Pesticide Risk Indicators Used in CEAP Cropland Modeling

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Introduction

The USDA Conservation Effects Assessment Project (CEAP) was designed to quantify the effects of conservation practices that are applied on agricultural lands. Management practices that reduce the potential for loss of pesticides from farm fields consist of a combination of Integrated Pesticide Management (IPM) techniques and water erosion control practices. Water erosion control practices mitigate the loss of pesticides from farm fields by reducing surface water runoff and sediment loss, both of which carry pesticide residues from the farm field to the surrounding environment. IPM consists of a management strategy for prevention, avoidance, monitoring, and suppression (PAMS) of pest populations.

CEAP analysis uses the physical process model Agricultural Policy/Environmental eXtender or APEX (Williams et al., 2008; Gassman et al. 2010) to quantify pesticide losses at the edge of the field and the bottom of the soil profile. All CEAP simulations are based on 47 years of historical daily weather, as described in the CEAP cropland reports. The effects of conservation practices on pesticide losses were evaluated using potential risk indicators developed as described in this documentation report.

Three ***edge-of-field*** pesticide risk indicators were used to assess the effects of conservation practices:

1. surface water pesticide risk indicator for aquatic ecosystems,
2. surface water pesticide risk indicator for humans, and
3. groundwater pesticide risk indicator for humans.

The surface water risk indicator includes pesticide residues in solution in surface water runoff and in all subsurface water flow pathways that eventually return to surface water. The groundwater risk indicator is based on pesticide residues in water leaching below the soil profile that eventually re-charges underground aquifers (deep percolation). The pesticide risk indicator for aquatic ecosystems is based on chronic toxicities for fish and invertebrates, and acute toxicities for nonvascular (algae) and vascular aquatic plants. The pesticide risk indicators for humans are based on EPA drinking water standards or the equivalent for pesticides that do not yet have drinking water standards established.

Potential environmental risk from pesticides sorbed to soil organic carbon or charged soil particles in sediment runoff losses is <u>not</u> evaluated in CEAP. These pesticides residues lost with waterborne sediment can contribute to the exposure concentrations for some aquatic organisms. Conservation practices that decrease surface water runoff will decrease risk from both soluble and sorbed pesticide losses.

Methods

Calculation of pesticide risk indicators for each pesticide at each sample point

Annual pesticide risk indicators were estimated for each pesticide applied to each sample point for each year in the 47-year model simulation. The process consists of the following five steps.

1. Annual mass loss estimates were obtained using the APEX model for each pesticide lost to surface water or groundwater. Annual estimates were obtained by summing over the daily losses estimated by APEX. Annual estimates were reported in grams per hectare.

2. APEX also provided estimates of the annual volume of water lost to surface water (surface water runoff, water flow in a surface or tile drainage system, lateral subsurface water flow, and groundwater return flow) and the portion of groundwater loss below the soil profile (deep percolation) that does not return to surface water as groundwater return flow. Annual estimates were reported in centimeters.

3. Annual concentrations at the edge of the field and the bottom of the soil profile were calculated for each pesticide at each sample point. Annual concentrations were estimated by the ratio of mass loss to water volume and converted to units in parts per billion (micrograms per liter). To compensate for very low or very high water volumes, which can sometimes result in extremely high or low pesticide concentrations, water volumes for each sample point were calculated as the average flow for all sample points in each 8-digit HUC (Hydrologic Unit Code) prior to calculating annual concentrations.

4. Pesticide risk indicators were calculated for each pesticide as the ratio of the concentration in water leaving the field to the "safe" concentration (toxicity thresholds) for each pesticide, where both are expressed in units of parts per billion. This ratio is called the Aquatic Risk Factor (ARF). ARFs are unit-less numbers that represent the relative toxicity of pesticides in solution. A risk indicator value of less than 1 is considered "safe" because the concentration is below the toxicity threshold for exposure at the edge-of-the field.[1]

$$\text{ARF} = \frac{\text{(Annual Concentration)}}{\text{(Toxicity Threshold)}} < 1 \quad \rightarrow \text{Little or no potential adverse impact}$$

5. Two aquatic toxicity thresholds were used in estimating potential risk:

   A. Human drinking water lifetime toxicity thresholds. These thresholds are either taken from the EPA Office of Water Standards, or derived from EPA Reference Doses or Cancer Slopes using the methods employed by the EPA Office of Water.

   B. Aquatic ecosystem toxicity thresholds. The lowest (most sensitive) toxicity is used from the fish chronic NOEL, invertebrate chronic NOEL, aquatic vascular plant acute EC50 and aquatic nonvascular plant acute EC50.

A total of 301 pesticides were reported in the farmer survey and used in the CEAP simulation modeling to derive estimates of pesticide risk indicators (appendix table 1).[2] Human drinking water toxicities were available for 290 of these pesticides, and aquatic ecosystem toxicities were available for 297 of these pesticides. Appendix table 1 provides a regional breakdown of the percentage of cropped acres treated with these 301 pesticides for at least one crop in the crop rotation used to simulate pesticide loss at CEAP sample points. Appendix table 2 presents the value of the human drinking water toxicity threshold and the value of the aquatic ecosystem toxicity threshold used for each pesticide in deriving the pesticide risk indicators.

[1] A threshold value of 1 for the pesticide risk indicator applies when assessing the risk potential for a single pesticide. Since the indicator is summed over all pesticides in this study, a threshold value of 1 would still apply if pesticide toxicities are additive and no synergistic or antagonistic effects are produced when non-target species are exposed to a mix of pesticides.

[2] A small number of additional pesticides were reported in the farmer survey, but sufficient data to estimate threshold toxicities were not available. The survey indicated that these pesticides were rarely used.

Human drinking water lifetime toxicity thresholds

Lifetime human drinking water toxicity thresholds were used to estimate the pesticide risk indicators for pesticides reported in the NRI-CEAP Cropland Survey. These chronic toxicity thresholds are compiled in the NRCS-UMass Extension Human Drinking Water Pesticide Toxicity Database (Plotkin, Bagdon and Hesketh, 2009). The basis for the lifetime human drinking water toxicity thresholds varied by pesticide depending on the scientific information available according to the hierarchy outlined below.

1. First choice, when available, was the Maximum Acceptable Level (MCL) established by the EPA Office of Water (2009). A total of 18 pesticides used in the cropland modeling had MCLs (appendix table 2).

2. For pesticides without EPA established MCLs, the EPA Office of Water (2009) Health Advisory (HA) was used as the chronic toxicity threshold, if available. HAs are lifetime toxicity thresholds for drinking water that are based on experimentally determined EPA toxicity References Doses (RfDs), which are empirically derived from mammalian testing. A total of 33 pesticides used in the cropland modeling had established HAs (appendix table 2).

3. For pesticides without established MCLs or HAs and were not known or likely carcinogens, estimated HAs were used. Estimated HAs were calculated from EPA RfDs that do not take into account pesticide carcinogenic properties. A total of 208 pesticides used in the cropland modeling had estimated HAs (appendix table 2).HAs were estimated by the following methods:

    a. For pesticides with EPA Reference Doses, NRCS/UMass Extension estimated HAs in accordance with EPA Office of Water methodology.

    b. For pesticides that did not have EPA RfDs, comparable Acceptable Daily Intake (ADI) values set by Canada, Europe, or New Zealand/Australia were used to estimate HAs.

    c. For pesticides without RfDs or ADIs , NRCS/UMass Extension estimated RfDs in accordance with EPA methods using mammalian chronic or subchronic tests with an empirically determined “No Observable Adverse Effect Concentration (NOAEC).” HAs were then calculated from the estimated RfDs.

4. For potentially carcinogenic pesticides without established MCLs or HAs, a Chronic Human Carcinogenic Level (CHCL) was calculated for the 1/100,000 probability of contracting cancer over a lifetime. These probabilities were based on cancer slopes from mammalian testing. The CHCL is an approximation of the MCL for pesticides that are known, likely, or possible human carcinogens. Pesticides with a CHCL accounted for 31 pesticides used in the CEAP cropland modeling (appendix table 2).

Very few of the biological pesticides in the ecosystem toxicity database have experimentally determined toxicity thresholds. However, on the basis of limited testing they have been described as nontoxic or practically non-toxic to humans by EPA biological pesticide fact sheets (EPA Office of Pesticides Programs). NRCS/UMass Extension estimated HAs to be greater than 50,000 micrograms per liter for all biological pesticides.

Aquatic ecosystem toxicity thresholds

Characterization of aquatic ecosystems should include as many animal and plant groups of the life web as possible. Ecosystem protection requires selection of the toxicity threshold of the most sensitive biological group (weakest link in the food web) for each pesticide. The Aquatic Ecosystem Toxicity Database contains the most sensitive threshold from the following biological groups[3]:

[3] Due to a paucity of available data at this time, other aquatic biological groups were not included in the aquatic wildlife criteria evaluation such as amphibians (e.g., frogs and salamanders) and aquatic reptiles (e.g., snakes, turtles).

- Fish chronic threshold—No Observable Effect Concentration (NOEL);
- Aquatic invertebrate chronic threshold (NOEL);
- Aquatic vascular plant acute toxicity thresholds—Effective Concentration that is lethal to 50% of the population (EC50).
- Aquatic nonvascular plant acute toxicity thresholds—Effective Concentration that is lethal to 50% of the population (EC50).

Preference was given to the EPA Office of Pesticide Programs Aquatic Life Benchmarks (EPA OPP, unpublished and as of July, 2010, not yet official). The EPA OPP recommends that their benchmarks be used as a guide by state environmental agencies in establishing aquatic biological criteria. EPA Aquatic Life Benchmarks were available for 105 of the pesticides included in the CEAP modeling, as follow (appendix table 2):

- Toxicity thresholds for 19 pesticides were based on the EPA Fish Benchmark NOEL;
- Toxicity thresholds for 49 pesticides were based on the EPA Invertebrate Benchmark NOEL;
- Toxicity thresholds for 26 pesticides were based on the EPA Nonvascular Aquatic Plants Benchmark EC50; and
- Toxicity thresholds for 11 pesticides were based on the EPA Vascular Aquatic Plants Benchmark EC50.

Toxicity thresholds for all other pesticides were taken from the NRCS/UMass Extension Fish NOEL, Aquatic Invertebrate NOEL, and Aquatic Plants EC50 databases (Plotkin, Bagdon and Hesketh, 2010a, 2010b and 2010c), as described below.

<u>Fish NOEL</u>. Fish NOELs were extrapolated from LC50 values (lethal concentration that kills 50% of the population usually over a 96-hour period), using the log-log based linear regression developed by Plotkin (unpublished, July, 2010), as follows:

$$\text{LOG10 (Fish NOEL)} = 0.889 \times \text{LOG10 (LC50)} - 0.779 \qquad R^2 = 0.81$$

The regression equation was derived from matched pairs of the same species from empirically determined LC50s and NOELs in the EPA OPP Environmental Effects Database. Aquatic ecosystem toxicity thresholds were based on Fish NOELs for 64 of the pesticides included in the CEAP modeling (appendix table 2).

<u>Aquatic Invertebrate NOEL</u>. Invertebrate NOELs in the NRCS/UMass Extension Invertebrate Database include mainly the water flea crustaceans *Daphnia pulex* and *Daphnia magna,* with about 10 percent coming from other crustaceans, aquatic insects, mollusks and other invertebrates. Invertebrate NOELs were extrapolated from EC50 values (concentration that kills or effects 50% of the population usually over a 48-hour period), using the log-log based linear regression developed by Plotkin (unpublished, July, 2010) as follows:

$$\text{LOG10 (Invertebrate NOEL)} = 0.928 \times \text{LOG10 (EC50)} - 0.981 \qquad R^2 = 0.86$$

Aquatic ecosystem toxicity thresholds were based on Invertebrate NOELs for 75 of the pesticides included in the CEAP modeling (appendix table 2).

<u>Aquatic Plant Acute Toxicity Thresholds</u>. Generally, acute testing duration for aquatic plants ranges from one to 14 days. The aquatic plant toxicity endpoint is usually an EC50 (concentration of pesticide that has an effect such as chlorophyll reduction or kills 50 percent of a species' population). The EPA OPP Environmental Effects Database provided EC50 data for both vascular and nonvascular aquatic plants. Aquatic vascular plants are at the base of the food chain providing both food and habitat for fish, invertebrates, turtles and other aquatic species. Most of the vascular plant thresholds in the toxicity database are from the floating aquatic macrophyte Duckweed (*Lemna gibba*).

Nonvascular plants are the primary producers of biomass in the aquatic ecosystem. These include free-floating algal species, as well as those species that attach to substrate such as rocks (epilithic) and macrophytes (epiphytic). Toxicity values in the database are almost exclusively for unicellular algae and diatoms as opposed to filamentous blue-green algae that are not very beneficial to an aquatic ecosystem.

Aquatic ecosystem toxicity thresholds were based on nonvascular aquatic plant EC50s for 18 of the pesticides included in the CEAP modeling and based on vascular aquatic plant EC50s for 35 of the pesticides included in the CEAP modeling (appendix table 2).

Calculation of the annual pesticide risk indicator for each sample point in each year

Pesticide risk indicators for each sample point in each year were obtained by summing over the ARFs for all pesticides used during a crop year.

$$\text{Annual pesticide risk indicator for a sample point} = \sum_{i=1}^{n} \text{Pesticide(i) ARF}$$

CEAP cropland reports use these annual pesticide risk indicators to show how pesticide risk varies from year to year over the distribution of cropped acres. Separate calculations were done for each of the three indicators. This aggregation assumes that pesticide risk is additive, and that risk from exposure to a mix of pesticides can be approximated by adding up the risk over all the pesticides in the mix once the amount of pesticide lost is normalized by dividing annual concentrations by the toxicity levels, as described in the previous section. That is, it assumes that the overall toxicity of a suite of pesticides is neither enhanced (synergism) nor diminished (antagonism) when organisms are exposed to the mix of pesticides.

A hypothetical example for pesticides used in one year at a single sample point is shown in tables 1 and 2 for each of the three pesticide risk indicators. In these examples, three herbicides are applied in a given year of a crop rotation—acetochlor, atrazine, and glyphosate isopropylamine salt. Application rates of acetochlor (840 grams per hectare) and glyphosate (544 grams per hectare) were greater than the application rate of 332 grams per hectare of atrazine. Due to the high water solubility and soil mobility of atrazine, the annual loss to surface water of atrazine residues was 3.1 ppb, and much higher than the concentration for glyphosate isopropalamine salt (0.14 ppb), while a little less than the concentration of acetochlor (5.09 ppb). The relatively high toxicity of atrazine in drinking water (MCL = 3.0 ppb) resulted in an ARF for humans in surface water of 1.0, which was twice as high as the ARF for acetochlor. In contrast, the low toxicity of glyphosate isopropalamine salt resulted in a negligible ARF of less than 0.001. When summed over the three pesticides, the annual surface water pesticide risk indicator for humans totaled 1.46. Because the toxicity thresholds are much lower (greater toxicity) for aquatic ecosystems, the surface water pesticide risk indicator for aquatic ecosystems was higher, totaling 6.66.

The groundwater pesticide risk indicator for humans was only 0.9 for this example (table 2), much lower than the 1.46 value for surface water because the concentration of pesticide residues in groundwater is lower.

Table 1. Example calculation for surface water pesticide risk indicators at a sample point

Pesticide	Annual mass loss to surface water (gr/ha)	Annual volume of water lost to surface water (cm), averaged over all sample points in the 8-digit HUC	Concen-tration (parts per billion)	Human drinking water lifetime toxicity threshold (parts per billion)	Surface water pesticide risk indicator for humans	Aquatic ecosystem toxicity threshold (parts per billion)	Surface water pesticide risk indicator for aquatic ecosystems
Acetochlor	3.562	7.0	5.09	11	0.46	1.43	3.56
Atrazine	2.153	7.0	3.10	3	1.0	1.0	3.10
Glyphosate isopropylamine salt	0.099	7.0	0.14	700	<.001	168	<.001
Pesticide risk indicator					1.46		6.66

Table 2. Example calculation for the groundwater pesticide risk indicator at a sample point

Pesticide	Annual mass loss to ground-water (gr/ha)	Annual volume of water lost to groundwater (cm), averaged over all sample points in the 8-digit HUC	Concentration (parts per billion)	Human drinking water lifetime toxicity threshold (parts per billion)	Groundwater pesticide risk indicator for humans
Acetochlor	0.002	3.2	0.01	11	0.0
Atrazine	0.82	3.2	2.60	3	0.9
Glyphosate isopropylamine salt	0.00	3.2	0.00	700	0.0
Pesticide risk indicator					0.9

Calculation of average annual pesticide risk indicators

Average annual pesticide risk indicators are used in the CEAP Cropland reports to assess the effects of conservation practices. The effects of conservation practices were estimated by determining the reduction in the average annual pesticide risk indicators when comparing a “no-practice” scenario to the conservation baseline scenario, as described in the CEAP Cropland reports.

Average annual pesticide risk indicators are determined for:

1. Each sample point, used to show the distribution of the average annual pesticide indicator within the CEAP region, and
2. Each 4-digit HUC within the region and for the region as a whole, used to characterize potential edge-of-field pesticide risk for large areas.

The average annual risk indicators for each sample point are derived by taking the average over the 47 years of the annual pesticide risk indicators for each sample point in each year.

Average annual risk indicators for large areas are calculated by taking the weighted average over the sample points of the average annual risk indicators for each point using the statistically derived acreage weights for each sample point. (See the CEAP Cropland report and references therein for information on the derivation of the acreage weights for each sample point.)

Discussion

Pesticide risk indicators were developed to represent risk at ***the edge-of-the field*** for surface water and the ***bottom of the soil profile*** for groundwater. These risk indicators are based on the ratio of pesticide concentrations in water leaving the field to "safe" concentrations (toxicity thresholds) so that the relative risk for individual pesticides could be estimated. These indicators provide a consistent measure that is comparable from field to field and that represents the effects of farming activities on risk reduction without being influenced by other landscape factors. As edge-of-field relative indicators, they are ideally suited for purposes of estimating potential risk reduction due to the use of conservation practices.

As estimated in this study, the indicators do not represent risk that non-target species would be subjected to in actual environmental settings. Consequently, these edge-of-field risk indicators cannot be used to predict environmental impacts. The pesticide risk indicators are treated as ***potential*** risk indicators for purposes of making ***relative comparisons*** from field to field.

Environmental risk is a function of both exposure concentration and the time of exposure. In an actual environmental setting, both exposure concentration and time of exposure vary throughout the year and from year to year. The risk indicators do not estimate realistic exposure concentrations or realistic times of exposure because of the following assumptions and protocols:

1. The exposure concentration used in the development of the indicators represents an annual exposure, calculated as the sum of the annual pesticide loss divided by annual volume of water flow. In an actual environmental setting, concentrations would range from near zero during some time periods to highest concentrations during the early stages of runoff events.

2. For aquatic ecosystems, the exposure is assumed to be long-term at the edge of the field in an environmental setting that receives water only from the cropped field. In most environmental settings, however, non-target species are exposed to concentrations that have been diluted by water from other sources, even when those environments are located adjacent to a field. With the data and information currently available, it is not possible to realistically estimate the extent to which water from fields has been diluted by base-flow, upstream water sources, and/or groundwater of various ages in actual environmental settings where ecosystems that support aquatic life would exist.

3. For drinking water, the assumption is that humans would be using runoff water from a cropped field as their only source of drinking water throughout the year, or in the case of groundwater, using water from a very shallow well that was recharged by percolation only from the cropped field. In contrast, drinking water supplies are typically treated prior to use and often are from water sources that are at least partially protected from contamination by water flows from cropped fields (such as deep wells and watersheds with land use restrictions).

Since the assumptions underlying the estimation of the pesticide risk indicators described here would only rarely be met in actual environmental settings, the indicators are suitable primarily for evaluation of ***potential*** risk under one set of conditions ***relative to*** another set of conditions, such as comparisons from field to field, comparisons of different farming activities on the same field, or comparisons from one region or area to another. The "safe" threshold value of 1 for the pesticide risk indicator is a useful benchmark, as it would be unlikely that ecosystem dysfunction or species mortality would occur in any nearby environmental settings where the edge-of-field risk indicator was less than 1. In actual environmental settings, where dilution from other sources of water occurs, a "safe" edge-of-field risk indicator would be expected to be greater than 1. However, because realistic estimates of dilution in actual environmental settings cannot be made, the value of the edge-of-field risk indicator associated with adverse impacts cannot be determined.

References

EPA Office of Pesticide Programs. This Version Currently Unofficial as of July, 2010. Office of Pesticide Programs' Aquatic Life Benchmarks. USEPA Office Pesticide Programs. Washington D.C.

EPA Office of Pesticide Programs. July, 2010. Environmental Effects Database (EEDB). USEPA Environmental Fate and Effects Division. Office of Pesticide Programs. Washington D.C.

EPA Office of Water. Fall, 2009. 2009 Edition of the Drinking Water Standards and Health Advisories. USEPA Office of Water. Washington D.C.

EPA Office of Pesticide Programs. December, 2008. Chemicals Evaluated for Carcinogenic Potential. USEPA Office of Pesticide Programs. Washington D.C.

Gassman, P.W., J.R. Williams, S. Wang, A. Saleh, E. Osei, L. Hauck, C. Izaurralde, and J. Flowers. 2010. The Agricultural Policy Environmental Extender (APEX) model: An emerging tool for landscape and watershed environmental analyses. *Trans. of the ASABE* (forthcoming).

Plotkin S. July, 2010. Fish Linear Regression Equation. Unpublished. USDA NRCS. Amherst, MA.

Plotkin S. July, 2010. Invertebrate Linear Regression Equation. Unpublished. USDA NRCS. Amherst, MA.

Plotkin S., J. K. Bagdon and E.S. Hesketh. September, 2010. CEAP Human Drinking Water and Aquatic Ecosystem Toxicity Database. USDA NRCS. Amherst, MA.

Plotkin S., J. K. Bagdon and E.S. Hesketh. July, 2010a. NRCS/UMass Extension Pesticide Fish NOEL Database. USDA NRCS. Amherst, MA.

Plotkin S., J. K. Bagdon and E.S. Hesketh. July, 2010b. NRCS/UMass Extension Pesticide Invertebrate NOEL Database. USDA NRCS. Amherst, MA.

Plotkin S., J. K. Bagdon and E.S. Hesketh. July, 2010c. NRCS/UMass Extension Pesticide Aquatic Plant EC50 Database. USDA NRCS. Amherst, MA.

Plotkin S., J. K. Bagdon and E.S. Hesketh. 2009. NRCS-UMass Extension Human Drinking Water Pesticide Toxicity Database. USDA NRCS. Amherst, MA.

Williams, J. R., R. C. Izaurralde, and E. M. Steglich. 2008. *Agricultural Policy/Environmental eXtender Model: Theoretical documentation version 0604*. BREC Report # 2008-17. Temple, TX: Texas AgriLife Research, Texas A&M University, Blackland Research and Extension Center. Available at: http://epicapex.brc.tamus.edu/downloads/user-manuals.aspx. Accessed 31 January 2010.

Appendix

Table 1: Percent of Cropped Acres within Each Region Treated with Pesticides in the CEAP Cropland Modeling

Pesticide name (active ingredient)	Upper Mississippi River	Chesapeake Bay	Great Lakes	Ohio-Tennessee	Missouri-(Easet)	Missouri-(West)	Arkansas-White (East)	Arkansas-White (West)	Lower Mississippi River	South Atlantic Gulf	Delaware River	Northeast	Souris-Red	Pacific Northwest	Texas Gulf	West	All Regions
No pesticide application	8	12	9	9	8	25	31	40	5	20	10	22	23	15	26	31	17
(Z,E)-7,11-Hexadecadien-1-yl acetate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0
1,3-Dichloropropene	0	<1	0	0	0	<1	0	0	0	3	0	0	0	1	0	<1	<1
2-(2,4-Dichlorophenoxy)propanoic acid, 2-butoxyeth	0	<1	<1	<1	0	0	0	0	0	0	<1	0	0	0	0	0	0
2,4-D acid, triisopropanolamine salt	0	0	0	0	0	<1	0	0	0	0	0	0	<1	<1	0	0	<1
2,4-D, 2-ethylhexyl ester	5	10	8	8	4	14	1	10	3	3	8	0	7	17	2	6	7
2,4-D, butoxyethyl ester	<1	1	1	2	<1	3	<1	<1	<1	<1	1	2	<1	2	<1	<1	<1
2,4-D, diethanolamine salt	0	0	<1	0	0	<1	0	0	<1	0	0	0	0	<1	0	<1	<1
2,4-D, dimethylamine salt	<1	4	3	2	2	8	1	8	8	7	5	6	2	12	4	8	4
2,4-DB, dimethylamine salt	0	<1	0	<1	<1	<1	0	<1	<1	7	0	0	<1	0	<1	<1	<1
2,4-Dichlorophenoxyacetic acid	3	3	4	4	4	15	3	8	4	3	0	4	7	14	3	3	6
2,4-DP, dimethylamine salt	<1	1	2	2	<1	3	3	1	2	<1	<1	0	3	3	<1	5	2
Abamectin	0	0	0	<1	0	0	0	0	<1	2	0	0	0	0	0	5	<1
Acephate	0	2	1	<1	0	0	<1	1	17	11	0	<1	0	0	7	4	2
Acetamiprid	0	0	0	0	0	0	0	0	<1	0	0	<1	0	<1	5	8	<1
Acetochlor	29	8	20	21	23	2	2	1	1	<1	6	<1	2	<1	0	0	12
Acibenzolar-s-methyl	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0
Alachlor	1	2	3	1	2	1	3	1	<1	2	1	3	0	2	<1	<1	1
Aldicarb	0	1	<1	<1	0	<1	0	<1	4	19	0	0	0	3	5	3	2
Ametryn	0	0	0	0	0	<1	0	0	<1	2	0	0	0	0	0	0	<1
Amitraz	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asulam	0	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0
Atrazine	60	67	59	71	52	19	24	20	21	27	65	47	3	3	19	3	37
Azadirachtin	0	0	0	0	0	<1	0	0	0	0	0	0	0	<1	0	0	0
Azinphos-Methyl	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	<1	<1	0
Azoxystrobin	<1	1	1	<1	0	<1	1	<1	7	7	<1	0	<1	4	3	3	2
Bacillus cereus strain BP01	0	<1	0	<1	0	0	<1	<1	4	8	0	0	0	0	2	1	<1
Bacillus subtilis GB03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0
Barban	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	<1	0
Benfluralin	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Benomyl	0	<1	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	0
Bensulfuron-methyl	0	0	0	0	0	0	<1	0	4	<1	0	0	0	0	1	<1	<1
Bensulide	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	1	0
Bifenox	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0
Bifenthrin	1	<1	<1	2	1	<1	<1	2	1	<1	1	0	0	<1	<1	1	1
Bispyribac-sodium	0	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	<1	0
Boscalid	0	0	<1	0	<1	<1	0	0	0	<1	0	0	0	<1	0	<1	<1
Bromacil	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0	0

Table 1--continued: Percent of Cropped Acres within Each Region Treated with Pesticides in the CEAP Cropland Modeling

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Bromoxynil	2	<1	2	<1	4	2	<1	<1	0	0	0	0	12	8	0	3	2
Bromoxynil octanoate	<1	<1	<1	<1	4	6	0	0	<1	<1	0	<1	26	12	0	2	3
Buprofezin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0
Butylate	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0	0	0
Cacodylic acid	0	0	0	<1	0	0	0	0	<1	0	0	0	0	0	0	<1	0
Captan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carbaryl	<1	0	<1	<1	<1	0	0	0	<1	1	0	2	<1	<1	<1	<1	<1
Carbofuran	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	0	0	<1	0	2	<1
Carboxin	0	0	0	0	0	0	0	0	0	0	0	0	<1	<1	0	0	0
Carfentrazone-ethyl	1	<1	<1	<1	1	<1	1	1	4	4	<1	0	<1	2	3	3	1
Chloramben, ammonium salt	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chlorethoxyfos	0	0	0	<1	0	0	0	0	0	0	0	0	0	<1	0	0	<1
Chlorfenapyr	0	0	0	0	<1	0	0	0	0	0	<1	0	0	0	0	0	0
Chlorimuron-ethyl	4	4	5	7	3	<1	1	0	2	2	3	0	<1	0	<1	0	3
Chloropicrin	0	0	0	0	0	0	0	0	0	2	0	0	0	<1	0	<1	<1
Chlorothalonil	<1	1	1	<1	0	<1	0	<1	<1	23	2	15	<1	5	<1	4	2
Chlorpyrifos	6	3	6	3	3	1	1	5	<1	5	8	2	4	3	<1	6	3
Chlorsulfuron	0	0	0	0	<1	2	19	5	<1	<1	0	0	0	3	<1	5	2
Chlorthal dimethyl	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	<1	0
Clethodim	2	<1	1	2	<1	2	<1	<1	1	1	<1	0	12	1	0	1	2
Clodinafop-propargyl	<1	0	0	0	<1	6	0	0	0	<1	0	0	8	5	0	0	2
Clomazone	<1	<1	<1	<1	<1	0	3	0	13	4	4	1	0	0	2	2	1
Clopyralid	11	1	10	4	4	2	<1	0	<1	<1	0	<1	17	4	<1	2	5
Clopyralid, monoethanolamine salt	0	0	0	0	0	<1	0	0	0	0	0	0	<1	<1	0	0	<1
Cloransulam-methyl	2	2	2	2	1	0	<1	0	1	3	1	0	2	0	0	0	1
Coniothyrium minitans strain CON/M/91-08 (A filame	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0
Copper hydroxide	<1	1	<1	<1	0	<1	0	<1	0	2	2	6	0	<1	0	1	<1
Copper oxychloride	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Copper sulfate pentahydrate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0
Cryolite	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0
Cyanazine	<1	<1	<1	<1	<1	0	0	0	<1	<1	<1	0	0	<1	<1	0	<1
Cyclanilide	0	<1	0	<1	0	0	0	<1	3	10	0	0	0	0	2	<1	<1
Cycloate	0	0	<1	0	0	0	0	0	0	0	0	0	0	<1	0	2	<1
Cyfluthrin	6	3	2	3	2	1	<1	0	6	8	1	3	<1	2	3	2	3
Cyhalofop-butyl	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	<1
Cymoxanil	<1	0	<1	0	0	<1	0	0	0	2	0	0	0	<1	0	0	<1
Cypermethrin	0	0	0	<1	<1	<1	0	0	7	4	0	0	0	0	1	2	<1
Cytokinin (as kinetin)	0	0	0	0	0	0	0	0	<1	0	0	0	0	<1	0	<1	0
Deltamethrin	0	0	0	0	0	0	0	0	0	1	0	0	<1	0	1	0	<1
Desmedipham	<1	0	3	0	0	<1	0	0	<1	0	0	0	8	4	<1	2	<1
Diazinon	0	0	<1	<1	0	0	0	0	0	<1	0	0	0	<1	0	3	<1

Table 1--continued: Percent of Cropped Acres within Each Region Treated with Pesticides in the CEAP Cropland Modeling

Pesticide name (active ingredient)	Upper Mississippi River	Chesapeake Bay	Great Lakes	Ohio-Tennessee	Missouri-(Easet)	Missouri-(West)	Arkansas-White (East)	Arkansas-White (West)	Lower Mississippi River	South Atlantic Gulf	Delaware River	Northeast	Souris-Red	Pacific Northwest	Texas Gulf	West	All Regions
Dicamba	6	6	6	3	5	14	<1	5	1	<1	5	3	8	6	2	2	6
Dicamba, diglycoamine salt	1	1	1	1	<1	2	0	<1	2	<1	2	0	2	<1	0	<1	<1
Dicamba, dimethylamine salt	3	2	3	3	2	5	0	5	2	<1	0	2	2	5	<1	5	3
Dicamba, potassium salt	5	<1	1	<1	2	<1	0	<1	0	0	0	0	0	0	<1	0	1
Dicamba, sodium salt	2	1	1	2	1	3	<1	4	<1	0	1	2	3	<1	<1	1	2
Dichlobenil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dichlorprop	0	0	<1	<1	0	0	0	0	0	<1	0	0	0	<1	0	0	0
Diclofop-methyl	0	<1	0	<1	0	0	<1	<1	<1	<1	0	0	<1	<1	<1	0	<1
Dicloran	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0	<1	0
Dicofol	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	<1
Dicrotophos	0	0	0	<1	0	0	0	<1	10	8	0	0	0	0	4	0	1
Difenzoquat methyl sulfate	0	0	0	0	0	<1	0	0	0	0	0	0	0	1	0	0	<1
Diflubenzuron	0	0	0	0	0	0	0	0	<1	1	0	0	<1	0	0	0	<1
Dimethenamid	3	<1	2	1	1	<1	<1	<1	<1	<1	<1	2	0	<1	<1	0	1
Dimethenamide-P	7	2	3	3	3	<1	2	1	<1	<1	<1	1	1	2	2	<1	3
Dimethipin	0	0	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	0
Dimethoate	<1	3	2	0	<1	<1	<1	<1	1	2	1	0	0	5	4	4	<1
Dimethomorph	0	<1	<1	0	0	0	0	0	0	0	0	<1	0	<1	0	<1	0
Dinocap	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dinoseb	0	0	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	0
Diquat dibromide	<1	0	<1	0	0	0	0	0	0	<1	<1	13	<1	1	0	<1	<1
Disulfoton	0	0	0	<1	0	0	0	0	<1	<1	0	0	0	<1	<1	<1	<1
Diuron	<1	<1	0	<1	0	<1	1	<1	14	10	0	0	0	3	7	12	2
Emamectin benzoate	0	0	0	0	0	0	0	0	<1	0	0	0	0	0	<1	0	<1
Endosulfan	0	<1	<1	<1	0	0	0	0	<1	2	<1	<1	0	<1	0	4	<1
Endothall	0	0	0	0	0	0	0	0	0	0	0	0	<1	0	0	<1	0
EPTC	<1	<1	4	<1	<1	<1	0	0	0	<1	0	0	2	5	0	2	<1
Esfenvalerate	<1	2	3	<1	<1	2	0	<1	1	7	1	<1	4	2	<1	4	2
Ethalfluralin	<1	<1	<1	<1	1	2	0	0	<1	7	0	<1	8	2	<1	<1	1
Ethephon	0	2	0	<1	0	<1	<1	1	20	28	0	0	0	<1	12	8	4
Ethofumesate	<1	0	<1	0	0	<1	0	0	0	0	0	0	4	5	<1	2	<1
Ethoprop	0	0	0	0	0	0	0	0	<1	<1	0	0	0	<1	0	0	<1
Etoxazole	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	<1
Etridiazole	0	0	0	0	0	0	0	<1	<1	<1	0	0	0	0	<1	0	<1
Famoxadone	0	0	0	0	0	<1	0	0	0	0	0	0	0	<1	0	0	0
Fenamidone	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0	0	0
Fenamiphos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fenbuconazole	0	0	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	0
Fenbutatin-oxide	0	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0
Fenoxaprop-ethyl	2	0	<1	2	3	6	<1	0	<1	0	0	0	30	2	<1	<1	4
Fenoxaprop-p-ethyl	0	<1	0	0	1	3	0	0	0	0	<1	0	14	2	0	<1	1

Table 1--continued: Percent of Cropped Acres within Each Region Treated with Pesticides in the CEAP Cropland Modeling

Pesticide name (active ingredient)	Upper Mississippi River	Chesapeake Bay	Great Lakes	Ohio-Tennessee	Missouri-(Easet)	Missouri-(West)	Arkansas-White (East)	Arkansas-White (West)	Lower Mississippi River	South Atlantic Gulf	Delaware River	Northeast	Souris-Red	Pacific Northwest	Texas Gulf	West	All Regions
Fenpropathrin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0
Fentin hydroxide	<1	0	<1	0	0	0	0	0	0	0	0	6	5	<1	<1	0	<1
Fipronil	<1	<1	1	<1	1	<1	0	<1	<1	0	0	0	0	0	0	<1	<1
Fluazifop-P-butyl	2	<1	<1	2	<1	0	<1	0	<1	<1	0	0	<1	0	<1	0	<1
Fluazinam	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	<1
Flucarbazone-sodium	0	0	0	0	0	<1	0	0	0	0	0	0	4	2	0	0	<1
Flucythrinate	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0	0	0
Fludioxonil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Flufenacet	2	<1	1	2	3	<1	<1	<1	<1	<1	<1	0	0	2	0	0	1
Flumetralin	0	0	0	<1	0	0	0	0	<1	3	0	0	0	0	0	<1	<1
Flumetsulam	11	5	11	5	4	<1	<1	<1	<1	1	<1	5	1	0	<1	0	4
Flumiclorac-pentyl	<1	0	<1	0	<1	0	<1	0	<1	<1	0	0	0	0	0	0	<1
Flumioxazin	1	0	1	2	1	<1	<1	0	3	3	0	0	<1	0	0	0	<1
Fluometuron	0	<1	0	0	0	0	0	<1	3	3	0	0	0	0	3	0	<1
Fluroxypyr	<1	0	<1	0	<1	2	0	0	0	<1	0	0	13	8	0	0	2
Flutolanil	0	0	0	0	0	0	0	0	0	<1	0	0	0	<1	0	0	<1
Fomesafen Sodium	2	1	3	3	<1	0	<1	0	2	<1	0	0	3	0	0	0	1
Foramsulfuron	<1	<1	<1	<1	<1	<1	0	0	0	<1	0	0	1	<1	0	0	<1
Fosetyl-Al	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0
Garlic oil	0	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0
Gibberellic acid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glufosinate-ammonium	5	<1	<1	<1	7	<1	0	<1	<1	<1	0	<1	2	<1	2	0	2
Glyphosate	3	4	3	3	2	2	0	<1	2	2	8	<1	0	<1	0	0	2
Glyphosate, isopropylamine salt	75	60	66	81	82	49	34	32	81	75	55	12	63	33	36	22	62
Glyphosate-trimesium	2	3	2	2	2	1	<1	<1	2	1	4	0	<1	<1	0	<1	1
Halosulfuron-methyl	<1	<1	<1	<1	1	0	<1	0	3	2	1	2	0	0	3	2	<1
Hexazinone	0	0	0	0	0	0	0	0	<1	0	0	0	0	<1	0	1	<1
Imazamethabenz-methyl	0	0	0	0	<1	<1	0	0	<1	0	0	0	3	2	<1	0	<1
Imazamox	2	<1	2	<1	<1	<1	<1	<1	<1	0	0	0	11	3	0	<1	2
Imazapic	0	0	0	0	0	0	0	<1	0	7	0	0	0	0	<1	0	<1
Imazapyr	1	<1	<1	5	<1	<1	<1	0	<1	<1	0	0	0	0	0	0	<1
Imazapyr, isopropylamine salt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Imazaquin	<1	<1	1	2	<1	<1	<1	0	<1	<1	<1	0	0	0	0	0	<1
Imazaquin, monoammonium salt	0	<1	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	0
Imazaquin, sodium salt	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Imazethapyr	5	4	5	7	5	<1	1	0	3	<1	3	<1	4	4	1	<1	3
Imazethapyr, ammonium salt	<1	0	<1	0	<1	0	0	0	<1	<1	2	0	<1	1	0	<1	<1
Imidacloprid	<1	<1	<1	<1	0	<1	0	0	6	3	0	4	<1	2	2	6	<1
Indole-3-butyric acid	0	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0
Indoxacarb	0	<1	0	0	0	0	0	0	<1	<1	0	0	0	0	2	7	<1
Iodosulfuron-methyl-sodium	0	0	0	<1	<1	<1	0	0	0	0	0	0	0	0	0	0	0

Table 1--continued: Percent of Cropped Acres within Each Region Treated with Pesticides in the CEAP Cropland Modeling

Pesticide name (active ingredient)	Upper Mississippi River	Chesapeake Bay	Great Lakes	Ohio-Tennessee	Missouri-(Easet)	Missouri-(West)	Arkansas-White (East)	Arkansas-White (West)	Lower Mississippi River	South Atlantic Gulf	Delaware River	Northeast	Souris-Red	Pacific Northwest	Texas Gulf	West	All Regions
Iprodione	0	0	0	0	0	0	0	0	<1	<1	0	0	0	<1	0	<1	<1
Isoxaben	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isoxaflutole	7	<1	2	6	8	1	0	1	0	0	2	0	<1	0	0	<1	3
Kinetin (plant hormone)	0	0	0	0	0	0	0	0	<1	3	0	0	0	0	<1	<1	<1
Lactofen	1	<1	<1	<1	<1	<1	<1	0	0	0	0	0	<1	0	0	0	<1
lambda-Cyhalothrin	3	11	3	4	3	<1	<1	<1	11	11	16	4	2	2	5	5	4
Lindane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Linuron	<1	1	<1	0	<1	0	0	0	<1	<1	<1	<1	0	<1	<1	1	<1
Live Chlamydospores of Phytophthora palmivora MWV	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0
Malathion	<1	0	<1	0	0	0	0	<1	4	<1	0	0	0	1	8	2	<1
Maleic hydrazide, potassium salt	0	<1	<1	<1	0	0	0	0	0	4	0	0	0	<1	0	0	<1
Mancozeb	<1	<1	1	<1	0	<1	0	0	0	2	1	14	<1	5	0	3	<1
Maneb	0	0	0	0	0	0	0	0	0	0	0	<1	0	<1	0	3	<1
MCPA	<1	<1	<1	<1	4	6	0	0	0	0	0	0	40	12	<1	3	4
MCPA, 2-ethylhexyl ester	<1	<1	<1	0	2	5	<1	<1	<1	<1	0	<1	16	15	0	<1	3
MCPA, dimethylamine salt	<1	<1	<1	<1	<1	<1	0	0	0	0	0	0	2	6	<1	2	<1
MCPA, isooctyl ester	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0
MCPB, sodium salt	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCPP, DMA salt	0	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0
Mecoprop-P	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mefenoxam	0	<1	<1	<1	<1	0	0	0	<1	1	1	0	0	2	0	<1	<1
Mepiquat chloride	0	1	0	<1	0	0	<1	1	12	19	0	0	0	0	6	8	2
Mepiquat pentaborate	0	<1	0	0	0	0	0	0	<1	1	0	0	0	0	<1	<1	<1
Mesosulfuron-methyl	0	0	0	0	0	<1	2	0	<1	<1	0	0	<1	2	0	<1	<1
Mesotrione	18	16	9	7	13	2	<1	2	<1	0	13	10	<1	<1	<1	0	7
Metalaxyl	0	0	0	0	0	0	0	0	<1	0	0	<1	<1	<1	0	0	<1
Metaldehyde	0	0	0	0	0	0	0	0	0	<1	0	0	0	<1	0	0	0
Metam-sodium	0	<1	<1	0	0	0	0	0	0	<1	0	0	0	3	0	1	<1
Methamidophos	0	0	0	0	0	0	0	0	<1	2	0	6	<1	1	0	<1	<1
Methanone, [3-(4,5-dihydro-3-isoxazolyl)-2-methyl-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Methidathion	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Methomyl	0	1	<1	0	0	0	<1	0	<1	2	<1	1	0	<1	<1	5	<1
Methoxyfenozide	0	0	0	0	0	0	0	<1	<1	2	0	0	0	0	<1	2	<1
Methyl bromide	0	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0
Methyl parathion	<1	<1	0	0	<1	<1	<1	1	5	2	0	0	2	<1	4	<1	1
Metiram	0	0	<1	0	0	0	0	0	0	0	0	0	0	<1	0	0	0
Metolachlor	4	11	6	10	5	3	4	<1	4	6	8	11	<1	<1	2	3	4
Metribuzin	2	<1	4	3	3	<1	<1	0	3	2	<1	13	<1	15	<1	2	2
Metsulfuron-methyl	0	0	0	0	<1	10	19	10	<1	<1	0	0	<1	18	2	2	4
Molinate	<1	<1	<1	<1	0	0	<1	<1	1	<1	0	0	0	0	1	2	<1
MSMA	0	<1	0	<1	0	<1	0	0	3	6	0	0	0	0	<1	<1	<1

Table 1--continued: Percent of Cropped Acres within Each Region Treated with Pesticides in the CEAP Cropland Modeling

Pesticide name (active ingredient)	Upper Mississippi River	Chesapeake Bay	Great Lakes	Ohio-Tennessee	Missouri-(Easet)	Missouri-(West)	Arkansas-White (East)	Arkansas-White (West)	Lower Mississippi River	South Atlantic Gulf	Delaware River	Northeast	Souris-Red	Pacific Northwest	Texas Gulf	West	All Regions
Myclobutanil	0	0	0	0	0	0	0	0	0	0	0	1	0	<1	0	<1	0
Naled	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0	2	0
Napropamide	0	0	<1	<1	0	0	0	0	0	<1	0	0	0	<1	0	<1	<1
Naptalam, sodium salt	<1	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0
Nicosulfuron	12	9	9	8	9	2	1	3	4	3	6	3	5	<1	2	2	6
Nonanoic acid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Norflurazon	0	0	0	<1	0	0	0	0	<1	0	0	0	0	0	<1	0	0
Novaluron	0	0	0	0	0	0	0	0	<1	0	0	0	0	<1	0	0	0
Oryzalin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxamyl	0	0	0	0	0	0	0	0	1	2	0	0	0	2	2	2	<1
Oxydemeton-methyl	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0	<1	0
Oxyfluorfen	0	<1	<1	0	0	0	0	0	<1	<1	0	0	0	2	<1	3	<1
Paraquat dichloride	<1	22	<1	4	<1	<1	0	<1	6	12	10	<1	1	2	13	9	3
Parathion	0	0	0	0	0	0	0	<1	<1	0	1	0	0	<1	<1	<1	<1
Pebulate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pendimethalin	6	18	10	4	6	2	<1	2	7	23	20	18	5	7	13	5	6
Penoxsulam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Pentachloronitrobenzene	0	0	<1	0	<1	0	0	<1	1	<1	0	0	<1	1	<1	0	<1
Permethrin, mixed cis,trans	1	4	1	2	<1	<1	<1	<1	<1	1	4	2	0	<1	<1	5	<1
Phenmedipham	<1	0	3	0	0	<1	0	0	<1	0	0	0	7	4	<1	2	<1
Phorate	<1	0	<1	0	0	0	0	<1	<1	8	0	0	0	2	<1	<1	<1
Phosmet	0	0	0	0	0	0	0	0	0	<1	0	0	0	<1	0	0	<1
Phosphorous acid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0
Phostebupirim	5	<1	<1	3	2	<1	0	0	<1	0	0	0	0	<1	<1	<1	2
Picloram, potassium salt	0	0	0	0	<1	<1	<1	2	0	0	0	0	0	<1	0	<1	<1
Pinoxaden	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0
Piperonyl butoxide	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	<1
Pirimicarb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Primisulfuron-methyl	3	2	2	3	3	<1	<1	<1	<1	<1	2	0	0	<1	<1	0	1
Prodiamine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Profenofos	0	0	0	0	0	0	<1	0	<1	<1	0	0	<1	0	0	0	<1
Prohexadione calcium	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0	0	0
Prometryn	0	<1	<1	<1	0	0	<1	<1	2	4	0	0	0	0	3	4	<1
Propachlor	0	<1	0	<1	<1	<1	0	0	0	<1	0	0	0	0	0	0	0
Propamocarb hydrochloride	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Propanil	0	0	0	0	0	0	3	0	9	<1	0	0	0	<1	3	8	1
Propargite	0	0	<1	0	0	<1	0	<1	<1	0	0	0	0	<1	<1	8	<1
Propazine	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0	0
Propiconazole	<1	4	<1	<1	<1	1	<1	<1	3	5	3	0	6	5	2	1	1
Propoxycarbazone-sodium	0	0	0	0	0	<1	2	0	0	0	0	0	<1	1	0	0	<1
Propyzamide	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	<1

Table 1--continued: Percent of Cropped Acres within Each Region Treated with Pesticides in the CEAP Cropland Modeling

Pesticide name (active ingredient)	Upper Mississippi River	Chesapeake Bay	Great Lakes	Ohio-Tennessee	Missouri-(Easet)	Missouri-(West)	Arkansas-White (East)	Arkansas-White (West)	Lower Mississippi River	South Atlantic Gulf	Delaware River	Northeast	Souris-Red	Pacific Northwest	Texas Gulf	West	All Regions
Prosulfuron	<1	<1	<1	2	2	<1	<1	<1	<1	<1	<1	0	0	4	3	0	1
Pymetrozine	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0	<1	0
Pyraclostrobin	<1	<1	1	<1	1	<1	0	<1	2	6	<1	0	5	1	<1	<1	1
Pyraflufen-ethyl	0	0	0	0	0	0	0	<1	0	2	0	0	0	0	1	3	<1
Pyrazon	0	0	<1	0	0	0	0	0	0	0	0	0	0	<1	0	0	0
Pyrethrins	0	0	0	<1	0	0	0	0	0	0	0	0	0	<1	0	4	<1
Pyridate	0	0	0	0	<1	0	0	0	0	0	0	0	0	<1	0	0	0
Pyriproxyfen	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	3	<1
Pyrithiobac-sodium	0	<1	0	0	0	0	0	<1	2	4	0	0	0	0	4	5	<1
Quinclorac	0	0	0	0	0	0	<1	<1	7	0	0	0	0	<1	2	<1	<1
Quizalofop-ethyl	0	0	0	0	<1	0	<1	0	0	0	0	0	<1	<1	0	0	<1
Quizalofop-p-ethyl	<1	<1	<1	<1	<1	2	<1	0	<1	0	0	0	4	5	<1	0	<1
Rimsulfuron	10	9	8	6	7	2	1	3	3	2	6	7	3	3	<1	3	5
Rotenone	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0	0	0
Sethoxydim	<1	<1	<1	<1	1	1	<1	0	<1	2	1	0	7	<1	0	<1	1
Simazine	2	20	4	8	<1	<1	0	0	<1	2	6	5	0	0	0	0	2
S-Metolachlor	18	40	25	22	14	6	6	6	6	9	34	25	<1	2	3	2	12
Sodium acifluorfen	<1	<1	<1	<1	<1	0	<1	0	2	4	0	0	<1	0	<1	0	<1
Sodium asulam	0	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0
Sodium bentazon	<1	<1	3	<1	1	<1	<1	0	1	5	1	<1	9	1	<1	<1	1
Sodium chlorate	0	0	0	<1	0	0	<1	<1	3	1	0	0	0	0	<1	2	<1
Spinosyn A	0	<1	0	0	0	0	0	0	<1	3	<1	3	0	0	<1	4	<1
Spiromesifen	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	0	1	0
Streptomycin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sulfentrazone	5	3	4	6	3	3	<1	<1	3	2	1	0	4	<1	0	0	3
Sulfometuron methyl	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0
Sulfosulfuron	0	0	0	0	0	<1	5	2	0	0	0	0	0	5	0	0	<1
Sulfur	0	0	<1	0	0	0	0	0	0	<1	0	0	0	1	0	4	<1
Tebuconazole	<1	<1	0	<1	<1	<1	0	0	<1	11	0	0	10	<1	<1	<1	1
Tebufenozide	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	<1	<1
Tebuthiuron	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0
Tefluthrin	6	2	2	6	1	<1	0	<1	0	0	3	4	0	<1	<1	0	2
Terbacil	0	<1	<1	0	0	0	0	0	0	0	0	0	0	<1	0	0	0
Terbufos	<1	1	<1	1	<1	<1	0	<1	<1	3	1	0	3	1	4	0	1
Tetraconazole	<1	0	2	<1	0	0	0	0	0	0	0	0	6	0	0	0	<1
Thiamethoxam	0	0	<1	<1	0	0	0	<1	6	<1	<1	<1	<1	<1	<1	3	<1
Thiazopyr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thidiazuron	0	<1	0	<1	0	<1	<1	<1	15	11	0	0	0	0	10	12	2
Thifensulfuron methyl	2	18	6	5	2	9	2	4	3	4	17	8	12	30	<1	2	6
Thiobencarb	0	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	3	<1
Thiodicarb	0	0	0	0	0	0	0	0	1	<1	0	1	0	0	<1	0	<1

Table 1--continued: Percent of Cropped Acres within Each Region Treated with Pesticides in the CEAP Cropland Modeling

Pesticide name (active ingredient)	Upper Mississippi River	Chesapeake Bay	Great Lakes	Ohio-Tennessee	Missouri-(Easet)	Missouri-(West)	Arkansas-White (East)	Arkansas-White (West)	Lower Mississippi River	South Atlantic Gulf	Delaware River	Northeast	Souris-Red	Pacific Northwest	Texas Gulf	West	All Regions
Thiophanate-methyl	0	<1	<1	0	0	0	0	0	<1	0	0	<1	<1	<1	0	<1	<1
Thiram	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tralkoxydim	0	0	0	0	0	1	0	0	0	0	0	0	0	5	0	<1	<1
Tralomethrin	0	0	0	0	0	0	0	0	<1	1	0	0	0	0	0	0	<1
Triallate	0	0	0	0	0	2	0	0	0	0	0	0	<1	2	0	<1	<1
Triasulfuron	0	0	0	0	<1	7	1	3	0	0	0	0	0	2	<1	0	1
Tribenuron-methyl	1	15	4	4	2	9	1	4	3	3	15	4	9	31	<1	2	5
Tribuphos	<1	<1	0	<1	0	0	<1	<1	13	19	0	0	0	0	6	3	2
Triclopyr	0	<1	<1	0	0	<1	<1	0	3	0	<1	0	0	0	<1	5	<1
Trifloxystrobin	0	<1	<1	<1	<1	<1	<1	0	1	1	0	0	1	<1	0	<1	<1
Trifloxysulfuron-sodium	0	<1	0	<1	0	0	0	0	2	1	0	0	0	0	<1	0	<1
Trifluralin	5	<1	3	<1	7	2	<1	4	1	7	3	0	10	4	30	16	6
Triflusulfuron-methyl	0	0	2	0	0	<1	0	0	0	0	0	0	7	2	0	0	<1
Trinexapac-ethyl	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	<1	0	0
Vernolate	<1	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	<1
Vinclozolin	0	1	<1	0	0	0	0	0	0	0	0	0	<1	<1	0	0	<1
Zeta-Cypermethrin	2	2	2	1	1	<1	2	1	4	4	3	0	<1	2	3	7	2
Zoxamide	0	<1	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2: Toxicity Thresholds for Pesticides Included in CEAP Cropland Modeling

APEX pesticide number	PC code	Pesticide name (active ingredient)	Type of pesticide	Aquatic ecosystem toxicity threshold (parts per billion)	Basis of aquatic ecosystem toxicity threshold	Human drinking water lifetime toxicity threshold (parts per billion)	Basis of human drinking water lifetime toxicity threshold
23	114101	(Z,E)-7,11-Hexadecadien-1-yl acetate	Attractant	19.497	Invertebrate NOEL	50000	HA*
30	29001	1,3-Dichloropropene	Fungicide	68.27	Fish NOEL	4	CHCL
41	31453	2-(2,4-Dichlorophenoxy)propanoic acid, 2-butoxyethyl	Herbicide	0.5722	Invertebrate NOEL	NA	
53	30035	2,4-D acid, triisopropanolamine salt	Herbicide	2370	Vascular Aquatic Plants EC50	70	MCL
54	30063	2,4-D, 2-ethylhexyl ester	Herbicide	0.2896	Invertebrate NOEL	70	HA*
55	30053	2,4-D, butoxyethyl ester	Herbicide	0.576	Vascular Aquatic Plants EC50	70	MCL
56	30016	2,4-D, diethanolamine salt	Herbicide	440	Vascular Aquatic Plants EC50	70	MCL
57	30019	2,4-D, dimethylamine salt	Herbicide	10.9248	Invertebrate NOEL	70	MCL
64	30819	2,4-DB, dimethylamine salt	Herbicide	247.247	Fish NOEL	70	HA*
65	30001	2,4-Dichlorophenoxyacetic acid	Herbicide	695	Vascular Aquatic Plants EC50	70	MCL
66	31419	2,4-DP, dimethylamine salt	Herbicide	5003.48	Fish NOEL	35	HA*
83	122804	Abamectin	Miticide	0.0035	Invertebrate NOEL	2.8	HA*
84	103301	Acephate	Insecticide	150	Invertebrate Benchmark NOEL	2.8	HA*
86	99050	Acetamiprid	Insecticide	2.5	Invertebrate NOEL	490	HA*
88	121601	Acetochlor	Herbicide	1.43	Nonvascular Aquatic Plants Benchmark EC50	11	CHCL
89	61402	Acibenzolar-s-methyl	Fungicide	26	Fish NOEL	350	HA*
94	90501	Alachlor	Herbicide	1.64	Nonvascular Aquatic Plants Benchmark EC50	2	MCL
95	98301	Aldicarb	Insecticide	0.46	Fish Benchmark NOEL	3	MCL
106	80801	Ametryn	Herbicide	3.67	Nonvascular Aquatic Plants Benchmark EC50	60	HA
112	106201	Amitraz	Insecticide	1.1	Invertebrate NOEL	1.75	HA*
125	106901	Asulam	Herbicide	10.2472	Invertebrate NOEL	252	HA*
126	80803	Atrazine	Herbicide	1	Nonvascular Aquatic Plants Benchmark EC50	3	MCL
127	121701	Azadirachtin	Miticide	10.859	Fish NOEL	225	HA*
132	58001	Azinphos-Methyl	Insecticide	0.036	Invertebrate Benchmark NOEL	10.5	HA*
135	128810	Azoxystrobin	Fungicide	44	Invertebrate Benchmark NOEL	1260	HA*
136	119802	Bacillus cereus strain BP01	Bacillus lic	510	Fish NOEL	50000	HA*
142	129068	Bacillus subtilis GB03	Fungicide	510	Fish NOEL	50000	HA*
163	17601	Barban	Herbicide	97.565	Fish NOEL	NA	
171	84301	Benfluralin	Herbicide	1.9	Fish Benchmark NOEL	210	HA*
174	99101	Benomyl	Fungicide	1.5	Fish NOEL	35	HA*
175	128820	Bensulfuron-methyl	Herbicide	800	Nonvascular Aquatic Plants EC50	1400	HA*
176	9801	Bensulide	Herbicide	4.2	Invertebrate NOEL	46.2	HA*
182	104301	Bifenox	Herbicide	3.3526	Invertebrate NOEL	1050	HA*
183	128825	Bifenthrin	Insecticide	0.0013	Invertebrate Benchmark NOEL	10.5	HA*
185	78906	Bispyribac-sodium	Herbicide	12	Vascular Aquatic Plants EC50	700	HA*
189	128008	boscalid	Fungicide	64.7114	Invertebrate NOEL	152.6	HA*
192	12301	Bromacil	Herbicide	6.8	Nonvascular Aquatic Plants Benchmark EC50	70	HA
197	35301	Bromoxynil	Herbicide	148.802	Fish NOEL	10.5	HA*
200	35302	Bromoxynil octanoate	Herbicide	2.6	Invertebrate NOEL	14	HA*
203	275100	Buprofezin	Insecticide	52	Fish NOEL	7	HA*
208	41405	Butylate	Herbicide	186.845	Fish NOEL	400	HA
209	12501	Cacodylic acid	Herbicide	63.5331	Invertebrate NOEL	5.618	CHCL
217	81301	Captan	Fungicide	16.5	Fish Benchmark NOEL	146	CHCL
218	56801	Carbaryl	Insecticide	0.5	Invertebrate Benchmark NOEL	70	HA*
221	90601	Carbofuran	Insecticide	0.75	Invertebrate Benchmark NOEL	40	MCL
225	90201	Carboxin	Fungicide	9.977	Fish NOEL	700	HA

* HAs estimated by NRCS/UMass Extension.
Note: NA in the toxicity threshold columns indicates “not available.”

Table 2—continued: Toxicity Thresholds for Pesticides Included in CEAP Cropland Modeling

APEX pesticide number	PC code	Pesticide name (active ingredient)	Type of pesticide	Aquatic ecosystem toxicity threshold (parts per billion)	Basis of aquatic ecosystem toxicity threshold	Human drinking water lifetime toxicity threshold (parts per billion)	Basis of human drinking water lifetime toxicity threshold
226	128712	Carfentrazone-ethyl	Herbicide	5.9	Vascular Aquatic Plants EC50	3500	HA*
233	29902	Chloramben, ammonium salt	Herbicide	35892.193	Fish NOEL	100	HA
239	129006	Chlorethoxyfos	Insecticide	0.0124	Invertebrate NOEL	4.2	HA*
241	129093	Chlorfenapyr	Miticide	0.172	Invertebrate NOEL	2.1	HA*
243	128901	Chlorimuron-ethyl	Herbicide	143.092	Fish NOEL	140	HA*
249	81501	Chloropicrin	Fumigant	0.713	Fish NOEL	56	HA*
250	81901	Chlorothalonil	Fungicide	0.6	Invertebrate Benchmark NOEL	15	CHCL
254	59101	Chlorpyrifos	Insecticide	0.04	Invertebrate Benchmark NOEL	2	HA
256	118601	Chlorsulfuron	Herbicide	0.42	Vascular Aquatic Plants EC50	350	HA*
257	78701	Chlorthal dimethyl	Herbicide	40.7699	Invertebrate NOEL	70	HA
269	121011	Clethodim	Herbicide	1033.6323	Invertebrate NOEL	70	HA*
270	125203	Clodinafop-propargyl	Herbicide	120.8804	Invertebrate NOEL	0.21	HA*
273	125401	Clomazone	Herbicide	167	Nonvascular Aquatic Plants Benchmark EC50	301	HA*
274	117403	Clopyralid	Herbicide	4798.91	Fish NOEL	3500	HA*
275	117401	Clopyralid, monoethanolamine salt	Herbicide	4778.394	Fish NOEL	NA	
276	129116	Cloransulam-methyl	Herbicide	2.7	Nonvascular Aquatic Plants EC50	700	HA*
281	23401	Copper hydroxide	Fungicide	6.71	Fish NOEL	1000	HA*
280	28836	Coniothyrium minitans strain CON/M/91-08 (A filame	Biological	510	Fish NOEL	50000	HA*
282	8001	Copper oxychloride	Fungicide	155.745	Fish NOEL	NA	
284	24401	Copper sulfate pentahydrate	Algicide	3.1	Nonvascular Aquatic Plants EC50	1000	HA*
292	100101	Cyanazine	Herbicide	4.8	Nonvascular Aquatic Plants EC50	1	HA
290	75101	Cryolite	Insecticide	282.907	Invertebrate NOEL	NA	
294	26201	Cyclanilide	Herbicide	80	Nonvascular Aquatic Plants EC50	49	HA*
295	41301	Cycloate	Herbicide	154.2039	Invertebrate NOEL	35	HA*
296	128831	Cyfluthrin	Insecticide	0.007	Invertebrate Benchmark NOEL	175	HA*
297	82583	Cyhalofop-butyl	Herbicide	47	Invertebrate NOEL	70	HA*
300	129106	Cymoxanil	Fungicide	0.98	Fish NOEL	91	HA*
301	109702	Cypermethrin	Insecticide	0.069	Invertebrate Benchmark NOEL	7	HA*
306	116801	Cytokinin (as kinetin)	Growth Reg	35892.193	Fish NOEL	50000	HA*
318	97805	Deltamethrin	Insecticide	0.0041	Invertebrate Benchmark NOEL	70	HA*
323	104801	Desmedipham	Herbicide	44	Nonvascular Aquatic Plants EC50	280	HA*
327	57801	Diazinon	Insecticide	0.17	Invertebrate Benchmark NOEL	1	HA
328	29801	Dicamba	Herbicide	61	Nonvascular Aquatic Plants Benchmark EC50	4000	HA
331	128931	Dicamba, diglycoamine salt	Herbicide	15893.931	Fish NOEL	4000	HA
332	29802	Dicamba, dimethylamine salt	Herbicide	35892.193	Fish NOEL	4000	HA
335	129043	Dicamba, potassium salt	Herbicide	5851.883	Fish NOEL	4000	HA
336	29806	Dicamba, sodium salt	Herbicide	1862.509	Invertebrate NOEL	4000	HA
338	27401	Dichlobenil	Herbicide	30	Vascular Aquatic Plants Benchmark EC50	9.1	HA*
343	31401	Dichlorprop	Herbicide	41.724	Fish NOEL	35	HA*
346	110902	Diclofop-methyl	Herbicide	7.5	Fish NOEL	4.755	CHCL
347	31301	Dicloran	Fungicide	11.733	Fish NOEL	175	HA*
349	10501	Dicofol	Miticide	4.4	Fish Benchmark NOEL	0.84	HA*
350	35201	Dicrotophos	Insecticide	0.99	Invertebrate Benchmark NOEL	0.07	HA*
359	106401	Difenzoquat methyl sulfate	Herbicide	120	Nonvascular Aquatic Plants EC50	1400	HA*
360	108201	Diflubenzuron	Insecticide	0.00025	Invertebrate Benchmark NOEL	140	HA*

* HAs estimated by NRCS/UMass Extension.
Note: NA in the toxicity threshold columns indicates "not available."

Table 2—continued: Toxicity Thresholds for Pesticides Included in CEAP Cropland Modeling

APEX pesticide number	PC code	Pesticide name (active ingredient)	Type of pesticide	Aquatic ecosystem toxicity threshold (parts per billion)	Basis of aquatic ecosystem toxicity threshold	Human drinking water lifetime toxicity threshold (parts per billion)	Basis of human drinking water lifetime toxicity threshold
363	129051	Dimethenamid	Herbicide	8.9	Vascular Aquatic Plants Benchmark EC50	35	HA*
364	120051	Dimethenamide-P	Herbicide	13	Vascular Aquatic Plants EC50	35	HA*
365	118901	Dimethipin	Herbicide	610	Invertebrate NOEL	14	HA*
367	35001	Dimethoate	Insecticide	0.5	Invertebrate Benchmark NOEL	0.35	HA*
368	268800	Dimethomorph	Fungicide	100	Invertebrate NOEL	700	HA*
372	36001	Dinocap	Fungicide	0.3957	Invertebrate NOEL	28	HA*
373	37505	Dinoseb	Herbicide	3.623	Fish NOEL	7	MCL
383	32201	Diquat dibromide	Herbicide	0.75	Vascular Aquatic Plants Benchmark EC50	20	MCL
385	32501	Disulfoton	Insecticide	0.01	Invertebrate Benchmark NOEL	0.7	HA
388	35505	Diuron	Herbicide	2.4	Nonvascular Aquatic Plants Benchmark EC50	20	CHCL
398	122806	Emamectin benzoate	Insecticide	0.0087	Invertebrate NOEL	1.75	HA*
399	79401	Endosulfan	Insecticide	0.01	Invertebrate Benchmark NOEL	42	HA*
400	38901	Endothall	Herbicide	1300	Fish Benchmark NOEL	100	MCL
404	41401	EPTC	Herbicide	677.58	Fish NOEL	175	HA*
405	109303	Esfenvalerate	Insecticide	0.017	Invertebrate Benchmark NOEL	140	HA*
406	113101	Ethalfluralin	Herbicide	0.4	Fish Benchmark NOEL	28	HA*
408	99801	Ethephon	Herbicide	1400	Nonvascular Aquatic Plants EC50	126	HA*
412	110601	Ethofumesate	Herbicide	250	Invertebrate NOEL	2800	HA*
413	41101	Ethoprop	Nematicide	0.8	Invertebrate Benchmark NOEL	12	CHCL
417	107091	Etoxazole	Miticide	0.13	Invertebrate NOEL	323	HA*
418	84701	Etridiazole	Fungicide	7	Nonvascular Aquatic Plants EC50	11	CHCL
422	113202	Famoxadone	Fungicide	0.085	Invertebrate NOEL	9.8	HA*
425	46679	Fenamidone	Fungicide	8.6	Fish NOEL	14	HA*
427	100601	Fenamiphos	Insecticide	0.12	Invertebrate NOEL	0.7	HA
430	129011	Fenbuconazole	Fungicide	27	Fish NOEL	21	HA*
431	104601	Fenbutatin-oxide	Miticide	0.31	Fish Benchmark NOEL	350	HA*
435	128701	Fenoxaprop-ethyl	Herbicide	7.3597	Invertebrate NOEL	17.5	HA*
436	129092	Fenoxaprop-p-ethyl	Herbicide	10.9	Invertebrate NOEL	17.5	HA*
438	127901	Fenpropathrin	Insecticide	0.012	Invertebrate NOEL	175	HA*
444	83601	Fentin hydroxide	Fungicide	0.0065	Fish NOEL	0.191	CHCL
448	129121	Fipronil	Miticide	0.011	Invertebrate Benchmark NOEL	0.14	HA*
454	122809	Fluazifop-P-butyl	Herbicide	31.5288	Invertebrate NOEL	51.8	HA*
455	129098	Fluazinam	Fungicide	0.69	Fish Benchmark NOEL	2.8	HA*
456	114009	Flucarbazone-sodium	Herbicide	4498.256	Fish NOEL	2520	HA*
459	118301	Flucythrinate	Insecticide	0.0012	Invertebrate NOEL	140	HA*
460	71503	Fludioxonil	Fungicide	19	Invertebrate NOEL	210	HA*
461	121903	Flufenacet	Herbicide	2.45	Vascular Aquatic Plants EC50	28	HA*
463	123001	Flumetralin	Growth Reg	0.46	Fish NOEL	NA	
464	129016	Flumetsulam	Herbicide	3.1	Vascular Aquatic Plants Benchmark EC50	7000	HA*
465	128724	Flumiclorac-pentyl	Herbicide	37.0953	Invertebrate NOEL	2450	HA*
466	129034	Flumioxazin	Herbicide	0.49	Vascular Aquatic Plants EC50	140	HA*
467	35503	Fluometuron	Herbicide	30	Nonvascular Aquatic Plants Benchmark EC50	7	HA*
472	128959	Fluroxypyr	Herbicide	292	Nonvascular Aquatic Plants EC50	3500	HA*
477	128975	Flutolanil	Fungicide	233	Fish Benchmark NOEL	4200	HA*
481	123802	Fomesafen Sodium	Herbicide	92	Nonvascular Aquatic Plants EC50	17.5	HA*
483	122020	Foramsulfuron	Herbicide	0.4	Vascular Aquatic Plants EC50	35000	HA*

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Table 2—continued: Toxicity Thresholds for Pesticides Included in CEAP Cropland Modeling

APEX pesticide number	PC code	Pesticide name (active ingredient)	Type of pesticide	Aquatic ecosystem toxicity threshold (parts per billion)	Basis of aquatic ecosystem toxicity threshold	Human drinking water lifetime toxicity threshold (parts per billion)	Basis of human drinking water lifetime toxicity threshold
496	128827	Garlic oil	Biological	510	Fish NOEL	50000	HA*
490	123301	Fosetyl-Al	Fungicide	115.261	Invertebrate NOEL	21000	HA*
499	43801	Gibberellic acid	Growth Reg	6355.531	Invertebrate NOEL	50000	HA*
503	128850	Glufosinate-ammonium	Herbicide	717.766	Fish NOEL	140	HA*
504	417300	Glyphosate	Herbicide	1800	Fish Benchmark NOEL	700	MCL
506	103601	Glyphosate, isopropylamine salt	Herbicide	176.1037	Invertebrate NOEL	700	MCL
507	128501	Glyphosate-trimesium	Insecticide	363.055	Fish NOEL	700	HA*
511	128721	Halosulfuron-methyl	Herbicide	0.042	Vascular Aquatic Plants EC50	700	HA*
520	107201	Hexazinone	Herbicide	7	Nonvascular Aquatic Plants Benchmark EC50	400	HA
527	128842	Imazamethabenz-methyl	Insecticide	320	Fish NOEL	441	HA*
528	129171	Imazamox	Herbicide	11	Vascular Aquatic Plants Benchmark EC50	21000	HA*
529	129041	Imazapic	Herbicide	96000	Invertebrate NOEL	3500	HA*
531	128821	Imazapyr	Herbicide	18	Vascular Aquatic Plants Benchmark EC50	17500	HA*
532	128829	Imazapyr, isopropylamine salt	Herbicide	14.1	Nonvascular Aquatic Plants EC50	NA	
533	128848	Imazaquin	Herbicide	11575.066	Fish NOEL	1750	HA*
534	128840	Imazaquin, monoammonium salt	Herbicide	NA		1750	HA*
535	129023	Imazaquin, sodium salt	Herbicide	NA		1750	HA*
536	128922	Imazethapyr	Herbicide	8.1	Vascular Aquatic Plants EC50	1750	HA*
537	128923	Imazethapyr, ammonium salt	Herbicide	NA		1750	HA*
538	129099	Imidacloprid	Fungicide	1.05	Invertebrate Benchmark NOEL	399	HA*
541	46701	Indole-3-butyric acid	Fungicide	2706.7732	Invertebrate NOEL	50000	HA*
542	67710	Indoxacarb	Insecticide	16.9	Fish NOEL	140	HA*
544	122021	Iodosulfuron-methyl-sodium	Herbicide	0.7	Vascular Aquatic Plants EC50	210	HA*
547	109801	Iprodione	Fungicide	170	Invertebrate Benchmark NOEL	7.973	CHCL
554	125851	Isoxaben	Herbicide	400	Fish Benchmark NOEL	35	HA*
555	123000	Isoxaflutole	Herbicide	1	Invertebrate NOEL	34	CHCL
559	116802	Kinetin (plant hormone)	Biological	510	Fish NOEL	50000	HA*
561	128888	Lactofen	Herbicide	0.6	Vascular Aquatic Plants Benchmark EC50	2.941	CHCL
563	128897	lambda-Cyhalothrin	Insecticide	0.002	Invertebrate Benchmark NOEL	7	HA*
568	9001	Lindane	Insecticide	2.9	Fish Benchmark NOEL	0.2	MCL
569	35506	Linuron	Herbicide	0.09	Invertebrate Benchmark NOEL	5.6	HA*
570	111301	Live Chlamydospores of Phytophthora palmivora MWV	Biological	510	Fish NOEL	50000	HA*
573	57701	Malathion	Insecticide	0.035	Invertebrate Benchmark NOEL	100	HA
575	51503	Maleic hydrazide, potassium salt	Herbicide	4687.1942	Invertebrate NOEL	4000	HA
576	14504	Mancozeb	Fungicide	2.2	Fish NOEL	5.824	CHCL
577	14505	Maneb	Fungicide	2.6803	Invertebrate NOEL	5.738	CHCL
579	30501	MCPA	Herbicide	137.992	Fish NOEL	30	HA
580	30564	MCPA, 2-ethylhexyl ester	Herbicide	14.2678	Invertebrate NOEL	3.5	HA*
582	30516	MCPA, dimethylamine salt	Herbicide	130	Vascular Aquatic Plants Benchmark EC50	4	HA*
583	30563	MCPA, isooctyl ester	Herbicide	6.0963	Invertebrate NOEL	NA	
586	19202	MCPB, sodium salt	Herbicide	210	Vascular Aquatic Plants Benchmark EC50	70	HA*
587	31519	MCPP, DMA salt	Herbicide	NA		7	HA*
591	129046	Mecoprop-P	Herbicide	4469.296	Fish NOEL	28	HA*
592	113502	Mefenoxam	Fungicide	100	Invertebrate Benchmark NOEL	518	HA*
595	109101	Mepiquat chloride	Herbicide	184	Nonvascular Aquatic Plants EC50	4200	HA*
596	109105	Mepiquat pentaborate	Herbicide	4178.378	Fish NOEL	4200	HA*

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Table 2—continued: Toxicity Thresholds for Pesticides Included in CEAP Cropland Modeling

APEX pesticide number	PC code	Pesticide name (active ingredient)	Type of pesticide	Aquatic ecosystem toxicity threshold (parts per billion)	Basis of aquatic ecosystem toxicity threshold	Human drinking water lifetime toxicity threshold (parts per billion)	Basis of human drinking water lifetime toxicity threshold
598	122009	Mesosulfuron-methyl	Herbicide	0.64	Vascular Aquatic Plants EC50	10850	HA*
599	122990	Mesotrione	Herbicide	6.7	Vascular Aquatic Plants EC50	49	HA*
600	113501	Metalaxyl	Fungicide	100	Invertebrate Benchmark NOEL	518	HA*
601	53001	Metaldehyde	Molluscici	452.37	Fish NOEL	3.5	HA*
602	39003	Metam-sodium	Multi-Targ	2.8307	Invertebrate NOEL	1.768	CHCL
607	101201	Methamidophos	Insecticide	4.5	Invertebrate Benchmark NOEL	7	HA*
608	123009	Methanone, [3-(4,5-dihydro-3-isoxazolyl)-2-methyl-	Herbicide	8	Vascular Aquatic Plants EC50	2.8	HA*
610	100301	Methidathion	Insecticide	0.66	Invertebrate Benchmark NOEL	1.05	HA*
612	90301	Methomyl	Insecticide	0.7	Invertebrate Benchmark NOEL	200	HA
615	121027	Methoxyfenozide	Insecticide	25	Invertebrate NOEL	700	HA*
618	53201	Methyl bromide	Sterilant	100	Fish Benchmark NOEL	10	HA
622	53501	Methyl parathion	Insecticide	0.25	Invertebrate Benchmark NOEL	1	HA
625	14601	Metiram	Fungicide	7.8	Invertebrate NOEL	2.1	HA*
627	108801	Metolachlor	Herbicide	1	Invertebrate Benchmark NOEL	700	HA
630	101101	Metribuzin	Herbicide	8.7	Nonvascular Aquatic Plants Benchmark EC50	70	HA
631	122010	Metsulfuron-methyl	Herbicide	0.36	Vascular Aquatic Plants EC50	1750	HA*
637	41402	Molinate	Herbicide	220	Nonvascular Aquatic Plants Benchmark EC50	1.4	HA*
643	13803	MSMA	Herbicide	703.707	Fish NOEL	70	HA*
645	128857	Myclobutanil	Fungicide	16.898	Invertebrate NOEL	175	HA*
648	34401	Naled	Insecticide	0.045	Invertebrate Benchmark NOEL	14	HA*
651	103001	Napropamide	Herbicide	400	Vascular Aquatic Plants EC50	700	HA*
653	30703	Naptalam, sodium salt	Herbicide	3635.39	Fish NOEL	371	HA*
656	129008	Nicosulfuron	Herbicide	35892.193	Fish NOEL	8750	HA*
661	217500	Nonanoic acid	Herbicide	4261.748	Fish NOEL	50000	HA*
662	105801	Norflurazon	Herbicide	9.7	Nonvascular Aquatic Plants Benchmark EC50	14	HA*
664	124002	Novaluron	Miticide	0.026	Invertebrate NOEL	581	HA*
675	104201	Oryzalin	Herbicide	15.4	Vascular Aquatic Plants Benchmark EC50	45	CHCL
679	103801	Oxamyl	Insecticide	27	Invertebrate Benchmark NOEL	200	MCL
681	58702	Oxydemeton-methyl	Insecticide	5	Fish Benchmark NOEL	3.5	HA*
682	111601	Oxyfluorfen	Herbicide	0.29	Nonvascular Aquatic Plants Benchmark EC50	2.1	HA*
691	61601	Paraquat dichloride	Herbicide	0.396	Nonvascular Aquatic Plants Benchmark EC50	30	HA
692	57501	Parathion	Insecticide	0.002	Invertebrate NOEL	0.231	HA*
693	41403	Pebulate	Herbicide	63.5331	Invertebrate NOEL	49	HA*
695	108501	Pendimethalin	Herbicide	5.4	Nonvascular Aquatic Plants Benchmark EC50	70	HA*
696	119031	Penoxsulam	Herbicide	3	Vascular Aquatic Plants EC50	102.9	HA*
697	56502	Pentachloronitrobenzene	Fungicide	13	Fish Benchmark NOEL	2.1	HA*
701	109701	Permethrin, mixed cis,trans	Insecticide	0.0014	Invertebrate Benchmark NOEL	37	CHCL
702	98701	Phenmedipham	Herbicide	104.871	Fish NOEL	1750	HA*
705	57201	Phorate	Insecticide	0.21	Invertebrate Benchmark NOEL	3.5	HA*
707	59201	Phosmet	Insecticide	0.8	Invertebrate Benchmark NOEL	7	HA*
709	76002	Phosphorous acid	Biological	20	Fish NOEL	50000	HA*
710	129086	Phostebupirim	Insecticide	0.011	Invertebrate Benchmark NOEL	1.4	HA*
713	5104	Picloram, potassium salt	Herbicide	755.606	Fish NOEL	500	MCL
715	147500	Pinoxaden	Herbicide	22.0688	Invertebrate NOEL	2100	HA*
718	67501	Piperonyl butoxide	Insecticide	30	Invertebrate NOEL	12	HA*
719	106101	Pirimicarb	Insecticide	0.9	Invertebrate NOEL	9.926	CHCL
736	128973	Primisulfuron-methyl	Herbicide	0.27	Vascular Aquatic Plants EC50	42	HA*

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Table 2—continued: Toxicity Thresholds for Pesticides Included in CEAP Cropland Modeling

APEX pesticide number	PC code	Pesticide name (active ingredient)	Type of pesticide	Aquatic ecosystem toxicity threshold (parts per billion)	Basis of aquatic ecosystem toxicity threshold	Human drinking water lifetime toxicity threshold (parts per billion)	Basis of human drinking water lifetime toxicity threshold
739	110201	Prodiamine	Herbicide	1.5	Invertebrate NOEL	35	HA*
740	111401	Profenofos	Insecticide	0.2	Invertebrate Benchmark NOEL	0.35	HA*
742	112600	Prohexadione calcium	Growth Reg	1100	Nonvascular Aquatic Plants EC50	5600	HA*
745	80805	Prometryn	Herbicide	1	Nonvascular Aquatic Plants Benchmark EC50	280	HA*
746	19101	Propachlor	Herbicide	5.2	Vascular Aquatic Plants EC50	10	CHCL
747	119302	Propamocarb hydrochloride	Fungicide	2218.397	Invertebrate NOEL	700	HA*
748	28201	Propanil	Herbicide	9.1	Fish Benchmark NOEL	3.5	HA*
749	97601	Propargite	Insecticide	9	Invertebrate Benchmark NOEL	1.823	CHCL
750	80808	Propazine	Herbicide	25	Nonvascular Aquatic Plants EC50	10	HA
753	122101	Propiconazole	Fungicide	93	Nonvascular Aquatic Plants Benchmark EC50	9.1	HA*
756	122019	Propoxycarbazone-sodium	Herbicide	6.4	Vascular Aquatic Plants EC50	5236	HA*
759	101701	Propyzamide	Herbicide	600	Invertebrate Benchmark NOEL	20	CHCL
760	129031	Prosulfuron	Herbicide	1.2	Vascular Aquatic Plants EC50	140	HA*
772	101103	Pymetrozine	Insecticide	25.1	Invertebrate NOEL	29	CHCL
773	99100	Pyraclostrobin	Fungicide	0.5	Invertebrate NOEL	210	HA*
774	30090	Pyraflufen-ethyl	Herbicide	1.5	Nonvascular Aquatic Plants EC50	11	CHCL
775	69601	Pyrazon	Herbicide	170	Nonvascular Aquatic Plants EC50	1050	HA*
777	69001	Pyrethrins	Insecticide	0.86	Invertebrate NOEL	44.8	HA*
780	128834	Pyridate	Herbicide	10.5864	Invertebrate NOEL	770	HA*
783	129032	Pyriproxyfen	Insecticide	0.015	Invertebrate Benchmark NOEL	2450	HA*
784	78905	Pyrithiobac-sodium	Herbicide	0.9	Vascular Aquatic Plants EC50	420	HA*
787	128974	Quinclorac	Herbicide	500	Nonvascular Aquatic Plants Benchmark EC50	2660	HA*
790	128711	Quizalofop-ethyl	Herbicide	10.9248	Invertebrate NOEL	63	HA*
791	128709	Quizalofop-p-ethyl	Herbicide	15.991	Fish NOEL	NA	
796	129009	Rimsulfuron	Herbicide	11.6	Vascular Aquatic Plants EC50	112	HA*
797	71003	Rotenone	Insecticide	1.01	Fish Benchmark NOEL	28	HA*
800	121001	Sethoxydim	Herbicide	57.6152	Invertebrate NOEL	630	HA*
805	80807	Simazine	Herbicide	36	Nonvascular Aquatic Plants Benchmark EC50	4	MCL
809	108800	S-Metolachlor	Herbicide	8	Nonvascular Aquatic Plants Benchmark EC50	700	HA
812	114402	Sodium acifluorfen	Herbicide	219.3003	Invertebrate NOEL	10	CHCL
813	106902	Sodium asulam	Herbicide	140	Vascular Aquatic Plants EC50	252	HA*
814	103901	Sodium bentazon	Herbicide	3013.9429	Invertebrate NOEL	200	HA
816	73301	Sodium chlorate	Herbicide	35892.193	Fish NOEL	NA	
823	110003	Spinosyn A	Insecticide	0.07	Invertebrate NOEL	187.6	HA*
826	24875	Spiromesifen	Insecticide	0.027	Invertebrate NOEL	154	HA*
831	6306	Streptomycin	Microbiocide	660	Nonvascular Aquatic Plants EC50	101	HA*
835	129081	Sulfentrazone	Herbicide	1.8	Nonvascular Aquatic Plants Benchmark EC50	98	HA*
836	122001	Sulfometuron methyl	Herbicide	0.48	Vascular Aquatic Plants EC50	175	HA*
837	85601	Sulfosulfuron	Herbicide	1	Vascular Aquatic Plants Benchmark EC50	340	CHCL
838	77501	Sulfur	Fungicide	4634.469	Fish NOEL	NA	
841	128997	Tebuconazole	Fungicide	12	Fish NOEL	21	HA*
842	129026	Tebufenozide	Insecticide	4.3	Invertebrate Benchmark NOEL	126	HA*
844	105501	Tebuthiuron	Herbicide	50	Nonvascular Aquatic Plants Benchmark EC50	500	HA

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Table 2—continued: Toxicity Thresholds for Pesticides Included in CEAP Cropland Modeling

APEX pesticide number	PC code	Pesticide name (active ingredient)	Type of pesticide	Aquatic ecosystem toxicity threshold (parts per billion)	Basis of aquatic ecosystem toxicity threshold	Human drinking water lifetime toxicity threshold (parts per billion)	Basis of human drinking water lifetime toxicity threshold
847	128912	Tefluthrin	Insecticide	0.00397	Fish NOEL	35	HA*
851	12701	Terbacil	Herbicide	11	Nonvascular Aquatic Plants Benchmark EC50	90	HA
852	105001	Terbufos	Insecticide	0.03	Invertebrate Benchmark NOEL	0.4	HA
858	120603	Tetraconazole	Fungicide	190	Invertebrate NOEL	15	CHCL
863	60109	Thiamethoxam	Fungicide	2.8307	Invertebrate NOEL	9.3	CHCL
864	129100	Thiazopyr	Herbicide	40	Vascular Aquatic Plants EC50	5.6	HA*
865	120301	Thidiazuron	Herbicide	100	Invertebrate NOEL	140	HA*
866	128845	Thifensulfuron methyl	Herbicide	1.59	Vascular Aquatic Plants EC50	91	HA*
867	108401	Thiobencarb	Herbicide	1	Invertebrate Benchmark NOEL	70	HA*
869	114501	Thiodicarb	Insecticide	9	Invertebrate Benchmark NOEL	19	CHCL
872	102001	Thiophanate-methyl	Fungicide	2	Fish Benchmark NOEL	30	CHCL
873	79801	Thiram	Fungicide	140	Nonvascular Aquatic Plants Benchmark EC50	56	HA*
879	121000	Tralkoxydim	Herbicide	385.619	Fish NOEL	3.5	HA*
880	121501	Tralomethrin	Insecticide	0.0005	Invertebrate NOEL	52.5	HA*
883	78802	Triallate	Herbicide	13	Invertebrate Benchmark NOEL	9.1	HA*
884	128969	Triasulfuron	Herbicide	0.19	Vascular Aquatic Plants EC50	70	HA*
887	128887	Tribenuron-methyl	Herbicide	2	Vascular Aquatic Plants EC50	5.6	HA*
888	74801	Tribuphos	Herbicide	1.56	Invertebrate Benchmark NOEL	4.177	CHCL
896	116001	Triclopyr	Herbicide	100	Nonvascular Aquatic Plants Benchmark EC50	350	HA*
902	129112	Trifloxystrobin	Fungicide	2.8	Invertebrate Benchmark NOEL	350	HA*
903	119009	Trifloxysulfuron-sodium	Herbicide	0.025	Vascular Aquatic Plants EC50	1400	HA*
906	36101	Trifluralin	Herbicide	1.14	Fish Benchmark NOEL	10	HA
907	129002	Triflusulfuron-methyl	Herbicide	2.82	Vascular Aquatic Plants EC50	16.8	HA*
911	112602	Trinexapac-ethyl	Herbicide	190	Vascular Aquatic Plants EC50	221.2	HA*
918	41404	Vernolate	Herbicide	16.2436	Invertebrate NOEL	7	HA*
920	113201	Vinclozolin	Fungicide	195.434	Fish NOEL	8.4	HA*
924	129064	Zeta-Cypermethrin	Insecticide	0.0008	Invertebrate NOEL	8.75	HA*
929	101702	Zoxamide	Fungicide	3.48	Fish NOEL	3360	HA*

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