White Paper - 2018

Pesticides and The Chesapeake Bay Watershed
White Paper on Assessing and Ranking Compounds of Concern and Classes-of Compounds

Background on the working group

The Research Working Group of the Pesticides and The Chesapeake Bay Watershed Project (the Project) is comprised of scientists and health experts from the U.S. Environmental Protection Agency, Smithsonian Environmental Research Center, U.S. Department of Agriculture, National Oceanic and Atmospheric Administration, U.S. Geological Survey, American Academy of Pediatrics and Maryland Department of Natural Resources. The information included in the Research Matrix Methodology was compiled by members of the group in their individual capacities; this acknowledgment of their contributions to the methodology does not indicate endorsement of any of the methodology outputs by them or their agencies and organizations. Moreover, this compilation of information is not intended to recommend or advocate for any specific course of action.

Background on the Project

The Pesticides and the Chesapeake Bay Watershed Project was established in 2007 by the Maryland Pesticide Education Network and the Johns Hopkins Center for a Livable Future. The Project is the first working group in Maryland dedicated to reducing the occurrence and risks of pesticides in the Bay watershed, in order to protect water quality, aquatic life, wildlife and public health. Project participants include scientists, public health experts, waterkeepers, watermen, federal, state, and county government agency representatives, representatives of the agricultural and pest management industries and environmental organizations.

Overview

The Research Working Group of the Pesticides and The Chesapeake Bay Watershed Project (the Project) originally decided to develop a methodology to compile and assess existing scientific data regarding the potential impact of the most heavily used pesticides in Maryland on the Bay – and to highlight data gaps for priority compounds. The matrix-based applications of this methodology provide key data regarding potential eco-toxic effects on the Bay of seven compounds and two classes of compounds.

While Chesapeake Bay is the largest and most biologically diverse estuary in the lower 48 states, living resources in this economically important watershed are stressed by various pollutants resulting from human activity, including the use of pesticides. Prompted by concern that no methodology had been established to assess and prioritize pesticides based on relative level of concern, members of the Research Working Group began work in October 2007 to develop such a system.

After more than 10 years of research, analysis and discussion, the result is a series of documents presenting research matrices based upon a unified methodology – for assessing compounds of concern and their potential impact on the watershed. While it is vital ultimately to assess the impact of these compounds in terms of human toxicity, this assessment focuses on issues of ecosystem toxicity. The seven compounds to which the working group has initially applied this methodology are: atrazine, chlorothalonil, glyphosate, metolachlor, permethrin, and s-fenvalerate and triclosan. In addition, the working group decided to try to accelerate this process by assessing classes of compounds; the first two to be assessed are triazines and neonicotinoids (scoring has not yet been completed for neonicotinoids).

The applications of this matrix-based methodology are intended to inform scientists, government agencies and policy makers about existing data on pesticides widely used in the Bay watershed, as well as to identify data gaps.

Addressing Data Gaps

The group intends that the methodology will also highlight specific concerns about data gaps relevant to priority compounds-of-concern. In the course of developing the methodology, the group recognized there is a particular challenge presented by data gaps related to toxicity to non-target species, synergistic effects of multiple compounds, and degradation by-products.

The toxicity of degradation by-products is sometimes uncertain and their concentrations have been observed to equal or exceed those of the corresponding parent compounds.

While acknowledging that not all categories of information are available for all compounds, the group has concluded that such a methodology can be useful for prioritizing action, because there are ways to approximate values for missing data, such as substituting values for a related compound when specific data is not available in literature or data repositories.

Explanation of the Methodology

The working group has refined its matrix-based methodology (see attached example) for each compound in three analytical spreadsheets (plus an additional spreadsheet with relevant technical definitions):

a) **Usage Matrix**
b) **Thresholds and additional relevant information**
c) **Scoring system**

a) Usage Matrix: This introductory portion of the methodology surveys existing data to answer key fundamental questions to profile the compounds-of-concern in the Chesapeake Bay watershed. Questions addressed by the Usage Matrix include:

i. Is it found in the watershed, in what quantities and where in the watershed?
ii. When is it used, for what purposes and/or on what crop(s), by whom, how it is applied and whether it is mixed with other substances?
iii. What are the known data gaps at this time?

The inquiry then moves on to examine how existing research has addressed questions of a compound's occurrence in the ecosystem, including:

iv. Where the pesticide is found in the ecosystem, what media are of most concern, and whether it is found beyond a particular concentration?
v. What are the degradation products, whether there are temporal or seasonal patterns to its presence, and what are the known data gaps regarding its occurrence?

The methodology then surveys existing research regarding a priority compound's chemical and physical properties, including:

vi. Its chemical structure, solubility, Kow, vapor pressure and its half-life.
vii. Its degradation mechanism, process or pathway, its pharmacokinetics, and data gaps regarding its chemical and physical properties.

The inquiry then focuses on issues of a compound's eco-toxicity to Bay watershed organisms, including:

viii. Whether certain species are unusually susceptible to the compound, whether it is acutely toxic at levels found in the ecosystem, whether it causes chronic toxicity and at what levels, and whether it is mutagenic, teratogenic or an endocrine disruptor at levels found in the ecosystem.
ix. A compound's exposure route and mechanism of action; and whether its inert ingredients, metabolites, degradation by-products are toxic to plants or animals at levels found in the environment, and data gaps regarding its eco-toxicity.

Next the methodology addresses questions regarding a compound's secondary effects in terms of eco-toxicity:

x. Whether it impacts organisms that are key to success of the ecosystem, whether it weakens organisms to make them more susceptible to other stressors.
xi. Whether there are known data gaps regarding secondary effects in terms of eco-toxicity.

b) Toxicity Thresholds and additional information: This second major section of each application of the matrix-based methodology surveys existing relevant research regarding a compound's acute and chronic toxicity thresholds for:

i. sub-aquatic vegetation
ii. emergent vegetation
iii. amphibians
iv. fish
v. invertebrates
vi. phytoplankton

c) Scoring System: The third major section of the methodology scores and/or ranks compounds-of-concern found in the Bay watershed. Briefly explained, the scoring mechanism first takes note of basic data needed to attempt such a toxicity scoring:

i. **Quantity** of the compound used in the Chesapeake Bay watershed annually.

ii. **Occurrence**; i.e., where the compound's presence is measured in the ecosystem.
iii. **Persistence** in terms of half-lives.
iv. **Environmental Toxicity**; i.e., acute, chronic and non-toxic.

To further inform the scoring exercise – particularly to assist in identifying data gaps for a specific contaminant – the methodology goes on to inquire regarding a compound's:

v. Potential for impacts on keystone or charismatic species with high sensitivity.
vi. Potential as an endocrine disruptor.
vii. Demonstrated food web effects.
viii. Known synergism with other stressors.

Summary of Scoring for the Seven Compounds & Two Classes of Compounds

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Scoring System

1) Occurrence

a. Can be measured bay wide all the time	Score 3
b. Can be measured bay wide during application season	Score 2.5
c. Can be measured regionally during application season	Score 2
d. Can be measured locally during application season	Score 1.5
e. Rarely detected	Score 1

2) Persistence

a. Half life in relevant media > 20 yrs	Score 3
b. Half-life in relevant media 5-20 yrs	Score 2.5
c. Half life in relevant media 1-5 yrs	Score 2
d. Half life in relevant media 0.5-1 yrs	Score 1.5
e. Half life in relevant media < 0.5 yr	Score 1

3) Environmental Toxicity

a. Acutely toxic at concentrations found in the field to non-target organisms offsite?	Score 3
b. Chronic toxicity at concentrations found in the field to non-target organisms offsite?	Score 2
c. Toxicity offsite rare to nonexistent	Score 1

Occurrence + Persistence x Enviro Toxicity = Score

Compound	Occurrence	+ Persistence	X Enviro toxicity	= Score
atrazine	2	2	3	12
chlorothalonil	1	1	2	4
esfenvalerate	2	2	2	8
glyphosate	3	1.5	2	9
metolachlor	2.5	2	3	13.5
permethrin	3	1	1	4
triclosan	3	1.5	3	13.5
triazines	3	3	4	24
neonicotinoids	--	--	--	pending
chlorpyrifos				pending