SCHOOL IPM 2015:
A Strategic Plan for
Integrated Pest Management
in Schools in the United States

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The editors are responsible for all content which may not represent the opinions of all contributors. This document will be reviewed and revised periodically. Corrections of factual errors and other comments are welcome and may be emailed to school.ipm.pmsp at ipminstitute.org.

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1. Executive Summary

Pest management practices in our nation's schools are in need of improvement. More than 50 published surveys and studies since 1994 have documented deficiencies including unmanaged pest infestations, unsafe and illegal use of pesticides, and unnecessary pesticide exposures to individuals at schools.

Improvement is feasible and affordable. Pest complaints and pesticide use in schools and other public buildings have been reduced by 71 to 93% through Integrated Pest Management (IPM), with no long-term increase in costs.

Full implementation of IPM includes a thorough understanding of pests and pest biology by pest managers; careful inspection and monitoring for pest presence and pest-conducive conditions; and pest prevention through effective education, sanitation and facility maintenance. Pesticides are used only when non-chemical measures are inadequate. When needed, pesticide products are selected that minimize toxicity and potential for exposure.

Our challenge is to replicate our well documented IPM successes in all of our schools. The goal of this Pest Management Strategic Plan is to assess the current status of pest management in our school systems, compile our current understanding of best practices and set out a plan of action to achieve full implementation of IPM in all of our schools by 2015.

Specifically, prompt and coordinated action is required to:

- Increase awareness among the school community and key influencers of the problems and availability of ready solutions to reduce pest problems and pesticide exposure;

- Generate a commitment from agencies, organizations and individuals already working in and influencing schools to actively participate;

- Provide financial, material and human resources to implement proven approaches including education, regulation and specific management tactics that prevent and avoid pest problems;

- Improve regulations and compliance with existing laws;

- Address research questions that may lead to less hazardous approaches to managing common and occasional pests in schools;

- Educate staff and students about the benefits of IPM and how they can apply this approach to their homes and workplaces; and

- Increase financial resources available to meet these objectives.

In preparing this plan, we have enlisted participation by leaders representing key influencer and practitioner groups, and have charged this work group with assisting in the implementation of the plan including recruiting others from their professions to achieve our goal.

Although much of the information included in this plan applies to pest management in other environments including housing, childcare facilities, college campuses, libraries and other public buildings, we have focused its scope on K-12 schools. We have not included anti-microbial pesticides in this document. Rather, we refer readers to excellent work in “green cleaning” practices designed to improve the effectiveness and reduce the hazards associated with sanitation and maintenance practices and products.

2. Introduction

Millions of children, teachers, support staff and parents spend substantial amounts of time in schools and on school grounds. Unmanaged pest problems and unsafe pesticide use practices threaten our children's health and our ability to educate them effectively. Full implementation of Integrated Pest Management (IPM) is affordable and cost-effective, and can reduce pesticide exposure, pesticide use and pest complaints. However, adoption remains low. A coordinated national effort is critically needed to make safe and effective pest management the standard for all of our schools. This strategic plan is designed to accomplish this objective by facilitating implementation of high level IPM in all schools nationwide by 2015.

Approximately 49.1 million students are served by 6.1 million staff including 3.1 million teachers in 14,383 public school districts in the US (US Dept. of Education 2005, 2007). These districts include approximately 95,726 elementary and secondary schools. An additional 5.3 million K-12 students are served by 425,406 teachers at 28,273 private schools.

Record levels of elementary and secondary school enrollment are expected every year over the next seven years, with 2014 enrollment predicted to be 6% higher than 2005 levels (US Department of Education 2005).

Children's special vulnerability to pesticides includes both increased opportunity for exposure and increased susceptibility vs. adults (Goldman 1995, National Academy of Sciences 1993, US EPA 2002, US GAO 1999). Routes of exposure include hand-to-mouth, hand-to-ground and hand-to-floor behavior, and increased consumption of air, food and water. Increased susceptibility is a factor of underdeveloped and rapidly developing bodies including nervous, endocrine and other systems.

Improvements are Needed

Numerous studies and surveys over the past 13 years have documented deficiencies in pest management in schools including hazardous pesticide use and uncontrolled pest problems (Appendix G). In non-IPM schools, neurotoxic pesticide residues can contaminate baseboards and floors (Williams *et al.* 2005). These residues were also found on walls at even higher concentrations, likely due to the fact that walls are washed infrequently. German cockroach allergen levels are also higher in non-IPM schools, and as high as 100 times greater than clinically relevant levels (C. Schal, NC State Univ., pers. comm., May 2007). In IPM schools, allergens were below levels of concern.

Regulations addressing pest management in, around and adjacent to schools vary greatly between states (Appendix B, Beyond Pesticides 2007). Requirements in some states include posting and notification of pesticide applications, re-entry periods before staff or students are permitted in treated areas, qualifications for applicators of pesticides in schools, pesticide product selection, adoption of IPM policies or plans, and buffers between neighboring pesticide uses and schools. Federal legislation has been proposed unsuccessfully since 1999 (re-introduced most recently as House Bill 3290 in August, 2007).

School district policies also vary widely, with the majority of districts having no formal policies specific to pest management practices and no designated IPM coordinator directing program implementation.

In 1999, a survey of Vermont schools indicated 75% of respondents used pesticides monthly and 30% made regular applications whether pests were present or not (Sterling and Browning 1999). Fifty-eight percent of schools using pesticides kept no records of use. Less than 13% of schools posted signs or warned students before or after applications.

Illegal practices have been reported in several surveys, including application of pesticides no longer registered for use in schools (Becker *et al*. 1998, Miller 2002). On-site evaluations of more than 29 school systems in more than 14 states indicated that nearly half were violating legal requirements or formal district policies related to pest management (Green *et al.* 2007). Three of the 29 districts had outdated, unregistered pesticides in storage, including DDT.

Both school district and general use policies and specifications for sanitation and maintenance, even those included in current standards for "green" buildings (US Green Building Council 2005), fall far short of even basic measures that impact pest management, such as installing door sweeps at the base of exterior doors to prevent pest entry which can reduce pest complaints by up to 65% (F. Oi, Univ. of Florida, pers. comm., June 2007). School district maintenance, operations, custodial and food service staff represent front-line defenses against pest problems and need greater support including education, support tools and recognition for their key roles.

Asthma is epidemic among children in the US and other countries, impacting nearly 6% of school children nationally, with rates as high as 25% in at least one urban center. (Centers for Disease Control 2006, Nicholas *et al.* 2005). Asthma can result from and be triggered by exposure to cockroaches, other pests and pesticides (reviewed in Beyond Pesticides 2005). The cost of treating asthma in children under 18 years of age is $3.2 billion per year (Centers for Disease Control 2006).

More than 12.8 million school days are lost per year due to asthma alone (American Lung Association 2005). Exposure to pests and pesticides can both cause asthma and trigger asthma attacks (reviewed in Beyond Pesticides 2005).

Learning ability and long-term health can also be directly affected by children's exposure to certain pesticides. Of the thousands of pesticide products that may legally be used in schools, some products and uses are especially hazardous and unnecessary. Liquid formulations sprayed on exposed interior and exterior surfaces, and volatile, semi-volatile, granular and dust formulations are more likely to result in exposure. A number of pesticides commonly used in schools (Beyond Pesticides 2003, Green *et al.* 2007) have been identified as neurotoxins or possible or known carcinogens or developmental and reproductive toxins by US EPA and other authorities (US EPA 2000, 2006; California EPA 2006). Yet these products and uses persist when effective, affordable and less hazardous options are available.

Currently, information to fully document the extent and impacts of pest problems and pesticide use in schools is not collected. Records detailing short-term illnesses due to pesticide exposure are limited, and virtually no information exists on occurrences of long-term illnesses resulting from pesticide use and exposures in schools. Barriers to documenting impacts include the multiple potential causes for short and long-term symptoms and illnesses associated with exposure to pests and pesticides. The absence of data does not mean the lack of harm to children and adults in schools or elsewhere in the community. Unknown or poorly understood potential hazards argue for additional levels of protection including exposures to multiple pesticides, at home, at school and in the diet; exposure to chemicals in combination with pesticides such as pharmaceuticals, industrial compounds and personal care products; and the general difficulty in attributing chronic illnesses to any one particular cause (US GAO 1999).

IPM has gained recognition among the school community as a desirable approach, however constraints to adoption remain similar to those developed by the Institutional Constraints Resolution Team at the National IPM Forum fifteen years ago (Sorensen 1992). These include low awareness of the need and benefits among those agencies, organizations and individuals with potential roles in school IPM; insufficient resources to apply available expertise and existing proven tools; poor enforcement of regulations and insufficient regulations in many states; competing priorities including budget shortfalls, deferred maintenance and security; and lack of national and regional coordination.

Poor understanding of the partnership required between pest managers and the rest of the school community, together with poor quality control over pest management services also impede the full implementation of IPM. In fact, many in the school community believe that adopting an IPM policy and/or entering into a contract for an IPM service is all that is required. Training in pest prevention is largely nonexistent for front line staff including administration, teaching, custodial, food service, maintenance and facility design and construction. Weed management is particularly challenging, with limited awareness and availability of alternatives to chemical-intensive management.

Schools provide an exceptional and underused opportunity to educate students about the benefits of IPM in homes, businesses and other public buildings. To date, only one state, Pennsylvania, requires instruction in IPM as part of the school curriculum. Conversely, schools that continue to use unsafe practices or put up with unmanaged pest problems are teaching the wrong lessons to both staff and students.

Substantial Near-Term Improvements are Achievable

The types of organisms that become pests in schools are well known, well understood and few in number. These potential pests can be readily managed with design, construction and maintenance practices to exclude pests and reduce harborage and access to water; sanitation practices that limit access to food; and mechanical controls including traps. When non-chemical approaches fail to deliver acceptable results, reduced toxicity pesticides including botanicals and other biopesticides, and pre-manufactured, tamper-resistant bait stations are available that can be placed in areas inaccessible to children to greatly limit potential for exposure.

Sharp reductions in both pesticide use and pest complaints in schools and other public buildings are achievable and affordable. An implementation model documented in two school systems achieved an average 71% reduction in pesticide use and 78% reduction in pest complaints over a two to three-year interval in each district (Gouge *et al.* 2006).

Implementing an IPM-based contract for structural pest control services coupled with competent oversight of service providers reduced pesticide use by 93% and pest complaints by 89%, with immediate reductions in insecticide sprays when the contracts were initiated (Greene and Breisch 2002).

The Center for Disease Control recommends reducing pest infestations and adopting IPM in schools as effective primary strategies for addressing asthma. Schools implementing IPM had lower pesticide residues on exposed surfaces, and costs and pest control were comparable to schools receiving regular pesticide applications (Williams et al. 2005).

Surveys indicate some improvement over time, or at the very least, an increased awareness of health and safety issues around pesticide use. For example, the number of school districts reporting insecticide use as the most common response to ant complaints dropped by 50% between 2001 and 2004 (Barnes and Sutherland 2005).

New legislation is driving IPM adoption in many states. As of 2002, 33 states had rules or regulations specifically addressing pesticide use in, around or near schools, up from 30 in 2000 (Owens and Feldman 2002). This assortment of state and local regulations could be standardized with comprehensive Federal legislation or with a “Best Practice” model.

Broader trends with potential to support accelerated change include:

- Green chemistry and specifically the development of reduced-toxicity pesticides, which have been the majority of new registrations in recent years, including biologically based products such as microorganisms and naturally occurring substances;

- Improved tracking of urban and suburban pesticide use patterns and documentation of health and environmental impacts;

- Green cleaning which focuses on increasing the effectiveness and reducing hazards associated with sanitation practices and product selection including anti-microbial pesticides;

- Green building which attempts to reduce negative environmental and personal health impacts of design, construction and maintenance practices and products, and has potential to incorporate IPM principles and practices in greater detail;

- Indoor air quality improvement programs which should incorporate reduction in pest-related airborne contaminants such as cockroach allergens and volatile pesticides; and

- The broader healthy schools movement which in some cases already includes IPM along with other health and safety issues including diesel fume reduction, student nutrition, and green cleaning, green building and indoor air quality.

A Plan for Coordinated Action

This strategic plan for pest management in schools is designed to:

- increase awareness among legislators, regulators, grant makers, researchers, Cooperative Extension, non-governmental organizations, administrators and other school staff, pest managers, parents and others of the need for accelerated improvements in pest management in schools;
- persuade these key influencers and implementers that high-level IPM is possible, practical, affordable and effective and worthy of their active commitment;
- identify research, education, regulatory and management priorities most in need of attention;
- incorporate education of students and others about the desirability and applicability of IPM approaches to homes, workplaces and outdoor environments; and
- provide a road map for making high-level IPM a reality in all of our nation's school systems by 2015, primarily by using existing, proven tools and pursuing the necessary financial, human and material resources to replicate successful models nationwide.

This strategic plan identifies priorities developed and ranked by a diverse group of stakeholders, lists key sectors and roles in fully implementing IPM in all schools by 2015, describes a process of changing behavior on a broad scale, and details key prevention practices and strategies for common pests in schools.

3. Stakeholder Priorities

A key function of Strategic Management Plans is to highlight priority needs to advance along the IPM continuum from basic monitoring and intervention as needed, towards effective, long-term prevention of pest problems. If our school systems are designed and maintained to eliminate conditions that lead to pest problems, the need for pesticide applications and other potentially hazardous interventions will be few and far between.

During the development workshop held in Las Vegas in October 2006, participants identified and ranked the following research, regulatory and educational priorities to be addressed to optimize IPM in school systems in the United States.

These priorities are likely to be used by readers to assess or document worthiness of a specific project for funding or implementation, i.e., has the project objective(s) been identified as a priority by stakeholders? If yes, how critical or highly ranked is the priority?

Priorities are ranked according to the number of votes received during the ranking process. Participants recommended that all priorities suggested be recognized in the document regardless of ranking. We listed those not receiving votes separately.

Management Priorities

Our working group was in agreement that we know how to achieve significant reductions in pest complaints and pesticide use in schools through IPM strategies. In addition, participants agreed that effective national management and coordination continues to be a major limiting factor to extending IPM to all school systems. Management functions include organizing information and coordinating appropriate actions by all key players. The following management-related priorities were identified and ranked:

Implement assessment programs to identify status of implementation and prioritize needed improvements in individual school systems, e.g., IPM STAR.

Establish highly visible demonstrations throughout the US.

Develop a national school IPM coalition of stakeholder organizations to coordinate implementation of proven approaches nationwide.

Partner with pest management professionals and organizations to create and implement effective, economical IPM service relationships.

Create incentives for implementation, e.g., reduce liability, recognition, publicity.

Create structural and landscape maintenance IPM contract specifications for use by school purchasing agents.

Increase funding for management, coordination, education, research and implementation.

Activate environmental health and safety professionals by creating awareness of the need, potential and effective methodology for success.

Establish appropriately trained IPM coordinators in school systems to oversee day-to-day implementation of IPM policies and programs.

Establish efficient communication networks among stakeholders.

Provide funding for school assessments including active participation by local actors including Extension.

The following management priorities did not receive votes during the ranking process.

Establish best design and construction practices to prevent pest problems in schools.

Create peer mentorships among key role players including service providers, administrators, maintenance and food service staff, parents and others.

Create job-specific IPM guidelines for roles within schools, e.g., athletic field managers, custodians, maintenance staff, principals, etc.

Establish IPM policies in school systems to institutionalize the commitment to IPM.

Develop and disseminate a protocol for grassroots implementation to increase effectiveness of local advocates.

Fully integrate IPM elements into EPA's Indoor Air Quality 'Tools for Schools' to ensure participating schools also implement IPM.

Educational Priorities

In line with the consensus that sufficient information is available to implement IPM, the group suggested a concerted effort is needed to carry that message to decision makers and implementers at all levels of school management and operations, as well as service providers, parents, students, media and other key influencers of school policies and practices. The following educational priorities were identified:

Provide education and advanced certification for pest management professionals specifically addressing high-level IPM practices for school environments.
Develop curricula to improve training of Extension, state regulators and other change agents.
Provide training for IPM coordinators to improve effectiveness in their role.
Educate policy makers, e.g., city councils and legislatures on need and benefits.
Provide resource management tools for teachers, administrators and librarians.
Develop and use art and theater to engage kids in learning about urban pests and IPM, e.g., the Roach Patrol at Lewis Cass Tech in Detroit.
Provide education for custodial, maintenance, kitchen and grounds staff, physicians and school nurses.
Develop undergraduate and graduate IPM courses for teachers and administrators.
Develop K-12 classroom curriculum.
Educate about pest and pesticide hazards.
Create basic awareness of the concept of IPM (not the word) among mass media.
Provide IPM and health information to teachers, parents and administrators.
Develop web-based training for all roles.

The following educational priorities did not receive votes during the ranking process.

Develop Best Management Practices for schools to use with vendors of pest management services, design and construction, food and drink products, etc.
Develop a centralized toolbox of existing materials.
Develop education for school furnishings/materials manufacturers.
Publish case studies describing how school IPM programs can be initiated
Develop materials for audiences with low literacy.
Create materials in languages other than English.
Educate about proper placement of light traps for pest management in urban environments.
Educate about the proper terminology for the term “seal” instead of “caulk”.

Research Priorities

Although lack of information was judged not to be a barrier to implementation of IPM, research data gaps were identified in a number of key areas. Top priorities were dominated by research questions focused on data needed to accelerate adoption of IPM including building a stronger case for IPM as essential for optimum student and school system performance.

Comparative effectiveness of different types of change agents, e.g., Extension, advocacy groups, parents.
IPM impacts on academic performance, e.g., asthma, absenteeism, grades.
Economics of IPM vs. conventional.
Independent efficacy data and hazard profiles on alternative, reduced-hazard options in school environments including botanicals, e.g., Orange Guard and limonene for fire ants, EcoSMART product line, cedar oil.
Evaluation of health hazards of pests and pesticides.
Third-party assessment of the quality of services provided to schools by pest management professionals.
Cross-over benefits of school IPM, e.g., impacts on larger community.
Awareness of and attitudes towards IPM among school community members.
Weed management.
Impact of building design and maintenance on pest management.
Efficacy of yellow jacket queen trapping, boric acid bait formulations on cockroaches, air curtains as exclusion devices.

The following research priorities did not receive votes during the ranking process.

Assessment of satisfaction with IPM.
Development of tools and measures for IPM and continuous improvement.
Development of pest monitoring techniques.
Bed bug management including attractants.
Basic insect biology.
Identification of entry points for implementation of IPM.
Stinging ant management.
Geographic distribution of Turkestan cockroaches.

Regulatory Priorities

Regulations specific to pest management in schools address a broad variety of practices including pesticide application notification and posting, reentry interval, applicator training and licensing requirements, restrictions on pesticide product selection and use, and requirements for IPM plans and policies. Lack of resources for monitoring and enforcement were cited as barriers to the effectiveness of regulation.

Increase funding for the enforcement of existing regulations including compliance by commercial pest management professionals and other businesses providing services to schools, and for evaluating pesticide-use records submitted to state-lead agencies in states with mandated reporting for compliance.
Mandate high level IPM training/licensing for pest management professionals.
Develop lobbying organizations and strategies for influencing change. Identify opportunities for influencing regulatory and legislative processes to improve IPM adoption, e.g., US Senate and House committees that work on school legislation at the federal level.
Provide IPM input into No Child Left Behind legislation.
Create and mandate minimum standards for school IPM at federal level, including applicator licensing, written IPM program, for example, through re re-introduction of the School Environmental Protection Act.
Develop a model compliance agreement for use by state lead agencies with violators of state pesticide and/or school IPM regulations.
Implement a best practice survey to form basis for regulation.
Create third-party or public agency standards and recognition for IPM, other Best Management Practices and continuing improvement, for example, Baldridge-Award type programs.
Enforce invasive species regulations to reduce weed pressure on school grounds.

The following regulatory priorities did not receive votes during the ranking process.

Require disclosure of pesticide inert ingredients so that potential users and programs can fully evaluate possible hazards.
Fund consultant services for IPM compliance assistance to provide schools with access to experts who can identify opportunities for improvements.
Establish minimum student rights for environmental health standards in schools.
Pesticide education program at national level to target schools.
Pursue registration of soap-based insecticides for additional pests.

4. Strategic Plan

IPM works in schools to reduce pest complaints, pesticide use and toxicity and potential for exposure (Gouge *et al.* 2006, Green *et al.* 2007, Lame 2005, Williams *et al.* 2004). Our challenge is to replicate these and other well-documented successes in all of our schools. The goal of this strategic planning effort is to set out a plan of action to achieve full implementation of IPM in all of our schools by 2015, including assessing progress on an ongoing basis.

Specific objectives include:

- Create 100% awareness among key influencers and lead decision-makers of the problems and availability of ready solutions to reduce pest problems and pesticide exposure;

- Identify, communicate with and generate a commitment from key individuals in each school system, and in each of the key organizations and agencies that we have identified to actively participate in IPM implementation, evaluation and reporting;

- Develop sufficient financial, material and human resources to implement proven approaches to IPM implementation including education, regulation and specific management tactics that prevent and avoid pest problems;

- Improve compliance with existing laws to 100% of school districts and identify best model regulations and have those implemented in all states;

- Identify ten priority research issues that may lead to less hazardous approaches to managing common and occasional pests in schools, update this list annually and ensure that these are being pursued;

- Establish education of staff and students in all schools about the benefits of IPM and how they can apply this approach to their homes and workplaces; and

- Maintain annual monitoring and reporting on our goal, specific objectives and priorities.

Table 4.1 Indicators of high-level IPM fully implemented in schools nationwide. A number of these indicators will be measured annually via the school IPM report card (Appendix C) to be completed by state lead contacts and reported to Sherry Glick, US EPA national school IPM coordinator, and the national working group. Others will be measured during evaluations to be conducted at mid-term (2012) and final (2015) evaluations.

1. All school systems have a board-approved IPM policy.
2. All school systems have a written IPM plan.
3. All schools have an IPM coordinator, i.e., a trained individual responsible for day-to-day interpretation of the IPM policy for a school or school system.
4. IPM is the way pests are managed for both structural and landscape pests including:
    a. Pest managers working in schools can accurately assess pest problems and respond appropriately.
    b. All schools have an inspection and monitoring program in place to detect pest problems and pest-conducive conditions early.
    c. Pest management actions are based on monitoring and thresholds.
    d. All schools can evaluate and oversee any structural pest and landscape management service providers for IPM performance.
    e. Prevention is the primary strategy, pest management is proactive.
    f. Pest proofing is a primary consideration in all new construction and renovations, and pest managers provide input on these plans and review construction in progress.
5. IPM training is a component of ongoing training for school staff in all schools.
    a. All staff and students are aware of what IPM is and what the benefits are.
    b. Everyone working on school health and safety issues including indoor air quality and green cleaning incorporates IPM in their work.
    c. All coaches are educated on IPM practices for athletic fields and facilities.
6. All Departments of Education incorporate pest proofing into facility design specifications.
7. US Green Building Council fully incorporates IPM into program for new buildings and existing buildings.
8. All states include a full set of school-specific IPM elements in training and licensing process for applicators.
9. Training curriculum is offered on an annual basis nationally for change agents (any person that acts as a resource and catalyst for change by marketing the advantages of IPM to decision makers in the school community).
10. Sustainable funding is secured for ongoing demonstrations and coalitions in all states, and for an individual in each state lead agency to focus on school IPM.
11. All school systems use science-based criteria for identifying and selecting least-hazardous pesticides when pesticides are needed.

12. All school IPM programs and plans are evaluated annually.
13. Pest problems and pesticide applications in schools are rare events due to successful implementation of IPM!

Overall Timeline and Milestones

We developed the following specific objectives to achieve our end goal and meet our priorities.

2008 Objectives

1. Form a national working group to coordinate implementation of the school IPM PMSP in cooperation with working groups in each IPM Center region.
2. Develop funding for years 1-3 of plan implementation.
3. Hire full time coordinator to work under direction of national working group steering committee. Roles include:
   - Maintain membership list and timeline for specific action steps.
   - Maintain list of state IPM contacts who are responsible for completing annual report card; coordinate distribution of report card, collection of completed reports, summary analysis.
   - Organize monthly conference calls, draft/circulate agendas, take/circulate call notes.
   - Build, maintain database of organizations (NGOs, public agencies) with roles in school pest management including key contacts, publications and meetings.
   - Recruit, maintain database of individuals from each organization to represent school IPM to its membership.
   - Facilitate articles and presentations on school IPM in related-organization media and meetings.
   - Maintain school IPM toolbox including funding sources and model proposals; model IPM policies, IPM plans, requests for proposals for pest management services, pre-approved least-toxic options lists; pest presses; pest-specific fact sheets; management zones fact sheets; curricula and training modules; etc.
   - Build, maintain database of individuals with pest management responsibilities in each school district.
   - Reinvigorate schoolbugs list serve: increase awareness of this resource; recruit participation by all individuals with pest management responsibility in each school system nationally, organization representatives, state school IPM contacts; coordinate regular, useful postings.
   - Circulate brief, regular and timely communications to contact database.
   - Coordinate liaison to regional school IPM working groups, Urban IPM Community of Practice, EPA Pesticide Environmental Stewardship Program, USDA IPM Coordinators.

- Maintain working group web pages.
- Identify funding sources, develop/submit proposals.
- Organize annual meeting to update PMSP.

4. Form and fund school IPM working groups for Northeast and North Central USDA IPM Center regions to complement existing Southern and Western groups.
5. Review school IPM websites for each state and request updates of any outdated information.
6. Create model maintenance and sanitation specifications that reflect high level IPM.
7. Negotiate an acceptable version of the School Environmental Protection Act.
8. Organize and hold national training opportunity for change agents.
9. Initiate demonstrations in five new states.
10. Initiate coalitions in five new states that have had demonstrations in the past.

2009 Objectives

1. Initiate demonstrations in five new states.
2. Create IPM committees in 15% of school-related organizations.
3. Develop IPM sessions at annual meetings for 15% of school-related organizations.
4. Place IPM articles in publications for 15% of school-related organizations.
5. Initiate coalitions in five new states that have had demonstrations in the past.
6. Organize and hold national training opportunity for change agents.

2010 Objectives

1. Initiate demonstrations in five new states.
2. Create IPM committees in an additional 25% of school-related organizations.
3. Develop IPM sessions at annual meetings for 25% of school-related organizations.
4. Place IPM articles in publications for 25% of school-related organizations.
5. Initiate coalitions in five new states that have had demonstrations in the past.
6. Organize and hold national training opportunity for change agents.
7. Develop funding for years 4-6 of plan implementation.

2011 Objectives

1. Initiate demonstrations in remaining states.
2. Create IPM committees in an additional 25% of school-related organizations.
3. Develop IPM sessions at annual meetings for 50% of school-related organizations.
4. Place IPM articles in publications for 50% of school-related organizations.
5. Gear up to initiate coalitions in all remaining states by end of year five.

6. Organize and hold national training opportunity for change agents.
7. Develop funding for years 4-6 of plan implementation.

2012 Objectives

1. Design, implement mid-term evaluation including sustainability of funding.
2. Create ongoing IPM committees in remaining school-related organizations.
3. Develop IPM sessions at annual meetings for all school-related organizations on at least an every-other-year basis.
4. Place IPM articles in publications in all school-related organizations on at least an every-other-year basis.

2015 Objectives

1. Design, implement final evaluation.

Metrics

- Survey of state regulations for 2015 evaluation.
- "Before and after" pesticide use reporting (NY has requirements).
- Numbers of violations (both pesticide and pest violations).
- Increased number of certified pesticide applicators.
- Funded programs for IPM.
- Numbers of Extension personnel involved.
- Changes in behavior of schools.
- Extension dollars going to school IPM.
- Number of certified school districts.
- Pesticide residues in schools and on grounds.
- Pesticide sales records.
- Extension driven school audits.
- "Before and after" pesticide inventory lists.
- Measure cost effectiveness/avoidance.
- Numbers of IPM coordinators involved.
- Number of staff trained.
- Number of school IPM policies.
- Number of incidence reports.
- Number of pest complaints.
- Number of pest problems resolved without pesticide applications.
- Number of pesticide applications.
- Student achievement measures as part of a comprehensive health and safety program.
- Approved product lists.
- Number of school IPM committees formed.
- Minimum requirements for people to apply pesticides.
- Compare school footage to professional pest manager ratio.

- Evaluate pesticide use by vocational-agricultural and vocational-technical schools.
- Pest management work hours.
- Number of consultants.
- Number and size of clients.
- Client performance metrics.
- Diffusion to second level clients.
- Market sectors included such as private schools.
- Number of facilities included.
- Third party certification, e.g. IPM STAR, NPMA Quality Pro Schools; EcoWise, Green Shield Certified.
- Service visits without a pesticide application.
- Types of pest management equipment used, e.g., vacuums vs. spray tanks.
- School service satisfaction evaluation.
- Grant-funded project outputs.

Sectors, roles and actions to achieve high-level IPM in all schools by 2015

Sector	Roles	Actions to Achieve Goal	Timeline	Tools Available	Tools Needed
National School IPM Working Group Diverse group of stakeholders representing all sectors including federal and state regulators, advocacy groups, research extension, school administrators, school design and construction professionals, structural and landscape pest management service providers, consultants, pest management product manufacturers, parents.	1. Coordinate effort to fully implement IPM in all schools by 2015. 2. Evaluate progress, revise plans. 3. Identify needs, secure and distribute necessary resources. 4. Liaison to all sectors with potential to contribute to improvements, lead/coordinate efforts to meet sector goals. 5. Liaison to regional and state working groups. 6. Maintain the School IPM PMSP.	1. Meet monthly by conference call to share information, identify needs, and pursue resources. 2. Meet annually in person to evaluate progress, review and revise plans.	1. Complete PMSP by May 2008. 2. Obtain continuation funding by January 2008. 3. Hire full-time coordinator to serve the national and regional working groups, including tasks described above in 2008 Objectives.	1. Grant proposals. 2. PMSP.	1. Additional funding/funding toolkit. 2. Additional members from unrepresented sectors.

Sector	Roles	Actions to Achieve Goal	Timeline	Tools Available	Tools Needed
State and Local Regulatory Agencies State departments of agriculture, environmental protection, local health departments, education, etc.	1. Enforces state regulations regarding public health, worker health and safety, food safety, pest management, pesticide use. 2. Education, compliance assistance. 3. On-site inspection. 4. Evaluate progress in implementing IPM in school districts within jurisdiction.	1. Form a national cross-agency committee to focus on school IPM. 2. Place articles in trade journals. 3. Organize school IPM session at national meetings. 4. Partner with advocacy organizations to lobby for additional funding for improved compliance assistance, inspection and enforcement. 5. Develop and catalog school-specific compliance assistance tools for applicators, health inspectors, school staff. 6. Set goals and standards for improving licensing standards. 7. Catalog and promote “clean sweeps” for hazardous chemicals in schools. 8. Develop an annual survey of state regulations regarding school IPM.	1. June- December 2007. 2. At least one article in a national publication annually. 3. Organize school IPM session for 2009 national meeting. 4. Develop model plan to develop additional support for by June 2009. 5. Develop compliance assistance tool catalog by December 2009. 6. Set licensing goals and standards by June 2010. 7. Catalog “clean sweeps” information by June 2009. 8. Work with Sherry Glick on annual report card to extract state regulation data by December 2008.	1. National organizations, meetings, publications: a. Association of Structural Pest Control Regulatory Officials, annual meeting, publication, website, membership list. b. American Association of Pesticide Safety Educators, annual meeting, publication, website, membership list. 4. Annual School IPM Report Card (Appendix C).	1. Additional funding/funding toolkit for compliance assistance and enforcement from fines, pesticide use fees and other sources. 2. Compilation of “best” model legislation.

Sector	Roles	Actions to Achieve Goal	Timeline	Tools Available	Tools Needed
Advocacy Groups Non-governmental organizations including PTAs, PTOs, environmental groups, local organizations that engage unions, parents, the medical community; American School Health Assoc., NRDC, Sierra Club, Audubon Society, American Public Health Assoc., etc. (See Appendix I).	1. Force policy changes. 2. Draft, propose legislation. 3. Lobby legislators. 3. Watch dog proposed policy/legislation. 4. Draw public attention to key issues.	1. Establish IPM policies in every school district. 2. Teach members and other community members how to recognize policy and legal violations and to act effectively to bring about positive change. 3. Liaison with NPMA and other key professional organizations societies to advocate for improvements in training and practices. 4. Lobby for passage of the School Environmental Protection Act. 5. Build IPM into No Child Left Behind legislation.	1. December 2010. 2. Organize at least one workshop or conference session by each organization annually by 2010. 3. Identify goals for improvements in training across key professions/associations by December 2009. 4. Develop legislative/policy coalition by June 2009.	1. School Pesticide Reform Coalition including website, list serve. 2. Model school IPM policies. 3. Model legislation for both state and federal levels. 4. Pest and pesticide crisis articles. 5. Pest press/newsletters. 6. Success stories. 7. Model memoranda of understanding (MOUs) between advocacy groups, trade organizations, government agencies.	1. Additional funding/funding toolkit. 2. Compilation of “best” model policies, legislation, MOUs.

Sector	Roles	Actions to Achieve Goal	Timeline	Tools Available	Tools Needed
Extension Cooperative States Research, Education and Extension Service (CSREES), county agents, state and regional specialists, national program leaders.	1. Third party objective educator. 2. Provider of third party resources. 3. Development and verification of tools and resources. 4. Technology transfer agents through education and demonstration. 5. Impact assessment. 6. Communication of all components both upstream to service providers and downstream to end consumers. 7. Train-the-trainer. 8. Evaluate progress in implementing IPM in school districts within jurisdiction.	1. Create internal awareness in each state and at the federal level. 2. Form statewide school IPM committee with IPM Centers, Extension Directors, eXtension, specialists, researchers, social scientists, communications staff, county/regional agents (including 4-H) and administrators. 3. Liaisons with school boards. 4. Higher level Extension strategic planning to include schools IPM/plan of work. 5. Engage county agents in more urban based programs. 6. Develop funding opportunities. 7. Pesticide Safety Education Program to add school IPM into curriculum for training for recertification. 8. Develop positive relationship with agriculture, avoid competition for resources.	1. Establish at least one annual communication in existing publications and one session in national meetings by 2010. 2. December 2010. 3. Draft plan/timeline to address actions 3-8 by January 2009.	1. School Pesticide Reform Coalition including website, list serve. 2. Model school IPM policies. 3. Model legislation for both state and federal levels. 4. Pest and pesticide crisis articles. 5. Pest press/newsletters. 6. Success stories. 7. Model memoranda of understanding (MOUs) between advocacy groups, trade organizations, government agencies. 8. Annual School IPM Report Card (Appendix C).	1. Additional funding/funding toolkit. 2. Compilation of “best” model policies, legislation, MOUs.

		9. Train agents to carry out school IPM certification. 10. Do pesticide inventories in school systems, educate on proper pesticide storage and disposal, support pesticide roundup/clean sweeps.			

Sector	Roles	Actions to Achieve Goal	Timeline	Tools Available	Tools Needed
School Administrators School superintendents, operations managers, risk managers.	1. Increase awareness among peers. 2. Provide funding for internal staff training. 3. Distribute resources. 4. Implement and champion internal policies. 5. Reward/recognize staff/vendor performance.	1. Develop, disseminate success stories. 2. Improve relationship between school and vendors. 3. Provide oversight of pesticide use and policy development. 4. Train key individuals to serve as IPM coordinators in each school district, e.g., facility manager. 5. Form a national committee including risk managers, environmental health managers, educators, industrial hygienists, planning project managers and others who understand the school district to organize presentations at association meetings, submit articles in trade press and internal school communications. 6. Form district-wide IPM committee in each district. 7. Oversee preventative maintenance schedules.	1. At least one success story in a national publication by December 2009 and annually thereafter. Develop plan to address 2-7 by January 2009.	1. Successful programs. 2. EPA guidance documents. 3. Pest presses/ newsletters, see Appendix M. Toolbox. 4. Health and Safety Road Shows. 5. Powerpoint presentations, see Appendix M. Toolbox. 6. Poster text available, see Appendix M. Toolbox.	1. Selling tool for IPM as part of comprehensive health and safety risk management programs, energy conservation programs, preventive maintenance programs. 2. IPM Elements (concise lists of IPM practices for each school role), Standard Operating Procedures (SOPs) for cleaning and maintenance staff. 3. Model bid specifications, contracts for purchasing departments.

Sector	Roles	Actions to Achieve Goal	Timeline	Tools Available	Tools Needed
Consultants Turf management consultants, pest management consultants, food safety consultants, operations consultants, tree care consultants, energy service consultants, environmental health and safety consultants, and green building consultants.	1. Training, train the trainer, education, implementation support. 2. Specialization. 3. Specialized case histories - high exposure. 4. Policy and procedure development. 5. Independent evaluation of effective alternative pest management practices and products. 6. Independent product use support. 7. Comparative analysis of programs, big picture perspective. 8. Create market demand for IPM.	1. Get information on services provided out to target school audiences nationwide. 2. Assess educational materials and products for their specialty or category. 3. Recruit other consultants to provide input on educational materials and products. 4. Recruit other consultants to IPM practice. 5. Participate on regional and national working groups and committees. 6. Provide presentations at trade and professional meetings. 7. Collaborate with extension to meet common goals.	1. Provide information on services to national working group by August 2008 for consultant resource directory to add to toolbox. 2. Identify additional consultant needs and recruit on an ongoing basis.	1. Own expertise. 2. Marketing budgets/expertise – education as a form of marketing. 3. Business plans.	1. More clients. 2. Research data/science to support decisions.

Sector	Roles	Actions to Achieve Goal	Timeline	Tools Available	Tools Needed
Pest Management Professionals Structural pest management service providers and landscape management service providers, including those employed by school systems.	1. Establish industry/staff performance standards. 2. Provide quality training for staff to meet standards. 3. Educate schools on proper way to create effective IPM partnership. 4. Creating demand for high-level IPM service. 5. Diagnose root causes of pest problems. 6. Recommend, implement long-term preventive strategies. 7. In-house professionals serve as liaisons to industry, other school staff.	1. Form internal school IPM committees in national and state organizations. 2. Make Quality Pro Schools available to in-house pest managers in schools. 3. Create/deliver uniform message. 4. Create model business plan for school IPM. 5. Develop association training programs/ seminars/CEUs. 6. Provide product application data and information. 7. Cooperate in research programs, data collection. 8. Train school staff in IPM. 9. Support education at universities to educate students. 10. Support small research projects. 11. Use convenience contracts/piggy back one contract for several clients.	1. PMP national working group members to draft plan/timeline by December 2008.	1. Quality Pro Schools for school IPM from NPMA. 2. Green Shield Certified for PMPs from the IPM Institute of North America. 3. IPM STAR for Schools from the IPM Institute of North America. 4. Boilerplate Request for Quotation (RFQ) for schools, see Appendix M. Toolbox. 5. Model contracts for schools, see Appendix M. Toolbox. 6. Service tickets that include IPM tactics and recommendations. 7. Northeast Organic Farming Association Landcare Standards and training programs.	1. Uniform message to deliver to industry. 2. Business plan including marketing plan for school IPM.

Sector	Roles	Actions to Achieve Goal	Timeline	Tools Available	Tools Needed
Federal Agencies USDA CSREES, US EPA, Center for Disease Control.	1. Provide national program leadership and coordination to advance knowledge with other Federal agencies, Land Grant Universities, and other partners for the IPM in Schools initiative. 2. Provide federal assistance through formula and competitive funding opportunities for research, extension, and education to Land Grant University and other partners. 3. Promote quality-of-life issues for human health including programs for research and teaching excellence and enhanced academic quality.	1. Participate in the national cross agency committee with focus on school IPM. 2. Investigate opportunities to leverage existing CSREES programs, (i.e., Agriculture in the Classroom, Healthy Homes, IPM, etc.).	1. US EPA to host national working group meeting by December 2008. 2. National working group members to draft plan/timeline by December 2008.	1. USDA, CSREES National Program staff for IPM and Higher Education. 2. Network of regional IPM Centers. 3. Federal IPM Coordinating Committee. 4. Pest Managers LISTSERV. 5. eXtension Communities of Practice: Integrated Pest Management In and Around Structures: Urban IPM; Fire Ants; Pesticide Environmental Stewardship; etc.	1 Continued and additional funding and resources for programs that directly and/or indirectly support IPM in Schools programs.

Sector	Roles	Actions to Achieve Goal	Timeline	Tools Available	Tools Needed
Pest Management Product Manufacturers, Distributors Pesticide registrants, device manufacturers, distributors/retailers.	1. Research, design, develop, test, manufacture and distribute products. 2. Provide information and training on product selection and use.	1. Participate in national and regional working groups. 2. Develop new reduced-risk alternatives for school use. 3. Develop efficacy data on new reduced-risk and EPA Exempt products applicable to schools. 4, Develop product support materials specific to school uses.	1. Work with national working group to develop priority list for development, efficacy testing and product support information by December 2008.	1. Research and development, technical support, marketing departments.	1. List of product priorities for development, efficacy testing and support materials developed by those working in schools.

Sector	Roles	Actions to Achieve Goal	Timeline	Tools Available	Tools Needed
School Design and Construction Professionals Consultants, institutions, corporations.	1. Plan, design, build, equip and maintain school facilities. 2. Educate planning, design, construction, equipment and supply manufacturers and maintenance professionals about best practices. 3. Evaluate performance of school buildings.	1. Participate in national and regional working groups. 2. Form a national committee, or add IPM to the responsibilities of an existing health/high performance schools committee in industry associations.	1. IPM and Green Schools Workshop, February 2008. 2. Recommendations developed from workshop to be published.	1. PMSP.	1. Design and construction specifications for pest prevention.

Sector	Roles	Actions to Achieve Goal	Timeline	Tools Available	Tools Needed
Parents	1. Advocate for healthier schools including IPM. 2. Watchdog school compliance with existing regulations and best practices. 3. Initiate conversations with school governance and administrators about pesticide use and pest management practices and policies.	1. Participate in national and regional working groups. 2. Become educated about pest and pesticide hazards and IPM as an effective solution. 3. Recruit other parents to participate in advocacy and oversight. 4. Participate in and educate organizations with related health and environmental missions about the benefits of getting the word out to their membership.	1. Parent representatives on national and regional working groups to work with national working group coordinator to develop plan of action by end of 2008.	1. PMSP. 2. School Pesticide Reform Coalition.	1. Action plan. 2. Effective communication piece to share with school governance and administrators.

5. IPM Adoption Process in Schools

The goal of an IPM program in the sensitive school environment is to make the site a safer place to learn and work, while also making it unattractive, inaccessible to and uninhabitable for pests. To accomplish this straightforward goal requires getting the school community and others to do what is perhaps the most difficult task of the "change agent" – changing human behavior. The restrictions to changing behavior related to pests and pest conducive conditions (whether in the agricultural or urban setting) have always related to the perception of IPM as being difficult to implement and the lack of ability of change agents to compete with the marketing for pesticide dependence.

The school community must recognize that their current pest management may be ineffective or problematic and that IPM is a better method. Further, that IPM is compatible with the other management functions inherent to the school culture. In other words, *"pest management is people management".*

This management process to get communities to adopt IPM is called "Diffusion", which is "the <u>process</u> by which new ideas or practices (called innovations) are communicated through certain channels over time, and are either adopted or rejected by, members of a social system over time" (Rogers 2003). Diffusion is to a community what adoption is to an individual. It is a sub-discipline of communication science.

While there are other models of technology transfer besides the Diffusion Model, it has some distinct advantages that make it useful for understanding and promoting the process of IPM adoption by school communities.

- Diffusion is a broad model that explains any technology adoption process in any social community (thus, it useful to know beyond the context of IPM in schools);
- Diffusion helps the person promoting the new technology (IPM) to see it from the potential adopter's perspective;
- The Diffusion Model has already been successfully applied to adoption of IPM in schools; and
- Many tools and resources needed at each stage of the diffusion process are widely available as outlined below.

While many school communities have been exposed to the IPM innovation (through conferences, trade journals, the internet, etc.), few have verifiable and/or sustainable programs. This lack of adoption is more a result of failed implementation rather than unavailable pest management technologies or inadequate funding or concern for school occupant health by school officials.

Failed implementation is often the result of the change agents not taking the adopting communities through the "innovation-decision" process (defined below) to diffuse the IPM innovation. A "change agent" is any person (inside or outside of the school community) that acts as a resource and catalyst for change by marketing the advantages of IPM to decision makers in the school community.

A component of the Diffusion Model called the “innovation-decision” process outlines five steps that change agents can use to promote and support adoption and implementation of any innovation by a target audience. One model of school IPM implementation (the Monroe IPM Model) that relies on the “innovation-decision” process has successfully reduced pesticide use as well as pest complaints in schools by an average of 71% and 78% respectively, in eight states over a ten-year period (Gouge *et al.* 2007). Furthermore, on a state-wide level this model has achieved an 18% diffusion rate or over half of the students in public schools in a five year period.

Thus, implementing IPM in the school community requires managing the process of adoption. This process is the stepwise management by change agents to transform the behavior of the school community. Further, these persons must realize they can influence the behavior and affect the attitudes of two critical audiences involved with the school community (Table 5.1).

Table 5.1 Agents of change involved in the diffusion of the IPM innovation in a school district.

Agents within School District	**Agents outside School District**
Administrators (Superintendent, Principals, School Board)	Federal Regulatory Agencies (USDA, USEPA, DOE, CDC)
Facility Management (Supervisor, Environmental Health Manager, Custodial, Maintenance)	State Regulatory Agencies (Agriculture, Education, Public Health, Environment/Natural Resources)
Food Service	Local Agencies (Health, Park & Recreation Departments)
Teachers, Associates	USDA Cooperative State Research, Education and Extension Service (CSREES)
School Nurse	Pest Management Professionals (PMP)
Parent Teacher Organizations	Advocacy Groups
Students	Concerned Citizens

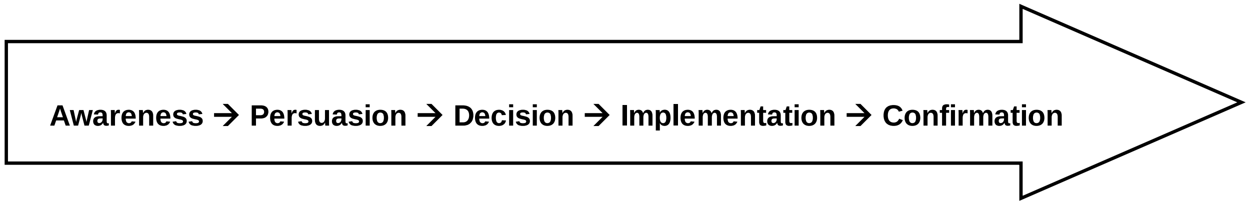
The motivation of both audiences may be voluntary or mandated (policy or legislation). Required venues (or “channels”) that change agents will use to transmit the IPM message so that the adopting community will diffuse IPM will include interpersonal as well as mass media methods such as:

- Educational and demonstrative workshops/sessions;
- Pilot programs;
- Selection of outreach materials;
- Assessment of pesticide use, pest problems and conducive conditions; and
- Examination of how IPM will mitigate risks to the school community.

Once completed, these components will be transferable to other school communities.

The "Innovation-decision" Process for Diffusion of IPM in Schools

Figure 5.1 The Innovation-Decision Process (Rogers 1995)



I. Awareness Stage - Where the change agents communicate the *innovation* (IPM) and how it can meet the community's need. This first stage requires the transfer of knowledge from change agents to potential audiences. Normally "mass media" such as news outlets (periodicals, television, internet, etc.) are used at this stage.

Examples of Tools & Resources

- Articles explaining recent research results on asthma, cockroaches, and pesticides
- School IPM success stories
- Publications documenting pest outbreak scenarios
- Publications documenting effects from improper pesticide choice and use

Examples of PMSP Priorities Supporting the Awareness Stage

- Develop lobbying organizations and strategies, identify what we can influence
- Education for policy makers (e.g., city councils, state and federal legislatures)
- Create basic awareness of the IPM concept among mass media
- Activate environmental health and safety professionals by creating awareness of the need, potential, and methodology for success
- Develop pesticide safety education program at national level to target schools

II. Persuasion Stage - Where the change agents communicate the *evidence* that the innovation will match the community's need. At this point data are presented to school community adopters to help lower the perceived risk of adopting IPM. This data contrasts the short- and long-term benefits (positive attributes) of IPM with the costs (negative attributes) of IPM.

The successful change agent will point out the positive attributes of the IPM innovation as: relative advantage over traditional pest management (e.g., fewer pests/fewer pesticides resulting in reduced risk, fewer complaints to administrators and potentially less expensive over the long-term); compatibility with the current community's norms and values (e.g., the cultural and mechanical aspects of IPM are currently part of the school system – education, sanitation, energy management, etc.); trialability, where the community can try IPM on a limited basis (i.e., pilot programs) before it has to commit valuable resources to full-scale adoption; and observability where the advantages of IPM can be observed by adopters and their peers.

Conversely, the change agent must also develop strategies to minimize the historically negative attribute of IPM – complexity (e.g., record keeping, matching conducive conditions to pests and integration of management technologies) – which may be viewed as labor intensive and thus a cost.

Specific “mass media” (professional/trade journals and internet, etc.) as well as larger interpersonal media (public meetings) are used at this stage.

Examples of Tools and Resources

- Articles explaining recent research results on asthma, cockroaches, and pesticides
- School IPM success stories (both research and testimonial)
- Publications documenting pest outbreak scenarios
- Publications documenting effects from improper pesticide choice, use
- Meetings with School Board Officials

Examples of PMSP Priorities Supporting the Persuasion Stage

- Impacts of IPM on academic performance (e.g., asthma, absenteeism, and student performance)
- Economics of IPM versus conventional pest management methods
- Efficacy of alternative, reduced-impact pest management options (e.g., pest proofing)
- Identification of cross-over benefits of school IPM (e.g., impacts on larger community)
- IPM and health information to teachers, parents, and administrators

III. Decision Stage - Where members of the community *decide* whether or not they will adopt the IPM innovation for use in their program. The school district is sending a clear message to the change agents that they are adopting the innovation. Normally “interpersonal” media such as legislative sessions and quorums are used at this stage.

Examples of Tools & Resources

- Policy
- IPM Contract with Management Professional (PMP) and/or IPM Standard Operating Procedure for School District Personnel
- Tools to help school district purchasing agents or others identify good IPM service providers for school buildings and grounds if outside contractors are to be used
- Training opportunities
- Building and Athletic Field construction standards

Examples of PMSP Priorities Supporting the Decision Stage

- Increase funding and enforcement of existing regulations, including PMP accountability

- Mandated (high standard) IPM training/licensing for PMP
- Resource management for teachers, administrators and librarians
- Provide IPM input into No Child Left Behind legislation
- Develop a compliance agreement with state lead agencies to force school IPM where there are violations
- Create and mandate minimum standards for school IPM at federal level, including applicator licensing, written IPM program
- Create structural and landscape maintenance IPM contract specifications for use by school purchasing agents
- Increase funding for management, coordination, education, research and implementation
- Establish appropriately trained IPM Coordinators in school systems
- Funding for school assessments including active participation by local actors including Extension

IV. Implementation Stage - Where the change agents *demonstrate* that the IPM innovation will match the community's need. This stage requires change agents to nurture those participating in the process. Thus, more interpersonal media (workshops, demonstrations, pilot programs, etc.) and targeted newsletters personalized to the school district are used at this stage.

Examples of Tools & Resources

- Policy
- Pilot school demonstrations of IPM
- IPM contract with PMP or IPM Standard Operating Procedure for School District Personnel
- Record keeping
- Training opportunities
- Newsletters (e.g., "Pest Press")
- School assessment form
- Pest monitoring protocol
- Pest sighting log
- Least toxic product list
- IPM curriculum

Examples of PMSP Priorities Supporting the Implementation Stage

- Education and advanced certification for PMP
- Curriculum for Extension and change agents
- Training IPM coordinators
- Implement assessment programs to identify implementation status and prioritize needed improvements in individual school systems, e.g., IPM STAR
- Establish highly visible demonstrations throughout the US
- Develop a national school IPM coalition of stakeholder organizations to coordinate implementation of proven approaches nationwide

- Partner with private pest management organizations, e.g., pest management professionals to create and implement effective and economical IPM service relationships
- Art theater approaches for kids; turn kids on to urban pests, Roach Patrol is a model
- Undergraduate and graduate courses for teachers/administrators for IPM
- Education for custodial, maintenance, physicians, school nurses, kitchen and grounds staff
- Develop K-12 classroom curriculum
- Establish efficient communication networks among stakeholders
- Impact of building design and maintenance on pest management
- Implement a best practice survey to form basis for regulation
- Web-based training

V. Confirmation Stage - Where the change agents *confirm* that the decision to adopt the innovation was worthwhile, and the adopters assure themselves that their decision to adopt was correct. All possible media are used at this stage (periodicals, television, internet, public meetings, workshops, one-on-one meetings, etc.).

Examples of Tools & Resources

- Pre/post evaluations of the efficacy of pilot school IPM programs
- 3rd Party Verification (e.g. IPM STAR)
- State or National awards (e.g. USEPA , OCE)
- State or National grants (e.g., USEPA, PESP)
- Mass media
- Plaques

Examples of PMSP Priorities Supporting the Confirmation Stage

- Comparative effectiveness of change agent types
- Evaluation of health hazards of pests and pesticides
- Third-party assessment of performance by pest management professionals
- Awareness of and attitudes towards IPM among school community members
- Create incentives for implementation, e.g., reduce liability costs, recognition and publicity
- Independent assessment of efficacy of management measures in school environment

Documenting a Verifiable School IPM Program

How do we know when a school community has implemented a verifiable and sustainable IPM program? The following metrics provide quantitative and qualitative measures of IPM implementation.

Evidence of IPM implementation in the school community

- Verifiable IPM
- IPM Certification
- Mass media coverage

- School Web site with IPM page(s)
- Administrative support within district and outreach to other districts
- Economic analysis
- Pest Press / Newsletter dissemination
- Student participation in IPM effort, training
- Building and athletic field construction standards followed
- Ongoing communication between school staff, management and PMP

Evidence of IPM implementation in the change agent community

- Funding, enforcing, researching and training from government/university entities
- Changes in PMP organization membership, certification, and promotion programs from the PMPs
- Documented agendas, workshops and policy shifts from not-for-profit groups - education professional associations (school business officials, supervisors, nurses, etc.), health care professionals (pediatricians, sanitarians, environmental health, etc.)

6. Overview of Pest Management in Schools

Although many organisms have potential to cause problems in school buildings and landscapes, those that achieve pest status are few in number. Pests and conducive conditions that encourage problems are generally readily detectable via an ongoing monitoring and inspection program. Effective, long-term preventive strategies including design and construction practices, sanitation, and exclusion are available and when applied, often resolve multiple pest problems.

When these preventive and avoidance strategies fail to produce acceptable results, pesticide products are available that are less toxic than those formerly used, many of which can be applied in ways that greatly reduce potential for exposure to staff, students, other organisms and the environment.

Surveys indicate that actual pest management practices in schools are highly variable (Appendix G). Pest management programs in schools includes the spectrum from well managed, prevention-based IPM approaches with very infrequent pest problems and little need to intervene, to frequent calendar-based applications of spray-applied liquids to exposed interior and exterior surfaces. Ineffectively managed pest problems, and applications of general use pest control products by untrained individuals continue to occur in many schools.

The goal of this chapter is to identify and briefly characterize those pests found in school buildings and landscapes, describe effective IPM techniques that can be applied to school systems in a holistic, preventive approach, and detail inspection, monitoring and suppression methods for specific pests. Priorities identified by the workgroup are included for each pest reviewed.

Emphasis has been placed on effective options that minimize toxicity and potential for exposure. For example, spray-applied liquids and volatile formulations are generally not favored due to potential for exposure to children who may contact surfaces to which the pesticide has been applied or has accumulated on through drift, for example onto walls after applications to baseboards (Williams *et al.* 2005), or re-deposition of volatiles, for example, onto unsprayed children's toys and other surfaces up to two weeks after application of semi-volatile pesticides to floors in an apartment (Gurunathan *et al.* 1998).

Additional information on the efficacy of management options is provided in Appendix A. Example brand name products commonly used in schools are included. No attempt was made to identify and list all products used in schools.

Common Pests

'Key pests' in schools, i.e., those typically requiring management action to avoid and prevent problems, are few (Table 6.1). Other pests less frequently encountered in or on school buildings may also call for intervention, including pests that are limited to specific geographic distributions within the US.

“Occasional invaders”, or pests found infrequently and/or not likely to establish populations within schools, may only rarely require action on our part to prevent or resolve a problem. These occasional invaders do and should provide an opportunity for staff and students to learn and appreciate the diversity of life on our planet, and the drive of all organisms to seek food, water and shelter, and to reproduce. A pest is a living, useful organism out of place, after all, and often one whose native home we have invaded and thus bear some responsibility for it becoming a pest. Our responsibility can be exercised by constructing and maintaining our structures so that these organisms are not enticed by food, water or shelter, or entrapped by inadequate prevention on our part.

The organisms described here provide very useful ecosystem services and only attain pest status when they interfere with us as humans, and with the safe and productive operation of our schools. Ants outdoors in the schoolyard or on the sidewalk, for example, are likely helping to decompose waste, aerate the soil and provide food for wildlife. The same ants may become pests when we fail to design and maintain tight buildings that prevent entry and leave food or other attractants exposed and accessible.

Table 6.1 Pests found within and around schools and status.

Structural Pests	**Landscape/Exterior Pests**
Key pests, typically requiring management action to prevent problems	
ants brown-banded, German and Oriental cockroaches mice	stinging insects weeds on athletic fields, in pavement or along fencerows or under bleachers turf diseases on athletic fields
Other pests often encountered in and around schools that may require action to reduce damage, injury or complaints	
bats bed bugs birds carpenter ants and carpenter bees crickets fruit, drain and filth flies fungus gnats head lice microbial pests: mold spiders stinging wasps or bees termites	caterpillars mosquitoes Norway rats plant-sap feeding pests: aphids, mites, scales, whiteflies weeds on school lawns

<table>
<tr><th colspan="2">Occasional invaders, found infrequently and/or unlikely to establish threatening or damaging populations in or around schools</th></tr>
<tr><td>booklice
centipedes
firebrats
fleas
millipedes
mites
silverfish
stored product moths and beetles
wood-boring beetles</td><td>snakes</td></tr>
<tr><th colspan="2">Regional pests that may require action</th></tr>
<tr><td>roof rats
Turkestan cockroaches</td><td>fire ants
gophers
scorpions
ticks</td></tr>
</table>

7. Management Zones: Preventing and Avoiding Pest-Conducive Conditions, Pests, and Pesticide Hazards

By carefully managing specific zones in the school environment to address pest-conducive conditions, a broad spectrum of pest problems and pesticide hazards can be effectively avoided.

Many tactics that prevent pest problems also contribute to water and energy conservation, indoor air quality, cost reduction and asset preservation. For example, effective door sweeps can reduce pest complaints by 65%, reduce infiltration of dirt and prevent escape of heat and air conditioning. Repairing leaking pipes prevents pest access to moisture and also water consumption and costs.

The following table identifies primary zones and tactics that can be employed in each zone.

Table 7.1 IPM zones, primary hazards of concern impacted by management activities in the zone, and tactics to prevent and avoid problems. Tactics include excerpts from IPM Standards for Schools (IPM Institute of North America 2004).

General	
Zone	**Preventive/Avoidance Tactics**
People – staff, parents and others using or impacting the school environment Problems reduced with all pests	Appropriate personnel (e.g., superintendent, facilities manager, principal, *IPM Coordinator*) understand and ensure that the school meets all Federal, State and local legal requirements related to *pest* management in schools (e.g., posting, notification, pesticide management, etc.). Resources are identified and acquired to assist in developing and implementing IPM (e.g., state/county Extension personnel, publications and on-line resources; non-governmental organizations, pest management professionals with expertise in school IPM). A written IPM policy is adopted which a) states a commitment to IPM implementation; b) identifies overall objectives relating to pest and pesticide risk management; c) is used to guide decision-making; and d) is reviewed at least once every three years and revised as needed. An IPM Committee is formed to create and maintain the IPM policy, provide guidance in interpreting the policy, and provide oversight of the program. An IPM Coordinator is designated to provide day-to-day oversight of the IPM program, and provided with IPM training and resources as needed.

	Pest management roles are developed for and communicated at least annually to: a) administrators (e.g., principals regarding posting, notification, reporting, etc.); b) teachers (e.g., do not bring in/apply pesticides, sanitation, etc.); c) custodians (e.g., pest sightings log, inspection, sanitation, exclusion, etc.); d) food handlers (e.g., sanitation, exclusion, etc.); and e) outside contractors (e.g., IPM policy, posting, pest control options to outside pest management professionals). A written IPM Plan is prepared that includes a schedule for inspection and monitoring of buildings and adjacent grounds, including a schedule for areas requiring more frequent inspection/monitoring (e.g., food storage, preparation and serving areas, athletic fields). The IPM Plan includes a list of key pests and action thresholds for each key pest (even if threshold is one, i.e., no tolerance). The IPM Plan includes a list of management options to be used when key pest problems occur and specifies lesser risk options (e.g., sanitation, exclusion) to be used before resorting to actions with greater hazards. Public access is provided on request to all information about the IPM policy, IPM plan and implementation. If outside contractors provide pest control services, a written contract identifies specific IPM practices to be used including regular inspections, monitoring where appropriate, record-keeping and agreement to abide by the IPM Policy and IPM Plan. A Pest Sightings/Damage Log is kept in a designated area (e.g., main office). Staffs are instructed to report all pest-related incidents to the log including date, time, exact location, a description of the pest or pest damage, and the name of the person reporting. Pest Manager reviews reports promptly and records and dates responses taken to each report. This log may be part of a general maintenance reporting system. Key staff (e.g., IPM Coordinator, Pest Manager, custodians, food service) participate in IPM training at least annually. Training is adequate and appropriate to the IPM roles fulfilled by these staff members. Designs for new or renovated buildings and landscapes are reviewed for pest-proofing prior to finalizing, and/or specific pest-proofing elements are included in general specifications for all new buildings and renovations. New construction or renovation projects are inspected while in progress to ensure adequate sanitation and pest management, and compliance with pest-proofing design specifications.

	Information, e.g., *Pest Press* editions, is distributed at least annually to inform staff, students, parents and others as appropriate about key IPM issues such as roles, reporting, sanitation, etc. Roles communicated to staff and students include proper disposal of food or food wrappers.

Structures	
Zone	**Preventive/Avoidance Tactics**
Building "skin" – exterior walls and ground within several feet of the wall, roofs, attics and crawlspaces Pest problems reduced: ants, birds, carpenter ants, carpenter bees, crickets, flies, mice, rats, spiders, stinging insects, termites, many occasional invaders	A comprehensive inspection of all buildings is conducted by an in-house or contracted professional Pest Manager for defects including cracks, crevices and other pest entryways; food, moisture and shelter resources available to pests; moisture, pest or other damage to structural elements; termite earthen tunnels, pest fecal matter or other signs of pest activity; etc. A report of all defects is prepared, corrective actions are identified. A written IPM inspection checklist or form is used for periodic inspections, listing each building feature (e.g., foundation, eaves, etc.) and room to be inspected, including specific locations within features or rooms (e.g., vents, storage closets) to be included in the inspection, and specific conditions to be noted (e.g., repair, cleaning needs). Legible records are maintained of inspection results, pest management actions and evaluations of results and maintained for at least three years. A timeline is established for completion of corrective actions and evaluation of results. Building eaves, walls, roofs and any attics or crawlspaces are inspected at least quarterly (e.g., for bird and other nests, puddling of water, etc.) and these conditions are corrected. Vegetation, shrubs and mulch are kept at least 12 in. away from structures. Tree limbs and branches that might provide vertebrate pest access to structures are maintained at least 6 ft. away from structures (10 ft. if tree squirrels are a problem). Exterior doors throughout the building are kept shut when not in use. Windows and vents are screened or filtered. Weather stripping and door sweeps are placed on doors to exclude pest entry and are maintained in good condition. Cracks and crevices in walls, floors and pavement are corrected. Openings around potential insect and rodent runways (electrical conduits, heating ducts and plumbing pipes) are sealed.
Food service - food storage, preparation and	Floors are cleaned daily.

serving areas, including student stores, concession stands, staff lounges and home economics classrooms Pest problems reduced: ants; cockroaches; fruit, drain and filth flies; mice; spiders	Incoming shipments of food products, paper supplies, etc. are inspected for pests and rejected if infested. Stored products are rotated on a "first in, first out" basis to reduce potential for pest harborage and reproduction. Inspection aisles (≥ 6" x 6") are maintained around bulk stored products. Bulk stored products are not permitted direct contact with walls or floors, allowing access for inspection and reducing pest harborages. Potential pest food items used in classrooms (e.g., beans, plant seeds, pet food and bedding, decorative corn, gourds) are refrigerated or stored in glass or metal containers with pest-proof lids. Food products not delivered in pest-proof containers (e.g., paper, cardboard boxes) and not used immediately are stored refrigerated or transferred to pest-proof containers. Empty food/beverage containers to be recycled are washed with soapy water before storage to remove food residue, stored refrigerated or in pest-proof containers. Food-contaminated dishes, utensils, surfaces are cleaned by the end of each day. Surfaces in food preparation and serving areas are regularly cleaned of any grease deposits. Appliances and furnishings in these areas that are rarely moved (e.g., refrigerators, freezers, shelve units) receive a thorough cleaning around and under to remove accumulated grease, dust, etc., at least monthly. Permanent bulletin boards, mirrors and other wall fixtures are sealed where edges meet walls to reduce pest harborage. Purchases of new kitchen appliances and fixtures are of pest-resistant design (i.e., open design, few or no hiding places for roaches, freestanding and on casters for easy thorough cleaning). Food that has come in direct contact with pests (e.g., ants, cockroaches, mice) is considered contaminated and is discarded. In food service areas, drain covers are removed and drains are cleaned weekly (e.g., with a long-handled brush and cleaning solution). In other areas, such as drains under refrigeration units, drains are cleaned monthly. Floor and sink drain traps are kept full of water. Out-of-date charts or paper notices are removed from walls monthly. Vending machines are maintained in clean condition inside and out.
Waste/Recyclables Handling – trash/recycling receptacles throughout	Trash/recycling storage rooms, compactors and dumpsters are regularly inspected and spills cleaned up and leaks repaired promptly. Waste materials in all rooms within the school building are collected

the building, trash collection carts, dumpsters, compactors Pest problems reduced: ants; cockroaches; fruit, drain and filth flies; mice; rats	and removed to a dumpster, compactor or designated pickup location daily. Packing and shipping trash (bags, boxes, pallets) is promptly and properly discarded or recycled. Food waste from preparation and serving areas is stored in sealed plastic bags thick enough to prevent tearing and spills before removal to dumpsters. Animal wastes from classroom pets or laboratory animals are flushed or placed in sealed containers before disposal. Indoor garbage is kept in lined, covered containers and emptied daily. All garbage cans and dumpsters are cleaned regularly. Outdoor garbage containers and storage are placed away from building entrances. Outdoor garbage containers have spring-loaded lids to exclude pests. Outdoor garbage containers are emptied frequently to prevent accumulated trash from blocking door closure. Outdoor garbage containers, dumpsters, compactors and storage are placed on hard, cleanable surfaces. Stored waste in dumpsters or compactors is collected and moved off site at least twice weekly. Recyclables are collected and moved off site at least weekly.
Mechanical/Custodial Pest problems reduced: ants; cockroaches; drain flies; mice; rats	Wiping cloths are disposable or laundered daily. Mops and mop buckets are properly dried and stored (e.g., mops hung upside down, buckets emptied). Floor and sink drain traps are kept full of water.
Hallways, Classrooms Pest problems reduced: ants, cockroaches, mice	Pest management roles communicated to staff and students include removing food or food wrappers from lockers and desks on a daily basis. Lockers and desks are emptied and thoroughly cleaned at least three times per year (e.g., winter and spring breaks and at the end of each school year). Any food items on hand in classrooms (e.g., snacks, food items used for arts/crafts) at end of year are removed. Floors are cleaned (free from spillage) and carpets vacuumed daily in areas where food is served, and at least weekly in other areas. Students are advised at the start of the school year not to exchange hats, combs or hairbrushes. Furniture in classrooms and offices that are rarely moved (e.g., staff desks, bookcases, filing cabinets) receive a thorough cleaning around and under to remove accumulated lint, etc., at least annually.

	Teachers incorporate pest and pesticide risk management into curricula and/or class projects.

Landscapes	
All managed landscapes Pest problems reduced: ants, stinging insects, plant-feeding insects, plant diseases, rodents and other vertebrates.	A written IPM Plan includes a list of actions to prevent and avoid pest problems (e.g., replacement of key, pest-prone plants, moving improperly placed plants to more favorable locations, slope modification to improve water drainage, pavement replacement and repair to reduce weed growth) and a timeline for implementation. The IPM Plan specifies preventative and avoidance strategies for ongoing grounds maintenance and for new or renovated landscape design. The IPM Plan divides turf and landscape areas by basic use level (i.e., athletic fields vs. lawns and general use, high visibility vs. less visible landscape areas). Monitoring frequency and thresholds are appropriate to each level and commonly encountered pests. The IPM Plan subdivides turf areas by advanced level of use (i.e., athletic fields with limited use for publicly attended events vs. athletic fields for daily practice and general use). Monitoring schedules and action thresholds are appropriate to each level. Pest-prone plants in the landscape are removed and replaced with plants less susceptible to pest problems. A comprehensive inspection of all school grounds is conducted by an in-house or contracted professionals for defects including cracks in walkways and driveways; food, moisture and shelter resources available to pests; moisture, pest or other damage to fences, retaining walls, irrigation and drainage systems, etc.; pest runways, pest fecal matter or other signs of pest activity; etc. A report of all defects is prepared and corrective actions are identified. Legible records are maintained of inspection results, including date, pests and/or pest damage found and location, estimate of pest density or damage level, recommendation, actions taken and evaluations of results. Litter is collected and properly disposed of from school grounds at least weekly. Cracks and crevices in paved areas are corrected. At least a rough landscape plant map is prepared: a) noting locations of trees, shrubs and ornamentals; b) dividing the landscape into management units; and c) copies of the map are updated annually, noting soil fertility tests, pest problems and key plants. Soil in landscape plantings is tested at least every five years for

	nitrogen, phosphorus, potassium and pH. Fertilizers and other soil amendments are applied according to soil and/or plant foliage test results, not on a routine or regularly scheduled basis. Fertilizer applications are split (e.g., one in spring and one in fall) rather than made in one single heavy application. When fertilizers are applied, they are watered into the soil to reduce wind or rain-induced movement from the site. When fertilizers are needed, slow-release forms of nitrogen are used. Identifying soil compaction is part of regular monitoring. Problem areas are corrected and/or traffic redirected. Irrigation of established plants is scheduled according to need and anticipated weather, not on a routine or regularly scheduled basis. Signs of erosion are minimal. New erosion sites are corrected promptly. Plant debris and leaves are not permitted to accumulate on hardscape (e.g., on sidewalks, parking areas, road and driveways) to avoid pest harborage movement into sewer systems and surface water bodies. Irrigation, if used, is scheduled to minimize the amount of time leaves remain wet to reduce opportunities for disease development (i.e., plant foliage is dry before nightfall). Irrigation is allowed to drain before heavy foot or vehicular traffic is permitted in planted areas to minimize compaction. Drip irrigation is used for annual beds and/or high visibility/demand beds.
Planted areas- trees, shrubs and bedding plants Pest problems reduced: aphids, caterpillars, weevils, whitefly, plant diseases, broadleaf and grassy weeds	Landscape plants are scouted at least three times during the growing season to assess plant health and to identify conditions requiring action (e.g., damaged, diseased, dead limbs; soil erosion/compaction; insect, disease, weed pests and damage). Key plants in the landscape are scouted more frequently during critical times of year (i.e., around key pest emergence, egg laying, etc.). Scouting follows a regular pattern to ensure all plantings are checked. Scouting results, corrective actions and evaluations of results are noted legibly in writing and these records are maintained for at least three years. Corrective actions are identified and a timeline is established for implementation and evaluation. When renovating, adding new plants or establishing new landscape areas, plant species are selected to address site-specific growing conditions (e.g., tolerance to key pests, pH levels, soil type, light levels, hardiness zone, annual rainfall, etc.). Plant spacing is adequate to ensure sufficient light, nutrients and

	water. When renovating, changes in grade or drainage around established trees are avoided unless necessary to correct an existing problem. In temperate areas, fertilizers are not applied after mid-summer or before complete dormancy to avoid delaying dormancy. Perennial beds are mulched to conserve soil moisture, improve organic matter, reduce compaction and moderate soil temperature. Root zones of trees and shrubs are mulched to at least the drip line.
General use turfgrass areas including lawns – lower visibility lawn areas, playgrounds, natural areas. Pest problems reduced: ants, stinging insects including ground-nesting wasps and bees, noxious weeds, wildlife including skunks, moles, gophers, groundhogs	Turfgrass areas are scouted at least 3 times during the growing season to assess plant health and look for any conditions requiring action (e.g. erosion sites, site compaction, destructive insect, disease, or mammalian pest damage, noxious weed populations). Appropriate corrective actions are identified and a timeline is established for implementation and evaluation. Mowing as needed to maintain function of areas. Natural rainfall to provide these turfgrass areas with water for plant survival. Aeration (solid tine, hollow cone, and/or shatter) conducted on general use turfgrass areas at least once every two years. Fertilizers and other soil amendments are applied according to soil test results, not on a routine or regularly scheduled basis. When fertilizers are needed, slow-release forms of nitrogen are used.
Athletic fields - practice and competition fields for baseball, football, soccer and other sports Pest problems reduced: ants, white grubs, turfgrass diseases, broadleaf and grassy weeds	Each turfgrass area scouted bimonthly during the growing season to assess plant health and look for any conditions requiring action. Predetermined thresholds for insects, plant diseases, and weeds established by IPM coordinator, grounds manager, and independent IPM consultant. Any corrective response to follow threshold values. Selection of turfgrass varieties based on expected pests, site conditions, anticipated seasonal use, area of country, available seed sources, and endophyte incorporations. Turfgrass areas must be irrigated to promote active growth and recovery after games. Aeration to be used 2-6 times each year, at a depth of 3” using a combination of times (solid tine, hollow core, and shatter). Deep tine or shatter to a depth of 8” at least once each year. Turfgrass areas should be topdressed with compost and/or sand in combination with aeration to prepare seed bed, modify soil, and smooth a given field. Fertilizers and other soil amendments are applied according to soil test results. A combination of slow and quick release nitrogen fertilizers will be used. Mowing height and frequency done so that no more than 1/3 of the

	plant height is removed each time the grass is cut. Overseeding should be done to competition turfgrass areas from August through November based on scouting. Any repair work needs to be accomplished during March through May. Any herbicides used against persistent weeds (e.g., crabgrass, knotweed, and broadleaf weeds) needs to be done in full coordination with annual overseeding program so desirable turf seed is not damaged. Persistent insect pests (e.g. billbugs, chinch bugs, white grubs, sod webworms) should be scouted more frequently during critical times of the growing season (e.g., adult emergence, egg laying, larval presence).
Grounds maintenance facilities – buildings housing grounds maintenance equipment and products including fertilizer	A complete inventory of all existing lawn maintenance equipment is maintained. A list of desired equipment to reduce pest-conducive conditions (e.g., aerator, de-thatcher, spring-tooth harrow, flotation tires, etc.) is developed so that these items can be worked into the budget over time. Fertilizer inventories are maintained and kept separate from the actual product. Fertilizers should be stored in a secure location and kept dry. The storage site should not have a heating system or hot water system in the exact area where fertilizers are stored.

Pesticides	
Pesticide storage, **selection and use –** Including pesticides that may be used for structural or landscape pest management, or used in agricultural or horticultural study programs, or by grounds and facilities maintenance staff for stinging insects encountered in the line of work.	Pesticide inventories are maintained by the district only if personnel properly licensed or certified to apply those pesticides are on staff. Storage is tightly controlled to prevent unauthorized access. Current stock is inventoried at least annually. Copies of the inventory are kept separately away from the storage area/facility and also provided to the local fire department. Inventory is managed to track current stock and use and ensure proper disposal of unused and outdated products and empty containers. Liquids are stored on shelves below dry formulations. Shelves are non-absorbent, e.g., metal, plastic, plastic-covered wood. Pesticide storage is locked, in a secure location, adequately ventilated, temperature controlled, well lighted, dry and structurally sound. The IPM coordinator is consulted prior to application of pesticides to confirm that reasonable non-chemical measures have been implemented and that the proposed application(s) is(are) consistent with the IPM policy and plan. All pesticide applications are made by a person certified and/or

	licensed by the state to apply pesticides in commercial facilities. All pesticide applications are made only after detection of a verifiable pest problem, accurate identification of the pest, review of all available options and use of non-chemical strategies. Applications are made at the appropriate time based on the pest's life cycle, and not made on a routine or regularly scheduled basis (e.g., weekly, monthly applications are not made). Complete, legible records of each pesticide application, including product, quantity used, date and time of application, location, application method and target pests are maintained for at least three years. A pesticide notification policy is implemented such that: a) At least 24 hours prior to pesticide application, postings are placed in a designated public area detailing locations to be treated and contact information for further information *(exceptions may be made for applications made for emergencies, where an imminent threat to health exists (e.g., stinging insects), or for applications of* anti-microbials *and for formulations with very low potential for exposure such as gels or pre-manufactured bait stations placed in accessible areas; for emergency applications, postings must be placed as soon as practical);* b) this notice remains posted for at least 48 hours post-application; and c) copies of the pesticide label and MSDS sheet for the material(s) to be used are available on request and maintained on file in a central location (e.g., main office). A list of pre-approved pesticides is identified by reviewing needs and pesticide hazards, with a procedure for reviewing new products as needed and for annual review and revision of the list by the IPM or related committee. Pesticides labeled "Danger" or "Warning" are not used. If a pesticide is classified as exempt from registration by US EPA, it does not meet criteria (acute oral, dermal or inhalation toxicity, skin or eye sensitivity) for labeling as "Danger" or "Warning." Pesticides with ingredients classified as possible, known, probable or likely carcinogens or reproductive toxicants by US EPA or the California Prop 65 list are not used. Pesticides with ingredients classified as endocrine disruptors by the European Commission or US EPA are not used. No pesticide ingredients are classified as nervous system toxicants such as cholinesterase inhibitors or neurotoxins on the Toxics Release Inventory. Pesticides are not used unless inert ingredients are disclosed and these inert ingredients also meet the restrictions listed above, and are

	not listed on the US EPA List 1: Inerts of Toxicological Concern. Pesticides used outdoors do not include label precautionary statements including “toxic” or “extremely toxic” to bees, birds, fish or wildlife, unless these organisms are the target pest. Pesticides used outdoors do not include ingredients with moderate or high mobility in soil, according to the Groundwater Ubiquity Score (GUS), or with a soil half-life of 31 days or more (except for mineral products). Preferred pesticide formulations include ready-to-use or pre-mixed before bringing onto school grounds. Spray applications of residual-active pesticides to an exposed surface of a structure (e.g., floor, baseboard, wall, etc) are not used. If dust formulations are used, these are applied only to areas that are sealed after treatment (e.g., wall voids) to prevent exposure of students to airborne dust particles. Building engineers are warned of potential hazards during future renovations. Baits (e.g., for ants, cockroaches, rodents), if used, are: a) placed in areas inaccessible or off-limits to children; b) placed in a locked, distinctively marked, tamper-resistant container designed specifically for holding baits and constructed of metal, plastic or wood; c) used in bait containers securely attached to floors, walls, etc. such that the container cannot be picked up and moved; d) placed in the baffle-protected feeding chamber of the bait container and not in the runway; e) parafinized or weatherproof if used in wet areas; and f) not used outdoors unless bait containers are inaccessible to children (e.g., placed underground in pest nests or on building roofs). Pesticide and fertilizers are loaded into application equipment over a hard surface where spills can be promptly and thoroughly contained and cleaned without danger of spill leaching into soil or runoff into soil, drains or sewers. School assesses potential pesticide hazards from use by neighbors such as drift from applications to farm fields, golf courses, lawns, etc. and acts to reduce exposure to those pesticides by requesting prior notification, buffer zones and/or scheduling of applications to avoid times when children or staff are present.
Pesticide practices specific to grounds management	All pesticide application equipment is calibrated at least at the start of each season and once in mid-season, and ideally prior to each use. Records (date, calibrator, etc.) are maintained for three years. Pesticide applications are limited to affected areas, plants or plant parts rather than treating an entire management unit, group of plants

	or entire plant, respectively, as per monitoring results (e.g., one corner of a lawn is treated for grubs, or one shrub or portion of a shrub is treated). When effective control can be achieved at reduced rates, pesticide applications are made at less than the maximum labeled rate, unless resistance development concerns dictate otherwise. Where appropriate (e.g., herbicide applications), a colorant is used to mark the treated area.

8. Pest-specific Information, Tactics, Emerging Issues and Priorities

The following section presents major pest groups, geographic distribution, monitoring techniques and a hierarchy of management options including strategies to prevent and avoid problems. Example pesticide options are categorized by toxicity and potential for exposure. Pest-specific emerging issues and priorities are also identified.

Detailed knowledge about pest biology and ecology is essential for effective IPM systems design and invaluable when intervention is needed to address a problem. This requirement for acquiring and sharing knowledge is an ideal complement to the school environment where the goal, above all, is learning.

For nearly all pests, a monitoring/reporting system must be in place to effectively address problems as soon as they occur. In general, perhaps the most effective monitoring tool for pest activity is the complaint or pest-sighting log. This reporting approach allows staff and others to report any pest sighting or problem to a central location and should include the time and date of the report, person reporting and the exact location of the sighting or complaint. This log can be part of, and often works extremely well in conjunction with an existing work-order request system including electronic systems. A log can be located in each school within a system, or maintained centrally with reports called or emailed in to the central location. In either case, the report should be delivered to the IPM coordinator, pest management staff or contractors within 24 hours, and the response noted including date it was addressed, and remedy implemented or recommended. If a recommendation, the system must relay this information to the appropriate party or the chain of report/resolution will not be complete. It is critical that the response to pest reports include diagnosis of the underlying cause and implementation of corrective measures, not simply a pesticide application.

Pesticide use, toxicity and potential for exposure should be minimized for a number of reasons in addition to the increased susceptibility of children to toxins. Pesticide applications are generally temporary measures and do not solve the underlying problem. The history of pest management includes many products that were considered safe when used as per label directions at the time they were introduced and were later found to have substantial hazards. Although most pesticide products undergo extensive testing and review prior to entering the marketplace, no amount of testing is adequate to identify all potential hazards including those associated with exposure to multiple toxins in combination. Finally, effective cultural and physical options are available for nearly all of the pest problems typically encountered in schools.

A written plan should ideally be in place that details ongoing pest prevention such as monthly or quarterly inspections of food service and other pest-prone areas, and annual inspections of the entire building for pest-conducive conditions. The plan should also include a hierarchy of actions to be taken when a pest problem arises, with an emphasis on identification, diagnosis of the underlying causes and contributing factors. The plan should include both short-term tactics to regain acceptable conditions and long-term preventive solutions. A written plan is key to continuity of IPM programs through staff and other changes.

A well-trained IPM coordinator should be in place and charged with implementing the IPM policy and plan, including reviewing proposed pesticide uses to ensure they are compatible with the policy and plan and that reasonable non-chemical measures have been taken. An IPM committee or other committee charged with pest management responsibilities should be in place to regularly review performance and update policies, plans and procedures to reflect current conditions and available options, and ensure continual improvement.

STRUCTURAL AND PUBLIC HEALTH PESTS

ANTS – Nuisance species

Several species of ants cause problems inside schools. Removing individual ants and using detergent and water to clean up any chemical (pheromone) recruitment trail can be immediately effective in stopping a limited invasion. This should be followed by identifying and sealing the point of entry as a permanent solution.

The key to solving persistent ant problems is proper identification of the species. After the problem ant has been identified, information on life cycle, preferred food, harborage and nesting sites and effective management options can be readily obtained.

Stinging ants are addressed with other stinging insects below. Carpenter ants are also addressed separately below.

Ants typically enter school buildings from a colony located outside the school building. In each colony, one to several queens produce workers who seek out food and water for the larvae in the colony. With the advent of warm weather in the spring, ant populations and the demand for food increase dramatically. It is during this time that ants are most commonly sighted and become a nuisance. Most nuisance ants do not damage structures. Their entry into buildings is entirely a response to the availability of food, water, warmth or sometimes to escape flooding.

Occasionally, in the spring or fall, an ant colony will sent out winged ants, usually around the time of a rain. This is a temporary event and does not require intervention other than vacuuming up any ants present. These ants do not bite or sting but rather are looking for mates and will disperse. It is very important not to mistake these winged ants for termites and wrongly determine that the school needs to be treated for termites.

Table 8.1 Nuisance ant species most likely to be encountered in schools and other structures in search of food, water or shelter. Stinging ants are addressed with other stinging insects below.

Common and species name	**Geographic distribution**
Argentine ant, *Linepithema humile*	Southeastern US and California.
acrobat ant, *Crematogaster spp.*	Throughout the US.
big-headed ant, *Pheidole* spp.	Eastern US from Canada to Florida.
crazy ant, *Paratrechina longicornis*	Southeastern US from Florida to Texas.
false honey ant, *Prenolepis impairs*	Throughout the US.
ghost ant, *Tapinoma melanocephalum*	Southern (tropical and sub-tropical) US.
little black ant, *Monomorium minimum*	Throughout the US.
odorous house ant, *Tapinoma sessile*	Throughout the US.
pavement ant, *Tetramorium caespitum*	Eastern US from Canada to Florida.
pharaoh ant, *Monomorium pharaonis*	Throughout the US.
pyramid ant, *Dorymyrmex spp.*	Throughout the US, most common in southern states.
thief ant, *Solenopsis molesta*	Throughout the US.

Monitoring and inspection for nuisance ants

Identifying the problem ant is the most critical step to take to solve a persistent problem. Monitoring for nuisance ants to determine which species are present is primarily visual inspection for foraging individuals, trailing ants or colonies. Additionally, bait stations may be monitored for evidence of feeding. Adhesive-coated monitoring traps may also capture ants. Finally, index cards can be baited with honey or sugar-water solutions, peanut butter and/or vegetable oil to attract and capture ants to identify which species are active in a specific area. On arrival at a site, the technician can place these and then check and remove after 30 minutes. Individual ants captured for identification purposes should be held in a small vial to preserve key identifying characters and sent to experts for identification, e.g., to your local county extension office or regional or state extension specialist.

Inspection practices should include checking for vegetation touching buildings, mulch contacting foundations, trash cans or dumpsters placed too close to building entryways, exposed food, inadequate clean up of spilled food or drink, unrinsed recycling, unsealed openings through the building exterior and missing or damaged door sweeps and door and window seals. Nests can also often be located by visual inspection and/or following trailing ants.

Cultural and physical options for nuisance ant management

Cultural and mechanical management options are preferred and include prompt clean up of spills, proper food storage and waste handling, preventing access to water by fixing plumbing leaks and repairing damp wood, eliminating harborage and access to the building by sealing cracks and crevices, and trimming vegetation and moving mulch away from buildings.

Many ant species leave behind a pheromone trail to recruit other ants to food and water sources. Small numbers of ants can be wiped up with a soapy sponge and washed down the drain. Care should be taken to wipe any trails that ants may be following with soap and water to eliminate any recruitment pheromones. This should be followed by identifying and sealing the point of entry as a permanent solution. Finally, exterior lighting should be positioned to avoid attracting crawling and flying insects to building entryways at night, which can then attract ants and other pests to these entryways to feed on dead insects.

Table 8.2 Cultural and physical strategies for nuisance ants.

- Remove individual ants using a vacuum or wipe.
- Use detergent and water to clean surfaces where ants have been traveling to eliminate any pheromone recruitment trail.
- Eliminate the access point where ants are entering by sealing cracks, installing door sweeps, repairing door and window seals, etc.
- Clean up food and drink spills immediately.
- Store food items in sealed containers.
- Use liners for waste containers and empty at the end of the day so that food is not left in the building overnight.
- Place exterior trash cans and dumpsters away from building entrances.
- Fix plumbing leaks, gutters that hold water and damp wood to eliminate access to water.
- Trim vegetation away from buildings to prevent ant access.
- Rake back mulch at least 6” from building foundations to ease inspection for ant trails.
- Position exterior lighting to avoid attracting crawling and flying insects to building entryways at night.
- Use sodium vapor or yellow bulbs for exterior lighting to reduce attraction to insects.

A limited number of non-chemical products are used for nuisance ants including monitoring devices, sealants and exclusion devices.

Table 8.3 Commonly used products for physical, cultural or mechanical management of nuisance ants and uses.

Type	Example Products	Uses
door sweeps and seals	Sealeze Weatherseal	Install to close gap between bottom of door and sill, and between edges of door and frame.
index cards baited with honey, peanut butter or vegetable		Place on ground near building, e.g., where ants

oil		have been reported, check in 30 minutes to help identify problem species.
insect monitors	Catchmaster® Insect Trap and Monitor Trapper® Monitor and Insect Trap Victor® Insect Glue Trap	Continuous monitoring of ants and other arthropods.
reusable bait stations	Ant Café Reusable Insect Bait Station	Installed indoors.
	AntPro® Ant Bait Station Kness Ants-No More Ant Bait Station	Installed outdoors, e.g., on a stake driven into the ground.
sealants	many	Close potential entryways.

Pesticide options for nuisance ants
Pesticides should not be used on a routine or calendar-based schedule but only where persistent ant problems occur, the ant species has been identified and non-chemical approaches have proven unsuccessful or uneconomical, e.g., repairs to old structures to exclude ants are not affordable.

Pesticide options that reduce potential for exposure include insecticide baits in pre-manufactured, enclosed bait stations and gel or liquid baits placed in cracks and crevices. Effective baits are available for most nuisance ant species.

Pesticide options that increase potential for exposure for students, staff and other facility users include spray formulations applied to exposed surfaces or broadcast granulars. These formulations are typically not required for successful management of nuisance ants in schools. Danger or Warning-labeled pesticides are not required for nuisance ant management. In addition, barrier applications to exposed impervious surfaces including foundations, walkways and driveways are prone to runoff into surface water and should be avoided.

Table 8.4 Commonly used insecticide products for nuisance ants and uses.

a. Insecticides carrying a CAUTION label or exempt from EPA registration, in formulations that reduce potential for exposure.

Active ingredient	Example products	Uses
disodium octaborate tetrahydrate Indoxacarb	Ant Café® RTU 73766-1 Advion® Ant Bait Arena 352-664	Pre-manufactured enclosed bait station that can be placed in inaccessible areas.
boric acid, orthoboric acid	Ant X® 739-12-2 Drax® Gel 9444-131 Intice™ Ant Gel 73079-1	Solution or gel that can be applied as drops in inaccessible areas where bait

borax disodium octaborate tetrahydrate Indoxacarb	Pro-Joe® Ant Bait 54452-7 Terro® Ant Killer II 149-8 Gourmet Ant Bait Gel 73766-1 Advion® Ant Bait Gel 352-746	stations do not fit. Wipe up any over-application.

b. CAUTION-label or exempt formulations with greater potential for exposure.

Active ingredient	Example products	Uses
fipronil sulfluramid	Maxforce® Prof Insect Control Ant Bait Station 432-1256 Prescription Treatment Advance® Dual Choice Ant Bait Stations 499-459	Volatile active ingredient in pre-manufactured enclosed bait station. Use alternative non-volatile products.
boric acid diatomaceous earth disodium octaborate tetrahydrate limestone	Borid® 9444-195 Eaton's KOI System 56-67 Boracide® 64405-7 NIC 235 Pro Organic® (EPA Exempt)	Dust formulation. To reduce exposure hazard, use alternative formulations if available, use only in voids that will be sealed after use or apply to surfaces in inaccessible areas. Wipe up any over-application.
boric acid mint oil 2-phenethyl propionate, eugenol	Prescription Treatment® 240 Permadust® 499-384 Earthcare® Naturals Ant & Roach Killer (EPA Exempt) Victor® Poison-Free Insect Killer (EPA Exempt) EcoEXEMPT KO	Pressurized aerosol formulation. Boric acid will leave dust residual. To reduce exposure hazard, use alternative formulations if available (Table 8.4a), use in voids that will be sealed after use or apply to inaccessible areas. Botanicals must be applied directly to insects (no residual activity). To reduce respiratory exposure, use outdoors.
boric acid orthoboric acid	ECO 2000-GR® 1677-191 Niban® FG 64405-2 Intice® Ant Granules 73079-2	Granular formulations which may be broadcast on ground. Granular formulations have potential to be picked up by non-target organisms. Apply only when ants are actively foraging and restrict reentry until granules are removed by ants.

c. CAUTION-label formulations with greater potential for toxicity and/or exposure.

Active ingredient	Example products	Uses
bifenthrin boric acid chlorfenapyr cyfluthrin deltamethrin	Talstar® One 279-3206 Mop-Up® 9444-132 Phantom® 241-392 Tempo® SC Ultra 11556-124 Suspend® SC 432-763	Liquids sprayed or otherwise applied to exposed interior and/or exterior surfaces. Spray applications can contaminate an area and make baiting ineffective until the residue degrades. To reduce exposure hazard and avoid contamination, use alternative formulations (Table 8.4a).

Emerging issues, new strategies and priorities for nuisance ants
Argentine and other ants may be tempted away from areas where they are causing a problem by "bribery" or "diversionary baiting." This strategy involves regular maintenance of bait stations placed outside and away from buildings, e.g., on the perimeter of a property. Starting by placing the baits outside and adjacent to the building, baits can be gradually moved out to the perimeter, drawing ant activity with them.

Granular formulations of botanical pesticides are broadcast around foundations to reduce ant activity and more information is needed on efficacy for specific ant species including residual activity.

Pyrethroids have been found at levels of concern in sediment of surface water in urban and suburban environments and associated with impacts on aquatic organisms. Other pesticides widely used for barrier perimeter treatments for ants including fipronil are also being examined for these potential hazards.

Table 8.5 Priorities for nuisance ants.

Research Efficacy of botanical pesticide products on nuisance ants including use along dripline of structures where nuisance ant activity is present. Efficacy of and optimum methods for diversionary baiting, e.g., baiting along perimeter of properties, away from structures, to reduce nuisance ant movement into structures. Alternatives for perimeter barrier treatments of residual insecticides for ants that are toxic to aquatic organisms and have potential to runoff into surface water.

Education Support materials for PMPs and others on effective diversionary baiting strategies.

Additional resources for nuisance ant management

Arizona Cooperative Extension. 2004. Ants. Pest Press. cals.arizona.edu/urbanipm/pest_press/2004/april.pdf (PDF)

Daar, S., T. Drlik, H. Olkowski and W. Olkowski. 1997. Chapter 5. IPM for ants in schools. Pp. 27-34. In *IPM for Schools: A How-to Manual*. US EPA. Line drawings, identification, communication, monitoring, management. www.epa.gov/pesticides/ipm/schoolipm/chap-5.pdf

Flint, M.L., ed. 2000. *Pests of Home and Landscape*. University of California Statewide IPM Project. Color images, description, biology and management. Available at www.ipm.ucdavis.edu/PMG/selectnewpest.home.html

Hedges, S.A. 1992. *Field Guide for the Management of Structure-Infesting Ants*. 155 pp. Color and B&W photos, line drawings, identification keys, biology, management. Available from GIE Media, Richfield, OH (800) 456-0707.

Hedges, S.A. 1997. Chapter 12. Ants. Pp. 503-589. In *Handbook of Pest Control*, A. Mallis, ed. Color and B&W photos, line drawings, identification keys, biology, management. Available from GIE Media, Richfield, OH (800) 456-0707.

Klotz, J., D. Williams, B. Reid, K. Vail and P. Koehler. Ant Trails: A Key to Management with Baits. edis.ifas.ufl.edu/IG123

National Park Service. 2003. Ants. In *Integrated Pest Management Manual*. www.nature.nps.gov/biology/ipm/manual/ants.cfm

University of Florida. 1998. IPM for Ants in Schools. schoolipm.ifas.ufl.edu/newtp6.htm

BATS

Bats are an interesting and valuable component of our environment. A few species (Table 8.6) frequently roost in buildings. While tolerable under some circumstances, the presence of bat roosts in close proximity to humans is often undesirable. Biologically (and often legally), the only long-term control technique is bat exclusion.

Physical contact with bats should be avoided. Potentially rabid bats pose a significant health threat to humans. School sites which regularly encounter bats on the premises should have an on-going student/staff/faculty education program to reduce potential for contact.

Individuals involved in bat management should be trained in basic bat biology, health concerns related to bats, and identifying signs of bat activity. Many states have laws requiring personnel involved with management projects to have a wildlife handler's permit or license. Pest situations involve incidental bats in human living space, bat roosts in buildings, and concerns with disease as rabies or histoplasmosis.

Table 8.6 Bat species most likely to be encountered in pest situations in school environments.

Common and species name	**Geographic distribution**
Big brown bat, *Eptesicus fuscus*	Throughout the US.
Little brown bat *Myotis lucifugus*	Throughout most of the US.
Mexican free-tailed bat *Tadarida brasiliensis*	Roughly the southern half of the US.
Evening bat *Nycticeius humeralis*	Eastern half of US north to southern Great Lakes.
Pallid bat *Antrozous palidus*	Southwestern US and west coast.
Yuma myotis *Myotis yumanensis*	Most of western third of US.

Monitoring and inspection for bats

Inspections should be done to determine bat entry points, the degree of structural modification needed to exclude bats, ways to prevent bats from entering human living space, and whether any person or pet has had direct contact with bats.

Bats normally enter near the top of structures. Unlike rodents, bats are not generally capable of chewing openings and must use existing holes. An opening ¼-inch by 1½-inch is sufficient for a small bat to squeeze through, but buildings with well-established roosts will probably have larger openings. Watching bats leave the roost at dusk can assist in locating the entry sites.

During an initial inspection, it should be ascertained whether any person or pet has been bitten, or otherwise had direct contact with a bat. If this has occurred, the local health department should be contacted.

Cultural and physical options for bat management

Buildings vary on the degree of structural modification needed to successfully seal bat entry points. Often, spot repairs with simple materials will be sufficient. In some cases, part of the structure (such as the roof) may need to be rebuilt. In still other situations, as many barns, total exclusion will not be practical.

Measures can be taken to prevent bats from entering the human living space of a building. Any opening to the walls or roof can provide access to bats. Common sites include gaps under and over attic doors, gaps around pipes passing into the ceiling, pocket doors which slide into the walls, loose fitting baseboards, and broken plaster. Either temporary (towel under attic door, steel wool in wall hole, etc.) or permanent steps can be taken to close these openings. Bats may also enter basements and other rooms through chimneys. The dampers should be kept closed on fireplaces when not in use, and chimney covers can help.

Bat exclusion on the exterior of a building is greatly facilitated with the use of checkvalves. These devices function as a one-way door for bats. When installed over the major entry sites, checkvalves allow bats to leave but not reenter the structure.

Somewhat controversial (and illegal in at least one state), bat traps are devices that, unlike checkvalves, do not allow one-way passage of bats but capture and hold the animals as they exit the entry site. The bats are generally either transported and released or destroyed. Individual bats can also be captured on sticky traps designed for rodents.

Some work has been done with combining exclusion with the use of bat houses as an alternative roosting site.

Increasing ventilation and illumination of attics and crawl spaces is sometimes done to try and reduce the environmental conditions attractive to roosting bats.

Although widely marketed to the public, ultrasonic devices purporting to repel bats have not shown in independent testing to be effective.

Table 8.7 Commonly used products for physical, cultural or mechanical management of bats and uses.

Type	**Example Products**	**Uses**
one-way exclusion checkvalves	netting, screen, Batcone™	Installed over openings bats use to enter and leave structures such that exit is allowed and reentry is not.
exclusion	sealant, hardware cloth, wood	Permanently seals openings after all bats have exited the structure.
disrupt the calm	ceiling fan, mylar balloons	Bats will not roost in disturbed areas, position fan to move balloons in problem roosting areas for several days.
slick surface		Cover substrate were bats are roosting with a smooth

		surface; bats will roost elsewhere.

Pesticide options for bat management

There are very few options in this category. A few products containing naphathalene (same ingredient as moth balls) are labeled for repelling bats. Napthalene-containing products should not be used due to human health hazards; naphthalene is one of the pesticides most frequently implicated in human pesticide poisonings.

Products containing polybutenes, that form an adhesive surface that are meant to repel pigeons and other birds, have been used around bat entry sites. However, since bats usually are not listed as target pests, this is an off-label use and thus prohibited in some states.

Until 1991, some states allowed the use of the anticoagulant chlorophacinone tracking powder (RoZol®) for lethal control of bats. This is no longer the case, and there are currently no pesticides that may be legally used to kill bats.

Table 8.8 Priorities for bat management.

Research Development of efficacious and least toxic repellents for use in bat roosts. Refinement of the use of off-site bat houses as alternative sites when excluding bats from a building.

Additional resources for bat management

Arizona Cooperative Extension. 2007. All About Bats. Pest Press. cals.arizona.edu/urbanipm/pest_press/2007/oct_nov.pdf (PDF)

Bat Conservation International. www.batcon.org

Curtis, P.D., J. Shultz, L. A. Braband, L. Berchielli and G. Batchelor. 2004. *Best Practices for Nuisance Wildlife Control Operators; A Training Manual*. NYS Department of Environmental Conservation and Cornell Cooperative Extension. nwco.net

Hygnstrom, S.E., R.M. Timm and G.E. Larson, eds. 1994. *Prevention and Control of Wildlife Damage.* University of Nebraska-Lincoln. 2 vols. digitalcommons.unl.edu/icwdmhandbook/

Internet Center for Wildlife Damage Management www.icwdm.org

Link, R. 2004. *Living with Wildlife in the Pacific Northwest*. Washington Department of Fish and Wildlife. 392 pp.

Salmon, T.P., D.A. Whisson and R.E. Marsh. 2006. *Wildlife Pest Control Around Gardens and Homes*. University of California. 122 pp.

Tuttle, M.D. 1988. *America's Neighborhood Bats; Understanding and Learning to Live in Harmony with Them*. University of Texas Press. 95 pp.

BIRDS

Birds are an attractive component of the exterior environment of a school. Under certain circumstances, some species in sufficient numbers can become pests and even health and safety hazards. Most bird species (including active nests, eggs, and young) are protected under federal and state wildlife laws. Even the small numbers that are not may have local or state humane ordinances that regulate how the birds may be handled.

Three species unprotected by federal and most state wildlife laws are among those most frequently causing problems on buildings: the rock pigeon, European starling and house sparrow. Problems are usually associated with their nests and/or fecal droppings. Nests on buildings can be unsightly, block ventilation systems and attract other pests such as bird mites or dermestid beetles. Accumulations of droppings can be a health hazard and deteriorate building surfaces.

Flocks of water birds, especially Canada geese and gulls, are an increasing problem on school grounds, especially athletic fields. In addition to creating a nuisance, these species may damage turf, deteriorate pond environments and create potential health hazards including slippery footing for athletes due to copious fecal droppings.

A wide range of other situations may result in birds becoming pests at schools. Roosting turkey vultures can become a nuisance with their distinctive sights and smells. Gulls may harass young children for food. Swallows may nest on the sides of school buildings, creating a problem with droppings and mites or dermestids left behind after they move on.

Crows have damaged certain roofing materials. Woodpeckers often drill into wooden buildings. Mississippi kites will dive at people near their nests. Blackbird roosts in trees can be a locally intense problem.

Table 8.9 Bird species most likely to become pests in school environments.

Common and species name	Geographic distribution
Rock Pigeon (formerly known as rock dove; also feral domestic pigeon), *Columba livia*	Throughout the US.
European starling, *Sturnus vulgaris*	Throughout much of the US.
House sparrow (also known as English	Throughout much of the US.

sparrow), *Passer domesticus*	
Canada Goose (resident, largely non-migratory populations), *Branta Canadensis*	Throughout the US.
Ring-billed gull, *Larus delawarensis*	Throughout the US, especially Great Lakes and coastal regions.

Monitoring and inspection for birds

Monitoring for bird problems at schools consists largely of logging and responding to complaints, and regular inspections of building exteriors including roofs. Early nesting efforts at problem sites, especially ventilation features, can be discouraged, removed and, if possible, prevented from reoccurring by exclusion with netting or spikes. Flocking behavior is generally easier to dissuade before bird patterns are well established.

Cultural and physical options for bird management

Most bird management procedures fall in this category. When possible, the best solution for bird problems is exclusion. This is most practical on buildings. A wide range of approaches are available from common building materials to bird netting, spikes and specialized products including electric tracks. Exclusion of geese and gulls from ponds is also possible using posts and wire or line.

Visual repellents are also available for birds ranging in price and sophistication from simple inflatable plastic balls with large eyespots to mechanical human effigies. The repellent effect is generally immediate but short term. Movement of the devices increases effectiveness, especially if the movement is unpredictable or irregular. Some schools have had success with the use of helikites, kites that use helium to remain in flight during periods of no wind, to dissuade gulls from athletic fields.

Among the most effective auditory devices are those that play distress calls of the target species. Other types of auditory repellents emit loud noises to startle the target. Devices that claim to repel birds by the use of ultrasonic waves not audible to humans have consistently proven to be ineffective.

Trained herding dogs have proven to be one of the most effective means to dissuade geese. Several schools have successfully used this technique, usually by hiring specialty companies which provide and manage trained dogs.

Table 8.10 Commonly used products for physical, cultural or mechanical management of birds and uses.

Type	Example Products	Uses
electrified barriers	Bird Jolt™ Flat Track	Apply to surfaces to deter birds from roosting.
helikites	Allsopp Helikites	Hawk mimic flies continuously with or without wind for

		extended periods to deter birds over a large area.
ledge eliminator	Bird Slope Ledge Eliminator	Apply to ledges to increase slope to discourage birds from roosting.
netting	Bird Net 2000™, PermanNet™	Cover voids to prevent access.
post and wire	FliteLine®, Springuard™	String wire between posts attached to structures to prevent roosting.
sound generators	Bird Chase Super Sonic™, BirdXPeller PRO™, Zon Mark Cannon	Device plays distress calls or generates annoying sounds to repel birds.
spikes	Bird Spike 2000™	Polycarbonate or steel spikes installed on surfaces to prevent birds from roosting.
trained herding dogs	Geese Police Inc.	Trained dogs discourage geese.
traps	Bird Motel™	Capture pigeons, sparrows, starlings.

Pesticide options for birds

There are few options in this category. Polybutenes form an adhesive surface that is uncomfortable for pigeons and other birds. Several products contain methyl anthranilate meant to make substances, e.g., turf, distasteful to grazing geese.

Avitrol® baits are poisons with flock-alarming properties. Birds that have fed upon the bait exhibit distress behavior that frightens the rest of the flock away. The baits are registered as chemical frightening agents (repellents) for use on pigeons, house sparrows, starlings and other species. Although true secondary poisoning does not occur, the product remains toxic to any bird that eats it even once it is in a bird's digestive tract. The possibility of a negative public reaction to dying birds needs to be considered when considering Avitrol® use.

A new product, Ovocontrol®, was recently registered for use on pigeons and geese. It reduces reproduction by impacting the hatchability of eggs. This product requires continued use during the breeding season, which can be year round for some species.

Table 8.11 Commonly used insecticide products for birds and uses.

a. CAUTION-label formulations.

Active ingredient	Example products	Uses
polybutenes	Bird Barrier® 55943-1 Bird-X Bird Proof Gel 8254-3-8708 4 the Birds Transparent Bird Repellant Liquid 8254-3 Tanglefoot Bird Repellent 1621-17	Non-drying solution applied to surfaces to discourage birds from roosting.
methyl anthranilate	Migrate™ Turf Spray Rejex-It 58035-9	Spray-applied liquid repellant for turf.

b. More hazardous formulations.

Active ingredient	Example products	Uses
methyl anthranilate	GooseChase™ 66550-1	Spray-applied liquid repellant for turf.
4-a minopyridine	Avitrol Concentrate 11649-10 Avitrol Double Strength Whole Corn 11649-8	Dust or treated seed, toxic to birds.
nicarbazin	Ovotrol P 802249-1 Ovotrol G 80224-5	Restricted use pesticide that suppresses reproduction of pigeons, geese or ducks. Applied as granules to an area that must remain under observation with any bait remaining removed after 30 minutes.

Table 8.12 Priorities for bird management.

Research

Development of guidelines for bird-proofing new construction especially exterior ventilation structures.

Development and testing of the efficacy of reproductive control as a bird management tool.

Development of improved strategies for repelling birds.

Development of improved strategies for excluding birds.

Best management practices for goose and gull management on school grounds.

Managing invasive monk parakeets especially nesting behavior on utility poles and substations.

Additional resources for bird management

Arizona Cooperative Extension. 2006. Birds. Pest Press. cals.arizona.edu/urbanipm/pest_press/2006/april.pdf (PDF)

Curtis, P.D., J. Shultz, L.A. Braband, L. Berchielli and G. Batchelor. 2004. *Best Practices for Nuisance Wildlife Control Operators; A Training Manual*. NYS Department of Environmental Conservation and Cornell Cooperative Extension. nwco.net

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Salmon, T.P., D.A. Whisson and R.E. Marsh. 2006. *Wildlife Pest Control around Gardens and Homes*. University of California. 122 pp.

The Internet Center for Wildlife Damage Management www.icwdm.org

CARPENTER ANTS

Carpenter ants play important roles as decomposers of decaying trees and can become very damaging pests when nesting in structures. Unlike termites, carpenter ants do not feed on wood, they simply nest there. Wood is damaged as these ants construct smooth "galleries" with rounded edges, excavated in softer parts of wood building elements. Galleries tend to follow the grain of the wood, with passages that cross harder wood.

Water-damaged or other softened wood is typically conducive to nesting, with gallery expansion into adjacent sound wood as the colony grows. Nest may also be constructed in wall voids, insulation, hollow doors or wood furnishings or fixtures.

Carpenter ant nests are kept clean, with frass, sawdust-like wood shavings, dead ants and other debris pushed out of the gallery through a crack or slit, creating tell-tale dump piles that look like sawdust from a distance.

Carpenter ants range in size from ¼ - ½ inch (7-15 mm) long with a single node between the abdomen and evenly rounded, spineless thorax. Color variations include black, red, red and black, or brown. Colonies will produce winged reproductives or swarmers. Male reproductives die after the female is mated and begins to form a new colony.

Carpenter ants will eat fruit, vegetation, insects, meat, grease, fat and sugars including insect honeydew. Carpenter ants typically forage in late afternoon and night, up to 100 yards from the nest, and will carry food back to the colony.

Table 8.13 Carpenter ant species most likely to become pests in school environments.

Common and species name	**Geographic distribution**
Black carpenter ant, *Camponotus pennsylvanicus*	Throughout the US.
Red carpenter ant, *Camponotus ferrugineus*	Throughout much of the US.
Smaller carpenter ant, *Camponotus nearcticus*	Throughout much the US.

Monitoring and inspection for carpenter ants
Carpenter ants forage outside the nest for food and water and are often sighted in infested dwellings around sinks or bathroom fixtures seeking water. Foraging ants can sometimes be followed to locate the nest, which may be outside of the structure and not require any action.

Sawdust-like waste piles, slits or windows are also telltale signs of nesting activity. An awl, spatula or screwdriver can be used to probe for damaged wood. Thermal imaging can also be used to locate potential nests within a building.

Cultural and physical options for carpenter ant management
A primary defense against carpenter ants is to avoid moisture-damaged wood including regular inspection and prompt correction of roof, window or vent leaks, clogged, damaged or improperly aligned gutters or wood that may be in contact with soil, vegetation, firewood piles or other debris that prevents proper drying. Similarly, decaying or softened wood building elements should be repaired or replaced including soft decking or window or door sills.

Remove tree stumps adjacent to structures. Trim branches touching structures, or touching wires leading to structures, to reduce transit opportunities for carpenter ants and other pests and improve air circulation and drying. Improve ventilation to speed drying in attics, crawlspaces and other enclosed areas.

At-risk wood that is low to the ground, in shaded locations or otherwise prone to moisture can be designed or replaced with insect-resistant woods including cedar, cyprus or jarrah.

Non-chemical controls include removing infested wood and vacuuming up ants, nests and debris. Heat treatment and freezing are also potential controls but rarely used.

Table 8.14 Commonly used products for physical, cultural or mechanical management of carpenter ants and uses.

Type	Example Products	Uses
sealants	many	Seal potential entryways, seal seams where floor meets baseboard to prevent moisture damage to wood.
structural repair		Replace damaged wood with sound, dry wood or a non-wood substitute.
vacuum		Remove individual ants.

Pesticide options for carpenter ants

Containerized baits and liquid or gel baits placed in inaccessible areas reduce potential for exposure. Containerized baits or reusable bait stations can be placed near ant trails. Liquid or gel baits can be placed in cracks or crevices adjacent to trails or nests. Baits may take up to 60 days to eliminate the colony. Replenish baits as needed until ants are no longer present.

Dusts may also be applied in a manner that greatly reduces exposure potential, including into voids reached by removing electrical outlet or switch plate covers, or in holes drilled for in infested wood and sealed after the application. Applications of residual-active pesticides to exposed, human-contact surfaces on the interior or exterior of structures, and use of Danger or Warning-label pesticides, are typically not needed and should be avoided. In addition, barrier applications to exposed impervious surfaces including foundations, walkways and driveways are prone to runoff into surface water and should be avoided.

Table 8.15 Commonly used insecticide products for carpenter ants and uses.

a. Insecticides carrying a CAUTION label or exempt from EPA registration, in formulations that reduce potential for exposure.

Active ingredient	Example products	Uses
abamectin	Prescription Treatment® Advance Granular Carpenter Ant Bait 499-370	Granular formulations which can be placed into voids or into reusable bait stations to reduce potential for exposure.
hydramethylnon	Prescription Treatment® Advance Granular Carpenter Ant Bait 499-370	
boric acid	Niban® FG 64405-2	
orthoboric acid	Intice® Ant Granules 73079-2	

boric acid, orthoboric acid borax	Drax® Liquid Ant Killer II SWT 9444-206 Intice™ Ant Gel 73079-1 Terro® Ant Killer II 149-8	Solution or gel that can be applied as drops in inaccessible areas. Wipe up any over-application.
disodium octaborate tetrahydrate	Bora-Care® Injectable Concentrate 64405-4	Injected into infested wood, reducing potential for exposure.

b. CAUTION-label or exempt formulations with greater potential for exposure.

Active ingredient	Example products	Uses
disodium octaborate tetrahydrate	Boracide® 64405-7 Nibor® 64405-8 Timbor® 64405-8	Dust formulation. To reduce exposure hazard, use only in voids that will be sealed after use or apply to surfaces in inaccessible areas. Wipe up any over-application.
boric acid	Prescription Treatment® 240 Permadust® 499-384	Pressurized aerosol formulation. Boric acid will leave dust residual. To reduce exposure hazard, use only in voids that will be sealed after use or apply to surfaces in inaccessible areas.

c. CAUTION-label formulations with greater potential for toxicity and/or exposure.

Active ingredient	Example products	Uses
deltamethrin	Delta Dust® 432-772	Dust formulation. To reduce exposure hazard, use only in voids that will be sealed after use or apply to surfaces in inaccessible areas. Wipe up any over-application.
bifenthrin chlorfenapyr cyfluthrin cypermethrin disodium octaborate tetrahydrate	Talstar® One 279-3206 Phantom® 241-392 Cykick® 499-304 Tempo® SC Ultra 11556-124 Demon® EC 100-1004 Bora-Care® 64405-1 Nibor® 64405-8 Timbor® 64405-8	Sprayed or otherwise applied to surfaces. Spray applications with repellant insecticides such as pyrethroids can contaminate an area and make baiting ineffective until the residue degrades. To reduce exposure hazard and avoid contamination, use alternative formulations and/or limit applications to non-volatile

deltamethrin	Suspend® SC 432-763	active ingredients applied to non-human contact surfaces in inaccessible areas.
imidacloprid	Premise® 2 Insecticide 432-1331 Premise® 75 Insecticide 432-1332	
lamda-cyhalothrin	Demand® CS 100-1066	

Table 8.16 Priorities for carpenter ant management.

Research Efficacy of bait formulations.

Additional resources for carpenter ant management

Arizona Cooperative Extension. 2004. Ants. Pest Press. cals.arizona.edu/urbanipm/pest_press/2004/april.pdf (PDF)

Collman, S.J., L. Hansen, R. Akre and A.L. Antonelli. 2008. Carpenter Ants. gardening.wsu.edu/library/inse004/inse004.htm

Hahn, J., C. Cannon and M. Ascerno. 2002. Carpenter Ants. University of Minnesota Cooperative Extension. www.extension.umn.edu/distribution/housingandclothing/DK1015.html

COCKROACHES

Although there are many species of cockroaches found in the US, only a few species are typically problems in schools. Cockroaches are often referred to by other, locally common names including waterbugs, palmetto bugs, etc.

Effective management includes cultural and mechanical practices such as removing incoming food products from cardboard containers as soon as they are delivered, cleaning drains regularly, removing other water sources such as leaking pipes and faucets, and sealing cracks and crevices in food storage, preparation and serving areas including openings around the edges of electrical boxes, bulletin boards and signage. Due to the development of effective insecticide bait formulations, cockroach problems have become much less prevalent in general. Spray-applied liquid insecticides are much less effective than baits in reducing cockroach populations and increase potential for exposure.

Table 8.17 Cockroach species most likely to be encountered in schools.

Common and species name	**Geographic distribution**
American cockroach, *Periplaneta americana*	Throughout the US.
brownbanded cockroach, *P.*	Throughout the US.

German cockroach, *P*	Throughout the US.
Oriental cockroaches, *P*.	Throughout much of the US.
smokybrown cockroach, *P*	Throughout the southern US.

Monitoring and inspection for cockroaches

The number one monitoring tool for cockroaches is an adhesive-coated, cardboard insect monitoring trap. These inexpensive devices should be placed in vulnerable areas including food storerooms and preparation areas, and anywhere else cockroaches have been a problem including laundry rooms, custodial closets, staff lounges and student stores. Insect monitors are exceptional in detecting cockroaches but also in indicating direction of travel, species present and whether immatures as well as adults are present.

These adhesive-coated cardboard traps are purchased pre-coated. For cockroaches, the ideal designs fold or are purchased pre-formed such that the sticky surface is enclosed within a cardboard “tent” to protect the adhesive from dust and debris. Food service and other staff must be alerted to their presence so that they do not disturb or remove them when cleaning. Some devices include a pheromone attractant although this enhancement is not required for effective monitoring.

Ideally, each device should be dated and numbered, and its location noted on a map or diagram of the facility or vulnerable areas. Wall tags, e.g., a colored sticker placed at eye level on the wall above the device and numbered # of #, e.g., 1 of 6 total devices in the room, can help the technician relocate these quickly during inspections. The device should be placed on the floor or under-sink cabinet floor, and up against the wall, with the entry/exits to the monitor parallel to the wall.

There is debate among professionals as to whether glue boards should be located in every potentially vulnerable area, e.g., under sinks in classrooms, or just in kitchens and food storerooms, or even used at all in facilities that have never experienced a cockroach problem. Checking these devices takes time and if no captures are recorded over an extended period, perhaps that time is better spent on other priorities.

A good strategy may be to use these devices when the IPM program is initiated, and re-evaluate use after six months or more. Old, dust-covered, undated cockroach monitoring traps are frequently found during walk-throughs of schools and other facilities, and are a sign that good intentions do not always coincide with practical realities. It may be preferable to limit the number of devices used to vulnerable areas where complaints have occurred in the relatively recent past than to load up a facility with traps that cannot possibly be maintained properly due to time constraints and proper prioritization of activity by IPM professionals. On the other hand, these traps will capture a wide variety of pests including mice and the occasional cricket, scorpion, spider, ground beetle, stored product pest or other invader, and can alert those checking the traps to incipient problems well before they might otherwise be noted.

In some locations, public health inspectors have recorded violations when insects are found in these traps during their inspection. If that is an issue, food service staff can be trained to inspect the traps daily, discard any with captures and report the capture to a central office and/or record the capture information directly in a pest sighting log housed at the site.

Cockroaches are primarily nocturnal – active at night and in harborages during the day. They are thigmotactic, preferring to harbor in locations where they have surface contact on both upper and lower body surfaces, hence their liking for the flaps of cardboard boxes and the space between wall-mounted fixtures and the wall. These are key locations for visual observation for cockroaches, egg cases and feces.

Inspection practices should include checking for unsealed openings such as missing or loose pipe and conduit escutcheons, unsealed edges around sinks and cabinets, unsealed edges of bulletin boards or wall-mounted electrical panels, mirrors, light fixtures, fire alarms or emergency lighting. Inspections should focus on areas where food and water are present including food storages, kitchens, food serving lines, cafeterias, locker rooms and staff lounges.

Cultural and physical options for cockroach management

Cultural and mechanical management options are preferred and include prompt clean up of spills, proper food storage and waste handling, preventing access to water by fixing plumbing leaks, eliminating harborage and access to the building by sealing cracks and crevices, removing products from cardboard shipping containers before shelving, and inspecting incoming product and rejecting any containing cockroaches, cockroach droppings or egg cases.

Table 8.18 Cultural and physical strategies for cockroaches.

- Remove individual cockroaches using a vacuum or wipe.
- Use a flushing agent, such as compressed air, directed into cracks and crevices harboring cockroaches and vacuum up cockroaches as they emerge.
- Eliminate the harborage by sealing cracks, sealing edges around wall-mounted electrical panels, light fixtures, bulletin board, posters, etc.
- Clean up food and drink spills immediately.
- Remove food products and food service supplies from cardboard containers as soon as they are delivered and put cardboard in outdoor recycling containers to avoid introducing cockroaches and egg cases.
- Inspect incoming products for cockroaches, droppings or egg cases and rejecting infested product.
- Follow up with suppliers who deliver infested products and change suppliers if the problem is not resolved.
- Store food items in sealed containers.
- Use liners for waste containers and empty at the end of the day so that food and food waste is not left in the building overnight.

- Place exterior trash cans and dumpsters away from building entrances.
- Fix plumbing leaks, gutters that hold water and damp wood to eliminate access to water.
- Position exterior lighting to avoid attracting cockroaches to building entryways at night.
- Use sodium vapor or yellow bulbs for exterior lighting to reduce attraction to cockroaches.

Table 8.19 Commonly used products for physical, cultural or mechanical management of cockroaches and uses.

Type	Example Products	Uses
compressed air, aerosol can	many	Flush cockroaches from cracks, crevices and other harborage.
insect monitors	Catchmaster® Trapper® Monitor and Insect Trap Victor® PCO Roach Pheromone Trap	Monitoring device indicates presence, species, relative numbers, direction of travel, location of harborages; use can suppress populations.
sealants	many	Seal cracks, crevices including edges of wall-mounted equipment to eliminate harborage.
vacuum, HEPA filtered	Sierra Backpack Vacuum	Vacuum up cockroaches, ootheca, droppings and associated debris.

Pesticide options for cockroach management

Chemical management options that reduce potential for exposure include insecticide baits in pre-manufactured, enclosed bait stations, or gel or liquid baits placed in cracks and crevices.

Chemical options that increase potential for exposure for students, staff and other facility users include spray formulations applied to exposed surfaces. These formulations are typically much less effective than baits for cockroaches.

Chemical options, including baits, should not be used on a routine or calendar-based schedule but only where cockroach presence been confirmed and non-chemical measures are also implemented.

Table 8.20 Commonly used pesticide products for cockroaches and uses.

a. Insecticides carrying a CAUTION label or exempt from EPA registration, in formulations that reduce potential for exposure.

Active ingredient	Example Products	Uses
disodium octaborate tetrahydrate	Ant Cafe® RTU 73766-2	Pre-manufactured enclosed bait station that can be placed in inaccessible areas.
boric acid hydramethylnon indoxacarb	Drax® Roach Assault PGF 9444-193 Maxforce® Professional Insect Control Roach Killer Bait Gel 432-1254 Advion® Cockroach Gel Bait 352-652	Solution, paste or gel that can be applied as drops in accessible areas. Gel can be applied in small amounts to cracks, crevices and other areas where bait stations cannot be used.

b. CAUTION-label or exempt formulations with greater potential for exposure.

Active ingredient	Example Products	Uses
fipronil	Maxforce® Professional Insect Control Roach Bait Station 432-1257	Volatile active ingredient in pre-manufactured enclosed bait station. Use alternative non-volatile products.
boric acid diatomaceous earth disodium octaborate tetrahydrate limestone	Borid® 9444-133 Eaton's KIO System 56-67 Boracide® 64405-7 NIC 325 Pro Organic® (EPA Exempt)	Dust formulation. To reduce exposure hazard, use only in voids that will be sealed after use. Wipe up over-application.
boric acid xanthine, oxypurinol orthoboric acid	ECO 2000-GR® 1677-191 Niban® FG 64405-2 Ecologix® Cockroach Bait 1001-13 Intice™ Ant Granules 73079-2	Granular formulations. To reduce exposure hazard, use only in voids that will be sealed after use.
boric acid mint oil	PT 240 Permadust® 499-384 Earthcare® Naturals Ant & Roach Killer (EPA Exempt)	Pressurized aerosol. Mint oil formulations must be applied directly to insects, no residual activity.

c. CAUTION-label formulations with greater potential for toxicity and/or exposure.

Active ingredient	Example Products	Uses
bifenthrin	Talstar® 279-3225	Liquids sprayed or otherwise applied to exposed interior

chlorfenapyr cyfluthrin cypermethrin deltamethrin lambda cyhalothrin	Phantom® 241-392 Tempo® SC Ultra 11556-124 Demon® EC 100-1004 Suspend® SC 432-763 Demand® CS 100-1066	and/or exterior surfaces. Spray applications can contaminate an area and make baiting ineffective until the residue degrades. To reduce exposure hazard and avoid contamination, use alternative formulations and/or limit applications to non-volatile active ingredients applied to non-human contact surfaces in inaccessible areas.
disodium octaborate tetrahydrate	Mop Up® 9444-132	Liquid, mop-applied to exposed interior surfaces, e.g., floors, will leave dust residual. To reduce exposure hazard and avoid contamination, use alternative formulations.

Table 8.21 Priorities for cockroaches.

Research Efficacy of botanical pesticide products for cockroaches including residual activity. Strategies for deployment of insect monitors, i.e., how many, where and when to place or remove monitors. Education Connection between cockroach infestations and asthma in children. Heath department education on benefits of insect monitors for cockroaches and detrimental effect of considering trap captures to be health code violations.

Additional resources for cockroach management

Arizona Cooperative Extension. 2005. Cockroaches. Pest Press. cals.arizona.edu/urbanipm/pest_press/2005/dec.pdf (PDF)

Daar, S., T. Drlik, H. Olkowski and W. Olkowski. 1997. Chapter 6. IPM for cockroaches in schools. Pp. 35-48. In *IPM for Schools: A How-to Manual*. Line drawings, identification, communication, monitoring, management. www.epa.gov/pesticides/ipm/schoolipm/chap-6.pdf

Ogg, B., D. Ferraro and C. Ogg. 1996. *Cockroach Control Manual*. University of Nebraska Cooperative Extension. Color images of adults and egg cases, identification, biology, least-risk management, public health.

www.pested.unl.edu/pesticide/pages/index.jsp?what=pageObjD&pageObjId=106

Rust, M.K., D.A. Reierson and A.J. Slater. Undated. Cockroaches. In *How to Manage Pests of Homes, Structures, People, and Pets.* University of California. www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7467.html

University of Florida. Least Toxic Methods of Cockroach Control. Undated. In *National School IPM Information Source*. schoolipm.ifas.ufl.edu/newtp3.htm

FLIES – House Flies, Filth Flies

Many species of flies can become a problem in schools. Each fly species has a distinct breeding site inside or outside the school building. In order to control flies, it is necessary to know which species is causing the problem and where it is breeding. Drain flies, fruit flies and fungus gnats are addressed in the next section.

Flies such as house flies, little house flies, dump flies, blow flies, and blue and green bottle flies which breed in food wastes (garbage) and/or animal feces are generally referred to as "filth flies." Other flies such as stable flies breed in decaying vegetable matter such as grass cuttings. Flies that invade cafeterias and kitchens are not only a nuisance; they also present a health hazard because they can contaminate food, utensils, and surfaces. Biting flies, such as stable flies, can inflict painful bites.

The key to solving persistent fly problems is proper identification of the species. After the problem fly has been identified, information on life cycle, breeding sites, and effective management options can be readily obtained from a number of sources.

Table 8.22 Flies most likely to be encountered in schools and other structures. Drain flies, fruit flies and fungus gnats are addressed in the next section.

Common and species name	**Geographic distribution**
house fly, *Musca domestica*	Throughout the US.
little house fly, *Fannia canicularis*	Throughout the US.
dump fly, *Hydrotaea aenescens*	Throughout the southeastern US.
blow fly, *Calliphora* sp.	Throughout the US.
blue bottle fly, *Phaenicia* spp.	Throughout the US.
green bottle fly, *Phaenicia* spp.	Throughout the US.
face fly, *Musca autumnalis*	Throughout the US.
stable fly, *Stomoxys calcitrans*	Throughout the US.

Monitoring and inspection for flies

It is important to correctly identify problem flies and pinpoint their breeding sites. Some of their characteristics can help you with identification; alternatively specimens can be taken or sent to a county extension agent who should be able to assist in identification.

If they cannot identify the specimen they will be able to refer you to a specialist who can. To collect specimens inside, use sticky flypaper or gather dead specimens from window sills and light fixtures. Individual flies captured for identification purposes should be held in a small vial to preserve key identifying characters.

Inspection practices should include ensuring that trash cans or dumpsters are placed away from building entryways; proper use of plastic bag liners in trash cans; all trash disposed in dumpsters is enclosed in sealed bags; adequate clean up of spilled food and drinks; properly sealed openings throughout the building exterior; and tightly fitting doors, door sweeps and window seals.

Cultural and physical options for fly management

To manage flies, you must find and reduce breeding sites, install and maintain screens to keep flies out of buildings, kill those flies that do get inside with a fly swatter or flypaper, and reduce or eliminate the odors that attract flies.

In schools that have programs where wastes are removed frequently, it is unlikely that flies are breeding on the school property. It is more likely that odors from dumpsters, garbage cans, kitchens, and cafeterias are attracting flies to the school from the surrounding neighborhood. House flies and blow flies, the species that most commonly invade buildings, usually develop outside and follow odors into the building. They can also be nuisance pests when students or staff eat outside of the building. In schools where waste removal is infrequent, fly populations can breed at the waste collection site.

Cultural, physical, and mechanical management options are preferred methods for management of flies and include the proper management of waste, physical methods such as screens and flyswatters, and properly maintained and fitting doors and windows.

Flies found inside a school building enter from the outside in almost all cases. Therefore, barriers preventing access of flies to the building are the first line of defense. Cracks around windows and doors where flies may enter should be sealed. Well-fitted screens will also limit their access to buildings. Outdoors, regular removal (at least once a week) and disposal of organic waste, including dog feces and rotting fruit, reduces the attractiveness of the area to adult flies and limits their breeding sites. Garbage should not be allowed to accumulate and should be placed in sealed plastic bags and held in containers with tight-fitting lids. Garbage should also be placed as far from a building entrance as is practicable. In general, poor exclusion and lack of sanitation are the major contributors to fly problems.

Sticky fly papers or ribbons are effective at eliminating low numbers of flies in relatively confined areas, but are not effective enough to manage heavy infestations or to provide control in an outdoor setting. A number of fly traps for outdoor control are commercially available and can be effective for periodic fly populations when they are not competing with nearby garbage or animal wastes. Indoor fly traps are also available.

Manufacturer's directions must be followed for the placement and use of these traps. For control of just a few flies, the time-tested fly swatter is appropriate. If fly swatters are used near food preparation areas, all food must be removed from the area and all food-contact surfaces thoroughly cleaned to avoid contaminating food with insect body parts.

Table 8.23 Cultural and physical strategies for flies.

- Remove individual flies using flyswatters, fly paper or appropriate indoor light traps. Do not place flypaper or sticky strips above or near food preparation areas.
- All food waste from the kitchen, cafeteria and other areas should be separated from other garbage, drained so it will be as dry as possible and then stored in sealed plastic bags before discarding. Place containers with small amounts of food waste, such as milk or yogurt cartons, into sealed plastic bags before disposal.
- Plastic bags used for waste disposal should be thick enough to avoid tearing or puncturing by insects such as yellow jackets.
- Promptly fix drains or electric garbage disposal units that leak, or drains that allow food waste to accumulate under sinks or floors. Leaky drains can attract many species of flies. Remove any food waste that has accumulated under sinks or floors or in crawl spaces or basements at the site of the broken drain, and then clean the area thoroughly.
- In food preparation areas, rinse all cans, bottles, and plastic containers before recycling or discarding.
- Inform students, teachers, and staff of the importance of placing garbage inside the proper containers. Garbage should not be left lying on the ground.
- Place exterior trash cans and dumpsters away from building entrances. To avoid attracting flies into the building, place dumpsters and recycling containers upwind from the outside doors of the school, particularly for the doors to the kitchen or cafeteria. When dumpsters are downwind, flies are attracted to the waste odors and then find the odor trails that the breeze blows down from the doorways. Following these odor trails, they find their way into the building.
- Wastes should be collected and moved off site at least once a week. Because flies breed faster in warm weather, garbage collection may have to be scheduled twice a week to reduce breeding sites.
- Make sure garbage can and dumpster lids seal tightly when closed and remain closed when not in use. Repair or replace garbage cans with holes or with lids that do not close tightly.
- Regularly clean garbage cans and dumpsters to prevent the build-up of food waste, an ideal place for flies to lay eggs. Use a high pressure stream of water or a brush and soapy water, if necessary. A solution of borax and water will eliminate odors. If possible, dumpsters should be fitted with drains so they can be hosed or scrubbed out as needed. Another option is to require the refuse company to clean the dumpster or replace it with a clean one more frequently.
- Replace dumpsters with self-contained, non-leak compactors specifically designed to prevent leaks.
- Properly clean and maintain exterior drains in trash handling areas including loading docks to avoid accumulation of organic matter and liquid.

- Flies can develop in soil soaked with water used to clean garbage cans and dumpsters. Check these areas regularly. If you see maggots, scrape them up along with the soil and dispose of everything in a plastic bag sealed tightly.
- Inspect dumpsters and other outdoor trash receptacles daily and remove any wastes lying on the ground.
- Garbage cans on the school grounds should have removable domed tops with self-closing, spring-loaded swinging doors. Cans should be lined with plastic bags that can be tightly sealed and removed daily.
- Keeping adult flies out of sensitive areas is the most important control measure that can be undertaken. Install screens over windows, doors, and vent holes to prevent flies from entering buildings. Weather-stripping or silicone caulk can be used to insure a tight fit. Torn screens can be repaired with clear silicone caulk. Screen doors should be fitted with springs or automatic closing devices that close the screen door firmly after it is opened. External doors that cannot be screened should be fitted with automatic closing devices, and/or vertical strips of overlapping plastic that allow human access but prevent fly entry. "Air walls" that force air across openings are another alternative to screen doors.
- Fly traps can be used to reduce adult fly populations, capture specimens for identification, and monitor the effectiveness of control programs. Fly traps are not toxic and are more selective than using insecticide. Traps need to be serviced regularly, appropriately placed, and repaired or replaced when damaged.
- Remove animal droppings promptly and put them into plastic bags that are sealed before disposal.
- Storing garbage in sealed plastic bags and having cans and dumpsters cleaned and emptied frequently to eliminate odors is very important.
- Eliminate the access point where flies are entering by sealing cracks, installing door sweeps, repairing door and window seals, etc.
- Clean up food and drink spills immediately.
- Store food items in sealed containers.
- Use heavy gauge liners for waste containers and empty containers at the end of the day so that food is not left in the building overnight.

Table 8.24 Commonly used products for physical, cultural or mechanical management of flies and uses.

Type	Example Products	Uses
sticky traps	Catchmaster Gold Stick® Fly Trap Catchmaster Bug and Fly Bonide Fly Catcher Ribbons	Tapes or traps mounted in areas where flies are entering or resting. Avoid placing over food preparation areas.
light traps with sticky capture surface	Catchmaster Dynamite 911 Gilbert® 2002GT Flying Venus Fly Trap	Mounted in entryways or other areas where flies are encountered. Mount so that light is not visible from outside to avoid drawing flies to entryways.
light traps with electrocuting grids	Fly-Zapper 22/14 Electrocutor Gilbert® 220 Guerrilla Fly Electrocutor Trap	Mounted in entryways or other areas where flies are encountered. Mount so that light is not visible from outside to avoid drawing flies to entryways. Not for use in food preparation areas where insect body parts may come into contact with food or food preparation surfaces.

Pesticide options for fly management
While chemical pesticides may be effective for suppressing adult fly populations in some situations, they are not a substitute for proper sanitation and aggressive elimination of nuisance-fly-development sites. Because flies can quickly develop resistance to insecticides, use them only as a last resort to obtain immediate control of severe adult fly infestations, after all possible nonchemical strategies have been employed.

In most school situations, pesticides are not needed or recommended for fly management. Sanitation along with exclusion to keep flies out should be sufficient. In rare cases where non-chemical methods are not possible or effective, a non-residual aerosol may be used to knock down flies. Outside, a residual insecticide may be applied to surfaces such as walls and overhangs that are being used by the flies as resting areas. Fly baits used in trash or other areas may be effective in reducing the number of adult flies if proper sanitation practices are followed. However, when flies have access to garbage, baits will not effectively control them.

Table 8.25 Commonly used insecticide products for flies and uses.

a. Insecticides carrying a CAUTION label or exempt from EPA registration, in formulations that reduce potential for exposure.

Active ingredient	Example products	Uses
imidacloprid	Maxforce® Granular Fly Bait 432-1359	Granular formulation. To reduce ingestion and exposure hazard, use in a pre-manufactured bait station or inaccessible areas.
imidacloprid	Maxforce® Fly Spot Bait 432-1359	Liquid formulation. To reduce exposure hazard, apply to inaccessible non-human contact surfaces.

b. CAUTION-label formulations with greater potential for exposure.

Active ingredient	Example Products	Uses
2-phenethyl propionate, eugenol	EcoEXEMPT KO (EPA Exempt)	Non-residual contact insecticides spray.

c. CAUTION-label formulations with greater potential for toxicity and/or exposure.

Active ingredient	Example Products	Uses
bifenthrin cyfluthrin cypermethrin deltamethrin lambda cyhalothrin N-octyl bicycloheptene dicarboximide, piperonyl butoxide, pyrethrins piperonyl butoxide, pyrethrins	Talstar® 279-3225 Tempo® SC Ultra 11556-124 Demon® EC 100-1004 Suspend® SC 432-763 Demand® CS 100-1066 Clean Air™ Purge® 9444-158, Konk® Flying Insect Killer 5978-10 Pyronyl™ 303 655-797	Residual insecticides sprayed or otherwise applied to exposed interior and/or exterior surfaces. Spray applications can contaminate an area and make baiting ineffective until the residue degrades. To reduce exposure hazard and avoid contamination, use alternative formulations and/or limit applications to non-volatile active ingredients applied to non-human contact surfaces in inaccessible areas.

Emerging issues, new strategies and priorities for flies

Urban filth fly problems are increasing in some states as the interface between urban areas and agricultural production areas has become close. Continued research is needed on more efficacious methods for fly surveillance and control.

Table 8.26 Priorities for flies.

Research Innovative and improved traps are needed for effective indoor and outdoor fly control of all nuisance fly species. Research is needed on techniques to reduce the attractiveness of building structures and entrances to nuisance flies. Education Support materials for PMPs and others on effective fly prevention methods and strategies.

Additional resources for fly management

Arizona Cooperative Extension. 2004. Filth Flies. Pest Press. cals.arizona.edu/urbanipm/pest_press/2004/march.pdf (PDF)

Daar, S., T. Drlik, H. Olkowski and W. Olkowski. 1997. Chapter 5. IPM for flies in schools. Pp. 63-70. In *IPM for Schools: A How-to Manual*. Line drawings, identification, communication, monitoring, management. www.epa.gov/pesticides/ipm/schoolipm/chap-9.pdf (PDF)

University of California. 2004. Flies. In *How to Manage Pests of Homes, Structures, People, and Pets.* www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7457.html

University of Florida. 1998. IPM for Flies in Schools. In *National School IPM Information Source*. schoolipm.ifas.ufl.edu/tp14.htm

FLIES – Drain Flies, Fruit Flies, Fungus Gnats

Drain flies (Family Psychodidae) and fruit flies (*Drosophila* spp) are often present in schools and other settings where food is stored, prepared or consumed. Drain flies are also called filter, moth or sewage flies and may be confused with fruit flies or other small flies. Fruit flies may also be called small fruit, pomace or vinegar flies, and are sometimes confused with other small flies including humpbacked flies (Family Phoridae), drain flies or fungus gnats (Family Fungivoridae).

Adult female drain flies deposit egg masses in the gelatinous film associated with decaying organic matter in drains, garbage disposals, grease traps, sewers, bird feeders and bird baths, gutters and other locations. Larvae feed on decayed organic matter and can survive extremely wet conditions. Most infestations are generated from within the school including food service areas and custodial closets. Drain flies can carry bacteria and other microorganisms from egg-laying sites to food and food contact surfaces and should not be tolerated.

Fruit flies are small-bodied (<1/8 inch long) and can pass through standard fly-screens to enter a structure. Adults, eggs or larvae may also be present on or in fruits or vegetables brought into kitchens, cafeterias or break rooms. Fruit flies, like drain flies, are strongly attracted to drains or any location where fermenting liquids are found. Large numbers of fruit flies may indicate unsanitary conditions including poorly managed garbage, and/or inadequate cleaning of drains, floors and hard-to-reach areas under and behind equipment.

Phorid flies are small flies up to 1/8 inch long. These flies can be recognized by the distinct "hump" or arch of the fly's thorax. Phorids feed on and breed in a wide variety of moist decaying organic matter including drains, garbage, paint, glue, and the bodies of decaying animals. Trash containers which are not cleaned regularly are a good source for breeding phorid flies especially where bags are not used as a lining of the container. Another important breeding site for phorids is the decaying organic matter that can get trapped in cracks of kitchen equipment or under the bases of the equipment.

Fungus gnats are also small flies which can be distinguished from drain and fruit flies by their long legs and long segmented antennae. Larvae feed on decaying matter including organic matter in plant pots if the soil is sufficiently wet. Fungus gnats typically do not harm healthy plants but their presence can indicate overwatering and insufficient soil aeration for healthy root growth. High populations may feed on plant roots and adversely affect plant growth, especially young plants, if preferred food, including microorganisms, is not available. Fungus gnats may also carry plant disease organisms from one plant to another.

Management practices include identifying and eliminating breeding sites and entry points. Frequent, regular cleaning of drains or locations where fermenting materials can accumulate, inspection of incoming produce, physical removal of over-ripe fruits and vegetables and prompt clean up of spilled food or drink generally provide the best results. Fungus gnats are often well controlled by moderating watering of potted plants so that soil dries in between waterings. Educating school staff is required since even well meaning practices such as saving unwashed empty beverage containers for recycling or composting kitchen waste could encourage infestation.
Table 8.27 Drain flies, fruit flies and fungus gnats most likely to be encountered in schools and other structures.

Common and species name	**Geographic distribution**
drain or moth fly, *Psychoda alternata*	Throughout the US.
filter fly, *Telematoscopus albipunctatus*	Throughout the US.
Humpback fly, Family Phoridae	Throughout the US.
sewage gnat or psychod fly, *Psychoda cinerea*	Throughout the US.
common fruit fly, *Drosophila melanogaster*	Throughout the US.
fruit fly, *Drosophila repleta*	Throughout the US; most common in Southwest.

fruit fly, *Drosophila hydei*	Throughout the US.
darkwinged fungus gnat, Family *Sciara*	Throughout the US.
fungus gnat, Family *Mycetophilidae*	Throughout the US.

Monitoring and inspection for drain flies, fruit flies and fungus gnats
Visual inspection of potential breeding sites including floor drains in food preparation and serving areas is required to ensure that drain and fruit flies do not become established. Visual inspection of incoming produce is essential to avoid introducing fruit flies. Indoor plants can be gently lifted and or shaken to determine if fungus gnats are present; adults will take flight when disturbed. Finally, when flies are present in a school, flies and fly carcasses of all types can often be found on or around window sills or in light fixtures.

Commercially available monitoring devices include cardboard sticky traps, baited traps designed specifically to attract adult fruit flies and glue-trap type fly lights. Yellow sticky traps can be mounted on stakes placed in potted plants to monitor for fungus gnats.

Fly traps should be numbered with the location noted on a list or ideally on a schematic diagram of the facility and dated and initialed each time they are checked or replaced. For drain and fruit flies, ideal placements include locations near plumbing fixtures, dishwashers, under prep tables and in trash or recycling storage areas.

Specific monitoring for fruit flies, including fruit fly traps, may not be required on an ongoing basis if the proper management practices are in place to prevent conditions conducive to fruit fly infestation.

Cultural and physical options for drain fly, fruit fly and fungus gnat management
Cultural, physical and mechanical management options are the best strategies and include posting notices to encourage the cleanup of spills, proper food storage and trash/recycle handling, elimination of standing water, fixing plumbing leaks, drying mops, emptying mop buckets and inspecting incoming produce and rejecting any infested or overripe product.

Biologically based drain and surface cleaners can be used at the end of the day to remove food residues from floors, coving, the underside of kitchen fixtures and equipment and drains. Foam based formulations are particularly effective under equipment and in drains.

When cleaning drains, great care must be taken to avoid spreading bacteria such as Listeria and other microorganisms, especially in food service areas. An initial cleanout may require scraping or brushing accumulated organic matter which should be done only after all food has been put away. Clean all food contact surfaces after cleaning the drains and before removing food from storage. Care should also be taken to prevent clumps of organic matter from falling down into and potentially clogging the drain pipe.

Table 8.28 Cultural and physical strategies for drain and fruit flies and fungus gnats.

- Clean areas where food residues may accumulate. Key locations include the undersides of prep counters and around kitchen equipment and fixtures. A steam cleaner may facilitate the cleaning process.
- Eliminate breeding sites by sealing cracks, edges around coving, tiles and kitchen fixtures/equipment to eliminate accumulation of organic matter.
- If necessary, use a squeegee to dry floors and under counter areas after mopping to eliminate standing water.
- Repair plumbing leaks promptly to prevent water accumulation.
- Clean up food and drink spills immediately.
- Rinse all beverage containers prior to placement in lined recycle bins. Do not store recycled containers for more than seven days.
- Inspect incoming fruit and vegetables for the presence of fruit flies. Over-ripe produce is most suspect and may be harboring eggs and larvae even if adults are not evident.
- Store fruit and vegetables in plastic bins in a cool storage room.
- Follow First In, First Out (FIFO) practices for food products that are susceptible to infestation, i.e., use up oldest inventory first.
- Use liners for waste containers and empty and clean these bins daily.
- Clean drains/traps and strainers at least twice per week to eliminate residues that encourage fly development.
- Maintain a slight positive air pressure in kitchens and cafeterias to discourage fly entry.
- Install air/strip curtains over the kitchen service entrance.
- Place exterior trash cans, recycle bins and dumpsters away from building entrances.
- Use non-toxic fruit fly traps to capture adult fruit flies.
- Avoid overwatering potted plants; allow soil to dry between watering to prevent fungus gnat breeding.
- Use yellow sticky traps placed on a stake in plant pots to capture adult fungus gnats.

Table 8.29 Commonly used products for physical, cultural or mechanical management of drain and fruit flies and uses.

Type	**Example Products**	**Uses**
baited traps	Natural Catch Plus® Fruit Fly Trap 960 Vector® Fruit Fly Trap	Place in areas where fruit flies are a problem.
unabated traps	Tangle-Trap Sticky Whitefly Trap	Place 3x5” trap in indoor plant pots to monitor for and suppress fungus gnats.
microbial-based drain cleaners	DrainGel™ InVade Bio Foam™	Used to break down organic matter in drains and other potential breeding sites.

Pesticide options for drain fly, fruit fly and fungus gnat management
Pesticide options have limited value and are rarely required for the management of drain and fruit flies and other small flies. Chemicals are sometimes used to "knock down" adult fruit flies or to help "break" the lifecycle and prevent the emergence of adults but will not provide long-term control.

Table 8.30 Pesticide products available for the management of fruit flies.

a. Insecticides carrying a CAUTION label or exempt from EPA registration, in formulations that reduce potential for exposure.

Active Ingredient	**Example products**	**Uses**
Bacillus thuringiensis	Gnatrol® 73049-11	Apply to soil for fungus gnat suppression.
hydroprene	Gentrol® 2724-351	Liquid spray or foam formulations applied to potential fruit fly breeding sites to help prevent the development of adult fruit flies.

b. CAUTION-label formulations with greater potential for toxicity and/or exposure.

Active Ingredient	**Example products**	**Uses**
pyrethrins	BP 100® 499-452 PT 565® 499-374	Space spray/aerosol for knock down of adult fruit flies.
cyfluthrin	Tempo® SC Ultra 3125-498	Liquid residual applied to exposed surfaces.

Table 8.31 Priorities for fruit fly management.

Research Efficacy of botanical pesticide products for flies including residual activity. Strategies for deployment of fly light traps, i.e., how many, where and when to place or remove monitors.

Additional resources for the management of drain and fruit flies and fungus gnats
Arizona Cooperative Extension. 2004. Filth Flies. Pest Press. cals.arizona.edu/urbanipm/pest_press/2004/march.pdf (PDF)

Iowa Insect Information Notes on Fruit Flies, Vinegar Flies, Pomace Flies. 2005. Iowa State University. www.ipm.iastate.edu/ipm/iiin/ffruitfl.html

Jacobs, S.B. 2008. Moth Flies in the Home. Penn State University Entomological Notes. http://www.ento.psu.edu/extension/factsheets/mothFliesHome.htm

Lyon, W.F. Undated. Drain Flies. Ohio State University Extension Fact Sheet. http://ohioline.osu.edu/hyg-fact/2000/2071.html

Potter, M.F. 2007. Fruit Flies. University of Kentucky College of Agriculture. www.ca.uky.edu/entomology/entfacts/ef621.asp

University of California. 2001. Fungus Gnats, Shore Flies, Moth Flies and MarchFlies. http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7448.html

HEAD LICE

In the US, there are between 6 to 12 million cases each year, most commonly among children three to twelve years of age. Head lice (*Pediculosis capitis)* are not a sign of uncleanliness and do not vector disease organisms. The most common symptoms are itching and sleeplessness. Scratching can lead to secondary bacterial skin infection. Head lice cases can result in extreme anxiety, embarrassment, unnecessary days lost from school and pesticide exposure. Millions of dollars are spent on remedies annually.

The adult louse is 2 to 3 mm long (the size of a sesame seed); color varies. The female lives for 3 to 4 weeks and lays approximately 10 eggs (nits) a day. The eggs are firmly attached to the hair shaft close to the scalp. Viable nits are camouflaged with pigment to match the hair color of the infested person. They are most easily seen at the hairline at the back of the neck. Empty egg casings are easier to see, appearing white against the hair.

Eggs are incubated by body heat and hatch in 10 to 14 days. After hatch, nymphs leave the shell casing grow for about nine to twelve days before reaching the adult stage. If left untreated, the life cycle may repeat every three weeks.

Lice feed by injecting small amounts of saliva and removing tiny amounts of blood from the scalp every few hours. The saliva may create an itchy irritation. A first case of head lice may not result in itching for four to six weeks. Once sensitized, subsequent infestations cause itching almost immediately.

Head lice usually survive for less than two days if away from the scalp at normal room temperature. Eggs cannot hatch at an ambient temperature lower than that near the scalp. Laundering and drying clothing and bedding at 130^{o}F will kill all stages.

Monitoring and inspection for head lice

Screening for head lice in schools is a very useful role for the school nurse. Active infestations need to be addressed individually. Providing information to families on the diagnosis, treatment and prevention of head lice extends benefits beyond the school environment.

An adult louse can move six to 30 cm per minute. They are hard to see and very difficult to remove. Nits are easier to spot, especially at the nape of the neck or behind the ears. Unhatched eggs will be within 1 cm of the scalp. In general, nits found more than 1 cm from the scalp are unlikely to be viable, but in warmer climates viable nits can occur farther from the scalp. However, screening for nits is <u>not</u> an accurate way of predicting which children will become infested. Only approximately 18% of children with nits alone will convert to an active infestation (Williams *et al.* 2001). Children with 5 or more nits within 1 cm^2 of the scalp are significantly more likely to develop an infestation, still only 1/3 of these higher-risk children convert. Generally, around 30% of school children with nits will also have adult lice.

The presence of active lice in a child's head is the only definitive indication of an infestation that should trigger a head treatment. If an active infestation is noted, the child's parent or guardian should be notified immediately. Treatment options may be suggested. Other members of the family should inspect each other along with children who regularly sleep-over or share hair apparel (hair clips, head-sets, hats, etc.). Parents and school nurses should be encouraged to recheck the student's head for lice after treatments have occurred if the child is still symptomatic.

The American Academy of Pediatrics and the National Association of School Nurses (www.nasn.org/Default.aspx?tabid=237) discourage "no nit" policies in schools. There is no need to send students home.

Cultural and physical options for head lice

Due to the short time period that head lice can survice off the head, transmission may occur most commonly with head-to-head contact which should be avoided. To further reduce potential for transmission, discourage sharing of combs, brushes, headbands, barettes, pillows, hats, scarves, coats, backpacks or other objects that may come in contact with the head. Where possible, place hats, scarves and coats on hooks or in separate lockers or cubbies to avoid contact. If hooks are shared or clustered, have children place their coats and hats in sealed plastic bags, especially if head lice are present. Hats and scarves can also be stored inside backpacks.

Manual removal of nits close to the head is always recommended. Fine-toothed "nit combs" are helpful. Combing and brushing <u>wet</u> hair damages lice and eggs significantly. Additionally, use of a hair dryer further injures adults, nymphs and nits.

Manual removal steps:

1. Comb and divide hair into sections, use a metal fine toothed louse comb to remove nits and lice. After combing each section dip the comb in a container of hot soapy water to remove lice and nits.
2. Repeat if nits are still attached within 1 cm of the scalp.
3. Repeat until all the sections of hair have been systematically combed.
4. Clean nit removal comb, clips, brushes, headphones, hats, etc. with hot soapy water.

Lice treatment kits often include nit removal aids. These are often lotions or sprays that are designed to help loosen the attachment of the egg on the hair shaft. Unfortunately, there is no independent scientific data indicating a benefit. For example, vinegar or vinegar-based products (e.g., Clear Lice Egg Remover Gel) can be applied to the hair for three minutes before combing out the nits. No clinical benefit has been demonstrated.

Occlusive substances including a "petrolatum shampoo" consisting of 30 to 40 g of standard petroleum jelly can be massaged onto the entire surface of the hair and scalp and left on overnight with a shower cap has been suggested. Diligent shampooing is usually necessary for at least the next 7 to 10 days to remove the residue. Other occlusive substances have been suggested (mayonnaise, tub margarine, herbal oils, olive oil) but benefits have not been demonstrated.

Table 8.32 Commonly used products for physical, cultural or mechanical management of head lice and uses.

Type	**Example Products**	**Uses**
combs	LiceMeister® Comb NitFree Terminator™	Removes lice and nits.
botanical-based removal aid	Lice-B-Gone®	Eases removal by combing.

Pediculicide options for head lice

Most treatments for lice are shampoos left on the head for no more than 10 minutes. Most will not kill eggs so a second treatment is suggested. Removing nits close to the head is usually included in the treatment instructions. Most products warn against using the products on broken skin which is practically impossible given that lice-related itching usually leads to excoriation of the scalp which may be severe.

If repeated treatments fail, some physicians will prescribe higher levels of permethrin (5%) or resort to scabies treatments (e.g. crotamiton, sulfamethoxazole, trimethoprim, ivermectin, etc.). These are **extremely** hazardous to children and not recommended.

Table 8.33 Commonly used pediculicide products for head lice.

a. Botanical formulations.

Active ingredient	**Example products**	**Uses**
Anise oil, coconut oil, and ylang ylang oil in an isopropyl alcohol carrier.	Hair-Clean-1-2-3®	Over the counter botanical reported to have a similar level of efficacy to Nix®. It has a very strong licorice smell and should be used with caution because of the high alcohol content making

		it highly flammable. The product is sprayed onto dry hair and left for 15 minutes. Then, lice and nits are removed with a metal nit comb (which comes with the product). A second application is suggested seven to tendays after the first. This product is most likely to be found in health food stores.

b. Formulations with greater potential hazards. Use less hazardous options.

Active ingredient	Example products	Uses
permethrin (1%)	Nix®	Over the counter head louse treatment kits, including nit comb, etc. Currently the recommended treatment of choice by pediatricians. It has a lower mammalian toxicity than pyrethrins and does not cause allergic reactions in individuals with plant allergies. The product is a cream rinse applied to hair that is first shampooed with a non-conditioning shampoo, and then towel dried. It is left on for ten minutes and then rinsed off, and it leaves a residue on the hair that is designed to kill nymphs emerging. 20% to 30% of eggs are not killed with the first application. It is suggested that the application be repeated if live lice are seen seven to ten days later. Permethrin is a possible carcinogen according to US EPA.

pyrethrins plus piperonyl butoxide	RID® A-200® Pronto® Clear lice System®	Over the counter head louse treatment kits, including nit comb, etc. Natural extracts from the chrysanthemum plus synthetic piperonyl butoxide synergist. Mostly shampoos that are applied to dry hair and left on for ten minutes before rinsing out, over a sink rather than in the shower to limit exposure, and with cool rather than hot water to minimize absorption. Neurotoxic to lice. Not ovicidal (newly laid eggs do not have a nervous system for several days); 20% to 30% of the eggs remain viable after treatment. A second treatment is suggested after 7 to 10 days. Possible allergic reaction including for those who are sensitive to ragweed or chrysanthemums. Piperonyl butoxide is a possible carcinogen according to US EPA.

c. Formulations with greater potential for acute toxicity. Use less toxic options (see above).

Active ingredient	Example products	Uses
malathion (0.5%)	Ovide®	Prescription only organophosphate (cholinesterase inhibitor) lotion that is applied to the hair, left to air dry, then washed off after eight to 12 hours. Malathion has high ovicidal activity. Product directions suggest reapplication if live lice are seen in seven to ten days. The product has a high alcohol content making it highly flammable. There is an associated risk of severe respiratory depression.
lindane (1%)	Kwell® 9160-3	Prescription only organochloride that has central nervous system toxicity in humans; several cases of severe seizures in children using lindane have been reported. The shampoo should be left on for no more than 10 minutes; a repeat application is suggested after

		seven to ten days. Low ovicidal activity (30% to 50% of eggs are not killed).

Emerging issues, new strategies and priorities for head lice
Resistance has been reported to lindane, pyrethrins and permethrin. None of the currently available pediculicides are adequately effective against the egg stage.

Table 8.34 Priorities for head lice.

Research Efficacy of botanical pesticide products on head lice. Thresholds for pesticidal treatment. Effective, least-toxic ovicides.
Education Support materials for schools offering reduced-risk treatment advice. Effective head lice screening guidance, i.e. an emphasis should be placed on screening for nymph and adult head lice, not just nits. The threshold for pesticidal treatment should be the presence of nymphs and adults, or a specified number of nits per cm^2 of scalp.
Regulatory Lindane is significantly more hazardous and significantly less effective than the over the counter alternatives. In 2003, the Food and Drug Administration (FDA) issued a Public Health Advisory concerning the use of topical formulations of lindane lotion and lindane shampoo for the treatment of scabies and lice. The warning states that lindane lotions and shampoos are to be used with caution in patients who weigh less than approximately 110 pounds (50 kilograms). www.fda.gov/bbs/topics/ANSWERS/2003/ANS01205.html
Management Sound response strategies: stop all "no-nit" policies, pesticidal treatments of school environments (classrooms, dormitories, busses, etc.).

Additional resources for head lice management
Arizona Cooperative Extension. 2005. Head Lice. Pest Press. cals.arizona.edu/urbanipm/pest_press/2005/sept.pdf (PDF)

Center for Disease Control. 2008. Head Lice. www.cdc.gov/lice/head/index.html

Frankowski, B.L., and L.B. Weiner. 2002. Head Lice. *Pediatrics* Vol. 110(3): 638-643.

Pollack, R.J. 2007. Harvard School of Public Health. Head Lice Information. Comprehensive website that answers many questions about and related to head lice including removal methods. www.hsph.harvard.edu/headlice.html

The American Academy of Pediatrics and the National Association of School Nurses www.nasn.org/Default.aspx?tabid=237

MOSQUITOES

There are approximately 175 species of mosquitoes in the continental United States. For management in and around schools, mosquito species can be divided into two types; nuisance species and vector species. Vector species can spread disease and thus require more vigilance than nuisance species. About 40 species of mosquitoes found in the US are medically important because they may transmit various forms of encephalitis, yellow fever, malaria, dengue and other conditions. Of these, the encephalitis group is currently the most significant for the continental US, including West Nile virus, Eastern equine encephalitis, Western equine encephalitis, St. Louis encephalitis and California encephalitis.

Table 8.35 Mosquito species most likely to be found in schools including diseases vectored, larval habitat, adult activity periods and geographic distribution.

Common and species name	**Diseases vectored (or suspected)**	**Larval habitat**	**Adult activity periods**	**Geographic distribution**
northern house mosquito, *Culex pipiens*	West Nile virus, St. Louis encephalitis, (eastern equine encephalitis)	artificial containers, catch basins, ground pools	dawn and dusk, night	Northern US.
southern house mosquito, *Culex quinquefasciatus*	West Nile virus, St. Louis encephalitis, (western equine encephalitis)	artificial containers, catch basins, ground pools	dawn and dusk, night	Southern US.
none, *Ochlerotatus japonicus*	West Nile virus, Japanese encephalitis, LaCrosse encephalitis	artificial containers	dawn and dusk, day	19 Eastern states and spreading.
Asian tiger mosquito, *Aedes albopictus*	yellow fever, dengue, (California encephalitis)	artificial containers	day	Southeastern US and moving north.
yellow fever mosquito, *Aedes aegypti*	yellow fever, dengue	artificial containers	dawn and dusk, day	Southeastern US.

Management strategies for mosquitoes vary depending upon which species are present and whether mosquito-vectored diseases pose a serious public health threat. Some states have relatively few mosquito species, e.g., West Virginia with 29, while others are particularly blessed, e.g., Texas with 84. Climatic differences between regions as well as unusual weather patterns impact mosquito status. For example, in northern areas where “mosquito season” begins in June and is over by October, management of mosquitoes at school is more easily accomplished. Tropical and subtropical areas, and school with year-round calendars will have a longer, more challenging season.

Effective management requires understanding the life cycle, behavior and dispersal ranges of mosquito species. Some of the most common nuisance and vector species breed only in artificial containers and fly no more than a half mile from the breeding site. Other species breed only in salt marshes and are capable of flying five to ten miles or more. Identification to species can save a great deal of trouble and reduce under or over-reaction to potential problems.

Mosquitoes pass through four distinct life stages: egg, larva, pupa and adult. Adult female mosquitoes bite animals including humans to obtain blood. Blood provides protein for forming eggs. A female lives two weeks on average, during which she may lay eggs in standing water up to ten times, 50-500 eggs at a time. Suitable water for egg laying can include swamps, storm retention basins, culverts, ponds, lakes, natural tree holes, hollow stumps or artificial containers such as pots, cans, tires, plastic covers, or plugged rain gutters. In general, anything that can hold water for four to seven days or more can provide a breeding site.

Eggs are deposited either individually or in groups called “rafts” on the surface of water or on soil where flooding will produce puddles or pools. Most eggs hatch within 48 hours. Larvae are called “wrigglers” reflecting their movement in the water. Wrigglers feed on organic debris and microorganisms, and breathe at the surface of the water through tubes. After molting several times, a pupa is formed. Pupae are C-shaped and sometimes called “tumblers” because they will somersault below the surface of the water when disturbed. Adults emerge from these puparia. As long as watery habitat is available, the population gradually increases. The entire life cycle varies from four to 30 days, depending on the species.

The recommendations below for mosquitoes in schools generally apply to the most common “domestic” mosquitoes that share the following characteristics:

a. widespread geographically;
b. breed in and around buildings in artificial containers;
c. always associated with humans;
d. typically small (<1/2 mile) flight range;
e. capable of transmitting disease.

These species are relatively easily managed by school personnel by eliminating larval habitat around buildings. However, your location may require special attention to other species. For example, malaria is reintroduced to the US regularly but currently only poses a very limited health threat. The malaria mosquito, *Aedes quadrimaculata*, occurs in only a few places and does not typically breed in and around buildings. Thus, it is not included for discussion here.

Some mosquitoes found around marsh habitats are capable of flying many miles, in which case, control may need to be area-wide. If a school is near such sources and intervention is necessary, efforts will have to be coordinated with county or state mosquito abatement authorities. Refer to your state departments of health for updates on medically important mosquito species in your area.

Monitoring and inspection for mosquitoes

The most effective monitoring method for mosquitoes is to look for larvae prior to the emergence of adults. Larvae and pupae of common domestic species are found primarily in standing water in artificial containers located around the school building itself. These sources can be inspected using a dipper to capture larvae and pupae if present. A sketch or plot plan of the school grounds is helpful in recording locations where surveillance may be needed.

If adult mosquitoes are present, they will find *you*! If mosquito-borne diseases are a concern in your area, capture several intact adults and preserve in a vial of alcohol for identification by mosquito specialists. State or county public health agencies, or pest control companies in mosquito-prone areas may have specialists on staff.

Cultural and physical options for mosquito management

In general, identification and elimination of mosquito breeding sites is more effective and less hazardous than attempting to eliminate adults. Elimination of such pools on a weekly basis preempts the emergence of adults. Adults, on the other hand, once flying, are difficult to control by any means, chemical or not. Least-hazardous adult control methods such as predators, traps, “bug-zappers” etc. do not effectively reduce mosquito populations. In all but the most extreme cases of mosquito infestations, widespread spraying of pesticides for adult mosquitoes around schools poses an unacceptable risk of exposure to non-target organisms including humans.

Keep in mind that during warm weather, mosquitoes can breed in any puddle of water that lasts more than four to seven days, depending on the temperature.

Table 8.36 Management strategies for mosquitoes.

a. Source elimination strategies.

• Identify anything outside that can hold water such as plastic, cans, containers, pots. Dispose, turn over, drill holes in such containers.
• Turn over wheelbarrows and other water-holding tools when not in use.
• Do not allow water to become stagnant in birdbaths, ornamental pools or other outside areas.
• Regularly inspect and clean out gutters and drainpipes.
• Cover dumpsters, trash and recycling receptacles to prevent water accumulation.
• Be aware of nearby piles of used tires, which have become important mosquito breeding sites. Remove or have holes drilled in them to drain water.

b. Habitat manipulation strategies for mosquitoes.

- Eliminate adult resting sites.
- Cut back or remove dense brush and other vegetation from around buildings.
- Keep grassy areas mowed.
- Promote natural breezes to discourage mosquito occurrence.
- Alter the landscaping to eliminate standing water.

c. Strategies to avoid adult mosquitoes and bites.

- Make sure window and door screens are in good repair.

Advise students to take the following precautions:

- Reduce outdoor exposure, especially at dawn, dusk and in the early evening during peak periods of mosquito activity in your location. (Exception: day-biting species.)
- Avoid areas where mosquitoes tend to concentrate— tall grass, margins of wooded areas, or heavily wooded areas in dense vegetation.
- Avoid wearing dark colors. Some mosquitoes and other biting flies are attracted to dark greens, browns and black. They are less attracted to light-colored clothing, especially whites and yellows.

Table 8.37 Commonly used products for physical, cultural or mechanical management of mosquitoes and uses.

Type	**Example Products**	**Uses**
netting	Readynet Mosquito Netting Curtain	Install over beds. Install over porches, doors.
window and door screens	many	Install on windows and doors.
traps	Mega-Catch™ Mosquito Trap Mosquito Magnet®	Install outdoors to reduce adult populations.

Biological control

Biological organisms used to control mosquitoes include predators of larvae and adult mosquitoes, or formulations of naturally occurring mosquito parasites or diseases. The latter are registered by EPA as pesticides and are covered in the next section.

Many naturally-occurring fish are predators of mosquito larvae. The killifish species *Gambusia holbrooki* and *G. affinis* (Cyprinodontidae) are native to southern and eastern US and have been used quite successfully for larval control in many situations. However, when translocated to new environments, these fish may compete unfavorably with local fish and other aquatic species. Thus, *Gambusia* spp. should be used selectively in self-contained water bodies that are not fed or drained by natural waterways. These include ornamental ponds, abandoned pools, mine pits, livestock waterers, fountains or large birdbaths. **Releasing *Gambusia* into waterways is illegal in some states.** Efficacy and recommended stocking rates for *Gambusia affinis* are reviewed at www.rci.rutgers.edu/~insects/gamb2.htm

While predators of adult mosquitoes such as bats and purple martins can be encouraged, they are opportunistic feeders and so will feed on many insects and may not have a noticeable impact.

Pesticide options for mosquitoes

Many states have laws governing the use of both chemical and biological pesticides in and around schools or other specific environments. This is particularly true in the case of mosquito control which may involve applications of pesticides to natural bodies of water and thus pose environmental hazards, and be regulated or managed under state and local mosquito control jurisdictions. It is important to be informed about these factors prior to using pesticide options.

If students are going to be in areas of high mosquito activity, advise their parents of this fact so that precautions can be taken. Insect repellents are considered to be pesticides by the EPA and as such, are not appropriate for application by staff to students. Precautions should be taken to avoid toxic repellents such as DEET. Alternative repellents are available.

Larvicides, pesticides used to kill immature mosquitoes, are typically more effective and target-specific than adulticides. Habitat modification is more permanent and preferred where possible. Larvicides include bacteria specific to mosquito and fly larvae, insect growth regulators (IGRs), and chitin synthesis inhibitors (Table 8.38). Conventional larvicides include several non-petroleum oils and monomolecular films.

The timing of larvicide applications depends on the product. Bacterial toxins must be consumed by the larvae and are usually applied well before the fourth molt. IGRs must be applied later in the life cycle to upset the molting process. Chitin synthesis inhibitors are effective throughout the entire larval life cycle. Monomolecular films prevent the insect from remaining at the surface of the water by reducing surface tension, causing the larvae and pupae to die. Non-petroleum oils kill larvae and pupae by suffocation. Conventional insecticides kill larvae at all stages and can be applied whenever larvae are present.

Adulticides targeting mosquito adults and applied from the ground or air are generally the least efficient approach and considered a last resort when all other methods have failed. They are often applied as ultra-low-volume sprays in which small amounts of insecticide are dispersed either by truck-mounted equipment or from fixed-wing or rotary aircraft. Pesticide droplets must contact the mosquito to be effective.

Table 8.38 Commonly used larvicidal products for mosquitoes.

a. Biological formulations.

Active ingredient	Example products	Uses
Bacillus thuringiensis israelensis (Bti)	Aquabac® 62637-3 Mosquito Dunks® 6218-47 Teknar® 2724-469	Slow release formulation in standing water, kills larvae. Not effective on pupae.
Bacillus sphaericus	VectoLex® 73049-20	Kills larvae, not effective on pupae (monitor early for larvae). Works in fresh water only.

b. CAUTION-label formulations that are more toxic and/or have greater exposure potential.

Active ingredient	Example products	Uses
diflubenzuron	Dimilin® 25W 400-470	To reduce impacts on non-target organisms, use only in artificial water bodies only.
ethoxylated alcohol	Agnique® MMF Granules	For the control of immature mosquitoes and midges. Breaks down surface water tension.
methoprene	Altosid® 2724-375	Slow release insect growth regulator formula, prevents larvae/pupae from emerging. Can affect other non-target organisms.
monomolecular film	Agnique® 53263-30	Apply to water. Surface tension weakens so larvae & pupae cannot stay on surface. Subsurface larvae unaffected.
oils	BVA 2 Lavacide 70589-1 Golden Bear GB-1111 8329-72	Apply to water surface to suffocate larvae & pupae. Subsurface larvae unaffected.
spinosad	Green Light Lawn & Garden Spray with Spinosad® 869-245	To reduce impacts on non-target organisms, use only in artificial water bodies only.

Organophosphate products applied to water for larval control are not recommended. (e.g. temephos, Abate®) due to both human exposure hazards and strong potential for widespread non-target impacts. Similarly, aerosol spraying, thermal fogging and/or

UltraLowVolume (ULV) fogging for adult mosquitoes with organophosphate, carbamate or pyrethroid products is strongly discouraged, especially on school grounds. Such tactics should only be initiated as a last resort by state mosquito abatement personnel as part of a strategic disease vector management program. Should your school grounds be subject to such spraying, it will be important to close down all ventilation intakes, be sure students are not present and advise parents of the date and time of such applications.

Emerging issues, new strategies and priorities for mosquitoes
The need for effective mosquito management tools will follow apace with the introduction of new mosquito species and new disease emergence in the US. As such, mosquito management is a moving target. Effective mosquito management requires increased knowledge, understanding of mosquito biology, communication with the public and coordination between managers at the school, community, county and state levels.

Table 8.39 Priorities for mosquitoes.

Education Importance of outdoor clutter control and proper waste handling to avoid standing water and mosquito breeding. Importance of avoiding compaction and promoting infiltration in landscapes including turf to avoid standing water and mosquito breeding. Efficacy of prevention plus larviciding as an alternative to fogging.

Additional resources for mosquito management
American Mosquito Control Association
www.mosquito.org/mosquito-information/control.aspx

Arizona Cooperative Extension. 2004. Scorpions and Mosquitos. Pest Press. cals.arizona.edu/urbanipm/pest_press/2004/may.pdf (PDF)

Florida Coordinating Council on Mosquito Control. 1998. Mosquito Control Benefits and Risks: Integrated Mosquito Management. In *Florida Mosquito Control White Paper*. mosquito.ifas.ufl.edu/Integrated_Mosquito_Management.htm

Long, K. 2006. *IPM for Pennsylvania Schools: A How-to* Manual. PA IPM Program.

National Park Service. Mosquitoes. In *Integrated Pest Management Manual.* www.nature.nps.gov/biology/ipm/manual/mosquito.cfm

O'Neill, J. 1997. Chapter 18. Mosquitoes. Pp. 837-880. In *Handbook of Pest Control*. A. Mallis, ed.

Rose, R. 2001. *Pesticides and Public Health: Integrated Methods of Mosquito Management in Emerging Infectious Diseases*. 7(1) CDC

Suffolk Co. Mosquito Control www.suffolkmosquitocontrolplan.org/control.html

OCCASIONAL INVADERS

Several species of insects and other organisms that are generally not considered serious pests can invade a school building or become established on school grounds. These infrequent visitors may be present in landscaped areas but rarely cause significant issues in schools. Many occasional invaders are drawn to the school by the presence of food in the form of plant feeding insects, leaf litter and trash or sources of moisture from irrigated landscapes or shelter including mulch and other ground cover.

The elimination of conducive conditions that attract these pests is often the most effective approach to managing most occasional invaders. A few occasional invaders are more problematic and may become established indoors for a few days to several weeks.

Physical and mechanical measures may be required to prevent occasional invaders from accessing school buildings.

Table 8.40 Occasional invaders most likely to be encountered in and around schools.

Common and species name	**Geographic distribution**
Asian lady beetle, *Harmonia axyridis*	Eastern and Midwestern US.
amphipods or scuds, Class *Crustacia*, Order *Amphipoda*	Throughout the US.
booklice, *Liposcelis corrodens*	Throughout the US.
Boxelder bugs, *Boisea trivittata*	Midwestern and West Central US.
centipedes, Class *Chilopoda*	Throughout the US.
clover mite, Class *Arachnida*, Order *Acari*	Throughout the US.
crickets, *Gryllus* spp.	Throughout the US.
earwigs, Order *Dermaptera*	Throughout the US.
firebrats	Throughout the US.
fleas	Throughout the US.
millipedes, Class *Diplopoda*	Throughout the US.
pillbugs and sowbugs, Class *Crustacea*, Order *Isopoda*	Throughout the US.
slugs and snails, Class *Gastropoda*	Throughout the US.
snakes	Throughout the US.

scorpions, Class *Arachnida*, Order *Scorpiones*	Southwestern US.
silverfish	Throughout the US.
springtails, Order *Collembola*	Throughout the US.
stored product moths and beetles	Throughout the US.
wood-boring beetles	Throughout the US.

Monitoring and inspection for occasional invaders
This is a very diverse group. Although many have common requirements for food, water or shelter, identification of the individual pest is required whenever one of these occasional invaders is found in a school. Any insects or other arthropods that are collected for identification purposes should be placed in a vial instead of plastic bags or tape to preserve key identifying characters.

Adhesive-coated traps are the best monitoring method for most occasional invaders. For some, special traps are available including pheromone traps for stored product moths and beetles.

Inspections for occasional invaders should be focused around doorways and at the exterior perimeter of the building particularly in areas where vegetation is present close to the structure.

Overwintering occasional invaders such as boxelder bugs or Asian lady beetles enter school buildings in late summer or early autumn through cracks or openings under siding, around flashing, or through weep holes. These insects congregate in voids such as attics or crawlspaces. In the early spring, during periods of warm weather, they may be observed on window ledges or emerge from around light fixtures.

Cultural and physical options for occasional invader management
Cultural, physical and mechanical management options are preferred and include eliminating harborage. Vegetation should be trimmed so that it does not contact structures and mulch should be raked away from the structure. Moisture reduction including repairing leaks, improving drainage, reducing irrigation and dehumidification often helps discourage occasional invaders. Sealing potential entry points such as holes in walls and the installation of door sweeps and screens are good exclusion techniques for occasional invaders.

Table 8.41 Cultural and physical strategies for occasional invaders.

- Remove individual pests using a vacuum where practical.
- Adhesive sticky traps can be used to catch individual or small numbers of crawling occasional invaders indoors.
- Use the least amount of landscaping/irrigation in areas adjacent to the structure and trim vegetation away from buildings to prevent access.
- Eliminate access points where occasional invaders might enter by sealing cracks and

exposed pipe chases, installing door sweeps and screens, repairing door and window seals, etc.

- Place exterior trash cans and dumpsters away from building entrances.
- Fix plumbing leaks, improve drainage to prevent water accumulation near the building and clean gutters that hold water.
- Remove mulch from building foundations to reduce harborage. Do not allow grass clippings or leaf litter to accumulate adjacent to school buildings.
- Remove debris, clutter or materials that are stored against perimeter walls.
- Position exterior lighting to avoid attracting crawling and flying insects to building entryways at night. Where possible, use reflective instead of direct lighting.
- Use sodium vapor or yellow bulbs for exterior lighting to reduce attraction to insects.

Table 8.42 Commonly used products for physical, cultural or mechanical management of occasional invaders and uses.

Type	Example Products	Uses
door sweeps and seals	Sealeze Weatherseal	Close gap between bottom of door and sill, and between edges of door and frame.
insect monitors, glue boards	Catchmaster®	Install near potential entry points and harborages to reduce populations/intercept individuals.
window and door screens	many	Install over windows and doorways.

Pesticide options for occasional invader management
Pesticides are rarely necessary for occasional invaders. However, if established populations are present in exterior perimeter locations and non-chemical methods are unsuccessful in achieving adequate control, crack & crevice or spot applications of a least-toxic product may be required. These treatments should be directed into suspected harborages for the specific pest.

Pesticide treatments are not recommended for overwintering occasional invaders that are present inside a building.

Pesticide options that reduce potential for exposure include insecticide baits in enclosed bait stations. A limited number of effective baits are available for specific occasional invaders. If granular baits are needed, these should be used in tamper resistant bait stations.

Pesticide options that increase potential for exposure for students, staff and other facility users include spray formulations applied to exposed surfaces or broadcast granular products.

Table 8.43 Insecticide products for occasional invaders.

a. Insecticides carrying a CAUTION label or exempt from EPA registration, in formulations that reduce potential for exposure.

Active ingredient	Example products	Uses
none		

b. CAUTION-label or exempt formulations with greater potential for exposure.

Active ingredient	Example products	Uses
boric acid diatomaceous earth disodium octaborate tetrahydrate limestone	Borid® 9444-195 Concern® 50932-12 Boracide® 64405-7 NIC 235 Pro Organic® (EPA Exempt)	Dust formulation. To reduce exposure hazard, use only in voids that will be sealed after use.
orthoboric acid indoxacarb	Niban Granular Bait® 64405-2 Provaunt® 352-716 Advion Mole Cricket Bait® 352-651	Granular formulations. To reduce exposure hazard, use only in voids that will be sealed after use.
boric acid	PT 240 Permadust® 499-384	Pressurized aerosol.

c. CAUTION-label formulations with greater potential for toxicity and/or exposure. Use less toxic options.

Active ingredient	Example products	Uses
bifenthrin chlorfenapyr cyfluthrin cypermethrin deltamethrin lambda cyhalothrin rosemary oil	Talstar® 279-3225 Phantom® 241-392 Tempo® SC Ultra 11556-124 Demon® EC 100-1004 Suspend® SC 432-763 Demand® CS 100-1066 Ecoexempt® 2C 67425-20	Liquids spray applied to exposed interior or exterior surfaces. Reduce exposure by using these products in cracks and crevices only.

Table 8.44 Priorities for occasional invaders.

Research Development of targeted baits. Efficacy of botanical pesticide products on arthropod occasional invaders. Education Support materials for PMPs and others on effective baiting strategies for individual occasional invaders.

Additional resources for occasional invader management

Arizona Cooperative Extension. 2004. Scorpions and Mosquitoes. Pest Press. cals.arizona.edu/urbanipm/pest_press/2004/may.pdf (PDF)

Daar, S., T. Drlik, H. Olkowski and W. Olkowski. 1997. Chapter 13. IPM for scorpions in schools. pp. 103- 105. Chapter 14. IPM for silverfish, firebrats and booklice in schools. pp. 107-110. In *IPM for Schools: A How-to Manual*. Line drawings, identification, communication, monitoring, management. www.epa.gov/pesticides/ipm/schoolipm/

University of Maryland Cooperative Extension. 2000. Occasional Invaders. Home & Garden Mimeo #HG8. www.hgic.umd.edu/_media/documents/hg8.pdf (PDF)

University of Florida. 2006. Occasional Invaders. A poster of 14 yard- and home-invading creatures, from slugs to centipedes. www.ifasbooks.ufl.edu/merchant2/merchant.mv?Screen=PROD&Store_Code=IFASBOOKS&Product_Code=SP+401&Category_Code=HCPS

RODENTS

Mice and rats are common problems in and around schools. Rodents cause fires by gnawing on electrical wires and transmit pathogens, and are associated with allergens and asthma triggers and should not be tolerated. Effective, low hazard options are available to eliminate rodents.

The house mouse weighs about one-half ounce and is three to four inches in length with a dark tail of about the same length. Its rod-shaped feces are pointed at each end about ¼" long. Mouse problems can occur at any time of year and are particularly likely in the fall when outdoor temperatures begin to cool. Open access points as small as ¼" in diameter act like beacons, attracting rodents with warm air and food smells.

House mice can survive without water. Rats require daily access to water. Norway and roof rats are up to 16" in length including the tail. Norway rats have small ears, tails shorter than head plus body, and capsule-shaped droppings. Roof rat ears are large, tails are longer than head plus body, and droppings are elongated with more sharply pointed ends. Norway rats reach 11 oz. at adulthood; roof rats rarely exceed 7 oz.

Table 8.45 Rodents most likely to be encountered in and around schools.

Common and species name	**Geographic distribution**
house mouse, *Mus musculus*	Throughout the US.
Norway rat, *Rattus norvegicus*	Throughout the US.
roof rat, *Rattus rattus*	Lower east, Gulf and Pacific coastal states and north to Arkansas in the Mississippi River Valley.

Monitoring and inspection for rodents
Rodent problems typically have obvious signs including droppings and pilfered food for mice and rats, and gnaw and grease marks for rats. Grease marks are dark oil stains from rats rubbing against surfaces along travel ways, entry points, corners, etc. These signs are most likely to be found along linear pathways including corners between walls and floors, along the base of foundations, along pipes or electrical conduits, etc. Rats and mice are more likely to be sighted from dusk through dawn.

Mice typically travel 30 feet or less from nesting sites so an intensive search near droppings or other signs will often uncover the nest in wall voids, cardboard boxes, wooden or plastic pallets, heating units, vending machines, appliances or kitchen equipment.

Norway rat burrows are typically found in existing cavities, softer soil, eroded areas adjacent to masonry or rocks, and where hard surfaces such as sidewalks or foundations meet soil. Entry holes are clean and smooth and may have grease marks on any hard edge. Inactive burrows may be obscured by plant growth, spider webs or debris.

Roof rats prefer elevated nesting sites including attics, walls, roofs, the tops of palms and other trees, and vine-covered fences and walls.

Rats often become active at dusk and can be seen travelling to food or water sources. Rats are active climbers and swimmers.

Cultural and physical options for rodent management
Outdoors in rural and many suburban environments, rodents face many natural enemies including very effective predators such as raptors, coyotes, dogs and cats. In urban environments, biological control is typically insufficient to suppress outdoor populations which readily move into and adjacent to unprotected structures.

Non-chemical measures including habitat modification, exclusion and sanitation are very effective in eliminating rodent problems. A mouse can squeeze through a hole the size of a pencil diameter. The first line of defense against mouse problems should include sealing up entry holes, cleaning up clutter inside classrooms, storage and other areas, and storing items off the floor to allow proper cleaning and inspection. A rat can enter through a ½" gap. For rats, exclusion, maintaining exterior trash handling areas clean and removing or trimming any vegetation that obscures the ground should be primary strategies.

Glue boards and live traps can result in prolonged suffering and so are less preferred then snap traps which typically but not always result in a swift death. Snap traps can be baited with various attractants including food items and cotton string. Peanut butter can be used to stick other foods to the trigger. Snap traps can also be placed in cardboard or plastic boxes designed to hold snap traps.

Table 8.46 Cultural and physical strategies for rodents.

- Seal any openings greater than ¼" diameter in foundations, walls, fascia, roof; screen vents; install door sweeps to prevent access.
- Install heavy-gauge kick plates at the base of any doors with evidence of rodent gnawing.
- Remove or trim ground cover and other landscape plants to expose ground and discourage rodent travel ways and rat burrowing.
- Avoid landscaping that creates ideal habitat for burrows including stone walls with unsealed gaps.
- Place exterior trash cans and dumpsters away from building entrances to avoid attracting rodents to building.
- Use exterior trash receptacles with tight-fitting or spring-loaded lids. Use self-contained, leak-proof compactors instead of dumpsters, or at least use dumpsters with tight-fitting lids.
- Empty exterior trash receptacles daily at the end of each day.
- Fix plumbing leaks, improve drainage to prevent water accumulation near the building.
- Clean gutters to prevent water retention.
- Remove mulch from building foundations to reduce harborage. Do not allow grass clippings or leaf litter to accumulate adjacent to school buildings.
- Remove debris, clutter or stored materials from building exterior and adjacent areas to reduce harborage and permit proper cleaning and inspection.
- Remove clutter and items stored on floor in interior entryways, storage and other areas to reduce harborage and permit proper cleaning and inspection.
- Place non-toxic monitoring bait blocks in tamper-resistant stations in non-visible, inaccessible areas and check regularly for feeding.
- Visually inspect vulnerable areas (e.g., food service, custodial closets, laundry rooms, vending areas, garages, under sinks, sill plates, crawlspaces, etc.) for droppings or grease marks.
- Place glue boards, snap traps, shock traps and/or live traps in non-visible, inaccessible areas to trap rodents.
- Clean up droppings, grease marks and urine promptly using water, detergent and disinfectant and wearing proper personal protective equipment. (See Harrison 1999 below.)
- Fill in inactive burrows with appropriate filler, e.g., mortar for burrows in or under

concrete, soil.
- If rats are entering through floor drains, seal these with hardware cloth with mesh smaller than ½”.

Table 8.47 Commonly used products for physical, cultural or mechanical management of rodents and uses.

Type	Example Products	Uses
barriers	hardware cloth, sheet metal, steel wool, Stuf-fit® Copper Mesh	Use to close potential entries including those around foundations, eaves, roofs, plumbing and electrical penetrations.
door sweeps	Sealeze Weatherseal	Install to close gap between bottom of door and sill, and between edges of door and frame.
glue boards	Catchmaster® 72MB Mouse Glue Board D-Sect® Custom Glueboard M320 Mouse & Roach Glue Trap	Place in areas inaccessible to children.
live traps	Ketch-All® Multiple Catch Mouse Trap	Place in areas inaccessible to children.
screen	many	Cover vents.
sealants	many	Seal all openings ¼” in diameter or larger.
snap traps	Victor® Rat & Mouse Snap Traps	Seal cracks, crevices including edges of wall-mounted equipment.

Pesticide options for rodent management
Where non-chemical measures are inadequate, rodenticides can be used in a manner that greatly reduces potential for non-target exposure. Place bait-block formulations on rods in tamper-resistant bait stations that are secured so that they cannot be easily moved, e.g., attached to permanent masonry or 40 lb. concrete blocks. Limit use of pellet formulations to placement deep within rodent burrows to reduce potential for translocation to unintended areas.

Pesticide options that increase potential for exposure for students, staff and other facility users include pelleted formulations used outside of burrows, place packs, granular or liquid formulations.

Table 8.48 Pesticide products for rodents.

a. Insecticides carrying a CAUTION label or exempt from EPA registration, in formulations that reduce potential for exposure.

Active ingredient	Example products	Uses
brodifacoum	Final® All Weather Blox 12455-89 Weatherblok XT® 100-1055	Place on rod in tamper-resistant bait station secured such that it cannot be moved.
bromadiolone	Contrac® All Weather Blox 12455-79 Maki® Mini Blocks 7173-188	
bromethalin	Fastrac® All Weather Blox 63333-35-7	
difethialone	Generation® Mini-Blocks 7173-218	
diphacinone	Ditrac® All Weather Blox 12455-56 Eaton Bait Blocks 56-23	

b. CAUTION-label or exempt formulations with greater potential for exposure.

Active ingredient	Example products	Uses
brodifacoum	Talon® Mini-Pellets	Place deep inside burrows to reduce potential for translocation (movement of pellets to unintended locations).
bromadiolone	Just One Bite® Rat & Mouse Bait 7173-188 Maki® Parafinized Pellets 7173-187	
difethialone	Generation® Pellets 7173-205	

c. Rodenticides with greater potential for toxicity and/or exposure.

Active ingredient	Example products	Uses
brodifacoum	Final® Ready-to-Use Place Pak 12455-91	Treated seed applied in packets or scattered, subject to translocation.
bromadiolone	Contrac® Ready-to-Use Place Pak 1255-76	
cholecalciferol	Qintox® Mouse Seed 1255-57	
diphacinone	Ditrac® Tracking Powder	Dust applied to burrows,

zinc phosphide	12455-56 Rozol® Tracking Powder 7173-113 ZP® Tracking Powder12455-16	voids and subject to translocation to other surfaces.

Table 8.49 Priorities for rodents.

Research Best practices for monitoring with non-toxic bait blocks. Education Connection between rodents and asthma.

Additional resources for rodent management

Arizona Cooperative Extension. 2004. House Mouse. Pest Press. cals.arizona.edu/urbanipm/pest_press/2004/dec.pdf (PDF)

Arizona Cooperative Extension. 2004. Mice and Roaches. Pest Press. cals.arizona.edu/urbanipm/pest_press/2004/feb.pdf (PDF)

Corrigan, R.M. 1997. Chapter 1. Rats and mice. Pp. 11-105. In *Handbook of Pest Control*. A. Mallis, ed. GIE Media, Richfield, OH.

Daar, S., T. Drlik, H. Olkowski and W. Olkowski. 1997. Chapter 12. IPM for rats and mice in schools. In *IPM for Schools: A How-to Manual*. Line drawings, identification, communication, monitoring, management. www.epa.gov/pesticides/ipm/schoolipm/chap-12.pdf (PDF)

Harrison, F.J. 1999. Protection from Rodent-Borne Diseases with Special Emphasis on Occupational Exposure to Hantavirus. Armed Forces Pest Management Board Technical Information Memorandum No. 41. www.afpmb.org/pubs/tims/tim41.pdf (PDF)

SPIDERS

Spiders (Order Araneae) are often more of a perceived pest than a clinical risk. There are several species capable of inflicting a harmful bite, but relatively few envenomations result in long-term injury. Spiders generally will not bite unless accidentally trapped against the skin or grabbed. Some species actively guard their egg sacs or young. Many spider species are too weak to puncture human skin. When envenomation does occur, mild reactions may include slight swelling, inflammation, burning or itching sensations lasting a few hours. Spiders of medical significance include widow spiders (*Latrodectus* spp.), recluse spiders (*Loxosceles* spp.) and yellow sac spiders (*Cheiracanthium* spp.).

Spiders are often implicated by medical professionals when patients present skin lesions. However, a US study showed that of 600 cases of suspected spider bites, approximately 80% were not caused by spiders. Very few fatalities occur, usually fewer than three annually.

Widow spiders have a neurotoxin in their venom, which is potentially lethal. In the United States approximately six percent of the *reported* bites prove to be potentially fatal (Meier, J, and J. White (1995) *Handbook of Clinical Toxicology of Animal Venoms and Poisons*. CRC Press, Boca Raton). Most often it is children under 18 kg (40 lbs), hypertensive individuals, or the elderly with immune deficiencies who are compromised, therefore, most sensitive. The majority of all widow bites (70%-80%) result in a local painful reaction.

There are 11 native recluse species in the US. Additionally, two non-native species of recluse species are found in certain areas: *Latrodectus rufescens* (Mediterranean recluse), and *Latrodectus laeta* (Chilean recluse). Recluse bites initially produce a reddened area which may form a bulls-eye lesion and blister, and eventually may give rise to a necrotic wound (an open, weeping wound characterized by dead tissues and slow healing). If not tended to, this can lead to disfiguring scarring; however, recluse bites are rarely fatal.

Sac spiders have been reported as responsible for more bites than any other spiders (Anonymous. Prescription Treatment University Online. www.pt-u.com/) The result of a yellow sac spider bite may be immediate pain followed by redness and a burning sensation at the site of the bite, perhaps with blistering and swelling. Rarely does an open sore develop.

At the present time there is no scientific evidence to support the theory that Hobo spiders, *Tegenaria agrestis,* aggressive house spider, *T. domestica*, or the giant House spider, *T. duellica*. have necrotizing venom. Spider bites may cause immediate pain followed by redness and a burning sensation at the site of the bite, perhaps with blistering and swelling. Spiders are beneficial predators that reduce pest populations (flies, crickets, mites, etc.) in and around buildings. Wholesale destruction of spiders should be avoided.

Table 8.50 Spider species most likely to be encountered in or around schools and other structures.

Common and species name	**Geographic distribution**
Cobweb or Black Widow Spiders (Theridiidae), *Latrodectus mactans, L. hesperus, L. geometricus, L. bishopi, L. variolus, Steatoda* spp., *Theridion* spp.	Throughout the US.
Orb Weaver Spiders (Araneidae), *Argiope* spp., *Neoscona* spp.,	Throughout the US.

Tetragnatha spp.,	
Funnel Web or Hobo Spiders (Agelenidae), *Tegenaria agrestis, T. domestica, T. duellica, Agelenopsis.*	*T. agrestis* occurs from Idaho to Vancouver ad Winnipeg.
Cellar Spiders (Pholcidae), *Psilochorus* spp., *Physocyclus* spp.	Throughout the US.
Wolf Spiders (Lycosidae), *Schizocosa* spp., *Hogna* spp., *Rabidosa* spp., *Pardosa* spp.	Throughout the US.
Jumping Spiders (Salticidae), *Menemerus bivittatus*, *Phidippus* spp*., Anasaitis canosa.*	Throughout the US.
Nursery Web Spiders (Pisauridae), *Pisaurina* spp.	Throughout the US.
Crab Spiders (Thomisidae and Philodromidae), *Misumenops* spp*., Xysticus* spp*., Tmarus angulatus*, *Coriarachne brunneipes, Tibellus* sp. and *Philodromus* sp.	Throughout the US.
Spitting spiders (Scytodidae), *Scytodes* spp.	Throughout the US.
Woodlouse spider (Dysderidae), *Dysdera crocata.*	Generally east of the Mississippi R.
Recluse spiders (Loxoscelidae), *Loxosceles reclusa, L. deserta, L. arizonica.*	*L. reclusa* is found south to the Gulf of Mexico, north to Illinois, west to Oklahoma and east to Tennessee and Georgia; *L. deserta* in southeastern California and western Arizona; *L. arizo*nica in south central Arizona.
Tarantula (Theraphosidae), *Aphonopelma chalcodes, Eurypelma californicum.*	Texas, Oklahoma and west to southern California.
Sac spiders (Clubionidae), *Cheiracanthium* spp.	Throughout the US.

Monitoring and inspection for spiders

Monitor for outdoor spiders at night with a flashlight or head lamp. This is the time when they are most visible. When making your inspections, focus on areas that are dark and undisturbed during the day, but not necessarily close to the ground. Check small cracks and crevices from the foundation to the eaves of buildings, under outdoor furniture, piles of wood, bricks, stones, around burrows, water meter and irrigation boxes, sheds, etc. Indoor spiders often become trapped on sticky traps.

Non-chemical management for spiders

General cleaning, reducing clutter, and harborage, can help reduce numbers. Vacuuming of webs, egg sacs and spiders is the most instant control method. Clothing and foot wear should be removed from floor areas in locker rooms, and other storage spaces. Many bites are sustained when putting on shoes or clothing that has lain on the floor.

Outside, remove piles of debris, wood and rock. Fill cracks in walls and foundations with mortar or concrete sealant. Remove heavy vegetation and leaf litter around the foundation. Wash spider webs off the outside of buildings using a high-pressure hose.

Good exclusion practices include:
- Tight-fitting screens on windows and doors; also install weather stripping and door sweeps.
- Seal cracks and crevices where spiders can enter buildings.
- Equip vents in soffits, foundations, and roof gables with tight-fitting screens.
- Install yellow or sodium vapor light bulbs outdoors; locate lights away from the house or turn them off when not needed.
- Tape the edges of cardboard boxes to prevent spider entry.
- Use plastic bags (sealed) to store loose items in storage areas.

Table 8.51 Commonly used products for physical, cultural or mechanical management of spiders and uses.

Type	**Example Products**	**Uses**
brush	Quickie Telescoping Web Duster	Brush on telescoping pole used to remove spiders, egg cases, webbing.
vacuum, HEPA filtered	Sierra Backpack Vacuum	Vacuum removal of spiders, egg cases, webbing.

Pesticide options for spider management

Vacuuming individual exposed spiders and egg sacs is far more effective than non-residual pesticides and many residual pesticides as well. Pesticide applications are unnecessary and often ineffective in reducing spider complaints. Existing egg sacs are often unaffected by aerosols. Residual liquid sprays applied to the outside perimeter of buildings are not very effective for species that display web-sitting behavior. Pesticide space treatments often fail to contact spiders in protected daylight harborages. Several species are affected minimally even if fully exposed. Barrier applications of residual-active pesticides to exposed impervious surfaces including foundations, walkways and driveways are prone to runoff into surface water and should be avoided.

Non-repellent dust formulations applied to webs are often more effective. Residual dusts can be applied to voids and inaccessible areas where spiders hide. Wettable powders or microencapsulated formulations of residual pesticides are sometimes applied to corners, in storage areas, etc. to control active hunting spiders and reduce reestablishment of new spiders. Aerosol flushing agents such as pyrethrins, though ineffective by themselves in providing long-term control, can cause spiders to move about so that they can be removed with a vacuum.

Table 8.52 Commonly used pesticides for spiders.

a. Insecticides carrying a CAUTION label or exempt from EPA registration, in formulations that reduce potential for exposure.

Active ingredient	Example Products	Uses
undisclosed non-hazardous substances as defined by OSHA's hazard communication standard 29 CFR 1910.1200	Dr. T's Cobweb Eliminator	Breaks down the spider web attachment points and makes for easy to remove. A residue remains that makes reformation of the web difficult. May be applied to wood, painted surfaces, vinyl, fiberglass, concrete, masonry or metal surfaces.
2-phenethyl propionate.	EcoPCO ACU 67425-14	Aerosol.
2-phenethyl propionate, pyrethrins	EcoPCO AR-X 67425-15	Aerosol.
eugenol (clove oil), 2-phenethyl propionate	Bioganic Safety Brands™ Dust Insecticide EcoExempt D EcoExempt KO	Contact dust formulations.
eugenol (clove oil), thyme oil	EcoExempt™ G	Granular insecticide.
thyme oil, 2-phenethyl propionate, pyrethrins	EcoPCO WP-X 67425-25	Wettable powder.
mint oil, mineral oil (USP), lecithin	Victor® Poison-Free® Ant & Roach Killer (EPA Exempt)	Aerosol.
rosemary oil, oil of wintergreen, mineral oil	EcoEXEMPT™ IC 2 (EPA Exempt)	Concentrate, mix with an adjuvant.
garlic extract	Garlic Barrier (EPA Exempt)	Odorless concentrate. Not found to be effective.
diatomaceous earth		DE is composed of finely milled fossilized shells of minuscule organisms called diatoms. The microscopically fine, sharp edges desiccate the insects' exoskeleton upon contact

		and the pests dehydrate and die within hours.

b. CAUTION-label formulations with greater potential for toxicity and/or exposure. Use less hazardous options.

Active ingredient	**Example products**	**Uses**
amorphous silica gel, piperonyl butoxide, pyrethrin dust	Drione Dust 73049-287	Sorptive dusts containing amorphous silica gel (silica aerogel) and pyrethrins, Particles of the dust affect the outer covering of spiders (and also insects) that have crawled over a treated surface, causing them to dry out. When applied as a dust-like film and left in place, a sorptive dust provides permanent protection against spiders. Dusts can be applied to cracks and crevices using a puffer.
acephate	PT Orthene Crack & Crevice Pressurized Residual 499-373	Crack and crevice treatments.
bifenthrin	Talstar One 279-3206	Labeled for inside, outside, and perimeter applications.
bioallethrin, sumithrin, coconut diethanolamide, naphtha, petroleum gases	Ortho Flying Insect Killer 239-2512	Aerosol.
orthoboric acid	Boric powder 9444-129 PIC Boric Acid 3095-2020	Apply to dry surfaces only. Lightly coat a thin layer of dust in the areas where pests are found or may hide such as cracks and crevices, behind and beneath stoves, refrigerators, sinks,

		cabinets, garbage cans, around pipes and drains, window frames in attics and basements.
cyfluthrin	Tempo Ultra WP 432-1304	Synthetic pyrethroid, wettable powder.
	Tempo Ultra SC 11556-124	Liquid formulation.
cypermethrin	Cy-Kick 499-304 Demon WP 10182-71 Cynoff WP 279-3070	Synthetic pyrethroid wettable powder.
	CB-Air Devil 9444-182	Synthetic pyrethroid low odor aerosol.
	Demon EC 100-1004 Cynoff EC 279-3081	Synthetic pyrethroid odorless liquid emulsifiable concentrate which leaves no visible residue.
deltamethrin	Suspend SC 432-763	Synthetic pyrethroid space treatment.
deltamethrin	Delta Dust 4-441	Waterproof dust.
esfenvalerate	Ortho Bug-B-Gon 239-2680	Concentrate.
imiprothrin, deltamethrin	Raid Max Roach Killer 4822-518	Aerosol.
lambda-cyhalothrin	Demand CS 100-1066 Spectracide Bug Stop 9688-176-8845	Water-based concentrate. Outdoor perimeter applications and barrier treatments as well as applications to lawns, turfgrass, and ornamentals. Indoors, can be used for crack and crevice treatments.
pyrethrins, piperonyl butoxide	Revenge Farm & Home Fly Bomb 9086-8 565 PLUS XLO 499-290	Pyrethrin Aerosol, not effective used as a lone management tactic. Used as a crack and crevice application to flush or kill.
pyrethrum, piperonyl butoxide	Kicker 432-1145	Flushing agent.

pyrethrins, permethrin	Ortho Indoor Insect Fogger 239-2626	Fogger.
permethrin	Dragnet SFR 279-3062	Indoor/outdoor spray.
pyrethrin, piperonyl butoxide, N-octyl bicycloheptene dicarboximide	ULD BP-300 499-450 565 Plus XLO 499-290	Indoor or Outdoor Application as a space, area or contact spray.
prallethrin	ULD Spy-300 1021-1718	Contact insecticide.
prallethrin, esfenvalerate, MGK-264 synergist	Ortho Roach, Ant and Spider Killer 239-2679	Aerosol.
silica dioxide (from diatomaceous Earth), piperonyl butoxide, pyrethrins	Perma-Guard 67197-6	Apply as a suspension or as a dust to cracks and crevices.

Emerging issues, new strategies and priorities for spiders
Expanding ranges of native species including the brown recluse and ongoing introductions of exotic species pose an increasing challenge for spider management. Education of physicians and other health professionals to promote accurate identification of suspected spider bites is also a challenge.

Table 8.53 Priorities for spiders.

Research
Efficacy of botanical pesticide products on spiders.
Characterization of *Tegenaria* spp. venom.
Safer antivenin treatments.
Education
Improved knowledge base of medical professionals diagnosing spider bites.
Support materials for schools contracting reduced-risk spider management protocols.
Improved knowledge base of PMPs managing spiders.
Management
Effective reduced-risk options information is lacking.

Additional resources for spider management
Arizona Cooperative Extension. 2004. Spiders. Pest Press.
cals.arizona.edu/urbanipm/pest_press/2004/june.pdf (PDF)

Arizona Cooperative Extension. 2006. Recluse Spider. Pest Press. cals.arizona.edu/urbanipm/pest_press/2006/november.pdf (PDF)

Bradley, R. 2002. Spider Bites. www.marion.ohio-state.edu/SpiderWeb/Spider%20Bites.htm

Edwards, G.B. 2002. Venomous Spiders in Florida. www.doacs.state.fl.us/pi/enpp/ento/venomousspiders.html

Hedges, S.A., and M.S. Lacey. 1995. *Field Guide for the Management of Urban Spiders.* 220 pp. Franzak & Foster Co., Cleveland, OH.

University of California. 2008. Brown recluse and other spiders. In *How to Manage Pests of Homes, Structures, People, and Pets.* www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7468.html

University of California. 2007. Spiders. In *How to Manage Pests of Homes, Structures, People, and Pets.* www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7442.html

STINGING INSECTS

Bees, wasps, hornets and yellow jackets are among the insects that can sting humans and other animals. Very few of the many species in these groups are aggressive and prone to cause problems in or around schools. Some types of ants, including fire ants, may also sting and are addressed in a separate section.

Reactions to stings can range from mild itching and swelling to severe allergic reactions with more than 500,000 emergency room visits and 150 deaths reported per year in US. School pest managers are thus justly concerned to limit the potential for stings to students, staff and visitors.

These insects are among the most beneficial organisms economically, with bees providing pollination services worth an estimated $3 billion annually in the US. Yellow jackets and paper wasps are also predators of key pests in agriculture, turfgrass, trees and gardens, including preying on cutworms and other caterpillars.

Table 8.54 Stinging insect species most likely to be encountered in schools.

Common and species name	**Geographic distribution**
Dolichovespula spp.	Throughout the US.
carpenter bees, *Xylocopa spp.*	Throughout the US.
cicada killer wasp,	Throughout the US.
digger bees, Anthophoridae	Throughout the US.
German yellow jacket, *Vespula germanica*	Throughout the US.

honey bees, *Apis mellifera*	Throughout the US.
leafcutter bees, *Megachile spp.*	Throughout the US.
mud daubers, *Chalybion*, *Sceliphron spp.*	Throughout the US.
paper wasps, *Polistes spp.*	Throughout the US.
sweat bees, Family Halictidae	Throughout the US.
western yellow jacket, *Vespula pennsylvanica*	Western US.

Monitoring and inspection
Stinging insect nests can be located in a variety of places including in the ground, in masonry or other wall voids, on the eaves of buildings, on fences or in trees. In environments where these species occur frequently, a monthly inspection of buildings and grounds for nests during the active season may be warranted, with more frequent inspections during nesting seasons for problem species.

Cultural and physical options for stinging insect management
Stinging insect nests that are located in areas where they are unlikely to be disturbed are best left alone. When persistent problems occur, proper identification of the species is essential due to the wide variety of food sources, nesting sites and behaviors of this large group. A good understanding of these characteristics is key to finding effective, long-term solutions.

Preventing access to food, water and shelter is critical to reducing problems with bees, wasps and hornets. Yellow jackets, paper wasps and hornets are scavengers and typically become a problem where food and waste handling occurs. Screens on windows and exterior doors, tight-fitting lids on outdoor trash cans and dumpsters and frequent cleaning of these receptacles, and heavy trash can liners that reduce rips and leaks are effective approaches. Nesting sites can be reduced by capping open fence-pipe ends, and by sealing gaps, holes and other openings into voids in walls, doorways, eaves and roofs.

Maintaining thick turf and installing landscape barrier cloth four to six inches below exposed sand or soil in playgrounds and playing fields can discourage nesting by cicada killers. Running sprinklers during nesting periods for cicada killers can also discourage activity.

Education is an important element of stinging insect management. Staff and students should be instructed to report stinging insect nests on school grounds, to avoid wearing strong perfumes or eating or drinking outdoors during problem times of year, and to avoid panic when encountering stinging insects or nests. Many more injuries and deaths from encounters with bees result from panic reactions including running into traffic, etc. than from an insect sting.

In southern regions where Africanized honey bees are potentially present, specific instructions should be provided for avoiding and responding to attacks. These include running away in a straight line to outrun an attacking swarm, seeking shelter in a building or vehicle, and avoiding other people to avoid drawing bees to them. In certain locations, specific regulations are in place for honey bee management, e.g., in several states, any nests or swarms must be assumed to be Africanized and destroyed rather than collected by a beekeeper.

Various types of traps can be used for certain species of yellow jackets, paper wasps and other hornets. These are typically baited with liquid or dry attractants and allow insects to enter but not escape. They may be useful for monitoring the types and relative numbers of these species present, and if used in larger numbers, may suppress populations. This strategy may be most useful where a problem is caused by insects nesting on an adjacent property you do not control. Competing food sources will reduce the effectiveness of traps.

Anyone taking action against a stinging insect nest or managing traps should take precautions to avoid being stung, including wearing protective gear where appropriate.

Table 8.55 Cultural and physical strategies for stinging insects.

- Remove individuals with a vacuum or flyswatter.
- Eliminate harborage by sealing openings in exterior surfaces including walls, masonry steps, bleachers, fences, playground equipment, etc.
- Clean up food and drink spills immediately.
- Store food items to be consumed outdoors in sealed containers.
- Use strong liners for waste containers that do not rip and create spills in dumpsters and trash cans.
- Empty outdoor trash cans frequently to prevent overflow, and ideally in early afternoon and again at dusk.
- Use outdoor waste containers with spring-loaded doors and keep dumpster lids closed.
- Place outdoor trash cans and dumpsters away from building entrances.
- Do not plant flowering trees, shrubs or flowers immediately adjacent to building entrances or walkways.
- Fix plumbing leaks, gutters that hold water, etc. to eliminate access to water.
- Knock down paper-wasp nests with a long-handled broom or stream of water.
- Fill ground nests with fine, dry sand, preferable after dark.
- Bag and remove problem hornet nests at night, and freeze the bag to kill the trapped insects.
- Discourage cicada killer nesting by maintaining thick turf or by installing heavy duty landscape barrier cloth 4-6” below the soil or sand surface.

Table 8.56 Commonly used products for physical, cultural or mechanical management of stinging insects and uses.

Active ingredient	Example Products	Uses
Yellow jacket trap	Sterling Rescue® Reusable Yellow jacket Traps	Bait with manufacturer-supplied bait or sweet liquid such as cider or soda.

Pesticide options for stinging insects

A number of low toxicity, effective pesticide options are available for stinging insects, including formulations that can be used in a way that minimizes exposure to non-target organisms.

Table 8.57 Commonly used pesticide products for stinging insects and uses.

a. Insecticides carrying a CAUTION label or exempt from EPA registration, in formulations that reduce potential for exposure.

Active ingredient	Example Products	Uses
phenethyl propionate, eugenol	EcoEXEMPT D	Dust formulation. To reduce exposure hazard, use in voids that will be sealed after the colony dies.

b. CAUTION-label or exempt formulations with greater potential for exposure.

Active ingredient	Example Products	Uses
sodium laurel sulfate phenethyl propionate, eugenol mint oil	EcoEXEMPT KO (EPA Exempt) Victor® Poison Free Flying Insect Killer (EPA Exempt)	Aerosol formulations used to knock down individual insects or applied to small nests.
rosemary oil	EcoEXEMPT IC (EPA Exempt)	Spray-applied liquid used to knock down individual insects or insect nests.

c. CAUTION-label formulations with greater potential for toxicity and/or exposure.

Active ingredient	Example Products	Uses
carbaryl	Apicide® 36272-14	Aerosol formulation.
pyrethrins, piperonyl butoxide 51-03-6	CB-80 Extra® Insecticide 9444-175	Aerosol formulation.
cyfluthrin	Tempo® 1% Dust 11556-136	Dust formulation. To reduce exposure hazard, use in voids that will be sealed after colony dies.

Table 8.58 Priorities for bees, hornets, wasps and yellowjackets.

Research Efficacy of botanical pesticide products for stinging insects. Efficacy of yellowjacket trapping. Education Current distribution of Africanized honeybees. Appropriate methods for responding to encounters with Africanized honeybees.

Additional resources for stinging insect management

Arizona Cooperative Extension. 2005. Bees. Pest Press. cals.arizona.edu/urbanipm/pest_press/2005/april.pdf (PDF)

Mussen, E.C. Undated. Yellowjackets and other social wasps. www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7450.html

University of Florida. 2005. Bees and Wasps. Pest Press. schoolipm.ifas.ufl.edu/Florida/Pest%20Press/Pest_Press-0205.pdf (PDF)

STINGING ANTS

A very limited number of ant species have potential to cause problems by stinging humans and animals. Hypersensitive individuals may experience allergic reactions and require immediate treatment. Bites can also become infected. Imported fire ants can infest electrical equipment including switch boxes, air conditioning, etc. and cause damage by chewing on electrical insulation.

Fire ants can also be beneficial, feeding on pests of crops and turf and landscape plants.

Table 8.59 Stinging ant species.

Common and species name	**Geographic distribution**
black imported fire ant, *Solenopsis richteri*	Alabama, Mississippi and Tennessee.
red imported fire ant, *Solenopsis invicta*	Southeastern US and Southern California.

Monitoring and inspection for stinging ants

Regular visual inspection of school grounds (and adjacent areas) in infested areas can help to identify ant activity and determine need for remedial action. However, in regularly infested areas, routine, calendar-based broadcast bait application is often recommended as the most efficient way to reduce ant populations and stings, including reducing the overall amount of insecticide applied, vs. inspecting and treating mounds as they occur.

Cultural and physical options for stinging ant management
Maintaining thick, healthy turf can reduce the number of fire ant mounds present on school and neighboring property. Frequent mowing can also disturb ant colonies and cause them to move to adjacent undisturbed areas. Mechanical options are limited primarily to physical removal (e.g., excavation) of individual fire ant mounts which does not address encounters with foraging ants from colonies not located on school property. Hot water (109 to 212 F) has been used to eliminate colonies but has the obvious hazard of burning oneself in the process.

Biological control for imported fire ants has included releases of parasitic phorid flies which have become established and spread. Effective management of fire ants with biological control is unlikely in the near future and will likely require establishment of a suite of natural enemies for this imported pest.

Pesticide options for stinging ants
Treatment of individual mounds with insecticides can limit exposure hazard, particularly if these mounds are made inaccessible during and after treatment. Insecticide baits or dust formulations can be applied to the base of the mound and up to three to four feet away as per label directions. Drenches (liquid insecticide formulations) may also be used to treat individual mounds. It can be difficult to locate all mounds in an area such as a school play yard. Foraging ants and new mounds may appear frequently from colonies in adjacent areas. Aerosols or liquid formulations may also be applied directly to mounds.

Broadcast applications of insecticide baits are often used twice or three times per year to reduce mound formation.

Table 8.60 Commonly used pesticide products for stinging ants and uses.

a. Insecticides carrying a CAUTION label or exempt from EPA registration, in formulations that reduce potential for exposure.

Active ingredient	**Example Products**	**Uses**
indoxacarb pyriproxifen	Advion® Fire Ant Bait 352-627 Esteem® Ant Bait 59639-114	Apply 3-4' around fire ant mounds when ants are actively foraging and rain is not expected for at least 6 hours. Foraging ants from untreated mounds outside of school property may continue to be a problem. Post and prohibit activity near treated mounds while granules are present.

b. CAUTION-label formulations with greater potential for exposure.

Active ingredient	Example Products	Uses
indoxacarb pyriproxifen	Advion® Fire Ant Bait 352-627 Esteem® Ant Bait 59639-114	Broadcast applied bait. To increase efficacy and reduce potential for exposure, apply only when ants are actively foraging and when rain is not expected for at least 6 hours. Post and prohibit reentry while granules are present.

c. CAUTION-label formulations with greater potential for toxicity and/or exposure.

Active ingredient	Example Products	Uses
fenoxycarb fipronil hydramethylnon	Award® Fire Ant Bait 100-722 Ceasefire® Fire Ant Bait 432-1219 Amdro® Fire Ant Bait 73342-1 Extinguish® Plus Maxforce Fire Ant Killer Granular Bait 432-1265	Broadcast applied bait. To increase efficacy and reduce potential for exposure, apply only when ants are actively foraging. Post and prohibit reentry while granules are present.
fipronil	Top Choice™ 432-1420	Broadcast applied insecticide.
bifenthrin cyfluthrin	Bifenthrin Pro 51036-392 CyKick CS 499-304	Spray-applied liquid.

Additional resources for stinging ant management

Oi, D.H., and P.G. Koehler. 2003. *Imported Fire Ants on Lawns and Turf*. University of Florida. edis.ifas.ufl.edu/lh059

Texas A&M University. Texas Fire Ant Research and Management Project. fireant.tamu.edu/

TERMITES

Termite prevention and control is inextricably linked to building construction type and quality. In schools, structurally damaging termites generally belong to one of two groups: drywood termites (family Kalotermitidae) and subterranean termites (family Rhinotermitidae). Most school buildings, with the exception of wooden portables, are constructed with concrete and steel. Therefore, termites do not generally pose a great risk to the structure. However, the contents, including cabinetry, can be subject to damage by termites belonging to both groups. It is important to identify the termite you are dealing with because control measures can differ significantly for each species.

Table 8.61 Termite species.

Common and species name	**Geographic distribution**
drywood termite	Southern US from Florida to California.
Formosan subterranean termite, *Coptotermes formosanus*	Southeastern US and Southwestern California.
southeastern drywood termite, *Incisitermes snyderi*	Southeastern US.
western drywood termite, *Incisitermes minor*	Central Arizona west to California and north to Washington State.
West Indian drywood termite, *Cryptotermes brevis*	Hawaii, Florida and west to Louisiana.
subterranean termites	Throughout the US except Alaska, with highest populations in the Gulf and Southeastern states.

All termites are true social insects, living in colonies. Drywood termite colonies contain reproductives, soldiers (which defend the colony), nymphs and immature forms called pseudergates or “false workers” (which perform most of the work in the colony). Drywood termites most commonly infest dry, sound (non-decayed) wood and are a problem more commonly associated with older schools.

Subterranean termites are the most significant pest termite group in the US. There are over 45 species of termite in the US. Subterranean termites belonging to the genera *Reticulitermes*, *Heterotermes* and *Coptotermes* are among the most damaging. Colonies can range from a few thousand up to 10 million individuals. They predominantly live in the soil, although it has been estimated that 20% of some species can nest aerially, without ground contact, under the right conditions. Whereas a drywood infestation starts with only two individuals in a wooden member, a house could literally be built over a huge colony of subterranean termites. Once the land is cleared for building, the only food source left in place is the new structure, which is why thorough termite pretreatments are important. There are several effective chemical and non-chemical control options, of which the most important is proper building construction.

Subterranean termites cause over $2 billion in damage, treatment, and repair of damage to structures annually in the US. Subterranean termites not only damage structures, but also their contents, including paper, family photographs, documents, cardboard and the like. They gain access most commonly through the outside foundation wall, especially those that have been covered with exterior insulation and finishing system installed below grade, or through plumbing and utility conduits. Bathrooms and kitchens are common entry points. Damage to structures and personal effects caused by this type of termite is the most common cause of litigation between service providers and clients.

Table 8.62 Drywood and subterranean termite comparison.

Termite	Usual Location	Damage	Frass	Control Methods
drywood	dry, sound wood	along and across wood grain	six-sided pellets, dry	wood replacement, spot treatment, fumigation
subterranean (control options for arboreal species are included here)	soil	along wood grain	sticky, incorporated into mud tubes and galleries	structural modification, liquid or granular chemicals, baits, physical barriers

Monitoring and inspection for drywood termites

A telltale sign of drywood infestation is the accumulation of six-sided fecal pellets. Fecal pellets are also known as “frass.” Termites inside infested wood push frass out through pencil-tip sized “kick-out holes” (1-2 mm diameter) in infested material. Frass can resemble “sawdust” or “coffee grounds”, but are distinctly six-sided. The pellets have a gritty texture when rolled between your fingers and can be from light brown to almost black in color. The color is not related to the age or the color of the wood. Pellets usually collect into piles on the floor and other surfaces. Drywood termites can infest wood flooring, framing members, window sills, doors, fascia boards and furniture. They are also known to infest attics where the temperature of the wooden members can exceed 110 F. A sign of advanced infestation is surface blistering or warping. Drywood termites sometimes tunnel just under the surface of the wood giving it a blistered, uneven appearance. Infestations may be detected by tapping the wood every few inches with the handle of a screwdriver or by probing with a sharp tool. Damaged wood sounds hollow - a papery, rustling sound indicates tunnels just beneath the surface.

Three of the most common drywood termites in the US include:

- The West Indian drywood termite soldier is easy to identify by its distinctive “phragmotic” head, which resembles a burnt match and is used to block the tunnels in the termite gallery system to protect the colony from intruders, especially ants. This termite typically infests picture frames, furniture, boxes and structural woodwork. Interestingly, this species is never found in natural environments but only in wood in human-made structures. Depending on location, this termite usually swarms from April to early July and November to early December.

- Southeastern drywood termite colonies are generally larger than those of the West Indian drywood termite and occupy larger pieces of wood. These termites are found in both natural and human-made environments and are the most common drywood in Florida. Development of the colony is slow, but structural damage can be extensive if multiple colonies are present in the same structure. This termite usually swarms from May through November in most locations.
- The Western drywood termite (*Incisitermes minor,* is a non-native termite and is the number one drywood termite pest in the western US. Depending on location, it usually swarms from the end of August through November.

Cultural and physical options for drywood termite management
Used lumber, furniture and other wooden articles should be carefully inspected for termite infestations. Drywood termite reproductives may enter a building through the attic or foundation vents, under or directly through shingles or under eaves. All vents, doors and windows, especially those in the attic, should be screened with 20-mesh screen. A good coat of paint on exposed wood will provide some protection against termite entry. Before painting, all cracks and crevices should be filled with putty or plastic wood. Pressure treated wood is resistant to termite attack. Certain woods are also naturally resistant to termites including heart wood of redwood, bald-cypress, mahogany and Spanish cedar. These woods can be more expensive and will become susceptible after several years of aging and weathering.

Construction should be designed to eliminate moisture and water leaks. Remove and replace infested or damaged wood. Microwaves, electroguns and liquid nitrogen require thorough access to wood. Heat treatment can be used for whole structure or compartment treatments.

Carefully inspect wooden objects including furnishings and equipment before moving from one school building to another to avoid introducing drywood termites.

If damage is localized, a drywood termite colony may be controlled by removing and replacing the damaged wood. It is very important to carefully inspect all woodwork in the building for pellets and/or damaged wood, especially in attics, baseboards, windowsills, floor joists and furniture.

Pesticide options for drywood termite management
Take time to research pest control companies and treatment options for your construction type. Soil treatments, either with liquid insecticides or termite baits are ineffective because drywood and dampwood termite colonies are inside the wood, not in the ground.

Localized treatments of infested wood for drywood termites include injecting insecticide directly into a termite gallery through kick-out holes or holes made with a drill. Applications can also be made to cracks and crevices such as the spaces between wooden pieces or between different building materials, such as wood and concrete, directly treating infested wood. Products registered for wood treatment are usually liquids applied by spraying it onto the wood.

If the infestation is too extensive and advanced for local treatment, it may be necessary to tent and fumigate the entire building. Although this method can be very expensive and disruptive, it may be the only option that will kill all termites in the structure.

Sulfuryl fluoride gas is used to create a toxic atmosphere within a confined space; under a tarp, within a sealed structure or inside a fumigation vault. After fumigation, the structure is cleared of sulfuryl fluoride and thus termites are not prevented from re-entering the structure. Because sulfuryl fluoride is odorless and colorless, chloropicrin ("tear gas") is used as a warning agent.

Inspection and monitoring for subterranean termites
Mud tubes, wood damage and termite wings (attached or detached) are common telltale signs of an infestation. Subterranean termites build earthen, shelter tubes to protect them from low humidity and predation. These tubes are usually ¼" to 1" wide. Structures should be inspected at least once a year for evidence of tubes, particularly around the outside foundation walls and plumbing penetrations and pipe conduits. Cracks in concrete foundations and open voids in concrete block foundations are also hidden avenues of entry. Wood damaged by subterranean termites is often not noticed because the exterior surface usually must be removed to see the damage. However, galleries can be detected by tapping the wood every few inches with the handle of a screwdriver. Damaged wood sounds hollow, and the screwdriver may even break through into the galleries.

General inspections for subterranean termites can be difficult because of the cryptic lifestyle of these insects. Laws and regulations will vary from state to state on inspection requirements.

Cultural and physical options for termite management
The best option for avoiding subterranean termite damage is prevention initiated during planning and construction. Prevention should include:

- Removal of all stumps, roots, wood, and similar materials from the building site before construction is begun.

- Removal of all form boards and grade stakes used in construction.

- There should be no contact between the building woodwork and the soil or fill. Exterior woodwork should be located a minimum of 6 inches above ground and beams in crawl spaces at least 18 inches above ground to provide ample space to make future inspections.

- Ventilation openings in foundations should be designed to prevent dead air pockets and of sufficient size to assure frequent changes of air -- at least 2 sq. ft.

to 25 running feet of outside foundation wall. This helps keep the ground dry and unfavorable for termites.

- Landscape plants and irrigation should not be placed within two feet of the foundation wall.

- Thorough annual inspections should be conducted to discover evidence of wood damage or termite activity such as shelter tubes on foundation surfaces, discarded wings or adult termites.

- Any wood that contacts the soil, such as fence posts, poles and general foundation structures, should be commercially pressure treated, and should not be attached to house.

Once termites find a structure by tunneling, tubing or surface foraging, they need moisture to establish and continue the infestation. Moisture related factors account for as much as 95% of those contributing to termite infestation. Examples of conducive conditions relating to moisture include:

- Leaky roofs, water heaters and pipes.
- Improper grading resulting in soil contact with structure above foundation.
- Improperly flashed windows, roofs, chimneys.
- Exterior Insulation and Finish Systems (EIFS) installed below grade wicks moisture into walls and obscures inspection space.
- Improperly installed wall systems, such as using plastic vapor barriers.
- Installing rigid foam board insulation below grade (wicks moisture).
- Absent or inadequate number of “weep holes” or holes obstructed by debris.
- Mulch pushed up against the house, obscuring inspection space.
- Irrigation directed toward the house.
- Landscape planted within 2 feet of the house.
- No gutters.
- Gutter downspouts directed toward wall of house or not far enough away.
- Air-conditioning condensate lines too close to house.
- Improperly installed windows.
- Inadequate vapor barrier coverage under slab.
- Inadequate ventilation of crawl spaces and attics.

Physical barriers include stainless steel mesh installed at entry points including wall cavities, piers and plumbing penetrations. Particle-size barriers have been available for many years, but have not gained wide acceptance by the building construction industry.

Table 8.63 Commonly used products for physical or cultural management of termites and uses.

Type	Example Products	Uses
barriers heat cold, liquid nitrogen	Termi-Mesh™ Termite Barrier	Install during construction.

Pesticide options for termite management
Preconstruction soil termiticide treatments are categorized as ”repellent” or “non-repellent.” Repellent termiticides include the pyrethroid class of insecticides. While these termiticides have good performance histories in USDA Forest Service trials, construction and landscaping practices that cause breaks and gaps in the chemical barrier compromise efficacy. Termites detect repellent chemistries at concentrations as low as 1 ppm. Termites will avoid the area and the structure will be protected only if the barrier remains continuous. Breaks in the barrier unavoidably occur during the construction process, creating untreated gaps through which termites can enter structures.

Non-repellent termiticides work to protect structures because termites unsuspectingly forage into treated areas, acquiring a lethal dose of the termiticide. The toxicant may act slowly enough that exposed individuals transfer the toxicant to other individuals in the colony through grooming and trophallaxis. The result of this transfer is death for many termites that are secondarily affected. The non-repellents have generally held up well in the USDA Forest Service trials.

Finally, wood treatments, specifically Boracare (Nisus) and baits (Sentricon, DowAgro Sciences) have been accepted by several states as stand-alone treatments for new construction.

Table 8.64 Commonly used pesticide products for termites and uses.

a. Insecticides carrying a CAUTION label or exempt from EPA registration, in formulations that reduce potential for exposure.

Active ingredient	Example Products	Uses
diflubenzuron	Prescription Treatment® Advance® Compressed Termite Bait 499-488	Bait block used in bait station.
hexaflumuron	Sentricon® AG III 62710-454	Bait block used in station for subterranean termites.
lamda-cyhalothrin	Impasse™ Termite System 100-1125 Impasse™ Termite Blocker	Polymer laminate barriers impregnated with insecticide and installed prior to slab

	100-1166	construction.

b. CAUTION-label formulations with greater potential for exposure.

Active ingredient	Example Products	Uses
imidacloprid	Premise® Foam 432-1391	Foam applied as a spot treatment for drywood termites.
imidacloprid	Premise® 75 432-1331	Dampwood and drywood termites.

c. Formulations with greater potential for toxicity and/or exposure.

Active ingredient	Example Products	Uses
boric acid	Bora-Care™ 64405-1 Tim-Bor 64405-8	Drywood termites.
chlorfenapyr	Phantom® 241-392	Drywood, southeastern termites.
cypermethrin	Demon® TC 100-1006	Dampwood, drywood termites.
deltamethrin	DeltaDust® 432-772	Dampwood, drywood termites.
fipronil	Termidor® SC 7969-210	Drywood termites.
sulfluryl fluoride	Vikane® 62719-4 Zythor® 81824-1	Fumigant for drywood termites.
thiamethoxam	Optiguard ZT 100-1170	Drywood termites.

Table 8.65 Priorities for termite management.

Research Efficacy of boric acid pretreatments.

Additional resources for termite management

Koehler, P.G., and C.L. Tucker. 2003. Subterranean Termites. University of Florida. edis.ifas.ufl.edu/ig097

Scheffrahn, R.H., and N. Su. 1997. Drywood Termite Control: Weighing All the Options. University of Florida. flrec.ifas.ufl.edu/pdfs/DrywoodTermiteControl.pdf (PDF)

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University of Florida. 2006. Termites in Mulch. Pest Press. schoolipm.ifas.ufl.edu/Florida/Pest%20Press/April%2006%20Pest%20Press%20Termites.pdf (PDF)

University of Florida. Termites and Other Wood-destroying Insects. edis.ifas.ufl.edu/TOPIC_IN_Household_Termites

TICKS

Ticks can be a concern for schools, especially species that can transmit serious diseases to humans such as Rocky Mountain spotted fever, Lyme disease and Powassan encephalitis. Approximately 12 species are of major public health or veterinary concern. Most of these species are in the family Ixodidae (hard ticks.)

Ticks are blood-feeding arthropods related to spiders and mites. The primary habitat for ticks is wooded areas and the open or grassy areas at the edges of wooded areas. On school properties, ticks are most often found on playgrounds, athletic fields, cross-country trails, paths and school yards located in and adjacent to wooded areas especially where deer and other wildlife hosts are abundant.

Table 8.66. Common disease-vector ticks occurring in North America from Tick Management Handbook. 2004. Kirby Stafford, Connecticut Agricultural Experiment Station.
www.ct.gov/caes/lib/caes/documents/publications/bulletins/b1010.pdf (PDF)

Common and species name	**Geographic distribution**	**Diseases vectored**
Blacklegged tick (*Ixodes scapularis*)	Northeastern and Midwestern US.	Lyme Disease, Babesiosis, Anaplasmosis
Western blacklegged tick (*Ixodes pacificus*)	Pacific coast & parts of Southwest US.	Lyme Disease, Babesiosis, Anaplasmosis
A woodchuck tick (*Ixodes cookei*)	Eastern US and northeast Canada.	Powassan encephalitis
Lone star tick (*Amblyomma americanum*)	Southeastern US, TX to NY.	Anaplasmosis, tularemia, Southern rash illness
American dog tick (*Dermacentor variabilis*)	Eastern US and west coast US.	Rocky Mountain spotted fever, tick paralysis, tularemia
Rocky Mountain wood tick (*Dermacentor andersoni*)	Rocky Mtn states south to NM & AZ.	Rocky Mountain spotted fever, Colorado tick fever, tick paralysis
Relapsing fever ticks (*Ornithodoros* species)	Western US.	Tick-borne relapsing fever

Monitoring and inspection for ticks
Ticks are typically monitored by dragging a piece of light colored soft cloth (usually corduroy or flannel) stapled to a dowel to which a cord is attached, across an area of grass or low brush. At fixed intervals (for example, every 10 meters at high tick density or every 100 yards at low density) the cloth is examined and the numbers of ticks attached to it are counted. This method catches about one out of every ten ticks.

Cultural and physical options for tick management
Management practices include personal protective measures, habitat modification and limited use of pesticides as a targeted barrier treatment.

Table 8.67 Cultural and physical strategies for ticks.

Personal protection

- Wear light-colored clothing with long-pants tucked into socks when going into tick-infested areas.
- Educate students, families and school staff about ticks, tick-vectored diseases, and the proper use of repellents.
- Keep to the center of trails to minimize contact with brush and tall grasses.
- Wash and dry clothing at the highest temperature setting upon returning from a tick-infested area.
- At the end of the day after being outdoors, carefully inspect the entire body. Carefully remove any attached ticks using fine-tipped tweezers to gently grasp the tick as close to the skin as possible. Pull the tick straight upward with steady even pressure. Save the tick for future identification by placing it in a waterproof, crushproof container with alcohol.

Habitat modification

- Manage landscape to reduce humidity where ticks are likely to be found.
- Reduce cover for mice. Eliminate wooded, brush-covered habitat, prune lower branches of bushes, clean-up storage areas, woodpiles and junk piles.
- Reduce deer habitat or erect deer-exclusion fencing.
- Rake leaf litter and use wood chips or plant shade-tolerant grass under shade trees to reduce tick abundance.
- Trim trees and brush to open up wooded areas in and around areas of human activity, allowing sunlight to penetrate to reduce moisture and thus reduce tick habitat.
- Keep grass mowed.
- Remove leaf litter, brush and weeds at the edge of the lawn.
- Restrict the use of groundcover, such as pachysandra in areas frequented by people.
- Discourage rodent activity. Cleanup and seal stonewalls and small openings on school properties.
- Move bird-feeders away from school buildings.
- Avoid landscape plantings that attract deer or use deer-exclusion fencing to keep deer off school properties.

- Keep playground equipment away from woodland edges and place them on wood-chip or mulch-type foundation.
- Trim trees and shrubs on the school properties and at the woodland edges to permit more sunlight.
- Create three foot or wider wood chip, mulch, or gravel border between turf and woods.
- Widen woodland trails/walkways to permit trail-users to avoid contact with woody vegetation and tall grasses.

Table 8.68 Commonly used products for physical, cultural or mechanical management of ticks and uses.

Type	Example Products	Uses
tick drags		White corduroy or cotton flannel (3'x4') stapled to a dowel with a cord attached and dragged across an area of grass or low brush generally for monitoring purposes.

Pesticide options for tick management

If tick-vectored disease risk is high, a targeted barrier treatment can reduce tick populations along wooded property edges where human activity is also high. These locations can include along edges of sports fields, along cross-country running trails, at margins of playgrounds. These applications should be timed to coincide with peak nymphal populations.

Pyrethrins plus synergist provide limited tick control. Pyrethrins plus synergist with insecticidal soap or silicon dioxide was more effective against ticks in one trial.

Table 8.69 Pesticide products available for the management of ticks.

a. Insecticides carrying a CAUTION label or exempt from EPA registration, in formulations that reduce potential for exposure.

Active ingredient	Example products	Uses
Metarhyzium anisopliae	Tick-Ex® 72098-12® Taenure® 72098-8	Fungal tick pathogen formulated as spray or granular for landscape application.
garlic oil	Mosquito Barrier® (EPA Exempt)	Tick and mosquito repellent used as outdoor landscape spray.

b. CAUTION-label insecticides in devices that minimize potential human exposure.

Active ingredient	Example products	Uses
permethrin	Damminix Tubes® 56783-1 4-Poster Deer Treatment Station	Contained in an artificial rodent harborage device. Deer feeding station where deer contact treated rollers.

c. CAUTION-label formulations with greater potential for toxicity and/or exposure.

Active ingredient	Example products	Uses
pyrethrins plus piperonyl butoxide as a synergist	Pyrenone® 432-1050	Applied as a targeted barrier treatment.
bifenthrin	Talstar® 279-3225	
cyfluthrin	Tempo® 11556-124 Powerforce® 72155-39	
deltamethrin	Suspend®432-763 DeltaGard® 432-835	
lambda-cyhalothrin	Scimitar® 100-1088 Demand® 100-1066	
permethrin	Astro® 279-3141	
carbaryl	Sevin® 432-1227	

Emerging issues, new strategies and priorities

Tick vectored diseases are on the rise in the US, therefore tick management issues are likely to be increasingly important for schools. For instance, Lyme disease is now found in 46 states and the number of new cases reported increased by 9.6% over the three-year period 2003-2005. Rocky Mountain spotted fever has been reported in 40 states. The number of cases reported in the US more than tripled between 2000 and 2003.

Current IPM strategies for tick management place an emphasis on pesticides used as repellents for treatment of skin and clothing, and as landscape barrier treatments. Most repellents are not recommended for use on young children. Research and surveillance is needed to improve understanding of tick ecology and epidemiology of tick-borne diseases.

Table 8.70 Priorities for ticks.

Research Tick ecology.

Epidemiology of tick-borne diseases.
Effective biocontrol options.
Low hazard pesticides including repellants.
Education Accurate identification of ticks and tick-borne diseases.
Proper use of protective clothing and repellents.

Additional resources for tick management

Pennsylvania IPM Program. 2004. *IPM for Pennsylvania Schools: a How-to Manual*. www.paipm.cas.psu.edu/206.htm

Stafford, K. 2004. *Tick Management Handbook*. Connecticut Agricultural Experiment Station. www.ct.gov/caes/lib/caes/documents/publications/bulletins/b1010.pdf (PDF)

US Centers for Disease Control. Learn about Lyme Disease. www.cdc.gov/ncidod/dvbid/lyme/index.htm

US Centers for Disease Control. MMWR Report, June 15, 2007 / 56(23);573-576. www.cdc.gov/mmwr/preview/mmwrhtml/mm5623a1.htm?s_cid=mm5623a1_e#ta

US Centers for Disease Control. Prevention and Control of Tick-borne Diseases. www.cdc.gov/ncidod/dvrd/ehrlichia/Prevention/Prevention.htm

US Centers for Disease Control. 2005. Rocky Mountain Spotted Fever: Epidemiology. www.cdc.gov/ncidod/dvrd/rmsf/Epidemiology.htm

US Centers for Disease Control. Websites for tick-borne diseases. www.cdc.gov/ncidod/diseases/list_tickborne.htm

TURF & LANDSCAPE MANAGEMENT

Healthy, attractive landscapes including trees, shrubs, annuals and turfgrass can be a valuable addition to school grounds. Healthy turf is essential for a wide variety of sports fields. Although a broad array of potential insect, disease, weed and vertebrate pests can affect landscape plants including turfgrass, an effective IPM program based on sound cultural management can prevent and avoid these threats.

TURFGRASS MANAGEMENT

Turfgrass IPM goals include improving the health of the turfgrass to achieve long-term prevention or suppression of pests with minimal impact on human health and the environment. Managing turfgrass pests must not depend on chemical inputs (fertilizer, herbicides, fungicides and insecticides), but employ a variety of non-chemical/cultural techniques. When those prove inadequate, least-toxic chemical products may be considered. Success requires active working relationships between the IPM coordinator, school administrators and those responsible for turfgrass care.

The IPM approach needs to be developed to address site-specific conditions and needs for the intended function of a given turfgrass area, e.g., high profile lawns vs. less visible lawns vs. practice fields vs. competition fields. The questions should be asked: Are the weed, disease, or insect problems affecting the function of the turf area? If so, why and what can be done to address the cause of the problem rather than treating the symptom?

Organic land care approaches (NOFA 2007, 2008) based on cultural methods and limited use of natural products have been successfully implemented on lawns (Grassroots Environmental Education 2007, Rossi 2005), including school lawns and athletic fields in a limited number of locations. Research and education priorities recommended to expand adoption of these approaches are included in the prioirities listed below.

Turfgrass IPM for schools includes the following elements:

1. **Assess and improve turfgrass and soil health.** Test soil for texture, pH, macro and micronutrients and organic matter. Assess turf root length, rooting depth. Turf grown in soil with the proper pH, fertility, organic matter and active biology will have strong rooting systems and will resist drought and pests. Conditions conducive to pest activity include:
    - soil compaction suppressing root growth and creating anaerobic conditions that encourage pathogen development and spread,
    - excessive use of pesticides suppressing beneficial soil organisms,
    - inadequate soil organic matter resulting in poor nutrient cycling,
    - mower height set too low resulting in short turf blade length and reduced photosynthesis by turf plants, and
    - improper fertilization and pH resulting in nutrient deficiencies.

2. **Active participation by the entire team**. All of those in school district with a role to play must agree to actively participate in the turfgrass IPM process including coaches, turf and landscape maintenance staff, principals and superintendents. Key items include dedication to and ongoing support for the IPM approach, participating in training, notifying the IPM coordinator of any pest problems and implementing appropriate cultural practices including irrigation scheduling, proper mowing height, etc.

3. **Training.** Turf management staff needs to develop a basic understanding of soil and turfgrass biology, proper cultural practices and signs and symptoms of threats to healthy turf including basic biology of the most likely potential pests.

4. **Mapping**. Grounds for each school property should have maps drawn to scale and overlaid with an identifying grid. Maps should depict:
   - Overall grounds; buildings, playgrounds, other turfgrass areas, sidewalk terraces and parking lot islands.
   - Athletic fields by type: football, soccer, baseball, track, competition vs. practice, etc.
   - High visibility areas such as front lawns, entry areas.
   - Other areas: Open courtyards, special gardens, etc.

5. **Identify management zones**. The IPM coordinator, groundskeeper and administrators should use the maps and classify each turfgrass area into one of three management zones:
   - <u>Highest care</u> – varsity and practice athletic fields; high-visibility grounds.
   - <u>Moderate care</u> – multipurpose fields, playground fields, common grounds areas.
   - <u>Lowest care</u> – low use areas, utility areas, slopes, ditches; natural areas; fence lines; property lines.

   Investment and thresholds for action should be appropriate to the site, e.g., competition athletic fields and lawns near main entrances deserve the greatest attention and demand the highest aesthetics. However, pesticides should not be used for aesthetic reasons alone.

6. **Set action thresholds**. Turfgrass maintenance and school personnel need to set action levels for the most likely potential pests <u>before</u> sampling begins. This will allow rational, objective decision-making when pests are found on school properties. These thresholds should be set from research-based studies (as available) by university and industry turfgrass specialists. Action thresholds should incorporate factors such as severity of pest problem, impacts on human health and safety, economic considerations, and aesthetics. Thresholds should reflect a willingness to tolerate pest damage that does not adversely affect the intended use.

7. **Monitor and inspect**. Turfgrass areas should be visually inspected for the presence of pests at appropriate times during the growing season. The number of inspections in the highest-care areas will be more than in lowest-care areas. Methods of sampling for specific turfgrass pests are determined by the life cycle of each pest.
   - An initial site inspection should be conducted for each turfgrass area prior to the growing season. Key turfgrass species and key locations should be identified on maps. The use of each area and current traffic patterns should also be noted. Key pests should be identified, as well as the primary nontarget organisms present, including natural enemies.

- Initial soil samples should be taken for moderate- and highest-care zones before the growing season begins. Samples should be analyzed and interpreted by a laboratory to provide recommendations for fertilizer and soil amendments. Soil compaction and site moisture drainage should also be assessed.
- A minimum of two additional monitoring events should be scheduled over the first year. Monitoring should include a record of known plant stressors, environmental concerns, customer involvement, turfgrass pest densities, and natural enemies present.
- Turfgrass maintenance personnel will collect appropriate samples of unknown pests and forward these to a diagnostic laboratory for identification.

8. **Management response**. Management strategies will be recommended based on monitoring results and the nature of the problem. Methods include:
    - <u>Cultural methods</u> – selection of turfgrass cultivars; overseeding; topdressing with compost; modifying irrigation, mowing, and/or fertilizing practices.
    - <u>Physical and mechanical methods</u> – removal of thatch if necessary; aeration; individual removal of pests (as practical).
    - <u>Biological controls</u> – use of bacteria, fungi, insects, nematodes, or viruses to control turfgrass pests. Use of endophyte-containing perennial ryegrass and tall fescue cultivars, as possible.
    - <u>Pesticide use</u> – if insect, disease or weed problems meet or exceed the predetermined action threshold values and nonchemical methods were not effective, least-toxic pesticides may be considered for use in a judicious manner following label instructions. Preventive pesticide applications should not be used because they may adversely affect soil biology. In addition, conditions conducive to pests vary from year to year and pest problems are not always predictable in advance. Spot treatments to affected areas are preferred to broadcast applications whenever possible. Any pesticide treatments should be made using appropriate drift reduction techniques, made when students and other users are not present and be posted to meet or exceed label re-entry intervals.

9. **Evaluate efforts**. After any type of management strategy, turfgrass areas should be inspected for results at intervals appropriate to the target pest. This information should be combined with other monitoring records and observations by school personnel to develop an IPM site history. After several seasons of a turfgrass IPM program and tracking financial records, the long-term success of the program can be assessed.

10. **Record keeping**. Compile a site-specific history of monitoring records, pest infestations, management strategies, evaluation records, and feedback from school personnel. These data may be helpful in predicting future pest occurrence, fine-

tuning action thresholds, and permit early intervention once pests reach action thresholds. It is important to keep a separate record of all chemical products (pesticides and fertilizers) used on school properties. These records should be kept for at least three years and be made accessible to all interested persons.

Table 8.71 Potential pests of turfgrass on school grounds.

Insects

- ants
- billbugs – larval and adult stages of weevil species, including bluegrass billbug, hunting billbug, and Denver billbug
- caterpillars – sod webworms, armyworms, cutworms
- chinch bugs
- click beetle larvae ('wireworms')
- crane fly larvae ('leatherjackets')
- frit fly larvae
- grasshoppers
- greenbug aphid
- ground pearl scale
- leafhoppers
- mole crickets
- Rhodesgrass mealybug
- spider mites – Banks grass mite, bermudagrass mite, clover mite, twospotted spider mite
- spittlebugs
- white grubs – larval stage of various scarab species, including black turfgrass Ataenius, May/June beetles, Japanese beetle, masked chafers

Plant diseases

- anthracnose
- Bermudagrass decline
- brown patch
- dollar spot
- leaf spot and melting out
- necrotic ring spot
- nematodes
- pythium blight
- red thread
- rust
- slime molds
- snow molds – pink, gray
- southern blight
- spring dead spot
- stripe smut
- summer patch
- take-all patch
- yellow patch

Weeds

- grasses – annual bluegrass, broomgrass, carpetgrass, crabgrasses, creeping bentgrass, crowfoot grass, dallisgrass, fingergrass, foxtails, goosegrass, gophertail lovegrass, Johnsongrass, nimblewill, panicum species, orchardgrass, paspalums, quackgrass, rock smutgrass, sandbur, sandspurs, signalgrass, smooth brome, stinkgrass, sweet vernalgrass, tall fescue, torpedograss, wild garlic
- sedges – annual sedge, cylindric sedge, dollarweed, false nutsedge, flat sedge, globe sedge, purple nutsedge, purple sedge, Surinam sedge, Texas sedge, water sedge, yellow nutsedge
- broadleaf weeds – alligatorweed, Asiatic hawksbeard, Asiatic pennywort, black medic, carpetweed, chickweeds, common lespedeza, creeping beggarweed, curled dock, dandelion, field bindweed, field pennycress, fireweed, ground ivy, henbit, mallows, prostrate knotweed, plantain species, prostrate spurge, purslane, red sorrel, shepherdspurse, smartweed, speedwell, thistles, white clover, violets, yellow woodsorrel
- algae and mosses

Vertebrates (turf damage results from foraging for earthworms, grubs and other insects)

- skunks
- moles
- voles
- ground squirrels
- birds

Cultural and physical options for turfgrass management

Cultural management is the key to maintaining healthy, pest-resistant turfgrass. The following are general guidelines for temperate regions that may need to be adapted for site-specific soil types and climatic conditions.

- Avoid planting turf in inappropriate locations. Select the proper variety of turf for the site including sunny vs. shaded locations. Tree and shrub roots compete with turfgrass for water in addition to blocking sunlight needed for photosynthesis and energy production. Heavily shaded areas are not generally conducive to healthy turf.
- Maintain soil pH between 6.5 and 7.0. Regular lime applications without regard to current soil pH can push pH out of this ideal range.
- Maintain soil calcium to magnesium ratio of approximately 10:1. Adjust the composition of any lime applied to improve this ratio. Dolomitic lime increases magnesium; calcitic lime increases calcium levels. Lime should be applied in the fall, but can be applied in early spring. Wait up to 100 days for lime to break down before retesting soil pH.
- Build and maintain soil organic matter to 5-8% by leaving clippings after mowing, topdressing with high organic matter topsoil or compost. Increasing soil organic matter supports natural nutrient cycling and reduces need for supplemental fertilizer applications.

- Maintain adequate nitrogen, phosphorus and potassium levels in the soil. Established turf generally does not need supplemental phosphorus. Fertilize in early spring and late summer/early fall. A third mid-summer application should only be considered if fertility is not adequate. Do not apply fertilizer when turf is not actively growing to reduce nutrient runoff. Multiple fertilizer applications at lower rates are preferable to single, high-rate applications which are also prone to runoff.
- Keep mower blades sharp to avoid tearing off leaf blades.
- Grass blades carry on photosynthetic activity for the turfgrass plant, so never remove more than 1/3 of the turf blade in a single cutting to avoid stressing the plant. Use a mulching mower to reduce the size of clippings.
- Leave clippings behind to decompose and contribute to soil organic matter and natural nutrient cycling. Clippings may be collected during the first mowing of the season to decrease overwintered plant pathogens.
- Correct uneven areas of athletic fields and high-visibility turfgrass areas. This will decrease the likelihood of mower scalp for a site.
- Mow grass high (3-4") to maximize photosynthesis and shade out weeds. The first mowing of the season can be at 2", increasing height to 3-4" gradually to suppress weed growth in spring and increase summer drought resistance. The inal cut in the fall should be at a height of 2" just prior to overseeding activities.
- If irrigated, water thoroughly and deeply with each irrigation to encourage deep rooting. Do not water late in day or at night to avoid leaving turf blades wet for a prolonged period, encouraging diseases.
- Aerate turf when it is actively growing and can fill in holes created during aeration.
- Excessive thatch is caused by the accumulation of dead turfgrass blades and roots. Thatch buildup is encouraged by overuse of broad-spectrum pesticides, which reduce natural degradation processes (microorganisms, earthworms). Topdressing the area with compost can restore biological activity to decompose thatch. Additionally, proper watering, fertilization, pH maintenance, and aeration should correct thatch buildup. Initial dethatching of a turfgrass area may be required, but this procedure should not be required during an IPM program. Overseed with a high-quality seed to provide new plants into aging turf. Rake, aerate and dethatch first if necessary. Use a spreader or hand-broadcast applicator to distribute seed. Water in and keep moist but do not overwater which will encourage disease. Compost mixed with the seed or applied after seeding emergence as a topdressing will improve performance. Good soil-to-seed contact can be encouraged by lightly tamping after application. Short, cool days approaching the end of the growing season are better for turf seed germination and growth. If seeding is needed at other times, a fast-germinating and growing variety such as

perennial rye can be used. Annual rye can also be used as a quick fill in followed by reseeding in the fall using other varieties.

- Finally, manage turf use to avoid excessive stress. Avoid use when overly wet to prevent compaction.

Weeds in turfgrass are encouraged by thin or weak turf. Mowing high and frequently, especially in the spring, overseeding and proper fertilization, irrigation, aeration and pH should be the first line of defense against weeds.

Table 8.72 Products for cultural or mechanical management of turfgrass and uses.

Type	Example Products	Uses
aerators	Turfvent 48 » Heavy-Duty Pull-Behind Aerator	Pull soil cores at regular intervals throughout the turf area to increase oxygen flow, water infiltration.
compost		Apply as a topdress to restore or improve healthy soil biology including beneficial microorganisms. Due to shipping costs, source locally from an experienced supplier with a guaranteed analysis.
compost tea		Solution spray-applied to turf to inoculate with microorganisms and other beneficials. Due to short shelf life, source from a local supplier or brew onsite.
endophytic turfgrass varieties	Citation II	Seed planted from varieties with resistance to foliage and stem-feeding insects.
mow strips		Concrete barrier placed underneath fencelines or other areas to prevent vegetative growth.
mulching mower blade	Cub Cadet Commercial HF174 8 Walk-Behind Mower Exmark Micro-Mulch System	Specially designed mowers and mower blades cut and recut turf blades to reduce bulk and increase surface area to speed decomposition.
weed burners	Weed Dragon™ Torch Kit	Propane-fed flame kills weeds by heating weeds to boiling

		point and above.
weed removal	Weed Hound®	Mechanical weed puller used to remove individual weeds such as dandelions by the roots.

Pesticide options for turf management
Routine or calendar-scheduled, broadcast pesticide applications should not be used to manage turfgrass. Such applications can suppress beneficial organisms in the soil and on turf plants, contribute to runoff into surface water and leaching into groundwater, and are least-likely to be effective against the target pest. A comprehensive cultural management program should be developed and implemented to prevent and avoid insect, disease and weed problems. Carefully timed and selected least-hazardous pesticide applications should be limited to affected areas and made only after cultural methods fail or are determined to be impractical. Pesticide options for turfgrass and other landscape plants (Table 8.75) are presented below.

LANDSCAPE PLANT MANAGEMENT

Ornamental plants including trees, shrubs, herbaceous annuals and perennials add to the beauty and function of the school landscape, as well as serve as living educational tools for curricula and community garden clubs.

Community groups, parent organizations, state agencies and memorial donations often provide a variety of trees, shrubs and herbaceous ornamental plants to schools. Unfortunately, many schools do not have a specific line item on their budget for maintenance of these landscape plants. It is in the district's best interest to sustain these plants by implementing preventive cultural measures and following a predetermined plan of action when problems arise.

There are hundreds of species of perennial and annual ornamental plants that could occur on a given school property, each with its specific combination of requirements including soil pH, soil type, water, sunlight, exposure, etc.

Landscape ornamental plants can be adversely affected by abiotic disorders, such as water (too little or too much), soil compaction, nutrient deficiencies, salt injury, temperature-induced injury, air pollution, storm injury (hail, wind, lightning, flooding), herbicides and natural gas line breaks. These plants can also be affected by biotic factors, most commonly insects and plant pathogens (bacteria, fungi, nematodes, phytoplasmas, and viruses) but also mites, land mollusks (slugs and snails), vertebrates (birds, deer, mice, rabbits, and squirrels) and weeds. And, to add to the complexity, each plant can be adversely affected by abiotic and biotic factors independent of neighboring plants susceptibility.

Table 8.73 General categories of insect, disease and other pests of landscape plants.

Insects

- sucking insects – aphids, cicadas, leafhoppers, mealybugs, mites, planthoppers, scales, thrips, treehoppers and whiteflies
- chewing pests – beetles, caterpillars, grasshoppers, land mollusks and sawflies, borers
- plant anomalies – gall makers and leafminers

Diseases

- blight
- canker
- decay
- leaf spots
- mildew
- mold
- rot
- rust
- scorch
- wilt

Weeds and vertebrate pests are identical to those listed in Table 8.71 above.

IPM for ornamental landscape plants involves similar steps as for turfgrass:

1. Map the landscape, identifying the location of ornamental plants. These can be entered onto a master map which includes turf areas. This document and the following items should become elements of a written landscape management plan.

2. Identify pest-prone species of plants (key plants) present, conditions conducive to health and to problems and strategies to prevent and avoid threats. For example, trees susceptible to compacted soils should be moved or protected from high traffic areas.

3. Provide grounds manager and staff with training including specific information about plants in the landscape and key abiotic and biotic factors emphasizing those factors that most critical to the health of each key plant or planting.

4. Plan annual plantings and new perennial plantings proactively to avoid key plants whenever possible and place any such plants in ideal conditions to promote plant health.

5. Monitor key plants for pest problems including drafting a written monitoring calendar reflecting best times and frequencies for each plant or planting requiring monitoring. Set thresholds for action based on scientific information and site-specific requirements. For example, a tree planted near the main entrance may require a lower threshold for damage than the same plant in a less visible location.

6. Draft a list of best management strategies to implement for each key plant or planting when problems arise.

7. Keep records of plants, planting dates, cultural methods including cultivation and mulching, irrigation and fertilization, monitoring results, and problems and resolution.

8. Evaluate the success of the program on at least an annual basis and make improvements accordingly.

Cultural and physical options for landscape management

Cultural options for landscape plants include both general strategies and plant and pest-specific options.

- Avoid high-maintenance and pest-prone plants. Identify these plants in existing landscapes and replace them with lower maintenance plants where appropriate.
- Plant new landscape plants in locations that meet the plants' specific needs for sunlight, shade, temperature, soil type, soil moisture levels, etc. Plant at appropriate depth.
- Use mulch or mulch in combination with barriers to suppress weeds. Keep mulch away from trunks of woody ornamentals.
- Test and amend soil for pH, fertility and organic matter to match the plants' specific requirements prior to planting to the extent possible. Maintain the planting site in an optimum range by periodic soil testing with amendments and fertilizer as needed.
- If irrigating, water thoroughly and deeply with each irrigation to encourage deep rooting. Direct irrigation heads so bushes/trees are not directly sprayed.
- Aerate soil as needed to correct compaction.

Organic land care (NOFA 2008) approaches based on cultural methods and limited use of natural products have been successfully implemented for landscape plant management in a limited number of locations (Grassroots Environmental Education 2007). Research and education priorities recommended to expand implementation of these methods in school environments are included in the prioirities listed below.

Table 8.74 Products for cultural or mechanical pest management of landscape plants and uses.

Type	Example Products	Uses
compost		Apply as a topdress to restore or improve healthy soil biology including beneficial microorganisms. Due to shipping costs, source locally from an experienced supplier

		with a guaranteed analysis.
compost tea		Solution spray-applied to landscape plant foliage to inoculate with microorganisms and other beneficials. Due to short shelf life, source from a local supplier or brew onsite.
weed barriers	DeWitt Weed Fabric, Typar Tree Weed Barrier Circle, WeedGaurd Plus Paper Weed Barrier	Cover soil to prevent weed germination and penetration. Cut fabric to keep from touching plant base.
weed burners	Weed Dragon™ Torch Kit	Propane-fed flame kills weeds by heating weeds to boiling point and above. Do not use within three feet of a desirable landscape plant to avoid accidental scorching.
weed removal	Weed Hound®	Mechanical weed puller used to remove individual weeds such as dandelions by the roots.

Pesticide options for landscape pest management

Due to the enormous number and possible combinations of biotic factors including pests affecting the hundreds of possible ornamental plants in a school landscape, a comprehensive list of specific pesticide products is beyond the scope of this document. Once the pest or aboitic factors adversely impacting plant health or appearance have been correctly identified and determined to exceed acceptable levels, refer to local resources to determine the best strategy taken to solve the pest problem. A hierarchy of cultural, then mechanical, then biological, then least toxic pesticide control is recommended for a given scenario. A number of products are included in the table below to illustrate a hierarchy of options from least to highest hazard. An extensive reference list is included at the end of this section.

Table 8.75 Pesticide products available for management of insect pests of turfgrass and other landscape plants.

a. Insecticides carrying a CAUTION label, biological formulations or formulations that reduce exposure hazard.

Active Ingredient	**Example Products**	**Uses**
Bacillus popillae	Milky spore 63191-1	Japanese beetle larvae only.
Bacillus thuringiensis aizawa	Xen Tari 73049-40	Caterpillars.

Bacillus thuringiensis kurstaki *Beauveria bassiana* Entomopathogenic nematodes *Steinerema carpocapsae* *Steinerema scapterisci* *Heterorhabditis* bacteriophora	Dipel 73049-5 Naturalis-T 53871-9 Millenium™ Biological Insecticide (EPA Exempt) Nematac® S (EPA Exempt)	Caterpillars. Multiple insects. Multiple turf insects, mole crickets.

b. CAUTION-label insecticides in formulations that increase potential for exposure.

Active Ingredient	**Example Products**	**Uses**
clothianidin	Arena® 0.5G 59639-156 Arena® 50 WDG 59639-152	Multiple insects.
halofenozide	Mach 2 (1.5G) 38167-29	White grubs, caterpillars.
imidacloprid	Merit® 0.5G 38167-29	Multiple insects.
indoxacarb	Advion® Mole Cricket Bait 352-651	Mole crickets.
spinosad	Conserve SC 62719-291	Caterpillars.
azadirachtin	Azatin® XL 70051-27	Grubs, sod webworm caterpillars, leafminers, thrips.

c. Insecticides carrying a CAUTION label that are more highly toxic or in formulations that increase potential for exposure. Use less hazardous options.

Active Ingredient	**Example Products**	**Uses**
carbaryl	Sevin SL 432-1227 Sevin 80WSP 432-1226	Multiple insects.
bifenthrin, imidacloprid	Allectus G 432-1407	Multiple insects.
deltamethrin	DeltaGard GC 432-837	Multiple insects.
thiamethoxam	Meridian 0.33G 100-961	White grubs.
trichlorfon	Dylox 6.2G 432-1308	Multiple insects.

Table 8.76 Pesticide products available for management of diseases of turfgrass and other landscape plants.

a. Fungicides carrying a CAUTION label or exempt from EPA registration, in formulations that reduce potential for exposure.

Active Ingredient	Example Products	Uses
none		

b. CAUTION-label fungicides in formulations that increase potential for exposure.

Active Ingredient	Example Products	Uses
propamocarb hydrochloride	Banol 432-942	Pythium blight and Phytophthora in turfgrass.

c. Fungicides carrying a CAUTION label that are more highly toxic or in formulations that increase potential for exposure.

Active Ingredient	Example Products	Uses
azoxystrobin	Heritage 100-1093	Broad spectrum disease control in turfgrass.
propiconazole	Banner MAXX 100-1244	Broad spectrum and systemic disease control for turfgrass.

Table 8.77 Pesticide products available for the management of weeds.

a. Herbicides exempt from EPA registration or carrying a CAUTION label in formulations that reduce potential for exposure.

Active Ingredient	Example Products	Uses
2-phenethyl propionate, eugenol	EcoEXEMPT™ HC	Post-emergent non-selective weed control.

b. CAUTION-label herbicides in formulations that increase potential for exposure.

Active Ingredient	Example Products	Uses
carfentrazone-ethyl	Quicksilver 279-3265	Post-emergent weed control with little residual.
fenoxaprop p-ethyl	Acclaim Extra 432-950	Post-emergent grass control.
glyphosate	Roundup Pro 524-529	Post-emergent nonselective weed control.
halosulfuron-methyl	SedgeHammer 81880-1	Post-emergent sedge control.
quinclorac	Drive 75DF 7969-130	Post-emergent control of grass and

		broadleaf weeds.
sulfentrazone	Dismiss 279-3295	Post-emergent broadleaf and sedge control.
triclopyr	Turflon Ester 17545-8-54705	Post-emergent broadleaf and Bermudagrass control.

c. Herbicides that are more highly toxic or in formulations that increase potential for exposure.

Active Ingredient	**Example Products**	**Uses**
acetic acid	BurnOut Weed & Grass Killer	Post-emergent non-selective weed control.
bensulide	Betasan 10163-198	Pre-emergent control of crabgrass and annual bluegrass.
chlorsulfuron	Corsair 228-375	Post-emergent selective control of grass and broadleaf weeds.
dithiopyr	Dimension Ultra 40WP 62719-445	Post-emergent selective control of grass and broadleaf weeds.
glufosinate ammonium	Finale 432-1229	Post-emergent non-selective weed control.
pendimethalin	Scotts Halts 538-192	Pre-emergent control of crabgrass.
prodiamine	Barricade 100-834	Pre-emergent control of grass and broadleaf weeds.
sulfosulfuron	Certainty 524-534	Post-emergent selective control of grass and broadleaf weeds.
triclopyr + fluroxypyr	Tailspin 34704-958	Post-emergent broadleaf weed control.

Table 8.78 Priorities for landscape plant management including turfgrass.

Education Training for trainers, IPM coordinators, grounds maintenance staff and contractors on cultural techniques for preventing and avoiding pests in turfgrass and landscape plants. Research Efficacy of corn gluten meal for pre-emergent weed control including impacts of long-term use on germination of grass seed.

Less hazardous herbicide options.

Organic and natural-product-based systems for turfgrass (including athletic fields) and landscape plant management.

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Appendix A. Pest Management Options Used In and Around Schools

The following options are used in and around schools to manage common and occasional pests of buildings. In this table, we provide efficacy ratings (E = excellent, G = good, F = fair, P = poor) for least-hazardous approaches including prevention, non-chemical and biological controls, and pesticides that are lower in toxicity (e.g., Caution signal word on the product label or exempt from registration) and/or can be applied in a way that reduces potential for exposure, for example, baits in gel form or in a pre-manufactured container.

Options not rated are either not labeled for the pest or not recommended due to the availability of effective, less hazardous alternatives.

Example product brand names are provided for reference only. No attempt was made to exhaustively list all product brand names for each active ingredient and formulation type.

Table A.1 Pest management options commonly used in and around schools.

							Efficacy (Excellent, Good, Fair, Poor)										
Management Option	**Formulation/Description**	**Sample Trade Names**	**Nuisance Ants**	**Ants: Carpenter Ants**	**Ants: Fire Ants**	**Bed bugs**	**Cockroaches**	**Fleas**	**Drain Flies**	**Filth Flies, Blow Flies**	**Fruit Flies, Fungus Gnats**	**Mosquitoes**	**Biting Flies**	**Spiders**	**Stored Products Pests**	**Wasps, Hornets, Yellowjackets**	**Bees**
STRUCTURAL & PUBLIC HEALTH PESTS																	
Prevention and monitoring																	
IPM professional review of structural construction/renovation plans			F	G			G			E				G		G	
exclusion	avoid infested plant pots				G												
	avoid used furnishings					G		G									
	air curtains on loading dock/kitchen									E		G	G			G	
	bird netting	Bird Net 2000™, PermanNet™															
	bird spikes	Bird Spike 2000™															
	bird post and wire	FliteLine®, Springuard™															
	door sweeps	Sealeze Weatherseal	F-G		F-G		E			G	E			G			
	inspect incoming food shipments						E										
	maintain water in P-traps of drains						E										
	mattress/box spring/pillow encasements (covers)	Protect-A-Bed Mattress Encasements				G											
	place composting operations away from building entrances									E						G	
	place dumpsters/ compactors away from building entrances		F				G			E	E						
	place trash cans away from building entrances									E						G	
	place exterior lighting >50 ft. away from building						G					G		G			
	prevent wood contact with ground																
	remove incoming product from cardboard prior to storage						E										
	screen vents									E		G	G	G		G	
	seal cracks & crevices		G	G	G	F-G	E							G		G-E	
	steel wool, copper mesh	Stuffit®					G										
	store food in tighly sealed containers		E				E										
	trim vegetation to prevent contact with building		E	G	G							G	G	G			
	wear appropriate clothing, e.g., long sleeves, pants											G	G			G	
	window screens									E	F-G	E		E		G	

Table A.1 Pest management options commonly used in and around schools. (continued)

			Efficacy (Excellent, Good, Fair, Poor)																			
Management Option	**Formulation/Description**	**Sample Trade Names**	**Nuisance Ants**	**Ants: Carpenter Ants**	**Ants: Fire Ants**	**Bed bugs**	**Cockroaches**	**Fleas**	**Drain Flies**	**Filth Flies, Blow Flies**	**Fruit Flies, Fungus Gnats**	**Mosquitoes**	**Biting Flies**	**Spiders**	**Stored Products Pests**	**Wasps, Hornets, Yellowjackets**	**Bees**	**Termites**	**Mice**	**Rats**	**Birds**	**Notes**
monitoring/identification aids	glue boards	Catchmaster®, Trapper® , Victor®	G			P-F	E	G	G					F-G					G			
	check backpacks, book bags if sightings occur					G																
	compressed air to flush out of harborage						E															
	detection dogs					F-G																
	double-sided sticky tape					P-F																
	gently lift and shake indoor plants										E											
	hand lens, magnifier		F			G		G	G		G			G								
	hot dogs, spam				G																	
	light traps	Gilbert®							G	E												
	light trap placed at floor level							G														
	light traps designed specifically for mosquito monitoring	Mosquito Magnet®, CDC Trap, NJ Trap										E										
	portable/desk microscope		E			G								G								
	index cards baited with honey or other sweet substance		E																			
	vacuum sampling							F-G														
	visual inspection for mounds				G-E																	
	white leggings, white socks pulled over shoes							G														
	yellow sticky traps										G											for fungus gnats
sanitation	clean drains		G				E		E		E											
	clean outdoor catchbasins								G		G											
	clean up/remove animal feces									G												
	clean vending machines		E				E									G						
	clean waste/recycling receptacles		E				E			G	G					G						
	clutter removal to allow proper cleaning and inspection		G		G	G	E							G				G				
	keep mulch 1-3 feet away from			G	G						G							G				
	limit watering of house plants to minimum needed to avoid overwet soil and breeding sites										G											
	prevent standing water in outdoor containers, catch basins, gutters, etc.		G									E										
	prompt cleanup of spills		E				E									G						
	proper storage of mops, brooms		E				E															
	remove tree stumps			G														G				
	repair moisture damaged wood																					
	store firewood away from structures													G		G		G				
	frequent vacuuming					G	G	G														

Table A.1 Pest management options commonly used in and around schools. (continued)

Management Option	Formulation/Description	Sample Trade Names	Nuisance Ants	Ants: Carpenter Ants	Ants: Fire Ants	Bed bugs	Cockroaches	Fleas	Drain Flies	Filth Flies, Blow Flies	Fruit Flies, Fungus Gnats	Mosquitoes	Biting Flies	Spiders	Stored Products Pests	Wasps, Hornets, Yellowjackets	Bees	Termites	Mice	Rats	Birds	Notes
			Efficacy (Excellent, Good, Fair, Poor)																			
STRUCTURAL & PUBLIC HEALTH PESTS																						
Cultural, physical options																						
clean up pheromone recruitment trails			E																			
cold	quick freezing	RapidFreeze				G																
flea comb								G														
fly swatter										G												
fly trap	container with solid or dry bait	Rid-Max® Fly Trap								G												
fly trap for outdoor use	container with liquid bait									G												
identification to species			E		E		G					E	E	E		E				E		
live/multiple catch traps		Catchmaster Multi-Catch™, Kness Pro-Ketch®, Victor® Tin Cat®																	F			
snap traps		Trapper®, Victor®																	G	G		
sticky traps	glue boards	Catchmaster®, Trapper®, Victor®					G												F	F		
fly tapes for non-food areas		Bonide® Fly Catcher Ribbons								F												
heat	foaming unwanted vegetation	Waipuna® System																				
heat	flaming unwanted vegetation	Red Dragon® burners																				
heat	heat gun					G																
heat	hot air fumigation	Thermapure®				G		G														
launder linens, clothing, soft goods	hot water wash, high heat dry					G		G														
light traps with sticky capture surface	used indoors only	Mantis®, Vector®, Fly Web®								G	G	G	G									
light traps with sticky capture surface	used indoors only	Vector® Fruit Fly Trap									G											
light traps with electrocuting grid		Gilbert 601T, Executor®								G												
modify exterior lighting	place lights on poles away from structure, yellow lighting, sodium vapor; avoid UV (mercury vapor)						G							G-E								
traps designed specifically for mosquitoes	combination of attractants	Mega-Catch®, Mosquito Magnet®										P-F										
pheromone traps		Storgard®													G							
physical/mechanical removal of individual pests	vacuum, cup	Sierra vacuums	G				G			G			G									
physical/mechanical nest removal			F-G	G												G						Efficacy is species-dependent for wasps and bees.
remove infested wood				G																		
steam clean carpets						G		G														
steamer, portable		Amerivap®				G																
vacuuming (HEPA filter preferred)		Sierra®	G			G	G	G						E		F						
yellowjacket traps																F						
reduce moisture next to building																		G				

Table A.1 Pest management options commonly used in and around schools. (continued)

			Efficacy (Excellent, Good, Fair, Poor)																			
Management Option	**Formulation/Description**	**Sample Trade Names**	**Nuisance Ants**	**Ants: Carpenter Ants**	**Ants: Fire Ants**	**Bed bugs**	**Cockroaches**	**Fleas**	**Drain Flies**	**Filth Flies, Blow Flies**	**Fruit Flies, Fungus Gnats**	**Mosquitoes**	**Biting Flies**	**Spiders**	**Stored Products Pests**	**Wasps, Hornets, Yellowjackets**	**Bees**	**Termites**	**Mice**	**Rats**	**Birds**	**Notes**
STRUCTURAL & PUBLIC HEALTH PESTS																						
Biological controls																						
Bacillus thuringiensis israeli	pathogen	Mosquito Dunks® 6218-47										G										
Bacillus sphaericus	pathogen	VectoLex® 73049-20										G-E										Very effective for *Anopheles* and *Culex* in polluted water.
Metarhizium anisopliae	pathogen	Bio-Path Cockroach Control Chamber					F															Most effective in humid areas in combination with baits.
Steinernema carpocapsae	pathogen	Flea Destroyer™, No Flea						F														For outdoor pet areas; higher efficacy in sandy soils.
Bacillus thuringiensis israelensis	pathogen	Gnatrol									G											
Bacillus thuringiensis israelensis	pathogen	VectoBac® G 73049-10, Aquabac® 62637-3, Teknar® 2724-469									G	E										
Bacterial drain cleaners		DrainGel™, InVade Biofoam™							E		E											Very effective in conjunction with
Gambusia affinis	predator											E										Must not enter natural waterways.
Steinernema feltiae	pathogen	ScanMask, NemaShield, Nemasys, Gnat Not, etc.			P						E											
Hypoaspis miles	predator										G											
Exempt products or formulations with a CAUTION signal word on the label in formulations that limit potential for exposure																						
acetamiprid	solution (gel bait)	Transport® 8033-91-279					?															
borates	solution in bait station	Ant Café® RTU 73766-1	G																			
borates	injectable solution	Jecta® 64405-4		G														G				
diflubenzuron	impregnated materials	Advance® Termite Bait System 499-488																G				TRI
hexaflumuron	impregnated materials	Sentricon® AG III 62710-454																G				
hydroprene	bait station	Gentrol® Point Source 2724-469					F															
indoxacarb	solution (gel bait)	Advion® Ant Bait Gel 352-746	E				E															
indoxacarb	bait station	Advion® Ant Bait Arena 352-664	E				E															
indoxacarb	solution (gel bait)	Advion® Cockroach Bait Gel 352-652					E															
indoxacarb	bait station	Advion® Cockroach Bait Arena 352-668					E															
imidacloprid	foam	Premise® Foam Insecticide 432-1391																G				
imidacloprid	solution (gel bait)	Premise® Gel Insecticide 3125-544																G				
lamda-cyhalothrin	impregnated materials	Impasse® Termite System 100-1125																G				TRI
nitenpyram	pet oral medication	Capstar®						G														
nithiazine	impregnated materials	Quickstrike® Fly Abatement Strip 2724-461								G												
turpentine, ammonia	liquid drench	Exxant® 63709-1			F																	Co, TRI
brodifacoum	bait block in tamper-resistant bait station	Final® All-Weather Blox 12455-89																	G	G		
bromadiolone	bait block in tamper-resistant bait station	Contrac® All-Weather Blox 12455-79																	G	G		
sulfluramid	impregnated materials	Advance Dual Choice® Ant Bait 499-459	G															G				
sulfluramid	impregnated materials	Firstline® GT Plus Termite Bait Station 279-3196																G				

Table A.1 Pest management options commonly used in and around schools. (continued)

							Efficacy (Excellent, Good, Fair, Poor)														
Management Option	**Formulation/Description**	**Sample Trade Names**	**Nuisance Ants**	**Ants: Carpenter Ants**	**Ants: Fire Ants**	**Bed bugs**	**Cockroaches**	**Fleas**	**Drain Flies**	**Filth Flies, Blow Flies**	**Fruit Flies, Fungus Gnats**	**Mosquitoes**	**Biting Flies**	**Spiders**	**Stored Products Pests**	**Wasps, Hornets, Yellowjackets**	**Bees**	**Termites**	**Mice**	**Rats**	**Birds**	**Notes**
STRUCTURAL & PUBLIC HEALTH PESTS																						
Exempt products or formulations with a CAUTION signal word on the label with identified hazards[1] in formulations that limit potential for exposure																						
abamectin, avermectin	solution (gel bait)	Avert Cockroach Gel Bait 499-406					G															DR, TRI, W
abamectin, avermectin	solution (gel bait)	Advance Carpenter Ant Bait 499-370	F-G	E																		DR, TRI, W
borates (boric acid, disodium octaborate tetrahydrate, orthoboric acid)	solution (gel bait)	Drax® Gel 9444-131	G				G	G														
borates (boric acid, disodium octaborate tetrahydrate, orthoboric acid)	solution (liquid bait)	Drax® Liquid Ant Killer II SWT		F-G																		
fipronil	gel bait or bait station	MaxForce® Ant Killer Bait Gel 432-1256	E				G															C, E, W
hydramethylnon	gel bait or bait station	MaxForce® Ant Killer Bait Gel Reservoirs 432-1256	E				G															C, DR, W
Exempt products or formulations with a CAUTION signal word on the label in formulations with greater potential for exposure																						
diatomaceous earth	dust	Concern® 50932-12				P-F	F-G															D
eugenol, thyme oil	granules	EcoEXEMPT G	F	F	F		F															D
garlic oil	spray-applied liquid	Mosquito Barrier®										G										Co
hydroprene	aerosol	Gentrol® Aerosol 2724-484				F-G	F	F														I
imidacloprid	spray-applied liquid	Premise® 75 432-1332, Merit 75 WSP 432-		G														G				Co, W
imidacloprid	granular fly bait	Maxforce® Granular Fly Bait 432-1359								G												D, W
imidacloprid	brush or spray-applied liquid bait	Maxforce® Fly Spot 432-1359								G												W
imidacloprid	granular	Premise® Granules 432-1385																G				D, W
indoxacarb	granular	Advion® Fire Ant Bait 352-627			G																	D
limestone	dust	NIC 235 Pro Organic®				P-F		G														D
limonene	liquid drench	OrangeGuard®			G																	Co
methoprene	briquets	Altosid® Briquets 2724-375										G										D
methoprene	spray-applied liquid	Precor® IGR Concentrate 2724-352						G														Co
methoprene	granular bait	Extinguish® 2724-475			F																	D
microorganisms	liquid drench or foam	DF 5000, DrainGel, Invade Biofoam							G													
mint oil	aerosol	Victor® Poison-Free Wasp & Hornet Killer														G						I
phenethyl propionate	aerosol	EcoPCO ACU 67425-14												G		G						I
phenethyl propionate, eugenol	dust	EcoEXEMPT D	F	F	F	F	F															D
phenethyl propionate, eugenol	aerosol	EcoEXEMPT KO														G						I
phenethyl propionate, thyme oil, pyrethrins	wettable powder	EcoPCO(R) WP-X 67425-25	F							F				G								Co, D, W
phenethyl propionate, pyrethrins	aerosol	EcoPCO® AR-X 67425-15	F				F									G						I, W
phenethyl propionate, pyrethrins	dust	EcoPCO® D-X 67425-16	F				F									G						D, W
pyrethrins	spray-applied liquid	Skeeter Defeater®										G										W
pyriproxifen	granular bait	Esteem® 59639-114			G																	D, W
rosemary oil	insecticide concentrate	EcoEXEMPT IC2												G		G						Co
selamectin	pet topical application	Revolution®						G														
spinosad	granular	Conserve® 62719-304			F-P																	D
sulfluramid	granular ant bait	Fluorgard® Ant Control Baits 279-3154	F																			D

Table A.1 Pest management options commonly used in and around schools. (continued)

							Efficacy (Excellent, Good, Fair, Poor)															
Management Option	**Formulation/Description**	**Sample Trade Names**	**Nuisance Ants**	**Ants: Carpenter Ants**	**Ants: Fire Ants**	**Bed bugs**	**Cockroaches**	**Fleas**	**Drain Flies**	**Filth Flies, Blow Flies**	**Fruit Flies, Fungus Gnats**	**Mosquitoes**	**Biting Flies**	**Spiders**	**Stored Products Pests**	**Wasps, Hornets, Yellowjackets**	**Bees**	**Termites**	**Mice**	**Rats**	**Birds**	**Notes**
STRUCTURAL & PUBLIC HEALTH PESTS																						
Exempt products or formulations with a CAUTION signal word on the label in formulations with greater potential for exposure and with identified hazards[1], use less hazardous options																						
abamectin, avermectin	granular, dust	Avert Dry Flowable Cockroach Bait 499-294					G															D, W, DR, TRI
allethrin, phenothrin	aerosol	Wasp Freeze 499-362														G	G					E, I, TRI, W
bifenthrin	spray-applied liquid	Talstar® One 279-3206	G			F																C, Co, DR, I, N, TRI, W
borates	spray-applied liquid	Bora-Care® 64405-4, Timbor® 64405-8		F-G																		Co, I
borates	granular bait	Intice™ Granules 73079-2, Niban® FG 64405-		G			G															D
borates	aerosol	PT® 240 Permadust 499-384	G				G															I
borates	dust	Boracide® 64405-7		F-G																		D
brodifacoum	pellets	Final® Ready-to-use Place Pack 12455-91																	G	G		D, W
bromadiolone	pellets	Contrac® Ready-to-Use Place Pak 12455-76																	G	G		D, W
chlorfenapyr	spray-applied liquid, interior only, crack and crevice	Phantom® 241-392	G	G		F												G				Co, I, W
cypermethrin	spray-applied lliquid	Demon® EC 100-1004, Tempo® SC 11556-124	G			F																C, Co, N, E, I, W
cythioate	pet oral medication	Proban®																				N
deltamethrin	dust	Delta Dust® 432-772	G																			D, E, W
deltamethrin	spray-applied liquid	Suspend® SC 432-763	G			F																C, E, I, W
fipronil	granular bait	Ceasefire® 432-1219			F-G																	C, Co, D, E, W
fipronil	granular	Top Choice® 432-1420			E																	C, Co, D, E, W
fipronil	spray-applied liquid	Termidor® 7969-210	G	E														E				C, Co, E, I, W
fipronil	spray-applied liquid	Termidor® 7969-210	G																			C, Co, E, I, W
fipronil, S-methoprene	pet topical application	FrontLine®						G														C, Co, E, W
hydramethylnon	granular bait	Amdro® Fire Ant Bait 73342-1			G																	C, D, DR, W
lambda-cyhalothrin	concentrated solution	Demand® CS 100-1066				F																Co, W, TRI
lufenuron, diflubenzuron	pet oral medication	Program®						G														G, TRI
methoprene, hydramethylnon	granular bait	Extinguish Plus® 2724-496			F-G			G														C, D, DR, W
permethrin	spray-applied liquid	Dragnet® 279-3062				F																C, Co, TRI
phenothrin, n-octyl bicycloheptene dicarboximide	aerosol	Bedlam® 1021-1767				F																C, I
propoxur	granular	Baygon® 2% Bait 432-1283					G															C, D, E, N, W

Table A.1 Pest management options commonly used in and around schools. (continued)

			Efficacy (Excellent, Good, Fair, Poor)																			
Management Option	**Formulation/Description**	**Sample Trade Names**	**Nuisance Ants**	**Ants: Carpenter Ants**	**Ants: Fire Ants**	**Bed bugs**	**Cockroaches**	**Fleas**	**Drain Flies**	**Filth Flies, Blow Flies**	**Fruit Flies, Fungus Gnats**	**Mosquitoes**	**Biting Flies**	**Spiders**	**Stored Products Pests**	**Wasps, Hornets, Yellowjackets**	**Bees**	**Termites**	**Mice**	**Rats**	**Birds**	**Notes**
STRUCTURAL & PUBLIC HEALTH PESTS																						
Formulations with WARNING or DANGER signal words on the label - no rating provided, use less hazardous alternatives																						
imidacloprid	topical solution	Advantage® 11556-122																				A
isopropyl alcohol, phenothrin	spray-applied liquid	Steri-fab® 397-13																				A, I
propetamphos	spray-applied liquid	Catalyst® 2724-450																				A, Co, I, N
zinc phosphide	dust	ZP® Tracking Powder 12455-17																				A, D, DR, RU

[1]Key to Notes

? = insufficient data
A = acute toxicity, e.g., WARNING, DANGER label
C = possible, probable or likely carcinogen according to California EPA, Intl. Agency for Research on Cancer or US EPA
Co = concentrate, requires mixing and increases exposure potential especially to applicator
E = possible endocrine disruptor
D = to reduce dust inhalation hazard, wear respiratory protection and where possible, apply to cracks and crevices sealed after application or directly into insect nests
DR = developmental or reproductive toxin according to California EPA or US EPA
I = to reduce inhalation hazard, wear respiratory protection
N = neurotoxin
RU = restricted use
TRI = listed on US EPA Toxics Release Inventory, http://www.epa.gov/tri/index.htm
W = toxic to wildlife, birds, fish and other aquatic organisms as per the product label

Additional Biological Controls
Many biocontrol agents have potential to impact pests typically found in or around schools in addition to those listed above that are commonly used in school environments. The following table includes both biologicals in common use and those that are not currently used to any great extent due to lack of efficacy or efficacy data, limited commercial availability, high labor or purchase cost relative to alternatives, or ready access to effective and practical alternatives in the non-chemical or preferred chemical categories. These agents may have potential for future use pending additional research. Pests listed that do not have natural enemies listed may be good candidates for research to identify any that may exist.

Table A.2 Compendium of biological control agents for pests found in schools. The following data reflect known biological controls, or natural enemies, of pests found in schools. Only a very limited number of these beneficial organisms are commercially available, effective alternatives or supplements to non-chemical or chemical controls. For effective biologicals currently used in school environments, see table A.1. We have included pests for which biological controls have not been identified to date.

Pest	**Biocontrol Type**	**Biocontrol Species**
STRUCTURAL PESTS		
ants		
acrobat Argentine carpenter crazy false honey		none identified
fire	pathogen parasitoid pathogen pathogen	*Beauveria bassiana* *Pseudacteon* *Steinernema carpocapsae* *Thelohania solenopsae*
ghost harvester leaf-cutter little black odorous house pavement pharaoh pyramid thief		none identified
bat bugs		none identified
bed bugs		none identified
bees, wasps and hornets		
baldfaced hornet carpenter bees digger wasps		none identified

honey bee mud daubers paper wasps potter wasps yellowjackets		
cockroaches		
American	parasite	*Aprostocetus (= Tetrastichus) hagenowii*
Asian		none identified
Australian	parasite	*Aprostocetus (= Tetrastichus) hagenowii*
brown		none identified
brownbanded	parasite parasite pathogen	*Anastatus tenuipes* *Comperia merceti* *Metarhizium anispoliae*
Cuban desert field Florida wood/stinkroach		none identified
German	pathogen pathogen pathogen pathogen	*Beauveria bassiana* *Metarhizium anispoliae* *Steinernema carpocapsae* *Verticulim lecanii*
lobster Madeira		none identified
Oriental	parasite	*Aprostocetus (= Tetrastichus) hagenowii*
Pennsylvania wood		none identified
Smokeybrown	parasite	*Aprostocetus (= Tetrastichus) hagenowii*
Surinam Turkistan		none identified
fleas		
cat	pathogen	*Steinernema carpocapsae*
dog	pathogen	*Steinernema carpocapsae*
human rat		none identified
flies: biting flies		
black	pathogen	*Bacillus thuringiensis israelensis*
deer horse midges stable		none identified
flies: filth flies		
blow (Calliphoridae)	parasite	*Nasonia vitripennis* *Spalangia cameroni* *Spalangia endius* *Spalangia nigroaenea*
Cluster		none identified
flesh (Sarcophagid)	Parasite	*Nasonia vitripennis*

		Muscidufurax raptor *Muscidifurax raptorellus* *Spalangia cameroni* *Spalangia endius* *Spalangia nigroaenea*
fungus gnats	predator pathogen pathogen	*Hypoaspis spp.* *Steinernema feltiae* *Bacillus thuringiensis israelensis*
fruit flies	parasite	*Aceratoneuromyia indica* *Diachasmimorpha longicaudata*
house flies	parasite	*Nasonia vitripennis* *Muscidufurax raptor* *Muscidifurax raptoroides* *Muscidifurax raptorellus* *Muscidifurax zaraptor* *Spalangia cameroni* *Spalangia endius* *Spalangia nigroaenea*
moth/drain phorid/humpbacked	pathogen	bacterial drain cleaners
sphaerocerid/dung		none identified
mosquitoes	pathogen pathogen predator	*Bacillus thuringiensis israelensis* *Bacillus sphaericus* *Gambusia affinis (mosquito fish)*
lice		
body, crab/pubic, head		none identified
occasional invaders, over-wintering pests		
centipedes crickets field house Jerusalem mole earwigs harvestmen kissing bugs/Reduviids lady beetles millipeds mites bird clover chiggers rodent scabies		**none identified**

pillbugs scorpions springtails		
paper, fabric and museum pests		
barklice/booklice casemaking moths carpet beetles firebrats silverfish webbing clothes moth		**none identified**
spiders		
cellar hobo house recluse sac widow		**none identified**
stored product pests		
Beetles: cigarette beetle confused flour beetle drug store beetle foreign grain beetle hide beetle khapra beetle larder beetle lesser grain borer merchant grain beetle red flour beetle redlegged ham beetle sawtoothed grain beetle spider beetle warehouse beetle cheese skipper mealworms moths: Angoumois grain moth Indian meal moth Mediterranean flour moth weevils: bean weevil granary weevil	predator	*Xylocoris flavipes*

rice weevil		
termites		
dampwood drywood		none identified
subterranean: desert Eastern Formosan Western	pathogen	*Steinernema carpocapsae*
ticks		
American dog bat bird soft (Argas) blacklegged brown dog lone star rodent soft (Ornithodorus)		none identified
wood-boring beetles		
ambrosia anobiid bostrichid buprestid cerambycid lyctid scolytid		none identified
PLANT PESTS		
Aphids	parasite predator pathogen predators parasite predator pathogen predator	*Aphelinus abdominalis* *Aphidius colemani* *Aphidius matricariae* *Aphidius ervi* *Aphidoletes aphidomyza* *Beauveria bassiana* *Chilocorus stigma* *Coleomegilla maculate* *Chrysoperla sp.* *Geocoris punctipes* *Harmonia axyridis* *Hippodamia convergens* *Iphiseius (=Amblyseius) degenerous* *Lysiphlebus testaceipes* *Orius insidiosus* *Paecilomyces sp.* soldier beetles (Cantharidae)

	pathogen	syrphids *Verticillium lecanii*
beetles – leaf feeding		
general larval	predator	*Podisus maculiventris*
elm leaf	pathogen	*Bacillus thuringiensis var san diego* (=*tenebrionis*)
Japanese	pathogen	*Bacillus popillae* *Bacillus thuringiensis subspecies japonensis Buibui strain*
beetles – root feeding		
general larval	pathogen	*Beauveria bassiana* *Heterorhabditis bacteriophora* *Heterorhabditis indica* *Heterorhabditis marelatus* *Heterorhabditis megidis* *Steinernema carpocapsae*
scarab	pathogen parasite	*Heterorhabditis bacteriophora* *Heterorhabditis indica* *Heterorhabditis marelatus* *Heterorhabditis megidis* *Tiphia pygidialis*
Japanese	pathogens	*Bacillus popillae* *Bacillus thuringiensis subspecies japonensis Buibui strain*
weevils		
annual bluegrass		none identified
citrus root	pathogen	*Steinernema riobrave*
strawberry root		none identified
wireworms		none identified
billbugs		
bluegrass	pathogen	*Beauveria bassiana*
hunting	pathogen	*Beauveria bassiana* *Steinernema carpocapsae* *Heterorhabditis bacteriophora*
bugs		
lace		none identified
lygus	parasite	*Anaphes iole*
spittle		none identified
stink		none identified
caterpillars, general	pathogen parasite predator pathogen	*Bacillus thuringiensis var. kustaki* *Beauveria bassiana* *Cotesia marginiventris* *Cotesia plutella* *Geocoris punctipes* *Geocoris uliginosus* *Heterorhabditis bacteriophora*

	 parasite predator pathogen parasite	*Heterorhabditis indica* *Heterorhabditis marelatus* *Heterorhabditis megidis* *Orius insidiosus* *Podisus maculiventris* *Soldier beetles (Cantharidae)* *Steinernema carpocapsae* *Trichogramma spp.*
armyworms	pathogen	*Beauveria bassiana* *Steinernema carpocapsae*
cutworm	pathogen parasite	*Multiple nucleopolyhedrovirus* *Beauveria bassiana* *Steinernema carpocapsae* *Trichogramma spp.*
Gypsy moth caterpillar	parasite pathogen	*Cotesia melanoscela* *Nucleopolyhedrosis virus (NPV)*
leafrollers	pathogen	*Nucleopolyhedrosis virus (NPV)*
sod webworm	pathogen parasite	*Beauveria bassiana* *Steinernema carpocapsae* *Trichogramma spp.*
chinch bugs		none identified
grasshoppers	pathogen	*Nosema locustae*
leafhoppers		none identified
leafminers, general	parasite	*Dacnusa sibrica* *Diglyphus isaea*
birch leafminers	parasite	*Lathrolestes nigricollis* *Lathrolestes luteolator*
mealybugs, general	predator	*Chilocorus stigma* *Chrysoperla sp.* *Cryptolaemus montrouzieri* *Orius insidiosus*
citrus mealybug	predator parasite	*Cryptolaemus montrouzieri* *Leptomastix abnormalis* *Leptomastix dactylopii*
Comstock mealybug	parasite	*Anagyrus pseudococci*
midges		none identified
mites	Predator	*Amblysieus fallacis* *Chrysoperla sp.* *Feltiella acarisuga* *Galendromus occidentalis* *Geocoris sp.* *Hippodamia convergens* *Hypoaspis sp.* *Mesoseiulus longipes* *Neoseiulus californicus* *Neoseiulus cucumeris*

		Orius insidiosus *Phytoseiulus persimilis* *Scolothrips sexmaculatus* *Stethorus spp.*
Banks grass clover two-spotted winter grain		none identified
psyllids	pathogen	*Beauveria bassiana*
sawflies		
European pine sawfly	pathogen	*Nuclear polyhedrosis virus*
scale insects, general	predator	*Chilocorus stigma* *Chrysoperla sp.* *Hemisarcoptes coccophagus* *Rhyzobius (=Lindorus) lophanthae*
ground pearl		none identified
Rhodes grass		none identified
pine needle scale	parasite predator	*Aphytis mytilaspidis* *Aphytis proclia* *Aspidiotiphagus nr citrinus* *Coccobius varicornis* *Encarsia bella* *Hemisarcoptes malus* *Marietta mexicana* *Microwesia misella* *Mulsantina picta*
slugs, snails	predator	*Rumina decollate*
thrips	predator pathogen predator	*Amblyseius barkeri* *Amblyseius cucumeris* *Amblyseius degenerans* *Chrysoperla sp.* *Hypoaspis miles* *Verticillium lecanii* *Orius insidiosus*
treehoppers		none identified
whiteflies	pathogen predator parasite predator pathogen	*Beauveria bassiana* *Chrysoperla sp.* *Delphastus catalinae* *Encarsia formosa* *Eretmocerus nr. Californicus* *Hippodamia convergens* *Paecilomyces fumosoroseus* *Verticillium lecanii*
mole crickets	pathogen parasite	*Beauveria bassiana* *Heterorhabditis bacteriophora* *Larra bicolor*

	pathogen	*Metarhizium anisopliae* *Steinernema carpocapsae* *Steinernema feltiae* *Steinernema riobrave* *Steinernema scapterisci*

References for additional information on biological controls:

Grewal, P. Undated. *Insect Parasitic Nematodes: The Essential Resource for Insecticidal Nematodes*. www.oardc.ohio-state.edu/nematodes/

Steiner, M. and D. Eliot. 1987. *Biological Pest Management for Interior Plantscapes*, 2nd edition. Alta Publication Services, Edmonton, Alberta, Canada. 32 pp.

Appendix B. School Pest-Management Legislation by State

The following table was provided courtesy of Gene Harrington, manager, government affairs, National Pest Management Association, with additional information added to reflect new legislation in Ohio. More detailed information on state laws and regulations pertaining to pest management in schools is maintained by Beyond Pesticides, see www.beyondpesticides.org/schools/schoolpolicies/index.htm.

State School Pest Management Requirements as of October 10, 2008

	Interior Posting	Outdoor Posting	Pre-Notification	IPM Law or Rule	Reentry or other Requirements Beyond label)	Min Requirements for Applicators (Training, Certification Supervision, etc.)
Alabama						
Alaska	X	X	X		X	X
Arizona	X	X	X			X
Arkansas						
California	X	X	X	X(v)	X	
Colorado		X				
Connecticut		X	X	X(v)	X	X
Delaware						X
Florida		X				
Georgia	X	X			X	
Hawaii						
Idaho						
Illinois		X	X	X		
Indiana		X				
Iowa		X				X
Kansas						
Kentucky		X	X	X		X
Louisiana			X(1)	X	X	X
Maine	X	X	X	X	X	X
Maryland	X	X	X	X		X
Massachusetts	X	X	X	X	X	X
Michigan	X	X	X	X	X	X
Minnesota		X	X	X(v)		X
Mississippi						
Missouri						
Montana	X			X(v)		X
Nebraska						
Nevada						
New Hampshire		X				X
New Jersey	X	X	X	X	X	X
New Mexico	X	X	X		X	X
New York		X	X	X		X
North Carolina			X	X		
North Dakota						
Ohio		X	X	X		X
Oklahoma						
Oregon						
Pennsylvania	X	X	X	X	X	X
Rhode Island		X	X	X	X	X
South Carolina						X
South Dakota						
Tennessee						X
Texas	X		X	X	X	X
Utah						
Vermont		X		X(v)		
Virginia						X
Washington	X	X	X			
West Virginia	X		X	X	X	X
Wisconsin	X	X				X
Wyoming	X	X	X			
(V) = Voluntary						
(I) = Schools must maintain a list of pesticide hypersensitive students						

Appendix C. Annual School IPM Report Card

Provided by Sherry Glick and developed with input from a number of PMSP meeting participants and others. It is intended to be circulated to a key state agency professional(s) in each state annually to document annual performance measures for progress in school IPM implementation.

Sherry Glick
National Coordinator, Pesticides and Schools
US Environmental Protection Agency
Office of Pesticide Programs
4220 S. Maryland Parkway
Las Vegas NV 89119

Date

Participant Address

Dear ________ :

Thank you for participating in this national effort to determine the level implementation of Integrated Pest Management (IPM) for K-12 schools and childcare facilities.

The purpose of this survey is to document current school Integrated Pest Management (IPM) activities and resources on a state-by-state basis. This information is very important to measure our progress, and identify resources and resource needs.

Please complete the survey considering all the school IPM efforts in state. If more than one agency or organization is working to implement school IPM in your state, a joint report would be ideal. For example, Extension, your state lead agency and a non-governmental organization (NGO) may work together on the report card. Please consider any school pest management surveys conducted in your state, as well as dialogue with knowledgeable colleagues.

If information is not available for a specific element of the report, please note that your response, or indicate that your reply is a rough estimate in the absence of data. After the initial report is completed, annual updates will easier and less time consuming to report. We will include your most recent report in each annual request.

See the sample report attached. A summary of the information we collect nationally will be reported annually, including via the National School IPM Website at schoolipm.ifas.ufl.edu/.

Your time and effort is greatly appreciated as we work to document our progress towards high-level IPM in all schools nationwide.

Please contact me if I can be of further assistance.

Sincerely,

Sherry Glick
702 784-8276
Fax 702 784-8231
glick.sherry at epa.gov

Annual School IPM Report Card
Inventory of Activities and Resources in Your State

Objective: Track progress towards IPM in all schools and identify resources and resource needs by providing a current snapshot of the status of school IPM in your state. If data from historical surveys are used, please update those data with your best estimate of current status.

I. Respondent Information

Your Name ______________________________ Title ________________________________

Phone ___________________________________ Email ___________________________

State __________ Organization ____

Date of completion _________________

Other individuals/organizations participating in completing the report (if any)

____

____

II. State-specific Demographics (Data available at http://nces.ed.gov/programs/stateprofiles/)

1. Number of public school districts in your state ______
2. Number of children in public schools (K-12) in your state ______

III. Laws, Policy and Planning

3. Please indicate which of the following are required of schools and/or childcare facilities by state law, rules or regulations. (Check all that apply.)

Schools	Childcare	
_____	_____	(a) Posting of indoor pesticide applications
_____	_____	(b) Posting of outdoor pesticide applications
_____	_____	(c) Pre-notification of parents or staff prior to pesticide applications
_____	_____	(d) IPM required for pest management in schools
_____	_____	(e) Minimal training requirements for applicators (e.g., certification)
_____	_____	(f) Re-entry requirements beyond the pesticide label
_____	_____	(g) Pesticide product restrictions (or “green” pesticide list)
_____	_____	(h) Other (*please specify in comments*)

Name/statute numbers for school IPM laws, rules or regulations in your state: _________

Comments:

4. Approximately what **percentage** of school districts have a Board of Education-approved written IPM policy? ______

5. Approximately what **percentage** of school districts have designated a committee that addresses school IPM? (For example, an IPM, safety or other stakeholder committee that meets at least annually to review pest management policies and practices.) ______

6. Approximately what **percentage** of school districts have a designated IPM Coordinator? (An IPM Coordinator is an individual employed by the school district responsible for overseeing day-to-day implementation of IPM.) ______

7. Approximately what **percentage** of school districts have a written IPM plan? (An IPM plan is a document that includes specifics for how pest management is performed in the school district including staff roles and specific strategies for important pests.) ______

IV. School IPM Implementation

8. What approximate **percentage** of school districts have implemented the following:

____ Avoiding calendar-based applications in structures

____ Avoiding calendar-based applications on grounds (fire ant applications excluded)

____ Regular inspections of structures for maintenance including pest-proofing

____ Regular inspections of grounds for pests and pest-conducive conditions

____ Certified applicators (structural and/or grounds) required for pesticide applications

____ Formal IPM decision-making protocols, e.g., steps taken before a pesticide is applied

____ Pest ID before any treatment

____ Monitoring schedules and action thresholds for structural and/or grounds

____ Formal protocols for food management, e.g., must be stored in sealed plastic containers

____ Pre-approved list of least-hazardous pesticide options

____ Record keeping for pesticide applications and pest complaints and/or monitoring results

____ Formal sanitation/housekeeping protocols addressing common pests, e.g., drain cleaning

____ Staff training on IPM, e.g., food handling, pest complaint reporting, clutter control

____ Focus on identifying and resolving cause of pest problems

How do you know? (e.g., survey, sample, estimate based on your work in schools, etc.)?

_____ (a) Survey as of (date) ________
_____ (b) Sample of school districts
_____ (c) Rough estimate based on work with schools
_____ (c) Other (describe):

9. Which of the following best represents the **level of outreach/education/support for school IPM implementation** in your state?

_____ (a) Statewide coordinated effort involving multiple agencies & institutions (i.e., a coalition, committee or working group)
_____ (b) Statewide program implemented by a single agency or institution
_____ (c) Independent outreach / implementation efforts engaged in by one or more entities locally (e.g., pilot programs)
_____ (d) Schools are making independent efforts towards IPM implementation
_____ (e) None of the above. *Please describe your state's situation:*

10. Does your state have a state-wide program for IPM in childcare facilities? ___ Yes ___ No

V. School IPM Training and Resources

11. About how many public agency or university/extension staff **FTE** (full-time equivalent) are committed to school IPM in your state? ______

12. Estimated additional **FTE** (non-public agency, e.g., ngo staff) working on school IPM. _____

13. Approximately how much money is spent on school IPM implementation programs in your state? Include funding from grants, staff salaries, other sources. Do not include funds spent by school districts as part of their annual pest management budget. **$**__________

14. Please indicate IPM training activities for school professionals in your state in the past 12 months:

a) **Number** of school districts trained in IPM by professionals not employed by the district this past calendar year (all kinds of training, all types of school staff) ____

b) **Number** of school staff represented in these trainings ______

c) **Number** of school IPM workshops conducted by agencies or ngos statewide ______

d) **Number** of school districts represented at workshops ______

e) **Number** of school staff trained at workshops ______

f) **Number** of school IPM presentations to school staff, school business officials, school health professionals, pest management professionals, etc., made by state agency, ngo, or industry ______

g) **Number** of school districts provided with on-site training (e.g., compliance assistance, problem resolution) ______

h) **Number** of school districts providing internal IPM training programs for school staff (e.g., for custodians, food service staff, etc.) ____________

i) In addition to the activities listed above, what other uses were made of the funding reported in question 13?

15. a) About how many **number** of school districts include IPM education for students in their curriculum, e.g., science, home economics, ag/hort or vo-tech study programs? ______

16. a) **Number** of IPM communication vehicles (newsletters, listserve, etc) distributed to school districts in the past calendar year ______

b) Total **number** of school districts receiving IPM these communications ______

17. Does your state have a website(s) or webpage(s) specific to school IPM? ____ Yes ____ No

If yes, please provide URL(s): ____

____

____

18. Please check any existing tools / resources for school IPM in your state (include others that may not be mentioned below).

- ❑ fact sheets
- ❑ posters
- ❑ videos
- ❑ IPM curricula for students
- ❑ IPM lesson plans for students
- ❑ school IPM manual
- ❑ train-the-trainer manual
- ❑ training curricula for school staff/contractors
- ❑ model news releases
- ❑ newsletters (e.g., Pest Presses)
- ❑ model IPM policy
- ❑ model contract for structural IPM

Other (please list) ____

VI. Awards

19. Please indicate the **number** of school districts in your state that have earned

_____ (a) The IPM STAR Certification
(IPM Institute of North America, www.ipminstitute.org/)

_____ (b) The Green Flag Award
(Center for Health, Environment and Justice, www.greenflagschools.org)

_____ (c) PESP Partnerships
(Environmental Protection Agency, www.epa.gov/oppbppd1/PESP/)

_____ (d) Other awards. *Please list:*

20. Additional comments; which could include historical issues, proposed legislation, funding issues, etc. (attach additional pages if necessary):

Thank you very much for contributing to our ability to track progress towards full implementation of high-level IPM in all of our schools! Please return form and any additional information or comments you would like to provide to: Sherry Glick, US EPA, PO Box 98517, Las Vegas, NV 89193-8517 or electronically to: glick.sherry at epa.gov

Appendix D. Glossary

The following terms are used in this document or are commonly used in structural or landscape pest management in schools.

Sources for the definitions used here include:

- *Complete Guide to Pest Control*, G. Ware
- *GEMPLER'S IPM Almanac,* 1999
- *Glossary of Terms Relating to Pesticides, International Union of Pure and Applied Chemistry Recommendations*, 1996, (www.iupac.org/publications/pac/1996/pdf/6805x1167.pdf) (PDF)
- *IPM Standards for Schools* (www.ipminstitute.org/school_standards.htm)
- *NPCA Field Guide to Structural Pests*
- *NPCA Service Technician's Manual*
- *Random House College Dictionary*
- US EPA (www.epa.gov/asthma/triggers.html)
- US EPA (www.epa.gov/OCEPAterms/sterms.html)
- US EPA Glossary (www.epa.gov/pesticides/glossary/index.html)
- US EPA Pesticide A – Z Index (www.epa.gov/pesticides/a-z/index.htm)

action thresholds (action level) – The number of pests or level of pest damage requiring action to prevent damage from exceeding tolerable levels. For some pests posing an immediate health hazard, the action threshold will be one, for example a single yellow jacket in a classroom. For others, such as houseflies in the dumpster area, a higher number may be more tolerable before action is needed.

For some pests, action may be needed before pests or pest damage appears. In those cases, an action threshold may be defined as a set of conditions, e.g., a plant is at a susceptible stage for a disease under the right weather conditions.

Including written action thresholds in an IPM plan presents a clear statement of intentions before a pest event occurs. This guidance can prevent under or over-reactions to pest problems by those called to respond to the situation.

For a great explanation of action thresholds, see Maryland Department of Agriculture, "Action Thresholds in School IPM Programs." Pesticide Regulation Section, Annapolis, MD. 10 pp. Available at schoolipm.ifas.ufl.edu/tp.htm

acute toxicity – ability of a substance to cause adverse effects within a short period following dosing or exposure, usually 96 hours or less.

aerosol – system of fine or solid or liquid particles (<30µm diameter) dispersed in a gas. Aerosol cans using an inert compressed propellant are a common means of dispensing insecticides for household use, and for commercial use against stinging insect nests.

aesthetic threshold – the pest density or level of damage based on appearance rather than potential for health, economic or structural harm. For example, a decision might be made to act against dandelions in a school lawn based on the number of dandelions present creating an unsightly appearance. Regulations in at least one state (Connecticut) prohibit the use of pesticides for aesthetic purposes on school grounds.

anti-microbial pesticide – a pesticide used for management of microbial pests including viruses, bacteria, algae and protozoa or the purpose of disinfecting or sanitizing. Anti-microbials do not include fungicides used on plants.

asthma trigger – allergens and irritants that can play a significant role in initiating an asthma attack.

beneficial organism or beneficial – a living thing that provides benefits to humans, including those that may reduce pest problems by feeding on pests. A yellow jacket can be a beneficial in gardens for example, by capturing and removing plant-eating caterpillars to feed its young, and a pest when nesting in or near, or entering structures.

biological control – management of pest populations using other living organisms such as pathogens, predators, parasites and parasitoids.

biopesticide – a compound produced from living organisms or their products which is used to suppress pest populations.

broadcast treatment – the application of pesticides over a large area, such as an entire athletic field, rather than a spot treatment to a small, localized areas where pests are concentrated, congregating or are just beginning to emerge.

calibration – the process of adjusting the output of pesticide application equipment so that the proper amount of pesticide can be applied to a given area.

canker – a dead, discolored, often sunken area on a plant.

carcinogen – a substance or agent that produces or incites cancerous growth.

caulk – materials used for filling small gaps (less than 1/4" or 6mm) where there is expected to be little or no movement of the surfaces to which it is applied. Caulks are non-elastomeric – they do not return to their original size and shape after being stretched or compressed.

change agent – an individual who helps to communicate the excitement, possibilities and details of a change in behavior to others.

chronic toxicity – capacity for a substance to produce injury to a living organism in which symptoms develop slowly over a long period of time, or recur frequently following exposure (whether or not they occur immediately upon exposure or are delayed).

common name – the generally used, non–Latin name given to plants, animals, or insects.

compaction – a compression of soil that results in poor water drainage, air movement and root growth.

compartment – part of an organism or ecosystem considered as an independent system for purposes of uptake, distribution and dissipation or a pesticide.

contaminant - any physical, chemical, biological or radiological substance or matter that has an adverse effect on air, water or soil.

complete metamorphosis – in insects, development where the immature stages consist of an egg followed by a series of larvae and then a pupal stage before the adult.

cross resistance – reduced susceptibility of a pest to more than one pesticide by the same mechanism, e.g., an insect may develop a mutation that detoxifies one insecticide, and that mutation may act in the same way to detoxify one or more additional insecticides.

cultural control – management of pests by manipulation of the school environment or implementation of preventive practices including using plants that are resistant to pests, raising the cutting height of turf to shade out weeds, aerating turf to reduce compaction and plant stress, etc.

cuticle – the outer waxy protective covering of plants and arthropods that aids in preventing moisture loss.

dermal – pertaining to the skin; absorption through the skin is one of the main ways in which pesticides can enter the body.

desiccation – drying out, for example, of a plant or insect. Some pesticides act through desiccation by damaging the waxy coating that naturally covers insects and protects them from dehydration.

diagnostic – distinguishing characteristics serving to identify or determine the presence of a disease or other condition.

diatomaceous earth – a geologic deposit of fine, grayish material composed chiefly or wholly of the remains of diatoms; it may occur as a powder or as a porous, rigid material; used in insecticides.

dieback – progressive death of shoots, leaves or roots, beginning at the tips.

disease – an abnormal condition, caused by living organisms or environmental changes, that impairs the normal functions of a living organism.

dormant – to become inactive due to environmental changes.

drift – the movement of pesticide away from the target area.

duster – an apparatus for applying pesticides in dry form.

economic damage – damage caused by pests which results in loss of income or a reduction of value.

economic threshold – the point at which the value of the damage caused by a pest exceeds the cost of managing the pest.

endocrine disruption – disruption of the endocrine system of humans and wildlife caused by selected chemicals.

endocrine disruptors – chemicals found to disrupt the endocrine system of humans and wildlife.

environmental contamination – the introduction into water, air and/or soil of microorganisms, chemicals, toxic substances, wastes or wastewater in a concentration that makes the medium unfit for its next intended use. Also applies to surfaces of objects, buildings and various household and agricultural use products.

exclusion – reducing pest problems by preventing pests from entering buildings or other areas. For example, installing door sweeps can be an effective exclusion technique to keep mice from entering school buildings in the fall.

eXtension – (pronounced ‘e x ten shun’) an Internet-based collaborative environment where Land Grant University content providers exchange objective, research-based knowledge to solve real challenges in real time. (about.extension.org/)

frass – fecal material produced by insects.

fumigant – a volatile substance that produces toxic or suffocating gases which is used to destroy insects, pathogens or other pests.

fungicide – a pesticide used for management of fungi.

fungus – (pl. fungi) a living microorganism characterized by a cell wall containing chitin and lacking chlorophyll. About 50 species cause disease in animals and more than 10,000 species cause plant diseases. Most of the more than 100,000 species of fungi are beneficial and feed on dead plant and animal matter which they help to decompose.

glue board – a small cardboard sheet or boxlike apparatus having one or more surfaces coated with a sticky paste for capturing pests.

gradual metamorphosis – in insects, development where the immature stages are the egg followed by a series of nymphs which are very similar in appearance to and habits of the adult stage, with no pupal stage.

grub – the immature (larval) life stage of certain beetles (Order: Coleoptera). For example, several grub species infest lawns and feed on grass roots. When reaching the adult or beetle stage, these species feed on plant foliage.

harborage – locations where pests seek shelter. For example, cockroaches use gaps between wall-mounted equipment and walls, cardboard boxes and other spaces where they can maintain upper and under-body contact with surfaces as harborage.

herbicide – a pesticide used for the management of weeds.

incomplete metamorphosis – in insects, development where the immature stages are the egg followed by a series of naiads which are aquatic and have gills, the naiads differing greatly in appearance from the adult stage, with no pupal stage.

indoor air quality (IAQ) – the quality of breathable air inside a habitable structure or conveyance.

inoculum – pathogen or part of a pathogen that can cause infection.

infestation – a troublesome level of pests within a particular area or associated with a plant or group of plants.

infiltration rate – the rate at which ponded water on a soil surface enters the soil profile.

insecticide – a pesticide used for the management of insects. Some insecticides are also used for the management of ticks, mites, spiders and other arthropods.

instar – in insects, the stage between molts or shedding of the exoskeleton. For example, a grub may pass through four or five larval instars before pupating prior to becoming a beetle. The early instars of some insects are more susceptible to pesticides, for example *Bacillus thuringiensis* can be effective when used against early, but not later instar caterpillars.

inspection – the systematic examination of a site for pest activity or conditions that might encourage or allow pests to become a problem. Careful regular inspection of school buildings and grounds with a focus on pest vulnerable areas such as loading docks, kitchens, food storerooms, cafeterias, mechanical rooms and teachers' lounges can greatly reduce pest problems and the need for pesticide applications or other interventions.

Integrated Pest Management (IPM) - a decision-making process that coordinates the use of pest biology, environmental information, and available technology to prevent unacceptable levels of pest damage by the most economical means, while posing the least possible risk to people, property, resources, and the environment. IPM provides an effective strategy for managing pests in all arenas from developed residential and public areas to wild lands. IPM serves as an umbrella to provide an effective, all encompassing, low-risk approach to protect resources and people from pests." (from USDA IPM Roadmap, May 17, 2004, northeastipm.org/whatis_ipmroadmap.pdf) (PDF)

IPM Committee – a group designated to addresses pest management issues on an ongoing basis. The committee should include representation from all segments of the school community, including administration, staff and parents. The role of the committee is to formulate IPM policy and plans and provide oversight and ongoing decision-making, incorporating input from all interested parties.

IPM Continuum – the progression of pest management strategies from high-risk, reaction-based action towards least-risk, long-term prevention and avoidance of pest problems. The Continuum begins with a focus on monitoring and chemical suppression when pests approach unacceptable levels, and ends with balanced systems where pests remain at tolerable levels with minimal cultural and biological interventions.

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. For example, the IPM Coordinator may be the facilities manager or environmental manager. For schools with an in-house professional pest management program, the IPM Coordinator may also be the Pest Manager.

IPM Plan – a written document including specific information regarding the operation of the school's IPM program. The IPM plan may include a description of IPM roles for all school staff, parents, students and other community members; pesticide application notification and posting policies; list of key pests; action thresholds, a hazard-based hierarchy of management options and prevention/avoidance strategies to be used for key pests; inspection schedules for school facilities; policies for working with outside contractors; lists of resources for resolving technical questions; and other pertinent information. The IPM plan provides an excellent tool for training new personnel including during management transitions. The plan is a "living document" updated frequently with new information as it becomes available. IPM plans are often developed in binder format so that information can be easily added and updated.

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.

key pest – an insect, mite, disease, nematode or weed that frequently results in unacceptable damage and thus typically requires a management action. Key pests vary from one region to the next. Key pest status is dependent on action thresholds set for the pest. For example, cutworms may be a key pest on high-visibility athletic fields, but not on adjacent lawn areas where the typical level of cutworm damage is very tolerable.

key plant – a plant that frequently experiences unacceptable pest damage and thus typically requires treatment. Key plants can vary from one region to the next as growing conditions become more or less favorable, or where specific pests may or may not be present. Poor care or improper placement of a plant within the landscape can result in increasing its susceptibility to pest problems, turning it into a "key plant".

larva – (pl. larvae) the typically soft-bodied and "worm like" immature life stage between the egg and pupal stage of an insect that undergoes "complete metamorphosis", such as a moth (caterpillar), beetle (grub), wasp (larva) or fly (maggot). For nematodes, larva refers to any life stage between embryo and adult.

LC50 – the concentration of a toxicant in the air or in a body of water that will kill half of a test animal population, typically expressed in parts per million (ppm) or parts per billion (ppb).

LD50 – the lethal dose of a pesticide that will kill half of a test animal population. Usually represents oral or dermal toxicity and is expressed as milligrams of toxicant per kilogram of body weight (mg/kg).

leaching – the process by which some pesticides or other chemicals move down through the soil, usually as a result of movement of water through the soil profile.

lesion – a well-defined area of diseased tissue, such as a canker or leaf spot.

life cycle – succession of stages in the growth and development of a living organism. Individual life stages may be spent in different environments or feeding on different resources. Pest and beneficial life cycles can be important to understand in IPM because certain pest life stages may be more amenable to specific management approaches than others.

maggot – the immature or larval life stage of a true fly (Order: Diptera).

material safety data sheet (MSDS) – an information sheet provided by a pesticide manufacturer describing chemical qualities, hazards, safety precautions and emergency procedures to be followed in case of a spill, fire or other emergency.

mechanical control – management of pests by physical means such as the use of a barrier (e.g., screens or row covers), trapping, weeding or removal of the pest by hand.

metamorphosis – the change in form that takes place as an insect is growing from immature to adult.

microbial – referring to a microscopic organism; commonly taken to mean a "germ." The majority of microbes do not cause disease and in fact are beneficial organisms providing food sources for other organisms, decomposing waste, etc. Some microbes are used as pesticides, for example *Bacillus thuringiensis* is a microbe used as an insecticide.

microbial pesticide – microorganisms that kill or inhibit pests, including insects or other microorganisms. Sometimes microorganisms get rid of pests simply by growing larger in numbers, using up the pests' food supply and invading the pests' environment.

micronutrient – a chemical element necessary in only extremely small amounts (less than 1 part per million in the plant) for the growth of plants or animals.

mildew – a grayish-white fungal disease found on the leaves, shoots and fruits.

mineral soil – a soil consisting predominantly of, and having its properties determined by, mineral matter.

mite – any of several tiny invertebrates related to spiders and belonging to the phylum Arthropoda, class Arachnida.

molds – fungi with conspicuous mycelium or spore masses.

molt – in insects and other anthropoids, the shedding of skin before entering another stage of growth.

monitoring – the regular, on-going inspection of areas where pest problems do or might occur, undertaken to provide accurate information to make appropriate decisions for managing pests.

monoculture – the production of the same plants over a large area, with no other types of plants present.

mulch – layer of material, such as organic matter or plastic, applied to the surface of the soil to retain water and inhibit weeds.

natural control – the suppression of pest populations by naturally occurring biological and environmental agents.

necrosis – death of tissue, usually accompanied by black or brown darkening.

nematicide – an agent such as a chemical or biological preparation used to kill nematodes.

nematode – microscopic cylindrical worms, parasitic on plants or animals or free–living in water.

nymph – the immature stage of an insect that hatches from eggs and gradually acquires the adult form through incomplete metamorphosis, or a series of molts where the nymph look like tiny versions of the adults without wings. Nymphs develop into adults without passing through a pupal stage.

ootheca – an egg case containing multiple eggs. Cockroaches are among the insect groups that produce ootheca.

organic – a material whose molecules contain carbon and hydrogen atoms. Also may refer to plants or animals that are grown without the use of synthetic fertilizers or pesticides.

overwinter – to survive or persist over the winter period.

oviposition – egg laying.

parasites – living organisms which feed on or in other living organisms, generally without killing the host.

parasitoids – arthropods that kill their hosts and complete their development using a single host.

particle size - the size of the individual physical pieces of a substance, e.g., particle size of granular pesticide formulations range in size from 20 to 80 mesh. Mesh size refers to the number of grids per linear inch of screen through which the particles will pass.

pathogen – a living disease–causing microorganism (i.e., bacteria, fungi, virus or mycoplasma).

pathology – the study of disease.

perennial – a plant that lives longer than two years.

pedicel – a flower stem.

pest – a label applied to an organism when it causes problems for humans, including damage to structures, health threats to humans, domestic animals or livestock. For example, there are thousands of species of ants, only a few of which cause problems and thus become pests. All ants, including those that can become pests, provide valuable ecosystem services including removal and decomposition of waste matter and providing food for other species.

pest vulnerable areas – sites where pests are especially likely to occur or cause damage, often due to availability of food, water or shelter. In schools, these include loading docks, dumpster areas, kitchens, food storerooms, cafeterias, teachers' lounges, mechanical rooms and custodial closets.

pesticide – any substance or mixture of substances intended for preventing, destroying or repelling any insect, rodent, nematode, fungus, weed or any other form of pest.

pesticide degradation (half-life) – time required for the concentration of a pesticide in a compartment to decline by one half.

pesticide formulation – pesticide product offered for sale. Pesticides are generally comprised of active ingredient(s), adjuvant(s) and other formulants combined to render the product useful and effective for the purpose claimed.

pesticide label – all printed material attached to or part of the pesticide container including directions for use, and storage and disposal instructions. Users are legally required to follow directions on pesticide labels.

pesticide resistance – natural or genetic qualities of a pest population that enable pests to tolerate the poisonous effects of certain types of pesticides that are toxic to other members of that species.

Pest Management Professional (PMP) – a contractual worker or employed staff engaged in the process of managing pest(s) to tolerable levels by methods that are effective, economically sound and protect human and environmental health.

pest management roles – the responsibilities assumed by individuals in the school system to maintain an environment free of interference from pest and pesticide risks.

pest manager – the individual who conducts actions and/or directs others to maintain effective pest management at a site. The pest manager receives specialized pest management and IPM training and is licensed and certified to apply pesticides in schools. The pest manager may be a school employee or a professional pest manager contracting with the school. For schools with an in-house professional pest management program, the IPM Coordinator may also be the pest manager.

petiole – the stalk connecting the leaf to a stem.

pH –a measure of how acidic or basic a material is. For example, a pH of seven is neutral; pH values less than seven are acidic; values greater than seven are basic). Highly acid (pH of 0-3) or highly basic (pH of 10-14) liquids can be very caustic and dangerous to handle.

phenology – the seasonal life history of a plant, insect or animal.

pheromone – a substance secreted by an animal or insect to attract another animal or insect of the same species.

physical control - management of pests by means such as the use of a barrier (e.g., screens or row covers), trapping, weeding or removal of the pest by hand.

phytotoxic – damaging action of a chemical or abiotic (non-living) substance to plants.

predators – living organisms which feed on other organisms and require several prey organisms to complete their development.

prey – an organism used by a predator for food, for example aphids on plants can be prey for ladybeetles.

primary infection – first infection of a plant by stage of the pathogen that survives the winter (or summer) in a dormant state.

pruning – any removal or cutting of wood from a tree or vine.

psi – pounds per square inch (a measure of pressure), such as output of a pesticide sprayer.

pupa – pre-adult life stage of an insect that undergoes a complete metamorphosis, for example larva, pupa and adult life stages. The pupal stage may take place in a cocoon or shell from which the adult emerges.

residue – traces of a pesticide or its metabolites (e.g., breakdown products) that remain on treated surfaces after a period of time.

resistance – the ability of an organism to withstand exposure to a formerly toxic pathogen or pesticide.

runoff – the liquid spray material that drips from the foliage of treated plants or from other treated surfaces; also the rainwater or irrigation water that leaves a managed area such as a lawn or sidewalk that may have been treated with a pesticide, carrying it to the stormwater drain and into streams.

russet – scorched or burnt appearance of plant surfaces, especially leaves or pods; roughened surface of fruit or vegetables.

rust – a type of fungus that causes a disease. Some rusts cause a reddish lesion on the infected plant.

sampling – removing and/or examining a portion of an entire set (i.e., examining three leaves per plant on 20 plants in a 10–acre field).

secondary pest – a pest that resurges following disruption of control by a natural enemy.

sealant – an elastomeric material used to seal gaps where movement of the treated substrate is expected because it returns to its original size and shape after being stretched (typically by 25 to 50%).

sealer - liquid coating applied to surfaces for filling pores and hairline cracks.

shelf life – the maximum period of time a pesticide can remain in storage before losing some of its effectiveness. Pesticides vary in their stability and response to storage conditions.

signal words – the words used on a pesticide label, i.e., Danger, Warning, Caution, to indicate level of acute toxicity with Danger representing the most toxic.

simple metamorphosis – in insects, development in which there is no pupal stage.

soil map – a map showing the distribution of soil types or other soil mapping units in a relation to the prominent and cultural features of the earth's surface.

soil profile – a vertical section of the soil through its horizontal layers.

spore – the reproductive "seed" of fungi and some bacteria which can be spread, and when arriving at a suitable host, can germinate and cause disease in the host.

spot treatment – the application of pesticides in small, localized areas where pests are concentrated, congregating or are just beginning to emerge rather than applying a broadcast application over a larger, general area.

sterilization – to treat with a chemical or other agent for the purpose of eliminating living organisms from soil, tools, surfaces, etc.; eliminating the ability of an organism to reproduce.

structural pest – a pest found in or on structures such as a termite or wood rot fungus that destroys wood in buildings, sometimes referred to indoor pests vs. outdoor or landscape pests.

surface tension – forces on the surface of liquid droplets that keep them from spreading out over treated surfaces.

susceptibility – inability of an organism to resist toxic affects of pathogens or pesticides.

suppress – to lower the level of a pest population.

swath – the area covered by one pass of the pesticide application equipment.

symptoms – the apparent changes in an organism as a result of attack, such as by a pathogen or pesticide.

thorax – the second of three main body divisions of an insect. The thorax bears the legs and wings.

tolerance – ability of an organism to withstand attack by pathogens or pesticides without suffering serious injury; the legal amount of pesticide residue permitted on a product.

top dressing – lime, fertilizer or manure applied after the seedbed is ready or after the plants are up.

toxicity – the inherent ability of a chemical substance or organism to produce injury.

toxin – a poison.

transpiration – loss of water in the form of water vapor from above–ground parts of plants.

volatile - any substance which evaporates quickly.

volatility – ability of a substance to evaporate rapidly.

volatilization – evaporation of a pesticide into the atmosphere from a solid or liquid form.

weed – a plant growing where it is not desired.

wetting agent – a compound that, when added to a spray solution, causes it to contact plant surfaces more thoroughly.

wilt – drooping of plants due to insufficient water supply, may be caused by insect or disease injury or simply lack of water.

Appendix E. Development Meeting Participant Contact Information and Biographies

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Darryl Alexander - Program Director, Health and Safety, American Federation of Teachers

Darryl Alexander established the AFT Health and Safety Program in 1989. She has testified on important public health issues before Congress and federal regulatory agencies on behalf of AFT members and their students and clients. Ms. Alexander has served on advisory committees of the National Institute for Occupational Safety and Health (NORA-Indoor Air Quality) and EPA (sub-committee on Children's Environmental Health). Most recently, she has been awarded a five- year OSHA grant to develop a comprehensive occupational safety and health training program for all school employees. IPM is an integral part of the annual five day training that the AFT holds for leaders, staff and activists. The IPM module covers policy as well as the technical issues involved in implementing an IPM program in a school district.

John Ayers – Co-Director, USDA Northeastern IPM Center

John Ayers is a Professor of Plant Pathology at Pennsylvania State University and is a co-Director of the Northeastern IPM Center. Cornell University and Penn State cooperate to manage the NE Center. The four regional IPM Centers along with CSREES provided funds to develop the School IPM Pest Management Strategic Plan. John also is the Director of Penn State's Pesticide Education Program which employs extension associates and related support staff (a total of nine individuals).

Thomas Babb- Senior Environmental Research Scientist, Department of Pesticide Regulation

Thomas Babb has over twenty-five years of agricultural production and pest management experience in private and public settings. Currently he is the lead scientist in charge of the Department of Pesticide Regulation's School Integrated Pest Management (SIPM) program established with the passage of the Healthy Schools Act in 2000. The program provides resources and training to assist school district staff to establish IPM policies and practices. To date, SIPM scientists have provided hands-on pest management training to over 60 percent of the nearly 1,000 school districts in California, published a comprehensive SIPM Guidebook, numerous curricula, fact sheets, posters and a pest prevention calendar, and established a website, www.schoolipm.info. Babb is Vice-President of the California Chapter of the American Society of Agronomy.

Herb T. Bolton, Ph.D., B.C.E. - National Program Leader, Plant Systems Unit, CSREES, USDA

In addition to his position at the USDA, Bolton provides leadership for planning, development, and organizing; and management of research, extension, and education programs related to the needs of Army pest management and environmental programs on Army installations (through an Interagency Agreement with the US Army Environmental Center – USAEC). He provides technical assistance to the USAEC on pest management, invasive species, environmental and conservation programs. The USAEC is actively involved in IPM STAR recognition of Army installation Child Development Centers. Herb is board certified in entomology in the medical and veterinary entomology and the urban and industrial entomology categories.

Lynn Braband- Extension Associate, NYS Community IPM Program at Cornell University

Lynn Braband, a certified wildlife biologist, was company vice president and franchise owner/manager of Critter Control, Inc. from 1986 through 1997. He has been an active participant and leader in both state and national vertebrate pest control organizations.

Braband's activities with the Community IPM Program have included organizing school IPM implementation workshops throughout New York state, surveying the status of school pest management programs, and conducting IPM demonstration projects at schools. His most recent project has been supervising a team-based "learning community" approach to the development of several model school IPM programs.

Paul Cardosi - Western Region Sales Manager, Ecolab Pest Elimination

Cardosi represents Ecolab Pest Elimination and is an Assistant Vice President of Corporate Accounts, Government Sales, Western US. He has just completed his 26th year with Ecolab. Sixteen of those years he spent with the Institutional Division and the last 10 years with the Pest Elimination Division holding various positions in Corporate Accounts. Paul continues to focus on developing Ecolab's IPM program for multiple market segments.

Dr. Robert Corrigan - President, RMC Pest Management Consulting

Corrigan has a bachelor's degree in urban and industrial pest control and his master's degree in vertebrate pest management from Purdue University. After graduating, he worked as a technical specialist for Terminix International. Corrigan then returned to Purdue and worked as an extension specialist, teacher and researcher at Purdue's Entomology Department for 16 years in vertebrate pest management, with an emphasis on rodent control. In his spare time he completed a Ph.D. in rodent pest management. Corrigan is author of *Rodent Control: A Practical Guide for Pest Management Professional*s, and co-author of several of the Purdue University pest control correspondence courses. During the past 15 years, Corrigan has published more than 100 technical articles focusing on structural pest control, and is a columnist for PCT (Pest Control Technology) magazine. He received a PCT Leadership Award in 2000. As a consultant, Corrigan has worked with numerous pest control companies and some of the largest food companies in the United States, conducting inspections and IPM programs. He has conducted pest management training and consulting services in more than 44 states as well as Europe, Canada, Asia and South America.

Ellie Engler - Director, Department of School Safety and Health, United Federation of Teachers

As a Special Assistant to the President and the Director of the Department of School Safety and Health for the United Federation of Teachers, Engler oversees all operations of two departments, works on strategic planning and policy for the Union and participates as a leader in special projects. Engler conducts safety and health inspections including air monitoring in public schools throughout New York City. She develops and conducts health and safety trainings (indoor air quality, laboratory safety, bloodborne pathogens, communicable diseases, ergonomics, emergency preparedness, workplace violence, etc.) for staff members, implements and oversees all aspects of health and safety grants, and develops and implements school-wide health and safety programs including the laboratory inspection program. Prior to 1996 when she began working full time for the UFT, she worked as an industrial hygienist consultant for a variety of unions including the UFT, AFT, and IBEW Local 25. She conducted site inspections, wrote curriculum for asbestos handler's courses, coordinated training on asbestos handling for IBE and wrote health and safety manuals for NYSUT, UFT, Empire College and other unions.

Jay Feldman - Executive Director, Beyond Pesticides

Feldman is a cofounder of Beyond Pesticides and has served as its director since 1981. Jay dedicated himself to finding solutions to pesticide problems after working with farm workers and small farmers through an EPA grant in 1978 to the national advocacy organization Rural America (1977-1981). Since that time, Jay has helped to build Beyond Pesticides' capacity to assist local groups and impact national pesticide policy. He has tracked specific chemical effects, regulatory actions, and pesticide law. He is very familiar with local groups working on pesticides and has helped develop successful strategies for reform in local communities. His work with media has helped to bring broader public understanding of the hazards of pesticides. Jay has a Masters in urban and regional planning with a focus on health policy from Virginia Polytechnic Institute and State University (1977), and a B.A. from Grinnell College (1975) in political science.

Michael Fitzner - Director, Plant and Animal Systems, USDA CSREES
Fitzner is director of the plant systems section at USDA's Cooperative State Research, Education, and Extension Service's (CSREES). He provides coordination and oversight for the plant system section's research and extension programs focused on the development of safe, environmentally friendly, and economically sustainable plant production and protection systems. He provides program leadership for the Regional Integrated Pest Management Centers and other agency investments in integrated pest management research and extension programs. Mike earned a B.S. in Horticulture from North Carolina State University, an M.S. in Agronomy (Plant Breeding) from the University of Florida, and a Ph.D. in Crop Science (Plant Breeding) from North Carolina State University. Prior to joining CSREES, he was a plant breeder with the peanut breeding program at North Carolina State University.

Al Fournier - IPM Program Manager, University of Arizona
In his current role, Fournier coordinates with faculty, clientele and other stakeholders to identify statewide pest management priorities, organizes UA faculty to develop solutions, supports efforts to secure external funding, and develops resources to measure and document IPM program adoption and impacts. His responsibilities span all program areas and departments related to pest management, including agricultural, urban and natural resource systems. He also coordinates pesticide information requests from EPA and USDA for 3 Southwest states (AZ, NM, NV, plus parts of CA) and serves as liaison to the Western IPM Center. He has a PhD in Entomology from Purdue University (2005) where he studied factors affecting adoption and implementation of IPM in K-12 public schools. After earning is MS in Entomology at University of Maryland (studying turf IPM) he wrote Crop Profiles for that state from 1998 to 2000.

Lyn Garling - Manager of Programs, PA IPM Program, Penn State University
Garling runs all IPM planning, grant writing, outreach, teaching, research and implementation activities dependent upon needs of the PA IPM Program. Recent program emphases at Penn State include community IPM education & pesticide use reduction, less-toxic pesticide choices, IPM implementation in inner-city, low income housing, IPM outreach to health professionals, and IPM in Schools. IPM in Schools efforts include formal education (developing IPM curriculum for K-12, IPM service-learning projects) and implementation (developing policies and guidelines for IPM implementation in schools, promoting IPM STAR Certification and EPA Indoor Air Quality Tools for Schools). Other continuing IPM outreach efforts include "The BugMobile!", a traveling educational experience that takes IPM to the general public at county fairs, schools and other events. Past IPM activities include collaboration on field manuals in conservation tillage and field crop IPM; cooperation with producers and retail outlets in IPM labeling; conducting IPM needs assessments and prioritization across 13 commodities.

Sherry Glick - National Coordinator, Pesticides and Schools, US EPA, Office of Pesticide Programs
Glick has been with the US Environmental Protection Agency for 25 years. Presently, she is a Sector Leader for the Pesticide Environmental Stewardship Program (PESP) in the Office of Pesticide Programs where she is lead for the schools and environmental sectors. She has

worked with PESP since its inception in 1994. Glick also serves as the National Coordinator for Schools and Pesticides within EPA. Prior to her work with PESP, she was accepted into the Greater Leadership Opportunity Program with EPA where she served at EPA's Region 3's Chesapeake Bay Program Office. She also had the opportunity of being the only graduate of GLO to shadow past Administrator Carol Browner. Glick was awarded the Hammer Award from Al Gore's Office of Reinvention for progress in developing the Partners for the Environment Program. Glick is a graduate of Michigan State University. She resides in Henderson, Nevada.

Dawn H. Gouge- Urban Entomologist, University of Arizona, Maricopa Agricultural Center
At the MAC Gouge is working to expand the current IPM in Schools and Child Care Facilities Program promoting Integrated Pest Management (IPM) in the urban environment. She is currently evaluating whether entomopathogenic nematodes are biocontrol agents of scorpion, cockroach, ant and subterranean termite pest species. Gouge also manages an urban IPM Web site, ag.arizona.edu/urbanipm/ and conducts regular IPM clinics.

Thomas Green - President, IPM Institute of North America
Green is president of the IPM Institute of North America, Inc., a non-profit organization he co-founded in 1998. The Institute's mission is to leverage marketplace power to improve health, environment and economics in agriculture and communities. The Institute operates the IPM STAR program, evaluating and certifying schools nationwide for their pest management practices and impacting more than 2 million children since its inception in 2003. In 2004 and 2005, the Institute was named a Pesticide Environmental Stewardship Program Champion by US EPA. Clients and funders have included US Army, US EPA, USDA, SYSCO Corporation, Whole Foods Market, General Mills and the Universities of Wisconsin, Florida, Cornell and Rutgers. Dr. Green has been an apple grower, and founder and owner of an IPM supply business that is now part of GEMPLER'S. He is a Certified Crop Advisor and holds a Ph.D. in entomology from the University of Massachusetts.

Linda Herbst - Associate Director, Western IPM Center, University of California-Davis
Herbst has been with the Western IPM Center (WIPMC) since its creation in 2000 and manages several of its functions. She helps to coordinate interactions among various pest management programs and stakeholders throughout the western United States, and as the Center's Pest Management Strategic Plan coordinator, Linda has facilitated numerous Pest Management Strategic Plans. She serves as the grant manager for WIPMC competitive funds and acts as the liaison between the WIPMC and funded workgroups. Linda is committed to assisting western stakeholders in identifying research, regulatory, and education priorities in agricultural, urban, and natural settings.

Lynnae Jess- Associate Director, North Central IPM Center
Jess is in charge of the Crop Profiles and the Pest Management Strategic Plans for the North Central Region and for the grants administered under the IPM Documents category of our Enhancement Grants. The IPM in Schools PMSP was one of the IPM Documents funded for 2006.

Marc Lame - Clinical Professor, Indiana University, School of Public and Environmental Affairs
Marc Lame spent the first nine years of his career as an Extension IPM Specialist with the University of Arizona Entomology Department, where he was responsible for the implementation of Integrated Pest Management in cotton and other field crops. In 1995 Marc initiated a school

Integrated Pest Management (IPM) program with the Monroe County Community School Corporation in Bloomington, Indiana. The "Monroe IPM Model" for schools proved to be sustainable in Bloomington as well as highly transferable. He and his colleagues have demonstrated and documented the effectiveness of this model in seven states (USEPA Regions 4, 5, 8 and 9 – including 3 Native American school districts), over ten years, showing an average 71% reduction in pesticide applications and 78% reduction in pest complaints to school administrations. Dr. Lame has recently published *A Worm in the Teacher's Apple: Protecting America's School Children from Pests and Pesticides*. In April of this year Marc was recognized by the US EPA and USDA sponsors of the National IPM Symposium with the first ever IPM Achievement Award.

Jack Marlowe - President, Eden Advanced Pest Technologies
Marlowe is the owner of Eden Advanced Pest Technologies in Olympia, Washington. Eden has been involved with IPM work for the past 18 years. During that time, Marlowe has participated in many IPM committees including the IPM in Schools Working Group in Washington State. Marlowe has served as an IPM consultant for many municipalities, school districts and commercial properties as well as being an active proponent of IPM within the pest control industry.

Rick Melnicoe - Director, Western IPM Center, University of California-Davis
Melnicoe has directed the Western Integrated Pest Management Center since 2000. In this capacity he helps to coordinate interactions among various pest management programs and stakeholders throughout the western US Rick has facilitated the majority of the Pest Management Strategic Plans workshops held in the west. These plans detail the pest management issues facing producers and outline current research, regulatory and educational needs of stakeholders. He has a strong commitment to helping find pest management solutions in agriculture, urban and natural settings.

Kathleen Murray - IPM Entomologist, Maine Department of Agriculture, Food and Rural Resources
Kathy Murray serves as the coordinator of IPM activities for the Maine Department of Agriculture, Food and Rural Resources. In that capacity she provides pest management expertise in a variety of agricultural and non-agricultural settings including vegetable crops, ornamental horticulture, livestock and poultry, and schools. Kathy coordinates the Maine School IPM Program which offers training, technical support and outreach to help all Maine schools adopt IPM in compliance with state regulations. She earned a Ph.D. in entomology from the University of Massachusetts and an M.S., also in entomology, from the University of Maine.

Faith Oi - Assistant Extension Scientist, University of Florida
Dr. Faith Oi is currently an Assistant Extension Scientist at the Entomology and Nematology Dept. at University of Florida where her research focuses on termite and ant IPM. She is also working on developing the urban pest management training facility and is co-director of the School IPM program with Dr. Rebecca Baldwin.

Chip Osborne - President, Osborne Florist and Greenhouse
Charles "Chip" Osborne owns and operates Osborne's Florist and Greenhouse in Marblehead, MA and is a professional horticulturist with over 30 years experience. Chip is the co-Chair of the Marblehead Pesticide Awareness Committee and he is also the co-chair of Marblehead's Living Lawn Project, a "seeing is believing" organic lawn and garden demonstration site. Chip lectures widely on organic turf management, both to homeowners and municipalities, and has

addressed many audiences. Currently, Chip is teaching classes to certify landscape professionals on natural, organic methods in conjunction with the New York State Turf and Landscape Association, Grassroots Environmental Coalition, and the County of Westchester in New York. He is also the president of Osborne Organics, a consulting company, specializing in working with municipalities and school districts in the area of pesticide reduction and natural turf management. As a member of the Town of Marblehead Recreation, Parks & Forestry Commission (an elected position) for the past six years, and the current chairman for the past four, Chip is currently implementing an Organic Turf Management Plan for the Town of Marblehead public lands, including athletic fields ~ leading the way for organic playing fields in Massachusetts.

Alan Paulson - Coordinator, Landscaping and Grounds, Clark County School District
Alan Paulson obtained a Bachelor of Landscape Architecture degree from Kansas State University. Upon graduation, Alan spent eight years in the Denver area in Landscape Design and Construction. Alan started in his position as Coordinator, Landscaping and Grounds in 1988. During his tenure, Clark County School District has grown from 119 schools to 325 schools. All these sites have some degree of issues of pest control inclusive of weeds, ants, killer bees, and hungry rodents. Alan's goal is to maintain a safe, healthy, and aesthetic outdoor environment while using the 'least toxic' pest controls reducing risk to the 300,000 students in the district.

Gretchen V. Pettis - IPM Program Coordinator, University of Georgia
Dr. Pettis is an Extension Entomologist for the University of Georgia. Gretchen develops, delivers and evaluates Integrated Pest Management (IPM) programs for turf, ornamental plant and urban insect pests. Of particular interest to her is determining decision making guidelines for landscape and nursery pests which incorporate knowledge of the biology, behavior, and damage potential, as well as associated beneficial arthropods and proper timing of chemical applications. Dr. Pettis also develops and conducts educational programs in the areas of pesticide risk reduction and pesticide applicator training in conjunction with the State Pesticide Coordinator. Gretchen has been involved with School IPM since 1999. She has developed self assessment tools and Extension publications for schools to assist with implementation and is currently in the process of piloting School IPM in two Georgia counties with grant funds from the Georgia Department of Agriculture.

James Reny- School Facilities Management Committee Chair, The National Association of School Business Officials and Business Manager, Waterville Public Schools
Reny has worked for the Waterville Public Schools for more than 18 years. He is responsible for all construction and major renovation projects for the district, and currently oversees the day-to-day operations of all district facilities, as well as short term planning and long term capital-asset management. He is past president of the Maine Association of School Business Officials and received their David Holden Award as the Outstanding School Business Official for 2002. He serves as co-chairman of the International Association of School Business Officials' School Facilities Management Committee. Jim also serves as president of the Maine Educational Plant Maintenance Association and is involved in planning its yearly three day custodial and maintenance conference/workshop. Jim has served as a stakeholder on several initiatives at the Maine Department of Education dealing with educational facility issues such as facility management, asset management, funding and IPM.

Paul J. Romano - Senior Research Architect, AIA
Romano is currently leading the effort to define the characteristics of educational facilities for the

nearly four hundred plus schools to be constructed over the next decade by the New Jersey Schools Construction Corporation. Paramount to such efforts is the intent to resolve many of the customary conflicts between Design & Construction and Operation & Maintenance procedures / regulations, specifically including pest management, across State Agencies. Prior to joining the Center, he was a Project Architect with Platt Byard Dovell & White, a NYC architectural firm specializing in educational and adaptive reuse projects. As an Associate of Steven Winter Associates (building system consultants specializing in sustainable design), he developed innovative prototypical housing for some of the nation's largest home builders under the DOE Building America Program and provided technical assistance to numerous governmental and industry clients including the National Renewable Energy Laboratory, the Federal Emergency Management Agency, the Louisiana Pacific and Dupont corporations. In addition to these consulting services he continues to lecture at both academic institutions and professional events, including the City University of New York, Oberlin College, NJIT, and the USGBC and NESEA annual conferences.

Guy Russell - Business Development Manager, EcoSMART
Russell has an extensive background in senior management and leadership roles in South Africa and Europe, with particular emphasis on strategizing, planning and program execution, specializing in business development, turnarounds and streamlining. Upon arriving in the US, Russell joined Steritech in the Pest Control Division and subsequently, EcoSMART Technologies as Business Development Manager. Russell has been working within the Structural Pest Control industry, including school district and university IPM programs in the development of safer pest control programs and protocols, using EXEMPT and Low Toxicity Registered products.

Mark Shour - Extension Entomologist, Iowa State University
At Iowa State University Extension, Shour is responsible for pesticide applicator training and implementation of IPM principles for trees, shrubs, turf, greenhouses, households, businesses, child cares and schools. Shour is also the school IPM coordinator for Iowa State University Extension. He has conducted a state pesticide use survey of K-12 public schools, an interior pest pilot program (4 schools) and an athletic field/landscape pilot program (5 schools) in Iowa. Shour plans to begin working with licensed child care centers autumn 2006 in association with Iowa Departments of Human Services and Public Health.

Richard E. Smith- Director, Environmental Health & Safety, Brevard Public Schools
Richard Smith's support for IPM began in 1995 when he joined Brevard Public Schools; currently the 9th largest school district in Florida, with over 75,000 students and 10 million square feet of building space. Richard's leadership led to the school district receiving recognition in a 1998 front page article in *Education Week* entitled, "Florida Schools Are Cleaning Up in Effort to Cut Pesticide Usage" and awards from the University of Florida and the USEPA for its support of IPM. He has directed district-level plant operations and custodial programs and actively participated in IPM activities at the state and national level. Richard received his B.S. degree in Zoology and M.S. degree in Biological Science from the University of Central Florida and holds three national board certifications in the field of environmental health and safety. He is a member of numerous professional organizations and president of the Florida School Plant Management Association.

Appendix F. References

The following publications are cited in the document or are recently published and pertinent to school IPM. For an extensive general bibliography of school-IPM-related publications organized by topic areas, see *IPM Standards for Schools* (www.ipminstitute.org/school_standards.htm).

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Appendix H. School IPM Planning and Evaluation Tool

Documenting impacts has become increasingly important for planning and funding new programs. An effective evaluation plan, specifically one that describes not only proposed activities but impacts that will result, can determine if a proposal will be funded. The following is a peer-reviewed model developed specifically for school IPM. It includes the following key elements to be identified as part of the planning and evaluation process:

- Inputs – What is needed to carry out the program effectively? Examples include: money, staff, and material resources.
- Target audiences – Who will the program reach? Target audiences can be very diverse and may include administrative, faculty and maintenance staff, students, parents, policy makers and others.
- Proposed activities – What specific kinds of actions will be taken when working with target audiences? Typically, these include training, education, site assessments, practice and product review, recommendations, pest management surveys, etc.
- Proposed outputs – Outputs are products that result from the program activity including print or electronic training materials, web sites and IPM contracts or bid documents. These are not impacts or outcomes, but means to those changes.

Impacts are actual changes in outcomes that occur over time:

- Short term impacts are achieved within one to two years and typically include basic changes in knowledge and practice that result from program activities and outputs. Examples include improved knowledge by target audiences of the role IPM can play in reducing pests, increased awareness of existing pest problems and the health effects of pest and pesticide exposure, and changes in basic practices such as improving exclusion by installing doorsweeps, or transitioning to less toxic pesticides or formulations that reduce exposure.
- Intermediate term impacts occur over a period of two to four years and include changes in behavior, attitude or formal policy. Documented evidence that schools, districts, or childcare facilities reduced use of highly toxic pesticides over an extended period of time is one such impact.
- Long term impacts are changes in some condition that occur over four to ten years. Sometimes referred to as “ultimate impacts”, these are significant impacts such as reducing children’s exposure to pesticides and improving health and the learning environment.

The following models include examples of measures that can be used to document impacts over the short, intermediate or long term. Additional impact indicators are likely to be identified during the course of your work and these can be added.

Focus Area: Residential and Public Areas (Schools and Child Care Facilities)
Impact Area: HUMAN HEALTH IMPACTS
Roadmap Goal: Reduce potential risks to human health from pesticide use through the use of cost-effective IPM practices

Inputs → **Audience Activities** → **Outcomes**: **Short Term (Knowledge)** → **Intermediate (Actions)** → **Long Term (Conditions/Impact)**

Inputs

- Money
- People
- Time
- Interagency Cooperation
- In-kind resources, including infrastructure for information delivery and support

Audience Activities

Audience

- Advocacy Groups
- Building Managers
- Children
- Food Service Staff
- Government Agencies (fed, state, local)
- Grounds Managers
- Extension
- Janitorial Staff
- Media
- Parents
- Pest Control Operators
- PTO's/PTA's
- Regulators & Lawmakers
- School Boards
- School Administrators
- School Nurses
- Teachers
- Unions
- Waste Management

Activities

- Interagency Cooperation
- Media
- Non-Formal Educational Channels (education publications)
- Partnerships with School Associations (e.g. Unions, PTA, etc.)
- Print/Electronic Materials
- Research & Demonstration
- Web Sites
- Workshops
- Orientation sessions
- Presentations
- Training sessions

Short Term (Knowledge)

Short Term Impacts

- Target audiences improve knowledge of IPM role in reducing pests in schools and child care facilities
- Target audiences increase awareness of existing pest problems and health effects of pest exposure
- Target audiences increase awareness of sources and health effects of pesticide exposure
- Target audiences improve knowledge of efficacy of lower risk IPM tactics and materials
- Target audiences increase knowledge of benefits of using precision application technology and equipment
- Target audiences increase knowledge of existing IPM laws/policies in other states/schools/districts
- Target audiences understand the need to train staff to implement pest management strategies
- Target audiences increase knowledge of how to develop a school/childcare facility IPM plan
- Target audiences increase knowledge of how to develop a school/childcare facility IPM contract and/or bid specification
- Target audiences increase awareness of School IPM Certification Programs

Intermediate (Actions)

- Schools districts, and child care facilities begin/increase use of IPM tactics
- Schools districts, and child care facilities reduce/eliminate pest problems
- Parents and school boards request/support fewer pesticide inputs through use of increased IPM practice
- Schools, districts, and child care facilities reduce use of highly toxic pesticides
- Schools districts, and child care facilities increase adoption of lower risk pesticides
- Schools districts, and child care facilities increase adoption of precision application technology and equipment
- Schools, districts, child care facilities and/or states adopt IPM laws and/or policies
- Schools and child care facilities provide/increase staff training in implementing IPM tactics
- School, day care facility maintenance staff become certified applicators
- Schools districts, and child care facility staff develop and implement an IPM plan
- Schools districts, and child care facilities develop and release an IPM contract and/or bid specification
- Schools districts, and child care facilities become IPM Certified
- Children influence parent's management of pests in their homes

Long Term (Conditions/Impact)

Reduce children's and others exposure to pesticides in schools and child care facilities and thus improve health and the learning environment

Possible Measures:

- Measure reduced pesticide incident reporting
- Measure reduced incidence of asthma or other health problems associated with pests or pesticides
- Measure improvement in indoor air quality
- Measure reduction in pest-related complaints
- Measure reduced school and child care facility absences

Focus Area: Residential and Public Areas (Schools and Childcare Facilities)
Impact Area: ECONOMIC IMPACTS
Roadmap Goal: Improve economic benefits of adopting IPM practices

Inputs → Audience Activities → Outcomes: Short Term (Knowledge) → Intermediate (Actions) → Long Term (Conditions/Impact)

Inputs

- Money
- People (economists)
- Time
- Interagency Cooperation
- In-kind resources, including infrastructure for information delivery and support

Audience Activities

Audience

- Advocacy Groups
- Building Managers
- Extension
- Government Agencies (fed, state, local)
- Media
- Pest Control Operators
- Policymakers
- School Administrators
- School Boards
- Taxpayers
- Teachers
- PTO's/PTA's

Activities

- Interagency Cooperation
- Media
- Non-Formal Educational Channels (education publications)
- Print/Electronic Materials
- Research & Demonstration
- Web Sites
- Workshops
- Orientation sessions
- Presentations
- Training sessions

Outcomes

Short Term (Knowledge)

- Target audiences increase awareness of IPM benefits in reducing pest management costs (including externalities) in schools/childcare facilities
- Target audiences increase knowledge of cost-effectiveness and efficacy of specific lower-risk IPM tactics and application technology
- Target audiences increase knowledge of cost-effectiveness of training staff (e.g., kitchen, custodial, educational or other) to implement IPM strategies
- Target audiences increase knowledge of how to develop a school/childcare facility IPM plan
- Target audiences increase knowledge of how to develop a school/childcare facility IPM contract and/or bid specification
- Target audiences increase awareness of School IPM Certification Programs

Intermediate (Actions)

- Target audiences prioritize IPM as a cost-effective long-term solution to pest management problems
- Parent groups and school boards request/support fewer pesticide inputs through use of increased IPM practices
- Increase in schools, districts, agencies, and/or states that develop IPM policies/laws
- Increase in schools/districts that become IPM Certified
- Government provides funding for implementing IPM in Schools programs
- Increase in number of schools/districts/childcare facilities that adopt IPM practices
- Schools, districts, childcare facilities, and/or agencies provide/increase staff training in implementing IPM strategies
- Maintenance staff become certified applicators after receiving IPM training
- Schools, districts, childcare facilities and/or agencies eliminate need for outside pest management contracts after staff become certified applicators
- Increase in schools, districts, childcare facilities, and/or agencies that develop IPM plans
- Increase in schools, districts, childcare facilities, and/or agencies that implement IPM plans
- Increase in the number of schools districts, childcare facilities, and/or agencies that develop contracts/bid specifications with specific IPM wording
- Increase in schools, districts facilities, and/or agencies that issue

Long Term (Conditions/Impact)

Schools use cost-effective IPM practices

Possible Measures:

- Measure change over the long term in school/child care facilities/agency cost of pest management after adopting IPM
- Measure increase in the number of IPM Certified Schools/Districts

Appendix I. Directory of Organizations with Roles in School IPM

National Organizations – School Related	Website
American Association of School Administrators	www.aasa.org
American Federation of School Administrators	www.admin.org/
American Federation of Teachers	www.aft.org
American School Health Association	www.ashaweb.org
Association of American Educators	www.aaeteachers.org/
Association of College and University Housing Officers International	www.acuho.ohio-state.edu
Association of School Business Officials International	www.asbointl.org
Children's Environmental Health Network	www.cehn.org
Children's Health Environmental Coalition	www.checnet.org/improve_main.asp
Council of Educational Facility Planners (CEFPI)	www.cefpi.org
National Association of School Nurses	www.nasn.org/
National Association of State Boards of Education	www.nasbe.org/
National Clearinghouse for Educational Facilities	www.edfacilities.org
National Independent Private Schools Association	www.nipsa.org/
National PTA	www.pta.org
National PTO	www.ptotoday.com
National School Boards Association	www.nsba.org
National School Foundation Association	www.schoolfoundations.org/
New England Sports Turf Managers Association	www.nestma.org/
SchoolFacilities.com	www.schoolfacilities.com
School Health Alert Newsletter	www.schoolnurse.com
School Leaders Risk Management Association	www.slrma.org/
School Nutrition Association	www.schoolnutrition.org/
Sports Turf Association	www.sportsturfassociation.com/
Sports Turf Managers Association	www.stma.org/
Sustainable Building Industry Coalition	www.buildingmedia.com/sbic
United Federation of Teachers	www.uft.org
US Department of Education	www.ed.gov

National Organizations – Pest Management Related	Website
American Association of Pesticide Safety Educators	www.aapse.org/
American Industrial Hygiene Association	www.aiha.org/
Association for International Agriculture and Extension Education	www.aiaee.org/
Association of American Pesticide Control Officials	www.aapco.ceris.purdue.edu/index.html
Association of Professional Industrial Hygienists	www.apih.us/
Association of Structural Pest Control Regulatory Officials	www.aspcro.org/
Hospitals for a Healthy Environment	www.h2e-online.org
National Association of County and City Health Officials	www.naccho.org/
National Pest Management Association	www.npmapestworld.org/
PestSure	www.pestsure.com/about.htm

State Organizations – School Related	Website
Alabama Association of School Boards	www.theaasb.org/
Alabama Association of School Business Officials	www.aasbo.com/
Alabama Independent School Association	www.aisaonline.org
Alabama Parent Teacher Association	www.alabamapta.org/
Alaska Association of School Boards	www.aasb.org/

Alaska Association of School Business Officials	www.alasbo.org/
Alaska Council of School Administrators	www.alaskaacsa.org/
Alaska PTA	www.alaska.net/~akpta/
Arizona Association of School Business Officials	www.aasbo.org/
Arizona PTA	www.azpta.org/
Arizona Private School Association	www.arizonapsa.org
Arizona School Administrators	www.azsa.org/
Arizona School Boards Association	www.azsba.org
Arizona Sports Turf Managers Association	www.azstma.com/
Arkansas Association of Educational Administrators	www.aaea.k12.ar.us/
Arkansas PTA	www.arkansaspta.org/
Arkansas School Boards Association	www.arsba.org/
Associated School Boards of South Dakota	www.asbsd.org/
Association of California School Administrators	www.acsa.org/
Association of Colorado Independent Schools	www.acischools.com/
Association of Independent Maryland Schools	www.aimsmd.org/
Association of Independent Schools in New England	www.aisne.org/
Association of School Business Officials Maryland and the District of Columbia	www.asbo.org/
Association of Wisconsin School Administrators	www.awsa.org/
Athletic Field & Grounds Managers of Indiana	www.iplla.com/afgmi.htm
California Association of Independent Schools	www.caisca.org/
California Association of Private School Organizations	www.capso.org/
California School Boards Association	www.csba.org
California School Employees Association	www.pub.csea.com/cseahome/
California State PTA	www.capta.org
California Teachers Association	www.cta.org
Carlisle School Association	www.carlisleschoolassociation.org/
Children's Home Society of Washington	www.childrenshomesociety.org/
Collaborative of High Performance Schools (CA)	www.chps.net/index.htm
Colorado Association of School Boards	www.casb.org/
Colorado Association of School Business Officials	www.coloradoasbo.org/
Colorado Parent Information and Resource Center	www.cpirc.org/
Colorado PTA	www.copta.org/
Colorado Private Schools Association	www.coloradoprivateschoolassociation.com/
Colorado Sports Turf Managers Association	www.cstma.org/
Connecticut Association of Boards of Education	www.cabe.org/
Connecticut Association of Independent Schools	www.caisct.org/cais/default.aspx
Connecticut Association of School Business Officials	www.ct-asbo.org/
Connecticut Association of School Personnel Administrators	www.ctaspa.org/
Connecticut PTA	www.ctpta.org/
Cooperative Council for Oklahoma School Administration	www.ccosa.org/
Delaware Association of School Administrators	www.edasa.org/
Delaware PTA	www.delawarepta.org/
Delaware School Boards Association	www.edsba.org/
Eastern North Carolina Sports Turf Association	www.ncsportsturf.org/easternturf/
Florida Association of Christian Colleges and Schools	www.faccs.org/
Florida Association of School Administrators	www.fasa.net/
Florida Association of School Business Officials	www.fasbo.org/
Florida Council of Independent Schools	www.fcis.org/
Florida PTA	www.floridapta.org/

Florida School Boards Association	www.fsba.org/
Florida Turfgrass Association	www.ftga.org
Georgia Association of Christian Schools	www.gacs.org/
Georgia Association of School Business Officials	www.gasbo.org
Georgia Association of School Nurses	www.gasn.org/
Georgia Golf Course Superintendents Association	www.ggcsa.com/
Georgia Independent School Association	www.gisa-schools.org
Georgia PTA	www.georgiapta.org/
Georgia School Boards Association	www.gsba.com/
Georgia Teachers Organization	www.gateachers.org
Hawaii Association of Independent Schools	www.hais.org/
Hawaii State PTSA	www.hawaiiptsa.org/
Idaho Association of School Business Officials	www.idahoasbo.org/
Idaho Golf Course Superintendents Association	www.idahogcsa.org/
Idaho PTA	www.idahopta.net/
Idaho School Boards Association	www.idsba.org/
Illinois Association of School Administrators	www.iasaedu.org/
Illinois Association of School Boards	www.iasb.com
Illinois Association of School Business Officials	www.iasbo.org/
Illinois PTA	www.illinoispta.org/
Independent Schools Association of Northern New England	www.isanne.org
Independent Schools Association of the Central States	www.isacs.org/
Independent Schools Association of the Southwest	www.isasw.org/
Indiana Association of School Business Officials	www.indiana-asbo.org/
Indiana Partnership Center	www.fscp.org/
Indiana PTA	www.indianapta.org/
Indiana School Boards Association	www.isba-ind.org/
Iowa Association of School Boards	www.ia-sb.org/
Iowa Association of School Business Officials	www.iowa-asbo.org/
Iowa PTA	www.iowapta.org/
Iowa School Buildings and Grounds Association	www.isbga.org/
Kansas Association of School Boards	www.kasb.org/
Kansas Association of School Business Officials	www.kasbo.org/
Kansas PTA	www.ptasonline.org/kspta/
Kentucky Association of School Administrators	www.kasa.org/
Kentucky PTA	www.kypta.org/
Kentucky School Boards Association	www.ksba.org/
Kentucky Sports Turf Managers Association	www.kystma.org/
Keystone Athletic Field Managers Organization	www.kafmo.org/
Louisiana Association of School Business Officials	www.lasbo.org/
Louisiana PTA	www.lapta.org/
Louisiana School Boards Association	www.lsba.com/
Maine Association of School Business Officials	www.measbo.org/
Maine Parent Federation	www.mpf.org/
Maine PTA	www.mainepta.org/
Maine School Boards Association	www.msmaweb.com/msba.htm
Maryland Association of Boards of Education	www.mabe.org/
Maryland PTA	www.mdpta.org/
Massachusetts Association of School Business Officials	www.masbo.org
Massachusetts State PTA	www.masspta.org/
Massachusetts Teachers Association	www.massteacher.org

Michigan Association of School Boards	www.masb.org/
Michigan Congress of Parents, Teachers and Students	www.michiganpta.org/
Michigan School Business Officials	www.msbo.org
Michigan Sports Turf Managers Association	www.mistma.org/
Middle States Commission on Higher Education	www.msche.org/
Minnesota Association of School Business Officials	www.mnasbo.org
Mississippi Private School Association	www.mpsa.org/default2.php
Minnesota Independent School Forum	www.misf.org/
Minnesota PTA	www.mnpta.org/
Minnesota School Boards Association	www.mnmsba.org/
Mississippi Association of School Administrators	www.msasa.org/
Mississippi Forum on Children and Families	www.mfcf.org/
Mississippi PTA	www.mississippipta.org/
Mississippi School Boards Association	www.msbaonline.org/
Missouri Association of School Business Officials	www.moasbo.org
Missouri PTA	www.mopta.org/
Missouri School Boards Association	www.msbanet.org
Montana Association of School Business Officials	www.masbo.com/
Montana PTA	www.montanapta.org/
Montana School Boards Association	www.mtsba.org/
National Education Association of Rhode Island	www.neari.org/
National Education Association of Vermont	www.vtnea.org/
Nebraska Association of School Boards	www.nasbonline.org
Nebraska Association of School Business Officials	www.ncsa.org
Nebraska State PTA	www.nebraskapta.org/
Nevada Association of School Administrators	www.nasanevada.com/
Nevada Association of School Boards	www.nvasb.org/
Nevada PTA	www.nevadapta.org/
New England Association of Schools and Colleges	www.neasc.org/
New England Sports Turf Managers Association	www.nestma.org/
New Hampshire Association of School Business Officials	www.asbonh.org/
New Hampshire PTA	www.nhpta1.org/
New Hampshire School Administrators Association	www.nhsaa.org/
New Hampshire School Boards Association	www.nhsba.org/
New Jersey Association of Independent Schools	www.njais.org/
New Jersey Association of School Administrators	www.njasa.net
New Jersey Association of School Business Officials	www.njasbo.com/
New Jersey PTA	www.njpta.org/
New Jersey School Boards Association	www.njsba.org/
New Mexico Association of School Business Officials	www.nmasbo.org/
New Mexico Coalition of School Administrators	www.unm.edu/~nmcsa/
New Mexico PTA	www.nmpta.org/
New Mexico School Boards Association	www.nmsba.org/
New York State Association for Superintendents of School Buildings and Grounds	www.sbga.org
New York State Association of Independent Schools	www.nysais.org/
New York State Association of School Business Officials	www.nysasbo.org/
New York State PTA	www.nyspta.org/
New York State School Boards Association	www.nyssba.org/
North Carolina Association of Educators, Inc.	www.ncae.org/
North Carolina Association of Independent Schools	www.ncais.org/

North Carolina Association of School Business Officials	www.ncasbo.org/
North Carolina Christian School Association	www.nccsa.org/
North Carolina PTA	www.ncpta.org/
North Carolina School Boards Association	www.ncsba.org/
North Dakota Association of School Administrators	www.ndcel.org/NDASA/
North Dakota Education Association	www.nd.nea.org/
North Dakota PTA	none yet
North Dakota School Boards Association	www.ndsba.org/
Ohio Association of Independent Schools	www.oais.org/
Ohio Association of School Business Officials	www.oasbo-ohio.org/
Ohio Education Association	www.ohea.org/
Ohio PTA	www.ohiopta.org/
Ohio School Boards Association	www.osba-ohio.org/
Ohio Sports Turf Managers Association	www.members.tripod.com/glstma/index.htm
Oklahoma Association of School Business Officials	www.okasbo.org/
Oklahoma Education Association	www.okea.org/
Oklahoma Federation of Teachers	www.ocft.org/
Oklahoma PTA	www.okpta.org/
Oklahoma State School Boards Association	www.ossba.org/
Oregon Association of School Business Officials	www.oasbo.com/
Oregon Education Association	www.oregoned.org/
Oregon PTA	www.oregonpta.org/
Oregon School Boards Association	www.osba.org/
Oregon School Employees Association	www.osea.org
Parent Advocacy Center for Education Rights	www.pacer.org/mpc/
Parent Education Network (Wyoming)	www.wpen.net/
Parents as Teachers Program (Alaska)	none yet
Parents as Teachers (North Dakota)	www.ndpass.com/pass-pat.html
Parents as Teachers (Texas)	www.txpat.org/
Parents Involved in Education (New Hampshire)	www.parentinformationcenter.org/
Parents Plus (Wisconsin)	www.parentspluswi.org/
Parents Reaching Out (New Mexico)	www.parentsreachingout.org/
Parentwise (South Carolina)	www.scparentwise.org/
Pennsylvania Association of School Business Officials	www.pasbo.org/
Pennsylvania PTA	www.papta.org/
Pennsylvania School Boards Association	www.psba.org/
Pennsylvania State Education Association	www.psea.org/
Private Schools Interscholastic Association (Texas)	www.psiaacademics.org/
Rhode Island Association of School Business Officials	www.riasbo.org/
Rhode Island Association of School Committees	www.riemc.org/
Rhode Island PTA	www.rhodeislandpta.org/
School Administrators of Iowa	www.sai-iowa.org/
School Administrators of South Dakota	www.sasd.org/
School Nurse Association of North Carolina	www.snanc.org/
SEAC Parents as Partners in Education of Alabama	www.seacparentassistancecenter.com
South Carolina Association of School Business Officials	www.scasbo.com/
South Carolina Education Association	www.thescea.org/
South Carolina Independent School Association	www.scisa.org/
South Carolina PTA	www.scpta.org/
South Carolina School Boards Association	www.scsba.org/
South Carolina Sports Turf Association	www.scstma.org/

South Dakota Association of School Business Officials	www.sasd.org/sdasbo/
South Dakota PTA	www.southdakotapta.org/
Southern Association of Schools and Colleges	www.sacs.org/
Southwestern Association of Episcopal Schools	www.swaes.org/
Sports Turf Managers Association of Southern California	www.socalstma.com/
Statewide Parent Advocacy Network (SPAN)	www.spannj.org/
Tennessee Association of Independent Schools	www.taistn.org/
Tennessee Association of School Business Officials	www.tasbo.net/
Tennessee PTA	www.tnpta.org/
Tennessee School Boards Association	www.tsba.net
Texas Association of School Administrators	www.tasanet.org/
Texas Association of School Business Officials	www.tasbo.org
Texas Association of School Boards	www.tasb.org
Texas PTA	www.txpta.org/
Texas Schools Risk Managers Association	www.txsrma.org
University School Association	www.uschool.utulsa.edu/USA/usa.html
Utah PTA	www.utahpta.org/
Utah School Boards Association	www.usba.cc/
Vermont Parent Child Network	none yet
Vermont PTA	none yet
Vermont School Boards Association	www.vtvsba.org/
Virginia Association of Independent Schools	www.vais.org
Virginia School Boards Association	www.vsba.org/
Virginia Sports Turf Managers Association	www.vstma.org.vt.edu/
Washington Association of Maintenance and Operations Administrators	www.wamoa.org/
Washington Association of School Administrators	www.wasa-oly.org/
Washington Association of School Business Officials	www.wasbo.org
Washington State PTA	www.wastatepta.org/
Washington State School Directors' Association	www.wssda.org/
Western North Carolina Sports Turf Association	www.ncsportsturf.org/westernturf/
West Virginia Association of School Business Officials	www.wvasbo.org
West Virginia Education Association	www.wvea.org
West Virginia PTA	www.wvpta.net/
West Virginia School Boards Association	www.wvsba.org/
Wisconsin Association of School Boards	www.wasb.org
Wisconsin Association of School Business Officials	www.wasbo.com/
Wisconsin PTA	www.wisconsinpta.org
Wyoming Association of School Business Officials	www.wyasbo.org/
Wyoming Education Association	www.wyoea.org/
Wyoming PTA	www.wyomingpta.com/
Wyoming School Boards Association	www.wsba-wy.org/

State Organization – Pest-Management Related	**Website**
Alabama Department of Agriculture & Industries	www.agi.alabama.gov/pesticide_management
Alaska Department of Environmental Conservation	www.dec.state.ak.us/eh/pest/index.htm
Arizona Department of Agriculture	www.azda.gov/ESD/esd.htm
Arizona Structural Pest Control Commission	www.sb.state.az.us/
Arkansas Pest Management Association	www.arkansaspest.org
Arkansas State Plant Board	www.plantboard.org/pesticides_about.html
Association of Ohio Health Commissioners	www.aohc.net/

California Conference of Local Health Officers	www.dhs.ca.gov/CCLHO/
California Environmental Protection Agency	www.cdpr.ca.gov/
California Industrial Hygiene Council	www.cihconline.com
Central Virginia Pest Management Association	www.cvpmaonline.com/
Clemson University	dpr.clemson.edu/index_flash.html
Colorado Department of Agriculture	www.ag.state.co.us/DPI/home.html
Connecticut Association of Directors of Health	www.cadh.org/
Connecticut Department of Environmental Protection	www.dep.state.ct.us/wst/pesticides/
County Health Executives Association of California	www.cheac.org/
Delaware Department of Agriculture	www.state.de.us/deptagri/pesticides/
Florida Department of Agriculture & Consumer Services	www.flaes.org
Florida Pest Management Association	www.flpma.org/
Georgia Department of Agriculture	www.agr.state.ga.us
Hawaii Department of Agriculture	www.hawaiiag.org/hdoa/pi_pest.htm
Health Officers Association of California	www.calhealthofficers.org/
Idaho State Department of Agriculture	www.agri.state.id.us/Categories/Pesticides/indexPesticides.php
Illinois Association of Public Health Administrators	www.iapha.com/
Illinois Department of Agriculture	www.agr.state.il.us/Environment/
Illinois Department of Public Health	www.idph.state.il.us/envhealth/structuralpest.htm
Indiana Pest Management Association	www.entm.purdue.edu/entomology/urban/IPMA/
Iowa Association of Local Public Health Agencies	www.i-alpha.org/
Iowa Department of Agriculture & Land Stewardship	www.agriculture.state.ia.us/pesticidebureau.htm
Iowa Pest Management Association	www.iowapest.org/iowapest/
Kansas Association of Local Health Departments	www.kalhd.org/
Kansas Department of Agriculture	www.ksda.gov/pesticides%5Ffertilizer/
Kentucky Department of Agriculture	www.kyagr.com/consumer/envsvs/
Kentucky Health Departments Association	www.khda-ky.org/
Local Public Health Association of Minnesota	www.mncounties2.org/lpha/
Louisiana Department of Agriculture & Forestry	www.ldaf.state.la.us/divisions/aes/pesticide-ep/default.asp
Louisiana Pest Management Association	www.lpca.org/
Louisiana Public Health Association	www.lpha.org/
Maine Board of Pesticides Control	www.maine.gov/agriculture/pesticides/
Maryland Department of Agriculture	www.mda.state.md.us/plants-pests/pesticide_regulation/
Massachusetts Association of Extension Educators	www.maee.org/
Massachusetts Department of Agricultural Resources	www.mass.gov/agr/pesticides/
Massachusetts Health Officers Association	www.mhoa.com/
Michigan Association for Local Public Health	www.malph.org/
Michigan Department of Agriculture	www.michigan.gov/mda/0,1607,7-125-1572_2875-8324--,00.html
Minnesota Association of Extension Agricultural Professionals	none yet
Minnesota Association of Extension Educators	www.extension.umn.edu/maee/
Minnesota Department of Agriculture	www.mda.state.mn.us/about/divisions/plantprotection.htm
Mississippi Department of Agriculture & Commerce	www.mdac.state.ms.us/n_library/departments/bpi/bpi_pesticide.html
Missouri Association of Local Public Health Agencies	www.moalpha.org/
Missouri Department of Agriculture	www.mda.mo.gov/Pest/bureauintro.htm
Missouri Pest Management Association	www.mopma.org/mo/

Montana Department of Agriculture	agr.state.mt.us/pestfert/pesticidePrograms.asp#one
Nebraska Department of Agriculture	www.agr.state.ne.us/division/bpi/bpi.htm
Nevada Department of Agriculture	agri.nv.gov/index_Plant2.htm
University of Nevada Cooperative Extension	http://www.unce.unr.edu/
New England Pest Management Association	www.nepma.org/
New Hampshire Department of Agriculture, Markets & Food	agriculture.nh.gov/divisions/pesticide_control/
New Jersey Department of Environmental Protection	www.nj.gov/dep/enforcement/pcp/
New Jersey Pest Management Association	www.njpestcontrol.com/nj/
New Mexico Department of Agriculture	nmdaweb.nmsu.edu/pesticides
New Mexico Pest Management Association	www.nmpma.org/nmpma/
New York State Association of County Health Officials	www.nysacho.org/
New York State Department of Environmental Conservation	www.dec.ny.gov/about/640.html
North Carolina Department of Agriculture & Consumer Services	www.ncagr.com/fooddrug/pesticid/
North Carolina Department of Agriculture & Consumer Services	www.agr.state.nc.us/str%2Dpest/
North Carolina Public Health Association	www.ncpha.com/
North Dakota Department of Agriculture	www.agdepartment.com/Programs/Plant/Pesticides.html
Northern Illinois Public Health Consortium	www.niphc.org
Ohio Department of Agriculture	www.ohioagriculture.gov/pesticides/
Office of Indiana State Chemist	www.isco.purdue.edu/pesticide/index_pest1.html
Oklahoma Department of Agriculture, Food & Forestry	www.oda.state.ok.us/cps-pesticidehome.htm
Oregon Department of Agriculture	oregon.gov/ODA/PEST/
Pennsylvania Department of Agriculture	www.agriculture.state.pa.us/agriculture/cwp/view.asp?a=3&q=127130
Pennsylvania Pest Management Association	www.papma.org
Pest Control Operators of California	www.pcoc.org
Public Health Association of Nebraska	www.publichealthne.org/
Rhode Island Department of Environmental Management	www.dem.ri.gov/programs/bnatres/agricult/
South Dakota Department of Agriculture	www.state.sd.us/doa/das/hp-pest.htm
Tennessee Department of Agriculture	www.state.tn.us/agriculture/regulate/aip/
Texas Association of Local Health Officials	www.talho.org/
Texas Department of Agriculture	www.agr.state.tx.us/agr/program_render/0,1987,1848_5319_0_0,00.html?channelId=5319
Texas Pest Management Association, Inc.	www.tpma.org/
Texas Structural Pest Control Board	www.spcb.state.tx.us/
The Virginia Pest Management Association	www.vpmaonline.com/
Utah Department of Agriculture & Food	ag.utah.gov/plantind/plant_ind.html
Vermont Agency of Agriculture, Food & Markets	www.vermontagriculture.com/pest.htm
Virginia Department of Agriculture & Consumer Services	www.vdacs.virginia.gov/pesticides/
Virginia Pesticide Control Board	www.vdacs.virginia.gov/pesticides/boardprofiles.shtml
Washington DC Department of Health	doh.dc.gov/doh/cwp/view,a,1374,Q,585693,dohNav_GID,1814,.asp
Washington State Association of Local Public Health Officials	www.wacounties.org/wsalpho/
Washington State Department of Agriculture	agr.wa.gov/PestFert/Pesticides/default.htm
West Virginia Department of Agriculture	www.wvagriculture.org/Division_Webpages/READ-regulatory.htm
Wisconsin Association of Local Health Departments and Boards	www.walhdab.org/
Wisconsin Department of Ag, Trade, and Consumer Protection	www.datcp.state.wi.us
Wisconsin Pest Management Association	www.wisconsinpest.org/wisconsinpest/
Wyoming Department of Agriculture	wyagric.state.wy.us/techserv/

State Departments of Education	Website
Alabama	www.alsde.edu/
Alaska	www.eed.state.ak.us/
Arizona	www.ade.state.az.us/
Arkansas	arkansased.org/
California	www.cde.ca.gov/
Colorado	www.cde.state.co.us/
Connecticut	www.sde.ct.gov/sde/
Delaware	www.doe.state.de.us/
Florida	www.fldoe.org/
Georgia	public.doe.k12.ga.us/
Hawaii	doe.k12.hi.us/
Idaho	www.sde.state.id.us/Dept/
Illinois	www.isbe.state.il.us/
Indiana	ideanet.doe.state.in.us/
Iowa	www.iowa.gov/educate/
Kansas	www.ksbe.state.ks.us/
Kentucky	www.kde.state.ky.us/KDE/
Louisiana	www.louisianaschools.net/
Maine	www.maine.gov/education/
Maryland	www.marylandpublicschools.org/
Massachusetts	www.doe.mass.edu/
Michigan	www.michigan.gov/mde
Minnesota	education.state.mn.us/mde/
Mississippi	www.mde.k12.ms.us/
Missouri	dese.mo.gov/
Montana	www.opi.mt.gov/index.html
Nebraska	www.nde.state.ne.us/
Nevada	www.doe.nv.gov/
New Hampshire	www.ed.state.nh.us/education/
New Jersey	www.state.nj.us/education/
New Mexico	sde.state.nm.us/
New York	www.nysed.gov/
North Carolina	www.dpi.state.nc.us/
North Dakota	www.dpi.state.nd.us/
Ohio	www.ode.state.oh.us/
Oklahoma	www.sde.state.ok.us/
Oregon	www.ode.state.or.us/
Pennsylvania	www.pde.state.pa.us/
Rhode Island	www.ridoe.net/
South Carolina	ed.sc.gov/
South Dakota	doe.sd.gov/
Tennessee	state.tn.us/education/
Texas	www.tea.state.tx.us/
Utah	www.usoe.k12.ut.us/
Vermont	education.vermont.gov/
Virginia	www.pen.k12.va.us/
Washington	www.k12.wa.us/
West Virginia	wvde.state.wv.us/

Wisconsin	dpi.wi.gov/
Wyoming	www.k12.wy.us/

Appendix J. IPM Curriculum Support Tools in English and Spanish

The following curricula and other educational tools are designed for use by educators with students in grades K through 12. This list is excerpted from I*PM Standards for Schools: IPM Curricula and Workshop Ideas; and School IPM and Related Resources in Spanish and Other Non-English Languages*. www.ipminstitute.org/school_biblio.htm#Curricula. For additional curricula, including those for pest managers, school staff and other professionals, see Appendix M. School IPM Toolbox.

English language support tools

American Museum of Natural History. 1999. *Seven entertaining modules on microbes including "Meet the microbes, bacteria in the cafeteria, How Lou got the flu, Prevention convention."* Available at www.amnh.org/exhibitions/epidemic/index.html

Bailey, S. 1999. Get This Bug Off of Me! University of Kentucky, Dept. of Entomology. *Color photo guide to more than 30 dangerous and harmless arthropods.* Available at www.uky.edu/agriculture/entomology /ythfacts/stories/hurtrnot.htm

British Society for Plant Pathology. 2004. "aMaizing Plant Disease Game." Simultaneously exercise your plant pathology and gaming skills and intuition in a contest to thwart a nasty virtual pathogen attempting to invade an innocent maize crop. The aim of the online game is to "grow" a maize crop, and do it profitably, with in a range of various input alternatives and a threat of disease capable of destroying the crop. The game, open to all, is on the BSPP website at www.bspp.org.uk/

Canadian Geographic. 2002. Grasshopper Facts website. "A grand look a grasshoppers" *includes interactive games, fun facts and scientific knowledge about grasshoppers.* Available at http://www.canadiangeographic.ca/magazine/mj02/grasshopperfeature.asp

Cullen, E. 1995. IPM Curriculum for Grades 9-12. 200 pp. *IPM basics including monitoring and cultural, physical, biological and least-toxic chemical controls; insect profiles, study programs, case studies, lab experiments, resource list, glossary; designed to be part of a science, chemistry or biology course; emphasis on agricultural, horticultural and garden pests.* Available from Bio-Integral Resource Center, P.O. Box 7414, Berkeley, CA 94707, (510) 524-2567, FAX (510) 524-1758, E-mail birc at igc.org, Website www.birc.org

Cycling Back to Nature: Food Production and Pesticides. *Nationally juried curriculum including food production and environmental and health effects of pesticide use in agriculture; food webs and biological diversity; analysis of agriculture and pesticide use in the US; global demand for food and population trends.* Available in print from National 4-H Council, 7100 Connecticut Ave, Chevy Chase, MD 20815. (301) 961-2908, FAX (301) 961-2894, E-mail: envstew%smtpgate at fourhcouncil.edu, more information including comments from reviewers available at http://www.4-hcurriculum.org/default.aspx

Dunn, G.A. and J. VanDyk. Iowa State Entomology Index: K-12 Educators' Recommended Sites. *Links to over 30 Web sites with insect-related curricula, projects and information.* Available at www.ent.iastate.edu/list/directory/158/vid/5

Environmental Protection Agency. 2003. “Learn to Use Pesticides Safely" (available as a poster or bumper sticker) and “Pesticides Are Meant to Poison These... [BUGS] Not These” [KIDS] (available in poster format only) now available. *Free copies of posters and stickers (bumper sticker size) urging consumers to use pesticides safely are available in both English and Spanish. Recognized for their colorful, eye-catching graphics and message, enlarged versions of these posters and stickers have appeared on trucks and metropolitan buses and trains traveling through the urban sectors of many cities.* To order, write US Environmental Protection Agency, Office of Pesticide Programs (7506C), Communication Services Branch, 1200 Pennsylvania Ave., N.W., Washington, D.C. 20460-0001 or call 703-305-5017. For orders larger than 10 copies, please contact the National Service Center for Environmental Publications (NSCEP) at 1-800-490-9198.

Environmental Protection Agency. Interactive Cockroach Activity Book. *The popular pest prevention activity book for children, Help! It's a Roach!, is now on-line. The activities have been converted to be interactive, to provide a fun way to learn about managing indoor insect pests. The messages of removing food, water, and shelter apply to many pests, not just cockroaches. A Spanish version of the web publication will be available soon.* The web version is found at www.epa.gov/opp00001/kids/roaches/english/. Paper versions of this book are available from EPA's publication center, (EPA 735-F-98-016, English and EPA 735-F-01-004, Spanish).

Environmental Protection Agency. Help Yourself to a Healthy Home: Protect you Children’s Health. *Popular 56 pp. booklet contains helpful information for parents, grandparents and other care givers. Contains information on environmental contaminants found in many American homes and how to protect your family from risks posed by carbon monoxide, unhealthy drinking waters, poor indoor air quality, lead poisoning, hazardous household products, pesticides, and much more.* Available in Spanish as "Contribuya a Tener un Hogar Sano." To order, call Kathy Seikel at 703-308-8272, or email seikel.kathy at epa.gov.

Environmental Protection Agency. Consumer Labeling Initiative. *Offers a wealth of information and free promotional items to raise awareness about the importance of reading pesticide products labels. Promotional items available free of charge to the public include rulers, bag clips, and jar openers. Also have developed a number of popular brochures including “Read the Label First! Protect your Household,” “Read the Label First! Protect your Garden,” “Read the Label First! Protect your Children,” and “Read the Label First! Protect your Pets.”* To order, call 703-305-5017 or send an email request to lormand.mary-jean at epa.gov.

EPA Region 2. 2003. EPA's Region 2 (New York) office has developed a free CD containing several documents relating to IPM in schools: *1)* "Pest Control in the School Environment,"*the popular 1993 EPA publication designed to acquaint readers with IPM as a potential alternative to scheduled spraying of pesticides; 2)* "Who Wants to be an IPM Super Sleuth? Integrated Pest Management Activities and Resources for Kids of All Ages" *developed by the IPM Institute of North America; 3)* "Neato Mosquito,"*the CD developed by the Centers for Disease Control (CDC) which contains a 4th grade curriculum designed to teach kids about mosquito biology through the use of animation, video images, interactive games, and student projects; and 4) a CDC-developed video about mosquito biology*. For copies of this CD, which includes all four items above, e-mail Henry Rupp at rupp.henry at epa.gov or call 732-906-6178.

EPA Region 8 (Denver, CO) and the Girl Scouts Mile Hi Council. *A "Bugged by Bugs" pesticide awareness patch has been developed through a partnership between the EPA and Girl Scouts, which reaches more than 36,000 girls between the ages 5-17. This exciting on-line resource can be accessed at www.girlscoutsmilehi.org/content/home.cfm. The Web site features on-line games, complete word searches and crossword puzzles which kids can tackle while learning more about safe pesticide use, risks and potential health concerns related to pesticides, as well as the IPM approach to pest control.*

Exploring Urban Integrated Management: Activities and Resources for Teaching K-6. 2002. *A 76 pp. curriculum guide for teaching school and community IPM in the elementary classroom. This resource includes teacher fact sheets, lesson plans, and student worksheets on topics including IPM steps and decision making, insect and rodent pests, inspections, and control method choices. From the Michigan State University Pesticide Education Program with a grant from US EPA Region 5 and the Michigan Department of Agriculture.* Available at www.pested.msu.edu/CommunitySchoolIpm/curriculum.htm

National School IPM Web site. *The CD-ROM contains everything on the Web site including IPM information from IPM experts across the nation that is orientated to administrators, teachers, parents and pest management professionals. It also includes advice on how to develop an IPM program; alternative methods of pest control; information on pests and pesticides safety; news releases on IPM and pests for school newsletters; Powerpoint presentations on; sample contacts and letters; educational materials; links to school related Web site in numerous areas (organized by subject and location); and much more.* The web site is now available complete on a CD-ROM for use in stand-alone or networking environments for both PCs and Macs. It requires a CD-ROM drive and graphical browser. The cost of this CD-ROM is $8. Additional copies may be purchased through the UF/IFAS Extension Bookstore by calling 800-226-1764 or on the Web at ifasbooks.ufl.edu. Discounts are not available at this price. Funds generated by the sale of this CD-ROM are used to maintain and add to the National School IPM Web site.

Kneen, Cathleen. *The Community Garden Game is a non-competitive card game designed to increase interest in community gardening. There are 12 vegetables so the game can be played with up to 12 players. With a roll of the dice you may find that the pony club has decided to compost their manure and donate it to the garden -- the whole garden takes a point -- or that a bunch of kids raid the garden -- peas and beans lose one each. You may find that you planted potatoes in the same place as last year and they get scab – potatoes lose one; or that the community kitchen develops a great bean recipe -- beans take one. There are 40 negative and 40 positive cards, so lots can happen in your garden!* The goal of the game is to harvest as much of each vegetable as possible. Order the Community Garden Game for $10 plus $2 for postage from: Cathleen Kneen, S-6, C-27, RR #1, Sorrento, B.C., V0E 2W0, Canada.

Koehler, P., T. Fasulo, C. Scherer and M. Downey, Eds. 1999. School IPM Web Site. University of Florida. *Links to IPM curricula from land grant institutions; Introduction to need for IPM in schools; descriptions and links to lesson plan and materials for students and for teachers and 8-week Internet course for teachers; example of school IPM lesson plan; references. Produced by Montana State University.* Available at schoolipm.ifas.ufl.edu/teach.htm

Leon County Mosquito Control. 2002. *Mosquito Control Education Program. Education plays a primary role in the integrated pest management program used by Leon County Mosquito Control. Leon Country Mosquito Control has designed a curriculum outline, videos, a school activity book, worksheets, and examples of prizes and more to use when educating children about IPM mosquito control.* Available at www.co.leon.fl.us/mosquito/index.asp

Lucas, P.L. Bug-Go. University of Kentucky IPM Program. *Bingo-like game, players match pictures of beneficial insects and pests, includes player game cards, templates for overhead transparencies or display sheets, information about each insect and instructions.* Available at http://www.uky.edu/Agriculture/ IPM/teachers/bug-go/bug-go.htm

LSU AgCenter. 2002. Learning Activity: Fight the Bite! Be a Skeeter Buster! *The LSU AgCenter has published a 6 pp. activity guide written by two 4-H agents. Includes 4 pages of a Q & A session as well as a step-by-step guide explaining how to play The Mosquito Game.* Available at www.lsuagcenter.com/nr/rdonlyres/17293970-a947-4773-ab73-25391c0b265e/5416/skeeterbusterlesson902.pdf (PDF)

Michigan State University Extension. 2001. *Exploring Urban Integrated Pest Management*. Michigan State University Extension *provides a comprehensive activities and resource book for teaching K-6.* The workbook includes twelve classroom activities and is available in PDF format at www.pested.msu.edu/CommunitySchoolIpm/index.html

Michigan State University Pesticide Notes. Jan.-Feb. 2002. *Michigan*

State University has developed an activity guide for teaching urban integrated pest management for grades K-6. The manual is written for teachers to incorporate IPM in their classroom teaching. The activity guide is available at www.pested.msu.edu/CommunitySchoolIpm/curriculum.htm

Minnesota Department of Agriculture. 2002. Fact sheets. *A series of 2 pp. face sheets dealing with many pests found in schools including an overview, and multiple facts sheets on various insects weeds, plant diseases, rodents and pesticides.* Available at www.mda.state.mn.us/plants/pestmanagement/ipm/ipminschools.htm

Minnesota Department of Agriculture. 2000. Join Our Pest Patrol - A Backyard Activity Book for Kids - An Adventure in IPM. *29 pp. book and companion third through fifth grade Teachers' Guide, includes many fun activities that can easily be incorporated into reading, science, or even math and art classes. It provides kids and teachers with important information about pest identity and biology, and ecology. Has recently been adapted for nationwide use.* Available at:
www.mda.state.mn.us/plants/pestmanagement/ipm/ipmpubs.htm
A US EPA version is available at: www.epa.gov/pesticides/kids/pestpatrol/index.htm

Minnesota Ideals. 1998. The Watershed Game. *Interactive question/answer game for elementary students addressing agricultural and urban impacts on watershed health.* Available at www.bellmuseum.org/distancelearning/watershed/watershed2.html

National Pediculosis Association. *Information for children about head lice, including interactive quiz and games; animations of lice, life cycle; frequently asked questions; poetry, books.* Available at www.headlice.org/kids/index.htm

Orkin. 2007. Junior Pest Investigators. *Through this innovative learning program available at no charge at www.juniorpi.com, students will put pests under surveillance and uncover the essentials of Integrated Pest Management (IPM). All Junior Pest Investigators materials are based on National Science Standards and Best Practice Instructional Strategies and approved by an advisory council of national, third-party experts in school IPM, so teachers can ensure students are learning as much as they are engaged. Whether IPM is mandatory or voluntary in your school, Junior Pest Investigators will help guide efforts toward positive change.* Available at www.juniorpi.com

Pennsylvania Departments of Agriculture and Education, and Pennsylvania State University. 1998. Memorandum of Understanding. *Outlines five areas of cooperation to increase public education of IPM concepts and tools.* Available at paipm.cas.psu.edu/113.htm

Pennsylvania IPM Program. 2002. "Join Our Pest Patrol" publication. *Educational resource for Pennsylvania teachers of students in grades 3 and 4. Addresses newly adopted state academic standards in environment and ecology focusing on integrated pest management. Includes crossword puzzles, fill-in-the-blanks, mazes and picture* *drawing. Also available is the accompanying teacher guide that includes facts, investigations, activities and resources to support children's curiosity and extended learning. Concepts include distinguishing insect pests from beneficial insects; understanding why humans want to manage pests; recognizing common pests in our homes, gardens and neighborhoods; choosing the least toxic ways to manage pests; and safeguarding against pesticide risks.* Can be obtained by contacting the Pennsylvania IPM Program at (814) 865-2839 or downloaded as printable PDF files from the Web at paipm.cas.psu.edu. Join Our Pest Patrol 4-H Leader Guide now available online. *6 pp. backyard activity book is formatted for 4-H leaders. Includes a brief description of IPM, a list of common pests, many ideas for projects, information on safe pesticide use as well as an extensive bibliography.* Available at www.mda.state.mn.us/plants/pestmanagement/ipm/ipmpubs.htm

Pennsylvania IPM Program. 2003. IPM for Teachers Curriculum. Text from the summer class, "IPM for Teachers: Meeting New Academic Standards," includes many activities to use in the classroom along with supplemental materials. Available in HTML form at paipm.cas.psu.edu/974.htm

Pennsylvania IPM Program. 2003. Video "Bugmobile Vs.The Invasive Species." *The video, hosted and narrated by BugMobile, the talking Volkswagen, identifies the effects of humans and human events on watersheds, explains species diversity, introduces species that are classified as pests in their new environment, and analyzes the benefits to the environment and society associated with alternative practices used in IPM. Geared toward lower and upper secondary students, the video addresses the several categories of the state's new Academic Standards. Each video includes a lesson plan with content objectives, assessment strategies and procedures.* Download the lesson plan free, or, to obtain a copy of the video and lesson plan, send a check or money order for $35 made payable to The Pennsylvania State University to ICT, 119 Ag Administration Building, University Park, PA 16802-2602. Visa and MasterCard orders will be accepted by calling (814) 865-6309. Shipping and handling costs are included in the price.

Pennsylvania State Department of Education. 2000. Academic Standards for Environment and Ecology, Section 4.5. Integrated Pest Management. *Detailed list of IPM topic areas to be included in curricula for students in Pennsylvania Public Schools through grade 12.* Available at paipm.cas.psu.edu/103.htm

Purdue University Cooperative Extension Service. 2002. IPM in Schools Activity Book. *This 24 pp. illustrated activity book contains mazes, matching games, coloring activities, connect-the-dots and much more to help kids understand Integrated Pest Management. Also includes an answer key and a "Certificate of Great Work."* The activity book is now available online at extension.entm.purdue.edu/ publications/Act_book.pdf. (PDF) Requests for hard copies can be sent to Al Fournier, Department of Entomology, Purdue University, Smith Hall, 901 W. State Street, West Lafayette, IN 47907-2054, Phone: 765-496-7520, Email: al_fournier at entm.purdue.edu.

Safer Pest Control Project. Kid's guide to pesticides. *Two pp. fact sheet in PDF format includes discussion of pests, pesticides, risks, pesticide safety.* Available at www.spcpweb.org (go to School IPM page and follow link).

Safer Pest Control Project. Integrated Pest Management in Schools: A Better Method. *This 12-minute video is aimed at helping schools, parents, pest control operators, and other groups understand and promote School IPM. Filmed at a Chicago-area school that has practiced IPM since 1994, it features testimony and advice from the school's pest control operator and operations manager. It addresses concerns about pesticide use, the advantages of practicing IPM, and the basic components of IPM.* For more information, see School IPM Video Brochure and Order Form or call Safer Pest Control Project at (773) 878-7378 ext 204.

Safer Pest Control Project. The Pest Invasion, The Pest Invasion II, and La Invasion de los Insectos II. *Three comic books that teach least hazardous pest control in a variety of settings. The Pest Invasion chronicles one family's successful battle against roaches and rodents in a Chicago Public Housing development.* To order for $1.00 each, call The Safer Pest Control Project at (773) 878-7378 ext 204 or email us at msaito at bpchicago.org.

Schumann, G.L., ed. APSNet Education Center: The Plant Health Instructor. American Phytopathological Society. *Plant pathology curricula for K through higher education including plant disease lessons, laboratory exercises, illustrated glossary, resource catalogs and links to additional materials.*

Radcliffe, T.B. and W.D. Hutchison, eds. Radcliffe's IPM World Textbook. *Electronic college-level IPM textbook including line drawings, color and B&W photos, chapters on biological and cultural control, computers in IPM, crop and commodity-specific IPM, ecology, IPM policy, medical and veterinary IPM, pesticides, stored product IPM, links to IPM resources including photographs and decision-support software.* Available at ipmworld.umn.edu/

US EPA. 2002. *In commemoration of National Poison Prevention Week, Mar. 17-23, EPA is making available several resources to educate the public about ways to prevent children from being poisoned by pesticides and household products. "Learn About Chemicals Around Your House" is an interactive web site (see* www.epa.gov/kidshometour/index.htm) *designed to teach children and parents about household products, including pesticides, that may contain harmful chemicals. "Ten Tips to Protect Children from Pesticide and Lead Poisonings Around the Home" is a brochure that provides simple steps to protect children from pesticide and lead poisonings around the home, and is available in both English and Spanish. This document is available at www.epa.gov/pesticides/factsheets/child-ten-tips.htm. "Pesticides Safety Tips" is a fact sheet that provides current household pesticide-related poisonings/exposure statistics, as well as recommendations for preventing poisonings and first aid guidelines and is available at*

http://www.epa.gov/pesticides/factsheets/pest_ti.htm. Finally, "Help! It's A Roach" is a roach prevention activity book for kids and parents. It teaches families what they can do to prevent and control roaches without using pesticides. An interactive Web site is also available at www.epa.gov/pesticides/kids/roaches/english/. All of these resources are also available by calling 1-800-490-9198. More information on Poison Prevention Week is also available at the Poison Prevention Week Council's website at www.poisonprevention.org

US EPA Region 6. 1999. Pesticide Safety Bingo Game. 49 pp. plus cards. *Beginner and advanced level games for K-6 grades about pest management and pesticides, including instructions, background information for teachers, discussion questions, picture and text cards in English and Spanish.* Available at www.epa.gov/region6/6pd/bingo/index.htm

University of Connecticut IPM Program. 1999. IPM Online Home Study Courses. *Self-paced, tuition-free, non-credit tutorial-type courses with a certificate issued upon completion including IPM for cockroaches, ants/termites, turfgrass, garden weed and insect pests, resistance of woody ornamental plants to deer damage.* Available at www.hort.uconn.edu/ipm/

University of Florida Department of Entomology and Nematology. 2002. Posters on a variety of pests. *The posters help identify many common pests in the home or community.* Go to the UF/IFAS Extension Bookstore to view or call (800) 226-1764 to order.

University of Florida Department of Entomology and Nematology. 2000. Best of the Bugs Web Site. *List of top web sites covering insects, mites and nematodes, including sites with teaching curricula.* Available at pests.ifas.ufl.edu/bestbugs/

Wyoming Agriculture in the Classroom. A Kid's Journey to Understanding Weeds. *Elementary school-level activities for students organized around 11 noxious weeds.* Available at www.cdfa.ca.gov/phpps/ipc/weededucation/Education_K-12/journey3rdgrade.htm

Spanish language support tools

ATTRA. 2004. El Manejo Integrado Organico de Algunas Plagas de la Agricultura. (Organic Integrated Pest Management Manual). *Spanish-language pictorial field guide to organic IPM. Focuses on ecologically based strategies that prevent insect and vertebrate pests, diseases, and weeds from becoming a problem in the first place. Guides feature color photos of important pests and beneficial organisms. Brief text provides take-home messages for farmers. English-language version coming soon.*

Environmental Protection Agency. Contribuya a Tener un Hogar Sano. *Popular 56 pp. booklet contains helpful information for parents, grandparents and other care givers. Contains information on environmental contaminants found in many American homes*

and how to protect your family from risks posed by carbon monoxide, unhealthy drinking waters, poor indoor air quality, lead poisoning, hazardous household products, pesticides, and much more. To order, call Kathy Seikel at 703-308-8272, or email seikel.kathy at epa.gov.

Environmental Protection Agency. 2003. "Learn to Use Pesticides Safely" (available as a poster or bumper sticker) and "Pesticides Are Meant to Poison These... [BUGS] Not These" [KIDS] (available in poster format only) now available. *Free copies of posters and stickers (bumper sticker size) urging consumers to use pesticides safely are available in both English and Spanish. Recognized for their colorful, eye-catching graphics and message, enlarged versions of these posters and stickers have appeared on trucks and metropolitan buses and trains traveling through the urban sectors of many cities.* To order, write US Environmental Protection Agency, Office of Pesticide Programs (7506C), Communication Services Branch, 1200 Pennsylvania Ave., N.W., Washington, DC 20460-0001 or call 703-305-5017. For orders larger than 10 copies, please contact the National Service Center for Environmental Publications (NSCEP) at 1-800-490-9198.

EPA. 2003. "10 Medidas Para Proteger A Sus Niños De Los Pesticidas Y Del Envenenamiento Debido Al Plomo." *This Spanish/English brochure outlines the ten most important steps you can take to protect children from accidental poisonings associated with the presence of lead and pesticides in the home.* Available at www.epa.gov/pesticides/factsheets/child-ten-tips-esp.htm

EPA Region 6 (Dallas, TX). 2003. "Tres Amigos al Rescate." *A new education and outreach package aimed at Spanish-speaking communities. The core component of this package is an entertaining and informative video that appeals to children and adults alike and provides practical information on safe use of household chemicals, including pesticides. The video is accompanied by a companion booklet, also in Spanish, designed for parents, teachers, and moderators. A helpful discussion guide and fact sheet complete the package and set the stage for stimulating discussions about steps people can take to make their homes environmentally safe.* To order "Tres Amigos al Rescate," e-mail Amadee Madril at madril.amadee at epa.gov or call (214) 665-2767.

Drlik, T. *Spanish IPM fact sheets include Argentine ants, cockroaches.* Bio-Intergral Resource Center, PO Box 7414 Berkeley, CA 94707, phone (510) 524-8404.

Hollingsworth, C. 2002. What is Integrated Pest Management? *An explanation of IPM, monitoring, natural enemies, habitat modification and pesticides in English, Spanish, Portuguese, French, German, Italian, Khmer, Vietnamese and Chinese.* Available from University of Massachusetts Extension, umassoutreachbookstore.com/catalog/

National Pest Management Association. *Pest management materials, including biology and management of bumblebees, carpenter ants, fruit flies, German cockroaches, head and body lice, and pavement ants, plus diseases transmitted by pests.* All are able to

be translated into Spanish, Chinese, French, German, Italian, Japanese, Korean, or Portuguese. Available at www.pestworld.org/

New York State Department of Health. *Spanish brochures include management of mosquitoes, mice, West Nile virus plus tick and insect repellents.* www.health.state.ny.us/nysdoh/pest/pesticid.htm

Orkin. 2007. Junior Pest Investigators. *An innovative learning program guides students as they put pests under surveillance and uncover the essentials of Integrated Pest Management (IPM). All Junior Pest Investigators materials are based on National Science Standards and Best Practice Instructional Strategies and approved by an advisory council of national, third-party experts in school IPM, so teachers can ensure students are learning as much as they are engaged. Whether IPM is mandatory or voluntary in your school, Junior Pest Investigators will help guide efforts toward positive change.* Available soon at www.juniorpi.com

Penn State University. 2003. Extension Fact Sheets. *Entomology fact sheets available for aphids, black vine weevils, eastern tent caterpillars, Japanese beetles, five types of cockroaches, pavement ants, cereal and pantry pests, cigarette beetles, larder beetles, bedbugs, lice and Pennsylvania spiders available in Spanish.* Available to download for free at www.ento.psu.edu/extension/fact_sheets.html. For more information, contact the department at (814) 865-1895 or visit the department's Web site at www.ento.psu.edu/

Pennsylvania IPM Program. 2004. "Unete a Nuestra Patrull contra las Plaga*." Translated version of "Join Our Pest Patrol" publication is fun, educational resource for Pennsylvania teachers of students in grades 3-4. Like the English version, the workbook is designed to serve two audiences; elementary school students who must learn about IPM to meet the new Academic Standards in environment and ecology, section 4.5.4, "Integrated Pest Management," and kids in 4-H programs.* Copies of the *Join Our Pest Patrol* publication in Spanish can be downloaded as printable PDF files from the PA IPM Program's web site at paipm.cas.psu.edu

Safer Pest Control Project. *Comic-style book in Spanish* "La Invasion de los Insectos", *addresses cockroach IPM in public housing.* Available from Safer Pest Control Project, 25 E. Washington St, Suite 1515, Chicago, IL 60602, (312) 641-5575, Fax (312) 641-5454, E-mail: inforequest at spcpweb.org, Website http://www.spcpweb.org/resources/index.php#factsheets

Texas Agricultural Extension Service. *Entomology Spanish language publications. Includes Cockroaches, How to Control Cockroaches at Home, Control of Rats And Mice, Fleas, Flea Control, House Infesting Ants, How to Control Ants at Home, Subterranean Termites, The Two Step Fire Ant Control, Ticks, and Tick Control.* Available at agrilifebookstore.org/publications_browse2.cfm?keywordid=107

University of Massachusetts. What is Integrated Pest Management? *This informative brochure is available through the University of Massachusetts* i*n nine different languages including English, Spanish, Portuguese, French, German, Italian, Khmer, Vietnamese and Chinese.* Available at www.umass.edu/umext/ipm/publications/ipm_multi_language.pdf (PDF)

University of Minnesota Extension Service. *Materials in Spanish include "Cockroaches – Your Safe Home," (also in English, Laotian, Cambodian and Hmong); "Molds – Your Safe Home" (English, Laotian, Cambodian, Hmong and Somali).* Available at www.extension.umn.edu/pesticides/IPM/pubstruct.htm

University of Nebraska Cooperative Extension. Head Lice Resources You Can Trust. *Family guide with practical, simple directions on head lice control in Spanish and English. Also includes online "Removing Head Lice Safely" video in both Spanish, Arabic and English.* Available at lancaster.unl.edu/pest/lice/

US EPA. 2002. *Socorro! Una Cucaracha! (Help! It's a Roach!)*. The Spanish version of the popular pest prevention activity book for children is now on-line. *The activities have been designed to be interactive, to provide a fun way to learn about managing indoor insect pests. The messages of removing food, water, and shelter apply to many pests, not just cockroaches.* The web version is found at www.epa.gov/pesticides/kids/roaches/spanish/index.html. Paper versions are available from EPA's publication center, www.epa.gov/ncepihom/ordering.htm (EPA 735-F-98-016?English and EPA 735-F-01-004?Spanish).

Appendix K. Public Agency State and Regional School IPM Contacts

The following individuals are public agency points of contact for referral to school IPM resources within the state or region. In the absence of a designated school IPM contact, we have included the USDA CSREES state IPM coordinator who may be able to direct inquirers to more specific resources in the state. A directory of state IPM coordinators is located at www.ipmcenters.org/contacts/IPMDirectory.cfm

NATIONAL
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www.epa.gov/pesticides/ipm/

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lab45 at cornell.edu

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school.ipm.iastate.edu

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Fax 334 844-5005
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Pest Management and Licensing
California Department of Pesticide Regulation
1001 I Street, Third Floor
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916 445-3914
Fax 916 445-4033
ssimmons at cdpr.ca.gov
www.schoolipm.info

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www.hort.uconn.edu/Ipm/ipmscool.htm

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www.entm.purdue.edu/Entomology/outreach/schoolipm/indiana_page.html

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www.maine.gov/agriculture/pesticides/schoolipm

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Maryland Dept. of Agriculture
Pesticide Regulation Section
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Annapolis, MD 21401
410 841-5710
Fax 410 841-2765
crowea at mda.state.md.us
www.mda.state.md.us/plants-pests/pesticide_regulation/
pesticide_info_for_consumers/integrated_pest_mgmt/index.php

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www.pested.msu.edu/CommunitySchoolIpm/

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www.state.nj.us/dep/enforcement/pcp/pcp-ipm.htm

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www.pestmanagement.rutgers.edu/IPM/SchoolIPM/

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Appendix L. Directory of School IPM Expertise

The following individuals have been identified by the working group as having expertise in school IPM and have provided information for the profiles.

Name and contact information	Profile
Karl Arne EPA Region 10 Office of Ecosystems, Tribal and Public Affairs 1200 6th Ave. Seattle, WA 98101 206 553-2576 Arne.karl at epamail.epa.gov	Mr. Arne serves as technical expert for pesticides to the EPA Region 10 office in Seattle, and as ag sector lead for the region, promotes environmentally sensible pest management, including IPM. In the early 90s, he helped found the Urban Pesticide Initiative (now the Urban Pesticide Education Strategy Team, or UPEST), a multiagency effort in Washington State with the aim of promoting IPM in cities and towns. A spin-off of this was an IPM in schools working group, a multi-stakeholder effort that continues under leadership from the Washington State Department of Agriculture. Karl serves on the advisory board for Washington State University's Center for Sustaining Agriculture and Natural Resources, and on the Stewardship Council of the Food Alliance, a Portland based eco-label that promotes sustainably grown food.
Stephen P. Ashkin, President The Ashkin Group, LLC 3644 Tamarron Dr. Bloomington, IN 47408 812 332-7950 Fax 812 332-7965 SteveAshkin at AshkinGroup.com www.AshkinGroup.com	As president of The Ashkin Group, LLC., Steve has been a leader in the effort to green the cleaning and maintenance industry for 15 years. Steve is a prolific writer, speaker and advocate for safer and healthier cleaning methods.
Paul Baker, Extension Specialist University of Arizona Dept. of Entomology Forbes 410 PO Box 2100: (36) Tucson, AZ 85721 520 621-1151 pbaker at ag.arizona.edu	Dr. Baker is the director of Arizona Pesticide Information and Training Office (PITO) and a structural pest management researcher at the University of Arizona. Paul's current research focuses on termite identification and survey work throughout Arizona. He also serves as commissioner on the Arizona Structural Pest Control Commission (SPCC), the state agency that regulates the use, disposal and storage of pesticides.
Rebecca Baldwin, Ph.D.	Dr. Baldwin is an extension entomologist and co-

Assistant Extension Scientist- School IPM University of Florida Bldg. 970, Natural Area Dr. PO Box 110620 Gainesville, FL 32611-0620 352 392-1901 x178 baldwinr at ufl.edu	directs, along with Dr. Faith Oi, of the Florida School IPM program. Rebecca's research involves least toxic control methods for cockroaches. Over the past six years, Rebecca has played an active roll in the pest control industry by leading CEU training sessions throughout Florida and for the National Pest Management Association. The EPA and the University of Florida have recognized Rebecca for her work in School IPM and the Professional Women of Pest Management and Pi Chi Omega Pest Control Fraternity have recognized her for her work in the field of urban entomology.
Lynn Braband, Community IPM Extension Educator Cornell University 249 Highland Ave. Rochester, NY 14620-3036 585 461-1000 x241 lab45 at cornell.edu	Mr. Braband, a certified wildlife biologist, organizes school IPM implementation workshops throughout New York and conducts IPM demonstration projects at schools.
Paul Cardosi, Assistant Vice President of Corporate Accounts, Government Sales Ecolab 7272 E Indian School Rd., Ste. 220 Scottsdale, AZ 85251 480 281-3603 paul.cardosi at ecolab.com	Mr. Cardosi has just completed his 26th year with Ecolab. Sixteen of those years he spent with the Institutional Division and the last ten years with the Pest Elimination Division holding various positions in Corporate Accounts. Paul continues to focus on developing Ecolab's IPM program for multiple market segments including schools.
Jon Carpenter Nevada Dept. of Agriculture 350 Capitol Hill Reno, NV 89502 775 688-1182 x276 jcarp at agri.state.nv.us	Mr. Carpenter's IPM experience began in the IPM program at the University of Nevada Reno as part of work towards a plant science degree. His work with the Department includes IPM-related training for agriculture as well as the school IPM program. Experience includes a five-year program with the Washoe County School District, with the Department providing IPM consulting to the district initially in two pilot schools. Current efforts include training programs for custodial staff and pursuing administrative buy-in.
John Carter, Director of Planning Monroe County Community Schools Corporation 560 E Miller Dr. Bloomington, IN 47401	Mr. Carter has worked for the Monroe County Community School Corporation since 1985 where he now manages a custodial staff of over 100. His position as director of planning involves personnel issues with custodial staff, redistricting, future

812 330-7720 x2 jcarter at mccsc.edu	school sites, safe schools, employee safety and IPM. He serves as liaison between the School Corporation and many city and county agencies. John has helped school districts across the country examine the fiscal impact of past pest management practices in relation to IPM programs. He is available for training on a part-time basis. John is a native of Bloomington, Indiana and graduated from Indiana University in 1978 with a degree in telecommunications.
Jeanne Ciborowski Integrated Pest Management Program Coordinator Minnesota Department of Agriculture 625 Robert St. North St. Paul, MN 55155-2538 651-201-6217 Fax 651-201-6120 jeanne.ciborowski at state.mn.us MDA IPM Web Site: www.mda.state.mn.us/ipm	Ms. Ciborowski has worked in school IPM since 1999. The Minnesota Dept of Agriculture developed school IPM fact sheets and Power Point presentations, available at www.mda.state.mn.us/plants/pestmanagement/ipm/ipminschools.htm. Jean can provide handouts and talk individually with interested school personnel, as time allows.
Pat T. Copps, M.S., B.C.E. Pacific Technical Manager Orkin Commercial Services 1049 Regatta Run Costa Mesa, CA 92627 404 915-5537 pcopps at rollins.com	Mr. Copps has been a Board Certified Entomologist in Urban and Industrial Entomology since 1994. He began his career in vector control in 1971. Since then, he has served in both technical and managerial roles with PCO Services (Toronto, Canada); the Arabian American Oil Company (Dhahran, Saudi Arabia); Prism Pest Elimination (Los Angeles, California) and Orkin. Pat has served on the Sanitation Education Committee for the National Pest Control Association (1988-89), the Board Certification Committee for the Entomological Society of America (2003) and the Food Safety Education Committee for the Orange County, CA Food Safety Advisory Council (2006). He has assisted in the preparation and oversight of IPM programs in agriculture, urban/industrial environments and mosquito mitigation. Pat is a Licensed Operator and Qualified Applicator (CA & ON) and a Registered Food Safety Instructor (NRA). His current position is Technical Services Manager for Orkin's Pacific Division. He obtained

	both a B.A. and B.S. (Ag) from the University of Manitoba before completing his M.S. in Entomology from the University of Guelph (Ontario Agricultural College) in 1983.
Jim T. Criswell Pesticide Coordinator Oklahoma State University 127 NRC Stillwater, OK 74078-3033 405 744-5531 jim.t.criswell at okstate.edu	Dr. Criswell has served as pesticide coordinator since 1988. Jim works with the Oklahoma Department of Agriculture, Food & Forestry in the pesticide certification program. He coordinates education programs for pesticide applicators and entities receiving pesticide applications. He is knowledgeable in FIFRA regulations, pesticide labels and pesticide safety and available for regional or national assistance continent on schedule and funding.
Bill Currie International Pest Management Institute PO Box 474 Ash Fork, AZ 86320 928 637-2378 bugebill at earthlink.net	Mr. Currie provides urban IPM consulting services to school systems and others and has worked with the Los Angeles Unified School District for many years helping to develop and support their IPM program.
Jaslyn Dobrahner US EPA Region VIII Pesticides Program Denver, CO 303 312-6252 Dobrahner.Jaslyn at epamail.epa.gov	Ms. Dobrahner is currently working with Dr. Marc Lame of Indiana University and the Salt Lake City School District to implement US EPA Region VIII's first school IPM program. Jaslyn is also working with several Indian tribes in the region to conduct school IPM evaluations as a first step to introducing school IPM to these districts.
Jay Feldman Executive Director Beyond Pesticides 701 E St. SE Washington, DC 20003 202 543-5450 x15 jfeldman at beyondpesticides.org	Mr. Feldman is cofounder of Beyond Pesticides and director since 1981. He dedicated himself to finding solutions to pesticide problems after working with farmworkers and small farmers through an EPA grant in 1978 to the national advocacy organization Rural America (1977-1981). Since that time, he has helped to build Beyond Pesticides' capacity to assist local groups and impact national pesticide policy. He has tracked specific chemical effects, regulatory actions, and pesticide law. His work with media has helped to bring broader public understanding of the hazards of pesticides. Jay has a Masters in urban and regional planning with a focus on health policy from Virginia Polytechnic Institute and State University.

Carrie Foss, Urban IPM Coordinator Washington State University 7612 E. Pioneer Way Puyallup, WA 98371 253 445-4577 cfoss at wsu.edu	Ms. Foss' responsibilities include educating pesticide applicators with an emphasis on personal safety, environmental protection, and IPM. She has conducted IPM STAR evaluations for several school systems in the state including Vancouver and South Kitsap.
Al Fournier IPM Program Manager Maricopa Agricultural Center University of Arizona 37860 W. Smith-Enke Rd. Maricopa, AZ 85239 520 381-2240 fournier at ag.arizona.edu	Dr. Fournier coordinates with faculty, clientele and other stakeholders to identify statewide pest management priorities, organizes UA faculty to develop solutions, supports efforts to secure external funding, and develops resources to measure and document IPM program adoption and impacts. His responsibilities span all program areas and departments related to pest management, including agricultural, urban and natural resource systems. He also coordinates pesticide information requests from EPA and USDA for 3 Southwest states (AZ, NM, NV, plus parts of CA) and serves as liaison to the Western IPM Center. Al has a PhD in Entomology from Purdue University (2005) where he studied factors affecting adoption and implementation of IPM in K-12 public schools.
Jody Gangloff-Kaufmann IPM Area Specialist Cornell Cooperative Extension 228 Thompson Hall Farmingdale, NY 11735 631 420-2022 jlg23 at cornell.edu	Dr. Gangloff-Kaufmann provides IPM education, demonstration and outreach including training workshops. She has provided expertise in stinging insect and bed bug IPM. She holds a Ph.D. in entomology from Cornell University.
Lyn Garling, IPM Education Coordinator Penn State University 501 ASI University Park, PA 16802 814 863-8884 ljg5 at psu.edu	Ms. Garling runs IPM planning, grant writing, outreach, teaching, research and implementation activities for the PA IPM Program. IPM in Schools efforts include developing IPM curriculum for K-12 and IPM service-learning projects, developing policies and guidelines for IPM implementation in schools, and promoting IPM STAR Certification and EPA Indoor Air Quality Tools for Schools.
Sherry Glick National Coordinator, Pesticides & Schools US EPA OPP 4220 S. Maryland Pkwy.	Ms. Glick has been with the US Environmental Protection Agency for 25 years and leads the schools sector for the Pesticide Environmental Stewardship Program (PESP) in the Office of

Las Vegas, NV 89119 702 784-8276 glick.sherry at epa.gov	Pesticide Programs. Glick also serves as the National Coordinator for Schools and Pesticides within EPA. Glick was awarded the Hammer Award from Al Gore's Office of Reinvention for progress in developing the Partners for the Environment Program. Glick is a graduate of Michigan State University.
Dawn Gouge, Urban Entomologist Maricopa Agricultural Center University of Arizona 37860 W. Smith-Enke Rd. Maricopa, AZ 85239 520 568-2273 x223 dhgouge at ag.arizona.edu	As director of the University of Arizona's School IPM Program since 2000, Dr. Gouge has facilitated implementation of IPM in 13 school districts, impacting over one-third of Arizona's school children (340,328). Three of these school districts have achieved STAR Certification from the IPM Institute of North America, Inc. In 2006, Dr. Gouge received an Environmental Achievement Award from the US EPA in recognition of her school IPM efforts.
Fudd Graham Auburn University Department of Entomology & Plant Pathology 301 Funchess Hall Auburn, AL 36849-5413 334 844-2563 fgraham at acesag.auburn.edu	Dr. Graham manages research, education and outreach for the fire ant program for Alabama and coordinates school IPM efforts in the state. He also co-leads the Southern Region School IPM Working Group and co-coordinates the School IPM Network of the Entomological Society of America.
Thomas Green, President IPM Institute 4510 Regent St. Madison, WI 53705 608 232-1410 Fax 608 232-1440 Ipmworks at ipminstitute.org	Dr. Green co-founded in the IPM Institute which operates the IPM STAR program for schools and Green Shield Certified for other facilities and pest control service providers, and has been named a national champion by the US EPA Pesticide Environmental Stewardship Program. He is available for presentations, training workshops and on-site evaluations of IPM programs at schools and other facilities.
Lyndon Hawkins Independent Contractor Nopesticides.com 916 685-2579 ipmexpo at yahoo.com	Lyn Hawkins retired from the IPM program with the California Department of Pesticide Regulation. One recent project was writing the IPM ordinance for Santa Clara County. He is currently working with the County of Sacramento on their IPM policy and he is also a trustee for the Sacramento-Yolo County Mosquito and Vector Control District, having just completed two years of significant outbreaks of West Nile virus.

Janet Hurley School IPM Program Coordinator Southwest Technical Resource Center Texas A&M Dallas Agricultural Research and Extension Center 17360 Coit Rd. Dallas, TX 75252-6599 972 952-9213 ja-hurley at tamu.edu	As Program Coordinator for the Southwest Technical Resource Center for IPM in Schools since 2001, Ms. Hurley implements a two-day training workshop for Texas IPM Coordinators, oversees the school IPM website and produces a bi-monthly newsletter, *School Pest News*. Janet has conducted IPM Coordinator training for schools in Texas, New Mexico and Oklahoma resulting in over 1,500 people trained and 500 school districts reached. In addition to standardized training and CEU presentations for the pest control industry, she has worked with 140 school districts in Texas helping them implement and organize their IPM program. In 2005 the Southwest Technical Resource Center was recognized as (EPA) PESP Champions for contributions to school safety and improved pest control. The school IPM Team was also recognized by Texas Cooperative Extension with a Team Award for Superior Service. Janet will travel anywhere to help spread the word of school IPM pending availability.
Marc Lame Indiana University Dept. of Public and Environmental Affairs 1315 E. 10th, Room 240 Bloomington, IN 47401 812 855-7874 mlame at indiana.edu	In 1995, Dr. Lame initiated a school Integrated Pest Management (IPM) program with the Monroe County Community School Corporation in Bloomington, Indiana. He and colleagues have demonstrated and documented the effectiveness of this model in seven states (USEPA Regions 4, 5, 8 and 9 – including 3 Native American school districts), over ten years, showing an average 71% reduction in pesticide applications and 78% reduction in pest complaints to school administrations. Marc recently published *A Worm in the Teacher's Apple: Protecting America's School Children from Pests and Pesticides*. In April of this year Marc was recognized by the National IPM Symposium with the first ever IPM Achievement Award.
Will Lanier Montana State University Dept. of Entomology 422 Leon Johnson Hall Bozeman, MT 59717 406 994-5690 wlanier at montana.edu	Mr. Lanier, M.S., has been with MSU as the IPM assistant for seventeen years. In that time he has developed and maintained a regional cutworm monitoring program, the Pest Recommendation Network, Crop Pest Management School and improved and expanded the MSU Insect diagnostics lab to meet requirements of the Great

	Plains Diagnostic Network. Mr. Lanier was directly involved in developing and evaluating the High Plains IPM Guide Web site, a regional recommendation source for insects and diseases of the high plains. The Guide is sponsored by the USDA, Cooperative States Research Service, Western Region IPM Special Grants Program and Environmental Protection Agency, Region 8. He has delivered presentations and training to community, producer and commodity groups throughout the state, and peers at national annual meetings like the National Integrated Pest Management Symposium, Entomology Society of America and National Extension Technology Conferences. Currently he is developing decision support systems and distance delivery methods for IPM information.
Alexandre Latchininsky Assistant Professor/Extension Entomologist University of Wyoming Dept. 3354 - Renewable Resources 1000 E. University Ave. Laramie, WY 82071-3354 307 766-2298 Latchini at uwyo.edu	Dr. Latchininsky is the only faculty-level Extension Entomologist in the state of Wyoming. His research expertise involves the development of IPM approaches to rangeland pest management, such as grasshoppers in North America and locusts in Africa and Asia. His Extension program promotes IPM strategies and addresses questions of rangeland, horticultural, crop, forest and urban pest management. Alex contributes to pesticide education and training in Wyoming (EPA Region 8) on a regular basis. In the past five years, via collaboration with USDA-APHIS-PPQ, he delivered grasshopper IPM training programs to 10 western states. He received his B.S. and M.S. in Entomology from St. Petersburg State University in Russia and his Ph.D. in Entomology from the University of Wyoming.
Sarah Leverette Outreach Program Director Oregon Environmental Council 222 NW Davis St., Suite 309 Portland, OR 97209-3900 503 222-1963 x105 saral at oeconline.org	Ms. Leverette's background is in outreach and social marketing. She joined the Oregon Environmental Council in 2007 to work on environmental and children's health programs, including her first experience with IPM. Previously she directed the Coalition for Commercial-Free Schools and the Oregon High School Earth Club Network for the Northwest Earth Institute. Sarah's degree is in Environment, Economics and Politics with a double in Spanish from Claremont McKenna

	College.
Richard Lumpkin Lumpkin Pest Management PO Box 217 Notasulga, AL 36866 334 501-6633 richardlump1 at aol.com	Mr. Lumpkin provides professional pest management services to schools and other clients in Alabama. He has also worked under Dr. Fudd Graham in training programs for pest management professionals in the state including school IPM.
Jack Marlowe, President Eden Advanced Pest Technologies 3425 Stoll Rd. SE Olympia, WA 98501 503 252-2048 jackmarlowe at edenpest.com	Mr. Marlowe is the owner of Eden Advanced Pest Technologies. Eden has been involved with Integrated Pest Management (IPM) work for the past 18 years. During that time, Jack has participated in many IPM committees including the IPM in Schools Working Group in Washington State, as well as the Western Region and National Strategic IPM working groups. Jack has participated as an IPM consultant for many municipalities, school districts, and commercial properties as well as being an active proponent of IPM within the Pest Control Industry. As such, Jack has conducted many training classes on IPM, both in the class room and in the school environment. His company offers a Green Shield Certified service called Natural Choice.
Michael Merchant, BCE Professor and Extension Entomologist Texas Cooperative Extension 17360 Coit Rd. Dallas, TX 75252-6599 972 952-9204 m-merchant at tamu.edu	Dr. Merchant has been actively involved in school IPM issues in Texas since 1992 when he served as chair of the state advisory board asked to draft new pesticide regulations affecting schools in Texas. In 1997 he wrote and produced an award-winning set of video (now DVD) and workbook training modules for school faculty, staff and students, the *ABCs of IPM*. He was lead author of *An Introduction to IPM in Schools: A Manual for Facilities Maintenance Professionals* (TCE Bulletin B-6015). Since 2001 he has led the *Southwest Technical Resource Center for School IPM* (SWTRC). He is a regular contributor to the *School Pest News*, a Texas newsletter with a current circulation of 1030 (representing over 500 school districts). Since 1994 he has authored or co-authored 12 successful school IPM-related grants worth over $520,000. Under his leadership, he and other faculty at Texas A&M University have trained over 1500 school and pest management professionals since 2002, including employees of over 488 Texas school

	districts. Current projects include evaluations of regional training programs, development of a cost-calculator decision-making tool for IPM coordinators, a statewide survey of IPM implementation in Texas schools, and a multistate project to train schools and develop green building recommendations for IPM. In 2005 he, and other members of the SWTRC, received the Texas Cooperative Extension Superior Service Team Award and were recognized as (EPA) PESP Champions for contributions to school safety and improved pest control.
Belinda Messenger, Associate Environmental Research Scientist Dept. of Pesticide Regulation PO Box 4015 Sacramento, CA 95812-4015 916 324-4077 bmessenger at cdpr.ca.gov	Ms. Messenger works with California's Department of Pesticide Regulations which has offered workshops in California since the Healthy School Act of 2000 became law. To date, the Department has trained 694 school staff in over 56% of the roughly 1000 school districts in California representing nearly 6,000 schools, including four workshops per year. Each workshop is limited to 40 school staff in order to maintain a practical, hands-on, site assessment format. Belinda's program is investigating ways to better give districts the tools needed to implement IPM. While the regional (day long) workshops accomplish the goal of introducing IPM concepts, it is clear that districts want and need more individual assessment and training.
Maria Moio Pittsburgh Board of Education Division of Plant Operations 8 South 12th St. Pittsburgh, PA 15203-1131 412 488-4275 mmoio1 at pghboe.net	Ms. Moio directs pest management in Pittsburgh public schools, including teaching IPM to students and staff, and has assisted Penn State in training programs throughout the state. The district earned IPM STAR certification in 2004.
Kathy Murray, IPM Entomologist Dept. of Agriculture, Food and Rural Resources 28 State House Station Augusta, ME 04333 207 287-7616 kathy.murray at maine.gov	Dr. Murray coordinates IPM activities for the Maine Department of Agriculture, Food and Rural Resources, providing pest management expertise in a variety of settings including vegetable crops, ornamental horticulture, livestock and poultry. Kathy coordinates the Maine School IPM Program which offers training, technical support and outreach to help all Maine schools adopt IPM in compliance with state regulations. She earned a

	Ph.D. in entomology from the University of Massachusetts and an M.S. in entomology from the University of Maine.
Rich Muscarella, IPM Consultant Ashland Professional Pest Management 406 Connecticut St. Buffalo, NY 14213 716 884-7431 richard.muscarella at gmail.com	Mr. Muscarella's background is in urban entomology. Ashland serves both the Buffalo and Williamsville school systems. He is a recipient of the NY State IPM Program's IPM Innovator Award.
Godfrey Nalyanya School IPM Project Coordinator North Carolina State University Dept. of Crop Science Raleigh, NC 27695-7620 919 515-5650 godfrey_nalyanya at ncsu.edu	Dr. Nalyanya coordinates school IPM efforts for Cooperative Extension in North Carolina. He earned his Ph.D. in entomology from NC State University.
Michelle Niedermeier Pennsylvania IPM Program 111 N 49th St., Suite KN3-100, 3rd Fl N Philadelphia, PA 19139 215 471-2200 x109 mxn14 at psu.edu	Ms. Neidermeier works with schools and community groups to implement IPM and Indoor Air Quality programs in the Philadelphia metropolitan area.
Faith Oi, Assist. Extension Scientist University of Florida Entomology & Nematology Dept. Bldg.970, Natural Area Dr. Gainesville, FL 32611-0064 352 392-1901 x145 foi at ufl.edu	Dr. Oi is currently an assistant Extension scientist at the Entomology and Nematology Dept. at University of Florida where her research focuses on termite and ant IPM. She is also working on developing the urban pest management training facility and is co-director of the School IPM program.
Chip Osborne Turf Manager Town of Marblehead Abbot Hall 188 Washington Street Marblehead, MA 01945 781 631-2467 ozflor at aol.com	Chip is a professional horticulturist with over 30 years' experience. He co-chairs the Marblehead Pesticide Awareness Committee and Marblehead's Living Lawn Project, a "seeing is believing" organic lawn and garden demonstration site. Chip lectures widely on organic turf management, both to homeowners and municipalities. Currently, Chip is teaching classes to certify landscape professionals on natural, organic methods in conjunction with the New York State Turf and Landscape Association, Grassroots Environmental Coalition and the County of Westchester in New York. He is president of Osborne Organics, a consulting company

	specializing in working with municipalities and school districts in pesticide reduction and natural turf management. As an elected member of the Town of Marblehead Recreation, Parks & Forestry Commission for the past six years, and the current chairman for the past four, Chip is currently implementing an organic turf management plan for Town of Marblehead public lands, including athletic fields.
Don Rivard Environmental Management Consultant Rivard's Resources: IPM 177 Seminole Ave. Waltham, MA 02451-0859 781 899-5843 donrivard22 at comcast.net	Mr. Rivard started as an engineering entomologist with the US Air Force in 1967. He has managed a multi-million dollar pest control firm for over 20 years and has been a professional consultant for over 14 years. Mr. Rivard is a member of the National Pest Management Association and the Massachusetts Public Health Association.
Kyrrah Sevco, Program Manager Ecology Action PO Box 1188 Santa Cruz CA 95061 831 426-5925 x109 ksevco at ecoact.org	Ms. Sevco provides technical training to California school districts in Madera, Monterey and Santa Cruz counties in a model program to help reduce reliance on pesticides. Ecology Action has received an IPM Innovator Award from the California Department of Pesticide Regulations for school IPM work as well as projects with home gardeners and landscaping professionals.
Mark Shour, Extension Entomologist Iowa State University 109 Insectary Building Ames, IA 50011-3140 515 294-5963 mshour at iastate.edu	As a member of Iowa State University Extension since 1999, Dr. Shour is responsible for pesticide safety education training and implementation of IPM principles for trees, shrubs, turfgrasses, households, and businesses, as well as child care, elder care and K-12 school facilities. Dr. Shour is also the coordinator of the school IPM and child care IPM programs in Iowa. He has conducted state pesticide use surveys of K-12 public schools and licensed child care centers, an interior pest pilot program (4 schools), centers (13 centers).
Michael Siciliano, Director of Pest Management NY Dept. of Education 44-36 Vernon Boulevard Long Island, City NY 11101 718 707-4493 Msiciliano at nycboe.net	Mr. Siciliano has directed pest management at NYC schools since 2006. In addition, he operates an IPM service to NYC restaurants and other accounts.

Sewell Simmons Pest Management and Licensing California Dept. of Pesticide Regulation 1001 I St., Third Fl. PO Box 4015 Sacramento, CA 95812-4015 916 445-3914 ssimmons at cdpr.ca.gov	Mr. Simmons has been actively involved with school IPM since 1995 and has published articles on pest prevention in schools emphasizing maintenance practices, facility design, and construction practices. He is currently the acting lead of the Department of Pesticide Regulation's School IPM Program. The program maintains a comprehensive web site on IPM in schools, publishes a model IPM program guidebook, conducts workshops throughout the state to train individuals designated by school districts to carry out school IPM, conducts an extensive outreach program to assist districts in establishing IPM policies and programs, and evaluates IPM adoption in schools.
Gregg Smith, Director of Facility Services Salt Lake City School District 440 East 100 South Salt Lake City, UT 84111-1891 801 886-8929 x150 gregg.smith at slc.k12.ut.us	Gregg has been involved with IPM only a few years. His school district's efforts were recognized in October 2006 by the EPA for achieving a 90% reduction in pesticide use in their IPM pilot project, which involved three schools. Recently, Gregg's group has begun IPM implementation throughout the entire SLC school district and is currently developing web-based tools to further enhance their program.
Richard Smith Director, Environmental Health & Safety Brevard Public Schools 2700 Judge Fran Jamieson Way Viera, FL 32940-6601 321 633-1000 x462 SmithRE at brevard.k12.fl.us	Mr. Smith led Brevard Public Schools IPM effort which received recognition in a 1998 front page article in *Education Week* titled, "Florida Schools Are Cleaning Up in Effort to Cut Pesticide Usage" and awards from the University of Florida and the US EPA. He has directed district-level plant operations and custodial programs and actively participated in IPM activities at the state and national level. Richard received his M.S. in Biological Science from the University of Central Florida and holds three national board certifications in environmental health and safety. He is president of the Florida School Plant Management Association.
Jennifer Snyder, Research Specialist University of Arizona Maricopa Agricultural Center 37860 W. Smith-Enke Rd. Maricopa, AZ 85239 520 381-2266	Ms. Snyder coordinates school IPM efforts in Arizona with Dr. Dawn Gouge. She has co-authored the *Pest Press* series of IPM fact sheets and newsletters published for the Arizona Children's Environmental Health Coalition.

jsnyder at ag.arizona.edu	
Ted St. Amand, President/Owner Atlantic Pest Solutions Companies PO Box F Kennebunkport, ME 04046 800 439-7716 ted at atlanticpestsolutions.net	Mr. St. Amand is a second-generation pest management professional running a company with two locations in Maine and serving schools as well as commercial and residential customers in the state. Atlantic Pest Solutions offers a Green Shield Certified service.
Tim Stock IPM Education Specialist Integrated Plant Protection Center Oregon State University 2040 Cordley Hall Corvallis, OR 97331-2915 stockt at science.oregonstate.edu	Tim received his MS degree in Agricultural Extension at the University of Reading in England. Over the past 20 years he has developed participatory education programs in Washington, California, and internationally. As IPM Education Specialist, he focuses on pesticide risk reduction training and IPM in Schools. His program is charged with developing an outreach and training program to promote the implementation of IPM in schools. This is in the early stages, and will progress as resources become available. His assessment of what is needed to move forward in Oregon is in a white paper "Improving Pest Management and Reducing Pesticide Risks in Oregon Public Schools, Parks, and Sensitive Sites (Care Facilities)", available at www.ipmnet.org/Tim/IPM_in_Schools/IPM_in_Schools-Main_Page.html
Bob Stoddard EnviroSafe Inc. 1774 Porter St. Wyoming, MI 49519 616 364-1890 envyrosafe at aol.com	Mr. Stoddard provides professional pest management services to school districts and other clients in Michigan. He is a former school district employee as presented at workshops throughout the state on IPM. His company is Green Shield Certified.
Larry Swain, Community Program Manager Michigan Dept. Of Agriculture PO Box 30017 Lansing MI 48909 517 373-1087 swainl at michigan.gov	Mr. Swain is the Community Program Manager for the Michigan Department of Agriculture and state's Pesticide Certification Manager. He has been involved in IPM for over 20 years and was a driving force behind the creation of Michigan's School IPM Board. He oversees an extensive IPM training program and created the IPM Academy to train new IPM trainers.
Allen Wilson Safe Zone IPM Consultation Service	Mr. Wilson has been working with the IPM program in the Westerville City School District for four years,

614 620-1643 safezonecs at wowway.com	retiring from the district as IPM Coordinator in 2007. He has since started Safe Zone IPM Consultation Services and continues to consult with the district. He also conducts IPM informational/training workshops throughout Ohio, most recently to the Ohio Public Facilities Maintenance Association's Annual Conference. He provides workshops on compliance with the new Ohio school environmental and safety mandate and also serves as a member on the national IPM in schools implementation team with Dr. Marc Lame.

Appendix M. School IPM Toolbox

The following tools were compiled primarily by Dr. Dawn Gouge and Jennifer Snyder, University of Arizona in 2007 with support from US EPA Office of Pesticide Programs. Additional tools were contributed by working group members and others. For a directory with links to downloadable files, see www.ipminstitute.org/school_ipm_pmsp_app_m_toolbox.htm. A number of these tools can also be found with additional tools including short videos at schoolipm.ifas.ufl.edu/toolbox.html

1. Model IPM Program Documents and Technical Guides
    - IPM Policy
    - IPM Policy Two
    - IPM Pest Monitoring Protocol
    - Architectural Guidelines
    - New Construction Specifications
    - Guide to Contracting with a Pest Management Professional
    - Best School IPM Implementation Manuals
    - Sources of IPM Fact Sheets for Specific Pests
    - IPM Pest Monitoring Protocol
    - Evaluating your IPM Program
    - IPM Program Flier
    - Notice of Pesticide Application

2. IPM Checklists
    - IPM Self-Inspection Sheet
    - Corrective Actions Needed Notice
    - School IPM Audit Checklist
    - School IPM Audit Report Template

3. Model Indoor Air Quality Checklists
    - Administrative Staff Checklist
    - Building Maintenance Checklist
    - Food Service Checklist
    - IPM Checklist
    - Renovation and Repair Checklist
    - School Official Checklist
    - Ventilation Checklist
    - Walkthrough Checklist

4. Model Pest Sighting Logs
    - Kitchen
    - Main Office
    - Staff Lounge

5. Powerpoint Presentations
    - Introduction to IPM
    - Asthma and School IAQ & IPM
    - School IPM for Custodians
    - School IPM for Faculty
    - School IPM for Kitchens
    - School IPM for Maintenance and Grounds Staff
    - School IPM for Students
    - Assorted Posters

6. Other Visual Aids
    - Pest Conducive Conditions Wheel, V1 Base (US EPA)
    - Pest Conducive Conditions Wheel, Middle
    - Pest Conducive Conditions Wheel, Top

7. Model IPM Training Curricula for Pest Managers and School Professionals

    The following curricula were developed by Bill and Jean Currie of the International Pest Management Institute:
    - Area Facilities Services Directors
    - Area Food Service Supervisors
    - Area Operations Supervisors
    - Cafeteria Managers
    - Cafeteria Training Specialists
    - Carpenters
    - Complex Project Managers
    - Delivery Staff
    - Electricians
    - Flood Covering Installers
    - Gardeners
    - HVAC Installers
    - Local District Facilities Directors
    - Manufacturing Kitchen Staff
    - Nurses
    - Nutrition Center Staff
    - Nutrition Specialists
    - Painters
    - Plant Managers
    - Plumbers
    - Pest Management Technicians
    - Principals
    - Project Managers
    - Roofers
    - Sheet Metal Installers

- Teachers
- Tree Trimmers
- Warehouse Staff

The following pest-specific curricula were developed by California Department of Pesticide Regulation (available at www.cdpr.ca.gov/schoolipm/training/main.cfm#curricula)

- Burrowing rodents
- Landscape weeds
- Structural IPM
- Turf weeds
- Yellowjackets

8. Recognition and Rewards
   - Rewards and Recognition Programs
     IPM STAR
     US EPA Office of Children's Health
     Green Flag
   - Model Certificate of Recognition

9. Pest Press Newsletters
   More than thirty editions of one to two-page newsletters on school IPM topics. Compendia available at schoolipm.ifas.ufl.edu/Florida/newsletter.htm and cals.arizona.edu/urbanipm/pest_press/index.html