California School IPM Model Program Guidebook

2nd Edition

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This guidebook evolved out of requirements from the Healthy Schools Act (Chapter 718, Statutes of 2000). The Department of Pesticide Regulation gathered ideas from surveying school districts (Tootelian, 2001), and discussions with its School IPM Advisory Group (See www.schoolipm.info for a list of advisory group members).

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Dear IPM Coordinator and School District Staff:

This letter introduces you to the California School IPM model program guidebook. Please review this guidebook and use it as a reference tool as you implement integrated pest management (IPM) in your school district.

Who Developed This Guidebook?

The California Department of Pesticide Regulation (DPR) developed this model program guidebook, as required by the Healthy Schools Act of 2000, for use by school districts that wish to adopt a least-hazardous IPM program. The authors drew their information from federal school IPM guidelines, other states' IPM programs, California state laws and regulations, the University of California Statewide IPM program, California school districts that have already implemented IPM programs, the pest control industry, and public interest groups.

What Is the Purpose of the Guidebook?

This guidebook is designed to help you use IPM in your school's pest management program. The guidebook serves as a guide and provides models for schools that choose to implement IPM. IPM is not required in California schools. We intend this guidebook to be useful as both a companion manual for the DPR California School IPM coordinator training and as a reference tool for your school district when implementing IPM. IPM coordinators can use this text to train school district personnel in IPM theory and practices. School staff can refer to it for day-to-day pest management questions.

Why Use the Guidebook?

Whether you are just starting to implement an IPM program or want to improve an existing program, this guidebook will serve as a useful resource to answer your IPM questions and to provide practical, hands-on steps that can be implemented as part of your IPM program. The first part of this book lays out the essential elements of a least-hazardous IPM program and the steps to adopting an IPM program. Specific strategies for pest management indoors and outdoors are covered in the second part of the guidebook, arranged by individual pests.

We hope you find this guidebook to be useful and we encourage your input into the next edition. Please contact Belinda Messenger at bmessenger@cdpr.ca.gov or 916-324-4077 with your suggestions.

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SECTION 1

Introduction to California School IPM

1.1 What is Integrated Pest Management (IPM)?

Integrated pest management (IPM) is an approach to pest control that uses regular monitoring and recordkeeping to determine if and when treatments are needed. It employs a combination of strategies and practices to keep pest numbers low enough to prevent unacceptable annoyance or damage. IPM does not eliminate the use of chemical pesticides, but instead uses them only when needed. There are many definitions of IPM; the Healthy Schools Act of 2000 (Food and Agricultural Code section 13181) defines IPM as:

> "...a pest management strategy that focuses on long-term prevention or suppression of pest problems through a combination of techniques such as monitoring for pest presence and establishing treatment threshold levels, using non-chemical practices to make the habitat less conducive to pest development, improving sanitation, and employing mechanical and physical controls. Pesticides that pose the least possible hazard and are effective in a manner that minimizes risks to people, property and the environment, are used only after careful monitoring indicates that they are needed according to pre-established guidelines and treatment thresholds."

At its most basic, IPM is a common-sense pest management approach that requires pest management action only when necessary and with the least-hazardous method. Many pest management methods, such as biological, cultural, physical, educational, and chemical methods, can be used in a least-hazardous IPM program. Educational methods are used to enhance pest prevention, and to build support for the IPM program. Chemical controls are used only when needed, and in the least-hazardous formulation that is effective against the pest.

Pest prevention begins with correct identification of the pest and knowledge of its needs and entry points. Available food, water, hiding places and entry points must be eliminated for long-term suppression of a pest. Use of least-hazardous IPM has been shown to dramatically reduce the use of chemical pesticides, while providing better, longer-lasting control of pests.

Box 1-1: What is a pesticide?

A pesticide is any substance intended to control, destroy, repel or attract a pest. Some common pesticide types include herbicides (for control of weeds and other plants), insecticides (for control of insects), disinfectants and sanitizers (to control disease-causing microorganisms on inanimate objects) and rodenticides (for control of rats, mice and other rodents).

Box 1-2: Principles of IPM

1. Perform thorough in-field or on-site assessments of each pest problem.
2. Establish scouting or inspection procedures to monitor pest population levels and severity of the pest problem.
3. Use appropriate control action thresholds, if available, for each (combination of) pest problem(s) to determine when corrective action(s) must be implemented.
4. Determine corrective action(s) when a control action threshold is reached. Use the following objectives in the selection of specific reduced-risk practices: least disruptive of natural controls, least hazardous to human health, least toxic to non-target organisms, least damaging to the environment, most likely to produce a permanent reduction in the supportive environment for the target pest(s), and most cost-effective considering both short- and long-term objectives.
5. Establish and maintain an accurate record-keeping system to catalog monitoring information and document management procedures.
6. Evaluate the effectiveness of the IPM program and make adjustments as needed.

1.2 Why implement an IPM program?

IPM is an accepted method of pest management in schools (Stauffer et al., 1998; Grant and Woodsen, 2001). Using least-hazardous IPM techniques can save time, money and energy, as well as decrease the use of pesticides. In a 2002 California Department of Pesticide Regulation (DPR) survey of California school districts, 53% of the respondents stated that IPM reduced or had no impact on cost (Geiger and Tootelian, 2002). IPM practitioners prevent pest problems by eliminating the conditions that allow pests to flourish, detecting pests early before the population grows, and by establishing records so that outbreaks can be predicted. Other school concerns, such as sanitation, maintenance and energy usage can be addressed with proper IPM practices.

Using fewer pesticides in an IPM approach addresses the growing concern for the health and safety of schoolchildren and other building occupants. Many parents, community organizations and advocacy groups have become more aware, and more cautious, of pesticide use around children. A desire to know that schools are using pesticides safely and judiciously has been expressed to legislators all over the United States and as a result, laws concerning pesticide use in schools are in place in several states including California.

1.3 What is DPR's role in California school IPM?

In 1993, DPR began a pilot program to work with interested school districts to provide them information about IPM practices and assist them in developing an IPM program. DPR also conducted an extensive survey of school districts in 1996 to gain information about their IPM policies and practices (Simmons et al., 1996). Governor Davis felt that IPM in schools was important enough to add a school IPM program to DPR's budget in July 2000, as part of his Children's Health Initiative. Governor Davis later signed Assembly Bill 2260 (the Healthy Schools Act of 2000, Education Code sections 17608–17613 and Food and Agricultural Code sections 13180–13188) into law on September 25, 2000. This law, authored by Assembly Member Kevin Shelley, puts into code DPR's existing voluntary school IPM program and added some new requirements regarding pesticides, such as notification, posting, and recordkeeping for schools, and enhanced pesticide use reporting. The Healthy Schools Act makes IPM the preferred pest management method in California schools. Most provisions of the law took effect January 1, 2001.

Through its school IPM program, DPR is committed to facilitating voluntary establishment of IPM policies and programs in schools throughout California, while assisting school districts with implementation of the new Education Code requirements. DPR also works with other boards and departments of the California Environmental Protection Agency and with the California Department of Education to tie IPM into related areas such as school gardens and environmental education.

How is DPR helping school districts?

1.3.1 DPR's School IPM Advisory Group

In 2000, DPR created a School IPM Advisory Group, consisting of representatives from 31 key school organizations and other interested stakeholders. This group meets to advise DPR about School IPM program elements. The advisory group's recommendations are helpful in ensuring that the program achieves its goals. See the DPR School IPM Web site at www.schoolipm.info for the current list of School IPM Advisory Group members.

1.3.2 DPR's School IPM Web Site

DPR has established an IPM in Schools Web site at www.schoolipm.info as a source of information on school IPM. The site includes home pages customized for parents/teachers, school administrators, maintenance and operations staff, and pest management contractors. Resources available include summaries of the Healthy Schools Act, frequently asked questions, new regulations on school pesticide use reporting, an exhaustive listing of pest prevention techniques, sample notification letters to parents about expected pesticide use, a worksheet to determine whether specific pesticide products are exempt from HSA requirements, and many other items. The Web site also allows school districts to compare the health and environmental impacts of management practices used for specific pests, and to identify the active ingredients associated with pesticide products schools may use. In addition, the Web site provides extensive links to other IPM resources.

1.3.3 School IPM Training

The Healthy Schools Act directs school districts to designate individuals (sometimes known as IPM coordinators) to carry out requirements of this law. DPR offers voluntary train-the-trainer programs so that those who carry out the IPM program understand principles of IPM and can train their staff. DPR also supports regional workshops that showcase model IPM programs and provide hands-on experience.

1.3.4 Assisting Districts to Establish IPM Policies and Programs

Some school districts already are working with DPR to establish IPM programs. Currently, DPR is working with California Department of Education and has information on its Web site about model programs. In addition, DPR publicizes its school IPM program at meetings attended by maintenance and operations directors and their staff, school administrators, educators, and parents.

1.3.5 School IPM Guidebook

This guidebook is the result of an effort to tailor an existing school IPM guidebook to conditions in California. The Healthy Schools Act requires DPR to include specified IPM program elements. These program elements are covered in Part 1.

1.3.6 Evaluating IPM Adoption in Schools

Baseline and follow-up surveys help DPR to measure IPM adoption in schools, to evaluate what kind of outreach school districts need, and to see whether this outreach has been effective.

1.3.7 Pesticide Use Reporting Form

The Healthy Schools Act requires DPR to prepare a school pesticide use reporting form to be used by licensed pest control businesses when they apply any pesticides at a school. Licensed pest control businesses must submit the form to DPR at least annually. This form can be downloaded from the DPR School IPM Web site at www.schoolipm.info or call 916-324-4100.

1.4 What are the requirements of the Healthy Schools Act for school districts?

All public school districts are required to comply with the Healthy Schools Act. These requirements include annual written notification with specified information on pesticides to all school staff and parents or guardians of students; the opportunity for interested staff and parents to register with the school district if they want to be notified of individual pesticide applications at the school before they occur; posted warning signs at each area of the school where pesticides will be applied and records kept of all pesticide use at the school for four years. Sample letters and posting signs are included in **Appendix A** to help schools comply with these requirements.

1.4.1 Notification (Education Code section 17612(a))

Each school district is required to "annually provide to all staff and parents or guardians of pupils enrolled at a schoolsite a written notification of the name of all pesticide products expected to be applied at the school facility during the upcoming year." This notification must include the active ingredient(s) in each pesticide product and the Internet address used to access information on pesticides and pesticide use reduction strategies developed by the DPR (pursuant to section 13184 of the Food and Agricultural Code). The notification may contain other information deemed necessary by the school district. Adding information about the target pest and the application method can be helpful to parents or staff unfamiliar with pests and pesticides, although this is not required by the Healthy Schools Act.

Recipients of the annual pesticide notice may register with the school district if they wish to receive notification of individual pesticide applications at the school facility. People who register for such notification must be notified of individual pesticide applications at least 72 hours before the application. This notice shall include the product name, the active ingredient or ingredients in the product, and the intended date of application. If a pesticide product is not included in the annual notification but is later intended for use at the school site, the school district must provide written notification of its proposed use at least 72 hours before application.

These notification requirements are intended to be inexpensive for school districts. Annual notification to parents and guardians may be included as part of any other written communication provided to individual parents or guardians. Registrants can be notified by U.S. mail, e-mail or telephone. Notice through first-class mail is not required. If districts contract for monthly or periodic pest management services, people on the registry may be notified of each pesticide application by the contractor, if this is agreed to as part of the contract.

The notification procedures described above are not required for pest control measures taken during an emergency condition, but the school district shall make every effort to provide the required notification for an application of a pesticide under emergency conditions.

1.4.2 Posting (Education Code section 17612(d))

School districts are required to post a warning sign in each area of a school site where pesticides will be applied. The sign must prominently display the term "Warning/Pesticide Treated Area," and will include "the product name, manufacturer's name, the United States Environmental Protection Agency's product registration number, intended date and areas of application, and reason for the pesticide application."

The warning sign must be visible to everyone entering the treated area and must be posted 24 hours prior to the application and remain posted until 72 hours after the application. One option is to silk screen the text onto metal signs with blanks for the product name, manufacturer's name and other information. Specifics of each application can then be filled in with a grease pencil.

1.4.3 Exemptions to Notification and Posting Requirements

The requirements for notification and posting change in a pest control emergency. See section 4.2 of this guidebook, under "Declaring an Emergency Under the Healthy Schools Act," for more details. "Emergency conditions" are defined in the law as "circumstances in which the school district designee deems that the immediate use of a pesticide is necessary to protect the health and safety of pupils, staff and other persons, or the school site." (Education Code section 17608[c]) In an emergency, staff, parents and guardians need not be notified 72 hours in advance; however, every effort must be made to provide the notification. The warning sign must be posted immediately upon an emergency application and remain posted until 72 hours after the application. (Education Code section 17612.2(c))

Pesticides used in an emergency should pose the least possible hazard to people, property, and the environment, and be used only after the emergency has been documented (including type of problem, associated risks and pest management alternatives considered but not used). Pesticide products selected for use must be registered with DPR to control the pest and be effective for the intended purpose.

The Education Code (section 17610.5) notification and posting requirements described above do not apply to "a pesticide product deployed in the form of a self-contained bait or trap, to gel or paste deployed as a crack and crevice treatment, to any pesticide exempted from regulation by the United States Environmental Protection Agency pursuant to the Federal Insecticide, Fungicide, and Rodenticide Act (7 U.S.C. Sec. 25 (b)), or to antimicrobial pesticides, including sanitizers and disinfectants." (For more information on exempt pesticides, see DPR's School IPM Web site at www.schoolipm.info or **Appendix B**).

Box 1-3 Where to find a copy of the Healthy Schools Act

A copy of the Healthy Schools Act, Assembly Bill 2260 (Chapter 718, Statutes of 2000) is in Appendix D, or an electronic copy is available at www.schoolipm.info.

The notification and posting requirements do not apply to schools operated by the California Youth Authority. The Healthy Schools Act however does require that "the school administrator of a school operated by the California Youth Authority shall notify the chief medical officer of that facility at least 72 hours prior to application of pesticides. The chief medical officer shall take any steps necessary to protect the health of pupils in that facility." (Education Code section 17612.2 (e)) See **Appendix C** and **Appendix D** for more details.

The notification and posting requirements described above do not apply to activities by participants in the state program of agricultural vocational education. School farms are regulated by another set of posting and notification requirements. (California Code of Regulations 6618) The notification and posting requirements do not apply to agencies that have a cooperative agreement with the State Department of Health Services. (Education Code section 17631)

1.4.4 Other Requirements for Schools

In addition to the activities outlined above, the law adds certain requirements to the Education Code (sections 17608–17613) to be implemented by all California schools:

Each school shall maintain records of all pesticide use at the school for four years and make the records available to the public upon request. Records can be computerized but paper copies kept in a file provide easy access. Records can simply be a copy of the posted warning sign with the amount of the pesticide used noted on the copy.

Each school district shall designate an individual (who may be the IPM coordinator) to carry out the requirements of the Healthy Schools Act, outlined above.

To assist school districts, DPR has posted on its Web site samples of the annual notification and the register, and a template of the warning sign. These documents can be downloaded at www.schoolipm.info. These forms are included in **Appendix A**.

1.5 What are the Healthy Schools Act requirements for licensed pest control businesses?

This law (Food and Agricultural Code section 13186) requires that:

Licensed pest control businesses shall report pesticide applications by school annually to the Director of DPR beginning with applications made on or after January 1, 2002. A downloadable copy of the Pesticide Use Reporting form for School Sites can be found in the laws and regulations section at www.schoolipm.info or call 916-324-4100.

SECTION 2

Adopting an IPM Program

One of the characteristics of an IPM approach that makes it so effective is that the basic decision-making process is the same for any pest problem in any location. The strategies and practices may change, but the steps taken to decide when action is needed, and which methods are appropriate, are the same each time. Thus, the pest manager does not need to memorize reams of pest control "recipes" for specific pests. Instead, it is an understanding of the components of an IPM program that must be mastered.

2.1 How to Develop an IPM Program

There are key components to the development of an IPM program. The adoption of an IPM policy by school administration is the most important, followed by educating key decision-makers about the need for the program and identifying the roles and responsibilities of the various members of the school community. IPM operations involve designing and implementing IPM programs for specific pests; training the pest management, custodial, grounds maintenance, and nursing staff in IPM methods; and institutionalizing the IPM program.

BOX 2-1: Components of an IPM program

Technical components include:

- Pest monitoring.
- Pest identification.
- Determining injury and action levels that trigger treatments.
- Timing treatments to the best advantage.
- Spot-treating the pest (in order to minimize human and other non-target organism exposure to pesticides).
- Selecting the least-disruptive practices.

Administrative components include:

- Adopting an IPM policy.
- Establishing a recordkeeping system.
- Evaluating the effectiveness of treatments to finetune future actions.
- Educating all people involved with the pest problem and with efforts for resolution.

Each of these components is discussed in detail in later sections of this manual.

2.1.1 Adopting an IPM Policy

The first step towards implementation of an IPM program is the adoption of an IPM policy by the school board. See section 2.2 on "Developing an IPM Policy Statement for School Pest Management". A model school IPM policy and some California school IPM policies are provided in **Appendix E**.

2.1.2 Educating Key Decision-Makers

The key to a successful program is education of the school board, superintendent, business operations manager, principals, PTA officers, and other decision-makers about benefits from adopting an IPM approach.

Box 2-2: Identifying Pest Management Roles*

In successful school IPM programs, students, staff, parents, pest managers, and decision-makers all have important roles. These functions and responsibilities are identified below.

Students and Staff—The Occupants

Students and staff play major roles in keeping the school clean. Sanitation should not be viewed as only the custodian's job. If students and staff learn the connection between food, garbage and pests such as cockroaches, ants, flies, and rodents, they are more likely to take san-itation measures seriously and comply with them.

The Pest Manager/IPM Coordinator

The pest manager (often called the IPM coordinator) is the person who observes and evaluates the site (or directs others to do so) and decides what needs to be done to achieve the pest management objectives. This person is often the school site designee who is responsible for complying with the requirements of the Healthy Schools Act. The pest manager designs the IPM program and keeps accurate records of the amount and location of all treatments.

Decision-Makers

Generally, people who authorize the IPM program and control the funding for the pest management program are people involved in the school administration, such as a superintendent or assistant superintendent of schools. However, a person indirectly involved with the site may become a pest management decision-maker, e.g., the Health Department inspector. On other occasions, the purchasing agent or contracting officer for a school system or district may be a major decision-maker for a school site. Decision-makers also determine if the pest manager is performing at an acceptable level and if the pest management objectives are being met. Decision-makers must also provide the necessary level of financial commitment for any IPM program to succeed.

*Adapted from U.S. EPA, 1993

2.1.3 Identifying Pest Management Roles and Responsibilities

It is critical to have the support of representatives from all segments of the school community and that they be involved from the beginning in setting up the IPM program. This includes school board members, administrators and their staff, teachers, students, parents, custodians, food service workers, ground maintenance personnel, school nurses, and pest control professionals. When the respective pest management roles of those involved directly or indirectly with pests in the school system are identified and agreed upon, and when these people communicate well with each other, an effective IPM program can progress. A discussion of pest management roles and responsibilities is provided in **Box 2-2**.

2.2 Developing an IPM Policy Statement for School Pest Management

Schools need a clear policy statement to secure agreement about how pest control will be performed. The policy statement should include a statement of pest management goals, a set of roles and responsibilities for occupants, pest management personnel and key decision makers, and a set of pest management guidelines.

Districts develop and adopt written policies on many topics, including pest management, and make them available to all interested persons. Policies serve as direction for the operation and successful and efficient functioning of the district's schools. The Board policies provide direction to the district. Policies include the general goals and acceptable procedures for the school district. District policies are framed in terms of state laws and regulations and other

Box 2-3: Tips for Starting an IPM Program

The following suggestions can help overcome barriers and smooth the transition to IPM implementation.

Require staff training in IPM. When writing the IPM policy document, include a requirement for the continuing education of pest management personnel. Ensure that budgetary allocations are made to assist them in obtaining the information, skills, and equipment they need to carry out the policy.

Start small. Begin IPM implementation in one location (e.g., a kitchen in a single school or a section of lawn at a single school) and include short-term objectives. For example, when dealing with a number of pest problems, identify one of the pests likely to respond quickly to an IPM approach, such as cockroaches, so a short-term objective can be realized. Test the IPM practices and fine-tune them. When the program is working successfully in one area, or against one pest, expand the program further.

Develop a list of resources. Know where information is available when needed, and know when to seek outside help. County Cooperative Extension personnel, teaching staff in the biology or entomology departments of a nearby university, staff at the local zoo, and even the high school biology teacher can help identify pests and their natural enemies. Ask these people if they know of experts in the particular pest problem. Gradually compile a list of people to call for advice.

Appendix G can be the beginning of a resource list.

Always post the telephone number for the local poison control center in a prominent place.

Build a library for pest management personnel, staff, and students to use. Cooperative Extension publications are usually free or inexpensive and can be good sources of information on pest biology. Even though these publications do not always recommend the least-hazardous approach, they are still useful. The recommended reading section of this manual, **Appendix H**, lists many useful books.

Don't change everything at once. To the degree possible, retain communication and accountability procedures already in use. Tailor new recordkeeping and reporting forms to fit existing agency formats.

Recycle existing equipment to uses consistent with IPM methods rather than immediately eliminating the equipment.

Share the process. Involve members of the student body and staff, especially pest management personnel, in the day-to-day IPM program process as early as possible so they will understand and support the program during the sometimes-difficult transition period.

Emphasize communication and plan for future training. During the IPM transition period, keep all personnel informed about what is planned, what is currently happening, the expected outcome, and what will happen next. Prepare written records and visual aids that will remain in the school when persons associated with development of the IPM program are no longer there.

Publicize the program. Develop good rapport with district public relations personnel and with the local news media. For interviews and photo sessions, include pest managers, custodians, and landscape maintenance personnel as well as principals, school board members, and the superintendent.

Involve the community. Form an IPM advisory committee (see section 2.4 for more information) composed of interested parents, school staff, community organizations, health specialists, and pest control professionals. They can help make IPM implementation a budgetary priority in the district, and can donate or locate resources that may not otherwise be available to the school.

*Adapted from Flint et al., 1991

regulatory agencies within state and federal levels of government.

The district also develops written administrative regulations and procedures, when such are required, to carry out the provisions of policies adopted by the board.

The California School Boards Association (CSBA) (http://www.csba.org) develops and provides sample policies and administrative regulations for its members, which include most of the school districts in the state. Contact CSBA to see the CSBA Sample Board Policy Business and Noninstructional Operations Environmental Safety (BP 3514(a)) and CSBA Sample Administrative Regulation Business and Noninstructional Operations Integrated Pest Management (AR 3514.2(a)), which include provisions and procedures that fulfill the requirements of the Healthy Schools Act.

See **Appendix E** for a model policy and examples of school board policies and administrative regulations from several Californian school districts.

2.3 IPM Operations

The operation of an IPM program involves designing IPM programs for specific sites and pests, delivering IPM services, and evaluating program costs. Fully developed, multi-tactic IPM programs are generally implemented in three stages, although components of each stage often overlap.

Monitoring and pest action thresholds should take the place of routine pesticide applications, and preliminary pest management objectives should be developed.

Box 2-3 outlines tips for getting programs started. The initial IPM program focuses primarily on moving away from routine use of pesticides by instituting a pest monitoring program to collect data and establish pest treatment (action) thresholds based on pest population levels (see sections 3 and 4 in part 1).- A pilot program can be initiated at one school site, so new skills can be gained and techniques fine-tuned before the program is expanded throughout the system. Pesticides may remain the primary control agents used during this stage, but applications are made only when pest numbers reach action levels. Spot treatments rather than area-wide applications are stressed, nonvolatile baits and dusts are substituted for vaporizing sprays, and less hazardous soaps, oils, and microbial materials replace compounds that are more hazardous. At the same time, a planning process is established to set pest management objectives, identify the fundamental causes of pest problems in the school system, and assess methods to address these causes with primarily non-chemical solutions.

Pest management plans are formalized as a program becomes more mature. A concerted effort to maximize pest proofing, non-chemical pest suppression and education should be made as well as incorporating physical, mechanical, biological, and educational strategies and practices into the pest management program. Most pests found in school buildings can be attributed to faulty building design, lack of structural repairs, accumulation of clutter and paper, poor food handling and poor waste management practices. To achieve permanent solutions to pest problems, pest management staff must devote time to educating building maintenance and custodial staff, food handlers, and teachers and students about their role in attracting or sustaining pests, and enlisting their participation in solving the problems.

A similar process is needed to solve outdoor pest problems. For example, pest managers need cooperation from physical education and coaching staff to reduce stress on athletic turf that leads to weed problems. Landscape maintenance staff need encouragement to locate pest-resistant plant materials, increase diversity in the plantings to attract natural enemies of pests, and experiment with non-chemical pest control methods. Assistance from playground supervisors is needed to insure that food debris and other wastes are placed inside waste receptacles where pests such as rats and yellow jackets cannot gain access to them.

The primary activities during this stage include developing site-specific pest management plans and educating all participants about their roles and responsibilities in helping to implement the IPM plans.

2.3.1 Developing Site-Specific Pest Management Plans

Written plans help move school pest control from a reactive system to a prevention-oriented system. Annual plans enable pest managers to prioritize use of resources, justify planned expenditures, provide accountability to IPM policies, and coordinate with other components of the school system. These plans emphasize repairing buildings, changing waste management procedures to deny food, water, and shelter to indoor pests, and modifying plant materials and landscape maintenance practices to relieve plant stress and improve plant health.

Costs of these repairs and changes may fall within ongoing operating expenses in existing budgets, or may require a one-time expenditure. In the long-term, however, these activities will reduce overall pest control costs as well as other maintenance and operating budget expenses.

2.3.2 Educating Participants

Food service and custodial staff, clerical and administrative staff, teaching staff, and students must be educated about their role in reducing pest presence and the necessity of a cooperative effort to control a pest.

Everyone must understand the basic concepts of IPM, who to contact with questions or problems, and their role in the program. Specific instructions should be provided on what to do and what not to do.

Teachers and other staff should be notified that applying pesticides (except those pesticides exempt from Healthy School Act requirements in **Appendix B,** such as baits) on school sites falls under the Healthy Schools Act and must meet all posting, notification and record-keeping requirements. They should be provided with clear instructions on how and to whom to report a pest problem, rather than attempting to control the pest themselves. One option is to provide teachers and others with "pest alert" cards on which they can write the date, location, and pest problem. The card can be returned to the teacher with a notation of what was (or will be) done about the problem and what, if any, assistance is requested of the teacher and students (e.g., better sanitation in the classroom).

If information on IPM can be woven into the current curriculum, students and teachers will better understand their roles and responsibilities in the program, but more than this, students will carry these concepts into their adult lives. The following ideas are just a few of the ways that this information can be included in the school curriculum:

- Involve science classes in identifying pests and beneficial insects, and in researching IPM strategies.
- Involve art classes and English classes in developing simple fact sheets and other educational materials on various school pests. Use information from the individual pest management sections in this manual.
- Involve vocational classes in making site plans of the school to use for monitoring, site inspections for structural defects that may exacerbate pest problems, and suggestions for structural modifications to eliminate the problems.
- Involve journalism classes in reporting on the new IPM program.
- Use some of the innovative curricula available that emphasize IPM (see **Appendix F** for a list).

A mature IPM program may become institutionalized. This includes developing ongoing incentives and reward systems for achieving IPM objectives, establishing an IPM library of educational materials and staff training programs, and writing operations manuals that describe IPM policies and procedures to be followed by pest management personnel.

2.3.3 Develop Incentives and Rewards

Involve staff in establishing benchmark objectives (e.g., 20% pesticide reduction the first year, testing of boric acid in wall voids in place of broadcast spraying for cockroaches, raising of mowing height on turf to shade out weeds).

Reward staff for innovations and for achieving objectives (e.g., a letter of commendation, recognition at a staff awards picnic, article in local news media, travel authorization to an out-of-town IPM conference.).

Provide IPM educational materials and staff training programs.

IPM programs are information-intensive rather than treatment-intensive. This necessitates motivating pest control staff to try new approaches and broaden their professional skills.

Build an IPM library of literature and training videos, and provide time for staff to attend training seminars or take courses in pest identification.

2.3.4 Prepare an IPM Operations Manual

Written policies and procedures are needed to insure clarity about responsibilities, authorized activities, permitted materials, and other program elements. A manual serves as an accountability mechanism, and helps insure program continuity despite personnel changes. A loose-leaf binder that allows for addition or deletion of materials over the years is a convenient format. In addition to official policies and procurement practices, the manual should specify the following:

- Pest management objectives.
- The overall IPM process for managing each pest.
- Biological and ecological information on the pest and its natural enemies.
- The monitoring system for each pest (and natural enemies when appropriate).
- Injury levels (i.e., damage by pests) and action thresholds for pests.
- The method of recordkeeping system to be used (e.g., paper or electronic).

- How to interpret field data.
- How to obtain, use, and maintain equipment and supplies required to carry out monitoring and treatment activities.
- The range of treatment practices authorized for use against the pest and how to employ them.
- A list of pesticides authorized for use in the district and the Material Safety Data Sheet (MSDS) for each pesticide.
- Safety procedures and resources for emergencies.
- How to evaluate treatment effectiveness.

2.3.5 Building Support for the IPM Program

Once an IPM policy has been adopted by a school board, implementation is usually the responsibility of the IPM coordinator, who will instruct the in-house pest control staff or outside contractors (see section 2.7 on contracting for pest management services and **Appendix I** for sample IPM contract specifications).

Change never comes easily, and a number of predictable obstacles may exist within a school system—both psychological and institutional—to be overcome when initiating IPM programs. At the same time, even if the public has been involved with development of a policy, there are likely to be occasional complaints and controversies, especially as pests, pest control practices, and public concerns change.

For more information on how to develop a program and how to overcome barriers to adoption, read the UC IPM Publication 12 "Establishing Integrated Pest Management Policies and Programs: A Guide for Public Agencies" (see **Appendix J**).

2.4 Community-Based School District Advisory Committee

Many school districts have established an IPM advisory committee to assist with developing and implementing the district's pest management policy. This committee can be very useful in making suggestions, doing research, and bringing in new information, but it need not have authority to make policy. It is helpful if the committee also has an independent pest management expert (preferably one trained in IPM). This group can be a valuable resource for tracking and evaluating the progress of the IPM program in meeting the district-wide pest management goals. Involving diverse representatives of the community in policy development is a good way to draw together vast support for the policy and program later. Periodic reevaluation and advice of the committee on implementation will be very helpful to ensure that the district's IPM goals and objectives are achieved while providing the best support possible for constituent groups within the district. The committee can help make IPM implementation a budgetary priority in the district, and can donate or locate resources that may not otherwise be available to the district.

Ideally the advisory committee should include concerned parents, school administrators, faculty, staff, pest control operators, maintenance and operations staff, other professionals with pest management experience, physicians with toxicological expertise, environmental organizations, health advocates, interested organizations, and other members of the community.

The committee should meet at least once each year. Regularly scheduled IPM committee meetings are necessary to monitor and evaluate progress, correct inefficient procedures that hinder meeting the stated goals of the school IPM policy statement, and educate concerned individuals involved with the program.

2.5 Community-Based Standard for Notification and Posting

More stringent standards for notification and posting than those required by the Healthy Schools Act can be recommended by stakeholders such as the community-based advisory committee, the IPM coordinator, interested parents or the School Board. The law states that each area of the schoolsite where pesticides will be applied must be posted. It does not, for instance, specify how many signs are required or exactly where those signs should be placed. The law also does not describe exactly how parents are to be notified of pesticide applications. The stakeholders mentioned above may develop and recommend more detailed procedures to the School Board regarding posting or notification of pesticide applications.

2.6 Selecting and Training an IPM Coordinator

2.6.1 Healthy Schools Act Responsibilities of the IPM Coordinator

Under the Healthy Schools Act of 2000, Education Code section 17609(d), each school district is required to appoint a "school designee" who is responsible for carrying out the requirements of the Healthy Schools Act at the schools within the district. These duties include notification, posting and recordkeeping. See section 1.4 for the requirements of the Healthy Schools Act. If the school district decides to implement an IPM program, the school designee may be known as the IPM coordinator. Often the director of maintenance and operations is chosen as the designee or IPM coordinator. For districts where the IPM coordinator is not experienced in least-hazardous IPM, a professional IPM consultant may be hired to assist in implementing a least-hazardous IPM program.

2.6.2 Other Responsibilities of the IPM Coordinator Within an IPM Program

The IPM coordinator will acquire a number of responsibilities, some of which are not directly related to pesticide applications. The school district must ensure that the IPM coordinator is trained in least-hazardous IPM concepts and methods, as defined by the Healthy Schools Act. The IPM coordinator's duties may include some or all of the following:

- Serving as a primary contact for pest control matters and coordinating all pest control decisions for the school district.
- Leading the development and implementation of an IPM policy and program.
- Scheduling and facilitating pest management advisory committee meetings.
- Monitoring pest problems or areas where pest problems may occur (see section 3).
- Recording monitoring data.
- Setting pest management action levels.
- Recording all pest sightings by school staff and students.
- Facilitating communication about pest management among all personnel levels in the district.
- Having school pests accurately identified

(this can be accomplished with the aid of the County Department of Agriculture, University of California Cooperative Extension, and the entomology or botany departments of local universities or community colleges, see also **Appendix K**, How to Collect and Preserve Specimens for Identification.).

- Devising IPM plans for school pests.
- Making decisions about appropriate pest management actions.
- Recording all pesticide use and other pest management actions.
- Evaluating the effectiveness of pest management procedures and revising IPM plans accordingly.
- Ensuring the completion of work orders for structural repairs and housekeeping and sanitation measures intended to reduce or prevent pest problems.
- Training staff in IPM practices and researching staff training opportunities.
- Coordinating with principals and district administration to carry out the education and IPM training provisions of the district's IPM policy.
- Coordinating the collection and dissemination of current information on pest management and pesticides or pest-related health and safety issues to staff and faculty.
- Overseeing pest management contractors.
- Informing contractors of the district's IPM policy and pest management procedures.
- Assuring that all of the contractor's recommendations on maintenance and sanitation are carried out where feasible.
- Ensuring that pest management implications are considered when planning new construction or site modifications.
- Meeting with the press and/or community groups about pest management issues.

An individual selected to be a school IPM coordinator must be knowledgeable in many areas. The school district should ensure that the IPM coordinator is trained in IPM concepts and methods. The IPM coordinator must be conversant in the following:

- The nature and benefits of IPM.
- IPM policy implementation.
- Components critical for success of an IPM program.
- Recordkeeping, notification, posting requirements pursuant to the Healthy Schools Act.
- Pest control measures including prevention, and mechanical, cultural, biological and chemical controls.
- Pest identification and reporting.
- Monitoring and inspection for pest problems.
- Program evaluation and quality control.
- Communication and interaction with the school community.
- Communication with mass media, the community, and parents.
- Community outreach and interaction.
- Liability issues in pest management and the operation of schools.
- Bids and contracts.
- Pesticide Safety Information Series leaflets, published by DPR.

2.7 IPM Contract Performance Specifications

Integrated pest management conducted by professionals should lead to a safe school free from significant pest problems and potentially harmful pesticide residues. Hiring a professional service to conduct pest management relieves the school district from the responsibility of having trained staff, storing potentially harmful chemicals, and continually maintaining a set of complex records. However, hiring a professional service does not exclude the importance of communication, follow through, and making sure that the contracting process achieves the desired result. This includes hiring a pest management company that is truly service-based and experienced in least-hazardous integrated pest management.

There are several categories of pest management services available for hire, primarily general pest control (indoors and around the perimeter of a structure), termite inspection and control, vertebrate pest control (birds and mammals such as skunks, ground squirrels, and feral dogs and cats), and weed management. There are also IPM consultants that schools can contract with to help develop an IPM plan, educate school personnel and evaluate pest control contractors. Clearly, not all companies offer the same range of service. More often than not, companies and usually the smaller companies are not licensed in both agricultural and non-agricultural categories. Companies licensed by the structural pest control board usually do termite management, general pest management, and some vertebrate pest management (rats, mice, and some birds). Companies licensed by DPR generally do weed management and some vertebrate pest management. Finally, DPR licenses companies that do maintenance gardening and some insect and weed management. Note that when it comes to mold in buildings, different licenses are required. Consideration should be given to what is likely to be encountered in the task. For example, assume mold is the problem to be remedied, but in the process of reconstruction, dry rot is found. Does the process stop because the company is not licensed to handle dry rot (which is under the jurisdiction of the Structural Pest Control Board) or can the company handle both types of problems? The pest manager must determine whether the contractor is qualified to handle both problems.

2.7.1 In-House or Contracted Services?

IPM programs can be successfully implemented by "in-house" school employees or by contracting with a pest control company. A combination of in-house and contracted functions may also suit the needs and capabilities of the school system. Each approach has advantages and disadvantages. Individual school systems must decide what is best for them given their unique circumstances. Whether using in-house or contracted services, pest management personnel should be trained to:

- Understand the principles of IPM.
- Identify pests and associated problems or damage.
- Monitor infestation levels and keep records.
- Know cultural or alternative methods.
- Know recommended methods of judicious, least-hazardous pesticide application.
- Know the hazards of pesticides and the safety precautions to be taken.

- Know the pesticide label's precautionary statement(s) pertaining to exposure to humans or animals.

2.7.2 In-House Services

One of the most important tasks for an in-house program is training staff to function within an IPM framework. Universities and State Cooperative Extension Services have the expertise to meet most IPM training needs. The Department of Pesticide Regulation has a School IPM training program to help train school districts. This guidebook is the basis of this training program. A Web site is also available with information and links for School IPM. See www.schoolipm.info.

2.7.3 Contracted Services

Pest control firms should work with the pest manager and the responsible school official to solve pest control problems. Use of an outside pest control firm may increase costs but eliminate the need to hire and train personnel and store pesticides. The contract should specify the use of least-hazardous IPM principles and practices in meeting pest management objectives.

When choosing a pest control firm, request references that attest to their knowledge and experience with least-hazardous IPM, as well as previous experience in schools. Contact the local Better Business Bureaus or state regulatory agencies (DPR at 916-324-4100 for landscape uses and the Structural Pest Control Board at 916-561-8700 for indoor uses) for information about whether they have received complaints about a pest control company. These state regulatory agencies can also provide information on pesticide applicator certification.

The pest management services contract should include IPM specifications. Contracts should be written to provide expected results. Pest management objectives specific to the site should be jointly developed, agreed upon, and written into the contract. Any special health concerns (such as those for old or young persons, for pets, or for individuals who are allergic) should be noted and reflected in the pesticides that can be used, or excluded from use.

If the school district is considering or has decided to use a contractor to implement an IPM program, the sample contracts in **Appendix I** can be used or adapted.

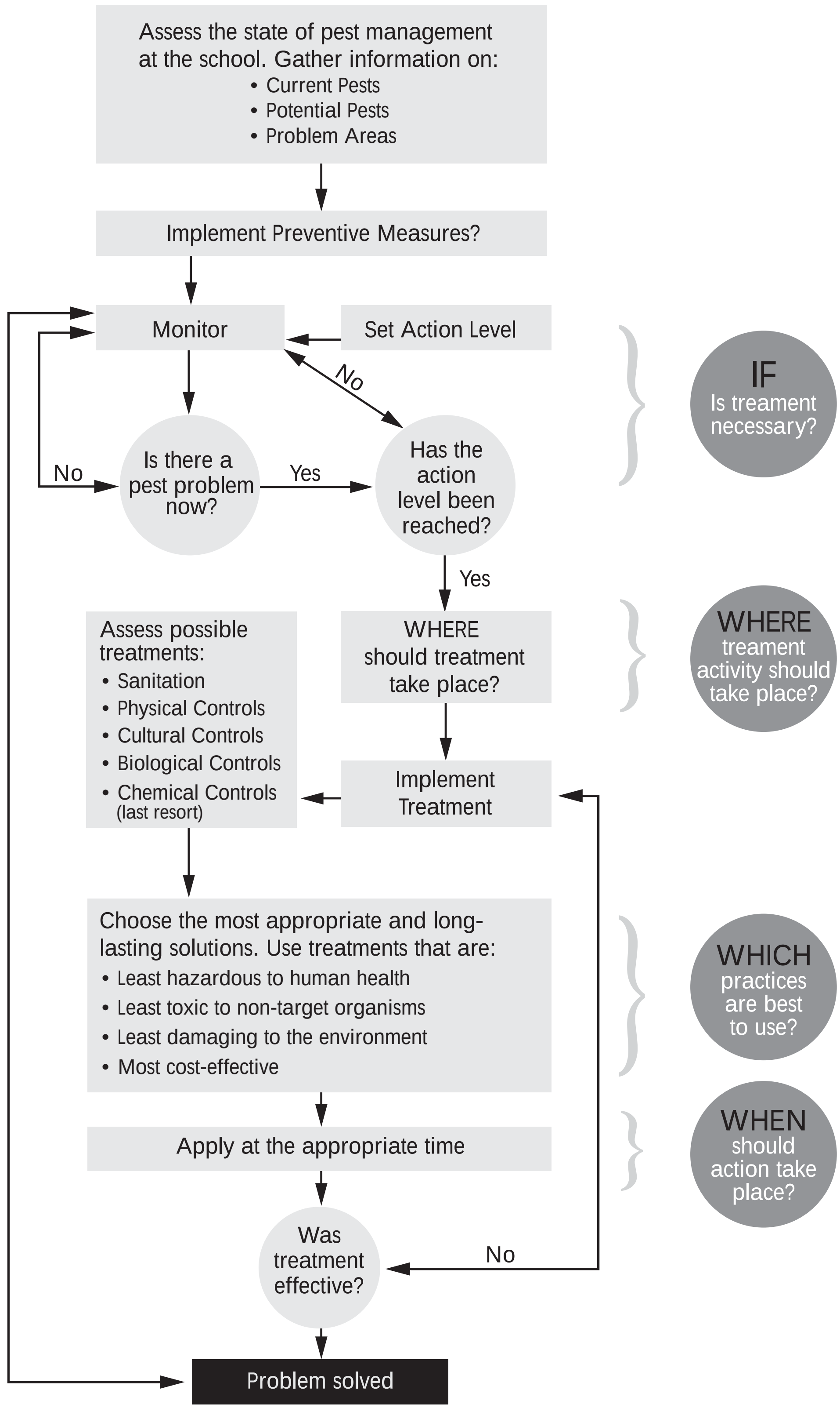
2.8 The IPM Decision-Making Process

This decision-making process, basic to IPM, helps answer four key pest management questions: IF treatment action is necessary, WHERE treatment activity should take place, WHEN action should take place, and WHICH mix of treatment practices are the best to use. See **Figure 2-1** for a flowchart of the IPM decision-making process.

2.8.1 IF Treatment Action Is Necessary

Instead of taking action at the first sign of a potential pest, the IPM process begins with asking whether any actions at all are needed (see section 4 for a discussion of injury and action levels). Sometimes, even a fairly large population of pests can be tolerated without causing a problem. In other cases, the presence of a single pest organism is considered intolerable. In still other cases, what is considered a pest by one group in society may be considered innocuous by another.

Figure 2-1: Flowchart of the IPM Decision-Making Process



Example: Occasionally when the weather is hot and dry, field cockroaches (Blattella vaga)*, small brown roaches that resemble the German cockroach, visit schools. Field cockroaches actually prefer to live outdoors in leaf litter and are only occasional indoor guests. By monitoring them with sticky traps, you'll see that their population is not increasing and they do not become established indoors.*

Example: Large rodent droppings and grease trails suggest there is a rat in a crawl space under the eaves. Even one rat can be a problem because it can gnaw on electric wires causing fires and leave fleas that can transmit pathogens to humans. Treatment action is usually required even if only one rat is suspected.

2.8.2 WHERE Treatment Activity Should Take Place

If it is decided that some treatment action is necessary, the IPM process encourages pest managers to look at the whole system for the best place to solve the problem. Treatment should take place where actions will have the greatest effect.

Example: When Argentine ants invade classrooms, it's tempting to douse them with an aerosol spray. Only a fraction of the worker ants are actually out foraging at any one time, and if these foragers are instantly killed, the pesticide doesn't poison nest mates and queens. It is more effective to eliminate indoor ant trails with soapy water and place self-contained baits outdoors. Ants will aggregate around the baits, so if you locate these indoors, you'll attract even more ants from outlying areas in the place where you don't want them.

2.8.3 WHEN Action Should Take Place

The timing of treatments is important. Often there is an optimal time in the life cycle of the plant or the pest to apply control measures. Conversely, there may be times when treatments actually increase pest problems. The human social system will also affect the timing of treatments. The IPM process encourages managers to discover the best timing for treatment actions (see section 5.2, "Timing Treatments") since long-term success of any treatment depends on timing.

Example of timing in the life cycle of a plant: Yellow starthistle, Centaurea solstitialis*, is an annual weed that grows in disturbed areas. As with many weed species, mowing before the plants flower is much more effective than battling seed head-laden plants later in the season.*

Example of timing in the life cycle of a pest insect: In the spring, yellow jacket queens are busy establishing nests. It's much more effective to trap these queens and the first flush of foraging workers then, rather than waiting until summer or fall when putting out traps will barely make a dent in the population.

Example of timing in the social system: When switching to IPM, it is essential to coordinate the IPM program plan with the overall budget process of the school district. For example, improving rodent and fly management may require modifications in food storage facilities or in the disposal of kitchen garbage. Substantial repair to windows or plumbing may be needed. Requesting funds for activities such as minor construction or new containers must be done at the appropriate time in the school district's budget development process.

2.8.4 WHICH Mix of Treatment Practices Are the Best to Use

There are three guiding principles to use when choosing treatments: conserve and enhance naturally occurring biological controls; use a multi-tactic approach; and view each pest problem in its larger context.

Conserve and Enhance Naturally Occurring Biological Controls

In a landscape setting, when we kill the natural enemies of pests, we inherit their work. In many cases, the combined action of all natural enemies present may result in substantial pest control. Even when they are not able to do the complete job, natural enemies are nonetheless providing some help in protecting school landscape plants from pest insects. The IPM program should be designed, when possible, to avoid damaging natural enemies.

(See "Biological Controls" in section 5.3 for more information).

Example: Many spider mite populations on various trees and shrubs are kept under control by naturally occurring predatory mites. In fact, the predators keep them under such good control we may never be aware of their presence until we spray a pesticide intended to kill more obvious pests, such as aphids. For a number of reasons, most pesticides are more harmful to the predatory mites then the pest mites. The pesticide kills almost all of the predators, the spider mites are only slightly affected, and now that they are free from their natural enemies, the pest mites quickly multiply and devastate the plant. By changing the practices for controlling the aphids, a spider mite problem can be avoided.

Use a Multi-Tactic Approach

Every source of pest mortality, no matter how small, is a valuable addition to the program. Biological systems are so complex, rarely will a single practice, such as the application of a pesticide, solve the problem for long. As many non-hazardous practices as needed should be combined to manage the pest problem.

Example: Controlling cockroaches requires direct practices such as applying boric acid dust to cracks, crevices, and wall voids; placing baits in areas inaccessible to students; using an insect-growth regulator and boric acid water washes in areas not in direct contact with food or people; and releasing parasitoids for certain roach species. But long-term cockroach control must also include habitat modification such as caulking or painting closed cracks and crevices; screening vents that may be used by cockroaches to travel between adjacent areas; eliminating water leaks and cracks around plumbing fixtures; and improving the storage of food supplies and organic wastes.

View Each Pest Problem in Its Larger Context

Each pest problem must be considered within the framework of the larger system in which it has arisen. Textbooks and manuals commonly treat pest problems one by one. However, in the real world setting of a school and the grounds around it, pest problems occur several at a time or in a sequence in which the management of one influences the others. In addition, pest problems are influenced by other human activities such as waste disposal and food handling indoors, and mowing, fertilizing, and irrigating outdoors, as well as the attitudes of the many people who work and study within the district. Using IPM means taking a whole system or ecosystem management approach to solving a pest problem.

A successful IPM program considers all of the components of an ecosystem. As biologists and ecologists use the term, an ecosystem is usually thought of as containing non-living (abiotic) and living (biotic) components. For instance, if one considers a school building as an ecosystem, the abiotic components of the building would be the building itself and the equipment and furnishings within it. The biotic components would be the people, insects, spiders, and other creatures that live or work in the building.

It is essential to consider who is involved in an IPM program—the social/political components. In a school system, this category includes teachers, students, custodians, grounds maintenance staff, food handlers, clerical staff, health personnel, carpenters, plumbers, pest control companies, refuse collectors, and other outside service providers who might be contracted for specific work in or around the school. The school district administration and school board, school neighbors or adjacent landowners, associated public agencies or institutions, professional associations and community groups, and the public must be included. The political and legal constraints of society should also be taken into consideration.

The many components of the school ecosystem can be thought of as a series of systems, each having an impact on the other and all potentially impacted by a pest management program. To design and implement a successful IPM program, it is necessary, at least to some degree, to be aware of and obtain information from each of these components.

This raises the classic problem in systems management: where to draw the boundary of the system. If the boundaries are drawn too narrowly and include only the pest, something important may be missed, like the fact that people are leaving food out at night that feeds the pest. It is better to read, question, and observe as much as possible about the larger system in which the pest problem exists. Otherwise, there is a risk that the solution to the pest problem will be overlooked.

Example: A nuisance fly problem inside the school may prompt use of space sprays or pesticide-impregnated plastic strips. A less hazardous quick fix might be to purchase and install electric insect traps. A broader view could lead to the observation that some window screens need repair and could be improved by the addition of weather-stripping around the frames to exclude flies. A still-larger view might include the observation that the outdoor trash containers on the school grounds are inappropriately placed or not adequately cleaned after being emptied each week, thus attracting flies.

Changing these conditions will involve cooperation from the custodial and maintenance staff. Perhaps the outdoor trash receptacle needs to be moved a greater distance from the door. Perhaps more frequent removal and replacement of the outdoor trash receptacle may be desirable. This will undoubtedly have budgetary consequences and will involve negotiations outside immediate school personnel. Ultimately it may be discovered that the flies are part of a community-wide problem. Complaints from the school system to the local municipal government may help in changing area-wide waste management practices. At first it may seem that there is little that a few individuals can do to influence the process of change in the larger ecosystem; however, the individual schools and the school district can assume a leadership role in educating their community about safer and more lasting methods of pest management. This can be done indirectly by educating the student population, and directly through the participation of school personnel in community forums on pest management-related matters.

Please see section 5, "Selecting Least-Hazardous Pest Control Practices" for more detailed information on the IPM decision-making process.

2.9 IPM Program Evaluation

An IPM-oriented program views the need to regularly apply pesticides as an indication that the program isn't working efficiently, and seeks other solutions in order to reduce pesticide use. One of the most important components of an IPM program is evaluating whether the IPM policy is being implemented and that specific pest problems are being solved. Evaluation is rarely done in conventional pest control. Evaluation should occur after each treatment and may involve monitoring.

For purposes of overall evaluation, it is helpful to view the IPM program as composed of many simultaneously occurring, interacting systems or processes. These can be either technical or administrative in nature.

Technical aspects to consider include:

- Prevention of pest infestations.
- Pest monitoring.
- Recordkeeping.
- Decision-making regarding pest treatment activities.
- Delivery of pest treatments.
- Evaluation of treatments.

Administrative aspects to consider include:

- Collection and cataloging of reference materials on management of the pests.
- Education and training of school personnel in IPM.
- Communication to school personnel regarding IPM program plans and progress.
- Budgetary planning.

Each of these components should have, as part of the development of the initial program plan, some expressed objectives or criteria by which the component is judged successful or not. Nevertheless, in addition, it is important to determine the following:

Were all the necessary components to the program actually developed?

Were they integrated successfully?

Were the right people involved in the integration of the components into a whole program?

2.9.1 Questions to Ask After Treatment Action

At the end of the year, use monitoring data to answer the questions below and make any necessary adjustments in methods for the next season. After two or three seasons of fine-tuning, including modifying the habitat, redesigning parts of the school facility, or changing behavioral practices to discourage pests, it is reasonable to expect problems to have lessened considerably, and in some cases disappear. After reaching this point, periodic monitoring rather than active management may be all that is needed. See also **Appendix L**, *Pest Management Assessment Tool.*

Was the pest population adequately suppressed below the set injury level?

Was the pest population suppressed in a timely manner?

Was the planned procedure used? If not, what was different?

What damage was produced? What damage was tolerable?

In the landscape, were natural enemies affected by treatments? How?

If natural enemies were killed by a pest management treatment, will this cause a problem elsewhere or at a later period?

Were there any other side effects from the IPM treatments? Were there any unanticipated consequences (good or bad)?

If ineffective, should the treatments be repeated or should another kind of treatment be evaluated?

Is the plant or structure worth maintaining? Can the site be changed to eliminate or reduce the problem for the same costs of treatment?

What were the total costs of the treatment—costs of suppression vs. cost of damage, costs of unexpected consequences, costs of risks from pesticides or benefits from reduction of pesticide.

2.9.2 Assessing Cost-Effectiveness

Cost-effectiveness is crucial to continuation of an IPM program. According to U.S. EPA (U.S. EPA, 1993), "preliminary indications from IPM programs in school systems suggest that long-term costs of IPM may be less than a conventional pest control program." Data from IPM programs in school systems and park districts across the country show that IPM can cost no more than conventional spray programs, and often costs considerably less. A DPR survey conducted in 2002 received responses from more than 400 school districts in California (Geiger and Tootelian, 2002). Some examples of cost-effectiveness are discussed below.

Two schools in Santa Barbara County, Peabody Charter School and Vista de Las Cruces, were demonstration sites in the Pesticides Reduction in Schools Project. The project was funded by U.S. EPA and the Santa Barbara Foundation, and managed by the Community Environmental Council and Organic Consulting Services (Boise and Feeney, 1998). They found that an IPM-based system was more effective in controlling pests, while saving money.

Staff time devoted to controlling ants at Peabody Charter School was reduced from eight hours per week to two and a half hours per week, a reduction of 70 percent. Long-term control of cockroaches required an initial investment of 14 hours to caulk cracks and crevices and to apply boric acid. These treatments for cockroaches did not have to be repeated and pest populations decreased. The cost of these treatments was $705.

Vista de Las Cruces School contracted for their pest control services prior to the IPM program. The monthly perimeter sprays to control indoor pests cost $1,740 per year. The school chose to cancel the contract and assign all pest management duties to the head custodian. The expenditures for pest management were reduced to $270 for a two-year period and the head custodian did not spend any additional time on pest management. Weeds are another pest management challenge at Vista de Las Cruces School. An application of mulch is expected to control weeds for three to five years and to cost $2,170. The previous cost of chemical herbicides was $934 per year, not including labor.

The Ventura Unified School District has reduced its reliance on herbicides by 95 percent while staying within historical spending limits for weed control materials. The money saved on herbicides was used to purchase mulch and a steam weeder with money left over for a contingency fund.

The Ann Arbor School District in Michigan found that hiring a contractor to monitor 35 schools on a regular basis, and treat only if action levels were reached, resulted in only a single treatment (a crack-and-crevice application of boric acid for cockroaches) during the course of a full year. In the first IPM year, this program cost the same as the previous conventional program. Costs were expected to drop the second year when in-house staff were scheduled to assume monitoring responsibilities (Cooper, 1990). In the 1999-2000 school year, 9 percent of the total budget for the Ann Arbor School District was used for operations and maintenance (Ann Arbor Public School District Web site at http://aapswww.aaps.k12.mi.us/).

A conventional pest control program at the Monroe County School District in Indiana, a 19-school district cost $34,000 annually. After an IPM program was implemented, the cost dropped to $28,000 (Forbes, 1991). As of 1998, the district realized a 35 percent reduction in pest management costs ("Cost of IPM in Schools" at http://spcpweb.org/schcost.pdf).

Whether an IPM program raises or lowers costs depends in part on the nature of the current housekeeping, maintenance, and pest management operations. The costs of implementing an IPM program can also depend on whether the pest management services are contracted out, performed in-house, or both.

Before 1985, Maryland's Montgomery County Public Schools had a conventional pesticide-based program. More than 5,000 applications of pesticides were made to school district facilities that year. Public concerns about potential hazards to students and school personnel led to development of an IPM program that emphasized prevention through sanitation and habitat modification, and less hazardous baits and dusts in place of conventional sprays. By 1988, annual pesticide applications had dropped to 600, and long-term control of pests had improved. According to William Forbes, pest management supervisor for the district, under conventional pest control in 1985, the district spent $513 per building per year. This covered two salaries, two vehicles, and materials for two employees who serviced 150 sites. Only crawling insects and rodents were managed by in-house staff. The IPM program serviced 200 school buildings (a 33 percent increase in the number of sites) for a cost of $575 per building per year, which covered three salaries, three vehicles and supplies. Contracting services, however at 11 of the sites cost an additional $2,400 per building per year under the conventional program. By 1988, under an IPM program, those same eleven sites were being managed by in-house staff at a cost of only $500 per site per year. In addition, no outside contracting was needed and the program covered virtually every structural pest, from pigeons to termites (Forbes, 1991). In 2002, operations and maintenance costs were $1.7 million out of a total budget of $1.4 billion (Montgomery County Public School District Web site).

During the start-up phase, there are usually costs associated with conversion to IPM. This is particularly true in schools that have not been well-maintained. Examples of these one-time expenses that may produce future budgetary savings include:

- Installing physical barriers such as air curtains over the outside entrances to kitchens to reduce flying insect problems. This is a one-time cost and results in fewer flying insect problems and a savings in years to come.

- Stepping up structural maintenance to correct such situations as leaky pipes. This effort reduces future maintenance problems, prevents pest problems, and saves money and energy in the long term.

- Training and/or certifying staff in IPM. The amount of information necessary to implement IPM is greater than that required for conventional pest control. As a consequence, training or certifying staff in IPM will probably increase costs.

- Re-landscaping the area adjacent to buildings to discourage pests.

Other expenses might include staff training, building repair and maintenance, new waste storage containers, screening, traps and/or a turf aerator. These expenses are usually recouped within the first few years of the program, and benefits continue to accrue for years.

Whether such costs are budgeted as a pest control expense or distributed to the building maintenance budget or the landscaping account depends on the budgetary format of the school system. In the long term, training, repair and maintenance activities, and equipment purchases will reduce overall costs of the pest control operations, as well as other maintenance and operating budgets.

2.9.3 Efficient Procurement

Some non-pesticide products, such as traps, can be stocked to reduce purchases in future years, but few savings can be realized by purchasing pesticides in bulk. It is probably best to keep no more than a 60-day pesticide inventory to assure product freshness and to avoid limiting cash flow. Pest managers should be able to anticipate needs to fit a 60-day buying schedule.

Successful practice of IPM relies on accurate recordkeeping, which leads to procurement that is more efficient. As the IPM program progresses, predictable events and pest control needs will be identified. Close consultation with the pest management specialist is essential for good decisions on purchases within the budget.

SECTION 3

Monitoring Pest Populations and Damage

IPM is based on consistently inspecting and monitoring for pests. The purpose of monitoring is to supply recent, accurate information with which appropriate decisions for managing pests can be made. Guidelines for making appropriate decisions can be established prior to monitoring (see section 4 on "Setting Injury and Action Levels"). Since each site is different, pest management decisions will depend on the circumstances encountered.

Monitoring as part of IPM was originally developed for agriculture. Over the years, this concept has been adapted for gathering information on pests of landscapes and structures in urban settings.

A regular and ongoing monitoring program will help answer the following questions:

- What is the extent of existing pest problems?
- Where are they located?
- What other pest problems exist?
- How are pests entering the building?
- What are the pests' sources of food, water, and shelter?
- Are there conditions conducive to future pest problems that can be corrected?

This section provides a general overview of how to set up and operate a monitoring program. Detailed discussions on monitoring techniques for individual pests are provided in Part 2.

3.1 What Is Monitoring?

Monitoring is the planned, regular visual inspection of an ornamental planting, landscape or structure for detecting pests, pest damage or conditions conducive to pests or pest damage. Monitoring should take place in areas where pest problems do or might occur. Monitoring frequently includes the use of pest traps, such as sticky traps for cockroaches. Information gathered from these inspections is always written down to help determine what actions to take. Examples of monitoring forms are provided in **Appendix M**. An inspection checklist for detecting structural decay and structural pest damage is provided in **Appendix N**.

3.1.1 Not Enough Time or Money?

Time and money will constrain what will realistically be possible. The most important thing is to go out and look at the problems, and write down what is observed. Figure out how monitoring can be included along with routine maintenance activities to ensure that this will be done. Make sure that personnel who are asked to monitor understand what to look for and how to record the information. Supply them with easy-to-use monitoring forms whenever they go out. If the school is contracting out its pest control services, give the pest control company copies of these forms to use or have them develop their own forms subject to the approval of the school's pest manager.

3.1.2 Levels of Effort Used in Monitoring

Monitoring need not be time consuming. The idea is to match the level of monitoring effort to the importance of the problem. Monitoring can vary from the extremely casual to the statistically strict, depending on what is most appropriate. The levels of effort are:

1. Reports from other people's (e.g., teachers) informal observations. This can be useful if used with a pest-sighting log to record verbal reports.

2. Monitoring as part of other tasks, with written observations. This serves to catch pest problems as they begin.

3. Careful inspection with written observations should be conducted when pest problems are significant.

4. Regular written observations and quantitative descriptions are appropriate when working on a pest problem related to public health.

3.2 Why Monitor?

A monitoring program increases familiarity with the workings of the target system. This knowledge allows anticipation of conditions that can trigger pest problems, and thus prevent them from occurring or catch them before they become serious. Monitoring enables intelligent decisions to be made about pest management actions, such as sealing cracks or setting traps.

Monitoring helps determine if action is needed. Is the pest population getting larger or smaller? If plants are being monitored, is the natural enemy population getting larger or smaller? These questions affect whether or not treatment is needed. These answers depend on inspection of the problem sites on several different occasions. How many pests or how much pest damage can be tolerated? This is also referred to as setting injury and action levels, which is discussed in detail in section 4. Even when tolerance for pest presence is at or near zero, as in the case of rats, monitoring will result in early pest detection, reducing the likelihood of unexpected pest outbreaks.

Monitoring helps determine where, when, and what kind of treatments are needed. This includes preventive treatments such as pest proofing and sanitation. Monitoring will show where these are most needed. It is unnecessary (and expensive) to treat all parts of a building or all plants on the school grounds for a pest when not all areas may be equally infested. Monitoring will pinpoint infestations and problem areas. On plants, monitoring will help time treatments to target the most vulnerable stage of the pest. The vulnerable stage may vary depending on the type of treatment used.

Monitoring allows evaluation of pest management actions. Monitoring after an action will show the success or failure of that action, so that future actions can be modified.

- Did the action reduce the number of pests below the level that causes intolerable damage?

- How long did the effect last?

- Did the action have to be repeated?

- Were there undesirable side effects?

- Do pest management action plans need to be adjusted?

3.3 What to Monitor?

Monitoring plants and their pests includes the regular observation and recording of:

- The condition of the plants (their vigor and appearance).
- The kind and abundance of pests (e.g., insects, mites, moles, weeds) as well as natural enemies (such as ladybugs, spiders, lacewing larvae and syrphid fly larvae).
- The amount of plant damage.
- Weather conditions (record any unusually dry, hot, wet, or cold weather in the last few weeks).
- Human behaviors that affect the plants or pests (e.g., foot traffic that compacts the soil, physical damage to plants caused by people, insistence on having certain plants grow in inappropriate situations).
- Cultural practices (e.g., pruning, fertilizing, mulching, treating pests) and their effects on the plants and the pest population.

Tables 3-1 and **3-2** provide more information to help quantify monitoring information. Using the abundance ratings in **Table 3-2** will make monitoring faster and easier, and will help standardize observations. If data that is more precise is needed, count the number of pests or their signs in a given area or on a certain number of leaves.

Monitoring weeds should be a seasonal activity timed to determine new weed pests or those that escaped treatment.

- Evaluate cultural practices that may favor weeds such as mowing, aeration, fertilizer use and irrigation practices.
- Review foot traffic patterns that may increase weeds.
- Monitor in spring and summer when most weeds are present and can be identified.

Monitoring structures involves the regular observation and recording of:

- The conditions of the building inside and out (structural deterioration, holes that allow pests to enter, conditions that provide pest harborage).
- The level of sanitation inside and out (waste disposal procedures, level of cleanliness inside and out, conditions that supply food to pests).
- The amount of pest damage and the number and location of pest signs (such as rodent droppings, termite shelter tubes and cockroaches caught in traps).
- Human behaviors that affect the pests (working conditions that make it impossible to close doors or screens, food preparation procedures that provide food for pests, etc.).
- Management activities (e.g., caulking, cleaning, setting out traps, treating pests) and their effects on the pest population.

Table 3-3 provides specific information on monitoring tools for both plants and structures.

3.4 Identifying the Target Pest

It is extremely important to correctly identify the problem pest and the cause of the pest problem. A pest cannot be effectively managed without knowing what it is or why it is present. For instance, putting out mousetraps to control what is really a rat problem can only result in failure. Setting out ant baits without caulking their entry point will not prevent more ant problems later. The UC IPM Pest Notes in Part 2 provide information that will help identify some of the most common pests found in and around schools. Take a specimen to a professional for identification for unusual pests. **Appendix K** describes how to properly collect and preserve an insect or plant specimen when seeking identification.

Once the pest is identified, read about its life cycle, food sources, habitat preferences, and natural enemies. Part 2, the UC IPM Pest Notes, will provide this information for the common pests, but if the pest is not included here, check the

Recommended Reading section, **Appendix H**, at the end of this manual for books that can help. Knowing the life habits of the pest will give clues about what to look for when monitoring and help decide how to best manage the pest.

If only damage symptoms and not the pest itself are visible, a sleuthing job is in order. More observation or observation at a different time of day may be necessary. Talk to other pest management professionals, local gardeners, nursery personnel, Cooperative Extension staff, or university researchers.

3.5 Timing Monitoring Activities

Timing and frequency of monitoring differs depending on the site and the pest(s). Outdoors, monitoring usually begins when plants put out new leaves in spring, and ends when leaves fall in autumn. Plants with annually recurring pest problems receive more attention than relatively pest-free plants. Monitoring can be incorporated into routine grounds maintenance activities such as weekly mowing, or can be a separate activity that occurs bi-weekly, monthly, or less frequently, depending on plant, pest, site, weather and other factors.

Indoors, monitoring might occur weekly during the early stages of solving a serious pest infestation, then taper off to monthly, once the pest problem is under control. Some pests are more active at night than during the day, thus, some monitoring may need to occur after dark. This is usually only necessary when trying to identify a nocturnal pest or trying to determine its travel routes and feeding habits. Once this is known, nighttime monitoring can often be replaced by daytime inspection of traps and plant foliage for signs of pest presence.

3.6 Recordkeeping

A monitoring program is only as useful as its recordkeeping system. Records serve as the memory of the IPM program. Written records should be kept since they are more accurate and detailed than human memory. Use of written records can avoid erroneous conclusions when comparing effects of treatment or other variables on the pest problem.

Recordkeeping is important to the pest manager because:

- Written observations about the specific pests and their management increase the pest manager's knowledge.
- More can be learned about the specific pest problems because details, such as past treatment success or failure won't be forgotten.

Recordkeeping is important to the school system and the IPM program because:

- Monitoring records form the basis for making decisions on the most sensible distribution of available resources to the areas most in need of attention or observation.

- Information can be easily and accurately passed from one employee to another.
- Information is not lost when employees leave or retire.

What Should the Records Show?

The record should always show:

- **What** is being monitored—name of the pest (common name and scientific name, if possible), stage of the pest (immature, adult), and for landscape pests, the name of the plant.
- **Where** monitoring is done—a map is always useful.
- **When** monitoring occurs—date and time.
- **Who** is doing the monitoring?

The rest of the information to record is listed under "What to Monitor," above. As mentioned before, the information in **Tables 3-1** and **3-2** will help to standardize some of the observations. Table 3-1 is specifically for plants, but **Table 3-2** can be used for structural pests as well as plant pests.

It is also important to standardize the format and the process by which the records are kept in order to maintain continuity from season to season and person to person. See

Appendix M for sample forms. Design forms with boxes to be checked off so less writing will be necessary.

Pest patterns emerge quickly when data gathered during monitoring are made visual, facilitating decision-making. This can be done by hand on graph paper, or by using one of the many graph-making features included in spreadsheet software. **Figure 3-1** shows fluctuations in cockroach trap counts.

No Time for Recordkeeping?

Try to make recordkeeping as easy and practical as possible. A person who is on the site frequently should be the person who monitors and keeps records. Try other solutions such as:

- Asking an interested parent to help record monitoring information, either by following the pest manager or by interviewing the person later.
- Setting up a small student project to follow pest managers around and record what they do.
- Having a quarterly or monthly meeting to discuss monitoring and using a cassette recorder to record the information.

3.7 Evaluating the Actions

Without evaluating the actions taken to reduce the pest problem, it will not be possible to improve the management program from year to year. Ask the following questions:

- Was the pest problem a significant one?
- Were the actions taken necessary or would the problem have gotten better if left alone?
- Did the actions taken and the least-hazardous treatments used adequately solve the problem?
- Could the problem be managed better next time? If so, how?
- Is more or better information needed to make treatment decisions in the future?

See **Appendix L** for sample pest management assessment of a school IPM program.

Table 3-1: Plant Condition Rating*

	Indicators of Plant Condition			
Plant Condition Rating	*Leaf Color*	*Amount/Size of Growth*	*Damaged Plant Parts*	*Presence of Pest Problems*
EXCELLENT	Good	Adequate	None to few	No major ones
GOOD	Good	Slightly reduced	Few to common	A few minor ones
FAIR	Poor	Much reduced	Common to abundant	Either major or minor ones occurring frequently
POOR	Poor	Severely reduced	Innumerable	Both major and minor ones occurring frequently

Leaf Color: Note that there are healthy plants that do not have bright green leaves. Leaves can be purple, yellow, or sometimes a mottled yellow and green (variegated). "Good" leaf color will not always be the same; it will depend on the kind of plant.

Amount/Size of Growth: This refers to the length of the new growth for the season as well as the number of new leaves, and the size of the leaves, flowers, or fruit.

Damaged Plant Parts: Look at the whole plant. Are there leaves with holes, spots, or discolorations? Are there wilted or dead leaves? Are there dead twigs or branches? Is the damage only on old leaves while new leaves look perfectly healthy?

Presence of Pest Problems: A major pest problem is one that has seriously affected or injured the plant and requires management. A minor pest problem may or may not have affected or injured the plant and may or may not require management.

*Adapted from Michigan State University, 1980

Table 3-2: Pest and Plant Damage Abundance Rating*

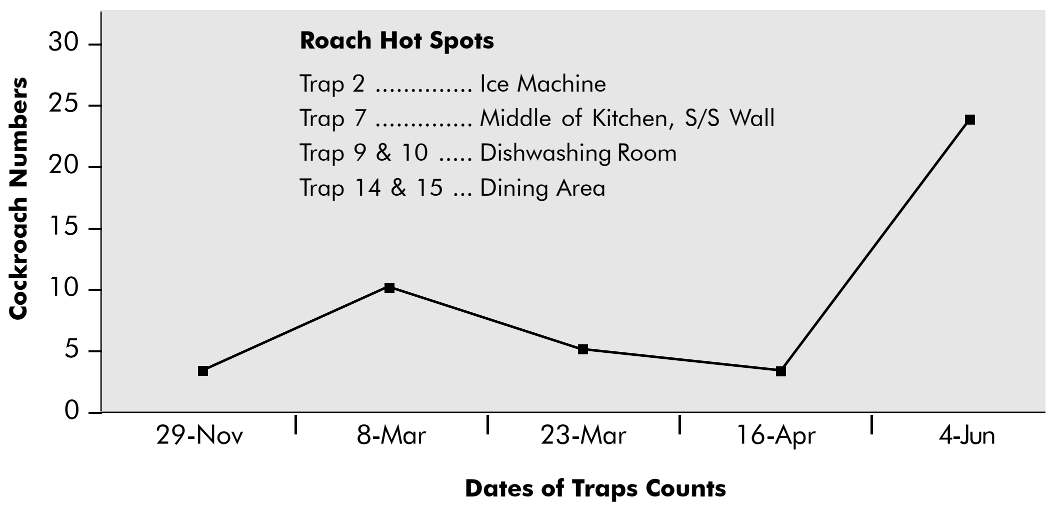
Abundance Rating	***Indicators of Abundance***
Few	Organisms or plant damage occasionally found, but only after much searching
Common	Organisms or plant damage easily found during typical searching
Abundant	Organisms or plant damage found in large numbers—obvious without searching
Innumerable	Organisms or plant damage extremely numerous—obvious without searching

*Adapted from Michigan State University, 1980

Table 3-3: Tools Used in Monitoring

Tools	***Use***	***Plants***	***Structures***
Monitoring forms	to write down what is seen	X	X
Maps or site plans of the buildings or grounds	to mark where pests are found and where traps are placed	X	X
Clipboard	to hold the monitoring forms and maps	X	X
Flashlight with a halogen bulb	to detect nighttime pest activity and for viewing darkened areas (e.g. under counters, in closets) during the day. A black light bulb can be substituted to detect scorpions.	X	X
Sticky traps (for many insects the color of the trap is important, e.g., thrips are attracted to blue; whiteflies prefer yellow). Glue boards are used for monitoring rodents.	to monitor a variety of insects, mites, and small rodents.	X	X
Hand lens (a small magnifying glass)	to help to see mites and small insects A lens that magnifies things at least 10 times (=10X) is usually adequate. A 15X lens can be used to distinguish among various mite species and other similarly small pest organisms such as thrips.	X	X
Plastic bags or small vials	to hold specimens for later examination or identification.	X	X
Small knife or screwdriver	to dig up weeds for specimens or for control, to probe damaged wood and to extract insect droppings from wood.	X	X
Ladder	for examining hard-to-reach spaces	X	X
Camera	for documenting pest damage to plants or structures before and after IPM methods have been applied	X	X

Figure 3-1: Fluctuating Cockroach Trap Counts



Setting Injury and Action Levels

SECTION 4

Total eradication of pest organisms is virtually impossible to achieve. A more realistic goal is to determine the injury level—the number of pests or the amount of pest-related damage that can be tolerated without suffering an unacceptable medical, economic, or aesthetic loss. The action level—the number of pests necessary for treatment to occur to prevent the injury level being reached—depends largely on pest biology and environmental conditions supporting the pest.

4.1 Determine Injury Levels First

Before determining the action level, first determine the injury level. This is the level of damage or the level of the pest population that causes unacceptable injury. The injury level will be higher than the action level (see **Figure 4-1** for sample thresholds).

4.1.1 Three Types of Injury

There are three types of injury relevant to school IPM programs:

- *Aesthetic injury* applies mainly to plants. This refers to injury that affects the appearance without affecting the health of the plant. There are few indoor pests or pests of structures that cause only aesthetic damage.
- *Economic injury* refers to pest damage that causes monetary loss, e.g., clothes moths destroying band uniforms or a plant disease that causes the death of a tree.
- *Medical injury* relates to human health problems caused by pests such as rodents, flies, yellowjackets and poison oak.

4.1.2 Injury Levels Differ Depending On The Pest And Its Location

The number of pests or amount of pest damage that can be tolerated (another way to think of injury level) will depend on the kind of pest and its location. A column of ants marching through an unused outbuilding is an entirely different situation from an ant invasion in the cafeteria. Many thousands of aphids can usually be tolerated on a tree, but one louse or nit on a child's head cannot.

Some pests are perceived as more frightening or disgusting than other pests, which in turn influences the number people will tolerate. Most people prefer crickets to cockroaches and find pigeons more acceptable than rats. Education and information can sometimes modify a person's tolerance level of a particular pest.

State, county, or local public health codes will have an impact on injury and action levels for pests such as rats, mice, cockroaches, and flies in areas where food is stored or prepared. In a public health emergency such as an outbreak of rabies or bubonic plague, government agencies may legally mandate control of certain pests. Consult the County Health Department for more information.

Box 4-1: Is a Response to an Existing Pest Population Needed?

- To determine whether a response is needed, ask the following questions:
- Are there state or county health codes requiring control of the pest problem (i.e., pests in areas where food is stored, prepared, or served)?
- Is the pest population growing?
- Are the pests located in a sensitive area (i.e., kitchens, cafeteria, or sick rooms)?
- Are the pests posing a health threat to humans?
- Are the pests damaging school property?
- Are the pests annoying or worrying students, faculty, and staff?
- Are the pests causing unacceptable aesthetic damage?

4.1.3 Don't Set the Level Too Low

One of the major causes of unnecessary treatments for pests is an unrealistically low tolerance level. Obviously, there is little leeway in tolerance for pests that have consequences for human health or the school budget, but for many other pests, the range of tolerance can be very wide. By understanding what damage is serious and by simply changing the way we view pests and pest damage, we can avoid many unnecessary treatments. For instance, most trees and shrubs can support substantial populations of caterpillars, aphids, psyllids, or leafhoppers without coming to any harm. Lawns can still be very attractive and functional even though the grass is not all of one kind and there are a number of weeds mixed in (as long as they don't pose a tripping hazard).

4.1.4 Determining the Injury Level

We all have intuitive, unspecified notions of injury level in various pest management situations, but these may not be accurate. In an IPM program, the aim is to try to make injury levels clear and precise. Monitoring is the only way to do this. It also takes knowledge and experience to understand the life cycles of pests, how fast their populations grow, and whether their damage will have serious consequences.

Example: Weeds in lawns are often only an aesthetic problem, but in other instances weaken ornamental plants. You may decide to set an aesthetic injury level in a lawn at 15 percent, or treat weeds in landscaped areas as soon as they begin to compete with ornamentals.

4.2 Determine Action Levels Based on Injury Levels

The action level is the level of pest damage or number of pests that triggers a pest management action to prevent pest numbers from reaching the injury level. The action is not necessarily a pesticide application. The action level will be lower than the injury level (see **Figure 4-1** for sample thresholds). Determining action levels involves making educated guesses about the likely impacts of numbers of pests present in a given place at a given time. In other words, an estimate of how high the pest population can grow before action is needed to prevent unacceptable injury. The action level must be determined and treatments applied before the injury level is reached.

Example: From previous experience, if more than ten cockroaches are found in a sticky trap in a classroom, teachers and students will complain. At two cockroaches per trap, no one notices that roaches are present. When there are *between two and ten roaches per trap, the treatment may consist of tracking down the infestation, sealing holes and cracks near the infestation, fixing leaks, and applying cockroach bait. At the same time, review food storage, sanitation, and trash handling procedures with the teacher. If catches exceed ten roaches per trap, check equipment and other inaccessible areas for harborage; vacuum and thoroughly clean the room; and ask the teacher to remove clutter and straighten all storage areas.*

4.2.1 Set Conservative Action Levels in the Beginning

During the beginning phase of an IPM program, it is wise to be conservative when establishing an initial action level. Set it low enough (i.e., low numbers of pests trigger treatments) to insure a wide margin of safety while learning monitoring methods. The initial action level should then be compared with other action levels for the same pest at different sites or locations. This is necessary to determine if the action level is set too high or too low, if treatments were necessary or not, and if they were properly timed.

The easiest way to collect comparative data is to set aside a portion of a school that remains untreated at the time another area is treated, or to monitor two schools where different action levels are applied to the same pest. By monitoring both sites, and comparing records, adjustment of the initial action level up or down can be evaluated.

Periodically, the action level should be re-evaluated for each pest and for each site. Changes in weather conditions, plant cultivars grown, horticultural practices, level of IPM experience of employees and building renovations can affect the setting of injury levels. See **Table 4-1** for example action levels for common school pests.

4.2.2 Avoid "Revenge" Treatments

Sometimes action takes place after the injury level has been reached and the pest population has begun to decline naturally, such as with seasonal changes (**Figure 4-2**). These "revenge" treatments are generally useless at controlling pests, are damaging to the environment, and an unnecessary expenditure of time and resources.

4.3 Declaring an Emergency Under the Healthy Schools Act

In the Healthy Schools Act, "emergency conditions" are defined as "circumstances in which the school designee deems that the immediate use of a pesticide is necessary to protect the health and safety of pupils, staff, or other persons, or the schoolsite." (Education Code section 17608(c))

Before an emergency occurs, the IPM coordinator (pest manager) must establish a communication "tree" with the names and phone numbers of people to contact in a crisis. Each contact should have a set of clearly defined responsibilities. For instance, the IPM coordinator notifies the public information officer who then handles the concerns of parents and the public. The IPM coordinator also notifies school administrators who decide who to notify at higher levels. The IPM coordinator must communicate effectively with all those involved in the emergency and must choose information that is appropriate for each person with whom he or she communicates. For instance, the superintendent will not need to be informed of specific mixing instructions for the pesticide, and the pesticide applicator will not need to know the names of the students and staff involved.

It is important to thoroughly document the emergency condition. Ask the following questions:

- **Who** is the person who is warning about the emergency? Is the person credible? Does he or she have the necessary knowledge to make a determination of an emergency?
- **What** is the problem? Find out as much as possible about the problem and what is causing it. What kind of pest is involved? Is the problem one of health and/or safety?
- **Where** is the problem? Is the location such that it is an immediate threat to health and safety? Can the area be cordoned off to prevent further problems?
- **When** did the problem occur? Is it happening at this moment, or did it happen two weeks ago, and is just now being reported?
- **How** did the problem occur? What are the circumstances surrounding the incident?
- **Why** did the problem occur? What factors contributed to the creation of the problem?

Once an emergency is declared and the channels of communication are open, the next step to take is assessing the possible options for solving the problem and choosing the most effective one. Once the treatment has been chosen, the IPM coordinator should communicate this decision. When the emergency is over, it is important to assess the effectiveness of the chosen course of action (see section 5 for more information) and to make adjustments in the pest management system so that the problem doesn't recur. This evaluation and the changes that are made should be reported to those involved in the emergency.

IPM is not simply a matter of substituting

Table 4-1: Examples of Action Levels* for Schools

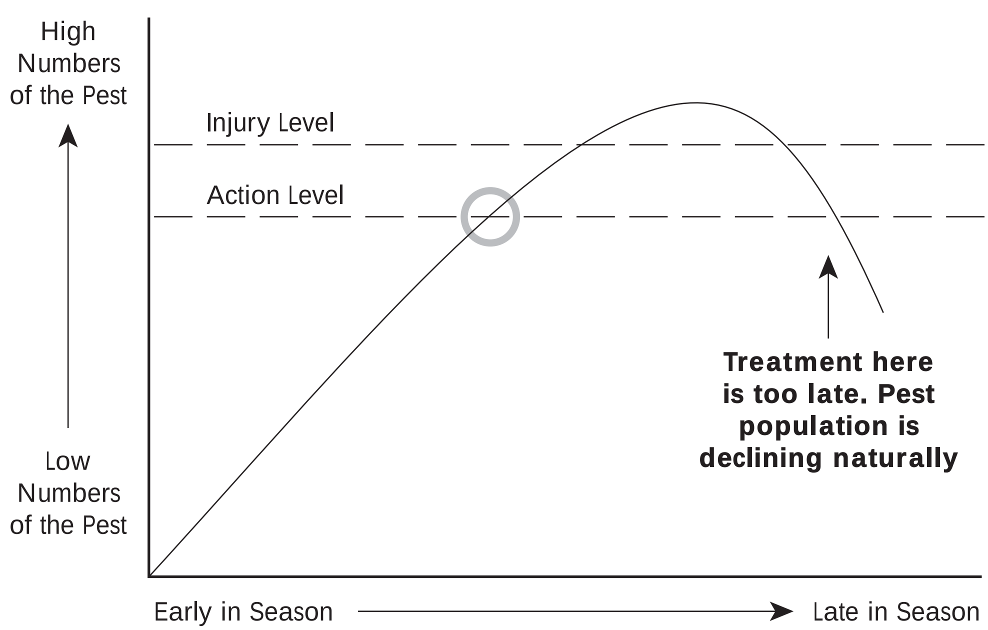
Pest	***Classrooms/ Public Areas***	***Maintenance Area***	***Infirmary***	***Kitchen***	***Grounds***
Ants, Argentine	5/room	5/100 ft^2 in 2 successive periods	1/room	3/room	1 nest within 25 ft of bldg.
Ants, carpenter	3/room	3/room	1/room	2/room	1 nest within 25 ft of bldg.
Bees, honey	1/room	3/room	1/room	1/room	If children threatened
Bees, bumble	1/room	3/room	1/room	1/room	If children threatened
Bees, carpenter	1/room	3/room	1/room	1/room	If children threatened; 1 carpenter bee/5 linear ft
Cockroaches	2/room	5/room	1/room	1/room	If noticeable or invading
Crickets	3/room	10/room	1/room	2/room	If nuisance
Grain & flour pests	1/package or container	N/A	N/A	1/package or container	N/A
Houseflies	3/room	5/room	1/room	1/room	5/trash can or 10 dumpster
Landscape Pest (general)	N/A	N/A	N/A	N/A	whenever damage approaches 10% per plant
Lawn pest (insects, nema-tode, disease)	N/A	N/A	N/A	N/A	whenever visible damage approaches 10% in any 100 ft^2 area
Lice (head or body)	Take no action, refer to nurse				
Mice	1/room	1/room	1/room	1/room	burrows or activity in any student area
Pigeons	Public area or roof: whenever droppings accumulate more than 1 inch or nests obstruct gutters or equipment. Roof ledges: 10/building for 3 consecutive inspections				
Poison Oak	Outdoor student activity areas: 1 plant Wooded areas: no control necessary unless near path or student activity area				
Rats	1/room	1/room	1/room	1/room	any burrow/activity
Silverfish	1/room	2/room	1/room	1/room	NA
Spiders, poisonous	1/room	1/room	1/room	1/room	1/activity area
Spiders, others	1/room	3/room	1/room	1/room	only if nuisance
Weeds	Lawns: whenever weeds approach 15% in any 100 ft^2 area Ornamental plantings: whenever competing with ornamental plans or whenever aesthetically displeasing				
Yellow jackets	Inside: 1/room; outside: 10/10 minutes at trash (this triggers more frequent trash pickup and/or search for nests)Outside in traps in early spring: 30 to 40 in 4 hours in a trap (this triggers area wide baiting)				

* The specific action levels mentioned in this table are offered as examples only. They are not required by regulation or law. Each school using action thresholds should develop action levels of their own, suited to specific conditions at the school.

This table was adapted from Pinto and Kraft, 2000.

Figure 4-1: Injury and Action Levels

Figure 4-2: Effect of "revenge" treatments.



Selecting Least-hazardous Pest Control Practices

SECTION 5

"good" pesticides for "bad" pesticides. Too often, we want an easy solution, a magic bullet that will solve all our problems in one shot. Unfortunately, pest management is complicated, and we cannot always expect a simple solution to pest problems. IPM works because combined strategies for pest management are more effective in the end than a single strategy. A good pest manager considers as many options as possible and tries to combine them into an effective program. The best pest managers have ideas for new and creative ways to solve pest problems. As defined by the Healthy Schools Act, IPM takes a preventive approach by identifying and removing, to the degree feasible, the basic causes of the problem rather than merely attacking the symptoms (the pests). This prevention-oriented approach is also best achieved by combining a number of treatment strategies.

5.1 Criteria for Selecting Least Hazardous Pest Control Practices

Once the IPM decision-making process is in place and monitoring indicates a pest treatment is needed, the choice of specific practices can be made. Choose practices that are:

- Least hazardous to human health.
- Least disruptive of natural controls in landscape situations.
- Least toxic to non-target organisms.
- Most likely to be permanent and prevent recurrence of the pest problem.
- Easiest to carry out safely and effectively.
- Most cost-effective in the short and long term.
- Appropriate to the weather, soils, water, and the energy resources of the site and the maintenance system.

5.1.1 Least Hazardous to Human Health

It is particularly important around children to take the health hazards of various strategies into consideration. Hazard refers to the extent and type of negative effects of the strategy in question.

Example: Aerosol sprays can kill cockroaches; however, they can also pose potential hazards to humans because the pesticide volatilizes in the air, increasing the likelihood of respiratory or lung exposure of students and staff. In addition, aerosol sprays may leave residues on surfaces handled by students and teachers. When cockroach baits are used instead, the pesticide is confined to a much smaller area, and if applied correctly, the bait will be out of reach of students and staff. Baits volatilize very little so lung exposure is not a problem. Cockroach baits manage cockroach populations much more effectively than aerosol sprays.

5.1.2 Least Disruptive of Natural Controls

In landscape settings, try to avoid killing off the natural enemies that aid in controlling pest organisms. Unfortunately, and for a number of reasons, natural enemies are often more easily killed by pesticides than are the pests. When choosing treatment strategies, always consider how the strategy might affect natural enemies. When choosing a pesticide, try to use one that has less effect on natural enemies. For help in determining this, see the resources listed in **Appendix G**.

5.1.3 Least Toxic to Non-Target Organisms

The more selective the control, the less harm there will be to non-target organisms in the environment.

Example: Aphid populations in trees often grow to high numbers because ants harvest the honeydew (sweet exudate) produced by the aphids, and protect them from their natural enemies. The ants that protect these aphid pests are often beneficial in other circumstances, aerating the soil and helping to decompose plant and animal debris. By excluding the ants from the tree with sticky bands around the trunk, it is often possible to achieve adequate suppression of the aphids without harming the ant populations.

5.1.4 Most Likely to Be Permanent and Prevent Recurrence of the Pest Problem

Finding treatments that meet this specification is at the heart of a successful IPM program because these controls work without extra human effort, costs, or continual inputs of other resources. These treatments often include changing the design of the landscape, the structure, or the system to avoid pest problems. The following are examples of preventive treatments:

- Educating students and staff about how their actions affect pest management.
- Caulking cracks and crevices to reduce cockroach (and other insect) harborage and entry points.
- Instituting sanitation measures to reduce the amount of food available to ants, cockroaches, flies, rats, mice, and other pests.
- Cleaning gutters and directing their flow away from the building to prevent moisture damage.
- Installing a sand barrier around the inside edge of a foundation to prevent termites from crawling up into the structure.
- Applying an insect growth regulator to prevent fleas from developing in an area with chronic problems.

5.1.5 Easiest to Carry out Safely and Effectively

While the application of pesticides may seem comparatively simple, in practice it may not be the easiest tactic to carry out safely or effectively. Use of conventional pesticides often involves wearing protective clothing, mask and goggles. In hot weather, people are often reluctant to wear protective gear because of the discomfort this extra clothing causes. By choosing not to wear the protective clothing, applicators not only violate the law but also risk exposure to hazardous materials.

5.1.6 Most Cost-Effective in the Long Term

In the short term, use of a pesticide often appears less expensive than a multi-tactic IPM approach; however, closer examination of the true costs of pesticide applications over the long term may alter this perception. In addition to labor and materials, these costs include licensing, maintaining approved pesticide storage facilities, disposing of unused pesticides, liability insurance, and environmental hazards.

Other factors to consider are whether a particular tactic carries a one-time cost, a yearly recurring cost, or a cost likely to recur a number of times during the season. When adopting any new technology (whether it be computers or IPM), there will be some start-up costs. IPM frequently costs less than, or about the same, as conventional chemically based programs, once the program is in place (see section 2.9.2 for a discussion on "Assessing Cost-Effectiveness").

In addition, parental and community concern about the use of conventional pesticides may make *any* use of pesticides in and around schools problematic. A public relations headache can develop over comparatively innocuous incidents, and require substantial amounts of time from the highest paid employees of the school district to attend meetings, prepare policy statements and other pest management duties. These costs should also be factored into the pest control equation.

5.1.7 Appropriate to the Weather, Soils, Water, and the Energy Resources of the Site and the Maintenance System

Skillfully designed landscapes can reduce pest problems as well as use of water and other resources. We cannot stress enough the importance of choosing the right plant for the right spot. Plants that are forced to grow in unsuitable sites where they are unable to thrive will be a continual source of problems. When plants die on the school site, take the time to find a replacement that is suited to the landscape. UCCE Master Gardeners are available in many counties for local planting recommendations. Look in the Yellow Pages under Government or go to http://ucanr.org/ to find the local County Cooperative Extension Office.

5.2 Timing Treatments

Treatments must be timed to coincide with a susceptible stage of the pest and, if possible, a resistant stage of any natural enemies that are present. Sometimes the social system (i.e., the people involved or affected) will impinge on the timing of treatments. Only monitoring can provide the critical information needed for timing treatments and thereby make them more effective.

Example: To control scales on plants using a low-hazard material such as insecticidal soap or horticultural oil, it is necessary to time treatments for the period (often brief) when immature scales (crawlers) are moving out from under the mother scales, seeking new places to settle down. It is at this stage that scales are susceptible to soaps and oils.

5.2.1 Spot Treatments

Treatments, whether pesticides or non-hazardous materials, should be applied only when and where needed. It is rarely necessary to treat an entire building or landscape area to solve a pest problem. By using monitoring to pinpoint where pest numbers are beginning to reach the action level and confining treatments to those areas, costs and exposure to hazardous materials can be kept to a minimum.

5.3 Summary of Available Treatment Options

The following is a list of general categories of treatment strategies. We have included some examples to help illustrate each strategy. The list is not intended to be exhaustive since products change, new ones are discovered or invented, and ingenious pest managers develop new solutions to old problems every day.

5.3.1 Education

Education is a cost-effective pest management strategy. Information that will help change people's behaviors—particularly how they store food and dispose of garbage—plays an invaluable part in managing pests like cockroaches, ants, flies, yellow jackets, and rodents. Education can also increase people's willingness to share their environment with other organisms so that people are less likely to insist on hazardous treatments for innocuous organisms. Teaching children about IPM will have a long-term effect on the direction of pest management as these students grow up to become consumers, educators, policy makers, and researchers. See **Appendix O** for training and licensing opportunities and **Appendix F** for IPM-related curricula and resources for the classroom.

5.3.2 Habitat Modification

Pests need food, water, and shelter to survive. If the pest manager can eliminate or reduce even one of these requirements, the environment will support fewer pests.

Design or Redesign of the Structure

Design changes can incorporate pest-resistant structural materials, fixtures and furnishings. Sometimes these changes can eliminate pest habitat. For example, buildings designed without exterior horizontal ledges will reduce pigeon problems. Inside, heavy-duty, stainless steel wire shelving mounted on rolling casters helps reduce roach habitat and facilitates cleanup of spilled food. For more information, a guide to pest management through prevention, "Pest Prevention: Maintenance Practices and Facility Design," can be located on the DPR School IPM Web site at www.schoolipm.info.

Sanitation

Sanitation can reduce or eliminate food for pests such as rodents, ants, cockroaches, flies, and yellowjackets.

Eliminating Sources of Water for Pests

This involves fixing leaks, keeping surfaces dry overnight, and eliminating standing water. Fixing any leaks has the added benefit of saving water.

Eliminating Pest Habitat

How this can be done will vary depending on the pest, but some examples are caulking cracks and crevices to eliminate cockroach and flea harborage, removing clutter that provides roach habitat, and removing dense vegetation near buildings to eliminate rodent harborage.

5.3.3 Modification of Horticultural Activities

Planting techniques, irrigation, fertilization, pruning, and mowing can all affect how well plants grow. A great many of the problems encountered in school landscapes are attributable to using the wrong plants or failing to give them proper care. Healthy plants are likely to have fewer insect, mite, and disease problems. It is very important that the person responsible for the school landscaping knows (or is willing to learn) about the care required by the particular plants at the school.

Designing/Redesigning of Landscape Plantings

- Choose the right plant for the right spot and choose plants that are resistant to or suffer little damage from local pests. This will take some research. Ask advice of landscape maintenance personnel, local nurseries, local pest management professionals, and County Extension agents or the master gardeners on their staffs.

- Include in the landscape flowering plants that attract and feed beneficial insects with their nectar and pollen, e.g., sweet alyssum (*Lobularia spp*.) and flowering buckwheat (*Eriogonum spp*.), species from the parsley family (Apiacae) such as yarrow and fennel, and the sunflower family (Asteraceae) such as sunflowers, asters, daisies, marigolds and zinnias.
- Diversify landscape plantings. A pest can devastate the entire area when large areas are planted with a single species of plant.

5.3.4 Physical Controls

Vacuuming

A heavy-duty vacuum with a special filter fine enough to screen out insect effluvia (one that filters out particles as small as 0.3 microns) is a worthwhile investment for a school. Some vacuums have special attachments for pest control. The vacuum can be used not only for cleaning, but also for directly controlling pests. A vacuum can pull cockroaches out of their hiding places and can capture adult fleas, their eggs, and pupae. A vacuum used outside can be used to collect spiders, box elder bugs, and cluster flies.

Trapping

Traps play an important role in least-hazardous pest control; however, in and around schools, traps may be disturbed or destroyed by students who discover them. To prevent this, place them in areas out of reach of the students in closets or locked cupboards. Another strategy is to involve students in the trapping procedures as an educational activity so they have a stake in guarding against trap misuse or vandalism.

Today a wide variety of traps is available to the pest manager. Some traps are used mainly for monitoring pest presence. These include cockroach traps and various pheromone (insect hormone) traps, although if the infestation is small, these traps can sometimes be used to control the pest. Other traps include the familiar snap traps for mice and rats, electric light traps for flies, and flypaper. There are also sticky traps for whiteflies and thrips, cone traps for yellowjackets, and box traps for skunks, raccoons, and opossums.

Barriers

Barriers can be used to exclude pests from buildings or other areas. Barriers can be as simple as a window screen to keep out flying and crawling insects or sticky barriers to exclude ants from trees. Barriers that are more complicated include electric fences to keep out deer and other vertebrate wildlife and L-shaped footings in foundations to exclude rodents.

Heat and Cold

Commercial heat treatments can be used to kill wood-destroying pests such as termites. A propane weed torch can be used to kill weeds coming up through cracks in pavement. Freezing can kill trapped insects such as yellow jackets before emptying traps, kill clothes moths, and kill the eggs and larvae of beetles and moths that destroy grain.

Removing Pests by Hand

In some situations removing pests by hand may be the safest and most economical strategy.

Tent caterpillars can be clipped out of trees, and scorpions can be picked up with kitchen tongs and killed in soapy water or in alcohol.

5.3.5 Biological Controls

Biological control uses a pest's natural enemies to attack and control the pest. We use the word "control" rather than "eliminate" because biological control usually implies that a few pests must remain to feed the natural enemies. The exception to this is a separate category of biological control called microbial control, which includes the use of plant and insect pathogens. Microbial controls are generally used like conventional chemical pesticides to kill as many pests as possible. Biological control strategies include conservation, augmentation, and importation.

Conservation

Conserving biological controls means protecting those already present in the school landscape. To conserve natural enemies you should do the following:

- Treat only if injury levels will be exceeded.
- Spot treat to reduce impact on non-target organisms.
- Time the treatments to be least disruptive in the life cycles of the natural enemies.
- Select the most species-specific, least-damaging pesticide materials, such as *Bacillus thuringiensis*, insect growth regulators that are specific to the pest insect, and baits formulated to be attractive primarily to the target pest.

Augmentation

This strategy artificially increases the numbers of biological controls in an area. This can be accomplished by planting flowering plants (also called insectary plants) to provide pollen and nectar for the many beneficial insects that feed on the pest insects or purchasing beneficials from a commercial insectary. Examples of the best-known commercially available natural enemies include lady beetles, lacewings, predatory mites, and insect-attacking nematodes. These are but a very small part of the large and growing number of species now commercially available for release against pests. Learning when to purchase and release them and how to maintain them in the field should be emphasized in any landscape pest management program. See the DPR Publication "Sources of Beneficial Organisms in North America" for commercial suppliers of biocontrol organisms (available online at http://www.cdpr.ca.gov/ under *Publications*).

Importation

People often ask if parasites or predators can be imported from another country to take care of a particularly disruptive pest in their area. It is true that the majority of pests we have in North America have come from other parts of the world, leaving behind the natural enemies that would normally keep them in check. "Classical" biological control involves searching for these natural enemies in the pest's native area and importing these natural enemies into the problem area. This is not a casual venture: it must be done by highly trained specialists in conjunction with certain quarantine laboratories approved by the United States Department of Agriculture. Permits must be obtained and strict protocols observed in these laboratories. Once the imported natural enemies become established in their new home, they usually provide permanent control of the pest. Patience is needed, however, because establishment of the natural enemies can take several years.

5.3.6 Microbial Controls

Microbial controls are naturally occurring bacteria, fungi, and viruses that attack insects and weeds. A growing number of these organisms are being sold commercially as microbial pesticides. Non-target organisms are much less likely to be affected because these microbial pesticides selectively attack pests.

The most well known microbial insecticide is *Bacillus thuringiensis*, or B.t. The most widely sold strain of B.t. kills caterpillars. Another strain kills only the larvae of black flies and mosquitoes, and a third strain kills only certain pest beetles.

Microbial herbicides made from pathogens that attack weeds are commercially available for use in agricultural crops. In the near future, there may be commercial products for use in urban horticultural settings.

5.3.7 Least-Hazardous Chemical Controls

The health of school occupants and long-term suppression of pests must be the primary objectives that guide pest control in school settings. To accomplish these objectives, an IPM program must always look for alternatives first and use pesticides only as a last resort. There are many chemical products to choose from that are relatively benign to the larger environment and at the same time effective against target pests. To find out whether a specific pesticidal product is exempt from the right-to-know requirements of the Healthy Schools Acts, see **Appendix B**.

"Least-hazardous" pesticides are those with all or most of the following characteristics: they are effective against the target pest, have a low acute and chronic toxicity to mammals, biodegrade rapidly, kill a narrow range of target pests, and have little or no impact on non-target organisms. There are many least-hazardous products being registered in California, including materials such as the following:

- Pheromones and other attractants.
- Insect growth regulators (IGRs).
- Repellents.
- Desiccating dusts.
- Pesticidal soaps and oils.
- Some botanical pesticides.

Pheromones

Animals emit substances called pheromones that act as chemical signals. The sex pheromones released by some female insects advertise their readiness to mate and can attract males from a great distance. Other pheromones act as alarm signals.

A number of pheromone traps and pheromone mating confusants are now commercially available for some insect pests. Most of the traps work by using a pheromone to attract the insect into a simple sticky trap. The mating confusants flood the area with a sex pheromone, overwhelming the males with stimuli and making it very difficult for them to pinpoint exactly where the females are.

Insect Growth Regulators (IGRs)

Immature insects produce juvenile hormones that prevent them from metamorphosing into adults. When they have grown and matured sufficiently, their bodies stop making the juvenile hormones so they can turn into adults.

Researchers have isolated and synthesized some of these chemicals and when they are sprayed on or around certain insects, these insect growth regulators prevent the pests from maturing into adults. Immature insects cannot mate and reproduce, so eventually the pest population is eliminated. These hormones do not affect us since humans and other mammals don't metamorphose as insects do.

Repellents

Some chemicals repel insects or deter them from feeding on treated plants. For example, a botanical insecticide extracted from the neem tree (*Azadirachta indica*) can prevent beetles and caterpillars from feeding on treated rose leaves. Current research shows that neem has a very low toxicity to mammals. A number of neem products are currently available but as with all pesticides, it is important to use them according to label instructions to ensure success and safety.

Desiccating Dusts

Insecticidal dusts such as diatomaceous earth and silica aerogel, made from natural materials, kill insects by absorbing the outer waxy coating that keeps water inside their bodies. With this coating gone the insects die of dehydration. Silica aerogel dust can be blown into wall voids and attics to kill drywood termites, ants, roaches, silverfish, and other crawling insects. Although these materials are not poisonous to humans directly, the fine dust travels freely through the air and can be irritating to the eyes and lungs: always use a dust mask and goggles during application.

Pesticidal Soaps and Oils

Pesticidal soaps are made from refined coconut oil and have a very low toxicity to mammals. They can be toxic to fish, so they should not be used around fishponds. Researchers have found that certain fatty acids in soaps are toxic to insects but decompose rapidly leaving no toxic residue. Soap does little damage to lady beetles and other hard-bodied insects but may be harmful to some soft-bodied beneficials. A soap-based herbicide is available for controlling seedling stage weeds; the soap kills the weeds by penetrating and disrupting plant tissue. Soap combined with sulfur is used to control common leaf diseases such as powdery mildew.

Insecticidal oils (sometimes called dormant oils or horticultural oils) also kill insects and are gentle on the environment. Modern insecticidal oils are very highly refined. Unlike the harsh oils of years ago that burned leaves and could only be used on deciduous trees during the months they were leafless, the new oils are so light they can be used to control a wide variety of insects even on many bedding plants.

Note: it as always wise to test a material on a small portion of the plant first to check for damage before spraying the entire plant.

Botanical Pesticides

Although botanical pesticides are derived from plants, they are not necessarily better or safer than synthetic pesticides. Botanicals can be easily degraded by organisms in the environment; however, plant-derived pesticides tend to kill a broad spectrum of insects, including beneficials, so they should be used with caution. The most common botanical is pyrethrum, made from crushed petals of the pyrethrum chrysanthemum flower. "Pyrethrins" are the active ingredient in pyrethrum, but "pyrethroids" have been synthesized in the laboratory, and are much more long lasting and powerful than the pyrethrins. Pyrethroids are toxic to fish and other aquatic invertebrates. Neem, another botanical pesticide, is discussed previously under "Repellents." Some botanicals, such as nicotine or sabadilla, can be acutely toxic to humans if misused, and rotenone is very toxic to fish. The same care must be used with these materials as with conventional pesticides.

5.4 How to Select a Pesticide for an IPM Program

When contemplating the use of a pesticide, it is prudent to acquire a Material Safety Data Sheet (MSDS) for the compound. MSDS forms are available from pesticide suppliers and contain some information on potential hazards and safety precautions. See **Appendix H**, the Recommended Readings section of this manual, for other reference materials on pesticides. **Appendix G,** Pesticide Information Resources, lists organizations that provide information on pesticide toxicity. You will find links to MSDS sites on the California School IPM Web site at www.schoolipm.info. Some pesticide products are exempt from the recordkeeping, notification and posting requirements of the Healthy Schools Act. Use the worksheet "Pesticides exempted from Healthy Schools Act right-to-know requirements" (**Appendix B**) to determine if a specific product is exempt. DPR's School HELPR Web page is a guide to choosing the optimal pest management action, depending on the situation.

The following criteria should be used when selecting a pesticide: safety, species specificity, effectiveness, endurance, speed, and cost.

5.4.1 Safety

This means safety for humans (especially children), pets, livestock, and wildlife, as well as safety for the overall environment. Read the pesticide label. Pesticide labels contain information to protect your health. Every label displays a "signal word" that indicates the level of acute (immediate) toxicity of the formulated pesticide product. See **Box 5-1** for explanations of the signal words. Questions to ask about safety are:

- What is the acute (immediate) and chronic (long-term) toxicity of the pesticide?

  Acute toxicity is the toxicity of the chemical after a single or limited exposure. It is measured by the lethal dose (LD50) or the lethal concentration (LC50) which causes death in 50 percent of the test animals (measured in milligrams of pesticide per kilogram of body weight of the test animal). The higher the LD50/LC50 value, the more poison it takes to kill the target animals and the less toxic the pesticide. In other words, a high LD50/LC50 value equals low toxicity. The LD50/LC50 does not reflect any effects from long-term exposure that may occur at doses below those used in short-term studies.

  Chronic toxicity refers to potential health effects from exposure to low doses of the pesticide for long periods. Chronic effects can be carcinogenic (cancer-causing), mutagenic (causing genetic changes), or teratogenic (causing birth defects). Sources of information on health effects of pesticides are provided in **Appendix G** or online at www.schoolipm.info.

- How mobile is the pesticide? Is the compound volatile, so that it moves into the air breathed by people in the building? Can it

Box 5-1: Definitions of signal words for pesticides

Federal law and the acute toxicity data determine the signal words and precautionary statements that must appear on pesticide labels (40 Code of Federal Regulations 156.10). Always read pesticide labels thoroughly before using and be sure to follow label directions. Misuse of any pesticide is not only illegal, but may create a dangerous situation.

The signal word (see below) indicates the most severe level of anticipated acute (immediate) toxicity of the formulated pesticide product to humans based on at least one of five to six tests conducted with laboratory animals. The chronic (long-term) toxicity is not indicated on the label. Note that chronic toxicity may be important for pesticide products used frequently. You can obtain chronic toxicity information from several reputable sources such as U.S. EPA (http://www.epa.gov/iriswebp/iris/index.html) or the National Pesticide Information Center (http:/npic.orst.edu). Pesticide labels typically bear the warning "Keep out of reach of children."

Signal Word	Toxicity category	Precautionary statements by toxicity category Oral, inhalation or dermal toxicity	 Skin and eye local effects
Danger — Poison Danger	I	Fatal (poisonous) if swallowed [inhaled or absorbed through skin]. Do not breathe vapors [dust or spray mist]. Do not get in eyes, on skin, or on clothing. [Front panel statement of practical treatment required]	Corrosive, causes eye and skin damage [or skin irritation]. Do not get in eyes, on skin, or on clothing. Wear goggles or face shield and rubber gloves when handling. Harmful or fatal if swallowed. [Appropriate first aid statement required].
Warning	II	May be fatal if swallowed [inhaled or absorbed through skin]. Do not breathe vapors [dust or spray mist]. Do not get in eyes, on skin, or on clothing. [Appropriate first aid statement required].	Causes eye [and skin] irritation. Do not get in eyes, on skin, or on clothing. Harmful if swallowed. [Appropriate first aid statement required].
Caution	III	Harmful if swallowed [inhaled or absorbed through skin]. Avoid breathing vapor [dust or spray mist]. Avoid contact with skin [eyes or clothing]. [Appropriate first aid statement required].	Avoid contact with skin, eyes or clothing. In case of contact, immediately flush eyes or skin with plenty of water. Get medical attention if irritation persists.
[No signal word]	IV	[No precautionary statements required]	[No precautionary statements required]

If no signal word occurs on the label, then the product has the lowest toxicity category or contains active ingredients that are exempt from federal and California registration; however, it may cause slight skin or eye irritation.

Products you select must be registered or exempted from registration*. Note that some products are neither registered nor exempted, and are, therefore, illegal to use. If chemical control is necessary, select legal products with no signal word or with caution as a signal word when available.

For information about products exempt from registration, see* **Appendix B *and California Notice to Registrants 2000-6, which is available on our Web site at* www.cdpr.ca.gov *under Programs and Services, Registration Branch.*

move through the soil into the groundwater? Does it run off in rainwater to contaminate creeks and rivers?

- What is the residual life of the pesticide? How long does the compound remain toxic in the environment?
- What are the environmental hazards listed on the label? What are the potential effects on wildlife, beneficial insects, fish, or other animals?

5.4.2 Species Specificity

The best pesticides are species-specific; that is, they affect just the group of animals or plants you are trying to suppress. Avoid broad-spectrum materials that kill many different organisms because they can kill beneficial organisms that keep pests in check. When broad-spectrum materials must be used, apply them in as selective a way as possible by spot treating.

5.4.3 Effectiveness

This issue is not as straightforward as it might seem since it depends on how effectiveness is being evaluated. For example, a pesticide can appear to be very effective in laboratory tests because it kills 99 percent of the test insects. In field tests under more realistic conditions, however, it may also kill 100 percent of the pest's natural enemies. This will lead to serious pest outbreaks later.

5.4.4 Endurance

A pesticide may have been effective against its target pest at the time it was registered, but if the pest problem is now recurring frequently, it may be a sign that the pest has developed resistance to the pesticide, in other words, that the pesticide has lost its endurance.

5.4.5 Speed

A quick-acting, short-lived, more acutely toxic material might be necessary in emergencies; a slow acting, longer lasting, less-hazardous material might be preferable for a chronic pest problem. An example of the latter is using slower-acting boric acid for cockroach control rather than a quicker-acting but more hazardous organophosphate.

5.4.6 Cost

This is usually measured as cost per volume of active ingredient used. Some of the newer, less-hazardous microbial and botanical insecticides and insect growth regulators may appear to be more expensive than some older, more hazardous pesticides. The newer materials, however, tend to be effective in far smaller doses than the older materials—one container goes a long way. This factor, together with their lower impact on the environment, often makes these newer materials more cost-effective.

5.5 Pesticide Use, Disposal, and Storage

In California, pesticide use, disposal, and storage are governed by laws in the California Food and Agricultural Code (FAC) and regulations in Title 3 of the California Code of Regulations (CCR). The laws and regulations concerning pesticide use have become increasingly complicated over the past few years. See the Pesticide Safety Information Series N in **Appendix P** for more detailed information regarding pesticide use in California schools. Pesticide applicators in schools must follow state and federal laws regarding pesticide use, disposal and storage in addition to following the requirements of the Healthy Schools Act.

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Abiotic: Nonliving component of an ecosystem, such as temperature, soil type or amount of sunlight.

Action level: The number of pests or level of pest damage that triggers a control action.

Action threshold: (see Action level)

Active ingredient: Chemicals in a pesticide formulation that are biologically active, i.e., responsible for killing or repelling the pest.

Acute toxicity: The degree to which a substance is poisonous or injurious to an organism after short-term exposure.

Adjuvant: chemicals added to a pesticide product to improve its effectiveness.

Aesthetic injury: Visually displeasing damage to plants or structures. Annoyance or embarrassment from visibility of a pest, or damage to the appearance of plants which may reduce aesthetic appeal but does not necessarily adversely affect plant health

Annual: A plant that completes its life cycle in one year and then dies.

Antimicrobial: Pesticides that are intended to disinfect, sanitize, reduce, or mitigate growth or development of microbiological organisms; or protect inanimate objects (for example floors and walls), industrial processes or systems, surfaces, water, or other chemical substances from contamination, fouling, or deterioration caused by bacteria, viruses, fungi, protozoa, algae, or slime, such as sanitizers and disinfectants. Although sanitizers and disinfectants are exempt from notification and posting requirements under the Healthy Schools Act, they are not exempt from licensed pest control business requirements to report pesticide use.

Augmentation: Releases of beneficial insects to establish or increase a natural population.

Bacillus thuringiensis: Insect pathogenic bacteria. A microbial insecticide effective against larval stages of many species of lepidoptera.

Bait: A food or other substance used to attract a pest to a pesticide or trap.

Barrier: Something material that prevents entry by pests into an area, such as screens on windows.

Beneficial insect: An insect that feeds on pest organisms.

Biennial: A plant that completes its growth in two years. The first year it produces leaves and stores food; the second year it produces fruits and seeds.

Biological control: Managing pests by using natural enemies such as predators, parasites and disease-causing organisms.

Biotic: The living components of an ecosystem, such as plants, animals and microorganisms.

Botanical pesticide: Pesticides derived from plants rather than synthesized.

Broad-spectrum: A pesticide effective against many species of pests.

Carcinogen: Any substance that can cause or aggravate cancer.

Chemical control: The use of a pesticide to reduce pest populations or activity.

Chronic toxicity: The capacity of a substance to demonstrate toxic effects as a result of repeated exposures over a period of time.

Common name: A name given to a pesticide active ingredient by a recognized committee on pesticide nomenclature

Control action threshold: Pest population level at which treatment is necessary to prevent economic loss.

Corrosive: A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact.

Crack-and-crevice treatment: As defined by the Healthy Schools Act of 2000, "the application of small quantities of a pesticide consistent with labeling instructions in a building into openings such as those commonly found at expansion joints, between levels of construction and between equipment and floors." The application of pesticides in the form of gels or pastes into cracks and crevices is exempt from the notification, posting and record keeping requirements of the Healthy Schools Act.

Cultural control: pest management practices which make the environment less favorable for pests. In schools, it involves changing people's behaviors and habits such as sanitation and garbage pickup schedules. It also refers to alterations in landscape design and installation and maintenance of grounds to reduce pest activity and damage.

Desiccating dust: A pesticide that dehydrates living tissues

Disinfectant: An agent that kills or controls vegetative forms of bacteria, molds, and mildews but does not ordinarily kill bacterial spores.

Dormant oil: An oil-based pesticide applied during the dormant stage of plant growth.

Economic injury level: Pest population level sufficient to cause economic losses greater than the cost of control.

Ecosystem: A self-sufficient habitat where living organisms and the abiotic environment continuously exchange matter and energy.

Emergency condition: As defined by the Healthy Schools Act of 2000, "any circumstances in which the school district designee deems that the immediate use of a pesticide is necessary to protect the health and safety of pupils, staff, or other persons, or the schoolsite."

EPA registration number: A number assigned to a pesticide product when U.S. EPA registers the product for use. The number must appear on all labels for the product. This number must appear on the pesticide application warning sign that must be posted when applying most pesticides on schools grounds. California uses U.S. EPA registration numbers for all products except adjuvant, which are given a California registration number.

Eradication: Control of diseases or pests by their complete elimination after introduction into a certain area.

Evapotranspiration: The total water loss from a soil by being drawn up through plant tissue and evaporated from leaf and soil surfaces.

Exclusion: A quarantine, usually defined by a legislative order, to prevent entry of certain exotic pests.

Exotic: referring to a species that is not indigenous to a region

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA): The federal law and its amendments that regulate pesticide registration and use.

Flushing: The use of an aerosol pesticide to drive a pest out of its hiding place.

Frass: The combined feces, shed skins and particles of food left by an insect pest; or the combined feces and wood fragments left by a wood-boring beetle.

Hand lens: A small, portable magnifying lens used to look at small insects.

Harborage: The hiding places or protected areas, such as cracks and crevices, which cockroaches and other pests inhabit.

Healthy Schools Act: A California right-to-know law passed in 2000 that requires all public K-12 schools to notify, post and keep records of pesticide use (see Section One for more detail).

Herbaceous: Plants having fleshy tissues rather than persistent woody tissues.

Herbicide: Pesticide to control unwanted vegetation either before or after its emergence from the ground.

Horticultural oil: Highly refined petroleum (or seed derived) oils that are manufactured specifically to control pests on plants.

Indigenous: Native to a specified area or region.

Inert ingredient: A material in a pesticide formulation that does not have anti-pest activity.

Insect growth regulator (IGR): An insecticide that interferes with insect hormones, affecting the insect's ability to develop from pupa to adult or to reproduce.

Insecticide: A substance that kills or controls insects.

Integrated pest management: As defined by the Healthy Schools Act, a pest management strategy that focuses on long-term prevention or suppression of pest problems through a combination of techniques such as monitoring for pest presence and establishing treatment threshold levels, using non-chemical practices to make the habitat less conducive to pest development, improving sanitation, and employing mechanical and physical controls. Pesticides that pose the least possible hazard and are effective in a manner that minimizes risks to people, property and the environment, are used only after careful monitoring indicates that they are needed according to pre-established guidelines and treatment thresholds. (Food and Agricultural Code section 13181)

Invertebrate: An animal without a spinal column (backbone). Examples: insects, spider, mollusks.

IPM coordinator: The school employee responsible for day-to-day interpretation of the IPM policy for a school or school system. The IPM Coordinator may or may not be a pest management professional, but is the decision-maker who receives specialized training in IPM, accesses the advice of professionals and chooses a course of action. In many districts, an IPM coordinator is equivalent to the school district designee.

IPM policy: A written document stating a school's commitment to IPM and defining overall IPM goals. This document is updated periodically, and used to guide decision-making as the IPM program is implemented.

LC50: The concentration of a substance in air that causes death in 50% of the animals exposed by inhalation. A measure of acute toxicity.

LD50: The amount of a substance which, when taken orally or absorbed through the skin, kills half of the test animals. An expression of a compound's acute toxicity.

Least hazardous: Referring to a pest management treatment that causes the least exposure or harm to humans and the environment. The pest management method, toxicity of pesticides used and exposure to the occupants are all considered.

Life cycle: The time of development of an organism from egg or birth to reproductive capacity.

Mechanical control: Pest control methods including cultivation and burning.

Metamorphosis: To change in form, as an insect does when developing from larva to adult.

Microbial control: Pest management using a pesticide whose active ingredient is a bacteria, virus, fungus, protozoa or nematode.

Monitoring: A systematic pest inspection that is conducted at regular intervals to determine the numbers of a pest, the amount of pest damage, access to food, water and harborage sites and the effectiveness of treatment methods.

Mulch: A layer of material placed on the soil surface to prevent weed growth

Mutagen: A chemical that is able to induce significant and permanent change in hereditary material thereby causing mutation in the succeeding generation.

Natural enemy: A predator or parasite that prey on or live in organisms in the natural habitat, thereby limiting their population.

Niche: An organism's place and role in its environment.

Nontarget species: Any plant, animal or other organism that may be accidentally damaged during a pesticide application.

Notification: A formal notice in writing to all parents and staff of a school district of expected pesticide use on a schoolsite.

Organic matter: A soil component resulting from the decay of plant and animal materials.

Perennial: A plant that lives from year to year.

Pest: Any living organism that interferes with or threatens human, animal or plant health, property or the environment. A pest in one environment may be beneficial in another.

Pest control: The use of any substance, method or device to prevent, destroy, repel, mitigate, or correct a pest infestation or inhibit, regulate, stimulate, or alter growth of plants (desirable or undesirable).

Pest proofing: A non-chemical, physical control measure to prevent the entry or movement of pests into or out of a structure or area. This includes sealing and caulking of crevices and holes, installation of screens, etc.

Pesticide: Any substance used to control, prevent, destroy, repel, attract or mitigate any pest. Pesticides include insecticides, insect repellents, miticides, herbicides, fungicides, fumigants, nematicides, rodenticides, avicides, plant growth regulators, defoliants, desiccants, antimicrobials, and algicides. Note: in California, adjuvants also must be registered as pesticides.

Pesticide application warning sign: A sign identifying the location, time and identity of a pesticide (including product name, manufacturer's name and the U.S. EPA's product registration number) that will be applied on a schoolsite. Signs must be posted 24 hours before a pesticide application and 72 hours afterward

Pheromone: A substance released by one organism that modifies the behavior of another of the same species. Synthetic pheromones are used in traps and lures as control or monitoring devices for some insect pests.

Physical control: Habitat alteration or changes in physical structure to reduce pest populations or their activity.

Phytotoxic: Causing injury or death to plants or portions of plants.

Population: A group of the same organisms living in a defined area.

Posting: The act of placing pesticide application warning signs in the location of a future pesticide application.

Prevention: The act of forestalling pest problems by taking actions such as sanitation.

Pyrethrins: Botanical insecticides, known collectively as pyrethrum, extracted from crysanthemums, having quick knockdown and short residual insecticidal effects.

Pyrethroid: Any of the various synthetic insecticidal compounds that are related to the pyrethrins.

Reduced-risk pesticide: a pesticides which: (1) reduce pesticide risks to human health; (2) reduce pesticide risks to non-target organisms; (3) reduce the potential for contamination of valued, environmental resources, or (4) broaden adoption of IPM or makes it more effective.

Repellent: Materials that keep pests away from plants or animals in need of protection, e.g. to protect humans from mosquitoes.

Residual pesticide: A pesticide that continues to be actively pesticidal on a treated surface or area for an extended time period after application.

Restricted use pesticide: A pesticide that can be sold to or used by only certified applicators.

Rodenticide: A pesticide used to control mice, rats, gophers and other rodents.

Runway: A path that rats and mice use to move to and from their burrows or nests. Runways usually follow along the base of a wall, building foundation or fence line.

Sanitation: Measures that promote cleanliness and pest-free surroundings. In pest management, steps taken to remove the source of a pest's food or harborage.

Sanitizer: A chemical that reduces, but does not necessarily eliminate, microorganisms from the inanimate environment to levels considered safe as determined by public health codes or regulations.

School district designee: As defined by the Healthy Schools Act of 2002, "the individual identified by the school district to carry out the requirements of this article at the schoolsite." This person may also be called the IPM Coordinator.

Schoolsite: As defined by the Healthy Schools Act, "any facility used for public day care, kindergarten, elementary, or secondary school purposes. The term includes the buildings or structures, playgrounds, athletic fields, school vehicles, or any other area of school property visited or used by pupils. "Schoolsite" does not include any postsecondary educational facility attended by secondary pupils or private day care or school facilities."

Scouting: Planned, routine monitoring for the purpose of detecting pests or pest damage.

Self-contained bait or trap: Tamper- and child-resistant bait stations whether they are for rodents, general pests, or termites.

Spot treatment: Treatment of localized or restricted patches within an area not to exceed two feet square.

Sticky trap: Traps containing a sticky substance that holds insects so they can be counted.

Teratogen: A substance or agent capable of producing or inducing functional deviations or developmental anomalies not heritable, in or on an animal embryo or fetus.

Thatch: An accumulation of partially decomposed dead stems, roots, rhizomes or leaves on the soil surface below the green top growth of turf.

Toxicity: The degree to which a material (such as a pesticide) is poisonous to an organism; the ability of a material to cause harmful, acute, delayed or allergic effects.

Transect: A sample area of vegetation usually in the form of a long continuous strip.

Vertebrate: An animal with a spinal column (backbone).

Volatile: Describing the quality in which a substance, usually a liquid, evaporates at ordinary temperatures if exposed to the air.