ENVIRONMENTAL RISKS OF PESTICIDES IN A RESIDENTIAL SETTING

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INTRODUCTION

One often hears that modern pesticides are environmentally friendly, and that there is no longer much need for concern since applicators are trained and pesticides are regulated by the EPA and the CTDEP Pesticide Division, especially since the real "bad actors" like DDT have been taken off the market. However, a close look at the published data on specific pesticide products as well as more general studies of pesticide persistence in the environment, points to continuing risks from residential pesticide use.[1]

Several large-scale USGS studies pesticides have detected a variety of pesticide compounds in surface waters. A Michigan study reported that pesticide concentrations frequently exceed EPA maximum contaminant levels (MCL's) in streams and small rivers (but not in large rivers) during the spring season of heavy runoff (USGS 1997).[2] This occurs in watercourses with largely suburban/urban watersheds as well as in agricultural areas. Another big study in New York State (46 sites)[3] also found comparable levels and numbers of pesticides and their breakdown products in streams in suburban/urban and agricultural settings. This is evidence on a broad scale that pesticides do not consistently remain contained in the area where they are applied and *do* reach regulated aquatic ecosystems. Numerous studies have also shown a consistent pattern of diminished diversity of benthic macroinvertebrates in streams, corresponding to the extent of development in their watersheds. [4] Pesticide runoff is often suggested as a contributing factor.

Environmental risks vary widely depending on the properties of individual pesticides, such as toxicity, solubility, half life and on the setting in which they are applied, including the terrain, soil type, and proximity of catchbasins, streams and/or wetlands; and the time of year. A USDA guidance document[5] provided data on the

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[1] Consideration of human health risks is not included here.
[2] US Dept. of the Interior. Geological Survey. 1997. *Pesticides in Surface waters*. National Water Quality Assessment (NAWQA), Pesticide National Synthesis Project. Fact Sheet FS 039-97.
[3] US Dept. of the Interior. Geological Survey. April 1997. *Pesticides in Surface waters of the Hudson River Basin, New York, and Adjacent States*. Fact Sheet FS 238-96.
[4] Morley, Sarah A. and James R. Karr December 2002. Assessing and Restoring the Health of Urban Streams in the Puget Sound Basin *Conservation Biology*.16(6) 1498-1509.
[5] USDA-NRCS National Water and Climate Center and US EPA Office of Pesticide Programs. March 2000. Conservation Buffers to Reduce Pesticide Losses.

need for stream buffers over 100 feet in width before highly soluble atrazine herbicides reached an acceptable concentration in groundwater; insoluble products were attenuated much more quickly.

The accompanying Table A12-1 lists several key pesticide properties, including toxicities, movement rating, half-life, solubility, and soil sorption coefficient for most of the active ingredients of insecticides, herbicides, and fungicides currently used in a residential setting, those readily available to homeowners as well as restricted use products, applied only by licensed landscapers. It was compiled from USDA and other Internet sources and government extension specialists. One to several brand names for each active ingredient is listed. (There are large numbers of brand names, many with several active ingredients, which keep changing.) The fine print on the pesticide container always includes the name of the active ingredients, and an Internet search for a pesticide brand name will usually provide a list of active ingredients. Refer to the end of the Residential Pesticides Properties Table A12-1 for explanatory text on toxicity ratings, the different pesticide mobility parameters, and links to the various Internet sources used in compiling the table. The following "primer" on pesticide risks will facilitate use of Table A12-1.

Pesticide Toxicity

Pesticides that do not reach wetlands and watercourses may have *indirect impacts on facultative wetland* and upland biota. Existing toxicity data (See Table A-2) shows that herbicides, insecticides, and fungicides are *often toxic to non-target organisms.* 99+% of all soil and garden invertebrates are harmless non-pests. Insects are the food-base foundation for the disturbance-tolerant wildlife community that persists in rural – residential zones and contributes to quality of life: spring peepers, songbirds, and rarely seen nocturnal creatures like the star-nosed mole also feed on invertebrates. Many songbirds that eat bird seed in winter need "bugs" in other seasons. Toxicity testing has emphasized fish and a few indicator aquatic organisms. Some data is available for additional organism groups (e.g. birds), but not for many pesticide compounds. There are wide ranges in susceptibilities among other different life forms, and testing of all potential targets is simply not practical or feasible. Subtle hormonal impacts are difficult to detect. Pesticide breakdown products may also be toxic, but only limited numbers have been tested.

Fungicides are widely variable in their toxicity ratings. Maneb is highly toxic to fish and non-toxic to bees. A widely used triazole turf fungicide (Triadimefon) is highly toxic to crustaceans – and probably also to other arthopod invertebrates, e.g. soil insects. The persistent and moderately soluble fungicide Thiabenzidole is very toxic to earthworms and moderately toxic to fish. However, Iprodine has a low toxicity rating for fish and birds, and a low movement rating. For fungicides, persistence is a key property, affecting the duration of disruption to the soil-root environment (turf fungicides) and duration of potential for harmful contact with foliage arthopods and their predators (tree/shrub fungicides).

Herbicides are generally less widely and acutely toxic than insecticides, but are usually very mobile, and are not without risk. Atrazine was among the compounds most frequently detected in Connecticut groundwater (Frink 1986).[6] This widely used agricultural herbicide is very similar to residential triazine products. Atrazine was found to affect the hormonal balance of leopard frogs at extremely low concentrations (changing males into females)[7] , which has been proposed as the reason for the rapid demise of this species in New England. The effects of other widely used triazine herbicides on other amphibians have not been systematically tested. Bensulide and Bentazon are toxic to fish and/or invertebrates. *Mode of application* affects the *quantities* used, and therefore potential risk from herbicides; for example cut-stump treatments or targeted foliar spraying of sprouts is recommended for triclopyr (Ortho-brush B-Gon) and glyphosate (in Rodeo and Roundup) by the Connecticut Invasive Plant Working Group. [8] Although these herbicides both have very low toxicity ratings for a variety of organism groups, highly targeted application limits even the potential for unforeseen subtle hormonal or chronic impacts

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[6] Frink, C.R. and L. Hankin. October 1986. *Pesticides in Groundwater in Connecticut*. Connecticut Agricultural Experiment Station Bulletin No. 839. Atrazine is an agricultural herbicide, but closely related herbicides such as Simazine are used in a non-farm setting.

[6] Research on hormonal alteration by atrazine was conducted by Tyrone Hayes at the University of California at Berkley, andwas reported in the April 2002 issue of Proceedings of the National Academy of Science. Does as low as 0.1 ppb induced feminizing changes; 3 ppb is the drinking water standard for Atrazine.

[7] Invasive Plant Management Guide on the web site of the Connecticut Invasive Plant Working Group (CIPWG) at http://www.hort.uconn.edu/cipwg/

Insecticides are formulated to control arthopods, and are therefore usually toxic to large numbers of insect species other than targeted pests. They impact major food sources for small mammals, birds, and tree frogs, both in vegetation and below ground. Even rapidly biodegradable pesticides may have longer lasting impacts due to disruption of existing communities. Most of the organophosphates and synthetic pyrethroids are also highly toxic to fish and often to birds. Seed-eating birds often consume pelletized pesticides. "Organic " alternatives with less toxic properties are included in Table A12-1. The *quantities* used influence the level of risk, which is obviously lower from application to a single infested shrub compared to treatment of a whole yard or lawn.

Pesticide Mobility

Potential for movement greatly influences the risk pesticides pose to off-site resources. Especially for the insecticides with high aquatic toxicity, this is a key property. Because broad-spectrum grub insecticides must penetrate the soil to be effective, they must have some mobility in the soil and moderate persistence, and therefore may affect not only the lawn itself, but also the soil in adjacent naturally vegetated areas. For example, Merit (with Imidochloprid) has a half-life of 48 to 190 days and moderate solubility in water. Grub insecticides and fertilizers are often applied in a *pelletized formulation*, which slows release, but is also vulnerable to being *washed downslope* during high intensity storm events. Such storms also dislodge *pesticides that adsorb strongly to soil particles*, for example diazinon, a toxic, persistent, hydrophobic organochlorine pesticide.[9] Likewise they dissolve soluble pesticides. Runoff may end up either in adjacent wetlands or setback areas, or may reach streams after flow into the street and thence into catchbasins and the storm drainage system. Several studies have shown elevated concentrations of hydrophobic organochlorine pesticides *after high surface runoff* (e.g. Hunt et al 1995[10]). Even well-designed, above-ground stormwater management systems do not have the capacity to treat most pesticides within a few days, because pesticide half lives are too long. (See Table A12-1).

Slope steepness and soils are key factors determining whether lawn runoff will infiltrate, or flow downhill as runoff. On a steep slope with shallow bedrock or hardpan, the shallow groundwater table often intersects the ground surface,

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[9] Fisheries biologists at the CT Department of Environmental Protection, have attributed several fish kills to runoff from sloping lawns in residential neighborhoods.

[10] Hunt, Anderson, Phillips, Tjeerrdema, Puckett, and deVlaming. July 1999. Patterns of aquatic toxicity in an agriculturally dominated watershed in California. *Agriculture, Ecosystems, and the Environment*. 75(1/2): 75-91.

resulting in seeps and springs[11], which reduces the *travel time* through soil and therefore the effective width of the wetland setback in filtering/transforming pesticides or other pollutants, by means of a variety of biotic and abiotic processes.[12]

Lack of movement does not necessarily mean that a product is risk free. The fungicides and insecticide formulations applied to woody ornamentals usually include adhesive additives that reduce washing off. This also means their toxic effects (and potential to harm non-target organisms) may persist *in place* for extended time periods, although risks to nearby streams is low. If a pesticide has not degraded before leaf fall, residues on leaves may still be blown to vulnerable resources.

IMPACTS MINIMIZATION

Data is available to help select pesticides with minimal risk in a particular setting, but this involves complicated, careful analysis. Many data gaps remain relating to impacts on non-target organisms and impacts of breakdown products or the effects of interactions with other pesticides. Following are four potential approaches to minimization of pesticide impacts from landscaping:

1) *A Conservative Integrated Pest Management Plan* [13] emphasizes measures to promote healthy, disease-resistant growth and biological/ cultural controls, allowing very limited pesticide use, based on careful screening of pesticide properties, using predetermined thresholds, and targeted application methods. "Emergency" pesticide selection follows the site-specific USDA (WINPST) approach, considering pesticide movement potential in relation to soil, topography, and landscape properties.

2) *Organic landscaping* is less complicated to implement, although a fully "organic" approach may not always be acceptable to residents. Guidance documents are available. [14] Both these approaches not only protect downgradient wetlands and watercourses, but also provide safe foraging

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[11] Ritter, Kochel and Miller. 1978, 1986, and 1995. *Process Geomorphology, 3rd Edition*. William C. Brown Publishers.

[12] Hemmond and Fisher. 1994. *Chemical Fate and Transport in the Environment*. Academic Press, San Diego. 337 pp.

[13] Many so-called IPM plans do in fact allow use of toxic products with potential to harm non-target organisms and fail to consider all pesticide properties, topography, soils, & local groundwater resources.

[14] *Standards for Organic Lawn Care – Practices for Design and Maintenance of Ecological Landscapes.* 2001. Organic lawn Care Committee of the Connecticut and Massachusetts Chapters of the Northeast Organic Farming Association (NOFA), PO Box 386 Northford, CT. Kimberly Stoner, PHD, Chair.

habitat for songbirds and other wildlife *within* a residential setting. Either of these approaches requires an organized residential community where landscaping is controlled by a single entity.

3) *Site design* is the appropriate approach for new projects where pesticide use by individual landowners cannot practically be regulated, e.g. a conventional subdivision with individually owned homes. Open space acquisition may be needed if resources are especially sensitive or valuable. In these situations, nearby watercourse resources (although not on-site fauna and flora) may be protected by broad setbacks to wetlands, especially where slopes are steep. Natural berms may protect resources from pesticide runoff, and low berms or grading can prevent lawn runoff from reaching storm drains, or optimally a by a “soft” street drainage system (without storm drains).

4) *Education* is a tool available to help individuals effectively use organic approaches and/or appropriately select low-risk pesticides when needed.