T&E Item 1
March 30, 2015
Worksession 2

MEMORANDUM

March 26, 2015

TO: Transportation, Infrastructure, Energy and Environment Committee

FROM: Josh Hamlin, Legislative Attorney

SUBJECT: **Worksession 2:** Bill 52-14, Pesticides – Notice Requirements – Non-Essential Pesticides – Prohibitions

Expected Attendees

Panel 1:

Dr. Dennis vanEngelsdorp, Assistant Professor, Entomology
University of Maryland
Dr. Mark Carroll, Associate Professor, Plant Science and Landscape Architecture
University of Maryland

Panel 2:

Jody Fetzer, Green Management Coordinator
Kevin May, Park Manager I, Cabin John Area
M-NCPPC – Montgomery Parks
Chip Osborne, President
Osborne Organics, LLC
Ryan Bjorn, Director, Grounds and Environmental Management
Maryland Soccerplex

Panel 3:

Eric Wenger, President
Complete Lawn Care, Inc. and
Complete Plant Care, Inc.
Zack Kline, AOLCP, LICM, Owner
A.I.R. Lawn Care
Paul Wolfe, II, Owner
Integrated Plant Care
Sean Surla, Principal
Surla Landscape Design

Bill 52-14, Pesticides – Notice Requirements – Non-Essential Pesticides – Prohibitions, sponsored by then Council Vice President Leventhal and Councilmembers Elrich, Riemer, Floreen, and Navarro was introduced on October 28. Public hearing on the Bill began on January 15, and was continued on February 12. A Transportation, Infrastructure, Energy and Environment (T&E) Committee worksession was held on March 16. An additional T&E Committee worksession will be scheduled at a later date.

Bill 52-14 would:

(1) require posting of notice for certain lawn applications of pesticide;
(2) prohibit the use of certain pesticides on lawns;
(3) prohibit the use of certain pesticides on certain County-owned property;
(4) require the County to adopt an integrated pest management program for certain County-owned property; and
(5) generally amend County law regarding pesticides.

Council Vice President Leventhal has explained the purpose of this Bill in his October 22, 2014 memorandum to Councilmembers (See ©14-17).[1]

Background

Shared Regulation of Pesticides

The regulation of pesticides is the shared responsibility of federal, state, and local governments. This shared approach, known as "environmental federalism," is consistently applied among several federal environmental protection laws,[2] and has evolved largely over the last 50 years.

At the national level, the Federal Insecticide, Fungicide and Rodenticide Act ("FIFRA") is the primary vehicle for pesticide regulation. FIFRA was enacted in 1947, and has evolved from being primarily a labeling statute to become a somewhat more broad regulation. In 1972, administration of FIFRA was transferred to the newly created Environmental Protection Agency ("EPA"), which is responsible for classifying pesticides based on a review of the scientific evidence of their safety and impact on the health of individuals and the environment. FIFRA also requires EPA to maintain a registry of all but "minimum risk" pesticides.[3] In addition to the

[1] For additional background on this Committee's recent consideration of pesticides and pesticide use in Montgomery County, see the packet for the September 9, 2013 discussion at: http://www6.montgomerycountymd.gov/content/council/pdf/agenda/cm/2013/130909/20130909_TE3.pdf. Video of the discussion is available, beginning at 22:10, at: http://montgomerycountymd.granicus.com/MediaPlayer.php?view_id=6&clip_id=5704.

[2] The 1972 Federal Water Pollution Control Act, the 1986 amendments to the Safe Drinking Water Act, the Toxic Substances Control Act, the Resource Conservation and Recovery Act, and the Oil Pollution Control Act of 1990 all provide for state and local regulatory roles.

[3] Minimum risk pesticides are a special class of pesticides that are not subject to federal registration requirements because their ingredients, both active and inert, are *demonstrably* safe for the intended use. Information about EPA's treatment of minimum risk pesticides can be found at: http://www.epa.gov/oppbppd1/biopesticides/regtools/25b/25b-faq.htm

classification and registry of pesticides, FIFRA provides a uniform national standard for labeling pesticides. FIFRA does not comprehensively regulate pesticides, however, and does not include public notice or permit requirements for the use of pesticides.

Under FIFRA, the states are the primary enforcers of pesticide use regulations, and FIFRA expressly authorizes states to enact their own regulatory measures concerning the sale or use of any federally registered pesticides in the state, provided the state regulation is at least as restrictive as FIFRA itself. In Maryland, pesticides are regulated by the Maryland Department of Agriculture, through the enforcement of Subtitles 1 and 2 of Title 5 of the Agriculture Article of the Maryland Code.[4] Maryland law and regulations generally create a pesticide registration and labeling regime at the state level, and a licensing program for the application of certain pesticides. Title 5 does not include any express preemption language, and does not appear to generally regulate pesticides so comprehensively that preemption can be implied. As a general matter, therefore, the County may regulate pesticides, at least as restrictive as, and consistent with, federal and State law.

The authority of local governments to regulate pesticides was the subject of significant litigation in the 1980s, with a County law struck down as preempted by FIFRA. In *Maryland Pest Control Assn. v. Montgomery County, Maryland*, 646 F. Supp. 109 (D. Md. 1986), the U.S. District Court held that FIFRA preempted the County's local law imposing pesticide posting and notice requirements. The Court held that if Congress had wanted to include local governments in the regulation of pesticides, it would have expressly done so. However, in *Wisconsin Public Intervenor v. Mortier*, 111 S. Ct. 2476 (1991), the U.S. Supreme Court held, contrary to the *Maryland Pest Control Assn.* decision, that a unit of local government has the power, under FIFRA, to regulate pesticides within its own jurisdiction, provided that the local regulation is at least as restrictive as, and consistent with, FIFRA and any applicable state law. Since *Mortier* was decided, many states have expressly preempted local jurisdictions from regulating pesticides, but Maryland is one of seven states which do not preempt local regulation of pesticides.[5] The County currently imposes certain notice, storage, handling, and consumer information requirements in Chapter 33B of the County Code.

Laws in Other Jurisdictions

Due to the fact that the vast majority of states have preempted local jurisdictions from regulating pesticides, there are only two examples of local jurisdictions that have banned pesticide use on public and private property[6]: Takoma Park, Maryland[7], and Ogunquit, Maine.[8] Several local jurisdictions have enacted legislation or adopted administrative policies related to pesticide reduction on public property, integrated pest management (IPM), and pesticide free parks.[9] Locally in addition to Takoma Park, the District of Columbia enacted the Pesticide Education and

[4] Subtitle 1 is entitled the "Maryland Pesticide Registration and Labeling Law." Subtitle 2 is the "Pesticide Applicator's Law."

[5] http://www.beyondpesticides.org/lawn/activist/documents/StatePreemption.pdf

[6] http://www.telegraph.co.uk/news/worldnews/10959057/End-of-the-perfect-American-lawn-Campaigners-call-for-pesticide-ban.html

[7] http://www.takomaparkmd.gov/safegrow

[8] http://ogunquitconservation.org/ogunquitconservation.org/Pesticide_Ordinance_Overview.html

[9] http://www.beyondpesticides.org/lawn/activist/

Control Amendment Act Of 2012[10] which restricts the application of certain pesticides near waterways and at schools, day care centers and on District property, and imposes certain reporting and data collection requirements. Most recently, Richmond, California, which has had an IPM ordinance since 2012, passed a resolution to implement a "twelve month long ban on the use of all toxic pesticides, including those containing glyphosate, on all weed abatement activities conducted, contracted, or managed by the city . . ."[11]

Perhaps the most comprehensive pesticide restriction law in North America took effect in the Canadian province of Ontario in 2009.[12] The Ontario law contains several classifications of pesticides, and generally bans the cosmetic use of over 100 pesticides.[13] Six other provinces have followed Ontario in restricting cosmetic use of pesticides.[14] British Columbia, however, considered, but did not implement a provincial ban on cosmetic pesticides.[15]

Pending legislation in the Maryland General Assembly

The Maryland General Assembly is currently considering two bills related to pesticides which have objectives similar to Bill 52-14. The bills would: (1) impose labeling requirements and future sale and use restrictions on neonicotinoid pesticides; and (2) prohibit, except in emergencies, the application of lawn care pesticides to certain areas used by children under the age of 18 years.

House Bill 605,[16] cross-filed with Senate Bill 163, would establish a labeling requirement for any seed, plant material, nursery stock, annual plant, bedding plant, or other plant that has been treated with a neonicotinoid pesticide[17] and would establish restrictions, effective January 1, 2016, on the sale and use of neonicotinoid pesticides. The future restrictions would: (1) limit the use of neonicotinoid pesticides to applicators certified by the Maryland Department of Agriculture (MDA), and farmers using the pesticide for agricultural purposes; and (2) require a seller of neonicotinoid pesticides to be permitted by MDA to sell restricted-use pesticides.

House Bill 995[18] would generally prohibit the application of certain pesticides on the grounds of certain child care centers, schools, and recreation centers and on certain other

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[10] The signed Act is at: http://lims.dccouncil.us/Download/26399/B19-0643-SignedAct.pdf. The Committee report is at: http://lims.dccouncil.us/Download/2594/B19-0643-COMMITTEEREPORT.pdf

[11] Discussion of the resolution begins at page 99 of the pdf of the agenda packet found at: http://sireweb.ci.richmond.ca.us/sirepub/cache/2/mz3m1yjgzymhc5rcpuma1wre/4261710309201510551 7360.PDF

[12] http://www.davidsuzuki.org/issues/health/science/pesticides/highlights-of-ontarios-cosmetic-pesticide-ban/

[13] https://www.ontario.ca/environment-and-energy/pesticides-home-lawns-and-gardens

[14] http://news.gov.mb.ca/news/index.html?item=30526

[15] The Report of the British Columbia Special Committee on Cosmetic Pesticides, which was "convinced that further restrictions on the use and sale of pesticides in British Columbia are necessary" but was "unable to reach a consensus on the need for a provincial ban on pesticide use for cosmetic purposes" is at: https://www.leg.bc.ca/cmt/39thparl/session-4/cp/reports/PDF/Rpt-CP-39-4-Report-2012-MAY-17.pdf

[16] http://mgaleg.maryland.gov/webmga/frmMain.aspx?id=hb0605&stab=01&pid=billpage&tab=subject3&ys=2015RS

[17] The required label would read:

> "WARNING: Bees are essential to many agricultural crops. This product has been treated with neonicotinoid pesticides, found to be a major contributor to bee deaths and the depletion of the bee population."

[18] http://mgaleg.maryland.gov/webmga/frmMain.aspx?id=hb0995&stab=01&pid=billpage&tab=subject3&ys=2015RS

recreational fields. The prohibition would apply to pesticides registered by the EPA and labeled pursuant to the FIFRA for use in lawn, garden, or ornamental sites and areas. A person would be able to apply for an emergency exemption from the prohibition when necessary to eliminate an immediate threat to human health. House Bills 605 and 995 were heard in the House Environment and Transportation Committee on March 13.[19]

Bill 52-14

Bill 52-14 includes provisions related to the application of pesticides on County-owned and private property, and requires the County to adopt an Integrated Pest Management (IPM) plan. IPM is a method of pest control which minimizes the use of chemical pesticides by focusing on pest identification, monitoring and assessing pest numbers and damage, and using a combination of biological, cultural, physical/mechanical and, when necessary, chemical management tools.[20]

Bill 52-14 will:

1) Require the posting of notice when a property owner applies a pesticide to an area of lawn more than 100 square feet, consistent with the notice requirements for when a landscaping business treats a lawn with a pesticide;
2) Require the Executive to designate a list of "non-essential" pesticides including:
   - all pesticides classified as "Carcinogenic to Humans" or "Likely to Be Carcinogenic to Humans" by the U.S. EPA;
   - all pesticides classified by the U.S. EPA as "Restricted Use Products;"
   - all pesticides classified as "Class 9" pesticides by the Ontario, Canada, Ministry of the Environment;
   - all pesticides classified as "Category 1 Endocrine Disruptors" by the European Commission; and
   - any other pesticides which the Executive determines are not critical to pest management in the County.
3) Generally prohibit the application of non-essential pesticides to lawns, with exceptions for noxious weed and invasive species control, agriculture and gardens, and golf courses;
4) Require the Executive to conduct a public outreach and education campaign before and during the implementation of the Bill;
5) Generally prohibit the application of non-essential and neonicotinoid pesticides to County-owned property; and
6) Require the County to adopt an Integrated Pest Management program.

Bill 52-14 has an expiration date of January 1, 2019.

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[19] Video of the Committee session can be viewed at: http://mgahouse.maryland.gov/house/play/56b57e29-21dd-4c73-b294-e4009837b178/?catalog/03e481c7-8a42-4438-a7da-93ff74bdaa4c (the hearing of HB995 begins at 28:12 and is immediately followed by HB605 beginning at 1:44:58).

[20] http://www.epa.gov/opp00001/factsheets/ipm.htm

Public Hearings and Correspondence

The Committee held public hearings on the Bill on January 15 and February 12, with 38 people testifying in January, and 30 speaking in February. In addition to the public hearing testimony, the Bill has been, and continues to be, the subject of a huge amount of written correspondence. The testimony and correspondence have coalesced around several recurring themes, which frame major issues for the Committee to examine as it considers the Bill. These themes include: (1) existing regulation of pesticides, particularly at the State and federal level is, or is not, sufficient; (2) chemical pesticides pose, or do not pose, serious threats to human health; (3) pesticides threaten, or do not threaten, the health of pollinators and the Chesapeake Bay watershed; and (4) it is, or is not, possible or feasible to maintain lawns and playing fields without the use of chemical pesticides.

March 16 Worksession

The T&E Committee held a worksession on Bill 52-14 on March 16. At that worksession, the Committee heard from regulators working at the County, State, and federal levels of government.[21] Representatives of the County's Department of Environmental Protection, the Maryland Department of Agriculture, and the U.S. Environmental Protection Agency described the roles of their respective agencies in the regulation of pesticides in the County. A second panel at the March 16 worksession consisted of physicians with expertise in environmental health and toxicology, and an environmental chemist specializing in environmental and human risk assessment, with a focus on pesticides. The physicians, Dr. Jerome Paulson and Dr. Lorne Garrettson, informed the Committee of their views of the human health risks, particularly to children, of exposure to chemical pesticides. The chemist, Dr. Stuart Cohen, asserted that the testing protocols used by the EPA are sufficient to determine that registered pesticides are generally safe when used as directed.

Agenda for This Worksession

This worksession is structured to allow the Committee to engage in dialogue with experts in environmental impacts of pesticides and turf management, as well as public- and private-sector landscaping professionals. The first panel consists of two faculty members at the University of Maryland, a Professor of Entomology and a Professor of Plant Science and Landscape Architecture, who will speak about pesticides and pollinator health and attenuation of pesticides applied to turf, respectively. The second panel includes representatives of the County Parks Department and the Director of Grounds and Environmental Management at the Maryland Soccerplex, who will describe their current turf management practices, and Chip Osborne, an expert in natural turf management, who will describe how turf can be maintained without the use of chemical pesticides. The third panel is composed of landscaping professionals working in the County, using both traditional and chemical pesticide-free methods, who will inform the Committee of their practices and results.

[21] The packet for the March 16 worksession is at:
http://www.montgomerycountymd.gov/COUNCIL/Resources/Files/agenda/cm/2015/150316/20150316_TE1.pdf

Panel 1: Environmental Issues

The Committee will first hear from Dr. Dennis vanEngelsdorp, a Professor of Entomology at the University of Maryland and recognized expert in pollinator health.[22] Dr. vanEngelsdorp will discuss the impact of pesticides on pollinator health, and can provide the Committee with the current state of the science related to links between neonicotinoid pesticides and bee deaths. Also on Panel 1 is Dr. Mark Carroll, Professor of Plant Science and Landscape Architecture at the University of Maryland. Dr. Carroll has been a lead researcher on a project to study the use of natural fertilization, weed, insect, and disease control at Glenstone in Potomac.[23] As of the time this packet is going to print, staff has been unable to secure a speaker to address issues of pesticides in the local watershed. Because of the significance of this issue, background information is included in this packet. If no speaker is identified for this worksession, a speaker will be arranged for a future worksession on the Bill if desired by the Committee.

Pollinator Health

In his memorandum that accompanied the Bill, Council President Leventhal cited a link between the use of neonicotinoid pesticides and the collapse of honey bee colonies. Neonicotinoids (or "neonics") are systemic insecticides that are taken up by a plant through either its roots or leaves and move through the plant like water and nutrients. Neonics are particularly useful for the control of piercing and sucking insects. In recent years, neonic insecticides have become increasingly important for use in agriculture and home landscapes. Because neonics move systemically within the plant, direct pesticide exposure to both the applicator and the environment is reduced. This fact is often cited as an advantage of using neonics, but it also may present a problem for honey bees and other pollinators: because a neonic spreads within the entire plant, it can also be found in the nectar and pollen of the flowers, exposing pollinators to potential toxins.

EPA seems to recognize the potential hazards posed by neonics to bees,[24] and in 2013 began requiring a new label on certain neonic pesticides (see ©26-34). In response to a report from the European Food Safety Authority,[25] the European Commission adopted a regulation to restrict the use of three pesticides belonging to the neonicotinoid family (clothianidin, imidacloprid and thiametoxam) for a period of 2 years, beginning December 1, 2013.[26] In the United States, Oregon temporarily banned the neonic pesticide dinotefuran,[27] and some U.S. cities, including Seattle,[28] have prohibited the use of neonics on public property.

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[22] In May 2014, Dr. vanEngelsdorp testified before the Standing Senate Committee on Agriculture and Forestry, discussing the importance of bees and bee health in the production of honey, food and seed in Canada. http://www.parl.gc.ca/content/sen/committee/412%5CAGFO/51409-E.HTM

[23] http://www.safelawns.org/blog/2011/05/glenstone-to-sponsor-major-organic-lawn-research-project/

[24] http://www2.epa.gov/pollinator-protection

[25] http://www.efsa.europa.eu/en/topics/topic/beehealth.htm?wtrl=01

[26] http://ec.europa.eu/food/archive/animal/liveanimals/bees/neonicotinoids_en.htm

[27] http://www.oregonlive.com/environment/index.ssf/2013/06/state_agency_temporarily_bans.html

[28] http://council.seattle.gov/2014/09/25/council-bans-neonicotinoid-pesticides-on-city-land-2/

Chesapeake Bay Watershed Health

A study of pesticides in rivers and streams by the United States Geological Survey ("USGS") was referenced by Council President Leventhal. The study found that 90% of urban area waterways now have pesticide levels high enough to harm aquatic life (©35-36). Robert Gilliom, one of the authors of the USGS study, has submitted correspondence and an annotated powerpoint presentation which presents excerpts and summarizes the findings of that study and four other related publications (©37-54).

The presence and impact of pesticides in the Chesapeake Bay watershed is examined in a 2009 white paper published by the Pesticides and the Chesapeake Bay Watershed Project (©55-95). The white paper recognized that "the most commonly detected pesticides were herbicides used on corn, soybean and small grain crops in agricultural regions," but noted that "pesticides were also detected in streams and groundwater in lower concentrations." While acknowledging the data gaps make the assessment of risks of pesticides in aquatic life difficult, the paper concluded that water-borne pesticides do pose health risks to aquatic life, wildlife and humans.

Panel 2: Large Scale Turf Management Practices

Panel 2 includes turf management and landscaping practitioners from the County Parks Department and the Maryland Soccerplex, as well as Chip Osborne, a national expert on organic turf care. This panel can describe the unique challenges to larger scale turf management and the maintenance of high standard natural turf playing fields. The Parks Department and Soccerplex representatives can speak to the use of integrated pest management and chemical pesticide use at their respective facilities. Mr. Osborne will discuss methods of turf care that do not use chemical pesticides in both the general parkland and playing field contexts, and describe the results that these methods deliver. See ©107-133.

Panel 3: County Landscaping Professionals

Private sector landscaping professionals working in the County will address the Committee on Panel 3. Eric Wenger of Complete Lawn Care, Inc., and Paul Wolfe of Integrated Plant Care will discuss their practices using integrated pest management, including, when deemed necessary, the use of chemical pesticides. Zack Kline of A.I.R. Lawn Care and Sean Surla of Surla Landscape Design will discuss their work in lawn and plant care without the use of chemical pesticides. See ©134-172.

Panelist materials:

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Bill No. 52-14
Concerning: Pesticides – Notice Requirements – Non-essential Pesticides – Prohibitions
Revised: October 22, 2014
Draft No. 9
Introduced: October 28, 2014
Expires: April 28, 2016
Enacted: ______
Executive: ______
Effective: ______
Sunset Date: January 1, 2019
Ch. ____, Laws of Mont. Co. ______

COUNTY COUNCIL
FOR MONTGOMERY COUNTY, MARYLAND

By: Council Vice President Leventhal and Councilmembers Elrich, Riemer, Floreen, and Navarro

AN ACT to:

(1) require posting of notice for certain lawn applications of pesticide;
(2) prohibit the use of certain pesticides on lawns;
(3) prohibit the use of certain pesticides on certain County-owned property
(4) require the County to adopt an integrated pest management program for certain County-owned property; and
(5) generally amend County law regarding pesticides.

By amending
Montgomery County Code
Chapter 33B, Pesticides
Sections 33B-1, 33B-2, 33B-3, 33B-4, 33B-5, 33B-6, and 33B-7

By adding
Montgomery County Code
Chapter 33B, Pesticides
Articles 2, 3, 4, and 5
Sections 33B-8, 33B-9, 33B-10, 33B-11, 33B-12, and 33B-13

Boldface	*Heading or defined term.*
Underlining	*Added to existing law by original bill.*
[Single boldface brackets**]**	*Deleted from existing law by original bill.*
Double underlining	*Added by amendment.*
[[Double boldface brackets**]]**	*Deleted from existing law or the bill by amendment.*
* * *	*Existing law unaffected by bill.*

The County Council for Montgomery County, Maryland approves the following Act:

Sec. 1. Sections 33B-1, 33B-2, 33B4, 33B-5, 33B-6 and 33B-7 are amended, and Sections 33B-8, 33B-9, 33B-10, 33B-11, 33B-12, and 33B-13 are added as follows:

ARTICLE 1. General Provisions

33B-1. Definitions.

In this [chapter] Chapter:

Agriculture means the business, science, and art of cultivating and managing the soil, composting, growing, harvesting, and selling sod, crops and livestock, and the products of forestry, horticulture and hydroponics; breeding, raising, or managing livestock, including horses, poultry, fish, game and fur-bearing animals, dairying, beekeeping and similar activities, and equestrian events and activities.

Custom applicator means a person engaged in the business of applying pesticides.

Department means the Department of Environmental Protection.

Director means Director of the Department of Environmental Protection[,] or the Director's designee.

Integrated pest management means a process for managing pests that:

(1) uses monitoring to determine pest injury levels;

(2) combines biological, cultural, mechanical, physical, and chemical tools and other management practices to control pests in a safe, cost effective, and environmentally sound manner that contributes to the protection of public health and sustainability;

(3) uses knowledge about pests, such as infestations, thresholds, life histories, environmental requirements, and natural control of pests; and

(4) uses non-chemical pest-control methods and the careful use of least-toxic chemical methods when non-chemical methods have been exhausted or are not feasible.

Larvicide means a pesticide designed to kill larval pests.

Lawn means an area of land, except agricultural land, that is:

(1) [Mostly] mostly covered by grass, other similar herbaceous plants, shrubs, or trees; and

(2) [Kept] kept trim by mowing or cutting.

Lawn includes an athletic playing field other than a golf course. *Lawn* does not include a garden.

Neonicotinoid means a class of neuro-active pesticides chemically related to nicotine. Neonicotinoid includes acetamiprid, clothianidin, dinotefuran, imidacloprid, nitenpyram, nithiazine, thiacloprid, and thiamethoxam.

Non-essential pesticide means a pesticide designated as a non-essential pesticide under Section 33B-4.

Pest means an insect, snail, slug, rodent, nematode, fungus, weed, or other form of plant or animal life or microorganism (except a microorganism on or in a living human or animal) that is normally considered to be a pest or defined as a pest by applicable state regulations.

Pesticide means a substance or mixture of substances intended or used to:

(1) prevent, destroy, repel, or mitigate any pest;

(2) be used as a plant regulator, defoliant, or desiccant; or

(3) be used as a spray adjuvant, such as a wetting agent or adhesive.

However, *pesticide* does not include an antimicrobial agent, such as a disinfectant, sanitizer, or deodorizer, used for cleaning that is not considered a pesticide under any federal or state law or regulation.

Private lawn application means the application of a pesticide to a lawn on property owned by or leased to the person applying the pesticide. *Private lawn application* does not include:

(1) applying a pesticide for the purpose of engaging in agriculture;

(2) applying a pesticide around or near the foundation of a building for purpose of indoor pest control;

(3) applying a pesticide to a golf course or turf farm.

Vector means an animal, insect, or microorganism that carries and transmits an infectious pathogen into another organism.

[33B-4.] 33B-2. Signs with retail purchase of pesticide.

A person who sells at retail a pesticide or material that contains a pesticide must make available to a person who buys the pesticide or material that contains a pesticide:

(a) [Notice] notice signs and supporting information that are approved by the [department] Department; and

(b) [The] the product label or other information that the federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) [, 7 U.S.C. 136 et seq.,] requires for sale of the pesticide.

The Department must enforce this Section and must annually inspect each person who sells at retail a pesticide or material that contains a pesticide.

[33B-5] 33B-3. Storage and handling of pesticides.

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[33B-6] 33B-4. Regulations.

(a) The [County] Executive must adopt regulations to carry out this Chapter under method (2).

(b) The Executive must include in the regulations adopted under this [section] Section the minimum size or quantity of pesticide subject to [section 33B-4] Section 33B-2.

(c) The Executive must include in the regulations adopted under this Section a list of non-essential pesticides. The list of non-essential pesticides must include:

(1) all pesticides classified as "Carcinogenic to Humans" or "Likely to Be Carcinogenic to Humans" by the U.S. Environmental Protection Agency;

(2) all pesticides classified by the U.S. Environmental Protection Agency as a "Restricted Use Product";

(3) all pesticides classified as a "Class 9" pesticide by the Ontario, Canada, Ministry of the Environment;

(4) all pesticides classified as a "Category 1 Endocrine Disruptor" by the European Commission; and

(5) any other pesticides which the Executive determines are not critical to pest management in the County.

(d) The Executive must include in the regulations adopted under this Section a list of invasive species that may be detrimental to the environment in the County.

(e) The Executive must review and update the lists of non-essential pesticides and invasive species designated under subsections (c) and (d) by July 1 of each year.

[33B-7] 33B-5. Penalty for violating chapter.

(a) Any violation of this Chapter is a class C violation.

(b) Each day a violation continues is a separate offense.

ARTICLE 2. Notice Requirements.

[33B-2] 33B-6. Notice about pesticides to customer.

(a) In this [section] Section:

(1) Customer means a person who makes a contract with a custom applicator to have the custom applicator apply a pesticide to a lawn.

(2) New customer includes a customer who renews a contract with a custom applicator.

(b) A custom applicator must give to a new customer:

(1) [Before] before application, a list of:

[a.](A) [The] the trade name of each pesticide that might be used;

[b.](B) [The] the generic name of each pesticide that might be used; and

[c.](C) [Specific] specific customer safety precautions for each pesticide that might be used; and

(2) [After] after application, a list of:

[a.](A) [The] the trade name of each pesticide actually used; and

[b.](B) [The] the generic name of each pesticide actually used; and

(3) [A] a written notice about pesticides prepared by the [department] Department under subsection (c) [of this section].

(c) The [department] Department must prepare, keep current, and provide to a custom applicator a written notice about pesticides for the custom applicator to give to a customer under subsection (b) [of this section].

(d) The notice prepared by the [department] Department under subsection (c) [of this section] must include:

(1) [Government] government agency phone numbers to call to:

[a.](A) [Make] make a consumer complaint;

[b.](B) [Receive] receive technical information on pesticides; and

[c.] (C) [Get] get assistance in the case of a medical emergency;

(2) [A] a list of general safety precautions a customer should take when a lawn is treated with a pesticide;

(3) [A] a statement that a custom applicator must:

[a.](A) [Be] be licensed by the Maryland Department of Agriculture; and

[b.](B) [Follow] follow safety precautions; and

(4) [A] a statement that the customer has the right to require the custom applicator to notify the customer before each treatment of the lawn of the customer with a pesticide.

[33B-3] 33B-7. Posting signs after application by custom applicator.

(a) Immediately after a custom applicator treats a lawn with a pesticide, the custom applicator must [post a sign on the lawn] place markers within or along the perimeter of the area where pesticides will be applied.

(b) A [sign posted] marker required under this [section] Section must:

(1) [Be] be clearly visible [from the principal place of access to] to persons immediately outside the perimeter of the property;

(2) [Be] be a size, form, and color approved by the [department] Department;

(3) [Be] be made of material approved by the [department] Department; [and]

(4) [Have] have wording with content and dimensions approved by the [department] Department[.]; and

(5) be in place on the day that the pesticide is applied.

33B-8. Posting signs after application by property owner or tenant.

(a) A person who performs a private lawn application treating an area more than 100 square feet must place markers within or along the perimeter of the area where pesticides will be applied.

(b) A marker required under this Section must:

(1) be clearly visible to persons immediately outside the perimeter of the property;

(2) be a size, form, and color approved by the Department;

(3) be made of material approved by the Department; and

(4) have wording with content and dimensions approved by the Department; and

(5) be in place on the day that the pesticide is applied.

ARTICLE 3. Application restrictions.

33B-9. Prohibited application.

A person must not apply a non-essential pesticide to a lawn.

33B-10. Exceptions and Exemptions.

(a) A person may apply a non-esssential pesticide for the following purposes:

(1) for the control of weeds as defined in Chapter 58, Weeds;

(2) for the control of invasive species listed in a regulation adopted under Subsection 33B-4(d);

(3) for pest control while engaged in agriculture; and

(4) for the maintenance of a golf course.

(b) A person may apply to the Director for an exemption from the prohibition of Section 33B-9 for a non-essential pesticide. The Director may grant an exemption to apply a non-essential pesticide on property where application is prohibited under Section 33B-9 if the applicant shows that:

(1) effective alternatives are unavailable;

(2) granting an exemption will not violate State or federal law; and

(3) use of the non-essential pesticide is necessary to protect human health or prevent significant economic damage.

(c) A person may apply to the Director for an emergency exemption from the prohibition in Section 33B-9 if a pest outbreak poses an imminent threat to public health or if significant economic damage would result from the inability to use a pesticide prohibited by Section 33B-9. The Director may impose specific conditions for the granting of emergency exemptions.

33B-11. Outreach and Education Campaign.

The Executive must implement a public outreach and education campaign before and during implementation of the provisions of this Article. This campaign should include:

(a) informational mailers to County households;

(b) distribution of information through County internet and web-based resources;

(c) radio and television public service announcements;

(d) news releases and news events;

(e) information translated into Spanish, French, Chinese, Korean, Vietnamese, and other languages, as needed;

(f) extensive use of County Cable Montgomery and other Public, Educational, and Government channels funded by the County; and

(g) posters and brochures made available at County events, on Ride-On buses and through Regional Service Centers, libraries, recreation facilities, senior centers, public schools, Montgomery College, health care providers, hospitals, clinics, and other venues.

ARTICLE 4. County Property

33B-12. Prohibition on County-owned property.

(a) *Prohibition.* Except as provided in subsection (b), a person must not apply to any property owned by the County:

(1) a non-essential pesticide; or

(2) a nionicotinoid.

(b) *Exceptions.*

(1) A person may use any larvicide or rodenticide on property owned by the County as a public health measure to reduce the spread of disease vectors under recommendations and guidance provided by the Centers for Disease Control and Prevention, the United States Environmental Protection Agency, or the State Department of Agriculture. Any rodenticide used must be in a tamper-proof product, unless the rodenticide is designed and registered for a specific environment inaccessible to humans and pets.

(2) A person may use a non-essential pesticide or neonicotinoid for the purposes set forth in Subsection 33B-10(a).

(3) A person may use a non-essential pesticide or neonicotinoid on property owned by the County if the Director determines, after consulting the Directors of General Services and Health and Human Services, that the use of pesticide is necessary to protect

human health or prevent imminent and significant economic damage, and that no reasonable alternative is available. If a pesticide is used under this paragraph, the Director must, within 30 days after using the pesticide, report to the Council on the reasons for the use of the pesticide.

33B-13. Integrated pest management.

(a) *Adoption of program.* The Department must adopt, by a method (2) regulation, an integrated pest management program for property owned by the County.

(b) *Requirements.* Any program adopted under subsection (a) must require:

(1) monitoring the turf or landscape;

(2) accurate record-keeping documenting any potential pest problem;

(3) evaluating the site for any injury caused by a pest and determining the appropriate treatment;

(4) using a treatment that is the least damaging to the general environment and best preserves the natural ecosystem;

(5) using a treatment that will be the most likely to produce long-term reductions in pest control requirements and is operationally feasible and cost effective in the short and long term;

(6) using a treatment that minimizes negative impacts to non-target organisms;

(7) using a treatment that is the least disruptive of natural controls;

(8) using a treatment that is the least hazardous to human health; and

(9) exhausting the list of all non-chemical and organic treatments available for the targeted pest before using any synthetic chemical treatments.

(c) The Department must provide training in integrated pest management for each employee who is responsible for pest management.

Sec. 2. Initial Lists of Non-Essential Pesticides and Invasive Species. The Executive must submit the lists of non-essential pesticides and invasive species required by Subsections 33B-4(c) and (d) to the Council for approval by October 1, 2015.

Sec. 3. Effective Date. The prohibitions on use of non-essential pesticides contained in Section 33B-9 and the prohibitions on use of non-essential pesticides and neonicotinoids contained in Section 33B-12 take effect on January 1, 2016.

Sec. 4. Expiration. This Act and any regulation adopted under it expires on January 1, 2019.

Approved:

____

George Leventhal, President, County Council Date

Approved:

____

Isiah Leggett, County Executive Date

This is a correct copy of Council action.

____

Linda M. Lauer, Clerk of the Council Date

LEGISLATIVE REQUEST REPORT

Bill 52-14

Pesticides – Notice Requirements – Non-Essential Pesticides - Prohibitions

DESCRIPTION:	This Bill would require posting of notice for certain lawn applications of pesticide, prohibit the use of certain pesticides on lawns, prohibit the use of certain pesticides on certain County-owned property and require the County to adopt an integrated pest management program for certain County-owned property.
PROBLEM:	Long term use of and exposure to certain chemical pesticides has been linked to several health problems, including birth defects, cancer, neurological problems, immune system problems, and male infertility.
GOALS AND OBJECTIVES:	To protect the health of families, especially children, from the unnecessary risks associated with the use of certain pesticides that have been linked to a wide-range of diseases.
COORDINATION:	Department of Environmental Protection
FISCAL IMPACT:	To be requested.
ECONOMIC IMPACT:	To be requested.
EVALUATION:	To be requested.
EXPERIENCE ELSEWHERE:	To be researched.
SOURCE OF INFORMATION:	Josh Hamlin, Legislative Attorney
APPLICATION WITHIN MUNICIPALITIES:	To be researched.
PENALTIES:	Class C violation

MONTGOMERY COUNTY COUNCIL
ROCKVILLE, MARYLAND

GEORGE LEVENTHAL
COUNCILMEMBER
AT-LARGE

MEMORANDUM

October 22, 2014

TO: Councilmembers

FROM: George Leventhal, Council Vice President

SUBJECT: Pesticide Legislation

This coming Tuesday, October 28, I will be introducing legislation aimed at protecting the health of families – and especially children - from the unnecessary risks associated with the use of certain cosmetic pesticides that have been linked to a wide-range of diseases, and which provide no health benefits.

As you know, for the better part of the last year, I have been working towards introducing legislation on this matter. Since the September 2013 meeting of the T&E committee, I have met with countless stakeholders, on both sides of the issue, to learn more about how pesticides are being applied in the county, what other governments are doing to ensure that the public's health is being protected, and what the latest research tells us about their risks. The legislation that I am introducing on Tuesday incorporates feedback I received from proponents and opponents on the previous draft of the bill, which I shared with your offices back in May. The result is a bill that balances the rights of homeowners to maintain a beautiful lawn with the rights of residents who prefer to not be exposed to chemicals that have known health effects; I view this bill as a starting point in our discussion which can be tweaked along the way.

I want to preface my concerns by affirming the value of pesticides when they are used to protect public health, the environment, our food or our water supply, but when pesticides are used solely to improve the appearance of landscapes, they can cause more harm than good. In my view, cosmetic pesticides present a substantial threat to the health of today's children. The American Academy of Pediatrics states that children face the greatest risk from the chemicals they contain, and that epidemiologic evidence demonstrates associations between early life exposure to pesticides and pediatric cancers, decreased cognitive function and behavioral problems such as ADHD.[1] Certain toxic chemicals can cause permanent brain damage in children even at low levels of exposure that would have little to no adverse effect in an adult.[2] A child doesn't even

[1] *Pediatrics*, Pesticide Exposure in Children, Volume 130, No. 6, 1757 – 1763, December, 2012
[2] Dr. Phillippe Grandjean, MD, Dr. Phillip Landrigan, MD, *The Lancet Neurology*, Neurobehavioral Effects of Developmental Toxicity, Volume 13, Issue 3, 330-338, March 2014

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have to be directly exposed to a pesticide to suffer negative health outcomes. During pregnancy, chemicals in women can cross the placenta and result in higher fetal exposure than the mother has been exposed to. Prenatal exposure to certain chemicals has been documented to increase the risk of cancer in childhood.[3] Virtually every pregnant woman in the United States is exposed to multiple chemicals during a sensitive period of fetal development that have been linked to adverse reproductive and developmental outcomes.[4]

Adults are also at risk of developing serious health problems due to pesticide exposure. Researchers at the National Institutes of Health have linked pesticide use to a wide range of diseases and conditions. Exposure to certain pesticides has been linked to Parkinson's disease, diabetes, leukemia, lymphoma, lupus, rheumatoid arthritis, dementia, reproductive dysfunction, Alzheimer's disease, and variety of cancers including breast, colon, prostate and lung cancer.[5]

In addition to the adverse health effects to humans, pesticides can also affect animals, both pets and wildlife, and our waterways. A recent study by the United States Geological Survey has found that 90% of urban area waterways now have pesticide levels high enough to harm aquatic life, and moreover, the USGS said the harm to aquatic life was likely understated in their report.[6] Terrestrial wildlife is also being harmed by the use of certain pesticides. The most concerning example involves honeybees, which pollinate nearly one-third of the food we eat, and a particular class of pesticides called neonicotinoids. Neonicotinoids have been repeatedly and strongly linked with the collapse of honey bee colonies. In just the last year, Maryland lost nearly 50 percent of its honeybee population, an increase over previous years, which averaged about a one-third loss annually.[7]

Before I describe what this bill does, let me describe what this bill does not do. This bill does not ban the use of all pesticides; it would, however, restrict the use of certain toxic chemicals that are most dangerous to human health. This bill does not prohibit the use of any pesticide for gardens. And this bill would not prohibit the use of any pesticide for agricultural use. What this bill does do is seek to limit children's exposure to harmful pesticides in places where children are most likely to be exposed to them. That being said, the major provisions of the bill are:

1) Require the posting of notice when a property owner applies a pesticide to an area of lawn more than 100 square feet, consistent with the notice requirements for when a landscaping business treats a lawn with a pesticides;
2) Require the Executive to designate a list of "non-essential" pesticides including:
    - all pesticides classified as "Carcinogenic to Humans" or "Likely to Be Carcinogenic to Humans" by the U.S. EPA;
    - all pesticides classified by the U.S. EPA as "Restricted Use Products;"

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[3] *American College of Obstetricians & Gynecologists*. Committee Opinion No. 575. American College of Obstetricians and Gynecologists. 931–5. October 2013

[4] *Environmental Health Perspectives*. Environmental Chemicals in Pregnant Women in the United States: NHANES 2003–2004, Tracey J. Woodruff, Ami R. Zota, Jackie M. Schwartz, Volume 119, No. 6, 878–885. June 2011

[5] Jan Ehrman. *NIH Record*. Pesticide Use Linked to Lupus. Rheumatoid Arthritis. http://nihrecord.nih.gov/newsletters/2011/03_18_2011/story4.htm (accessed August 3, 2014)

[6] *U.S. Geological Survey*, An Overview Comparing Results from Two Decades of Monitoring for Pesticides in the Nation's Streams and Rivers, 1992–2001 and 2002–2011, Wesley W. Stone, Robert J. Gilliom, Jeffrey D. Martin, http://pubs.usgs.gov/sir/2014/5154/pdf/sir2014-5154.pdf (accessed October 20, 2014)

[7] Tim Wheeler, Mysterious bee die-off continues, extends beyond winter, *Baltimore Sun*, http://articles.baltimoresun.com/2014-05-15/features/bal-mysterious-bee-dieoff-continues-nearly-half-maryland-hives-lost-20140515_1_bee-informed-partnership-honey-bee-beekeepers (accessed October 20, 2014)

- all pesticides classified as "Class 9" pesticides by the Ontario, Canada, Ministry of the Environment; and
- all pesticides classified as "Category 1 Endocrine Disruptors" by the European Commission

3) Generally prohibit the application of non-essential pesticides to lawns, with exceptions for noxious weed and invasive species control, agriculture and gardens, and golf courses;
4) Require the Executive to conduct a public outreach and education campaign before and during the implementation of the Bill;
5) Generally prohibit the application of a non-essential or neonicotinoid pesticide to County-owned property; and
6) Require the County to adopt an Integrated Pest Management program.
7) Sunset the act and any regulation adopted under it on January 1, 2019

The pesticide industry will respond to this legislation by saying "the science isn't there" and that "all pesticides are extensively tested and approved as safe by the EPA," but while both statements sound believable, they belie the truth. In response to the charge that the science isn't there to legislate, the absence of incontrovertible evidence does not justify inaction. As evidenced by this memo, the number of studies from respected institutions of science linking pesticides to a variety of cancers, neurodevelopmental disorders and diseases is abundant and persuasive. Furthermore, due to the inestimable number of chemical combinations possible from the thousands of products on the market and the complex interactions with the human body, the research that opponents to this legislation will demand will never be possible within the ethical confines of research. The real danger lies not in being exposed to one chemical, but a mixture of chemicals. The EPA risk assessment fails to look at the synergistic effects of multiple chemicals, even though studies show that exposure to multiple chemicals that act on the same adverse outcome can have a greater effect than exposure to an individual chemical.[8]

And to the charge that a pesticide must be safe if it has been approved by the EPA, the Government Accountability Office (GAO) has found that many pesticides are currently being approved for consumer use by the EPA without receipt and review of data that the manufacturer is required to provide on the safety of the chemicals.[9] Alarmingly, in some cases the manufacturer was given two years to submit studies on the effects of a pesticide, and ten years later no studies had been received or reviewed by the EPA.[10] What's more, the EPA itself publishes an entire manual – *Recognition and Management of Pesticide Poisonings* - for healthcare professionals that acknowledges the toxic nature and effects of many pesticides. As an educated populace, we like to think that we have a high bar for pesticide safety in this country, but sadly, when a pesticide has been approved by the EPA, it connotes little about its safety.

Lawn care does not have to be poisonous to people, pets, wildlife, or our waterways. It is simply false to say that you can't have a lush, green lawn - free of weeds - without the use of toxic pesticides. Through proper management of the soil, along with the use of natural, organic alternatives to synthetic pesticides, a high quality landscape can be achieved. And under my

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[8] *National Research Council*. Committee on Improving Risk Analysis Approaches Used by the U.S. EPA. Science and Decisions: Advancing Risk Assessment. Washington, DC: National Academies Press; 2008
[9] *United States Government Accountability Office*. Pesticides – EPA Should Take Steps to Improve its Oversight of Conditional Registrations, http://www.gao.gov/assets/660/656825.pdf (accessed October 20, 2014)
[10] *United States Government Accountability Office*, Pesticides – EPA Should Take Steps to Improve its Oversight of Conditional Registrations, http://www.gao.gov/assets/660/656825.pdf (accessed October 20, 2014)

legislation, residents will still be free to hire any lawn care professional to treat their lawn or to manage their own lawn care.

Much like the public debate that occurred in the 1950's before cigarettes were found to be cancer-causing, I believe we are approaching a similar turning point in the discourse on pesticides as the public is made more aware of the known health effects. In a poll taken earlier this year, more than three-quarters of Marylanders expressed concern about the risk that pesticides pose to them or their families, and when respondents learned of the adverse health effects that pesticides are linked to, 90% of Marylanders expressed concern.[11]

America lags behind by the rest of the developed world in recognizing the serious risks that certain pesticides pose to health and life. The GAO's report confirms that the regulatory approach taken by the EPA is broken and failing the public. In the face of mounting scientific evidence, and in the absence of action on the federal level, I find it impossible not to act now to protect the health of our children. In Montgomery County, we regularly take a precautionary approach to public health and environmental issues, such as with the forthcoming legislation on e-cigarettes and the Council's action on Ten Mile Creek. Our approach to pesticides should be no different.

I have attached all of the studies that I have cited in this memo for your reference, but I hope you will take time to review research beyond what I have provided. If, after reviewing the research, you feel compelled to act as I do, I would welcome your co-sponsorship on this bill.

This issue is among the most technically complex which the Council has ever faced. Therefore, it is critical that we approach this in a thoughtful manner and that we consult with a variety of experts who are knowledgeable in the field so we can make a well-informed decision regarding this important public health issue.

[11] *OpinionWorks*, Maryland Voter Survey on Pesticides http://www.mdpestnet.org/wp-content/uploads/2014/02/Pesticide-Poll-Memo-2-10-14.pdf (Accessed on October 20, 2014)

ROCKVILLE, MARYLAND

MEMORANDUM

January 26, 2015

TO: George Leventhal, President, County Council

FROM: Jennifer A. Hughes, Director, Office of Management and Budget
Joseph F. Beach, Director, Department of Finance

SUBJECT: FEIS for Bill 52-14, Pesticides -Notice Requirements -Non-Essential Pesticides Prohibitions

Please find attached the fiscal and economic impact statements for the above-referenced legislation.

JAH:fz

cc: Bonnie Kirkland, Assistant Chief Administrative Officer
Lisa Austin, Offices of the County Executive
Joy Nurmi, Special Assistant to the County Executive
Patrick Lacefield, Director, Public Information Office
Fariba Kassiri, Acting Director, Department of Environmental Protection
Joseph F. Beach, Director, Department of Finance
David Platt, Department of Finance
Matt Schaeffer, Office of Management and Budget
Alex Espinosa, Office of Management and Budget
Felicia Zhang, Office of Management and Budget
Naeem Mia, Office of Management and Budget

Fiscal Impact Statement

Bill 52-14: Pesticides – Notice Requirements – Non-Essential Pesticides – Prohibitions

1. **Legislative Summary.**

   The bill would update county law with regard to pesticides application in the following manner:

   (1) require posting of notice for certain lawn applications of pesticide;
   (2) prohibit the use of certain pesticides on lawns;
   (3) prohibit the use of certain pesticides on certain County-owned property;
   (4) require the County to adopt an integrated pest management program for certain County-owned property;
   (5) generally amend County law regarding pesticides; and
   (6) require the creation of a media campaign to inform residents and businesses of the change in county law related to non-essential pesticides.

2. **An estimate of changes in County revenues and expenditures regardless of whether the revenues or expenditures are assumed in the recommended or approved budget. Includes source of information, assumptions, and methodologies used.**

   County revenues are not expected to be impacted by Bill 52-14. The Maryland-National Capital Park and Planning Commission (M-NCPPC) did report that there is a potential for lost revenues if playing fields are not able to be adequately maintained – this revenue has traditionally come in in the form of field rental from athletic leagues.

   County departments and agencies performed a fiscal impact analysis of the major provisions and conclude the following:

   - Section 33B-4 requires the county to develop a list of non-essential pesticides and invasive species which would be detrimental to the environment. The Department of Environmental Protection (DEP) does not envision a fiscal impact as a result of these tasks given that many jurisdictions have taken the similar action with regards to non-essential pesticides and significant documentation exists related to successful implementation of this type of prohibition. If classification becomes difficult, a consultant may need to be brought in to assist with this task.
   - Section 33B-13 requires the County Executive to create an Integrated Pest Management (IPM) program. The Department of General Services (DGS) reported no fiscal impact and is currently operating under an IPM and the Executive branch would utilize this plan across county departments under Bill 52-14.
   - Enforcement of Bill 52-14 is not clarified in great detail within the legislation. Similar to other prohibition legislation, executive staff recommends a complaint-driven enforcement model to control costs of implementation. It is likely that complaint-driven enforcement would have a minimal fiscal impact on county departments while estimates for a proactive enforcement effort include a dedicated inspector with estimated personnel costs of $75,000 and vehicle costs of approximately $40,000 for a total of $115,000 per inspector.
   - Bill 52-14 would also require county departments and agencies to convert to approved landscaping practices outside of the list of banned non-essential pesticides

in the cases wherein prohibited pesticides are being used.

Montgomery County Public Schools (MCPS) reported that it is likely that pesticides prohibited under Bill 52-14 are being used currently and that a conversion cost estimate would be available after an agreed list of prohibited pesticides is established. Based on estimates of conversion costs for M-NCPPC fields, the costs of maintaining similar fields within MCPS are expected to be significant.

Montgomery College reported no fiscal impacts as a result of Bill 52-14.

To maintain the quality of fields at the current level, M-NCPPC reported the following conversion costs associated with the move to allowable treatment methods on fields:

Athletic Fields:

- 40 athletic fields can be organically treated at the following cost:
  $648,048 in supplies and labor costs;
  $327,062 to provide a top dressing;
  $100,000 for the purchase of two aerators;
  for a total first year cost of $1,075,110.
  Additional costs in subsequent years also include:
  Sod replacement every two years at a cost of $20,440 per field or $817,600 and additional grading every four years at a total of $10,000 per field or $400,000.
- Five Bermuda playing fields cannot be organically treated and would need to be replaced with treatable sod for $102,200 per field or a total cost of $511,000.
- *Optional* replacement costs for a synthetic turf option are $1,400,000 per field with $3,700 in annual maintenance or a total capital cost of $56,000,000 and a $148,000 annual maintenance cost for all forty fields.

Regional Fields:

- 35 regional fields will need irrigation installed to maintain organic maintenance standards at the following cost:
  $3,500,000 in capital costs for system installations;
  $231,000 in annual water costs;
  $350,000 in annual maintenance costs;
  for a first year cost of $4,081,000.

Local Fields:

- 300 local fields would require manual or mechanical weed elimination at a total annual cost of $229,860.

In total, implementation costs to bring M-NCPPC fields into compliance (absent a total conversion to synthetic turf) would be:

Total first year costs to M-NCPPC would be $5,896,970.

Recurring annual costs for M-NCPPC would be $810,860.

Sod Replacement costs every two years would be $817,600.

Additional grading costs every four years for M-NCPPC would be $400,000.

3. **Revenue and expenditure estimates covering at least the next 6 fiscal years.**

Total conversion costs to allowable landscaping practices for the county would include an undetermined amount for MCPS to replace current pesticides in inventory and a six year total of $12,804,070 for M-NCPPC as a part of converting maintenance practices on current fields to allowable practices under Bill 52-14.

M-NCPPC's six-year estimate of $12,804,070 in conversion costs consists of:
$5,896,970 in first year costs
$4,054,300 in subsequent annual expenses [$810,860 X 5 years]
$2,452,800 in sod replacement costs on athletic fields [$817,600 X 3 applications]
$400,000 in additional grading costs

If it is determined that a proactive enforcement effort is needed to enforce the bill, a dedicated inspector would be required at a personnel cost of $75,000 and a vehicle cost would of $40,000, for a total of $115,000 for the first year and a six year total of $490,000. The County Executive recommends a complaint-driven enforcement program.

Bill 52-14 also requires the County Executive to establish an awareness campaign related to the prohibitions noted in the bill. Costs related to the media campaign will depend on the scope and size of the media campaign. The County Executive recommends an education and outreach program of minimal cost to the county.

4. **An actuarial analysis through the entire amortization period for each bill that would affect retiree pension or group insurance costs.**

   Not Applicable.

5. **An estimate of expenditures related to County's information technology (IT) systems, including Enterprise Resource Planning (ERP) systems.**

   Not Applicable.

6. **Later actions that may affect future revenue and expenditures if the bill authorizes future spending.**

   Not Applicable.

7. **An estimate of the staff time needed to implement the bill.**

   The impact of implementation of Bill 52-14 on staff time will depend on the extent of the enforcement required for the provisions in the bill. Inspections on lawns, commercial sales establishments for signage, and other general enforcement actions will have an impact on various county departments similar to other countywide ban legislation.

   If Bill 52-14 requires an enforcement inspector, approximate personnel costs of an inspector would be $75,000 and a vehicle would be $40,000 for a total of $115,000 per inspector.

If enforcement of Bill 52-14 is complaint-driven, there would be an impact to current inspection operations by increasing the extent of some existing inspection protocols but would result in minimal fiscal impact to the county.

8. **An explanation of how the addition of new staff responsibilities would affect other duties.**

   Depending on the enforcement model of Bill 52-14, the bill would impact the total number of inspection hours required. An inspector carrying out an inspection in a retailer for health code and other violations, for example, could be required to add on additional inspections for checks of signage and other sales requirements of pesticides to their normal inspection process.

9. **An estimate of costs when an additional appropriation is needed.**

   There are three potential areas of cost related to Bill 52-14:

   1) Conversion costs related to replacing old pesticides or converting contracts to include compliant pesticide application- County departments reported no fiscal impacts considering DGS already operates an IPM. MCPS reported that there would be costs associated with converting to approved pesticides from pesticides currently in use and that the extent of these conversion costs will not be known until a final list of banned pesticides has been established by DEP.

   M-NCPPC estimates their conversion costs to allowable landscaping practices (excluding a conversion to artificial turf) to be $12,804,070 over the next six years. See item 3 for additional information on M-NCPPC's estimated conversion costs.

   2) Costs associated with a media campaign-Bill 52-14 requires that the County Executive establish a media campaign to publicize the ban on certain non-essential pesticides. Costs related to this media campaign will vary depending on the scope and size of the campaign; and
   3) Costs associated with enforcement of Bill 52-14-If dedicated enforcement personnel are needed to enforce the provisions of Bill 52-14, approximate personnel costs of an inspector would be $75,000 and a vehicle would be $40,000 for a total of $115,000 per inspector.

10. **A description of any variable that could affect revenue and cost estimates.**

    See Item 9 above.

11. **Ranges of revenue or expenditures that are uncertain or difficult to project.**

    M-NCPPC reports that loss of revenue is likely to occur if the spraying of certain non-essential pesticides prohibited in Bill 52-14 is eliminated as a part of the current playing field maintenance program. M-NCPPC reports that other jurisdictions have seen a loss of revenue from athletic tournaments leagues choose to take outside of the county.

12. If a bill is likely to have no fiscal impact, why that is the case.

Not Applicable.

13. Other fiscal impacts or comments.

Both M-NCPPC and the Department of Recreation (REC) are also concerned about how this prohibition will impact recreational and sport fields throughout the county. There are multiple jurisdictional studies suggesting a prohibition of this type on sport fields leads to degradation of the playing field and may lead to injury.

14. The following contributed to and concurred with this analysis:

Stan Edwards, Department of Environmental Protection
James Song, Montgomery County Public Schools
David Vismara, Maryland-National Capital Park and Planning Commission
Beryl Feinberg, Department of General Services
Matt Schaeffer, Office of Management and Budget

Jennifer A. Hughes

Jennifer A. Hughes, Director
Office of Management and Budget

1/26/15

Date

Economic Impact Statement
Bill 52-14, Pesticides – Notice Requirements - Non-Essential Prohibitions

Background:

This legislation would require the posting of a notice when a property owner applies a pesticide to an area of lawn more than 100 square feet. Bill 52-14 requires the County Executive to designate a list of "non-essential" pesticides that include the following:

- All pesticides classified as "Carcinogenic to Humans" or "Likely to Be Carcinogenic to Humans" by the United States Environmental Protection Agency (USEPA);
- All pesticides classified by USEPA as "Restricted Use Products";
- All pesticides classified as "Class 9" by the Ministry of the Environment and Climate Change, Government of Ontario, Canada
- All pesticides classified as "Category 1 Endocrine Disrupters" by the European Commission; and
- Other pesticides which the County Executive determines are not critical to pest management in the County.

The Bill would prohibit the application of non-essential pesticides to lawns, with exceptions for noxious weed and invasive species control, agriculture and gardens, and golf courses. The Bill would also require the County Executive to conduct a public outreach and education campaign during the implementation of Bill 52-14, and would prohibit the application of non-essential and neonicotinoid pesticides to County-owned property.

1. The sources of information, assumptions, and methodologies used.

Department of Environmental Protection (DEP)
SafeLawns.org
Diffen.org
The Fertilizer Institute (TFI)
Grassroots Environmental Education

2. A description of any variable that could affect the economic impact estimates.

The variable that could affect the economic impact estimates is the cost differential between organic pesticides and chemical pesticides. However, according to SafeLawns.org, the cost differential is comparing apples to oranges since one product provides a short-term solution while the other product aims to provide a long-term solution. Organic products "function by building up life in the soil (soil biology) and their payoff is long-term and lasting" while synthetic products, which are instantaneous, are applied frequently and in greater amounts. Therefore, SafeLawns.org indicates that the users of organic products will spend less money on lawn care over a two-year period than users of chemical or synthetic pesticides.

According to Diffen.org, organic pesticides are much more expensive than synthetic or chemical pesticides because synthetic or chemical pesticides have more concentrated levels of nutrients per weight of product than organic pesticides. The user of organic pesticides needs several pounds of organic pesticide that would provide the same nutrient levels as synthetic or chemical pesticide. That differential in the amounts would result in a higher cost of organic pesticide.

Therefore, there is a conflict between the information provided by SafeLawns.org and Diffen.org regarding the cost differential between organic and synthetic/chemical pesticides. SafeLawns.org suggests there is less application of organic to synthetic/chemical pesticide while according to Diffen.org, one needs a higher quantity of organic pesticide to synthetic/chemical pesticide to achieve the same nutrient level.

3. **The Bill's positive or negative effect, if any on employment, spending, saving, investment, incomes, and property values in the County.**

   Because of the differences of opinions in terms of the amount of application of organic versus synthetic/chemical pesticide as stated in paragraph #2, it is uncertain whether Bill 52-14 would have economic impact on employment, spending, saving, investment, incomes, and property values in the County. Because of the specific climate and soil type endemic to Montgomery County, more consultation with the experts and research are needed to determine the economic effect on the County.

4. **If a Bill is likely to have no economic impact, why is that the case?**

   It is uncertain if Bill 52-14 has an economic impact.

5. **The following contributed to or concurred with this analysis:** David Platt and Rob Hagedoorn, Finance, and Stan Edwards, Department of Environmental Protection.

[signature]

Joseph F. Beach, Director
Department of Finance

1/23/15
Date

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

JUL 22 2013

To: Registrants of Nitroguanidine Neonicotinoid Products

Subject: Registered Products Containing Imidacloprid, Dinotefuran, Clothianidin or Thiamethoxam

Dear Registrant:

As you are aware, the Environmental Protection Agency (EPA) has been actively involved in pollinator protection. Although research conducted by the U.S. Department of Agriculture has not demonstrated that Colony Collapse Disorder, nor the broader declines in pollinator health, are caused by pesticides, this research has indicated that pesticides in combination with other factors (e.g., pests, pathogens, nutrition, bee management practices) may be associated with the declines. The relative contribution of these factors, however, has not been identified. Based on potential effects of neonicotinoid insecticides on honeybees and other pollinators as well as recent bee kill incidents in Oregon and Canada, which may indicate that applicators are not aware of the potential for harming bees when they use these products, EPA is concerned about potential adverse effects on non-target arthropods, including pollinators. Consequently, EPA is initiating a project to develop clearer language that will strengthen pollinator protective labeling on neonicotinoid products by more effectively highlighting the risks to pollinators. The intent is to achieve clarity and consistency as well as to highlight pollinator protective text to both commercial applicators and general consumers. All registrants of products containing imidacloprid, thiamethoxam, clothianidin and dinotefuran are being notified of this project.

EPA is developing new label language that will apply to all neonicotinoid products registered for outdoor sites, regardless of formulation or intended user. The language being developed will incorporate advice received through the Office of Pesticide Program's Federal Advisory Committee (the Pesticide Program Dialogue Committee). It is essential to this critical effort that registrants adopt these label statements. It is our goal to have this language on as many products as possible by the 2014 use season and we will consider an appropriate regulatory response if registrants decline to adopt the new language. We expect to send you the label statements in early August. To facilitate this implementation it would be helpful if you could provide the following:

- Production cycle for the subject products
- Timeframe of next product label printing

This information would be of most use to the Agency if provided within 7 business days from receipt of this letter.

With this letter we are also informing you that we are requiring the submission of product performance (efficacy) data. While EPA has generally waived the requirement to submit product performance data for non-public health pests, all registrants must ensure through testing that their product is efficacious when used in accordance with label directions. As stated in Title 40 of the Code of Federal Regulations section 158.400(e), test note 1, EPA reserves the right to require, on a case-by-case basis, submission of product performance data for any pesticide product registered or proposed for registration. At this time we are requesting that you submit product performance (efficacy data) that describes the movement and concentration of active ingredients and major degradates in plant structures, fluids and tissues over the period when efficacy is expected for specified insect pests within 30 working days of the date of receipt of this letter. Based on the data received, EPA may request additional product performance (efficacy) data.

In addition to the efficacy data described above, we are also requesting that you submit a synopsis of your company's pollinator stewardship plan(s) for both agricultural and non-agricultural registrations. All of the information described above should be submitted to Meredith Laws, U.S. Environmental Protection Agency, Office of Pesticide Programs, 1200 Pennsylvania Ave., NW (Mail Code 7505P), Washington, DC 20460. Courier deliveries may be made to Meredith Laws, Office of Pesticide Programs, One Potomac Yard, 2777 S. Crystal Drive, Arlington, VA 22202.

Finally, as noted above, OPP is concerned about reports of adverse incidents involving pollinators, particularly honeybees and bumblebees. As a registrant of pesticide products registered under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), you are required to notify the EPA pursuant to FIFRA section 6(a)(2) of any "*additional factual information regarding unreasonable adverse effects on the environment.*"

EPA's implementing regulations at 40 CFR Part 159 identify the types of information that registrants must submit to the Agency pursuant to FIFRA section 6(a)(2). Those regulations include a provision that requires registrants to submit information that "*the registrant knows, or reasonably should know, that if the information should prove to be correct, EPA might regard the information alone or in conjunction with other information about the pesticide as raising concerns about the continued registration of a pesticide or about the appropriate terms and conditions of registration of a product,*" 40 CFR 159.195(a), and a provision requiring that information be submitted if "*the registrant has been informed by EPA that such additional information has the potential to raise questions about the continued registration of a product or about the appropriate terms and conditions of registration of a product.*" 40 C.F.R. §159.195(c). By this letter, OPP is reminding you of your general obligations under 40 CFR 159.195(a), and is informing you of certain specific types of information that it considers reportable under 40 CFR 159.195(c).

If, after the date of this letter, your company, any subsidiary of the company, or any consultant, attorney, or agent who acquired such information while acting as a consultant, attorney, or agent for your company, receives any studies showing that any of imidacloprid, thiamethoxam, clothianidin or dinotefuran is more persistent or is found in greater amounts in any portion of a plant than has previously been reported in a study submitted to the Agency (or is present in any portion of a plant at all if no previous study has been submitted to the Agency), or learns of any incidents or allegations of incidents involving harm or potential harm to pollinators resulting from exposure to imidacloprid, thiamethoxam, clothianidin or, dinotefuran, such information must be reported to EPA's Office of Pesticide Programs as adverse effects information under section 6(a)(2) of FIFRA. The submission of such information must meet the requirements of 40 CFR §159.156, and the information must be received by EPA no later than ten (10) days after you or your subsidiary, consultant, attorney, or agent first receive the study or learn of the incident or allegation. Information on bee kills must not be aggregated, regardless of the number of individual pollinators involved in any incident.

If you or your subsidiary, consultant, attorney, or agent currently have information in your files that would be reportable to EPA under the previous paragraph and that has not yet been provided to EPA, you must provide such information to EPA, following the requirements of 40 CFR §159.156, on the accelerated 10 day schedule. Any information currently in your possession related to an incident previously reported to EPA need not be provided again in response to this letter.

Please note that the requirements to report information to EPA pursuant to section 6(a)(2) continue as long as the product is registered, and must be reported consistent with the terms of this letter unless the Agency notifies you in writing of any modification to the terms of this letter. In addition to submitting the information consistent with the requirements of 40 CFR §159.156, I request that you provide an additional copy of any 6(a)(2) information to Meredith Laws at the address listed above.

If you have any questions about this letter, please feel free to call Lois Rossi at (703) 305-5447 or Meredith Laws at (703) 308-7038.

Sincerely,

Steven Bradbury, Ph.D., Director
Office of Pesticide Programs

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

AUG 15 2013

OFFICE OF CHEMICAL SAFETY AND POLLUTION PREVENTION

TO: Registrants of Nitroguanidine Neonicotinoid Products

SUBJECT: Pollinator Protection Labeling for Nitroguanidine Neonicotinoid Products

Dear Registrant:

You are receiving this letter because your company holds registrations for products containing clothianidin, dinotefuran, imidacloprid or thiamethoxam that have use directions for outdoor foliar application.

I. Summary

This letter is a follow up to my July 22, 2013 letter which indicated that the EPA was developing label text intended to minimize exposure to bees and other pollinators from nitroguanidine neonicotinoid pesticides. Additionally, the July 22, 2013 letter requested the submission of efficacy data and your company's pollinator stewardship plan. The letter also notified you to report under section 6(a)(2) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) any incidents involving pollinators on an accelerated 10-day schedule.

The EPA has completed its assessment of what new labeling terms are necessary on all products registered for outdoor foliar use. As described below, the necessary label changes include a "Pollinator Protection Box," as well as new pollinator language to be added to the Directions for Use section of each label. These labeling terms will highlight the measures necessary to better protect pollinators and also help achieve label clarity and consistency across this chemical class. It is essential that these label statements are immediately implemented on the labeling of eligible products. If you do not address the labeling changes described in this letter, EPA will take appropriate action to ensure that these products are consistent with the requirements of FIFRA. If these changes are made in the expedited fashion described in this letter, we anticipate labels with the new language will be available for the 2014 use season.

II. Products Addressed in this Letter

This letter applies to all products (FIFRA Section 3 and 24(c) Special Local Need registrations) that have outdoor foliar use directions (except granulars) containing the active ingredients clothianidin, dinotefuran, imidacloprid or thiamethoxam regardless of formulation, concentration, or intended user.

III. What You Need to Do

Submit a fast-track amendment to revise product labels incorporating the new labeling as described below and in the attachments no later then September 30, 2013.

On EPA Form 8570-1, Application for Pesticide Amendment, please indicate in the explanation box that this is a fast-track amendment to incorporate the new pollinator protective labeling.

A. Label Changes

1. Pollinator Protection Box: Place the Pollinator Protection Box on the label following the Environmental Hazards section. Note: the Bee icon provided must not be altered.

2. Directions for Use: Place the pollinator language under the "Directions for Use" header directly following the misuse statement ("It is a violation of Federal Law to use this product in a manner inconsistent with its labeling"). At this time these statements are not intended to be placed under each crop or site.

3. In current labeling you must replace any reference to bees "actively visiting," "actively foraging," or "visiting" with "foraging." Do not delete or change any other existing bee/pollinator statements.

EPA acknowledges that these labeling changes are generic in nature and that there may be existing pollinator safety information on your current label that may not be fully compatible with the generic statements attached to this letter. We also recognize that there could be product-specific pollinator language that provides additional protection and EPA does not intend that this language be removed. We will address all other product-specific issues with individual companies during our review of the labels with the goal of maintaining the objective of label consistency and enforceability.

Please note that the new text must follow the requirements for prominence, legibility and font size specified in 40 C.F.R. 156.10.

B. Submission of an Electronic Label

1. Registrants are requested to submit an electronic label (text .pdf) along with the fast-track amendment application. Guidance for electronic submission, including e-labels, can be found on the EPA's website at:

   http://www.epa.gov/pesticides/regulating/registering/submissions/index.htm

2. The electronic label must be a text .pdf (not image) file and should be named using the filename syntax in the guidance below:

[co#]-[prod#].[yyyymmdd].[anything else].PDF

3. Please ensure that you have provided a highlighted copy of the draft label showing all of the changes that you have made.

C. Address

The submissions are to be sent to the Document Processing Desk address listed below.

Personal/Courier Service Deliveries (e.g., FedEx)

The following address should be used for amendments that are hand-carried or sent by courier service Monday through Friday, from 8:00 AM to 4:30 PM, excluding Federal holidays.

Document Processing Desk
Office of Pesticide Programs (7505P)
U.S. Environmental Protection Agency
Room S-4900, One Potomac Yard
2777 South Crystal Drive
Arlington, VA 22202-4501
ATTENTION: Pollinator Fast-Track Amendment

As a reminder, if it has not already been submitted, the EPA is awaiting the arrival of the requested pollinator stewardship plans and the requested efficacy data. Please submit the stewardship plan and efficacy data no later than September 3, 2013 via email to laws.meredith@epa.gov. If EPA does not receive this information by that date, the Agency will consider whether further action on your products is appropriate.

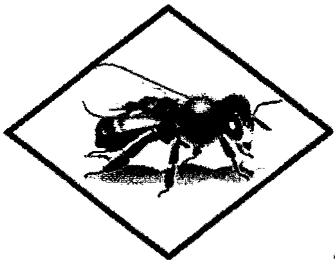
If you have any questions about this letter, please feel free to call Lois Rossi at (703) 305-5447 or Meredith Laws at (703) 308-7038.

Sincerely,

Steven Bradbury, PhD., Director
Office of Pesticide Programs

Attachments: Pollinator Protection Box
Directions for Use Statements

PROTECTION OF POLLINATORS



APPLICATION RESTRICTIONS EXIST FOR THIS PRODUCT BECAUSE OF RISK TO BEES AND OTHER INSECT POLLINATORS. FOLLOW APPLICATION RESTRICTIONS FOUND IN THE DIRECTIONS FOR USE TO PROTECT POLLINATORS.

Look for the bee hazard icon  in the Directions for Use for each application site for specific use restrictions and instructions to protect bees and other insect pollinators.

This product can kill bees and other insect pollinators.

Bees and other insect pollinators will forage on plants when they flower, shed pollen, or produce nectar.

Bees and other insect pollinators can be exposed to this pesticide from:

- Direct contact during foliar applications, or contact with residues on plant surfaces after foliar applications
- Ingestion of residues in nectar and pollen when the pesticide is applied as a seed treatment, soil, tree injection, as well as foliar applications.

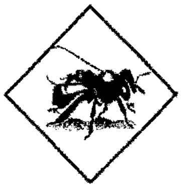
When Using This Product Take Steps To:

- Minimize exposure of this product to bees and other insect pollinators when they are foraging on pollinator attractive plants around the application site.
- Minimize drift of this product on to beehives or to off-site pollinator attractive habitat. Drift of this product onto beehives or off-site to pollinator attractive habitat can result in bee kills.

Information on protecting bees and other insect pollinators may be found at the Pesticide Environmental Stewardship website at: http://pesticidestewardship.org/PollinatorProtection/Pages/default.aspx.

Pesticide incidents (for example, bee kills) should immediately be reported to the state/tribal lead agency. For contact information for your state, go to: www.aapco.org/officials.html. Pesticide incidents should also be reported to the National Pesticide Information Center at: www.npic.orst.edu or directly to EPA at: beekill@epa.gov

DIRECTIONS FOR USE

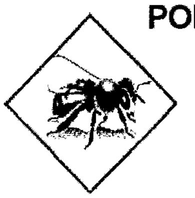


1. FOR CROPS UNDER CONTRACTED POLLINATION SERVICES

Do not apply this product while bees are foraging. Do not apply this product until flowering is complete and all petals have fallen unless the following condition has been met.

> **If an application must be made when managed bees are at the treatment site, the beekeeper providing the pollination services must be notified no less than 48-hours prior to the time of the planned application so that the bees can be removed, covered or otherwise protected prior to spraying.**

2. FOR FOOD CROPS AND COMMERCIALLY GROWN ORNAMENTALS NOT UNDER CONTRACT FOR POLLINATION SERVICES BUT ARE ATTRACTIVE TO POLLINATORS

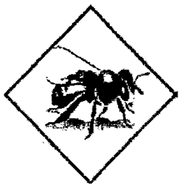


Do not apply this product while bees are foraging. Do not apply this product until flowering is complete and all petals have fallen unless one of the following conditions is met:

- **The application is made to the target site after sunset**
- **The application is made to the target site when temperatures are below 55°F**
- **The application is made in accordance with a government-initiated public health response**
- **The application is made in accordance with an active state-administered apiary registry program where beekeepers are notified no less than 48-hours prior to the time of the planned application so that the bees can be removed, covered or otherwise protected prior to spraying**
- **The application is made due to an imminent threat of significant crop loss, and a documented determination consistent with an IPM plan or predetermined economic threshold is met. Every effort should be**

made to notify beekeepers no less than 48-hours prior to the time of the planned application so that the bees can be removed, covered or otherwise protected prior to spraying.

3. Non-Agricultural Products:



Do not apply [insert name of product] while bees are foraging. Do not apply [insert name of product] to plants that are flowering. Only apply after all flower petals have fallen off.

Josh Hamlin
Legislative Attorney
Montgomery County Council
100 Maryland Ave, 6th Floor
Rockville MD 20850
(240) 777-7892

March 9, 2015

Dear Mr. Hamlin,

Thank you for your recent inquiry and interest regarding U.S. Geological Survey (USGS) findings about pesticides in urban streams and groundwater and any related topics that may help your County Council understand the occurrence and potential significance of pesticides in the water resources of urban environments. I understand from the material you sent me as background for your Council's consideration of Bill 52-14 that the following specific reference was made to a USGS publication:

"A recent study by the United States Geological Survey has found that 90% of urban area waterways now have pesticide levels high enough to harm aquatic life, and moreover, the USGS said the harm to aquatic life was likely understated in their report."

The citation to this report, which is also attached to the accompanying email is:

(1) **An overview comparing results from two decades of monitoring for pesticides in the Nation's streams and rivers, 1992-2001 and 2002-2011,** by Wesley W. Stone, Robert J. Gilliom, Jeffrey D. Martin: 2014, USGS Scientific Investigations Report 2014-5154

In our discussion, you also asked about any additional publications with findings that may help expand on the information, and if we could point out and explain the findings most relevant to your topic. There are four additional recent publications to which I refer you and that are listed below with a brief annotation (all are attached):

(2) **Pesticides in U.S. streams and rivers: occurrence and trends during 1992-2011,** by Wesley W. Stone, Robert J. Gilliom, Karen R. Ryberg, 2014, Environmental Science and Technology (48) 11025-11030
This article is a condensed version of Reference (1) that covers mostly the same information and is included because it is the version that was much more broadly distributed to the public and states findings in a concise style.

(3) **Contaminants in stream sediments from seven United States metropolitan areas: part I: distribution in relation to urbanization**, by Lisa H. Nowell, Patrick W. Moran, Robert J. Gilliom, Daniel L. Calhoun, Christopher G. Ingersoll, Nile E. Kemble, Kathryn M. Kuivila, Patrick J. Phillips, 2013, Archives of Environmental Contamination and Toxicology (64) 32-51
Some pesticides occur in urban streams in sediments, rather than in the water. Analysis of sediment contaminants in several urban areas across the country showed that one particular pyrethroid insecticide, bifenthrin, was of particular concern related to potential toxicity to aquatic organisms in some urban streams.

(4) **Trends in pesticide concentrations in urban streams in the United States, 1992-2008**, by Karen R. Ryberg, Aldo V. Vecchia, Jeffrey D. Martin, Robert J. Gilliom, 2010, USGS Scientific Investigations Report 2010-5139
Trends in concentrations in urban streams show distinct declines in pesticides for which use was reduced by regulation, and increases in other pesticides that were added to the market or expanded in use as other pesticides were phased out.

(5) **Pesticides in groundwater of the United States: decadal-scale changes, 1993-2011**, by Patricia L. Toccalino, Robert J. Gilliom, Bruce D. Lindsey, Michael G. Rupert, 2014, Groundwater, Vol. 52, Groundwater–Focus Issue 2014 (pages 112–125)
Pesticides were detected in about half of the monitoring wells in urban areas during the decades of both 1993-2001 and 2002-2011.

In addition to copies of these publications, I have also attached a powerpoint file that presents excerpts from these reports relative to urban areas. Selected graphs are in the slides and excerpts of text are in the notes.

After you have a chance to take look through this material, please call or email if you have any questions to clarify prior to your meetings.

Robert J. Gilliom

RJGilliom

Chief, Surface Water Assessment
National Water Quality Assessment Program
U.S. Geological Survey

Selected Excerpts on Pesticides in Urban Streams and Groundwater

All material summarized is from the following five published reports:

An overview comparing results from two decades of monitoring for pesticides in the Nation's streams and rivers, 1992-2001 and 2002-2011, by Wesley W. Stone, Robert J. Gilliom, Jeffrey D. Martin: 2014, USGS Scientific Investigations Report 2014-5154

Pesticides in U.S. streams and rivers: occurrence and trends during 1992-2011, by Wesley W. Stone, Robert J. Gilliom, Karen R. Ryberg, 2014, Environmental Science and Technology (48) 11025-11030

Contaminants in stream sediments from seven United States metropolitan areas: part I: distribution in relation to urbanization, by Lisa H. Nowell, Patrick W. Moran, Robert J. Gilliom, Daniel L. Calhoun, Christopher G. Ingersoll, Nile E. Kemble, Kathryn M. Kuivila, Patrick J. Phillips, 2013, Archives of Environmental Contamination and Toxicology (64) 32-51

Trends in pesticide concentrations in urban streams in the United States, 1992-2008, by Karen R. Ryberg, Aldo V. Vecchia, Jeffrey D. Martin, Robert J. Gilliom, 2010, USGS Scientific Investigations Report 2010-5139

Pesticides in groundwater of the United States: decadal-scale changes, 1993-2011, by Patricia L. Toccalino, Robert J. Gilliom, Bruce D. Lindsey, Michael G. Rupert, 2014, Groundwater, Vol. 52, Groundwater–Focus Issue 2014 (pages 112–125)

Sites Evaluated

Table 2. Land-use classifications and watershed land-use criteria

Land-use classification	Watershed land-use criteria
Agriculture	Greater than 50 percent agricultural land and less than or equal to 10 percent urban land
Urban	Greater than 25 percent urban land and less than or equal to 25 percent agricultural land
Undeveloped	Less than or equal to 5 percent urban land and less than or equal to 25 percent agriculture land
Mixed	All other combinations of agriculture, urban, and undeveloped land use

Table 3. Number of stream sites by land-use classification

Land-use classification	Number of stream sites 1992–2001	Number of stream sites 2002–11	Number of common stream sites
Agriculture	59	36	28
Mixed	83	59	45
Urban	40	30	23
Total	182	125	96

An overview comparing results from two decades of monitoring for pesticides in the Nation's streams and rivers, 1992-2001 and 2002-2011, by Wesley W. Stone, Robert J. Gilliom, Jeffrey D. Martin: 2014, USGS Scientific Investigations Report 2014-5154

This report summarizes pesticide stream concentration data from samples collected during 2002–11 and compares the results to findings from 1992–2001. Site selection was based on the number of years with data, watershed size, and frequency of sampling within each year. For a sampling site, all years of sampling that met the minimum sampling criteria were included in the summaries. The summaries for both decades are based on the estimated amount of time a pesticide was detectable at a stream site and the number of times HHBs and chronic ALBs were exceeded. For summary purposes, sampling sites were grouped by dominant land-use classification.

Frequency of Detections

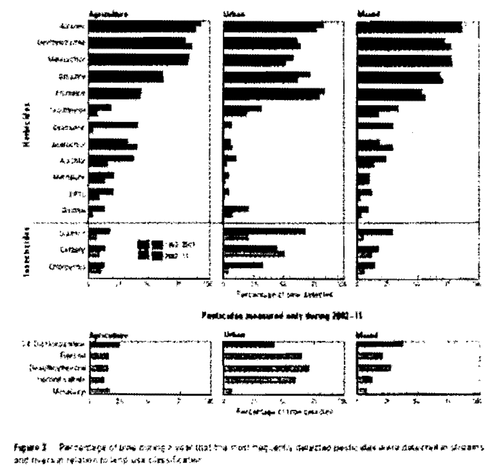
Table 4. Percent of time one or more pesticides or pesticide degradates were detected in streams, by land-use classification.

Land-use classification	Percent of time detected for 1992–2001	Percent of time detected for 2002–11
Agriculture	98	95
Mixed	96	96
Urban	98	99

An overview comparing results from two decades of monitoring for pesticides in the Nation's streams and rivers, 1992-2001 and 2002-2011, by Wesley W. Stone, Robert J. Gilliom, Jeffrey D. Martin: 2014, USGS Scientific Investigations Report 2014-5154

One or more pesticides or pesticide degradates were detectable more than 90 percent of the time in streams across all land uses during 2001–11 (table 4). As mentioned previously, the data from this second decade included analysis of nearly twice as many pesticides and pesticide degradates than the first decade; however, the overall percent of time they were detected in streams was nearly the same for both decades (table 4). Variations in percent of time pesticides and pesticide degradates were detected in streams was more evident for individual compounds.

Frequency of Detections



An overview comparing results from two decades of monitoring for pesticides in the Nation's streams and rivers, 1992-2001 and 2002-2011, by Wesley W. Stone, Robert J. Gilliom, Jeffrey D. Martin: 2014, USGS Scientific Investigations Report 2014-5154

There were some major changes in insecticides in urban streams since 1992. The report states" "Various uses of chlorpyrifos and diazinon, primarily residential, began being voluntarily cancelled during the late-1990s, and these regulatory changes continued into the early-2000s. In addition, fipronil was first registered for use in the United States in 1996 (Jackson and others, 2009) and was suggested as an alternative to organophosphate insecticides for residential and commercial turf applications during the early- 2000s (U.S. Environmental Protection Agency, 2001). Fipronil was detected in streams across all land-use clas-sifications from 17 to 63 percent of the time during 2002–11 (fig. 3); however, fipronil was not included in the NAWQA and NASQAN efforts during 1992–2001 because it was not registered for use until 1996. Ryberg and others (2010) found a preponderance of increasing fipronil stream concentration trends for urban land-use streams from 2000 to 2008."

Aquatic-Life Benchmark Exceedances

Table 5. Percent of streams with one or more pesticide concentration statistics that exceeded a chronic Aquatic Life Benchmark (ALB), by land-use classification.

Land-use classification	Percent of streams exceeding ALB 1992–2001	Percent of streams exceeding ALB 2002–11
Agriculture	69	61
Mixed	45	46
Urban	53	90

An overview comparing results from two decades of monitoring for pesticides in the Nation's streams and rivers, 1992-2001 and 2002-2011, by Wesley W. Stone, Robert J. Gilliom, Jeffrey D. Martin: 2014, USGS Scientific Investigations Report 2014-5154

During 2002–11, nearly two-thirds of agriculture land-use classification streams and nearly one-half of mixed land-use classification streams exceeded a chronic ALB (table 5). For urban land-use classification streams, 90 percent exceeded a chronic ALB.

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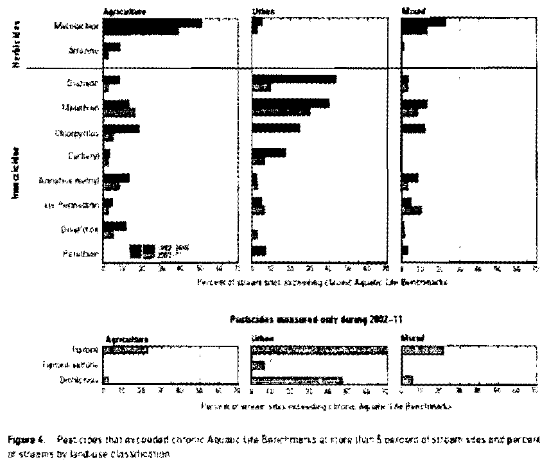
Aquatic-Life Benchmark Exceedances



An overview comparing results from two decades of monitoring for pesticides in the Nation's streams and rivers, 1992-2001 and 2002-2011, by Wesley W. Stone, Robert J. Gilliom, Jeffrey D. Martin: 2014, USGS Scientific Investigations Report 2014-5154

The insecticide fipronil exceeded chronic ALBs for more than 20 percent of the streams across all land-use classifications (fig. 4). The herbicide metolachlor (chronic ALB for *S*-metolachlor) exceeded chronic ALBs for more than 10 percent of agriculture and mixed land-use streams. Similarly, the insecticide malathion exceeded chronic ALBs for more than 10 percent of agriculture and urban land-use streams. The insecticides cis-permethrin (chronic ALB for per-methrin) and dichlorvos exceeded chronic ALBs for more than 10 percent of mixed and urban land-use streams, respectively.

For streams in the urban land-use classification group, the organophosphate insecticides chlorpyrifos, diazinon, and malathion, and the carbamate insecticide carbaryl all had decreases (greater than 10 percent) in the percent of streams exceeding a chronic ALB from the first decade to the second decade (fig. 4). This is consistent with the decreasing stream concentration trends found by Ryberg and others (2010) for chlorpyrifos and diazinon in individual urban land-use streams. These pesticides also were detected less frequently in streams during 1992–2001 compared to 2002–11 (fig. 3). In contrast, the percent of streams, across all land-use classifications, exceeding a chronic ALB for fipronil during the second decade was greater than all other insecticides during both decades. As discussed previously, fipronil registration and use began toward the end of the first decade and was a suggested alternative for organophosphate insecticides during the second decade.

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Implications and Next Steps

"Pesticides assessed during 1992–2011, which represent somewhat less than half the amount of synthetic organic herbicides, insecticides, and fungicides used for agriculture in the U.S., frequently occurred in streams and rivers and pose continuing and widespread concerns for aquatic life based on benchmark exceedances. The potential for adverse effects is likely greater than these results indicate because a wide range of potentially important pesticide compounds were not included in the assessment. Recent regional studies in high-use areas, for example, indicate the likelihood that neonicotinoid insecticides and fungicides occur frequently in surface waters, but the environmental significance is not yet clear. In addition, sampling frequencies in this study were not adequate to reliably characterize the highest short-term concentrations and it focused on pesticides dissolved in water, whereas some hydrophobic pesticides, such as legacy organochlorines and pyrethroid insecticides, are important as contaminants of sediment and tissues and should be considered when evaluating stream ecosystems. Pyrethroid insecticides have been found to be toxicologically important in both agricultural and urban affected streams. Clearly, some of the pesticides not included in the present assessment may add substantially to overall occurrence and potential environmental significance. Expanded assessment should include additional pesticides that are currently used, improved characterization of short-term acute exposures, consideration of multiple environmental media (e.g., sediment and tissues), and coincident assessment of biological conditions. Results suggest that a relatively small proportion of individual pesticides in use may account for most of the concerns for aquatic life, based on comparisons to individual water-quality benchmarks. "

An overview comparing results from two decades of monitoring for pesticides in the Nation's streams and rivers, 1992-2001 and 2002-2011, by Wesley W. Stone, Robert J. Gilliom, Jeffrey D. Martin: 2014, USGS Scientific Investigations Report 2014-5154

Excerpt from closing section of the 2014 Environmental Science and Technology article.

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Contaminants in stream sediments from seven United States metropolitan areas

Contaminants in stream sediments from seven United States metropolitan areas: part I: distribution in relation to urbanization, by Lisa H. Nowell, Patrick W. Moran, Robert J. Gilliom, Daniel L. Calhoun, Christopher G. Ingersoll, Nile E. Kemble, Kathryn M. Kuivila, Patrick J. Phillips, 2013, Archives of Environmental Contamination and Toxicology (64) 32-51

These study areas vary
with respect to ecoregion, climate, geology and soil properties,
streamflow characteristics, and pre-urban land cover
(Table 1). A total of 98 stream sites were sampled during
2007, with 12–14 sites in most study areas

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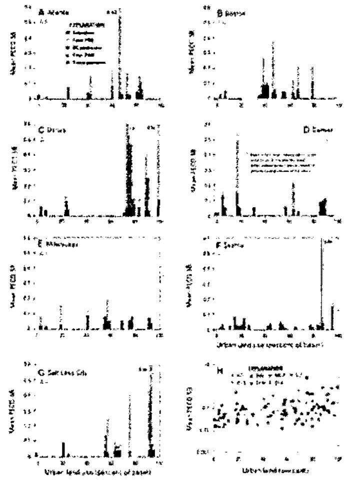
Contaminants in stream sediments from seven United States metropolitan areas



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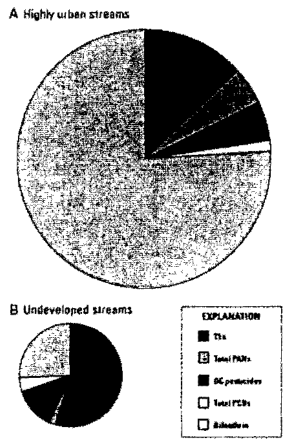
Mean PECQ-5B is the estimated toxicity of a sample. Each sample in each metropolitan area is represented by a bar on the graph and each segment of the bar is a particular contaminant or group. The light blue bars that are prevalent for many of the more urbanized streams are the pyrethroid insecticide, bifenthrin.

Excerpt from article: The overall mean PECQ-5B increased significantly with increasing urbanization. At highly urban sites ([50 % urban), pyrethroids accounted for an average of approximately 75 % of the mean PECQ-5B, all other organics combined approximately 11 %, and trace elements only approximately 13 %.

Contaminants in stream sediments from seven United States metropolitan areas



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Excerpt from article: The overall mean PECQ-5B (estimated toxicity) increased significantly with increasing urbanization. At highly urban sites ([50 % urban), pyrethroids accounted for an average of approximately 75 % of the mean PECQ-5B, all other organics combined approximately 11 %, and trace elements only approximately 13 %.

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Contaminants in stream sediments from seven United States metropolitan areas

"The results of the present study confirm the importance of bifenthrin as a primary cause of potential toxicity in urban streams reported previously for residential creeks, especially near storm drain outfalls, in parts of California (Weston et al. 2005; Amweg et al. 2006; Holmes et al. 2008), Illinois (Ding et al. 2010), and Texas (Hintzen et al. 2009). Findings for the pyrethroids illustrate the importance of tracking new contaminants introduced to aquatic ecosystems and the development of analytical methods and toxicity thresholds to support the assessment and management of contaminated sediments."

Contaminants in stream sediments from seven United States metropolitan areas: part I: distribution in relation to urbanization, by Lisa H. Nowell, Patrick W. Moran, Robert J. Gilliom, Daniel L. Calhoun, Christopher G. Ingersoll, Nile E. Kemble, Kathryn M. Kuivila, Patrick J. Phillips, 2013, Archives of Environmental Contamination and Toxicology (64) 32-51

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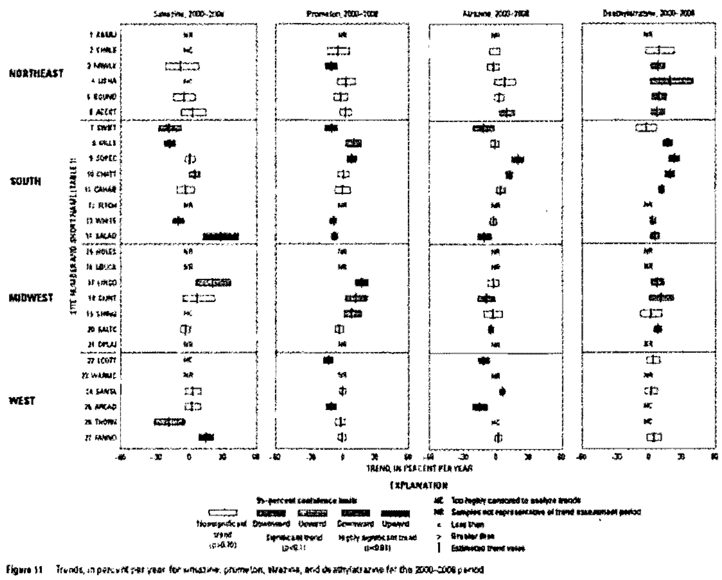
Trends in Herbicide Concentrations in Urban Streams



Trends in pesticide concentrations in urban streams in the United States, 1992-2008, by Karen R. Ryberg, Aldo V. Vecchia, Jeffrey D. Martin, Robert J. Gilliom, 2010, USGS Scientific Investigations Report 2010-5139

Trend results for the herbicides indicated many significant trends, both upward and downward, with varying patterns depending on period, region, and herbicide. Overall, for all of the herbicides and periods, deethylatrazine showed the most consistent pattern of upward trends in concentrations, especially in the Northeast (2000–2008), South (1996–2004 and 2000–2008), and Midwest (1996–2004 and 2000–2008). Other herbicides showed less consistent increases, including simazine in the South (1996–2004), prometon in the Midwest (2000–2008), and atrazine in the South (1996–2004). The most consistent downward trends were for simazine in the Northeast and Midwest (1996–2004), prometon in the Northeast and Midwest (1996–2004) and West (1996–2004 and 2000–2008), and tebuthiuron in the South (1996–2004 and 2000–2008) and West (2000–2008).

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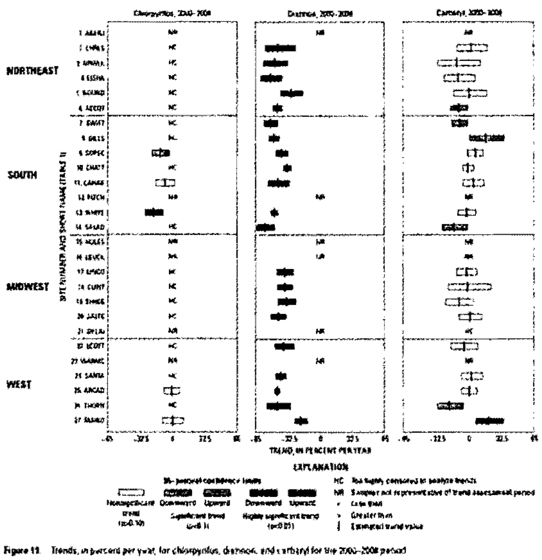
Trends in Insecticide Concentrations in Urban Streams



Trends in pesticide concentrations in urban streams in the United States, 1992-2008, by Karen R. Ryberg, Aldo V. Vecchia, Jeffrey D. Martin, Robert J. Gilliom, 2010, USGS Scientific Investigations Report 2010-5139

Trend results for two organophosphate insecticides, chlorpyrifos and diazinon, were consistent with known decreases in urban uses of these chemicals. Many residential uses of chlorpyrifos were phased out or eliminated at various times during 1997–2001, which is consistent with highly significant chlorpyrifos downward trends during 1996–2004 and substantially decreased chlorpyrifos concentrations in urban streams. Diazinon trended strongly downward during both the 1996–2004 and 2000–2008 analysis periods, which is consistent with various changes in regulation that reduced or eliminated most residential uses of diazinon during 2000–2004.

The insecticide carbaryl had mostly upward trends during 1996–2004, although only four of the upward trends were significant. The upward trends in carbaryl during that time may be due at least in part to replacement of chlorpyrifos and diazinon with carbaryl. However, there were two sites with significant downward trends in carbaryl during the same period. For the 2000–2008 analysis period, carbaryl trends were mixed upward and downward and were mostly nonsignificant. Despite voluntary cancellation of many residential uses of carbaryl beginning in about 2000, there were only four significant downward trends during 2000–2008 and two significant upward trends during that time.

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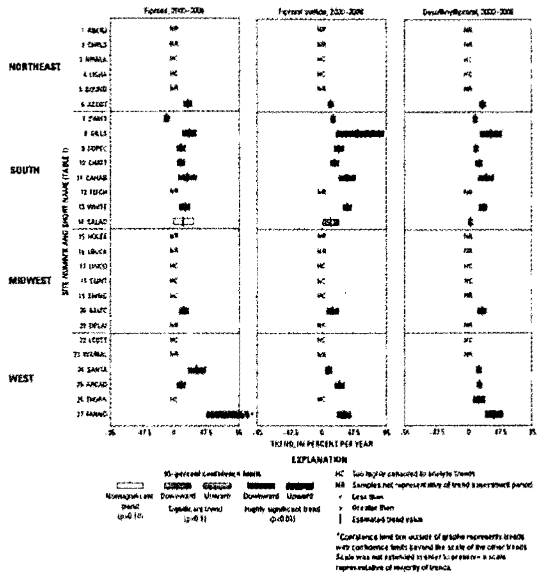
Trends in Insecticide Concentrations in Urban Streams



Trends in pesticide concentrations in urban streams in the United States, 1992-2008, by Karen R. Ryberg, Aldo V. Vecchia, Jeffrey D. Martin, Robert J. Gilliom, 2010, USGS Scientific Investigations Report 2010-5139

Trends in the insecticide fipronil and its degradation products fipronil sulfide and desulfinylfipronil were analyzed only for the analysis period 2000–2008. Fipronil was introduced in 1996 and concentrations were analyzed by the U.S. Geological Survey beginning in 1999. For 13 sites that were not too highly censored to analyze trends, fipronil and both degradation products trended strongly upward. Significant upward trends were noted at 10 sites for fipronil and both degradation products. One anomalous site had a significant downward trend in fipronil and highly significant upward trends in both degradation products. The strong upward trends in fipronil and its degradates are consistent with expected increasing use after its introduction, in 1996, particularly as a substitute for organophosphate insecticides.

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Pesticides in Groundwater in Urban Areas

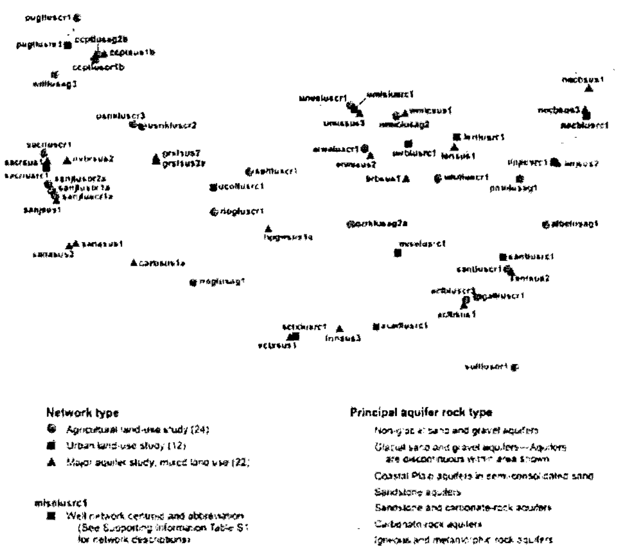

Figure 1. Locations of 58 well networks sampled for pesticide compounds by the USGS National Water-Quality Assessment Program, 1993–2011. Principal aquifers were grouped according to lithology into rock-type categories using classifications in the National Atlas (Miller 2000).

Pesticides in groundwater of the United States: decadal-scale changes, 1993-2011, by Patricia L. Toccalino, Robert J. Gilliom, Bruce D. Lindsey, Michael G. Rupert, 2014, Groundwater, Vol. 52, Groundwater–Focus Issue 2014 (pages 112–125)

The national occurrence of 83 pesticide compounds in groundwater of the United States and decadal-scale changes in
concentrations for 35 compounds were assessed for the 20-year period from 1993–2011. Samples were collected from 1271
wells in 58 nationally distributed well networks. Networks consisted of shallow (mostly monitoring) wells in agricultural and
urban land-use areas and deeper (mostly domestic and public supply) wells in major aquifers in mixed land-use areas. Wells
were sampled once during 1993–2001 and once during 2002–2011.

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Pesticides in Groundwater in Urban Areas

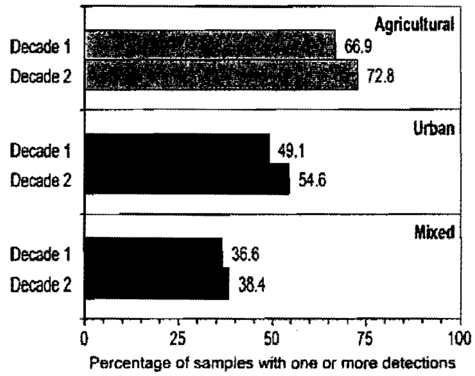

Figure 2. Detection frequencies of pesticide compounds—by land use—for groundwater samples collected from 1271 wells during Decade 1 (1993–2001) and Decade 2 (2002–2011).

Pesticides in groundwater of the United States: decadal-scale changes, 1993-2011, by Patricia L. Toccalino, Robert J. Gilliom, Bruce D. Lindsey, Michael G. Rupert, 2014, Groundwater, Vol. 52, Groundwater–Focus Issue 2014 (pages 112–125)

The highest frequencies of detection were in shallow groundwater beneath agricultural land use areas, where more than two-thirds of the samples had detections of one or more pesticide compounds. Pesticides were detected in about half of the samples collected from shallow groundwater beneath urban land-use areas, and from more than one-third of samples from deeper groundwater in major aquifers (Figure 2). These findings are consistent with previous studies, which show that shallow groundwater, because of its proximity to the land surface, is more vulnerable to contamination from pesticide applications and other human activities than deep groundwater (Gilliom et al. 2006; Haarstad and Ludvigsen 2007;Toccalino et al. 2010; Close and Skinner 2012).

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Pesticides in Groundwater in Urban Areas

Table 1
Summary of the Occurrence of Pesticide Compounds Detected at Concentrations Greater Than Human-Health Benchmarks—by Land Use and Well Type—for 1271 Wells Sampled During Decade 1 (1993–2001) and Decade 2 (2002–2011)

	Public-Supply Wells		Domestic Wells		Observation Wells	
Land Use	Number of Wells Sampled	Number of Wells with BQ > 1[1]	Number of Wells Sampled	Number of Wells with BQ > 1[1]	Number of Wells Sampled	Number of Wells with BQ > 1[1]
Decade 1						
Agricultural	1	0	168	4 (3 dieldrin, 1 dinoseb, 1 *alpha*-HCH)[2]	320	3 (2 dieldrin, 1 norflurazon)
Urban	0	0	0	0	271	10
Mixed (major aquifers)	125	0	326	1	60	0
Decade 2						
Agricultural	1	0	168	2	320	6
Urban	0	0	0	0	271	17
Mixed (major aquifers)	125	1	326	2	60	0

[1] All benchmark exceedances were accounted for by dieldrin unless noted otherwise
[2] One sample had benchmark exceedances for both dieldrin and *alpha*-HCH

Pesticides in groundwater of the United States: decadal-scale changes, 1993-2011, by Patricia L. Toccalino, Robert J. Gilliom, Bruce D. Lindsey, Michael G. Rupert, 2014, Groundwater, Vol. 52, Groundwater–Focus Issue 2014 (pages 112–125)

Pesticide concentrations seldom exceeded human health benchmarks in groundwater. Altogether, 1.4% of Decade 1 samples and 2.2% of Decade 2 samples had concentrations of one or more pesticides greater than a benchmark. In Decade 1, dinoseb, *alpha*-HCH, and norflurazon each were detected once at a concentration greater than their respective benchmarks. Dieldrin, however, accounted for most benchmark exceedances in Decade 1 and all benchmark exceedances in Decade 2 (Table 1).

Across both decades, 78% of samples (36 of 46) with BQ>1 were collected from observation wells that are not sources of drinking water; moreover, 27 of these 36 samples were from urban land-use areas. Less than 1% of samples from domestic wells or public-supply wells had one or more pesticide compounds with BQ>1 (Table 1). Altogether, benchmarks were exceeded in 5% of samples from urban land-use areas, <2% of samples from agricultural areas, and <1% of samples from mixed land-use areas, consistent with findings from Gilliom et al. (2006). The greater prevalence of benchmark exceedances in groundwater from urban areas compared to other land uses may have resulted from urban applications of dieldrin for termite control, which were permitted until 1987, whereas USEPA banned all other uses more than a decade earlier (Agency for Toxic Substances and Disease Registry 2002).

Dieldrin, a highly persistent organochlorine insecticide compound, originates from historical applications of dieldrin and aldrin, which degrades to dieldrin in the

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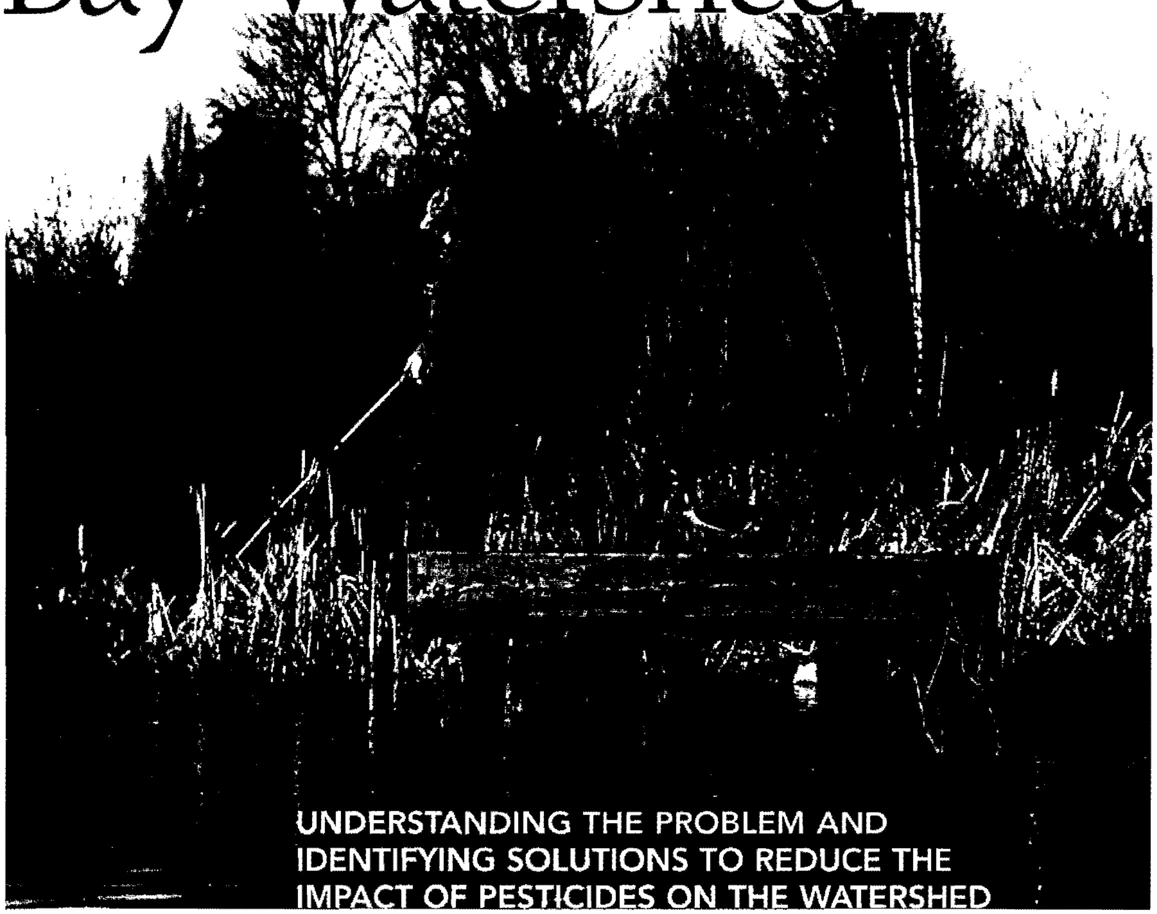
environment. Historically, dieldrin was used to control insects on some crops, and to control locusts, mosquitoes, and termites. The USEPA banned all uses of dieldrin in 1987 (Agency for Toxic Substances and Disease Registry 2002). As a result, detections of dieldrin reflect pesticide use practices that are no longer allowed, and illustrate that source-water protection strategies that rely on changes in human activities and practices at the land surface to achieve water-quality objectives can take many decades to affect the quality of some groundwater resources (McMahon et al. 2008).

WHITE PAPER

Pesticides and the Maryland Chesapeake Bay Watershed



July 2009

Maryland Pesticide Network

in collaboration with

The Pesticides and the Chesapeake Bay Watershed Project
Working Group facilitators, project stakeholders and technical experts

About the White Paper

This paper was produced by staff of the *Pesticides & the Chesapeake Bay Watershed Project*, with content contributed by a diverse group of scientists, public health and policy experts from among the Project's stakeholders. Topical technical reviews were provided by scientists from federal agencies and research institutions. While research is limited and more data are needed, certain pesticides have been shown to have a potential adverse impact on the Chesapeake Bay watershed. In response, the Maryland Pesticide Network and the Johns Hopkins Center for a Livable Future launched the Project in May 2007 – a collaborative effort of more than 100 stakeholders and technical experts, whose shared mission is to reduce risk of adverse effects to living resources from pesticides in the Chesapeake Bay and its tributaries.

PROJECT WORKING GROUPS, STAKEHOLDERS AND TECHNICAL EXPERTS

The Project's stakeholders comprise five issue-specific working groups: 1) Sharing Research and Identifying Data Gaps; 2) Federal and State Laws and Policies Addressing Pesticides; 3) Preventing Pesticides from Entering Waterways; 4) Building Collaborative Relationships with the Agricultural Community, and 5) Increasing Demand and Production of Healthier Alternatives. The working groups have met at least quarterly since May 2007 and to date have come together for two day-long annual meetings.

Stakeholders include: Scientists from federal agencies with regulatory responsibilities (NOAA, US EPA, USFWS); as well as representatives from state agencies (Maryland Departments of Natural Resources, Health and Mental Hygiene, Agriculture and Environment); local government agency representatives; scientists from research institutions; public health experts; waterkeepers; watermen; Maryland tributary team chairs; extension service experts; farmers; environmental organizations, and landscape industry representatives.

Technical experts include scientists from federal agencies and research institutions, including USGS and USDA.

WORKING GROUP INITIATIVES AND OUTPUTS

The Project Working Groups are: 1) developing a methodology to assess the risks of pesticides in the Bay watershed; 2) identifying data gaps; 3) identifying best management practices for reducing/eliminating pesticide occurrence and impacts in the watershed and, 4) working to implement certain solutions which include educating target populations in order to reduce occurrence and impact of pesticides, and making policy recommendations.

REVIEW OF THE WHITE PAPER

The Project stakeholders and technical experts mentioned in the Acknowledgements section of this paper have extensively reviewed and critiqued this document. This paper has not been reviewed by independent reviewers. The recommendations included in this paper were developed by the working groups; their inclusion does not indicate full endorsement of all or any of them by individual working group members.

The intent of this white paper is to inform stakeholders, regulators, policymakers and the public about the current data and data gaps regarding the impact of pesticides on the watershed and to provide proposed actions to address this salient issue.

ACKNOWLEDGMENTS

The *Pesticides and the Chesapeake Bay Watershed Project* co-sponsors, Maryland Pesticide Network and the Johns Hopkins Center for a Livable Future, as well as project participants, wish to thank the following people for their input and editorial efforts that were critical to the production of this publication:

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Executive Summary

THE PROBLEM

The Chesapeake Bay watershed is the largest and most biologically diverse estuary in the United States. Living resources in this economically important watershed are stressed by various pollutants resulting from human activity, including the use of chemical pesticides. Exposure to pesticides also presents risk to human health. Recent U.S. Geological Survey (USGS) reports (Gilliom et al. 2006; Phillips et al. 2007), suggest to the author(s) of this White Paper that reducing current levels of chemical pesticides flowing into the Bay should be a priority for agencies working to protect the Bay.

The 2007 USGS report found that *"synthetic organic pesticides and their degradation products have been widely detected at low levels in the watershed [Susquehanna River Basin, Potomac River Basin, Delmarva Peninsula], including emerging contaminants such as pharmaceuticals and hormones."* Pesticides were detected more frequently in streams than in ground water. While the most commonly detected pesticides were herbicides used on corn, soybean and small grain crops in agricultural regions, pesticides were also detected in streams and groundwater in urban areas at lower concentrations. Pesticides in ground water were found at higher concentrations in areas underlain by permeable soils and aquifer material than in areas underlain by less permeable materials.

Other recent reports indicate that pesticides and their degradation products have occurred at concentrations that exceed water quality benchmarks for the parent compounds. For example, a USGS team found that while concentrations of parent compounds were lower than drinking water standards in ground water samples from the Maryland coastal plain, degradation products for some pesticides were found to exceed the parent compounds. Pesticides detected in the streams in the Potomac River Basin (Maryland, Pennsylvania, Virginia, West Virginia, and the District of Columbia), included atrazine, metolachlor, simazine, prometon, tebuthiuron, diazinon, carbaryl, and 18 other compounds. (Ator and Denver, 2006).

Certain pesticides are frequently detected in Bay waters and its tributaries. For example:

- Liu et al. (2002) concluded that the annual mass loads for atrazine, CIAT, metolachlor, simazine, and CEAT from the Susquehanna River to the Chesapeake Bay ranged from high to low (1600, 1600, 1100, 820, and 720 kilograms/year, respectively.) Annual loadings of insecticides and organochlorine compounds ranged from 2.8 kg/year for alpha-HCH to 34 kg/year for diazinon. While the Susquehanna contributes a significant portion of river inputs to the Bay, it is but one of many sources of pesticide loadings to the Bay.
- McConnell et al. (2004) found herbicides and two triazine degradation products, 2-chloro-4- isopropylamino-6-amino-s-triazine (CIAT), and 6-amino-2- chloro-4-(ethylamino)-s-triazine (CEAT), in surface water from four sites sampled at regular intervals from April 4 through July 29, 1996 in the Patuxent River estuary. Of the pesticides measured, atrazine was most persistent and was present in the highest concentrations (maximum = 1.3 μg/L). This is below the U.S. Environmental Protection Agency (EPA) drinking water standard of 3 μg/L. Metolachlor, CIAT, CEAT, and simazine were frequently detected (with maximum concentration values of 0.61, 1.1, 0.76, and 0.49 μg/L, respectively).
- In a study of Chesapeake waters in 2004, researchers detected atrazine in 100% of water samples taken at sixty different stations spread across five different Bay tributaries (McConnell et al., 2007).

A growing body of evidence has shown that many pesticides, which are designed to affect specific organisms, may also be toxic to non-target species, such as aquatic life, wildlife, and humans that co-inhabit the ecosystem. Even at low levels, the toxic effects of pesticides place additional stress on resident microbiota, plants, fish and other wildlife. Reduction in the growth of key living resources of the Chesapeake Bay have been observed in the laboratory at low part per billion concentrations for some pesticides. The cumulative effect of pesticides and their degradation products on aquatic life is poorly under-

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"Chesapeake Bay Program Executive Level Goal: Reduce the potential risk of pesticides to the Bay by targeting education, outreach and implementation of Integrated Pest Management and specific Best Management Practices on those lands that have higher potential for contributing pesticide loads to the Bay (2000)"

stood and may present additional challenges to the living resources of the Chesapeake Bay watershed.

The Chesapeake Bay Program (CBP) is a regional partnership which includes the states of Maryland, Pennsylvania, Virginia, and the District of Columbia; the Chesapeake Bay Commission, a tri-state legislative body; US EPA representing the federal government; and participating advisory groups. Its vision for the Chesapeake Bay watershed is *"a system with abundant, diverse populations of living resources, fed by streams and rivers, sustaining strong local and regional economies, and our unique quality of life."* One the CBP's six goals is to *"achieve and maintain the water quality necessary to support the aquatic living resources of the Bay and its tributaries and to protect human health."* Reduction of chemical contaminants, including pesticides, is part of CBP's strategy; however, in recent years only three to five percent of CBP's resources have been devoted to issues of toxic chemicals.

There are many sources of pesticide contamination in U.S. waters such as in the Chesapeake Bay watershed. Although the agricultural sector accounts for about 80% of pesticide use in the United States, pesticides are also found in a wide range of everyday household products – including weed and insect killers, hand soap and kitchen cleansers – and often end up in ground and surface waters flowing into Chesapeake Bay. Runoff from non-residential turf areas, such as golf courses, rights-of-way and landscaping, is another source of pesticide pollution. The following is a more complete accounting of pesticide pollution sources:

Common Sources of Pesticides in Water (NOAA, 2005)

- Runoff from lawns, gardens and or golf courses.
  - May enter storm drains discharging into surface waters.
- Runoff from treated agricultural fields, especially during storms; even proper use and handling may lead to runoff into surface waters.
- Proper or Improper disposal of pesticides. Even proper use and handling may lead to runoff into surface waters.
- Accidents, improper handling and disposal.
  - Spills or careless use of pesticides, such as over-spraying drainage ditches or water courses, or careless disposal of empty containers or leftover pesticides.
- Land-based applications for agriculture, lawn care and on golf courses.
- Spray Drift
  - Occurs when pesticides are sprayed over an area by ground application equipment (trucks, tractors) or airplanes for agricultural purposes; large lawn areas or for insects such as mosquitoes. Pesticides are transported through air, and wind blows this spray into an adjacent body of water (NOAA, 2005).
- Atmospheric Deposition
  - Occurs in the form of rainfall or dry deposition as airborne particles settle on land or in bodies of water.
- Direct discharge from treated wastewater effluent.
- Sewage sludge from wastewater treatment plants.
- Disinfectants such as triclosan occur in sewage sludge, and these bio-solids may later be applied to agricultural land (Kinney et al., 2006).

DATA GAPS

While a growing body of research underscores that pesticides, along with certain of their degradation products, are being widely detected in groundwater and streams in the watershed, there is a need to define further their occurrence and impact on aquatic life, human health and water quality. For example, when thresholds are set for pesticides, each chemical is evaluated in isolation; however, in a real-life setting, simultaneous exposure to multiple chemicals is more likely. Very little research has been done on the multiple and synergistic effects of multiple pesticides or the impacts of pesticides when combined with non-pesticide stressors. Virtually no research has

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been done on the 'other' ingredients in pesticide mixtures that alter solubility properties of 'active' ingredients. What research has been done indicates biological activity by the solvents/surfactants in the mixes, as well as magnified total biological effects.

The current risk assessment process, in some cases, lacks key toxicological data on both animal and human health effects and does not consider or account for the cumulative and aggregate risks of exposure to pesticides and other synthetic chemicals. Of emerging concern are pesticide degradation products whose toxicity is sometimes uncertain and whose concentrations have been observed to equal or exceed those of the corresponding parent compounds. Yet these pesticide by-products remain largely unregulated today, both for drinking water and aquatic life.

Another important concern is that many pesticides are now being shown to cause harm even at low doses to the environment or to humans. For example, low-dose exposures to the herbicides aldicarb and atrazine in well water, along with nitrate used as fertilizer, may cause adverse effects on behavior and on the immune and endocrine systems (Porter, et al. laboratory study, 1999). Epidemiological data suggest seasonal changes in atrazine and nitrate in water may alter genitalia, language and mathematical skills and other subtle biological responses in children conceived in months when concentrations are high (Winchester et al, 2009). Chronic exposure to low levels of atrazine leaves phytoplankton more susceptible to a short-term exposure to higher levels (Pennington and Scott, 2001).

In addition, the effects of some pesticides and their degradation products on aquatic life have not been explored because they were not thought to occur in water. This point is illustrated by the antimicrobial consumer product additives triclosan and triclocarban, whose widespread occurrence in Chesapeake Bay and other U.S. water resources has been recognized only recently.

The role pesticides may play as endocrine disruptors triggering reproductive abnormalities is an alarming possibility. In September 2006, the discovery of male fish bearing immature oocytes in the Potomac River caused continuing concern (Chesapeake Research Consortium, 2006). Shortly after these findings, a Mid-Atlantic science forum was held to discuss the effects of possible endocrine disrupting chemicals, including herbicides, insecticides, and antimicrobials (Chesapeake Research Consortium, 2006). However, the specific agents causing these episodes of intersex fish have not yet been determined with any certainty.

In March 2008, USGS scientists identified several pesticides in the Potomac River that could be responsible for "intersex fish," or male fish with testicular oocytes. One of these – atrazine, a common herbicide used in agriculture and on lawns – is already linked to sexual abnormalities in frogs (Hayes et al, 2006). EPA does not currently evaluate or consider the endocrine-disrupting properties of pesticides during registration or re-registration, but in 2009 EPA released a list of 67 pesticides that will be evaluated as potential endocrine disruptors.

RECOMMENDATIONS

Given the limitations in the risk-assessment process and in containing nonpoint sources such as land-based applications, policymakers, businesses and consumers should collaborate on implementing best management practices to prevent pesticides from entering the watershed and, following a precautionary approach, to reduce pesticide use.

The following recommendations are offered to prevent pesticides from entering the Chesapeake Bay Watershed and to promote efficacious alternatives to pesticide usage:

1. Provide incentives that encourage farmers to use best management practices, including the creation of buffer zones to reduce the amount of pesticides entering the watershed.
2. Encourage farmers to transition from unsustainable agricultural methods to strategies that reduce or eliminate reliance on pesticides. Critical to effecting this transition are financial incentives that reward farmers who implement pest management techniques that go beyond minimum requirements. Programs such as USDA's Environmental Quality Incentives Program should responsibly address pesticides in its funding criteria.
3. Educate farmers about the dangers pesticides pose to their health and the health of their families.
4. Encourage the commercial sector to be more proactive in developing and offering healthier technologies, services and products.

"A growing body of evidence has shown that many pesticides, which are designed to affect specific organisms, may also be toxic to non-target species, such as aquatic life, wildlife and humans that co-inhabit the ecosystem."

5. Promote the use of Integrated Pest Management (IPM), a strategy focusing on non-chemical prevention techniques and the use of least-toxic pesticides as a last resort. IPM is applicable to residential and commercial use as well as agriculture.
6. Educate consumers about the public health and environmental concerns related to pesticide exposures.
7. Encourage consumers to question aesthetics-based behaviors (i.e., desire for visually attractive lawns or produce) in lieu of decision-making based on human health and ecological concerns. Promote IPM, preventative and organic land care practices as efficacious alternatives.
8. Educate consumers about the hazards of antibacterial soaps containing pesticides and the false assumption that they are necessary for preventing illnesses.
9. Promote awareness of the importance of reducing mosquito breeding habitats to reduce mosquito-borne illnesses and lessen the need for pesticide spraying. Favor the use of low-toxicity larvicides.
10. Support research on the synergistic impact/interaction of using multiple pesticides over time on the watershed and public health.
11. Support federal and state funding for research on the effects of endocrine-disrupting chemicals, including pesticides in the watershed and their suspected link to sex alteration in fish and other adverse effects in fish.
12. Identify data gaps regarding the impact of pesticides and their degradation products that are or may be expected to be found in the watershed on water quality, aquatic life, wildlife, and public health, and promote further research regarding pesticides of greatest concern in the watershed.
13. Expand the charge of the Chesapeake Bay Program beyond nutrient management to include pesticide management.
14. Assess the need for strengthening and expanding existing policies and laws and identify needed policies to reduce the impact of pesticides on the watershed.
15. Assess the applicability of the European Union's Regulation on Registration, Evaluation, Authorization and Restriction (REACH) program, as well as California's Green Chemistry program. REACH puts the burden on manufacturers to evaluate the safety of their products prior to registration – in contrast to existing federal policy, whereby pesticides are registered and sold unless they are proven to be unsafe after the fact – and endorses the principle that hazardous chemicals should be replaced with safer ones. The Green Chemistry program aims to reduce the use of toxic substances that endanger public health and the environment. The program evaluates ways to use less-toxic materials, less energy and produce less waste. It strives to identify data gaps on problem chemicals, explore safer alternatives, and educate the public.
16. Implement state-based centralized systems for pesticide use data collection and requirements for reporting pesticide use by certified applicators, so government agencies and research institutions can accurately determine pesticide use patterns and their relationship to occurrence and impact in the watershed.

Introduction

The Chesapeake Bay watershed, the largest and most biologically diverse estuary in the United States, is threatened by multiple stressors produced by human activities. Because of the presence, persistence, toxicity and amount used in the watershed, pesticides represent a significant risk factor to aquatic life and the health of local residents. Although water quality mitigation in the watershed is focused mainly on nutrient loadings, recent reports indicate that a wide variety of pesticide contaminants are also found throughout the watershed and sometimes at levels that exceed water quality benchmarks for protecting drinking water, aquatic life and safety of fish consumption. For example, USGS found that while concentrations of parent compounds in Maryland coastal plain samples were lower than drinking water standards, concentrations of pesticide degradation products exceeded the parent compound concentrations (Ator and Denver, 2006).

A growing body of evidence has shown that many pesticides, which are designed to affect specific organisms, may also be toxic to non-target species, such as aquatic life, wildlife, and humans that co-inhabit the ecosystem. Even at low levels, toxic effects from pesticides place additional stress on resident microbiota, plants, fish and other wildlife. In addition, some pesticides can bioaccumulate in the food web, sometimes leading to higher levels in larger fish and fish-eating birds, where they have been linked to reproductive dysfunctions. Contamination of drinking water and edible fish may also harm people. Comprehensive data on the health effects of chronic, low-level pesticide exposure in the Chesapeake Bay watershed have not been collected, and understanding of these risks remains unknown. Data are missing for vulnerable populations, such as infants (with developing immune systems) and people with weakened immune systems. While municipalities test public water and wells serving over 25 people, those who depend on smaller private wells (serving less than 25 people) may have an increased risk of exposure to unregulated pesticides in their drinking water.

Many pesticides previously thought to cause relatively little harm to the environment or to humans are now being shown to have harmful effects. The current risk-assessment process suffers from key toxicological data gaps for both animal and human health effects and from the lack of consideration for cumulative and aggregate risks of exposure to multiple pesticides and other synthetic chemicals. The process is also unable to keep up with the rapid introduction of new pesticide products. Pesticide breakdown products, many of uncertain toxicity, remain largely unregulated today for both drinking water and aquatic life, despite observed concentrations equal to or exceeding those of the corresponding parent compounds. In addition, the effect of some pesticides and their by-products in aquatic environments remains under-explored because these toxics were not expected to be transported to water. For example, the termiticide chlordane has been found in high levels in fish tissues even though this was thought to be soil-bound and would not migrate to water; triclosan and triclocarban used as antibacterial compounds in soaps have been found in Chesapeake Bay and other U.S. waters.

Given limitations in the risk assessment process linking pesticide usage to effects on aquatic species and in non-point source control, policymakers, regulators, businesses, and consumers should collaborate on implementation of best management practices that prevent pesticides from entering the watershed and should follow the precautionary principle, reducing use of pesticides wherever possible. The Precautionary Principle states:

"When an activity raises threat of harm to human health or their environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."

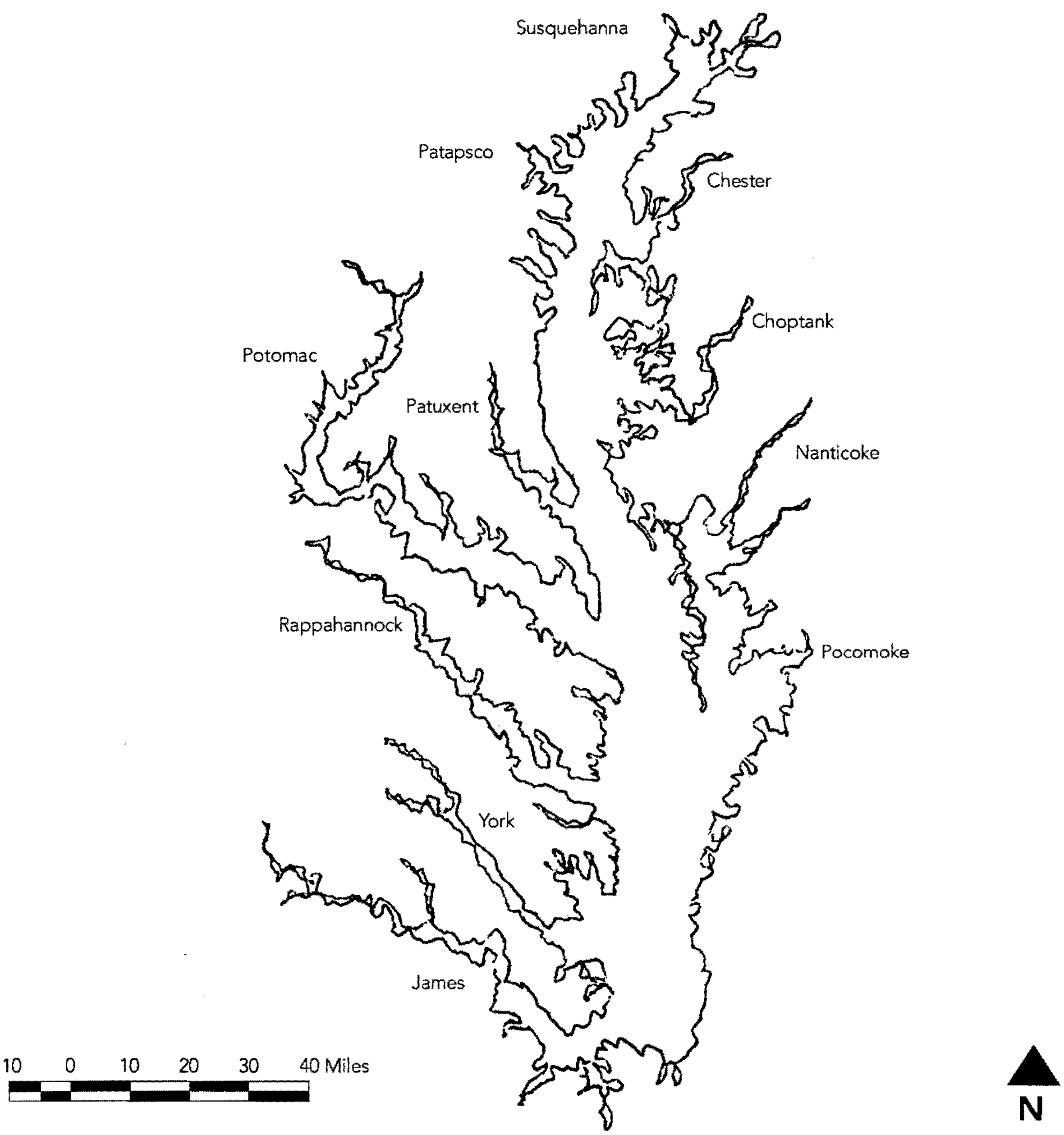
Businesses (manufacturers, vendors, distributors) should be proactive in developing and offering healthier technologies, services, and products. Educated consumers can demand and use these more environmentally-friendly methods, services and products in their businesses and at home. Governments and educators should collaborate with businesses to:

- Inform the public on how to prevent pesticides from being transported to non-target ecosystems;

- Develop non-chemical and least-toxic strategies, methods and products;
- Reward businesses that engage in "best management practices," such as pest control and lawn care companies that use Integrated Pest Management (IPM).

Government agencies should enforce existing laws more rigorously to better meet pesticide water-quality benchmarks. Federal and state funding to ensure capacity for proper enforcement is critical. Federal and state agencies should develop new standards for recently identified pesticides and degradation products that are found to commonly occur in the watershed – and to prioritize those with the greatest potential for causing harm to the environment and humans. Meanwhile, scientists should continue to research this important issue and draw more frequently on collaborations and data sharing for advancing the knowledge base.

The Chesapeake Bay and its Major Tributaries



Source: Chesapeake Bay Program

WHAT IS THE CHESAPEAKE BAY WATERSHED AND WHY FOCUS ON MARYLAND?

Chesapeake Bay is the largest estuary in the United States, with a watershed that spans the District of Columbia and parts of six states. The Bay is fed by six major river systems: the Susquehanna, Potomac, Patuxent, Rappahannock, York and James Rivers.

The watershed includes both surface and ground waters that are hydraulically connected (Winter et al, 1998). More than 16 million people now live in the Chesapeake Bay watershed (U.S. Census Bureau, 2000).

While developing and implementing solutions at a watershed level is a long- term goal, this White Paper focuses initially on Maryland because 93% of the state falls within the Bay watershed. Also, about a third of the watershed's population resides in Maryland (U.S. Census Bureau, 2000).

WHAT ARE PESTICIDES?

Pesticides are substances used to prevent, destroy, mitigate or repel any unwanted insects, plants, fungi, rodents, prions,[1] and microorganisms such as viruses and bacteria (U.S. Environmental Protection Agency, 1999). Pesticides include insecticides, herbicides, fungicides, rodenticides or antimicrobials. Commercial pesticide products contain both active and so-called "inert" ingredients. Inert ingredients, frequently listed as "other ingredients" on product labels, support the effectiveness of active ingredients. The health effects or other properties of inert ingredients are not considered during the pesticide registration process, and inert ingredients designated as proprietary or "trade secrets" may not be included on a product label, regardless of their concentration or potential hazard to public health and the environment (U.S. Environmental Protection Agency, 2008).

While the agricultural sector accounts for about 80% of pesticide use in the United States, pesticides are also found in everyday products, such as weed killers and hand soap, and often end up in ground and surface waters serving as drinking-water sources.

PESTICIDE DEGRADATION PRODUCTS

Degradation products of pesticides are breakdown products created by abiotic (i.e., physical and chemical) or biological reactions. Evidence is mounting that the environmental occurrence and concentrations of some pesticide degradation products may equal or substantially exceed that of the corresponding parent compound (Ator et al, 2005; Debrewer et al, 2007; Ator and Denver, 2006). These findings are discussed below in Section I.B. No pesticide degradation products are currently regulated under the Safe Drinking Water Act (U.S. Environmental Protection Agency, 2003a). However, degradation products of two commonly used pesticides, atrazine and alachlor, are on EPA's 2005 Contaminant Candidate List (CCL) (U.S. Environmental Protection Agency, 2005) and under consideration for regulation under the Safe Drinking Water Act. The CCL is a list published periodically by EPA that identifies unregulated contaminants which may require a national drinking water regulation in the future. This list is used by EPA to prioritize research and data collection efforts and to determine if a specific unregulated contaminant should be regulated.

PESTICIDES: AN ENVIRONMENTAL HEALTH THREAT IN THE CHESAPEAKE REGION

Pesticides are an important issue with respect to the health of Chesapeake Bay. While pesticides are designed to kill specific target organisms, they also can be toxic to aquatic life, wildlife and humans, even at low levels. Emerging evidence, as noted in this paper, suggests that toxic chemicals are contributing to the waning health of waterways and may adversely impact the health of people living in the Chesapeake Bay watershed.

A USGS report, (*Pesticides in Our Nation's Streams and Ground Water* 1992-2001, Gilliom et al, 2006) found pesticide concentrations above water quality benchmarks in surface and ground water throughout the U.S., including the Chesapeake Bay watershed. A 2007 USGS report (Phillips et al, 2007) found that "synthetic organic pesticides and their degradation products have been widely detected at low levels in the watershed, including emerging contaminants such as pharmaceuticals and hormones."

Another concern is the effect of pesticides as endocrine disruptors triggering reproductive abnormalities. Endocrine disruptors mimic hormones and may be mistaken for hormones by the body, altering the functions of the endocrine system. In spring 2003, scientists found male fish in the Potomac River with immature oocytes in

[1] Abnormal prion proteins can become infectious agents that may be responsible for diseases such as "transmissible spongiform encephalopathies." Prions were recently added to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) as a type of pest.

"The role pesticides may play as endocrine disruptors triggering reproductive abnormalities is an alarming possibility."

their testes (Blazer et al. 2007). Shortly after the discovery of these "intersex" fish, a Mid-Atlantic science forum was held to discuss the effects of possible endocrine-disrupting chemicals, including herbicides, insecticides, and antimicrobials (Chesapeake Research Consortium, 2007).

The specific agents causing intersex fish have not yet been determined with any certainty, but in March 2008, USGS scientists identified several pesticides in the Potomac River that could be responsible; researchers also are considering whether intersex fish are caused by complex mixing of such compounds after they enter the watershed. The suspected chemicals include atrazine, the most commonly used herbicide in the United States (Hayes et al, 2003), which is used in agriculture and on lawns. It is a suspected endocrine disruptor. It already has been linked to sexual abnormalities in frogs (Hayes, et al, 2006), although other studies have produced differing results and research is ongoing. EPA does not currently evaluate or consider the endocrine-disrupting properties of pesticides during registration or re-registration, but in 2009 EPA released a list of 67 pesticides that will be evaluated as potential endocrine disruptors. Some scientists believe that wildlife provide early warnings of endocrine-disrupting effects that may, as yet, be unobserved in humans.

While a growing body of research indicates that a number of pesticides pose a risk to the health of the Chesapeake Bay watershed, agencies working to protect the Chesapeake Bay have more recently become focused almost solely on nutrient load and not on chemical pesticides. While excessive nitrogen and phosphorus runoff from intensive farming practices throughout the Chesapeake watershed pose a substantial threat, these are not the only threats to the health of the Bay.

One of the Chesapeake Bay Program (CBP)'s goals to restore the watershed is to "achieve and maintain the water quality necessary to support the aquatic living resources of the Bay and its tributaries and to protect human health." Reduction of toxic chemicals, including pesticides, is part of the CBP's strategy. However, in recent years, only three to five percent of CBP's resources have been devoted to issues of "toxics."

Usage, Loading and Concentration in the Chesapeake Bay

PESTICIDE USAGE

Data on pesticide usage throughout the Chesapeake watershed are sparse and recent data is not readily available. Estimates for Maryland are based on 2004 and earlier voluntary surveys of certified applicators conducted by the Maryland Department of Agriculture, reported only on a statewide level **(in 2004)**, and do not include home and garden pesticide use or personal care products usage (Maryland Department of Agriculture, US Department of Agriculture, 2002, 2006).

Home and Garden Usage of Pesticides in Chesapeake Region

Data on residential use are largely unavailable, but estimates can be made by scaling from nationwide usage data. Accordingly, at a per-capita loading of 0.42 pounds of pesticides per person per year, the total usage of home, garden and personal care pesticides in the Chesapeake Bay watershed is estimated to be about 6.5 million pounds (Kiely et al, 2004; U.S. Census Bureau, 2000).[2]

Agriculture, Industry, Commercial, Government Pesticide Usage in Maryland

About 11 million pounds and 281 different types of pesticides are estimated to have been used in the agriculture, industry, commercial, and government sectors in Maryland in 2004 (Maryland Department of Agriculture and U.S. Department of Agriculture, 2006). This represents an estimated 18% increase since 1988, although yearly usage rates have fluctuated considerably (Table 1). Table 1 summarizes the estimated usage rates of the top 20 pesticides in Maryland in four sectors: agriculture, industry, commercial and government (Maryland Department of Agriculture and U.S. Department of Agriculture, 2002, 2004 and 2006). Pesticide usage in Maryland has increased for most of these products. Only seven of the top 20 pesticides – namely atrazine, metolachlor, potassium salts of phosphoric acid, 2,4-D, thiophanate-methyl, vinclozolin and dicamba – decreased in usage by relatively modest amounts during that period.

Estimates provided by the Maryland Department of Agriculture (MDA) were based on a sample of voluntary survey responses from farmers (response rate: 56%), private applicators (response rate: 51%), commercially licensed businesses (response rate: 41%), and public agencies (response rate: 70%). It is not clear whether the surveys were distributed randomly; hence the sample may exhibit selection bias. While earlier reports provided county-wide data, the most recent 2004 survey design only enabled collection of State-level statistics, consequently not providing those having regulatory and public health interests with adequate usage data (by watershed) to assess occurrence and impact of pesticides. MDA no longer conducts the triennial voluntary survey due to lack of funding.

[2] 18% of 5 billion lbs annually = 900 million lbs of conventional pesticide usage in U.S.
13% of 900 million lbs annually = 117 million lbs of home and garden pesticide usage in U.S. 117 million lbs/ 281,421,906 (U.S. population in 2000) = 0.42 lbs/person/year
0.42 lbs/person/yr on average x 15,594,241(Chesapeake Bay Watershed Population in 2000)
= 6.5 million lbs of home and garden pesticide usage in the Chesapeake Bay Watershed

Table 1. Estimated Rate of Change in Pesticide Usage Rates in Maryland (1988-2004): Farms, Private Applicators, Commercial Businesses & Public Agencies (Top 20; Total)

			Usage Estimate in Maryland (lbs of Active Ingredient)				
Rank in 2004	Pesticide Common Name	Type*	1988	1994	2000	2004	% Rate of growth (decline) 1988-2004
1	Glyphosate	H	480,000	410,291	950,269	2,821,085	488
2	Chlorothalonil	F	1/*	76,600	115,194	1,529,493	1897
3	Atrazine	H	1,810,000	1,166,064	618,515	1,109,475	-39
4	Fosetyl aluminum	F	195,000	13,355	19,592	980,072	403
5	S-Metolachlor	H	1,170,000	1/	109,566	872,768	-25
6	Mancozeb	F	210,000	17,572	38,107	254,254	21
7	Metolachlor	H	295,000	2,166,308	1,000,654	246,509	-16
8	Chlorpyrifos	I	128,000	240,325	136,670	237,508	86
9	Potassium salts of phos. Acid	F	345,000	1/	1/	201,112	-42
10	2,4-D	H	1/	226,054	225,426	199,141	-12
11	Thiophanate-methyl	F	250,000	6,502	19,939	130,637	-48
12	Imidacloprid	I	46,000	186	131,773	128,707	180
13	Paraquat	H	54,000	175,607	156,131	127,869	137
14	Vinclozolin	F	318,000	40,104	43,706	122,853	-61
15	Dithiopyr	H	1/	1,028	83,224	101,247	9749
16	Mesotrione	H	62,000	1/	1/	85,138	37
17	Diuron	H	1/	29,473	9,875	82,342	179
18	Dicamba	H	172,000	52,007	85,414	79,937	-54
19	Simazine	H	54,000	153,240	301,427	72,883	35
20	Cypermethrin	I	1/	5,637	57,280	63,871	1033
	Total Pesticide Usage		**9,070,325**	**13,881,629**	**17,123,643**	**10,722,796**	**18**

* 1/ = not reported because the product is either a new formulation or used for only 1 or 2 crops
Sources: Maryland Department of Agriculture and U.S. Department of Agriculture. Maryland Pesticide Statistics for 2000. 2002 August, MDA-265-02; Maryland Department of Agriculture and U.S. Department of Agriculture. Maryland Pesticide Statistics for 2004. 2006 September. MDA 14-01-07. Estimates are based on voluntary surveys.
* F=Fungicide; H=Herbicide; I=Insecticide

Impact of Best Management Practices (BMPs) to Reduce Nutrient Load

Some BMPs designed to reduce nutrient loadings also may serve to reduce pesticide runoff. However in some cases, BMPs implemented for nutrient management may increase pesticide use and subsequent runoff. For example, many corn and soybean growers use no-till farming practices, which reduce the amount of nutrients needed, but increase reliance on the herbicide atrazine. Best management practices must introduce methods that address both concerns.

Monitoring Data for Selected Pesticides and their Degradates

The 2007 USGS report on the Chesapeake Bay watershed indicated that pesticides are present year round in streams of the Bay watershed and that changes in pesticide concentration over time generally reflect changes in application rates, as well as physical and chemical properties that determine fate and transport of compounds. The following pesticides and degradation products were found in one or more headwater streams during spring base flow, shallow groundwater in agricultural areas, groundwater used for domestic supply or groundwater used for public supply:

- acetachlor
- acetochlor ESA
- acetochlor OA
- alachlor
- alachlor ESA
- alachlor OA
- atrazine
- bromacil
- carbofuran
- cyanazine
- deethylatrazine
- desiopropylatrazine
- dieldrin
- flumetsulam
- glyphosate
- imazaquin
- imazethapyr
- lindane
- metalachlor
- metolachlor ESA
- metolachlor OA
- pendimethalin
- prometon
- simazine
- tebuthiuron

While usage and loading estimates are needed for identifying potential pesticides of concern, concentrations of pesticides (typically measured in micrograms per liter, mg/L) are the determinant of potential environmental and human health effects. McConnell et al. (2004) reported that water concentrations of herbicides and two triazine degradation products, CIAT and CEAT, were measured in surface water from four sites sampled at regular intervals from April 4 through July 29, 1996 in the Patuxent River estuary, part of the Chesapeake Bay system. Atrazine was most persistent and present in the highest concentrations (maximum = 1.29 µg/L). Metolachlor, CIAT, CEAT and simazine were frequently detected (with maximum concentration values of 0.61, 1.1, 0.76, and 0.49 µg/L, respectively.) In a study of Chesapeake waters in 2004, researchers detected atrazine in 100% of water samples taken at 60 different stations in five Bay tributaries (McConnell et al., 2007). This report detected atrazine, simazine, metolachlor and their degradation products in 21 sample sites throughout the Chesapeake Bay, with the highest herbicide concentrations in the Chester River, located on the Eastern Shore. The highest concentration for any analyte in these studies was for the ethane sulfonic acid of metolachlor (MESA) at 2,900 ng/L in the Nanticoke River. The degradation product MESA also had the greatest concentration of any analyte in the Pocomoke River (2,100 ng/L) and in the Chester River (1,200 ng/L; McConnell et al., 2007).

USGS found that pesticides or their degradation products are frequently found in streams and ground water throughout the United States (Gilliom et al., 2006). During 1993-2000, on average 57% of stream water samples in agricultural areas contained at least one pesticide that exceeded safety thresholds for aquatic life (Gilliom et al., 2006). During this same time period, about 83% of all urban streams sampled had at least one pesticide that exceeded safety thresholds and 42% of mixed-land-use streams exceeded safety thresholds (Gilliom et al., 2006). Degradation products – the natural decomposition products of pesticides – are often found in much higher concentrations than the parent compound and are not regulated because they are not defined as an active ingredient nor are found to any great extent in the applied product. The McConnell et al. (2007) study indicated persistence of metolachlor's degradation product, finding its concentration surpassed that of its parent compound in almost all of the samples.

USGS found that while concentrations of parent compounds in ground water in the Eastern Shore were lower than federal/state drinking water standards, concentrations of pesticide degradation products exceeded those of the parent compounds. Drinking water standards only exist for four of the 29 compounds the team detected (Ator and Denver, 2006). Ator, et al. (1998) found concentrations of organochlorine pesticides in the Potomac River Basin to be among the highest of 19 study areas in the United States. Major field investigations in the remaining National Water Quality Assessment (NAWQA) study units have not been completed.

These researchers also detected five or more pesticide compounds in all 23 surface water samples in a separate study on *Water Quality in the Delmarva Peninsula* (Denver et al., 2004). The Delmarva Peninsula is bordered on the west by the Chesapeake Bay and on the East by the Atlantic Ocean. Herbicides were detected year round in streams throughout the Delmarva Peninsula, although concentrations were highest in the spring during spring applications on cropland (Denver et al., 2004). Authors of these reports found that concentrations of pesticides in their surface water samples rarely exceeded harmful benchmarks for aquatic life, but only 40% of the pesticides they analyzed have such benchmarks. Observed concentrations of agricultural herbicides are believed to exceed thresholds for ecological effect for key components of the Bay ecosystem (e.g., phytoplankton and submerged aquatic vegetation) at least during the spring application period. For example, chronic exposure to low levels of atrazine may reduce the primary production of phytoplankton and its value in the food chain in the Chesapeake Bay (Pennington and Scott, 2001).

Evidence shows that many pesticides which are designed to kill target organisms in terrestrial environments and homes may also be toxic to aquatic life, wildlife and humans. Even at low levels, the toxic effects of pesticides place additional stress on resident microbiota, plants, fish and other wildlife. Also, reduction in the growth of key living resources of the Chesapeake Bay, such as fish and invertebrates, have been observed in the laboratory at concentrations as low as 23 parts per billion. (Reregistration Eligibility Science Chapter for Atrazine, p.57-64. April 2002).[3] The cumulative effect of pesticides and their degradation products may further threaten the living resources of the Chesapeake, the largest and most biologically diverse estuary in the United States.

Table 2. Concentration of Pesticide or its Degradate or Metabolite

		Mean Concentration Reported in Chesapeake Bay Tributaries					
Pesticide Common Name, Degradation Product or Metabolite	Type*	2/97-3/98 Susquehanna (ng/L)	3/92-2/93 Potomac (ng/L)	3/92-2/93 James (ng/L)	2/97-11/97 Patuxent (ng/L)	5/97-11/97 Choptank (ng/L)	Gwynns Run, MD (ng/L)
References:		Liu et al. 2002	Foster, Lippa 1996	Foster, Lippa 1996	Lehotay et al. 1998	Lehotay et al. 1998	Halden,Paull 2004, 2005
Alachlor	H	9	12	10			
Atrazine	H	67	160	61	47	245	
Metolachlor	H	39	96	31	9	20	
Simazine	H	37	62	50	18	121	
Cyanazine	H	25	160	61	47	245	
Diazinon	I	6	10	7	3.3		
A-HCH	I	0.1					
y-HCH	I	0.3			0.45	0.3	
P,p'-DDE	I	2			1.6		
Triclocarban	PCP						33 – 5,600 6750**
Triclosan	PCP						1600**

* H=Herbicide; I=Insecticide; PCP= Personal Care Products ** Baltimore City streams impacted by raw sewage

Sources: Liu B, McConnell LL, Torrents A. Herbicide and insecticide loadings from the Susquehanna River to the northern Chesapeake Bay. J Agric Food Chem. 2002 Jul 17;50(15):4385-92. Foster GD, Lippa KA. Fluvial Loadings of Selected Organonitrogen and Organophosphorus Pesticides to Chesapeake Bay. J. Agric. Food Chem.,1996 44 (8), 2447 -2454. Lehotay SJ, Harman-Fetcho JA, McConnell LL. Agricultural pesticide residues in oysters and water from two Chesapeake bay tributaries Mar. Pollut. Bull. 1998, 37, 32-44. Halden R.U., Paull D.H. Analysis of Triclocarban in Aquatic Samples by Liquid Chromatography Electrospray Ionization Mass Spectrometry, Environmental Science & Technology. 2004 38(18):4849-55. 28. Halden, R.U. and D. H. Paull. 2005. Co-Occurrence of Triclocarban and Triclosan in U.S. Water Resources. Environ. Sci. Technol. 39(6):1420-1426.

[3] http://www.thecre.com/pdf/exhibit-a-efed_redchap_22apr02.pdf

"...Chesapeake Bay is the most biologically diverse estuary in the United States."

USDA also studies the environmental fate of pesticides in the Chesapeake Bay. Table 2 above summarizes the mean concentration reported in five Chesapeake Bay tributaries for four herbicides and four insecticides as well as the estimated concentration for two antimicrobial compounds in Gwynns Run in Maryland. Among other findings, researchers discovered much higher concentrations of atrazine, metolachlor, simazine and cyanazine in the Potomac River than in the Susquehanna River (Liu, McConnell and Torrents, 2002). Simazine and cyanazine were also found in greater concentrations in the Potomac, James, and Choptank Rivers. Atrazine was found in much higher concentrations in the Potomac (160 ng/L) and the Choptank (245 ng/L), than in the Susquehanna River (67 ng/L).

Banned DDT and Chlordane Still Occur in Chesapeake's Streambed Sediment

Although use of DDT was banned in the U.S. in 1972, USGS researchers still detected this persistent organic pollutant in 1998 in most streambed sediment sites in the Potomac basin (Ator et al., 1998). Chlordane, which was banned in 1988, was found in 13 of 26 sites monitored. At four of these locations, pesticide (or chlordane) concentrations were found to exceed benchmark(s) for aquatic life (Ator et al., 1998). In addition to this information, toxic contaminants data are also available on the Chesapeake Bay Program's (CBP) website, which draws on information from the USGS, NOAA, and USDA.

Ecological and Human Health Risks

Assessing the risks of pesticides in terms of aquatic life, wildlife, and human health is immensely difficult because of vast data gaps due to deficiency in research, as well as a lack of regulations and standards for pesticide concentrations in water. The USGS summary of compound detections in the Potomac River Basin lists 28 herbicides and 14 insecticides that were detected in ground and surface waters (Ator, 2008). By examining the existing federal standards and benchmarks used to protect aquatic life, wildlife, and human health for these compounds, it is apparent that some of these pesticides exceeded existing criteria for aquatic life, fish-eating wildlife, or humans – including alachlor, atrazine, metolachlor, cyanazine and diazinon (Ator, 2008; US Environmental Protection Agency, 2003b). It is also apparent that standards are lacking for many of the pesticides detected in this study (EPA, 2003).

Table 3 lists nine of the pesticides found in the Potomac River Basin (Ator, 2008). The EPA's list of contaminants and their standard maximum contaminant limits (MCL) was used to show that pesticide contaminations present in the Chesapeake Bay watershed in the Potomac have reached or exceeded levels that are harmful to drinking water (Ator, 2008; US Environmental Protection Agency, 2003b). Table 3 also shows the lack of standards for several of the pesticides found during the USGS study.

Table 3. Existing national primary drinking water standards and adverse effects on humans for risk and action prioritization

Pesticide	MCL[1] (mg/L)	MCL Goal[2] (mg/L)	Standards for drinking water exceeded?	Potential health effects from ingestion of water
Reference:	US Environmental Protection Agency 2003a	US Environmental Protection Agency 2003a	Ator 2008, Gilliom et al. 2006[3]	US Environmental Protection Agency 2003a?
Alachlor	0.002	0.000	Yes	Eye, liver, kidney or spleen problems; anemia; increased risk of cancer
Atrazine	0.003	0.003	Yes	Cardiovascular system or reproductive problems
Simazine	0.004	0.004		Problems with blood
Metolachlor	No EPA standard	No EPA standard	Yes	
Cyanazine	No EPA standard	No EPA standard	Yes	
Diazinon	No EPA standard	No EPA standard	Yes	
A-HCH	No EPA standard	No EPA standard		
y-HCH	No EPA standard	No EPA standard		
p,p'-DDE	No EPA standard	No EPA standard		

[1] Maximum Contaminant Level (MCL) - The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards (US Environmental Protection Agency 2003a).

[2] Maximum Contaminant Level Goal (MCLG) - The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals (US Environmental Protection Agency 2003a).

[3] Selected water-quality standards and guidelines (Gilliom et al, 2006)

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Gilliom et al., (USGS National Water Quality Assessment Program, 2006), in a study, Pesticides in the Nation's Streams and Ground Water, 1992 – 2001, documented levels at which adverse effects of several of these pesticides have been observed. Atrazine was found to have adverse effects at 17.5 μg/L (0.0175 mg/L), diazinon at 0.1 μg/L (0. 0001 mg/L), and p,p'-DDE at 0.001 μg/L (10-6 mg/L). Alachlor had adverse effects on non-vascular plants at 1.64 μg/L (0.000164 mg/L). Another study done by Halden and Paull (2005) looked at the water in three tributaries to the Patapsco River - Gwynns Run, Gwynns Falls and Jones Falls. This study found that triclocarbon exceeded the standards for drinking water in this location, and had adverse effects at 240 μg/L (0.24 mg/L). Study results suggest that the magnitude and frequency of triclorcarbon contamination (regional, 6750 ng/L, 68%)) were markedly higher than non-peer reviewed numbers (240 ng/L, 30%, U.S.) currently used by EPA for evaluating triclorcarbon's ecological and human health risks.

The lack of water quality standards for most pesticides found in the Chesapeake reveals a regulatory deficiency. Only a small percentage of all pesticides have benchmarks associated with their use. Degradation products often exceed concentrations of their parent compounds but resulting ecological or human health risks are difficult to assess in this vacuum of knowledge gaps and lacking regulations.

Another concern is that only a fraction of all pesticides currently in use and few of their degradation products are assessed by the USGS National Water Quality Assessment (NAWQA) Program, which provides an assessment of water-quality conditions throughout the nation (USGS, 2006) (see Section VII below). In this report, only 75 pesticides and eight degradation products were analyzed nationally, whereas in the state of Maryland, 281 types of pesticides are used – not including those used in homes and gardens (MDA, 2006). While USGS studied the use of 80% of the most heavily used herbicides, only 64% of the most heavily used insecticides, and very few fungicides, fumigants or other types of pesticides were monitored.

EFFECTS OF PESTICIDES ON AQUATIC LIFE AND WILDLIFE

Home to more than 3,600 species of plants, fish and animals, Chesapeake Bay is the most biologically diverse estuary in the United States (Chesapeake Bay Program, 2003). Pesticides may adversely impact the Bay's most important aquatic species and major sources of income such as blue crabs and oysters.

Pesticides in Fish

Pesticides that occur in streambed sediment can make their way up the food chain and bio-accumulate in edible fish increasing human exposure risk. Although there are few documented cases of pesticide lethality to aquatic organisms in large estuaries, chronic effects and bioaccumulation have been detected. A few examples:

- Chlordane and DDT were found in samples of the Asiatic clam, *Corbicula fluminea* and in fish tissues obtained in 1992 and 1996 from the Potomac River Basin (Zappia, 1996) (Field Study).
- Studies on atrazine have documented potential adverse effects to fish at exposure levels below those predicted by EPA and recorded through monitoring (Saglio and Trijasse, 1998). Documented effects include renal system damage (Fischer-Scherl et al., 1991; Oulmi et al., 1995); also disruption to endocrine and olfactory systems affecting behavioral functions related to survival and reproduction (Moore and Waring, 1998; Moore and Lower, 2001).
- Microbial communities can be altered by exposure to Roundup (Perez et al, 2007) or atrazine (Thom et al, 2003). Roundup affected the structure of phytoplankton and periphyton communities. Total micro- and nanophytoplankton decreased in abundance, while the abundance of picocyanobacteria increased by a factor of about 40. Primary production also increased in treated mesocosms (roughly by a factor of two). Observed changes in the structure of microbial communities are consistent with a direct toxicological effect of glyphosate.
- Increased sensitivity of phytoplankton to atrazine occurred after long-term exposure to low levels (Pennington and Scott, 2001) (lab study).
- Fiprinol negatively impacted populations of grass shrimp (40% survival at 355 ng/L and 0% survival at 5000 ng/L) but not juvenile clams or fish (Wirth et al, 2004) (lab study).

POSSIBLE PUBLIC HEALTH EFFECTS OF EXPOSURE TO PESTICIDES IN WATER

Long-term, chronic exposure to low-level concentrations of pesticides may be a chronic-disease health risk for residents of the Chesapeake Bay watershed. A growing body of epidemiological research suggests an association between pesticide exposures and chronic diseases such as certain cancers, as well as reproductive, neurological, respiratory and developmental disorders. Many pesticides have not been studied for their carcinogenic or other toxic effects (US Environmental Protection Agency, 2007), and health care providers often overlook or misdiagnose health problems caused by pesticide exposure. (Goldman and Links, 2004).

Acute and Chronic Health Effects of Pesticide Exposure

Pesticides may cause a wide range of acute and chronic illnesses. Low-dose, short- and long-term exposures to pesticides have been linked to cancers, reproductive dysfunction, developmental disabilities, immune system disorders, asthma and other respiratory diseases, and neurological and behavioral disorders.

Exposure to glyphosate can more than double one's risk of developing non-Hodgkin lymphoma (Eriksson et. al, *International Journal of Cancer,* 2008) . Some pesticides on the market today are known to be highly toxic, particularly for pregnant women, children, seniors, and those with compromised immune systems. A study published in the *Journal of the National Cancer Institute* found that household and garden pesticide use can increase the risk of childhood leukemia as much as seven-fold (Lowengart et al. 1987). Studies show that children living in households where pesticides are used suffer elevated rates of leukemia, brain cancer and soft-tissue sarcoma (Leiss, J., et al. 1995; Gold, E. et al. 1979; Lowengart, P., et al. 1995; Reeves, J. 1982; Davis, J., et al. 1993; Buckley, J., et al. 1994).

EPA has classified nearly 100 pesticides in use today as probable or likely carcinogens, and nearly 90 pesticides as possible carcinogens. Pesticides are one of the many potential causes for cancer. In 2006, Maryland was ranked out of the 50 states as the 17th highest in both cancer incidence and mortality (Lee, 2007).

In 1990, 24 of 51 pesticides demonstrated carcinogenicity in chronic bioassays after being evaluated by the U.S. National Cancer Institute and the U.S. National Toxicology program (Zahm, Hoar and Ward, 1998). Some pesticides may cause or promote cancer through: a) genotoxic effects that change DNA; b) promotion, causing proliferation of abnormal cell clones; c) hormone disruption; and d) immunotoxic effects that may interfere with the body's normal cancer surveillance mechanisms. Low doses of a genotoxic chemical can initiate the conversion of a normal cell into a malignant one.

Duke University School of Medicine researchers linked pesticides to the epidemics of obesity and type 2 diabetes. (T. Lassiter, et. al, *Environmental Health Perspectives,* 2008). Researchers at the University of California Los Angeles, found chronic exposure to commonly used fungicides contribute to Parkinson's disease development (Chou et. al; J. Biol. Chem, 2008). Pesticide exposure can increase the risks for developing Parkinson's disease by 70% (Ascherio et. al; Ann Neurol. 2006). Toxic chemicals are key drivers in Alzheimer's and Parkinson's diseases, according to the report, *Environmental Threats to Healthy Aging.* (Stein et. al; Greater Boston Physicians for Social Responsibility & Science and Environmental Health Network, 2008).

There is also growing evidence that pesticides are linked to autism. A recent study found that children born to mothers living within 500 meters of pesticide-treated fields are six times more likely to develop autism spectrum disorders (Roberts et. al; *Environmental Health Perspectives,* 2007).

Another study found that low-dose exposures to the herbicides aldicarb and atrazine in well water, along with nitrate used as fertilizer, may cause adverse effects on behavior and on the immune and endocrine systems (Porter, et. al , 1999). Another study found that a common lawn herbicide mixture, 2,4-D, Mecoprop and Dicamba can induce abortions and resorption of fetuses in mice at levels well below those considered safe by EPA (Cavieres et. al.,2002). Moreover the greatest effects were at the lowest ppb doses.

Furthermore, some people may have genetic or developmental susceptibilities to certain pesticides or combinations of chemicals. Fetuses, infants, and children are particularly vulnerable to pesticide exposure; their organs are still developing and they eat and breathe more compared to adults (on a per-body-weight basis).

Endocrine Disruptors

Pesticides can affect the endocrine – or hormonal – systems of fish, birds, other wildlife and humans. Hormones act as chemical messengers directing long-term changes

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such as growth and development. Some pesticides may disrupt this system and interfere with normal development. Even at low-dose exposures, certain pesticides act as "environmental estrogens" and endocrine disruptors (Hayes et al., 2006). Endocrine disruptors function by mimicking the action of a naturally-produced hormone such as estrogen or testosterone, thereby setting off similar reactions in the body. They can additionally block the receptors in cells receiving the hormones thereby preventing the action of normal hormones and can also affect the synthesis, transport, metabolism and excretion of hormones, thereby altering the concentrations of natural hormones.

Potential Higher Risk

* *Bioaccumulation*
  When pesticides bioaccumulate in edible fish, there is an increased exposure risk for individuals who consume contaminated fish, especially mothers who may pass the pesticides on to their offspring through the placenta or breast milk. Mothers may also pass pesticides to their offspring (Wu et al., 2001)
* *People who use small private wells have increased risks*
  The majority of metropolitan area residents obtain water for drinking, bathing, etc., from surface water sources, while those living in small or rural areas often rely on groundwater from private wells (US Environmental Protection Agency, 2006b). Federal laws that require testing for water-borne contaminants do not apply to private water systems that serve fewer than 25 people. While pesticides have been found to occur less frequently in groundwater than in surface water (Ator and Denver, 2006; US Geological Survey, 2006; Ator et al., 1998), rural populations relying on well water may still be at risk.

About 15% of the U.S. population receives its drinking water from private wells that are not subject to national standards and are not regulated by EPA (U.S. Environmental Protection Agency, 2006b). It would be too costly for the average household to use a state-certified laboratory to test its well water for a large number of pesticides, metals and other contaminants. Such a household would need to test several times per year to avoid missing seasonal hot spots for pesticide use.

THE RISK ASSESSMENT PROCESS AND ITS LIMITATIONS

As part of the pesticide registration process, EPA conducts a risk assessment. That process does not measure aggregate and cumulative exposures to the thousands of pesticides and other toxic chemicals that are in common use. As many pesticides are detected at concentrations of < 1 microgram/liter, they may not appear to cause significant risks in isolation (a single exposure to a single product). Yet multiple compounds are often detected in a single water sample (Ator et al., 1998; Denver et al., 2004), raising concern that true ecological and human health risks are seriously underestimated. Furthermore, there are many exposure pathways (respiration of indoor or outdoor air sprayed with pesticides, ingestion of foods with pesticide residues, skin exposure to insect repellents or chlorine, etc.). In addition to the above problems with risk assessment, people may be exposed to other types of chemicals besides pesticides, and research regarding the synergistic effects of multiple chemical exposures is limited.

EPA's risk assessment is only for pure 'active' ingredients, and not for the end product sold to consumers containing solvents and surfactants that are not assessed in combination with the 'active' ingredients and contaminants of production. While there is a provision that allows the agency to ask for such testing if the agency has reason to believe that the end product may be more toxic than the active ingredient, in practice, that rarely happens. For example, 2,4-D contains forms of 'small' dioxins not monitored by the EPA. These dioxins are a consequence of the synthesis process of 2,4-D production (Sears et al, 2006).

Many new pesticides are thought to be less persistent in the environment, but most have not been completely assessed for risk, because of insufficient toxicological data. In addition, important recent research has identified that the "dose does not necessarily make the poison." For example, one study found harmful effects of pesticide mixtures on frogs, even though the levels of the individual pesticides were 10 to 100 times below EPA standards (and therefore considered harmless) (Hayes et al., 2006). Similar research has demonstrated that exposure to doses of atrazine as small as 0.1 parts per billion – a level permitted in drinking water by EPA – turns tadpoles into hermaphrodites, which have both male and female sexual characteristics (Hayes et al., 2002a).

However, other studies have produced differing results, and more research is ongoing. It is interesting to note that although these are different species with different routes of exposure, nonetheless this is the level of exposure permitted by EPA. Other research by Dr. Warren Porter at the University of Wisconsin has shown that very low

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levels of pesticide exposure can disrupt an endocrine system – specifically thyroid hormone levels in mice. Thyroid hormone controls brain development, bone development, sexual development, interacts with the immune system to alter immune function and recently has been shown to interact with a key very early developmental hormone that determines whether or not adrenal glands and gonads will develop. In addition, it has been found that atrazine upregulates aromatase (Sanderson et al., 2000), which alters the ratio of testosterone to estrogen in organisms, thereby inducing feminization of males not only in the gonads but possibly in the brain, where sexual behavior is controlled. Other research from Dr. Paul Winchester, neonatologist at St. Francis Hospital in Indianapolis, Indiana, suggests the important impact on early human fetal development of the presence of atrazine in surface and ground waters. Concentrations found during springtime when compared against month of conception suggest impacts on human learning abilities both in quantitative math skills and language skills (Winchester et al., 2007).[4]

[4] http://medicine.indiana.edu/news_releases/viewRelease.php4?art=686&print=true

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"Understanding Water-Borne Pesticide Risks and Solutions

SOURCES OF PESTICIDES IN WATER

The major categories of pesticide users include: 1) agriculture; 2) commercial, including golf courses and landscaping; 3) government; and 4) residential for home and garden.

Agriculture

Our traditional reliance and growing dependency on pesticides are the root cause of pesticides occurring in our waterways and the Bay. In large part, this is due to agricultural practices used to support a rising population. The undesirable side effects of modern agriculture may threaten the lands and the very livelihood that farmers are trying to sustain. For example, monoculture, i.e., the large-scale and long-term cultivation of a single crop on agricultural land, is seen as a more efficient way to grow food. However, this common practice makes crops more susceptible to damaging pests and requires extensive use of both pesticides and fertilizers.

Sustainable agriculture necessitates farmers reaching the goal of producing adequate yields and good profits following production practices that minimize any negative short-and long-term side effects on the environment and the well-being of the community. The major goals of this approach are thus to develop economically viable agro-ecosystems and to enhance the quality of the environment, so that farmlands will remain productive indefinitely.

Commercial

While the pest control and lawn care industries increasingly have been moving toward embracing IPM, conventional pest and land care management continues to rely, for the most part, on pesticides as a first line of defense.

Government

State agency use of pesticides in rights of way, for forest management and for mosquito control, for example, add to the potential pesticide load in the watershed. In addition, a variety of federal and state agencies use herbicides on public lands to control invasive species.

Residential

Public perception of what is aesthetically acceptable in foods, lawns and gardens is another major factor in pesticide use; Americans have grown accustomed to large, weed-free lawns that are maintained using a variety of chemical pesticides and fertilizers. Consumers falsely believe that antibacterial soaps and other personal care products containing persistent chemical compounds, including registered pesticides, are necessary for protecting family health. The public has become accustomed to produce that is free of blemishes – an outcome requiring pesticides. (Pollan, 2006).

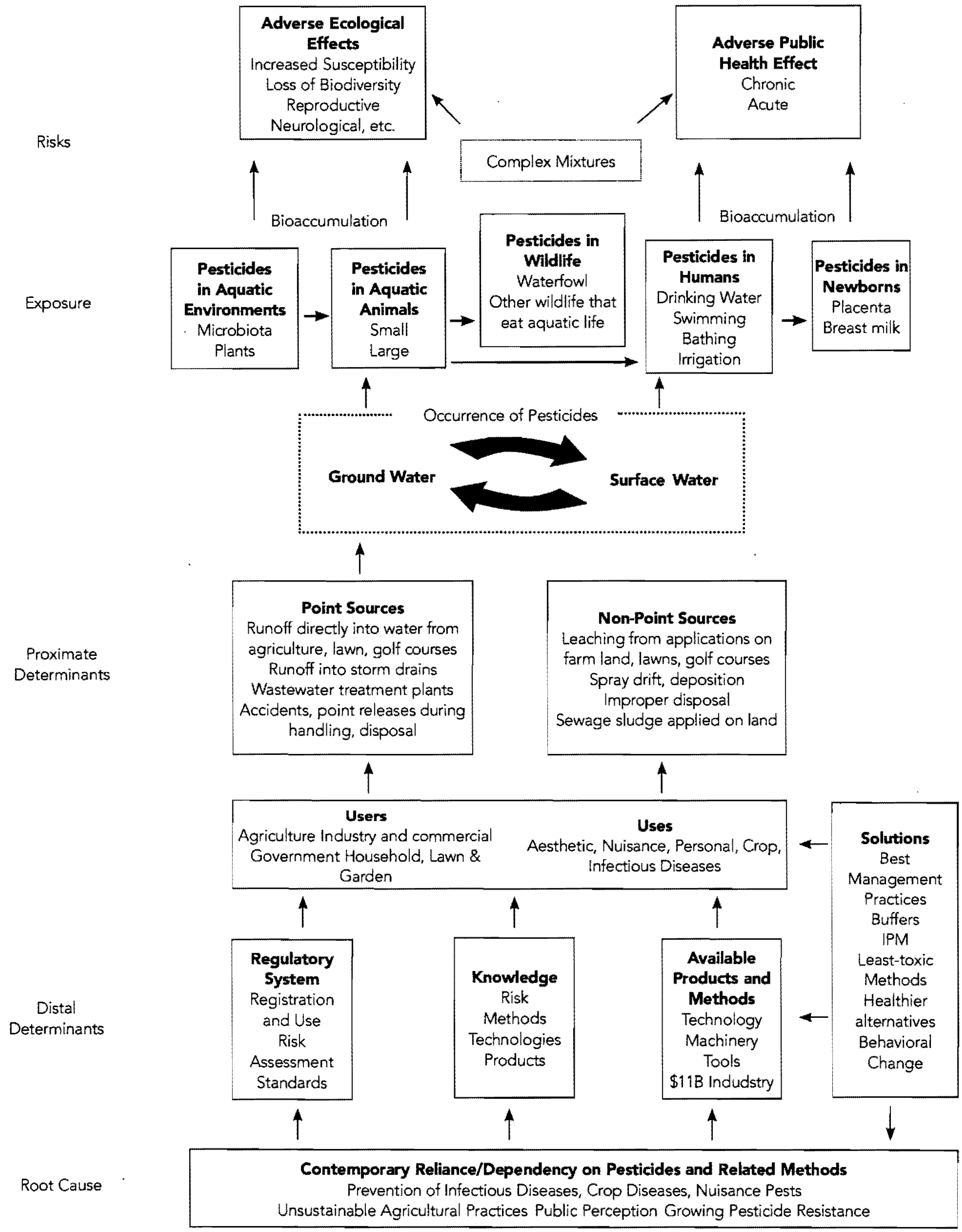
Indirect Sources of Pesticides in Water

As illustrated in Figure 1 (next page), the first major determinant of pesticide occurrence in water is the regulatory system governing the use and registration of pesticides. At least a dozen national and local laws and policies affect the use and monitoring of pesticides. Registration of pesticides is based upon weighing certain ecological and human health risks against the benefit of the chemical to users. A second important underlying determinant is that most consumers lack knowledge about the risks of exposure to pesticides, and about the existence of effective and healthier alternatives – including organic practices and products, Integrated Pest Management methods and least-toxic products. A third determinant is the available products, tools, machinery, technology and methodologies for applying traditional pesticides, many of which were developed without regard to sustainability and external societal costs resulting from pollution.

How Pesticides Enter Ground and Surface Water

Figure 1 summarizes a number of proximal causes for the occurrence of pesticides in water. Pesticides used for agriculture, lawns and even those in common antibacterial

Figure 1. Framework illustrating pathways and risks of pesticide exposures through water as well as important sources and opportunities for intervention.



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soaps may end up in streams and groundwater (Ator et al. 2006, USGS, 2006; Halden and Paull, 2005). A variety of factors can influence how they enter a water source. While some pesticides can enter water directly through point sources such as storm drains or sewage pipes, the majority enter indirectly through nonpoint sources. Fissures, cracks and holes in the ground, as well as infiltration, can provide a conduit for pesticides to reach the underlying groundwater (Gustafson, p. 194, 1993).

Common Point Sources of Pesticides in Water

- Runoff from lawns, gardens and or golf courses
  - * May also enter storm drains discharging into surface waters (NOAA, 2005).
- Accidents, improper handling and disposal
  - * Spills or careless use of pesticides, such as over spraying drainage ditches or water courses, or careless disposal of empty containers or leftover pesticides.

Common Nonpoint Sources of Pesticides in Water

- Storm events
  - * Even proper use, handling and disposal may lead to runoff or sewage overflows into surface waters due to heavy storms.
- Land-based applications for agriculture, lawn care and on golf courses.
- Runoff from treated agricultural fields, especially during storms; even proper use and handling may lead to runoff into surface waters.
- Spray Drift
  - * Occurs when pesticides are sprayed over an area by trucks or airplanes (e.g., for agricultural purposes, large lawns or mosquito control) and wind blows this spray into an adjacent body of water (NOAA, 2005).
- Atmospheric Deposition
  - * Occurs in the form of rainfall or dry deposition as airborne particles settle onto land or bodies of water.
- Proper or Improper disposal of pesticides.
  - * Even proper use and handling may lead to runoff into surface waters.
- Sewage sludge from wastewater treatment plants.
  - * Disinfectants such as triclosan occur in sewage sludge, and these biosolids may later be applied to agricultural land (Kinney et al., 2006)
- Direct discharge from treated wastewater effluent.

Pesticide Properties that Affect Movement into Water

The persistence and mobility of a pesticide is a key determinant of its potential for reaching surface and groundwater via, e.g., soil runoff and chemical leaching (Gustafson, 1993). Water-soluble pesticides may readily migrate in water, whereas hydrophobic ones tend to become attached to organic material or sediment particles, and may therefore be transported along with such suspended material in streams. Also, such suspended transport is mainly limited to surface water conditions; groundwater loads are nearly always dissolved. This mechanism is important for chemical migration in both surface and groundwater and may help explain the detection in drinking water of compounds with low water solubility. For example, the herbicide atrazine has low water solubility (33 mg/L) (Gustafson, 1993), yet its degradation products are among the most commonly found pesticides in surface and ground waters of the Chesapeake (Ator et al., 1998; Ator and Denver, 2006; Denver et al., 2004; and Liu et al., 2002). Atrazine occurs widely in dissolved form in stream and ground water. Also, selected degradation products are soluble and move in dissolved form in both streams and ground water.

Pesticides enter ground water through soil and can flow to and from surface water

Studies indicate that pesticides applied on cropland may contaminate the underlying groundwater and later can enter surface waters through natural outflows (Winter et al., 1998). Conversely, contaminants from surface waters can enter groundwater. Soil type and usage also affect mobility. Agriculture accounts for about 80% of pesticide use in the United States (Ator et al. 1998, US Geological Survey, 2005). However, pesticide use on golf courses and lawns is also a pathway for groundwater contamination.

ENVIRONMENTAL AND HEALTH RISKS FROM EXPOSURE TO PESTICIDES IN THE CHESAPEAKE

Water-borne pesticides pose health risks to aquatic life, wildlife and humans. The diagram shown in Figure 1 illustrates potential receptors for pesticide exposure. It also may be used to identify potential problems and solutions, as discussed further in subsequent sections.

As indicated earlier in this White Paper, pesticide concentrations have been observed to exceed national water-quality benchmarks for aquatic life. These toxic chemicals that contaminate Chesapeake waterways may harm the environment and endanger human health. Human health effects, including low birth weights (Munger et al., 1997),

"Natural control factors regulate pest populations and are maximized in Organic farming and IPM as the primary means of management; if this strategy fails to maintain pests below economic levels, in IPM, then pesticides in combination with other tactics are used as a last resort."

– UMD Extension Services

breast cancer (Kettles et. al, 1997), low sperm counts (Adams, 2003) and immune dysfunction (Fiore et al, 1986) are linked to herbicide-contaminated water. As pesticides enter water systems, plants and other aquatic life such as blue crabs and oysters, or fish and their related food chains may also be affected (see Section VI. A.).

HOW TO REDUCE PESTICIDE IMPACTS ON WATER

We can reduce pesticide runoff by using certain technologies, buffers and other best management practices. We can reduce and even eliminate many common uses of pesticides outlined in Figure 1 (Framework Illustrating Pathways and Risks Pesticide Exposures Through Water as well as Important Sources and Opportunities for Intervention) by transitioning to Integrated Pest Management, a method of pest management based on preventive, non-chemical strategies and least-toxic products as a last resort. Organic farming and landcare utilize practices that do not rely on pesticides. Interventions are most effective when they address root causes. Potential solutions and initial recommendations are discussed in Sections VIII and IX.

LAWS AND POLICIES AFFECTING THE CHESAPEAKE BAY WATERSHED

Laws and policies that affect the health of the Bay and its watershed cross several subject areas, principally water quality, food safety, and toxics reduction. The principal legal and policy tools for promoting Bay health include the Clean Water Act, the Safe Drinking Water Act, the Federal Insecticide, Fungicide, and Rodenticide Act, and the Food Quality Protection Act. These federal laws and programs are supplemented by state and regional laws, policies, and delegations of authority. For example, the groundbreaking Maryland Integrated Pest Management in Schools law, enacted in 1998, established pesticides as a public health issue in Maryland, and created a model for balanced, sustainable pest management for the nation. A description of these tools and how they can affect Bay outcomes is included in the Appendix.

Solutions: Preventing Pesticide Pollution

"When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."

– Wingspread Statement on the Precautionary Principle, January 1998

The Precautionary Principle is gaining in popularity in the United States. After World War II, heavy organopesticide use became the industry norm for preventing crop disease and destruction, meeting the growing demand for food, and preventing illnesses and infectious diseases. Pesticides are also now relied upon to achieve aesthetic goals in lawn care and are incorporated into other products – e.g., personal care products – such as hand soaps and sunscreen lotions, cosmetics and cleaning products. Over time, increasing resistance to pesticides has led to an increase in the number of pesticide formulations and their potency. To restore the health of Chesapeake Bay, we need to replace this ongoing race between increasing pest resistance and reformulation of new pesticides with a more comprehensive strategy for dealing with various "pests" and limiting pesticide occurrence and impact.

AGRICULTURE: VEGETATED BUFFER ZONES AND INTEGRATED PEST MANAGEMENT

Vegetated buffer zones that prevent nutrients from entering surface waters can also prevent pesticide runoff (Norris, 1993). A recent bill was passed in Pennsylvania to provide economic incentives for farmers to create these buffer zones around the perimeters of their farms.

Federal and state agencies, agricultural extension services, NGO's, and other watershed and/or agricultural stakeholders should work to educate farmers and provide incentives – including financial incentives – to enable implementation of best management practices (BMPs) that prevent pesticides from entering nearby waterways (buffer zones, etc.) as well as BMPs for transition to sustainable agriculture.

The use of Integrated Pest Management (IPM) strategies that focus on non-chemical prevention, monitoring, and least-toxic methods for pest control should also be promoted by state and federal agencies and private sector organizations and business associations. Financial incentives (e.g., NRCS - the Natural Resources Conservation Service's Environmental Quality Incentives Program (EQUIP), which reward farmers who implement pest management techniques that go beyond the minimum requirements of the NRCS Pest Management standard-Code 595), are critical to such transition. Farmers will need assistance transitioning to these new methods. A collaborative effort is needed to fully understand this complex issue and develop effective solutions and transition strategies. Farmers successfully using IPM as well as organic farmers can also help educate conventional farmers on how to transition to practices that reduce or even eliminate pesticide use and provide evidence of cost savings.

COMMERCIAL AND HOME LAWN AND GARDEN PESTICIDE USE

While examples abound of healthy green lawns and landscapes grown relying on non-chemical methods, public perception remains that a weedless green lawn requires chemical fertilizers and pesticides. When the goal is not met quickly, there often are additional applications or fertilizers and pesticides. However, increasing numbers of lawn care companies now offer natural or organic program

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"While examples abound of healthy green lawns and landscapes grown relying on non-chemical methods, public perception remains that a weedless green lawn requires chemical fertilizers and pesticides."

options to customers. In addition, pesticide manufacturers are increasing their production and sales of non-chemical products .

Organic land care is a problem-solving strategy that prioritizes a natural, organic approach to turf grass and landscape management without the use of pesticides. It focuses primarily on soil health as the key preventative measure against turf and landscape pests. Other key practices include selection of appropriate grasses and other plants, aeration of compacted soil, timely thatch removal, proper mowing, correct watering, and organic fertilizing methods.

The use of various media sources, publications, and awareness programs, such as city, county and state-sponsored IPM demonstration projects, can help change perceptions and foster use of healthier alternatives, such as IPM and organic land care.

Collaboration among various stakeholders (e.g., federal and state agencies, extension services, waterkeepers, associations such as the Northeast IPM Center; non-profit organizations such as the Maryland Pesticide Network, Clean Water Action, the Chesapeake Bay Foundation and Beyond Pesticides; and businesses, including pest management and lawn care companies that practice IPM and natural and/or organic land care) is critical to bringing about fundamental change.

COMMERCIAL AND HOME PESTICIDE USE

A campaign must also educate the public about safer alternatives for cleaning products, cosmetics and other household products that include pesticides. Major retailers from Whole Foods to Wal-Mart sell alternative products that do not include pesticides, and major companies such as Clorox are introducing lines of "natural" products as alternatives to their chemical products. These trends should be encouraged by consumer education.

Antimicrobial Products

Thousands of products marketed for protection against germs contain pesticides; many people have the false impression that washing with antibacterial soaps is necessary for preventing illness. For example, antimicrobial hand soaps often contain the pesticides triclosan or triclorcarban. However, antimicrobial soaps only kill some bacteria and do not prevent illnesses caused by viruses, the most common causes of infectious diseases. Hand washing with any type of soap before eating and after using bathrooms is an effective method of preventing infectious illnesses (Centers for Disease Control and Prevention, 2007).

INSECT-BORNE DISEASES

A sustainable mosquito management strategy should emphasize education, prevention (source reduction and larval control) and monitoring for both mosquito-borne and pesticide-related illnesses. This strategy will ensure that the use of pesticides does not add to health problems associated with insect-borne diseases. Successful control of mosquito populations requires that local governments and community leaders educate residents and business owners on how to reduce breeding habitats and mosquito bites.

While larvicides are considered less toxic than the common pesticides sprayed to reduce adult mosquito populations, they too can present health impacts. However, it may be necessary to use larvicides, which kill mosquito larvae, where it is not possible to eliminate breeding sites, especially when dealing with mosquito-borne diseases. Several municipalities have supplemented tight budgets and/or small staff sizes by enlisting volunteers at critical times to help apply larvicides.

FOREST PEST MANAGEMENT

The blue crab populations of Maryland and neighboring states have diminished to the point of serious economic impact on the watermen in those states. As noted in a September 24, 2008 article in the Washington Post ["Blue Crab 'Fishery Failure' Declared"], "The crabs' numbers have fallen by more than 70% since the 1990s" and "the value of the bay's crab harvest, including hard- and soft-shell crabs, had declined 41% since the late 1990s." Dimilin/diflubenzuron used for gypsy moth eradication

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"The blue crab populations of Maryland and neighboring states have diminished to the point of serious economic impact on the watermen in those states."

in Maryland is known to be toxic to aquatic invertebrates and may also account for the blue crab's declining population by disrupting their molting process (A. Walker and M. Horst, 1992) (lab study). In addition, a 1996 lab study found that dimilin is toxic to juvenile blue crabs, but said data were not yet conclusive as to whether dimilin in the watershed environment retains its toxicity to blue crabs, and further research is needed (Rebach and French, 1996).

EPA classifies Dimilin as "moderately toxic" to humans. Two breakdown products of diflubenzuron are classified as probable carcinogenics according to EPA, p-chloroaniline (PCA) and p-chlorophenylurea (CPU). CPU is the major degradation product found in water and therefore could be widely distributed in certain waterways following aerial application of dimilin. Because of dimilin's toxicity to crab, shrimp, and other aquatic invertebrates, it is a restricted pesticide and the label warns of hazards to aquatic invertebrates. The state would benefit from investigating the work of other states that have suspended the use of chemical means for suppressing forest pest infestations, such as gypsy moth. Rhode Island, for example, no longer uses pesticides for gypsy moth eradication.

RESEARCH NEEDED

Consensus among participants in the *Pesticides and the Chesapeake Bay Watershed Project* is that while the growing body of research underscores the threat of pesticides and degradate products throughout the watershed, there is a need to further define the occurrence of these threats and their potential impact on aquatic life, wildlife and human health. This includes aggregate and cumulative impacts as well as the interaction/impact and synergistic effects of pesticides and non-pesticide stressors.

The current thresholds for estimating effects of pesticides on living organisms are established on a compound-by-compound basis, rather than on the basis of multiple stressors (i.e., pesticides, other contaminants and even natural stressors) that can have a combined negative impact. While scientists are aware of the need to assess the impact of multiple stressors, to date there is little published data on such effects. The Project's *Research and Data Gaps Working Group* reported that watershed research has generally focused on individual stressors, and also tends to use effects thresholds such as 50% reduction in SAV photosynthesis as toxicity end points. Such thresholds are not sufficiently protective of this Bay living resource and are not supportive of Bay restoration goals. EPA's 2002 *Reregistration Eligibility Science Chapter for Atrazine Environmental Fate and Effects* concluded "Atrazine could be contributing to reductions in submerged aquatic vegetation and primary productivity at certain sites in the Bay" (U.S. Environmental Protection Agency, p.59). Underwater vegetation in the Bay watershed is subjected to multiple stressors such as reduced light, nutrient contamination and pesticides, including atrazine. It would be worthwhile, for example, to look at the combined impact of light and atrazine on SAV.

Conclusion and Recommendations

Water-borne pesticides present policymakers, government agencies, scientists and public experts with serious challenges. Health threats include a wide range of acute and chronic illnesses, such as cancers, reproductive dysfunction, developmental disabilities, and other diseases and disorders. Even low-dose exposures to some pesticides may harm human health and aquatic life.

The current risk-assessment process is not designed to fully evaluate pesticide contamination in our waters as health hazards, especially in terms of aggregate and cumulative exposures to pesticides, their degradation products and other chemicals. Given these limitations and the dearth of toxicological data, policymakers, regulators and consumers would do well to follow the precautionary principle. Policymakers and government agencies should encourage the implementation of best management practices that prevent pesticides from entering the watershed as well as the use of non-chemical alternatives and Integrated Pest Management, in order to replace practices that rely on routine use of pesticides. Pesticide products should be registered only after their health impacts have been properly assessed, particularly for endocrine disruption and the synergistic and cumulative effects of chemical mixtures.

Stakeholders need better data on pesticide use within the watershed, and must reach consensus on how to reduce pesticide runoff as well as the use of pesticides – and therefore their impact on aquatic life, fish-eating wildlife and humans. The *Pesticides and the Chesapeake Bay Watershed Project*, launched in May 2007, is an example of the kind of collaboration that is needed. The project's mission is to reduce the occurrence and risks of pesticides in the watershed in order to protect water quality, aquatic life, wildlife and public health. Project participants – who include scientists, regulators and policymakers from local, state and federal government agencies; technical experts; representatives from industry; nonprofit organizations; tributary teams; extension services; watermen; waterkeepers; and the agricultural community – conduct quarterly meetings of five working groups to:

- Identify relevant research and data gaps regarding the impact of pesticides and their degradation products on water quality, aquatic life, wildlife, and public health, and to identify the main pesticides of concern.
- Identify Best Management Practices (BMPs) that prevent pesticides from entering waterways or allow substitution of non-chemical and less-toxic alternatives.
- Develop a strong and interactive relationship with the agricultural community to educate farmers about better practices, inform them about the potential health hazards of certain pesticides, and help them implement changes.
- Educate homeowners and businesses about preventing pesticides from entering the watershed and encourage them to adopt IPM and natural land care, which stress non-chemical and least-toxic alternatives to pesticides.
- Assess how pesticide impact can be reduced through better policies and laws, or better enforcement.

While pesticide degradation products are not currently regulated by drinking water standards, recent scientific findings have prompted their careful consideration. Policymakers and other stakeholders also need to reassess the aesthetic and nuisance benefits of pesticide use in light of the risks to humans and aquatic life in the Chesapeake Bay watershed. For example, the Canadian province of Quebec and more than 70 Canadian towns and cities (including Montreal, Toronto and Vancouver) have banned or restricted all public and private use of lawn care pesticides.

In the U.S., and specifically in the Chesapeake Bay watershed region, the greatest obstacles may be overcoming public perceptions. Attitudes about the use of pesticides can be changed through environmental and health communication campaigns. Increased demand for existing alternatives would ensue. Negotiating with the industry to develop and offer healthier services and products will be crucial; approximately $110 million is spent each year on home and garden pesticides in the Chesapeake region alone. A combination of targeted policies and market-based incentives will likely be most effective in reducing the amount of pesticide usage for ornamental and nuisance purposes.

State and county departments should also collaborate to increase use of least-toxic methods for such state-sponsored programs as spraying for mosquito control, pesticide applications on rights of way, and aerial applications of pesticides for infestations such as gypsy moth. Such broad-based applications have serious implications for the health of the watershed and the public. These agencies would also benefit from being better informed about the risks pesticide pose to public health and the watershed in weighing the risks and benefits of certain applications. Pesticides should be prioritized in terms of their relative occurrence and potential for serious adverse health effects.

Reducing the use of pesticides for prevention of infectious diseases is not as simple to justify, as acute and chronic risks may result from both. Health professionals and the public must be sufficiently educated on the immediate and long-term efficacy of preventive and least-toxic alternatives.

Policymakers are also encouraged to assess the applicability of the European Union's REACH (Registration, Evaluation and Authorization of Chemicals) program, which puts the burden on manufacturers to evaluate the safety of their products prior to registration, in contrast to our existing federal policy whereby pesticides are registered and sold unless they are proven to be unsafe after the fact. REACH mandates that chemicals with higher usage and chemicals of concern be evaluated for safety data (as opposed to the U.S. system of seeking thresholds of allowable harm). Chemicals considered "of highest concern" include carcinogenic, mutagenic or reproductive toxins and persistent, bio-accumulative and toxic chemicals. REACH endorses the principle that hazardous chemicals should be replaced with safer ones. REACH's provisions to seek least-toxic alternatives can generate new markets with positive incentives that will help correct the externalities of chemical manufacturing and make more evident the true cost of chemical production and use. Less harmful chemicals will also have an easier entry into the market.

Policy makers should review California's Green Chemistry Initiative to assess its applicability to Maryland. Launched in April 2007, the program is aimed at reducing the use of toxic substances that are endangering public health and the environment. The plan could serve as a model to look at ways to use less-toxic materials, less energy and produce less waste – thereby improving air quality and drinking water, and creating safer workplaces. California's Green Chemistry Initiative has much in common with the *Pesticides and the Chesapeake Bay Watershed Project.* It is striving to identify data gaps on problem chemicals, explore safer alternatives, and educate the public.

The Pesticides and the Chesapeake Bay Watershed Project participants urge the Chesapeake Bay Program (CBP) to play a stronger role in the effort to significantly reduce the pesticide load in the watershed. The charge of the CBP should expand to encompass pesticide management, in addition to nutrient management. To meet its goals for reducing toxics in the Bay, the CBP must address the toxic threat posed by pesticides.

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Appendix

Laws and Policies Affecting the Chesapeake Bay Watershed

EXISTING FEDERAL LAW POLICIES AFFECTING THE CHESAPEAKE BAY WATERSHED

The Clean Water and Safe Drinking Water Acts

Discharges of pollutants into the nation's water are regulated under the Clean Water Act (CWA), while the Safe Drinking Water Act (SDWA) is the principal federal law for ensuring drinking water quality. While there is considerable overlap in how these two laws operate, together they are the principal authorities for protecting ground and surface water resources in the US (US Environmental Protection Agency, 2006a).

How the CWA Works

The CWA protects the nation's waters through a framework of shared responsibilities between the federal and state governments with jurisdiction over a body of 'navigable' water (Getches, 1997). The CWA prohibits all unpermitted discharges of pollutants from point sources into navigable waters of the United States. A "point source" is a single identifiable 'point', such as a pipe or storm water outfall. Discharge permits under the CWA's National Pollutant Discharge Elimination System (NPDES) place effluent limitations on dischargers, with a goal of pollution elimination. Compliance with and enforcement of permit requirements are the principal means of regulating pollution from these sources.

The CWA also requires statewide planning for control of nonpoint source (NPS) pollution. Pesticides, applied as they are, for example, in agriculture, mostly fall under this second category of pollution. NPS pollutants are much more difficult to monitor and regulate, and quickly became the leading cause of water quality degradation after the point source discharge permit program was implemented (EPA, 2006).

How the SDWA Works

The SDWA requires that public water supplies must be below maximum contaminant levels (MCLs) for pollutants. EPA sets these national standards to protect human health and enforces compliance by public water suppliers. Systems that supply water to 25 or more people must comply with MCLs set forth in the SDWA. The SDWA also establishes more stringent, non-enforceable, health-based maximum contaminant level goals (MCLGs) for each contaminant. In practice, MCLs are set as close to MCLGs as possible, subject to limitations such as the best available technology, treatment technique, and cost.

Amendments to the SDWA enacted in 1996 made standards more stringent to protect vulnerable populations, including individuals with weakened immune systems. Toward this end, EPA is "conducting additional research regarding possible impacts of various contaminants on children and other vulnerable populations, and on new and emerging contaminants." (US Environmental Protection Agency, 1999). Today, MCLs are in place for 91 contaminants, whereas only 23 contaminants were so regulated in 1986.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

This law regulates the distribution, sale, and use of pesticides. FIFRA is a licensing statute that requires registration of pesticide products with EPA before they can be marketed. EPA evaluates the risks and benefits of a product prior to registration. FIFRA requires all pesticides registered to demonstrate "they will perform their intended functions without causing 'unreasonable adverse effects on the environment" (Percival, 1996, p.522). Over 50,000 pesticide products are currently registered under FIFRA. These products also include 900 inert ingredients (Percival, 1996), which are considered proprietary and are not subject to risk/benefit review.

Food Quality Protection Act of 1996

In amending FIFRA and the Federal Food, Drug, and Cosmetic Act (FFDCA), the Food Quality Protection Act (FQPA) of 1996 fundamentally changed the way EPA regulates pesticides (US Environmental Protection Agency, 2003b) by changing the way the FFDCA sets residue limits, also referred to as tolerances, for pesticides on foods. The FQPA also required EPA to consider the aggregate impact of pesticide exposure on both foods and water used for drinking (US Environmental Protection Agency, 2007).

As a result, EPA now employs a health-based safety standard that "there is a reasonable certainty that no harm will result from aggregate exposure to the pesticide chemical residue" (United States Public Laws, 1996). This more stringent safety standard regulates trace amounts of pesticides (residues), while food tolerances limit the amounts of pesticides that can be used. The law requires the EPA to: (1) publish specific safety findings before a tolerance can be established; (2) "tighten" tolerances by a factor of ten to protect the health of infants and children; (3) facilitate re-registration of existing pesticides; (4) consider the special vulnerability of infants and children to pesticide risks; and (5) to first address those pesticides that pose the greatest health hazards. The FQPA required EPA to complete review of the registration of all existing pesticides within 15 years, and to reassess existing residue tolerances whenever it reevaluates a pesticide's registration (Percival et al, 1998).

It should be noted that despite its mandate to use an extra ten-fold margin of safety to ensure that tolerances are safe for infants and children, EPA has not consistently applied the 10X safety factor in its review of pesticides and has been known to reduce the safety factor down to 1x for certain pesticides. Although funding has prevented EPA from implementing all of the proposals in this law, after an outbreak of contaminated beef, oysters and raspberries, the Clinton Administration proposed a significant increase in food safety inspection and research in December 1997 (Broder, 1997).

Consumer Labeling Initiative

The consumer labeling initiative is implemented by the EPA, the Consumer Product Safety Commission, the FDA, key industry groups, parents, and health professionals with a goal to "expand the amount of hazard and health information on pesticide labels, similar to new food nutrition labels" (US Environmental Protection Agency, 2000).

Despite the laws, policies, and regulations under CWA, SDWA, FIFRA and FQPA, EPA has not established drinking water standards for all pesticides found in water. Also, degradation products, mixtures and synergisms have not been considered or studied, even though pesticides normally occur in mixtures of several compounds and not individually. Combinations of pesticides with other contaminants in water have also not been taken into account. In addition, EPA has yet to assess the significance of sub-lethal doses.

REGIONAL LAWS, POLICIES, AND OTHER INSTRUMENTS

Chesapeake 2000 Agreement

The Chesapeake 2000 Agreement follows on similar cooperative efforts established in 1983 and 1987 to protect and restore the ecosystem through the Chesapeake Bay Program partnership (Chesapeake Bay Program, 2000). Signatories include the Chesapeake Bay Watershed Partnership, including the District of Columbia, the states of Maryland, Virginia, and Pennsylvania, U.S. EPA and the Chesapeake Bay Commission. Among other goals, the signatories agreed to fulfill the goal of a toxics-free Chesapeake Bay by "reducing or eliminating the input of chemical contaminants from all controllable sources to levels that result in no toxic or bioaccumulative impact on the living resources that inhabit the Bay or on human health" (Chesapeake Bay Program, 2000). With specific regard to pesticides, the Agreement states:

"Reduce the potential risk of pesticides to the Bay by targeting education, outreach and implementation of Integrated Pest Management and specific Best Management Practices on those lands that have higher potential for contributing pesticide loads to the Bay" (Chesapeake Bay Program, 2000).

CWA Delegated State Authority

Forty-plus states (including Maryland, Virginia, West Virginia, Pennsylvania, and New York, but not the District of Columbia), implement the NPDES permit program within their jurisdictions under delegated CWA authority. Delegated state NPDES programs retain substantial discretion when issuing permits to facilities, and may impose more stringent standards than those set forth by the EPA, though they may not impose less stringent standards.

Key responsibilities of a delegated State include:

- verifying facility qualifications for an NPDES permit;
- issuance of individual or general permits for industrial and municipal sources;

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- review and revision of water quality standards every three years, including submittal to U.S. EPA for review and approval; and
- compliance assurance and enforcement.

The Operation of the CWA's Permit Program

All facilities that discharge pollution into the nation's surface waters must obtain an NPDES permit. Standards in permits usually include technology-based treatment requirements that specify the minimum level of control that must be imposed in an issued permit. Specifically, these technology standards comprise the following:

- best practicable control technology (BPT), which represents the minimum level of required treatment for all pollutants;
- best conventional technology (BCT), which applies to discharges of conventional pollutants;
- best available technology (BAT), which applies to discharges of toxic and non-conventional pollutants; and
- best available demonstrated technology (BADT), for new sources, which is generally similar or equal to BAT (CWA sections are 122.44(a), 122.44(e), and 125.3.) (Marshall, 1995).

These standards afford the permitting agency a means of controlling effluent discharges and also offer industry a fair degree of "certainty" that compliance can be easily demonstrated. Though the CWA retains water quality-based controls as a safety net to back technology-based controls, enforcement of water quality-based controls in a water body subject to multiple discharges is impractical. This was historically demonstrated by years of failed enforcement efforts by the original Federal Water Pollution Control Act (1948), which relied on statues that stipulated "water quality standards" as a performance standard.

Strengths and Weaknesses of CWA

The effectiveness of CWA relies on a complex array of cooperative relationships between Congress, the EPA, state agencies, industry, and the public to set the standards and implement the program. For example, permit issuance follows a 14-step process. Moreover, the States must review and revise their water quality standards every three years, submitting them to the EPA for approval, a substantial administrative burden for State agencies. The States bear the majority of the administrative costs for implementation.[5]

As stated by Salamon (1989), "regulatory programs function by imposing restrictions." CWA regulations are no exception. At base, regulated parties are restricted from discharging unchecked levels of pollution into our nation's surface waters. From this perspective, CWA regulation is a coercive policy instrument; however, the burden on permittees is substantially reduced by reliance on 'knowable' technology, rather than performance, standards.

OTHER RELEVANT CHESAPEAKE BAY LAWS, POLICIES AND INSTRUMENTS

Chesapeake's Healthy and Environmentally Sound Stewardship of Energy and Agriculture Act of 2007 (CHESSEA)

The CHESSEA bill was introduced in the U.S. Congress in March 2007. Its primary goal is reduction of nitrogen pollution from agricultural runoff entering the watershed annually by 65 million pounds, achieved by providing matching funds for implementation of conservation efforts. Researchers estimate that 40% of Chesapeake Bay's nutrient contamination can be attributed to agricultural runoff.

If passed, CHESSEA would become the federal government's largest investment in addressing the Chesapeake's water quality and help fund the region's Tributary Strategies to help meet the goals of the Chesapeake 2000 Agreement (discussed above). Under this Act, Farm Bill funding would improve water quality and farm viability throughout the watershed and target farms that have developed a strategy and commitment for reducing nutrient pollution. It also would establish a technical assistance pilot program for conservation planning.

[5] Title II of the CWA originally proposed the Construction Grants Program, which provided Federal grants for the construction of wastewater treatment plants. Congress phased out this program in favor of the State Revolving Loan (SRL) fund in the 1987 amendments, which helped local governments and others build projects that would improve water quality.

Glossary

Best Management Practices (BMPs) - Policies, practices, procedures, or structures implemented to be the most effective means of controlling point and non-point pollutants.

Bioaccumulation - The uptake and storage of a substance, such as a toxic chemical, in various tissues of a living organism.

Carcinogenic - Substances that have the ability to produce cancer or cancer growth.

Degradate - A breakdown product of a pesticide. Degradation products may be more harmful than the original chemical.

Endocrine Disruptor - A chemical agent that interferes with natural hormones in the body. Hormones are secreted by endocrine glands, are transported through the body in the bloodstream, and regulate body growth and metabolism, other endocrine organs, and reproductive functions. Hormones are biologically active at very low concentrations (at parts per billion or less), so low levels of endocrine disruptors may be similarly active.

Epidemiological - Relating to the study of incidences, distribution, control and prevention of diseases in populations.

Genotoxic - Capable of damaging genetic material such as DNA, and thus causing mutations or possibly cancer.

Hermaphroditic - An organism possessing both female and male reproductive structures.

Integrated Pest Management (IPM) - IPM is an effective and environmentally sensitive approach to pest management that relies on a combination of commonsense practices. IPM programs use current, comprehensive information on the life cycles of pests and their interactions with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment. IPM programs take advantage of all pest management options possible, seeking to reduce reliance on chemical treatments and utilizing least-toxic pesticides as a last resort.

Metabolite - A compound produced from chemical changes of a chemical.

Microbiota - Microscopic organisms in a certain area, including microflora and microfauna.

Monoculture - The growth of only one species in a given area; such as a cornfield or other agricultural field.

Non-point Source – A source of pollution in which pollutants are discharged over a widespread area or from a number of small inputs rather than from distinct, identifiable sources.

Organochloride - Any of many chlorine substituted organic compounds, many of which are insecticides. Also called an organochlorine or chlorocarbon.

Point Source - A source of pollution that is distinct and identifiable with a confined discharge point.

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Review

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A restatement of the natural science evidence base concerning neonicotinoid insecticides and insect pollinators

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There is evidence that in Europe and North America many species of pollinators are in decline, both in abundance and distribution. Although there is a long list of potential causes of this decline, there is concern that neonicotinoid insecticides, in particular through their use as seed treatments are, at least in part, responsible. This paper describes a project that set out to summarize the natural science evidence base relevant to neonicotinoid insecticides and insect pollinators in as policy-neutral terms as possible. A series of evidence statements are listed and categorized according to the nature of the underlying information. The evidence summary forms the appendix to this paper and an annotated bibliography is provided in the electronic supplementary material.

1. Introduction

Neonicotinoid insecticides are a highly effective tool to reduce crop yield losses owing to insect pests. Since their introduction in the 1990s, their use has expanded so that today they comprise about 30% by value of the global insecticide market [1]. They are commonly applied to crops as seed treatments, with the insecticide taken up systemically by the growing plant, so that it can be present in all plant parts, including nectar and pollen that bees and other pollinating insects collect and consume. Pollinators can potentially be exposed to neonicotinoids in other ways, for example through plant exudates, dust from planting machines and contamination of soil and water.

There is evidence that in Europe and North America many species of pollinators are in decline; both in abundance and distribution. There is a long list of potential causes for these declines, including parasites, disease, adverse weather and loss of habitat [2,3]. However, there has been particular concern about the impact on pollinators of the relatively recently introduced neonicotinoids and the European Union (EU) imposed a partial restriction on their use in December 2013. This decision has been criticized on the grounds that the benefits of neonicotinoid use outweigh any detriment they might cause.

The tension between the agricultural and environmental consequences of neonicotinoid use, and the recent EU restriction, has made this topic one of the most controversial involving science and policy. Here, we describe a project that aimed to provide a 'restatement' of the relevant natural science evidence base expressed in a succinct way that is comprehensible to non-expert readers. We have tried to be policy-neutral though are aware that complete neutrality is

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impossible. The evidence restatement forms appendix A to this paper and is accompanied in the electronic supplementary material by a detailed annotated bibliography that provides an entry into the technical literature. The restatement is divided into six sections: after a description of the methodology and the importance of pollinators and insecticides, successive sections consider evidence for exposure paths, laboratory evidence for lethal and sublethal effects, the occurrence of residues in pollinators and their products in the environment, experiments conducted in the field, and consequences for pollinators at colony and population levels.

Experiments to establish the effect of defined doses of insecticides upon individual pollinators are required by regulatory authorities and can be carried out under laboratory conditions. These laboratory studies have the strength of allowing carefully controlled experiments to be performed on individual insects subjected to well-defined exposure. However, because they are conducted under artificial conditions, it is hard to assess a number of processes that may be relevant in the field. For example, neonicotinoids may affect the sensitivity of insects to other stressors; pollinators may actively avoid food contaminated by insecticide and responses at the colony or population level may mitigate or exacerbate the loss or impairment of individual insects. Nevertheless, such experiments provide important information about the range of concentrations where death or sublethal effects are to be expected.

Purely observational surveys in the field are used to establish the levels of exposure that occur under normal use. A number of large surveys in different countries have measured neonicotinoid residues in wild-foraging honeybees and unmanaged pollinators, as well as in nectar, pollen, honey and wax within bee colonies. These data are heavily weighted towards honeybees, and long time series are seldom available.

Experiments in the field are used to establish the impact of different doses of insecticide on pollinator behaviour, mortality and colony performance. They may be conducted as part of the registration process or for general research. One class of experiment involves bees artificially exposed to neonicotinoids and then observed to forage in the field. These are designed to discover whether neonicotinoids affect the performance of individual pollinators (and where appropriate their colonies) under field conditions. The critical issue here is whether the experimental exposure to insecticides is representative of what pollinators are actually likely to experience. The second class of experiment involves placing bee colonies in the environment in situations where they are exposed to crops treated with neonicotinoids, with suitable controls. These are large, difficult experiments where the unit of replication is typically the field site and where there are potentially many confounding factors to be taken into consideration. So far only one such study has been concluded successfully. The statistical power of this type of experiment is likely to be constrained by the expense and logistics of high levels of replication.

To understand the consequences of changing neonicotinoid use, it is important to consider pollinator colony- and population-level processes, the likely effect on pollination ecosystem services, as well as how farmers might change their agronomic practices in response to restrictions on neonicotinoid use. While all these areas are currently being researched, there is at present a relatively limited evidence

2. Material and methods

The literature on pollinators and neonicotinoids was reviewed and a first draft evidence summary produced by a subset of the authors. At a workshop, all authors met to discuss the different evidence components and to assign to each a description of the nature of the evidence using a restricted set of terms. We considered several options to describe the nature of the evidence we summarize including the GRADE [4] system widely used in the medical sciences, or the restricted vocabulary used by the International Panel on Climate Change [5]. However, none precisely matched our needs and instead we used a scoring system based on one previously developed for another 'restatement' project concerning bovine tuberculosis [6]. The categories we used are:

— [D_{ata}] a strong evidence base involving experimental studies or field *data* collection, with appropriate detailed statistical or other quantitative analysis;
— [E_{xp_op}] a consensus of *expert opinion* extrapolating results from related ecological systems and well-established ecological principles;
— [S_{upp_ev}] some *supporting evidence* but further work would improve the evidence base substantially; and
— [P_{rojns}] *projections* based on the available evidence for which substantial uncertainty often exists that could affect outcomes.

These categories are explicitly not in rank order.

A revised evidence summary was produced and further debated electronically to produce a consensus draft. This was sent out to 34 stakeholders or stakeholder groups including scientists involved in pollinator research, representatives of the farming and agrochemical industries, non-governmental organizations concerned with the environment and conservation, and UK government departments and statutory bodies responsible for pollinator policy. The document was revised in the light of much helpful feedback. Though many groups were consulted, the project was conducted completely independently of any stakeholder and was funded by the Oxford Martin School (part of the University of Oxford).

3. Results

The summary of the natural science evidence base concerning neonicotinoid insecticides and insect pollinators is given in appendix A, with an annotated bibliography provided as the electronic supplementary material.

4. Discussion

The purpose of this project is not to conclude whether neonicotinoids are 'safe' or 'dangerous' but to try to help set out the existing evidence base. When neonicotinoids are used as seed dressing on crops visited by pollinators there is no doubt that these systemic insecticides are typically present in pollen and nectar and so bees and other pollinators can be exposed to them [7,8]. The concentrations in pollen and nectar are nearly always some way below those that would cause immediate death. The great problem is to understand whether the sublethal doses received by pollinators in the field lead to significant impairment in individual performance, and whether

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pollination in farmed and non-farmed landscapes and the viability of pollinator populations [3].

For this topic, the published literature is a small fraction of the evidence that has been collected. The process of registering a new insecticide requires the production of detailed environmental risk assessments (see http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:093:0001:0084: EN:PDF and http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:093:0085:0152:EN:PDF). These include substantial evidence on toxicity to non-target organisms (including honeybees) and a range of further studies that will, in some cases, escalate to full-scale field trials of toxicity. The data generated in such studies are not typically in the public domain, or only in a form summarized by the regulatory agencies, and hence we have not been able to include reference to them. There are understandable commercial reasons for the withholding of this information, though the chief reason is not that it contains proprietary intellectual property but that the information would be commercially advantageous to a competitor in registering the compound when it is out of licence. We wonder if registration rules might be amended to allow this type of data to be published, a clear public good, without disadvantaging companies that had invested in its collection.

If neonicotinoids are not available, then farmers will have to choose alternative pest-management strategies, alternative crops or accept greater losses. The impact upon pollinators of withdrawing neonicotinoids will be greatly influenced by such choices. Farmers' likely strategies when faced with restrictions on the use of neonicotinoids are being researched, but there is currently only limited evidence to guide policy-makers in what changes to expect. This is just one aspect of human behaviour, economics and other social science that may be relevant to questions about threats to pollinators. However, it was not the purpose of this review to summarize the social science literature in this area (the annotated bibliography provides an entry into this literature).

There is clear evidence of the great value of neonicotinoids in agriculture [1] as well as the importance of the ecosystem services provided to agriculture by managed and wild pollinators [9]. Pollinators also have intrinsic importance as components of natural biodiversity that cannot, or can only inexactly, be accorded economic value. In some cases, intelligent regulation of insecticide use can provide 'win-wins' that improve both agricultural and biodiversity outcomes but in other cases there will be trade-offs, both within and between different agricultural and environmental objectives. Different stakeholders will quite naturally differ in the weightings they attach to the variety of objectives affected by insecticide use, and there is no unique answer to the question of how best to regulate neonicotinoids, an issue that inevitably has both economic and political dimensions. But economic and political arguments need to be consistent with the natural science evidence base, even though the latter will always be less complete than desirable. We hope that our attempt to set out this evidence base in as policy-neutral a manner as possible will stimulate discussion within the science community about whether our assessments are fair and where investment most needs to be made to strengthen them. We hope it will also make the evidence base less contested and so help stakeholders from all perspectives develop coherant policy and policy recommendations.

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Appendix A. A restatement of the natural science evidence base concerning neonicotinoid insecticides and insect pollinators

For an annotated bibliography of the evidence supporting each statement, see the electronic supplementary material.

(a) Introduction and aims

(1) Wild and managed insect pollinators play a critical role in the production of a variety of different foods (and in the case of honeybees also produce various 'hive products' of which the most important is honey) and are an important functional and cultural component of biodiversity. Insecticides are applied to crops to control insect pests and make a very important contribution to achieving high yields. Insecticides kill insects and thus clearly have both positive and negative effects on different aspects of food security and the environment. Concern has been expressed by a number of bodies that neonicotinoid insecticides may be harming pollinators and a partial restriction on their use in the EU came into force across all 28 member states in December 2013 (to be reviewed after 2 years). Other bodies have criticized this decision, arguing that the benefits of neonicotinoid use outweigh their costs.

(2) The aim here is to provide a succinct summary of the evidence base relevant to policy-making in this area as of April 2014. It also provides a consensus judgement by the authors on the nature of the different evidence components; a consensus arrived at using the studies listed in the annotated bibliography. We use the following descriptions, which explicitly are not a ranking, indicated by abbreviated codes. Statements are considered to be supported by:

- $[\mathrm{D_{ata}}]$ a strong evidence base involving experimental studies or field *data* collection, with appropriate detailed statistical or other quantitative analysis;
- $[\mathrm{E_{xp\_op}}]$ a consensus of *expert opinion* extrapolating results from related ecological systems and well-established ecological principles;
- $[\mathrm{S_{upp\_ev}}]$ some *supporting evidence* but further work would improve the evidence base substantially; and
- $[\mathrm{P_{rojns}}]$ *projections* based on the available evidence for which substantial uncertainty often exists that could affect outcomes.

(3) The review focuses on the natural science evidence relevant to pollinator policy in the EU but includes relevant

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evidence from social sciences and economics. The statements are based on the evidence in the peer-reviewed scientific literature, though the annotated bibliography also notes the existence of information in non-reviewed reports and industry studies.

(b) Pollinators and neonicotinoid insecticides

(4) Insect pollinators are required to achieve optimum yield and quality for a number of important food crops. The most economically significant crops in the UK include oilseed rape (canola), soft fruits (strawberry, raspberry, etc.), top fruits (apple, pear, plum, etc.) and vegetables (courgettes, runner beans, tomato, etc.), whereas in continental Europe sunflower, peaches, melon and other crops are also important. Insect pollinators are important for both field crops and those grown under glass, though in their absence some crops can, to differing extents, be wind- or self-pollinated without the involvement of insects. Many plant species in pastureland and non-agricultural habitats require insect pollinators for successful reproduction [D_{ata}].

(5) A lack of pollinators can reduce crop yields and quality [D_{ata}], and there is some evidence that pollinator diversity can reduce the variance in pollination and hence improve crop yield stability [S_{upp_ev}]. Where insect-pollinated crops are grown in glasshouses or 'polytunnels' the introduction of pollinators can be particularly important for both quality and quantity of yield [D_{ata}]. There is emerging evidence for the potential of economically significant pollination deficits in some UK field crops in some years [S_{upp_ev}], but data do not currently exist to determine whether observed changes in pollinator abundance and diversity (see para. 7) have affected the economic value of crop yields [E_{xp_op}].

(6) Pollination may be carried out by wild or managed insects. The most important pollinators for crops include honeybees, which are native to Europe (their status in the British Isles is unclear [E_{xp_op}]) but are now almost entirely managed, bumblebees, solitary bees and true flies (including hoverflies).[1] Other pollinators such as butterflies and moths are not as important for crop pollination, particularly in northern temperate regions, but do pollinate wild plant species. Wild pollinators can be viewed as an element of natural capital[2] that provides (with managed species) pollination, an ecosystem service of economic importance to society. Pollinators are also an important component of a nation's biodiversity [D_{ata}].

(7) Data from volunteer recording schemes that record species presence (but not abundance or absence) have revealed changes in the diversity and distribution of pollinators. In Great Britain, The Netherlands and Belgium (where the best data exist) the average numbers of species of bumblebees, butterfly and moths, and solitary bees in different areas have declined since the 1950s [D_{ata}]. There is some evidence of a recent slowdown in the rate of decline in species richness (for bumblebees in all three European countries) and also some increases (solitary bees in Great Britain and The Netherlands but not in Belgium where the decline continues) [D_{ata}]. The data for hoverflies are more complex with species richness reported to have increased, decreased or remained unchanged depending Long-term published data on abundance are only available for butterflies and moths and show reductions in abundance of many, but not all, species [D_{ata}]. There are several potential (and non-exclusive) explanations for these observed changes in pollinator biodiversity with evidence suggesting habitat loss and alteration to be the most important causes of the decline [S_{upp_ev}]. There is not a consensus on the reason(s) for recent slowdowns or reversals in the rates of species loss [E_{xp_op}].

(8) Honeybees throughout Europe (and elsewhere) have been severely affected by the introduction of the *Varroa destructor* mite which both parasitizes bees and acts as a vector for a number of debilitating and paralytic honeybee viruses [D_{ata}]. In addition, honeybee colony losses have increased in frequency across Europe and the USA because of overwintering mortality [D_{ata}] which is thought to arise from multiple factors, including adverse weather, poor nutrition as well as parasites and disease [S_{upp_ev}]. Some of these losses in the USA have been ascribed to a particular syndrome, colony collapse disorder, though its precise nature is debated [E_{xp_op}]. Not all parts of the world have experienced recent increases in overwintering colony mortality [D_{ata}].

(9) Neonicotinoids are a relatively new class of insecticide, introduced in the early 1990s. They target the nicotinic acetylcholine receptor (nAChR) with high affinity for insect receptors and low affinity for mammalian receptors and have relatively low (but not zero) mammalian and bird toxicity. They can be used as sprays, applied to soils as drenches or in granular form, introduced into irrigation water or injected into trees. However, they are most frequently (approx. 90% by volume in the UK) applied as seed treatments with the insecticide being taken up systemically by the growing plant. The convenience and cost-effectiveness of seed treatments, the development of resistance to other classes of insecticide by many insect pests, and restrictions on the use of other compounds, have resulted in neonicotinoids capturing 28.5% of the global insecticides market (2011; worth US$3.6B) and their wide use in Europe [D_{ata}].

(10) Five neonicotinoids are approved for use in the EU: three from the *N*-nitroguanidine group—clothianidin, imidacloprid and thiamethoxam (metabolized to clothianidin in the plant, insect and environment); and two from the *N*-cyanoamidine group: thiacloprid and acetamiprid. Concern over their possible effects on pollinators has focused on the first three because they are the most used compounds, they have greater honeybee toxicity and they are used as seed treatments so can be present in the pollen and nectar of treated crops [D_{ata}].

(11) In Europe (and elsewhere), environmental risk assessments of pesticides including all neonicotinoids are required before a product can come to market. A tiered approach has been adopted to ensure cost-effectiveness and proportionality. The tiers start with laboratory tests to determine hazard to a standard set of seven non-target organisms (including honeybees) and, if potential hazards are identified, may progress through more complex semi-field experiments and modelling to simulate exposure under different more realistic conditions, culminating with full-scale toxicity assessments to identify potential risks in the field. Field trials were conducted

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for neonicotinoids. Extensive data are often generated during the registration process but typically is not placed in the public domain, except in summary form [D_{ata}].

(c) Exposure of pollinators to neonicotinoid insecticides

(12) Neonicotinoids have been widely used in Europe as a seed treatment for oilseed rape, sunflowers, maize, potato, soya bean (and other crops such as cereals and beets not visited by pollinators).

(a) A single treated oilseed rape seed is typically treated with approximately 35 µg neonicotinoids and a maize seed with 1.2 mg (see Endnote 3) [D_{ata}].

(b) Pollinators may be exposed to neonicotinoids applied as sprays. The use of *N*-nitroguanidine neonicotinoids at flowering time is restricted in most countries though acetamiprid and thiacloprid (from the less toxic *N*-cyanoamidine group) are sprayed on raspberries, fruit trees and oilseed rape at flowering time [D_{ata}].

(13) The plant absorbs some of the insecticide from the seed treatment and as it grows the insecticide spreads to all plant parts including the nectar and pollen that bees and other pollinators collect and consume [D_{ata}].

(a) Estimates of the concentration of neonicotinoids in the pollen and nectar of seed-treated crops vary considerably with average maximum levels (from 20 published studies) of 1.9 (nectar) and 6.1 (pollen) ng g^{-1}. Concentrations vary across crops and can be appreciably higher if neonicotinoids are applied as foliar sprays, soil drenches or through drip irrigation [D_{ata}].

(14) Some plants secrete droplets of liquid (xylem sap) called guttation fluid at leaf tips or margins. High concentrations of neonicotinoids have been measured in the guttation fluid of seed-treated plants (up to 10^4–10^5 times that in nectar), especially when plants are young [D_{ata}]. There has been concern that were pollinators to use guttation fluid as a source of water they would ingest highly toxic levels of insecticides. The available evidence does not suggest that pollinators collect guttation fluid containing neonicotinoids to any great extent, in part because it chiefly is present at times of the year when crops are unattractive to pollinators and other sources of water are present [E_{xp_op}].

(15) Dust emitted from seed drilling machines can contain high concentrations of neonicotinoids; as well as being deposited on the soil, the dust can drift to contaminate neighbouring flowering crops and natural vegetation as well as surface waters. Sporadic incidents of mass honeybee mortality in several EU countries, the USA and Canada have been caused by dust from seed drilling machines [D_{ata}].

(a) Issues concerning dust chiefly involve the formulation of the insecticide, in particular, how it is made to 'stick' to the seed. EU and national regulations on formulation and seed drilling have been introduced to reduce the risks of these problems [D_{ata}].

(16) Neonicotinoids introduced into the environment as seed treatments can affect soil insects and other invertebrates, effects considered in insecticide evaluation typical half-lives estimated to be of the order 15–300 days (with some longer estimates from laboratory studies and in the field under drought and freezing conditions). There is evidence that neonicotinoids can accumulate in soils when treated crops are grown repeatedly in the same field. Neonicotinoids can sometimes, but not always, be detected in weeds or in subsequent crops grown in the same soil, though when present the concentrations are considerably lower than in the target crop. Neonicotinoids have been detected in surface or groundwater around fields where they have been used as seed treatments [S_{upp_ev}].

(17) Bees bring pollen and nectar (which in social bees is often extensively modified post-ingestion) to their hives or nests to feed their developing larvae [D_{ata}] which thus may have different patterns of exposure and susceptibility compared with adults (see also para. 24) [S_{upp_ev}].

(18) The risk of exposure to neonicotinoids for different pollinator species will be influenced by many aspects of their biology and ecology including body size, flower preference, whether they are a social species, and whether the time of year at which they are active (or in the case of social species experiencing rapid colony growth) coincides with the flowering of neonicotinoid-treated crops. There may also be differences in the physiological susceptibility of different pollinator species to neonicotinoids [E_{xp_op}].

(19) The exposure of pollinators to neonicotinoids will be affected by the distribution of flowering crops in the landscape, the fraction that are treated with neonicotinoids, the length of time the treated crops are in flower, and the availability of alternative, suitable floral resources (including weeds and managed resources in floral strips, wildflower headlands, untreated crops, etc.) and whether they are contaminated with insecticide. Over multiple years the frequency of treated crops in agricultural rotations will affect long-term population exposure [E_{xp_op}].

(20) The distance between treated fields and nest sites or honeybee hives will affect insect exposure to neonicotinoids [E_{xp_op}].

(a) Pollinators can forage over a large area: the maximum foraging distance for bumblebees is 2–3 km from the colony (though with considerable variation) and for honeybees 10–15 km (median distances are 1–6 km); some solitary bees may only forage a few hundred metres or less. Observed foraging distances are strongly influenced by the distribution of flowering plants [D_{ata}].

(21) *Summary*. There are several proven pathways through which pollinators may be exposed to neonicotinoid insecticides applied as seed treatments (or in other ways). Quantitative information about the extent and significance of these different routes in the published literature is poor [E_{xp_op}].

(d) Laboratory studies of lethal and sublethal effects of neonicotinoids

(22) Estimates of LD_{50}s (see Endnote 4) for different

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although a majority of the studies have considered only the honeybee [D_{ata}.].

(a) The acute oral LD_{50}s for the major neonicotinoids have been estimated (by EFSA[5]) to be 3.7 ng per honeybee for imidacloprid, 3.8 ng per honeybee for clothianidin and 5.0 ng per honeybee for thiamethoxam (these estimates are used in the calculations below). A meta-analysis of 14 studies of imidacloprid estimated an LD_{50} of 4.5 ng per honeybee (95% confidence limits 3.9–5.2 ng) [D_{ata}].

(b) Equivalent acute contact LD_{50}s have been estimated (by EFSA) to be 81 ng per honeybee for imidacloprid, 44 ng per honeybee for clothianidin and 24 ng per honeybee for thiamethoxam [D_{ata}].

(c) There is considerable variation among LD_{50}s measured across different bee species, and this is influenced by type of neonicotinoid and mode of application [D_{ata}]. This complicates simple comparison with honeybee data [E_{xp_op}].

(d) A honeybee, returning to the hive after foraging, typically carries 25–40 mg nectar or 10–30 mg pollen. If nectar or pollen is contaminated with insecticide at the concentrations described in Para. 13a, then these loads will contain approximately 0.06 ng (nectar) or 0.12 ng (pollen) of insecticide. Depending on the type of neonicotinoid this is 1–3% of the LD_{50} acute oral dose (though note that none of the pollen and hardly any of the nectar is metabolized by the forager). A colony of 10 000 workers was observed to store 750 g of pollen in four days. If all the pollen was similarly contaminated this equates to 8–11% of the acute oral LD_{50} [P_{rojns}].

(e) Maximum pollen consumption is found among nursing honeybees that can consume 7.2 mg d^{-1}. If the pollen contains 6.1 ng g^{-1} neonicotinoid the daily intake is 0.044 ng or, depending on the compound, 0.8–1.1% of the acute oral toxicity LD_{50}. Maximum nectar consumption is found among nectar-foraging honeybees and can be 32–128 mg d^{-1}. If nectar contains 1.9 ng g^{-1} neonicotinoid the daily intake is 0.061–0.243 ng, or 1.2–6.7% of the LD_{50} acute oral [P_{rojns}].

(f) Honeybee colonies collect pollen and nectar from multiple sources, which dilutes the effects of foraging on neonicotinoid-treated crops [D_{ata}]. For this reason and because they are based on the average maximum neonicotinoid concentrations in Para. 13a, the calculations in subparagraphs d and e above should be viewed as a worst-case scenario [E_{xp_op}].

(23) Prolonged exposure of pollinators in the laboratory to doses of neonicotinoids that do not cause immediate death can reduce longevity (chronic toxicity). Because chronic effects can be estimated in many different ways, comparisons are harder than for acute toxicity [D_{ata}].

(a) For honeybees and bumblebees, chronic lethal effects have typically been reported when bees are fed diets containing 10–20 ng g^{-1} neonicotinoid over 10–20 days, although some studies with higher doses have not observed such effects [D_{ata}].

(b) These neonicotinoid concentrations are higher than the worst-case assumptions of maximum insecticide consumption in para. 22e [P_{rojns}].

(24) Effects of neonicotinoids on adult pollinators have below those that cause death. At the lowest doses responses involve metabolic changes (for example, in acetylcholinesterase activity) and subtle neurological and behavioural responses. As doses increase (including concentrations in food similar to that observed in the nectar and pollen of treated crops) olfactory learning, memory and feeding behaviour can be affected, though there is considerable variability in the results reported in different studies. When doses approach lethal concentrations substantial neurological and locomotory impairment can occur [D_{ata}].

(a) The majority of studies have involved honeybees; where comparisons of honeybees with bumblebees and solitary bees have been made differences are frequently observed, although these depend on species, assay and type of neonicotinoid and general patterns are difficult to discern [S_{upp_ev}].

(b) There has been debate in the literature as to the extent that neonicotinoids accumulate in pollinators; recent studies have suggested that bees have a substantial capacity to extrude neonicotinoids from cells and tissue (honeybees were estimated to clear 2 ng d^{-1} imidacloprid from their body—approximately 50% of oral LD_{50}—and larger bumblebees 7 ng d^{-1}) [D_{ata}].

(25) Sublethal effects on larval development and colony productivity have been identified in the laboratory.

(a) Delayed larval and pupal developments have been observed in honeybees though at neonicotinoid concentrations higher than those expected to occur in the field [D_{ata}].

(b) Increases in development time, and reductions in worker egg laying, worker production, worker longevity and male and new queen (gyne) production have been observed in bumblebee colonies when food is provided containing concentrations of neonicotinoids towards the high end of those observed in nectar and pollen in treated crops in the field. Similar results have been found for larval development and reproductive output in solitary bees [S_{upp_ev}].

(26) Stressed pollinators tend to be more susceptible to neonicotinoids (and vice versa), although data are largely restricted to honeybees [S_{upp_ev}].

(a) Honeybees stressed by disease are more susceptible (lethal and sublethal effects occur at lower doses) to neonicotinoids, whereas in bumblebees synergistic effects of neonicotinoids and parasites on queen longevity, but not other colony parameters, have been observed. Neonicotinoids can modulate insect innate immunity negatively affecting anti-viral and other defences [D_{ata}].

(b) Laboratory molecular biological studies show a potential for the presence of other pesticides (targeted at fungi and *Varroa*) to exacerbate the effects of neonicotinoids though there is limited evidence for such effects from studies with live insects [S_{upp_ev}].

(c) It is likely that pollinators exposed to poorer diets are more susceptible to neonicotinoids (and other stressors) [E_{xp_op}].

(27) In interpreting these laboratory results, the following issues need to be considered:

(a) There is extensive information on the acute lethality of major neonicotinoids in honeybees, but data on other effects, on other pollinators and with the full

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(b) Stress affects insect responses to neonicotinoids and laboratory conditions may be more or less stressful than in the field, an effect that is probably pollinator-species specific and rarely directly assessed in experiments [E_{xp_op}].

(c) Laboratory experiments normally involve feeding pollinators with sugar solution or mixed pollen which may affect insects differently to naturally collected food [E_{xp_op}].

(d) Chronic and sublethal effects will depend on the pattern of dietary consumption and the rate at which ingested neonicotinoids are cleared from the body [E_{xp_op}]. In addition, neonicotinoids can act as anti-feedants and hence may affect pollinators through reduced food intake, though typically at concentrations higher than expected in the field. How insecticide treated food is presented to pollinators in laboratory experiments, and whether the insects have access to alternative foods, will thus influence the observed responses [S_{upp_ev}].

(e) It is challenging to study the impacts of neonicotinoids on entire colonies in the laboratory (particularly for honeybees). As a result, the majority of laboratory studies examine effects on individual bees or queenless groups (often referred to as micro-colonies in bumblebee studies). These results need careful interpretation when assessing how they might translate to whole colony impacts for social bees in the field [E_{xp_op}].

(28) *Summary*. The strengths of laboratory studies are that they allow carefully controlled experiments to be performed on individual insects subjected to well-defined exposure. The weaknesses are that they are conducted under very artificial conditions (which may affect tolerance to external stress), any avoidance response by the insect is limited and hence the exposure dose and form is determined solely by the experimenter, and responses at the colony or population level are both difficult to study and to extrapolate to the field. Nevertheless, they provide important information about the range of concentrations where death or sublethal effects may be expected to occur [E_{xp_op}].

(e) Neonicotinoid residues observed in pollinators in the field

(29) Nectar and pollen collected from bees constrained to feed on treated crops have similar insecticide concentrations to those found in samples taken from the plant [D_{ata}].

(30) There have been few surveys of pesticide and metabolite levels in honeybees in the field. Two studies in Belgium (sample size, $n = 48$ and 99) and one in the USA ($n = 140$) found no honeybees with residues, while a survey in France conducted in 2002–2005 ($n = 187$) detected imidacloprid in 11% of honeybees (at concentrations of 0.03–1.0 ng per bee) [D_{ata}]. We are aware of no data on other pollinators [E_{xp_op}].

(31) Insecticide residues are more likely to be found in nectar and pollen collected by honeybees and in honey than in the insects themselves. Thus, the French study that also found residues in 22% of honey samples and 40% of pollen samples (mean and range: 0.9, 0.2–5.7 ng g^{-1}). Some large surveys (e.g. a Spanish study with $n = 1021$) found no contaminated pollen; a German study that surveyed hives ($n = 215$) after oilseed rape flowering found low incidence of those neonicotinoids used in seed treatments (though higher incidence of thiacloprid); an American study found imidacloprid in 3% of pollen ($n = 350$) and 1% of wax samples ($n = 208$) [D_{ata}].

(32) *Summary*. Neonicotinoids can be detected in wild pollinators as well as honeybee and bumblebee colonies but data are relatively few and restricted to a limited number of species. Studies to date have found low levels of residues in surveys of honeybees and honeybee products. Observed residues in bees and the products they collect will depend critically on details of spatial and temporal sampling relative to crop treatment and flowering [E_{xp_op}].

(f) Experiments conducted in the field

(33) This section discusses recent studies that have explored the consequences of providing bee colonies placed in the field with food containing insecticide, as well as experiments where the performance of colonies placed adjacent to fields treated or not treated with neonicotinoids are compared. Some earlier studies with limited statistical power are listed in the annotated bibliography [E_{xp_op}].

(34) Schneider *et al.* 2012 [10]. Individual honeybees were given single sublethal doses of imidacloprid or clothianidin and their foraging behaviour was monitored. Reductions in foraging activity and longer time foraging flights were not observed at field-relevant doses although negative effects were seen at doses greater or equal to 0.5 ng per bee (clothianidin) or 1.5 ng per bee (imidacloprid) [D_{ata}].

(a) These doses are higher than those likely to be encountered by honeybees foraging on nectar from treated plants (see calculations in para. 22e) [E_{xp_op}]

(35) Henry *et al.* 2012 [11]. Honeybees fed a single high dose of thiamethoxam (1.34 ng, equivalent to 27% of the LD_{50}) and then released away from the hive were significantly less likely to return successfully than controls. The return rate depended on the local landscape structure and the extent of the honeybees' experience of the landscape. The failure to return per trip was estimated to be up to twice the expected background daily mortality [D_{ata}].

(a) The rate of forager loss per trip (15%) was analysed as if it were excess daily mortality but as foraging honeybees make 10–30 trips per day real loss rates would be very much higher, reflecting the high dose of insecticide used in the experiment (see para. 22e for calculation of likely field doses) [E_{xp_op}].

(b) Assuming honeybees were exposed every day to this dose rate (much higher than expected from observed residues in pollen and nectar), mathematical modelling of colony development predicted severe decline within a season though this conclusion depends critically on poorly understood aspects of honeybee colony dynamics [P_{rojns}].

(36) Whitehorn *et al.* 2012 [12]. Bumblebee (*Bombus terrestris*) colonies fed exclusively on imidacloprid-treated sugar

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pollen (either 6 or 12 ng g^{-1}) for two weeks in the laboratory before being placed in the field (for six weeks) showed reductions in growth rate and queen production. A subsequent study [13] using the same concentrations of imidacloprid found the bumblebees' capacity to forage for pollen (but not nectar) was impaired [D_{ata}].

(a) The concentrations of insecticide are at the high end of those observed in the nectar and pollen of treated plants (Para. 13a) and are likely to be greater than most bees will receive in the field because alternative food sources were not available [E_{xp_op}].

(37) Gill *et al.* 2012 [14]. Bumblebee (*B. terrestris*) colonies given access to sugar water containing imidacloprid (10 ng g^{-1}) and allowed to forage for pollen and nectar in the field grew more slowly than controls; individual foragers from imidacloprid-treated colonies were less successful at collecting pollen, and treated colonies sent out more workers to forage and lost more foragers, compared to controls. Combined exposure to imidacloprid and a second pesticide of a different class (a pyrethroid) tended to reduce further colony performance and increase the chances of colony failure [D_{ata}].

(a) The concentration of insecticide in the sugar water is within the range observed in nectar in the field but considerably higher than the average (1.9 ng g^{-1}; Para. 13a). The actual amount of imidacloprid consumed by individual bumblebees was not measured but will be diluted through foraging from other sources (no pollen was provided). Although it is difficult to make precise comparisons, the pyrethroid concentrations used were towards the upper end of recommended application rates for field or fruit crops [E_{xp_op}].

(38) Thompson *et al.* 2013 [15]. Bumblebee (*B. terrestris*) colonies were placed adjacent to single oilseed rape fields grown from seeds that were treated with clothianidin, imidacloprid or had no insecticidal seed treatment. No relationship between the oilseed rape treatment and insecticide residues was observed, presumably because the bees were foraging over spatial scales larger than a field. Insecticide residues varied among colonies and the authors reported no evidence of a correlation with colony performance [D_{ata}].

(a) The experimental design, in particular the lack of replication at field level and absence of a clear effect of treatment, allows only limited inference about the effects of neonicotinoids in the field [E_{xp_op}].

(39) Pilling *et al.* 2013 [16]. Over a 4 year period, honeybee colonies (six per 2 ha field) were placed beside thiamethoxam-treated or control fields of maize (three replicates) or oilseed rape (two replicates) for between 5 and 8 days (first 3 years) or 19 and 23 days (fourth year) to coincide with the crop flowering period (at other times the colonies were kept in woodland presumed to have no local exposure to insecticides). Honeybees from treatment hives had higher concentrations of insecticide residues, but no differences in multiple measures of colony performance or overwintering survival were observed [D_{ata}].

(a) Levels of replication precluded formal statistical analysis though the lack of any differences between treatment and control was reasonably consistent

(40) *Summary*. The experiments described in Paras. 33–37 involve bees artificially exposed to neonicotinoids and observed to forage in the field. They show the potential for neonicotinoids to affect the performance of individual pollinators and pollinator colonies in the field. The main issue for their interpretation is the extent to which the doses received by the bees are representative of what they will receive under normal use of neonicotinoids in the field. It appears that most studies have used concentrations at the high end of those expected in the field. The experiments described in Paras. 38 and 39 are true field experiments in the sense that the treatments involve the normal use of neonicotinoids, though only the Pilling *et al.* [16] study was successfully concluded and found no effects of neonicotinoids, but with limited statistical power to detect differences [E_{xp_op}].

(g) Consequences of neonicotinoid use

(41) At the colony or population level, there may be processes that can compensate for the deaths of individual insects which would mitigate the potential effects of mortality caused by neonicotinoid insecticides. Thus, the deaths of individual pollinators may not lead to a simple proportionate decrease in the overall numbers of that pollinator species. In the case of rare species, extra mortality caused by insecticides could lead to a threshold population density being crossed below which the species declines to extinction, hence magnifying their effects. However, there is a weak evidence base to help understand the presence and magnitude of these effects in the field. Models of honeybee and bumblebee colony dynamics, as well as population-level models of all pollinators, are important tools to explore these effects [E_{xp_op}].

(42) There is evidence that some crops do not always receive sufficient pollination [D_{ata}], and further limited evidence that this has increased in recent decades [S_{upp_ev}]; but the information available does not allow us to determine whether or not this has been influenced by the increased use of neonicotinoids [E_{xp_op}]. Whether pollination deficits in wild plants have increased is not known [E_{xp_op}].

(43) Declines in the populations of many insect species in general and pollinators in particular have been observed (para. 7) although the decline in bees predate by some decades the introduction of neonicotinoid insecticides, and there is some evidence of a recent abatement in the rate of decline for some groups [D_{ata}]. Habitat alteration (especially in farmland) is widely considered to be the most important factor responsible. The evidence available does not allow us to say whether neonicotinoid use has had an effect on these trends since their introduction [E_{xp_op}].

(44) There have been marked increases in overwintering mortality of managed honeybee populations in recent decades (para. 8) [D_{ata}]. It has been suggested that insecticides (particularly neonicotinoids) may be wholly or partly responsible. The weak evidence base cannot at present resolve this question although honeybee declines began before the wide use of neonicotinoids and there is poor geographical correlation between neonicotinoid use and honeybee decline [E_{xp_op}]. Two studies using different

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(a) Cresswell *et al.* 2012 [17]. Used 'Hill's epidemiological "causality criteria"' and concluded that the evidence base did not currently support a role for dietary neonicotinoids in honeybee decline but that this conclusion should be seen as provisional [E_{xp_op}].

(b) Staveley *et al.* 2014 [18]. Used 'causal analysis' methodology and concluded that neonicotinoids were 'unlikely' to be the sole cause of honeybee decline but could be a contributing factor [E_{xp_op}].

(45) Neonicotinoids are efficient plant protection compounds and if their use is restricted farmers may switch to other pest-management strategies (for example, different insecticides applied in different ways or non-chemical control measures) that may have effects on pollinator populations that could overall be more or less damaging than neonicotinoids. Alternatively, they may choose not to grow the crops concerned, which will reduce exposure of pollinators to neonicotinoids but also reduce the total flowers available to pollinators [E_{xp_op}].

(46) *Summary*. To understand the consequences of changing neonicotinoid use, it is important to consider pollinator colony-level and population processes, the likely effect on pollination ecosystem services, as well as how farmers might change their agronomic practices in response to restrictions on neonicotinoid use. While all these areas are currently being researched there is at present a limited evidence base to guide policy-makers [E_{xp_op}].

Endnotes

[1]The honeybee is *Apis mellifera* (Apidae); bumblebees are *Bombus* species (Apidae), while solitary bees belong to a number of different, related families (Apiformes). Bees belong to the order Hymenoptera, while true flies are in the order Diptera (hoverflies are in the family Syrphidae) and butterflies and moths in the order Lepidoptera.

[2]Natural capital describes the components of the natural environment that produce value (directly and indirectly) for people; the actual benefits are called ecosystem services (which can be thought of as the flows that arise from natural capital stocks).

[3]A milligram (mg) is one thousandth (10^{-3}) of a gram (g); a microgram (μg) is one millionth (10^{-6}) of a gram and a nanogram (ng) is one billionth (10^{-9}) of a gram. We express concentrations as nanograms insecticide in 1 g of substance and hence in units of ng g^{-1} (the equivalent metrics 'one part per billion' or 1 μg kg^{-1} are frequently used in the literature). Concentrations are also sometimes expressed per volume (μg l^{-1}); for neonicotinoids 1 ng g^{-1} is approximately 1.3 μg l^{-1} in a 50% weight for weight sugar solution.

[4]The LD_{50} (lethal dose 50%) is the amount of a substance that kills 50% of exposed organisms.

[5]European Food Safety Authority.

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Maintenance Practices for Fields 23 and 24
South Germantown Recreational Park
Patriot Bermudagrass

March
- Aerate
- Inspect goals/hang nets and place on field
- Layout and paint lines

April
- Mow grass 2x/wk between ¾ and 5/8 of inch to encourage sunlight to penetrate
- Shift layout of lines every two weeks, shift players benches and receptacles to opposite side of field to eliminate wear
- Aerate using solid 7/8" solid tines one way

May
- Continue Mowing at same height
- Move lines, benches and receptacles
- Fertilizer granular at 1 lb per 1000'ft
- First application of Holganix--an organic tea for turf and landscape plantings rate of 5 gal/2 A
- Second application of Holganix add Ammonia Sulfate fertilizer
- Aerate continue using 7/8 " solid tines
- Take soil samples
- Early post emergent herbicide application for goosegrass and crabgrass

June
- Change height of mowing to 3/8"
- Spray out perennial rye grass using herbicide (Revolver)
- Fertilize with granular at 1 lb. per 1000'ft 24-0-12 used Vicon broadcast spreader
- Irrigate early in morning when necessary
- Aerate using 7/8" hollow tines leaving plugs
- Verticut two different ways
- Fertilize with Holganix and Ammonium sulfate
- Apply growth inhibitor (Cutless, Primo etc.) at the medium rate and reapply every two weeks in the height of the growing season. This will encourage lateral growth instead of upward growth

July
- Continue mowing at 3/8" height or lower
- Continue watering when needed
- Shock Wave one way
- Fertilize with granular NPK as before
- Continue to shift lines, benches and cans
- Spot treat with early post emergent herbicide application for goosegrass and crabgrass

August
- Continue mowing at reduced height
- Continue shifting lines
- Continue watering as needed to achieve the 1 to 2 inches per week
- Apply Holganix and Ammonium sulfate then water in on a 10 minute cycle.
- Sod where needed (goal mouths, center and sidelines)
- Aerate with core tines one way
- Seed with intermediate rye or perennial rye grass at 5 to 6 lb. per 1000'ft

September
- Continue mowing at the shorter height
- Continue watering to establish rye grass seed
- Continue shifting new lines.
- Aerate with solid tines one way
- Verticut then blow off thatch
- Top dress with sand (fine to medium construction sand) 30 tons over 2.2 acres
- Fertilize with granular at 1 lb. per 1000'ft

October
- Mowing at 5/8'' to 1"in height.
- Continue moving lines benches and cans
- Over seed with rye grass at lower rate
- Aerate with solid tines one way

November
- Mowing will be as needed
- Apply Acelepryn insecticide if grubs are detected

Registered Employee Training
Maryland National Capital Park and Planning Commission
Topics specified by the Maryland Dept. of Ag. Pesticide Regulation Section 15.05.01.04

Date: ______________________ **Start time:** __________ **End time:** __________

Your name: ______________________ ______________________
Print your name Sign your name

Instructor: Jody Fetzer, Green Management Coordinator, M-NCPPC

Topics covered today: **Photo taken?** Yes No

- **PowerPoint presentation**
  - ☐ Pest identification, characteristic feeding damage
  - ☐ Choice of control methods—Integrated Pest Management
  - ☐ Timing and pest biology
  - ☐ Maryland pesticide regulations
  - ☐ Prior notification of sensitive individuals list; Pesticide sensitive crop list
  - ☐ Certification requirements to become an Applicator
  - ☐ Invasive Plant awareness
  - ☐ Glyphosate application tips & techniques
- **Video: "Using Pesticides Safely" Modules 1 - 6**
  - ☐ Pesticide law and regulations
  - ☐ Label comprehension
  - ☐ Safety and emergency procedures
  - ☐ Pesticide exposure, health risks, poisoning
  - ☐ Personal protective equipment (PPE)
  - ☐ Proper pesticide handling and storage
  - ☐ Spill procedures
  - ☐ Environmental concerns
  - ☐ Non-target effects
- **"Where to locate" walking tour led by:** ______________________
  - ☐ First aid kit
  - ☐ Spill kit
  - ☐ Personal Protective Equipment
  - ☐ Pesticide labels, MSDS, Application Forms
  - ☐ Posting signs
  - ☐ Water spigot with a backflow preventer
- **Quiz score:** ________ ______________________

Instructor's signature certifying completion of checked topics

Focal point

Plant Health and Public Perception

Pesticides in Public Spaces: Protecting Plants, People, and the Environment

Jody Fetzer and Cindy Baker

Beauty, serenity, and safety are essential components of the visitor experience in public gardens. Pesticide safety has been in the news and under discussion both in the United States and Canada due to potential adverse effects on children, bees, and the environment. To protect their citizens, several states, cities, counties, and municipalities have passed legislation to prohibit pesticides.

Pesticide safety is not a new concern. In 1959, entomology professors from University of California's Riverside and Berkeley campuses published an article in *Hilgardia* mentioning potential "hazards to insecticide handlers and to persons, livestock, and wildlife subjected to contamination by drift." They further stated, "Unquestionably, some of these problems have arisen from our limited knowledge of biological science; others are the result of a narrow approach to insect control."[1]

Today, after years of scientific research, we have gained knowledge regarding the molecular mechanisms of pesticides; we have the ability to analyze biochemical pathways; and researchers have amassed biological data to better understand complex plant health issues. Decades of data have led to more effective strategies and safer products for managing pests. Due to rigorous scientific testing and registration requirements implemented in the 1970s with federal oversight, the required labeling provides instructions that protect handlers and minimize environmental risks. Just as the entomology professors—Stern, Smith, van den Bosch, and Hagen—predicted, detailed knowledge of biological science has broadened our approach to insect control!

The authors further noted that pest populations were on the increase because of the environmental changes caused by humans accommodating their needs for food and space; the transporting of plants and pests across geographical barriers, leaving their specific predators, parasites, and diseases behind; and changes in the economic threshold levels—people expecting higher quality produce. All of this holds true today; pests continue to be on the move, and climate change may accelerate this process. Public gardens are facing some very serious plant health-management challenges!

Emerald Ash Borer at Chicago Botanic Garden

When the Emerald Ash Borer (EAB) was first discovered in Detroit, we viewed it as something insignificant and far away—a host-specific, slow-moving pest. But a few years later, everyone realized that this was a devastating pest and—through human intervention—was spreading fast and broadly.

At the Chicago Botanic Garden (CBG) we felt it was necessary to prepare for the worst-case scenario—EAB would likely invade Chicago. Our inventory listed 451 *Fraxinus* in the ornamental collection. This meant a significant number of trees would either need to be treated with pesticides to keep them healthy, or removed to prevent hazardous liability issues.

Our plan and our recommendations for any botanic garden facing these issues are as follows:

1. **Develop close networking** with Federal, State, and professional green industry groups including the United States Department of Agriculture, your state's Department of Agriculture, International Society of Arboriculture, Sentinel Plant Network (SPN), APGA, local extension services, and neighboring botanic gardens to stay on the forefront of any and all information regarding detection and treatment options.
2. **Inventory and assess.** —An accurate and thorough inventory of what exists is critical to developing a plan. Record tree health, aesthetic aspects, collection value, and donor trees.

Focal point

3. **Develop a plan** to save the best and most important trees. At CBG we selected a core group of approximately fifty ash trees to protect as part of the collection.
4. **Research product options** and carefully select the most effective and appropriate pesticide and strategy. Our smallest trees, <10", would receive soil drench treatments with imidacloprid. Larger trees would be injected with TREE-äge®.
5. **Identify and budget** for removals that are not critical to the collection. We identified four hundred trees in the gardens—near high visitor areas that needed a plan for removal. Many were old and very large; estimates to have them removed by a professional tree company ranged from $750 to $1,500 each. That was an expense we would not be able to meet even if spread out over ten years. Therefore, grant requests were written to help cover costs of removals and replacement trees. Corporate sponsor SavATree was brought on board to help us with costs of both removal and protective treatment. Operating expenses were requested from our board for additional removal costs—both labor and hauling of ash wood.
6. **Develop plan phases**. We developed a multi-task plan which included removing a predetermined number of ash trees annually—alive or dead—and proactively treating all others that would then be removed at a future date. This allowed us to control costs and labor and prevent hazardous tree conditions that we could not keep up with.

As it turned out we had developed our plan just in the nick of time. EAB did arrive at CBG, and when the insects invaded, they came in the millions! We expected EAB to "creep" across our property and take several years before all the trees were affected. Instead they came as a smothering blanket, affecting all 385 acres within almost the same year. What was predicted as a five- to ten-year decline took less than four.

As environmental stewards and responsible pesticide users, we believed that saving all 451 trees in the collection would have been the wrong choice even though most were beautiful and healthy pre-EAB. As collections managers, we felt that it was very important to save select trees. By planning ahead, we were able to make good choices grounded in facts.

We shared our story with homeowners and municipalities in our region to help others make better informed choices. Our EAB battle built new bridges connecting us with governmental and educational institutions. We feel better prepared for the next invasive pest—and you know there will be one!

Pesticides helped us to preserve important trees and to lower costs—by delaying tree death, we gained time to create a fiscal plan for expensive removals. Pesticides have associated risks, but they also provide many benefits and are critical tools when used as part of a well-thought-out management plan. This process of analyzing options and combining strategies to manage pests is known as Integrated Pest Management (IPM).

Integrated Pest Management

The 1959 Integrated Control Concept forms the backbone of our current IPM approach to plant pest management throughout public gardens and parks. Developed by Stern, Smith, van den Bosch, and Hagen, it was proposed as a new and more sustainable way of making decisions regarding pest management for agricultural crops. It is based on these principles:

- Recognition that agriculture is part of the larger ecosystem, comprised of all the living organisms of an area and their environment;
- Supervision of insect levels so that chemical applications take place only when and where they are absolutely necessary;

Focal point

- Promotion of beneficial insects through conservation and augmentation;
- Use of products and application timing to target specific pests, minimizing the effect of treatment on pests' natural enemies.

Intervention with pesticides or plant removal may be the only options for some fast-moving pests such as EAB, but IPM includes much more than pesticides. Steve Stauffer, Kristine Ciombor, and Mike Rose stressed the importance of using biological control agents as part of an IPM program in public gardens.[3] Biological control is especially effective for managing pests in conservatories with very diverse plant species. While it may seem simple to create a system based on multiple methods of control, introducing biological controls leads to complicated details; both the pest and beneficial organisms are living organisms whose environmental responses must be considered so that beneficial organisms prevail over the specific pest. Beneficial organisms are more widely available now, and we have options to help manage many challenging pest problems. The Association of Natural Biocontrol Producers (anbp.org) is a resource with lists of producers and distributors of beneficial organisms used for biological control. It is important to examine beneficial organisms upon arrival and to monitor pest and beneficial populations to determine if additional measures are needed to protect plant health.

IPM specialists, supporting staff, volunteers and students—the people—are essential for collecting site-specific data and designing programs that integrate strategies for a park or public garden's specific problems. Nancy J. Bechtol detailed options for gardens lacking the financial resources to hire specialized IPM staff.[2]. Bechtol provided guidelines for building a successful IPM program if specialized staff were brought in. Her work inspired staff at many public gardens and parks including the Minnesota Landscape Arboretum and NYBG. Since its inception in the early 1990s, the Maryland National Capital Park and Planning Commission located in Montgomery County, Maryland, has become a recognized leader in the mid-Atlantic region for innovative and comprehensive IPM programs that encompass public gardens, parks, recreational fields, forests, natural habitats, and storm water facilities.

People, beneficial organisms, pesticides, and timing! Optimum time of application leads to less pesticide and fewer numbers of applications. University extension e-newsletters, pest alerts, and diagnostic networks keep us informed of the emergence of local pests and arrivals from outside our state. The National Plant Diagnostic Network (http://www.npdn.org) provides links to regional plant health threats. The SPN is a resource for public gardens (http://www.publicgardens.org/content/sentinel-plant-network).

Pesticides—newer, safer, better—will continue to be a component of our diversified toolbox of options used for managing weeds, insect pests, and pathogens. Public gardens and parks with their broad diversity of plants have much more varied pests than do agricultural crops—we also have more visitors! Responsible pesticide use by public gardens is important: why chemical options are needed, what products and alternative organisms are selected, how they are administered and timing strategies for applications are decisions critical to our missions of providing the best care for our collections, the environment, and visitors.

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2. Nancy J. Bechtol, "Guidelines for Establishing an Integrated Pest Management Program." *Public Garden* 4 (1): 44-47.

3. Steve Stauffer, Kristine K. Ciombor, and Mike Rose. "Whither Goest Pest Control?" *Public Garden* 11 (1): 23-25.

Weed Management in Montgomery Parks

Innovation
Invention
Integrated Pest Management

Why does Parks manage weeds?

- Protect function
  - Stormwater facilities
  - Athletic fields
  - Signs and fence posts
  - Playground buoyancy
- Improve safety
  - Walkways & paths
  - Train tracks
  - Infields
  - Noxious plants e.g. poison ivy
- Minimize infrastructure deterioration
- Reduce resource competition near desirable plants
  - Tree rings
  - Shrub beds
  - Turf areas

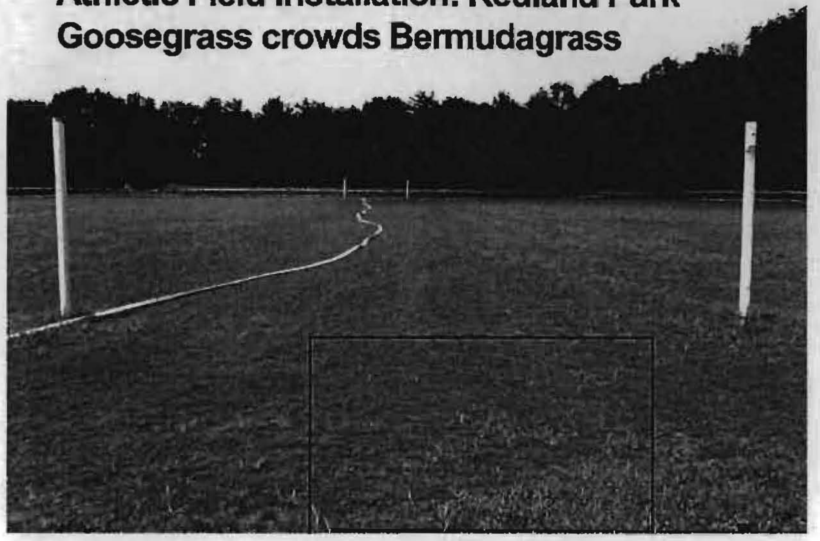
Weed management in Parks:
Innovation, Invention and IPM strategies

- Tried and true
  - Weed barrier
  - Rip & replant
- Targeted applications
- 25(b) exempt products
- Alternative methods
  - Giant weed bar
  - Propane flaming
  - Biological control
- Collaborative decisions
- Volunteers

Poor turf stands on new & existing sites lead to erosion & run-off

- Selective herbicides
- Staff training

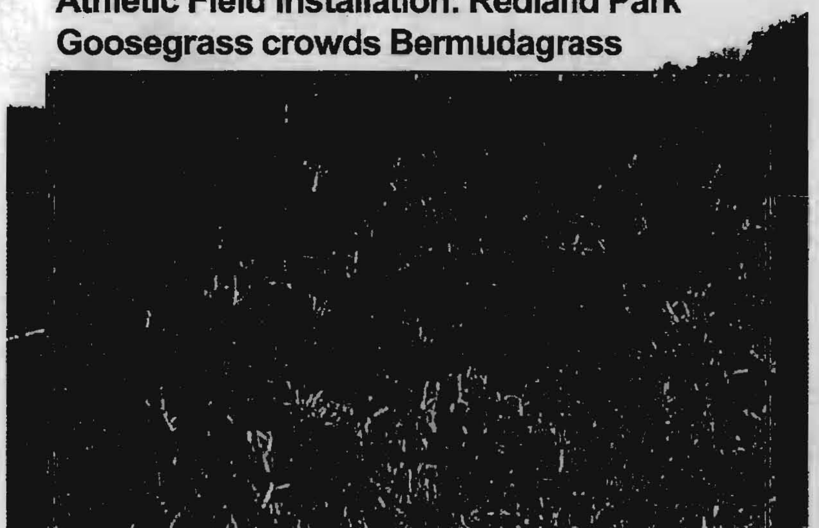
Athletic Field installation: Redland Park
Goosegrass crowds Bermudagrass



Goosegrass (*Eleusine indica*)

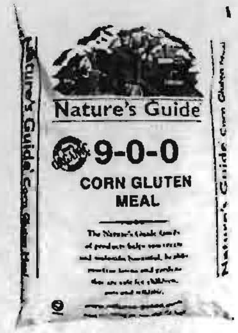
- Clumped summer annual
- Germinates when soil temperatures reach 63°F–65°F for at least 24 consecutive hours
- No seed dormancy, Long seed viability
- Tolerates close mowing and compacted wet or dry soil
- Managed with selective herbicide application

Athletic Field installation: Redland Park
Goosegrass crowds Bermudagrass



Innovative weed bar for infields

Corn Gluten Meal



- Pre-emergent weed suppression
- Odor for several days
- Apply on calm day so product doesn't blow away
- Rate is high so best under mulch
- Suppresses germination
- Not compatible with seed planted grass, flowers, or vegetables

S)

Not a good choice in Parks due to Fertilizer Law!
OK for flower or vegetable gardens if doing transplants

Flower Bed, Bulb, Rose, Garden and Shrub Application:
To control annual weeds in and around flowers, roses, bulbs and shrubs apply 20 lbs. per 1000 sq. ft. by sprinkling evenly over the soil surface. Product works best if it is scratched in or worked into the top 2 inches of soil. Apply water to soil to activate the product.

Broadcast Spreaders (Rotary)	Settings 15 lbs. 1000 sq. ft.
True Temper	8
Republic EZ/Ortho	8 (2 passes)
Republic EZGrow	14 (2 passes)
Spyker	10
Scotts Speedy Green	9 (2 passes)
Scotts Easy Green	30 (2 passes)
Drop Spreaders	
True Temper CD20	10
Republic EZ Ortho	12
Scotts AcuGreen	14
Scotts Precision Green	18

Guaranteed Analysis
Total Nitrogen (N) 8.0%
8.00% Water Insoluble Nitrogen
Available Phosphate (P_2O_5) 2.0%
Soluble Potash (K_2O) 4.0%
This product contains 8.00% slowly available nitrogen.
Derived from: Corn gluten meal, bone meal, and potassium sulfate

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Acetic Acid

Acetic acid concentrations over 11% can cause burns upon skin contact. Eye contact can result in severe burns and permanent corneal injury. The other concentrated acetic acid products registered through EPA and the states for commercial use all have restricted entry intervals of 48 hours and list personal protection equipment to be used by the applicator.

Flame weeding

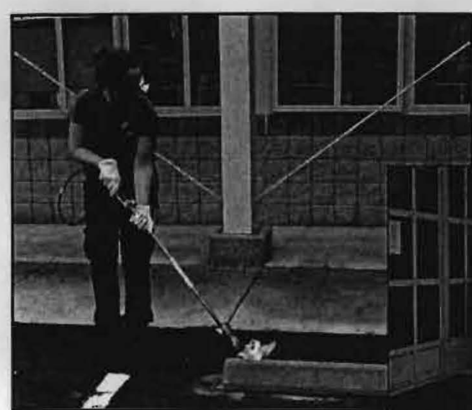
- Invasive plants
- Near water
- Parking lots
- Curb edges

Acetic Acid not a 25(b) exempt pesticide

CAUTION!

What Is Actually Registered For Use?
Five products containing acetic acid and marketed as herbicides are currently registered for use in Washington. Two of them are 25% concentrates with instructions to dilute down to 6.25% and use on rights-of-ways, non-crop, and industrial lands. Three of them are labeled for homeowner use (St. Gabriel Labs Fast Acting Burn Out RTU, Nature's Glory Weed and Grass Killer RTU, and Greenergy's Blackberry and Brush Block). Their acetic acid concentrations are 6.25%, 6.25%, and 7% respectively. Curiously, Greenergy's product label lists acetic acid as an inert ingredient; citric acid is listed as the active ingredient. By listing the ingredients this way, Greenergy is able to take advantage of EPA's "Minimum Risk Pesticide" definition. Products falling under this category are also known as "25(b) products" after the FIFRA rule describing criteria for minimum risk pesticides. Such products need not be registered at the Federal level and do not carry an EPA registration number. Washington law requires 25(b) products to go through the Washington State Department of Agriculture's (WSDA) registration process regardless, whilethe Oregon Department of Agriculture (ODA) does not require state registration of 25(b) products. Fast Acting Burn Out RTU (EPA Reg # 69836-2-63191) is not registered in Oregon, leaving two products, Nature's Glory Weed and Grass Killer RTU (EPA Reg #69836-2), and Greenergy's Blackberry and Brush Block (25(b) product so no EPA number) as legal to use in Oregon.

Propane Flame Training at Red Wiggler organic farm (note the fire extinguisher)




Kills weeds in sidewalks & curbs

Flaming invasive weeds in parks


Oplismenus hirtellus ssp. undulatifolius


Wavyleaf basketgrass

Small & Large Flamers: 30# wheeled tank and hand-held for spot treating weeds

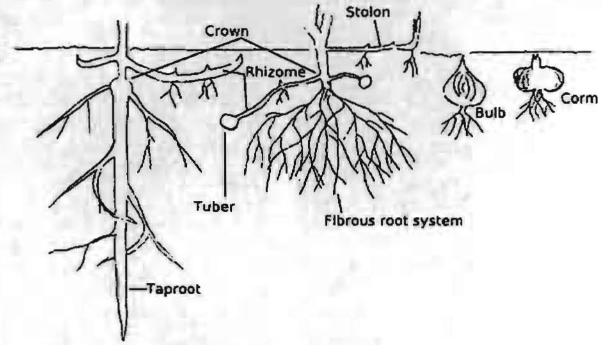


Irritating weeds

- Spines on leaves & stems e.g. Thistle
- Milky sap e.g. Euphorbia sp.
- Poison ivy
- Mugwort

Weed Roots Survival Structures

- Taproot
- Rhizome
- Tuber
- Stolon
- Fibrous
- Bulb
- Corm

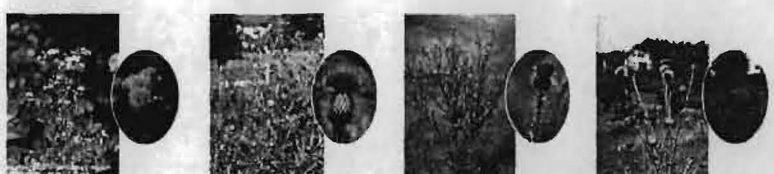


Broadleaf seedlings. Figure credit: Mark Schonbeck, Virginia Association for Biological Farming.

Noxious Weeds

MARYLAND NOXIOUS WEED I.D.

CANADA THISTLE (Cirsium arvense) | BULL THISTLE (Cirsium vulgare) | PLUMELESS THISTLE (Carduus acanthoides) | MUSK THISTLE (Carduus nutans)



Thistle root growth

Canada Thistle

- Root system
  - deep (6 - 10 ft)
  - wide (10 ft. per year)

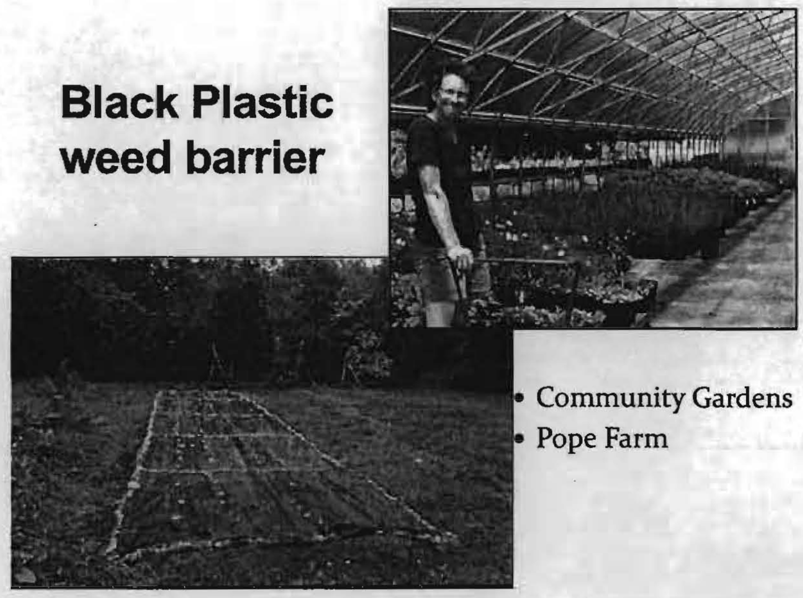
Wood Mulch weed barrier

This bed was dug and excavated 3 feet deep to get rid of thistle...

It didn't work!

South Germantown driving range

Black Plastic weed barrier



- Community Gardens
- Pope Farm

Weeds in Stormwater Facilities

- What plants are supposed to be in Bio-retention?
  - Remove weeds that have invaded
  - May have woodies as part of their design

Managing Weeds in Stormwater facilities

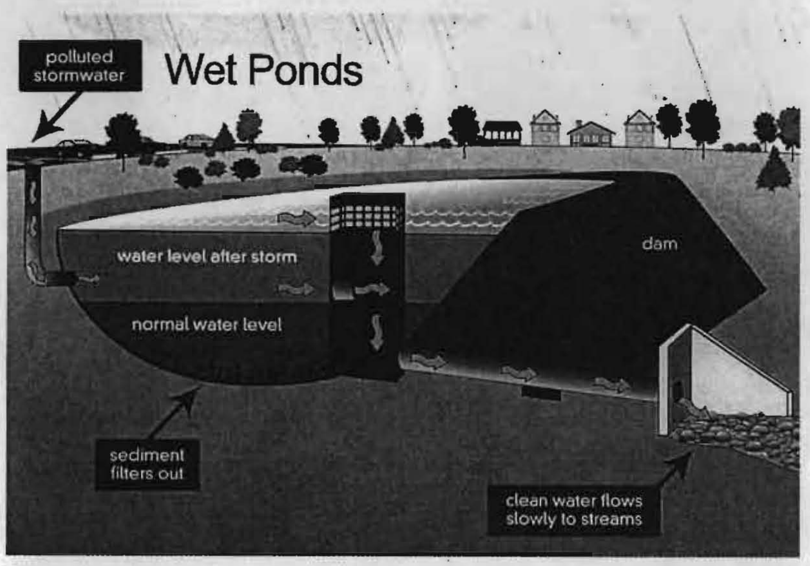
- Management Methods
  - Mow if possible or string trim
  - Paint stumps with glyphosate
  - Hand pull some herbaceous
  - If over grown with weeds, start from scratch

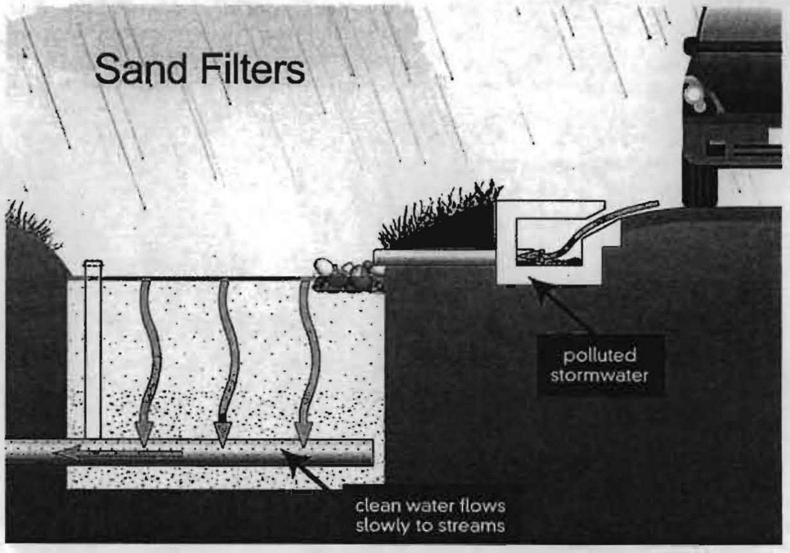
450 Stormwater Facilities

- Non-structural maintenance
- Trash removal & sediment removal; infalls/outfalls, low flows
- Mow, string trim dam embankments
- Woody weed and vegetation management

Spot treat: Paint cut stumps, twigs

- Woody growth on storm water dams
- Dry ponds
  - Multiflora Rose
  - Barberry
  - Tree of Heaven
- Buckthorn
- Invasive vines





Weed Challenges
in Stormwater Facilities

- Dry ponds if not maintained invaded by:
  - Barberry, multiflora rose, mile a minute, tree of heaven
  - Cut and paint with herbicide to kill
    - if dig weeds it breaks up integrity of dam
  - Know what areas are supposed to be without woody growth
    - Dams, outfalls, infalls (embankments)
    - If huge trees in basin, may leave or may remove

Flaming or glyphosate is used to kill weeds in stormwater management areas

Bio-Retention Facilities

filter pollutants using soil, stone and plants.

Rip & replant

Winding Creek Bioretention SWM filled with Invasive weeds so replanted, then a storm came in and entirely planted again

Rip & replant

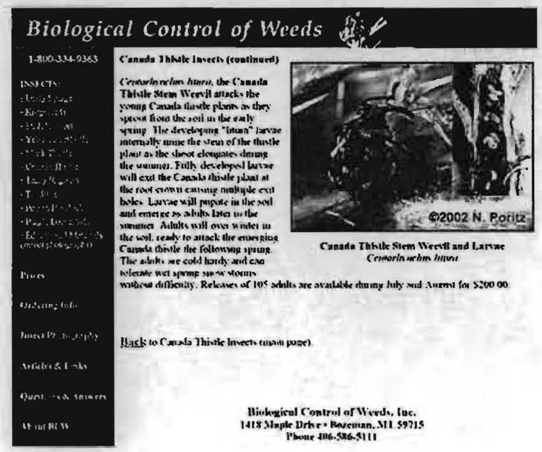
Winding Creek Bioretention SWM filled with Invasive weeds so replanted, then a storm came in and entirely planted again

Rip & replant

Winding Creek Bioretention SWM filled with Invasive weeds so replanted, then a storm came in and entirely planted again

Targeted applications for NNI
Spot treat with herbicide

Naturally occurring or introduced
Watch for biocontrol "helpers"



Biological control of weeds

- Mile a Minute (MAM) weevils obtained from Maryland Department of Agriculture in May 2010
- 1000 weevils were released in Little Bennett
- Summer of 2013 detected them 25 miles away in Sligo!

"Currently we see MAM weevils in just about every Park"
Carole Bergmann



Biological control organisms

- Conserve naturally occurring organisms
- Introduce purchased bio controls
- Use as component of IPM for weed problems
- Insect & mite management in Brookside Conservatory
- Natural controls important during "Wings of Fancy"

Collaborative decision-making

- Kate, Wildlife Biologist
- Nancy, Parks Northern Region Stormwater Specialist
- Dean, Park Manager with park staff
- Jody, IPM Specialist

IPM for Cattails

Reduce cattail population to clusters instead of the current wide band encircling the pond

- Conserve habitat and protect wildlife
- Identify cattail species and grassy plants
- Filter stormwater with some cattail clusters
- Manage a band of tall grasses to slow stormwater
- Improve access to the lake for recreation

An integrated multi-step approach was decided upon that takes into account water quality, plant preservation, habitat conservation as well as pond use and function.

Cattails reach invasive levels in stormwater pond

Protect water quality!
Reduce nutrient load, reduce cattails

Volunteers

Community garden weed project
Playground weed pullers

Weeds compete with vegetable plants

- Wiregrass
- Mugwort
- Creeping Charlie

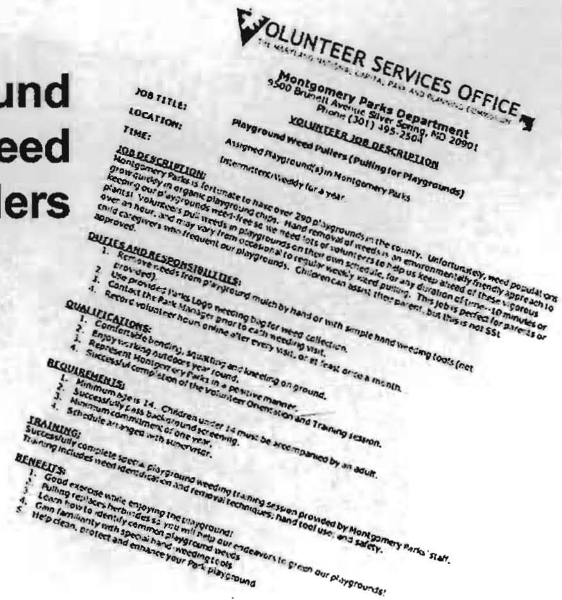
Community Garden Weed Project
Propane Flaming then Black Plastic

Community Garden Weed Project
Propane Flaming (2 set-aside plots)

(124)

Playground Weed Pullers
South Germantown Adventure Playground

Playground Weed Pullers


VOLUNTEER SERVICES OFFICE

Montgomery Parks Department
9500 Brunett Avenue Silver Spring, MD 20901
Phone (301) 495-2504

VOLUNTEER JOB DESCRIPTION

JOB TITLE: Playground Weed Pullers (Pulling for Playgrounds)

LOCATION: Assigned Playground(s) in Montgomery Parks

TIME: Intermittent/Weekly for a year.

JOB DESCRIPTION:
Montgomery Parks is fortunate to have over 290 playgrounds in the county. Unfortunately, weed populations grow quickly in organic playground chips. Hand removal of weeds is an environmentally friendly approach to keeping our playgrounds weed-free so we need lots of volunteers to help us keep ahead of these vigorous plants! Volunteers pull weeds in playgrounds on their own schedule, for any duration of time--10 minutes or over an hour, and may vary from occasional to regular weekly weed pulling. This job is perfect for parents or child caregivers who frequent our playgrounds. Children can assist their parent, but this is not SSL approved.

DUTIES AND RESPONSIBILITIES:
1. Remove weeds from playground mulch by hand or with simple hand weeding tools (not provided).
2. Use provided Parks Logo weeding bag for weed collection.
3. Contact the Park Manager prior to each weeding visit.
4. Record volunteer hours online after every visit, or at least once a month.

QUALIFICATIONS:
1. Comfortable bending, squatting and kneeling on ground.
2. Enjoy working outdoors year round.
3. Represent Montgomery Parks in a positive manner.
4. Successful completion of the Volunteer Orientation and Training session.

REQUIREMENTS:
1. Minimum age is 14. Children under 14 must be accompanied by an adult.
2. Successfully pass background screening.
3. Minimum commitment of one year.
4. Schedule arranged with supervisor.

TRAINING:
Successfully complete special playground weeding training session provided by Montgomery Parks' Staff. Training includes weed identification and removal techniques; hand tool use; and safety.

BENEFITS:
1. Good exercise while enjoying the playground!
2. Pulling replaces herbicides so you will help our endeavors to green our playgrounds!
3. Learn how to identify common playground weeds
4. Gain familiarity with special hand-weeding tools
5. Help clean, protect and enhance your Park playground

Playground Weed Pullers

- Nature –friendly weed management in parks playgrounds
- South Germantown pilot program 2015
- Classroom and field training
- Training in April

Weed Management in Montgomery Parks

Jody Fetzer
Green Management Coordinator
jody.fetzer@montgomeryparks.org
240-863-4149

Maryland Certified Pesticide Applicator Recertification Training options

It's that time of year when Certified Applicators need to look for training opportunities so we get the necessary annual recertification credits. This is best accomplished by attending an educational meeting. See the list below for options

Some of these meetings also offer Professional Fertilizer applicator recertification credits so watch for that option if you register.

Maryland requires every commercial applicator to attend re-certification training each year between July 1 and June 30 in order to renew their certificate. If an applicator is certified in multiple categories they must attend re-certification for each category. The training does not have to be held in Maryland. In order to become re-certified, an individual must obtain the following credits on an annual basis:

- Categories 1, 3, 7, 8, and 9 and 13 must receive **8 credits**
- Categories 2, 5, and 6 must receive **6 credits**
- Category 10 must attend re-certification training that pertains to the area of their work
- **1 credit is equal to one half hour of training**

Sponsors of the re-certification sessions must ensure that individuals needing re-certification credit attend the appropriate sessions and submit documentation to MDA that each individual has satisfied the training requirements. Documentation includes each participant's name, social security number and certificate number. If the meeting was not submitted by the sponsor, documentation of attendance must be supplied to MDA by the applicator. Certificates of completion or similar documentation can be used.

Upon submission of proof of training, MDA will update the certified applicator's training records and a renewal form will be mailed to the applicator in April. If a certified applicator does not attend re-certification training, or provide MDA with proof of attendance, the applicator will have to retake the certification exams by June 30 in order to renew the certificate.

Pesticide re-certification options for Jan/ Feb 2015

The following is a list of meetings that have been approved by MDA for re-certification credit in Maryland.

January 6, 2015 Maryland Turfgrass Conference and Trade Show. University of Maryland, College Park. Ornamental and Turf categories 3A, 3C, 6, 10

January 22, 2015 FALCAN's Pest Management Conference, Frederick Fairgrounds, Null Building, 797 East Patrick Street, Frederick, MD 21701 Ornamental and Turf categories 3A, 3C, 5, 6, 10 Also Fertilizer CEU's for recertification. Contact Dan Felice, 301.606.8631dfelice@synateksolutions.com

February 12, 2015 Landscape Contractors Association Pesticide Recertification Conference. Universities at Shady Grove Conference Center, 9630 Gudelsky Drive, Building 2 II-1400, Rockville, MD 20850 Categories 2, 3ABC, 5, 6, 10http://www.lcamddcva.org/programs/recertification.cfm
https://www.lcamddcva.org/commerce/Pest_Recert_2015.cfm

http://extension.umd.edu/ipm/conferences

Link to list of educational conferences, some offer recertification credits.

MARYLAND DEPARTMENT OF AGRICULTURE
PESTICIDE REGULATION SECTION

TRAINING STANDARDS FOR REGISTERED EMPLOYEES

Each employee performing pest control sales or service must complete a training program approved by the Maryland Department of Agriculture that satisfies the requirements established by the Regulations Pertaining To The Pesticide Applicators Law, Section 15.05.01.04(3)(a). The purpose of the training is to instruct employees in the proper use of pesticides and the basic principles of pest control. The employee should be competent to recommend, handle or apply pesticides without harming themselves, children, other individuals, pets and the environment. The training can be accomplished with use of the Core and category specific manuals used for taking the certification examinations, or a DVD training series "Using Pesticides Safely" developed by the University of Maryland Extension (UME). The DVD series provides general information and does not address specific information regarding pest identification and control recommendations. The employee must receive training in the following topics and should have a basic understanding of the concepts associated with each subject. The following is a listing of the required topics and associated concepts along with a listing of the corresponding Core Manual Chapters and DVD modules that covers the information:

1. **Pesticide Law and Regulations** – Chapters 2 and 13 of the Core Manual or Module 1 of the DVD

    a. Federal pesticide laws (FIFRA)
    b. Maryland Laws and Regulations
    c. Certification requirements
    d. Enforcement of pesticide laws and regulations

2. **Label Comprehension** – Chapter 3 and Chapter 10 page 150 of the Core Manual or Module 2 of the DVD

    a. Required information and the organization of pesticide product label
    b. General or restricted use classification
    c. Following label directions

3. **Safety and Emergency Procedures** – Chapters 5, 6 and 9 of the Core Manual or Module 3 of the DVD

    a. Pesticide exposure
    b. Potential health effects
    c. Personal protective equipment
    d. Pesticide poisoning
    e. Spill procedures

4. **Proper Pesticide Handling and Storage** – Chapters 8, 10 and Chapter 11 page 163 of the Core Manual or Module 4 of the DVD

    a. Mixing and loading
    b. Proper application
    c. Stroage
    d. Disposal

5. **Pest Identification and Control Recommendations** – Chapter 1 pages 1 through 9 of the Core Manual and Category Manuals

    a. Identification of pests
    b. Characteristics of damage caused by pests
    c. Pest biology
    d. Choice of control methods and timing of control techniques

6. **Pesticide Application Techniques** – Chapter 10 pages 153 through 159 and Chapter 11 of the Core Manual and Category Manuals

    a. Procedures for applying different formulations
    b. Proper placement of pesticides
    c. Misuse of pesticides

7. **Environmental and Health Concerns** – Chapter 7 of the Core Manual and Module 5 of the DVD

    a. Identification of sensitive areas
    b. Hazards to non-target organisms and endangered species
    c. Contamination of water sources
    d. Pesticide persistence and residues

8. **Integrated Pest Management Principles** – Chapter 1 pages 10 through 16 of the Core Manual and Module 6 of the DVD

    a. IPM concepts
    b. Monitoring pest populations
    c. Integrated control techniques

Rev 12/10

Steps to Becoming a Certified Pesticide Applicator in Maryland

If you have questions please contact Jody Fetzer, Green Management Coordinator, M-NCPPC
Email: jody.fetzer@montgomeryparks.org
Mobile phone: 240.863.4149
or
Maryland Department of Agriculture
Pesticide Regulation Section
50 Harry S. Truman Parkway
Annapolis, MD 21401
(410) 841-5710

Each applicant for a public agency applicator certificate must meet the following requirements:

	18 years of age or older
	Demonstrate proof of practical and scientific knowledge of pest control
	Have one of the following:
	(i) One year of experience acceptable to the Department as a full-time registered employee engaged in those categories in which the applicant seeks to be certified (proof of experience may include affidavits from former employers, certification or licensure from other states or the federal government) see "VerifyExperienceFrm"
	(ii) A degree or academic certificate acceptable to the Department
	(iii) A combination of education and experience acceptable to the Department see "EducationExamples"
	Submit all forms to MDA (you can scan the completed form and submit electronically) see below:
	http://mda.maryland.gov/plants-pests/Documents/certification_form.pdf
	MDA will contact you when approved and will schedule you for an exam date
	Study Maryland regulations Title 15.05.01 (an abbreviated version is available from supervisor or Jody)
	Study the Training manuals: Core manual and Ornamental & Turf (we have some to borrow or if the individual wants to keep them, we can purchase more from University of Maryland (see below)
	Bring Photo ID to the test AND a calculator (no payment is needed)
	Pass examination given by the Department (70% needed to pass)
	A pest control applicator certificate is valid beginning July 1, or whenever obtained, until June 30.
	An individual who has not renewed the certificate by its expiration date, June 30th of each year, may be reexamined
	Public agency applicators are exempt from the fee

University of Maryland---Pesticide Applicator Training Manuals
For Commercial/ Public Agency/ Consultant Certification –
Get these from Jody Fetzer jody.fetzer@montgomeryparks.org
240.863.4149 (call or text)

- Core Manual
- Agricultural Manual
- Ornamentals & Turf Manual
- Aquatic Pest Control Manual

Osborne Organics

Statement of
Chip Osborne, President
Osborne Organics
on
Bill 52-14
Pesticides - Notice Requirements - Non-Essential Pesticides - Prohibitions
to
Transportation, Infrastructure, Energy and Environment Committee
Montgomery County Council

January 15, 2015

Thank you for the opportunity to present a statement to the Montgomery County Council in support of Bill 52-14.

Natural Turf Management: An Overview

At some point, discussion takes place regarding lawn and turf management programs in a variety of different situations. We understand that for many people there is a growing awareness about the chemical products used to maintain lawns and turf. Many also realize the impact of some of these products on the environment. They are aware that some chemicals, even at low dose exposures, may be harmful to public and children's health.

Included here is an explanation of the principles and protocols of natural turf management based on detailed soil test data, site assessments, and then recommendations for beginning a natural approach to turf management. I will talk a bit about how we do an RFP for these types of programs.

It is important first to document the existing physical condition of the turf areas and to establish a baseline soil analysis for chemistry, texture, and nutrient availability. A review is generally prepared with the idea that the property will be incorporated into a natural, organic management program, and all recommendations are made with that in mind. One important difference between an organic program and a conventional one is that our programs become much more site specific as opposed to a generalized approach to fertility and weed control. We are addressing what needs to be addressed in an appropriate way. Certainly, product for fertility management and building the soil biomass is important, and our approach is to address the needs of individual properties. That is not to say that we are going to have many different programs on multiple areas or playing fields, but rather that we are addressing any deficiencies or allowing for the inclusion of strategies that will help move a property through the transition process as quickly and efficiently as possible.

11 Laurel Street, Marblehead, MA 01945
781-631-2468 co@osborneorganics.com

When we discuss different management levels, we are referring to the cultural intensity required to maintain an individual turf area to the degree that meets expectations. There is not just one organic program, but rather different programs with different levels of intensity that can be created to meet the needs of an individual site. Recommendations are made based on communicated expectations.

Cultural intensity is the amount of labor and material inputs required to meet those expectations. One fact is a given in either a conventional or natural turf management program; minimal product and labor inputs meet low expectations, while higher levels of inputs meet higher expectations. This is true in any type of program, conventional or natural. We design programs to address the soil and turfgrass that will meet the expectations for the site.

When a natural management program is put in place, there is a window of time referred to as the transition period. It is during this timeframe when new products are put in place and specific cultural practices are followed. During transition, the most important aspect is to focus on the soil, not just texture and chemistry, but the biomass as well. Addressing the living portion of the soil from the beginning makes the transition successful. The length of time for this process has a direct relationship to the intensity of conventional management practices that may be currently employed.

Conventional turf management programs are generally centered on a synthetic product approach that uses highly water-soluble fertilizers and pesticide control products to continually treat symptoms on an annual basis. It is important to acknowledge that in addition to having adverse effects on human health and the environment, pesticides by definition kill, repel, or mitigate a pest. They do not grow grass. Our approach will be to implement a strategy that proactively solves problems by creating a healthy soil and turfgrass system. Healthy, vigorously growing grass will out-compete most weed pressures, and a healthy soil biomass will assist in the prevention of many insect and disease issues.

We are following a Systems Approach to Natural Turf Management® that is designed to put a series of preventative steps in place that will solve problems. This approach forms the basis for our recommendations. This systems approach is based on three concepts. It involves 1) natural product where use is governed by soil testing or site considerations, 2) the acknowledgement that the soil biomass plays a critical role in fertility, and 3) specific and sound horticultural practices.

The goal of a Natural Turf Management program is to create turf that is both aesthetically pleasing and meets site objectives. At the same time, this turf will provide a surface that will be healthy and free from toxic chemicals. The products and program discussed will be designed to utilize materials and adopt cultural practices that will avoid any runoff or leaching of nutrients and control products into the water table.

Ours is a "feed-the-soil" approach that centers on natural, organic fertilization, soil amendments, microbial inoculants, compost teas, microbial food sources, and topdressing as needed with high quality finished compost. It is a program that supports the natural processes that nature has already in put in motion. These inputs, along with very specific cultural practices, that include mowing, aeration, irrigation, and over-seeding are the basis of the program.

It is our experience that this approach will build a soil environment rich in microbiology that will produce strong, healthy turf that will be able to withstand many of the stresses that affect turfgrass. The turf system will be better able to withstand pressures from use, insects, weeds, and disease, as well as drought and heat stress, as long as good cultural practices continue to be followed and products are chosen to enhance and continually address the soil biology. While problems can arise in any turf system and may need to be dealt with, they should be easier to alleviate with a soil that is healthy and that has the proper microbiology in place.

As you can see, there is a lot that goes into a natural program, but it does not have to be overly complicated or costly. It is much more than just a product for product swap. When we see situations where an organic program has been simply the product swap, we usually see situations that have not resulted in satisfying higher levels of expectations. In a situation where a municipality or other entity subcontracts applications of product and cultural practices, it requires someone internally that possesses the knowledge about organic turf management to perform the initial soil testing an outline a program. That program then is incorporated into an RFP and goes out to bid. What cannot happen is letting an individual service provider come in and create a program that seems to make sense to them based on their product choice.

When we craft an RFP for an annual program, it becomes very specific. Detailed dates, products, rates, and cultural practices are included so that when service providers bid, it is apples to apples. If a service provider takes the soil tests, then they would interpret them and suggest a program. That leaves a very variable situation that might lead to multiple program approaches with very different costs being presented. It is a little trickier with a RFP for outsourced program implementation than it is when the work is being done in-house.

A little about Osborne Organics; we are neither service providers nor a product company. Osborne Organics has been part of the process of moving turf and landscapes from conventional management practices to a natural approach in a variety of situations and at different levels for the past twelve years. We have the technical expertise to apply the principles and practices of natural turf management in the field. It is an approach backed by sound science that responds to the need for a safer and healthier landscape from both the environmental and human health perspective.

Osborne Organics provides educational opportunities in the form of in-depth trainings to both landscape contractors and the municipal sector in natural turf methods. We have conducted programs in various regions of the country with the goal of assisting in growing the knowledge base in the field of natural turf management. These seminars are presented to large audiences or customized to small individual groups.

One of the unique capabilities of Osborne Organics is the ability to discuss the concept of healthy turf and landscapes with groups ranging from homeowners to politicians and municipal and private sector grounds staff to decision makers. With fifteen years experience in the arena of turf and sustainability from the environmental and public health perspective, we have amassed a body of knowledge that supports the mission of the company

When turf and landscape management programs are designed to address the move from a conventional approach to a natural one, we work within the transition period to assess and address the needs of our clients. As a consultants, we create different levels of management whereby we determine the cultural intensity required to meet the needs of the soil and turfgrass and at the same time meet expectations of the client while working within budget constraints.

Thank you for the opportunity to present this information in support of Bill 52-14 for your consideration.

ORGANIC LAWN CARE

WHAT DOES IT MEAN?

Presented By Eric M. Wenger


IPM

"OUR WATER IS OUR LIVES"

WHO DECIDES WHAT IS CLEAN?

- DOES ORGANIC LAWN CARE MEAN A CLEANER CHESAPEAKE BAY OR A CLEANER ENVIRONMENT?
- WHICH IS CLEANER, A SPILL OF 100% ORGANIC FERTILIZER OR A SPILL OF SYNTHETIC FERTILIZER?
- ARE NATURAL SOURCES OF NUTRIENT POLLUTION FACTORS?

OUR WATERWAYS ARE POLLUTED BY MANY DIFFERENT SOURCES

WHERE DOES NUTRIENT POLLUTION COME FROM?

- INADEQUATE STREAM BUFFERS ON FARMS
- WASTE WATER TREATMENT PLANTS
- CONSTRUCTION SITE RUNOFF
- POOR CONTROL OF STREET AND PARKING LOT RUNOFF
- BREECH OF LANDFILL BASINS
- DEER WASTE, WASTE FROM GEESE, NATURAL DECOMPOSITION OF LEAVES ETC...
- DOMESTIC PET WASTE
- ILLEGAL DUMPING
- IMPROPER APPLICATION OF FERTILIZERS
- PEOPLE AND THEIR COMMUNITIES

COMMON LAWN WEEDS
Are There Organic Controls?

- CRABGRASS
- GOOSEGRASS
- QUACKGRASS
- STILTGRASS
- BERMUDA GRASS
- NUTSEDGE/KYLLINGA
- ORCHARD GRASS
- PANICUM
- FOXTAIL

- GROUND IVY
- HYDROCOTYLE
- WILD VIOLET
- SPURGE
- OXALIS
- BLACK MEDIC
- BITTERCRESS
- THISTLE
- VERONICA

ORGANIC WEED CONTROL

- PRE-EMERGENT – Corn Gluten, short chain amino acid, highly ineffective and creates a Nitrogen imbalance i.e. too much N in the spring creating excessive growth and potential runoff*. Fall applications not as bad but may interfere with re-seeding. Violates MD Nutrient Management Law

*The Myth of Weed-Killing Gluten: "*Corn meal gluten is an effective organic herbicide*" Linda Chalker-Scott, Ph.D., Extension Horticulturist and Associate Professor, Puyallup Research Center, Washington State University

*Corn gluten meal did not prevent weeds from germinating in OSU study By: Carol Savonen
Source: Tom Cook

- POST-EMERGENT – Soaps, Vinegars, Citric Extracts

All are non-selective and do not kill roots, only foliage. Some are very dangerous and can cause severe burns and eye damage

- SELECTIVE – Fiesta Iron HDTA (not organic, expensive, not highly effective), ADIOS Sodium Chloride (expensive, temperature an issue) – They Do Not Control Difficult Weeds

- Hand Pulling – Can be very expensive and impractical

A THICK LAWN IS THE BEST WEED CONTROL

- SEED WITH HIGH QUALITY WEED FREE SEED USING RECOMMENDED VARIETIES
- USE SLICING, SPIKING OR VERTI-CUTTING WHEN SEEDING
- DO NOT USE CORE TYPE AERATION UNLESS COMBINED WITH TOP-DRESSING AND/OR ONE OF THE OTHER TYPES OF AERATION ABOVE
- CORE AERATE TO RELIEVE COMPACTION AND TO HELP INCORPORATE COMPOST

WHEN TO FERTILIZE?

"SOIL TEST AND FALL IS BEST"
APPLY 75% OF N BETWEEN AUGUST 15th AND NOVEMBER 15th WHEN TURF IS ACTIVELY GROWING

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COMPOST AND COMPOST TEAS

- COMPOST IS VERY BENEFICIAL FOR MOST SOILS
- COST CAN BE A FACTOR WHEN YOU CONSIDER ONE CUBIC YARD PER 100 SQ.FT.
- TOP-DRESSING CAN BE DONE WITH LESSER RATES - ONE CUBIC YARD PER 600 SQ.FT. (BUT MAY VIOLATE MARYLAND NUTRIENT MANANGEMENT LAW
- THE JURY IS OUT ON COMPOST TEAS AT THIS TIME, NO PROVEN BENEFITS, BUT THEY DO NOT HARM AS LONG AS THEY ARE NOT CONTAMINATED WITH HARMFUL BACTERIA
- COMPOST AND COMPOST TEAS CAN CONTRIBUTE TO NUTRIENT RUNOFF AND MAY VIOLATE MARYLAND NUTRIENT MANAGEMENT LAW

COST COMPARISON

- CONVENTIONAL IPM LAWN CARE OR A BLEND OF CONVENTIONAL AND ORGANIC ARE MORE COST EFFECTIVE AND LESS LABOR INTENSIVE
- ORGANIC LAWN CARE CAN COST BETWEEN 25% AND 100% OR MORE THAN CONVENTINAL LAWN CARE DUE TO HIGHER COSTS OF MATERIALS AND LARGER QUANTITIES OF LABOR AND MATERIALS AND WITH LESS ABILITY TO CONTROL WEEDS AND PESTS
- HIGHER COST AND LOWER RESULTS

CHESAPEAKE CLUB (defunct)

THERE ARE FEW RESOURCES OR REFERALL SERVICES STRICTLY FOR ORGANIC OR NATURAL LAWN CARE. ALTHOUGH THE CHESAPEAKE CLUB DOES NOT REFER STRICTLY NATURAL ORGANIC LAWN CARE SERVICES, MANY OF ITS MEMBERS OFFER THOSE SERVICES
www.chesapeakeclub.org

NO MOW LAWNS

Are best in shaded areas and where terrain is not too daunting according to Bill Soley of Wild Ones, www.for-wild.org
Mr. Soley does not recommend "No Mow" for small urban or suburban lots; the types of grasses used for no mow are usually sheep Fescues, Hard Fescues and Fine Fescues. Remember that "No Mow" does not like to be walked on or traversed regularly; also, weeds such as thistle etc... will still need to be controlled to avoid losing the desired plants.

CONTROLLING LAWN PESTS

- BEETLE GRUBS – Milky Spore is ineffective and nematodes and other newer bacterium are not practical for home lawns
- CHINCHBUGS – Beuavaria can be effective but can also harm bees, Essentria and Grandevo are very expensive and impractical for home lawns
- WEBWORMS – Bt, Essentria, and Grandevo are effective
- BILLBUGS – Nematodes are not practical for home lawns
- BROWN PATCH DISEASE – Proper turf management helps, but weather conditions and host plant are biggest factors. No truly effective practical controls for home lawns
- LEAF SPOT DISEASE – Proper turf management. No truly effective practical controls for home lawns
- RED THREAD/PINK PATCH – Proper turf management

BIBLIOGRAPHY AND RESOURCES

- Chesapeake Club - www.chesapeakeclub.org
- Fertilizer Institute - www.tfi.org
- Nutrients For Life Foundation - www.nutrientsforlife.org
- University of Maryland Home And Garden Information Center – www.hgic.umd.edu
- Oregon State University – http://extension.oregonstate.edu
- Washington State University -
- University of Florida Extension – http://edis.ifas.ufl.edu
- Clemson University Extension – http://hgic.clemson.edu
- Colorado State University Extension – www.ext.colostate.edu
- Linda Chalker-Scott Ph.D. – www.theinformedgardener.com
- Associated Press
- WTOPnews.com
- The Baltimore Sun

The Plant Health Specialists

INTEGRATED PLANT CARE

2279 Lewis Avenue □ Rockville, Maryland 20851
301-881-8130 □ Fax 301-881-3695

RESUME OF
PAUL L. WOLFE, II

March 25, 2015

EDUCATION, CERTIFICATIONS AND AWARDS:

Michigan State University Bachelor of Science, Soil Science 1974
Attend approximately 10 days of professional seminars annually
Licensed Tree Expert- Maryland (License # 319)
Certified Pesticide Applicator- Maryland (Ornamental and Turf) since 1975
Tree Risk Assessment Qualification- International Society of Arboriculture
Award of Merit- National Arborist Association 1994
President's Award- National Arborist Association 1997

EMPLOYMENT:

Bartlett Tree Expert Co. 1974-1977 Area Manager Marshall, VA
Gustin Gardens Tree Service 1977-1988 Arborist Rockville, MD
Integrated Plant Care 1988-present President Rockville, MD

Professionally employed as an arborist since 1974 actively participating in all the following activities:

- Formulate and implement plant health care (IPM) programs
- Street tree inventories
- Diagnose and treat plant insects and diseases
- Consultant to homeowners, communities, developers, schools, etc.
- Tree appraisals and evaluations
- Collaborate with attorneys and testified in United States District Court as expert witness
- Testified before United States House of Representatives
- Guest speaker at numerous meetings and seminars
- Organized 2 volunteer tree care projects at Arlington National Cemetery utilizing services of 600 arborists from 22 states plus Canada

ORGANIZATIONAL AFFILIATIONS:

Past President- National Arborist Association (NAA)
Past President- Maryland Arborist Association
Past President- Maryland Association of Green Industries
Member- Tree Care Industry Association
Member- International Society of Arboriculture
Member- Professional Grounds Management Society

Comments of Paul Wolfe, Principal, Integrated Plant Care
As Submitted to the Montgomery County Council
Transportation, Infrastructure, Energy and Environment Committee
Work Session
March 30, 2015

Thank you for the opportunity to provide information about naturally derived pesticide product benefits and risks. Today I will focus my remarks on horticultural vinegar and horticultural oil, two commonly used products available to professionals and homeowners. It is not my intention to create a preference for synthetic products or to disparage naturally derived products. All products can be a part of a successful integrated pest management program. Integrated pest management is defined by the U.S. Environmental Protection Agency (EPA) as an "effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices." The EPA states, "IPM takes advantage of all appropriate pest management options including, but not limited to, the judicious use of pesticides." As defined by the EPA, this is how an IPM program works:

- **Set Action Thresholds:** Decide at what point pest populations or conditions require action.
- **Monitor and Identify Pests:** Identify pests and their risk accurately in order to take appropriate action when thresholds are reached.
- **Prevention:** Control pests before they become a problem through proper maintenance and sanitation.
- **Control:** When an action threshold is identified and preventative measures are no longer an option, effective pest control options are evaluated. These include biological, mechanical, and chemical options. The EPA states, "Effective, less risky pest controls are chosen first . . . If further monitoring, identifications and action thresholds indicate that less risky controls are not working, then additional pest control methods would be employed."

My goal today is to bring clarity to the discussion about naturally-derived products in the context of Bill 52-14, given such products would ultimately be among the only substances remaining (though that is not assured with several natural products on the proposed lists) for pest control on lawns, turf and horticulture should the bill pass as currently written. All pesticides are not the same. This is true for natural products as well. Simply because something is natural does not mean it is benign or inherently safe. I urge the committee to consider the potential impact to resident's health and safety and to the environment from naturally derived, non-regulated pesticides, and "homemade" pesticides. Many so-called natural products are not registered with U.S. EPA, so are beyond the reach of federal and state regulatory authorities and their power to educate, protect, and enforce. Also, their health effects and environmental fate may be unknown, because no such data is required for non-EPA registered products.

Horticultural Vinegar
Horticultural vinegar would be applied as a herbicide to kill weeds. The concentration of acetic acid providing an herbicidal effect ranges from and 10-20%. Most commercially available products are at 20% concentration. Acetic acid can burn skin at concentrations over 11%. This "vinegar" is not for human consumption or contact. A copy of the label and Material Safety Data Sheet for one product, Bradfield's

Natural Horticultural Vinegar, is appended to these comments. Vinegar available in grocery stores is in a 2% concentration.

The caution words on the "vinegar" product label are:
Keep out of Reach of Children
Caution: strong irritant. May cause eye, skin and respiratory irritation. If exposed, wash area with water.

While called Bradfield Horticultural Vinegar, the product is labeled as a cleaner with the label stating, *"Thus this product (at 20% acidity) is not to be labeled, marketed or characterized in any way as having any herbicidal virtues."* This means it is not registered with U.S. EPA as a pesticide and it does not qualify under the Minimum Risk Pesticide category for non-registration. Further, the label does not provide clarity for professionals or consumers who might purchase such a product seeking effective natural weed control. Most people think of vinegar as something to dress a salad and are mostly unaware of the significant danger of higher concentrations.

Here is a sample of language on acetic acid labels:
Eye: may cause burns and permanent corneal injury
Unusual Fire & Explosion Hazards: Toxic gases and vapors may be released in a fire involving concentrated vinegar.
Accidental release measures: Do not flush into streams or sewers....Protect skin and eyes from exposure.

Here are some of the requirements for personal protective equipment:
Skin: Rubber or neoprene gloves recommended. Rubber apron or other protective equipment.
Other PPE: Eye wash station, safety shower.

Hazardous decomposition products:
May produce carbon monoxide (CO) and/or carbon dioxide (CO_2)

This very same concentration of acetic acid provided by a medical supply company for laboratory purposes contains these warnings:
Poison! Danger! Corrosive. Liquid and mist cause severe burns to all body tissue. May be fatal if swallowed. Harmful if inhaled. In halation may cause lung and tooth damage. Flammable liquid and vapor.

A product with 5% concentration from another medical supply company requires this level of personal protective equipment: Splash goggles. Lab coat. Vapor respirator. Be sure to use approved respirator or equivalent. Gloves.

Certainly, there are many precautions to consider when selecting a "vinegar" product for weed control in lawns, turf, and public parks and as part of an integrated pest management approach. This is the type of product that will be used by professionals and consumers when most, if not all, synthetically-derived weed control products are prohibited by the county.

PHARM SOLUTIONS, INC.

WEED PHARM

For Organic Production

WEED & GRASS KILLER

1 gal.
Ready-to-Use

A HORTICULTURAL BIOPESTICIDE

For non-selective control of herbaceous broadleaf weeds and weed grasses which surround food crops, non-food crops and non-production agricultural, farmstead, right-of-way, and institutional land sites.

KEEP OUT OF REACH OF CHILDREN
DANGER - PELIGRO

Si usted no etiquets, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

EPA Registration No. 81936-1-81935
EPA Establishment No. 85804-NC-001
Batch Code:______________

Pharm Solutions, Inc.
2023 E. Sims Way, Suite 358
Port Townsend, WA 98368
www.pharmsolutions.com

Active Ingredients by Wt.

Acetic Acid	20.0%*
Other Ingredients	80.0%
Total	100%

*Equivalent to 200 grain vinegar by filtration

FIRST AID

IF IN EYES:
Hold eyelids open and flush with a steady, gentle stream of water for 15-20 minutes.

Remove contact lenses, if present, after the first 5 minutes. then continue rinsing eye.

Call a poison control center or doctor for advice.

IF ON SKIN OR CLOTHING:
Take off contaminated clothing.

Rinse skin immediately with plenty of water for 15-20 minutes.

Call a poison control center or doctor for further treatment advice.

IF SWALLOWED:

Call a poison control center or doctor immediately for treatment advice.

FIRST AID CONT'D
Have person sip a glass of water if able to swallow.

Do not induce vomiting unless told to do so by poison control center or doctor.

Do not give anything by mouth to an unconscious person.

IF INHALED:

Move person to fresh air.

If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth, if possible.

Call a poison control center or doctor for further treatment advice.

NOTE TO PHYSICIAN: Probable mucosal damage may contra-indicate the use of gastric lavage.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-858-7378 for emergency medical treatment.

See label back panel for additional precautionary statements.

PRECAUTIONARY STATEMENTS

Hazards to Humans and Domestic Animals

DANGER: Corrosive - causes irreversible eye damage. Wear goggles or face shield when handling. Harmful if absorbed through skin. Harmful if swallowed. Do not get in eyes, on skin, or on clothing. In case of contact, immediately flush eyes or skin with plenty of water. Get medical attention if irritation persists. Wash thoroughly with soap and water after handling. Wear personal protection equipment when handling and/or applying.

PERSONAL PROTECTION EQUIPMENT (PPE): Applicators and other handlers must wear appropriate protective eyewear, such as face shield or goggles, and face mask (with MSHA/NIOSH approval number prefix such as N-95, R-95, or P-95), long sleeved shirt and long pants, waterproof gloves and shoes plus socks.

USER SAFETY RECOMMENDATIONS: Users must:

- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

Environmental Hazards:

This pesticide is toxic to birds exposed to spray drift, direct treatment or residues on crops or weeds. Do not apply this product or allow to drift to crops or weeds if birds are actively visiting the treatment area.

This pesticide is toxic to fish and aquatic invertebrates.

For terrestrial use only. Do not apply directly to water.

PETRO-CANADA *

PURESPRAY™

SPRAY OIL 10E

ACTIVE INGREDIENT:	BY WEIGHT.
Petroleum Oil	98.00%
INERT INGREDIENTS:	2.00%
TOTAL	100.00%
Unsulfonated Residue	99.00% (minimum)
Aromatic Composition by ASTM D2140	0.00%

KEEP OUT OF REACH OF CHILDREN

CAUTION

See Inside For Additional Precautionary Statements.

FIRST AID

Have the product container or label with you when calling a poison control center or doctor or going for treatment.

If swallowed:	• Immediately call a poison control center or doctor. • Do not induce vomiting unless told to do so by a poison control center or doctor. • Do not give any liquid to the person. • Do not give anything by mouth to an unconscious person.
If in eyes:	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
If on skin or clothing:	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
If inhaled:	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible. • Call a poison control center or doctor for further treatment advice.

NOTE TO PHYSICIAN: Petroleum distillate poses aspiration pneumonia hazard. Only minor irritation should be expected from any type of exposure other than pulmonary aspiration. Ingestion may result in some gastroenteritis and mild diarrhea. Since systemic toxicity is not expected, the added risk of aspiration from attempts to induce vomiting or lavage are deemed not warranted. **FOR A MEDICAL EMERGENCY INVOLVING THIS PRODUCT CALL:**

PETRO-CANADA 403-296-3000, CANUTEC TRANSPORTATION: 613-996-6666, POISON CONTROL CENTRE.

EPA REG. NO. 69526-5

EPA EST. NO. 69526-CAN-001

MADE AND PACKAGED IN CANADA FOR SALE AND USE IN THE USA.

™ TRADEMARK OF PETRO-CANADA

PETRO-CANADA

965 SOUTHDOWN ROAD, MISSISSAUGA, ONTARIO, L5J 2Y3

905-822-4222

PRECAUTIONARY STATEMENTS
Hazards to Humans and Domestic Animals
CAUTION

Harmful if swallowed or absorbed through skin or inhaled. Prolonged or frequently repeated skin contact may cause allergic reaction in some individuals. This product is a potential skin sensitizer. Causes moderate eye irritation. Avoid contact with eyes, skin, or clothing. Avoid breathing spray mist. Wash thoroughly with Soap and water after handling. Remove contaminated clothing and wash clothing before reuse.

Personal Protective Equipment:
Some materials that are chemical-resistant to this product are listed below. If you want more options, follow the instructions for category E on the EPA chemical resistance category selection chart.
Applicators and other handlers must wear: long-sleeved shirt and long pants, chemical-resistant gloves (such as Barrier Laminate, Nitrile rubber, Butyl, Neoprene rubber or Viton) and shoes plus socks.
Follow manufacturer's instructions for cleaning and maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.
Engineering controls statements:
When handlers use closed systems, or enclosed cabs in a manner that meets with requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240 (d) (4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

USER SAFETY RECOMMENDATIONS

Users should: Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet. Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

ENVIRONMENTAL HAZARDS

This product is toxic to fish. Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment wash waters. Apply this product only as specified on the label.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
Do not apply this product through any type of irrigation system.
Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application.
For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation. Do not apply this product aerially.

AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.
Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 4 hours.
PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is: coveralls over long-sleeved shirt and long pants, shoes and socks and chemical-resistant gloves (such as Nitrile, Butyl, Neoprene, and/or Barrier Laminate).

SUPPORTING A BALANCED, STRATEGIC APPROACH

Background

In recent years, children's safety in outdoor school and community settings has come to the forefront of policy discussions about limiting or prohibiting pesticide use. The unintended consequence of such policies is removing the option to treat harmful pest problems with pesticides, which leads to increased exposure to potential health risks caused by weeds, poisonous plants, and insects.

A more proactive, effective approach to safeguarding children and communities comes from the implementation of an integrated pest management (IPM) program which protects everyone from harmful pests by following a plan to identify, monitor and, as much as possible, prevent problems.

IPM Defined

The U.S. Environmental Protection Agency (EPA) clearly defines Integrated Pest Management (IPM) as an "effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices." The EPA states, "IPM takes advantage of all appropriate pest management options including, but not limited to, the judicious use of pesticides." As defined by the EPA, here's how an IPM program works:

- **Set Action Thresholds:** Decide at what point pest populations or conditions require action.
- **Monitor and Identify Pests:** Identify pests and their risk accurately in order to take appropriate action when thresholds are reached.
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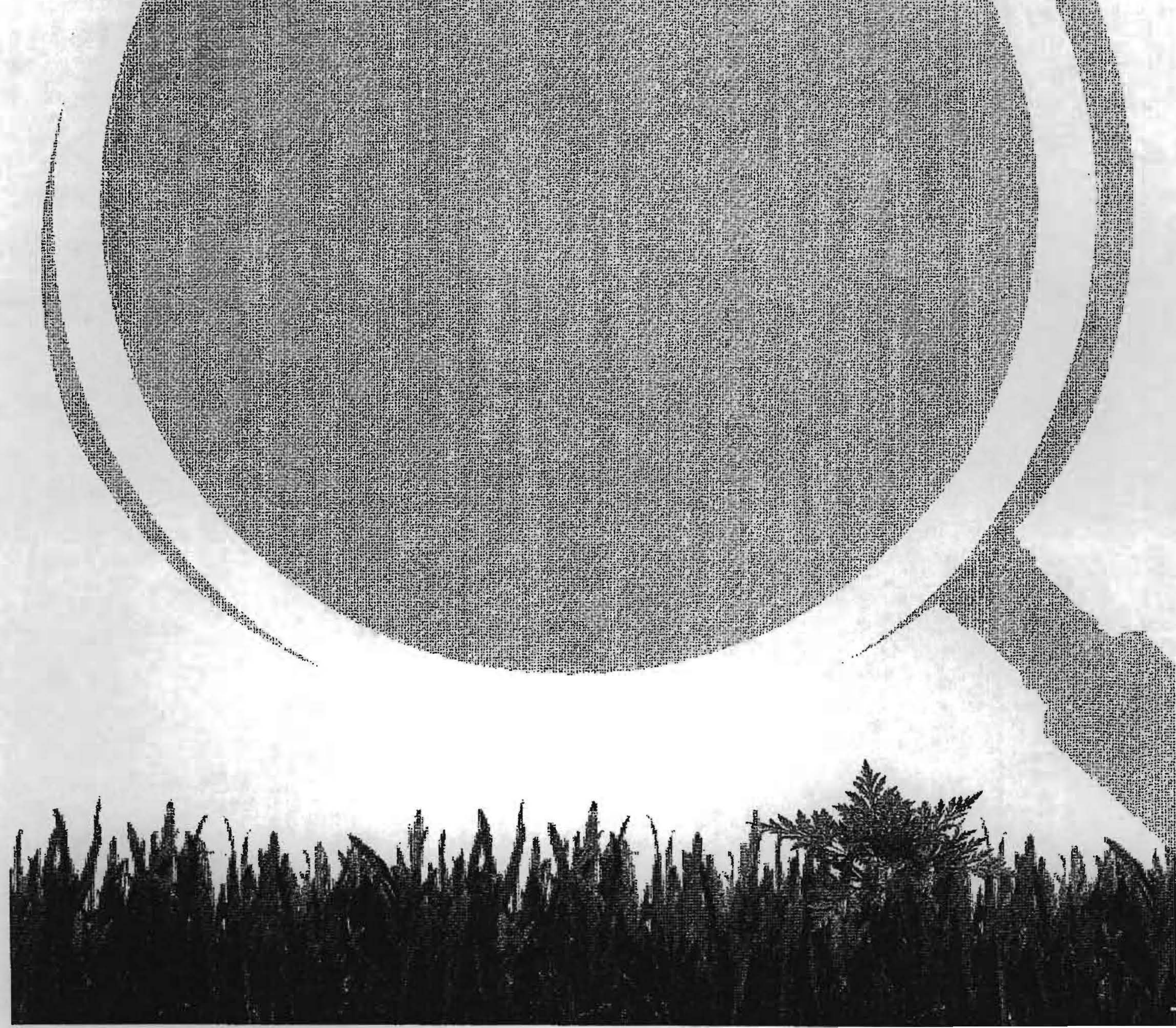
Public Health Impact

IPM programs create a plan to monitor, identify, and prevent problems. It also widens the scope of tools available for professionals, including groundskeepers and parks departments, to keep daycare centers, playgrounds, recreational fields and schools healthy and safe, ultimately helping to maintain the long-term health and economic benefits of communities. National and academic scientists recommend IPM programs, which proactively include EPA-approved pesticides.

Pesticides are just one tool in the IPM toolbox, and when used judiciously and in accordance with labels, they play a valuable role in IPM programs by providing economically viable, effective solutions to controlling weeds, rodents, and other pests that spread disease and damage fields. Removing the option to treat harmful pest problems with pesticides through an IPM approach can increase children's exposure to health risks and significantly impact economic costs. For example, failure to control ragweed can increase incidence of seasonal allergies and asthma. Poorly maintained outdoor spaces can hide wasps, and other hazards.

Balanced Approach

IPM offers a proven, balanced method that relies primarily on proactive approaches and extensive monitoring with the option to treat pest problems using appropriate EPA-approved products. Every community has a responsibility to protect its residents through effective, strategic pest control solutions, reducing the risk of health concerns caused by pests.



A.I.R. Lawn Care
14207 Chadwick Lane
Rockville, MD 20853

March 26, 2015

Montgomery County Council
T&E Committee
100 Maryland Ave # 6
Rockville, MD 20850

Dear T&E Committee:

Attached is information about my company A.I.R. Lawn Care. I will be sharing more about what we do, how we do it, and the results we get at the T&E Committee work session on Monday, March, 30th. However, before then I wanted to share some other information I think will be important to you as you consider Bill 52-14. This information pertains to the education and alternative products that will be needed if Bill 52-14 passes.

As I mentioned in my testimony at the first public hearing I am an Accredited Organic Land Care Professional. This accreditation was obtained from an organization called The Northeast Organic Farmer's Association (NOFA). NOFA has been running their Organic Land Care Program (OLC) since 1999. The OLC Program is a national leader in organic land care, having developed the first:

- Written standards, the NOFA Standards for Organic Land Care: Practices for Design and Maintenance of Ecological Landscapes, in 2001, based on organic agricultural standards (which won a Green Circle Award from CT Dept. Environmental Protection in 2001)
- Comprehensive courses in organic land care
- Accreditation program in the country for organic landscapers

There course is perfect for homeowners, lawn care professionals, government officials, and anyone else who is interested in learning about organic land care. I have attached the following with this letter for your review:

- NOFA Accreditation Course Agenda
- NOFA Standards for Organic Land Care: Practices for Design and Maintenance of Ecological Landscapes
- NOFA Accreditation Course Fact Sheet 2-26-15
- Spreadsheet that outlines the costs for their NOFA Accreditation Course

If Bill 52-14 were to pass I recommend reaching out to NOFA when setting up the education component of the bill and measuring its fiscal impact. Another component of education will be informing homeowners and professionals about the alternative products they can use instead of the banned products.

Two products landscaping companies will most likely add to their toolkit if this law passes are compost and compost tea. Compost is organic matter that has decomposed and is used as a soil amendment to improve soil conditions which improve lawn conditions. People in the industry often refer to it as "Black Gold" because of how good it is for the soil. Compost tea is an aerobic water solution that has extracted the microbe population from compost along with the nutrients. In simple terms, it is a concentrated liquid created by a process to increase the numbers of beneficial organisms as an organic approach to plant/soil care.

There are ten compost facilities within a 50 mile radius of Montgomery County—two of which are located here in Montgomery County. One of them—the Compost Facility in Dickerson, MD—could potentially be used as a site to set up a compost tea brewing and extraction station that could supply county land with compost tea, but also sell it through the same distributors that sell Leafgrow®.

Additionally, homeowner's could have the option to purchase compost tea at local facilities such as American Plant, Home Depot, Strosnider's, MOM's Organic Market, Whole Foods, and many other locations. I have attached a PDF with more information on the Compost Facility in Dickerson.

Along with compost and compost tea homeowners and landscapers are going to want to know what other alternative products they can use. I recommend contacting the Organic Materials Review Institute. The Organic Materials Review Institute (OMRI) supports organic integrity by providing organic certifiers, growers, manufacturers, and suppliers an independent review of products intended for use in certified organic production, handling, and processing. OMRI is a 501(c) 3 nonprofit organization founded in 1997. When companies apply, OMRI reviews their products against the organic standards. Acceptable products are OMRI Listed® and appear on the OMRI Products List© or OMRI Canada Products List©. OMRI also provides technical support and training for professionals in the organic industry.

I have provided their contact information below:

Mailing Address
Box 11558
Eugene OR 97440-3758

Street Address
2649 Willamette Street
Eugene, OR 97405-3134

Phone: 541-343-7600
Fax: 541-343-8971

I hope this information helps you as you consider Bill 52-14. I look forward to sharing more information with you on the 30th.

Sincerely,

John "Zack" Kline

Enclosure

A.I.R. Lawn Care

Company Profile

ABOUT US

Founded in 2011, A.I.R. Lawn Care is the leading local provider of eco-friendly landscaping services. A Montgomery County Green Certified Business, A.I.R. is ideal for property owners and managers who are concerned about their tenant's health, reducing their carbon footprint, the long lasting health of their lawn and landscape, or making a small contribution to the Earth.

TEAM

Our team has multiple graduate degrees in Landscape Architecture with over 35 years of combined industry experience in: residential landscape management, design and build, commercial landscape management, soil and erosion control in design, urban designs incorporating public art, and sustainable landscape designs among others. Additionally, our team has multiple certifications including Accredited Organic Land Care Professionals, and Landscape Industry Certified Managers.

WHY US?

We have been in many national publications because of our leadership in using—clean and more importantly quiet—electric equipment in our operations.

Furthermore, our experience and expertise in sustainable landscaping and lawn care will help you make an easy transition from conventional methods to natural, organic methods.

MISSION

Our mission is to improve and renew the atmosphere people breathe in through business, education, and services.

CORE VALUES

- ✓ Sustainability
- ✓ Innovation
- ✓ Quality
- ✓ Experience & Expertise

SERVICES

- ✓ Landscape Management
- ✓ Landscape Design
- ✓ Natural, Organic Lawn Car

CONTACT

www.airlawncare.com
info@airlawncare.com
844-247-5296
240-772-1639

Take the A.I.R. Dare® and try eco-friendly land care today!

A.I.R.
Lawn Care

Services

ndscape Management

- Mowing
- Edging
- Leaf Mulching & Removal
- Mulch installation
- Bed weed control
- Shrub shearing
- Shrub pruning
- Groundcover trimming
- Perennial cutback
- Tree Pruning
- Insect & disease control
- Season color rotations

Landscape Design

Design & Rendering Services

- Planting plans
- 3D Models
- Perspectives
- Sections and elevations
- Poster design

Hardscape Services

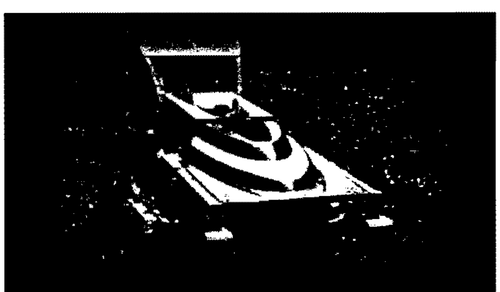
- Retaining walls
- Patios
- Pathways
- Sidewalks

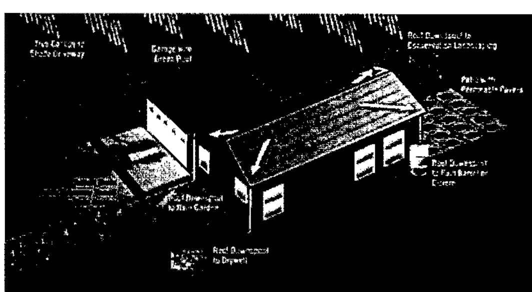
Rainscape Services

- Rain gardens
- Conservation landscaping
- Tree canopy
- Permeable pavement
- Green roofs
- Rain barrels
- Cisterns & Dry wells

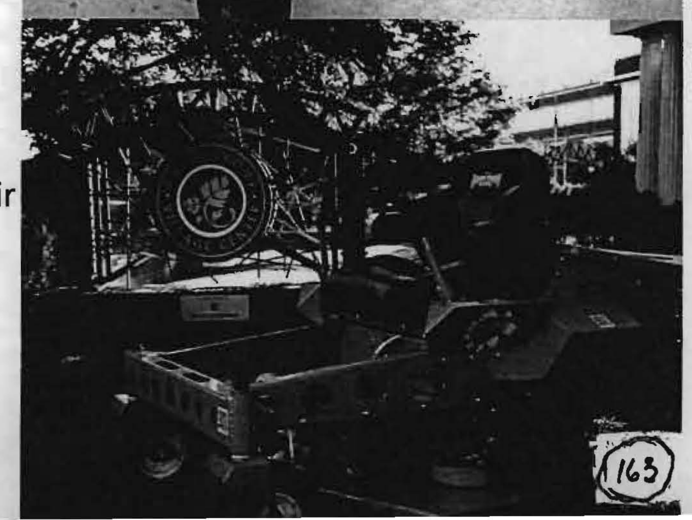
Natural, Organic Lawn Care

- Compost Tea Applications
- Compost Top Dressing
- Turf Aeration
- Overseeding
- Natural, organic turf fertilization
- Natural, organic turf weed control
- Soil Testing





Electric Equipment Charged By Solar Panels



.EAN

any people think they know the amount of noise and gas wn care equipment creates. However, the problem is:

- *Small engines contribute to 5% of the US's air pollution*

1 hour, 1 gas lawn mower:

- *Pollutes the same as 40 late model cars*
- *Contributes 93 times more smog-forming emissions than 2006 model cars*
- *Is equivalent to a 100 mile automobile ride*

ıe electricity used to power our equipment is generated / solar panels that are mounted on our trucks (top picture) ıd trailers resulting in no emissions on or off site.

UIET

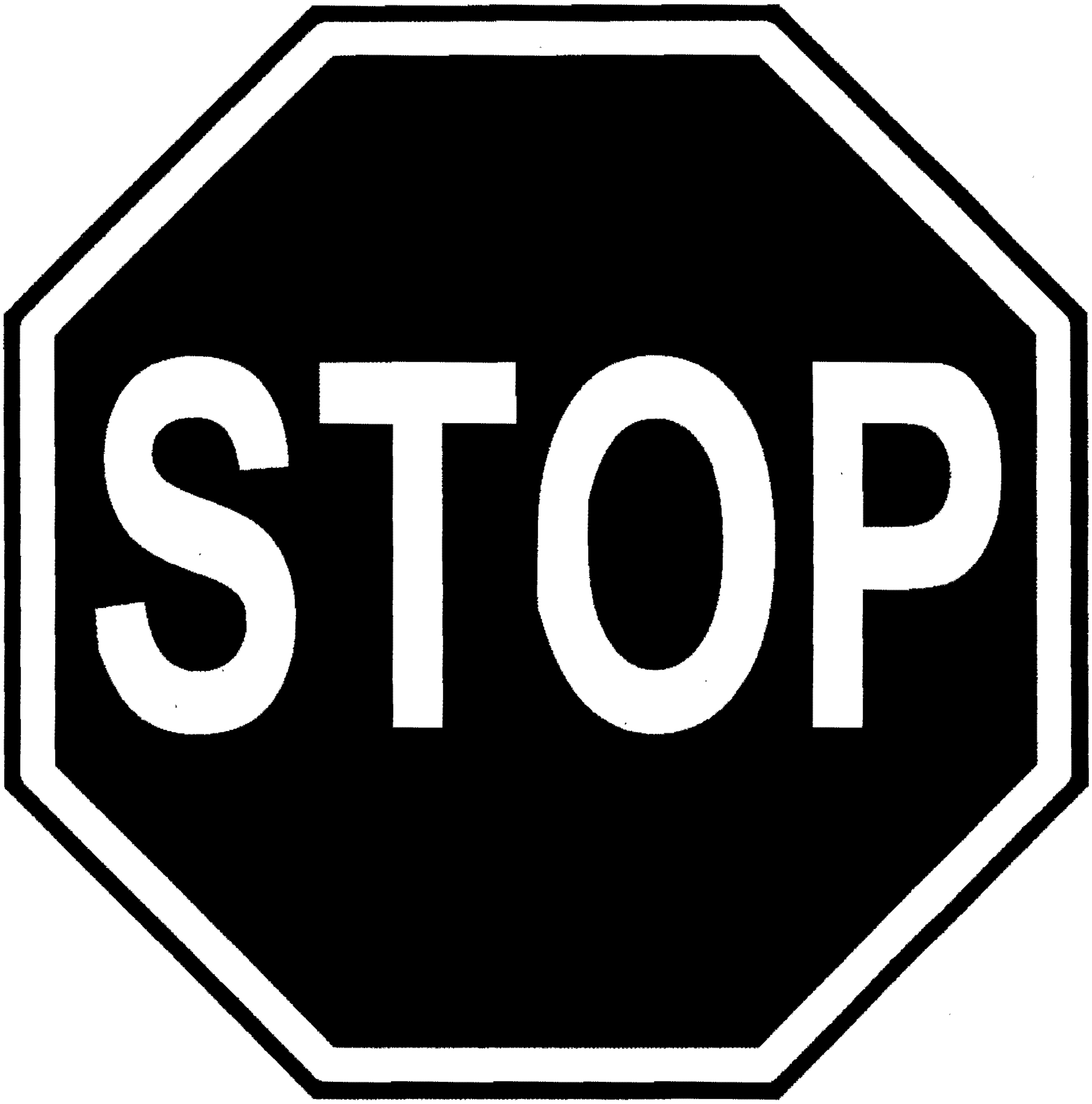
ne of the biggest problems with companies that use gas ɿuipment is the noise they generate while operating them.

- *Hearing loss is possible at 85db with gas-powered landscaping equipment operating between 85db and 110db.*

ur equipment is powered by batteries (middle picture) ɜsulting in a 50% noise reduction. Many of our clients say ıey did not even know our crews were doing work on their ·operties.

UALITY

'e have the same type of equipment that other big ɔmpanies have (bottom picture), but it's all electric. The ɜsult—we deliver clean, quiet, and quality service.



efore considering our natural, organic lawn care program you must be omfortable with the following:

1) **Having clover in your turf.**

2) **Understanding that our natural, organic lawn care is not an overnight process. It can take some time depending on the state of your soil.**

f you are comfortable with both of these protocols then our program is right for you.

A.I.R. Lawn Care Natural, Organic Lawn Care Program

When they say "It's Organic Based"...**IT'S NOT ORGANIC!**

Well, it usually means that they are trying to make you think that they are safer than chemical lawn care companies. It's unfortunate, because it may be false advertising and attempting to lead you to believe that they don't use synthetic chemical fertilizers and dangerous pesticides.

Many lawn care companies use "Bridge" products that contain chemical sources of nitrogen and phosphorus combined with reconstituted sewer sludge (Biosolids) and call it "organic based." Most of the time these companies also continue to use pesticides freely and with no concern for reduction.

In addition, just using an "organic" product like chicken manure, without the added beneficial microbes and nutrients that our products provide, will simply not work very well.

THIS IS HOW WE DO IT: **Contact Us Today! 240-772-1639 or 844-AIR-LAWN**

1. **Perform soil test to determine the amount of nutrients, pH level, and percentage of organic matter.**
2. **Aerate, and compost top dressing application for pre-emergent control.**
3. **Apply compost tea with natural micronutrients to boost root growth and/or apply all-natural, organic fertilizer.**
4. **Apply compost tea with natural micronutrients to boost root growth.**
5. **Apply compost tea with natural micronutrients to boost root growth.**
6. **Apply all-natural, organic fertilizer, which breaks down slowly. Spot treat with organic weed killer as necessary.**

Rockville, MD 20853 · 844-247-5296 · info@airlawncare.com · www.airlawncare.com

A.I.R. Lawn Care Natural, Organic Lawn Care Program FAQ

1 **ARE YOUR PRODUCTS SAFE TO USE AROUND CHILDREN AND PETS?**

Yes. Our products are made from natural products and are non-toxic. There is no re-entry time after application of our products. Your children and pets can go on the lawn immediately after the treatment is done.

2 **DO YOUR PRODUCTS REALLY WORK?**

Yes, they really do. All of our products are specifically designed to improve your soil and to feed the grass. We have scientific test data and customer testimonials that demonstrate superior plant growth rates and resistance to stress.

3 **HOW ARE YOUR PRODUCTS APPLIED?**

All of our liquid products are applied by using a hose end sprayer. All of our granular products are applied using a spreader.

4 **ARE YOUR PRODUCTS LIQUID OR GRANULAR?**

We use a combination of liquid and granular fertilizer and nutrient products. The liquid applications are organic liquid foliar concentrates.

5 **DOES IT TAKE LONGER FOR YOUR PRODUCTS TO WORK?**

It does take a little bit longer, but not a great deal longer. The reason synthetic chemical fertilizers that are applied by chemical lawn care companies work so quickly is because they are water-soluble and dissolve and leach immediately. The downside to this is that according to the USDA up to 80% of the product ends up "off target" by leaching through the soil, getting washed off from rainwater, or vaporized into the air.

6 **HOW DO YOU CONTROL WEEDS AND DISEASE WITHOUT CHEMICALS? HOW ABOUT INSECTS?**

We offer a combination of organic and natural preventative weed control solutions . However, you will find that, if you adhere to proper cultural practices when it comes to mowing and watering, weeds will become less of a problem. Also, as you improve the health and pH of your soil with our products and services, the grass will be thicker and stronger creating an environment that is much less hospitable for weed growth. A little tolerance is necessary too. What is really wrong with a few dandelions or patches of clover?

As for disease activity, you will immediately see a decrease in nuisance diseases that result from overuse of synthetic chemicals and are a side effect of a sterile soil environment. Healthy soil creates healthy plants! We can offer suggestions for insect control, grubs, etc., without hurting earthworms and other beneficial insects. You will also find that as your soil improves, and your turf becomes healthier, the need for controls decreases significantly.

A.I.R. Lawn Care

Natural, Organic Lawn Care Program FAQ

7

WHY SHOULD I SWITCH?

Think about millions of acres of lawns being treated with synthetic fertilizers, fungicides, insecticides, and pesticides. What is the effect?

A. Human Health Issues

These synthetic chemical fertilizers cause skin irritations, digestive symptoms and other health issues. Many synthetic fertilizers contain dangerous chemicals and heavy metals and should be avoided. Fertilizers made from hazardous waste byproducts may contain arsenic, lead, mercury, cadmium, and radon. These toxins are known to cause cancer, kidney disease, diminished fertility, and birth defects. Of the 26 most widely used pesticides in the U.S., 12 are classified by the EPA as carcinogens. Americans use approximately 380 million pounds of pesticides per year. (U.S. EPA. 1998. Office of Pesticide Programs, list of chemicals evaluated for carcinogenic potential).

Young children and pets are particularly susceptible to damage from these products and, since they frequently play on lawns, they are at risk of exposure from direct contact.

B. Water Pollution

Overuse and run off is a common problem and can lead to ground water contamination and water pollution. When synthetic fertilizer washes into streams and rivers it can build up, causing eutrophication (excessive growth due to a surplus of nutrients). Nitrogen and phosphorus are nutrients found naturally in the air and in water systems. Fertilizer run-off dumps too many of these nutrients into the water. The resulting algal bloom occurs when water plants become invasive. Fish are unable to get the nutrients and oxygen they need from the water. Also, many pesticides can harm fish, even in very small amounts.

C. Soil Depletion / Sterile Soil

Fungi, and other beneficial microorganisms that naturally occur in the soil, work symbiotically with plants, helping them obtain oxygen from the soil. Some synthetic fertilizers, fungicides, insecticides, and pesticides disturb this process. When overused, these products make the soil sterile and deplete it over time.

D. Eco-system Damage

Beneficial insects can be decimated by pesticide use, since pesticides are designed to kill (the suffix cide comes from the Latin meaning of "killer," and "act of killing"). Most insects are beneficial, performing valuable functions such as pollination. Due to our use of insecticides and pesticides, the bee population in the United States has suffered dramatic losses in recent years. It makes sense to avoid harmful insecticides and pesticides in order to preserve beneficial insect populations which control pests naturally.

Thus, you should switch to natural, organic lawn care primarily because it is better for human health safety and for the environment. It also works just as well or better. When there is a healthy and effective alternative to a more dangerous method it just makes sense. If you are pregnant, have small children, pets or chemical sensitivities there is no reason to create a potential risk by using dangerous pesticides and synthetic chemical fertilizers.

A.I.R. Lawn Care

Natural, Organic Lawn Care Program FAQ

8

IS IT MORE EXPENSIVE TO USE ORGANICS?

The cost of organic may seem high at first, but it decreases over time. On the other hand synthetic lawn care costs increase over time due to the lawns requiring higher quantities of fertilizer, fungicides, insecticides, pesticides, and weed-control products the longer they are part of a synthetic program.

Not to mention synthetic fertilizer prices will tend to increase when home fuel prices increase because it takes about 33,000 cubic feet of natural gas to create 1 ton of nitrogen, which is enough for 150 bags of 32-10-18 fertilizer.

9

WHAT IS SO BAD ABOUT CHEMICAL FERTILIZERS?

We could write an entire book here but will focus on a few important issues. Synthetic Chemical fertilizers pollute ground and surface water, because they leach readily. Experts have surmised that up to 60% of a chemical fertilizer application ends up off target. There is a “dead zone” the size of Rhode Island in the Gulf of Mexico that is legitimately caused by chemical fertilizers being carried by the Mississippi River. There is no aquatic life whatsoever in this area during certain times of year because algae blooms deplete oxygen. These algae blooms are caused by nitrogen runoff. Streams, rivers, ponds, lakes and bays are also affected. Regulations have begun to restrict the use of chemical fertilizers to combat algae blooms. Secondly, chemical fertilizers are a very short-term solution to having a nice lawn. Perhaps you’ve noticed that the more you or your lawn company uses the more your lawn needs. Synthetic chemical fertilizers sterilize the soil and actually create a chemical dependency for your lawn.

So, choose the natural, organic way instead. You help protect the environment and get a great looking lawn.

10

HOW MUCH SHOULD I WATER?

It sounds silly but you should only water as much as your lawn needs and it’s difficult to put an exact amount on “how much” is enough. When your lawn begins to show drought stress water it deeply. As long as it is raining occasionally you don’t need to water your lawn. When it gets hot and dry you should try to water your lawn a few times a week. Infrequently and deeply is ALWAYS better than every day for ten minutes per zone. If your lawn begins to go dormant from lack of water, it’s okay! It’s a natural defense mechanism to stay alive and it will come back as healthy as ever when sufficient water is available. You will find that by using organic products you will see a HUGE reduction in the amount of water needed to keep your lawn green.

11

DO YOUR PRODUCTS SMELL BAD?

Some of our products have kind of a slight earthy odor, but it is not noticeable after the treatment has

A.I.R. Lawn Care Natural, Organic Lawn Care Program FAQ

12 **CAN YOUR PRODUCTS BE APPLIED NEAR BODIES OF WATER AND WILL THEY CONTRIBUTE TO ALGAE BLOOMS?**

All of our products can be applied near bodies of water because they do not contain synthetic sources of nitrogen and phosphorus. They will not contribute to algae blooms because of this. Liquid application is also more efficient and greatly reduces any run off effect.

13 **SHOULD I BAG OR MULCH MY CLIPPINGS? WILL THE CLIPPINGS CONTRIBUTE TO THATCH?**

If you can you should always mulch your clippings. According to studies at Ohio State University, allowing grass clippings to remain on the lawn recycles nutrients back to the soil in approximately a 4-1-3 ratio, meaning 100 pounds of grass clippings can account for about 4 pounds of nitrogen, 1 pound of phosphorus, and 3 pounds of potassium. Leaving your own clippings on your lawn will account for a quarter to a half of your lawn's fertilizer needs for the year.

Grass clippings will not contribute to thatch. In fact, when you switch to organic products you will notice that the thatch layer in your turf will decrease significantly.

14 **HOW HIGH SHOULD I MOW?**

It depends. You will want to vary the height depending on the type of grass and time of the year. Every grass species has an ideal height for optimum lawn performance. When the grass is actively growing in th spring, the cutting deck can be lower. In the summer when the temperatures are high, the cutting deck can be higher. Prior to winter and in areas where snow is expected, you should mow with the cutting dec at 2 inches.

15 **DO I NEED TO DO A SOIL TEST EVERY YEAR?**

We recommend doing a soil test annually for THREE years, and then once every three years.

16 **MY LAWN CARE COMPANY SAYS THAT THEY ARE "ORGANIC BASED." WHAT DOES THAT MEAN?**

Well, it usually means that they are trying to make you think that they are safer than chemical lawn care companies. It's unfortunate, because it may be false advertising and attempting to lead you to believe that they don't use synthetic chemical fertilizers and dangerous pesticides. Many lawn care companies use "Bridge" products that contain chemical sources of nitrogen and phosphorus combined with reconstituted sewer sludge (Biosolids) and call it "organic based." Most of the time these companies also continue to use pesticides freely and with no concern for reduction.

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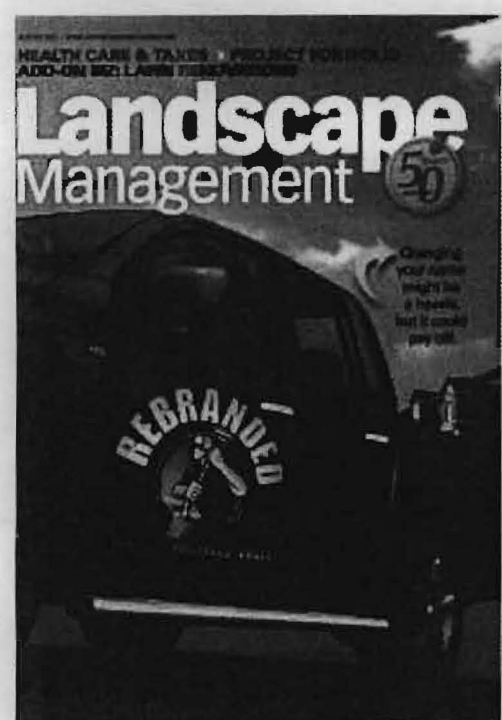
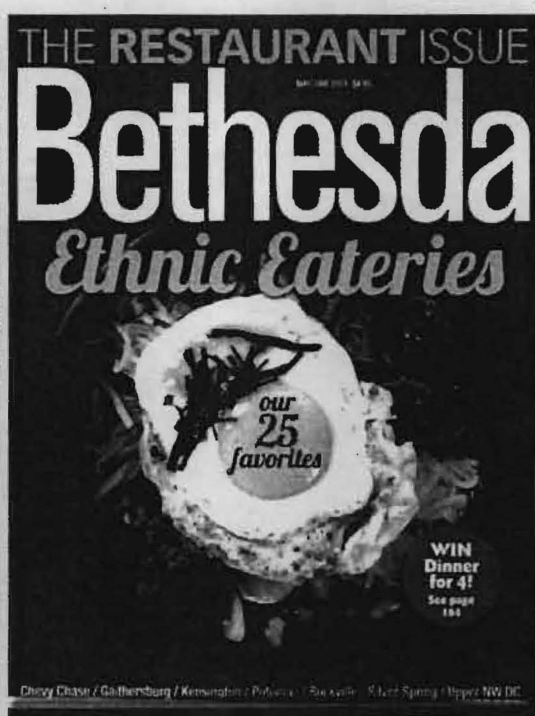
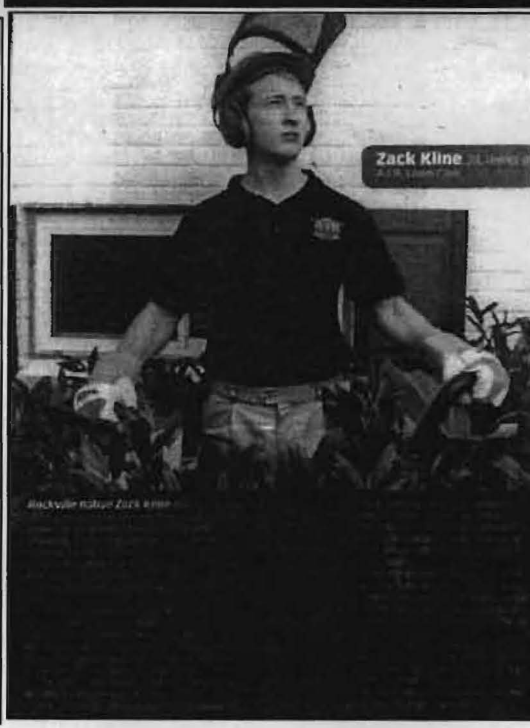
Publications







Landscape Management 2012

Bethesda Magazine 2013

Turf Magazine 2013

A.I.R. Lawn Care

Affiliations & Certifications

MONTGOMERY COUNTY, MD
CERTIFIED GREEN BUSINESS

landscape industry certified

ORGANIC LAND CARE
NOFA
organiclandcare.net
ACCREDITED PROFESSIONAL

PLANET
Professional Landcare Network

A.I.R.
Lawn Care

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