SCHOOL IPM 2020: A Strategic Plan for Integrated Pest Management in Schools in the United States

Version 3.0

September 14, 2015

Edited by Thomas A. Green, Ph.D., IPM Institute of North America, Inc.,
Dawn H. Gouge, Ph.D., Department of Entomology, University of Arizona

TABLE OF CONTENTS

Foreword

Pest Management Strategic Plans (PMSPs) are living stakeholder-owned documents, facilitated and funded by the USDA Office of Pest Management Policy and designed to be updated periodically, typically by the original grantees. Along with guidance on developing and updating PMSPs, completed plans are posted online by the IPM Centers at http://www.ipmcenters.org/pmsp/index.cfm

PMSPs are typically developed for specific crops and regions by groups of stakeholders including commodity groups, land-grant university specialists, expert consultants, industry product and service providers and federal and state agencies. PMSPs typically take a pest-by-pest approach and identify current management practices, both chemical and non-chemical, as well as those under development. Plans also identify priorities for research, regulation and education to improve pest management practices and outcomes. PMSPs are used by researchers, educators, regulators and others to assess the current state of pest management, identify needs, support requests for funding and other purposes. Components of a PMSP may be incorporated in funding proposals, or further developed into outreach materials.

This document is one of the few PMSPs addressing a non-crop environment and with a national scope. It is also unusual in that it sets a goal of implementing high-level IPM in all US public schools by 2020. For an update on the national effort, including the national steering committee and regional working groups, see:

Northeastern Region School IPM Working Group
http://northeastipm.org/work_school.cfm

Southern Region School IPM Working Group
http://www.sripmc.org/schoolIPM/

North Central Region School IPM Working Group
http://www.ipminstitute.org/NC_IPMIS_Working_Group/main.htm

Western Region School IPM Working Group
http://cals.arizona.edu/apmc/westernschoolIPM.html

National Steering Committee
http://www.ipminstitute.org/school_ipm_2020/steering_committee.htm

Acknowledgements

The first version of this document, released in 2008, was the result of a large collaborative effort involving the IPM Institute of North America, the USDA NIFA IPM Program and USDA Regional IPM Centers, US EPA, Land-Grant universities, school district personnel, and representatives from private industry, non-governmental organizations and consultants. The second version, released in 2009, included minor technical updates. Additional updates to the second version were released in 2012, including updated priorities.

Version 3.0 includes updated national and working group priorities,

The editors gratefully acknowledge the contributions of the following individuals to version 3.0:

Lynn Braband
Pat Copps
Carrie Foss
Fudd Graham
Janet Hurley, MPA, Extension Program Specialist II - School IPM, Texas A&M AgriLife Extension Service
Kathy Murray
Claudia R
Mark Shour

The following IPM Institute staff provided support for this revision: Mariel Snyder and Matt Neff.

The editors are responsible for all content, which does not necessarily represent the opinions of all contributors or all of those who provided comments. This document will be reviewed and revised periodically. Corrections of factual errors and other comments are welcome and may be emailed to info@ipminstitute.org. All hyperlinks were verified in July 2015.

Citation. Green, T.A., and D.H. Gouge, eds. 2015. *School IPM 2020: A Strategic Plan for Integrated Pest Management in Schools in the United States*. Version 3.0. 316 pp. http://www.ipminstitute.org/school_ipm_2020/SCHOOL_IPM_2020_V3_070615.pdf

Rather than post this document, the project team asks that users link to the hyperlink in the citation above to ensure readers are directed to the current version.

For a log of changes made to prior editions, visit http://www.ipminstitute.org/school_ipm_2015/school_ipm_2015_Updates.htm

1. Executive Summary

Pest management practices in our nation's schools are in need of improvement. More than 63 published surveys and reports from public agencies, advocacy groups and others since 1994 (Appendix G) have documented deficiencies including unmanaged pest infestations and inappropriate and off label use of pesticides in and around schools. The American Academy of Pedatrics (2012) warns that, "High-dose pesticide exposure may result in immediate, devastating, even lethal consequences,".

Improvement is feasible and affordable. Pest complaints and pesticide use in schools and other public buildings have been reduced by up to to 93% through Integrated Pest Management (IPM), with no long-term increase in costs in multiple well-documented studies (Gouge *et al.* 2006; Greene and Breisch 2002, Williams *et al.* 2005).

IPM includes a continuum of practices progressing from basic monitoring and inspection, and higher risk, reactive strategies, to lower-risk, long-term prevention and avoidance of pest problems and pest-conducive conditions (Balling 1994, Jacobsen 1997, eXtension 2010). The ultimate goal is a balanced system where pests remain at tolerable levels with minimal cultural and biological interventions.

Full implementation of IPM in schools at the advanced end of the continuum 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 (Chapter 2, Table 1). Pesticides are used only when reasonable non-chemical measures are inadequate. When needed, pesticide products are selected that minimize toxicity and/or 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, identify priorities for management, education, research and regulation, and 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 2020.

Specifically, prompt and coordinated action is required to:

- Increase awareness among key influencers and the school community of the problems and availability of ready solutions to reduce pest problems and pest-conducive conditions, reduce the need for pesticide applications and reduce toxicity and potential for exposure when a pesticide application is called for;

- Generate a commitment from agencies, organizations and individuals including product and service providers 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 and pest-conducive conditions;

- Improve regulations and compliance with existing laws;

- Improve knowledge and understanding of the proper role and use of pesticides in pest management;

- Address research questions that may lead to reduced-risk 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 and implementing this plan, we have enlisted participation by a broad stakeholder group including leaders representing key influencer and practitioner groups, who are now actively working to implement IPM in all schools nationwide and recruiting others from their professions to achieve our goal.

We are eight years into the effort of full implementation of IPM in our schools. The strategic plan proposal was developed in 2009 and in 2012 we evaluated our progress. Many positive changes have been made but there are still many challenges to overcome. Chapter 4 of the strategic plan has been updated to reflect the changing priorities of the National School IPM Working Group Joint Steering and Advisory Committee.

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 risks associated with sanitation and maintenance practices and products. We have also not addressed IPM in horticulture or agricultural educational programs, which often present a great opportunity to adopt, and teach IPM.

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 pest and 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 (Table 2.1) in all schools nationwide by 2020.

A record-setting 49.5 million students were served by 6.2 million staff including 3.3 million teachers in 13,558 public school districts in the US in 2011 (US Dept. of Education 2011,2012). These districts include approximately 132,183 elementary and secondary schools. An additional 5.5 million K-12 students were served by 437,410 teachers at 33,370 private schools.

Record levels of elementary and secondary school enrollment are expected every year over the next eight years, with 2019 enrollment predicted to be 6% higher than 2007 levels (US Department of Education 2011).

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 brain, nervous, endocrine, reproductive, and other systems.

Many definitions of IPM have been published. Perhaps the strongest consensus is represented in the *IPM Roadmap* (USDA 2004), which describes IPM as "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."

The American Academy of Pediatrics recommends that pediatricians work with schools and governmental agencies to advocate for application of low risk pesticides by using IPM principle and promote community right-to-know procedures when pesticide spraying occurs in public areas (American Academy of Pediatrics 2012).

The goal of *School IPM 2020* is for every US public school to be practicing high-level IPM by 2020. The term "high-level" refers to the high end of the IPM continuum, which describes the progression of pest management strategies from high-risk, reaction-based action towards least-risk, long-term prevention and avoidance of pest problems and pest-conducive conditions. The continuum begins with a focus on monitoring and chemical suppression when pests approach unacceptable levels, and ends with a balanced system where pests remain at tolerable levels with minimal cultural and biological interventions (Balling 1994, Jacobsen 1997, eXtension 2010). The key question for schools and other potential practitioners is then, “How much IPM are you doing?” rather than, “Are you doing IPM?”

In 2010, Steve Owens, EPA Assistant Administrator for Chemical Safety and Pollution Prevention announced a $250,000 grant to the IPM Institute of North America to expand efforts to reduce pest and pesticide risks, reduce asthma incidence, and further environmental justice in school districts across the county. EPA has made a commitment to IPM in schools to protect children’s health and reduce their exposure to pesticides in schools.

The working group distributed a state-level survey in 2012 and a US public school district survey in 2013 to measure progress towards the goal of implementing IPM in all US public schools by 2020. The survey, produced with support from the 2010 US EPA Pesticide Registration Improvement Renewal Act (PRIA) grant, has been distributed to public school districts in 41 states in partnership with leaders in each state. Eight states conducted independent surveys, which were integrated into the results from the district survey. Topics covered in the survey include IPM policies and plans, IPM coordinators, IPM tools or resources in use, pest management strategies, funds spent on pest management and tracking of pest complaints, pesticide applications and pest management costs.

Of a total of 2,672 districts that have responded as of August 2015, 50% reported that they had written IPM policies and 46% had written IPM plans. Additionally, 52% had an IPM coordinator, most with more than two years of experience. More than 83% of districts reported that only licensed pesticide applicators applied any product in school buildings. The findings likely suffer from bias, i.e., districts with an IPM coordinator are more likely to be in a position to respond to the survey.

The survey identified opportunities for improvement. More than half of districts reported applying pesticides on a regular or routine basis in and around school buildings. Although more than 42% of responding districts report using pest or IPM factsheets, only 17% use IPM training tools for staff and 14% read IPM newsletters. The states listed in the below table are examples of high indicators of how much school IPM has improved.

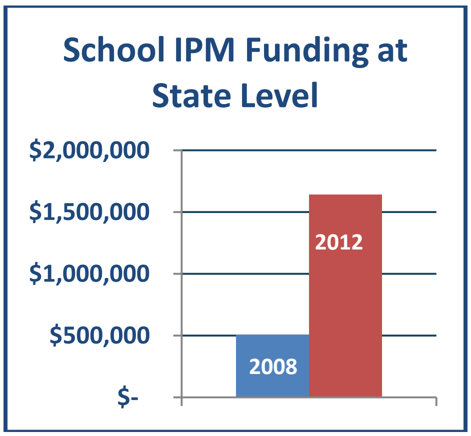
State	IPM Policy?	IPM Plan?	IPM Coord.?	Pest Monitoring?	Routine Grounds?	Routine Building?	Only Contractors?
Maine	95%	74%	95%	77%	10%	12%	35%
Maryland	100%	100%	100%	92%	8%	8%	8%
West Virginia	75%	75%	71%	88%	25%	38%	63%
Texas	98%	73%	98%	90%	52%	58%	55%

Louisiana	81%	81%	88%	71%	52%	74%	61%
Washington	54%	54%	54%	54%	25%	18%	73%

States reporting a statewide, coordinated IPM effort with multiple agencies and institutions engaged jumped from five in 2008 (10% of respondents) to 21 in 2012 (42% of respondents).

Survey bias include the following

- School districts without an IPM program or IPM coordinator may be less likely to respond.
- We did not achieve our goal of hitting a 40% response rate in each state. Where possible, we partnered with collaborators in the state, e.g., Dept. of Ed, Extension.
- It is difficult to compare results between 42 PRIA-funded and eight non-PRIA-funded state surveys.

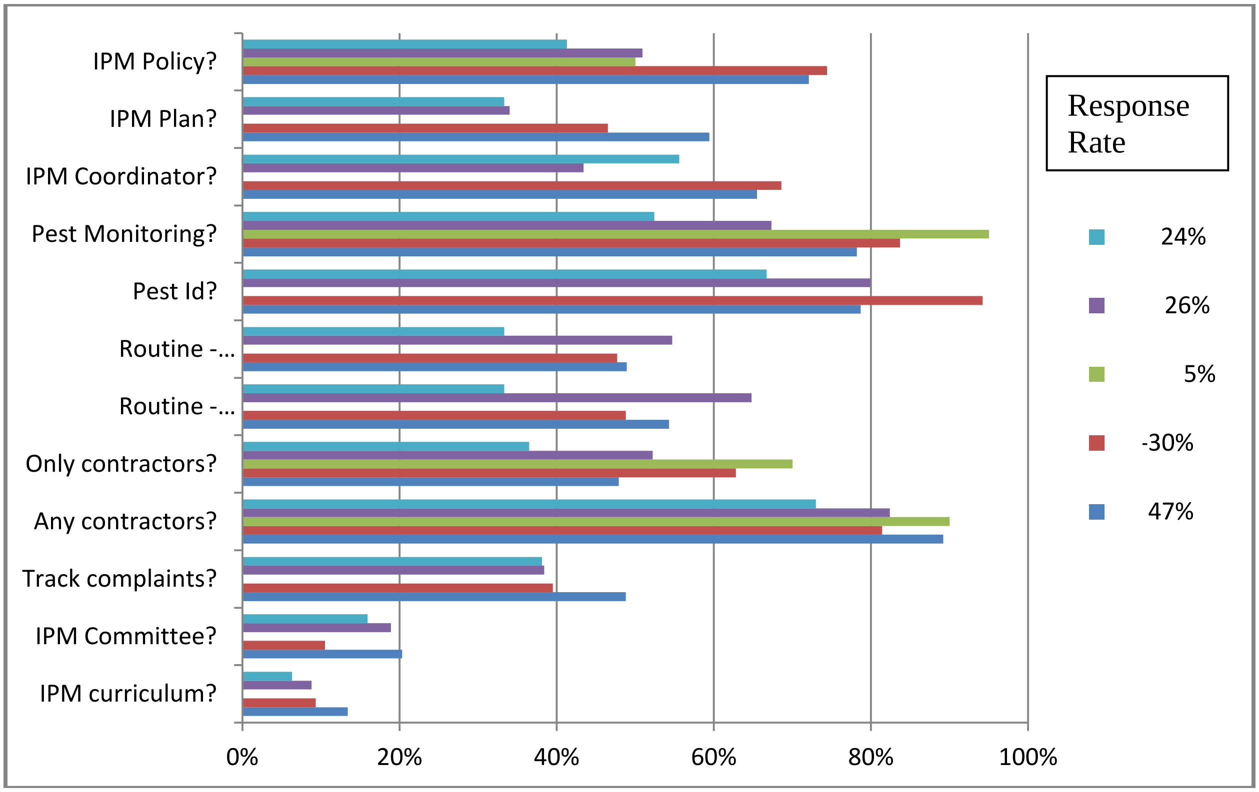


School IPM Funding at State Level

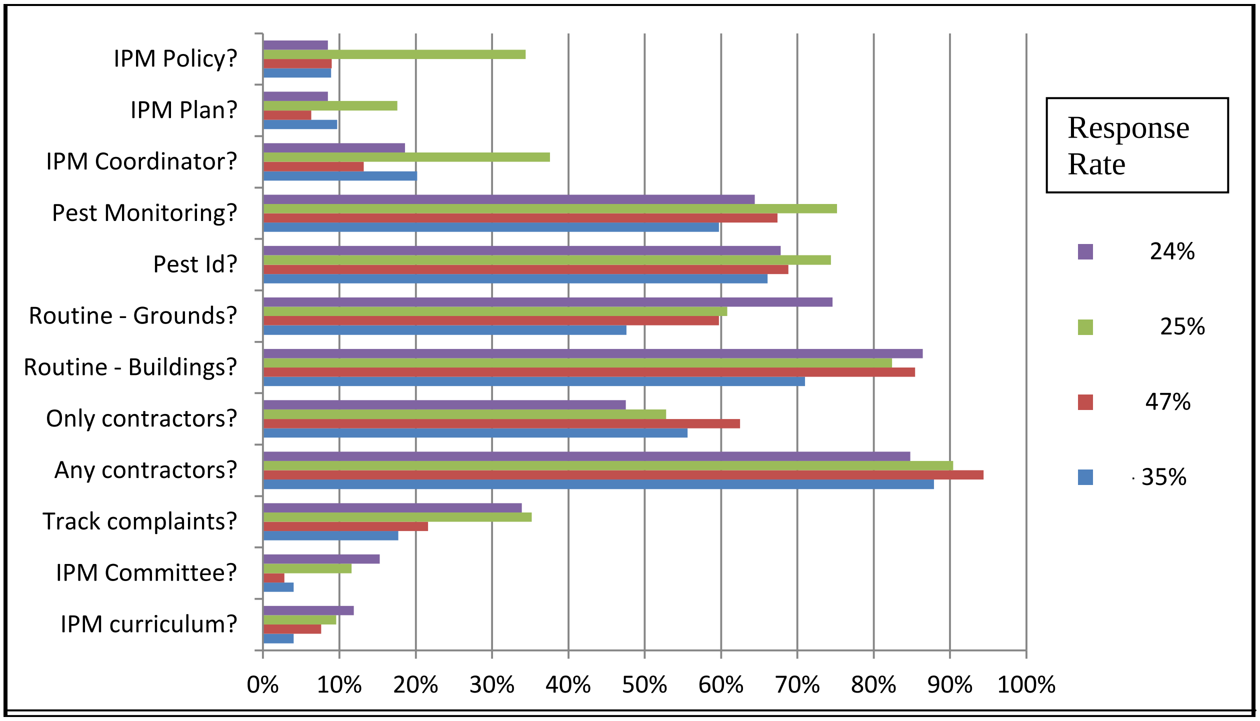
	Yes	No	Don't know
Written IPM policy?	50.5%	38.4%	11.1%
Written IPM plan?	46.5%	49.4%	4.2%
IPM coordinator?	52.3%	42.4%	5.3%
- more than two years of experience?	*81.5%*	18.5%	
- are you the IPM coordinator?	*68.4%*	31.6%	
Do you have a school committee for IPM?	*15.5%*	78.4%	6.1%
Do you track pest complaints?	41.0%	59.0%	
Do you track pest mgt costs?	43.6%	37.0%	19.4%
Do you track number of pesticide applications?	53.6%	29.3%	17.1%
***Any* contracted pest services? (vs. in house)**			
- general structural	81.8%		
- general grounds	64.3%		

***Only* contracted pest services? (vs. in house)**			
- general structural	50.3%		
- general grounds	34.3%		

National Results of School District Survey



District Survey Results, US EPA Region I



District Survey Results, US EPA Region III

The following statistical updates have been made to the strategic plan:

- **Pg 8.** More than 63 published surveys and reports from public agencies, advocacy groups and others since 1994 have documented deficiencies including unmanaged pest infestations and inappropriate and off label use of pesticides in and around schools (surveys are compiled in Appendix G). *Updated number to include three IPM Institute surveys.*
- **Pg 10.** A record-setting 49.5 million students were served by 6.2 million staff including 3.3 million teachers in 13,558 public school districts in the US in 2011 (US Dept. of Education 2011,2012). These districts include approximately 132,183 elementary and secondary schools. An additional 5.5 million K-12 students were served by 437,410 teachers at 33,370 private schools.
- **Pg 10.** Record levels of elementary and secondary school enrollment are expected every year over the next eight years, with 2019 enrollment predicted to be 6% higher than 2007 levels (US Department of Education 2011).
- **Pg 13.** The School IPM District Survey: A Nationwide Snap Shot was completed in 40 states with the following results: 50.9% of school districts have a written IPM policy, 46.5% have a written IPM plan and 52.7% have an IPM coordinator. Pest/IPM fact sheets are used by 43.3% of schools districts and 40.4% use school IPM manual on best practices (IPM Institute of North America. 201 2. School District Survey).
- **Pg 13.** Asthma is epidemic among children in the US and other countries, impacting nearly 9.3% of school children nationally, with rates as high as 25% in at least one urban center (Centers for Disease Control, 2013).
- **Pg 13.** The cost of treating asthma in children under 18 years of age is $3.8

billion per year (Centers for Disease Control, 2013). More than 12.8 million school days are lost per year due to asthma alone (American Lung Association 2005).

Table 2.1 Indicators of high-level IPM fully implemented in schools nationwide. A number of these indicators will be measured periodically via the school IPM report card (Appendix C) to be completed by state lead contacts and compiled by the national working group. Other indicators will be measured during 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 designated by the school district and 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 pest-conducive conditions, 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, students and parents 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 and athletic directors 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 programs 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. A training opportunity is available at least annually for change agents. Change agents are those individuals who act as a resource and catalyst for change by marketing the advantages of IPM to decision makers in the school community, and can include Extension, EPA or state lead agency staff, facility managers, pest management professionals, consultants, teachers, parents or others.
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 low risk pesticides appropriate for controlling the problem when pesticides are needed.
12. All school district IPM programs and plans are evaluated annually by the district IPM committee or other committee charged with IPM.

13. Pest problems and pesticide applications in schools are increasingly infrequent due to successful implementation of IPM.

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, 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 have been recorded at as high as 100 times greater than clinically relevant levels (Nalyanya *et al.* 2009). 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, Owens 2009). 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 schools and neighboring pesticide applications. Federal legislation has been proposed unsuccessfully since 1999 (re-introduced most recently as House Bill 4159 in December 2009).

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.

Policymakers in 35 states have acknowledged the special risks posed by pesticides to children's health by approving specific restrictions on pesticide use in schools and, in 38 states, childcare facilities. Nevertheless, we estimate that in more than 5,000 of the nearly 14,000 school districts in the US, any individual may make a pesticide application without prior training, license, or certification (Hurley *et al*. 2013).

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 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 9.3% of school children nationally, with rates as high as 25% in at least one urban center (Centers for Disease Control 2013). Development of asthma, asthma attacks and asthma-like symptoms have been associated with exposure to cockroaches (reviewed in Gore and Schal 2007), other pests and pesticides (Alarcon *et al.* 2005, Salam *et al.* 2004, Salameh *et al.* 2003). Children exposed to pests or pesticides in the first year of life were more than two times more likely to develop asthma than children never exposed (Salameh *et al.* 2003). Asthma allergens associated with pests can occur at higher levels in schools than in homes (Sheehan *et al.* 2009).

The estimated cost of treating asthma is $50.1 billion per year and loss of productivity resulting in missed school or work days cost $3.8 billion per year. More than 10.5 million school days are lost per year due to asthma alone (Centers for Disease Control 2013.

The US EPA, the Centers for Disease Control and the American Lung Association recommend reducing pest infestations and adopting IPM in schools as one effective strategy for addressing asthma.

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 more hazardous than others and unnecessary due to the availability of effective alternatives. 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, possible or known carcinogens, 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. Parents of children exhibiting non-specific symptoms potentially related to pest exposure such as fever of unknown origin are rarely asked by health professionals about exposure history to pests (Lieberman 2009). 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 of both pest infestations and pesticide exposures include the multiple potential causes for short and long-term non-specific symptoms and illnesses. 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). While additional research is needed to address these data gaps, it is unlikely that complete information will ever be developed given the thousands of chemicals in commerce and hundreds of thousands of possible combined exposures. In many instances, IPM offers an opportunity to reduce the need for pesticide applications by effectively addressing the causes of pest problems, i.e., eliminating pest access to food, water and harborage through sanitation and exclusion.

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 nearly 20 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. Simply adopting an IPM policy and/or entering into a contract for an IPM service is not adequate for a sustainable, effective program. 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-risk 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 2010, 35 states had rules or regulations specifically addressing pesticide use in, around or near schools, up from 30 in 2000 (Owens 2009). 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 2020, 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 2020, 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 Pest Management Strategic Plans (PMSPs) 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 and pest-conducive conditions. Most PMSPs are crop and region-specific and include priorities related to pest management from land preparation through harvest and storage. In our plan, we address priorities from planning and design through daily operation of school systems.

If our school systems are designed and maintained to eliminate conditions that lead to pest problems, the need for pesticide applications and other interventions can be reduced.

During the development workshop held in Las Vegas in October 2006, participants identified and ranked an initial set of priorities to optimize IPM in school systems in the United States which were published in the first edition of this document. The following updated priorities were identified and ranked with input from 22 stakeholders active on the national level. 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.

In addition to the priorities listed here, regional school IPM priorities have also been developed, reflecting regional differences in pest pressure and other influences and constraints. For additional priorities, see:

> North Eastern Region (2012):
> http://www.northeastipm.org/neipm/assets/File/Priorities/Priorities-SchoolIPMWG-2012.pdf
>
> Southern Region (2012):
> http://www.sripmc.org/schoolIPM/docs/SRSIPM_priorities_2012.pdf
>
> North Central Region (2011):
> http://www.ipminstitute.org/NC_IPMIS_Working_Group/NC_SIPM_WG_Priorities_2010-2011.pdf
>
> Western Region (2014):
> http://cals.arizona.edu/apmc/docs/Education_Management_Regulatory_Research_Needs-012914.pdf

Stakeholder priorities should be updated periodically to ensure they remain current.

The following priorities are scheduled for updating in 2013.

Table 3.1 Management priorities, 2014.
Management functions include organizing information and coordinating appropriate actions by all key players. The following management-related priorities were identified and ranked:

Priority	Outcomes	Example Strategies	Example Tactics	Status
1. Track adoption of IPM practices in schools and disseminate economic, environmental and/or health impacts of IPM. Educate policy makers about the needs and benefits of IPM in terms of dollars, health, environmental and academic performance.	More effective planning. Greater appreciation of benefits and support from funders and policy makers. More effective policies, programs and regulations.	Periodic surveys.	Repeat state level surveys every three years. Conduct district-level survey every five years. Conduct targeted surveys in specific states to measure progress towards outcomes for projects in those states.	Unfunded. Most recent surveys completed in 2013.
		Gather existing and new data as they are developed on IPM impacts.	Compile and maintain database of research, e.g., existing and emerging data including any collected in research priorities #2 and # 3.	Unfunded.
		Communicate specific priorities to researchers.	Identify and report research gaps.	Unfunded.
		Compile and distribute results in approachable/clear format and present to policy makers	Circulate existing resources, e.g., *Business Case* to policy makers. Use existing data to develop/improve outreach materials including case studies, brochures, presentations that help support and determine training needs and goals. Distribute outreach materials to policy makers describing how school IPM programs impact children and school environments and how effective programs can be initiated and sustained. Develop and publish estimate of economic	Unfunded.

			impacts for US and globally.	
			Track and communicate adoption metrics from existing projects.	
Priority	**Outcomes**	**Example Strategies**	**Example Tactics**	**Status**
2. Identify and piggyback with ongoing environmental health efforts and coordinate with partners in promoting IPM to help schools and child care facilities meet health, high performance and safety, economic, and energy efficiency goals.	More efficient use of resources. More effective collaborations including learning from others' successes.	Identify and collaborate with effective broader pollution prevention initiatives at school district, state and national level.	Identify, evaluate impacts of environmental organizations/groups working in schools with related priorities/projects including indoor air quality, green schools, high-performance schools.	Part of EPA Center of Expertise for School IPM "wholesale strategy".
		Engage successful environmental health and safety professionals by creating awareness of the need for and benefits from IPM and sharing effective methodologies for success.	Compile database of organizations, projects, objectives, tools, impacts, contacts. Add contacts to newsletter circulation lists; invite to participate in regional working groups and collaborate on grant proposals and funded projects.	Unfunded.
3. Create job-specific IPM guidelines for roles within schools including	Improved monitoring, sanitation, exclusion; fewer pest complaints and pesticide	Inform and educate school staff about their specific role in	Create IPM guidelines for each staff role based on the objectives outlines in the Stop School Pests Training Program; promote use via certificate/certification program.	North Central School IPM Working Group,

management, facility and grounds maintenance, custodial, food service, school health, instructional.	applications.	IPM.		University of Arizona
Priority	**Outcomes**	**Example Strategies**	**Example Tactics**	**Status**
4. Develop IPM decision-making tools.	Reduced learning curve; improved prioritization of needs within budget constraints; improved effectiveness of design, construction, maintenance, monitoring.	Continue to develop and promote Pest Prevention by Design, School Dude, MUNIS, iPEST, IPM Cost Calculator.	Introduce version 2 of iPEST to one school district in each state and inform school staff on the use, advantages and disadvantages of iPEST. Host an informational workshop on the use of iPest. This workshop will be held at the quarterly meeting of the Colorado Coalition for School IPM.	Colorado State University, North Central School IPM Working Group, Salt Lake City School District
			Create one-stop shop for tools. *IPM Cost Calculator.*	Texas A&M University
			Publish articles on Pest Prevention by Design and other tools as they become available in publications read by school architects, construction, facility managers.	Unfunded.
5. Identify, educate and activate appropriate	Increased adoption; improved leadership within infrastructure	Organize state-level associations to provide school	Continue to develop new state associations modeled after Texas IPM Affiliate Public Schools; e.g., I-IPM.	North Central School IPM

school-related organizations to embed IPM into the organizational culture.	serving schools.	professionals information on IPM, professional development opportunities and a space for networking.		Working Group: Illinois IPM Association
		Develop and maintain outreach materials in non-expert language and identify school-related organizations receptive to learning more about IPM and implementation.	Identify contacts at school-related organizations; add to circulation lists for newsletters; invite to participate in working groups, projects. Circulate existing outreach materials; identify needs for new materials. Present at organization meetings. Recruit leaders to add IPM to organizations' and appropriate committee charges, e.g., health and safety.	Unfunded.
Priority	**Outcomes**	**Example Strategies**	**Example Tactics**	**Status**
6. Recognize schools, organizations and PMPs for practicing verifiable, high-level IPM and provide incentives.	Improved visibility/increased awareness of leaders; improved buy in.	Support current award opportunities, continue to develop new opportunities.	Promote Quality Pro Schools; IPM STAR; Green Shield Certified. Continue to develop Stop School Pests certificate/certification programs, Master Class. Renew EPA awards/recognition program, EPA recognition letter for Stop School Pests certificate holders.	IPM STAR, Green Shield Certified, Master Class, Texas A&M

- Develop realistic goals for high level IPM in schools by 2020.
- Promote inclusion of IPM in certification standards, e.g., USGBC, Green Seal.
- Coordination with state agencies (e.g., posters for schools, packets for teachers).
- Increase funding for management, coordination, education, research and implementation, e.g., outreach to non-traditional funders for IPM STAR, establish a travel fund to support interstate travel for school IPM coordinator and applicators.
- Establish demonstration schools in each state, including states that have not had pilots in the past and underserved school districts.
- Provide funding for school assessments including active participation by local actors (e.g. Extension, public health agencies) to prioritize needed improvements in individual school systems (e.g., IPM STAR).
- Expand expertise into public health, wildlife, school officials and medical professionals.
- Establish a go-to-person for assistance in each state.
- Strengthen support for struggling states.
- Develop national school IPM coalition of stakeholder organizations to coordinate implementation of proven approaches nationwide.
- Establish a relationship with IPM Voice (allow for advocacy). Send priority list to IPM voice so they can advocate.

Table 3.2 Educational priorities, 2014.
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:

Priority	Outcomes	Example Strategies	Example Tactics	Status
1. Develop and utilize educational methods to provide education and hands-on training for custodial, maintenance, kitchen and grounds staff, school nurses, facility directors, administrators, teachers and IPM coordinators. Provide training for IPM coordinators to improve effectiveness in their role.	Improved staff knowledge and effectiveness, reduced costs.	Develop and implement Stop School Pests – A National IPM Standard Training Program with modules available in online version and in-person training version.	Continue development of training material for learning modules and quiz/exam with review committee.	North Central IPM Working Group, University of Arizona, National Pest Management Association.
			Business plan committee will develop strategies for financial suitability of the training program as well as a strategy for keeping modules updated with relevant material.	
2. Partner with pest management professionals (PMPs) and organizations to create and implement effective, economical IPM service relationships.	Improve effectiveness of contractors, partnerships.	Develop tools to improve partnerships.	Partner with the National Pest Management Association and others to offer school-IPM-specific PMP training modules and certification.	Unfunded
			Review, improve and market tools including model bid specs, contracts, contract oversight guidance for school IPM coordinators, service tickets.	Unfunded
3. Create best management practice for schools to use with vendors of pest management services, design and construction	Reduced learning curve, improved effectiveness of contractors,	Develop Best Management Documents for site-specific best management practices for school IPM.	Promote the Best Management Documents, now available online: http://www.northeastipm.org/bmps-for-school-ipm/	Northeastern IPM Center

services, custodial services, food and drink product service providers, etc.	partnerships.			
Priority	**Outcomes**	**Example Strategies**	**Example Tactics**	**Status**
4. Improve superintendent, principal and teacher pre-service training courses and develop curricula for training Extension, state legislators and other change agents	Improved knowledge and effectiveness.	Expand scope, develop and promote Stop School Pests educational materials.	Expand Stop School Pests to include pre-service training for superintendents, principals and teachers, e.g., create a pre-service training module or add a pre-service training section to the administrator and teacher modules.	Unfunded
			Building on Stop School Pests training modules, develop training material for Extension, state legislators and other change agents.	Unfunded
5. Create multi-state coordinated train-the-trainer programs on School IPM, e.g., resources for peer-to-peer training.	Reduced learning curve, improved effectiveness.	Develop, promote Stop School Pests in-person training for trainers including for leaders working in school roles.	Implement Stop School Pests pilot-training sessions, which will serve as test train-the-trainer programs.	North Central IPM Working Group, University of Arizona, collaborators.
			Stop School Pests in-person modules will be made available online for use in peer-to-peer and other training programs.	

- Provide IPM and health information to teachers, support staff, department of education, parents and administrators, e.g., common display content that allows each state to use their own logos
- Create basic awareness and understanding of the concept of IPM (and the acronym) among mass media which can be used to educate the general public about IPM, e.g., develop bed bug information in ‘lay’ language, create fact sheet marketing IPM and develop organizational chart of IPM entities.
- Market IPM in conjunction with other environmental improvements.
- Implement/promote K-12 curriculum-based education and encourage inclusion of IPM in education standards. Promote IPM Service Learning, e.g., using school buildings/grounds and community settings.
- Create pesticide education program at national level to target schools.
- Educate school IPM coordinators/facilities director on how to interpret service tickets/invoices from pest control providers, e.g., develop a model IPM service resource for use in promoting easily understood and comprehensive service.
- Develop web-based distance education through extension.
- Outreach to schools and the public about turf management options that are sustainable, organic, and/or use IPM management practices.
- Promote inclusion of IPM lessons into teacher education programs at universities and develop web-based distance education through extension.
- Allow participants input early in the process when implementing demonstrations or coalitions.
- Promote IPM STAR evaluator training.
- Create Spanish language materials.
- Create more interactive/downloadable based training materials, e.g., develop a YouTube subcommittee to organize production with other workgroups to develop content topics and scripts and create IPM coordinator video testimonials.
- Coordinate and piggyback education efforts with parallel efforts, e.g., ‘Tools for School’s type programs, e.g., participate in trade shows/health expos, etc.
- Develop speaker resources (bureau) by region, organized by driving distance.
- Revisit working group marketing and outreach strategies, e.g., develop learning labs which travel from school to school covering specific pest topics.

Table 3.3 Research priorities, 2014.
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.

Priority	Outcomes	Example Strategies	Example Tactics	Status
1. Identify effective least-risk products and tools to manage pests and measure IPM continual improvement.	Reduced pesticide risk. Improved impact measurement.	Identify and evaluate potential low-risk tools; compile, maintain a list of the best of the best effective least-risk products.	Evaluate reduced-risk options: turf management options, organic 25b, home remedies, stinging insect, microbial drain cleaners, bed bug IPM and head lice management. Complete a report that can be cross analyzed and used as a reporting tool when making the case for IPM cost effectiveness. Review, update current lists, e.g., in *School IPM 2020*. Evaluate and publish report on the PRI Product Evaluator developed by the Pesticide Research Institute.	Unfunded.
			Identify, evaluate and report tools track IPM improvement.	Unfunded.
2. Research the cost of IPM, including: implementation and education versus conventional pest management. Conduct a cost analysis for misapplication of	Improved effectiveness, reduced costs.	Conduct and report on a comparative analysis of the cost of in-house versus contracted pest management including effectiveness, safety and costs.	Implement and evaluate version two of I-PEST, with a focus on collecting cost data, including labor costs, to implement IPM. Complete a report that can be cross analyzed and used as a reporting tool when making the case for IPM cost effectiveness.	Colorado State University

pesticides (indoor and outdoor); calculate the cost savings of exclusion practices, research effectiveness of pesticides/pest treatments.				
Priority	**Outcomes**	**Example Strategies**	**Example Tactics**	**Status**
3. Research IPM impacts on indoor and outdoor school environmental health, e.g., school well water, school gardens, use of adjacent properties, children's health, (asthma, allergies, absenteeism, grades, ADHA), academic performance and safety factors.	Improved understanding of IPM benefits, ability to increase funding, promotion, mandates, adoption.	Conduct and report on a comparative analysis of impacts of IPM vs. conventional pest management.	Before and after study, e.g., following methods described in unsuccessful 2013 proposal to EPA STAR program submitted by IPM Institute and collaborators.	Unfunded.
4. Research and evaluate outreach methods to determine most effective methods of school/community	Improved outreach, adoption.	Identify and evaluation entry points and sociological factors affecting adoption of IPM.	Conduct a comparative analysis of effectiveness of different types of change agents, such as Extension and parent advocacy groups, have on IPM adoption. Expand Washington State University Survey and distribute to schools in other	Unfunded.

audiences.			states.	
Priority	**Outcomes**	**Example Strategies**	**Example Tactics**	**Status**
5. Evaluate building design, construction, renovation and maintenance criteria.	Improved understanding of cost-benefit of IPM-friendly criteria	Evaluate and report on current recommendations in existing resources.	Evaluate recommendations in Pest Prevention by Design, LEED (Leadership in Energy and Environmental Design), LEED for Schools EB (Existing Buildings) and CHPS building criteria and codes. Develop detailed report that can be used as a reference for regulatory priority # 5.	Unfunded.

- Develop analysis tools and conduct in-depth inspections of schools to determine what pest management practices are really being used.
- Efficacy of training methods for school-district based IPM coordinators, custodians and teachers.
- Research corporate avenues for financial support of high level IPM in schools, e.g., cleaning and supply companies.
- Potential cross-over benefits of school IPM, e.g., impact school IPM has on improving the greater community.
- Raise awareness of and attitudes towards IPM among school community members through the assessment of their satisfaction with IPM, e.g., success stories of IPM adoption.
- Research the geographic distribution of pest species and range of expansion.
- Research the most effective methods for third-party assessment of the quality of services provided to schools by pest management professionals.
- Compile, update, and evaluate state requirements and resources for school IPM.
- Research the use of mosquito repellent at home with student/employee versus on school property.

Table 3.4 Regulatory priorities, 2014.
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.

Priority	Outcomes	Example Strategies	Example Tactics	Status
1. Establish IPM policies in school systems to institutionalize a commitment to IPM.	Increased adoption, improved enforceability and sustainability of school IPM programs.	Market benefits to state school boards, influential organizations, e.g., Parent Teacher Associations (PTA).	Identify, contact, develop relationships with state school boards, PTA and others; present IPM policies and benefits; secure commitments.	EPA Center of Expertise for School IPM
2. Identify and promote interagency cooperation among regulatory, environmental, health, insurance, education, state and Federal, Cooperative Extension and other agencies.	Improved efficiency and consistency of communication, policies, mandates, recommendations and implementation.	Identify, communicate, collaborate.	Identify organizations and contacts; add to circulation lists for newsletters; invite to participate in working groups, projects.	North Central, Northeastern, Southern, Western and National Steering Working Groups
			Publish article series including pesticide, IPM and healthy schools regulations.	First article submitted 2013 to *American Entomologist*.
3. Create and mandate minimum standards for school IPM at	Improved adoption, consistency and level of implementation.	Improve awareness of policy makers of needs and benefits, provide model legislation.		Unfunded.

federal level established through high level IPM training/licensing for pest management professionals.				
		Develop and promote voluntary, high-level IPM certification program for pest management professionals.	Continue development of Stop School Pests program for PMPs; track and report how many PMPs earn certification and build this information into outreach materials given to policy makers.	North Central IPM Working Group, University of Arizona, National Pest Management Association.
Priority	**Outcomes**	**Example Strategies**	**Example Tactics**	**Status**
4. Implement and enforce existing IPM laws and policies at the highest level of economic and regulatory accountability.	Improved adoption, consistency and level of implementation.	Identify and pursue opportunities for improving enforcement of existing mandates; develop partnership with regulatory agencies and key influencers to ensure IPM law is enforced.	Identify and create database of opportunities for improvement of existing mandates, key influencers and decision makers.	Unfunded.
5. Work to incorporate IPM strategies into building codes.	Improved effectiveness of design, construction, maintenance.	Work with CEFPI to identify ways IPM can be applied to building codes	Using Pest Prevention by Design, research ways that building codes already align with IPM strategies and reword to reflect this similarity (addressed by research priority #5). Identify ways that IPM strategies could improve building codes	Unfunded.

			(economically, environmentally and human health). Develop relationship with CEFPI individual and bring them into the discussion. Present findings; identify opportunities to collaborate to implement improvements. Continue to develop and promote Pest Prevention by Design.	

- Develop organizations and strategies for influencing change that will result in state Department of Education, Health and Safety regulations and policies that call for IPM, e.g., seek state legislator champion to present successful legislation at NCSL annual conference.
- Quantify costs to regulatory agencies for enforcement of school IPM regulations and advocate for funds, e.g., 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 pesticides-use records submitted to state-lead agencies in states with mandates reporting for compliance.
- Develop a model compliance agreement for use by state lead agencies with violators of states pesticides and/or school IPM regulations, i.e., regulations with "teeth".
- Fund consultant services for IPM compliance assistance to provide schools with access to experts who can identify opportunities for improvements.
- Establish or use existing diverse local stakeholder committees to advocate for policies and procedures that implement proven IPM strategies and practices, e.g., develop and disseminate a protocol for grassroots implementation to increase effectiveness of local advocates, partner with National Pest Management Association, Beyond.
- Review pesticide labels for risks to children in school/childcare setting.
- Complete overhaul of signal words on label (ability to easily ID low impact or reduced risk pesticides by EPA). Encourage EPA to create a database of low impact pesticides that uses searchable terms that allow one to easily identify low impact or reduced risk pesticides, based on MSDS and label information which define low impact.
- Establish minimum students' rights for environmental health standards in schools and include students and teachers in OSHA-like protections.
- Advocate for a requirement for continuing education of school nurses on IPM.
- Evaluate regulatory approaches to use of EPA exempt (25b) products and determine if these products are accessible for use by schools under existing state and federal regulations.

4. Strategic Plan

IPM works in schools to reduce pest complaints, pesticide use and therefore 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 2020, 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, pest-conducive conditions 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 lesser risk approaches to managing common and occasional pests in schools, update this list regularly 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.

Overall Timeline and Milestones

We developed the following specific objectives to achieve our end goal and meet our priorities. Completed objectives represent the work of many individuals and school districts, supported by a variety of funders including US EPA, USDA National Institute for Food and Agriculture (NIFA), USDA NIFA IPM Centers, Centers for Disease Control and others.

2008 Objectives Completed

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 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, industry) 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 low risk 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. State level coordinators may build the contact databases and communicate them to the national committee, or function as the delivery service distributing relevant information to school staff.
   - 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 or state coordinators.
   - Coordinate liaison to regional school IPM working groups, Urban IPM Community of Practice, EPA Pesticide Environmental Stewardship Program, USDA IPM Coordinators.
   - Maintain national working group web pages.
   - Identify funding sources, develop/submit proposals.
   - Organize periodic meetings to update *School IPM 2020*.
4. Maintain funding for school IPM working groups in Northeast, North Central, Southern, and Western regions.
5. Organize and hold national training opportunities for change agents (October, Denver CO).

6. Initiate demonstrations in five new states (IL, LA, RI, OR, NH).
7. Initiate coalitions in five new states that have had demonstrations in the past (CO, MO, NE, NC, PA).
8. Assess which school sites are most commonly used and request updates of any outdated information.

2009 Objectives Completed

1. Initiate new demonstrations in five states (CO, NM, OR, SD[2], WY).
2. Initiate coalitions in five new states that have had demonstrations in the past (AL, IL, IN, OH, WA).
3. Organize and hold national training opportunity for change agents (March, Portland OR).
4. Review school IPM websites for each state and request updates of any outdated information.
5. Maintain funding for school IPM working groups in Northeast, North Central, Southern, and Western regions.

2010 Objectives Completed

1. Initiate new demonstrations (AR, NE [2], NM, TN [3], VT).
2. Organize and hold national training opportunity for change agents (July, Phoenix AZ).
3. Develop funding for years four to six of plan implementation; maintain funding for school IPM working groups in Northeast, North Central, Southern, and Western regions

2011 Objectives Completed

1. Publish guidance document for coalitions.
2. Publish cost/benefit case for School IPM.
3. Publish take-home document for students and families outlining the connection between indoor air quality, asthma, pests, pesticides and IPM, and what can be done to minimize asthma triggers associated with pests and pest management.
4. Initiate demonstrations in new states (MT underway, also targeting OR, MI).
5. Gear up to initiate coalitions in all remaining states by end of 2012, targeting IA for 2011.
6. Organize and hold national training opportunity for change agents.

7. Fully engage with EPA regional leads for school IPM including newly designated leads.
8. Begin to focus on several states currently making good progress to learn/demonstrate ability to achieve high level of school district participation in individual states, e.g., reach 70% of students in the state attending schools with high-level IPM programs.
9. Review school IPM websites for each state and request updates of any outdated information.
10. Create model maintenance and sanitation specifications that reflect high level IPM. Maintain funding for school IPM working groups in Northeast, North Central, Southern, and Western regions.
11. Develop funding for years five to seven of plan implementation.

2012 Objectives

1. Design, implement mid-term evaluation including sustainability of funding.
2. Others to be identified.

2013 Objectives Completed

1. Provide expert IPM services to CESA 10's contracted schools (WI)
2. Increase schools in Colorado and Utah with verifiable IPM programs by 25%
3. Two district demonstrations (CO)
4. Evaluate decision-making tools to substantiate IPM costs (CO)
5. Expand Indiana/Ohio IPM Coalition.
6. Ten-school pilot (IN, OH)
7. Participate in national standards/training/certification (IN,OH)
8. Survey schools in WA/OR
9. Form and support regional consortium (WA)
10. Use IPM STAR (WA)
11. Diffuse implementation model to other regions(WA)
12. Create/support AL/GA/FL consortium
13. Increase number of school districts with IPM (FL)
14. Advanced IPM certification and pilot training (National)
15. IPM Practitioners Association pilot in Illinois
16. IPM Coalitions in South Dakota/North Dakota/Minnesota
17. Market existing SIPM resources including business case (North Central Region)
18. Best Management Practices Document (Northeastern Region)

2014 Objectives

1. Comprehensive, national training and certification program for pesticide applicators and school staff in key roles; create a sustainable mechanism to increase the IPM proficiency of pesticide applicators, administrators, facility managers, custodians, teachers, and food service, maintenance, school health and grounds management staff

2. Pilot training and exam in 10 states, 200 individuals (20 per role) (AZ)
3. National Standard IPM Training Team meeting in Texas
4. Build a national website to consolidate and refine existing IPM resources and post in one location, similar to the national Pesticide Information Center website (TX)
5. Develop a mobile application for school IPM (TX)
6. Work with SchoolDude to integrate verifiable IPM into their maintenance software
7. Build a bi-state school IPM Coalition for Michigan and Indiana
8. Develop web-based trainings for specific stakeholders including custodians and maintenance workers, PTA/PTO, school board members, superintendents, facility managers and school IPM coordinators
9. Focus on underserved communities to be used as demonstration schools (MI)
10. Link to school IPM program materials developed by other Healthy Schools programs (MI)
11. US EPA SIPM Center of Expertise, Strategic Plan and two-state pilot
12. National Pest Management Association, Quality Pro Schools update
13. ASCPRO bulleted list of SLA opportunities to increase adoption of SIPM
14. Business plan for National Certification Program
15. I-IPM launch
16. Expansion of IPM information tools
17. Coalition development (IN/OH)
18. Working Group calls and National Steering Conference calls and School IPM 2020 eNewsletter
19. School IPM 2020 Strategic plan updated
20. US EPA is creating a national calendar of events for school IPM, including urban IPM, compiling resources for IPM coordinators for each region of best practices from across the regions in order to build partnerships and combine useful information from everyone’s implementation and is creating a tiered recognition program for schools
21. US EPA renovated Healthy Schools Website
22. NC State University will develop (national) "IPM eAcademy” - essentially an online series of presentations.
23.

2015 Objectives

1. Design, implement final evaluation.
2. Others to be identified.

Table 4.1 List of potential metrics for measuring school IPM.

- Survey of state regulations for 2015 evaluation.
- “Before and after” pesticide use reporting (NY has requirements).
- Numbers of violations (both pesticide and pest violations).
- 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.
- Low-risk product lists.
- Number of school IPM committees formed.
- Minimum requirements for people to apply pesticides.
- School square 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, EcoWise, Green Pro, 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.

Table 4.2 List of sectors, roles and possible actions to achieve high-level IPM in all schools by 2020 developed by the stakeholder group, including suggested actions and timelines to meet 2020 goal.

Sector	Roles	Suggested 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 2020. 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. Release first edition strategic plan by January 2009. 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. 4. Update strategic plan periodically as needed, including priorities. 5. Conduct thorough mid-term evaluation in 2012.	1. Grant proposals. 2. PMSP.	1. Additional funding/funding toolkit. 2. Additional members from unrepresented sectors.

Sector	Roles	Suggested 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- Dec. 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 secure necessary support by June 2011. 5. Develop compliance assistance tool catalog by Dec. 2010. 6. Set licensing goals and standards by June 2011. 7. Catalog free or low-cost hazardous waste disposal information for schools (e.g., "clean sweep" programs by June 2011.	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	Suggested 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. Assist with adoption of 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 new and improved legislation. 5. Build IPM into existing legislation. 6. Build awareness of IPM through after-school programs, environmental clubs, other school-community-based groups.	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 2010. 4. Develop legislative/policy coalition by June 2011.	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	Suggested Actions to Achieve Goal	Timeline	Tools Available	Tools Needed

Extension Cooperative Extension Service, 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. 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.	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.
Sector	**Roles**	**Suggested 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. 7. Facility maintenance software with IPM components, e.g., pest-related work order generation, tracking.	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. 4. Training (on-line and in-person) for tracking performance of IPM and other environmental/healthy schools programs.

Sector	Roles	Suggested 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. Case studies of cost-effective collaborations with schools. 2. Research data/science to support recommendations, management decisions. 3. Case studies of low-input management of turf grass in southern, western climates. 4. Integration of indoor air quality, pesticide safety, food safety, sanitation, school security, energy conservation, exclusion, green buildings, LEED into one healthy schools management program with guidance documents for school administrators.

Sector	Roles	Suggested 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 2011.	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. 3. Case studies, guidance documents on low input programs for urban lawns and athletic fields.

Sector	Roles	Suggested Actions to Achieve Goal	Timeline	Tools Available	Tools Needed
Federal Agencies USDA NIFA; US EPA Office of Pesticide Programs, Office of Children's Health, Office of Air; Department of Education; Department of Health and Human Services, Centers for Disease Control and Prevention, National Institutes of Health, National Institute for Occupational Safety and Health.	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 NIFA programs, (i.e., Agriculture in the Classroom, Healthy Homes, IPM, etc.). 3. Work across federal and state agency boundaries to secure and coordinate funding for student health-related initiatives including IPM.	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, NIFA 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. 2. Awareness training across agencies and offices on IPM and relation to food safety, security, energy conservation, indoor air quality, asthma, etc.

Sector	Roles	Suggested 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 2011.	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 2. Cost-benefit data for new products. 3. Training for PMPs on new reduced-risk products.

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. Recommendations developed from 2008 IPM and Green Schools Workshop in Texas workshop to be published by 2011.	1. *School IPM 2020* Chapter 7.	1. Design and construction specifications for pest prevention.

Sector	Roles	Suggested Actions to Achieve Goal	Timeline	Tools Available	Tools Needed
Parents Parents, guardians, other adult relatives concerned about health and safety of children in schools.	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 risks 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 2010.	1. PMSP. 2. School Pesticide Reform Coalition.	1. Action plan. 2. Effective communication piece to share with school governance and administrators.

Lessons Learned

Wholesale Audience (School Districts)

1. It is critical to help school board members, administrators, staff and students understand how IPM fits within their maintenance and sanitation program, there is a lack of understanding. Poor administrative understanding of school IPM is evident in some districts
2. LISTEN and learn about school dynamics, systems differ. School administrative structures differ between urban, suburban, rural, Tribal, etc.
3. Partner with school associations to communicate and contact with school staff. Relationships are central.
4. EPA endorsed documents are powerful tools. More EPA approved SIPM materials are needed.
5. School staff (especially contracted food service, maintenance staff, and custodial service) should have an element of IPM in their employment contract. Custodian union challenges because of additional time dealing with pest logs.
6. Standards are generally lower in low-income areas, border regions, poor Tribal communities, some Territories. Territory located schools appear to be the most reactive systems relative to others.
7. Sometimes you have to visit on-site to facilitate implementation. During implementation, be accessible, problems occur in real-time, solutions need to happen in the same time-frame. Review of school IPM documents and a conference call ahead of onsite meetings improves efficiency.
8. It is critical for the school community to understand the importance of IPM to environmental health, safety and academic performance.
9. Get dirty, demonstrate physically what you think should be done. People with practical responsibilities respond best to practical exercises and demonstrations.
10. Never fail to follow-up/show-up/communicate. Care about school staff time and resources, prioritize remediation requests.
11. Recognition is a small investment that often generates significant long-term gains.
12. Advise on Federal, State and local ordinance compliance issues constantly. State mandates help by providing/mandating training for staff.
13. Find the advocate in each district. Internal champions are critical. Orchestrate outreach using established school teams.
14. In the absence of any contact, most systems back-slide (new hires, change in PMP, etc.). There are always new challenges and resistant individuals. External oversight is important.
15. Not all in the school want to do this, and will not help unless a problem occurs. Highlight issues that affect everyone e.g. bed bugs.
16. Get facility managers or superintendents to WITNESS problems first hand.
17. Understand the entire school community communication network. Disasters happen when key people are not well informed.

18. A lot of the things we do during the implementation process have multiple purposes: a) the obvious, b) to engage, encourage the community to invest/take ownership, question, investigate, etc. (e.g. Pest Press, sighting logs, school inspections). Use incentives to increase attendance.
19. Confidentiality is important.
20. Documenting/reporting dangerous activity may cost you the district, but sometimes it's the only ethical thing to do.
21. If it’s not happening, be prepared to walk away and focus on those who really want to do it right.
22. Be a visionary. A strategic focus is essential. Site specific IPM plans are ideal and they should be reviewed and updated. Just having a plan is insufficient.
23. Monitoring is poorly understood. Sanitation standards and poor maintenance hamper progress.
24. US Territories have a critical lack of training opportunities.
25. A consistent bed bug policy is needed.
26. Quality PMP services can compensate for a lack of school administration understanding.

Retail Audience (Education Leaders and Organizations)

1. Use peers to train and facilitate implementation.
2. Include community members at large: social services, neighborhood services, fire marshals, SLAs, EHP inspectors, school boards, etc.
3. Must have administrative buy-in so it’s possible to expand implementation efforts. Most administrators believe they are already doing IPM. They need to invest enough time to realize if they really are or not.
4. Funding for maintenance and sanitation is always a problem. Upper administration need to understand that pest management is an EH priority.
5. Whether mandated or voluntary, a State commitment to school IPM appears to result in lower pesticide dependence.
6. Be a partner that understands the school perspectives (nurse perspective will be different from the teacher perspective, etc.). Understand the needs identified, understand the perceived problems and solutions, appreciate the school priorities may be different from yours and the district priorities need to take president (unless a public health situation exists).
7. Internal (intra-agency) collaborations are beneficial.
8. Institutionalize IPM using EH committees and policies, but committees sustain better standards.

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, including making it unattractive, inaccessible to and uninhabitable for pests. To accomplish this straightforward goal requires engaging the school community and others to do what is perhaps the most difficult task of the "change agent" – changing human behavior. The reluctance to change behavior related to pests and pest-conducive conditions (whether in agricultural or urban settings) has long been reinforced by the perception of IPM as being difficult and/or costly to implement, and by the lack of ability of change agents to compete with pesticide and pest control marketing tactics.

Administrators, teachers, custodians, maintenance workers, food service staff and others in the community typically do not understand the role they have to play in reducing pest and pesticide risks. Too often school staff and pest management professionals believe that a pest control service and pesticide applications are all that are needed to make a pest problem go away. They do not understand that IPM is an integrated approach, dependent on improved sanitation, exclusion and communication to resolve the reason why the pest is present. Eliminating pest-conducive conditions is how IPM can reduce <u>both</u> pest complaints and pesticide use in schools and other public buildings by more than 70% with no increase in long-term costs (Gouge *et al.* 2006). Creating this awareness is essential to reach our 2020 goal.

In addition, the school community must recognize that their current pest management approach may be ineffective or problematic and that IPM is a better method. Often, decision makers are unaware of serious pest problems and high-risk pesticide use and use practices. Further, the community must be educated that IPM is compatible with and indeed a cornerstone for the other management functions inherent to a healthy school culture and environment including food safety, indoor air quality and energy savings. The critical importance of creating awareness and engagement by all key roles is reflected in the phrase, *"pest management is people management".*

Practitioners of the science of behavior change use the term "diffusion" to describe the management process designed to get communities to adopt IPM. Generally, diffusion 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. Diffusion 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 is useful 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, inadequate funding or concern for school occupant health by school officials.

Failed implementation is often the result of 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 known as 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 and 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	Land-Grant Universities, Cooperative Extension
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)

Awareness → Persuasion → Decision → Implementation → Confirmation

I. <u>Awareness Stage</u> - 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

- Work with advocacy organizations and strategies, identify what we can influence.
- Education for policy makers (e.g., city councils, state and federal legislatures) about what has worked and not worked in state and local laws and regulations.
- 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 to target schools at the national level.

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.
- For an extensive collection including implementation manuals, videos and other resources from multiple states, see *School IPM Toolbox*, http://schoolipm.ifas.ufl.edu/toolbox.html and *School IPM 2020 Resources*, http://www.ipminstitute.org/school_ipm_2015/resources.htm.

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 crossover 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 and 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 PMPs.
- Resource management education for teachers, administrators and librarians
- Provide IPM input into existing legislation related to education.
- 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, e.g., 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 and Resources

- Policies.
- 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.
- Low risk 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 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 IPM courses for teachers/administrators.
- 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 and 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. US EPA, 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, e.g., IPM STAR.
- Mass media coverage.
- School website 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.
- Contracting with an EcoWise, Green Pro or Green Shield Certified pest management provider or service.

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 relatively 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 range 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/or 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, such as 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). Use of baits, including baits in enclosed, pre-manufactured containers, does not eliminate potential for exposure. The active ingredients in baits can be spread by the organisms feeding on those baits, e.g., in ant, cockroach and rodent feces. Special attention should be paid to sanitation in areas where baits are used to reduce exposure potential.

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 those that are 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 about 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 and grasshoppers (if heavy infestation occurs) 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 turf fungal diseases on school lawns
Occasional invaders, found infrequently and/or unlikely to establish threatening or damaging populations in or around schools	
booklice centipedes firebrats fleas millipedes mites silverfish stored product moths and beetles wood-boring beetles	snakes box elder bugs
Regional pests that may require action	
roof rats Turkestan cockroaches	fire ants gophers, Prairie dogs moles scorpions ticks voles

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

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 and pest-conducive conditions 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 conditioned air. Repairing leaking pipes prevents pest access to moisture and also reduces 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). Staff is 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, maintenance and grounds staff) participates 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, landscapes and playgrounds 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 including termite

	pretreatments, and compliance with pest-proofing design specifications. Educational information, e.g., *Pest Press* editions, fact sheets, blogs, is distributed at least annually to inform staff, students, parents and others as appropriate about key IPM issues such as roles, reporting, sanitation, etc. Ideally, this information is distributed monthly during the school year and addresses ongoing issues as well as seasonal topics such as ants in spring, mice and stinging insects in fall. Electronic distribution can be effectively supplemented by posting print copies in key locations, e.g., staff room, building entrances. Roles communicated to staff and students include proper disposal of food or food wrappers, clutter control, etc.

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 and corrective actions are identified. The inspection should be mapped on the site and floor plan. 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 lighting is mounted away from building, e.g., on poles, to avoid attracting insects and spiders to the building. Any lights mounted on building are mounted away from building entrances, and/or yellow light bulbs or sodium vapor light fixtures are used to reduce attraction. If brighter lighting is desired, e.g., metal halide, use those away from building, e.g., in parking areas. Exterior doors throughout the building are kept shut when not in use. Weep holes, or openings in masonry to allow moisture to escape, are screened to prevent pest access, e.g., stinging insect nesting. Flashing, or metal cladding used to cover seams and joints, is sealed along edges to prevent pest access and moisture intrusion. 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 with the appropriate sealant, caulk or sealer. See *Resources* below for more information on making the proper choice of materials. Openings around potential insect and rodent runways (electrical conduits, heating ducts and plumbing pipes) are sealed. Roles communicated to maintenance staff and contractors include sealing entry points after repairs and renovations including new plumbing and electrical penetrations. All staff are reminded about proper reporting of pest-conducive conditions including damaged door sweeps, leaking plumbing, torn window screens, etc., as well as

Food service - food storage, preparation and 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	Floors are cleaned daily. 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 ($\geq$ 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. School breaks are an ideal time for thorough deep cleaning. Permanent bulletin boards, mirrors and other wall fixtures are sealed where edges meet walls to reduce pest harborage. Newly purchased 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. Mineral oil added to traps in infrequently used drains can slow evaporation. For problematic drains, trap guards are installed to prevent sewer gas and pest entry into school buildings. Out-of-date charts or paper notices are removed from walls monthly.

	Vending machines are maintained in clean condition inside and out. Grease traps are cleaned at least during each break in the school year and maintained with bioremediation or enzyme treatments throughout the rest of the year. Roles communicated to food service staff include avoiding removal of or damage to pest monitoring devices. All staff is trained to report pest problems immediately, to avoid applying pesticides on school grounds or bring pesticides from home, and to clean and/or report spills immediately. Responsibility for cleaning food preparation surfaces and equipment, and food storage areas including refrigerators/freezers in staff lounges are clearly defined.

Waste/Recyclables Handling – trash/recycling receptacles throughout the building, trash collection carts, dumpsters, compactors Pest problems reduced: ants; cockroaches; fruit, drain and filth flies; mice; rats	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 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 (e.g., 2 mil) to prevent tearing and spills before removal to dumpsters. Bags should be sealed with an overhand knot, not a two or four-corner tie. If a composting operation is used to recycle food waste, containers are properly covered and cleaned, and removed with sufficient frequency and timing to prevent pest access and egg deposition (oviposition) by flies or other pests. 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 with bioremediation or an enzyme-based cleaner. 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 weekly to prevent accumulated trash from blocking door closure. Containers should be inspected after outdoor events. 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. Roles communicated to custodial staff include proper cleaning of waste receptacles in food service areas and classrooms where food is served, floor drains in food service and trash handling areas (including under and around dumpsters and compactors).
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 wrung out well and hung upside down, buckets emptied) to avoid providing a moisture source for pests including microbes. Floor and sink drain traps are kept full of water. Roles communicated to staff include maintaining clean and clutter-free custodial storage areas, laundry facilities, mechanical rooms, supply rooms, hallways, etc.

Hallways, Classrooms Pest problems reduced: ants, cockroaches, mice	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. Upholstered furniture is not recommended. Teachers incorporate IPM including pest and pesticide risk management into curricula and/or class projects. Roles communicated to staff and students include removing food or food wrappers from lockers and desks on a daily basis.

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. Plan should include a map and list all plants/plant types in the landscape with a schedule for key activities for each plant, e.g., pruning, fertilization, scouting. The IPM plan specifies preventative and avoidance strategies for ongoing grounds management and for new or renovated landscape design and installation. 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 identified and recommended for removal and replacement 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 in the landscape that contribute to pest problems 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 and prioritized including costs and benefits. 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 every two to 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 to reduce potential for runoff. Or, slow release formulations are applied in summer. 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. 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 and organic matter movement into sewer systems and surface water bodies. Plant debris known to harbor pests, e.g., apple scab, are removed and/or destroyed, e.g., thoroughly composted or chopped to ensure full decomposition before overwintering disease spores mature in spring. Irrigation of established plants is scheduled according to need and anticipated weather, not on a routine or regularly scheduled basis. Plants with similar water needs are grouped within irrigation zones. 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). Drip irrigation is used to minimize evaporation, foliage wetting periods, especially for annual beds and/or high visibility/demand beds. Irrigation is allowed to drain before heavy foot or vehicular traffic is permitted in planted areas to minimize compaction.

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). Usage charts are developed for all turfgrass areas and used to help guide management decisions. 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) is conducted on general use turfgrass areas at least once every two years; with higher frequency based on need, e.g., playgrounds, high traffic areas around entrances or other locations people congregate or leave walkways. 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 are established collaboratively by the IPM coordinator, athletic director, grounds manager and any independent consultants used. Any corrective response to follow threshold values. Selection of turfgrass varieties are based on expected pests, site conditions, anticipated seasonal use, area of country, available seed/sod sources and budget. Varieties containing endophytes, which are beneficial organisms which live within the plant and convey resistance to pests, are used where appropriate. 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 (hollow core, knife-type solid tine, hollow core or shatter). Deep tine or shatter to a depth of 8" at least once each year. Do not use shatter aeration on sand-based or capped fields or areas to avoid disturbing surface integrity. Do not aerate deeper than sand profile to avoid introducing contaminants. 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. Use particle analysis to determine appropriate materials, especially for sand-based or capped fields. 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. Mowing should be done ideally at three to four inches. Mowing height can be reduced for the first spring and final fall cuts. 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) are applied in full coordination with annual overseeding program so desirable turf seed is not damaged. Weed maps are created/updated annually and spot treatments are used when possible. 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	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

maintenance equipment and products including fertilizer	tires, etc.) is developed with cost/benefit projections and purchase timing coordinated with budget officials. 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.	Always adhere to the storage and use directions detailed on the label. 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 lit, 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. In most cases, pesticide applications should be made only after detection of a verified pest problem that exceeds a threshold level for the pest. Exceptions to this rule might include pesticide applications made in anticipation of a pest that research or experience dictates will occur with a high degree of regularity in the absence of the application (e.g., pre-emergent herbicides for certain weeds, or bait applications for fire ants). Routine or regularly scheduled pesticide applications should be rare, especially in indoor environments. 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) All parents are informed of potential pesticide applications at the beginning of the school year and offered an opportunity to be notified prior to applications, with sufficient time afforded for parents to make arrangements to reduce potential for exposure should they so choose. b) Prior to pesticide application, postings are placed in a designated public area(s) detailing locations to be treated and contact information for further information. c) The notice remains posted for at least 48 hours post-application. d) 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). e) Exceptions to posting and notification include emergencies, where an imminent threat to health exists (e.g., stinging insects), applications of antimicrobials and/or for formulations with very low potential for exposure such as gels or pre-manufactured bait stations placed in accessible areas. For emergency applications, postings should be placed as soon as practical. A process and criteria are established for identifying preferred pesticide products for use in facilities and on grounds when a pesticide application is needed. Potential criteria for selecting reduced-risk pesticides and reference sources include: a) Caution signal word on the product label. Pesticides labeled "Danger" or "Warning" are rarely needed or used in schools. Pesticides classified as exempt from registration by US EPA do not carry a signal word but can be evaluated by qualified professionals to determine if the product meets criteria (acute oral, dermal or inhalation toxicity, skin or eye sensitivity) for labeling as "Danger" or "Warning." b) Pesticides without ingredients classified as possible, known, probable or likely carcinogens or reproductive toxicants by US EPA or the California Prop 65 list. c) Pesticides without ingredients classified as endocrine disruptors by the European Commission or US EPA. d) Pesticides without ingredients classified as nervous system toxicants such as cholinesterase inhibitors or neurotoxins on the US EPA Toxics Release Inventory. e) Pesticides without undisclosed inert ingredients or without ingredients listed on the US EPA List 1: Inerts of Toxicological Concern. Currently, inert ingredients are not disclosed for the majority of registered pesticides, however, US EPA is considering requiring disclosure. f) 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. g) 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). h) Pesticide formulations are ready-to-use or pre-mixed before bringing onto school grounds. i) Spray applications of residual-active pesticides to an exposed surface of a structure (e.g., floor, baseboard, wall, etc.) are not used unless alternative control measures either are not

	available or have failed to resolve the problem. j) If dust formulations are used, these are applied only to areas that are inaccessible (e.g., wall voids) to minimize exposure of students to dust particles on surfaces or in air. 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 risks 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 developing and implementing a policy including requesting prior notification, establishing 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. Whenever possible, 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.

Additional Resources

Corrigan, R. M. Undated. *Recommendations for Selecting and Using Caulks and Sealants in Pest Management Operations.* 2 pp. http://www.ipminstitute.org/school_ipm_2015/Corrigan_on_sealants.pdf

Gouge, D.H., J. Snyder, M. Lame and S. Glick. 2008. *Integrated Pest Management – Design Considerations for Schools.* 2 pp.

Hochmuth, G., R. Neill, J. Sartain, J.B. Unruh, C. Martin, L. Trenholm and J. Cisar. 2011. *Urban Water Quality and Fertilizer Ordinances: Avoiding Unintended Consequences: A Review of the Scientific Literature*. 2nd edition. http://edis.ifas.ufl.edu/ss496

National Association of State Departments of Agriculture Research Foundation. 2014. *National Pesticide Applicator Certification: Core Manual*. Second edition. 198 pp. http://www.nasda.org/9381/Foundation/11379/11383/30485.aspx

Northeastern IPM Center. 2011. *Draft checklist for IPM-friendly construction features*. 2 pp. http://stoppests.typepad.com/files/draft-checklist-for-ipm-for-building.docx

Shangle, D.L. 2003. *Integrated Pest Management – New Construction/Rehab Specs*. Safer Pest Control Project. http://www.ipminstitute.org/School_IPM_Toolbox/New_Construction_IPM_Specs_Revised_7.25.03.doc

Snell, E.J. 1997. Chapter 22. Equipment. Pp. 1187-1247. In *Handbook of Pest Control*, A. Mallis, ed. Available from GIE Media, Richfield, OH (800) 456-0707.

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 is needed, 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 and exposure potential should be minimized for a number of reasons including the increased susceptibility of children to toxins. Pesticide applications are generally temporary measures and do not solve the underlying problem, although they are sometimes useful to remove pests and facilitate resolution of the underlying problem. Although pesticide products undergo extensive testing and US EPA review prior to entering the marketplace, even the most rigorous testing is not adequate to identify all potential hazards. Our history includes many products that were once considered safe when used as per label directions and were later found to have substantial risks, resulting in regulatory action removing those products and uses from the market. Recent removals from uses in schools and other community environments include chlorpyrifos and diazinon.

Testing also cannot adequately cover exposures to each pesticide in combination with the very large number of other chemicals, including pesticides, to which we may be exposed at the same time. Many non-pesticide chemicals, and many chemicals contained in pesticides which are exempt from registration, have little or no safety testing relevant to their use in pest control. Pesticide incidents are underreported due to a lack of a national reporting system, inadequate clinical tools, limited training for clinicians and the fact that children present exposure symptoms differently than adults (US EPA 2002a). Over-reliance on pesticides, and especially repeated use of pesticides with the same mode of action, can result in development of resistance, or the ability of pests to tolerate exposure to pesticides without the intended effect. Finally, effective cultural and physical options are available for nearly all 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 environmental or safety 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 the food source, individual ants and then using detergent and water to clean up any chemical (pheromone) recruitment trail can be immediately effective in stopping the number of ants typically found entering a school at one time. 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. With accurate identification, information on life cycle, preferred food, harborage and nesting sites, effective management options can be readily determined.

Fire ants are addressed below in the section on stinging insects. 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 develop a number of winged ants, which will leave the colony 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 usually bite or sting but rather are looking for mates and will disperse. However, they all have mandibles and can bite, and winged females can sting. 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. Fire ants are addressed below in the section on stinging insects.

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
Correct identification of the problem ant is the most critical step 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. Ants which form trails typically follow structural lines, e.g., where floors meets walls, and monitoring should focus on those areas. 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 in the landscape and then check and remove them after 30 minutes. Multiple attractants can be used on the same card. 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. Note that some ant species are active at specific times of day, and the time cards are placed can affect the species captured. Those captured may or may not be the problem species.

Nests can often be located by visual inspection and/or following trailing ants. 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.

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 repairing plumbing leaks and replacing damp wood, eliminating harborage and access to the building by sealing cracks and crevices, 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. Lights mounted on buildings at entryways can attract ants and other pests to feed on dead insects attracted to the lights. Lights mounted on poles away from the building can illuminate the building and entryways without drawing insects to the building.

Table 8.2 Cultural and physical strategies for nuisance ants.

- Remove individual ants using a vacuum or wipe or wash away.
- Use detergent and water or bioremediation or an enzyme-based cleaner to clean surfaces where ants have been traveling to eliminate any pheromone recruitment trail.
- Eliminate access points 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 buildings.
- Fix plumbing leaks, gutters that hold water and replace 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 lights 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. Use of baits, including baits in enclosed, pre-manufactured containers, does not eliminate potential for exposure. The active ingredients in baits can be spread by the organisms feeding on those baits, e.g., in feces. Special attention should be paid to sanitation in areas where baits are used to reduce exposure potential and to remove completion for baits.

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 oil		Place on ground near building, e.g., where ants 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; minimize indoor placements to avoid attracting ants that would otherwise not enter.
	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 for ants 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.

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.

More information is needed on efficacy of granular formulations of botanical pesticides broadcast-applied around foundations for ants, including duration of residual efficacy.

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

Corrigan, R. M. Undated. *Recommendations for Selecting and Using Caulks and Sealants in Pest Management Operations.* 2 pp. http://www.ipminstitute.org/school_ipm_2015/Corrigan_on_sealants.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*. Line drawings,

identification, communication, monitoring, management.
http://www.birc.org/SchoolManual.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.

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. However, they are considered a high-risk rabies reservoir group in the US. 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.

Bats are highly beneficial wild mammals. Some bat species eat insects and consume up to their weight in food each night. Others are important pollinators. Bats are not flying rodents, but belong to a unique order of mammals called the Chiroptera (Latin for "hand wing"). A common myth about bats is that they are blind. Bats have good vision; however, they can also use sound waves (echolocation) to help them navigate and locate food.

Only about one-half to one percent of bats carry the rabies virus; however, any bat found on the ground, or that is active during the day, should be suspected of being rabid. Anyone who has direct contact with a bat in which a bite may have occurred might have been exposed to rabies.

School administrators and IPM managers should protect students, faculty, and staff from bat exposure and other potential rabies exposures. Officials should have a general understanding of bats and the principles behind preventing or excluding colony establishment within school buildings. Each district and school should have a written plan for responders to follow when handling any high-risk rabies species.

Bats may live in large colonies or in small family roosts. Eviction strategies should reflect the type of roost. 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. In other states, those who exclude bats may also need a pest control applicators license; check with your state regulatory agency to learn more. 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**
Colonial species	
Big brown bat, *Eptesicus fuscus*	Throughout the US.
Little brown bat, *Myotis lucifugus*	Throughout most of the US.
Brazilian free-tailed bat, *Tadarida brasiliensis* including *T. b. Mexicana* and *T. b. cynocephala*	Roughly the southern half of the US. *T. b. Mexicana* will migrate from north to south in autumn, returning in spring.
Evening bat, *Nycticeius humeralis*	Eastern half of US north to southern Great Lakes. May be colonial or solitary.
Yuma myotis, *Myotis yumanensis* and Cave myotis, *Myotis velifer*	Most of western third of US.
Solitary species	
Seminole bat *Lasiurus seminolus*	Southeastern US north up to Great Lakes region
Pallid bat, *Antrozous palidus*	Southwestern US and west coast.
Hoary Bat *Lasiurus cinereus*	Throughout the US.
Eastern pipistrelle *Pipistrellus subflavu*	Most of eastern third of the US

Monitoring and inspection for bats

The first step in bat management is to identify potential bat entry points located in and around buildings. Inspections should be conducted during early evening (dusk) and just prior to dawn to locate bats entering or exiting the building. During cooler months, this step may need to be repeated several nights in a row to establish exit/entry points, as bats do not leave the roost at night if temperatures are too cold. This step is extremely important in identifying where to place bat eviction tubes and nets. 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. Determining the species can help identify roosting behavior; bats that roost in large colonies are likely to use multiple access points, making eviction and exclusion more challenging.

Any opening of sufficient size in walls or roofs 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 or other wall or ceiling coverings.

During an initial inspection, be sure to determine 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, barns used in ag education programs for example, total exclusion may not be practical. In those instances, measures may be taken to prevent bats from entering any spaces frequently used by staff and students.

Temporary measures to deny access (towel under door, steel wool in wall hole, etc.) can be taken while awaiting more-permanent solutions. Bats may also enter basements and other rooms through chimneys which may exist in older school buildings. Dampers should be kept closed on any fireplaces when not in use. Chimney covers can help.

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

Some success has been achieved by combining exclusion with the use of bat houses as an alternative roosting site. Running fans in areas of structures where bats are found has discouraged roosting in some instances, including the addition of reflective mylar balloons which are moved about by the fans. Although widely marketed to the public, ultrasonic devices purporting to repel bats have not shown to be effective in independent testing.

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

Type	Example Products	Uses
one-way exclusion check valves	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.
slick surface		Cover substrate were bats are roosting with a smooth surface; bats will roost elsewhere.

Table 8.8 Priorities for bat management.

Research Development of efficacious and low risk repellents for use in bat roosts. Refinement of the use of off-site bat houses as alternative sites when excluding bats from a building, including information on the safety and benefit to the public More information on migratory patterns, attractive building features, rabies transmission mechanisms, variation in rabies viruses and rabies infection rates including an apparent increase in rabid bats in recent years. Extension Development of regional management plans to help schools to eliminate bats. Education Development and distribution of short videos, PowerPoint or other presentations on bats to be delivered to teachers, students and staff. “What to do if you see a bat”. Region-specific information for teachers and parents about local bats, benefits of bats and cautions if bats are sighted.

Additional resources for bat management

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

Gouge, D. H., Li, S. and Nair, S. 2015 revision of 2008. Bats. University of Arizona Cooperative Extension AZ1456, pp. 11.
https://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az1675-2015.pdf

Bat Conservation International. www.batcon.org

Constantine, D.G. 2009. *Bat Rabies and Other Lyssavirus Infections*. U.S. Department of Interior and U.S. Geological Survey. Circular 1329.

Corrigan, R. M. Undated. *Recommendations for Selecting and Using Caulks and Sealants in Pest Management Operations.* 2 pp.
http://www.ipminstitute.org/school_ipm_2015/Corrigan_on_sealants.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.
http://www.nwco.net/

French, B., L. Finn and M. Kiser. 2002. *Bats in Buildings: An Information and Exclusion Guide.* Bat Conservation International, Austin, TX. www.batcon.org
Bat Conservation International. 2014. Bats in buildings
http://www.batcon.org/pdfs/education/fof_ug.pdf

Bat Conservation International. 2014. Bats & Human Contact.
http://www.batcon.org/resources/for-specific-issues/bats-human-contact

Greenhall, A.M. and S.C. Frantz. 1994. *Bats: Damage Prevention and Control Measures*. Cooperative Extension Division, Institute of Agriculture and Natural Resources, University of Nebraska – Lincoln.

Hurley, J., B. French, M. Goodman, and B. Nix. 2007. *Integrated Pest Management Plan for Bats*. 6 pp.

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

BED BUGS

Bed bugs, *Cimex lectularius*, are soft-bodied, flat-shaped, brown to rusty-red colored insects. Adults are about the size of an apple seed. Like fleas, ticks, head lice and mosquitoes, bed bugs feed on blood. Similar to mosquitoes, bed bug abdomens swell and become brighter red as they feed. Bed bugs can survive for months without feeding.

Unlike fleas, ticks and mosquitoes, to date, bed bugs have not been shown to transmit disease causing pathogens. Pathogens, including Methicillin-resistant *Staphylococcus aureus* (MRSA) have been isolated from bed bugs, however there is no evidence that MRSA or other pathogens have been transmitted by bed bugs to humans. Many insects are capable of carrying pathogens, but relatively few are effective vectors (meaning they can transfer the pathogens.

Bites are often painless initially but may become large, itchy welts. Although bed bugs are most often found associated with locations where humans sleep, or rest for extended periods of time, they may be carried on clothing and other belongings and can be found in any location frequented by people including hotels, workplaces, movie theaters, public transport, and schools.

Bed bugs are most active at night, often sheltering during the day within the bed frame, boxspring, mattress or headboard, or within ten feet of a bed, chair or couch. Bed bug eggs, immature nymphal stages and adults can all be found together in bed frames, seams of mattresses, cushions and box springs, and under and behind other furnishings. Bed bugs excrete digested blood which appears as dark spots or smears in these same locations.

Bed bugs typically become a problem in schools when carried in by students or staff on backpacks and clothing. In communities experiencing high rates of bed bug infestations in homes, introductions into schools can occur frequently. Schools generally do not experience established, reproducing infestations unless children and staff board at the school, or the school shares space with facilities where humans sleep at night.

When a bed bug is found, it can be difficult to determine the person of origin. A bed bug found on a student or student’s belongings is most likely from that individual’s home, however, schools and other public places can be transition locations, and it is possible the insect may have come from another student. Similar to head lice, it is very important to address the issue with care and sensitivity. Anyone can experience a bed bug infestation. Parents with bed bug infestations at home may not be able to afford treatment or treatment may be ongoing but not effective for several months. Treatment may be the responsibility of a landlord rather than the parent. If an infestation is ongoing in student home, frequent reintroductions into school are likely unless steps are taken to provide the student with bed bug-free school attire and back-pack. The number of families living with long-term bed bug infestations at home is increasing. Schools should be prepared to respond to concerns about bed bugs at school. School districts should consider developing a bed bug policy for support of students living with bed bugs, so they can attend school normally with as little disruption as possible. District policies may include steps taken to reduce the chances of schools acting as transition zones. Most often bed bugs found in classrooms are individual roving bed bugs doomed to starvation.

If a suspected bed bug is found in a school, it should be collected and submitted for identification by a knowledgeable staff member or PMP. Related species may be found in schools, including species that feed on bats or birds. To collect the specimen, use forceps or a tissue, place the specimen in a vial or plastic bag and tape the bag closed. Do not crush the specimen. If the specimen will not be identified immediately, place the bag in a freezer until it can be identified. Do not mail or transport live specimens which can escape during transit, freeze them for 3 days prior to sending or place in hand sanitizer or rubbing alcohol.

Collect the following information for each specimen: date and time found, name and contact information person collecting specimen, location found (e.g., on a student, on student's belongings or on desks or furniture), room number, school name, school principal name and phone number.

If the specimen is confirmed to be a bed bug, the principal and school health professional should be notified and the following steps are recommended:

1. The classroom or other area where the bed bug was found should be carefully inspected by a knowledgeable staff member or PMP including desks, floors, walls and storage areas used to house student belongings. A thorough cleaning may be advisable including vacuuming with special attention to cracks and crevices in furniture and equipment, walls and floors, and laundering washables and drying on a double drying cycle (dry items normally, then put on a timed drying cycle for an additional 40 minutes). Delicate fabrics can be dry cleaned or bagged and placed in a freezer for 3 days. When transporting potentially infested items, place in plastic bags to reduce the potential for accidental spread of bed bugs to other areas. If taking potentially infested items to a dry-cleaners, double-bag the items and notify the establishment so that they can take additional precautions to prevent spread.

2. If the bed bug was found on a child's clothing or other belongings, the child's parent(s) or guardian(s) should be notified. There is no need to send the child home. Similar to head lice, the school health professional is often the best equipped to manage the situation. Student belongings such as backpacks can be isolated in sealable plastic containers or bags to reduce the potential of bed bug dispersal.

3. Some districts notify the parents of all children using the room where roving bed

bugs are found. While it is always helpful to provide parents and guardians with basic information, panic should be avoided. Good results have been generated by schools distributing start of year guidance documents that provide information about bed bugs including: how to send students to school free of bed bugs; signs and symptoms; strategies to eliminate infestations in homes including cleaning, laundering and specially designed mattress and box-spring covers that can entrap bed bugs and reduce harborage; and actions that the school is taking to address bed bugs. The information may include where to go for additional help.

Table 8.9 Products for physical, cultural or mechanical management of bed bugs and uses. In nearly all cases, careful inspection, vacuuming, laundering and school health professional case management will be adequate to resolve a confirmed bed bug sighting in schools without space heat or steam treatment. Note: Bleach and ammonia are not effective against bed bugs. Soap and water is effective for removing bed bugs, eggs and debris from surfaces.

Type	**Example Products**	**Uses**
active monitors	Verifi® Monitor	Place in rooms in the location a bed bug was found.
passive monitors	Climbup™ Insect Interceptor, Blackout Bed Bug Detector	Place under legs of furniture to intercept bed bugs for detection/monitoring purposes.
space heating equipment	ThermaPureHeat®	Increase temperature of an enclosed space, e.g., classrooms to 140F or higher for at least 4-hours.
heat vaults	ThermalStrike Ranger Bed Bug Heat Treatment	Items are heated in a portable container.
sealants	many	Seal cracks, crevices especially in areas used to store student belongings brought from home to eliminate harborage.
steamers	many	Penetrate carpet, cracks and crevices in furniture and equipment with high temperature steam to kill bed bugs and eggs.
vacuum, HEPA filtered	Sierra Backpack Vacuum	Vacuum up bed bugs, eggs and associated debris.
washing/drying	many	Launder infested/potentially infested bedding, clothing, other washables.

Pesticide options for bed bugs
Effective pesticide options for bed bugs are available but are rarely needed in schools.

Table 8.10 Priorities for bed bug management.

Research Development of effective remediation protocols for low-income families.. Education Education for school administrators and health professionals on effective case management to reduce bed bug detections in schools by supporting more effective management at home.

Additional resources for bed bug management

Armed Forces Pest Management Board. 2010. Technical Guide No. 44, Bed Bugs - Importance, Biology and Control Strategies.
http://www.afpmb.org/pubs/tims/TG44/TG44.pdf

Michigan Bed Bug Working Group. 2009. *Bed Bugs: What Schools Need to Know.*
www.michigan.gov/documents/emergingdiseases/Bed_bugs_schools_293498_7.pdf

New York City Dept. of Health and Mental Hygiene. 2008. *Stop Bed Bugs Safely.* Two-page fact sheet available in English and Spanish.
www.nyc.gov/html/doh/downloads/pdf/vector/vector-faq1.pdf

Wang, C. 2010. *Detecting Bed Bugs Using Bed Bug Monitors.* Fact Sheet FS 1117. Rutgers Cooperative Extension. 3 pp.
http://njaes.rutgers.edu/pubs/publication.asp?pid=FS1117

BIRDS

Birds are a component of the exterior environment of a school. Under certain circumstances, some species in sufficient numbers can become pests and even create health and safety hazards. Birds may cause damage to property, and their droppings may create unpleasant odors. Bird droppings can also ruin vegetation, painted surfaces, gutters and awnings, and cause electrical equipment to malfunction. Birds may carry diseases which are capable of infecting humans, and bird droppings can promote soil conditions favoring development of such fungal diseases as *Histoplasmosis.* House sparrows can damage rigid foam insulation, and their nests can become fire hazards. Nests on buildings can be unsightly, block ventilation systems and attract other pests such as bird mites or dermestid beetles. Accumulations of droppings can deteriorate building surfaces.

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.

The first step in your bird control program should be identification of the pest bird; if you cannot positively identify the bird, consult an expert before taking action. The Migratory Bird Treaty and Endangered Species Acts prohibit trapping or killing of most birds, eggs or nests without a permit. House sparrows, starlings, and pigeons are not protected under these Acts, but may be covered under local ordinances, so be sure to consult with local wildlife authorities.

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 8.11 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 sparrow), *Passer domesticus*	Throughout much of the US.
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. The most practical method associated with buildings is to look for areas that can become common nesting areas and develop exclusion methods to prevent the birds from nesting on school property. The best time to do this is during the design review phase, prior to construction or renovation. In addition to design changes to avoid creating nest or roosting sites, 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.

Pesticide options for birds
There are few options in this category. Polybutenes form an adhesive surface that is uncomfortable for pigeons and other birds. Polybutene repellents can be applied to ledges or beams to prevent roosting. These repellents are non-toxic, but feel sticky and unpleasant to birds attempting to land. Apply repellent in tight wavy closely spaced

rows. Repellents must be reapplied with some frequency as they can become coated with dust or leaves and lose their sticky feel. Apply masking tape to the surface prior to using the repellent so that it may be more easily cleaned up and reapplied. Repellents are best suited for small- or medium- sized infestations.

Several products contain methyl anthranilate meant to make substances, e.g., turf, distasteful to grazing geese.

Ovocontrol is 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. Nicarbazin was developed by Merck in the mid-1950's as an anticoccidial drug for use in poultry. Mixed into the feed, the drug prevents coccidiosis, an often fatal disease in young chickens. Interference with egg hatchability was an unwanted side effect that would occur when medicated feed was inadvertently fed to breeder chickens. Nicarbazin has an acute toxicity value equivalent to table sugar, so is an attractive option for area-wide management of pigeons on school sites.

Table 8.12 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.

Table 8.14 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.

Managing barn swallow populations.

Education
Development of handouts, *Pest Presses* to educate teachers and staff about bird management

Best management practices for bird feeders, bird houses and other items on school property.

Additional resources for bird management

Arizona Cooperative Extension. 2006. Birds. Pest Press.
cals.arizona.edu/urbanipm/pest_press/2006/april.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.
http://www.nwco.net/

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

Illinois Department of Public Health. Undated. *Prevention and Control: Bird Exclusion and Dispersal.* www.idph.state.il.us/envhealth/pcbirds.htm

Link. R. 2004. *Living with Wildlife in the Pacific Northwest*. Washington Department of Fish and Wildlife. 350 pp.

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 wood and become pests when foraging or nesting in structures. Unlike termites, carpenter ants do not feed on wood, they simply nest there. These ants construct smooth "galleries" with rounded edges in softer parts of wood tissues. Galleries tend to follow the grain of the wood, with passages that cross harder wood.

Water-damaged or fungi-softened wood is typically conducive to nesting. Nest sites also include wall voids, rigid foam 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.

Carpenter ants range in size from ¼ - ½ inch (7-15 mm) long with a single-node petiole between the abdomen and the evenly rounded, spineless thorax. Color variations include black, red, red and black, or brown. Colonies will produce winged reproductives or "swarmers" that take flight to form a new colony. Male reproductives die after mating, while females form new colonies.

Carpenter ants will eat fruit, vegetation, insects, meat, grease, fat and sugars (e.g., flower nectar and insect honeydew). Carpenter ants typically forage in late afternoon and night, up to 100 yards (90 meters) from the nest, and will carry food back to the colony.

Table 8.15 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.

Monitoring and inspection for carpenter ants
Carpenter ants seen indoors during summer and fall months only indicate an outdoor nest and ants foraging for food and water; no action may be needed. When carpenter ants are seen indoors year around or winged ants are seen indoors before swarming, this indicates an indoor nest, requiring careful inspection and control measures.

Sawdust-like waste piles and slits or windows in the surface of wood 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. Sometimes a nest can be located by careful listening (unaided ear or stethoscope) for sounds of crinkling cellophane or paper.

Cultural and physical options for carpenter ant management
A primary defense against carpenter ants is to regularly inspect wood for moisture accumulation/pooling inside and outside the structure. Areas to check include: roof elements; window sills; door frames; ;vents; clogged, damaged or improperly aligned gutters; siding; decking; or wood that may be in contact with soil, vegetation, firewood piles or other debris that prevents proper drying. When wet wood is discovered, you should make immediate corrections to water flow/accumulation or replace the wood element.

Remove tree stumps adjacent to structures. Trim branches touching structures, or touching wires leading to structures, to reduce transit opportunities for carpenter ants and improve air circulation. 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, cypress (*Taxodium distichum*) or jarrah (*Eucalyptus marginata*). At-risk wood can also be sealed (e.g., deck boards) or painted to repel water and edges closed with weather-resistant sealants. Wood could also be treated with a boric-acid formulation.

If an indoor nest is located and exposed a vacuum can be used to clean up ants and nest debris; the vacuum bag or contents of the dirt collection chamber can be frozen to destroy all life stages. Heat treatment is a potential control method that is rarely used.

Table 8.16. Commonly used products for physical, cultural or mechanical management of carpenter ants and uses.

Type	Example Products	Uses
Paint	Interior or exterior latex	Cover the wood to help resist water
Wood sealers, stains	Many	To cover exterior wood to help it repel water
Sealants	Many (silicone, latex, etc.)	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, nest debris.

Pesticide options for carpenter ants

Nontoxic ant baits can be used to determine the focus of an infestation or to locate small, isolated colonies. This baiting helps determine what type of food (e.g., sweet, protein, grease) the foragers are taking back to the nest.

Baits (containerized, liquid, or gel) contain slow-acting insecticides that are taken back to the nest by foragers. These products should be placed in inaccessible areas reduce potential for human 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. A residual insecticide should never be used near ant baits as these may repel or kill the foragers directly.

Insecticidal dusts must be applied in a manner that greatly reduces exposure potential. This includes placing in voids reached by removing electrical outlet or switch plate covers, or in holes drilled for in infested wood; holes are then sealed after the application. Dust applications in school structures should be for unusual situations, as these products can remain toxic for long periods of time and can be uncovered during reconstruction activities.

Applications of residual-active pesticides to exposed, human-contact surfaces on the interior or exterior of structures, and use of Danger or Warning-labeled insecticides, are typically not needed. In addition, barrier applications to exposed impervious surfaces including foundations, walkways and driveways are prone to runoff into surface water and should be avoided unless all other options have failed.

Table 8.18 Priorities for carpenter ant management.

Research Efficacy of bait formulations. How to design buildings to avoid carpenter ants.

Additional resources for carpenter ant management

Arizona Cooperative Extension. 2004. Ants. Pest Press.
http://cals.arizona.edu/urbanipm/pest_press/2004/april.pdf

Hahn, J. and S. Kells. 2014. Carpenter ants. University of Minnesota Extension.
http://www.extension.umn.edu/garden/insects/find/carpenter-ants/

Jones, S.C. 2010. Carpenter ants. The Ohio State University.
http://ohiowood.osu.edu/images/Carpenter_Ants.pdf

Ogg, B. 2008. Carpenter ant management. University of Nebraska-Lincoln.
http://lancaster.unl.edu/pest/resources/carpant004.shtml

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 water bugs, 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 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 less effective than baits in reducing cockroach populations and increase potential for exposure. Bioremediation or enzyme-based cleaners can also be effective in cleaning up food residue and debris.

Table 8.19 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 not only 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.

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 developing 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. Educating health inspectors regarding IPM is critical. Altering health department policies may be required to support the use of monitoring traps.

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 storage, kitchens, food serving lines, cafeterias, locker rooms and staff lounges. Occasionally broken or uncapped drain or sewage pipes, including within walls or under floors, can be difficult-to-identify sources of cockroaches in schools and other buildings.

Cultural and physical options for cockroach management

Cultural and mechanical management options are preferred. These 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 8.20 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 reject infested products.
- 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 lights or yellow bulbs for exterior lighting to reduce attraction to cockroaches.
- Clean drains, cracks and crevices with bioremediation or an enzyme-based cleaner.
- Store classroom and art supplies, e.g., cardboard, beans, macaroni, rice, etc, that may provide food and/or harborage in sealed containers.

Table 8.21 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 Atrix Express Plus Bug Vacuum ProTeam	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 has been confirmed and non-chemical measures are also implemented and found to be inadequate.

Table 8.22 Commonly used pesticide products for cockroaches and uses.

a. Example insecticides carrying a CAUTION label or exempt from EPA registration, in formulations that reduce potential for exposure. Use of baits, including baits in enclosed, pre-manufactured containers, does not eliminate potential for exposure. The active ingredients in baits can be spread by the organisms feeding on those baits, e.g., in feces. Special attention should be paid to sanitation in areas where baits are used to reduce exposure potential.

Active ingredient	Example Products	Uses

disodium octaborate tetrahydrate fipronil	Ant Cafe® RTU 73766-2 Maxforce® Professional Insect Control Roach Bait Station 432-1257	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. Examples of CAUTION-label or exempt formulations with moderate potential for exposure.

Active ingredient	**Example Products**	**Uses**
boric acid diatomaceous earth disodium octaborate tetrahydrate	Borid® 9444-133 Eaton's KIO System 56-67 Boracide® 64405-7	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. Examples of CAUTION-label formulations with greater toxicity and/or potential for exposure.

Active ingredient	**Example Products**	**Uses**
bifenthrin chlorfenapyr cyfluthrin cypermethrin deltamethrin indoxacarb lambda cyhalothrin	Talstar® P 279-3206 Phantom® 241-392 Tempo® Ultra SC 432-1363 Demon® EC 100-1004 Suspend® SC 432-763 Arilon™ 352-776 Demand® CS 100-1066	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 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 8.23 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. Education for heath departments on benefits IPM including benefits of insect monitors for cockroaches and detrimental effect of considering trap captures to be health code violations. Education on compliance assistance using IPM.

Additional resources for cockroach management

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

Corrigan, R. M. Undated. *Recommendations for Selecting and Using Caulks and Sealants in Pest Management Operations.* 2 pp. http://www.ipminstitute.org/school_ipm_2015/Corrigan_on_sealants.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. http://www.birc.org/SchoolManual.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. http://lancaster.unl.edu/pest/RoachManual.shtml

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 were addressed in the last 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.

House, filth and biting flies are also a common problem in areas and around buildings associated with agricultural education programs, especially those involving livestock. If large populations develop in these areas, flies can migrate to other areas and buildings on the campus or neighboring properties.

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 were addressed in the last 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.

During the inspection, look for conditions conducive and ensure the following best practices are in place: 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/screens.

Cultural and physical options for fly management

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

In schools that have programs where wastes are removed frequently (twice weekly), 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 the management of flies and include the proper management of waste, physical methods such as screens and flyswatters, and ensuring that properly maintained and fitting doors and windows are in place.

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. Dumpsters should be clean and maintained with functioning drains and lids. Self-contained, liquid-tight garbage compactors are ideal. 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 paper or ribbons designed for flies 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 and should not be used in food preparation and serving areas. A number of fly traps for outdoor control are commercially available and can be helpful 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 and sanitized to avoid contaminating food with insect body parts.

Table 8.25 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 damaged drains/pipes 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 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 and indoor floor drains 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 tightly sealed plastic bag.
- 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. These containers 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 should be replaced or 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 away from the building, 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 refuse is not left in the building overnight.

Table 8.26 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.

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 or other preferred foods, baits may not be as effective due to this competition.

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 8.28 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. Efficacy and safety of misting systems including in agricultural situations. 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

Daar, S., T. Drlik, H. Olkowski and W. Olkowski. 1997. Chapter 9. IPM for flies in schools. Pp. 63-70. In *IPM for Schools: A How-to Manual*. Line drawings, identification, communication, monitoring, management. http://www.birc.org/SchoolManual.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*. http://schoolipm.ifas.ufl.edu/newtp14.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 or similar locations. The 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 drain lines associated with custodial closets. Drain flies could 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 including cavities in damaged floor tiles, missing grout, loose baseboards in food service areas. 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 to line the container. Other important breeding sites for phorids are the decaying organic matter that can get trapped in cracks of kitchen equipment or under the bases of the equipment and sewage that may be present under a slab floor due to the presence of a broken drain line.

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 fungus that grows on decaying matter including organic matter/soil in potted 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 with young plants. Fungus gnats may also carry plant disease organisms from one plant to another.

Small Fly Management practices include identifying and eliminating breeding sites and entry points. Frequent, regular cleaning of drains or locations where fermenting materials can accumulate; repair of cavities in floor tile, missing grout and damaged baseboards; 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 8.29 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.
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.
Dark-winged fungus gnat, Family Sciaridae	Throughout the US.
Fungus gnat, Family Fungivoridae	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. Other problem areas include grease traps, grease storage areas and occasionally broken or uncapped drain or sewage pipes. 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. Each device should have a card that is and dated and initialed every time it is checked. For drain and fruit flies, ideal placements include locations near plumbing fixtures, dishwashers, under prep tables and in trash or recycling storage areas. Traps baited with vinegar may also be used.

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, brushing or hydrojetting accumulated organic matter which should be done only after all food has been put away. Enclosing the drain with a bucket that has the bottom removed is one method that will reduce splatter when cleaning with a drain brush. Clean and sanitize 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. Trap guards can be installed after infrequently used drains are cleaned to prevent sewer gases and pests from entering buildings through drains.

Table 8.30 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 eliminating accumulations of moist organic matter, by repairing damaged floor tile, missing grout and damaged baseboards; and sealing cracks, edges around coving, tiles and kitchen fixtures/equipment.
- 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.
- Use traps baited with vinegar to capture drain flies, fruit flies and fungus gnats.

Table 8.31 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.
unbaited traps	Tangle-Trap Sticky Whitefly Trap	Place 3x5" trap in indoor plant pots to monitor for and suppress fungus gnats.
bioremediation (microbial-based drain cleaners)	DrainGel™ InVade Bio Foam™ BioStim®	Used to break down organic matter in drains and other potential breeding sites.
enzymes	EarthEnzymes	Designed to quickly digest solid wastes, converting them to an easily disposed of liquid state through natural enzymatic action.
drain trap guards	ProSet Systems Trap Guard	Inhibits evaporation of drain trap water and prevents escape of sewer gases, microorganisms and insects from drains.

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 8.33 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.
Education
Educational materials for teachers and other staff about sources of fly problems and how to avoid fly-conducive conditions.

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

Daar, S., T. Drlik, H. Olkowski and W. Olkowski. 1997. Chapter 9. IPM for flies in schools. Pp. 63-70. In *IPM for Schools: A How-to Manual*. Line drawings, identification, communication, monitoring, management. http://www.birc.org/SchoolManual.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

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 March Flies. 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. Some studies indicate that girls contract head lice more often than boys, girls are in general more likely to make head-to-head contact. Head lice are more common among Caucasians compared to other races due to differences in hair structure. Head lice (*Pediculosis capitis)* are not a sign of uncleanliness and do not vector disease organisms. The most common symptoms are itching, embarrassment and sleeplessness. Scratching can lead to secondary bacterial skin infection. Head lice cases can result in extreme anxiety, embarrassment, and unnecessary days lost from school and pesticide exposure. Millions of dollars are spent on remedies annually.

Head lice are acquired most commonly as a result of head-to-head contact with an infected person. While it is possible for them to transfer on inanimate objects, it is a very rare occurrence. A large number of infestations can be traced back to slumber-parties or occurrences when children are in close proximity and head-to-head contact is likely.

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, and feed and grow for about nine to twelve days before reaching the adult stage. If left untreated, the life cycle may repeat every three weeks.

Hair grows at different speeds per individual depending upon health status, and even the time of year. But, in general it grows about 1.5 cm per month. Nits attached close to the scalp hatch or die within 2 weeks so if nits are found 1 cm (half an inch) or more away from the scalp they are not of concern.

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 do not infest pets they can only survive on humans.

Head lice cannot fly, burrow or jump, but the adults can crawl quite quickly across the scalp. Off the head they desiccate and starve very quickly. Most will die in less than 24 hours. Under some circumstances they can survive longer, but for less than two days away from the scalp at normal room temperature. Individuals typically carry fewer than 12 active lice at a time, but may have hundreds of eggs incubating near the scalp. Occasionally, individuals support numbers in the hundreds at a time which can cause a high degree of irritation and stress. Eggs require the heat and humidity generated by the head to support embryonic development, but many die naturally. Laundering and drying clothing and bedding at 130^{o}F will kill all stages.

Monitoring for head lice

Screening for head lice in schools has been a very useful role for the school health professional. Active infestations need to be addressed individually. Providing sound information to families on the diagnosis, treatment and prevention of head lice extends benefits beyond the school environment. However, no-nits policies are not an effective way of reducing the transmission of lice, and by excluding infested children from school, students suffer unnecessarily, schools lose significant funding, employers lose workers, and parents forced to stay home with young children incur financial loses also. The American Academy of Pediatrics and the National Association of School Nurses (http://www.nasn.org/PolicyAdvocacy/PositionPapersandReports/NASNPositionStatementsFullView/tabid/462/ArticleId/40/Pediculosis-Management-in-the-School-Setting-Revised-2011) discourage “no nit” policies in schools. There is no need to send students home.

School nurses are the most logical group to assist and nurse/student interaction is always beneficial. But school nurses are often over-burdened and may lack the expertise, time and equipment to accurately determine active infestations that require treatment. Mass-screenings for head lice by volunteers has led to misdiagnosis and unnecessary treatment. No pesticide treatment is necessary (or helpful) unless lice have successfully hatched. However, combing and nit removal is helpful.

Studies have indicated that of thousands of samples of presumed lice and nits submitted to IdentifyUs.Com for examination, fewer than half contained bona fide lice or louse eggs. Most samples were composed of miscellaneous insects or of artifacts that resembled eggs. Of those samples that did contain louse eggs, many were comprised solely of hatched or dead eggs; thus, no treatment would be warranted. The investigators noted that: 1) health care professionals as well as non-specialists frequently over-diagnose infestations, 2) non-infested children are quarantined often as infested children, and 3) traditional pediculicides and ‘alternative’ formulations are frequently over-applied (Pollack, R.J. 2011).

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.
Generally, around 30% of school children with nits will also have adult lice (eXtension. 2014). Screening for nits is <u>not</u> an accurate way of predicting which children will become infested. Results from one research study found that only 18% of children with nits alone converted to an active infestation (Williams *et al.* 2001). Children with five or more nits within 1 cm^2 of the scalp are significantly more likely to develop an infestation, still only one third of these higher-risk children convert.

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.

Parents of all children using the room with any child with confirmed head lice should also be notified and provided with basic information including description, signs and symptoms; strategies to eliminate head lice. The information should include where to go for additional help.

Cultural and physical options for head lice
Due to the short time period that head lice can survive 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, barrettes, 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. 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. They are delicate creatures and dry out readily.

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.
Occlusive agents may be helpful, but some require diligent shampooing to remove the residue. Occlusive substances reported to be beneficial include: (mayonnaise, tub margarine, herbal oils, olive oil) but benefits have not been clinically demonstrated.

It's often unclear if a specific product or remedy is effective or if the repeated shampooing, brushing, combing and hair drying results in the mechanical destruction of the lice. Studies have shown significant reductions associated with hair drying, brushing, and the use of everyday hair conditioners (Lapeere *et al.* 2014).

Table 8.34 Commonly used products for physical, cultural or mechanical management of head lice and uses.

Type	**Example Products**	**Uses**
combs	Walgreens Stop Lice Egg & Nit Removal System Veridian Electronic Comb Lice-B-Gone®	Removes lice and nits.
botanical-based removal aid	De-Licer®	Eases removal by combing. Shampoo loosens nits and allows for easy 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 as there are safe and effective alternatives.

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

the egg stage.

Table 8.36 Priorities for head lice.

Research Efficacy of botanical pesticide products on head lice. Useful thresholds for pesticidal treatment. Effective, low-risk ovicides.
Education Educational materials for school nurses and parents that facilitate accurate identification of head lice. 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 Remove lindane and malathion-based products from the market. Prohibit “no-nit” policies in public schools.
Management Sound response strategies: stop all district level “no-nit” policies, pesticidal treatments of school environments (classrooms, dormitories, buses, etc.).

Additional resources for head lice management

Burkhart, C.G. and C. N. Burkhart. 2006. Safety and efficacy of pediculicides for head lice. Expert Opinion on Drug Safety 5(1): 169-179.

Center for Disease Control. 2013. Head Lice.
http://www.cdc.gov/parasites/lice/head/epi.html

eXtension. 2014. IPM Action Plan for Head Lice.
https://www.extension.org/pages/20989/ipm-action-plan-for-head-lice#.VL-7UkfF-qF

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

Lapeere, Hilde; Brochez, Lieve; Vander Stichele, Robert H.; Remon, Jean-Paul; Lambert, Jo; Leybaert, Luc. Efficacy of Products to Remove Eggs of *Pediculus humanus capitis* (Phthiraptera: Pediculidae) From the Human Hair. Journal of Medical Entomology, February 2014 DOI: 10.1603/ME13106

Pollack, R.J. 2011. IdentifyUs, LLC. Head Lice. Comprehensive website that answers many questions about and related to head lice including removal methods.

https://identify.us.com/idmybug/head-lice/index.html

The American Academy of Pediatrics and the National Association of School Nurses
http://www.nasn.org/PolicyAdvocacy/PositionPapersandReports/NASNPositionStatementsFullView/tabid/462/ArticleId/40/Pediculosis-Management-in-the-School-Setting-Revised-2011
https://www.extension.org/pages/20989/school-ipm-action-plan-for-head-lice#.U_YL-WJ0zIU

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 8.37 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.
(No common name), *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 have many, 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 site where eggs are deposited. 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 site for egg deposition.

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:

- widespread geographically;
- breed in and around buildings in artificial containers;
- always associated with humans;
- typically small (<1/2 mile) flight range;
- 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 mosquitoes, *Anopheles quadrimaculata* and *Anopheles freeborni*, occur in only a few places and do not typically deposit eggs (oviposit) in and around buildings. Thus, these species are 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 mosquito-borne diseases are a concern in your area, adult mosquitoes may be captured and preserved in between tissues in a small box or frozen 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 oviposition 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. Adult control methods such as predators, traps, “bug-zappers” etc, may not effectively reduce mosquito populations. 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 8.38 Management strategies for mosquitoes.

a. Source elimination strategies.

• Identify anything outside that can hold water such as plastic, cans, containers, pots. Dispose, turn over or 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 egg deposition (oviposition) 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 8.39 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 may 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 will be in areas of high mosquito activity, advise 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 repellents containing DEET which has been shown to generate adverse effects on the mammalian nervous system (Corbel *et al.* 2009). Alternative, effective repellents are available. Use of repellants is often governed by school policy.

Larvicides 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. 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. Mosquito abatement activities are often undertaken by municipality or county agencies.

Table 8.40 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. Examples of 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 Larvacide 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 concerns and the potential for widespread non-target impacts. Similarly, aerosol spraying, thermal fogging and/or Ultralow Volume (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, consider closing 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 8.40 Priorities for mosquitoes.

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

Additional resources for mosquito management

American Mosquito Control Association
http://www.mosquito.org/index.php?option=com_content&view=article&id=37&Itemid=114

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

Florida Coordinating Council on Mosquito Control. 1998. Mosquito Control Benefits and Risks: Integrated Mosquito Management. In *Florida Mosquito Control White Paper*.

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

OCCASIONAL INVADERS AND OTHER INFREQUENT PESTS

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 8.42 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. For overwintering invaders, removal using a vacuum can be effective.

Cultural and physical options for occasional invader/infrequent pest 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 dehumidifying 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 8.43 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.
- Eliminate harborage. 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. Properly remove feral cats or other animals to avoid flea problems.
- 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 lights or yellow bulbs for exterior lighting to reduce attraction to insects.

Table 8.44 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/infrequent pest 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 and crevice or spot applications of a pesticide 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 if available for the target pest.

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 8.45 Insecticide products for occasional invaders.

a. Example products 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 moderate 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. Example CAUTION-label formulations with greater toxicity and/or potential for toxicity and/or exposure. Use less toxic options.

Active ingredient	Example products	Uses
bifenthrin chlorfenapyr cyfluthrin cypermethrin deltamethrin indoxacarb lambda cyhalothrin rosemary oil	Talstar® P 279-3206 Phantom® 241-392 Tempo® Ultra SC 432-1363 Demon® EC 100-1004 Suspend® SC 432-763 Arilon™ 352-776 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 8.46 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/infrequent pest management

Arizona Cooperative Extension. 2004. Scorpions and Mosquitoes. Pest Press. cals.arizona.edu/urbanipm/pest_press/2004/may.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. http://www.birc.org/SchoolManual.pdf

University of Florida. 2006. Occasional Invaders. A poster of 14 yard- and home-invading creatures, from slugs to centipedes. http://ifasbooks.ifas.ufl.edu/p-275-occasional-invaders.aspx

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. Normway 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 8.47 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 and into Central TX
Deer Mice *Peromyscus maniculatus*	Fairly widespread across the U.S, with the major exception being the southeast United States and the far north.

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. These rats may use ground-level and below ground-level air vents and air vent wells to gain access to buildings. Norway rats will travel from 100 to 300 feet in search of food, but are known to travel up to 500 feet.

Roof rats prefer elevated nesting sites including attics, walls, roofs, the tops of palms and other trees, and vine-covered fences and walls. Roof rats will travel from 25 to 100 feet from their nest and up to 1000 feet when searching for food or new nesting locations. Roof rats may use downspouts, gutters and other structures to climb up and around buildings.

Rats often become active at dusk and can be seen traveling to food or water sources. Rats generally feed after dark and prior to dawn. 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 juvenile mouse can squeeze through a hole the size of a pencil diameter; and adult can enter through a dime-sized hole. 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.

For roof rats, pay particular attention to closing gaps under flashing and around plumbing and electrical penetrations. Trim tree branches overhanging or touching buildings.

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 is often used including to stick other foods to the trigger, however this strategy is not recommended to avoid severe allergic reactions by students or staff with peanut allergies. Snap traps can also be placed in cardboard or plastic boxes designed to hold snap traps. Snap traps should not be used in classrooms unless they are placed in tamper-resistant containers or other areas inaccessible to students. Alternatively, snap traps they may be set at night and removed in the morning before students arrive. These should be labeled with a number and marked on a diagram to ensure all are recovered. Electronic devices (e.g., Rat Zappers) may also be used in place of snap traps.

Both Norway and roof rats are "neophobic", hesitant to interact with new objects placed in their environments. Pre-baiting is a strategy used to to improve the efficacy of these devices by first placing the baited device without setting it. After rats begin taking the bait, the device is set. After setting, check the device daily until captures cease. Do not move the device to a new location during this period. Place traps along runways, e.g., along walls, with the trigger side of the trap intersecting the runway, i.e., agains the wall. Select items for bait that rats are already feeding on, e.g., catsup packages, bread. Generally roof rats prefer fruit and nuts. Norway rats prefer meat or fish. Other effective baits include chocolate and dry oatmeal. Using a variety of baits can help you identify the most effective bait. Pregnant female rats can be attracted to traps baited with cotton balls or string for nesting material. The effectiveness of any trapping program will be greatly diminished if competing sources of food are not eliminated first.

Table 8.48 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 (e.g., Detex® with Biomarker) in tamper-resistant stations in non-visible, inaccessible areas and check regularly for feeding. Use black light to detect biomarker in rodent feces to identify travel routes and optimal placement for traps.
- 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 or bioremediation (microbe-based) or an enzyme-based cleaner 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”.
- During construction and renovation projects, ensure that all contractors are removing food trash daily and that no food trash is left behind in wall voids, etc. Ensure that pest management is ongoing prior to and during construction. Complete a full pest inspection prior to taking possession of new buildings to identify any pest situations that are the responsibility of the contractor are resolved.

Table 8.49 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	Close gap between bottom of door and sill, and between edges of door and frame.
electronic traps	Rat Zapper® Victor® Electronic Rat Trap	Place in areas inaccessible to children
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.
monitoring/tracking bait bocks	Detex® with Biomarker NoTox Mini Blocks	Place in bait station, monitor for feeding activity. Track rodent droppings contaminated with biomarker using blacklight. NoTox uses red dye for ready visibility.
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. Use of rodenticides indoors is rarely required in school settings.

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. Tamper-resistant bait stations are required for all outdoor, above-ground placements of second-generation anticoagulant rodenticides, and for indoor applications where exposure to children, pets or non-target animals is possible.

Pesticide options that increase potential for exposure for students, staff and other facility users include pelleted formulations used outside of burrows, place packs, granular, dust or liquid formulations. Phosphine fumigants have been associated with accidental poisonings; use around school buildings is now prohibited. Rodenticide tracking powders are not needed; talcum powder can be used if rodents need to be tracked.

Table 8.50 Pesticide products for rodents.

a. Example rodenticides carrying a CAUTION label, in formulations that reduce potential for exposure.

Active ingredient	Example products	Uses
First-generation anticoagulatns:		
diphacinone	Ditrac® All Weather BLOX™ 12455-80	Place on rod in tamper-resistant bait station secured such that it cannot be moved.
Second-generation anticoagulants:		
brodifacoum	Final® All Weather BLOX™ 12455-89 Weatherblok® XT 100-1055	
bromadiolone	Contrac® All Weather BLOX™ 12455-79 Maki® Mini Blocks 7173-202	
difethialone	Generation® Mini-Blocks 7173-218	
Non-anticoagulants:		
bromethalin	Fastrac® All Weather BLOX™ 12455-95	

b. Example CAUTION-label or exempt formulations with greater potential for exposure. Due to great potential for rodents to translocate non-block formulations, these are not recommended for use deep in burrows only, and only when lesser risk alternatives are not adequate.

Active ingredient	Example products	Uses
Second-generation anticoagulants:		
brodifacoum	Talon®-G Mini-Pellets 100-1057	Place deep inside burrows to reduce potential for translocation (movement of pellets to unintended locations).
bromadiolone	Maki® Parafinized Pellets 7173-187	
difethialone	Generation® Pellets 7173-205	
Non-anticoagulants:		
bromethalin	Fastrac® Pellets 12455-137	

c. Example rodenticides with greater potential for toxicity and/or exposure. Not recommended for use in schools.

Active ingredient	Example products	Uses
First-generation anticoagulants:		
diphacinone	Ditrac® Tracking Powder 12455-56	Dust applied to burrows, voids and subject to translocation to other surfaces.
chlorophacinone	Rozol® Tracking Powder 7173-113	
Second-generation anticoagulants:		
bromadiolone	Final® Ready-to-Use Place Pak 12455-91	Treated seed applied in packets or scattered, subject to translocation.
	Contrac® Ready-to-Use Place Pak 12455-76	
Non-antocoagulants:		
zinc phosphide	ZP® Tracking Powder12455-16	Dust applied to burrows, voids and subject to translocation to other surfaces.

Table 8.51 Priorities for rodents.

Research Best practices for monitoring with non-toxic bait blocks. Best practices to keep rodents out during construction. Deterring rodents from entering school property when neighboring agricultural fields are harvested. 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

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

Corrigan, R.M. 2001. *Rodent Control: A Practical Guide for Pest Management Professionals*. Moreland, D., ed. GIE Media. 355 pp.

Daar, S., T. Drlik, H. Olkowski and W. Olkowski. 1997. Chapter 12. IPM for rats and mice in schools. Pp. 87-102. In *IPM for Schools: A How-to Manual*. Line drawings, identification, communication, monitoring, management. http://www.birc.org/SchoolManual.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. http://www.afpmb.org/sites/default/files/pubs/techguides/tg41.pdf

US EPA. *Controlling Rodents and Regulating Rodenticides.* www.epa.gov/oppsrrd1/reregistration/rodenticides/finalriskdecision.htm

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 mistakenly implicated by medical professionals when patients present skin lesions. Spiders are often misidentified, including in areas outside of known geographic ranges. A US study showed that of 600 suspected brown recluse spiders submitted for identification from California, only one was a brown recluse, collected from a home of a family that had moved from Missouri, within the known geographic range of the insect. 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 <u>potentially</u> fatal. Most often it is children under 18 kg (40 lbs.), hypertensive individuals or 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. Recluse bites are rarely fatal.

Sac spiders have been reported as responsible for more bites than any other spiders. A yellow sac spider bite may result in 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 8.52 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., Tetragnatha spp.,	Throughout the US.
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. Remove spider webs from the outside of buildings using a telescoping-handled brush, or wash off with 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.
- To avoid attracting insects that spiders feed on to buildings, install yellow light bulbs or sodium vapor light fixtures outdoors; locate lights away from the building (e.g., on a light pole);and/or turn off exterior lights 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 8.53 Commonly used products for physical, cultural or mechanical management of spiders and uses.

Type	Example Products	Uses
brush	Quickie Telescoping Web Duster Webster	Brush on telescoping pole used to remove spiders, egg cases, webbing.
sealant	many	Seal small gaps and openings to discourage spider webbing over openings which can be difficult to brush away. Do not seal essential openings, e.g., weep holes, drains for screened windows.
vacuum, HEPA filtered	Sierra Backpack Vacuum Atrix Express Plus Bug Vacuum ProTeam Vacuum	Vacuum removal of spiders, egg cases, webbing.
weep-hole guards	many	Pervious material (screen, cotton wick) placed in weep holes to discourage spider webbing over openings which can be difficult to brush away.

Pesticide options for spider management

Vacuuming or sweeping away individual exposed spiders and egg sacs is far more effective than non-residual pesticides and many residual pesticides as well. Pesticide applications are generally 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, walls, 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 8.54 Commonly used pesticides for spiders.

a. Examples of 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 67425-14-655	Aerosol.
2-phenethyl propionate, pyrethrins	EcoPCO® AR-X 67425-15-655	Aerosol.
eugenol (clove oil), 2-phenethyl propionate, soybean oil	Essentria™ D	Contact dust formulations.
eugenol (clove oil), thyme oil, wintergreen oil	Essentria™ G	Granular insecticide.
thyme oil, 2-phenethyl propionate, pyrethrins	EcoPCO® WP-X 67425-25-655	Wettable powder.
rosemary oil, oil of wintergreen, mineral oil	Essentria™ IC^3 (EPA Exempt)	Concentrate, mix with an adjuvant.

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

Active ingredient	Example products	Uses
amorphous silica gel, piperonyl butoxide, pyrethrin dust	Drione® 73049-992	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	Prescription Treatment® Orthene® Crack & Crevice Pressurized Residual 499-373	Crack and crevice treatments.
bifenthrin	Talstar® P 279-3206	Liquid insecticide. Labeled for inside, outside, and perimeter applications.
cyfluthrin	Tempo® Ultra WP 432-1304	Synthetic pyrethroid, wettable powder.
	Tempo® SC Ultra 432-1363 Cy-Kick 499-304	Liquid formulation.
cypermethrin	Demon WP 10182-71 Cynoff WP 279-3070 CB-Air Devil 9444-182	Synthetic pyrethroid wettable powder. 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.
	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.
permethrin	Dragnet® SFR 279-3062	Indoor/outdoor spray.
pyrethrin, piperonyl butoxide	ULD® BP-300 499-522 Prescription Treatment® 565 Plus XLO® 499-290	Indoor or outdoor application as a space, area or contact spray.

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 8.55 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

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

Daar, S., T. Drlik, H. Olkowski and W. Olkowski. 1997. Chapter 15. IPM for spiders in schools. Pp. 111-116. In *IPM for Schools: A How-to Manual*. Line drawings, identification, communication, monitoring, management. http://www.birc.org/SchoolManual.pdf

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.

Meier, J., and J. White. 1995. *Handbook of Clinical Toxicology of Animal Venoms and Poisons.* CRC Press, Boca Raton. 768 pp.

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. Management of these insects should not be attempted by inexperienced or ill-equipped individuals.

Very few of the many species in these groups are defensive 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 requiring medical attention. Wasps and bees cause 30-120 deaths yearly in the US (Vankawala and Park 2009). School pest managers are thus justly concerned with limiting 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 cutworms and other caterpillars.

Table 8.56 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.
Eastern yellowjacket, *Vespula maculifrons*	Eastern U,S, as far as TX
Southern yellowjacket, *Vespula squamosa*	Eastern United States south through Mexico

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, grounds and playground equipment 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.

Honey bees become defensive when people and animals approach colonies with broods present. In regions where Africanized honey bees are present, specific instructions should be provided for avoiding and responding to attacks. These include a set of guidelines on what to do if bumped or stung by a bee. For example, guidance can include if you find yourself bumped by a bee, stop and cover your head with clothing or at least cover your nose and mouth with your hands, look through your fingers or clothing to see if you can determine where the colony is and move in the opposite direction; if you are stung by a bee carefully run away fast at least the length of a football field, seek shelter in a building or vehicle, and avoid other people unless they are offering you aid.

In certain locations, regulations specify that feral nests or swarms must be assumed to be Africanized and destroyed rather than collected by a beekeeper. Region-specific advice is usually available from local Extension specialists, the Department of Agriculture, or your state beekeeping association.

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 when appropriate, and remediating colonies at the appropriate time of day.

Table 8.57 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, preferably 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 Victor® Poison Free® Yellow Jacket & Flying Insect Trap Surefire® Deluxe Yellow Jacket And Wasp Trap	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 8.59 Commonly used pesticide products for stinging insects and uses.

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

Active ingredient	**Example Products**	**Uses**
2-phenethyl propionate, pyrethrins	EcoPCO® D-X 67425-16-655	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**
rosemary oil, peppermint oil, 2-phenethyl propionate, geraniol d-limonene, pyrethrins, potassium salts of fatty acids	EcoEXEMPT® Jet (EPA Exempt) Safer® Brand Flying Insect Killer (EPA Exempt)	Aerosol formulations used to knock down individual insects or applied to small nests.
rosemary oil	Essentria™ IC^3(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 432-1373	Dust formulation. To reduce exposure hazard, use in voids that will be sealed after colony dies.

Table 8.60 Priorities for bees, hornets, wasps and yellow jackets.

Research Efficacy of botanical pesticide products for stinging insects. Efficacy of yellow jacket trapping. Education Appropriate methods for responding to encounters with Africanized honeybees. What is a pollinator and how you can help preserve them and what you can do a school to preserve them.

Additional resources for stinging insect management

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

Daar, S., T. Drlik, H. Olkowski and W. Olkowski. 1997. Chapter 9. IPM for yellowjackets and hornets in schools. Pp. 145-152. In *IPM for Schools: A How-to Manual*. Line drawings, identification, communication, monitoring, management. http://www.birc.org/SchoolManual.pdf

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

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. Red 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 8.61 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.
Southern fire ant, *Solenopsis xyloni*	Desert, Southwest

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 southern fire ant mounds present on school and neighboring property. Southern fire ants prefer bare soil, with direct sun exposure. However, other fire ant species are not as easily deterred.

Biological control for imported fire ants has included releases of parasitic phorid flies and microsporidia which have become established and spread. Biological control options work to enhance existing management strategies, but will not manage populations by themselves.

Pesticide options for stinging ants

Broadcast baits are the most effective for large areas but require 2-4 applications, depending on area. Advion® and Top Choice® are broadcast treatment products with proven fire ant control efficacy, which can be applied when school is not in session. Other products are available for individual mound treatments including soil drenches, baits, and dusts.

Table 8.62 Commonly used pesticide products for stinging ants and uses.

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

Active ingredient	Example Products	Uses
indoxacarb	Advion® Fire Ant Bait 352-627	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.
pyriproxifen	Distance® Fire Ant Bait 1021-1728-59639	
	Esteem® Ant Bait 59639-114	Esteem is registered for pastures and livestock areas. Distance is registered for non-agricultural areas.
methoprene	Extinguish® 2724-475	Bait formulation carried back to the mound by foraging workers. Insect growth regulator (IGR), slower acting than non-IGR baits.
spinosad	Conserve® Fire Ant Bait 62719-304	Bait formulation approved for USDA Certified Organic production.

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

Active ingredient	Example Products	Uses
indoxacarb	Advion® Fire Ant Bait 352-627	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.
pyriproxifen	Esteem® Ant Bait 59639-114	

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

Active ingredient	Example Products	Uses
fenoxycarb	Award® Fire Ant Bait 100-722	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	Ceasefire® Fire Ant Bait 432-1219	
hydramethylnon	Amdro® Fire Ant Bait 73342-1 Extinguish® Plus Maxforce Fire Ant Killer Granular Bait 432-1265	
fipronil	Top Choice™ 432-1420	
methoprene and hydramethylnon	Extinguish Plus® 2724-496 Amdro Fire Strike® 2724-496	
bifenthrin	Bifenthrin Pro 51036-392	Spray-applied liquid.
cyfluthrin	CyKick CS 499-304	

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. http://**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. All termites are true social insects, living in colonies. It is important to identify the termite you are dealing with because control measures can differ significantly for each species.

Table 8.63 Termite species.

Common and species name	Geographic distribution
Drywood termites	Southern US from Florida to California.
Formosan subterranean termite, *Coptotermes formosanus*	Southeastern US. A confirmed specimen was reported from Southwestern California but species not considered established in this area.
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 (different species inhabit different regions: *Heterotermes aureus, Reticulitermes tibialis, R. flavipes, R. virginicus, Coptotermes formosanus).*	Throughout the US except Alaska, with highest populations in the Gulf and Southeastern states.

Subterranean termites
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 structure 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 damage repair costs 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.

Table 8.64 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 termiticides, baits, physical barriers

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 variable in size, 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 may have a warped surface, and the screwdriver may even break through into the galleries.

Thorough, careful inspections are needed for subterranean termites 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 24 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 the building.

Once termites find a structure by tunneling, tubing or surface foraging, they need moisture to establish and continue the infestation. Moisture-related factors can be among the most important contributing to termite infestation including:

- 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 building, obscuring inspection space.
- Irrigation directed toward the building.
- Landscape planted within 2 feet of the building.
- No gutters.
- Gutter downspouts directed toward wall of building or not far enough away.
- Air-conditioning condensate lines too close to building.
- 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 subterranean termites and uses.

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

Pesticide options for subterranean 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 performed well in the USDA Forest Service trials.

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

Table 8.66 Commonly used pesticide products for **subterranean termites** and uses.

a. Example insecticides carrying a CAUTION label, in formulations that reduce potential for exposure.

Active ingredient	**Example Products**	**Uses**
diflubenzuron	Prescription Treatment® Advance® Compressed Termite Bait II 499-500	Bait blocks used in bait stations for subterranean termites.
novaflumuron	Sentricon® AG III 62710-454	
novaluron	Trelona™ Compressed Termite Bait 499-557	

b. Example CAUTION-label formulations with greater potential for exposure. Altriset has no signal word.

Active ingredient	Example Products	Uses
chlorantraniliprole	Altriset™ 352-829	Spray-applied liquid.
imidacloprid	Premise® Foam 432-1391	Foam

c. Additional example formulations with greater potential for toxicity and/or exposure.

Active ingredient	Example Products	Uses
chlorfenapyr	Phantom® 241-392	
cypermethrin	Demon® TC 100-1006	
deltamethrin	DeltaDust® 432-772	
disodium octaborate tetrahydrate	Tim-Bor 64405-8	
fipronil	Termidor® SC 7969-210	
imidacloprid	Premise® 75 432-1331	

Drywood termites
Colonies of drywood termites 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.

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, where a portion of the colony takes flight to form a new colony, 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 but is typically not the most effective option.

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 prior to releasing the gas.

Table 8.67 Commonly used pesticide products for **drywood** termites and uses.

a. Example CAUTION-label formulations.

Active ingredient	**Example Products**	**Uses**
deltamethrin	DeltaDust® 432-772	Dampwood, drywood termites.
disodium octaborate tetrahydrate	Tim-Bor 64405-8	Drywood termites.
fipronil	Termidor® SC 7969-210	Drywood termites.
glycol borate solution	Bora-Care™ 64405-1	Drywood termites.
imidacloprid	Premise® 2 432-1331	Dampwood and drywood termites.
thiamethoxam	Optiguard ZT 100-1170	Drywood termites.

c. Additional example formulations with WARNING or DANGER signal word reflecting greater potential for acute toxicity.

Active ingredient	Example Products	Uses
cypermethrin	Demon® TC 100-1006	Dampwood, drywood termites.
sulfuryl fluoride	Vikane® 62719-4 Zythor® 81824-1	Fumigant for drywood termites.

Table 8.68 Priorities for termite management.

Research
Efficacy of boric acid pretreatments.

Extension
Best practices for new buildings, especially for LEED-certified buildings during preconstruction and post construction.

Additional resources for termite management

Scheffrahn, R.H., and N. Su. 1997. Drywood Termite Control: Weighing All the Options. University of Florida.

University of California. Termites. In *How to Management Pests of Homes, Structures, People and Pets*. www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7415.html

University of Florida. Termites and Other Wood-destroying Insects. http://edis.ifas.ufl.edu/topic_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 8.69 Common disease-vector ticks occurring in North America from Tick Management Handbook (Revised Edition). 2007. Kirby Stafford, Connecticut Agricultural Experiment Station.
www.ct.gov/caes/lib/caes/documents/publications/bulletins/b1010.pdf

Common and species name	**Geographic distribution**	**Diseases vectored**
Blacklegged tick (*Ixodes scapularis*)	Northeastern, southeastern and midwestern US.	Lyme Disease, Babesiosis, Anaplasmosis
Western blacklegged tick (*Ixodes pacificus*)	Pacific coast & parts of southwestern US (NV, AZ, UT).	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 parts of west coast US.	Rocky Mountain spotted fever, tick paralysis, tularemia
Rocky Mountain wood tick (*Dermacentor andersoni*)	Rocky Mountain states south to NM & AZ.	Rocky Mountain spotted fever, Colorado tick fever, tick paralysis
Winter tick (*Dermacentor albipictus)*	Canada, US south to Central America	Anemia in animal, occasionally feed on humans
Pacific coast tick (*Dermacentor occidentalis)*	CA, OR, northern Baja peninsula	Rocky Mountain spotted fever, tularemia
Brown dog tick (*Rhipicephalus sanguineus)*	All US and worldwide	Rocky Mountain spotted fever
Relapsing fever ticks (*Ornithodoros* species)	Western US.	Tick-borne relapsing fever
A bat tick (*Carios kelleyi)*	Northeast US (PA, NY, & CT)	Occasionally bite humans

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.

A researcher collecting ticks in the field using the tick dragging method. Tick drag is pulled slowly through vegetation. Ticks attach to fabric, which is checked periodically for ID and counting. Photo from US EPA.

A “tick flag” is easier to use on vegetation. Flagging low-level vegetation (i.e. moving the light colored cloth in a waving motion over and through vegetation) in densely brushy ground is another method to monitor ticks. Ticks that are questing for passing hosts cling to the cloth and can be removed for ID and counting.

Tick flag is wiped slowly across and around vegetation. Ticks attach to fabric, which is checked periodically for ID and counting. Photo from CDC.

Dry-ice trap is another method to efficiently collect ticks. This method is to use carbon dioxide vaporizing from the dry ice to attract ticks onto a light colored cloth panel on which they are easily visible and can be removed regularly. The traps need to be kept in the field for several hours (preferably overnight) for best results.

A simple dry ice trap for ticks. Photo from CDC.

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 8.70 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 the 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.

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 a synergist provide limited tick control. Pyrethrins plus a synergist with insecticidal soap or silicon dioxide has been found to be more effective against ticks in one trial.

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. In 2013, it was the 6th most common Nationally Notifiable disease. Rocky Mountain spotted fever is the most lethal and most frequently reported rickettsial illness in the United States. The incidence of RMSF (the number of RMSF cases for every million persons) has increased during the last decade, from less than 2 cases per million persons in 2000 to over 6 cases per million in 2010.

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. Please read the label carefully. Research and surveillance is needed to improve understanding of tick ecology and epidemiology of tick-borne diseases.

Table 8.71 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
Johnson, G. 2010. *Ticks of Veterinary and Public Health Importance in Montana*. Montana State University Extension.

Pennsylvania IPM Program. 2004. *IPM for Pennsylvania Schools: a How-to Manual*.

Stafford, K. (Revised Edition) 2007. *Tick Management Handbook*. Connecticut Agricultural Experiment Station.
www.ct.gov/caes/lib/caes/documents/publications/bulletins/b1010.pdf

US Centers for Disease Control. Learn about Lyme Disease. http://www.cdc.gov/lyme/

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. http://www.cdc.gov/ehrlichiosis/

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. http://www.cdc.gov/ticks/diseases/

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 many of 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 solely depend on chemical inputs (fertilizer, herbicides, fungicides and insecticides), but should employ a variety of non-chemical/cultural prevention-based techniques. Success requires active working relationships between the IPM coordinator, school administrators and those responsible for turfgrass care.

The IPM approach must address site-specific conditions and the intended function of a given turfgrass area, e.g., high profile lawns vs. less visible lawns vs. practice fields vs. competition fields. These 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 approaches (NOFA 2007, 2008) based on cultural methods and with some use of natural products have been successfully implemented on lawns in the northeast (Grassroots Environmental Education 2007, Rossi 2005), including school lawns and athletic fields in a limited number of locations. Recent legislation in two northeastern states restricts the use of conventional pesticides on school turf. Research and education priorities related to organic approaches are included 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 and 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
    - 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 districts 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:
    - Highest care – varsity and practice athletic fields; high-visibility grounds.
    - Moderate care – multipurpose fields, playground fields, common grounds areas.
    - Lowest care – low use areas, utility areas, slopes, ditches; natural areas; fence lines; property lines.

   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 more resources.

6. **Set action thresholds**. Turfgrass maintenance and school personnel need to set action levels for the most likely potential pests before 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 the 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 species and cultivars; overseeding; topdressing; irrigation management; mowing; and/or fertilizing practices.
    - <u>Physical and mechanical methods</u> – removal of thatch if necessary; aeration; individual removal of pests where appropriate.
    - <u>Biological controls</u> – use of bacteria, fungi, insects, nematodes, or viruses to control turfgrass pests; use of perennial ryegrass and tall fescue cultivars that contain endophytes, or beneficial organisms living within the plant, where appropriate.
    - <u>Pesticide use</u> – if insect, disease or weed problems meet or exceed the predetermined action threshold values and reasonable nonchemical methods are not effective, application of pesticides may be considered. Preventive pesticide applications are generally not necessary or effective, and may have adverse impacts on biological control and non-target organisms. Conditions conducive to pests vary from year to year and pest problems cannot always be predicted in advance. Reduced-risk pesticide options should be identified and used if a pesticide application is required. 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 is implemented, turfgrass areas should be evaluated 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. **Recordkeeping**. 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 or longer if required by law. Records should be made accessible to all interested persons.

Table 8.72 Examples of potential pests of turfgrass on school grounds. (note: Pest problems are generally regionally specific).

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')
- cranefly 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
- downy mildew
- microdochium patch

- leaf spot and melting out
- necrotic ringspot
- nematodes
- Pythium blight or root rot
- red thread
- rust
- slime molds
- snow molds – pink, gray
- southern blight
- spring dead spot
- stripe smut
- summer patch
- take-all patch
- yellow patch

Weeds

- algae and mosses
- 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
- 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

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

- birds
- ground squirrels
- moles
- raccoons
- skunks
- voles

Cultural and physical options for turfgrass management

Cultural management is critical to maintaining healthy, pest-resistant turfgrass in all climates.

- 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 appropriate for your region and turf species/cultivars, e.g., for temperate regions, typical optimum pH for turf is between 6.5 and 7.0. Conduct a soil test prior to lime applications. Regular lime applications without regard to current soil pH can increase pH above of the 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 by leaving clippings after mowing, or topdressing with compost-amended topsoil or compost. Increasing soil organic matter supports natural nutrient cycling and reduces need for supplemental fertilizer applications. Compost has also been shown to suppress some turf diseases in multiple studies (Nelson 1997, Ohio State University 2002, Rossi 2005, Stutz *et al.* 2003).
- Maintain adequate nitrogen, phosphorus and potassium levels in the soil. Fertilize as per local Extension guidelines and soil test results. Immediately after application, remove any fertilizer inadvertently landing on impervious surfaces, e.g., walkways, driveways, parking lots, to reduce potential for runoff into storm sewers and surface water. Applying fertilizer only when turf is actively growing can also reduce nutrient runoff. Multiple fertilizer applications at lower rates may be preferable to single, high-rate applications which are also prone to runoff. Apply slow-release formulations on slopped areas, in sandy soils or near sensitive sites.
- 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.
- 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 turf at the height recommended for your turf species and use. Check local Extension recommendations. Mowing at a higher cut maximizes photosynthesis, can shade out weeds and reduce watering needs but may also increase disease pressure due to slower drying. In temperate regions, lower mowing heights may be appropriate for the first cut of the season to remove dead or diseased material. Increasing height to 3-4” gradually may help to suppress weed growth in spring and increase summer drought resistance. The final cut in the fall can be lowered, e.g., to 2”, just prior to

overseeding to improve germination.

- If irrigated, water thoroughly and deeply with each irrigation to encourage deep rooting. Do not water late in the day or at night to avoid leaving turf blades wet for a prolonged period, which encourages diseases.
- Aerate turf when it is actively growing and can fill in the holes created during aeration. Aeration should be timed when turf is actively growing.
- Overseed with a high-quality seed to introduce 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.
- Manage turf use to avoid excessive stress. Avoid use when overly wet to prevent compaction.

Weeds in all turfgrass species 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 8.73 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,		Compost applied as a topdress, can utilize material that would otherwise occupy landfill space, increase organic matter content, improve soil structure, and provide nutrients and beneficial microorganisms. Seed planted from varieties with resistance to foliage and stem-feeding insects. Concrete barrier placed underneath fencelines or other

		areas to prevent vegetative growth.
endophytic turfgrass varieties	Citation II	Specially designed mowers and mower blades cut and recut turf blades to reduce bulk and increase surface area to speed decomposition.
mow strips		Propane-fed flame kills weeds by heating weeds to boiling point and above. Follow any restrictions on open burning for your location.
mulching mower blade	Cub Cadet Commercial HF174 8 Walk-Behind Mower Exmark Micro-Mulch System	Mechanical weed puller used to remove individual weeds such as dandelions by the roots.
weed burners	Weed Dragon™ Torch Kit	Cuts a slit into the ground and inserts a seed inside. Used for overseeding.
weed removal	Weed Hound®	
slit seeders	Bluebird	

Pesticide options for turf management

Routine or calendar-scheduled, broadcast pesticide applications should not be used to manage turfgrass. Such applications may suppress beneficial organisms in the soil and on turf plants, contribute to runoff into surface water and leaching into groundwater and may not be effective against the problem pest. A comprehensive cultural management program should be developed and implemented to prevent and avoid insect, disease and weed problems. Carefully timed and selected lowest-risk pesticide applications should be limited to affected areas whenever possible and made only after cultural methods fail or are determined to be impractical. .

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.

In addition to ornamentals, fruit and vegetable gardens are increasingly being encouraged for educational purposes. IPM for these plantings is not addressed here.

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.

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 are 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, physical and mechanical 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 priorities listed below.

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

Type	Example Products	Uses

compost		Compost applied as a topdress, can utilize material that would otherwise occupy landfill space, increase organic matter content, improve soil structure, and provide nutrients and beneficial microorganisms.
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 abiotic 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 hazardous 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.

Additional resources for landscape plant management including turfgrass

Abbey, T.A., ed. 2004. *Alternatives for Invasive Ornamental Plant Species*. Connecticut Agricultural Experiment Station. www.ct.gov/caes/lib/caes/documents/special_features/NativeAlternatives.pdf

Anonymous. 1989. *Insects and Diseases of Trees in the South*. USDA Forest Service Protection Report R8-PR16. 98 pp. www.forestpests.org/southern/

Baxendale F. and R. Gaussoin. 1997. *Integrated Turfgrass Management for the Northern Great Plains*. Institute of Agriculture and Natural Resources, University of

Nebraska, Communications & Information Technology, Box 830918, University of Nebraska, Lincoln, NE 68583-0918. 236 pp.

Beard, J. B. and M. P. Kenna (eds). 2008. *Water Quality and Quantity Issues for Turfgrasses in Urban Landscapes.* Council for Agricultural Science and Technology Special Publication 27. Ames, IA.

Beyond Pesticides. *Read Your "Weeds" – A Simple Guide to Creating a Healthy Lawn.* http://www.beyondpesticides.org/pesticidefreelawns/resources/Read%20Your%20Weeds-Organic%20Lawns.pdf

Bio-Integral Resource Center. IPM for Turfgrass in Schools. www.birc.org/ipmturf.htm

Brandenburg R. and M. Villani. 1995. *Handbook of Turfgrass Insect Pests*. The Entomological Society of America. 140 pp.

Canadian Wildlife Federation. 2008. *Meet the Good Bugs*. On-line on Wild About Gardening. www.wildaboutgardening.org/en/features/section1/goodbugs/about_the_good_bugs.htm

Colorado State Cooperative Extension. Lawns and Grasses. www.coopext.colostate.edu/4dmg/Lawns/lawns.htm

Colorado State University Extension. 2008. Insect Resources. www.ext.colostate.edu/menu_insect.html

Cornell University. IPM for Landscapes, Parks & Golf Courses. www.nysipm.cornell.edu/landscapes/default.asp

Cornell University. Wildlife Management for Turfgrass. Pest Management Guidelines.

Cornell University College of Agricultural and Life Sciences. Soil and Turf Entomology. http://entomology.cals.cornell.edu/extension/soil-and-turf-entomology

Costello, L.R., E.J. Perry, N.P. Matheny, J.M. Henry, and P.M. Geisel. 2003. *Abiotic Disorders of Landscape Plants: A Diagnostic Guide*. University of California, Agriculture and Natural Resources Publication #3420, Oakland, CA. 242 pp.

Cranshaw, W. 2004. *Garden Insects of North America: The Ultimate Guide to Backyard Bugs*. Princeton Press, Princeton, NJ. 656 pp.

Driedstadt, S., J.K. Clark, and M.L. Flint. 2004. *Pests of Landscape Trees and Shrubs: An Integrated Pest Management Guide.* University of California, Agriculture and Natural Resources Publication #3359, Oakland, CA. 501 pp.

Drooz, A.T. 1985. *Insects of Eastern Forests.* US Department of Agriculture, Forest

Service Misc. Publication #1426, Washington, DC. 608 pp.

Farrell-Poe, K., R. Koenig, B. Miller and J. Barnhill. 1997. *Using Compost in Utah Turf Applications*. Utah State University Cooperative Extension. 3 pp. http://extension.usu.edu/files/publications/factsheet/HG_Compost_03.pdf

Grassroots Environmental Education. 2007. *Natural Turf Pro.* Two DVD set plus resource guide. Port Washington, NY.

Hanson, T., and E.B. Walker. Undated. *Field guide to common insect pests of urban trees in the Northeast*. Vermont Department of Forests, Parks and Recreation, Waterbury, VT www.forestpests.org/vermont/

Hartman, J.R., T.P. Pirone, and M.A. Sall. 2000. *Pirone's Tree Maintenance.* Oxford University Press, Oxford, UK. 545 pp.

Hochmuth, G., R. Neill, J. Sartain, J.B. Unruh, C. Martin, L. Trenholm and J. Cisar. 2011. *Urban Water Quality and Fertilizer Ordinances: Avoiding Unintended Consequences: A Review of the Scientific Literature*. 2nd edition. http://edis.ifas.ufl.edu/ss496

Iowa State University. Turfgrass Central. www.hort.iastate.edu/turfgrass/

Iowa State University Entomology Department. 2004-2005. School Athletic Field IPM Pilot Project.

Iowa State University Entomology Department. 2004-2005. School Landscape IPM Pilot Project. www.ipm.iastate.edu/ipm/schoolipm/landscape

Iowa State University Entomology Department. Iowa Insect Information Notes. www.ipm.iastate.edu/ipm/iiin/taxonomy_menu/3/14

Iowa State University Extension. Horticulture & Home Pest News. www.ipm.iastate.edu/ipm/hortnews/

IPM Institute of North America. Turf Cultural Management. www.ipminstitute.org/school_grounds_turf.htm

Johnson, W.T., and H.H. Lyon. 1991. *Insects that Feed on Trees and Shrubs: An Illustrated Practical Guide*. Cornell University Press, Ithaca, NY. 560 pp.

Krischik, V. and J. Davidson. 2004. *IPM (Integrated Pest Management) of Midwest Landscapes*. Minnesota Agricultural Experiment Station, Project of NCR 193, North Central Committee on Landscape IPM. SB-07645. 316 pp. On-line: http://cues.cfans.umn.edu/old/ipmbook.htm

Landscape Management Magazine. Pest Control articles.

Lloyd, J. 1997. *Plant Health Care for Woody Ornamentals.* University of Illinois Board of Trustees and the International.

Malinoski, M.K., J.H. Traunfeld, and D.L. Clement. 1996*. IPM: A Common Sense Approach to Managing Landscape Problems*. University of Maryland. Taken from Home and Garden Mimeo #HG62(8/96). http://extension.umd.edu/learn/ipm-common-sense-approach-managing-problems-your-landscape-hg62.

McCullough, D.G., S.A. Katovich, M.E. Ostry, and J. Cummings-Carlson. 1998. *Christmas Tree Pest Manual.* US Department of Agriculture Forest Service and Michigan State University, Extension Bulletin E-2676, East Lansing, MI. 143 pp.

Michigan State University. Turfgrass Science. www.turf.msu.edu/

Mussey, G.J., D.A. Potter, and M.F. Potter. 1997. *Timing Control Actions for Landscape Insect Pests Using Flowering Plants as Indicators*. University of Kentucky Cooperative Extension Service.
www.ca.uky.edu/entomology/entfacts/entfactpdf/ent66.pdf

National Turfgrass Evaluation Program. www.ntep.org/contents2.shtml

Nelson, E.B., 1997. Biological control of turfgrass diseases. *Golf Course Management.* http://www.sustane.com/pdf/Research/TurfDis2.pdf

Nett, M. T., Carroll, M. J., Horgan, B. P., and Petrovic, A. M. (eds). 2008. *The Fate of Nutrients and Pesticides in the Urban Environment*. American Chemical Society, Volume 997. Washington, D.C.

Niemczyk, H.D., and D.J. Shetlar. 2000. *Destructive Turf Insects.* HDN Books, Wooster, OH. 148 pp.

NOFA Organic Land Care Program. 2007. *The NOFA Organic Lawn and Turf Handbook*. Northeast Organic Farming Association, Stevenson, CT. 104 pp.

NOFA Organic Land Care Program. 2008. *Practices for Design and Maintenance of Ecological Landscapes.* Fourth edition. Northeast Organic Farming Association, Stevenson, CT. 87 pp.

Ohio State University. Bug Doc Fact Sheets.
www.bugs.osu.edu/%7Ebugdoc/Shetlar/factsheet/index.htm

Ohio State University Extension. 2003. *Insect and Mite Control on Woody Ornamentals and Herbaceous Perennials*. Bulletin 504.
www.ohioline.osu.edu/b504/index.html

Ohio State University. 2002. *Session Abstracts: Disease Suppression*. International Symposium Composting and Compost Utilization. http://www.oardc.ohio-state.edu/michel/diseasesuppression.htm

Ohio State University Extension. 1996. *Disease Control in the Landscape*. Bulletin 614. www.ohioline.osu.edu/b614/index.html

Ohio State University Extension. Undated. *Controlling Weeds in Nursery and Landscape Plantings*. Bulletin 867-99. www.ohioline.osu.edu/b867/index.html

Ohio State University Extension. Buckeye Yard and Garden Online Newsletter. http://bygl.osu.edu/

Olkowski, W., S. Daar, and H. Olkowski. 1991. *Common-Sense Pest Control.* The Taunton Press, Newton, CT. 715 pp.

Orton, D.A., and T.L. Green. Undated. *Coincide: The Orton System of Pest Management.* Plantsmen's Publications, Flossmoor, IL. 189 pp.

Pennsylvania State University. 2000. *Seven Common Diseases of Landscape Trees*.

Pennsylvania State University Cooperative Extension. Landscape Insect Identification. http://woodypests.cas.psu.edu/Services/BugID.html

Petrovic, A.M., J. Gruttadaurio, J. Barlow, E.Z. Harrison, J. Bonhotal, M. Schwartz, and D.J. Soldat. 2008. Influence of site conditions on soil responses to manure-based compost applications on athletic fields. *Acta Horticulturae* 783:415-424.

Petrovic, A.M., J. Gruttadaurio, J. Barlow, E.Z. Harrison, J. Bonhotal, M. Schwarz and D.J. Soldat. 2008. Turfgrass response to manure-based compost applications on athletic fields bases on site factors. *Acta Horculturae* 783:425-436.

Potter, D.A. 1998. *Destructive Turfgrass Insects: Biology, Diagnosis, and Control.* Sleeping Bear Press/Ann Arbor Press, Inc., Chelsea, MI. 344 pp.

Purdue University. Landscape Entomology Laboratory. www.entm.purdue.edu/Entomology/research/cs/

Purdue University. Plant & Pest Diagnostic Laboratory. www.ppdl.purdue.edu/ppdl/

Purdue University Extension. On-line educational materials. www.ces.purdue.edu/extmedia/menu.htm

Riffle, J.W., and G.W. Peterson. 1986. *Diseases of Trees in the Great Plains.* US

Department of Agriculture, Forest Service General Technical Report RM-129, FT. Collins, CO. 149 pp.

Rossi, F. 2005. *Lawn Care Without Pesticides.* Cornell Cooperative Extension. 20 pp. http://ecommons.library.cornell.edu/handle/1813/3574

Schultz , W., and S. Buchanan. 1999. *Natural Insect Control: The Ecological Gardener's Guide to Foiling Pests.* Brooklyn Botanic Garden, Brooklyn, NY. 112 pp.

Schumann, G.L., P.J. Vittum, M.L. Elliott, and P.P. Cobb. 1998. *IPM Handbook for Golf Courses.* Sleeping Bear Press/ Ann Arbor Press, Inc., Chelsea, MI. 264 pp.

Sinclair, W.A., H.H. Lyon, and H. Lyon. 2005. *Diseases of Trees and Shrubs.* Cornell University Press, Ithaca, NY. 660 pp.

Solomon, J.D. 1995. *Guide to Insect Borers in North American Broadleaf Trees and Shrubs.* US Department of Agriculture, Forest Service Agricultural Handbook #706, Washington, DC. 735 pp.

Texas A&M University. Insects in the City. http://citybugs.tamu.edu/factsheets/

University of Arizona. 1998. *Arizona Master Gardener Manual: Pests of Landscape Plants*. Ch.3, pp. 24-28. www.ag.arizona.edu/pubs/garden/mg/entomology/landscape.html#landscape

University of California. 2007. *How to Manage Pests in Gardens and Landscapes: Landscape Plants*. www.ipm.ucdavis.edu/PMG/GARDEN/plantmenu.html

University of California Statewide IPM Program. Pest Management Guidelines - Turfgrass. www.ipm.ucdavis.edu/PMG/selectnewpest.turfgrass.html

University of Connecticut Turfgrass Disease & Diagnostic Center. www.turf.uconn.edu/diagnosticcenter.shtml

University of Florida IFAS Extension. Home Landscape Pests. http://edis.ifas.ufl.edu/topic_home_landscape_pests

University of Florida IFAS Extension. Turfgrass Disease Management. http://edis.ifas.ufl.edu/lh040

University of Illinois Turfgrass Program. www.turf.uiuc.edu/

University of Kentucky College of Agriculture. Kentucky Pest News. www.uky.edu/Ag/kpn/kpnhome.htm

University of Kentucky Cooperative Extension Service. Chemical Control of Turfgrass

Diseases 2008. www.ca.uky.edu/agc/pubs/ppa/ppa1/ppa1.pdf

University of Massachusetts Extension. Insect and Mite Fact Sheets. www.umassgreeninfo.org/fact_sheets/insectsandmites_alph.htm

University of Nebraska. Key to Common Turfgrass Insect Pests.

University of Nebraska. Recommended Turfgrass Cultivars- 2007.

University of Wisconsin. Gardening and IPM. http://hort.uwex.edu/topics/other/pests/

Yepsen, Jr., R.B., ed. 1984. *The Encyclopedia of Natural Insect & Disease Control.* Rodale Press, Emmaus, PA. 490 pp.

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.

The hazards identified in the table include information from product labels, MSDS documents and recognized authorities.

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)

			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																						
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 the 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 honey bee mud daubers paper wasps potter wasps yellowjackets		none identified
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	*Beauveria bassiana*

	pathogen pathogen pathogen	*Metarhizium anispoliae* *Steinernema carpocapsae* *Verticilium 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 millipedes mites bird clover chiggers rodent scabies pillbugs scorpions springtails		none identified
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 rice weevil	predator	*Xylocoris flavipes*
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 pathogen	*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) 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	*Heterorhabditis bacteriophora* *Heterorhabditis indica*

	parasite	*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 parasite predator pathogen parasite	*Bacillus thuringiensis var. kustaki* *Beauveria bassiana* *Cotesia marginiventris* *Cotesia plutella* *Geocoris punctipes* *Geocoris uliginosus* *Heterorhabditis bacteriophora* *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	*Beauveria bassiana*

	parasite	*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	*Aphytis mytilaspidis*

	predator	*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 pathogen	*Beauveria bassiana* *Heterorhabditis bacteriophora* *Larra bicolor* *Metarhizium anisopliae* *Steinernema carpocapsae* *Steinernema feltiae* *Steinernema riobrave* *Steinernema scapterisci*

References for additional information on biological controls:

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

FPO. AN EXPANDED TABLE IS CURRENTLY BEING UPDATED. The following courtesy of Gene Harrington, manager, government affairs, National Pest Management Association. More detailed information is maintained by Beyond Pesticides, see www.beyondpesticides.org/schools/schoolpolicies/index.htm.

State School Pest Management Requirements as of October 1, 2009

	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	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(v)		X
Oklahoma						
Oregon	X	X	X	X	X	X
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)		X
Virginia				X(v)		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. School IPM Report Card

Developed with input from a number of PMSP meeting participants and others, this survey was first circulated in 2008. It is intended to be completed by key professional(s) in each state periodically to document annual performance measures for progress in school IPM implementation. The survey was revised and recirculated by the IPM Institute of North America in 2012.

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,

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	□	train-the-trainer manual
□□	posters	□	training curricula for school staff/contractors
□□	videos	□	model news releases
□□	IPM curricula for students	□	newsletters (e.g., Pest Presses)
□□	IPM lesson plans for students	□	model IPM policy
□□	school IPM manual	□	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: Mariel Snyder, Project Coordinator, Steering Committee, National School IPM Working Group, IPM Institute of North America, 1020 Regent St., Madison WI 53715. schoolipm@ipminstitute.org**.**

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)
- *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 http://mda.maryland.gov/plants-pests/Documents/ipmacthr.pdf

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 – pesticides derived from natural materials such as animals, plants, bacteria and certain minerals.

bioremediation – removal of contaminants, e.g., grease, organic matter, using microorganisms or their biproducts. Commonly used for drains, walls, floors in food service areas.

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 of 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.

endophyte – An organism, usually a bacterium or fungus, that spends at least part of its life cycle within a plant without harming the plant. For example, endophytes include organisms that protect turfgrass plants against insect pests.

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 pesticide vaporized to kill pests. Used in buildings, greenhouses, soil.

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)

IPM Committee – a group designated to address 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 – a 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 member 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 including 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.

swarm – Insects in a group that have left their original colony to form a new one. These individuals, called swarmers, typically represent only a portion of the original colony.

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; also refers to 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. 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).

Alarcon, W.A., G.M. Calvert, J.M. Blondell, L.N. Mehler, J. Sievert, M. Propeck, D.S. Tibbetts, A. Becker, M. Lackovic, S.B. Soileau, R. Das, J. Beckman, D.P. Male, C.L. Thomsen and M. Stanbury. 2005. Acute illnesses associated with pesticide exposure at schools. *J. of the American Medical Association.* 294 (4):455-65.

American Academy of Pediatrics. 2012. *Pesticide Exposure in Children.* American Acedmy of Pediatrics 130(6):1757-1763. http://pediatrics.aappublications.org/content/130/6/e1757.full.html

American Lung Association. 2010. Trends in Asthma Morbidity and Mortality. Epidemiology and Statistics Unit, Research and Program Services, American Lung Association. 43 pp. http://www.lungusa.org/finding-cures/our-research/trend-reports/asthma-trend-report.pdf

Hurley, J., Green, T., Gouge, D., Bruns, Z., Stock, T., Braband, L., Murray, K., Westinghouse, C., Ratcliffe, s., Pehlman, D. and L. Crane. 2013. Regulating Pesticide Use in United States Schools. *Amer. Entomol.* 60(2):105-114.

Arbes Jr., S.J., M. Sever, J. Mehta, J.C. Gore, C. Schal, B. Vaughn, H. Mitchell and D.C. Zeldin. 2004. Abatement of cockroach allergens (Bla g 1 and Bla g 2) in low-income urban housing. Month 12 continuation results. *J. Allergy and Clinical Immunology* 113:109-114. www4.ncsu.edu/~coby/schal/2004Arbes12Months.pdf

Arbes Jr., S.J., M. Sever, J. Archer, E.H. Long, J.C. Gore, C. Schal, M. Walter, B. Nuebler, B. Vaughn, H. Mitchell, E. Liu, N. Collette, P. Adler and D.C. Zeldin. 2003. Abatement of cockroach allergen (Bla g 1) in low-income, urban housing: A randomized controlled trial. *J. Allergy and Clinical Immunology* 112:339-345. www4.ncsu.edu/~coby/schal/2003ArbesJACINIEHS.pdf

Arruda, L.K., L.D. Vailes, V.P. Ferriani, A.B. Santos, A. Pomes and M.D. Chapman. 2001. Cockroach allergens and asthma. *J. Allergy and Clinical Immunology* 107:419-428.

Balling, S. 1994. The IPM Continuum. In *Constraints to the Adoption of Integrated Pest Management: Regional Producers Workshops*. National Foundation for IPM Education. 60 pp.

Barnes, C. and S. Sutherland. 2005. *2004 Integrated Pest Management Survey of California School Districts*. Institute for Social Research, California State University, Sacramento, CA.

Baumgartner, D. 2004. Challenges to development and implementation of school IPM. In *Proceedings, Midwest School IPM Conference*. Iowa State University. www.ipm.iastate.edu/ipm/schoolipm/conference

Baumgartner, D. 2004. IPM in schools: federal funding. In *Proceedings, Midwest School IPM Conference*. Iowa State University. www.ipm.iastate.edu/ipm/schoolipm/conference

Bearer, C.F. 2000. The special and unique vulnerability of children to environmental hazards. *Neurotoxicology* 21:925 – 934.

Becker, B., E. Bergman, N. Zuelsdorff, K. Fenster, B. Swingle and J. Larson. 1998. *Final Report on Pesticide Use in Wisconsin Schools*. Publication # AR-0263. Wisconsin Department of Agriculture, Trade and Consumer Protection, Madison, WI.

Belanger, E., C. Kielb and S. Lin. 2006. Asthma hospitalization rates among children, and school building conditions, by New York State school districts, 1991-2001. *J. School Health* 76(6):408-413.

Benbrook, C.M., E. Groth, J.M. Halloran, M.K. Hansen and S. Marquardt. 1996. *Pest Management at the Crossroads.* Consumer's Union, Yonkers, NY.

Beyond Pesticides. 2003. *Health Effects of 48 Commonly Used Toxic Pesticides in Schools.* Washington D.C. 3 pp. www.beyondpesticides.org/schools/publications/48%20School%20Pesticides.pdf

Beyond Pesticides. 2005. *Asthma, Children and Pesticides: What You Should Know to Protect Your Family.* Washington D.C. 10 pp.

Beyond Pesticides. 2007. *State and Local School Pesticide Policies.* www.beyondpesticides.org/schools/schoolpolicies/index.htm

Beyond Pesticides and School Pesticide Reform Coalition. 2003. *Safer Schools: Achieving a Healthy Learning Environment through Integrated Pest Management.* Beyond Pesticides, Washington D.C. 60 pp. www.beyondpesticides.org/schools/publications/IPMSuccessStories.pdf

Bienvenida, S., and E. Jenkins. 2001. *Creating Sustainable Community-Based IPM Groups:The Michigan Model*. Michigan State University Extension, East Lansing, MI. http://ipminstitute.org/pdf/CommunityBasedIPM-MiModel.pdf

Boise, P. 2003. Reduced Risk Zone Management Model for School and Park Landscape Managers. US EPA Pesticide Environmental Stewardship Program.

Lapeere, H., L. Brochez, R.H. Vander Stichele, J. Remon, J. Lambert and L. Leybaert. 2014. Efficacy of Products to Remove Eggs of Pediculus humanus capitis (Phthiraptera: Pediculidae) From the Human Hair. J. Med. Ent. February 2014 DOI: 10.1603/ME13106

Boise, P., E.R.A.N. Smith, and J. Carey. 2004. *GreenCare for Children. Measuring Environmental Hazards in the Childcare Industry: Pesticides, Lead, and Indoor Air Quality*. Community Environmental Council, Santa Barbara, CA.

Bouchard, M.F., D.C. Bellinger, R.O. Wright and M. G. Weisskopf. 2010. Attention-deficit/hyperactivity disorder and urinary metabolites of organophosphate pesticides. *Pediatrics.* 125(6):1270-1277. http://pediatrics.aappublications.org/content/early/2010/05/17/peds.2009-3058.full.pdf+html

Brent, R.L., and M. Weitzman. 2004. The current state of knowledge about the effects, risks, and science of children's environmental exposure. *Pediatrics.* 113:1158-1166.

Brodkin, J. 2005. Pest Control: State says half of all schools do not comply. *MetroWest Daily News*. Herald Media Inc., Boston, MA.

Bush, A., and P. Clary. 2004. *Are Schools Flunking Out? Mid-Term Report Card on Chemical Pest Management.* Californians for Alternatives to Toxics. Three-year study reports level of compliance of 305 public schools in 89 California school districts with the Healthy Schools Act. 25 pp. www.alternatives2toxics.org/pdfs/schoolsrpt-web.pdf

Burns, M. 2004. Responding to public outcry. In *Proceedings, Midwest School IPM Conference*. University of Iowa. www.ipm.iastate.edu/ipm/schoolipm/conference

California Environmental Protection Agency. 2015. *Chemicals Known to the State to Cause Cancer or Reproductive Toxicity.* Office of Environmental Hazard Asessment. 23 pp. http://www.oehha.ca.gov/prop65/prop65_list/files/P65single061915.pdf

Calvert, G.M., W.A. Alarcon, A. Chelminski, M.S. Crowley, R. Barrett, A. Correa, S. Higgins, H.L. Leon, J. Correia, A. Becker, R.H. Allen and E. Evans. 2007. Case report: Three farmworkers who gave birth to infants with birth defects closely grouped in time and place - Florida and North Carolina 2004-2005. 26 pp. *Environmental Health Perspectives.* 115(5):7897-791. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1867963/pdf/ehp0115-000787.pdf

Carter, J. 2003. *Extension of a Successful IPM Model to Pilot School Districts in States Not Currently Practicing IPM in Public Schools - Final Report*. Monroe County Community Schools Corporation, Bloomington, IN.

Centers for Disease Control and Prevention. 2013. *Asthma Facts, CDC's National Asthma Control Program Grantees.* http://www.cdc.gov/asthma/pdfs/asthma_facts_program_grantees.pdf

Centers for Disease Control and Prevention. 2013. *Summary Health Statistics for U.S. Children: National Health Interview Survey, 2012*. 10pp. http://www.cdc.gov/nchs/data/series/sr_10/sr10_258.pdf

Centers for Disease Control and Prevention. 2006. Addressing asthma within a coordinated school health program. National Center for Chronic Disease Prevention and Health Promotion, Atlanta, GA.

Centers for Disease Control and Prevention. 2010. Strategies for addressing asthma within a coordinate school health program. CDC, Atlanta, GA.

Centers for Disease Control and Prevention. 2012. National health interview survey data. CDC, Atlanta, GA. http://www.cdc.gov/nchs/fastats/asthma.htm

Chambers, K., T. Green, D. Gouge, J. Hurley, T. Stock, Z. Bruns, M. Shour, C. Foss, F. Graham, K. Murray, L. Braband, S. Glick and M. Anderson. 2011. *The Business Case for Integrated Pest Management in Schools: Cutting Costs and Increasing Benefits*. 8 pp. http://www.ipminstitute.org/school_ipm_2015/ipm_business_case_print_version.pdf

Child Proofing our Communities: Poisoned School Campaign. 2001. *Poisoned Schools: Invisible Threats, Visible Actions.* Center for Health, Environment and Justice, Falls Church, VA. 79 pp. www.beyondpesticides.org/schools/publications/Poisoned_Schools.pdf

Ciborowski, J. 2004. School integrated pest management resources. In *Proceedings, Midwest School IPM Conference*.. University of Iowa. www.ipm.iastate.edu/ipm/schoolipm/conference

Cohen Hubal, E.A., P.P. Egeghy, K.W. Leovic and G.G. Akland. 2006. Measuring potential dermal transfer of a pesticide to children in a child care center. *Environ Health Perspect*. 114(2):264-9.

Collaborative for High Performance Schools. 2006. High Performance Schools Best Practices Manual. Volumes I-VI. www.chps.net/dev/Drupal/node/288

Colt, J.S., S.H. Zahm, D.E. Camann and P. Hartge. 1998. Comparison of pesticides and other compounds in carpet dust samples collected from used vacuum cleaner bags and from a high-volume surface sampler. *Environ Health Perspect.*106 (11):721-4.

Corbel, V., M. Stankiewicz , C. Pennetier, D. Fournier, J. Stojan, E. Girard, M. Dimitrov, J. Molgo, J. M. Hougard and Bruno Lapied. 2009. Evidence for inhibition of cholinesterases in insect and mammalian nervous systems by the insect repellent deet. *BMC Biology* 7:47. www.biomedcentral.com/1741-7007/7/47/abstract

Corrigan, B.M. Undated. *Recommendations for Selecting and Using Caulks and*

Sealants in Pest Management Operations. 2 pp. www.entm.purdue.edu/entomology/outreach/schoolipm/pdfs/EXC.pdf

Corrigan, B. 2000. Rodent IPM in schools. *Pest Control Technology On-Line*. www.pctonline.com/Article.aspx?article_id=39587

Corrigan, B. 2001. IPM for child-care facilities. *Pest Control Technology On-Line*. www.pctonline.com/Article.aspx?article_id=39366

Corrigan, R. 2004. "Hands-on" IPM considerations for the common pests of schools. In *Proceedings, Midwest School IPM Conference*. University of Iowa. www.ipm.iastate.edu/ipm/schoolipm/conference

Corrigan, R.M. 2001. *Rodent Control: A Practical Guide for Pest Management Professionals.* GIE Media, Richfield, OH. 351 pp.

Council for Agricultural and Science and Technology (CAST). 2003. *Integrated pest management: current and future strategies.* Task Force Report no. 140. CAST, Ames, IA.

Curl, C., R.A. Fenske and K. Elgethun. 2003. Organophosphorus pesticide exposure of urban and suburban preschool children with organic and conventional diets. *Environ Health Perspect*. 111(3):377-82.

Daar, S., T. Drlik, H. Olkowski and W. Olkowski. 1997. *Integrated Pest Management for Schools: A How-To Manual*. Bio-Integral Resource Center, Berkeley, CA. 215 pp. www.birc.org/schoolmanual.htm

Eskenazi, B., A. Bradman and R. Castorina. 1999. Exposures of children to organophosphate pesticides and their potential adverse health effects. *Environ. Health Perspectives* 107 (Suppl. 3):409-19.

Eskenazi, B., A.R. Marks, A. Bradman, L. Fenster, C. Johnson, D.B. Barr and N.P. Jewell. 2006. In Utero Exposure to Dichlorodiphenyltrichloroethane (DDT) and Dichlorodiphenyldichloroethylene (DDE) and Neurodevelopment Among Young Mexican American Children. *Pediatrics* 118: 233-41.

eXtension 2010. *What is the IPM Continuum?* www.extension.org/faq/39701

Faustman E.M., S.M. Silbernagel, R.A. Fenske, T.M. Burbacher, and R.A. Ponce. 2000. Mechanisms underlying children's susceptibility to environmental toxicants. *Environ Health Perspect.* 108(Suppl 1):13 –21.

Flower, K.B., J.A. Hoppin, C.F. Lynch, A. Blair, C. Knott, D.L. Shore and D.P. Sandler. 2004. Cancer Risk and Parental Pesticide Application in Children of Agricultural Health Study Participants. *Environ. Health Perspectives.* 112 (5): 631-635.

Fournier, A., T.J. Gibb and C.Y. Oseto. 2010. *Go to the Head of the Class: A Research-based Approach to Understanding Adoption and Implementation of Integrated Pest Management in Schools.* Purdue IPM Technical Resource Center, Purdue University. West Lafayette, IN.

Fournier, A. 2005. *Factors Affecting Adoption and Implementation of Integrated Pest Management (IPM) in Indiana K-12 Public Schools*. Ph.D. Dissertation. Purdue University, West Lafayette, IN. 607 pp.

Fournier, A. 2004. Key contributors to a successful IPM program (presentation). In *Proceedings, Midwest School IPM Conference*. University of Iowa. www.ipm.iastate.edu/ipm/schoolipm/conference

Fournier, A. 2004. IPM in childcare: challenges and opportunities. *Pest Control Magazine.* July, pp. 25-32.

Fournier, A., F. Whitford, T.J. Gibb and C.Y. Oseto. 2003. Protecting US schoolchildren from pests and pesticides. *Pesticide Outlook* 14 (1): 36-40

Gilliam, XX

Gooch, H. 2004. School IPM's vicious cycle. *Pest Control Magazine.* July, p 5.

Goldman, L. R. 1995. Children – unique and vulnerable: environmental risks facing children and recommendations for response. *Environ. Health Perspectives* 103 (Suppl. 6): 13-18.

Gore, J.C., and C. Schal. 2004. Laboratory evaluation of boric acid-sugar solutions as baits for management of German cockroach infestations. *J. Economic Entomology* 97:581-587. www4.ncsu.edu/~coby/schal/2004GoreJEEborates.pdf

Gore, J.C. and C. Schal. 2007. Cockroach biology and mitigation in the Indoor Environment. *Annu. Rev. Entomol.* 52: 439-463.

Gouge, D., T. Green, K. Chambers, J. Hurley, T. Stock, M. Shour, C. Foss, L. Braband, F. Graham, K. Murray, S. Glick, Z. Bruns and M. Anderson. 2011. *Reducing Your Child's Asthma Using Integrated Pest Management: A Practical Guide for Parents Around the Home*. National School IPM Steering Committee. 4 pp. http://www.ipminstitute.org/school_ipm_2015/IPM_Asthma.pdf

Gouge, D.H., M.L. Lame and J.L. Snyder. 2006. Use of an implementation model and diffusion process for establishing Integrated Pest Management in Arizona Schools. *Amer. Entomol.* 52 (3): 190-196.

Green, T.A., D.H. Gouge, L.A. Braband, C.R. Foss and L.C. Graham. 2007. IPM STAR

Certification for School Systems: Rewarding Pest Management Excellence in Schools and Childcare Facilities. *Amer. Entomol*. 53 (3): 150-157.

Greene, A., and N.L. Breisch. 2002. Measuring integrated pest management programs for public buildings. *J. Econ. Entomol*. 95: 1-13.

Gruchalla, R.S., J. Pongracic, M. Plaut, R. Evans, C.M. Visness, M. Walter, E.F. Crain, M. Kattan, W.J. Morgan, S. Steinbach, J. Stout, G. Malindzak, E. Smartt and H. Mitchell. 2005. Inner City Asthma Study: Relationships among sensitivity, allergen exposure, and asthma morbidity. *J. Allergy Clin. Immunol.* 115: 478-485.

Grün, F., H. Watanabe, Z. Zamanian, L. Maeda, K. Arima, R. Cubacha, D.M Gardiner, J. Kanno, T. Iguchi and B. Blumberg. 2006. Endocrine-Disrupting Organotin Compounds Are Potent Inducers of Adipogenesis in Vertebrates. *Mol Endocrinol*. 20 (9): 2141-2155.

Gurunathan, S., M. Robson, N. Freeman, B. Buckley, A. Roy, R. Meyer, J. Bukowski and P.J. Lioy. 1998. Accumulation of Chlorpyrifos on Residential Surfaces and Toys Accessible to Children. *Environ Health Perspect.* 106(1):9-16.

Harris, M.K. 2001. IPM, what has it delivered? A Texas case history emphasizing cotton, sorghum, and pecan. *Plant Disease* 85: 112-121.

IPM Institute of North America, Inc. 2004. IPM Standards for Schools; Tactics and Resources for Reducing Pest and Pesticide Risks in Schools and Other Sensitive Environments. V3.2. 165 pp. www.ipminstitute.org/pdf/ISS V3.2 073004.pdf

IPM Institute of North America, Inc. 2004. *IPM STAR Program Guide and Evaluation Form for Schools and Childcare Facilities.* 22 pp. http://www.ipminstitute.org/IPM_Star/IPM_Star_Evaluation_for_Schools_V3_091406.pdf

Jacobsen, B.J. 1997. Role of Plant Pathology in Integrated Pest Management. *Annual Review of Phytopathology*. 35: 373-391.

Jenkins, E. 2001. *Exploring Urban Integrated Pest Management: Activities and Resources for Teaching K-6.* Michigan State University Extension, Pesticide Education Program, East Lansing, MI. www.pested.msu.edu/CommunitySchoolIpm/curriculum.htm

Johnson, S.L., and J.E. Bailey. 1999. Food Quality Protection Act of 1996. *In* N.N. Ragsdale and J.N. Seiber (eds.), *Pesticides: Managing Risks and Optimizing Benefits.* American Chemical Society, Washington, D.C. pp. 8-15.

Julien, R., G. Adamkiewicz, J.I. Levy, D. Bennett, M. Nishioka and J.D. Spengler. 2007. Pesticide loadings of select organophosphate and pyrethroid pesticides in urban public housing. *J. Exposure Science and Environmental Epidemiology* 1-8.

Juneau, K., Scherer, C., Baldwin, R. and Koehler, P. July 2009. 10 Years and Counting. Pest Control Technology 68-74.

Kandziora, P. 2004. School IPM as a new work-load responsibility. In *Proceedings, Midwest School IPM Conference*. University of Iowa. www.ipm.iastate.edu/ipm/schoolipm/conference

Kats, G. 2005. *National Review of Green Schools: Costs, Benefits, and Implications for Massachusetts*. A Report for the Massachusetts Technology Collaborative. 72 pp.

Kats, G. 2006. *Greening America's Schools: Costs and Benefits*. A Capital E Report. 24 pp.

Kielb, C., S. Lin and S. Hwang. 2007. Asthma prevalence, management, and education in New York State Elementary Schools: A Survey of School Nurses. *J. School Nursing*. 23(5): 38-45.

Kubista-Hovis, K., and M.L. Lame. 2004. The economics of school integrated pest management: An analysis of the Monroe IPM model in Bloomington, Indiana. *National Schools Update.* US EPA BPPD 1(3): 5-7.

Lambur, M.T., M.E. Whalon and F.A. Fear. 1985. Diffusion Theory and Integrated Pest Management: Illustrations from the Michigan Fruit IPM Program. *Bull. Entomol. Soc. Am.* 31 (2):40-45.

Lame, M.L. 2005. *A Worm in the Teacher's Apple: Protecting America's School Children from Pests and Pesticides*. Authorhouse, Bloomington, IN. 238 pp.

Lame, M. 1999. *The National IPM in Schools Workshop 1999: Efforts for National Coordination and Implementation of IPM in Child Sensitive Facilities.* Indiana University School of Public and Environmental Affairs, Bloomington, IN.

Lame, M., E.J. Andersen, L. Andriyevska, C. Beekman, R. Burns, K. Crowley, J. Fox, D. Henry, T.D. Jackson, D.S. Lanier, M. McDavid, H. Park, N. Patti, M. Quirindongo, J. Riley, B. Roberts, P. Senne, H. Tsukada and D. Weston. 2001. *Draft Agency Initiative and Implementation Plan for Integrated Pest Management in Schools.* Indiana University School of Public and Environmental Affairs, Bloomington, IN.

Lavendel, B. 2001. Taking back the halls. *Audubon*, October, pp. 26-30.

Lieberman, J.M. 2009. North American zoonoses. *Pediatric Annals.* 38(4): 193-8.

Lu, C. 2001. Biological monitoring survey of organophosphorus pesticide exposure among pre-school children in the Seattle metropolitan area. *Environ Health Perspect.*

109(3):299-303.

McKenna, L. 2001. Don't miss the bus. *Pest Control Technology*, July, pp. 22-34. www.pctonline.com/Article.aspx?article_id=39369

Meerburg, B.G., G.R. Singleton and A. Kijlstra. 2009. Rodent-borne diseases and their risks for public health. *Critical Reviews in Microbiology.* 35(3): 221-270.

Merchant, M. 2004. Mandatory vs. voluntary IPM in schools. In *Proceedings, Midwest School IPM Conference*. University of Iowa. www.ipm.iastate.edu/ipm/schoolipm/conference

Merchant, M. 2004. Training schools to do IPM. In *Proceedings, Midwest School IPM Conference*. University of Iowa. www.ipm.iastate.edu/ipm/schoolipm/conference

Miller, S. 2002. *Reading, Writing, and Raid®: Pesticide Use at Vermont Schools.* The Vermont Public Research Interest Group, Montpelier, VT.

Minner, D. 2004. IPM for athletic fields. In *Proceedings, Midwest School IPM Conference*. University of Iowa. www.ipm.iastate.edu/ipm/schoolipm/conference

Nalyanya, G., J.C. Gore, H.M. Linker and C. Schal. 2009. German cockroach allergen levels in North Carolina Schools: Comparison of Integrated Pest Management and conventional cockroach control. *J. Med. Entomol.* 46(3): 420-427.

National Academy of Sciences - National Research Council Committee on Pesticides in the Diets of Infants and Children. 1993. *Pesticides in the Diets of Infants and Children.* National Academy Press, Washington, D.C. www.nap.edu/catalog.php?record_id=2126

National Foundation for IPM Education. 2002. *Proceedings: National IPM in Schools Workshop*. Washington, D.C. www.ipminstitute.org/pdf/IPMIS Proceedings103102.pdf

National Parent Teachers Association. 1992. *Position Statement: The Use of Pesticides in Schools and Child Care Centers*. 1 pp. http://ipminstitute.org/pdf/PTAPositionStatement1992.pdf

National Pest Management Association. 2002. *IPM in Schools: A Practical Guide for Pest Management Professionals.* 61 pp.

National Pest Management Association. 2004. *QualityPro Schools.* http://npmaqualitypro.org/qualitypro-schools/

Nicholas, S.W., B. Jean-Louis, B. Ortiz, M. Northridge, K. Shoemaker, R. Vaughan, M. Rome, G. Canada, V. Hutchinson. 2005. Addressing the childhood asthma crisis in Harlem: the Harlem Children's Zone Asthma Initiative. *Am J Public Health* 95(2):245-9.

Nishioka, M.G., R.G. Lewis, M.C. Brinkman, H.M. Burkholder, C.E. Hines, and J.R. Menkedick. 2001. Distribution of 2,4-D in air and on surfaces inside residences after lawn applications: Comparing exposure estimates from various media for young children. *Environ Health Perspectives* 109: 1185-1191.

Ontario College of Family Physicians. 2007. Public Policy Documents – Environment and Health.
www.ocfp.on.ca/English/OCFP/Communications/Publications/default.asp?s=1 - EnvironmentHealth

Owens, B.B., J. and R. Corrigan. 2003. *Truman's Scientific Guide to Pest Management Operations*. 6th ed. Advanstar Communications, Woodland Hills, CA. 574 pp.

Owens, K. 2009. Schooling of State Pesticide Laws 2010 Update. Pesticides and You. 29(3): 9-20. http://www.beyondpesticides.org/schools/publications/Schooling2010.pdf

Owens, K., and J. Feldman. 1998. The Schooling of State Pesticide Laws: Review of State Pesticide Laws Regarding Schools. *Pesticides and You*. 18(3): 9-23.

Owens, K., and J. Feldman. 2002. *The Schooling of State Pesticide Laws – 2002 Update.* Beyond Pesticides, Washington, D.C. 4 pp.
www.beyondpesticides.org/schools/publications/School_report_update_2002.pdf

Penn State University. 2004. *IPM for Teachers Curriculum*.
paipm.cas.psu.edu/974.htm

Pilcher, C. 2004. Developing a pesticide use survey. In *Proceedings, Midwest School IPM Conference*. University of Iowa.
http://www.ipm.iastate.edu/ipm/schoolipm/conference

Pilcher, C. 2004. Program evaluation: quantifying outcomes. In *Proceedings, Midwest School IPM Conference*. University of Iowa.
www.ipm.iastate.edu/ipm/schoolipm/conference

Piper, C., and K. Owens. 2002. Are schools making the grade? *Pesticides and You* 22 (3): 11-20. Beyond Pesticides, Washington, D.C.
http://www.beyondpesticides.org/schools/publications/SD%20study_2003.pdf

Rajotte, A. 2004. Asthma and pesticides in public schools: Does the ADA provide a remedy where FIFRA fails to protect? *Boston College Environmental Affairs Law Review* 31:149-175.

Rauh, V.A., R. Garfinkel, F.P. Perera, H.F. Andrews, L. Hoepner, D.B. Barr, R. Whitehead, D. Tang and R.W. Whyatt. 2006. Impact of prenatal chlorpyrifos exposure on neurodevelopment in the first three years of life among inner-city children. *Pediatrics*

118 (6): 1845-1859.

Rogers, E.M. 1995. *Diffusion of Innovations*. 4th ed. The Free Press, New York, NY. 512 pp.

Rosenberg, R. 2004. Integrated Pest Management in Chicago Public Schools. In *Proceedings, Midwest School IPM Conference*. University of Iowa. www.ipm.iastate.edu/ipm/schoolipm/conference

Salam, T., Y. Li, B. Langholz and F.D. Gilliland. 2004. Early-life environmental risk factors for asthma: Findings for the Children's Health Study. *Environ. Health Perspectives* 112: 760-765.

Salameh, P.R., I. Baldi, P. Brochard, C. Raherison, B. Abi Saleh and R. Salamon. 2003. Respiratory symptoms in children and exposure to pesticides. *European Respiratory Journal* 22:507-512.

Schuler, K. 2001. *Reducing Pesticides in Minnesota Schools: Pilot Project Final Report.* St. Paul Neighborhood Energy Consortium, St. Paul, MN. 45 pp.

Sheehan, W.J., P.A. Rangsithienchai, M.L. Muilenberg, C.A. Rogers, J.P. Lane, J. Ghaemghami, D.V. Rivard, K. Otsu, E.B. Hoffman, E. Israel, D.R. Gold and W. Phipatanekul. 2009. Mouse allergens in urban elementary schools and homes of children with asthma. *Ann. Allergy Asthma Immunol.* 102(2):125-130.

Shendell, D.G., C. Barnett and S. Boese. 2004. *Science-based recommendations to prevent or reduce potential exposures to biological, chemical, and physical agents in schools.* Healthy Schools Network, Albany, NY. 51 pp. www.healthyschools.org/documents/HPSchlsWhtPpr.pdf

Shour, M. 2004. School Landscape IPM: insect pests. In *Proceedings, Midwest School IPM Conference*. University of Iowa. http://www.ipm.iastate.edu/ipm/schoolipm/conference

Smith, B. 2004. Keys to a great relationship with a pest management professional. In *Proceedings, Midwest School IPM Conference*. University of Iowa. http://www.ipm.iastate.edu/ipm/schoolipm/conference

Soldin, Offie P, Nsouly-Maktabi, Hala, Genkinger, Jeanine M, Loffredo, Christopher A., Ortega-Garcia, Juan Antonio, Colantino, Drew, Barr, Dana B, Luban, Naomi L, Shad, Aziza T., Nelson, David. 2009. Pediatric acute lymphoblastic leukemia and exposure to pesticides. *Therapeutic Drug Monitoring* 31(4): 495-501.

Sorensen, A.A. 1992. Proceedings of the National Integrated Pest Management Forum. American Farmland Trust Center for Agriculture in the Environment, Dekalb, IL. 86 pp.

Sterling, P. and B. Browning. 1999. *Chemicals in Vermont's Classrooms: Pesticides and Maintenance Chemicals in Vermont Schools.* Vermont Public Interest Research Group.

Texas Cooperative Extension Service. 2004. *An Introduction to IPM in Schools: A Manual for Facilities Maintenance Professionals*. Texas A&M University. 71 pp.

Trunelle, K.J., D.H. Bennett, N.S. Tulve, M.S. Clifton, M.D. Davis, A.M. Calafat, R. Moran, D.J. Tancredi, I. Hertiz-Picciotto. 2014. Urinary pyrethroid and chlorpyrifos metabolite concentrations in Northern California families and their relationship to indoor residential insecticide levels, part of the study of use of products and exposure related behavior (SUPERB). *Environ. Sci. Technol.*48(3): 1931-1939.

US Consumer Safety Product Commission. 2006. *School Chemistry Laboratory Safety Guide.* 86 pp. www.cpsc.gov/CPSCPUB/PUBS/NIOSH2007107.pdf

US Department of Agriculture. 2013. *IPM Roadmap*. northeastipm.org/whatis_ipmroadmap.pdf

US Department of Education, National Center for Education Statistics. 2012. *Digest of Education Statistics: 2012*. http://nces.ed.gov/programs/digest/d12/

US Department of Education, National Center for Education Statistics. 2012. *Public Elementary and Secondary School Student Enrollment and Staff Counts from the Common Core of Data: School Year 2010-11* http://nces.ed.gov/pubs2012/2012327.pdf

US Department of Education, National Center for Education Statistics. 2011. *Projections of Education Statistics to 2019*. http://nces.ed.gov/pubs2011/2011017.pdf

US Department of Energy. *2003 US Climate Zones*. www.eia.doe.gov/emeu/cbecs/climate_zones.html

US Environmental Protection Agency. 2000. Table 1. Toxicity Data by Category for Chemicals Listed Under EPCRA Section 313. Office of Environmental Information. 11 pp.

US Environmental Protection Agency. 2002. *Protecting Children from Pesticides*. www.epa.gov/pesticides/factsheets/kidpesticide.htm

US Environmental Protection Agency. 2002a. *National Strategies for Health Care Providers: Pesticides Initiative.* 149 pp. www.epa.gov/oppfead1/safety/healthcare/implemen-plan-document.pdf

US Environmental Protection Agency. 2003. *America's Children and the Environment Report: Measures of Contaminants, Body Burdens, and Illnesses*. 181 pp.

www.epa.gov/opeedweb/children/publications/ace_2003.pdf

US Environmental Protection Agency. 2006. *Chemicals Evaluated for Carcinogenic Potential.* Science Information Management Branch, Health Division, Office of Pesticide Programs. 33 pp. npic.orst.edu/chemicals_evaluated.pdf

US Environmental Protection Agency. 2006. Indoor Air Quality Tools for Schools: Effective Facility Maintenance for Healthy, High Performing Schools. August 4: 1-11. www.epa.gov/iaq/schools/pdfs/publications/facilities_bulletin.pdf

US Environmental Protection Agency. 1993. *Pest Control in the School Environment: Adopting Integrated Pest Management.* Publication No. EPA 735-F-93-012. 25 pp. www.epa.gov/pesticides/ipm/brochure/

US Environmental Protection Agency. 2014. Integrated Pest Management in Schools. http://www.epa.gov/opp00001/ipm/

US Food and Drug Administration, 2009. Treating Head Lice. www.fda.gov/ForConsumers/ConsumerUpdates/ucm171730.htm

US General Accounting Office. 1999. *Use, Effects, and Alternatives to Pesticides in Schools.* Publication no. GAO/RCED-00-17. Washington, D.C. 22 pp. www.gao.gov/new.items/rc00017.pdf

US General Accounting Office. 2000. *Children and Pesticides: New Approach to Considering Risk is Partly in Place.* Publication no. GAO/HEHS-00-175. Washington, D.C. 40 pp. www.gao.gov/new.items/he00175.pdf

US Green Building Council. 2014. *LEED v4 for Building Operations and Maintenance.* 111 pp. http://www.usgbc.org/sites/default/files/LEED%20v4%20EBOM_10.01.14_current.pdf

Vankawala, H. H. and R. Park. 2009. Hymenoptera stings. *eMedicine* http://emedicine.medscape.com/article/768764-overview

Wagner, S.L. 1993. Allergy from Pyrethrin or Pyrethroid Insecticides. *Journal of Agromedicine* 1: 39-45.

Washington State University. 1999. *Calculating the True Costs of Pest Control.* Department of Ecology Hazardous Waste and Toxics Reduction Program, Publication No. 99-433. 20 pp. www.ecy.wa.gov/pubs/99433.pdf

Weiss, B. 2000. Vulnerability of children and the developing brain to neurotoxic hazards. *Environ Health Perspect*. 108 (suppl 3) :375 –381.

Whyatt, R.M. and D.B. Barr. 2001. Measurement of organophosphate metabolites in postpartum meconium as a potential biomarker of prenatal exposure: a validation study. *Environ Health Perspect.* 109(4):417-20.

Williams, G.M., H.M. Linker, M.G. Waldvogel, R.B. Leidy and C. Schal. 2005. Comparison of conventional and integrated pest management programs in public schools. *J. Economic Entomology*. 98: 1275-1283. http://www.ncbi.nlm.nih.gov/pubmed/16156581

Woodley, D. 2004. West Des Moines Community School District IPM case study. In *Proceedings, Midwest School IPM Conference*. University of Iowa. http://www.ipm.iastate.edu/ipm/schoolipm/conference

Zahm, S.H., and S.S. Devesa. 1995. Childhood cancer: overview of incidence trends and environmental carcinogens. *Environ. Health Perspectives* 103 (Suppl. 6): 177-184.

Appendix F. Bibliography of Reports and Surveys on Pest Management and Pesticide Use in Schools

Alaska
Alaska Department of Environmental Conservation, Pesticide Program. 1999. Results from the Alaska School Pesticide Use Survey. *On the Cidelines*, Spring 1999.

Rumph, M., T. Cofer, S. Adams, W. Foshee, W. Johnson, B. Alverson, B. Cauthen, R. Pont and L. Graham. 2000. *Report of the Alabama IPM in Schools Working Group: 2000 Alabama School IPM Survey*.

California
Barnes, C., and S. Sutherland. 2005. *2004 Integrated Pest Management Survey of California School Districts*. Institute for Social Research, California State University, Sacramento, CA.

Brajkovich, L., A. Hanger, B. Messenger, S. Simmons. 2010. California's Use of IPM in Managing Pests in Schools. *Outlooks on Pest Management* 21(1): 25-30(6).

Bush, A., and P. Clary. 2004. *Are Schools Flunking Out? Mid-Term Report Card on Chemical Pest Management*. Californians for Alternatives to Toxics. www.alternatives2toxics.org/pdfs/schoolsrpt-web.pdf

Cowles, E., Livington, B., and J. Cunningham. 2010. *Integrated Pest Management Survey of California School Districts.* Instiute for Social Research California State University, Sacramento CA.

Geiger, C.A., and D.H. Tootelian. 2002. *2002 Integrated Pest Management Survey of California School Districts.* Report no. PM03-01. State of California Environmental Protection Agency, Department of Pesticide Regulation, Sacramento, CA.

Geiger, C.A. and D.H. Tootelian. 2005. Healthy Schools Act spurs integrated pest management in California public schools. *California Agriculture* 59 (4): 235-241. http://californiaagriculture.ucanr.org/landingpage.cfm?article=ca.v059n04p235&fulltext=yes

Kaplan, J, S. Marquardt and W. Barber. 1998. *Failing Health: Pesticide Use in California Schools*. CALPIRG Charitable Trust and Californians for Pesticide Reform. http://pesticidereform.org/downloads/failingHealth.pdf

McKendry, C. 2002. *Learning Curve: Charting Progress on Pesticide Use and the Healthy Schools Act.* California Public Interest Research Group Charitable Trust, San Francisco, CA. http://eric.ed.gov/?id=ED473864

Olle, T.M.. 2000. *"P" is for Poison: Update on Pesticide Use in California Schools*. CALPIRG Charitable Trust and Californians for Pesticide Reform.

http://eric.ed.gov/?id=ED450545

Simmons, S.E., T.E. Tidwell and T.A. Barry. 1996. *Overview of Pest Management Policies, Program and Practices in Selected California Public School Districts.* PM96-01. State of California EPA-DPR.

Tootelian, D.H. 2001. *2001 IPM Baseline Survey of School Districts*. State of California Environmental Protection Agency, Department of Pesticide Regulation, Sacramento, CA.

Coloardo/Utah
Young, D. 2012. *Survey of School Districts.* Colorado State University.

Connecticut
Addiss, S.S., N.O. Alderman, D.R. Brown, C.N. Eash and J. Wargo. 1999. *Pest Control Practices in Connecticut Public Schools.* Environment and Human Health, Inc., North Haven, CT. www.ehhi.org/reports/pestschools/

District of Columbia
McCauley, M. 1988. *Contaminated Classrooms: An Investigation of Pest Control Practices in Washington, D.C. Area Schools.* Public Citizen's Congress Watch. California Environmental Protection Agency, Sacramento, CA.

Florida
Scherer, C.W. 2000. *School Integrated Pest Management: Annual Report of the Florida School IPM Advisory Board, April 2000*. University of Florida.

Illinois
Safer Pest Control Project. 2001. *Implementation of IPM and Pesticide Notification in Illinois Schools: Results from a Survey by Safer Pest Control Project.*

Safer Pest Control Project. 1998. *Pesticide Use in Illinois Public Schools: Survey Findings.*

Indiana
Fournier, A., T.J. Gibb and C.Y. Oseto. 2010. *Go to the Head of the Class: A Research-based Approach to Understanding Adoption and Implementation of Integrated Pest Management in Schools.* Purdue IPM Technical Resource Center, Purdue University. West Lafayette, IN.

Fournier, A., and T. Johnson. 2003*. Implementation of Pilot Integrated Pest Management Programs in Indiana Schools and Child Care Facilities.* Department of Entomology, IPM Technical Resource Center, Purdue University, West Lafayette, IN. www.entm.purdue.edu/entomology/outreach/schoolipm/Update May 2003/IDEM Pilot report fin.htm

Gibb, T.J. and A. Fournier. 2006. *Survey of Indiana Public Schools Pest Management Policies and Practices*. Bulletin No. B17872. 2006. Department of Entomology, Purdue University, West Lafayette, IN.
www.entm.purdue.edu/entomology/outreach/schoolipm/1pmp/pdf/EPA_survey.pdf

Gibb, T.J., and F. Whitford. 1998. *Parents, Public Schools and Integrated Pest Management*. Bulletin No. B-770. Department of Entomology, Purdue University, West Lafayette, IN. [Note: Survey of parent knowledge and perceptions of IPM conducted in a single elementary school in Indiana.]

Iowa

Shour, M. 2001. *Study of Pest Control Practices in Iowa's Public Schools. Pest Management & the Environment Program*. Iowa State University.
www.ipm.iastate.edu/ipm/schoolipm/node/103

Massachusetts

Clifton, N. 2007. Survey of Northeastern states in preparation, results anticipated in 2008. Pers. comm. March 7, 2007.

Hollingsworth, C.S. 1996. *Pest Management in Massachusetts Public Schools: A Survey of Practices and Perceptions*. University of Massachusetts Extension Bulletin no. 217, University of Massachusetts Extension, Amherst, MA.
www.umass.edu/umext/ipm/projects/community_education/pest_management_MA_schools.html

Massachusetts Public Interest Research Group. 1996. *Primary Exposure: Pesticides in Massachusetts Schools.* www.masspirg.org/

Maryland

Brown, A.E., and J.Z. Schmidt. 2000. Response to Pre-notification of Pesticide Application in a Public School System. *J. Pesticide Safety Education* 2: 1-14. scholar.lib.vt.edu/ejournals/JPSE/v2/brown.pdf [Note: Survey of parent and school staff responses to pesticide pre-notification in a single public school system in Maryland.]

Maryland Department of Agriculture. 1997. *Summary of Structural Pest Control Programs and Implementation of Integrated Pest Management in Maryland Public Schools*. 37 pp.

Maryland Department of Agriculture. 2000. *Implementation of Integrated Pest Management in Maryland Public Schools*.

Maryland Pesticide Network. 2004. *Are We Passing the Grade? Assessing MD Schools' Compliance with IPM-in-Schools Laws.*

Maryland, State of. 1998. *A Report on Pesticide Use in Maryland Schools*. Available from Maryland Public Interest Research Group, Baltimore, MD, (410) 467-0439. E-mail: marypirg at pirg.org. www.marylandpirg.org/home

Maine
Murray, K. 2000. *What's Bugging Our Schools?: Pest Concerns and Pesticide Use in Maine Public Schools.* Maine Department of Agriculture, Food and Rural Resources, Augusta, ME. www.state.me.us/agriculture/pesticides/schoolipm/what/survey.htm

Minnesota
Jones, P. 2002. Minnesota Head Start/Day Care/Preschool Pest Management Practices Survey: Report of Survey Results. Minnesota Center for Survey Research, University of Minnesota, Minneapolis, MN. For more information, contact Jeanne Ciborowski, MDA at 651-201-6217 or Jeanne.ciborowski at state.mn.us

Kells, S. 2011. *Pesticide use and IPM Assessment for Minnesota Schools.* University of Minnesota.

Minnesota Department of Agriculture. 2000. Quantitative Research Regarding Pest Management Practices in Minnesota K-12 Schools. Executive summary is available at: www.mda.state.mn.us/news/publications/pestsplants/pestmanagement/ipm/pestuseexecsumm.pdf

Montana
Montana Department of Agriculture. 1994. *The Montana Model School Integrated Pest and Pesticide Management Program.*

Nebraska
Ogg, B., C. Ogg, S. Hygnstrom, J. Campbell and G. Haws. 2003. *Pest Management Practices in Nebraska Schools: Results of a Survey of School Officials.* University of Nebraska Lincoln Cooperative Extension.

North Carolina
Karel, B., F. Pattison and A. Rogers. 2003. *Clean Schools, Safe Kids: Striving for Safer Pest Management in North Carolina Public Schools.* Agricultural Resources Center, Inc., Raleigh, NC. www.toxicfreenc.org/informed/cleanschools.html

Lilley, S. 1999. *A Pest Management Survey of North Carolina Public Schools*. IPM Center, College of Agriculture and Life Sciences, North Carolina State University. ipm.ncsu.edu/urban/cropsci/SchoolIPM/documents/1999Surveyreport1.pdf

Nalyanya, G., and S. Lilley. 2002. *Pest Control Practices in North Carolina Public Schools*. IPM Center, College of Agriculture and Life Sciences, North Carolina State University. ipm.ncsu.edu/urban/cropsci/SchoolIPM/documents/2002Surveyreport.pdf

North Carolina State University. 2012. *School IPM Survey.*

New Mexico
New Mexico Department of Agriculture. 2010. *New Mexico Public School Pest Management Survey.*

New York
Abrams, R., D.I. Volberg, M.H. Surgan, S. Jaffe and D. Hamer. 1993. *Pesticides in Schools: Reducing the Risks.* New York State, Department of Law. Summary and update.

Braband, L., E. Horn and L. Sahr. 2002. *Pest Management Practices: A Survey of Public School Districts in New York State.* NYS IPM No. 613. New York State Integrated Pest Management Program. www.mindfully.org/Pesticide/2002/Pest-Management-Practices-Survey-NYIPMJun02.htm

Surgan, M.H., J. Enck, and A. Yu. 2000. *Pesticide Use at New York Schools: Reducing the Risk*. Office of the Attorney General, Environmental Protection Bureau, New York, NY.

Ohio

Goland, C., et al. 2001. *Reducing Pesticide Use in Schools: The Ohio Schools Pest Management Survey and a Guide for Integrated Pest Management in Granville Schools.* Denison University, Granville, OH, Environmental Capstone Seminar, Spring 2001.

Oregon
Arkin, L. 2008. *Warning! Hazards to Children: Pesticides in our Schools.* Oregon Toxics Alliance, Eugene, OR. 37 pp.

Northwest Coalition for Alternatives to Pesticides and Oregon Center for Environmental Health. 1998. *Pesticide Use by the Portland School District.*

Pennsylvania
Long, J.K. 1998. *Final Report of the IPM in Schools Survey: Results from the 1998 Survey of Pennsylvania Schools.* Pennsylvania Integrated Pest Management Program, University Park, PA.

Long, J.K. 2001. *Final Report of the IPM in Schools Survey: Results from the 2001 Survey of Pennsylvania School Districts.* Pennsylvania Integrated Pest Management Program, University Park, PA.

Tennessee
University of Tennessee. 2012. *Tennessee School Intrated Pest Management Phone Questionnaire.*

Vail, K.M. 2001. *Integrated Pest Management in Tennessee's Schools?* E & PP Info Note #656. University of Tennessee Agricultural Extension Service.

Texas
Mitchell, K., ed. 1999. *Pesticide Report Card: Texas Schools Score from A to F in the Integrated Pest Management Program*. Texas Pesticide Information Network/Consumers Union, Austin, TX, (512) 477-4431. www.texascenter.org/txpin/schools.pdf

Walton, M. and L. Kiplin. 2001. *Final Report School IPM Demonstration Project Compliance Assistance - Urban IPM*. Texas Structural Pest Control Board.

Vermont
Miller, S. 2002. *Reading, Writing, and Raid®: Pesticide Use at Vermont Schools.* The Vermont Public Research Interest Group, Montpelier, VT.

Sterling, P., and B. Browning. 1999. *Chemicals in Vermont's Classrooms: Pesticides and Maintenance Chemicals in Vermont Schools.* Vermont Public Interest Research Group, Montpelier, VT.

Sterling, P., and N. Paquette. 1998. *Toxic Chemical Exposure in Schools: Our Children are at Risk.* Vermont Public Interest Research Group, Montpelier, VT.

Washington
Loudon, E. 1999. *Weed Wars: Pesticide Use in Washington Schools*. Washington Toxics Coalition, Seattle, WA.

Northwest Coalition for Alternatives to Pesticides and Washington Toxics Coalition. 1998*. Pesticide Use by the Seattle School District.*

Storey, A. 2004. *A Lesson in Prevention: Measuring Pesticide Use in Washington Schools.* Washington Toxics Coalition, Seattle, WA. www.watoxics.org/files/lesson-in-prevention.pdf

xxWashington State University. *School IPM Survey.*

Wisconsin
Becker, B., E. Bergman, N. Zuelsdorff, K. Fenster, B. Swingle and J. Larson. 1998. *Final Report on Pesticide Use in Wisconsin Schools*. Publication # AR-0263. Wisconsin Department of Agriculture, Trade and Consumer Protection, Madison, WI.

National Reports
Mage, D.T., G. Gondy, G. Yimesghen. 2002. *Pesticides in Schools: Planning for a Feasibility Study to Determine the Need for a Full-Scale National Study*. Temple University Institute for Survey Research, Philadelphia, PA. Contract Report to EPA #DC-01-00250.

Piper C., and K. Owens. 2002. Are schools making the grade? *Pesticides and You* 22 (3): 11-20. Beyond Pesticides, Washington, D.C. www.beyondpesticides.org/schools/publications/SD%20study_2003.pdf

US General Accountability Office. 1999. *Pesticides; Use, Effect and Alternatives to Pesticides in Schools*. Pub. No. GAO/RCED-00-17. www.gao.gov/new.items/rc00017.pdf

IPM Institute of North America. 2012. State IPM Report Card Survey.

IPM Institute of North America. 2012. Coalition Survey.

IPM Institute of North America. 2012. School District Survey.

Appendix G. 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 pests and 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)	Outcomes: Intermediate (Actions)	Outcomes: 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

Outcomes

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 (asthma, IAQ, absenteeism)
- 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 (improved academic performance)
- 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 and 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 parents' management of pests in their homes

Long Term (Conditions/Impact)

Reduce children's and others exposure to pests and 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

- 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
- Parent groups and school boards request/support fewer pesticide inputs
- 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
- Maintenance staff become certified applicators
- 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 an IPM contract and/or bid specification

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 H. 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	http://afsaadmin.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	http://www.acuho-i.org/
Association of School Business Officials International	www.asbointl.org
Children's Environmental Health Network	www.cehn.org
Children's Health Environmental Coalition	http://healthychild.org/main/
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.ncef.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	http://aapco.ceris.purdue.edu/index.html
Association of Professional Industrial Hygienists	www.apih.us/
Association of Structural Pest Control Regulatory Officials	www.aspcro.org/
National Association of County and City Health Officials	www.naccho.org/
National Pest Management Association	www.npmapestworld.org/
PestSure	http://pestsure.com/

State Organizations – School Related	Website
Alabama Association of School Boards	http://www.alabamaschoolboards.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	
Arkansas Association of Educational Administrators	http://theaaea.org/
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	
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	http://members.csea.com/memberhome/
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)	http://www.chps.net/dev/Drupal/node
Colorado Association of School Boards	www.casb.org/
Colorado Association of School Business Officials	www.coloradoasbo.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	http://www.caisct.org/
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/
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	http://www.gisaschools.org/
Georgia PTA	www.georgiapta.org/
Georgia School Boards Association	www.gsba.com/
Georgia Association of Educators	http://pv.gae2.org/
Hawaii Association of Independent Schools	www.hais.org/
Hawaii State PTSA	http://www.hawaiistateptsa.org/
Idaho Association of School Business Officials	www.idahoasbo.org/
Idaho Golf Course Superintendents Association	www.idahogcsa.org/
Idaho PTA	www.idahopta.org/
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.kansas-pta.org/
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.louisianapta.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	http://www.msmaweb.com/
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 Association of Independent Schools	http://www.msais.org/index2.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 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	http://www.nvadministrator.org/
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 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	http://www.newmexicopta.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	http://www.ndcel.org/ndasa
North Dakota Education Association	www.ndea.org/
North Dakota PTA	www.ndpta.org/
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	http://ok.aft.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)	http://ruralcap.com/?option=com_content&view=article&id=194&Itemid=71
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/
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/
Pesticide Research Institute	http://www.pesticideresearch.com/site/
Private Schools Interscholastic Association (Texas)	www.psiaacademics.org/
Rhode Island Association of School Business Officials	www.riasbo.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.alabamaparentcenter.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.com/

Southern Association of Schools and Colleges	www.sacs.org/
Southwestern Association of Episcopal Schools	www.swaes.org/
Statewide Parent Advocacy Network (SPAN)	www.spannj.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/
Tri-State Association of School Business Officials (ME, NH, VT)	www.tristateasbo.org/
Texas Public Risk Management Association	http://www.texasprima.org/
Utah PTA	www.utahpta.org/
Utah School Boards Association	www.usba.cc/
Vermont PTA	www.ptacentral.org/vermont.htm
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/
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/
West Virginia Association of School Business Officials	https://sites.google.com/site/wvasbo/about-wvasbo-2
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.ptacentral.org/wyoming.htm
Wyoming School Boards Association	www.wsba-wy.org/

State Organization – Pest-Management Related	**Website**
Alabama Department of Agriculture & Industries	http://www.agi.alabama.gov/divisions/pesticide-management
Alaska Department of Environmental Conservation	www.dec.state.ak.us/eh/pest/index.htm
Arizona Office of Pest Management	http://opm.azda.gov/
Arkansas Pest Management Association	www.arkansaspest.org
Arkansas State Plant Board	http://plantboard.arkansas.gov/Pages/default.aspx
Association of Ohio Health Commissioners	www.aohc.net/
California Conference of Local Health Officers	www.dhs.ca.gov/CCLHO/
California Environmental Protection Agency	http://www.calepa.ca.gov/
California Industrial Hygiene Council	www.cihconline.com
Central Virginia Pest Management Association	www.cvpmaonline.com/

Colorado Department of Agriculture	www.colorado.gov/ag
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	http://hawaii.gov/hdoa/
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 Counties Public Health Association	www.i-cpha.org/
Iowa Department of Agriculture & Land Stewardship	http://www.iowaagriculture.gov/
Iowa Pest Management Association	www.iowapest.org/
Kansas Association of Local Health Departments	www.kalhd.org/
Kansas Department of Agriculture	http://agriculture.ks.gov/
Kentucky Department of Agriculture	www.kyagr.com/consumer/envsvs/
Kentucky Health Departments Association	www.khda-ky.org/
Local Public Health Association of Minnesota	www.lpha-mn.org/
Louisiana Department of Agriculture & Forestry	http://www.ldaf.louisiana.gov/portal/
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	http://mda.maryland.gov/plants-pests/pages/pesticide_regulation.aspx
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
Minnesota Association of Extension Educators	http://www.mda.state.mn.us/
Minnesota Department of Agriculture	http://www.mda.state.mn.us/
Mississippi Department of Agriculture & Commerce	https://www.mdac.ms.gov/
Missouri Association of Local Public Health Agencies	www.moalpha.org/
Missouri Department of Agriculture	http://mda.mo.gov/plants/ipm/
Missouri Pest Management Association	http://www.mopma.org/
Montana Department of Agriculture	http://agr.mt.gov/
Nebraska Department of Agriculture	http://www.nda.nebraska.gov/
Nevada Department of Agriculture	http://agri.nv.gov/
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	http://agriculture.nh.gov/
New Jersey Department of Environmental Protection	www.nj.gov/dep/enforcement/pcp/
New Jersey Pest Management Association	http://njpma.com/
New Mexico Department of Agriculture	http://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	http://www.dec.ny.gov/
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	http://www.agri.ohio.gov/
Office of Indiana State Chemist	www.isco.purdue.edu/pesticide/index_pest1.html
Oklahoma Department of Agriculture, Food & Forestry	www.ok.gov/~okag/
Oregon Department of Agriculture	oregon.gov/ODA/PEST/
Pennsylvania Department of Agriculture	http://www.agriculture.state.pa.us/portal/server.pt/community/pennsylvania_department_of_agriculture/10297
Pennsylvania Pest Management Association	http://www.papmaonline.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	http://sdda.sd.gov/
Tennessee Department of Agriculture	http://www.state.tn.us/agriculture/
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/
The Virginia Pest Management Association	www.vpmaonline.com/
Utah Department of Agriculture & Food	http://ag.utah.gov/
Vermont Agency of Agriculture, Food & Markets	http://www.vermontagriculture.com/ARMES/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	http://doh.dc.gov/
Washington State Association of Local Public Health Officials	http://www.wsalpho.org/
Washington State Department of Agriculture	http://agr.wa.gov/Portals/PF/
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 Control Association	http://wisconsinpest.com/
Wyoming Department of Agriculture	http://wyagric.state.wy.us/

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	http://www.sde.idaho.gov/
Illinois	www.isbe.state.il.us/
Indiana	http://www.doe.in.gov/
Iowa	www.iowa.gov/educate/
Kansas	http://www.ksde.org/
Kentucky	http://education.ky.gov/Pages/default.aspx
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	http://www.education.ne.gov/
Nevada	www.doe.nv.gov/
New Hampshire	http://education.nh.gov/
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	http://www.ode.state.or.us/
Pennsylvania	www.pde.state.pa.us/
Rhode Island	http://www.ride.ri.gov/
South Carolina	ed.sc.gov/
South Dakota	doe.sd.gov/
Tennessee	state.tn.us/education/
Texas	www.tea.state.tx.us/
Utah	http://www.schools.utah.gov/main/
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 I. 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."*

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@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@fourhcouncil.edu

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 Your Children’s Health. *Popular 56 pp. booklet contains helpful information for parents, grandparents and other caregivers. 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@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@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@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.girlscoutsofcolorado.org/*. 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 http://www.ipm.msu.edu/uploads/files/Community_and_Schools_PDFs/wholedoc.pdf

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 pesticide safety; news releases on IPM and pests for school newsletters; Powerpoint presentations; sample contacts and letters; educational materials; links to school related Web site in numerous areas (organized by subject and location); and much more.* The complete web site is now available 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. 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 http://schoolipm.ifas.ufl.edu/teacherresources.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 http://cms.leoncountyfl.gov/Home/Departments/Public-Works/Operations/Mosquito-Control/Community-Education-and-Information/School-and-Youth-Programs

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/Ag/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

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. fact 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 http://www.mda.state.mn.us/plants.aspx

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: http://www.mda.state.mn.us/en/plants/pestmanagement/ipm/ipmschools.aspx
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.*

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.*

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 low risk ways to manage pests; and safeguarding against pesticide risks.* Can be obtained by contacting the Pennsylvania IPM Program at (814) 865-2839 or downloading 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 http://www.mda.state.mn.us/kids.aspx

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.*

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 http://extension.psu.edu/pests/ipm/invasive-species/bugmobile-vs.-invasive-species/invasive-species-lesson-plan

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. Requests for hard copies can be sent to Timothy Gibb, Department of Entomology, Purdue University, Smith Hall, 901 W. State Street, West Lafayette, IN 47907-2054, Phone: 765-494-4570, Email: gibb@purdue.edu

Midwest Pesticide Action Center. Kid's guide to pesticides. *Two pp. fact sheet in PDF format includes discussion of pests, pesticides, risks, pesticide safety.* Available at http://www.spcpweb.org/factsheets/KidsGuidetoPesticidesBW.pdf .

Midwest Pesticide Action Center. 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 (Now the Midwest Pesticide Action Center) at (773) 878-7378 ext 204.

Midwest Pesticide Action Center. 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 (773) 878-7378 ext 204 or email us at msaito@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 several resources available 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.*

Wyoming Agriculture in the Classroom. A Kid's Journey to Understanding Weeds. *Elementary school-level activities for students organized around 11 noxious weeds.*

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@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 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@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.

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, bed bugs, 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

Midwest Pesticide Action Center. "La Invasion de los Insectos". *Comic-style book in Spanish addresses cockroach IPM in public housing.* Available from Midwest Pesticide Action Center, 4611 N. Ravenswood, Chicago, IL 60640 , (773) 878-7378 , Fax (773) 878-8250, E-mail: general at pesticideaction.org, Website http://midwestpesticideaction.org/what-you-can-do/all-resources/

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.*

University of Massachusetts. What is Integrated Pest Management? *This informative brochure is available through the University of Massachusetts* in *nine different languages including English, Spanish, Portuguese, French, German, Italian, Khmer, Vietnamese and Chinese.*

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 J. 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 NIFA 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
Sherry Glick
EPA's Center of Expertise for School IPM
National Coordinator, Pesticides and Schools
US Environmental Protection Agency
Office of Pesticide Programs
Physically located at: US EPA/Region 6 Dallas
glick.sherry@epa.gov
https://www.epa.gov/managing-pests-schools

REGIONAL
Northeast Region
Kathleen Murray
IPM Entomologist and Northeastern Region School IPM Working Group Co-Leader
Maine Department of Agriculture, Food and Rural Resources
28 State House Station
Augusta, ME 04333
207 287-7616
Fax 207 287-7548
kathy.murray@maine.gov
www.maine.gov/agriculture/pesticides/schoolipm
http://northeastipm.org/work_school.cfm

North Central Region
Thomas A. Green, PhD, CCA, TSP
President, IPM Institute of North America Inc., and North Central Region School IPM Working Group Co-Leader
1020 Regent St.
Madison WI 53715
608 232-1410
Fax 608 232-1440
ipmworks@ipminstitute.org
www.ipminstitute.org
http://www.ipminstitute.org/NC_IPMIS_Working_Group/main.htm

Southern Region
Janet Hurley

Southern Region School IPM Working Group Co-Leader and School IPM Program Coordinator Southwest Technical Resource Center Texas AgriLife Research and Extension Center
17360 Coit Road
Dallas, TX 75252-6599
972 952-9213
Fax 972 952-9632
ja-hurley@tamu.edu
schoolipm.tamu.edu
http://www.sripmc.org/schoolIPM/

Western Region
Dawn H. Gouge
Western Region School IPM Working Group Co-Leader and
Urban Entomologist
University of Arizona
Maricopa Agricultural Center
37860 W. Smith-Enke Road
Maricopa, AZ 85239
520-374-6223
Fax 520-374-6394
dhgouge@ag.arizona.edu
http://cals.arizona.edu/apmc/westernschoolIPM.html

STATE
Alabama
Fudd Graham
Auburn University
Alabama Fire Ant Management Program
Department of Entomology & Plant Pathology
301 Funchess Hall
Auburn, AL 36849-5413
334 844-2563
Fax 334 844-5005
grahalc@auburn.edu

Alaska
Lydia Clayton
Agriculture and Horticulture Specialist
University of Alaska Fairbanks Cooperative Extension
43961 K-Beach Road, STE A
Soldotna, AK 99669-9728
907 262-5824
Fax 907 262-3939
lclayton2@alaska.edu

Arizona
Dawn H. Gouge
Urban Entomologist
University of Arizona
Maricopa Agricultural Center
37860 W. Smith-Enke Road
Maricopa, AZ 85239
520 568-2273 x223
Fax 520 568-2556
dhgouge@ag.arizona.edu

Arkansas
John Hopkins
University of Arkansas
2301 South University Ave.
Box 391 Rm. 305F
Little Rock, AR 72203
501 671-2217
Fax 501 671-2301
jhopkins@uaex.edu

California
Lisa Estridge
Senior Environmental Scientist
California Department of Pesticide Regulation
1001 I Street, P.O. Box 4015
Sacramento, CA 95812-4015
(916) 445-2489Fax 445-4033
lisa.estridge@cdpr.ca.govhttp://apps.cdpr.ca.gov/schoolipm/main.cfm

Colorado
John W. Scott
Pesticide Program Manager
Colorado Dept. of Agriculture
Division of Plant Industry

700 Kipling Street, Suite 4000
Lakewood, CO 80215-5894
303 869-9063
john.scott@ag.state.co.us

Connecticut
Diane Jorsey
Connecticut Dept. of Environmental Protection
Pesticide Management Division
79 Elm St.
Hartford, CT 06106
860 424-3328
diane.jorsey@po.state.ct.us
http://ipm.uconn.edu

Florida
Faith Oi
Assist. Extension Scientist
University of Florida
Entomology & Nematology Department Bldg. 970
Natural Area Drive
Gainesville, FL 32611-0064
(352) 392-1901 ext 145
Fax 352 392-0190
foi@ufl.edu
schoolipm.ifas.ufl.edu/

Georgia
Brian Forschler
Professor of Entomology
Department of Entomology
University of Georgia
413 Biological Sciences Building
Athens, GA 30602-2603
706-542-2816
bfor@uga.edu

Daniel Suiter
Associate Professor of Entomology
Department of Entomology
UGA Griffin Campus
1109 Experiment Street
Griffin, GA 30223-1797
770-233-6114
dsuiter@uga.edu

Hawaii
Julian Yates
Urban Entomologist
University of Hawaii
3050 Maile Way, Room 310
Honolulu, HI 96822
808 956-6747
Fax 808 956-2458
yates@hawaii.edu

Idaho
Kathryn Goldman
Pesticide Action Network of Blaine County
208 721-3108
kgoldwoman@gmail.com

Illinois
Ruth Kerzee
Midwest Pesticide Action Center (formerly Safer Pest Control Project)
773 878-7378 x204
rkerzee@pesticideaction.org

Susan Ratcliffe
North Central IPM Center
University of Illinois, Department of Crop Sciences
217 333-9656
sratclif@uiuc.edu

Indiana
Margaret Huelsman
Improving Kids Environment
1111 E. 54th Street, Ste. 212
Indianapolis, IN 46220
317 677-4760
mhuelsman@ikecoalition.org

Iowa
Mark Shour
Extension Entomologist
Iowa State University
Pest Management & the Environment
109 Insectary Building
Ames, IA 50011-3140
515 294-5963
Fax 515 294-8027
mshour@iastate.edu

http://school.ipm.iastate.edu

Kansas
Frannie Miller
Pesticide Safety Education and IPM Coordinator
123 W. Waters Hall
Kansas State University
Manhattan KS 66506-4004
Phone: (620) 241-1523
Fax: (785) 532-6232
fmiller@ksu.edu

Louisianna
Dennis Ring
Professor and Extension Coordinator
LSU Ag Center
Department of Entomology
547 Life Sciences Building
Baton Rouge, LA 70803-1710
225 578-2180
Fax 225 578-2257
dring@agcenter.lsu.edu

Marty Pousson
Program Coordiantor, Pesticide Certification & Training
LA Dept. of Agriculture and Forestry
Office of Agricultural & Environmental Sciences
P.O. Box 3596
Baton Rouge, La 70821(225)
225 925-3787
marty_p@ldaf.state.la.us
www.ldaf.state.la.us

Maine
Kathleen Murray
IPM Entomologist
Maine Department of Agriculture, Food and Rural Resources
28 State House Station
Augusta, ME 04333
207 287-7616
Fax 207-624-5065
kathy.murray@maine.gov
www.maine.gov/agriculture/pesticides/schoolipm

Massachusetts
William M. Coli
USDA NIFA State IPM Coordinator

Dept. of Entomology
University of Massachusetts
Agricultural Engineering Building
Amherst, MA 01003
413 545-1051
Fax 413 545-5858
wcoli@umext.umass.edu
www.umass.edu/umext/schoolipm/

Trevor Battle
Mass. Dept. of Agricultural Resources and Food
251 Causeway Street Suite 500
Boston, MA 02114-2151
617 626-1775
Fax 617 626-1850
Trevor.Battle@state.ma.us
http://massnrc.org/ipm

Michigan
Bob Stoddard
Envirosafe
1774 Porter St.
Wyoming, MI 49519
bob@envirosafeipm.com
Phone 616 364-1890
Fax 616 364-1891

Minnesota
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@state.mn.us
www.mda.state.mn.us/ipm

Mississippi
Blake Layton
Department of Entomology & Plant Pathology
Box 9775
Mississippi State, MS 39762
(662) 325-2085
Blayton@entomology.msstate.edu

Missouri
Anastasia Becker
Missouri Dept. of Agriculture
PO Box 630 / 1616 Missouri Blvd.
Jefferson City, MO 65102
573 -526-0837
Anastasia.Becker@mda.mo.gov

Montana
Amy Bamber
Montana Department of Agriculture
P.O. Box 200201
Helena, MT 59620-0201
406 444-3676
Fax 406 444-5409
abamber@mt.gov

Nebraska
Clyde Ogg
Asst. Extension Educator
University of Nebraska-Lincoln Extension
Pesticide Education Office
Southeast Research & Ext Cent
101 NRH UNL
Lincoln, NE 68583-0820
402 472-1632
cog@unl.edu
schoolipm.unl.edu/

Nevada
Jon Carpenter
Pest Management
Nevada Dept. of Agriculture
350 Capitol Hill
Reno, NV 89502
775 688-1182 x276
Fax 775 688-1178
jcarp@agri.state.nv.us

New Hampshire
Lynn Rose
NH Department of Environmental Services
PO Box 95
Concord, NH 03302-0095
(603) 271-3503

lynnfaith@comcast.net

New Jersey
Tim Boyle
Senior Environmental Specialist and IPM Coordinator
Pesticide Control Program
NJ Department of Environmental Protection
Mail Code 401-04A
P.O. Box 420
Trenton, NJ 08625-0411
609 984-6908
Fax 609 984-6555
tim.boyle@dep.state.nj.us
www.state.nj.us/dep/enforcement/pcp/pcp-ipm.htm

Patricia Hastings
Program Associate
New Jersey School IPM Program
Pest Management Office
93 Lipman Dr.
New Brunswick, NJ 08901
848 932-9802
hastings@aesop.rutgers.edu
www.pestmanagement.rutgers.edu/IPM/SchoolIPM/

New Mexico
Bonnie Rabe
Division Director
Agricultural & Environmental Services
New Mexico Department of Agriculture
3190 S. Espina
Las Cruces, New Mexico 88003
(575) 646-3007 ddaes@nmda.nmsu.edu
New York
Lynn Braband
Community IPM Extension Educator
Cornell University
249 Highland Ave.
Rochester, NY 14620-3036
585 461-1000 x241
Fax 585 442-7577
lab45@cornell.edu

North Carolina
Michael Waldvogel
Extension Associate Professor and Extension Specialist

North Carolina State University
Dept. of Entomology
Raleigh, NC 27695-7613
919 515-8881
mike_waldvogel@ncsu.edu
schoolipm.ncsu.edu/

North Dakota
Jeremiah Lien
North Dakota Department of Agriculture
600 E Boulevard Ave Dept 602
Bismarck ND 58505-0020
701 328-1504
jjlien@nd.gov

Ohio
Dave Shetlar
Extension Entomology
1991 Kenny Road
Columbus, OH 43210
614 292-3762
shetlar.1@osu.edu

Oklahoma
Tom Royer
Professor and IPM Coordinator
Oklahoma State University
Department of Entomology & Plant Pathology
127 Noble Research Center
Stillwater, OK 74078
405 744-9406
Fax 405 744-6039
Tom.royer@okstate.edu

Brad Kard
Professor and Interim Extension Pesticide Coordinator
Oklahoma State University
Department of Entomology & Plant Pathology
127 Noble Research Center
Stillwater, OK 74078-3033
302 218-2451
b.kard@OKSTATE.EDU
Oregon
Tim Stock
IPM Education Specialist
Integrated Plant Protection Center

Oregon State University
2040 Cordley Hall
Corvallis, OR 97331-2915
(541) 737-6279
stockt@science.oregonstate.edu

Pennsylvania
Lyn Garling
Program Manager
Pennsylvania Integrated Pest Management Program
317 Ag Admin Bldg
Penn State University,
University Park, PA 16802
(814) 863-8884
ljg5@psu.edu

Rhode Island
Peggy Siligato
URI Coop Extension
Tech Staff Assistant, CELS-PLS, CELS-PLS
Ce Education Center
Kingston RI 02881
(401)874-5997
siligato@uri.edu

South Carolina
Leslie Godfrey
Investigator
Clemson University
Dept. of Pesticide Regulation
PO Box 290069
Columbia, SC 29229-0069
803 736-7680
Fax 803 736-8457
lgdfry@clemson.edu

South Dakota
Darrell Deneke
USDA NIFA State IPM Coordinator
Plant Science Dept.
South Dakota State University
Box 2207A, Ag Hall 239
Brookings, SD 57007
605 688-4595
Fax 605 688-4602
deneke.darrell@ces.sdstate.edu

Tennessee
Karen M. Vail, Ph.D
Professor and Extension Urban Entomologist Entomology and Plant Pathology
2431 Joe Johnson Drive
205 Ellington Plant Sciences Bldg.
University of Tennessee
Knoxville, TN 37996-4560
kvail@utk.edu
http://schoolipm.utk.edu
http://eppserver.ag.utk.edu/personnel/Vail/vail.htm
(865) 974-8800
Fax 865 974-4744

Texas
Janet Hurley
Southern Region School IPM Working Group Leader and
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
Fax 972 952-9632
ja-hurley@tamu.edu
schoolipm.tamu.edu

Maron Finley
IPM Specialist
Texas Department of Agriculture
Structural Pest Control Service
P.O. Box 12847
Austin, TX 78711-2847
(512) 463-2686
Maron.Finley@TexasAgriculture.gov

Utah
Gregg Smith
Salt Lake City School District
(801) 886-8929 ext. 150
gregg.smith@slcschools.org

Vermont
Carol Westinghouse
Informed Green Solutions
PO Box 60

East Burke, VT 05832
802 626-8643
westinghouse@informedgreensolutions.org

Virginia
Dini Miller
Assistant Professor
Virginia Tech
Urban Pest Management
Dept. of Entomology
320 Price Hall (0319)
Blacksburg, VA 24061
540 231-4045
Fax 540 231-9131
dinim@VT.EDU

Washington
Carrie Foss
Urban IPM Coordinator
Washington State University
7612 E. Pioneer Way
Puyallup, WA 98371
253 445-4577
Fax 253 445-4569
cfoss@wsu.edu
http://schoolipm.wsu.edu/

Washington, D.C.
Russell Noratel
Toxic Substances Division Pesticide Program of the Hazardous Materials Branch,
District Department of the Environment
1200 First Street, NE
Washington, DC 20002
202 741-0838
Russell.Noratel@DC.Gov

West Virginia
Phillip Smith
West Virginia Department of Agriculture
1900 Kanawha Boulevard, East State Capitol, Room E-28
Charleston, WV 25305-0170
(304) 558-2209 Ext. 432
psmith@wvda.us

Wisconsin
John Stier

University of Wisconsin-Madison
Dept. of Horticulture
1575 Linden Dr.
Madison, WI 53706
608 262-1624
Fax 608 262-4743
jstier@facstaff.wisc.edu

Wyoming
John Connett
School IPM Specialist
University of Wyoming Extension
Dept. 3354 - Renewable Resources
1000 E. University Ave.
Laramie, WY 82071-3354
(307) 766-5022Fax 307 766-6403
jconnett@uwyo.edu

Appendix K. 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
Patricia Alder Dept. of Entomology North Carolina State University Campus Box 7613 Raleigh, NC 27695 919.513.3805 patricia_alder@ncsu.edu	Ms. Alder was formerly employed as Entomologist for Clegg's Termite & Pest Control in Durham, NC. She now serves as the Training Coordinator for the Entomology Department's Structural Pest Management Training and Research Facility. She is responsible for organizing and conducting specialized training programs for pest management professionals, school, day care, and long-term care management and staff. She also serves on the NC Pest Management Association's Pest Control School Planning Committee.
Juliann Barta US EPA Region 10 Pesticides Unit (OCE-084) 1200 Sixth Ave, Suite 900 Seattle, WA 98101 206-553-1495 barta.juliann@epa.gov	Mrs. Barta is the EPA Region 10 contact for school IPM and has worked for EPA on pesticide safety issues for the past three years. She is actively involved in the Urban Pesticide Education Strategy Team (UPEST), a group of Washington state agency and university representatives formed to address urban pesticide issues. She also is working with the Indian Health Service to provide community IPM outreach to interested tribes in Oregon, Idaho, and Washington. She has a Masters Degree from the University of Washington in Public Administration, with a focus on Environmental Policy.
Lynn Braband, Community IPM Extension Educator Cornell University 249 Highland Ave. Rochester, NY 14620-3036 585 461-1000 x241 lab45@cornell.edu	Mr. Braband, a certified wildlife biologist, was a Senior Extension Associate with the New York State IPM Program of Cornell University. Previously, he was a company vice president and franchise owner/manager with Critter Control, Inc. the nation's leading firm specializing in nuisance wildlife control. He has been an active participant and leader in both state and national vertebrate pest control organizations. With the NYS IPM Program, Lynn had major responsibilities in assisting New York State schools and municipalities in the implementation of IPM. Activities have included organizing school IPM implementation workshops throughout the state, surveying schools

	on the status of their pest management programs, and conducting IPM demonstration projects at schools. Projects have included supervising a team-based "learning community" approach to the development of several model school IPM programs, one of which received STAR Certification from the IPM Institute of North America, Inc. and organizing workshops focusing upon the pest management needs of small, rural school districts in the Adirondacks. One of his areas of applied research has been proactive approaches to stinging insect control.
Jon Carpenter Nevada Dept. of Agriculture Sparks, NV 89341 (775) 688-1182 jcarp@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.
Jeanne Ciborowski Integrated Pest Management Program Coordinator Minnesota Department of Agriculture 625 Robert St. North St. Paul, MN 55155-2538 651-201-6217 (office) 651-503-0955 (cell) Fax 651-201-6120 jeanne.ciborowski@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 http://www.mda.state.mn.us/plants/pestmanagement/ipm/ipmschools.aspx. Jeanne 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 (949) 548-2214 pcopps@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

	assisted with the development of formalized school IPM programs and is available to assist with program preparation, training needs, and consulting for school IPM projects.
Carrie Foss, Urban IPM Coordinator Washington State University 2606 W Pioneer Puyallup, WA 98371 253 445-4577 cfoss@wsu.edu	Ms. Foss manages the WSU IPM Certification Program and Pesticide Safety Education Program in western Washington. Landscape maintenance personnel, including school employees, are trained in plant problem diagnosis, integrated pest management, personal safety and environmental protection through lectures and workshops. Carrie also guides schools toward IPM program implementation and IPM STAR certification. She earned a Bachelor of Science degree in botany from the University of Washington and a Master of Science degree in plant pathology from the University of Hawaii. Her background includes plant problem diagnosis, research on beneficial microorganisms and management strategies for turf and ornamental diseases.
Al Fournier IPM Program Manager Maricopa Agricultural Center University of Arizona 37860 W. Smith-Enke Rd. Maricopa, AZ 85138 520 381-2240 Fournier@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 Sr. Extension Associate/Entomologist New York State IPM Program - Cornell University 228 Thompson Hall, SUNY Farmingdale Farmingdale, NY 11735 631 539-8680 jlg23@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 Program Manager, PA IPM Program Penn State University 317 Ag Administration Building University Park, PA 16802 814 863-8884 ljg5@psu.edu	Ms. Garling manages Program activities in urban, school and community IPM outreach, teaching, research and implementation. IPM in Schools efforts include developing IPM curriculum for K-12 teachers, IPM service-learning projects, IPM training modules for schools and childcares staff and facilities managers, and promoting IPM STAR Certification and EPA Indoor Air Quality Tools for Schools. Ms Garling holds an MS in entomology from University of Connecticut.
Sherry Glick National Coordinator, Pesticides & Schools US Environmental Protection Agency Office of Pesticide Programs Washington DC 20460 Sitting at: USEPA Region 6, 1445 Ross Ave Ste 1200 (6PD-P), Dallas, TX 214 665-6713 glick.sherry@epa.gov	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 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) 374-6223 dhgouge@ag.arizona.edu	Entomologist and IPM specialist since 1995. Co-directs the Western Regional IPM in Schools Working Group, which involves participants in 13 western states. Serves on Board of Directors for the IPM Institute of North America. Serves on national school IPM 2020 committee. Serves on the advisory board of the IPM Institute Green Shield Certification program. Research efforts focus on pest ecology and reduced-risk management of public health pests. Liaise and support state and government agencies regarding, pollution prevention, pest related children's health issues, vector management, and professional education. Teach course accredited classes on IPM.
Fudd Graham Auburn University Department of Entomology & Plant Pathology 301 Funchess Hall Auburn, AL 36849-5413 Phone: (334) 844-2563 Cell: (334) 750-3994 grahalc@auburn.edu	Dr. Graham manages research, education and outreach for the fire ant program for Alabama, coordinates school IPM efforts, coordinates the Pesticide Safety Education Program in the state and is co leader of the eXtension Urban IPM Community of Practice with Dr. Faith Oi. He has facilitated implementation of IPM in 8 school districts. One of these school districts has achieved STAR Certification from the IPM Institute of North

	America, Inc. He Is also co-leader of the Southern Region School IPM Working Group with Janet Hurley and co-coordinator of the School IPM Network of the Entomological Society of America with Dr. Dawn Gouge.
Thomas Green, President IPM Institute 1020 Regent St. Madison, WI 53715 608 232-1410 Fax 608 232-1440 ipmworks@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.
Janet A. Hurley, MPA Extension Program Specialist II - School IPM Texas AgriLife Extension Service Southwest Technical Resource Center for IPM in Schools 17360 Coit Road Dallas, TX 75252 972-952-9213 or 877-747-6872 Fax 972-952-9632 ja-hurley@tamu.edu	As Program Coordinator for the Southwest Technical Resource Center for IPM in Schools since 2001, Ms. Hurley oversees and conducts a two-day training workshop for Texas IPM Coordinators; other responsibilities include the school IPM website and *School Pest News* a quarterly newsletter for school IPM coordinators. Janet has conducted IPM Coordinator training for schools in Texas, New Mexico, 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 over 200 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 AgriLife 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@indiana.edu	In 1995, Dr. Lame initiated a school Integrated Pest Management program with the Monroe County Community School Corporation in Bloomington, Indiana. 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. Marc recently published *A Worm in the Teacher's Apple: Protecting America's School Children from Pests and Pesticides*. In April 2008 Marc was recognized by the National IPM Symposium with the first ever IPM Achievement Award.
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@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.
Jack Marlowe, President Eden Advanced Pest Technologies 3425 Stoll Rd. SE Olympia, WA 98501 360 456-0287 jackmarlowe@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.	Dr. Merchant has been actively involved in school IPM issues in Texas since 1992 when he served as chair of the state advisory board that drafted the original pesticide regulations affecting schools in

Dallas, TX 75252-6599 972 952-9204 m-merchant@tamu.edu	Texas. In 1997 he wrote and produced an award-winning set of videos (now DVDs) 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 shared leadership for Texas AgriLife Extension's school IPM program (*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 1300 (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@cdpr.ca.gov	Dr. Messenger was trained in integrated pest management at UC Riverside as part of her doctoral work. She has worked in the school IPM field for over ten years training and conducting outreach to schools and writing technical materials, including two editions of a comprehensive school IPM guidebook. She became the lead of the Child Care IPM Program at the Department of Pesticide Regulation in 2007 and has since written articles for the child care setting, conducted a pest management survey of child care centers and develops and presents IPM talks for child care providers and child care service agency personnel. She continues to work closely with DPR's School IPM team with their IPM efforts, including a periodic

	statewide pest management survey of California public schools.
Kathy Murray, IPM Entomologist Dept. of Agriculture, Food and Rural Resources 28 State House Station Augusta, ME 04333 207 287-7616 kathy.murray@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.
Faith Oi, Assist. Extension Scientist University of Florida Entomology & Nematology Dept. Bldg.970, Natural Area Dr. Gainesville, FL 32611-0064 352-392-1901 ext 145 foi@ufl.edu	Faith Oi is the Director of the Florida School IPM program, with special concern for issues surrounding children's environmental health. She is also the Director of Pest Management University, a hands-on training facility whose mission is to "*be a world leader in training the pest control industry by delivering quality instruction using science-based information on current technologies, with concern for the environment, and human health and well-being*." She does applied research with graduate and undergraduate students to solve industry problems surrounding community IPM.
Chip Osborne Osborne Organics 11 Laurel Street Marblehead, MA 01945 781-631-2468 ozflor@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@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.
Mark Shour, Extension Entomologist Iowa State University 109 Insectary Building Ames, IA 50011-3140 515 294-5963 mshour@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 and an interior pest pilot program. Dr. Shour has participated in school IPM projects in Colorado, Indiana, Missouri, Nebraska, and South Dakota.
Tim Stock IPM Education Specialist Integrated Plant Protection Center Oregon State University 2040 Cordley Hall Corvallis, OR 97331-2915 (541) 737-6279 stockt@science.oregonstate.edu	Tim Stock coordinates the Oregon State University School IPM Program and the State Pesticide Safety Education Program. He 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 IPM in Schools and pesticide risk reduction training. His program is charged with expanding verifiable implementation of IPM in schools through school assessments, outreach and training.
Bob Stoddard EnviroSafe Inc. 1774 Porter St. Wyoming, MI 49519 616 364-1890 bob@envirosafeipm.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.

Michael Waldvogel Dept. of Entomology North Carolina State University Campus Box 7613 Raleigh, NC 27695 919.515.8881 michael_waldvogel@ncsu.edu	Dr. Waldvogel is Extension Associate Professor and Extension Specialist in the Entomology Department. He has extension responsibilities for structural and industrial pests statewide. He serves School IPM Coordinator and the director of the Structural Pest Management Training and Research Facility. Dr. Waldvogel teaches Ornamental and Turf Entomology in the College of Agriculture and Life Sciences' two-year Agricultural Institute. He has served for 16 years as the Vice-Chairman of the North Carolina Structural Pest Control Committee.
Allen Wilson Safe Zone IPM Consultation Service 614 620-1643 safezonecs@wowway.com	Mr. Wilson has been working with the IPM program in the Westerville City School District for six years, 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 in conjunction with OSU Extension Entomology at the Montgomery Educational Service Center in Dayton. 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 L. 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 School District
    PMP credentials: EcoWise, Green Pro, Green Shield Certified, QualityPro Schools.
    US EPA Office of Children's Health
    US EPA Office of Pesticide Programs Pesticide Environmental Stewardship Program: Bronze, Silver and Gold Status
    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