Abstract

Title: **HOME GARDENER PREFERENCES, PERCEPTIONS, KNOWLEDGE AND BEHAVIORS ASSOCIATED WITH PEST MANAGEMENT STRATEGIES AND INFORMATION ACQUISITION**

Amanda Leigh Matheny, M.S., 2009

Directed By: **Dr. Amy Brown, Department of Entomology**

The overuse and/or misuse of pesticides by home gardeners has been verified through various reports indicating home gardeners may fail to recognize opportunities to implement more preferable pest management practices such as Integrated Pest Management (IPM). A series of three surveys, facilitated by Master Gardeners, were conducted to investigate home gardeners' knowledge, values, and attitudes about pest management; changes in their behavior over time; and factors that impact their acquisition of pest management information.

Respondents were primarily over age 50 and highly educated, with a high level of environmental concern. They preferred sources of information that could present both pesticides and alternatives, and preferred to access gardening information from Cooperative Extension, Master Gardeners, and the Internet. These respondents showed strong agreement between environmental concerns and their pest control decisions.

The results of the study will help educators improve the efficacy of educational outreach on IPM and pesticide safety.

HOME GARDENER PREFERENCES, PERCEPTIONS, KNOWLEDGE AND BEHAVIORS ASSOCIATED WITH PEST MANAGEMENT STRATEGIES AND INFORMATION ACQUISITION

Amanda Leigh Matheny

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Advisory Committee:
Professor Amy E. Brown, Chair
Professor Michael J. Raupp
Senior Agent & Director Jennifer Thorn Bentlejewski

Dedication

To my mother, Merla R. Matheny and late father, Thomas W. Matheny, I am forever indebted to you for your love and support. Thank you for always believing in my ability to succeed.

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Chapter One

Introduction

Characterization of the Home Gardener

Gardening is tremendously popular in the United States for numerous reasons. While many home gardeners enjoy gardening to improve the aesthetic value of their living space, other motives for gardening include the desire to grow edible foods, to promote environmental integrity, or simply as a leisure time activity. Various organizations such as the National Gardening Association and other private interest groups conduct market surveys to evaluate and characterize home gardeners. Generally, this information is only available to those willing or able to pay a sizeable yearly fee. This indicates the information is developed for the retail market, and less for the academic community at large. Summaries of the information, however, are available on the Internet. In 2007, the National Gardening Association estimated that 71% of households in the United States, comprising about 82 million households, participated in some form of gardening that year (National Gardening Association, 2008).

Home gardeners can be categorized by their attitudes and beliefs on pest management. A 2005 Environmental Lawn and Garden Survey identified four basic types of gardener with regard to their perspectives on pest management (Butterfield, 2005). The largest group identified, labeled Conventional Gardeners (39%), were described as users of both synthetic fertilizers and conventional chemical control products. Conventional gardeners were followed closely by Hybrid Gardeners (35%), and used both synthetic

and all-natural fertilizers and pest control products and methods. Organic Gardeners (5%) who only made use of all-natural products comprised the smallest group. Gardeners classified as Do-nothing Gardeners (13%) did not use any pest control tactics or fertilizer, and a small percentage of gardeners were classified as Don't Know (8%). These data reflect that the majority of gardeners are potentially using a wide variety of pest control tools and strategies, including the use of both synthetic and all-natural means of pest control.

A prominent pest management approach in the agricultural sector that is becoming more widely emphasized among home gardeners is integrated pest management (IPM). The goal of an IPM strategy is management of pests at acceptable levels rather than eradication. This is accomplished through an understanding of the factors that impact plants in the garden, and employing least-toxic solutions for management of pest problems. IPM can include the use of chemical pesticides when alternatives are unavailable or when other methods are not feasible (Malinoski *et al.* 2003). With the variety of pest management options available to home gardeners, anecdotal information suggests home gardeners will often choose a simple pesticide solution rather than utilizing IPM approaches. When home gardeners choose to use a pesticide, there is also concern that safe use practices may not be implemented. Considerable research has been conducted to characterize public reaction to pests, especially insects (Baldwin *et al.* 2008; Kellert, 1993); however, as with implementation projects very little work has been conducted to examine how home gardeners control or manage pests. According to the University of Maryland Home and Garden Information

Center (UMHGIC), which maintains records of interactions with clientele, it is not uncommon for callers to the UMHGIC hotline to report having used a pesticide without proper diagnosis of the pest situation, or in a manner inconsistent with label directives or recommended practices (Traunfeld, 2008). In many cases, the general public shows apprehension or aversion to insects that do not possess an inherent positive aesthetic or practical value (*e.g.*, butterflies and bees) (Kellert, 1993). In addition to a fear of insects, gardeners may not have an adequate knowledge base on insects which may affect proper management of pest problems (Barrows *et al*. 1983).

The U.S. Environmental Protection Agency (EPA) Pesticide Program Dialogue Committee (PPDC) Consumer Labeling Work Group (PPDC-CLWG) has identified consumers' general failure to read and follow the pesticide label as a problem (Wible & Spagnoli, 2006). The PPDC-CLWG recommended that providing background on the reasoning behind certain label statements would likely increase consumers' compliance with label directions. Aside from a general failure to read pesticide labels, Greishop *et al*. (1992) recognized that home gardeners commonly use rules of thumb, or heuristics regarding decisions made about pest control options, potentially resulting in overly simplified pest management decisions.

Education for home gardeners

The previously discussed studies as well as anecdotal information suggest that home gardeners need additional and/or redesigned educational materials to help shape their pest management decisions. Across the U.S., various approaches to promoting

education for home gardeners about IPM and safe pesticide use have been implemented, but rarely has the impact of these approaches been studied or reported. Only a few instances in the peer-reviewed literature address implementation of direct outreach to homeowners or home gardeners.

One project involved direct outreach to women who were pregnant or had small children and visited health clinics. The women were provided an educational brochure along with a brief message about pesticide safety. These authors concluded that the use of such brochures reinforced by a verbal educational message in the clinical setting was effective in increasing knowledge about pesticides and alternatives to pesticide use (Sklansky *et al.* 2003).

In an urban IPM program developed for home gardeners in the state of Maryland, a series of pilot programs were developed to teach homeowners various IPM strategies such as how to identify pest problems, as well as proper use of pesticides and non-chemical alternatives (Rajotte *et al*. 1987). After participating in the program, homeowners were surveyed to determine differences between those who adopted IPM strategies following the program and those who had not. The researchers found the majority of the education program participants had retained knowledge of and were using IPM practices in their yard or garden. The IPM users were more satisfied with the IPM program, more likely to use general books and Extension services for information, and used monitoring strategies more than non-users. The non-users of IPM were more likely

to employ professional lawn care services, and more non-users used pesticide labels as important information sources.

A mass media campaign conducted in Seattle, Washington between 1997 and 2000 created a character, Bert the Salmon, to influence people to reduce pesticide use on lawns and gardens (Reilly, 2001). The message of the campaign was, "When it comes to your lawn, act naturally." Bert the Salmon was featured in television and radio, at promotional events, educational events, and in distributed informational materials to support the case. This project did evaluate the impact of the outreach. After four years of media advertising, it was concluded the campaign resulted in about a 13% increase in homeowners who left grass clippings on the lawn (a practice recommended through the campaign), and about the same increase in the reduction of pesticide application to lawns. This success story did not come without considerable cost, as project estimates for the four year campaign totaled well over $1,000,000.

Another logical and less costly approach to improve home gardener knowledge about IPM principles and safe use of pesticides has involved outreach through retailers that sell pesticides. A 2007 informal survey of members of the American Association of Pesticide Safety Education (AAPSE) showed that, while several states have implemented such projects, working with retailers and developing sustainable outreach projects has been difficult due to a variety of reasons (Matheny & Brown, 2007). Factors that have proven difficult to resolve include high rates of retail worker turnover, increased desire to promote a sale versus spending time educating clientele, and inconsistency in how

information is provided to the consumer. AAPSE members reported no attempts to evaluate the success of retailer-facilitated educational campaigns by assessing improved practices adopted by clientele.

A project initiated by University of Illinois Extension in 2001 involved the creation of training sessions for retail employees in Illinois on aspects of IPM and pesticide safety (Czapar *et al.* 2004). These investigators concluded that the stores were generally open to offering educational programming, but problems such as time concerns and the inability to maintain trained staff undermined the potential effectiveness of the project.

In at least one case, market research has been paired with educational outreach implemented through retail outlets (Grieshop *et al.* 1990). In Sacramento California, "shelf talker" postcards were made available to consumers in retail outlets advertising free educational outreach materials from the University of California titled, "Using Pesticides Safely in the Home and Yard." After mailing in the postcard, the consumer was then mailed a 16-page informational packet. Consumers were sent either the 1979 publication or a revised 1987 version of the same title. An evaluation was then sent to the consumers asking them about attitudes, opinions and behaviors concerning pesticides as well as general preferences and attitudes toward the publication itself. An important conclusion of this study was that although educators strive to communicate safe pesticide use, many consumers show a strong interest in knowing more about specific techniques

used in pest control. This indicates a need for more advanced educational outreach in addition to the basics.

The material an educator would like to convey is not always the information that is most important to the home gardener (Grieshop *et al.* 1990). Educational materials are not always developed with a clear understanding of the values and needs of the target audience. Educators must understand what home gardeners want to know, what they value, and what they need to know (Kelley & Wehry, 2006). Educators must also consider the best ways to reach out to a broad general audience of people who may be actively seeking information, as well as those who are not, but who might find the information useful (Pounds, 1985).

In a community-oriented approach to transfer IPM knowledge to suburban homeowners, Fear *et al.* (1983) surveyed homeowners in a Michigan town to determine how to best implement an IPM outreach program. This program was developed through joint efforts between Michigan State University project staff and input from the local community. The researchers believed incorporating the community's needs and desires would maximize the transfer and adoption of IPM knowledge by homeowners. Survey respondents reacted favorably to IPM and indicated they preferred to receive information about pest management through manuals and demonstration yards. ProjectPEST was ultimately designed to provide information based on these findings. This study was limited to effective program development and did not measure program impact.

Information on pest management targeted toward the home gardener audience is available from a variety of sources ranging from formal institutions such as Cooperative Extension to informal methods of information delivery or exchange such as friends and neighbors or garden clubs. Outreach may include promoting awareness of IPM, answering home gardener questions, and providing further means for assistance within the gardening realm. Traditional formats include written materials such as books, newspapers or magazines. Hands-on demonstrations and slide programs may be implemented at garden clubs, libraries, plant clinics, and other outreach venues. In recent years, websites as well as home gardening programs delivered through radio and television media have become increasingly prevalent. These websites and programs vary based on the source of the information, the intended target audience, and, sometimes, the source of funding. Evaluation of the effectiveness of websites and television or radio programming has not been published.

Cooperative Extension, and specifically Master Gardeners, represent two well-established infrastructures that can be employed to reach out to the gardening community. While each state makes different use of Master Gardeners, who are volunteers, they all serve as sources of information on gardening and pest management exclusively directed toward home gardeners. The Master Gardener Program recruits motivated gardeners interested in utilizing their interest in gardening and the environment to help home gardeners in their local community make environmentally sound gardening decisions. Every state in the U.S. has a Master Gardener Program, guided by the states' Cooperative Extension to provide educational outreach to the public. In 1972, David

Gibby, a County agent in Washington State, trained volunteers to help Extension staff meet the demands the public communicated for gardening information. Other states facing similar public demands also began Master Gardener programs (McAleer, 2005). Today, Master Gardeners are trained volunteers who interface with home gardeners on various matters related to all aspects of gardening. McAleer (2005) identified three reasons why Master Gardener programs have become so popular in the United States. First, interest in gardening grew with the suburbs, and Master Gardener programs serve to meet this growing demand from avid gardeners. Second, these programs represent a local focus, where more specific needs can be addressed. Last, since Master Gardener programs are part of Cooperative Extension, there is a higher standard for quality, science-based information conveyed to home gardeners via Master Gardeners. Due to the nature of the venues Master Gardeners serve, they have the ability to reach a broad audience. This audience includes gardeners who are very familiar with Master Gardeners as well as gardeners who may not have had any previous interaction with a Master Gardener. However, currently Master Gardeners do not routinely have consistent materials written for the home gardener audience which they can offer to their clientele.

In 2002, The Alliance for the Chesapeake Bay began an outreach project to promote the use of least toxic, most effective pest control methods such as IPM (Alliance for the Chesapeake Bay, 2003). They aimed to do this by providing outreach through retailers and through Master Gardeners. Promotional materials were placed in retail stores, and employees were educated about IPM through in-store presentations. It was concluded that the retailer outreach was successful as measured through increased sales

of products considered less toxic (Alliance for the Chesapeake Bay, 2003; Canadian Centre for Pollution Prevention, 2004; Jermyn, 2005). Unfortunately, the researchers did not solidify a relationship with Cooperative Extension and Master Gardeners prior to implementing the study. By failing to do this, half of their outreach program disintegrated before the idea could be thoroughly examined.

A dual state study in Indiana and Illinois investigated whether an educational program for Master Gardeners would be an effective means to minimize insecticide use and increase adoption of biological control techniques against garden pests (Sadof *et al.* 2004). Along with the educational program, the participating Master Gardeners were provided with tools for conducting research and asked to carry out small-scale studies in their gardens during the growing season. These researchers concluded that an increase in the use of biological control was more likely among those participants who conducted research and also reduced pesticide use following workshops. This study provides evidence that educational programs can impact the behavior of Master Gardeners; however, it did not examine the impacts of knowledge transfer from the Master Gardener to the home gardener.

Limited data indicate that Master Gardeners do not transfer as much information about best practices such as integrated pest management (IPM) as they could. A 2007 University of Maryland Master Gardener report indicated that only 28% of reporting home gardeners learned how to reduce the use of pesticides by “very much”, or “a good

deal" (Traunfeld & Hessey, 2007). This finding reflects a need for improved educational materials for Master Gardeners to use in their outreach.

Study Rationale

Educational outreach directed toward home gardeners has been attempted through various approaches over time. As evidenced above, most educational outreach projects conducted to date have been pure implementation projects. Since most outreach targeting home gardeners has not been evaluated for efficacy, a great deal is still unknown about how home gardeners make decisions about gardening and pest management. Reports and anecdotal accounts of overuse and/or misuse of pesticides by home gardeners indicate gardeners are missing opportunities to implement IPM in their own yard or garden. It would be desirable to develop methods that would promote the use of more environmentally friendly pest management decisions and practices in home gardeners.

Promoting environmentally friendly behaviors in home gardeners begins with providing the best quality educational information on IPM and pesticide safety. To do this, educators must understand the factors that impact use of educational resources, perceptions and attitudes about the environment, pesticides and pest management tactics, and factors that may motivate or limit the adoption of IPM and safe pesticide use by home gardeners. Understanding these factors, educators can better target outreach to improve the chances of adoption and implementation of environmentally friendly decisions and behaviors in home gardeners.

This study was designed to identify the potential motivating factors as well as barriers to the adoption of preferred pest management practices such as IPM and safe pesticide use. This includes identifying home gardeners' preferred sources of educational information, factors associated with information acquisition, specific strategies used in the yard or garden, and environmental and/or human health entities the home gardener is compelled to protect. The study was designed to be facilitated through the Master Gardener program which possesses an established infrastructure for outreach to home gardeners. Through incorporating structured presentations by Master Gardeners, the study was also able to investigate transfer of knowledge from Master Gardeners to home gardeners. The study design also addressed behavioral changes in home gardeners' pest management decisions and practices over time.

There were three overall objectives in the study: 1.) Characterize home gardeners' values, knowledge, and attitudes toward pest management, including IPM. 2.) Identify the factors involved in home gardener acquisition of pest management information. 3.) Assess actual changes in pest management practices and beliefs by home gardeners.

Chapter Two

Materials and Methods

Project Overview

The overall goal of the study was to gain an understanding of home gardeners' values, knowledge, and attitudes toward pest management; identify the factors involved in home gardener acquisition of pest management information; and assess actual changes in pest management practices. A series of three survey instruments and one educational outreach component were developed. The outreach component comprised a PowerPoint set addressing both IPM and pesticide safety.

Home gardeners in Maryland, Delaware, and West Virginia were the target audience for this project. To take advantage of existing successful infrastructure in the three states, the project was designed to be facilitated by Master Gardeners throughout the region. Their role included soliciting participants, delivering the outreach component, and facilitating administration of the survey instruments.

The first survey was aimed at characterizing home gardeners' preferences on sources of gardening information, environmental concerns, and attitudes and beliefs about IPM tactics and pesticides in general. This survey was distributed to home gardeners visiting Master Gardener venues from spring through fall of 2008. Home gardeners who took this survey were also recruited to participate in the third survey (see below).

The second survey was designed to assess knowledge gain following the PowerPoint presentation on IPM and pesticide safety. This survey was conducted on-site following the presentation at various Master Gardener venues. Home gardeners who attended the presentation and took this survey were also recruited to participate in the third survey (see below).

The third survey was developed to assess changes in behavior with regard to pest management and pesticide handling practices. This survey was conducted through e-mail, the U.S. Postal Service, and a secure website.

Approach and Preparation

To achieve a greater understanding of home gardeners in the region of study and to build on the insights of Master Gardeners, the researcher coordinated, conducted, and participated in a series of meetings in the fall of 2007 between the Pesticide Safety Education Coordinator, Master Gardeners, and key state specialists active in pest management, survey design, and Master Gardener training and oversight including the University of Maryland Home and Garden Information (UMHGIC) staff. Outreach pertaining to IPM was identified by the group as a subject home gardeners would benefit from learning more about. The resulting project comprised an educational outreach component as well as the research component.

This project obtained funding from the Northeastern IPM Center (NE IPMC) as a multi-state IPM Issues Project. The goals of the funded project were to maximize the

effectiveness of outreach to home gardeners in Maryland, Delaware, and West Virginia and to evaluate home gardener attitudes, knowledge, and behavior concerning IPM.

Prior to beginning the project, the study protocol was approved by the University of Maryland Institutional Review Board (IRB). The surveys and all accompanying materials were also approved by the IRB. No identifying information was requested on any of the survey components.

Outreach Component

The outreach component of this project included the development of a PowerPoint set with a script to enhance IPM and pesticide safety knowledge transfer between Master Gardeners and home gardeners. In addition, two educational brochures on IPM and pesticide safety were developed to fulfill the requirements of the NE IPMC grant. All of these educational materials were developed in the fall of 2007 with input from the Pesticide Safety Education Coordinator, the staff at the University of Maryland Home and Garden Information Center (UMHGIC), Master Gardeners, University faculty involved in home gardener outreach through Cooperative Extension, as well as state specialists in Delaware and West Virginia. The outreach materials incorporated information for state-specific resources home gardeners could use to access more information about gardening and pest management. Information on these resources was included on a single panel of the tri-fold brochure and was also imbedded in various slides throughout the PowerPoint presentation.

PowerPoint presentation

A 53-slide PowerPoint presentation titled, “Safe and Beautiful Yards: Making Smart Pest Management Decisions” (Appendix 1) was developed for use by Master Gardeners in their educational outreach. The specific concepts presented focused on developing home gardener knowledge of the importance of record keeping in the garden, identifying pests and learning their life cycle, setting personal pest control thresholds, and making decisions about pest management options. The presentation also discussed specific pest management tactics including the use of cultural, biological, physical, and chemical methods. The slide set included a script designed to run approximately 40 minutes. Graphics were used to appeal to home gardeners, and to reinforce concepts presented in the slide set. The PowerPoint presentation addressed general principles of IPM applicable to home gardeners in the Northeast. Because Master Gardeners and campus specialists had provided insight into the fact that home gardeners would likely be unfamiliar with the terms “integrated pest management” or the acronym, IPM, a decision was made to refrain from heavy use of the terms. Instead, a focus was placed on developing a step-wise strategy for pest management that included all of the relevant portions of an integrated pest management approach. The steps in the strategy included: (1) Monitor Your Landscape, (2) Identify the Pest, (3) Learn the Life Cycle of the Pest, (4) Decide Your Pest Threshold, (5) Consider all Control Methods, (6) Choose and Use a Control Method, and (7) Take Note of Results. The PowerPoint identified all of these steps and provided reasons why they are necessary in a good pest management program. Specific control options were also reviewed in the PowerPoint to provide the audience with an understanding of the variety of choices they have when making their pest

management decision. This PowerPoint set was an integral part of the research project. It was utilized in assessing home gardeners' knowledge gain.

Brochures

Development and distribution of two brochures fulfilled a commitment to the grant agency. Although they focused on subjects integral to the study project, they were not a direct component of the research project. The brochure titled "Creating Safe and Beautiful Yards" (Appendix 2) focused on best management practices/IPM practices for home gardens, lawns, and landscapes that could be adopted by home gardeners in the Northeast. Concepts covered in this brochure included prevention of pest infestations, identifying and learning about pests, and safe management of pests including pesticides and alternatives to pesticides. The tri-fold brochure was split into three main panels with the following headings: "Prevent Pests in Your Yard", "Learn About Pests You Find", and "Safely Manage Pests." This information also included the specific reasons why a home gardener should perform these preferred practices. One panel titled, "Resources for Information about Caring for Your Yard" included local resources for the home gardener. The resources on this panel were unique to each participating state.

The second brochure, titled, "Using Pesticides Safely to Manage Pests and Protect Your Environment" (Appendix 3), addressed best pesticide handling practices for home gardeners. This tri-fold brochure was split into three main panels with the following headings: "Before Using a Pesticide", "During Pesticide Application", and "After Using a Pesticide." The content included safety procedures associated with pesticide use.

Information was organized temporally, focusing on best practices before, during and after the use of a pesticide. This information also included the specific reasons why a home gardener should perform these preferred practices. One panel titled, “Resources for Information about Caring for your Yard” included local resources for the home gardener. The resources on this panel were also unique to each participating state.

Research Component

Survey instrumentation development

Specific questions in the survey instruments were developed through working collectively with the Pesticide Safety Education Coordinator, the UMHGIC staff, Master Gardeners, and other University faculty involved in home gardener outreach and/or survey design. The UMHGIC and University faculty provided examples of past questionnaires used to evaluate home gardeners, and provided assistance on specific questions asked in the questionnaires. Three different questionnaires were developed, all of which were submitted, processed, and approved by the University of Maryland IRB.

Solicitation of subjects

Master Gardeners in Maryland, Delaware, and West Virginia were recruited to facilitate both the outreach and research components of the project. Specialists from each state were contacted via e-mail or telephone to discuss the project. The specialists advised the researcher on how to best gather support for the project in their states and provided information on contacting county extension offices or county Master Gardener coordinators. In total, 77 counties were contacted by e-mail about the project in

Maryland, Delaware and West Virginia during the winter and spring of 2008. This included 19 counties in Maryland including Baltimore City, all three counties in Delaware, and all 55 counties in West Virginia. These contacts served to inform each county about the research project as well as to generate Master Gardener volunteer support of the research project components in each state. In most cases, the researcher was placed into direct contact with interested Master Gardeners (through e-mail or telephone number) by the county Master Gardener coordinator, allowing for direct transfer of study materials between the researcher and the Master Gardener. In a few cases the county Master Gardener coordinator preferred to remain the main contact and distributor of study materials to Master Gardeners in their county.

Participating Master Gardeners were sent the educational materials and the research components, including questionnaires, via U.S. Mail. Their role in the project included recruiting home gardeners to participate in the various surveys, presenting the PowerPoint outreach tool, administering two of the surveys, and returning collected surveys to the researcher. A small monetary incentive, described below, was offered to home gardeners willing to participate in the third survey.

The first survey was designed to identify attitudes and beliefs about pest management as well as motivating factors or barriers to the adoption of IPM practices. The second questionnaire focused on assessing knowledge transfer of IPM principles to home gardeners who attended a Master Gardener's PowerPoint presentation, "Safe and Beautiful Yards: Making Smart Pest Management Decisions." The third and final

questionnaire served as a follow-up to the first and second questionnaires and examined changes in behavior concerning pest management and adoption of IPM practices.

As an incentive to participate in the third questionnaire, respondents of the first and second questionnaire who signed up to participate in the follow-up survey were entered into a random drawing to win a $25.00 gift card to a garden center. A sign-up sheet that was separate from the questionnaire was provided (Appendix 4) for those interested, and the home gardener was asked to provide either a home address or e-mail address for follow-up contact.

Survey one: Attitudes and beliefs about pest management

The first questionnaire (Appendix 5), focusing on pest management attitudes and beliefs, hereafter referred to as Q.AB, was developed in the winter of 2008 for use in the spring and summer of 2008. A preliminary set of questions was pilot-tested on a group of aspiring Master Gardeners in St. Mary's County, Maryland to assess structural- and content-related issues such as the overall organization of questions, or whether particular questions were confusing. The results and comments from the pilot-tested responses were used to refine the questionnaires to be used in the research project. Improvements made on the basis of results of the pilot test included changes to the directions for answering each question, reading level, terminology, and overall "look" of the questionnaire. Questions assessed information sources home gardeners felt were good, conveniences associated with obtaining information, environmental and human health concerns,

likelihood of using IPM tactics, factors involved in a choosing pest control method, perceived gaps in knowledge, and demographic information.

The resulting final version of Q.AB consisted of twelve multi-part questions. The question types included multi-answer partially closed-ended questions, open-ended questions, a scenario-based closed-ended question, closed-ended questions, and Likert-Scale closed-ended questions. Likert-Scale, first described by Rensis Likert, is a method of assessing respondent attitudes or opinions by supplying survey participants with a range of response alternatives on which to choose a level of agreement (Likert, 1932; Clayson & Dormody, 2000).

Master Gardeners volunteering at venues such as farmer's markets, plant clinics, State and county fair events, and other similar sites facilitated the distribution and collection of the first questionnaire. Home gardeners approaching Master Gardeners at these sites were asked to participate in the survey. The Master Gardener also asked these home gardeners if they would be interested in being contacted for a follow-up survey (survey three, below) to assess implementation of pest control practices.

Q.AB was also made available on-line through a web link on the University of Maryland Home and Garden Information Center (UMHGIC) website at http://www.hgic.umd.edu. The on-line questionnaire was developed in the same structure and format as the paper version of the same survey using the on-line survey software Survey Monkey at http://www.surveymonkey.com. The UMHGIC maintains a hotline

home gardeners can call to ask Master Gardeners specific gardening questions. Master Gardeners solicited the hotline callers to participate in the on-line version of Q.AB by directing the home gardener to navigate to the UMHGIC website homepage. Home gardeners simply seeking on-line resources from this website were also able to reach the on-line version of Q.AB. The final question on this on-line version of Q.AB solicited home gardeners to be contacted for the follow-up survey to assess implementation of pest control practices (survey three, below). Interested participants were able to provide either a home or e-mail address for follow-up contact.

Survey two: IPM knowledge transfer

The second questionnaire (Appendix 6), which addressed IPM knowledge transfer (Q.KT), was developed in the winter of 2008 for use in the spring and summer of 2008. The principles learned from the previously described pilot-test findings were also applied to the development of Q.KT. Questions assessed home gardeners' perceived knowledge of various IPM components before and after viewing the PowerPoint presentation, the perceived impact of the presentation on future behavior, and demographic information. In keeping with the more casual format of the PowerPoint presentation, the researcher chose to test perception of knowledge rather than actual knowledge which would have required a more formal quiz format. To measure perceived knowledge gain from the presentation, the survey was designed as a post-then-pretest evaluation rather than a standard pretest-posttest research design. Asking survey respondents to compare perception of knowledge before and after an educational event has been shown to be a useful way of adding strength to outcome assessment (Taylor-Powell & Renner, 2000). In many situations the

post-then-pre test design is preferable when assessing populations that may not initially have adequate knowledge to sufficiently answer questions about their behavior (Rockwell & Kohn, 1989). In the case of the current research project, it was believed the respondents might understand a particular concept related to integrated pest management (IPM), but might not have adequate knowledge of some of the terminology associated with this subject. Other question types included Likert-Scale closed-ended questions, open-ended questions and closed-ended questions.

Participating Master Gardeners were asked to present the PowerPoint set with script verbatim to address home gardeners attending Master Gardener meetings at libraries and other venues. Following the presentation, the Master Gardener asked the home gardeners to participate in the brief questionnaire, Q.KT. After completion of Q.KT, the Master Gardener collected responses and asked the home gardeners if they were willing to be contacted for a follow-up survey to assess implementation of pest management practices (survey three, below). A sign-up sheet (Appendix 4) was provided for those interested, and willing home gardeners were asked to provide either a home or e-mail address for follow-up contact.

Survey three: Pest management behavioral changes

The third questionnaire (Appendix 7), focused on pest management behavioral changes (Q.BC), was developed in the fall of 2008 for use in the winter. The principles learned from the previously described pilot-test findings were applied to the development of Q.BC. Results of qualitative data collected on pest control information sources in

Q.AB were also used in development of questions on Q.BC. Questions on Q.BC assessed monitoring and control of pests from a past and present perspective, beliefs about specific types of pesticides (fungicides, herbicides, and insecticides), changes in behavior over time, sources of pest management information, reasons for choosing certain sources, and demographic information. This questionnaire consisted of 14 multi-section questions. The question types included a partially closed-ended question, closed-ended questions, multi-answer closed ended-questions, open-ended questions, and multiple-answer partially closed-ended questions.

Because it had been envisioned that recruitment of participants for survey three would be the most difficult (*i.e.,* there was no direct contact with a facilitating Master Gardener at the actual time of the survey), a monetary incentive was offered for participating in this survey. Those who enrolled to be contacted for the survey were entered into a drawing for a $25.00 gift certificate to a garden supply store.

Participants in surveys Q.AB and Q.KT who had signed up to be contacted for the follow-up survey were contacted (Appendices 8 and 9) in the winter of 2008, as described below. A period of one month was allowed for respondents to complete the questionnaire. Reminders were sent out to all participants extending the deadline for completion by one week.

Participants who had provided an e-mail address for contact were sent an email memo (Appendix 8) with a Word file attachment of the questionnaire. These participants

were instructed that they could (1) open the attached Word file, print out the questionnaire, complete the questions, and mail the completed questionnaire back to the researchers at the University of Maryland via U.S. Mail, or (2) open the attached Word file, complete the questions, re-save the document, and e-mail it back to the researchers. Participants were also able to (3) complete and submit the questionnaire on-line through a provided web-link via Survey Monkey at: http://www.surveymonkey.com.

Participants who had provided a U.S. Mail address for contact were sent a hard copy of the survey and instructions (Appendix 9) indicating that they could (1) complete the questions on the paper copy and mail the completed questionnaire back to the researchers via U.S. Mail in a provided, postage-paid envelope, or (2) complete and submit the questionnaire on-line through a provided web-link via Survey Monkey at: http://www.surveymonkey.com.

Institutional Review Board Compliance

To fulfill the confidentiality agreement with the IRB, no identifying information was asked of respondents on Q.AB, Q.KT, or Q.BC. Master Gardeners sent completed questionnaires to the researchers at the University via U.S. Mail. Upon arrival, the completed responses were locked in a secure location at the University of Maryland, College Park.

The study was conducted in compliance with all IRB requirements concerning information provided to potential study participants. Master Gardeners facilitating

administration of Q.AB and Q.KT were provided two folding signs constructed of 8”x11” cardstock that could be folded to sit upright on a table. The first folding sign (Appendix 10) was titled, “Assessment of Pest Management Opinions,” and provided information on the purpose of the first questionnaire and also informed readers that no identifying information was requested. The second folding sign (Appendix 11) was titled “Implementation of Pest Control Practices,” and explained the purpose of the follow-up survey as well as the confidentiality agreement. This sign also described the $25.00 gift card incentive for signing up to participate in Q.BC. Both folding signs provided contact information for the researchers at the University of Maryland.

Questionnaire Analysis

Data from returned questionnaires were entered into the Statistical Package for Social Sciences (SPSS 16.0) for Windows for analysis at the University of Maryland. Each questionnaire (e.g. Q.AB, Q.KT, and Q.BC) was entered into a different SPSS file for separate analysis of each questionnaire.

Survey one: Attitudes and beliefs about pest management (Q.AB)

Descriptive statistics including frequencies and percentages were examined for all questions presented in Q.AB to characterize respondents’ attitudes and beliefs. A series of chi-square goodness of fit tests were conducted to determine how well gardeners’ stated concerns were reflected in their stated likely pest control decisions. Four chi-square goodness of fit tests were conducted. These tests were conducted on pairs of concerns and actions where the connection was less obvious. One test examined

respondent concern for bee populations and the likelihood that the respondent would apply a pesticide in the early morning or evening. Another focused on concern for natural enemies and the importance that a pest control method kill all of the pests rather than just control them. The final two tests conducted examined concern for water sources (in the respondent's own yard as well as water sources affected by urban runoff) with the likelihood that the respondent would leave a pesticide untreated strip of land next to areas that drain into water sources.

Qualitative data were collected in Q.AB. Qualitative results concerning sources of gardening information used by these respondents were collected and incorporated into Q.BC as potential information sources used by home gardeners in making pest management decisions. Additional qualitative responses were collected to determine reasons the respondents would choose a pesticide over a non-pesticide alternative, or would choose a non-pesticide alternative over a pesticide and were coded by the researcher into categories. Qualitative responses throughout the entire study were conceptualized via coding based on fitting the data into categories identified by the researcher (Strauss, 1987). The categories were not defined before data collection, but were instead defined after all responses were collected. This process, understood as Grounded Theory, allows for a more context-sensitive view of qualitative data responses (Miles & Huberman, 1984). Another open-ended question queried perceived gaps in knowledge and topics of interest for more education. Responses to the open-ended portion of this question were collected and coded into categories.

Survey two: IPM knowledge transfer (Q.KT)

Descriptive statistics included frequencies and percentages to characterize respondent demographics as well as whether respondents would use and share information learned from the PowerPoint presentation. Mean and standard deviation were computed for each question for respondent understanding of concepts before and after presentation viewing. Paired-samples t-tests were also computed for each question to determine perceived knowledge change from before and after viewing the presentation.

Since the PowerPoint presentation was used to educate both home gardeners as well as new Master Gardeners in training, the response data were also split and examined individually for each group. To allow the researcher to separate the data appropriately, Master Gardeners who participated in Q.KT were asked to indicate on their questionnaire that they were a Master Gardener by writing "MG" on the top of the questionnaire. To examine potential differences between the groups, mean and standard deviation were computed as well as paired-samples t-tests for each item in the questionnaire.

Qualitative data responses were collected to determine other topics the respondents learned about that were not covered in Q.KT. Another question focused on determining other topics of interest of respondents that were not included in the PowerPoint presentation. These responses were coded by the researcher into categories according to the procedures described above (Miles & Huberman, 1984; Strauss, 1987).

Survey three: Pest management behavioral changes (Q.BC)

Frequencies and percentages were computed for the majority of the questions on Q.BC. These descriptive statistics were used to characterize demographics, tactics used in the yard or garden, perceptions of pesticide risk, and information sources used to make pest management decisions. A series of six contingency tables were computed to examine perceptions of risks associated with insecticides, herbicides, and fungicides to humans and pets, and to the environment over time with potential changes in pest control behavior over time.

Respondents were asked to identify methods used to control insect, weed, and disease pests in the past and within the last year. Mean and standard deviation were computed for each pest control method used in the past as well as within the last year. Paired-samples t-tests were also conducted to determine differences in respondents' pest management behavior over time. Qualitative responses were collected to determine alternate methods of controlling insect, weed or disease pests in the past and within the last year. Qualitative data were also collected concerning information sources used by respondents in making pest management decisions, and the reasons the respondent preferred a particular source as a major source of information.

Chapter Three

Results

Survey One: Attitudes and Beliefs about Pest Management (Q.AB)

Survey participation

A total of 313 surveys were completed and returned from home gardener participants in Maryland, Delaware, and West Virginia combined. Counties in which Master Gardeners facilitated the surveys included 10 from Maryland (41.7% of total counties) three in Delaware (100% of total counties) and two in West Virginia (3.6% of total counties). The survey was also distributed by Master Gardeners at the Maryland State Fair. It should be noted that actual county of residence of participants is unknown. The majority of the questionnaires completed were from the state of Maryland, followed by Delaware, and West Virginia respectively (Table 1).

Table 1. State of origin respondents completed survey. (n=313)

Location	No. (%)
Maryland	162 (51.8)
Delaware	52 (16.6)
West Virginia	33 (10.5)
Unknown State of Origin	66 (21.1)

Demographics

The median age category of respondents was between 51 and 60 years of age (Table 2). These home gardeners were extremely well educated with well more than half of respondents possessing a Bachelor's degree or higher.

Table 2. Respondent demographics.

Demographic (n)	No. (%)
Age (years) (n= 298)	
Under 20	5 (1.7)
21-30	10 (3.4)
31-40	24 (8.1)
41-50	64 (21.5)
51-60	87 (29.2)
61-70	86 (28.9)
> 71	22 (7.4)
Highest Education Level (n=297)	
Grade School	4 (1.3)
High School	28 (9.4)
Some College	45 (15.2)
Associate's Degree	32 (10.8)
Bachelor's Degree	82 (27.6)
Graduate Degree	106 (35.7)

Information acquisition preferences

Respondents were asked to choose good sources for various types of gardening-related information (Table 3). More than half the respondents reported Master Gardeners, Cooperative Extension, and the Internet as good sources for both general gardening information and information on pest management. These same three sources were also identified by respondents as their top sources for information on pesticides and non-pesticide alternatives. Library resources were also rated as a good source for general gardening information by 44.4% of respondents, and by a fifth to a quarter of respondents for most other information. Only about a quarter of respondents chose pest control companies as a good source for information even on pest management or pesticides.

Table 3. Perceptions of information sources on gardening and pest management information.[1] (n=313)

	No One	Master Gardener	Neighbor	Cooperative Extension	Employees at a Retailer	Pest Control Company	Resources on the Internet	Resources at a Library	Other
Factor	**No. (%)**	**No. (%)**	**No. (%)**	**No. (%)**	**No. (%)**	**No. (%)**	**No. (%)**	**No. (%)**	**No. (%)**
A good source for general gardening information	3 (1.0)	216 (69.0)	85 (27.2)	176 (56.2)	61 (19.5)	21 (6.7)	192 (61.3)	139 (44.4)	31 (9.9)
A good source for pest management information	3 (1.0)	164 (53.2)	35 (11.4)	172 (55.8)	53 (17.2)	76 (24.6)	162 (52.6)	84 (27.3)	28 (9.1)
Has provided me a positive past experience	7 (2.3)	150 (49.8)	68 (22.6)	149 (49.5)	59 (19.6)	25 (8.3)	140 (46.5)	76 (25.2)	32 (10.6)
A good source for pesticide information	9 (3.0)	139 (46.8)	16 (5.4)	151 (50.8)	56 (18.9)	70 (23.6)	143 (48.1)	63 (21.2)	27 (9.1)
A good source for pesticide alternative information	8 (2.7)	149 (50.2)	21 (7.1)	134 (45.1)	15 (5.1)	24 (8.1)	140 (47.3)	71 (23.8)	23 (7.7)
A source I would LIKE to get information from	12 (4.3)	153 (55.4)	19 (6.9)	148 (53.6)	30 (10.9)	21 (7.6)	114 (41.3)	52 (18.8)	14 (5.1)

[1]Respondents could select more than one response

This survey question presented an option for respondents to identify additional sources of good information for the various types of gardening information. Respondents identified books or references they already own, magazines, newspapers, family, friends, television, radio, garden clubs and podcasts.

Respondents were also asked to identify the level of importance of various factors in obtaining information. The following were most often rated as very important by respondents: distance required to travel (70%), time required to access (65.9%), cost to obtain information (64.2%), and that the information is available without leaving home (52.5%) (Table 4). Only about one-third of respondents indicated they did not want to have to use the Internet to access pest control information. While most of the factors listed were related to ease of obtaining information, more than 90% of respondents reported that it was at least somewhat, if not very important, that an information source be able to provide both pesticide and non-pesticide alternative information.

Table 4. Importance of factors involved in pest control information acquisition.

Factor (n)	No. (%)
Information is available without leaving home (n=303)	
Very Important	159 (52.5)
Somewhat Important	113 (37.3)
Not Important	26 (8.6)
Don't Know	5 (1.7)
Cost of obtaining information (n=307)	
Very Important	197 (64.2)
Somewhat Important	83 (27.0)
Not Important	19 (6.2)
Don't Know	8 (2.6)
Time required to access information (n=305)	
Very Important	201 (65.9)
Somewhat Important	89 (29.2)
Not Important	15 (4.9)
Don't Know	0 (0.0)
Travel distance required to obtain information (n=307)	
Very Important	215 (70.0)
Somewhat Important	71 (23.1)
Not Important	17 (5.5)
Don't Know	4 (1.3)
Does not require Internet access (n=301)	
Very Important	44 (14.6)
Somewhat Important	59 (19.6)
Not Important	87 (62.1)
Don't Know	11 (3.7)
Source offers pesticide AND alternative information (n=305)	
Very Important	226 (74.1)
Somewhat Important	52 (17.0)
Not Important	18 (5.9)
Don't Know	9 (3.0)

Home gardener values

A series of questions queried respondents about factors that impact their choice of a particular pest control method. For the majority of the factors, more than 80% of respondents indicated the factor was somewhat if not very important (Table 5). The only exception involved availability from catalogues or through the Internet, which was identified as somewhat if not very important to 68.4% of respondents. A method that is least harmful to the environment (98.7%), is easy to use (97.3%), and is least harmful to humans (97%) were the top three factors reported as somewhat, if not very important.

Table 5. Factors involved in choosing a pest control method.

Factor (n)	No. (%)
Is easy to use (n=301)	
Very Important	206 (68.4)
Somewhat Important	87 (28.9)
Not Important	7 (2.3)
N/A	1 (.3)
Is available where I already shop (n=299)	
Very Important	123 (41.1)
Somewhat Important	128 (42.8)
Not Important	44 (14.7)
N/A	4 (1.3)
Is available from catalogues or through the Internet (n=294)	
Very Important	69 (23.5)
Somewhat Important	132 (44.9)
Not Important	85 (28.9)
N/A	8 (2.7)
Is least harmful to humans (n=303)	
Very Important	273 (90.1)
Somewhat Important	21 (6.9)
Not Important	9 (3.0)
N/A	0 (0.0)
Is least harmful to the environment (n=305)	
Very Important	276 (90.5)
Somewhat Important	25 (8.2)
Not Important	4 (1.3)
N/A	0 (0.0)
Is recommended by a source I already know (n=299)	
Very Important	124 (41.5)
Somewhat Important	132 (44.1)
Not Important	42 (14.0)
N/A	1 (0.3)
Can be used on or near vegetable gardens or fruits (n=301)	
Very Important	227 (75.4)
Somewhat Important	54 (17.9)
Not Important	12 (4.0)
N/A	8 (2.7)
Will kill the pests (not just keep them under control) (n=300)	

Very Important	156 (52.0)
Somewhat Important	106 (35.3)
Not Important	35 (11.7)
N/A	3 (1.0)

When asked about specific concerns when deciding on a pest control method, 75% of the respondents rated all of the factors as “lots of concern” except for water sources in their own yard, which was rated at this level by 74.3% (Table 6). The top concern was protection of the family/home/yard (97.9%), followed by the surrounding neighborhood (97.7%), and protection of natural enemies (97.3%). Almost 96% of respondents expressed at least some concern for protecting bee populations, and 93.5% expressed at least some concern for protecting water sources that could be affected by urban runoff. Protection of self (93.2%), pets living around the home (88.9%), children (87.5%), and water sources in the respondents own yard were also of at least some concern to respondents in choosing a pest control method.

Table 6. Entities respondents want to protect when choosing a pest control method.

Factor (n)	No. (%)
Family/home/yard (n=307)	
Lots of Concern	279 (90.9)
Some Concern	22 (7.2)
No Concern	4 (1.3)
N/A	2 (0.7)
The surrounding neighborhood (n=305)	
Lots of Concern	233 (76.4)
Some Concern	65 (21.3)
No Concern	5 (1.6)
N/A	2 (0.7)
Children in the home or around the yard (n= 305)	
Lots of Concern	242 (79.3)
Some Concern	25 (8.2)
No Concern	23 (7.5)
N/A	15 (4.9
Pets living around the home or yard (n=306)	
Lots of Concern	244 (79.7)
Some Concern	28 (9.2)
No Concern	24 (7.8)
N/A	10 (3.3)
Yourself as an applicator of a pest control method (n=307)	
Lots of Concern	232 (75.6)
Some Concern	54 (17.6)
No Concern	18 (5.9
N/A	3 (1.0)
Natural enemies (n=302)	
Lots of Concern	232 (76.8)
Some Concern	62 (20.5)
No Concern	6 (2.0)
N/A	2 (.7)
Bee populations (n=304)	
Lots of Concern	243 (79.9)
Some Concern	48 (15.8)
No Concern	12 (3.9)
N/A	1 (.3)
Water sources in your own yard (n=304)	

Lots of Concern	226 (74.3)
Some Concern	30 (9.9)
No Concern	24 (7.9)
N/A	24 (7.9)
Water sources that could be affected by urban runoff (n=307)	
Lots of Concern	244 (79.5)
Some Concern	43 (14.0)
No Concern	13 (4.2)
N/A	7 (2.3)

Use of integrated pest management (IPM) tactics

Respondents were asked how likely they are to perform certain IPM tactics in their yard or garden (Table 7). Concerning all of the IPM strategies, 75% or more of respondents indicated they were at least somewhat likely to take a particular action. The top three actions these respondents indicated they were somewhat or very likely to take included pulling out weeds by hand (96.7%), promoting plant diversity in the landscape (94.4%), and willingness to accept some number of insect pests or damage to plants (94.1%).

Table 7. Likelihood of using a specific IPM strategy.

Factor (n)	No. (%)
Regularly monitor your landscape for pests (n=306)	
Very Likely	151 (49.3)
Somewhat Likely	123 (40.2)
Very Unlikely	31 (10.1)
N/A	1 (0.3)
Choose a pest control method that is easy to use (n=291)	
Very Likely	147 (50.5)
Somewhat Likely	123 (42.3)
Very Unlikely	13 (4.5
N/A	8 (2.7)
Use mulch to prevent weeds (n=303)	
Very Likely	216 (71.3)
Somewhat Likely	67 (22.1)
Very Unlikely	19 (6.3)
N/A	1 (0.3)
Spot treat localized weeds (n=302)	
Very Likely	138 (45.7)
Somewhat Likely	94 (31.1)
Very Unlikely	66 (21.9)
N/A	4 (1.3)
Pull out weeds by hand (n=305)	
Very Likely	244 (80.0)
Somewhat Likely	51 (16.7)
Very Unlikely	10 (3.3)
N/A	0 (0.0)
Promote plant diversity in your landscape (n=304)	
Very Likely	210 (69.1)
Somewhat Likely	77 (25.3)
Very Unlikely	14 (4.6)
N/A	3 (1.0)
Accept some number of insect pests or damage to plants (n=305)	
Very Likely	168 (55.1)
Somewhat Likely	119 (39.0)
Very Unlikely	16 (5.2)
N/A	2 (0.7)
Accept some number of weeds in your landscape (n=305)	

Very Likely	152 (49.8)
Somewhat Likely	126 (41.3)
Very Unlikely	26 (8.5)
N/A	1 (0.3)
Use knowledge about the life cycle of a pest to help with control (n=305)	
Very Likely	152 (49.8)
Somewhat Likely	109 (35.7)
Very Unlikely	43 (14.1)
N/A	1 (0.3)

The next set of questions focused on consideration and use of pesticides on the lawn or garden (Table 8). About 2/3 (67.9%) of respondents indicated they were very likely to consider alternatives to the use of pesticides, and 59% were very unlikely to consider only pesticide options for control. An overwhelming majority (85.6%) of respondents indicated they were very likely to take special measures to protect children or pets from pesticide exposure as opposed to 63.5% of respondents who indicated the same level of likelihood for protecting wildlife in the yard.

Table 8. Likelihood of using a specific pesticide-related strategy.

Factor (n)	No. (%)
Consider only pesticide options (n=300)	
Very Likely	36 (12.0)
Somewhat Likely	82 (27.3)
Very Unlikely	177 (59.0)
N/A	5 (1.7)
Consider alternatives to the use of pesticides (n=296)	
Very Likely	201 (67.9)
Somewhat Likely	84 (28.4)
Very Unlikely	7 (2.4)
N/A	4 (1.4)
When using a pesticide, leave an untreated strip of land next to areas that drain into water sources (n=297)	
Very Likely	128 (43.1)
Somewhat Likely	71 (23.9)
Very Unlikely	46 (15.5)
N/A	52 (17.5)
When using a pesticide, apply in the early morning or evening (n=295)	
Very Likely	148 (50.2)
Somewhat Likely	93 (31.5)
Very Unlikely	18 (6.1)
N/A	36 (12.2)
Take special measures to protect wildlife in your yard from pesticide exposure (n=299)	
Very Likely	190 (63.5)
Somewhat Likely	76 (25.4)
Very Unlikely	19 (6.4)
N/A	14 (4.7)
Take special measures to protect children or pets from pesticide exposure (n=298)	
Very Likely	255 (85.6)
Somewhat Likely	19 (6.4)
Very Unlikely	11 (3.7)
N/A	13 (4.4)

Home gardener beliefs and behaviors

To determine whether home gardeners' concerns are reflected in the actions they are likely to take, a series of chi-square tests were conducted using data on respondents' reported concerns or the importance placed on certain entities and likely actions (Table 9). The hypothesis for all tested cases stated that each frequency for the response choices would occur an equal number of times.

Respondent concern for bees was tested with the likelihood that, when the gardener applies a pesticide, they do so in the early morning or evening. The significant deviation from the hypothesis for this chi-square test ($X^2(9)= 18.916$, $p=.026$) indicates respondents who expressed concern for protecting bees were, in fact, more likely to apply a pesticide in the early morning or evening. A closer look into a cross-tabulation of the frequency of responses indicates that respondents who expressed lots of concern for protecting bee populations were, by far, more likely to apply pesticides in the early morning or evening (Table 10).

Respondent concern for protecting water sources in the yard was compared with the likelihood that, when using a pesticide, the respondent leaves an untreated strip of land next to areas that drain into water sources. The significant deviation from the hypothesis for this chi-square test ($X^2(9)= 22.192$, $p=.008$) indicates respondents who expressed concern for protecting water sources in the yard were, in fact, more likely to leave an untreated strip of land next to areas that drain into water sources.

Concern for protecting more distant water sources that could be affected by urban runoff was compared with the likelihood that, when using a pesticide, the respondent leaves an untreated strip of land next to areas that drain into water sources. The significant deviation from the hypothesis for this chi-square test ($X^2(9)= 21.316$, $p=.011$) indicates respondents who expressed concern for protecting more distant water sources were, in fact, more likely to leave an untreated strip of land next to areas that drain into water sources.

Concern for natural enemies was compared against the desire to use a pest control method that would keep pests under control as opposed a method that would kill all of the pests. The lack of significant deviation from the hypothesis for this chi-square test ($X^2(9)= 3.608$, $p=.935$) indicates respondents who expressed concern for protecting natural enemies were, in fact, not more likely to choose a pest control method that would just keep pests under control rather than kill all of the pests.

Table 9. Condensed results of chi-square goodness of fit tests.[1]

Factors (n)	X^2	df	Sig (2-sided)
Concern for bee populations, When using a pesticide, apply early morning or evening (n=291)	18.916[a]	9	.026*
Concern for water sources in own yard, When using a pesticide, leave an untreated strip of land next to areas that drain into water sources (n=294)	22.192[b]	9	.008*
Concern for water sources that could be affected by urban runoff, When using a pesticide, leave an untreated strip of land next to areas that drain into water sources (n=296)	21.316[c]	9	.011*
Concern for natural enemies, importance pest control method will kill all pests (n=295)	3.608[d]	9	. 935

[1] * Implies significance at $\alpha = 0.05$
[a]Eight cells (50.0%) had an expected frequency of less than five
[b]Five cells (31.3%) had an expected frequency of less than five
[c]Seven cells (43.8%) had an expected frequency of less than five
[d]Ten cells (62.5%) had an expected frequency of less than five

Table 10. Cross-tabulation of concern for bees and the likelihood of using pesticides in the early morning or evening. (n=291)

Concern for bee populations		When using a pesticide, apply early in the morning or evening			
		Very Likely	**Somewhat Likely**	**Very Unlikely**	**N/A**
		(No.)	**(No.)**	**(No.)**	**(No.)**
	Lots of Concern	127	60	15	30
	Some Concern	17	24	2	4
	No Concern	2	7	1	1
	N/A	1	0	0	0

Choice between pesticides and non-pesticide alternatives

Respondents were presented with specific scenarios and the option to choose between using a pesticide or a non-pesticide alternative control method for control in each case. In the majority of the scenarios, 75% or more of the respondents indicated a desire to use a non-pesticide alternative as the preferred method of control (Table 11). Even if the non-pesticide alternative takes longer to work, more than half of the respondents indicated a desire to use the non-pesticide alternative method. Exceptions to the desire to use non-pesticide alternatives included the scenarios where the alternative was more expensive than the pesticide, and when the pesticide is considered more effective. When the alternative was presented as being more harmful than the pesticide to humans or the environment, 55.1% of respondents reported a desire to use a pesticide.

Table 11. Motivating factors for choosing pesticide or alternative method.

	Use a Pesticide	Use an Alternative Method	Unsure
Scenario (n)	**No. (%)**	**No. (%)**	**No. (%)**
The pesticide and the alternative are effective with little difference in cost (n=296)	21 (7.1)	253 (85.5)	22 (7.4)
Using the pesticide would control your current pest, but might result in the OUTBREAK of a different pest (n=295)	11 (3.7)	239 (81.0)	45 (15.3)
The alternative is MORE EXPENSIVE than the pesticide (n=297)	58 (19.5)	168 (56.6)	71 (23.9)
The pesticide will control the pest immediately. The alternative will TAKE SOME TIME to control the pest (n=290)	69 (23.8)	170 (58.6)	51 (17.6)
The pesticide will manage the pest but will also KILL THE PEST'S NATURAL ENEMIES (n=297)	19 (6.4)	246 (82.2)	32 (10.8)
The pesticide is MORE EFFECTIVE than the alternative (n=295)	115 (39.0)	107 (36.3)	73 (24.7)
Repeated use of a pesticide might lead to that pesticide being LESS EFFECTIVE for YOU in the future (n=296)	15 (5.1)	241 (81.4)	40 (13.5)
Repeated use of a pesticide might lead to that pesticide being LESS EFFECTIVE for FARMERS in the future (n=295)	9 (3.1)	229 (77.6)	57 (19.3)
The PESTICIDE is easier to use than the alternative but is MORE HARMFUL to humans or the environment (n=295)	11 (3.7)	263 (89.2)	21 (7.1)
The ALTERNATIVE is easier to use than the alternative but is MORE HARMFUL to humans or the environment (n=292)	161 (55.1)	59 (20.2)	72 (24.7)

Qualitative data on use of pesticides or non-pesticide alternatives

Two questions were asked of respondents on Q.AB to determine other reasons they would choose a pesticide rather than a non-pesticide method, and why they might choose a non-pesticide method over a pesticide. Responses were coded for both questions separately. In many cases, the respondent's answer overlapped over categories, so for a single response the answer may have been coded in two different categories.

One-hundred and one responses were collected indicating reasons for choosing a pesticide over a non-pesticide alternative method. The major reasons for choosing a pesticide over a non-pesticide method were coded into seven categories, plus a category for unclear responses (nearly 14%). Nearly 19% of this subset of respondents indicated factors concerning convenience of obtaining the method or speed of the method as a reason to choose a pesticide over a non-pesticide alternative. About 15% of respondents indicated they would use a pesticide because it is a proven effective method. Another 19% stated they would use a pesticide in severe situations that have no alternative. About 13% indicated they would only use a pesticide as a last resort, or when other methods had not shown results. Fewer than 10% of respondents indicated they would choose to use a pesticide when the pest poses a threat to humans, animals or structures. The smallest percentage of respondents (4.9%) indicated lack of knowledge of alternatives as a reason to choose a pesticide. About 14% stated they would never use a pesticide.

A total of 99 responses were collected from respondents indicating reasons for choosing a non-pesticide alternative method over a pesticide. Five categories of responses

were created plus a category for unclear responses (13%). Nearly 69% of respondents indicated they would choose a non-pesticide method over a pesticide method because of safety concerns, including humans, pets and/or the environment. Eight percent of respondents reported a desire to use a non-pesticide as long as it was effective, convenient, and/or easy to use. About 8% of these respondents also stated that they preferred not to use conventional pesticides, and about 3% described a personal interest in trying alternative methods and sharing what they find with others. Another 3% of respondents mentioned cost as a reason to use a non-pesticide method.

Perceived gaps in knowledge

Respondents indicated most interest in learning more about IPM approaches including recognizing beneficial insects (70.7%), using natural enemies to control pests (69.1%), and choosing least-toxic pesticides for humans (62.5%) and the environment (66%) (Table 12). Fewer than 50% of respondents indicated a desire to learn more about any of the pesticide-related items offered in this question.

Eighteen people responded to the open-ended question asking for additional topics. Using plants that are less susceptible to pests or that promote beneficial organisms was indicated by five respondents. Three respondents expressed desire to learn more about least-toxic pest control methods. How lawn control might affect water wells, better ways to dispose of chemical pesticides, and how to access or synthesize alternative controls were each identified by two respondents as subjects on which they would like

more information. Four responses to this open-ended question were uncategorizeable and appeared unrelated to the question. Each of these was mentioned by only one respondent.

Table 12. Respondents' desire for specific knowledge.[1] (n=259)

Topic	No. (%)
Safely use pesticides	100 (38.6)
Properly store pesticides	85 (32.8)
Properly dispose of pesticides	122 (47.1)
Understand pesticide label directions	56 (21.6)
Choose appropriate protective clothing for pesticide use	56 (21.6)
Recognize beneficial insects in the yard	183 (70.7)
Use natural enemies to control pests	193 (74.5)
Use non-pesticide control methods	179 (69.1)
Choose least-toxic pesticides for humans	162 (62.5)
Choose least-toxic pesticides for the environment	171 (66.0)
Other	18 (6.9)

[1]Respondents could select more than one response

Survey Two: Knowledge Transfer (Q.KT)

Survey participation

A total of 52 surveys were completed by a mixture of both urban and rural gardeners in Maryland, Delaware, and West Virginia combined. The initial target audience of the PowerPoint presentation was the general gardening public; however, in some cases, the presentation was actually used to train new Master Gardeners. Two of the three participating states decided to incorporate the PowerPoint presentation as a learning tool for new Master Gardeners in training. Thirty-one of the survey respondents were Master Gardeners in training (59.6%), and 21 respondents were regular home gardeners (40.4%).

Demographics

The average age of respondents was between 61 and 70 years (Table 13). There were no respondents under 30 years of age. Almost three-quarters had a Bachelor's degree or higher and about 45% of respondents possessed a graduate degree.

Table 13. Respondent demographics.[1] (n= 51)

Demographic	No. (%)
Age (years)	
Under 20	0 (0.0)
21-30	0 (0.0)
31-40	1 (2.0)
41-50	4 (7.8)
51-60	9 (17.6)
61-70	25 (49.0)
> 71	12 (23.5)
Highest Education Level	
Grade School	0 (0.0)
High School	2 (3.9)
Some College	10 (19.6)
Associate's Degree	2 (3.9)
Bachelor's Degree	14 (27.5)
Graduate Degree	23 (45.1)

[1] One respondent on Q.KT did not report demographic information

Perceived knowledge about IPM

Following the PowerPoint presentation, all participants (both regular gardeners and Master Gardeners in training) answered a series of questions about their knowledge of IPM before and after viewing and hearing the presentation. The first set of questions focused primarily on basic IPM principles. Mean and standard deviation were computed for respondent understanding of IPM principles before and after viewing the presentation (Appendix 12).

A series of paired-samples t-tests were conducted to compare the means from the post-then-pre test on knowledge of basic IPM principles (Table 14). The paired-samples t-tests indicated significant increases ($\alpha = 0.05$) in perceived knowledge gain on all concepts queried except one. No significant difference in knowledge gain was associated with learning about reasons to protect pollinators in the yard ($t(51)= 1.939$, $p=.058$). The mean for this concept prior to viewing the presentation was 2.88 (sd=.323), and the mean following the presentation was 2.98 (sd=.139).

Table 14. IPM knowledge before and after educational presentation: All respondents.[1, 2]

Topic	t-value	df	Sig (2-sided)
How monitoring your yard for pests helps in making pest control decision	6.153	51	.000*
The importance of correctly identifying a pest	4.335	51	.000*
How understanding pest life cycles helps in their control	5.907	51	.000*
Why the goal of good pest control should be managing pests rather than killing all of the pests	5.019	51	.000*
How to use cultural controls to manage pests	5.236	51	.000*
How to use physical controls to manage pests	3.267	51	.002*
How to promote natural enemies in your yard	5.646	51	.000*
Reasons to protect pollinators in our yards	1.939	51	.058
What IPM means (what the letters stand for)	2.817	51	.007*
Where to find reliable resources for gardening and pest management information	5.196	51	.000*

[1] * Significance at $\alpha = 0.05$

[2] Responses were made on a 3-point Likert Scale (1= did not or do not understand, 3= understood or understand well)

Since the PowerPoint was presented to both regular gardeners and Master Gardeners in training, mean and standard deviation on perceived knowledge of basic IPM principles were calculated for each group separately, (Appendices 13 and 14). Paired-

samples t-tests were also conducted separately for each group to determine differences in responses among the two groups of gardeners (Table 15). While the basic trends remained intact suggesting an overall increase in perceived knowledge, there were two concepts on which Master Gardeners and regular gardeners differed in perceived knowledge gain.

Regular gardeners demonstrated a significant increase in knowledge gain about how to use physical controls to manage pests, whereas Master Gardeners did not gain significant knowledge of this concept ($t(30)= 1.793$, $p=.083$). The mean for Master Gardeners prior to viewing the presentation was 2.87 (sd=.341), and the mean following the presentation was 2.97 (sd=.180).

Conversely, Master Gardeners demonstrated a significant increase in knowledge gain concerning the meaning of the acronym, IPM .Regular gardeners did not gain significant knowledge of this concept ($t(20)= 1.451$, $p=.162$). The mean for regular gardeners prior to viewing the presentation was 2.86 (sd=.359), and the mean following the presentation was 2.95 (sd=.218).

Table 15. IPM knowledge before and after educational presentation: Regular Gardeners vs. Master Gardeners.[1, 2]

	Regular Gardeners				Master Gardeners		
Topic	**t-value**	**df**	**Sig (2-sided)**		**t-value**	**df**	**Sig (2-sided)**
How monitoring your yard for pests helps in making pest control decision	4.382	20	.000*		4.353	30	.000*
The importance of correctly identifying a pest	3.508	20	.002*		2.683	30	.012*
How understanding pest life cycles helps in their control	4.564	20	.000*		4.062	30	.000*
Why the goal of good pest control should be managing pests rather than killing all of the pests	3.286	20	.004*		3.780	30	.001*
How to use cultural controls to manage pests	4.690	20	.000*		3.057	30	.005*
How to use physical controls to manage pests	2.828	20	.010*		1.793	30	.083
How to promote natural enemies in your yard	3.873	20	.001*		4.062	30	.000*
Reasons to protect pollinators in our yards	1.000	20	.329		1.793	30	.083
What IPM means (what the letters stand for)	1.451	20	.162		2.402	30	.023*
Where to find reliable resources for gardening and pest management information	3.162	20	.005*		4.062	30	.000*

[1] * Significance at $\alpha = 0.05$

[2] Responses were made on a 3-point Likert Scale (1= did not or do not understand, 3= understood or understand well)

The second collection of questions focused on potential effects of pesticides, pesticide use, and safety. Mean and standard deviation were also computed for respondent understanding of pesticide-related knowledge and understanding before and after viewing the presentation (Appendix 15).

Another series of paired-samples t-tests was conducted to compare the means from the post-then-pre test on knowledge of pesticide effects, use and safety (Table 16). Significant increases in perceived knowledge gain were found for all of the tests (α = 0.05).

Table 16. Pesticide knowledge before and after educational presentation: All respondents.[1,2]

Topic	t-value	df	Sig (2-sided)
Potential benefits of using pesticides	4.123	51	.000*
Potential human health risks of pesticides	3.708	50	.001*
Potential environmental risks of pesticides	2.820	50	.007*
How pests become resistant to pesticides	5.794	48	.000*
How runoff or drift can move pesticides through the environment	2.817	51	.007*
Why chemical control should preferably be considered only when alternatives are unavailable or when benefits outweigh the risks	3.120	51	.003*
The importance of using the smallest effective amount of a pesticide	3.267	51	.002*
The importance of reading the pesticide label	2.062	51	.044*
The role of pesticides in the development of a secondary pest outbreak	7.189	50	.000*

[1] * Significance at α = 0.05

[2] Responses were made on a 3-point Likert Scale (1= did not or do not understand, 3= understood or understand well)

Again, mean and standard deviation on knowledge gain on pesticide effects, use, and safety were calculated separately for regular gardeners and for Master Gardeners in training (Appendices 16 and 17). Paired-samples t-tests were also conducted separately for each group to determine differences in responses among the two groups (Table 17). The basic trends remained intact suggesting an overall increase in perceived knowledge, but there were three instances where Master Gardeners and regular home gardeners differed on perceived knowledge gain.

Regular gardeners demonstrated a significant increase in knowledge gain about potential environmental risks of pesticides, whereas Master Gardeners did not gain significant knowledge about this topic ($t(29)= 1.493$, $p=.161$). The mean for Master Gardeners prior to viewing the presentation was 2.83 (sd=.379), and the mean following the presentation was 2.90 (sd=.305).

Master Gardeners demonstrated a significant increase in knowledge concerning why chemical control should be considered only when alternatives are unavailable or when benefits outweigh the risks, but regular gardeners did not demonstrate a significant increase in knowledge on this topic ($t(20)= 1.826$, $p=.083$). The mean for regular gardeners prior to viewing the presentation was 2.76 (sd=.436), and the mean following the presentation was 2.90 (sd=.301).

Master Gardeners also demonstrated a significant increase in knowledge concerning how runoff or drift can move pesticides through the environment. Regular

gardeners did not demonstrate a significant increase in knowledge on this topic (t(20)= 1.451, p=.162). The mean for regular gardeners prior to viewing the presentation was 2.71 (sd=.561), and the mean following the presentation was 2.81 (sd=.512).

While combining mean scores and conducting a paired-samples t-test for Master Gardeners and regular gardeners produced a significant increase in perceived knowledge gain concerning the importance of reading the pesticide label, this was not the case when a paired-samples t-test was conducted on each group separately. A significant increase in knowledge was not demonstrated by Master Gardeners for this concept (t(30)= 1.000, p=.325). The mean for Master Gardeners on this concept prior to viewing the presentation was 2.90 (sd=.301), and the mean following the presentation was 2.94 (sd=.250). Concerning the regular gardeners, a significant increase in knowledge was not demonstrated for this concept (t(20)= 1.826, p=.083). The mean for regular gardeners prior to viewing the presentation was 2.86 (sd=.359), and the mean following the presentation was 3.00 (sd=.000).

Table 17. Pesticide knowledge before and after educational presentation: Regular Gardeners vs. Master Gardeners.[1, 2]

	Regular Gardeners				Master Gardeners		
Topic	**t-value**	**df**	**Sig (2-sided)**		**t-value**	**df**	**Sig (2-sided)**
Potential benefits of using pesticides	3.508	20	.002*		2.402	30	.023*
Potential human health risks of pesticides	2.828	20	.010*		2.408	29	.023*
Potential environmental risks of pesticides	2.500	20	.021*		1.439	29	.161
How pests become resistant to pesticides	4.067	19	.001*		4.137	28	.000*
How runoff or drift can move pesticides through the environment	1.451	20	.162		2.402	30	.023*
Why chemical control should preferably be considered only when alternatives are unavailable or when benefits outweigh the risks	1.826	20	.083		2.528	30	.017*
The importance of using the smallest effective amount of a pesticide	2.609	20	.017*		2.108	30	.043*
The importance of reading the pesticide label	1.826	20	.083		1.000	30	.325
The role of pesticides in the development of a secondary pest outbreak	5.587	20	.000*		4.817	29	.000*

[1] * Significance at $\alpha = 0.05$

[2] Responses were made on a 3-point Likert Scale (1= did not or do not understand, 3= understood or understand well)

Perceived impact of IPM on future behavior

Respondents indicated a strong likelihood of sharing the information they learned from the presentation with their friends and/or family (80.8%) (Table 18). Similarly, more than three-quarters (76.9%) indicated the information they learned from the presentation would very likely impact the way they manage pests in the future.

Table 18. Likelihood of impact: All respondents. (n=52)

Action	No. (%)
How likely are you to share what you learned today with friends and/or family?	
Very Likely	42 (80.8)
Somewhat Likely	10 (19.2)
Very Unlikely	0 (0.0)
Do you believe this presentation will impact the way you manage future pest situations?	
Very Likely	40 (76.9)
Somewhat Likely	12 (23.1)
Very Unlikely	0 (0.0)

Frequencies and percentages were computed to examine differences between regular gardeners and Master Gardeners on the likelihood that they would share the information they learned from the PowerPoint presentation. A majority of regular gardeners (66.7%) indicated they would be very likely to share the information they learned with friends or family, and 33.3% indicated they were at least somewhat likely to share what they learned. An overwhelming 90.3% of Master Gardeners indicated they were very likely to share the information they learned with friends or family, and almost 9.7% indicated they were at least somewhat likely to take this action.

Frequencies and percentages were also computed to examine differences between regular gardeners and Master Gardeners on the likelihood that the presentation would impact the way they manage their own pest situations in the future. A majority of regular

gardeners (85.7%) indicated it was very likely the presentation would impact their future pest management behavior, and 14.3% indicated it was somewhat likely the presentation would have an impact. Seventy-one percent of Master Gardeners indicated it was very likely the presentation would impact their future pest management behavior, and 29.0% indicated it was somewhat likely that the presentation would have an impact on behavior.

Qualitative data analysis

Qualitative data were collected in Q.KT to assess other items respondents learned about from the presentation and topics they would like to learn more about that were not covered in the presentation. Seventeen responses were collected concerning topics the respondents learned about that were not mentioned in Q.KT. The majority of respondents (76.5%) replied with information unrelated to the question. For those respondents of this question that did respond correctly (23.5%), the responses included: That there is a Northeastern IPM Center; Pheromone traps can draw good and bad insects, from other areas, not just your own; Importance of understanding IPM and its benefits to the environment and people as a society; and Importance of removing debris.

A total of 22 responses were collected concerning topics of interest that were not covered in the presentation. Five respondents described wanting to learn more about beneficials including which animals are beneficial, and how to protect and promote them. Four respondents indicated they would like to learn more about specific IPM- related pest control methods. The use of organic methods was indicated by two respondents. Two respondents also indicated a desire to learn more in depth about IPM, or specific

information related to IPM in vegetable gardens. Another two respondents indicated a desire to learn more about how to identify insects or weeds. Other responses indicated by only one respondent each were as follows: Danger to children and pests of garden chemicals and how lawn treatment effects children; Natural pest cycle and why some years a pest is bad, but hardly there the next year; Example of a pesticide label; Define resistance; People need to set a higher threshold of tolerance; and How pests can cause damage in all cycles of life. Two responses unrelated to the question included comments of "Nothing" or a general critique of the presentation.

Survey Three: Pest Management Behavioral Changes (Q.BC)

Survey participation

In total, 73 home gardeners signed up to be contacted to participate in Q.BC. At the time of Q.BC distribution, a total of 6 e-mail addresses failed to send and bounced back to the researcher. Out of the remaining 67 successful contacts, 15 (23.4%) were sent via U.S. Mail. The remaining 52 contacts were sent information about Q.BC via personal e-mail addresses. A total of 41 surveys were completed and returned by a mixture of both urban and rural gardeners, reflecting a 61.2% response rate. The majority of respondents completed the survey on-line (65.9%), followed by U.S. Mail (24.4%) and E-mail (9.8%).

Respondents were asked the type of venues at which they had been approached to enroll to take Q.BC (Table 19). The majority of respondents indicated the initial survey

they took was Q.AB through the University of Maryland Home and Garden Information website (36.6%).

Table 19. Enrollment venue. (n=41)

Location	No. (%)
On-line through UM HGIC website	15 (36.6)
Responded at other location	8 (19.5)
County fair event	4 (9.8)
Farmer's market	4 (9.8)
Respondent did not know where they were approached	4 (9.8)
Respondent did not take an initial survey	3 (7.3)
Garden club meeting	2 (4.9)
Plant clinic	1 (2.4)
State fair event	0 (0.0)

Qualitative data were coded to look at the venues respondents listed as other locations (19.5%). Six of the eight respondents (75%) indicated they took the initial survey at a Master Gardener meeting. The other two respondents (25%) reported they took the initial survey at the Boonsboro Craft Fair.

Demographics

The average age of participants was between 51 and 60 years of age (Table 20). About 70% of respondents had graduated from college, with 19.5% possessing a Bachelor's degree and 48.8% a graduate degree. Although almost 40% of respondents had been gardening for 21 or more years, about half the respondents had 15 or fewer years of experience.

Table 20. Respondent demographics. (n=41)

Demographic	No. (%)
Age (years)	
Under 20	0 (0.0)
21-30	1 (2.4)
31-40	7 (17.1)
41-50	11 (26.8)
51-60	7 (17.1)
61-70	10 (24.4)
> 71	5 (12.2)
Highest Education Level	
Grade School	0 (0.0)
High School	1 (2.4)
Some College	9 (22.0)
Associate's Degree	3 (7.3)
Bachelor's Degree	8 (19.5)
Graduate Degree	20 (48.8)
Gardening Experience (years)	
Less than 5	4 (9.8)
6-10	8 (19.5)
11-15	8 (19.5)
16-20	5 (12.2)
> 21	16 (39.0)

Maintenance of the yard or garden

Respondents were asked a series of questions to determine how they generally monitor for pests, make control decisions, and maintain their yard or garden. Three-quarters of respondents reported they use a monitoring technique, with the majority (65.9%) indicating their monitoring technique involved "eyeballing" how the yard looks, *i.e.* making an informal assessment (Table 21).

Table 21. Monitoring technique. (n=41)

Action	No. (%)
Eyeballing how the yard looks	27 (65.9)
Counting the number of pests on a plant or within an area	4 (9.8)
Do not monitor for pests	10 (24.4)

Sixty-one percent of respondents indicated they set some sort of threshold for level of insect pest damage, and 43.9% indicated they do the same for weed pests (Table 22). Far more respondents (50%) indicated they control weeds as soon as they are noticed them than those who reported controlling insect pests as soon as they are noticed (15%).

Table 22. Pest action threshold.[1] (n=41)

Action	No. (%)
Control insect pests as soon as they are noticed	6 (14.6)
Do not control insects pests until they reach a certain number	8 (19.5)
Do not control insect pests until a certain level of plant damage is reached	25 (61.0)
Control weeds as soon as they are noticed	21 (51.2)
Do not control weeds until they reach a certain number or level	18 (43.9)

[1]Respondents could select more than one response

Using native plants, removing debris, and using resistant cultivars were the most commonly reported actions relating to preparation and maintenance of the yard or garden (Table 23).

Table 23. Preparation and maintenance of the yard or garden.[1] (n=40)

Action	No. (%)
Use plants native to the area respondent resides	29 (72.5)
Use resistant cultivars	25 (62.5)
Remove debris from the yard or garden	28 (70.0)
Use preventative insecticides on the lawn or garden to prevent pests	7 (17.5)
Use preventative herbicides/weed killers on the lawn or garden to prevent pests	10 (25.0)

[1]Respondents could select more than one response

Pest management

A section of Q.BC focused only on those who controlled a pest within the last year. Thirty-two respondents (78%) indicated they had experienced a pest control situation in the past year that required control. The statistics in the next six sections do not include the ineligible respondents.

Eligible respondents (those who had experienced a pest control situation in the past year that required control) were asked a series of questions about specific pest management techniques that could be used in insect, weed, and disease pest control. They were asked whether they had used a particular method in past, within the last year, or if the method was not applicable. Within each block, if a single question was left blank, the response was counted as not applicable.

1. Control of insect pests

Respondents were asked a series of questions about specific behaviors which they had used to control insect pests in the past, and which they had used within the last year. Mean and standard deviation were computed for practices implemented to control insect in the past and within the last year (Appendix 18).

Paired-samples t-tests were computed to determine whether respondents' insect pest control behavior had changed over time. Only one significant change in behavior was found for all of the tested insect pest control measures (Table 24). Concerning use of insect traps, the mean score for use of the method in the past was 1.47 (sd=.512) and the

mean score for use of the method within the last year was 1.84 (sd=.375). A significant difference was found between use of insect traps this year compared to previous years (t(18)= -2.689, p=.015). These data reflect a decreased use of insect traps within the last year compared to the past.

Table 24. Tactics to control insect pests: Past vs. present.[1, 2]

Action (n)	t-value	df	Sig (2-tailed)
Accepted some level of damage or number of insects before taking action	.811	24	.425
Used an insecticide as a first option for control	.000	16	1.00
Used an insecticide as a last option for control	1.283	21	.213
Spot treated with an insecticide	-.371	22	.714
Treated the entire lawn and/or garden with an insecticide	-1.468	14	.164
Used a non-insecticide approach as a first option for control	1.000	23	.328
Used a non-insecticide approach as a last option for control	-.562	12	.584
Used a trap (sticky trap or other) to control an insect pest	-2.689	18	.015*
Promoted or released natural enemies to control an insect pest	-.566	17	.579
Hand-picked or pruned off insects	.000	21	1.000
Used insecticidal soap to control an insect pest	-.436	15	.669
Used horticultural oil to control an insect pest	-.437	17	.668

[1] * Significance at $\alpha = 0.05$

[2]Note: A response of "Yes" was coded = 1. A response of "No" was coded = 2

Qualitative data were collected to determine whether there were other methods used by respondents controlling insect pests currently or in the past. Very few responses indicated a use of pesticides in the past and within the last year. The following methods were each indicated by one respondent.

- Insect Control in the Past:
    - Companion planting to encourage beneficials

    - Promoted the growth/reproduction of praying mantids and toads
    - Ignored the pests and tried insecticide soap
    - Hormone traps
    - Learned to tolerate them
- Insect Control This Year:
    - Inundated with stink bugs. Pesticides didn't work but a flock of starlings came and cleared up the problem
    - Companion planting to encourage beneficials
    - Promoted the growth and habitat of toads
    - Diatomaceous earth
    - Identified pest and spot treated with rotenone
    - Pepper and garlic spray

2. *Control of weed pests*

Respondents were asked to report the specific weed control behaviors which they had used in the past, and which they had used within the last year. Mean and standard deviation were computed for practices implemented to control weed pests in the past and within the last year (Appendix 19).

Paired-samples t-tests were computed to determine whether respondent weed control behavior had changed over time. Only one significant change in behavior was found for all of the tested weed pest control measures (Table 25). In the case of pulling weeds out by hand, the mean score for the past was 1.16 (sd=.374), and the mean score for this year was 1.00 (sd=.000). A significant difference was found between use of the hand-pulling of weeds as a pest control method in the past compared to within the last year ($t(30)= 2.402$, $p=.023$). These data reflect an increased use of hand-pulling of weeds within the last year compared to the past.

Table 25. Tactics to control weeds: Past vs. present.[1, 2]

Action (n)	t-value	df	Sig (2-tailed)
Accepted some amount of weeds before taking action	-.811	24	.425
Used a herbicide as a first option for control	.000	16	1.000
Used a herbicide as a last option for control	.567	19	.577
Spot treated specific weeds or problem areas with a herbicide	-.810	22	.426
Treated the entire lawn and/or garden with a herbicide	-1.143	18	.268
Used a non-herbicide approach as a first option for control	1.447	22	.162
Used a non-herbicide approach as a last option for control	-1.000	14	.334
Pulled out weeds by hand	2.402	30	.023*

[1] * Significance at $\alpha = 0.05$

[2]Note: A response of "Yes" was coded = 1. A response of "No" was coded = 2

Qualitative data were collected to determine whether there were other methods used by respondents controlling weeds this year or in the past. The majority of responses about weed control in the past and within the last year centered on the use of mulches as a control tactic. Unless otherwise noted, each of the following responses was indicated by one respondent.

- Weed Control in the Past:
  - Fabric cover, mulches, crop rotation, cover crops
  - Mulched (2 responses)
  - Used newspaper to smother then applied bark mulch
  - Used mulch and compost from our bin
  - Vinegar spray and flame weeder
  - Learned to live with them and consider some attractive
- Weed Control This Year:
  - Fabric cover, mulches, crop rotation, cover crops
  - Smothered them with piles of pulled weeds and garden debris
  - Mulched with lawn clippings
  - Mulched (2 responses)
  - Used newspapers to smother then applied bark mulch
  - Used mulch and compost from our bin

- Newspaper barrier to smother weeds
- Vinegar spray and flame weeder
- Mulch and competitive ground covers in specific areas

3. *Control of disease pests*

Respondents were asked a series of questions about particular behaviors which they had used to control disease pests in the past, and which they had used within the last year. Mean and standard deviation were computed for practices implemented to control disease pests in the past, and within the last year (Appendix 20).

Paired-samples t-tests were computed to determine whether respondent disease pest control behavior had changed over time. A significant difference was found between use of conventional insecticides to control a pest that transmits a disease as a pest control method in the past compared to within the last year ($t(14)= -2.256$, $p=.041$) (Table 26). The mean score for this practice in the past was 1.47 (sd=.516), and the mean score for this year was 1.73 (sd=.458). These data reflect a decreased use of these conventional insecticides within the last year compared to the past.

Table 26. Tactics to control disease pests: Past vs. present.[1, 2]

Action (n)	t-value	df	Sig (2-tailed)
Accepted some level of damage or disease before taking action	1.803	26	.083
Used a fungicide or bactericide as a first option for control	-.437	17	.668
Used a fungicide or bactericide as a last option for control	-.566	16	.579
Spot treated diseased areas with a fungicide	-2.024	20	.056
Treated an entire area with a fungicide, including areas not showing disease	1.000	14	.334
Used a non-fungicide approach as a first option for control	.000	18	1.00
Used a non-fungicide approach as a last option for control	1.000	14	.334
Hand-picked or pruned off diseased areas	1.000	25	.327
Used a conventional insecticide to control an insect pest that transmits a disease	-2.256	14	.041*
Used insecticidal soap to control an insect pest that transmits a disease	.000	14	1.00

[1] * Significance at $\alpha = 0.05$

[2]Note: A response of "Yes" was coded = 1. A response of "No" was coded = 2

Qualitative data were collected to determine whether there were other methods used by respondents controlling disease pests this year or in the past. None of the responses indicated a use of pesticides to control disease pests. The results here also show that the methods used in the past do not generally differ from the methods used within the last year. Each of these responses was indicated by one respondent.

- Disease Control in the Past:
  - Companion planting and cleaning up debris
  - Released beneficials
  - Plant removal, use of resistant varieties
- Disease Control This Year:
  - Companion planting and cleaned up debris
  - Released beneficials
  - Cultural practices (A.M. watering), plant removal, resistant varieties

- Used a home remedy of milk, a dash of dish detergent and water to try to beat powdery mildew on a non-invasive honeysuckle vine

4. Perceived changes in pest control decisions

Twenty respondents (62.5%) indicated their overall decisions about how they choose to control pests (insects, weeds, or disease) had changed over time. Of the 20 respondents reporting a change in their pest control decisions, 19 supplied reasoning for the change (Table 27). The most frequently reported reason for changing the way respondents control pests today was because the methods they now use are less likely to harm the environment (94.7%), followed by methods are less likely to harm humans or pets (89.5%) and methods are better for the respondent's yard or garden (78.9%). Decreased cost and increased effectiveness of the method were reported by small percentages. Fewer than 20% of respondents indicated the methods they now use are easier to find and purchase, take less time, or work quickly against a pest.

Qualitative measures from this section were reported by one respondent. The response of "Identify pest and read about options" was provided, from which the researcher concluded that the respondent's pest control method changed because he or she now identifies pests and considers all of the options for control.

Table 27. Why did respondents change their pest control tactics?[1] (n=19)

Reason	No. (%)
Are less likely to harm the environment	18 (94.7)
Are less likely to harm humans or pets	17 (89.5)
Are better for my yard/garden	15 (78.9)
Cost less	5 (26.3)
More effective	4 (21.1)
Easier to find and purchase	3 (15.8)
Take less time	3 (15.8)
Work quickly against a pest	1 (5.3)
Other reasons	1 (5.3)

[1]Respondents could select more than one response

5. Perceived changes in beliefs about pesticides

Respondents were asked to report whether there were changes in their beliefs of perceived risks concerning insecticides (Table 28), herbicides (Table 29), and fungicides (Table 30) in relation to humans and pets, and to the environment.

5.a. Beliefs about Insecticides

No respondents reported that they used to believe insecticides could be risky to humans and pets, but now do not feel insecticides pose significant risk. Only one respondent (3.1%) believed the same for the environment. However, 34.4% of respondents used to think insecticides were not risky, but now believe they are risky for humans and pets, and 37.5% believe they are risky for the environment. Twenty-one respondents (65.6%) indicated their thoughts about insecticide risk to humans and pets had not changed, and about 60% reported the same belief concerning the environment.

Table 28. Changes in beliefs about insecticide risk.

Risks to humans and pets (n=32)	**No. (%)**
Used to think insecticides could be risky **to humans and pets**, but now think insecticides do not pose significant risk to humans and pets	0 (0.0)
Used to think insecticides were NOT risky **to humans and pets**, but now think insecticides could be risky to humans and pets	11 (34.4)
Thoughts about insecticide risk **to humans and pets** has not changed	21 (65.6)
Risks to the environment (n=32)	
Used to think insecticides could be risky **to the environment**, but now think insecticides do not pose significant risk to the environment	1 (3.1)
Used to think insecticides were NOT risky **to the environment**, but now think insecticides could be risky to the environment	12 (37.5)
Thoughts about insecticide risk **to the environment** has not changed	19 (59.4)

5.b. Beliefs about Herbicides

About 35% of respondents indicated they used to think herbicides were not risky, but now think they may be risky to both humans and pets and to the environment. Only one respondent indicated their perception of herbicide risk to the environment had decreased (3.2%) and none that their perception of risk to humans and pets had decreased. Twenty-one respondents (65.6%) indicated their beliefs about herbicide risk to humans and pets had not changed and 19 respondents (61.3%) reported the same about the environment.

Table 29. Changes in beliefs about herbicide risk.

Risks to humans and pets (n=32)	**No. (%)**
Used to think herbicide could be risky **to humans and pets**, but now think herbicides do not pose significant risk to humans and pets	0 (0.0)
Used to think herbicides were NOT risky **to humans and pets**, but now think herbicides could be risky to humans and pets	11 (34.4)
Thoughts about herbicide risk **to humans and pets** has not changed	21 (65.6)
Risks to the environment (n=31)	
Used to think herbicides could be risky **to the environment**, but now think insecticides do not pose significant risk to the environment	1 (3.2)
Used to think herbicides were NOT risky **to the environment**, but now think insecticides could be risky to the environment	11 (35.5)
Thoughts about herbicide risk **to the environment** has not changed	19 (61.3)

5.c. Beliefs about Fungicides

Respondents indicated by 65.6% and 56.2% that their perceptions about fungicide risk to humans and pets and to the environment, respectively, had not changed (Table 30). Very few respondents reported a decreased perceived risk of fungicides over time as indicated by 9.4% of respondents for the environment, and 3.1% for risk to humans and pets. Increased perception of fungicide risk was reported by 31.2% of respondents concerning humans and pets, and 34.4% of respondents concerning the environment.

Table 30. Changes in beliefs about fungicide risk.

Risks to humans and pets (n=32)	**No. (%)**
Used to think fungicides could be risky **to humans and pets**, but now think fungicides do not pose significant risk to humans and pets	1 (3.1)
Used to think fungicides were NOT risky **to humans and pets**, but now think fungicides could be risky to humans and pets	10 (31.2)
Thoughts about fungicide risk **to humans and pets** has not changed	21 (65.6)
Risks to the environment (n=32)	
Used to think fungicides could be risky **to the environment**, but now think fungicides do not pose significant risk to the environment	3 (9.4)
Used to think fungicides were NOT risky **to the environment**, but now think fungicides could be risky to the environment	11 (34.4)
Thoughts about fungicide risk to **the environment** has not changed	18 (56.2)

6. Risk perception and change in overall pest control behavior

On one question, participants in Q.BC were asked to indicate whether their pest control methods had changed over time. Another question on Q.BC asked respondents to indicate whether their perception of pesticide risks to humans and pets as well as to the environment had changed over time. The data from these two questions were compiled into six contingency tables to examine how changes in pest control behavior vary with perception of pesticide risks.

Concerning respondent perception of insecticide risk to humans and pets over time, all of the respondents who indicated an increased perception of insecticide risk to humans and pets also indicated that their pest control practices had changed over time (Table 31). Of the respondents indicating their perception of insecticide risk to humans and pets had not changed over time, more than half indicated their pest control practices had not changed over time, and slightly more than 40% indicated their pest control practices had changed.

More than 90% of respondents who indicated an increased perception of the potential risks of insecticides to the environment also indicated that their pest control practices had changed over time (Table 32). Only one respondent indicated a decreased risk perception of insecticides on the environment but also indicated their pest control methods had changed over time. Of the respondents who indicated their perception of insecticide risk to the environment had not changed over time, 42.9% of these respondents still indicated a change in their pest control practices over time.

Table 31. Perception of insecticide risk for humans and pets and behavior change. (n=32)

	I have changed the way I control pests over time	I have NOT changed the way I control pests over time
	No. (%)	No. (%)
I used to think insecticides could be risky to humans and pets, but now I think they do not	0 (0.0)	0 (0.0)
I used to think insecticides were NOT risky to humans and pets, but now I think they COULD BE risky	11 (100.0)	0 (0.0)
My thinking about insecticide risk to humans and pests has NOT changed	9 (42.9)	12 (57.1)

Table 32. Perception of insecticide risk to the environment and behavior change. (n=32)

	I have changed the way I control pests over time	I have NOT changed the way I control pests over time
	No. (%)	No. (%)
I used to think insecticides could be risky to the environment, but now I think they do not	1 (100.0)	0 (0.0)
I used to think insecticides were NOT risky to the environment, but now I think they COULD BE risky	11 (91.7)	1 (8.3)
My thinking about insecticide risk to the environment has NOT changed	8 (42.1)	11 (57.9)

Similar to responses on perception of insecticide risk to humans and pets, all of the respondents indicating an increased perceived risk over time of herbicides to humans and pets also indicated a change in their pest control methods over time (Table 33). Nearly 43% of respondents who indicated their perception of herbicide risk to humans and pets had not changed also indicated their pest control methods had changed over time.

Only one respondent indicated a decreased perception of herbicide risk to the environment but also indicated a change in pest control practices over time (Table 34). All of the respondents who indicated an increased perception of herbicide risk to the environment also indicated a change in the way they control pests over time. The majority of respondents who indicated no change in perception of herbicide risk to the environment also indicated they had not made changes in the way they control pests.

Table 33. Perception of herbicide risk to humans and pests and behavior change. (n=32)

	I have changed the way I control pests over time	**I have NOT changed the way I control pests over time**
	No. (%)	**No. (%)**
I used to think herbicides could be risky to humans and pets, but now I think they do not	0 (0.0)	0 (0.0)
I used to think herbicides were NOT risky to humans and pets, but now I think they COULD BE risky	11 (100.0)	0 (0.0)
My thinking about herbicide risk to humans and pests has NOT changed	9 (42.9)	12 (57.1)

Table 34. Perception of herbicide risk to the environment and behavior change. (n=31)_

	I have changed the way I control pests over time	**I have NOT changed the way I control pests over time**
	No. (%)	**No. (%)**
I used to think herbicides could be risky to the environment, but now I think they do not	1 (100.0)	0 (0.0)
I used to think herbicides were NOT risky to the environment, but now I think they COULD BE risky	11 (100.0)	0 (0.0)
My thinking about herbicide risk to the environment has NOT changed	7 (36.8)	12 (63.2)

Ninety percent of respondents who indicated an increased perception of fungicide risk to humans and pets over time also indicated a change in the way they controlled pests over time (Table 35). About half of the respondents who expressed no change in perception of herbicide risk to humans and pests also indicated their pest control methods had changed over time. Only one respondent indicated a decreased perception of fungicide risk to humans and pets over time, and this single respondent also indicated their pest control methods had not changed over time.

Nearly 91% of the respondents who expressed an increased perception of fungicide risk to the environment over time also indicated a change in pest control practices over time (Table 36). Half of the respondents who indicated no change in perception of fungicide risk to the environment also indicated a change in pest control methods over time. Three respondents indicated a decreased perception of fungicide risk to the environment over time, and one of these respondents indicated a change in their pest control methods over time.

Table 35. Perception of fungicide risk to humans and pets and behavior change. (n=32)

	I have changed the way I control pests over time	**I have NOT changed the way I control pests over time**
	No. (%)	**No. (%)**
I used to think fungicides could be risky to humans and pets, but now I think they do not	0 (0.0)	1 (100.0)
I used to think fungicides were NOT risky to humans and pets, but now I think they COULD BE risky	9 (90.0)	1 (10.0)
My thinking about fungicide risk to humans and pests has NOT changed	11 (52.4)	10 (47.6)

Table 36. Perception of fungicide risk to the environment and behavior change. (n=32)

	I have changed the way I control pests over time	I have NOT changed the way I control pests over time
	No. (%)	No. (%)
I used to think fungicides could be risky to the environment, but now I think they do not	1 (33.3)	2 (66.7)
I used to think fungicides were NOT risky to the environment, but now I think they COULD BE risky	10 (90.9)	1 (9.1)
My thinking about fungicide risk to the environment has NOT changed	9 (50.0)	9 (50.0)

Information acquisition

Respondents were asked to confirm where they sought information to help them make decisions on managing pests. The top five resources reported were books or references previously owned (65.9%), the Internet (63.4%), interaction with Master Gardeners/Cooperative Extension (61%), the University of Maryland Home & Garden Information Center (56.1%), and magazines (53.7%) (Table 37). Ten or fewer respondents listed no one, television, a pest control company, garden club, radio, podcasts and other resources as sources used to acquire information about pest control. Three respondents indicated other resources used in making pest management decisions. These responses included research from several universities nationwide, reading labels on many products, and resource handbooks or other literature.

Table 37. Sources used in making pest management decisions.[1] (n=38)

Source	No. (%)
Books or references you own	27 (65.9)
The Internet	26 (63.4)
Interaction with Master Gardeners/Cooperative Extension	25 (61.0)
University of Maryland Home & Garden Information Center	23 (56.1)
Magazines	22 (53.7)
Neighbors and/or friends	19 (46.3)
Newspapers	15 (36.6)
Books or references from a public library	15 (36.6)
Family members	14 (34.1)
Retail employees	11 (26.8)
No one	10 (24.4)
Television	7 (17.1)
Pest control company	6 (14.6)
Garden club	5 (12.2)
Radio	4 (9.8)
Other resources	3 (7.3%)
Podcasts	2 (4.9)

[1]Respondents could select more than one response

Respondents were asked to choose the one source of pest management information that was most influential in their pest control decision. The top three sources reported were interaction with Master Gardeners/Cooperative Extension (26.3%), the University of Maryland Home & Garden Information Center (21.1%) and the Internet (18.4%) (Table 38). No respondents selected television, radio, newspapers, podcasts, neighbors/friends or a garden club as the single most important source of information they use for pest control information. The one respondent who offered a different or other information source indicated combining knowledge, information and experience with observation and common sense.

Table 38. Most important source of pest management decision-making information. (n=38)

	No. (%)
Interaction with Master Gardeners/Cooperative Extension	10 (26.3)
University of Maryland Home & Garden Information Center	8 (21.1)
The Internet	7 (18.4)
Books or references owned by respondent	4 (10.5)
Family members	2 (5.3)
Books or references from a public library	2 (5.3)
Magazines	1 (2.6)
Retail employees	1 (2.6)
Pest control company	1 (2.6)
No one	1 (2.6)
Other resources	1 (2.6)
Television	0 (0.0)
Radio	0 (0.0)
Newspapers	0 (0.0)
Podcasts	0 (0.0)
Neighbors and/or friends	0 (0.0)
Garden club	0 (0.0)

By a wide margin, the primary reason respondents chose for relying on their top source of pest control information was that it was a trusted information source (70.7%) (Table 39). Five respondents supplied qualitative data suggesting other reasons they use their top pest control information choice. The following responses were indicated by one respondent each: Can compare multiple sources; Convenience of Master Gardener stand at a farmer's market; Information based on current research; My own beliefs; and Only grow hot peppers, so not many pests.

Table 39. Qualities of most important source of pest management decision-making information.[1] (n=45)

Reason	No. (%)
Trusted source of information	29 (70.7)
Provides a variety of pest management options	19 (46.3)
Respondent prefers to use non-pesticide methods, and source gives best information on them	17 (41.5)
Not too costly to access	13 (31.7)
Other reason	5 (12.2)
Respondent prefers to use pesticides and source gives best information on them	4 (9.8)
The only source available to respondent	1 (2.4)

[1]Respondents could select more than one response

Chapter Four

Discussion and Conclusions

The anticipated population for this study was the general gardening public in Maryland, Delaware, and West Virginia who attended venues where Master Gardeners volunteer. As evidenced by their attendance at Master Gardener venues, these respondents were active seekers of gardening information. The majority of the respondents for all three surveys were over the age of 50, and more than 70% of the respondent population for Questionnaire: Behavior Change (Q.BC) had maintained a yard or garden for more than 11 years. The respondents for all three surveys were extremely well educated; with well over 60% of respondents possessing a bachelor's or graduate-level degree. Overall, these respondents also appeared to be knowledgeable about the environment. Ostman & Parker (1987) found a positive relationship between education level and environmental awareness in the general public. While the relatively high education level of the respondents in this study may have influenced their environmental awareness, another reason for such elevated environmental knowledge may be related to the age of these respondents. As the majority of these respondents are in their 50's or older, possibly approaching or already in retirement, they may have more time than the general population to devote to their gardening activities and garden information research.

Overall, this study had a very good response rate. However, a limitation of the study was the impact of environmental conditions, such as hot weather on further successful survey solicitation by Master Gardeners. Throughout the period during which

Questionnaire: Attitudes and Beliefs (Q.AB) was made available, many of the Master Gardener volunteer sites were outdoors, subject to the seasonal elements. Several Master Gardeners indicated that many potential survey participants declined to participate because of the hot weather. This would also have potentially affected the response rate for Q.BC, since enrollment for that survey took place principally during the outreach connected with Q.AB. A method could be devised in the future to promote solicitation of the survey at other more environmentally comfortable sites.

Home Gardeners' Knowledge, Values, and Attitudes toward Pest Management

Knowledge of IPM

Questionnaire: Knowledge Transfer (Q.KT) demonstrated significant changes in perception of knowledge about IPM principles following a PowerPoint presentation. The unplanned use of the PowerPoint presentation as an educational tool for Master Gardeners in training allowed the researcher to compare and contrast knowledge gain in these two groups. Overall, there was an increase in perceived knowledge gain of IPM-related topics by both Master Gardeners and regular gardeners following the presentation. This indicates the presentation was a useful tool for improving the perceived knowledge of participants. The single topic on which these respondents collectively did not show significant knowledge gain was related to reasons to protect pollinators in the yard. Prior to viewing the presentation, these respondents indicated a high level of understanding of the reasons to protect pollinators. News media in the last year or two have increasingly drawn attention to the problem of disappearing pollinators locally and worldwide, and this may well have contributed to prior acceptance of this concept by the study

participants. The presentation, therefore, may have served to simply reinforce the concept of pollinator protection in this group, and this may be why a significant gain in perceived knowledge was not found.

Although the PowerPoint presentation was developed for use by Master Gardeners to give presentations to the public, the set was actually used in some cases to train new Master Gardeners. Sadof *et al.* (2004) found that training on specific topics helped to increase positive behavioral change in Master Gardeners. The anticipation in the design of this component of the current study was that increasing knowledge via specific training would promote positive behavioral change in all respondents. While actual behavior was not explored in this section, overall, both Master Gardeners and regular gardeners expressed significant gains in perceived knowledge following the PowerPoint presentation. While in a few cases significant increases in perceived knowledge were not indicated, a general upward trend was reflected in the data for all questions. Based on these trends, it is obvious the PowerPoint presentation can be viewed as a valuable educational tool for promoting use of IPM tactics in the home garden.

Concerning the use of physical control tactics to manage pests, and the potential environmental risks of pesticides, Master Gardeners did not show significant increases in perceived knowledge gain whereas regular gardeners did. However, as evidenced by response means, the Master Gardeners reported a high level of understanding of these concepts prior to viewing the presentation, which may explain why a significant increase in knowledge gain was not found.

Collectively, Master Gardeners and regular gardeners showed significant gains in understanding the importance of reading a pesticide label. However, when examined separately, neither Master Gardeners nor regular gardeners showed significant increases in understanding the importance of reading a pesticide label. Both groups indicated a high understanding before the presentation, and this, more than likely, indicates that the increases seen in knowledge gain on this topic were too small to be considered statistically significant.

Regular gardeners did not show significant increases in perceived knowledge gain concerning the meaning of the term IPM. However, it is more important that these gardeners understand the concepts of IPM rather than simply understanding the term. In fact, these gardeners did express significant gains in perceived knowledge of specific IPM tactics following the presentation, thus meeting an important goal of the researcher to promote concepts over terminology. The regular gardeners also did not show a significant increase in understanding why chemical control should preferably be considered only when alternatives are unavailable or when benefits outweigh the risks and how runoff or drift can move pesticides through the environment. These gardeners indicated a high understanding of these concepts before the presentation, and this may have had an impact on the realization of significant knowledge gain. It may also be the case that these are areas of the PowerPoint presentation where refinement may be useful.

A strong majority of both regular gardeners and Master Gardeners indicated they

were likely to share the information learned from the presentation with friends or family, thus establishing both groups as good potential transmitters of IPM knowledge. In fact, Master Gardeners indicated a 90% likelihood of sharing information, which is a reasonable finding as the role of the Master Gardener is to transmit information between Extension and gardeners in their regions. Also, this high level of likelihood of sharing this particular information indicates Master Gardeners who viewed the PowerPoint presentation were interested in extending IPM education specifically. This implies the concepts in the presentation may be disseminated beyond the initial gardeners participating in the presentation. Dillman *et al.* (1989) showed that, in agriculture, diffusion of new practices is a slow process that begins with the early user farmers who influence other farmers to adopt certain practices, thus furthering the impact of Extension-based initiatives. This same principle can be applied to the current study where the IPM PowerPoint presentation attendees can be considered early adopters who can then serve as an important influence on other gardeners in the promotion and use of IPM as a pest management strategy. A strong majority of both regular gardeners and Master Gardeners also indicated the presentation would likely impact their own future pest control decisions. A greater number of regular gardeners than Master Gardeners indicated the presentation would have an impact on their future decisions. The regular gardeners may have had less previous experience with IPM concepts, and this may explain the difference, albeit small, between these two groups.

Values and attitudes

These respondents are strongly motivated to protect both human health and

environmental integrity in making pest control decisions. More than 80% of respondents expressed concern for protecting themselves, their families, and pets when deciding on a pest control method. Similar levels of concern were expressed by these respondents regarding environmental issues including the importance that a pest control method protects natural enemies, bee populations, and water sources. Strong concern was reported for both local water sources, such as those in the respondents' own yard, as well as in more distant water sources that could be affected by urban runoff. This indicates these respondents are not simply concerned with themselves and their immediate surroundings, but that they also have concern for how their actions affect more distant environments. To some degree, this may be a sign that these respondents have a level of understanding about the interconnected nature of their environment.

Nearly all of the respondents indicated it was at least somewhat important that a pest control method be easy to use. Clearly, these gardeners value pest control methods that will meet their desired goals without being too difficult to implement.

Three-quarters of respondents found it very important that a pest control method be able to be used on or near vegetable gardens or fruit. This may suggest that a large proportion of these respondents grow fruits, vegetables, herbs, and/or other edibles. Recent studies have suggested an upward trend in the amount of edible gardening in the United States within the last few years (Nardozzi, 2008).

These respondents were particularly consistent in their motivation to use non-

pesticide alternative methods for pest control. More than 50% of these respondents said they were willing to pay more money, if necessary, to use a non-pesticide alternative rather than a pesticide. If an alternative method would work as effectively as a pesticide, but might take longer to produce a result, nearly 60% of respondents were still very motivated to use the non-pesticide alternative control method. These findings are supported by Grieshop *et al.* (1992) who found that in order to decrease pesticide use, respondents reported they would be willing to pay more money or spend extra time applying a pest control method. Measuring a different input, Fear *et al.* (1983) found survey respondents would be willing to spend more time in the yard in order to decrease pesticide use. Taken together, results from Grieshop *et al.*, Fear *et al.*, and the current study show many home gardeners are willing to spend time, effort, and money to avoid using pesticides in their yards.

Repeatedly throughout this study, respondents indicated a strong desire to use a pest control method that was easy to use, but when factors such as harm to humans or the environment were incorporated into the scenario, the broad majority of respondents desired to use the method that would impose the least amount of harm. The overall strong desire to use non-pesticide alternative methods diminished only when presented with the scenario of a more effective pesticide, or if the alternative method was more harmful to humans or the environment. These results indicate that there are only very few instances where a pesticide would be the primary method chosen for control by these respondents.

Pest management strategies

Many of the behaviors indicated by these respondents reflect use of some practices that are typically considered elements of an IPM strategy. Almost 90% of respondents indicated they were at least somewhat likely to monitor their yard for pests in Q.AB. In Q.BC wherein more detailed questioning investigated the actual monitoring practices of respondents, the most common monitoring strategy among respondents involved making an informal assessment of how the yard looks. Grieshop *et al.* (1992) found gardeners commonly employ heuristics to simplify pest management decisions. Focusing mainly on aesthetics, these gardeners are generally not using more complex monitoring strategies. This suggests a heuristic approach to monitoring that serves to simplify complicated decisions about pest monitoring and management. However, conducting any kind of monitoring may be considered a key element of IPM, and the fact that the respondents in the current study were largely implementing monitoring sets them apart from gardeners who spray on a schedule. This finding is in agreement with Rajotte *et al.* (1987), who found that more IPM users than non-users employed monitoring strategies in their yard, and these IPM users, like respondents in the current study, implemented monitoring strategies such as simply "noticing damage on plants" rather than using more complex strategies.

At least some willingness to accept a number of insect pests or plant damage was indicated by more than 90% of respondents in Q.AB, with more than 50% of respondents indicating they were very likely to accept some insect pests. These findings are supported by the results in Q.BC where a majority of respondents (61%) indicated that a certain

population of insect pests or level of plant damage must be reached before they take pest control action. With respect to weeds, in Q.AB, again about 90% of respondents showed willingness to accept some number of weeds in the yard or garden, with about half of the respondents indicating they were very likely to accept some weeds. Respondents' weed control decisions were fairly split among respondents in Q.BC indicating a desire to control weeds as soon as they are noticed (51.2%) and respondents indicating they do not control weeds until a certain number or level are reached (43.9%). The findings of the two surveys are moderately consistent considering about 50% of respondents of Q.AB said they accept some level of weeds and in Q.BC slightly over 40% of respondents reported the same behavior.

It can, therefore, be concluded that these gardeners are using some kind of threshold, or have some tolerance for pests in the yard or garden. Baldwin *et al.* (2008) found that there is a difference in thresholds for taking action against insect pests between pesticide and non-pesticide users. In that study, non-pesticide users were most likely to take pest control action when the pest posed a threat to family. The respondents in the current study showed a strong propensity to use non-pesticide alternative methods for pest control. It is unclear to what extent home gardeners in the current study set action thresholds for either insect pests or for weeds.

These respondents consistently indicated in many places throughout the series of questionnaires that they were already using, or at least somewhat likely to be taking actions that are part of an IPM strategy. This is consistent with previous research.

Through an interactive home gardener survey quiz of gardeners at the Philadelphia Flower Show, Sellmer *et al.* (2003) found many respondents actually indicated use of IPM principles such as pest identification before taking control action.

Preventative measures such as use of native plants or resistant cultivars is evidence of planning ahead to avoid potential pest problems. Fear *et al.* (1983) found that although survey respondents were receptive to IPM, most were reacting to pest problems rather than taking steps to prevent potentially serious pest infestations. Respondents in the current study indicated they used several preventative tactics including mulch, native plants, resistant cultivars, and removal of garden debris. These gardeners strongly indicated knowledge of IPM strategies whereas the survey respondents in Fear *et al.* only indicated a receptiveness to learn about IPM strategies, and were therefore not making use of preventative tactics in their yards. Use of preventative herbicide and/or insecticide treatments was not prevalent among respondents in the current study, as might be predicted by their general avoidance of pesticides. These findings are similar to those of Baldwin *et al.* (2008), who found that consumers who do not use pesticides were more likely to take measures to prevent more serious insect infestations. Those respondents preferred non-pesticide alternatives and also tended to use many garden preparation and treatment tactics in the yard or garden.

In examining how well these home gardeners' actions reflected their concerns, it does appear that, in many cases, respondents did take positive action in support of their concerns. With one exception, all of the comparisons tested showed agreement between

respondents' reported concerns and their actions. Based on the findings of the chi-square goodness of fit tests, the concern these respondents expressed for protecting water sources in their own yard as well as more distant water sources that could be affected by urban runoff was reflected in their action of leaving a pesticide-free strip of land next to areas that drain into water sources. This finding indicates these respondents are very aware of the potential effects their actions may have on water sources both near their home as well as in more distant environments. Similarly, the chi-square goodness of fit test indicated respondents who expressed concern about protecting bee populations also reported using pesticides in the morning or evening. These respondents might have chosen to spray in the morning and evening simply because that was the time of day most convenient for them, or because they were aware bees are less active at these times. However, the fact that those who expressed the most concern about protecting bees were also by far the most likely to avoid spraying during the middle of the day suggests these respondents did understand the protective effect of their actions.

The sole exception to agreement between concern and appropriate action was in regard to natural enemies. Throughout the study, respondents expressed considerable interest and concern for protecting natural enemies; however, the results of the chi-square test indicated inconsistency between their concern for natural enemies and their expressed desire to use a pest control method that would kill all of the pests. This implies a general lack of understanding that maintaining some level of pests is necessary to promote a food source on which natural enemies can survive. A study by Sellmer *et al.* (2003) supports this finding, where gardeners at the Philadelphia Flower Show selected

partially correct responses on a quiz on IPM, indicating a lack of understanding of certain IPM concepts. In both of these cases it is clear that even in users of IPM, a continued need for home gardener educational initiatives exists.

Generally speaking, it is unclear whether or not these respondents understand the positive actions they indicate taking are part of an IPM approach. It is very clear, however, that these respondents are making use of IPM strategies. While some educational materials focus on promoting knowledge of terminology such as IPM, the concepts that are most important in educational transactions are the positive environmentally preferable actions rather than terminology alone. Understanding that gardeners are using these environmentally preferable actions is useful for educators in developing outreach materials. They can build upon what is already known about home gardener actions and can target areas requiring more specific attention. As indicated by the failure of respondents to understand the linkage between natural enemies and maintaining a pest population to exploit for food, it is also important that educators provide the reasoning for these environmentally preferable actions in order to promote and reinforce positive action.

Summary of home gardener knowledge, values, attitudes, and strategies

In considering pest control, these respondents expressed strong values concerning both human health and the environment. In making pest control decisions, the respondents showed a strong propensity for and interest in using non-pesticide alternative control measures. Whether or not these gardeners currently possess enough knowledge to

recognize that many of the tactics they report using in their yard or garden are IPM strategies, it appears they are taking positive action to promote the safety, health and integrity of the things they value. Both Master Gardeners and regular gardeners expressed considerable knowledge of IPM concepts, and also indicated that educational outreach such as PowerPoint presentations can further improve upon perceptions of IPM knowledge. Educators can build upon these gardeners' knowledge and actions to further promote preferred practices and understanding of IPM.

Factors Involved in Home Gardener Acquisition of Pest Management Information

Home gardener information acquisition

Respondents consistently identified Extension, Master Gardeners and the Internet as valuable resources in both Q.AB and Q.BC. These sources were rated the highest for each type of gardening information, including general information as well as more specific information on pest management, pesticide information and non-pesticide alternative information. This indicates that these three sources provide a wide range of useful gardening information. These sources were also reported to have provided the majority of respondents with a positive experience in the past. Additional sources strongly indicated by respondents as useful included the University of Maryland Home and Garden Information Center (UMHGIC), and books or references owned by the respondent. All of the above mentioned sources were indicated as important sources used in making pest management decisions. Retail employees and pest control companies were not generally reported as good sources for any kind of gardening information, and they were not identified as important sources in making pest management decisions.

In comparison with previous studies, these findings constitute a major difference in both sources preferred and sources that affect pest management decisions. Barrows *et al.* (1983) found gardeners with plots in Washington D.C. community gardens tended to use magazines, books, National Park Service newsletters, or friends and family for gardening information. Other studies have implicated pest control operators or lawn care services as important sources for gardening information (Frankie & Levenson, 1978; Levenson & Frankie, 1982; Rajotte *et al.* 1987). Retail establishments have also been implicated as major sources of gardening information in the past (Kerrigan, 1993), which these respondents did not indicate utilizing for information. Pounds (1985) proposed there may be differences in where people seek information compared to where they ultimately locate useful information; however, the current study does not reflect that finding as these respondents tended to use resources they initially sought out in making a pest management decision.

Several factors may be responsible for these clear differences in the types of sources used for information. Respondents' high education level and their elevated knowledge and use of IPM strategies may well be a factor in their strong reliance on Cooperative Extension and Master Gardeners. Previous research has shown that use of Cooperative Extension services is associated with higher education (Kelley & Wehry, 2006). The Maryland Urban IPM Impact Study found that users of IPM in the home garden were more likely to use Extension services for gardening and pest management information (Rajotte *et al.* 1987). The respondents' consistent use of these particular sources indicates they do have an opinion as to where they will find the most useful

gardening and pest management information that will impact their decisions. Respondents on Q.AB reported having had satisfactory resolution of gardening questions from these sources in the past, and it is reasonable to expect they would continue to rely on these sources. These respondents may have developed a relationship with their local Master Gardener and as a result may not rely on retail employees or pest control companies for gardening and pest management information. Another factor relates to comfort with using the Internet for information. Many previous studies investigating home gardener information source preferences were conducted before widespread use of the Internet. The Internet has expanded significantly in the last 20+ years to become a new source of information relied upon by these gardeners. Resources such as Cooperative Extension as well as the UMHGIC are highly publicized on the Internet as both maintain extensive websites dedicated to providing outreach. As the Internet has gained in popularity, this increase in these particular sources visibility to the public serves to inform home gardeners that these sources exist.

Earlier research has expressed a need for study of factors that impact choice in a gardening information source (Kelley & Wehry, 2006). The factors most commonly indicated by respondents as reasons for using a particular source of information for making pest management decisions included trust in the source, source's ability to provide a variety of pest management options, and low cost. These respondents also expressed a preference for using non-pesticide alternatives and indicated the source they used in making a pest management decision provides the best information on alternatives. While some of these factors are based on preferences and values, some are based on

convenience.

Conveniences associated with information acquisition

Concerning convenience, the respondents indicated a number of factors that impact how information is acquired. Varlamoff *et al.* (2002) found that essential features of obtaining gardening information included convenience and free availability. This finding supports the results of the current study where 90% or more of respondents indicated cost, time required to access information, and travel distance as somewhat, if not very important.

About 90% of respondents also reported that it was at least somewhat important that information be available without leaving home. Only a small minority of respondents (14.6%) specified that the Internet not be required to access information. The Internet is obviously a tool that is accessible within the home. This finding also implies these respondents are generally comfortable using the Internet to access information. This is in contrast to a previous study that found the Internet to be a lesser used source for gardening information (Varlamoff *et al.* 2002). However, Varlamoff *et al.* also noted increased use of the Internet to access information was associated with higher education. In the current study, a great majority of respondents possessed a Bachelor's degree or higher, which may help explain why such a small percentage of respondents indicated a desire to attain information without use of the Internet. The time interval between the 2002 study and the current study also is likely a factor, as more people have become more comfortable with the Internet. Older individuals comprise a rapidly expanding

group using the Internet (Trocchia & Janda, 2000). As Iyer & Eastman (2006) pointed out, the increase in use of the Internet by older individuals presents a significant opportunity for marketers to target these users. Similarly, educators can capitalize on this finding to promote educational initiatives targeting these respondents.

Summary of home gardener acquisition of information

The sources of pest control information most used by respondents are those that tend to be convenient to access, including cost, travel distance, and time required to access information. This is reflected in the factors they listed as important, as well as in the sources these respondents listed as utilized resources. Respondents are comfortable using the Internet to access information, but also use Master Gardeners, Cooperative Extension and written materials in making gardening and pest management decisions. Respondents also overwhelmingly reported that it was important for the information source to provide multiple options for pest control, including pesticide and non-pesticide alternative information. IPM includes the consideration of all viable pest management options for a particular situation. Since these respondents express a desire for access to information on multiple methods for pest control, they appear to posses the framework to consider multiple options, thus using IPM in making pest management decisions.

Actual Changes in Pest Management Practices and Beliefs by Home Gardeners

Perception of pesticide risk

Changes in pest management beliefs were assessed in Q.BC and included perceived risk of insecticides, herbicides and fungicides on humans, pets, and the

environment. Very few respondents indicated a decreased perceived risk of insecticides, herbicides, or fungicides over time, while a majority indicated no change in their perception of pesticide risk to humans and pets or to the environment. Notably, a sizeable minority of between 30 - 40% of respondents indicated an increased perception of pesticide risk (insecticides, herbicides, or fungicides) to humans and pets or to the environment over time.

A majority of respondents indicated their overall pest control decisions had changed over time. Considering this sturdy minority of respondents who indicated an increased perception of insecticide, herbicide, or fungicide risk to humans and pets or the environment over time, 90% or more also indicated they had changed their pest control behavior over time. Additionally, sizable numbers of between 35% and as high as 52% of respondents who indicated their risk perceptions for insecticides, herbicides, or fungicides had not changed over time also indicated their pest control tactics had changed over time. In this case where risk perception had not changed but behavior had, the motivating factor for the change was less clear. Interestingly, Greishop *et al.* (1992) suggested there is commonly a discrepancy between home gardener beliefs and behaviors. This is not found to be true of the respondents in the current study who indicated an increased perception of pesticide risk, as the majority have changed their practices over time. For those respondents who expressed no change in risk perception but who had changed their pest control behavior, the discrepancy described by Greishop *et al.* (1992) appears plausible. It is also quite possible that the behavioral change in these respondents was motivated by factors other than risk perception.

On questions directly asking about motivation for change, about 80% - 95% of respondents indicated the top three reasons for changing their pest control behavior were that the methods currently used were less likely to harm the environment, less likely to harm humans or pets, or were considered better for the yard or garden. Few of the respondents (<16%) reported being motivated by reasons of convenience (easier to find and purchase, takes less time, works quickly), and only about one-fifth to one-quarter of respondents indicated lower cost and/or greater efficacy contributed to their decisions to change their pest control methods. It is very interesting to contrast respondents' expressed desire for convenient access to pest management information with their lack of demand for convenience in pest control methods. In choosing pest control methods, these respondents overwhelming made decisions based on their values more than convenience.

Although not tested in this study, another potential reason for changes in pest control tactics may involve trends in the consumer market. Recent trends have driven more toward environmentally friendly or "green" products. Current research has shown this as a developing trend (Roberts, 1996; Ginsberg & Bloom, 2004; Rex & Baumann, 2007; Brown, 2008). While the specific pest control methods these respondents have switched to using is unclear, the strong desire to use non-pesticide alternative methods for pest control is very clear and is reflective of the current trends of more environmentally friendly methods.

Home gardener change in behavior

Although many respondents suggested they had made changes in behaviors taken to control pests, answers to specific questions concerning pest control actions within the last year did not indicate significant change in pest management behavior. Respondents indicated a significant decrease in the use of conventional insecticides to control an insect pest that transmits a disease within the last year compared to in the past. It is possible these respondents may not have had an infestation of pests that transmit disease within this particular year. Significant decreases in the use of traps to control insect pests were also indicated by these respondents. Anecdotal information offered by some attendees of the PowerPoint presentation indicated at least some respondents did not feel insect traps were effective. It is also possible that in the past year respondents did not have insect pests for which traps are appropriate and available. A significant increase in the number of respondents indicating hand-pulling of weeds as a control tactic within the last year compared to the past was found. This increased use of physical control of weed pests may indicate respondents had fewer weeds in the last year, and therefore found hand-pulling to be a less burdensome task.

It must be noted the questions on specific actions were based on changes in behavior made within the last year. In contrast, where respondents indicated in response to a general question that they had made changes in their pest management behavior, no specific time frame was indicated. Respondents reported having made changes in the way they control pests, but quite possibly the changes were implemented previous to the time frame of the study questions about changes in specific actions in the previous year. The

study design does not allow conclusions about when these respondents began to make specific changes in their pest management behavior.

Summary of home gardener pest management practices and beliefs

A sizable number of these respondents indicated an increased perception of pesticide risk over time which may have functioned as a catalyst for their change in pest control behavior. While the majority of the respondents indicated no change in perception of pesticide risk over time, a considerable minority of these respondents have still changed their pest control behaviors over time. While it is unclear exactly when strategies may have originally been implemented, respondents clearly indicated their current methods were friendlier to humans and/or the environment. The majority of respondents were driven more toward the use of least-toxic or non-pesticide alternative methods. It would be interesting to see whether this subset actually purchases "green" products in general. Results of this study indicate this audience is primed for the use of safer or "green" methods and for such products if and when they become available and marketed.

Conclusions

Respondents were very well educated, seasoned gardeners who were primarily interested in learning about and using non-pesticidal methods to control pests in their yards and gardens. They expressed considerable concern for protecting human health and promoting environmental integrity in making pest management decisions. In accessing information on gardening and pest management, the majority of these gardeners used very different sources of information compared to what has been found in previous

studies. Their preferred sources were Master Gardeners, Cooperative Extension, the Internet, and written reference materials they own.

This group was already incorporating IPM tactics into their gardening strategy. The extent to which these respondents understood exactly why the actions they took are beneficial, or whether they knew their actions constitute portions of an IPM program is unclear. This study did not directly query this connection. However, the statistically significant combination of specific actions in the cases of leaving a barrier strip and spraying during the morning or evening, protective of water and bees, respectively, provides some evidence that respondents may have understood the consequences of at least some of their pest control decisions.

Most respondents reported their perception of the level of risk associated with various types of pesticides had not changed. Importantly, the majority of those who did express an increased perception of pesticide risk over time also reported they had changed their pest control behavior over time. The major reasons offered for the change in pest control decisions reflected the consistent level of concern for human health and the environment throughout the study. This group was highly motivated to adopt safer or more environmentally friendly pest control tactics; lack of convenience and higher cost were not barriers.

Both regular gardeners and Master Gardeners in training perceived their knowledge of IPM principles had improved due to the outreach material presented in this

study. Both groups believed they would be likely to transfer what they had learned about IPM to others. This indicates that regular gardeners can serve as early adopters of IPM and preferred practices and promote these practices throughout their local community. Master Gardeners can fulfill this role on a more regional basis.

Educators should capitalize on the knowledge and motivations of environmentally aware gardeners to further promote preferred pest management practices. The extent to which gardeners understand the consequences of their pest control decisions on entities they value is unclear. Gardeners who are already using some IPM techniques and strategies in their own yard are seeking to educate themselves on concepts beyond the basics. Educators should design outreach that moves beyond the most basic gardening and pest management theory to explain higher level concepts such as the fundamentals of predator-prey relationships. Providing the reasons specific practices are protective of human health and/or the environment should help gardeners understand the clear connection between their concerns and actions, and should increase the likelihood they will adopt preferred practices.

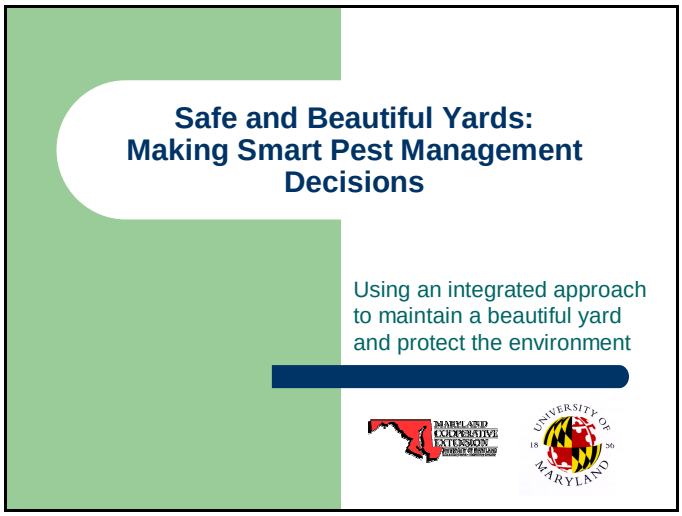
Educators should target outreach through information sources most used by these gardeners including the Internet, Cooperative Extension and Master Gardeners. The comfort these respondents expressed with accessing information through the Internet reflects an opportunity for educators to develop materials accessible on the Internet for home gardeners. Written educational materials the gardener can keep at home are also important resources educators may desire to promote. Educational materials should be

made widely available through sources that are low-cost and accessible and should focus on providing a variety of pest control options.

Future research may build upon the current findings through multiple avenues. It is unclear whether the motivations of this group are reflective of the gardening population as a whole in this region or in the broader U.S. An investigation of the same study objectives in a more broadly characterized group in terms of age, education level, and gardening experience would be useful. This study found that some gardeners do set certain thresholds for the control of pests, but little is known about how or to what extent action thresholds are set. An actual test of knowledge on IPM concepts, as opposed to a survey of perceived knowledge gain, would be valuable. Future researchers may also want to consider attempting to further characterize home gardeners' pest control choices and practices.

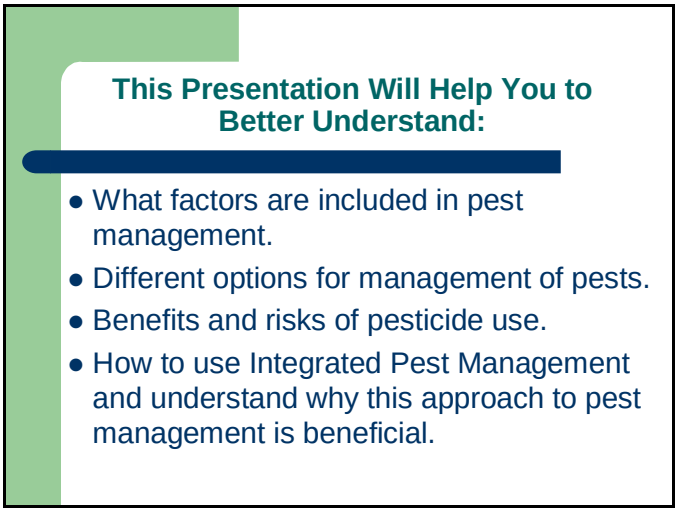
List of Appendices

Appendix 1. PowerPoint “Safe and Beautiful Yards: Making Smart Pest Management Decisions”



Today we will learn how to control lawn and garden pests to promote a beautiful and healthy landscape. By using the methods we talk about today, you will be safeguarding yourself, the environment, and the lives of those you care about.

This presentation is designed to provide the basic tools for promoting a healthy landscape, but may not answer specific questions you may have. So, at certain points throughout this discussion I will provide reputable resources you may use to answer your specific questions. I can also provide you with these resources at the end of the presentation.



This Presentation Will Help You to Better Understand:

- What factors are included in pest management.
- Different options for management of pests.
- Benefits and risks of pesticide use.
- How to use Integrated Pest Management, or IPM, and understand why this approach to pest management is beneficial.

Yard Areas Managed by Homeowners

- Lawn
- Flower Garden
- Vegetable Garden
- Small Fruits
- Shrubs and Trees

M.J. Raupp, Univ. of Maryland

Just as our yards are valuable to us in one way or another, they can be valuable spots for pests to thrive, too.

Types of Pests We Encounter

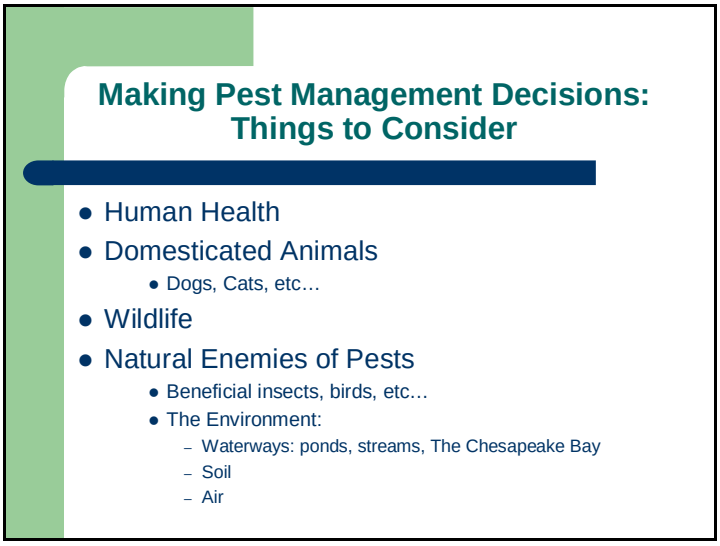
- Weeds
- Insects
- Disease-causing organisms: fungi, bacteria, viruses
- Wildlife

Images Courtesy of M.J. Raupp, Univ. of Maryland

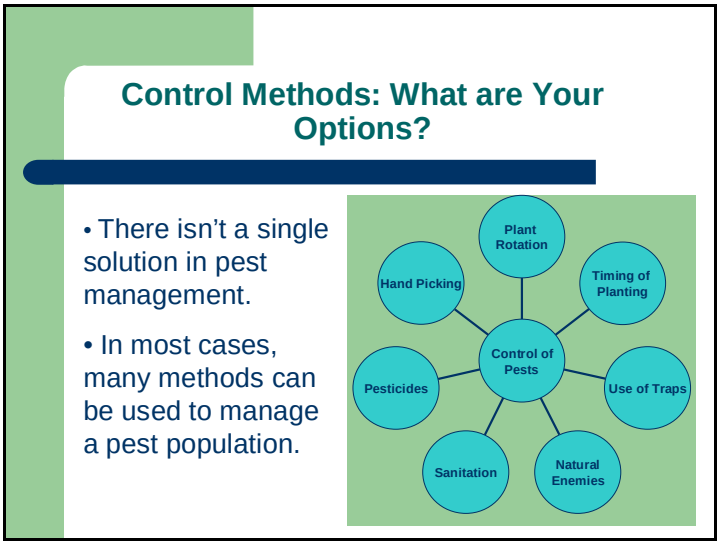
So what are pests? Pests are any organisms that are in a place where you don't want them to be.

Weeds, insects, disease causing organisms and wildlife can all be pests when they are causing damage.

If you have a pest situation, could your decision have other impacts besides just controlling your pest?



Yes! When making pest management decisions, we need to also think about how our decisions may have an impact on human health, pets, wildlife, and natural enemies of pests.



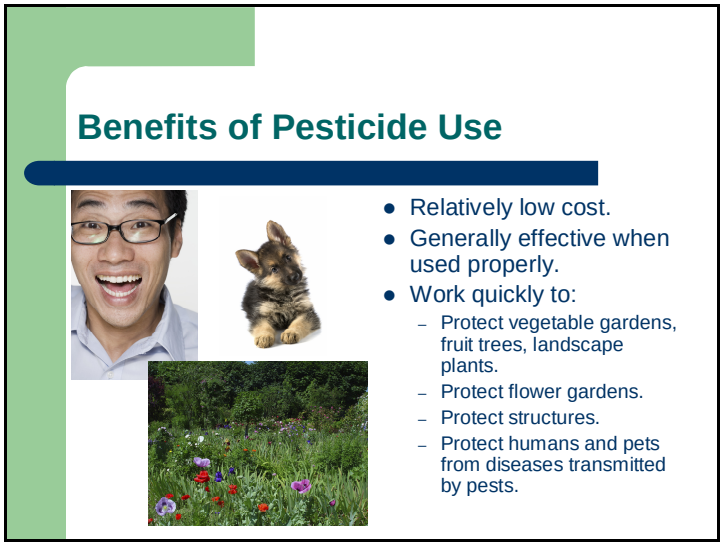
There isn't a single solution in pest management. In most cases, many options or tactics can be used to manage a pest population.

In this diagram we see just a few methods that you can use to help control a pest.

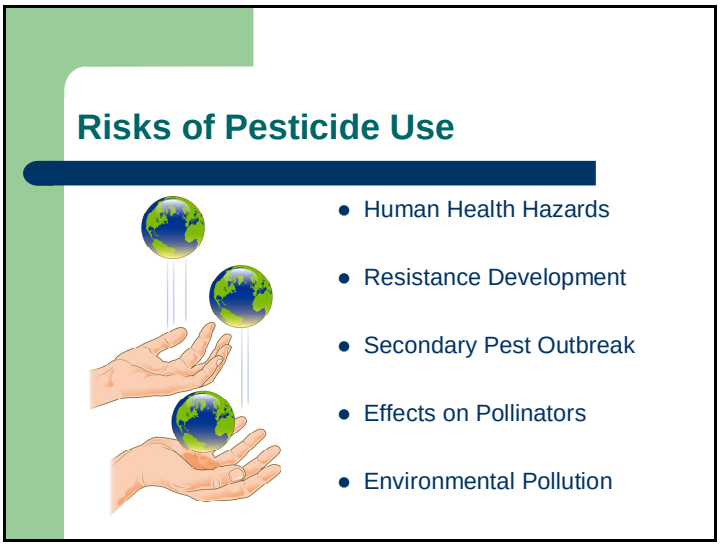
Pesticides are just one method of pest control. Historically, pesticides became increasingly available after World War II. Since these pesticides were effective and cheap, they could be used in many places from industry to households. This resulted in widespread acceptance and reliance on pesticides among many people in this country.

We can all think of people in our lives, or even ourselves as users of pesticides. The use of pesticides sometimes has a negative stigma attached to it. Should pesticides carry a negative stigma?

Before you answer that question, I'll tell you that it's a trick question.

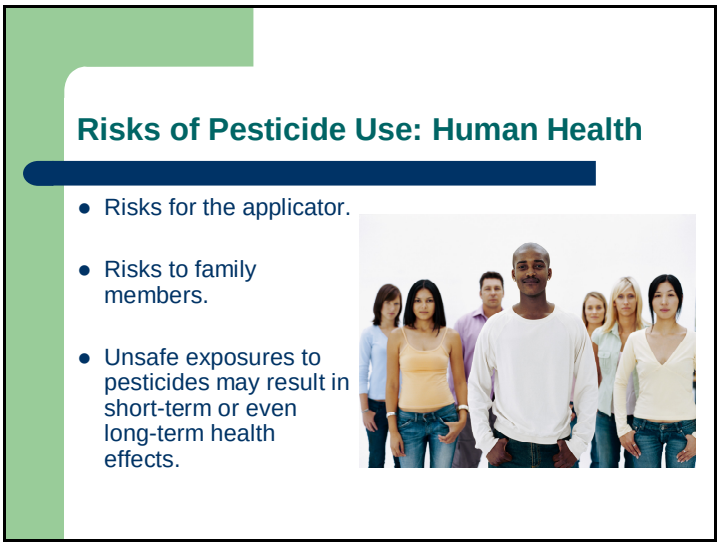


There are major benefits associated with use of pesticides. As a control option, they may be relatively low cost. They are generally effective WHEN USED PROPERLY.
I stress proper use here because improper use can possibly result in a laundry list of negative impacts. Pesticides are also useful in protecting the things that we value. However, we cannot discuss the benefits of pesticides without looking into the risks associated with pesticide use.



Pesticides can have negative effects.

We'll discuss human health hazards, pesticide resistance development, secondary pest outbreak, effects on pollinators and environmental pollution.

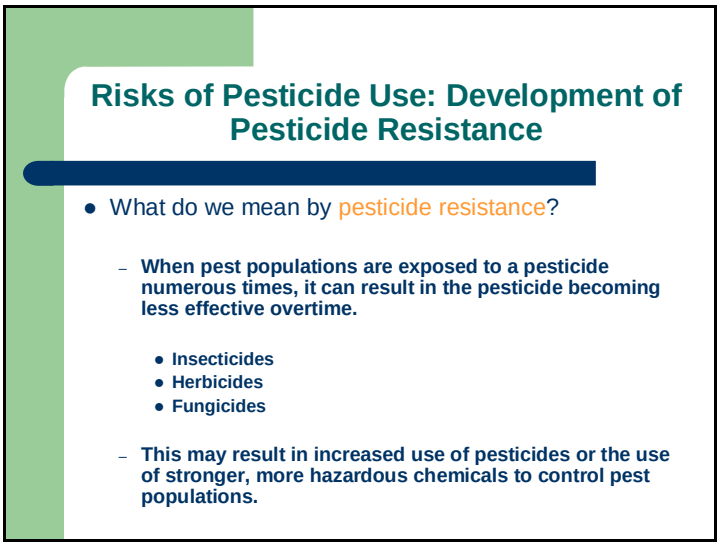


We will begin with Human Health Risk.

First, there may be health risks for the applicator.

Our family members or people near an area where a pesticide has been applied may also be exposed to the pesticide or its residues.

Proper use of pesticides is extremely important to protect those around us. Unsafe exposures to pesticides may result in short or long-term health impacts. So MINIMIZING exposure is important.

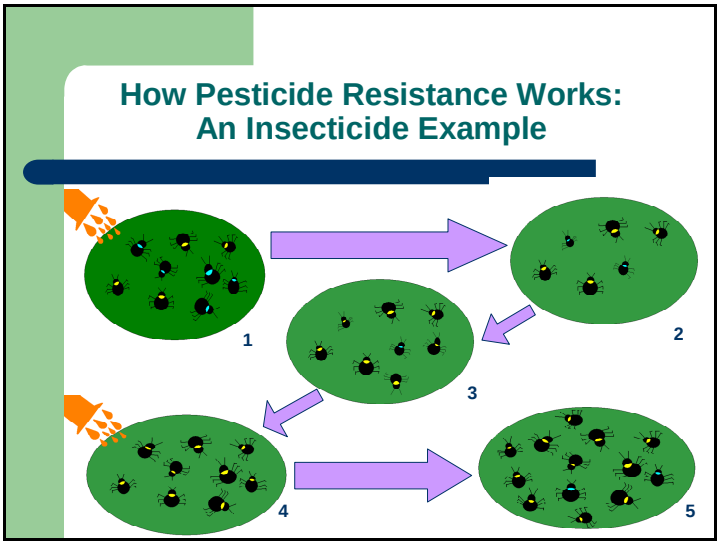


The second potential risk of pesticides is the development of pesticide resistance.

When pest populations are exposed to a pesticide numerous times, it can result in the pesticide becoming less effective over time.

We have seen pests develop resistance to insecticides, herbicides and fungicides.

When a pest population becomes resistant to a pesticide, it may require more applications, a higher concentration, or a different pesticide to attain an effective level of control.



Here is a visual depiction of how pesticide resistance may develop.

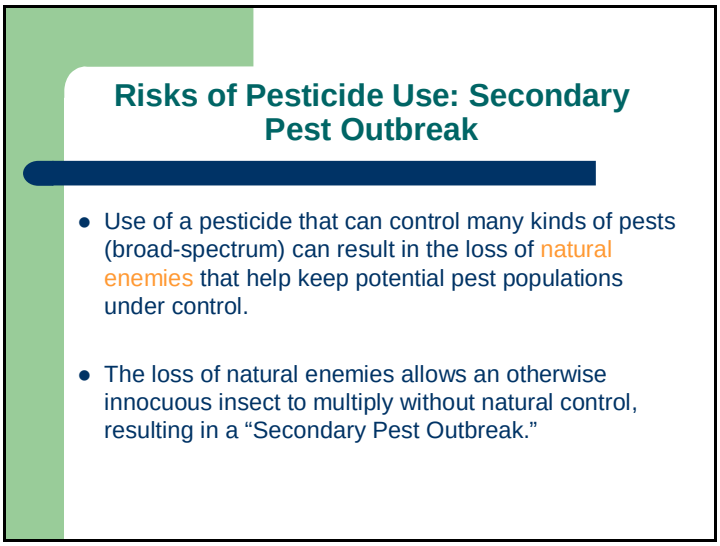
1. The insects in this picture all represent the same species- we'll call them Brightneck Bugs- but they have slight differences in genetic makeup.

2. After an insecticide application, we see that most of the blue Brightneck Bugs were killed by the insecticide, but the yellow Brightneck Bugs were mostly unaffected. The blue Brightneck Bugs represent those that are SUSCEPTIBLE to the insecticide, while the yellow Brightneck Bugs possess genetic RESISTANCE to the insecticide. That is, the resistant bugs possess some mechanism that allows them to be unaffected by this insecticide.

3. As these insects mature and mate, there are more yellow bugs available to pass on their genes to their offspring. With each successive generation, there will be fewer blue (susceptible) bugs and more yellow (resistant) bugs.

4. As the resistant bugs continue to reproduce, the homeowner sees more of them, so she sprays again, using the same insecticide.

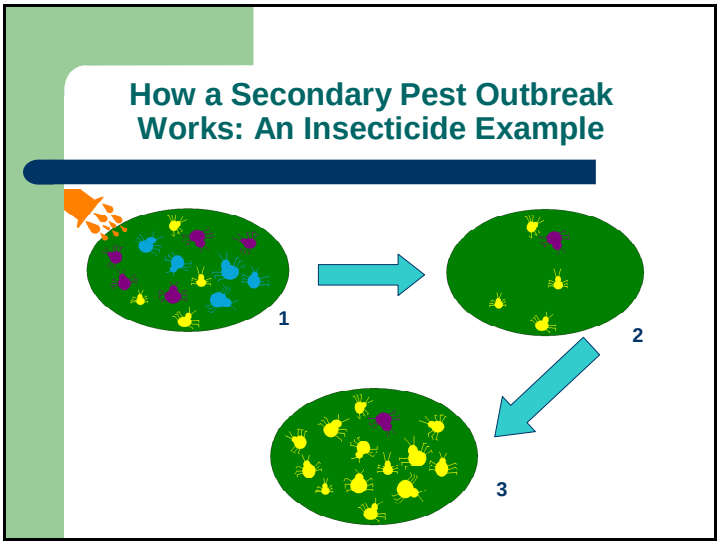
5. The problem actually continues to get worse, as now, virtually the entire population of Brightneck Bugs in the yard is resistant to the insecticide. The homeowner would have to use MORE of the same insecticide or use another insecticide - possibly a more hazardous chemical for humans and wildlife.



Aside from pesticide resistance, another risk of pesticide use is the development of a secondary pest outbreak.

When we use a pesticide that controls many kinds of pests (many species) we can lose natural enemies that might otherwise help keep pest populations under control.

This loss of the natural enemy allows an otherwise innocuous or relatively harmless insect to multiply without natural control, thus becoming a "Secondary Pest Outbreak."

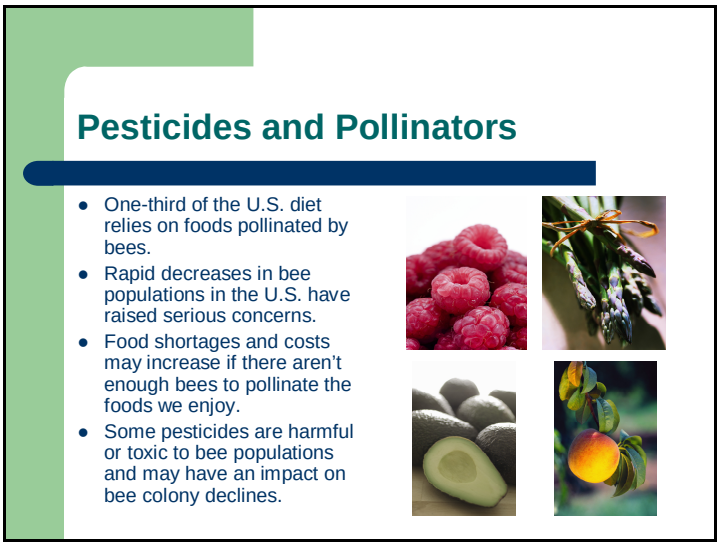


Here is a visual depiction of how a secondary pest outbreak may develop.

1: Three different species of insect reside on the same plant. The PLENTIFUL PURPLE insects eat the BAD BLUE and the YUCKY YELLOW insects. The PLENTIFUL PURPLE'S are the Natural Enemy. Not realizing the PLENTIFUL PURPLE insects are natural enemies that can help to control the others, an insecticide is applied to control the BAD BLUE insect.

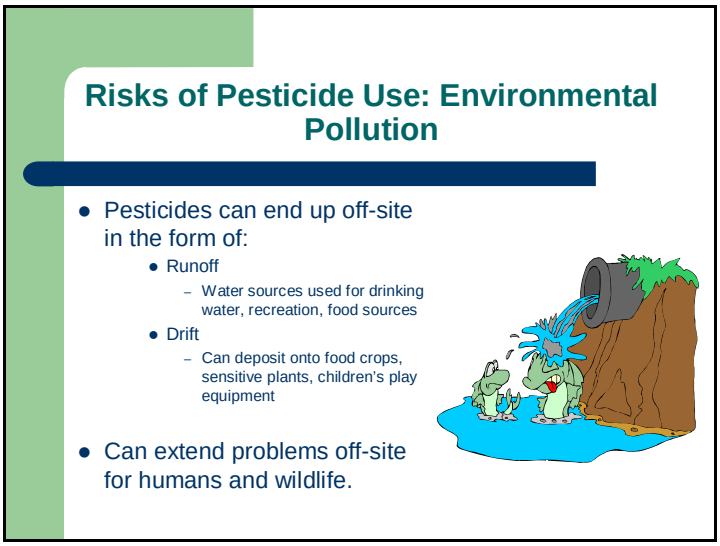
2: The insecticide application killed all of the BAD BLUE insects, but also killed the majority of the PLENTIFUL PURPLE natural enemy insects. The YUCKY YELLOW insect population remained unaffected by the pesticide.

3: Since the PLENTIFUL PURPLE insects have been so severely affected by the insecticide application that was directed toward the BAD BLUE insects, the YUCKY YELLOW insects have been able to reproduce in greater numbers. The PLENTIFUL PURPLE insects can no longer control the population of YUCKY YELLOW insects, resulting in a secondary pest outbreak.



Bees are beneficial organisms that are heavily relied on by humans for food production. One-third of the U.S. diet relies on foods pollinated by bees. The drastic losses of bee colonies all around the country make it imperative that we try to conserve bees in our own yards.

If you are interested in seeing a more extensive list of the foods pollinated by bees, I have one on hand that you can look at after the presentation, or I can provide you with the website.



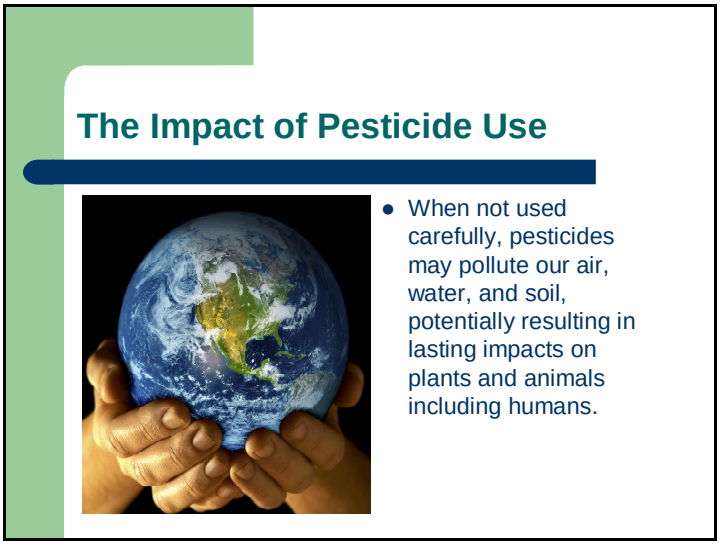
Improper use of pesticides can result in environmental degradation.
When we use a pesticide in our yard, if we're not careful, the chemical can end up off-site, away from the intended area in the form of:

- Runoff which can impact water sources

OR in the form of:

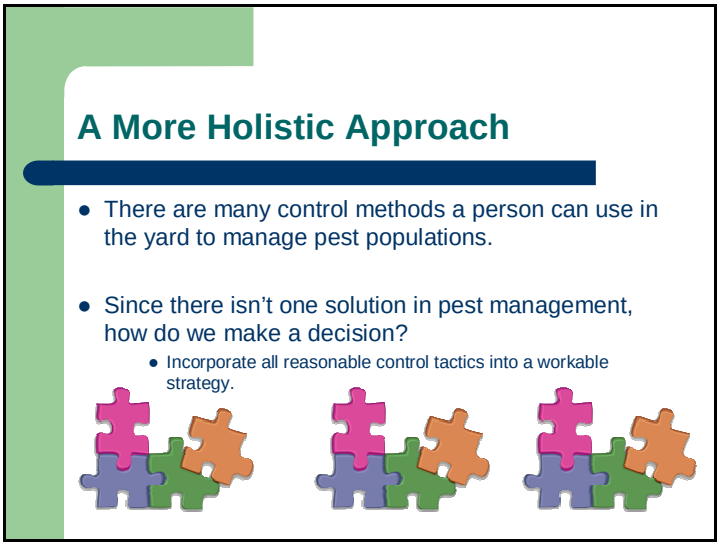
- Drift which can redeposit where we don't want it.

Drift or runoff of pesticides can impact the human environment, but can also cause an imbalance in ecosystems, threatening wildlife and species habitat.



Basically, we see that the impact of pesticide use can be a global issue.

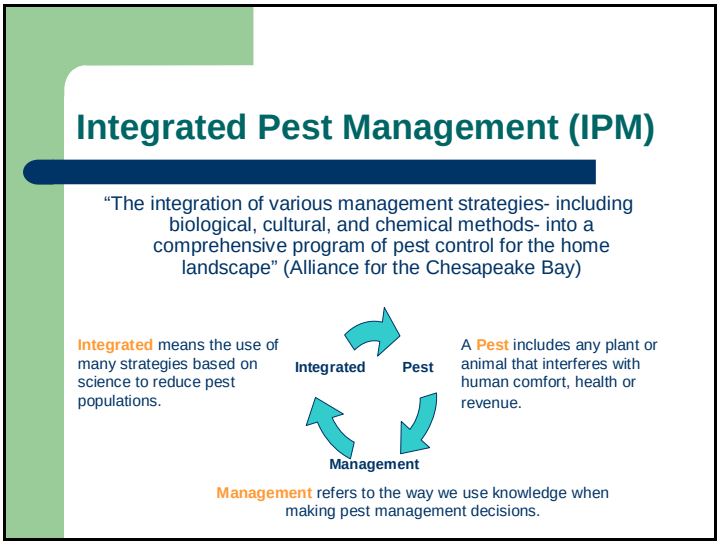
When not used carefully, pesticides may pollute our air, water, and soil, potentially resulting in lasting impacts on plants and animals including humans.



So we understand that there are both significant benefits and risks in the use of pesticides. But do we have other options besides using pesticides? The answer is Yes!

There isn't one solution in pest management, so how do we make a decision?

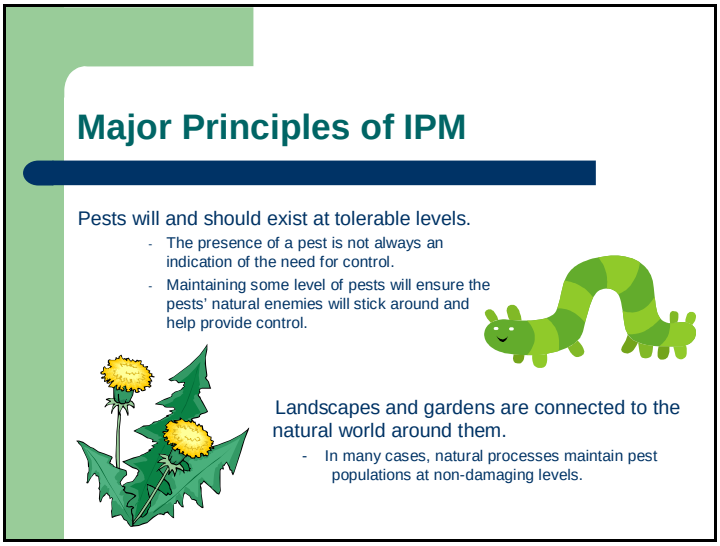
We will now learn how to develop a STRATEGY for pest management in our own yards. We will do this by learning the concepts of Integrated Pest Management, or IPM.



Integrated Pest Management is the integration of many strategies, including biological, cultural and chemical methods to manage pest populations at acceptable, tolerable levels.

We usually think of insects, disease and wildlife as being the cause of a pest problem.

Did you know that over half of the plant problems observed by home gardeners are caused by environmental or cultural imbalances? Minimizing pest problems begins with preventing favorable habitat conditions. (Reference: University of Maryland Home and Garden Information Center)



We can use Integrated Pest Management to reach a balance between pests, plants, beneficial organisms, and other desirable landscape features.

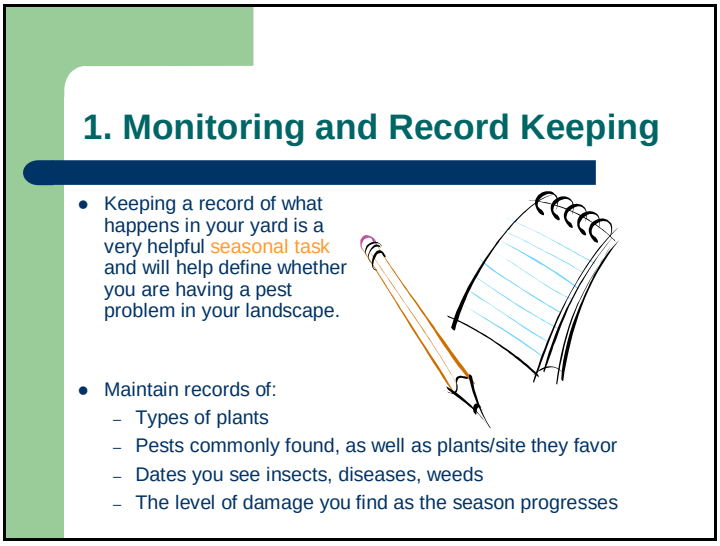
The first two major principles of IPM are:

- Pests will and should exist at tolerable levels.
- Landscapes and gardens are connected to the natural world around them.

The second two principles of IPM are:

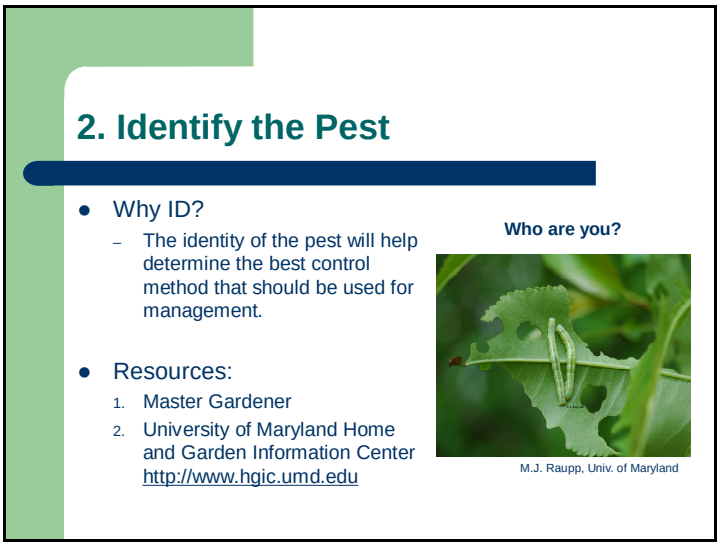
- When pest control is necessary, the utilization of natural control is desired.
- Any control measure has the potential to fall short of expectations.

Now let's set up a stepwise approach that uses these 4 principles in an integrated strategy for pest management.



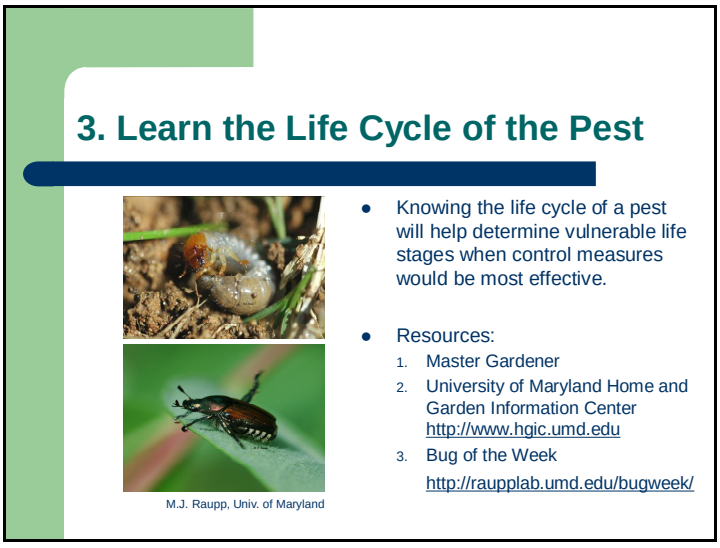
The first thing a gardener should do is keep a record of what is happening in the yard. Keeping a record every season will help you figure out if you are having an ongoing pest problem.

It is helpful to keep this record in the same place, such as a notebook, composition book or on your computer. This way, each year, you can add to your record and observe trends or changes in your landscape.



As you monitor your yard, you may begin to notice changes that may indicate a pest problem. If you think you may be dealing with a pest situation, the first thing you need to do is Identify the Pest. The identity of the pest will help determine the best control method that should be used.

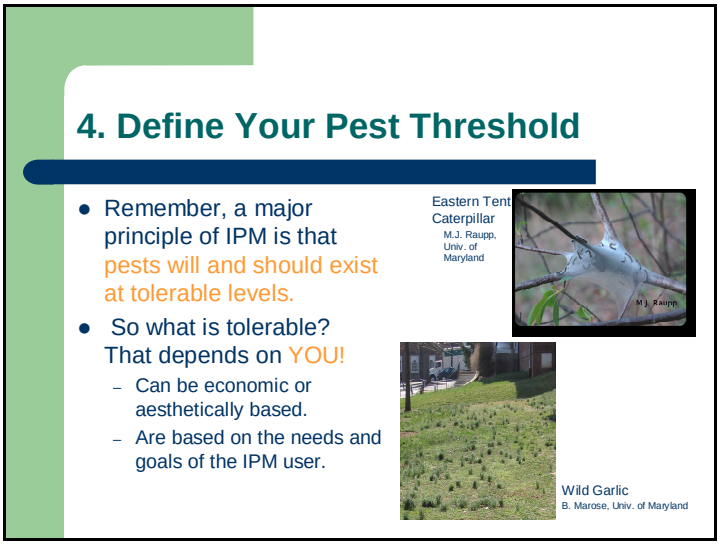
The provided resources are excellent sources of information on pest management. These resources, among others, are also provided in the two brochures I have for you today.



After you have successfully identified the pest, the next important step in IPM is to Learn the Life Cycle of your pest.

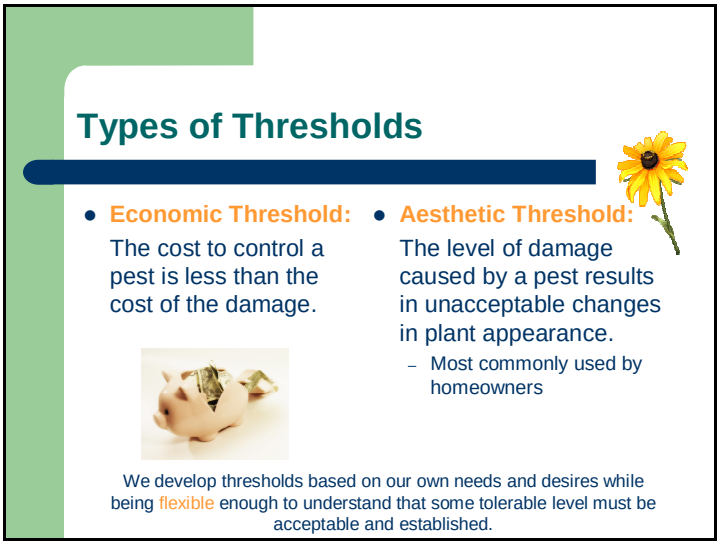
The life cycle of a pest will help determine vulnerable life stages when control measures would be most effective.

The Bug of the Week is a website developed and maintained by Dr. Mike Raupp of the University of Maryland. This website describes various regional insects and their life cycles. If you know the identity of your pest, you can search Dr. Raupp's bug archive to learn more about your pest. The website describes "good bugs", too.



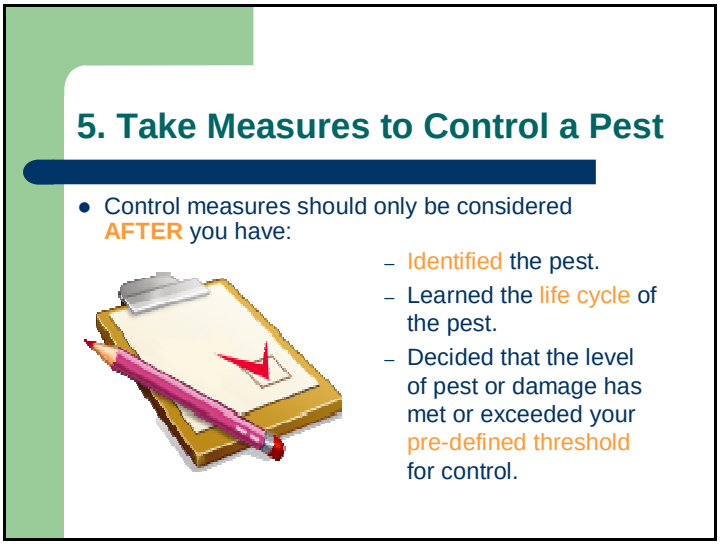
If you have identified your pest and learned something about its life cycle, your next step is defining your Personal Pest Threshold. Remember, a major principle of IPM is that pests will and should exist at tolerable levels.

Pests are necessary to maintain populations of natural enemies that control pest populations. It is a circular process that helps maintain balance within the ecosystem.
Pest thresholds can be economic or aesthetically based. Also, thresholds are based on the needs and goals of the IPM user.



An economic threshold is one where the cost to control a pest is less than the cost of the damage.

An aesthetic threshold is one where the level of damage caused by a pest is unacceptable to you in terms of the way it looks. Whether you are more concerned with cost, aesthetics, or both, you can develop thresholds based on your own needs and desires.
If the level of a pest, for example, the number of weed pests in a yard, exceeds your personal threshold for weeds, control measures must be considered.

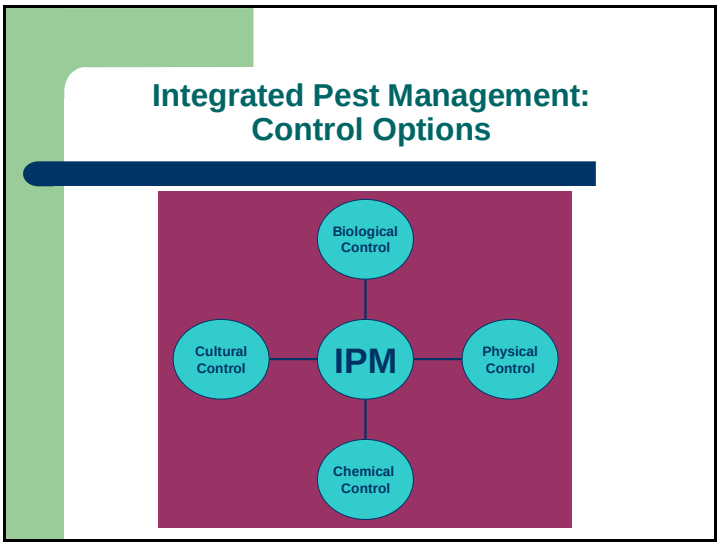


The final step in an IPM strategy is Taking Measures to Control a Pest.

Control measures should only be considered **AFTER** you have:

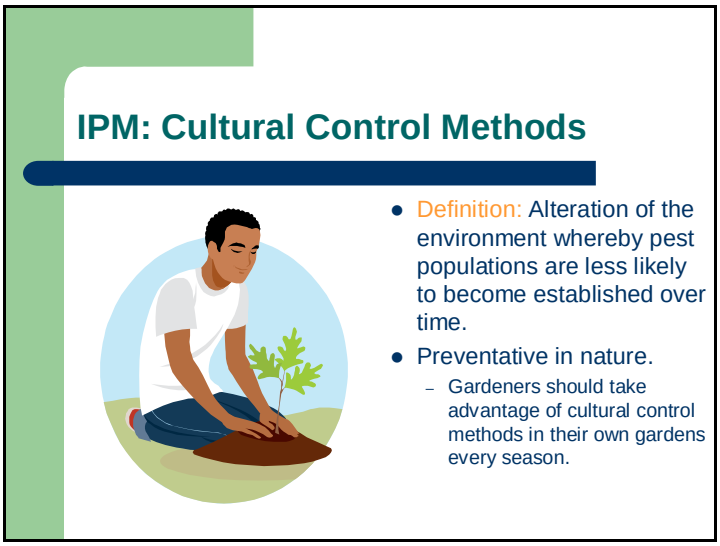
- Identified the pest.
- Learned the life cycle of the pest.
- Decided that the level of pest or damage has met or exceeded your pre-defined threshold for control.

So, what are acceptable pest management methods in IPM?



IPM places emphasis on using Cultural, Biological and Physical control measures to help prevent and manage pest populations at tolerable levels.

Chemical control, though an important component of an IPM approach, is used when no other options are available or practical.

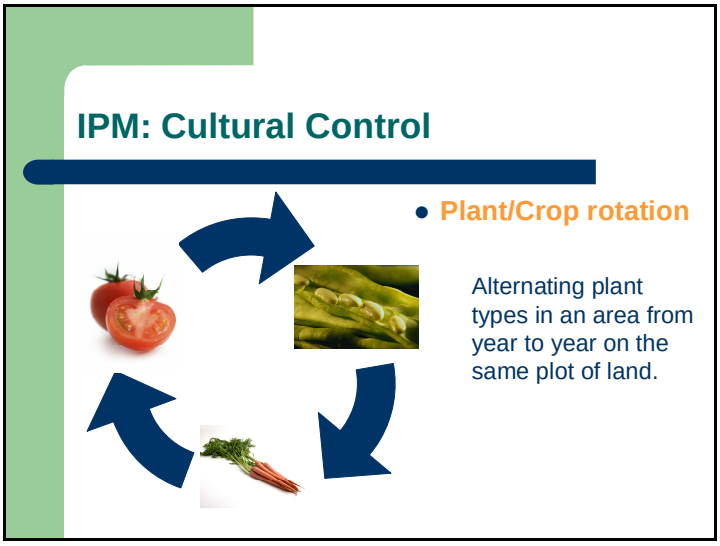


One of the first components of an IPM control strategy involves Cultural Control.

Cultural control is the alteration of the environment so pest populations are less likely to establish overtime. Cultural control methods are preventative in nature. So, what kinds of things can you do in your yard that fit under "Cultural Control"?

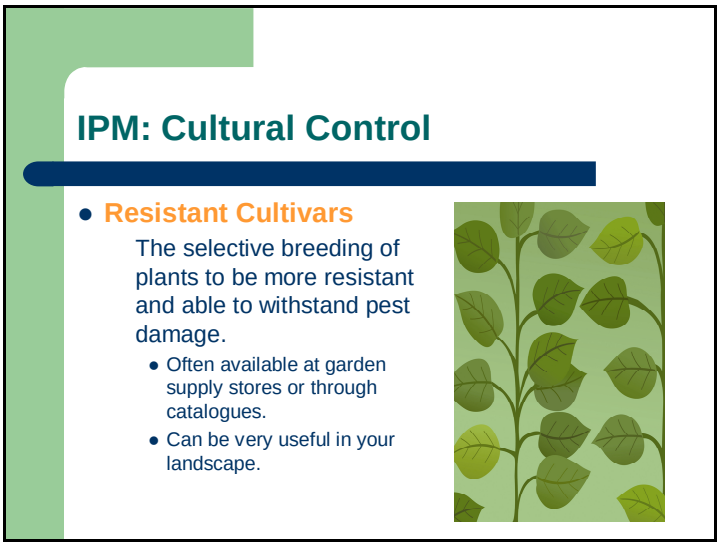
You have many options in Cultural Control. In this region, some of these include:

- Rotating Plants or Crops
- Choosing Resistant Cultivars
- Planting at the Right Time
- Diversifying the plants in your yard
- Removing Debris
- Using Native Plants



When you alter plant types in an area from year to year on the same plot of land, this is called plant or crop rotation.

Alteration of plants can help promote healthier, richer soils, allowing plants to thrive in their environment. When plants are able to flourish they are less susceptible to impacts from insect, weed, or disease pests.



Resistant cultivars are plants that have been bred to be more resistant and better able to withstand pest damage.

Seed and plant catalogues will note plants that have been cultivated to be resistant to pests.

IPM: Cultural Control

- **Plant at the Right Time**

  Ensuring adequate time to flourish and grow before pest populations become active allows the plant to tolerate pests better.

When the plants in your landscape are healthy and able to grow under the best conditions available, they can more easily out-compete weed pests and are better able to handle insect and disease pests. This is why planting at the right time helps to prevent pest problems in your yard.

IPM: Cultural Control

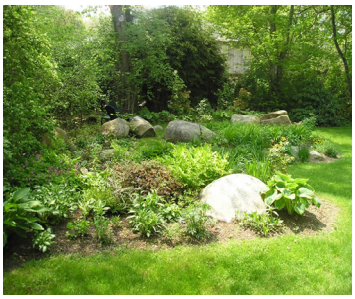


Image Credit: http://www.sustainability.uconn.edu/sustain/biodiv/05.html

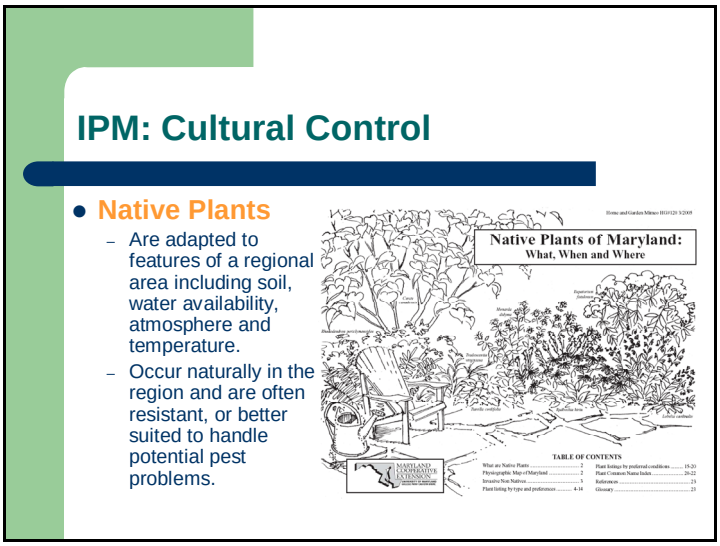
- **Diversify**

  A variety of plants in a garden will support a diverse array of organisms which will help minimize pest problems.

Maintaining plant diversity is another method of cultural control you can use in your yard. A variety of plants in a garden will support a diverse array of organisms which will help minimize pest problems.

Natural enemies often thrive in diverse habitats.

Removal of debris (plant or otherwise) from gardening areas can eliminate breeding and habitat areas for pests.

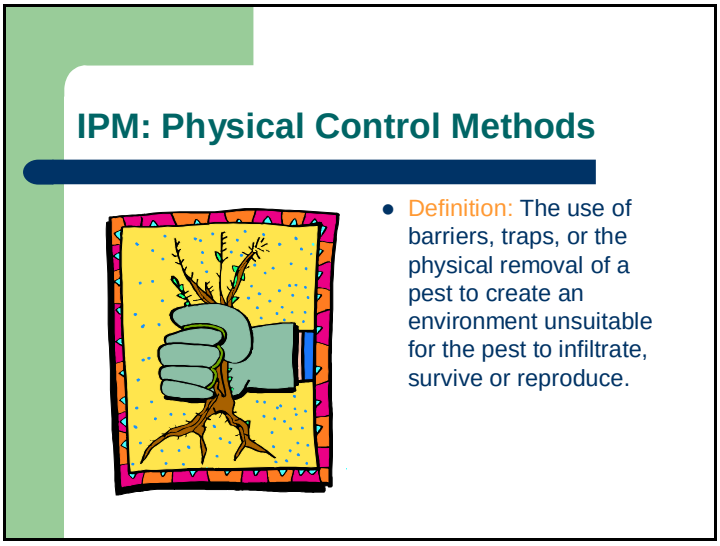


Native plants are plants that are adapted to a region and are often resistant or better able to handle potential pest problems.

By using native plants in your yard you will help to support both plant and animal communities.

Native plants are also energy efficient! Since they are well adapted to the region, they require less maintenance in terms of water, fertilizer and general maintenance.

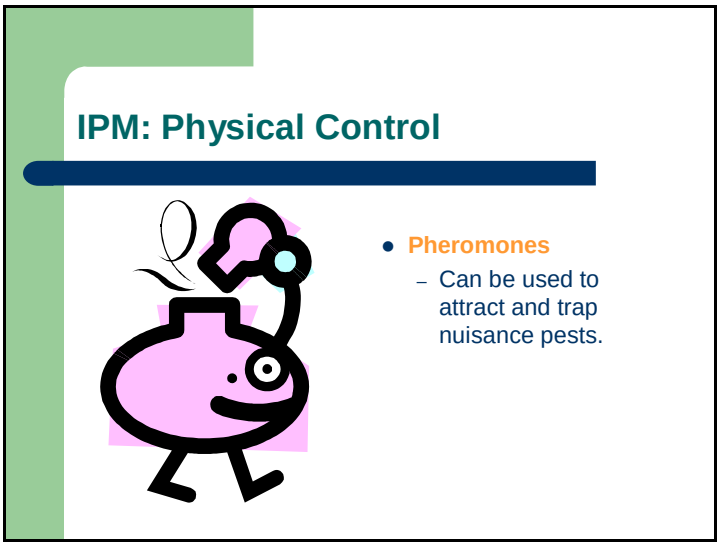
The University of Maryland Home and Garden Information Center is a great resource for learning about plants native to this area. They have knowledgeable staff and publications on their website about plants native to our area. This pictured image is a publication about native plants that can be found on the HGIC website.



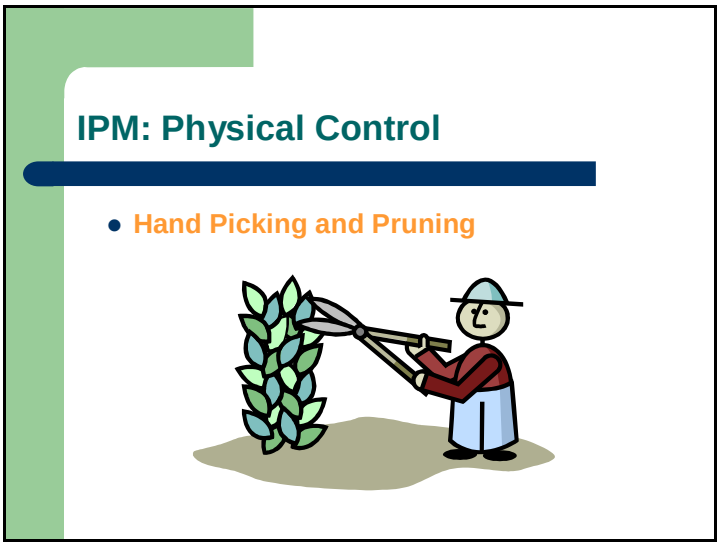
Lets move on to Physical Control Methods in IPM. Physical control measures include the use of barriers, traps or the physical removal of a pest to create an environment unsuitable for the pest to infiltrate, survive or reproduce.

Physical control measures generally require a little more work than the other described methods, but can be very effective.

Some physical control options include the use of pheromones, hand picking and pruning and use of sticky traps.



Pheromones can be used to attract and trap nuisance pests. Many companies sell pheromone traps for use in gardens.



Weed pests can be pulled out by hand, and you can also pick insect pests off of your plants. You need to kill the insects that you pick off if you want to see any results.

Diseased plants can be pruned of their diseased branches, leaves, etc..

IPM: Physical Control

- **Sticky Traps**

  Traps with a sticky surface collect insect pests as they walk or fly around the environment.

Image Credit:
http://ipm.ncsu.edu/cotton/insectcorner/photos/images/Wing_sticky_traps.jpg

Sticky traps collect insect pests as they walk or fly around the environment.

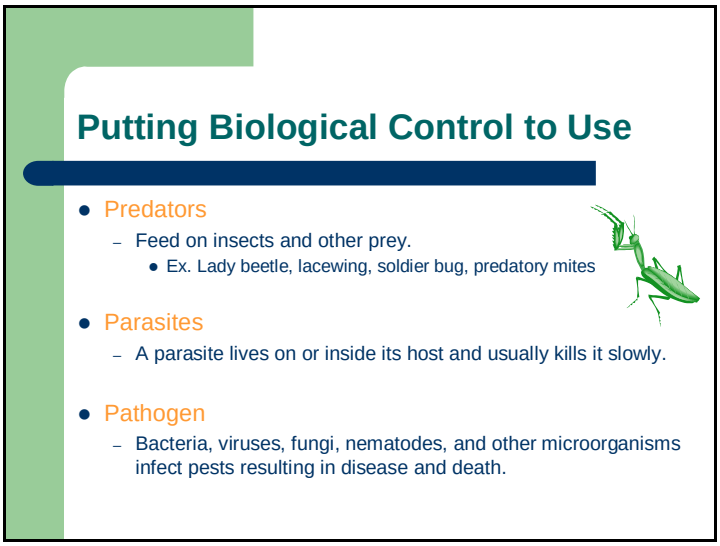
Sticky traps can be purchased at garden centers or through catalogues.

IPM: Biological Control Methods

- Definition: The use of natural enemies including predators, parasites, or pathogens to reduce a pest population to a tolerable level.

Images Courtesy of M.J. Raupp, Univ. of Maryland

Biological control is another important IPM method and includes the use of natural enemies to reduce pest populations to tolerable levels.

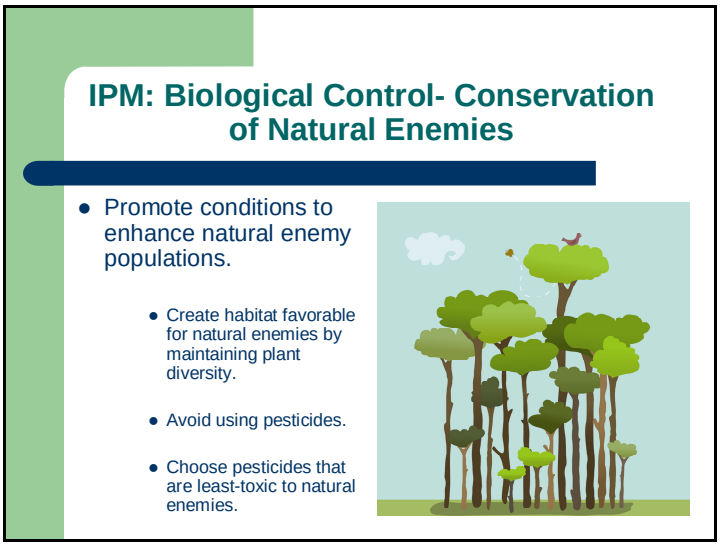


There are three classes of organisms used in biological control. These include predators, parasites and pathogens.

There are two ways of incorporating these organisms into your landscape.

One way of incorporating natural enemies into your landscape is to directly place them there. You can buy natural enemies for release in your yard.

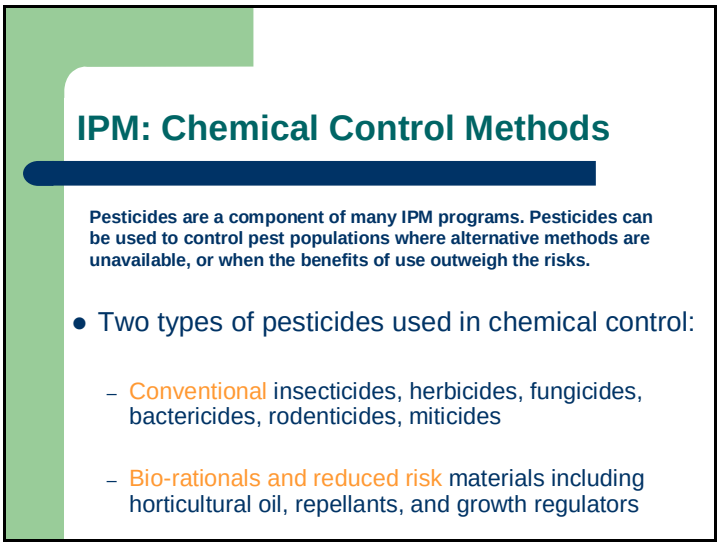
The University of Maryland Home and Garden Information Center and their website provide information on where natural enemies can be purchased for release.



Conserving natural enemies is another great biological control method in IPM.

Plant diversity, avoidance of pesticides when possible, or choosing least-toxic pesticides promotes natural enemy populations.

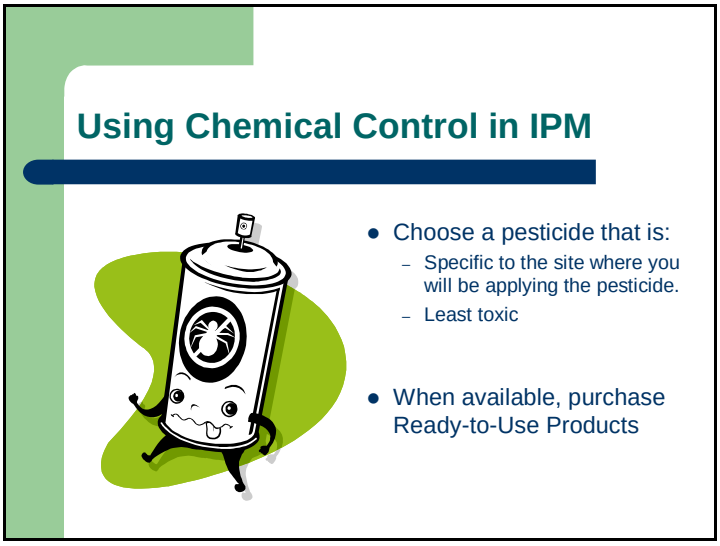
Conservation of natural enemies through biological control is very promising because it doesn't require the purchase of organisms that might end up leaving the part of the landscape where you need control most.



The last control measure that is part of IPM strategy is Chemical Control.

Pesticides are a component of many IPM programs. Pesticides can be used to control pest populations where alternative methods are unavailable, or when the benefits of use outweigh the risks.

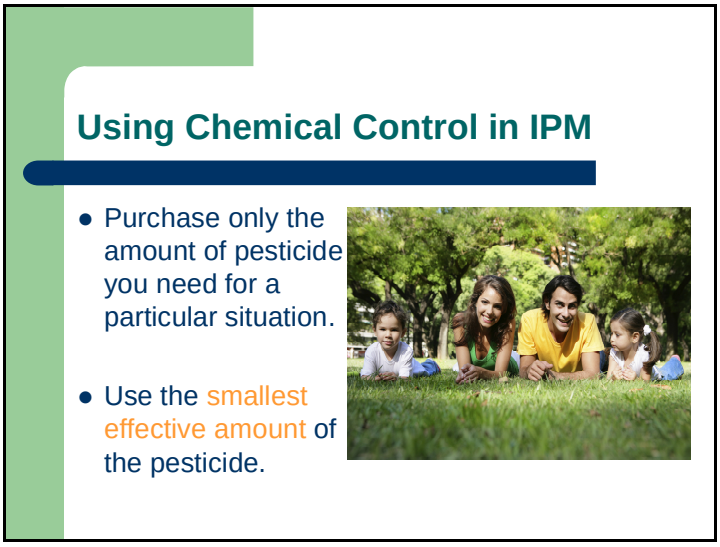
There are a few important concepts that will help you to make educated decisions about pesticide use in your own yard.



If you've considered cultural, physical, and biological controls, perhaps have implemented some, but still have a pest problem, then it's time to consider using an appropriate pesticide.

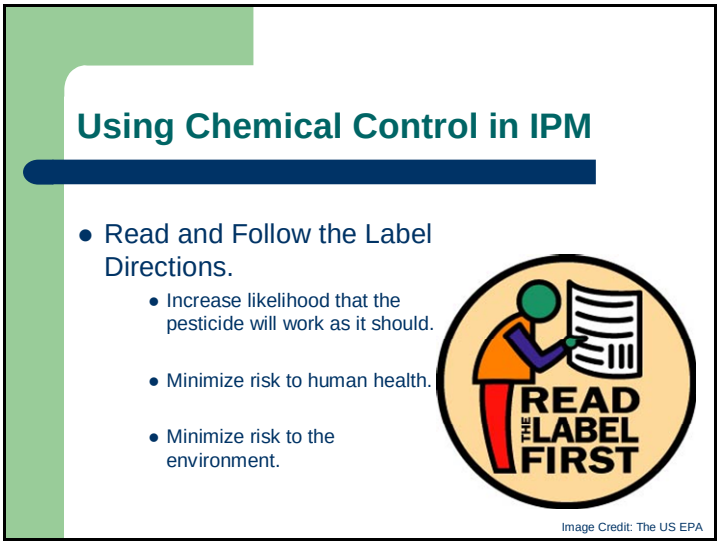
Look at the label to find a product that can be used in the place you want to use it. The label will also tell you if the product is toxic to wildlife such as bees, birds or fish.

Buying products that you won't have to mix decreases chances of mistakes and/or overexposure.



Limiting the size of the product to what you need for just one season means less of a storage problem.

Using the smallest effective amount will save you money, minimize risk of direct contact for you, your family and non-target organisms, and minimize risk of off-site contamination.



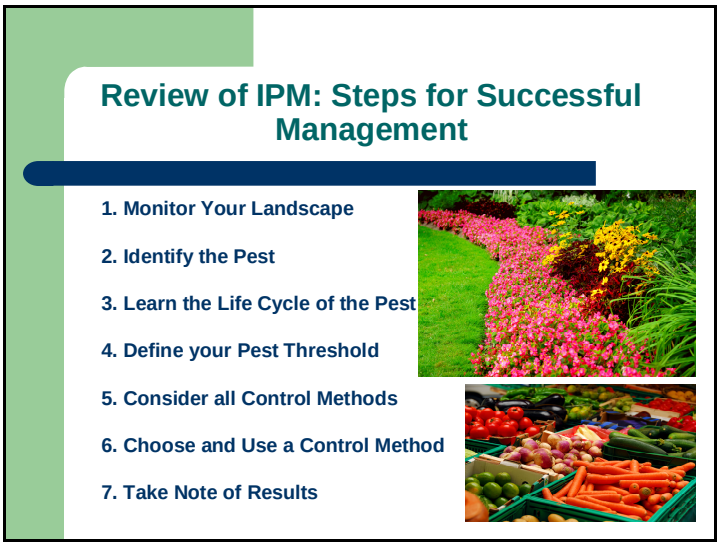
Each time you use a pesticide you should read and follow all of the label directions.

Following these directions will:

- Increase the likelihood that the pesticide will work as it should,
- Minimize risk to human health,

AND

- Minimize risk to the environment.



To review the stepwise strategy we have just learned, the steps you should follow for successful pest management in your yard are:

(READ EACH STEP)

By taking these steps, you are practicing IPM, and helping to safeguard the environment as well as the health of your family.

Resources For You

- Master Gardener
- Maryland Home and Garden Information Center
  - 1-800-342-2507
  - http://www.hgic.umd.edu
- Bug of the Week Website
  - http://raupplab.umd.edu/bugweek/

All of these resources are identified in the brochures that I have brought with me today.

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Acknowledgments

- This presentation was developed with support from:
  - Northeastern IPM Center
  - UM Pesticide Education & Assessment Program
- Many thanks to all of the contributors and reviewers of this project!!

Resources for Information about Caring for Your Yard

Bug of the Week Website: This website provides information about various regional insects and their life history patterns.

Web site:
http://raupplab.umd.edu/bugweek/

Master Gardeners: Your County Cooperative Extension Office can help you contact a Master Gardener. For more information, check the blue pages of your local phone book or visit the website below.

Web site:
http://mastergardener.umd.edu/local/index.cfm

The Maryland Home and Garden Information Center: The University of Maryland HGIC provides general gardening information and can make recommendations about appropriate pest control methods.

Mon-Fri: 8 a.m. - 1 p.m. (Eastern)
1-800-342-2507
or
1-410-531-1757

Website: http://www.hgic.umd.edu

This information was developed by the Pesticide Education and Assessment Program, University of Maryland, in collaboration with the University of Delaware and West Virginia University.

Web site: http://www.pesticide.umd.edu

This project was funded through a grant from the Northeastern Integrated Pest Management (IPM) Center.

Creating Safe and Beautiful Yards

Learn about how to prevent, identify and control pests in your yard while protecting the health of your family and being environmentally-friendly!

Prevent Pests in Your Yard

Take advantage of and use cultural, preventative practices every season.

Choose Healthy Plants. When buying plants, examine them closely and avoid bringing unhealthy plants into your yard.

Use Native Plants. These plants occur naturally in the region and are often resistant, or better suited to handle potential pest problems.

Use Resistant Cultivars. Some plants are bred to be resistant to pests. You can find them at local garden centers or through catalogues.

Plant at the Right Time. Ensuring adequate time for plants to flourish and grow before pest populations become active allows the plants to better tolerate pests.

Diversify. A yard with many different kinds of plants will support insect diversity, which helps control pest insects at tolerable levels.

Remove debris. Pruning or otherwise removing dead/dying plant parts and other debris eliminates disease agents as well as breeding areas for pests.

Promote Beneficial Organisms. Parasites, predators, and other beneficials help maintain pest populations at tolerable levels. Decreasing pesticide use and promoting plant diversity in your yard will help promote habitat for beneficial organisms.

Learn About Pests You Find

Make good decisions by gaining an understanding of the pests in your yard.

Watch for signs of pests. Throughout the season, examine plants for pests as well as damage – decay, brown or rotten areas, and other signs of disease or infestation.

Consider a damage level you can live with. Decide whether the level of damage is enough to warrant control of the pest. It is usually not necessary or even desirable to kill all of the pests. Maintaining a small population of pests helps maintain their natural enemies.

Correctly identify the pest. Whether your pest is a weed, insect, or other, its identity will help determine the best control method. T

Learn about the life cycle. Once you have identified the pest, you can use many resources available to learn about its life cycle. Knowing the pest's life cycle will help determine vulnerable life stages when control measures would be most effective.

Safely Manage Pests

When a pest has become a problem, consider all control strategies.

Try alternatives to pesticides

- Use physical controls, including pheromone traps and sticky traps. Handpick or prune pests off.
- Promote biological control by conserving beneficial organisms in your yard.

If non-pesticide alternatives are unavailable, chemical control can be considered

If using a pesticide, take special care.

- Select a pesticide that can be used in the area you want to treat (for example, on or near vegetables).
- Choose a pesticide that won't interfere with biological control.
- Follow label directions to protect humans, wildlife and sensitive areas.
- Use the smallest effective amount of the pesticide.

For more information about pesticides see the leaflet titled "Using Pesticides Safely."

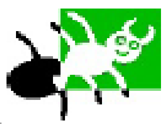
Appendix 3. Educational Brochure “Using Pesticides Safely to Manage Pests and Protect Your Environment”

Resources for Information on Safe Pest Management

National Pesticide Information Center: NPIC can answer your specific questions about pesticide chemistry, toxicology, environmental fate, and safe use of pesticides.

7 days a week 6:30am - 4:30pm (Pacific)
1-800-858-7378

Website: http://npic.orst.edu



Master Gardeners: Your County Cooperative Extension Office can help you contact a Master Gardener. For more information, check the blue pages of your local phone book or visit the website below.

Web site:
http://mastergardener.umd.edu/local/index.cfm

The Maryland Home and Garden Information Center: The Maryland HGIC provides general gardening information and can make recommendations about appropriate pest control methods.

Mon-Fri: 8 a.m. - 1 p.m. (Eastern)
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For more information on the prevention and management of pests in your yard please see the leaflet titled “Creating Safe and Beautiful Yards.”

MARYLAND COOPERATIVE EXTENSION
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Using Pesticides Safely to Manage Pests and Protect Your Environment

Pesticides (insecticides, weed killers, fungicides, etc.) are neither friend nor foe. It is **how** a pesticide is used that determines the risk to human health and the environment.

Learn how to safely use pesticides in your yard while protecting human health and environmental integrity.

Before Using a Pesticide

Read the label first to help you choose an appropriate product.

Know where you plan to use it. Make sure the application site is listed on the pesticide label. Using a pesticide on a site not listed could cause harm to humans or wildlife, or contaminate the environment.

Learn about requirements and precautions. The pesticide label provides information about:

- necessary safety measures to protect yourself and others during and after application;
- required application equipment;
- whether the pesticide is harmful to certain plants or animals;
- how to protect sensitive areas (water sources, drainage areas, etc.).

Buy in small amounts. Purchase and use the least amount of pesticide necessary to complete the job. Try to buy a size of product you can use up within one season. Pesticides in storage may lose effectiveness over time. Also, accidental poisonings have occurred when pesticides have been stored improperly.

During Pesticide Application

Follow label directions to ensure you use the pesticide properly and safely.

Wear clothing that protects you. Appropriate clothing protects you from potentially dangerous pesticide overexposure. At the least, wear:

- long pants,
- a long-sleeved shirt,
- waterproof gloves, and/or
- any additional protective gear directed by the pesticide label (for example, chemical-resistant or nitrile gloves).

Follow all directions for applying the pesticide. The label tells you how much, where, and when to use the pesticide.

- Use the smallest amount directed on the label to ensure maximum effectiveness against the pest plus the lowest risk to you, your family and the environment.
- When possible, treat only problem spots instead of spraying an entire area.

Apply pesticide only when timing and weather conditions are right.

- Applying in the early morning or evening helps protect bees, which are less active then. Bees ensure flowering of many fruits, vegetables, and ornamentals.
- Avoid applying a pesticide when it is windy. Winds are often calmest in the early morning and evening.
- Don't apply shortly before rain is expected, since rain can move pesticide residue off-site into the environment. Also avoid watering soon after an application unless the label directs you to water the pesticide in.

After Using a Pesticide

Maintain good precautions and continue to follow label directions for storage and disposal.

Protect children and pets. Keep children and pets away from pesticide-treated areas, at least until spray has dried or dust has settled. Children and pets may be more vulnerable to smaller amounts of pesticide exposure and therefore should be especially protected.

Store pesticides properly.

- Store pesticides in their original containers so the directions will always be available when you use the pesticide again. This also helps prevent accidents -- children and others have been poisoned by drinking pesticides stored in bottles originally containing milk, juice, or other drinks.
- Keep pesticides in a locked cabinet away from areas where children have access. The storage area should be cool, dry, and ventilated, and should have a light.

Implementation of Pest Control Practices by Consumers

In the fall of 2008, the University of Maryland Pesticide Education and Assessment Program will be conducting a survey to determine consumer pest control decisions and practices. The survey will consist of a brief questionnaire that may be answered on-line, via e-mail, or returned through the US mail (we will provide a stamped, addressed envelope.) No identifying information will be requested on the questionnaire. The survey results will be used to help educators develop better outreach materials for consumers.

Consumers who agree to participate in this portion of the study will be entered into a drawing to win a $25.00 gift card to a garden center. The study directors are Dr. Amy Brown (amybrown@umd.edu or 301-405-3911) and Ms. Amanda Matheny (mathenya@umd.edu or 301-405-3635).

If you would be willing to participate in the fall 2008 survey, please **tell us how you would prefer to be contacted – by Email or through the US mail**. Please respond in only ONE box:

I prefer to be contacted by **Email**. (Provide your email contact information.)	**OR**	I prefer to be contacted through **US Mail** . (Provide your name and address.)
I prefer to be contacted by **Email**. (Provide your email contact information.)	**OR**	I prefer to be contacted through **US Mail** . (Provide your name and address.)
I prefer to be contacted by **Email**. (Provide your email contact information.)	**OR**	I prefer to be contacted through **US Mail** . (Provide your name and address.)

Appendix 5. Survey One: Attitudes and Beliefs about Pest Management

The University of Maryland Pesticide Education and Assessment Program is conducting a survey-based study to assess consumers' attitudes about pest management. No identifying information is requested. The survey results will help educators develop better outreach materials for consumers.

For more information about this survey please contact:

Dr. Amy Brown
4112 Plant Sciences Building
University of Maryland
College Park, Maryland 20742
301-405-3928 Ofc.
301-314-9290 Fax
amybrown@umd.edu

Amanda Matheny
4112 Plant Sciences Building
University of Maryland
College Park, Maryland 20742
301-405-3635 Ofc.
mathenya@umd.edu

Note: In this survey, the word "PESTICIDE" means any chemical that kills or controls a pest of any kind including insecticide, fungicide, herbicide, weed killer, etc.

1. Please select ALL responses that apply. If you believe a response choice is missing, write it into the "Other" category.	**No One**	**Master Gardener**	**Neighbor**	**Cooperative Extension**	**Employees at a Retailer**	**Pest Control Company**	**Resources on the Internet**	**Resources at a Library**	**Other**
A good source for general gardening information.	8	7	6	5	4	3	2	1	
A good source for pest management information.	8	7	6	5	4	3	2	1	
Has provided me a positive past experience.	8	7	6	5	4	3	2	1	
A good source for pesticide information.	8	7	6	5	4	3	2	1	
A good source for pesticide alternative information.	8	7	6	5	4	3	2	1	
A source I would LIKE to get information from.	8	7	6	5	4	3	2	1	

2. How important are the following in deciding where you go to get pest control INFORMATION?	**Don't Know**	**Very Important**	**Somewhat Important**	**Not Important**
Information is available without leaving home.	4	3	2	1
Cost of obtaining information.	4	3	2	1
Time required to access information.	4	3	2	1
Travel distance required to obtain information.	4	3	2	1
Does not require Internet access.	4	3	2	1
Source offers pesticide AND alternative information.	4	3	2	1

3. In deciding on a pest control method, do you have concerns about protecting:	N/A	Lots of Concern	Some Concern	No Concern
Your own family/home/yard.	N/A	3	2	1
The surrounding neighborhood.	N/A	3	2	1
Children in the home or around the yard.	N/A	3	2	1
Pets living around the home or yard.	N/A	3	2	1
Yourself as an applicator of a pest control method.	N/A	3	2	1
Natural enemies (organisms that naturally control pests).	N/A	3	2	1
Bee populations.	N/A	3	2	1
Water sources (ponds, streams) in your own yard.	N/A	3	2	1
Water sources that could be affected by urban runoff (e.g. Chesapeake Bay).	N/A	3	2	1

4. It is important to me that a PEST CONTROL METHOD:	N/A	Very Important	Somewhat Important	Not Important
Is easy to use.	N/A	3	2	1
Is available where I already shop.	N/A	3	2	1
Is available from catalogues or through the Internet.	N/A	3	2	1
Is least harmful to humans.	N/A	3	2	1
Is least harmful to the environment.	N/A	3	2	1
Is recommended by a source I already know.	N/A	3	2	1
Can be used on or near vegetable gardens or fruits.	N/A	3	2	1
Will kill the pests (not just keep them under control).	N/A	3	2	1

5. How LIKELY are you to do the following?	N/A	Very Likely	Somewhat Likely	Very Unlikely
Regularly monitor your landscape for pests.	N/A	3	2	1
Use mulch to prevent weeds.	N/A	3	2	1
Spot treat localized weeds.	N/A	3	2	1
Pull out weeds by hand.	N/A	3	2	1
Promote plant diversity in your landscape.	N/A	3	2	1
Accept some number of insect pests or damage to plants.	N/A	3	2	1
Accept some number of weeds in your landscape.	N/A	3	2	1
Use knowledge about the life cycle of a pest to help with control.	N/A	3	2	1

6. In each of the following scenarios, where both a pesticide and a non-pesticide alternative are available to control a pest, choose which action you would MOST LIKELY take.	**Use a Pesticide**	**Use an Alternative Method**	**Unsure**
The pesticide and the alternative are effective with little difference in cost.	3	2	1
Using the pesticide would control your current pest, but might result in the OUTBREAK of a different pest.	3	2	1
The alternative is MORE EXPENSIVE than the pesticide.	3	2	1
The pesticide will control the pest immediately. The alternative will TAKE SOME TIME to control the pest.	3	2	1
The pesticide will manage the pest but will also KILL THE PEST'S NATURAL ENEMIES.	3	2	1
The pesticide is MORE EFFECTIVE than the alternative.	3	2	1
Repeated use of a pesticide might lead to that pesticide being LESS EFFECTIVE for YOU in the future.	3	2	1
Repeated use of a pesticide might add to overuse in the general area which might lead to that pesticide being LESS EFFECTIVE for FARMERS in the future.	3	2	1
The PESTICIDE is easier to use than the alternative, but is MORE HARMFUL to humans or the environment.	3	2	1
The ALTERNATIVE is easier to use than the pesticide, but is MORE HARMFUL to humans or the environment.	3	2	1

7. When controlling ANY pest, how LIKELY are you to do the following?	**N/A**	**Very Likely**	**Somewhat Likely**	**Very Unlikely**
Consider only pesticide options.	N/A	3	2	1
Consider alternatives to the use of pesticides.	N/A	3	2	1
Choose a pest control method that is easy to use.	N/A	3	2	1
When using a pesticide, leave an untreated strip of land next to areas that drain into water sources (e.g. sewer drain, pond, etc.)	N/A	3	2	1
When using a pesticide, apply in the early morning or evening.	N/A	3	2	1
Take special measures to protect wildlife in your yard from pesticide exposure.	N/A	3	2	1
Take special measures to protect children or pets from pesticide exposure.	N/A	3	2	1

8. Please tell us any other reasons why you might choose a pesticide rather than a non-pesticide method.

_____
_____
_____

9. Please tell us any other reasons why you might choose a non-pesticide method rather than a pesticide.

_____
_____
_____

10. Please select ALL that apply. If there is something you are interested in knowing more about that is not included in this list, please write it into the "Other" category.

I wish I knew more about how to:
_____ Safely use pesticides.
_____ Properly store pesticides.
_____ Properly dispose of pesticides.
_____ Understand pesticide label directions.
_____ Choose appropriate protective clothing for pesticide use.
_____ Recognize beneficial insects in the yard.
_____ Use natural enemies to control pests.
_____ Use non-pesticide control methods.
_____ Choose least-toxic pesticides for humans.
_____ Choose least-toxic pesticides for the environment.
_____ Other: _____

11. What is your age group?	**12. What is the highest level of education you have completed?**
A) Under 20 years old	A) Grade School
B) 21-30 years old	B) High School
C) 31-40 years old	C) Some College
D) 41-50 years old	D) Associate's Degree (2-year institution)
E) 51-60 years old	E) Bachelor's Degree (4-year institution)
F) 61-70 years old	F) Graduate Degree
G) 71 years and older	

The University of Maryland Pesticide Education and Assessment Program is conducting a survey-based study to determine knowledge changes associated with specific outreach programs. No identifying information is requested. The survey results will help educators develop better outreach materials for consumers.

For more information about this survey please contact:

Dr. Amy Brown
4112 Plant Sciences Building
University of Maryland
College Park, Maryland 20742
301-405-3928 Ofc.
301-314-9290 Fax
amybrown@umd.edu

Amanda Matheny
4112 Plant Sciences Building
University of Maryland
College Park, Maryland 20742
301-405-3635 Ofc.
mathenya@umd.edu

For each statement, circle one response in each section (AFTER and BEFORE).	Please rate your level of understanding AFTER viewing the presentation.			Please rate your level of understanding BEFORE viewing the presentation.		
	Understand Well	Understand Some	Do Not Understand	Understood Well	Understood Some	Did Not Understand
Potential benefits of using pesticides.	3	2	1	3	2	1
Potential human health risks of pesticides.	3	2	1	3	2	1
Potential environmental risks of pesticides.	3	2	1	3	2	1
How pests become resistant to pesticides.	3	2	1	3	2	1
The role of pesticides in the development of a secondary pest outbreak.	3	2	1	3	2	1
Reasons to protect pollinators in our yards.	3	2	1	3	2	1
How runoff or drift can move pesticides through the environment.	3	2	1	3	2	1
What IPM means (what the letters stand for).	3	2	1	3	2	1
How monitoring your yard for pests helps in making pest control decisions.	3	2	1	3	2	1
The importance of correctly identifying a pest.	3	2	1	3	2	1

For each statement, circle one response in each section (AFTER and BEFORE).	Please rate your level of understanding AFTER viewing the presentation.			Please rate your level of understanding BEFORE viewing the presentation.		
	Understand Well	Understand Some	Do Not Understand	Understood Well	Understood Some	Did Not Understand
How understanding pest life cycles helps in their control.	3	2	1	3	2	1
Why the goal of good pest control should be managing pests rather than killing all of the pests.	3	2	1	3	2	1
How to use cultural controls to manage pests (plant diversity, remove debris, native plants etc.).	3	2	1	3	2	1
How to use physical controls to manage pests (hand picking, pruning, etc.).	3	2	1	3	2	1
How to promote natural enemies in your yard.	3	2	1	3	2	1
Why chemical control should preferably be considered only when alternatives are unavailable or when the benefits outweigh the risks.	3	2	1	3	2	1
The importance of using the smallest effective amount of a pesticide.	3	2	1	3	2	1
The importance of reading the pesticide label.	3	2	1	3	2	1
Where to find reliable resources for gardening and pest management information.	3	2	1	3	2	1

Please circle ONE response per question.	Very Likely	Somewhat Likely	Very Unlikely
How likely are you to share what you learned today with friends and/or family?	3	2	1
Do you believe this presentation will impact the way you manage future pest situations?	3	2	1

Please tell us anything else you learned from the presentation that was not mentioned above.

_____

_____

_____

Please tell us if there is anything you would like to know more about that was not covered in today's presentation.

_____

_____

_____

What is your zip code? _____

What is your age group?
A) Under 20 years old
B) 21-30 years old
C) 31-40 years old
D) 41-50 years old
E) 51-60 years old
F) 61-70 years old
G) 71 years and older

What is the highest level of education you have completed?
A) Grade School
B) High School
C) Some College
D) Associate's Degree (2-year institution)
E) Bachelor's Degree (4-year institution)
F) Graduate Degree

Thank you for your participation in this study. Your answers will help us improve educational materials about pest management.

The University of Maryland Pesticide Education and Assessment Program is conducting a survey-based study to assess consumer pest control decisions and practices. No identifying information is requested. The survey results will help educators develop better outreach materials for consumers.

For more information about this survey please contact:

Dr. Amy Brown
Department of Entomology
University of Maryland
College Park, Maryland 20742
301-405-3928 Ofc.
amybrown@umd.edu

Ms. Amanda Matheny
MEES program
University of Maryland
College Park, Maryland 20742
301-405-3635 Ofc.
mathenya@umd.edu

NOTE:

- **In this questionnaire, the word "PESTICIDE" means any chemical that kills or controls a pest of any kind, including insecticide, fungicide, herbicide, weed killer, etc.**
- **In this questionnaire, "N/A" means not applicable.**

1. Earlier this year, did you take a University of Maryland survey about your opinions on pest management? Please select only ONE response.

____ I don't know
____ No, I did not
____ Yes, at a farmer's market
____ Yes, at a plant clinic
____ Yes, at a garden club meeting
____ Yes, at a County Fair Event
____ Yes, at the State Fair
____ Yes, online through the University of Maryland Home and Garden Information website
____ Yes, Other:_____

2. For each part of question 2, please place an X by the choice(s) that most closely reflect(s) how you usually maintain your yard or garden.

2.A. Monitoring (Please select only ONE answer)
____ I monitor for pests by "eyeballing" how the yard looks.
____ I monitor for pests by counting the number of pests on a plant or within an area.
____ I generally do not monitor for pests.

2.B. Control Decisions (You may select more than one answer)
____ I try to control insect pests as soon as I notice any of them.
____ I usually do not control insect pests until they reach a certain number.
____ I usually do not control insect pests until a certain level of plant damage is reached.
____ I try to control weeds as soon as I notice any of them.
____ I usually do not control weeds until they reach a certain number or level.

2.C. Preparation/Maintenance (You may select more than one answer)
____ I try to use plants that are native to the area where I live.
____ I try to use resistant cultivars (plants that are bred to be more resistant to certain pests).
____ I remove debris (dead plant matter, trash, etc. that could harbor pests) from my yard or garden.
____ I use preventative pesticides (insecticide treatments) on my lawn or garden to prevent pests.
____ I use preventative pesticides (herbicides/ weed killers) on my lawn or garden to prevent pests.

3. In the past year, did you experience a pest situation that you decided you needed to control?

____ Yes. >> >> Please continue with **Question 4.**
____ No. >> >> Please skip to **Question 9.**

The following questions (#4, #5, and #6) contain specific questions for insect, weed and disease pests. Please only fill out the section or sections on pests for which you used control techniques within the past year.

4.A. For each choice below, please indicate how you controlled INSECT PESTS in the past and how you controlled them THIS YEAR.

	N/A	PAST	THIS YEAR
Accepted some level of damage or number of insects before taking action.			
Used an insecticide as a **first** option for control.			
Used an insecticide as a **last** option for control.			
Spot treated with an insecticide.			
Treated the entire lawn and/or garden with an insecticide.			
Used a non-insecticide approach as a **first** option for control.			
Used a non-insecticide approach as a **last** option for control.			
Used a trap (sticky trap or other) to control an insect pest.			
Promoted or released natural enemies to control an insect pest.			
Hand-picked or pruned off insects.			
Used insecticidal soap to control an insect pest.			
Used horticultural oil to control an insect pest.			

4.B. Is there another way you controlled insect pests that was not listed in question 4.A.? If YES, please fill out the boxes below. If NO, please move on to question 5.

In the PAST:
THIS YEAR:

5.A. For each choice below, please indicate how you controlled WEEDS in the past and how you controlled them THIS YEAR.

	N/A	PAST	THIS YEAR
Accepted some amount of weeds before taking action.			
Used a herbicide as a **first** option for control.			
Used a herbicide as a **last** option for control.			
Spot treated specific weeds or problem areas with a herbicide.			
Treated the entire lawn and/or garden with a herbicide.			
Used a non-herbicide approach as a **first** option for control.			
Used a non-herbicide approach as a **last** option for control.			
Pulled out weeds by hand.			

5.B. Is there another way you controlled weeds that was not listed in question 5.A.? If YES, please fill out the boxes below. If NO, please move on to question 6.

In the PAST:
THIS YEAR:

6.A. For each choice below, please indicate how you controlled DISEASE PESTS in the past and how you controlled them THIS YEAR.

	N/A	PAST	THIS YEAR
Accepted some level of damage or disease before taking action.			
Used a fungicide or bactericide as a **first** option for control.			
Used a fungicide or bactericide as a **last** option for control.			
Spot treated diseased areas with a fungicide.			
Treated an entire area with a fungicide, including areas not showing disease.			
Used a non-fungicide approach as a **first** option for control.			
Used a non-fungicide approach as a **last** option for control.			
Hand-picked or pruned off diseased areas.			
Used a conventional insecticide to control an insect pest that transmits a disease.			
Used insecticidal soap to control an insect pest that transmits a disease.			

6.B. Is there another way you controlled disease pests that was not listed in question 6.A.? If YES, please fill out the boxes below. If NO, please move on to question 7.

In the PAST:
THIS YEAR:

7.A. Please choose the statement that best describes your pest control decisions.

____ Overall, **I have** changed the way I control pests today compared to the past. >> >> Please continue with **Question 7.B.**
____ Overall, **I have not** changed the way I control pests today compared to the past. >> >> Please skip to **Question 8.**

7.B. Overall I changed the way I control pests today because… (Check all that apply.)

____ The methods I now use cost less.
____ The methods I now use take less of my time.
____ The methods I now use work quickly against a pest.
____ The methods I now use are more effective.
____ The methods I now use are easier to find and purchase.
____ I think the methods I now use are less likely to harm humans or pets.
____ I think the methods I now use are less likely to harm the environment.
____ I think the methods I now use are better for my yard/garden.
____ Other: _____

8. In each grouping below, select the statement that most closely reflects your position. Select only one choice in each section.

Beliefs About Insecticides	
A	____ I used to think insecticides could be risky **to humans and pets** when used according to the label directions, but now I think insecticides do not pose significant risk **to humans and pets** when used according to the label directions.
	____ I used to think insecticides were NOT risky **to humans and pets** when used according to the label directions, but now I think insecticides could be risky to **humans and pets** when used according to the label directions.
	____ My thinking about insecticide risk to **humans and pets** has not changed.
B	____ I used to think insecticides could be risky to **the environment** when used according to the label directions, but now think insecticides do not pose significant risk to **the environment** when used according to the label directions.
	____ I used to think insecticides were NOT risky to **the environment** when used according to the label directions, but now I think insecticides could be risky to **the environment** when used according to the label directions.
	____ My thinking about insecticide risk to **the environment** has not changed.

Beliefs About Herbicides	
C	____ I used to think herbicides could be risky to **humans and pets** when used according to the label directions, but now I think herbicides do not pose significant risk to **humans and pets** when used according to the label directions.
	____ I used to think herbicides were NOT risky to **humans and pets** when used according to the label directions, but now I think herbicides could be risky to **humans and pets** when used according to the label directions.
	____ My thinking about herbicide risk to **humans and pets** has not changed.
D	____ I used to think herbicides could be risky to **the environment** when used according to the label directions, but now I think herbicides do not pose significant risk to **the environment** when used according to the label directions.
	____ I used to think herbicides were NOT risky to **the environment** when used according to the label directions, but now I think herbicides could be risky to **the environment** when used according to the label directions.
	____ My thinking about herbicide risk to **the environment** has not changed.

Beliefs About Fungicides	
E	____ I used to think fungicides could be risky to **humans and pets** when used according to the label directions, but now I think fungicides do not pose significant risk to **humans and pets** when used according to the label directions.
	____ I used to think fungicides were NOT risky to **humans and pets** when used according to the label directions, but now I think fungicides could be risky to **humans and pets** when used according to the label directions.
	____ My thinking about fungicide risk to **humans and pets** has not changed.
F	____ I used to think fungicides could be risky to **the environment** when used according to the label directions, but now I think fungicides do not pose significant risk to **the environment** when used according to the label directions.
	____ I used to think fungicides were NOT risky to **the environment** when used according to the label directions, but now I think fungicides could be risky to **the environment** when used according to the label directions.
	____ My thinking about fungicide risk to **the environment** has not changed.

9. The following is a list of information sources you might have used in making a pest management decision. In the first column, please select ALL information sources you used. In the last column, please identify the SINGLE MOST IMPORTANT source you used (CHOOSE ONLY ONE).

	I used these sources for information (SELECT ALL THAT APPLY)	This was the SINGLE MOST IMPORTANT source I used. (SELECT ONLY ONE OPTION)
No One (relied on own knowledge)		
Television		
Radio		
Newspapers		
Magazines		
Podcasts		
Interaction with Master Gardeners/Cooperative Extension		
University of Maryland Home & Garden Information Center		
Family Members		
Neighbors and/or Friends		
Garden Club		
The Internet		
Retail Employees		
Books or References You Own		
Books or References from a Public Library		
Pest Control Company		
Other:_____		

10. Please tell us why you relied so heavily on the source of information you listed as your MOST IMPORTANT source. (Check all that apply.)

____ It is the only source available to me.
____ It is a source of information I trust.
____ It is not too costly for me to access.
____ The source provides a variety of pest management options (pesticide and non-pesticide methods).
____ I prefer to use pesticides and I believe this source gives the best information on them.
____ I prefer to use non-pesticide methods, and I believe this source gives the best information on them.
____ Other:_____

11. How long have you maintained a yard or garden?

____ Fewer than 5 years
____ 6-10 years
____ 11-15 years
____ 16-20 years
____ 21 years or more

12. What is your zip code?

_____

13. What is your age group?

____ Under 21 years old
____ 21-30 years old
____ 31-40 years old
____ 41-50 years old
____ 51-60 years old
____ 61-70 years old
____ 71 years and older

14. What is the highest level of education you have completed?

____ Grade School
____ High School
____ Some College
____ Associate's Degree (2-year institution)
____ Bachelor's Degree (4-year institution)
____ Graduate Degree

Thank you for your participation in this study.

Your answers will help us improve educational materials about pest management.

Appendix 8. Contact Letter for Participants Requesting E-mail Contact

UNIVERSITY OF MARYLAND

COLLEGE OF CHEMICAL AND LIFE SCIENCE
DEPARTMENT OF ENTOMOLOGY

4112 Plant Sciences Building
College Park. Maryland 20742-4454
301.405.3911 TEL 301.314.9290 FAX
www.entomology.umd.edu

December 3, 2008

TO: Participant, University of Maryland Pest Management Survey
FROM: Amanda Matheny, Graduate Student, University of Maryland

Earlier this year, you signed up to participate in a follow-up survey conducted by the University of Maryland. This study's objective is to determine how home gardeners make decisions about pest control practices. No identifying information is requested, and no individual results will be released. The survey results will be used to help educators develop better outreach materials for consumers.

Since you agreed to participate in this portion of the study, your name has been entered into a drawing to **win a $25.00 gift card** to a garden center. The drawing will be conducted no later than January 30, 2009, and the winning participant will be notified at that time.

The survey questionnaire has been finalized and is now available for you to answer. Please be sure to carefully read all of the directions associated with each question. To complete the survey, please choose any one of the following options:

1. Access and submit the survey on line. Go to https://www.surveymonkey.com/s.aspx?sm=2MRT_2fiNFc29Bi9AuWbsQMg_3d_3d (You may need to copy the link and paste it into your browser or manually type it in.) Complete the on-line questionnaire and click Done when you are finished.

OR

2. Access the survey through this email and submit it by U.S. mail. Open the attached Word/Richtext document, print the file, complete the questions, and mail the completed survey to Ms. Amanda Matheny, University of Maryland, Department of Entomology, 4112 Plant Sciences Bldg., College Park, MD 20742.

OR

3. Access and submit the survey through email. Open the attached Word/Richtext document, complete the questions, save the completed file as a Word or Richtext

document, and email the completed survey file back to us as an attachment to mathenya@umd.edu.

If you have any questions or concerns, please feel free to contact me at 301-405-3635 or by email at mathenya@umd.edu.

I would like to thank you in advance for your participation in this follow-up survey. Your responses are valuable to us and the community. Please submit your completed survey **no later than January 5, 2009.**

Appendix 9. Contact Letter for Participants Requesting US Mail Contact

UNIVERSITY OF MARYLAND

COLLEGE OF CHEMICAL AND LIFE SCIENCE
DEPARTMENT OF ENTOMOLOGY

4112 Plant Sciences Building
College Park. Maryland 20742-4454
301.405.3911 TEL 301.314.9290 FAX
www.entomology.umd.edu

December 3, 2008

TO: Participant, University of Maryland Pest Management Survey
FROM: Amanda Matheny, Graduate Student, University of Maryland

Earlier this year, you signed up to participate in a follow-up survey conducted by the University of Maryland. This study's objective is to determine how home gardeners make decisions about pest control practices. No identifying information is requested, and no individual results will be released. The survey results will be used to help educators develop better outreach materials for consumers.

Since you agreed to participate in this portion of the study, your name has been entered into a drawing to **win a $25.00 gift card** to a garden center. The drawing will be conducted no later than January 30, 2009, and the winning participant will be notified at that time.

The survey questionnaire has been finalized and is now available for you to answer. Please be sure to carefully read all of the directions associated with each question. To complete the survey, please choose any one of the following options:

4. Access and submit the survey on line. Go to https://www.surveymonkey.com/s.aspx?sm=2MRT_2fiNFc29Bi9AuWbsQMg_3d_3d (You may need to copy the link and paste it into your browser or manually type it in.) Complete the on-line questionnaire and click Done when you are finished.

OR

5. Complete the survey attached with this memo and submit it by U.S. mail. Answer the questions and mail the completed survey back to Ms. Amanda Matheny, University of Maryland, Department of Entomology, 4112 Plant Sciences Bldg., College Park, MD 20742. You may use the enclosed pre-addressed postage-paid envelope to mail the survey back.

If you have any questions or concerns, please feel free to contact me at 301-405-3635 or by email at mathenya@umd.edu.

I would like to thank you in advance for your participation in this follow-up survey. Your responses are valuable to us and the community. Please submit your completed survey **no later than January 5, 2009.**

Appendix 10. Assessment of Pest Management Opinions

Assessment of Pest Management Opinions

The University of Maryland Pesticide Education and Assessment Program is conducting a survey-based study to assess consumers' attitudes about pest management. No identifying information is requested. The survey results will help educators develop better outreach materials for consumers.

If you are willing to participate in this study, the Master Gardener can provide you with the questionnaire and will collect it when you are done.

For more information please contact:

Dr. Amy Brown (301-405-3911) or Ms. Amanda Matheny (301-405-3635)
Department of Entomology, University of Maryland, College Park, MD 20742

Appendix 11. Implementation of Pest Control Practices by Consumers

Implementation of Pest Control Practices by Consumers

In the fall of 2008, the University of Maryland Pesticide Education and Assessment Program will be conducting a survey to determine consumer pest control decisions and practices. The survey will consist of a brief questionnaire that may be answered on-line, via e-mail, or returned through the US mail (we will provide a stamped addressed envelope). No identifying information will be requested on the questionnaire. The survey results will be used to develop better outreach materials for consumers.

Participants in the fall 2008 survey will be entered into a drawing to win a $25.00 gift card to a garden center. If you are interested in participating in the fall 2008 survey, please ask the Master Gardener for the roster and fill out your contact information.

For more information, contact Dr. Amy Brown (301-405-3911) or Ms. Amanda Matheny (301-405-3635).

Appendix 12. IPM Knowledge: All respondents

IPM knowledge before and after educational presentation. [1]

Topic (n)	Before			After	
	Mean	**SD**		**Mean**	**SD**
How monitoring your yard for pests helps in making pest control decision (n=52)	2.46	.576		2.92	.269
The importance of correctly identifying a pest (n=52)	2.63	.525		2.90	.298
How understanding pest life cycles helps in their control (n=52)	2.44	.608		2.94	.235
Why the goal of good pest control should be managing pests rather than killing all of the pests (n=52)	2.62	.530		2.98	.139
How to use cultural controls to manage pests (n=52)	2.52	.577		2.90	.298
How to use physical controls to manage pests (n=52)	2.75	.437		2.92	.269
How to promote natural enemies in your yard (n=52)	2.37	.595		2.75	.437
Reasons to protect pollinators in our yards (n=52)	2.88	.323		2.98	.139
What IPM means (what the letters stand for) (n=52)	2.85	.364		2.98	.139
Where to find reliable resources for gardening and pest management information (n=52)	2.54	.541		2.88	.379

[1] Responses were made on a 3-point Likert Scale (1= did not or do not understand, 3= understood or understand well)

Appendix 13. IPM Knowledge: Regular gardeners

IPM knowledge before and after educational presentation. [1]

Topic (n)	Before			After	
	Mean	**SD**		**Mean**	**SD**
How monitoring your yard for pests helps in making pest control decision (n=21)	2.38	.669		2.95	.218
The importance of correctly identifying a pest (n=21)	2.52	.602		2.90	.301
How understanding pest life cycles helps in their control (n=21)	2.29	.717		3.00	.000
Why the goal of good pest control should be managing pests rather than killing all of the pests (n=21)	2.57	.598		3.00	.000
How to use cultural controls to manage pests (n=21)	2.33	.577		2.86	.359
How to use physical controls to manage pests (n=21)	2.57	.507		2.86	.359
How to promote natural enemies in your yard (n=21)	2.29	.463		2.71	.463
Reasons to protect pollinators in our yards (n=21)	2.86	.359		2.95	.218
What IPM means (what the letters stand for) (n=21)	2.86	.359		2.95	.218
Where to find reliable resources for gardening and pest management information (n=21)	2.62	.498		2.95	.218

[1] Responses were made on a 3-point Likert Scale (1= did not or do not understand, 3= understood or understand well)

Appendix 14. IPM Knowledge: Master Gardeners

IPM knowledge before and after educational presentation. [1]

Topic (n)	Before			After	
	Mean	**SD**		**Mean**	**SD**
How monitoring your yard for pests helps in making pest control decision (n=31)	2.52	.508		2.90	.301
The importance of correctly identifying a pest (n=31)	2.71	.461		2.90	.301
How understanding pest life cycles helps in their control (n=31)	2.55	.506		2.90	.301
Why the goal of good pest control should be managing pests rather than killing all of the pests (n=31)	2.65	.486		2.97	.180
How to use cultural controls to manage pests (n=31)	2.65	.551		2.94	.250
How to use physical controls to manage pests (n=31)	2.87	.341		2.97	.180
How to promote natural enemies in your yard (n=31)	2.42	.672		2.77	.425
Reasons to protect pollinators in our yards (n=31)	2.90	.301		3.00	.000
What IPM means (what the letters stand for) (n=31)	2.84	.374		3.00	.000
Where to find reliable resources for gardening and pest management information (n=31)	2.48	.570		2.84	.454

[1] Responses were made on a 3-point Likert Scale (1= did not or do not understand, 3= understood or understand well)

Appendix 15. Pesticide Knowledge: All respondents

Pesticide knowledge before and after educational presentation. [1]

Topic (n)	Before			After	
	Mean	**SD**		**Mean**	**SD**
Potential benefits of using pesticides (n=52)	2.62	.491		2.87	.345
Potential human health risks of pesticides (n=51)	2.69	.469		2.90	.300
Potential environmental risks of pesticides (n=51)	2.80	.401		2.94	.238
How pests become resistant to pesticides (n=49)	2.43	.612		2.88	.389
How runoff or drift can move pesticides through the environment (n=52)	2.92	.334		2.97	.457
Why chemical control should preferably be considered only when alternatives are unavailable or when benefits outweigh the risks (n=52)	2.71	.498		2.90	.298
The importance of using the smallest effective amount of a pesticide (n=52)	2.65	.590		2.88	.323
The importance of reading the pesticide label (n=52)	2.88	.323		2.96	.194
The role of pesticides in the development of a secondary pest outbreak (n=51)	2.08	.744		2.78	.461

[1]Responses were made on a 3-point Likert Scale (1 = did not or do not understand, 3= understood or understand well)

Appendix 16. Pesticide Knowledge: Regular gardeners

Pesticide knowledge before and after educational presentation. [1]

Topic (n)	Before			After	
	Mean	**SD**		**Mean**	**SD**
Potential benefits of using pesticides (n=21)	2.43	.507		2.81	.402
Potential human health risks of pesticides (n=21)	2.62	.498		2.90	.301
Potential environmental risks of pesticides (n=21)	2.76	.436		3.00	.000
How pests become resistant to pesticides (n=20)	2.25	.716		2.80	.523
How runoff or drift can move pesticides through the environment (n=21)	2.71	.561		2.81	.512
Why chemical control should preferably be considered only when alternatives are unavailable or when benefits outweigh the risks (n=21)	2.76	.436		2.90	.301
The importance of using the smallest effective amount of a pesticide (n=21)	2.52	.680		2.90	.301
The importance of reading the pesticide label (n=21)	2.86	.359		3.00	.000
The role of pesticides in the development of a secondary pest outbreak (n=21)	2.05	.669		2.81	.512

[1]Responses were made on a 3-point Likert Scale (1 = did not or do not understand, 3= understood or understand well)

Appendix 17. Pesticide Knowledge: Master Gardeners

Pesticide knowledge before and after educational presentation. [1]

Topic (n)	Before			After	
	Mean	**SD**		**Mean**	**SD**
Potential benefits of using pesticides (n=31)	2.74	.445		2.90	.301
Potential human health risks of pesticides (n=30)	2.73	.450		2.90	.305
Potential environmental risks of pesticides (n=30)	2.83	.379		2.90	.305
How pests become resistant to pesticides (n=29)	2.55	.506		2.93	.258
How runoff or drift can move pesticides through the environment (n=31)	2.84	.374		3.00	.000
Why chemical control should preferably be considered only when alternatives are unavailable or when benefits outweigh the risks (n=31)	2.68	.541		2.90	.301
The importance of using the smallest effective amount of a pesticide (n=31)	2.74	.514		2.87	.341
The importance of reading the pesticide label (n=31)	2.90	.301		2.94	.250
The role of pesticides in the development of a secondary pest outbreak (n=30)	2.10	.803		2.77	.430

[1]Responses were made on a 3-point Likert Scale (1 = did not or do not understand, 3= understood or understand well)

Appendix 18. Tactics Used to Control Insect Pests

Tactics to control insect pests: Past vs. present. [1]

Action (n)	Past			This Year	
	Mean	SD		Mean	SD
Accepted some level of damage or number of insects before taking action (n=25)	1.28	.458		1.20	.408
Used an insecticide as a first option for control (n=17)	1.65	.493		1.64	.493
Used an insecticide as a last option for control (n=22)	1.59	.503		1.41	.503
Spot treated with an insecticide (n=23)	1.39	.499		1.43	.507
Treated the entire lawn and/or garden with an insecticide (n=15)	1.73	.458		1.87	.352
Used a non-insecticide approach as a first option for control (n=24)	1.42	.504		1.29	.464
Used a non-insecticide approach as a last option for control (n=13)	1.77	.439		1.85	.376
Used a trap (sticky trap or other) to control an insect pest (n=19)	1.47	.512		1.84	.375
Promoted or released natural enemies to control an insect pest (n=18)	1.39	.502		1.44	.511
Hand-picked or pruned off insects n= 22	1.32	.477		1.32	.477
Used insecticidal soap to control an insect pest (n=16)	1.56	.512		1.62	.500
Used horticultural oil to control an insect pest (n=18)	1.61	.502		1.67	.485

[1]A response of “Yes” was coded = 1. A response of “No” was coded = 2

Appendix 19. Tactics Used to Control Weed Pests

Tactics to control weeds: Past vs. present.[1]

Action (n)	Past			This Year	
	Mean	**SD**		**Mean**	**SD**
Accepted some amount of weeds before taking action (n=25)	1.16	.374		1.24	.436
Used a herbicide as a first option for control (n=17)	1.82	.393		1.82	.393
Used a herbicide as a last option for control (n=20)	1.60	.503		1.55	.510
Spot treated specific weeds or problem areas with a herbicide (n=23)	1.43	.507		1.52	.511
Treated the entire lawn and/or garden with a herbicide (n=19)	1.58	.507		1.74	.452
Used a non-herbicide approach as a first option for control (n=23)	1.35	.487		1.26	.449
Used a non-herbicide approach as a last option for control (n=15)	1.80	.414		1.87	.352
Pulled out weeds by hand (n=31)	1.16	.374		1.00	.000

[1]A response of “Yes” was coded = 1. A response of “No” was coded = 2

Appendix 20. Tactics Used to Control Disease Pests

Tactics to control disease pests: Past vs. present. [1]

Action (n)	Past			This Year	
	Mean	SD		Mean	SD
Accepted some level of damage or disease before taking action (n=27)	1.26	.447		1.15	.362
Used a fungicide or bactericide as a first option for control (n=18)	1.56	.511		1.61	.502
Used a fungicide or bactericide as a last option for control (n=17)	1.65	.493		1.71	.470
Spot treated diseased areas with a fungicide n= 21	1.33	.483		1.57	.507
Treated an entire area with a fungicide, including areas not showing disease (n=15)	1.87	.352		1.80	.414
Used a non-fungicide approach as a first option for control (n=19)	1.53	.513		1.53	.513
Used a non-fungicide approach as a last option for control (n=15)	1.80	.414		1.73	.458
Hand-picked or pruned off diseased areas (n=26)	1.23	.430		1.19	.402
Used a conventional insecticide to control an insect pest that transmits a disease (n=15)	1.47	.516		1.73	.458
Used insecticidal soap to control an insect pest that transmits a disease (n=15)	1.47	.516		1.47	.516

[1]A response of “Yes” was coded = 1. A response of “No” was coded = 2

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