander about the house without congregating in any particular room. They can be especially troublesome during the mating season, which is often May and June. Male woods cockroaches are strong fliers and will come from considerable distances, often in large numbers. They are readily attracted to lights at night, and accidentally gain entry indoors. Large numbers may also be found in the rain gutters of homes. Woods cockroaches feed primarily on decaying organic matter.

Woods Cockroach Management

Woods cockroaches are usually only occasional invaders of houses. They are difficult to manage with insecticides inside the house because the infestation originates outdoors. At times they may be numerous in crawl spaces under a house. In these situations, a thorough treatment with a residual insecticide spray or dust will be effective. Woods cockroaches are common in woodpiles, so firewood should be stored away from the house to reduce their movement inside. Because the males fly to lights at night, the use of residual insecticide sprays around doors, windows, porches, patios and any other areas where outside lights will be useful.

Australian Cockroach

The Australian cockroach is similar in appearance to the American cockroach but is rarely more than 1.25 inches long. It is reddish-brown and can be distinguished by prominent yellow stripes along the outer front edge of either wing, and by a prominent dark spot on the center of the head. Adult females drop their egg capsule in a crack, crevice or other hidden area shortly after it is formed. The eggs hatch about 30 days after the egg capsule is dropped. There are approximately 24 eggs per capsule, but only about 2/3 of these numbers usually hatch. Egg capsules are dropped at about 10-day intervals. The

nymphs are strikingly marked with distinct splotches of yellow on the dorsal side of the thorax and abdomen.

Nymphs move about under loose bark and in moist decaying vegetation, as do the adults. This cockroach is found chiefly in the South, but has been found in greenhouses, zoo buildings (especially where plant material and humid conditions are prevalent) and houses in the northern states. It feeds predominantly on plant materials, although it will feed on various starchy materials in homes.

Brown Cockroach

Brown cockroaches are generally distributed in southern states, from Florida to Texas. They have found as far north as Philadelphia, Pennsylvania and Columbus, Ohio. The brown roach resemble the American cockroach, except it have a broader body and less distinct markings on the thorax. The last segment is short and blunt, when compared to that of the American cockroach. Brown cockroaches occur indoors and outdoors, where they are found under the bark of trees, in sewers, crawl spaces and similar places. In the South, this cockroach is associated with trees, particularly palm trees. The brown cockroach normally feeds on plant materials. Egg capsules contain an average of 24 eggs each. The egg capsule is normally glues on a wall near the ceiling, usually in open places in either homes or commercial buildings. Indoors, it seems to prefer sticking the egg capsule to cement or plaster, rather than wood. Outdoors, placement of the egg capsules is similar to that of the American cockroach.

Australian Cockroach

These roaches can be controlled with the usual residual insecticide sprays or dusts in the same manner discussed for the American cockroach.

Field Cockroach

This is a small cockroach, slightly smaller than the German cockroach, but can be distinguished by a blackish area on the front of the head, extending from the mouthparts to between the eyes. Its distribution is from California to Texas. The field cockroach feeds largely on decomposing vegetation and is common in irrigated areas. It normally lives outdoors occupying areas under stones, clumps of earth and similar locations. Occasionally, however, it wanders into homes during dry parts of the year. The egg capsules are carried by the female until they are ready to hatch. The capsules are normally dropped outdoors. When these roaches come indoors, they wander about the walls and floors during the daylight hours, and make no attempt to hide in dark cracks as German cockroaches do.

Field Cockroach Management

Field cockroaches are found living on decomposing vegetation and under stones or clumps of earth. They come into homes only during drier portions of the year, to get moisture. They can usually be controlled by removing decomposing plant materials from the area, or when necessary, by spraying or dusting with direct contact insecticides.

Asian Cockroach

This species is native to various areas in Southeast Asia, and appears to have been introduced through the Port of Tampa. It is established in the Tampa, Lakeland and St. Petersburg areas of Florida. It is very similar in appearance to the German cockroach, but has very different behavior. It prefers to infest shaded and moist areas in the landscape, grassy areas and groundcovers. It typically becomes most active just at dusk, remaining so for a few hours thereafter. Adults will fly quite readily and for relatively long distances. They will fly to lights at night. Because they will enter homes, they are a particular nuisance when they fly inside (into TV screens, onto people, etc). They are also a considerable nuisance

when they fly into backyard barbecues and other patio events in the evening. This species is quite susceptible to all the insecticides typically used for cockroach control. The limits of its ultimate geographical spread within the United States are difficult to estimate at this time, but it may spread to other warm and moist regions of the Gulf coastal states and California.

Asian Cockroach Management

Asian cockroaches present a rather difficult pest management challenge for professionals and homeowners in the affected areas. Typically, these cockroaches are an outdoor pest problem, but they do readily enter the home and can establish an infestation inside. The adults are strong fliers and are attracted to exterior and interior lighting and/or other light-colored surfaces and areas around a home. Management should begin with raking and removal of any leaf litter or other conditions which provide harborage to these roaches in the landscape. Then, if possible, bright lights should also be eliminated or their brightness reduced. Exclusion techniques (caulking, weather stripping, sealing of weep holes, etc.) should be considered. Insecticide applications at entry points into the structure may be helpful. In the landscape, cockroach baits can be scattered into those areas where the roaches are harboring. Spray formulations which are labeled for cockroach control outdoors can also be used in these areas. Whenever Asian cockroaches enter the home, they can be controlled by the same methods as were discussed for German cockroaches.

Cockroach Management

The presence of cockroaches is often detected by their damage, smell or by the fecal matter (called "frass") the deposit. These are clues which can aid in diagnosing a cockroach problem. Cockroaches may use such things as glue or paste (especially from animal-based materials), starch and certain color dyes as foods. As a result, items such as stamps, envelopes, bindings of older books, draperies and occasionally wallpapers may show signs of feeding. The size of the mandible marks the apparent degree of vigor with which they feed are indications of the type of roach which did the damage. The size and shape of fecal droppings are also clues to the cockroach species involved. The most important aspect of cockroach damage derives from their habit of feeding and harboring in damp and unsanitary places such as sewers, garbage disposals, kitchens, bathrooms, and storage areas indoors. Filth from these sources is spread by the cockroaches to food supplies, food preparation surfaces, dishes, utensils, and other surfaces. Far more food is contaminated by the cockroaches than they are able to eat. Diseases transmitted as a result of these habits were discussed earlier. These same habits are why people are so disgusted and repulsed by the mere presence of cockroaches. For many people, personal disgust and the social stigma attached to cockroaches produce a complete lack of tolerance for any cockroaches in their home or elsewhere. However, recent studies have found that some people have a less severe attitude about cockroaches, such that low levels of cockroach presence and an occasional sighting are acceptable. In case, a carefully considered and executed management program will be necessary. Understanding basic cockroach biology and behavior is essential to the professional in managing cockroaches. Also, the more that is understood about cockroaches, the greater the likelihood of success in those occasions where standard management methods do not work or cannot be used. However, in some cases, it may be practically impossible to achieve total elimination due to the various circumstantial factors unless a relatively broad-reaching (and thus expensive) program is implemented. In such cases, managing a cockroach infestation to a "tolerable level" is more realistic. Consistent and effective cockroach management requires a considerable degree of planning and organization to develop a multi-faceted program which includes the following steps-inspection and survey, treatment, client education and follow-up. It is important to keep adequate records throughout this process. Record-keeping will be necessary to satisfy legal or regulatory requirements in some states, and also toward organizing and implementing an effective program. This attention to detail and record keeping

will be especially helpful where the initial management efforts are not satisfactory. Additional steps may be needed to modify the program to eliminate any surviving cockroaches. Before proceeding with a general discussion of these steps, it is important to understand the main objective of cockroach management program. That objective is to management a cockroach infestation to the lowest possible level. In many cases, this means total elimination of the existing infestation. This is what most clients who call professional pest management firms expect. Whichever objective is pursued, a reasonably detailed program should be planned, explained to the customer, and executed. The necessary program steps are outlined and discussed below with the greatest detail given for German cockroach management. Management programs for other species indoors will usually be conducted in a similar manner as for German cockroaches, except that certain aspects of the behavior of other species should be taken into account.

Some other species will also require substantial attention to outdoor insecticidal treatments and other management measures, details of which are discussed in the following sections for each individual species. In most cases, cockroach management should be proposed as more than a “one-time” treatment. Very rarely will elimination be possible with one treatment, or the use of only one type of insecticide in the cockroach management program. (A possible exception to this statement would be use of fumigation to eliminate all cockroaches (and other pests) form a structure. However, fumigation alone will not leave any protection against re-infestation, so it is rarely done except as part of a broader program). Pest management firms which offer one-visit cockroach management and clients who will settle for this should understand that the objective of such a program can only be accurately stated as to provide a treatment. Such treatments usually lead only to temporary reduction in the infestation, and not effective long-term management or elimination. Pest management firms should provide a higher level of service than just spray treatments. Most clients turn to professionals for their knowledge and expertise to design and conduct a safe and effective cockroach management program. Otherwise, PestSupply.com has Do-it-Yourself products readily available to consumers. In fact, these consumer products include version of most of the insecticides commonly used by professionals.

Inspection and Survey

The primary goal of a cockroach inspection is to locate as many cockroach hiding places or “harborages” as possible (to determine insecticide treatments and other management activities). It is also important to note safety considerations such as the location of pets and presence of small children. In many specialized or difficult accounts, proper inspection includes preparation of a diagram of the indoor and outdoor areas where the program will be conducted. This diagram should include notes on all cockroach sightings, areas where frass was spotted, conditions which are conducive to cockroach presence, sanitation problems, locations of sensitive areas (e.g. pets, children, invalids, sensitive people, sensitive equipment) and other treatment considerations. For highly complex situations, and where a heavy infestation exists, a series diagrams and extensive notes may be necessary. This leads to the necessary “customization” of the various safety and a minimum number of re-treatments. Such forms and record-keeping are also important for accounts involving regulatory inspections and the potential for lawsuits. The tools required to conduct a professional cockroach inspection include a heavy-duty flashlight, a mechanic’s mirror (to allow inspection of difficult cracks and crevices), a flushing agent (e.g. pyrethrins), and screwdrivers, pliers and other hand tools to open equipment panels or gain access to other possible cockroach haborage areas. Knee pads and a bump cap are useful when inspecting in those dark and difficult to reach areas, sometime called “dead” spaces, which cockroaches often prefer. When conducting a cockroach inspection indoors, especially for German cockroaches, it is important to spend time either sitting on the floor or crawling around. This allows a different perspective on all the available cockroach harborages. If all inspections (and treatments) are made from a standing position,

important harborages, sanitation considerations and other factors are likely to be overlooked. Keep in mind that a cockroach crawls around with its head and antennae less than one inch from the floor, wall, or other surfaces. Thus an inspection made with the head and eyes 5-6 feet above the floor does not permit the inspector to view the world in which the cockroach lives. It has often been said about cockroach management that, "You need to think like a cockroach!" In many ways, this is good advice, especially in the inspection and survey phase of the program. In addition to a floor level perspective an above floor level perspective is required. Thus, a ladder is an important tool for proper inspections and treatments. This is especially true in commercial establishments such as restaurants and supermarkets which often have suspended or high ceilings. Keep in mind the behavior of the cockroach species involved and, if necessary, include an inspection of affected outdoor areas. Trees, shrubs, groundcovers, mulched areas, locations near food and water sources (e.g. pools and pet dishes), woodpiles, trash receptacles, door and window casings, roof areas, clogged rain gutters, and other possible harborages should be inspected if necessary. Attics, garages and crawl spaces should be considered for some species, particularly in regions with warm, moist climates. Night inspections are another good technique occasionally necessary in different situations.

When the cockroaches are normally out and foraging at night, you can gain a much better idea of where they are harboring and traveling. A type of yellow filter can be put over the flashlight lens to allow searching for German cockroaches without startling them. Their presence and movement can then be monitored effectively, with less disruption of normal behavior. In this way, the professional can observe and trace cockroach movement to overlooked or unseen harborage areas. A cockroach survey (trapping) is sometimes necessary to determine the extent of an infestation because even a thorough inspection will not reveal all the cockroach harborages, or where they are foraging most actively at night. Surveys are particularly useful in large, complex accounts, and especially where there is a moderate to heavy level of infestation. A second advantage to surveys comes when the survey is repeated in the exact same manner some time after the management program is implemented. A basis for estimating the program's effectiveness is gained. This can be especially useful when the goal is total elimination, or zero cockroaches. The accuracy and validity of such program estimates will depend on the pretreatment and post-treatment surveys being conducted in exactly the same manner. Professionals sometimes resort to intensive surveys after trying and failing with one or more inspections and treatment regimes. In general, when a cockroach problem persists despite thorough treatments, a survey can assist in at least narrowing down the areas which may be serving as sources of infestation or are not receiving proper insecticide treatment. Once the last few remaining harborages are identified, final elimination of the cockroach infestation will follow.

Cockroach surveys involve the use of sticky traps placed at strategic locations within the structure or in the landscape (for outdoor species). Whenever possible, place survey traps either against a wall or in a corner of the floor, shelf, or a drawer. Cockroaches have a behavioral trait known as "thigmotaxis" which means that they prefer to have the side or top of their body touching another object. Thus, they prefer to walk along walls and close to furniture, and to hide in cracks and crevices during daylight hours when not foraging. Traps placed even a couple of inches from a wall or the sidewall of a cabinet or drawer, will not be found nearly as readily by the cockroaches as those which are placed against walls or other objects. Most commercially available traps come complete with bait to encourage cockroaches to enter. One night of trapping with a sufficient number of trap locations will usually provide enough information to design a much more complete and effective management program. If survey results are low on the first night, and an infestation is suspected, it may be necessary to re-position some of the traps and survey for a second or third night in order to locate some harborage more precisely. When traps are picked up, record the numbers captured in each trap and make notes on the diagram or floor

plan you prepared during the inspection phase. Also, notice the position and direction in which captured cockroaches were heading. These observations can give important clues regarding the location of nearby cockroach harborage. Use this information to direct further inspections, trap placements or insecticide applications.

Sanitation

The first aspect of the treatment phase is sanitation. Sanitation efforts will help to eliminate food, moisture and harborage available to the cockroach population: thereby stressing cockroach populations which will lead to better control results. Sanitation not only involves various types of cleaning procedures to remove food and water sources, it also involves the elimination of cockroach harborage by caulking or similar structural repairs. Of course, sanitation should be practiced for general public health reasons. In commercial facilities, it is generally mandated by public health codes applicable to restaurants and other food handling procedures have been applied to cockroach-infested apartments failed to show that sanitation alone can substantially reduce German cockroach numbers. Other research indicates that insecticide applications applied, and then routinely followed. These latter observations are supported by researchers who have noted that grease and other typical forms of soiling on household or commercial kitchen surfaces can substantially decrease the residual action of insecticide applications.

Rigorous sanitation also causes stress on German cockroach populations, so they will forage more actively and may be controlled more readily by insecticide applications. Some laboratory studies have also shown that starved German cockroaches are more susceptible to insecticides. In general, all sanitation deficiencies should be noted during the inspection and survey. Recommendations should be made and reinforced with the client (commercial or residential) to correct these problems, and continuously monitored thereafter. Some pest management firms conduct all aspects of a necessary sanitation program as part of the overall program for commercial clients, at extra cost. Others have devised ways to encourage or force these clients to follow-up on needed sanitation procedures. Very often, high quality programs which guarantee cockroach elimination will include their guarantees a requirement that the client must adhere to rigid sanitation standards. Pest management professionals who are unable to gain client assistance with sanitation considerations, and are therefore unable to provide satisfactory cockroach management, are in effective selling insecticide treatments and not pest management or elimination. Clients who do not understand the importance of sanitation to the overall program or who will not implement reasonable sanitation recommendations will either be forcing the professional into excessive reliance on insecticide treatments or should expect to continue having a cockroach problem. Pest management firms which have a policy of canceling accounts with such unresponsive customers, after first doing everything possible to education them to these needs are generally better off in the long run. A policy of canceling accounts with such customers will result in gaining a reputation as a serious and highly professional pest management firm, and will help build and maintain morale among the profession service staff in the field.

Other non-chemical methods

We have already discussed caulking and screening to eliminate harborage as part of the sanitation effort. These procedures are also effective to prevent cockroach movement between rooms or floors of a structure or to keep invading outdoor species from entering the premises. These are called exclusion techniques. Other exclusion techniques would be the use of sticky barriers (e.g. using rodent glue board adhesive or special insect trap adhesives) to prevent cockroaches from climbing the legs of tables or other furniture. There are also aerosol formulations of Teflon which leave a dry, powdery film on treated surfaces. If properly applied on vertical surfaces, these films can be effective cockroach barriers.

Such techniques may be especially useful under special situations where no pesticide can be used. Some items which cannot be treated with insecticides (e.g. in food-handling facilities) can be routinely bagged in sealed plastic garbage bags each evening to exclude cockroaches from using them as harborage or contaminating them. Use of heat greater than 102F for several hours, or cold at 0F for 60 minutes (or several hours at 32F) with German cockroaches may also be practical to effectively control cockroaches in situations where insecticides cannot be used or no residues are permitted. For example, when portable items such as toasters, clocks, books or other items cannot be treated with insecticide, these items can be placed inside sealed plastic garbage bags and placed into a freezer overnight. While use of traps was stressed for survey purposes, they can be used as part of the treatment program. However, they will rarely provide acceptable levels of control when used alone. Many types of electrical or mechanical devices have been marketed for cockroach (and other pest) control in recent years. These include electromagnetic, ultrasonic and mechanical vibration devices. To date, no valid scientific studies have shown any of these devices to be effective at repelling, sterilizing, killing or otherwise affecting cockroaches or their behavior in a way which can be used effectively in a management program. Therefore, none of the devices currently in the marketplace are recommended. Professionals are cautioned to view any new devices with great skepticism until reliable, published scientific data from at least several qualified and unbiased sources are made available. Lastly, there are a number of predators, parasites and disease organisms present in nature which act to naturally limit the size of cockroach populations. This is called biological control. Some types of wasps lay their eggs in cockroach egg capsules of the *Periplaneta* species and the brown-banded cockroach. The wasp larvae eat the content of the roach egg capsule.

Spiders can also serve as cockroach predators. Microorganisms, such as yeast and other bacteria, can provide substantial population reduction or suppression under specific circumstances. Overall, however, the slow speed of action, low levels of control and the inconsistency of results experienced with biological control renders this approach of little use in urban cockroach management programs.

Insecticide Control Methods

In spite of the most rigorous sanitation and non-chemical management procedures, cockroach management will usually require carefully selected and conducted insecticide applications. Remember that these applications should be made in conjunction with, and complementary to, the other appropriate sanitation and non-chemical procedures discussed above. Taken as a whole, these treatment procedures, when directed by careful inspection, surveys and use of your experience and judgment, will constitute integrated pest management. This integrated approach should involve looking at the "big picture" while examining all aspects of the cockroach's behavior and the structural factors which affect the management program. This approach will ensure that maximum control is obtained with the greatest safety and efficiency. Perhaps the golden rule for applying insecticides against cockroaches is this: regardless of the type of insecticide used, insecticides placed directly into, or near cockroach harborage will produce far better control than those placed where roaches will only walk over them occasionally. Search, locate and treat harborage. Typical insecticide application techniques used with residual insecticide formulations are crack & crevice, spot and general. These techniques are discussed on the previous page. Remember to prevent misapplications, always check the label before applying an insecticide.

Residual spray formulations made from emulsifiable concentrates (E or EC), flowable micro-encapsulations (FM or ME), wettable powders (WP) and oil or water solutions (S), along with ready-to-use aerosols, are available for use against cockroaches. Dusts (D) and baits, along with ULV or aerosol formulations of non-residual insecticides, are also available. During the inspection phase of the

cockroach management program, take note of the types of surfaces and other conditions present, and choose insecticides and formulations accordingly. In general, formulations such as wettable powders and microencapsulations will give better residual action against cockroaches on porous surfaces such as unpainted wood, particle board, concrete, or paper, and latex-painted or vinyl surfaces. Emulsifiable concentrates are generally used where no visible residue can be allowed, or where long residual action is either unwanted or impossible, and more moderate residual action will be acceptable. Little or no residual action can be expected where treated surfaces are exposed to excessive heat or moisture in commercial kitchens, laundry rooms and some bathrooms. Use of residuals in either a crack and crevice or spot treatment mode around sources of heat and steam will not give significant residual action, so consider use of non-residuals (e.g. aerosols) applied into such cockroach harborages and baits placed nearby, where any surviving cockroaches will find them. Voids that will remain dry are usually best treated with dusts or residual aerosols (with crack and crevice tips). If other areas require treatment, this should generally be done with non-residual aerosol or ULV applications. Baits can be placed in other areas where cockroaches are expected to forage. ULV treatments with non-residual insecticides are frequently used to supplement thorough crack and crevice and void treatments. There are many types of sprayers, dusters and other equipment available for use in applying insecticides for cockroach management. Compressed air sprayers, aerosol insecticide systems and hand dusters are most commonly used. Power sprayers are often used in outdoor applications, while power dusters and ULV equipment can be used for certain indoor applications.

IGRs (Insect Growth Regulations)

Chemicals which mimic the cockroach's natural juvenile hormone, such as hydroprene (gencor) and fenoxycarb (Torus) are useful in cockroach management. While they can be thought of as merely another type of insecticide their action is quite different from that of traditional insecticides which generally affect the nervous system. When used properly, these IGRs will sterilize a high proportion of the adult cockroaches which survive other insecticide applications and management efforts. While they may kill some immature cockroaches, their most important action is to prevent the immatures from becoming reproductively capable as adults. Since the adults present at the time of IGR application will not be sterilized, it is important to use these IGRs in conjunction with an effective conventional residual insecticide (Demon WP). This can be done as a combination spray, or by use of an IGR fogger and a separate residual spray. In general, the conventional residual treatment should provide 1-2 months of 80% or greater control in order for the added IGR effect to be of significant value to the overall management program. Repeating applications at 2-4 month intervals (or when the proportion of adults with twisted wings captured in traps drop below 80%) will not only produce a high level of control, but most remaining adults will not be capable of reproduction. In general terms, IGRs restrict the high reproductive potential of the cockroach population. And because this reproductive potential is a key aspect of the success and persistence of cockroach populations (especially German cockroaches), IGRs provide a substantial advantage to the pest management professional in many circumstances. However, it is important to understand that IGRs are only useful additions to cockroach management programs, which may permit the use of fewer insecticide applications, spaced at longer intervals, over the long run. These products are not effective tools when used alone. IGRs have less utility in intensive cockroach management and elimination programs that rely on frequent and thorough applications of conventional insecticides. On the other hand, IGRs are particularly valuable in multi-family housing units or in other situations with chronic cockroach problems where frequent insecticide applications are not practical. They might also be useful in situations where applications of conventional insecticides are less desirable or not permitted for whatever reason. In multi-family housing units and other complex structures, it is important to use the IGR in every unit so non-sterile cockroaches will be less likely to invade IGR treated

units. These IGRs are not recommended for outdoor use in spray applications, because they degrade in the outdoor environment.

Simple Cockroach Control Tips

Roaches can't help the fact that to most humans, they are unwanted company. It's funny, though, how these pesky insects can often make a grown man or woman scream, tremble and run for cover faster than you can say "Where's the bug spray?" But that's just the way it is. If you have a roach problem and the Raid TM just isn't working, and if you want to get rid of roaches in your house, we can help. Basically there are 5 species of roaches that are common in the Western Hemisphere. It is interesting to note that each of these cockroaches has its own distinct habits and traits, each cockroach behaves differently. Therefore each must be treated differently. For instance, the German cockroach (number 1 roach in USA) is an indoor roach. Sometimes they are called kitchen roaches or grocery store roaches because they live in kitchens and bathrooms and infest cabinets. Most of the time they are brought in through goods from the grocery store. Brown Banded Roaches are also an indoor roach. They are common to closets where you find small clusters of eggs glued to the ceilings or walls. For these two roaches you must treat indoors, especially cabinets and closets.

Smoky Brown, American, and Oriental roaches can grow up to 2 or more inches in length and are commonly called water roaches, waterbugs, palmetto bugs, etc. These roaches live outdoors and treatment outdoors and especially under pier and beam homes (one of their favorite hiding places) will help keep them away.

Simple steps that will help control any cockroach infestation:

Step 1: Cut down on their food supply. You will leave less food for the roaches if you:

Vacuum or sweep the floor after every meal. Wash dishes in soapy, hot water to eliminate all traces of grease. Keep trash in a tight lidded container. Keep compost as far from the house as possible. Cover each new "deposit" with a fresh layer of sand or soil. Store unused portions of chips, cereal, cookies, flour, sugar, rice etc. in tightly sealed plastic containers or large glass jars with screw-on lids. After a pet has eaten, remove their food bowl and sweep the floor. Don't walk through the house eating; contain crumbs in one room (less cleaning for you). Don't forget to clean crumbs from under appliances daily.

Step 2: Make it hard for them to hide. If they can't hide, you can get them. So, move woodpiles away from outside walls. Take your recycling out promptly; avoid letting old food cans, stacks of newspapers or magazines pile up. Use boric acid or Drione Dust and put it into nooks and crannies where roaches hide. Maxforce roach gel also works great.

Warning: Boric acid, while safer than many pesticides, is not safe for pets or humans to breathe, eat or have on skin.

Put the boric acid in a clean, dry duster. Using a flashlight, inspect cracks in areas where you have spied roaches. Remember to check cracks between walls and floors, behind sinks and under appliances. Where you can see them hiding, puff the boric acid into the cracks. Follow label directions EXACTLY and do not get the powder near food or into pet environments, such as goldfish bowls or bird cages.

Step 3: Dry up their water supply like humans, roaches can go much longer without food than without water. To keep roaches away, keep them thirsty. Fix dripping faucets. Pour some Lysol into toilets at night to make the water undrinkable. Don't over water house plants. Soggy soil is a delicious cockroach cocktail.

Step 4: Keep them out!! To prevent roaches from migrating from your neighbor's place to yours, seal up common roach entryways. Fill holes where pipes disappear into walls with steel wool or caulk. Pour a little Lysol down your drains nightly to discourage roaches from crawling up into your sinks. Keep sink plugs over drains. Of course these are just a few steps that can be taken to help remedy your cockroach problems.

Monitoring

1. Place sticky traps under refrigerators, dishwashers, and sinks.
2. Monitor traps on regular basis.

Sanitation

1. Sanitation will not eliminate a cockroach problem, but it will make a treatment more effective and deter future infestations.
2. Place all food (and pet food) in glass or plastic containers with tight sealing lids.
3. Garbage should be removed at least daily.
4. Wash all trash cans.
5. Vacuuming hiding places and freezing small objects will kill some cockroaches.

Section 13-Cockroaches

1. Done by pest control operator.
2. Do a thorough inspection before treatment.
3. Baits and gels should be the primary treatments.
4. After treatments some areas can be sealed and caulked.

All roaches need food and a source of water. Infestations are most likely in kitchens, teacher's lounges, food storage areas and bathrooms. Once established, roaches use plumbing and electrical wires to move to other areas. German roaches will be the most common problem in Massachusetts.

Continuing re-infestations may be associated with food vendors or in some cases roaches are carried in by students. Roaches can mechanically carry bacteria are leading causes of allergy problems.

Monitoring and thresholds

1. Sticky traps should be used to monitor problems. Place traps under refrigerators, dishwashers, and sinks. Traps should be monitored on a regular basis by staff or pest control professional.
2. Treatment is needed ONLY when a problem is discovered. All roach sightings need to be communicated to the IPM coordinator so that proper treatment can be started before populations build.

Non-Chemical Control

1. Sanitation traps should be used to monitor problems. Place traps under refrigerators, dishwashers, and sinks. Traps should be monitored on a regular basis by staff or pest control professional.
2. Repair leaking pipes, faucets, and other water sources and caulk all cracks.
3. All food including pet food in classrooms should be sealed tight, insect-proof fitting containers.
4. Garbage should be removed daily and sealed in plastic bags.
5. Try to eliminate corrugated cardboard boxes and other roach harborages.
6. Vacuuming in hiding places or freezing of small articles can be used in some situations to control roaches.

Chemical Control

1. Cockroach problems are difficult and should be handled by a pest control operator (PCO). A thorough inspection should be done before treatment.
2. These use of baits and gels should be the primary treatments. Crack and crevice treatments will be more effective and cut down on exposure. After treatment some areas can be sealed or caulked.
3. Less toxic materials include insect growth regulators (IGRs) such as hydroprene and priproxyfen. IGRs take a few weeks to work.
4. Boric acid, silica aerogel, and drone dust can be used in voids.
5. Baits containing abamectin, boric acid, and hydramethylnon.
6. Clean out treatments should be scheduled when students are not present.

Section 14 Athletic Fields

1. Mowing with enough frequency to adhere to the 1/3 rule which states that one-third or less of the leaf tissues is removed at any one mowing. Mowing height should be at least 1-2 inches for soccer field and 2-3 inches for football field.
2. Irrigation – irrigate sufficiently to provide approximately one inch of water each week with rainfall amounts included. Example: if ¼” of rain falls one week, supply ¾” through irrigation.
3. Fertilization – apply a minimum of four pounds of nitrogen per thousand square feet annually to low use fields with light to medium traffic. Higher use fields may require six or more pounds of nitrogen per thousand square feet. NO MORE THAN 1lb Nitrogen per 1000 feet at any one time.
4. Aeration as needed to minimize compaction. Aeration can be performed at up to two to three intervals during the growing season, although one aeration in the spring and one in the autumn may be sufficient.
5. Top dressing of soil and sand, 1/16” – ¼” layers each time.
6. Overseeding thin areas in which the turf density provides less than 90-95 % coverage as needed.

Non Chemical Control

Proper mowing and fertilization practices can reduce potential weed population 70% or more.

Chemical Control

Herbicide selection should be based on the ability to control the target weed(s) relative safety to the applicator and to the environment. Allying herbicides when children are not present (e.g. after school, weekends).

Level “A” athletic fields

The level A athletic field has dense turf >85% cover, good drainage, and irrigation. The soil may be either sand based or native soil. Uniformly smooth surfaces no major ruts, and appropriate turf, which will sustain a high level of traffic. Annual events should be limited to 50 or fewer events. Events in case of inclement weather should be cancelled to prevent major and costly repairs to the field.

Primary cultural practices for a Level A athletic field are regular mowing, fertilization and irrigation. Secondary cultural practices include routine aeration, topdressing or sodding to replace worn areas.

The turf needs to be mowed with frequency to adhere to the 1/3 rule which states that one-third or less of the leaf tissue is removed at any one mowing. Keep blades sharp to provide a clean cut leaves to quickly recover and minimize disease and maintain stress. Keep mowers in good repair as leaking oil and grease can damage and even kill turf.

Irrigation – irrigate sufficiently to provide approximately one inch of water each week with rainfall amounts included. Example if ¼” of rain falls one week, supply ¾” through irrigation.

Aerification promotes drainage, alleviates compactions, and promotes turf growth, particularly rooting, resulting in increased stress tolerance, improved nutrient, and reduced weed invasion. Aerifications can also manage thatch buildup. Fields with sand based root zones generally will not require aerification unless an organic layer has formed between the turf and root zone which is preventing proper water movement and root growth.

Section 14 Athletic Fields

Aerification should be performed as needed to minimize compaction, up to two to three intervals during the growing season, although one aerification in the spring and /or fall may be sufficient. Use hollow tines which pull cores out of the field rather than solid tines or water injected systems. The cores can be left on the surface and will disintegrate within a few weeks, or they can be broken up using a drag mat. Cores can also be removed with sweepers, rakes or shovels, but the field will need to be top dressed to replace the lost soil. The soil must be moist enough to allow good penetration.

Athletic fields require top dressing consisting of regular applications of soil and sand. Top dressing of soil and sand, 1/16” – ¼” layers each time. Section 15 Section Miscellaneous

These areas include non-turf areas such as playgrounds, fence lines, and parking lots.

1. Pulling or weed whacking weeds is preferred method of control.
2. If pesticides are used, glyphosate (Round up) is preferred, and only used when children are not present, preferably for a few days.

Weed barriers (e.g. landscape fabrics) used to underlay mulch. Suitable mulch of wood, pea gravel, sand, rubber chips and rubber mats. Wood and rubber mulches provide the softest landing surfaces, but wood, while inexpensive, may also increase weed and insect problems. Shredded bark mulch should be avoided because it rapidly disintegrates. Sand will also harbor weeds but fewer insects than wood. Crumb rubber and rubber mats offer the least amount of weed infestation but are expensive.

Miscellaneous areas bleachers and other structures. Turf may or may not be present or desired.

Cultural practices for pest management

Chemical weed control may provide much longer lasting weed control than hand weeding or weed whacking, particularly for perennial weeds.

1. Glyphosate (Round-up, Kleenup), a foliar-applied post-emergent herbicide, could be applied once or more annually as needed and should be considered for use in play or grassy areas over Prometon due to its shorter residual in soil and less toxic signal word. Prometon (Pramitol) is another non-selective herbicide designed primarily for industrial sites, right of way, fence lines, etc. Prometon is meant to be applied to soil to control weeds both pre and post emergent. IT is also useful for applying directly to or mixing in with, asphalt to prevent weeds. Prometon has much longer residual activity than glyphosate and can control weeds for up to one year after application.

Miscellaneous areas, parking lots, blacktop play areas, and sidewalks

1. Weeds in these areas should be controlled by physical removal (hand pulling weed whacking) when possible.
2. For hard to control weeds including many perennials, glyphosate or prometon could be used; glyphosate is preferred because it is less toxic product. Chemical control is most appropriate for blacktop parking lots due to the need to protect the large investment of these areas. Spot treatments are appropriate and should be performed when school is out of session. Glyphosate will need to be applied when weeds are actively growing for best results; the ideal time is once the school year is finished in June.

Massachusetts Association of School Committees – 2001

Adopted: January 22, 2001