

## **USDA Document**

### **Reducing Risks to Health, the Environment and the Economy through Community IPM – A White Paper for a National Community Integrated Pest Management Initiative**

#### **Abstract:**

Integrated pest management (IPM), in theory and application, has evolved during a period of over 40 years to be applicable in nearly all settings where pests are found. Federal IPM initiatives have traditionally been focused on agricultural commodities, where IPM was used to mitigate pesticide resistance and prevent crop losses through the use of multiple crop management techniques. To many, IPM has become a tool used for managing economic and environmental risk. In recent years, IPM has broadened to include non-agricultural settings and much work has gone into research and resource development to promote IPM in the human environment, or Community IPM. Land grant universities have pieced together programs that address non-agricultural pest management needs, there are a few federally funded programs targeted at specific aspects of Community IPM, but needs are growing and there is no unifying Federal initiative to support States in their attempt to fill this research and extension gap. This paper attempts to define the meaning and scope of Community IPM and proposes a framework that includes partnerships and addresses the issues at the agriculture-urban interface.

#### **Community IPM Defined:**

The concept of IPM has long been recognized in agricultural settings as a way to reduce various risks, prevent pesticide resistance, and optimize the outcomes of pest management practices. In order to address similar needs of non-agricultural pest management, or pest management in places other than the production or trade of a commodity, the idea of Community IPM has been established. Community IPM focuses on the direct interactions between people and pests with development and delivery of feasible and cost-effective pest management tools that pose minimal health and environmental risks. The scope includes a diversity of opportunities, from head lice outbreaks in elementary schools, to pest problems in hospitals, parks, zoos, and museums, to mitigating wildlife damage to utilities. All environments where humans live, work and play are part of Community IPM. It is an expansion of the concept of “urban” pest management that includes non-urban settings, such as athletic fields in rural towns, as well as homes on farmland.

Traditional agricultural IPM focuses on avoiding dietary intake of and worker exposure to pesticides, and reducing a range of environmental and economic risks. Community IPM encompasses pest management in the overall human environment, and in this way overlaps with agricultural IPM in synergistic ways. Both endeavors promote reducing risks by monitoring, recordkeeping, and combining pest control techniques in a logical way. Both involve and affect the public directly, and both aim to protect environmental quality while reducing economic and human health risks. Community IPM often differs, however, in the decision-making criteria. Thresholds that stimulate action are commonly based on human health and comfort, social concerns and aesthetic quality. The impact of

community pests, and tolerance for them, can vary greatly depending on the situation and people involved – making economic impacts difficult to measure and solutions different from site to site. For these reasons, public education plays a significant role in communicating the flexibility, complexities and benefits of Community IPM. By increasing awareness of the risks and benefits of pesticide use, broadening perception of what pest management includes, and promoting the idea of functional thresholds and aesthetic tolerance in places such as the landscape, Community IPM expands public understanding of central issues in agriculture, especially those at the crossroads of agriculture and community.

**Risks Associated with Current Non-Agricultural Pest Management Activities:**

More information is available today about the dangers of pesticide exposure than ever before, yet the public remains largely uninformed about pests and the best means to control them. In 1999 US consumers purchased over \$1.7 billion worth of pesticide products for home and garden use (Donaldson, et al. 2002). Urban and suburban areas account for significant non-agricultural pesticide consumption. As of October 2001, 12,140 pesticide products were registered for residential use in the United States (Audubon 2002). Additionally, the value of the professional landscape, lawn and tree care services industry in the United States has doubled from \$14.6 billion 1997 to \$28.9 billion in 2003 (American Nursery and Landscape Association, 2004).

Agencies, such as the US Environmental Protection Agency, are emphasizing the reduction of environmental risks to children through the promotion of school IPM and the implementation of new pesticide risk evaluation criteria that account for the greater sensitivity of children. Such efforts are helping to slowly raise public awareness of pesticide issues. However, in the non-agricultural sector, pesticides are often misunderstood. For example, well-meaning citizens sometimes create policies that completely ban pesticide use, when no pest management alternatives are available. At the other extreme, many homeowners do not realize that over-the-counter pesticide products are hazardous. The public has little appreciation for IPM as a viable option for minimizing risks from both pests and pesticides. A lack of public awareness also creates the risk of unintentional overuse or misuse of pesticides and fertilizers. The rising incidence of asthma throughout the US, particularly in lower income communities, may be exacerbated by poor pest management practices that expose individuals to pests such as cockroaches (Rosenstreich et al. 1997, Cullinan and Taylor 1994) or some chemical pesticides used to control them (Eskenazi et al. 1999). In general, children are known to be more sensitive to the effects of environmental contaminants than adults (National Research Council 1993). For these reasons, the 1996 Food Quality Protection Act requires the reassessment of many pesticides for cumulative effects of exposure. As a result of FQPA, many non-agricultural pesticide products have been withdrawn from the market. These changes usually necessitate the re-education of licensed applicators about implementation of the law and the use of alternative products and practices to withdrawn products.

Those seeking alternative management products and practices can access a vast amount of information on the internet, where unregulated products and unproven practices are

frequently billed as “safe”, “least-toxic”, “natural” and “fitting into an IPM plan”. In many cases, these products and practices have never been tested. There is a tremendous need to support research and extension in the community pest management arena and create a scientific base for decision-making, as has been traditionally provided for agriculture. Implementation of complete IPM programs that follow the essential steps of inspection, prevention, record keeping, and follow-up evaluation must be promoted. There is a profound need for unbiased research that investigates alternative pest management products and practices and determines their role in IPM programs. Equally important is the need for the continuing education of practitioners, a task that is beyond the capacity of most statewide extension programs.

### **Risks Associated with Non-Agricultural Pests:**

While IPM implementation has begun in many non-agricultural settings, the majority of both problems and solutions remain unexplored. The spectrum of Community IPM is vast and full of needs and opportunities (see Appendices for more information). For instance, critical, emerging issues such as the resurgence of bed bugs, invasive species of mosquitoes, or urban wildlife damage are addressed by very few research and extension personnel. Pests must be safely and effectively managed in buildings frequented by the public, such as museums, where they can pose significant risks to historical items and rare specimens. Pests can be problematic and even dangerous in places such as schools, hospitals, zoos, parks, rights-of-way, airports, airplanes, backyards and almost all conceivable places where humans are present. Invasive species, such as Asian longhorned beetle, are significant community IPM issues as communities weigh pesticide use versus the loss of thousands of trees. Problems like these account for a significant number of the diagnostic questions and recommendations in cooperative extension offices across the nation.

School buildings and grounds are an obvious first target for reducing children’s exposure to pesticides. Yet only 17 states in the US are mandated to practice IPM in schools and childcare facilities, with some additional school districts adopting local policies in the remaining 33 states. Even when IPM policies exist, training and ongoing research efforts are seldom available to support them.

Turfgrass and ornamental plants are another part of the daily surroundings of US citizens where pest and pesticide risks need to be minimized. Urban, suburban and rural dwellers encounter these potential risks at home, in office complexes, and a variety of recreational facilities. For example, there are over 15,828 public and private golf courses in the United States--many of which exist within communities and in close proximity to homes, schools, farms, parks, and protected lands. Golf course managers and members have begun to embrace IPM, but again the research and training resources are woefully inadequate. IPM implementation on golf courses has the potential to protect water quality, wildlife habitat, golfer and worker health, and community resources throughout the US.

More opportunities exist beyond the traditional perception of pest problems and pesticide issues yet require pesticidal remedies. For instance, the application of anti-fouling paints

to the hulls of marine equipment and vehicles is an example of a non-traditional use of pesticides that may comprise a considerable, yet overlooked, quantity of use. Furthermore, the question of whether IPM is applicable to urban wildlife pest problems, where pesticides are not significant tools is being addressed by the nuisance wildlife control industry. This group of experts has begun to define a framework that is consistent with IPM philosophy, such as long-term, sustainable control, with the unique goal of humane treatment of animals. As shown by these examples, the opportunities for Community IPM to minimize environmental and human health risks are everywhere. Reduction of environmental, economic, and human health risks from pests and pest control techniques can be accomplished in a diversity of settings, if sufficient resources are allocated.

### **Agriculture – Urban Interface:**

Community IPM education and demonstration provide a unique opportunity to improve public awareness and understanding of agriculture practices. The audience of Community IPM includes a diverse array of the non-agricultural public, such as the structural, turf and landscape industries and their customers. Additionally, Community IPM addresses many non-traditional audiences such as health and environmental advocates, community groups, school children, indoor air quality professionals, physicians, and health and safety specialists. The Community IPM initiative focuses on assessing risks associated with pests and pesticides and making informed choices about whether and how to manage pests. When people discover options for managing pests in their own homes, they can better understand the choices that farmers make every day. For example, by teaching a homeowner to inspect a shrub for spider mites before considering control methods, a parallel can be drawn to thresholds used in agricultural settings to optimally select and time the use of an insecticide. In addition, Community IPM can communicate to the public the significance of the impact of non-agricultural pesticide use, including the risks posed by homeowner products. Many people are not fully aware of which products used in the home are actually labeled as pesticides. Many do not associate their “four-step” lawn care practices with the use of pesticides. The public is generally very skeptical of pesticide use, yet some may themselves be misusing products or putting others in harm’s way. By raising awareness of all pest management practices, community IPM can enhance public understanding of how food is grown, when judicious pesticide use is warranted, and provides a way to improve the relationship between the public and farmers.

Farming occasionally draws negative attention (real or perceived) from communities, so good public relations are extremely valuable for farmers. For example, flies from farms may infest neighboring schoolyards or homes, or an aerial application of seed may be incorrectly perceived as an application of pesticide. Moreover, Asian ladybeetles, initially released for biological control purposes, invade homes by the millions each fall and cause problems for homeowners. Community IPM provides a channel for educating individuals, groups, and communities about the nature of pest problems, and the causes, risks, and viable solutions. Overall, Community IPM supports agriculture by interfacing with the general public, educating people about relative risks, and empowering people with knowledge to make good decisions in their own environments. This contributes to

better consumer decisions at the supermarket, better-informed policy making, and a greater understanding and respect for those who produce agricultural products.

### **Proposed Solutions:**

Pest management approaches in communities, homes, schools, and parks are evolving as residents are becoming more concerned about their own health, and the health of the environment and its wild inhabitants. Consumers seek environmentally friendly products, such as insecticidal soaps, beneficial microbes, and natural enemies. Many states have school IPM laws and policies that are in various stages of implementation. Some municipalities are phasing out the use of pesticides on public property. Low-input management strategies are being investigated for disease, insect, and weed management on public and private golf courses. But IPM implementation in non-agricultural settings requires the creation of an enormous research base and educational effort. Government funding of research projects will enable many more scientists to contribute to existing information on non-agricultural pests, and significant pests of the agriculture-urban interface. Support of extension programs for community IPM initiatives will enable the expansion of community IPM outreach to practitioners, non-government organizations, and the public. A Federal Community IPM initiative can act as an umbrella, under which extension programs can be developed, stakeholders engaged, priorities determined and addressed, and implementation can take place. Partnerships will be fostered on a national level. Results and outcomes can be documented much in the way they have been in agriculture.

### **Research and Outreach Opportunities:**

Community IPM is a multidisciplinary field with both basic and applied research needs. The basic biology of many pests, particularly invasive species, is often not well understood but is an important component in designing an integrated control approach. Everything about a pest organism, from molecular biology to ecology, may be pertinent to forming a management plan. Applied research is especially significant. For an increasing number of pest problems, traditional products are being eliminated from the market. Community IPM supports efficacy tests of new or alternative products, but emphasizes the need for multiple approaches. Specific pest problems, such as turfgrass disease management on golf courses, require expertise in various disciplines, and result in collaborations between plant pathologists, entomologists, soil scientists, and golf course managers. Today, multidisciplinary approaches are considered a priority by scientists and the agencies funding them.

Research needs in community IPM exist everywhere. Controlling poison ivy without the reliance on conventional herbicides is a high priority issue for municipalities and parks seeking to reduce or eliminate pesticide use. What is the solution? How do alternative disease management treatments, such as the application of compost tea, fit into an IPM program? How can we design a tick IPM program to manage the spread of Lyme disease? How are invasive species management programs incorporated into legislation, such as school IPM laws? After schools, what should be the top priority for community IPM programs? These questions represent a broad sampling of major issues challenging IPM programs throughout the US.

Outreach in the field of Community IPM involves connecting with practitioners of pest management, as well as their customers who have the potential to influence the direction of product and service markets by demand. Community IPM also addresses the interests of environmentally concerned citizens who support reducing the use of pesticides. Community IPM can be used to train the public and practitioners about pest management in sensitive areas, and those used by sensitive individuals who are vulnerable to toxins and impurities. It can be used to approach private food handling establishments that must adhere to health department regulations.

Policies that mandate the reduction or elimination of pesticide use in public areas have also created a tremendous opportunity for IPM research and education. For example, communities that have banned pesticide use on golf courses are now facing questions of how to follow the policy and retain playable recreational facilities. A recent research and demonstration project in New York (Grant and Rossi, 2004) educated policy makers in a neighboring county, resulting in modifications of their local pesticide ban to be more scientific and IPM-based.

There are numerous popular media outlets where the concept and practice of Community IPM can be promoted. Radio public service announcements, radio call-in talk shows, news and magazine articles, news broadcasts, posters, written materials, workshops, school curricula, vendor tables, and internet resources have all been utilized for community and urban IPM publicity efforts to date. However, these efforts have been limited by the lack of targeted, widely available funding. The integration of IPM into K-12 school curricula should also be encouraged as a way of instilling environmental concepts into the next generation and their parents. A successful example of this approach is the widespread adoption of recycling practices nationwide, fostered by the intensive education of school children. School children are an enormous audience that are both vulnerable to the toxic effects of pesticide overuse and open to new ideas through effective education programs. Successful school IPM models have been developed in Florida, Minnesota, Montana, and Pennsylvania. Only a few other states are in the process of developing similar educational programs. By engaging the public in pest management issues in their lives, homes, and communities, the concept of integrated pest management can be taught and reinforced on many levels.

### **Partnerships:**

The partners in a multidisciplinary initiative such as Community IPM are as varied as the settings in which IPM can be implemented. The efforts typically begin with land grant universities and their associated cooperative extension networks. These experts lay the groundwork by conducting research and demonstrations, and gathering and creating the resources needed to promote Community IPM. They in turn engage pest management practitioners, environmental advocates, health and safety officials, master gardeners, and other local and regional connections, all of which have a trusted educational role with the general public. Training workshops, educational materials, Internet and other electronic resources, and innovative teaching tools can be used to multiply the message of Community IPM to a diverse audience of educators.

To date many IPM partnerships have been successful and productive. For instance, in California, eight San Francisco Bay area counties have partnered with local nurseries and hardware stores to provide the public with information about less toxic products and the use of IPM at home. Their goal is to reduce the amount of pesticides entering creeks and bays through sewers and storm drains (Brosseau 2001). The IPM Institute of North America is a non-profit organization that fosters IPM development and recognition of efforts for those who practice IPM. The Institute has partnered successfully with academic institutions and private industry to help bring IPM to K-12 schools throughout the country. By providing IPM standards, the Institute gives schools a tool for self-evaluation and pest management goals to strive for. Several schools have been successful and bear the Institute's "IPM STAR Certification" (IPM Institute 2004). Furthermore, one of the most successful partnerships has been achieved by Audubon International's Cooperative Sanctuary Program, where nearly 300 golf courses have been engaged in environmental stewardship, including the use of integrated pest management and pesticide use reduction strategies. Golfers on these sanctuary courses are offered information about the sanctuary program, thereby multiplying the IPM educational effect (Audubon International 2004). By engaging various stakeholders as both multipliers and audience, Community IPM creates alliances that can bridge gaps between philosophically disparate groups.

### **How Anticipated Results Would be Documented**

In states where IPM is being implemented, surveys often mark the early stages of the effort and represent a baseline of information upon which the program is built. For example, in New York, a survey of school pest management practices was conducted by the New York Agricultural Statistics Service in cooperation with the state IPM program and the NY State Departments of Health and Education. Results are helping researchers and IPM educators to focus on the most critical issues for NY schools. For example, the survey indicated that almost half of the schools in New York have a written pest management policy, but only about 13% have a pest management advisory committee. Therefore, IPM specialists recognize that creation of advisory committees is a priority for their school IPM efforts. In the future, educators in New York will be able to measure the reduction of risk and the adoption of IPM in schools by documenting the changes in policy, practice and opinion from the time of this baseline survey. Over 20 statewide school IPM surveys have been conducted across the United States. These surveys have and will continue to be used to track the trends in pest occurrence, education, awareness, IPM adoption, and pesticide use.

The benefits of IPM include reduced exposure to pesticides. Previous studies have shown that significant amounts of pesticides are tracked into homes by homeowner-applicators and pet dogs after lawns are treated with pesticides (Nishioka et al. 2001). A recently published study of households in East Harlem, NY shows that a significant reduction of risks of exposure to cockroaches and insecticides can be achieved using IPM and targeted education (Brenner et al. 2003). Another study demonstrated the utility of IPM in reducing indoor allergens among children living with asthma in NY (Kinney et al. 2002).

In most cases the IPM strategy costs no more than traditional methods. These types of studies can and should be repeated in a variety of community settings.

Research efforts supported by Community IPM would provide information about pests themselves, alternative pest control products, and the efficacy of new and innovative practices. Demonstration projects will facilitate the adoption of IPM in new situations. Informed policy development will also be facilitated by Community IPM, particularly in challenging settings, such as correctional facilities or on airport runways. As institutions adopt such policies, the efficacy and prevalence of IPM can be documented, published and further promoted.

### **Cost and Timeframe**

Given that Community IPM is in its infancy relative to IPM in agriculture and that it has the potential to benefit all citizens, the timeframe for support is indefinite. The new initiative could encompass all of Community IPM or could be directed at specific components: structural (government, private, homes, schools, restaurants, hospitals, childcare facilities, etc.), turfgrass, trees and shrubs, interior landscapes, or other areas.

As a starting point, it is suggested that \$10 million/yr be directed to support of Community IPM research and outreach. Resources would be allocated to the four regional IPM Centers to enhance existing state programs in Community IPM and a create a new national competitive grants program permitting university and USDA, ARS scientists to advance the management of community pests through fundamental and applied research. Resources would also be used to promote the implementation of Community IPM through extension/outreach programs across the US.

Based on experience from the limited settings where Community IPM is currently being addressed and the intense demand for Community IPM information, adoption of IPM practices in the non-agricultural sector is expected to be relatively rapid. Noticeable results would be expected in most venues within 1-2 yrs. The challenge would be the multitude of pests and settings, and scope of the opportunities.

### **Impact of Community IPM**

The impact of a Community IPM initiative would be felt by every person in the United States. Just as each person consumes agricultural products, they also need to live and work in a safe, healthy environment. Community IPM heightens public awareness of an individual's role in pest management in their own environment, influences consumer decisions and behavior, and informs public policy actions. It emphasizes a logical, integrated (not a "silver-bullet") approach that helps individuals and communities choose the lowest risk approaches to pest management with the greatest benefits. Community IPM also has the capacity to define integrated approaches to non-traditional IPM settings, such as mosquito control, weed management, and nuisance wildlife control, as well as support current national efforts to implement school IPM programs. The goal of an effective National Community IPM program is to promote the management of risks to human health and the environment associated with exposure to pests and the means of controlling pests.



## References

- Audubon. 2002. Audubon at Home, Fast Facts. Vol. 1, No. 1. Audubon Society. Data provided by National Pesticide Telecommunications Network in October 5, 2001 telephone call. Source of their data – National Pesticide Information Retrieval System (NPIRS).
- Audubon International. 2004. Audubon Cooperative Sanctuary Program. Retrieved June 2, 2004 from <http://www.audubonintl.org/programs/acss/golf.htm>
- Brenner, B. L., S. Markowitz, Maribel Rivera, Harry Romero, Matthew Weeks, Elizabeth Sanchez, Elena Deych, Anjali Garg, James Godbold, Mary S. Wolff, Philip J. Landrigan, and Gertrud Berkowitz. 2003. Integrated pest management in an urban community: A successful partnership for prevention. *Environmental Health Perspectives*. 111(13): 1649-1653.
- Brosseau, G. 2001. San Francisco Bay Area's Pesticide Toxicity Reduction Strategy. Retrieved June 2, 2004 from <http://www.epa.gov/ORD/WebPubs/nctuw/Brosseau.pdf>
- Cullinan P, Taylor AJ. 1994. Asthma in children: environmental factors. *British Medical Journal*. 308:1585-1586.
- Donaldson, D., T. Kiely, and A. Grube. 2002. Pesticide Industry Sales and Usage – 1998-1999 Market Estimates. U.S. Environmental Protection Agency, Washington D.C.
- Eskenazi, B., A. Bradman, and R. Castorina. 1999. Exposures of children to organophosphate pesticides and their potential adverse health effects. *Environmental Health Perspectives* 107(suppl 3):409-419.
- Grant, J.A. and F.S. Rossi, 2004. Evaluation of reduced chemical management systems for putting green turf. *USGA Turfgrass and Environmental Research Online*. 3(4):1-13.
- IPM Institute of North America. Retrieved June 2, 2004 from <http://www.ipminstitute.org>
- Kinney, P.L., M.E. Northridge, G.L. Chew, E. Gronning, E. Joseph, J.C. Correa, S. Prakash, I. Goldstein. 2002. *American Journal of Public Health*. 92(1): 24-26
- National Research Council (U.S.). 1993. *Pesticides in the Diets of Infants and Children*. Committee on Pesticides in the Diets of Infants and Children. National Academy Press, Washington D.C.
- Nishioka, M.G., R.G. Lewis, M.C. Brinkman, H.M. Burkholder, C.E. Hines, 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. *Environmental Health Perspectives*. 109 (11): 1185-1191.

Rosenstreich, D.L., P. Eggleston, M. Kattan, D. Baker, R. Slavin, P. Gergen, H. Mitchell, K. McNiff-Mortimer, H. Lynn, D. Ownby, F. Malveaux, (1997) The role of cockroach allergy and exposure to cockroach allergen in causing morbidity among inner-city children with asthma. *New England Journal of Medicine*. 336:1356-1363

## Appendix A. Community (non-agricultural) settings and pests for which pesticides are routinely used in the United States

**Table I. Setting for IPM, types of pests, pesticide use risks, and the benefits of using integrated pest management.**

Setting	Invasive Species	Landscape pests	Structural pests	Turfgrass pests	Vector Control	Greatest risks from pesticides				Integrated Pest Management in this setting will....
						Public Health	Children exposures	Surface and groundwater contamination	Non-target organisms and wildlife effects	
Airport runways (weed management)	*	*	*	*		*		*	*	Protect aviation industry and flight safety without harming environment
Aquariums, public		*	*	*		*	*			Protect public, esp. children's health, protect animals in aquariums
Arboreta and botanical gardens	*	*	*	*	*	*	*	*	*	Help arboreta maintain landscapes without harming environment, help manage invasive species
Athletic fields				*		*	*	*	*	Protect children's health and reduce groundwater contamination
Boats, water craft, docks and marine equipment (anti-fouling paints)	*		*			*		*	*	Protect marine and freshwater environments from contamination with copper-based paints
Cafeterias and concessionaires			*			*	*			Manage food pests and lower risks to public of pesticide exposure
Cemeteries	*	*		*	*	*		*	*	Protect the health of visitors and reduce groundwater contamination
Child day care facilities		*	*	*	*	*	*			Protect children's health
College campuses	*	*	*	*	*	*	*	*	*	Protect the health of students and staff
Correctional facilities		*	*	*		*				Provide livable conditions for inmates without endangering their health
Court houses		*	*	*		*	*			Protect the large number of visitors, help reduce pests introduced by visitors
Municipal farms (4-H and others)	*	*	*	*	*	*	*	*	*	Protect public, esp. children's health, make farming environmentally friendly
Fire, rescue, police, and emergency facilities and vehicles			*			*	*			Protect workers from public health pests, protect workers and public from pesticide exposures

Food processing, transport and storage			*			*				Food industry, consumers, including commercial customers benefit from pest and pesticide-free products
Golf courses, public and private	*	*	*	*	*	*		*	*	Reduce exposure of golf players to pesticides, reduce contamination of groundwater, benefit public and private courses
Greenhouses, municipal and private		*	*			*				Help growers grow better products and prevent exposures through residues
Hospitals		*	*	*		*	*			Protect the ill and infirm from hospital pests and pesticide exposure
Hotels, motels, bed and breakfasts		*	*	*		*	*			Help hotel industry manage pests effectively while protecting health of visitors
Landscapes and lawns	*	*		*	*	*	*	*	*	Protect homeowners and help landscape industry manage pests more effectively
Movie theaters			*			*	*			Protect moviegoers from pesticide exposure and pests, such as lice
Multiple family dwellings	*	*	*	*	*	*	*	*	*	Protect families from unwarranted pesticide use, help prevent spread of pests, such as bed bugs and roaches
Municipal properties	*	*	*	*	*	*	*	*	*	Lower risks of exposure to pests and pesticides, allow municipalities to set a good example for communities
Museums			*			*	*			Protect valuable and historical items and documents from pest damage
New construction		*	*	*		*		*	*	Help construction industry build pests out of new construction and create healthy landscapes from installation
Nursing and elder care facilities		*	*	*		*				Protect the health of the elderly, visitors, and caretakers
Office buildings		*	*	*		*				Protect the health of workers, improve indoor air quality, help prevent sick-building syndrome
Ornamental plant distribution and sales sites		*		*		*		*		Improve pest management of retail garden centers and ornamental growers, while lowering pesticide exposures
Parks	*	*	*	*	*	*	*	*	*	Protect human health and environment, while managing pests effectively, including invasive species
Public transportation			*			*	*			Protect the health of PT users while limiting spread of urban pests
Restaurants			*			*	*			Lower incidence of food-borne illness due to food pests and reduce public health threat of pests and pesticides
Rights-of-way	*	*		*	*	*		*	*	Improve pest management while preventing harm to the environment

Schools		*	*	*	*	*	*	*		Protect children's health by lowering exposure to pests and pesticides
Single family dwellings	*	*	*	*	*	*	*	*		Protect families from unwarranted pesticide use through awareness
Zoos and animal care facilities		*	*	*	*	*	*			Protect the health of captive animals, while reducing pest problems

**Table II. Examples of pests and the associated damage and risks in settings from Table I.**

Types of pests	Damage and risks
<b>Blood feeding pests</b> – bed bugs, fleas, lice, mosquitoes	Vector of parasites, nuisance, allergies, especially in pets, contributes to asthma and allergies, bites lead to anemia, stress, public health pest, nuisance
<b>Dangerous and venomous pests</b> – bees, centipedes, fire ants, ticks, venomous spiders, wasps	Potentially deadly sting, remains of colonies facilitate other pests, nuisance indoors and outdoors, potentially deadly or injurious venomous bite, nuisance and feared pest
<b>Mold and mildew</b>	Contaminates air, can cause severe allergic reactions and sick building syndrome, reduces indoor air quality
<b>Nuisance household pests</b> – centipedes, crickets, earwigs, flies, ladybeetles, silverfish, springtails, wasps	Account for great amounts of pesticide application due to fear and misunderstanding, usually aesthetic or accidental pests, or indicators of other structural problems such as moisture, create aesthetic problems
<b>Pests of food, fabric, and paper</b> – ants, beetles, moths, mites	Destroy natural fibers and cloth, historical items and documents, contaminate and destroy food products
<b>Public health pests</b> – ants, bed bugs, cockroaches, flies, lice, mosquitoes, scabies mites	Present serious threats to public health through food-borne illness, vector-borne illness, asthma, and other direct health complications, plus risk of overexposure to pesticides as treatment for pest
<b>Rodents</b> – mice and rats	Increases asthma and allergies, food borne illness, food contamination, public health pest, structural damage including fires, facilitate mites, ticks, and fleas, nuisance pest indoors and outdoors.
<b>Wildlife</b> – squirrels, birds, chipmunks, raccoons, opossum	Structural damage, public health pest, may carry rabies, facilitate mites, ticks, and fleas, nuisance, create fire hazards, cause significant losses of ornamental plants
<b>Wood-destroying pests</b> – ants, beetles, carpenter bees, termites, mold, borers, bark beetles	Excessive structural wood damage, nuisance pest when swarming indoors, facilitate other wood-destroying pests, especially mold, reduces lifespan of larger trees through destruction of heartwood and cambium
<b>Plant root and crown feeding pests</b> – grubs, wireworms, mole crickets, nematodes, mites	Plants wilt, die, or fail to grow from root and crown damage, which can be extensive and severe, increases drought stress, can render athletic field surfaces unsafe, treatment often involves soil-drenching pesticides
<b>Leaf and stem feeding pests -</b>	Damage occurs through various feeding styles, may facilitate drought stress, transmission of plant disease, reduces fruiting and flowering, causes defoliation and loss of energy-producing leaf surface area.
<b>Plant root diseases -</b>	Loss of newly seeded plants, potential death of larger trees and shrubs that can be very costly to replace, potential loss of rare specimens
<b>Plant leaf and stem diseases-</b>	Can cause great aesthetic damage – sometimes resulting in significant pesticide use, diseases often weaken or kill plants, great economic losses are possible

<b>Diseases of turfgrass-</b>	Can cause rapid and widespread loss of turf (and are often misdiagnosed) resulting in great economic loss and/or pesticide use on golf courses, lawns, and athletic fields
<b>Weeds -</b>	Competition with desirable plants for light, nutrients, and water, disruption of landscape uniformity and visual quality, destruction of high maintenance golf course greens, reduction of cushion and traction of playing surfaces on athletic fields, harborage of plant diseases and arthropod pests, invasive tendencies
<b>Invasive species of plants, animals, and microorganisms</b>	Accidental and intentional introductions disrupt natural ecosystems, destroy habitats such as wetlands, estuaries, lakes, and other sensitive areas, alter the landscape, cause severe crop and ornamental plant losses, threaten protected and endangered species, spread quickly, adapt quickly, may cross-breed with native species, choke waterways, kill livestock, threaten National Parks...