Chapter 16

IPM for Wood-Damaging Pests in Schools

Introduction

The job of maintaining a building includes detecting structural pest problems before they become severe. Early detection means less costly repairs. Although the discovery of wood-destroying insects often generates panic and premature decisions, these pests are slow to cause new damage, and there is ample time to accurately identify the pest and decide on an appropriate IPM program. Some of the work can be done by school personnel, and the rest contracted out to a professional, or the entire job can be contracted out to professionals. This chapter will discuss wood-attacking fungi, termites, and wood-boring beetles.

Identification and Biology

Wood-Attaching Fungi

Fungi reproduce from seed-like spores present in the air and soil. Thread-like structures called hyphae grow from the spore and penetrate directly into wood. A mass of hyphae, called a mycelium, is frequently visible on the surface of the wood. A mycelium often takes the shape of a fan or a fluffy mat. Optimal growth occurs at temperatures between 50°F and 95°F on wood containing at least 20 percent moisture.

The three major groups of wood-attacking fungi are surface-staining fungi (molds and mildews), sapstaining fungi (wood-stains), and decay fungi (wood rots). Surface-staining and sap-staining fungi do not cause loss of structural strength and will not be discussed here; however, they are evidence of moisture problems needing correction. The third group, decay fungi, attack the cellulose and lignin in wood and cause structural weakness. They are hard to detect in their early stages; however, advanced stages are quite evident from the changes in the wood's appearance.

Brown Rot

- characterized by white mycelial mats
- causes wood to crack into small cubical pieces perpendicular to the wood grain
- wood rapidly loses its strength and eventually crumbles to powder
- changes the color of the wood to a distinctive brown

Dry Rot or Water-Conducting Rot

- relatively rare problem
- a special kind of brown rot most often found in new construction
- can disperse rapidly throughout wood, destroying large amounts in one to two years
- characterized by large, papery, white-yellow mycelial fans
- forms large tubes called rhizomorphs that are up to an inch in diameter and can conduct water to 25 feet
- rhizomorphs are dirty white to black, and grow out and away from the moisture source
- rhizomorphs allow the fungus to extend its growth into dry wood containing less than 20% moisture
- wood surface may appear sound but wavy, even while the interior is heavily decayed

White Rot

- makes wood look bleached
- affected wood feels spongy when probed and is stringy when broken
- no abnormal shrinkage
- strength of the wood gradually diminishes

Soft Rot

- seldom encountered in buildings, except where wood is in contact with constantly wet soil
- develops in marine habitats in wood that is too wet for other decay fungi
- attacks surfaces of wood and produces a gradual softening inward

Identification and Biology

Termites

Although there are a number of groups of termites in the United States (including subterranean, drywood, dampwood, and powderpost termites), only subterranean termites are found in Nebraska. They are social insects and form colonies that contain several castes. These castes differ greatly in their form and function.

The total number of eggs deposited by subterranean queens number in the tens of thousands. Nymphs hatch in 6 to 12 weeks and are tended by the reproductives. As the nymphs increase in size and number, castes are formed. The worker caste maintains and feeds the colony, and there is a soldier caste that defends the colony. The darkly pigmented, winged reproductive caste (kings and queens) serves only to reproduce and start new colonies. Reproductives "swarm" (fly away from their original colony) only at certain times of the year.

Subterranean Termites

Subterranean termites require specific ecological conditions. Knowing these requirements is critical to their successful detection and management.

- Subterranean termites must be in regular contact with moisture, which, in most cases, means they must stay in contact with the soil.
- In rare cases, they live in the wood above the soil, getting their moisture from a leaky air-conditioner, regular condensation, or some other constant moisture source.
- They construct distinctive earthen tubes to bridge the distance between the soil and wood.
- The passageways protect them from predators and help prevent desiccation as they travel. These tubes are important visible clues to subterranean termite presence.
- Initially, subterranean termites tunnel into soft spring wood, but as the infestation grows, they remove more and more wood until most of it is gone.
- They reinforce their excavations with "carton," a mixture of wood fragments and fecal material held together by saliva.
- Subterranean termite galleries are coated with a carton-like substance that gives the interior of the galleries a rough and uneven appearance.

Identification and Biology

Wood-Boring Beetles

Although some wood-boring beetles can cause serious damage, there is always time to identify the type of beetle present before taking action. When dealing with wood-boring beetles, it is important to know whether or not they will reinfest a piece of wood. Some beetles cannot, and seeing their holes in wood means they have done their damage and left. See Table 16-1 for more information to help you identify some of the most important beetles. Listed here are three examples of wood-boring beetles.

Lyctid Powderpost Beetles

These are small (1/8-1/4 inch), slender beetles that vary from reddish brown to black. Lyctids attack only the sapwood (outer wood) of hardwoods and are the most common and widespread of the beetles that reinfest wood in the United States.

Females lay an average of 20 to 50 eggs in exposed areas of partially seasoned lumber with a high starch content. The hatched larvae bore down the vessels of the wood making straight tunnels that then turn and become irregular. Most species complete their life cycle in 9 to 12 months, but they can develop more quickly if the temperature and starch content of the wood are favorable. The larvae pupate near the surface of the wood, and the emerging adults drill a hole through the wood to get out.

You are unlikely to see adult beetles during an inspection, and the larvae are always inside the wood. There is no outside evidence of infestation on wood that has been attacked for only a short time; however, once adult beetles emerge, you will see their small exit holes in the wood. You may also see piles of the fine, flour-like frass (beetle excrement) that sifts from the holes.

Anobiid Beetles (sometimes called deathwatch or furniture beetles)

These beetles are small (1/8-1/4 inch), reddish brown to black, and elongate with a very rounded back. In general, beetles in the family *Anobiidae* are more frequently a problem in unheated dwellings or

wherever the humidity is high. Furniture kept in centrally-heated living spaces is usually too dry for them to infest.

Anobiids attack both hardwoods and softwoods and will feed on either newly seasoned or older wood. Although they feed mainly on the sapwood, they can also damage heartwood that is close to the sapwood. In the wild, they live in dead tree limbs or in bark-free scars on the trunks.

The females lay their eggs in small cracks or crevices on the surface of the wood. When the larvae hatch, they bore a short distance into the wood, then turn at a right angle and tunnel with the grain. Their tunnels get larger as the larvae grow, and eventually, become so numerous that they intersect, and the wood becomes a mass of fragments. Tunnels are packed with fecal pellets from the larvae. It may take two to three years for larvae to complete their development.

Larvae usually pupate in the spring. The newly emerged adults bore holes straight out of the wood, and a large proportion of the females lay eggs in the same wood from which they emerged.

Old House Borer (Hylotrupes bajulus)

These beetles are brownish black, slightly flattened, and about 5/8 to 1 inch long. The segment just behind the head is marked by a shiny ridge and two shiny knobs that suggest a face with two eyes. These beetles are very common in some parts of the country, but because they can be moved around in infested wood, they can become established anywhere.

Despite being called the "old" house borer, this insect is also very common in new construction. This beetle attacks coniferous wood, such as pine, spruce, hemlock, and fir, but it will also feed on hardwoods. The female lays her eggs in cracks and crevices on the surface of wood, and the hatched larvae sometimes crawl around before finding a place through which they can bore into the wood. They remain near the surface, feeding on the sapwood and only gradually penetrating deeper as they grow. They do not feed on heartwood.

The larval period may be completed in two to three years, but it can take as long as 12 or 15 years in dry wood, such as that found in attics. Old house borer tunnels have a distinctive rippled appearance on the inside. Unless the moisture content is high, the tunneling proceeds slowly.

Although this beetle can reinfest wood, the likelihood of this happening in buildings that are occupied, heated, and well ventilated is small.

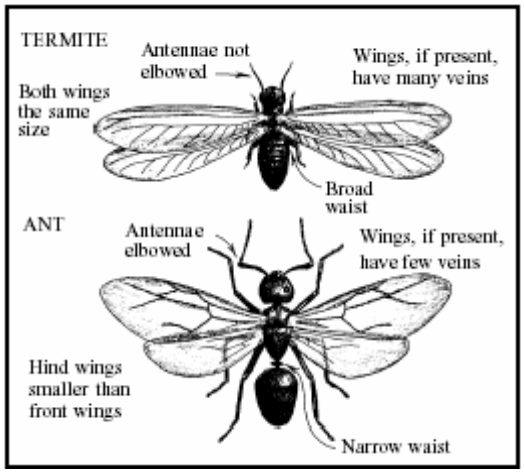


Figure 16-1. Differences between ants and termites.

Detection and Monitoring

It is important to determine exactly which organisms are present and causing damage before deciding on treatment strategies. The actual damage caused by structural pests occurs slowly over a period of months or years so there is time to study the situation and make a decision. Correct identification of the pest is critical to determining appropriate management strategies. The diagnostic key in Table 16-2 will help you identify the pest that is causing the problem. Figure 16-1 illustrates some of the major differences between ants and termites, which are often confused with each other. Note that in some cases more than one kind of wood-damaging pest may be present.

Table 16-1 describes the major groups of wood-boring beetles and the damage they cause. Wood-boring beetles can be distinguished from one another by the type of frass they produce and the size and shape of the holes they create. It is important to distinguish between those species of beetles that can reinfest wood, causing extensive damage, and those beetles whose damage is limited to one generation.

If you are uncertain about which pest is present, get help making an identification from the local Cooperative Extension office or a pest management professional. The time and potential expense needed to correctly identify the pest will be compensated by the fact that you will be able to develop an effective management program for your school.

Table 16-1. Characteristics of Damage Caused by Common Wood-Boring Beetles

	WOOD ATTACKED		RECOGNIZING DAMAGE			
TYPE OF BORER	**Part and type**	**Condition**	**Exit Holes**	**Galleries (tunnels)**	**Frass**	**Reinfest?**
Anobiid powderpost beetles	Sapwood of hardwoods and softwoods; rarely in heartwood	Seasoned	Circular, 1/16 to 1/8 inch diameter	Circular, up to 1/8 inch diameter; numerous; random	Fine powder with elongate pellets conspicuous; loosely packed in isolated clumps of different sizes; tends to stick together [a]	Yes
Bostrichid Powderpost Beetles	Sapwood or hardwoods primarily; minor in softwoods	Seasoning and newly seasoned	Circular, 3/32 to 9/32 inch diameter	Circular, 1/16 to 3/8 inch diameter; numerous; random	Fine to coarse powder; tightly packed, tends to stick together	Rarely
Lyctid Powderpost Beetles	Sapwood of ring- and diffuse-porous hardwoods only	Newly seasoned with high starch content	Circular, 1/32 to 1/16 inch diameter	Circular, 1/16 inch diameter; numerous; random	Fine, flour-like, loose in tunnels	Yes
Roundheaded Borers (general)	Sapwood of softwoods and hardwoods; some in heartwood	Unseasoned, logs and lumber	Oval to circular 1/8 to 3/8 inch long diameter	Oval, up to ½ inch long diameter, size varies with species	Coarse to fibrous; may be mostly absent	No
Old house Borer	Sapwood of softwoods, primarily pine	Seasoning to seasoned	Oval, 1/4 to 3/8 inch long diameter	Oval, up to 3/8 inch long diameter; numerous in outer sapwood, ripple marks on walls	Very fine powder and tiny pellets; tightly packed in tunnels	Yes
Flat-headed Borers	Sapwood and heartwood of softwoods and Hardwoods	Seasoning	Oval, 1/18 to ½ inch long diameter	Flat oval, up to 3/8 inch long diameter; winding	Sawdust-like, may contain light and dark portions if under bark; tightly packed	No
Bark beetles	Inner bark and surface of sapwood only	Unseasoned, under bark only	Circular, 1/16 to 3/32 inch diameter	Circular, up to 3/32 inch diameter; random	Coarse to fine powder, bark-colored, tightly packed in some tunnels	No
Ambrosia Beetles	Sapwood and heartwood of hardwoods and Softwoods	Unseasoned, logs lumber	Circular, 1/50 to 1/8 inch diameter	Circular, same diameter as holes; across grain, walls stained	None present	No

[a] In hardwood, pellets may be absent and frass packed tightly.

Regular Monitoring

Monitoring means looking for signs of damage to the wooden parts of the structure on a regular basis. Information gathered from these regular site inspections should be written down. Include a map of the site with notes about problem areas. Monitoring should show whether a pest problem is getting worse and requires treatment and whether the treatment has been effective.

Monitoring for structural pests should be regarded as an ongoing responsibility, repeated every one to five years depending on the kind of problems in your area. Early detection of structural pest activity will result in considerably less expensive treatment later.

School Staff Responsibilities for Monitoring

All personnel responsible for maintaining wooden structures should be trained to identify the conditions that can lead to infestation by wood damaging pests (see the inspection checklist in Appendix I). Box 16-A provides a list of equipment needed for monitoring. If monitoring by school personnel indicates signs of termite or wood-boring beetle activity, a more thorough inspection should be made by a pest management professional. These staff members should also be trained to recognize obvious signs of damage, such as those listed under Symptoms in Table 16-2. Although major structural pest management decisions should be based on the

Table 16-2. Diagnostic Key to Wood-Attacking Organisms Based on Symptoms

Fungi: Wood damaged and discolored with shrinkage and/or loss of structural strength. Colored stains or dusty coating on underside of floor, on walls, or on ceilings.	
Specific Symptoms	**Probable Cause**
Fan-shaped white fungal mat with large 1 inch wide dirty white, brown or black threadlike strands (mycelia)	Poria fungus, or 'dry rot'.
Soft decayed wood with mycelia and checking (cracking) at right angles to the grain of the wood, particularly on floor or perimeter joists. Wood looks brown and crumbles to a powder when touched.	Brown rot.
Insects: Holes, tunnels, galleries or chambers on or beneath the surface of the wood.	
Specific Symptoms	**Probable Cause**
Holes greater than 1/2 inch in diameter.	Carpenter bees.
Holes less than 1/2 inch in diameter	Wood boring beetles.
Galleries or chambers found in wood. The wood surface is easily penetrated with a screwdriver or ice pick.	Subterranean termites.
Surface earthen tubes or tunnels running from soil to wood	Subterranean termites
Swarming winged insects at base of fence post, Foundation,or indoors, or a collection of wings but no insect specimens.	Ants or termites (refer to Fig. 16-1 to distinguish).
Large bumble bee-like insects flying around exterior near the eaves of the house. Some enter large holes. Damage mostly confined to siding or outer boards.	Carpenter bees.
Sawdust or tiny wood scraps on floor	Carpenter ants

recommendations of a trained inspector, having someone on the school district staff who is knowledgeable about structural pests and who can supervise outside contractors can improve the quality of pest control and contain costs.

Using a Pest Control Service

When contracting for structural pest control services, the choice of a company should be based partially on their willingness to provide monitoring services for a fee separate and distinct from treatments. It is still common for pest management professionals in Nebraska to offer free termite inspections with the expectation that the inspection cost will be covered by the fees for the treatments that follow. Since there is a potential conflict of interest in having the inspection and treatments performed by the same company, inspection services should be purchased separately. Separate payment increases the likelihood of an unbiased inspection, especially if the inspection and treatment companies are different.

Box 16-A. Tools and Safety Equipment for Monitoring Termites

- Flashlight with spare batteries and bulbs
- Screwdriver or ice pick for probing wood suspected of being infested
- Hammer or similar instrument for hitting wood and listening for indications of hollowness
- Ladder for inspecting roof trim and other off-ground areas
- Moisture meter with a range of at least 15 percent to 24 percent moisture
- Pencil, clipboard, graph paper, and measuring tape; with these, records can be made precisely on the floor plan or elevation of the building where moisture is evident or wood is damaged
- Tools for opening access entrances into crawl spaces
- Hacksaw blade for checking earth filled porches adjacent to crawl spaces; when inserted under the sill, the thin portion of the blade should not penetrate beyond the sill or headers
- Good-quality caulk, such as silicone seal, and a caulking gun to plug suspicious exterior cracks and crevices; silicone seal is also available in a thinner consistency that can be applied with a brush

You can use the checklist in Appendix I to confirm the thoroughness of an inspection performed by a professional. A compromise that can save money might involve school personnel checking the relatively accessible areas once or twice a year using this checklist and hiring a professional to check the harder-to-see places less frequently. Inspect both the inside and the outside of the buildings. If a professional is hired to do the inspection, ask to see examples of sites that were found to have damaged wood. Discovering subterranean termite tubes or beetle damage is not necessarily evidence of an active infestation. Termite tubes or beetle exit holes or frass indicate only that termites or beetles were there at one time. In the case of beetles, the adults that made the exit holes may have been the last beetles that will ever emerge if they are from a species that does not reinfest wood. Treatment of inactive infestations would be an unnecessary expense. Ask for confirmation that living termites or beetles are present as some companies do not make this confirmation normal practice.

Detection Techniques for Termites

There are several ways to identify termite activity. The observation of swarming reproductives is an indication of a current termite infestation in the area but simply finding a pile of discarded wings can be misleading.

Winged termites are attracted to light and so could come from other areas. If only swarming insects are seen, a distinction must be made between ants and termites (see Figure 16-1).

Wood-boring beetles make holes in wood and, in some species, fine sawdust-like fecal pellets sift from the holes. Table 16-1 can be used to help identify the pest based on the kind of fecal pellets (frass) left and the kind of hole and tunnels produced by the pest.

The discovery of a mud tube extending from the soil up to the wood is an indication of probable subterranean termite infestation (these tubes are described above under Biology). If only one tube is located, monitoring for other tubes should begin immediately. Break open tubes to see if the termites are active or if the tubes are deserted; an active tube will be rebuilt within a few days. Finding soil in cracks and crevices can also be an indication of subterranean termites.

It isn't always possible to detect damaged wood by looking at the surface. An ice pick can help you probe the wood, and listening for sound differences

while pounding on the wood surface can help you find the hollow areas (see Box 16-B).

For many years, the only structural pest detection method available was visual observation by trained, experienced pest control inspectors. This method has been further improved by inspection tools such as moisture sensors.

Moisture Meters

A moisture meter will help determine whether or not the moisture content of the wood is high enough to support the growth of wood-inhabiting fungi, wood-boring beetles, or subterranean termites. The needles of the meter should be inserted along the grain of wood to give the most accurate readings. Temperature corrections should be applied to readings taken below 70°F and above 90°F (correction tables are supplied with meters). The meters should not be used in wood treated with water-borne wood preservatives or fire retardants.

Monitoring for Beetle Infestations

When wood-boring beetle larvae mature into adults inside the wood, they bore exit holes to the surface to get out. Table 16-2 can help you determine what kind of insect created the holes you find. If it is a beetle, the information in Table 16-1 will help to identify the kind of beetle and whether or not it is capable of reinfesting. Consultation with a professional is also advised.

Discovering beetle damage is not necessarily evidence of an active infestation. Signs that the infestation is still active include fresh frass the color of new-sawn wood and live larvae or adults in the wood. Where you suspect an infestation of the kind of beetles that do not emerge for several years (such as old house borers), you can confirm their presence by listening for the chewing sounds they make inside the wood. To amplify the sounds, use a doctor's stethoscope or the cardboard tube from a roll of paper towels. You can also place a cloth or piece of paper underneath the suspicious area for a week or two to monitor for the fresh debris and frass that are indications of activity for some beetles.

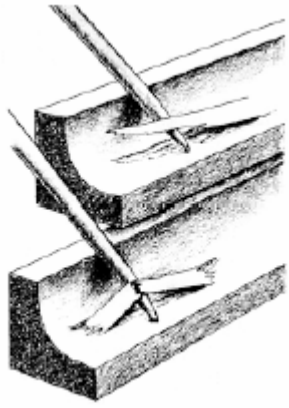
Management Options

Habitat Modification (All Wood-Damaging Pests)

No structural pest control program is complete unless the conditions that favor the survival of the pest are modified. Moisture in or on wood is the single most important predisposing condition for wood damage and structural failure.

Reduce the moisture level of the wood
The investment in installing, fixing, or relocating gutters, siding, roofing, vents, drains, downspouts, and vapor barriers will pay for itself in long-term protection against termites, wood-boring beetles, and fungi. Leaking pipes, drains, sinks, showers, or toilets should be repaired. For wood-boring beetles and fungi, often the only control measures necessary are fixing leaks, installing vapor barriers, and using central heating to dry out wood and keep it dry. The most common wood-boring beetles cannot establish themselves in wood with a moisture content below percent, and the old house borer probably needs more than 10 percent moisture. Wood must contain at least

Box 16-B. The Pick Test
When monitoring your building, use an ice pick or screwdriver to probe wood you feel might be decayed based on its color or other changes you detect. Insert the pick about 1/4 inch into the wood and press sharply downward perpendicular to the grain. If the wood is sound, a long splinter will pull out of the wood along the grain (as shown in the figure below). If the wood is decayed, the splinter will be brittle and break into short pieces across the grain, especially at the point where the pick enters the wood and acts as a lever. You can also detect decayed wood by its lack of resistance relative to sound wood.



Mudsills (wood installed on footings) can be pick-tested without producing excessive visual or structural damage since they are not visible from outside the crawl space. Sometimes wood treated with a preservative on the surface is decayed inside. The pick test can help reveal these hidden pockets of decay.

20 percent moisture before it will support the growth of fungi. Few species of fungi can extend their growth into dry wood, and these fungi are relatively rare.

Ensure proper drainage under buildings
If the soil under buildings is constantly wet or becomes wet after it rains, this problem should be corrected. Equip downspouts with plastic extensions to direct water away from foundations. Grade the soil around the building to slope gently away from the structure. Installation of a vapor barrier under the building will correct many situations, but more serious moisture accumulations need other measures. Coat foundations walls with rubberized asphalt membranes to reduce moisture under the building. Extreme cases may require the installation of a sump pump or French drains. French drains are lengths of perforated pipe placed under the soil below the outside foundation footings to catch and drain water away from the building.

Improve irrigation or landscape practices to decrease water collection near buildings
Remember that water that falls on the sides of buildings from sprinklers can cause as many problems as natural rainfall.

Eliminate direct contact between wood and soil
Ideally, wood should be at least 8 inches above the soil to prevent direct access by subterranean termites and to prevent wood from absorbing excessive moisture. Wood in contact with the soil must be replaced with concrete. If wood is too close to the soil, remove some of the soil and grade it so that it slopes away from the building.

Replace damaged wood with treated wood
When wood must be replaced, especially wood in vulnerable areas, it can be treated with borates (see discussion below under Chemical Controls) to protect it from termites and fungal decay. Whenever wood will be exposed to the weather, it is important to paint a water repellent on the bare wood before it is stained or painted. Depending on the product, water sealed wood must dry for a few days to over a month before being painted. Studies show that wood treated in this manner resists weathering and decay many years longer than wood that is only painted or stained.

Replace moisture-prone wood with aluminum, concrete, or vinyl
Sometimes it is more cost-effective to eliminate wood altogether from the most vulnerable areas of the building.

Remove tree stumps and wood debris
Decaying stumps, construction debris, and wood scraps near or under the building can be a source of termite infestation. Remove all wood debris within 10 feet of foundations. To kill stumps, make a new cut horizontally across the top and a number of cuts vertically into the stump. Immediately rub handfuls of soil into the vertical cuts and cover the stump with a tarp to block out all light. Leave for several months until the stump has decomposed. Never bury wood pieces; they can become termite nesting areas. Wood debris containing live termites should be taken to a landfill.

Store wood piles properly
Firewood or lumber piles should be constructed so that no wood rests directly on the ground. Use cinder blocks or concrete as a base on which to pile lumber or firewood and inspect the pile periodically. Large piles should be as far from the building as is practical; smaller amounts of wood can be moved closer to the building as they are needed but do not store logs inside or in a place where they can touch the building or a wooden deck.

Plant trees away from buildings
Since trees and shrubs used in landscaping are often planted when young, a common mistake is to site them too close to a structure. Roots, branches and eventually decaying stumps provide avenues for termite, carpenter ant, and wood-boring beetle infestations. Trees and large shrubs may also provide squirrels, and other animals nesting places and access to the upper portions of the building. Leaves clog gutters and can lead to water damage.

Maintain buildings in good repair
The most effective indirect strategy for controlling structural pests is keeping buildings in good repair. Keep the skin of the structure sealed using paint, putty, and caulk. Repair cracked foundations by injecting cracks with various materials (patching compounds). Cracks should be chiseled out to a 1/2 inch depth and 3/4 inch width before patching. Injectable bonding materials have some elasticity to resist cracking, whereas cement mixes are likely to crack if soil heaving or settlement is causing ongoing foundation movement.

Inspect lumber
Lumber and other wood items should be carefully examined for wood-boring beetle damage, such as small holes, sawdust, or fine wood fragments, before using or storing. Wooden furniture should be examined carefully for current beetle infestations before placement in the building.

Use kiln-dried or air-dried lumber
Although close visual inspection of wood is essential, it is not a guarantee against beetle infestation. Some infestations can go undiscovered for years before damage is seen. Kiln-dried or air-dried lumber should be used in all construction projects.

Physical Controls

For termites, heavily damaged wood should be replaced with sound wood. Wherever possible, use lumber treated with wood preservatives such as borates (see Chemical Controls below). Dispose of wood as described above under removing tree stumps and wood debris.

For wood-boring beetles, simply removing and replacing infested wood should be the first treatment option you consider. Carefully inspect wood in contact with the pieces that are removed to see if there is further infestation. In some situations, this may not be practical because of inaccessibility of the wood or prohibitive labor costs. If any wood has been damaged to the point of structural weakness, it must be replaced or reinforced no matter what treatment is used.

Chemical Controls

If non-chemical methods alone prove insufficient to solve the problem, then integrating a pesticide into your management program may be warranted. For information on the hazards of various pesticides and on how to select an appropriate pesticide for your situation, consult Appendix G for a list of resources.

Pesticides must be used in accordance with their EPA approved label directions. Applicators that are hired by the school must be certified to apply pesticides and should always wear protective gear during applications. All labels and Material Safety Data Sheets (MSDS) for the pesticide products authorized for use in the IPM program should be maintained on file. Do not apply these materials when buildings are occupied and never apply them where they might wash into the sanitary sewer or into outside storm drains.

Always post durable signs where pesticides have been used in attics and crawl spaces so that future inspectors and repair technicians can identify and avoid the materials if necessary.

Borate-based wood treatments (Subterranean Termites, and Wood-Attacking Fungi)

Borates are fungicides and slow-acting insecticides. They are not repellent to insects (termites will construct tubes over borate-treated wood) but do act as antifeedants, which means that pests prefer not to feed on wood treated with borates. When insects feed on wood treated with borate or, in the case of wood-boring beetles, chew emergence holes through treated wood, the borate acts as a stomach poison to kill the insects over a number of days. As fungicides, borates act by inhibiting the growth of wood-attacking fungi.

Borates are used both in the pre-treatment of lumber for the construction industry and in remedial treatment of lumber in existing buildings. Pre-treated lumber can be used to replace existing lumber to prevent reinfestation in areas of potential termite activity or in areas vulnerable to rot. Crawl spaces and attics can be treated by a professional by spraying or painting liquid solutions directly on the wood or by pressure injecting the solution into the wood. Borates can sometimes be effective as an insecticide to eliminate small termite and wood-boring beetle infestations.

Since borates are water soluble, they cannot be used to treat exterior wood unless a finish (paint or stain) or sealant is subsequently applied to the wood. Since borates can move easily through the soil and leach away from the area of application, they should not be used in close proximity to lakes, streams, ponds, or areas where there is standing water. High concentrations of borates are toxic to plants so treatments of the perimeter of buildings can result in inadvertent poisoning of plants and shrubs near the building.

Desiccating dusts such as diatomaceous earth and silica gel (Wood-Boring Beetles)
Desiccating dusts can help in preventing future infestations of wood-boring beetles. They are particularly useful in confined spaces such as attics and wall voids where they can remain effective for the life of the building. Desiccating dusts alone are effective and safe. They act primarily as physical, not chemical, agents but are commonly combined with pyrethrins.

Desiccating dusts act by abrading the oily or waxy outer layer that coats the body of an insect. Water inside an insect is contained by this waterproof coating, and damage to the coating causes the insect to die from dehydration. Diatomaceous earth can be easier to handle because it is composed of larger particles than the silica gel. It is important to note that the product described here is not the glassified

diatomaceous earth used for swimming pool filters but rather "amorphous" diatomaceous earth.

Conventional barrier soil-applied termiticides (Subterranean Termites)
Repellent or non-repellent termiticides are applied into the soil surrounding a structure. The termiticide must be applied so that the structure is completely protected. Drilling is often necessary in order to apply termiticide into the soil beneath concrete slabs and into the interior of concrete blocks. As long as the termiticide barrier remains intact and at a sufficient concentration and thickness, termites are prevented from entering the structure. Non-repellent termiticides have emerged as the most effective when using the conventional barrier application method. Using insecticides as termite barriers in the soil relies on uniform distribution in the soil; however, in some cases, soil characteristics may prevent this, and barriers will fail.

Termiticides can also be applied as a foam to more effectively coat hard-to-reach surfaces. This can be particularly useful when treating a slab where the underlying soil has subsided or washed away. Injections of liquid pesticide may not coat all vulnerable surfaces, especially the underside of the slab. Since the foam fills the void, it leaves a residue on all surfaces.

Termite baits (Subterranean Termites)
The termite baiting strategy involves two steps: attracting termites and then exposing them to a slow-acting toxicant. The toxicant must be slow-acting so that termites have time to go back to the nest to spread the toxicant among their nest mates through food sharing and through mutual grooming. Since termites habitually wall off members of the community and/or galleries when they sense a problem with their food supply, the toxicant must work slowly enough that it goes undetected until a good portion of the colony has been exposed.

Baiting can eliminate a termite colony over a number of months (conventional chemical barrier treatments prevent termites from entering a structure), but elimination may not be practical.

Safety of Baits
Much smaller amounts of active ingredient are used in baits than are used in chemical barrier treatments so there is less of a risk of contamination by the poison. Most of the toxicants that are used in termite baits have low acute toxicity, and the concentrations in which they are used are generally low. Manufacturers are designing bait stations to be self-contained and tamper-resistant to protect children and animals from accidental exposure.

When to Bait
Since termite activity is seasonal, baiting is more effective at certain times of the year than other times. The best time to bait the eastern subterranean termite is in the late spring and early summer.

Two Types of Baiting Strategies
There are two general types of food baiting that can be used: perimeter baiting or interceptive baiting. If the whereabouts of the termites are unknown, perimeter baiting is used. Wooden stakes, bait blocks, or plastic monitoring stations are set around the perimeter of a structure either in a continuous circle or in a grid pattern. Perimeter baiting relies on the certainty that termites foraging will eventually discover the bait. Once termites have been located, either by perimeter baiting or by finding shelter tubes or active galleries, interceptive baiting can be used. Here, actively foraging termites are intercepted with a toxic bait. Interceptive baiting of structures has the disadvantage that quite often termite damage has already been done, and even though the colony is eliminated, the wood may have to be replaced.

Resources

For management practices and pesticide recommendations on termite control, see the publications available from UNL Cooperative Extension, located in most counties, or from Communications and Information Technology, Box 830918, University of Nebraska, Lincoln, NE 68583-0918, or see them on-line at: http://www.ianr.unl.edu /pubs/.

For detailed information on termites and their control, see *Subterranean Termites: A Handbook for Homeowners* available from the Lancaster County Cooperative Extension office, 444 Cherrycreek Rd., Lincoln, NE 68528, (402) 441- 7180, or on-line at: http://pested.unl.edu/termite.

Educational resource guides and a termite picture gallery are available at: http://lancaster.unl.edu /enviro/pest/insect.htm.