# Report on the Status of Products Registered for Use as Wide Area Public Health Mosquito Adulticides in Maine—2013

and

# Summary of EPA's Most Recent Public Health and Environmental Risk Assessments

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# ACRONYMS

| ACRONYM | DEFINITION |
|---|---|
| A | Acres |
| AChE | Acetylcholinesterase |
| ACR | Acute to Chronic Ratio |
| AgDISP | Model used by OPP to predict the motion of spray material released from aircraft |
| AgDRIFT® | Atmospheric model that predicts spray deposition patterns from aerial pesticide applications |
| ai | active ingredient |
| atm | atmospheres |
| BCF | Bio-concentration Factor |
| BPG | Butoxypropylene glycol |
| C | Degree Centigrade |
| CAS | Chemical Abstract System |
| CAS# | Chemical Abstract System Number |
| CFR | Code of Federal Regulations |
| Chemcode | EPA's chemical identity number, PC Code |
| DACF | Department of Agriculture, Conservation and Forestry |
| DCI | Data-call-in |
| DDVP | Dichlorvos |
| DEET | N,N-Diethyl-meta-toluamide |
| $EC_{50}$ | Median effective concentration |
| EEC | Estimated Environmental Concentration |
| EEE | Eastern Equine Encephalitis |
| EFED | Environmental Fate and Effects Division |
| EPA | Environmental Protection Agency |
| EXAMS | Exposure Analysis Modeling System |
| F | Degree Fahrenheit |
| FDA | Food and Drug Administration |
| FFDC | Federal Food Drug and Cosmetic Act |
| FIFRA | Federal Insecticide Fungicide Rodenticide Act |
| FQPA | Food Quality Protection Act |

# ACRONYMS

| ACRONYM | DEFINITION |
|---|---|
| FQPA SF | Food Quality Protection Act Safety Factor |
| FR | Federal Register |
| g | grams |
| GENEEC | Generic Estimated Environmental Concentration Model |
| HED | Health Effects Division |
| IR | Insect Repellent |
| IRAC | Insect Resistance Action Committee |
| JCF | Japan Chemical Research Foundation |
| Kd | The ratio of sorbed to solution pesticide concentrations after equilibrium of a pesticide in a water / soil slurry |
| kg | kilograms |
| Koc | Soil organic carbon sorption coefficient of an active ingredient in mL/g. |
| lbs ai/A | Pounds of active ingredient per acre |
| lbs ai/A/yr | Pounds of active ingredient per acre per year |
| $LC_{50}$ | Median Lethal Dose (mg/kg) |
| $LD_{50}$ | Median Lethal Dose (mg/kg) |
| LOAEC | Lowest Observable Adverse Effect Concentration (ppm or ppb) |
| LOAEC | Lowest Observable Adverse Effect Concentration (ppm or ppb) |
| LOAEL | Lowest Observable Adverse Effect Level (mg/kg/day) |
| LOAEL | Lowest Observable Adverse Effect Level (mg/kg/day) |
| LOC | Level of Concern |
| Log Kow | Log of the octanol water partition coefficient |
| ME CDC | Maine Center for Disease Control |
| mg/kg | milligrams per kilogram body weight |
| mg/kg/day | milligrams per kilogram body weight per day |
| MGK | McLaughlin Gromley King |
| mM | millimole: moles of chemical per liter |
| mmHg | millimeters of mercury |
| MOE | Margin of Exposure |
| MRL | Maximum Residue Level |
| NA | Not Applicable |

# ACRONYMS

| ACRONYM | DEFINITION |
|---|---|
| nAChR | Nicotinic Acetylcholine Receptor |
| ND | Not Determined |
| NOAEC | No Observable Adverse Effect Concentration (ppm or ppb) |
| NOAEL | No Observable Adverse Effect Level (mg/kg/day) |
| NSPIRS | National States Pesticide Information Retrieval System |
| OCSPP | Office of Chemical Safety and Pollution Prevention |
| OPP | Office of Pesticides Program |
| PBO | Piperonyl butoxide |
| PC Code | EPA's chemical identity number, chemcode |
| PMD | p-Methane 3,8-diol |
| POE | Poly(oxy-1,2-ethanediyl), alpha-isooctadecyl-omega-hydroxy- |
| ppb | Parts per billion (ug/L water or ug/kg feed) |
| ppm | Parts per million (mg/L water or mg/kg feed) |
| PRZM | Pesticide Root Zone Model |
| Q*1 | Cancer slope factor |
| RED | Registration Eligibility Decision document |
| RfD | Reference dose, mg/kg body weight/day |
| RQ | Risk Quotient |
| RTU | Ready-to-use |
| RUP | Restricted Use Product |
| SRC | Syracuse Research Center |
| TOXNET | National Library of Medicine's Toxicology Network |
| T-REX | Terrestrial Residue Exposure Model |
| TTR | Total Toxic Residues |
| UF | Uncertainty Factor |
| ULV | Ultra-Low-Volume |
| USDA | United States Department of Agriculture |
| WNV | West Nile Virus |

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## 1.0 INTRODUCTION

Mosquitoes are considered biting flies with a life cycle which includes larval and adult stages. The larval stages of mosquitoes live in water and the adults fly and have resting areas in foliage. Certain mosquitoes serve as vectors for viruses which are pathogenic in humans and other mammals. Viruses with current activity in Maine's mosquito, bird and mammal populations are Eastern equine encephalitis virus (EEE) and West Nile virus (WNV).

Pesticides are products with labels which make claims to "kill, repel or otherwise mitigate" pests (7 USC Chapter 125, FIFRA 2008). Pesticide products are composed of active ingredients (compounds with which kill, repel or otherwise mitigate the pests) and "inert" or "other ingredients" which serve as carriers, emulsifiers, etc., and have no activity against the pest. Synergists are added to pesticide products to increase their activity, but also have no activity against the pest. Synergists are treated as active ingredients. Pesticides are registered federally by the Environmental Protection Agency (EPA) and the Maine Board of Pesticides Control in Maine.

There are basically three types of pesticides used to control mosquitoes and decrease the number of adult mosquito bites: (1) repellents, used on human skin or gear and used directly on animals; (2) aquatic larvicides, compounds added to the aquatic habitat to kill larvae; and (3) adulticide products, designed to kill adult mosquitoes in their resting habitat or in the air (DACF 2013a, DACF 2013b, ME CDC 2013).

The EPA Office of Pesticides Programs (EPA OPP) pesticide risk assessment processes for human health are performed by the Health Effects Division (HED) and Environmental Fate and Effects Division (EFED). The types of guideline studies which are used in the risk assessment processes are:

- Chemical-physical characteristic (Appendix I, Section 2.0)
- Mammalian toxicology (Appendix II, Sections 1.0 and 2.0)
- Toxicology studies with representatives of ecological groups (birds, wild mammals, non-target invertebrates, aquatic species freshwater and marine, fish and invertebrates (Appendix III, Section 1.0 and 2.0)

**NOTE: All guideline studies are subject to EPA's good laboratory practices (GLP) requirements (40 CFR 160) (Appendix II, Section 3 and Appendix III, Section 3.0)**

Specific information regarding the products registered in Maine for 2013, with wide-area public-health ultra-low-volume (ULV) mosquito adulticide and summaries of EPA's risk assessment methodologies, are found in:

- Products registered in Maine for products (Appendix I, Section 5.0)
- EPA's risk assessment methodology, human health risk assessment (Appendix II, Section 5.0) and environmental risk assessment (Appendix III, Section 5.0)
- Environmental residue and fate models (Appendix I, Section 4) and Appendix III, Section 4.0)

The types of mosquito-control products, risks to human populations and risks to organisms in ecological niches associated with the ULV applications are described below. The details of the ULV

application risk assessments are presented in the appendices, and the EPA registration documents contain risk assessment information including dietary, drinking water and occupational risks. Risk assessments change as the science evolves.

## 2.0 PRODUCTS, MOSQUITO CONTROL

There are over 1,000 pesticide products registered in Maine for the year 2013 with mosquitoes listed as pests on their labels. Some pesticide products contain more than one type (repellents, aquatic larvicides and adulticides) of active ingredient. These may be combinations of two adulticides, adulticide plus a synergist, an adulticide plus an insect growth regulator, etc. In addition, the products may contain one type of product with two or more chemical classes of active ingredients. Most of the products with mosquitoes listed as pests on their labels have multiple insects as pests, multiple sites (where the insects are controlled), multiple types of users (homeowner, professional, agricultural, etc.) and directions for multiple types applications (air, ground, ULV, chemigation, etc.). The use of the product other than according to the label directions is a violation of federal law (7 USC Chapter 125, FIFRA 2008).

Of the 1,322 products registered for use on mosquitoes, 1,125 of these products contain at least one adulticide, and at least 30 have specific directions for use in wide-area public health uses (Appendix I, Section 5.0) (NSPIRS 2013).

## 2.1 MOSQUITO CONTROL PRODUCTS MAINE—2013

The following is a list of mosquito-control products registered in Maine in 2013 (NSPIRS 2013). They are identified by the type products, number of products (n =), mode of insecticidal action and the active ingredients in those types of products. **NOTE: active ingredients in bold are registered for wide-area public-health mosquito-control applications and are subject to this review.**

- Biological Larvicides (n = 32): Microbial disruptors of insect midgut membranes (IRAC 2013), *Bacillus thuringiensis, B. sphaericus*

- Repellents (n = 179): DEET, IR3535, Oil of Lemon Eucalyptus, Picaridin,p-Menthane-3,8-diol PMD, Linalool, Metofluthrin, BPG (Butoxypolypropylene glycol), MGK 326 Repellent (Dipropyl isocinchomeronate), Oil of Eucalyptus, Oil of Citronella

- Synergists increase the activity of the insecticide, with no insecticidal activity of their own (EPA 2006a) (n = 455): **PBO (piperonyl butoxide) [(b)]**, MGK 264 (N-Octyl bicycloheptene dicarboximide)

- Insect Growth Regulators, Juvenile Hormone Analogue (IRAC 2013) (n = 258): Methoprene (found in aquatic larvicide, 12 products), Methoprene and Pyriproxyfen, used on cats and dogs for flea and tick control

- Neonicotinoids (these compounds activate the insect nicotinic acetylcholine receptor) (nAChR) (IRAC 2013) (n = 38): Acetamiprid, Dinotefuran, Imidacloprid

- Organophosphates (act by irreversibly inhibiting the enzyme acetylcholinesterase in the nervous system (IRAC 2013) (n= 39): **Chlorpyrifos**, DDVP is a contaminant, metabolite and breakdown product of naled, **Malathion**, **Naled**, Temephos, an aquatic larvicide and Tetrachlorvinphos and DDVP which have agricultural uses

- Carbamates (reversible inhibition of the enzyme acetylcholinesterase in the nervous system) (IRAC 2013) (n =10): Carbaryl

- Pyrethrins-Pyrethroids (modulate the sodium channels in neurons) (IRAC 2013) (n = 1181): **Ethofenprox**, **Permethrin**, **Phenothrin**, **Prallethrin**, **Pyrethrins**, **Resmethrin**, Allethrins, Bifenthrin, Bioallethrin-s, Cyfluthrins, Cyhalothrins, Cypermethrins, Deltamethrin, Esfenvalerate, Fluvalinate, Tetramethrin

- Miscellaneous (n = 148): 2-Phenylethyl propionate, d-Limonene, Fipronil, mineral oil, NEEM, POE isooctadecanol, soap, Spinosad and Triethylene glycol

The synergist PBO is found in all but two of the pyrethroid-pyrethrin products and is not in the organophosphate products (NSPIRS 2013). The use of a synergist increases the activity of the pyrethroid-pyrethrin insecticides while having no insecticidal efficacy of their own (EPA 2006a). Co-application of PBO and an organophosphate insecticide which requires metabolic activation, reduces the efficacy of the organophosphates (EPA 2006a).

## 2.2 Wide Area Public Health ULV Mosquito Adulticides

### 2.2.1 Wide Area Public Health ULV Mosquito Adulticide Products

A search of the National States Pesticide Information Retrieval System (NSPIRS) for products with wide-area public-health mosquito adulticides with ULV by air and ground methods was undertaken. The search terms included: adult mosquito and aerial or ground ULV (NSPIR 2013). There were approximately 30 products identified by the search, with the language on their labels specifying:

> "*For use only by federal, state, tribal, or local government officials responsible for public health or vector control, or by persons certified in the appropriate category or otherwise authorized by the state or tribal lead pesticide regulatory agency to perform adult mosquito control applications, or by persons under their direct supervision."*

Typical wide-area public-health ULV adulticide products are described in Table 2.1

| **Table 2.1 Typical Public Health Adult Mosquito Products Registered in Maine for 2013 (NSPIRS 2013) [a]** | | |
|---|---|---|
| **Percent Active Ingredients** | **Diluent (Solvent added)** | **Registrants [b]** |
| **Pyrethrins-pyrethroids and PBO** | | |
| 4% Etofenprox | Ready to use | Wellmark |
| 20% Etofenprox | Oil | |
| 2% Permethrin, 2% PBO [c] | Ready to use | Univar |
| < 5% Permethrin, < 5% PBO | Oil | Prentiss, Univar |
| 20% Permethrin, 20% PBO | Water | Bayer [d] |
| 20.6% Permethrin, 20.6% PBO | Oil or Water | Control Solutions |
| > 30 % Permethrin, > 30% PBO | Oil | Univar, Bayer, Prentiss |
| 10% Phenothrin[e], 10% PBO | Oil | Clarke [f] |
| 5% Phenothrin [e], 1% Prallethrin, 5% PBO | Oil | |
| 5 to 12% Pyrethrins, 25 to 60% PBO | Oil | MGK [g] |
| 4.14 to 18% Resmethrin, 12.42 to 54% PBO | Oil | Bayer |
| **Organophosphates** | | |
| 19.36% Chlorpyrifos [h] | Oil | Control Solutions |
| 96.5% Malathion | Oil | Cheminova |
| 62% Naled | Water | AMVAC |
| 78% Naled | None | |
| 87.4% Naled | Oil | |

a) Selection of a product for label review does not constitute an endorsement
b) The label citations for these products are included in the reference list
c) PBO = Piperonyl butoxide, pesticide synergist
d) Bayer = Bayer Environmental EPA Company number 432
e) Phenothrin = Sumithrin
f) Clarke Mosquito Control is the distributer for these products
g) MGK = McLaughlin Gormley King
h) There are a number of other chlorpyrifos containing products registered for public health mosquito adulticide use (NSPIRS 2013)

Given the complexity of organic chemistry and the variety of nomenclature systems, it is critical to specifically identify and characterize the active ingredients in this review. The active ingredients found in wide-area public-health mosquito adulticide products, their Chemical Abstract Systems Number

(CAS#) and EPA's chemical codes (Chemcodes) from the National Library of Medicine's Toxicology Data Network (TOXNET, 2013) are listed with their identifying codes in Table 2.2. Because of their differences in chemistry and mechanisms of action, the active ingredients will be identified as belonging to the pyrethrins-pyrethroids-PBO or organophosphate groups of chemicals.

**Table 2.2 Compound Identifiers for Mosquito Adulticides (TOXNET 2013)**

| Compound | CAS# | EPA Chemcode |
|---|---|---|
| **Pyrethroid-Pyrethrins and PBO** | | |
| Etofenprox | 80844-07-1 | 128965 |
| PBO | 51-03-6 | 67501 |
| Phenothrin (Sumithrin [tm]) | 26002-80-2 | 69005 |
| Permethrin | 52645-53-1 | 109701 |
| Prallethrin | 23031-36-9 | 128722 |
| Pyrethrins [(a)] | 8003-34-7 | 69001 |
| Pyrethrin I | 121-21-1 | 69008 |
| Cinerin I | 25402-06-6 | 69010 |
| Jasmolin I | 4466-14-2 | 69011 |
| Pyrethrin II | 121-29-9 | 69006 |
| Cinerin II | 121-20-0 | 68010 |
| Jasmolin II | 1172-63-0 | 69012 |
| Resmethrin | 10453-86-8 | 69005 |
| **Organophosphates** | | |
| Chlorpyrifos | 2921-88-2 | 59101 |
| Dichlorvos [(b)] | 62-73-7 | 84001 |
| Malathion | 121-75-5 | 57701 |
| Naled | 300-76-5 | 34401 |

a) Pyrethrins extract Defined as 57 to 58%, Mixed esters of (+)-trans-chrysanthemic acid and (69008, 69009 and 69011) and (+)-pyrethroic acid 69006, 69010 and 69012)
b) Dichlorvos (DDVP) is included here as a contaminant, metabolite and breakdown product of naled

### 2.2.2 Physical-Chemical Properties

The physical-chemical nature (Appendix I, Sections 1.0 and 2.0) of pesticide active ingredients determines the distribution in the body and/or the environment, toxicity, likelihood of bio-concentration in fish (Appendix I, Section 3.0), the metabolism and excretion of the chemicals. The

physical-chemical properties of the wide area public health mosquito adulticides are summarized in Appendix I, Table 2.,1 and the details for each of the active ingredients are presented in Appendix I, Tables 2.2 to 2.11. These characteristics, along with the mechanics of application equipment, are used in EPA's modeling programs for both human health (Appendix II, Section 4.0) and environmental risk assessments (Appendix III, Section 4.0).

## 3.0 Human Health Risk Assessment

### 3.1 Methodology

In the process of human health risk assessments, there are many non-cancer toxicological endpoints evaluated. These include: effects on body weight, organ weight, organ function, reproductive and developmental endpoints, etc. The toxicology studies required to support registration of pesticide products are found in Appendix II, Table 1. The EPA toxicity categories (40 CFR 156.62, 2013) (Appendix II, Section 2.1) and the required statements on the label associated with a particular category are found in Appendix II, Section 2.2 (40 CFR 156.64, 2013, EPA 2007 to 2012). The toxicity effect on which EPA bases their human health risk assessments may be identified in epidemiology studies on human populations or in laboratory animals.

The other part of risk assessment is that of human exposure assessment. EPA uses a combination of models (Appendix III, Section 4.0). These models incorporate residue studies, different metrics (body weight for a particular age group, skin surface area, etc.) and human behavioral habits identified in their Exposure Factor Handbook (EPA 2011d) and their standard Operating Procedures for Residential Risk Assessment (EPA 2012g). EPA's human health risk assessment methodology is summarized in Appendix II, Section 5.0.

### 3.2 EPA's Most Recent Human Risk Assessment Materials

The human health risk information provided here can be viewed in terms of the aggregate risks from exposure to pesticide residues via dietary, water and residential scenarios. This review is limited to the residential bystander risks related to ULV mosquito adulticide applications. Aggregate risks, cumulative risks and occupation risks are beyond the scope of this review and may be found in the EPA Registration Eligibility Decision (RED) documents, scoping documents and other registration action documents and their supporting documents identified in Table 3.1

**Table 3.1 EPA Chemical Specific Resources for Human Health Risk Assessments**

| Compound | EPA Human Health Risk Assessment Resources |
|---|---|
| Etofenprox | Health Risk Assessment for the Proposed Section 3 Uses on Rice and as a ULV Mosquito Adulticide (EPA 2008b) |
| Chlorpyrifos | Interim Re-registration Eligibility Decision for Chlorpyrifos (EPA 2002b; Finalized in 2006 (EPA 2006b), Chlorpyrifos Occupational and Residential Risk Assessment (EPA 2011f) |
| Malathion | Re-registration Eligibility Decision (RED) for Malathion (EPA 2009b), Revised (EPA 2009f) |

| Table 3.1 EPA Chemical Specific Resources for Human Health Risk Assessments | |
|---|---|
| **Compound** | **EPA Human Health Risk Assessment Resources** |
| Naled | Interim Re-registration Eligibility Decision for Naled (EPA 2002a); Finalized in 2006 (EPA 2006a) |
| PBO | Re-registration Eligibility Decision (RED) for Piperonyl Butoxide (PBO) (EPA 2006a), Occupational and Residential Exposure Assessment and Recommendations for the Re-registration Eligibility Decision (RED) for Piperonyl Butoxide (EPA 2005c) |
| Permethrin | Re-registration Eligibility Decision (RED) for Permethrin (EPA 2009c)<br>Sixth Revision of the Health Effects Division (HED) Chapter of the Re-registration Eligibility Decision Document (RED) (EPA 2009d)<br>Permethrin Re-registration Review Scoping Document for Human Health Assessments (EPA 2011a) |
| Phenothrin (d-Phenothrin, Sumithrin) | Re-registration Eligibility Decision for d-Phenothrin (EPA 2008a)<br>Re-registration Eligibility Decision (RED) Document PC Code No. 069005; DP Barcode No. 326933 and Petition PP# 7F7251 and Associated Section 3 Registration Action (EPA 2008c) |
| Prallethrin | Human Health Assessment Scoping Document in Support of Registration Review (EPA 2012g), The Re-registration Eligibility Decision (RED) for prallethrin was scheduled for 2012 and is not yet finalized (EPA 2013k). |
| Pyrethrins | Eligibility Decision (RED) for Pyrethrins (EPA 2006c),<br>Pyrethrins: 2nd Revised Occupational and Residential Exposure Assessment and Recommendations for the Re-registration Eligibility Decision (RED) (EPA 2005d) |
| Resmethrin | Re-registration Eligibility Decision (RED) for Resmethrin (EPA 2006d) |

## 3.3 Uncertainty in Human Health Risk Assessment

EPA accounts for uncertainty factors, extrapolation from lab animals to humans 10x, variability among humans 10x, database uncertainty 1x to 10x, depending on the database and the Food Quality Protection Act (FQPA) Safety Factor SF between 1x and 10x, depending on the sensitivity of developing organisms. In addition, the FQPA in 1996 amended the Federal Food Drug and Cosmetic Act (FFDCA) (21 USC Title 9) by requiring EPA to: incorporate a safety factor of 10x if there are sensitivities to developing mammals (FQPA SF) [21 USC Title 21 § 346(a) (b) (2) (C)]. The uncertainty factors and the FQPA SF are used to establish EPA's levels of concern for risks from different scenarios.

### 3.4 CONCLUSIONS OF EPA'S NON-CANCER HUMAN HEALTH RISK ASSESSMENTS

The active ingredients in the pesticide mosquito adulticide products have been through the post-Food Quality Protection Act of 1996 human health risk assessment process performed by the EPA Heath Effects Division (HED). Both the pyrethrins-pyrethroids-PBO and the organophosphates have undergone the aggregate risk assessments combining exposures from diet with residential exposures and the pyrethrins/pyrethroids (EPA 2011b), and the organophosphates (EPA 2006h) have undergone cumulative risk assessments evaluating the risks associated with residues from all members of the respective chemical classes.

Two factors which heavily influence the outcome of a human health risk assessment are the label rate and the uncertainty/FQPA SF incorporated into the level of concern. The use rates in lbs ai/A are presented in Table 3.2.

**Table 3.2 Application Rates (lbs ai/A) used for Human Health Post-application Exposure Scenario Compared to the use Maximum Use rate allowed for Adult Mosquito Control**

| Active Ingredients | Maximum Mosquito Use rate (lbs ai/A) | Rates (lbs ai/A) used in EPA Human Health Risk Assessment | | | Reference |
|---|---|---|---|---|---|
| | | Oral | Dermal | Inhalation | |
| **Pyrethrins-Pyrethroids-PBO** | | | | | |
| Etofenprox | 0.007 | 0.007 | No hazard | 0.007 | EPA 2008b |
| PBO [(a)] | 0.08 | **1.0** [(b)] | No hazard | 0.08 | EPA 2005e |
| Permethrin | 0.007 | **0.87** [(b)] | **0.87** [(a)] | 0.007 | EPA 2009d |
| Phenothrin | 0.0036 | **1.1** | No hazard | 0.0036 | EPA 2008c |
| Prallethrin [(c)] | 0.0008 | No Data | No Data | No Data | EPA 2012g |
| Pyrethrins | 0.008 | **0.1** [(b)] | No hazard | 0.008 | EPA 2005d |
| Resmethrin | 0.007 | **0.25** [(b)] | **0.25** [(a)] | 0.007 | EPA 2006f |
| **Organophosphates** | | | | | |
| Chlorpyrifos | 0.01 | 0.01 | 0.01 | 0.01 | EPA 2011f |
| Malathion [(d)] | 0.23 | 0.23 | 0.23 | 0.23 | EPA 2006e, EPA 2009b |
| Malathion [(e)] | 0.11 | 0.11 | 0.11 | 0.11 | |
| Naled [(f)] | 0.1 | 0.05 | 0.05 | No Concern [(h)] | EPA 2002a, EPA 2006a |
| Naled [(g)] | 0.1 | 0.02 | 0.02 | No Concern [(h)] | |

a) PBO is the pesticide synergist piperonyl butoxide.
b) The lawn care application rates used in the estimation of incidental oral and dermal risks are those used in lawn care and are in **bold**. These use rates are higher than the mosquito rates for PBO, permethrin, phenothrin, pyrethrins and resmethrin.

c) EPA has not performed a residential lawn or mosquito adulticide post application risk assessment for the mosquito uses of prallethrin.
d) The maximum use rate for malathion by air is 0.23 lbs ai/A (Cheminova 2011a).
e) The maximum use rate for malathion by ground is 0.11 lbs ai/A (Cheminova 2011a).
f) The maximum use rate for naled by air is 0.1 lbs ai/A (AMVAC 2009a, AMVAC 2010a, AMVAC 2012a). EPA used the most common use rate of 0.05 lbs ai/A for aerial applications rather than the maximum.
g) The maximum use rate for naled by ground is 0.1 lbs ai/A (AMVAC 2009a, AMVAC 2010a, AMVAC 2012a). EPA used the most common use rate of 0.02 lbs ai/A for ground applications rather than the maximum.
h) In their 2009 Human Health Assessment Scoping Document for Naled, EPA stated: "Provided the use rate is limited to 0.1 lbs ai/A, exposure to bystanders will not result in risks of concern (EPA 2009e)."

EPA's human health risk estimates resulting from ULV mosquito adulticiding applications are presented below. The risk estimates from aerial and ground applications for pyrethrins-pyrethroid and PBO compounds are found in Table 3.3, for toddlers, and 3.4, for adults. Similar risk estimates for the organophosphates are presented in Tables 3.5, for toddlers, and 3.6, for adults. The impact of the FQPA is seen in the incorporation of the FQPA SF into the levels of concern for toddler risk during and after ULV applications of phenothrin, pyrethrins (Table 3.3) and chlorpyrifos (Table 3.5).

### 3.4.1 Pyrethrins-Pyrethroids-PBO Active Ingredient Human Health Risk Assessments

Use of pyrethrins-pyrethroid and PBO active ingredients in ULV mosquito adulticide application by either air or ground methods results in risks which are within EPA's levels of concern (LOC) for both toddlers and adults. The human health risks for both toddlers and adults for pyrethrins-pyrethroid and PBO active ingredients following mosquito adulticide ULV applications, are between a thousand and a million times within EPA's levels of concern for the ULV mosquito use (Tables 3.3 and 3.4).

**Table 3.3 Risks to Toddlers (15 kg, 33 lbs), MOE [(a)], LOC [(b)] from Post-application Residential Mosquito Adulticide Use of Pyrethrins-pyrethroid and PBO [(c)] by Active Ingredient**

| Compound | Method | Oral MOE [(a)] | Dermal MOE | Inhalation MOE | LOC [(b)] | Reference |
|---|---|---|---|---|---|---|
| Etofenprox | Air | 109,000 | No Hazard | 1,300,000 | 100 | EPA 2008b |
| | Ground | 156,000 | No Hazard | 160,000 | | |
| PBO [(c)] | Air | 4,800 | No Hazard | 160,000 | 100 | EPA 2005c, EPA 2006a |
| | Ground | 4,800 | No Hazard | 20,000 | | |
| Permethrin | Air | 14,000 | 12,000 | 250,000,000,000 | 100 | EPA 2009c, EPA 2009d, EPA 2011a |
| | Ground | 14,000 | 12,000 | 28,000 | | |
| Phenothrin | Air | 27,200 | No Hazard | 450,000 | 1,000 | EPA 2008a, EPA 2008c |
| | Ground | 27,200 | No Hazard | 40,000 | | |

| **Table 3.3 Risks to Toddlers (15 kg, 33 lbs), MOE [a], LOC [b] from Post-application Residential Mosquito Adulticide Use of Pyrethrins-pyrethroid and PBO [c] by Active Ingredient** | | | | | | |
|---|---|---|---|---|---|---|
| **Compound** | **Method** | **Oral MOE [a]** | **Dermal MOE** | **Inhalation MOE** | **LOC [b]** | **Reference** |
| Prallethrin | Air and Ground | No Data [d] | | | | EPA 2012g |
| Pyrethrins | Air | 11,000 | No Hazard | 27,000 | 300 | EPA 2005d, EPA 2006c |
| | Ground | 11,000 | No Hazard | 2,700 | | |
| Resmethrin | Air | 8,900 | 16,000 | 2,000,000 | 1,000 | EPA 2006d |
| | Ground | 8,900 | 16,000 | 24,000 | | |

a) MOE = Margin of Exposure: ratio of the no observable adverse effect level (NOAEL) / exposure dose.
b) LOC = Level of Concern: accounts for uncertainty factors, extrapolation from lab animals to humans 10x, variability among humans 10x, database uncertainty 1x to 10x depending on the database and the FQPA SF between 1x and 10x depending on the sensitivity of developing organisms .
c) PBO is the pesticide synergist piperonyl butoxide.
d) EPA has not performed a residential bystander risk assessment for prallethrin (EPA 2012g).

| **Table 3.4 Adult (70 kg, 150 lbs) MOE [a] and LOC [b] from Residential Post-application Mosquito Adulticide Use of Pyrethrins-Pyrethroid by Active Ingredient** | | | | | |
|---|---|---|---|---|---|
| **Compound** | **Method** | **Dermal MOE [a]** | **Inhalation MOE [a]** | **LOC [b]** | **Reference** |
| Etofenprox | Air | No Hazard | 5,000,000 | 100 | EPA 2008b |
| | Ground | No Hazard | 590,000 | | |
| PBO [c] | Air | No Hazard | 740,000 | 100 | EPA 2005c, EPA 2006a |
| | Ground | No Hazard | 75,000 | | |
| Permethrin | Air | 20,000 | 500,000,000,000 | 100 | EPA 2009c, EPA 2009d, EPA 2011a |
| | Ground | 20,000 | 57,000 | | |
| Phenothrin | Air | No Hazard | 1,000,000 | 1,000 | EPA 2008a, EPA 2008c |
| | Ground | No Hazard | 422,000 | | |
| Prallethrin | Air and Ground | No Data [d] | | | EPA 2012g |
| Pyrethrins | Air | No Hazard | 89,000 | 100 | EPA 2005d, EPA 2006c |
| | Ground | No Hazard | 8,900 | | |

| Table 3.4 Adult (70 kg, 150 lbs) MOE [(a)] and LOC [(b)] from Residential Post-application Mosquito Adulticide Use of Pyrethrins-Pyrethroid by Active Ingredient | | | | | |
|---|---|---|---|---|---|
| **Compound** | **Method** | **Dermal MOE [(a)]** | **Inhalation MOE [(a)]** | **LOC [(b)]** | **Reference** |
| Resmethrin | Air | 27,000 | 4,000,000 | 1,000 | EPA 2006d |
| | Ground | 27,000 | 540,000 | | |

a) MOE = Margin of Exposure: ratio of the no observable adverse effect level (NOAEL) / exposure dose.
b) LOC = Level of Concern: accounts for uncertainty factors, extrapolation from lab animals to humans 10x, variability among humans 10x, database uncertainty 1x to 10x, depending on the database.
c) PBO is the pesticide synergist piperonyl butoxide.
d) EPA has not performed a residential bystander risk assessment for prallethrin (EPA 2012g).

### 3.4.2 Organophosphate Active Ingredient Human Health Risk Assessments

The risks estimates for residential bystanders for organophosphate ULV applications found in Table 3.5, for toddlers, and Table 3.6, for adults, are lower than the risks posed by the pyrethrins-pyrethroid and PBO compounds (Tables 3.3 and 3.4). This is due to the fact that the organophosphates with ULV mosquito adulticide uses on their labels are generally more toxic and are applied at high rates (Table 3.2).

The risk assessment information for the organophosphates for toddler bystander exposure following ULV adulticide applications of the products containing organophosphates is presented in Table 3.5 and similar information for adult bystanders is found in Table 3.6. EPA used the highest labeled used rates, 0.01 lbs ai/A for chlorpyrifos (EPA 2011f), 0.23 lbs ai/A for malathion applied by air, 0.11 lbs ai/A for malathion applied by ground (EPA 2006e, EPA 2009b) to asses children and adult bystander risks from ULV adulticide applications. The use rates used in EPA's human health risk assessments for naled were 0.05 lbs/A by air and 0.02 lbs ai/A ground. For naled, these rates are the typical rates, not the maximum labeled rate for this us of 0.1 lbs ai/A (EPA 2009e).

With the exception of inhalation in both toddlers and adults when chlorpyrifos is applied ULV by air, the risks from organophosphates used in ULV mosquito applications are within EPA levels of concern. There are also differences in the risks from organophosphate ULV applications depending on method of application. For malathion and naled ULV mosquito applications looking at toddler exposure, the margins of exposure (MOEs) are higher for ground applications, because the application rates are lower for ground applications (Table 3.5). In addition, the type of aircraft used changes the MOE for toddlers exposed to malathion (Table 3.5).

| **Table 3.5 Toddler (15 kg, 33 lbs) MOE [a], LOC [b] from Post-application Mosquito Adulticide Use of Organophosphate by Active Ingredient** | | | | | | |
|---|---|---|---|---|---|---|
| **Active Ingredient** | **Method** | **MOE [a]** | | | **LOC [b]** | **Reference** |
| | | **Oral** | **Dermal** | **Inhalation** | | |
| Chlorpyrifos [c] | Air (0.01 lbs ai/A) | 130 | 260 | NA [d] | 100 | EPA 2011f |
| | Ground (0.01 lbs ai/A) | 1,300 | 670 | NA | 100 | |
| | Air (0.01 lb ai/A) | NA | NA | 1,600 | 300 | |
| | Ground (0.01 lbs ai/A) | NA | NA | 17 | 300 | |
| Malathion [e, f, g] | Air (fixed wing) (0.23 lbs/A) | 6,000 | 15,000 | 120,000 | 100 [b] | EPA 2006e, EPA 2009b |
| | Air (rotary) (0.23 lbs/A) | 6,000 | 15,000 | 40,000 | | |
| | Ground (0.11 lbs ai/A) | 85,000 | 230,000 | 23,000 | | |
| Naled [g] | Air (0.05 lbs ai/A) | 540 | 1,717 | No concern [e] | 100 | EPA 2002a, 2006a, EPA 2009e |
| | Ground (0.02 lbs/A) | 8,000 | 23,263 | | | |

a) MOE = Margin of Exposure: the ratio of the no observable adverse effect level (NOAEL) / exposure dose.
b) LOC = Level of Concern: accounts for uncertainty factors, extrapolation from lab animals to humans 10x, variability among humans 10x, database uncertainty 1x to 10x, depending on the database.
c) The LOCs for chlorpyrifos are 100 for oral and dermal exposure and 300 for acute inhalation exposure. Also EPA had the same MOEs for adults as children for short-term risks (EPA 2011f). If chlorpyrifos is ever discussed as a viable option for mosquito adulticiding in Maine, this risk assessment will require further evaluation.
d) NA = Not Applicable.
e) The FQPA SF for malathion is 1x, if the study used in the risk assessment was done using juvenile animals, and 10x if the study was done using adult animals.
f) Malaoxon is a degradate and the active metabolite of malathion. It is 61 times more potent at inhibiting cholinesterase than malathion. Mosquito adulticiding use of malathion can result in formation of malaoxon on surfaces. This can result in exposures to toddlers by oral and dermal routes. Malaoxon MOEs exceed the levels of concern for oral and dermal exposure to toddlers and no exposure is expected by inhalation (EPA 2009b).

g) In their 2009 Human Health Assessment Scoping Document for Naled, EPA stated: "Provided the use rate is limited to 0.1 lbs ai/A, exposure to bystanders will not result in risks of concern (EPA 2009e)."

When ULV mosquito adulticide applications of the organophosphates chlorpyrifos and malathion are done, the risks are lower for aerial applications than ground ULV applications (Table 3.6). Naled ULV mosquito applications have lower risks from ground applications than aerial applications.

**Table 3.6 Adult (70 kg, 150 lbs) MOE [(a)] and LOC [(b)] from Post-application Mosquito Adulticide Use of Organophosphate by Active Ingredient**

| Compound | Method | MOE [(a)] Dermal | MOE [(a)] Inhalation | LOC [(b)] | Reference |
|---|---|---|---|---|---|
| Chlorpyrifos [(c)] | Air (0.01 lbs ai/A) | 260 | NA[(d)] | 100 | EPA 2011f |
| | Ground (0.01 lbs ai/A) | 670 | NA | 100 | |
| | Air (0.01 lbs ai/A) | NA | 1,600 | 300 | |
| | Ground (0.01 lbs ai/A) | NA | 17 | 300 | |
| Malathion | Air (fixed wing) (0.23 lbs ai/A) | 10,000 | 500,000 | 100 | EPA 2006e, EPA 2009b |
| | Air (rotary) (0.23 lbs ai/A) | 10,000 | 200,000 | | |
| | Ground (0.11 lbs ai/A) | 150,000 | 27,000 | | |
| Naled [(e)] | Air (0.02 lbs ai/A) | 2,870 | No concern [(b)] | 100 | EPA 2002a, 2006a, EPA 2009e |
| | Ground (0.05 lbs ai/A) | 38,930 | | | |

a) MOE = Margin of Exposure: ratio of the no observable adverse effect level (NOAEL) / exposure dose.
b) LOC = Level of Concern: accounts for uncertainty factors, extrapolation from lab animals to humans 10x, variability among humans 10x, database uncertainty 1x to 10x, depending on the database.
c) The LOCs for chlorpyrifos are 100 for oral and dermal exposure and 300 for acute inhalation exposure. Also EPA had the same MOEs for adults as children for short-term risks (EPA 2011f). If chlorpyrifos is ever discussed as a viable option for mosquito adulticiding in Maine, this risk assessment will require further evaluation.
d) NA = Not Applicable.
e) In their 2009 Human Health Assessment Scoping Document for Naled, EPA stated: "Provided the use rate is limited to 0.1 lbs ai/A, exposure to bystanders will not result in risks of concern (EPA 2009e)."

## 3.5 Other Human Health Concerns

### 3.5.1 Cancer Human Health Risk Assessments

Quantitative cancer risk assessments are performed for pesticides which have dose-related increases in tumors in well-conducted chronic bioassays (Appendix II, Section 5.2). These risk assessments utilize the linear multi-stage model to estimate the potency of the compound. The potency of the compound, along with the environmental exposure dose, results in a cancer risk, which is then compared to EPA's level of concern, which is one (1) in a million for dietary risks, and changes in registration may occur if risk estimates are outside the level of concern. Using data from epidemiology and animals studies, EPA employs a weight of evidence procedure to classify carcinogenic potency. In order to perform a cancer risk assessment, the chemical must have enough tumor data from the animal studies to generate a dose response curve—in the case of the public health adulticides, permethrin and resmethrin. EPA's "weight of evidence" for cancer potentials for the adulticides is:

- "Not likely" or "No evidence" for phenothrin, and naled
- "Not likely at low doses" etofenprox and pyrethrins
- "Suggestive" or "Possible" for PBO and malathion
- "Likely" for permethrin and resmethrin (EPA 2012a)

The cancer risks from exposure to permethrin following ULV applications is three orders of magnitude (1,000 times) lower than EPA's acceptable risk level of one (1) in a million (1 in $10^{-6}$) by ground, and eleven orders of magnitude lower when the application is done by air (EPA 2009d). The residential cancer risks following mosquito adulticiding with resmethrin both by air and ground are lower than EPA's acceptable risk level of one (1) in a million (1 in $10^{-6}$) (EPA 2006f).

### 3.5.2 Immunotoxicity

The function of the immune system is to keep the body in balance by recognizing "self" and "non-self" proteins found in the body. Examples of "self" include your own tissues, organs, and cells. Examples of "non-self" are foreign entities such as pathogens, both viral and bacterial and non-normal tissues such as tumors (Kaminski et al., 2006). Chemical allergy is an immune system mediated response and requires an initial or sensitizing exposure. This hypersensitivity can manifest itself by skin, eye or lung responses. Most chemicals are too small to illicit this type of reaction on their own and must bind to a protein (hapten) to form a fully functional allergen (Eaton and Gilbert 2006).

All pesticide technical grade active ingredients are tested for allergic sensitization reactions in the skin model of the Guinea pig or mouse assay (EPA 2003a). With the exception of naled, with a weakly positive reaction (EPA 2002b, 2006b), the other mosquito adulticides are negative in this assay. In addition to the skin model described above, EPA also gathers immunotoxicity data from the routine sub-chronic, chronic and reproductive toxicity tests (EPA 1998f).

The requirements for the immunotoxicity study guideline 880.8700 came about in 2007. Human Health risks assessments for both pyrethrins-pyrethroids and PBO and the organophosphates registered for ULV adult mosquito control performed prior to 2007 do not mention immunotoxicity studies. The two risk assessments performed post 2007 for etofenprox and phenothrin, concluded that

the existing data was sufficient for etofenprox (EPA 2008b) and the immunotoxicity study was not required. For phenothrin, a data-call-in for the immunotoxicity study was issued (EPA 2009h).

### 3.5.3 ASTHMA

Chemically induced asthma is also a hypersensitivity reaction. In their asthma fact sheet for adults, the American Lung Association defines asthma as: "Asthma is a reversible obstructive lung disease, caused by increased reaction of the airways to various stimuli. It is a chronic inflammatory condition with acute exacerbations. Asthma can be a life-threatening disease if not properly managed (American Lung Association 2012)."

The nature of asthma triggers is further defined as: "Asthma is characterized by excessive sensitivity of the lungs to various stimuli. Triggers range from viral infections to allergies, to irritating gases and particles in the air. Each person reacts differently to the factors that may trigger asthma, including:

- Respiratory infections and colds
- Cigarette smoke
- Allergic reactions to such allergens as pollen, mold, animal dander, feather,
- Dust, food, and cockroaches
- Indoor and outdoor air pollutants, including ozone and particle pollution
- Exposure to cold air or sudden temperature change
- Excitement/stress
- Exercise (American Lung Association 2012)"

Allergic occurrences as a result of insecticide exposure, including allergic asthma are difficult to predict. Because of this, the message to the public, if a municipal adulticiding application were to occur, would be for persons with allergies to take extra care (stay inside, close windows, etc.) to reduce exposure.

### 3.5.4 CONCLUSION REGARDING OTHER HUMAN HEALTH CONCERNS

The potential for the active ingredients in the wide-area ULV mosquito adulticide products to cause an increase in cancer is low. Most of the compounds are classified as non-carcinogenic or not likely to cause cancer in humans at low doses. The two compounds with quantifiable cancer risks, permethrin and resmethrin, have cancer risks below EPA's level of concern of 1 in a million.

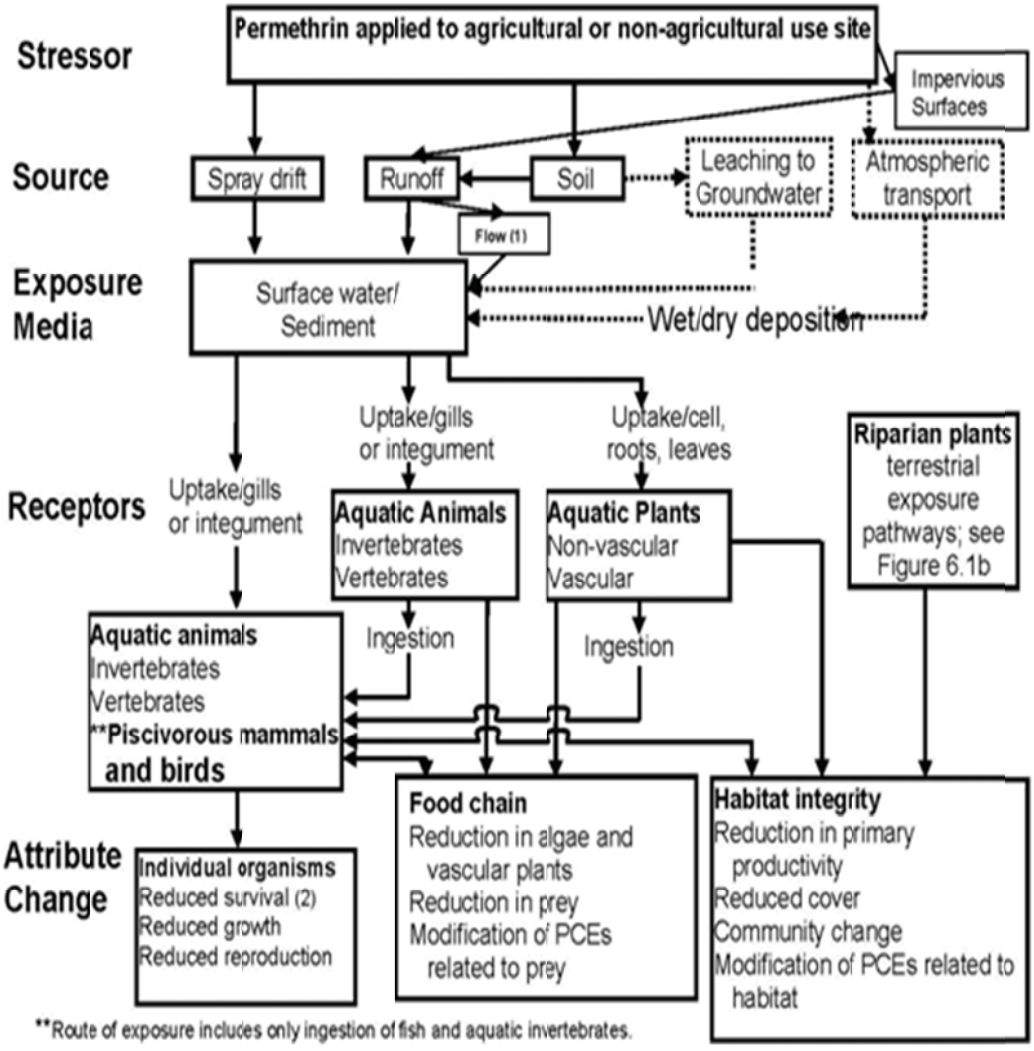
Because immune system responses to exposure to these products, including allergies including allergic asthma, are difficult to predict, the message to the public if a municipal adulticiding application were to occur, would be for persons with allergies and other sensitivities to take extra care (stay inside, close windows, etc.) to reduce exposure.

## 4.0 Ecological Risks

### 4.1 Ecological Conceptual Model and methodology

EPA has constructed conceptual models for exposure pathways evaluated in ecological risk assessment. The aquatic conceptual model is presented in Figure 4.1. Similar models for terrestrial exposures to permethrin and biological receptors, both terrestrial and aquatic, are found in the environmental problem statements for the other mosquito adulticides.

**Figure 4.1 Aquatic Conceptual Model of Exposure Pathways for Permethrin (EPA 2011h)**




The guideline studies and EPA toxicity categories for ecological studies required to support registration for pesticide products are found in Appendix III, Sections 1.0 and 2.0. Similar to the studies required to support human health risk assessments, those required to support environmental risk assessment are subject to good laboratory practices (Appendix III, Section 3.0). EPA assesses

ecological risks using environmental models (Appendix III, Section 4.0) to determine estimated environmental exposures (EEC) and the most toxicity data on the most sensitive species within a group of organisms. The groups of organisms include: terrestrial species—birds, wild mammals and non-target insects, and aquatic species—freshwater fish and invertebrates and marine fish and invertebrates.

One of the critical points in Figure 4.1 is noted by the double asterisks, that is, biological receptors which bio-accumulate pesticide residues and then serve as food sources for other biological receptors. EPA evaluates pesticides and their total toxic residues for bioaccumulation in whole-fish, edible portions of the fish and the visceral organs of the fish. The rate at which the fish rids itself of these total toxic residues is depuration. Depuration is reported as the half-life of the total toxic residues in the fish. The pyrethrins-pyrethroid compounds bio-accumulate to a greater extent in fish, than PBO and the organophosphates. Bio-concentration factors and depuration rates are found in Appendix I, Section 3.0.

Regarding environmental risks, the most sensitive groups are the terrestrial and aquatic invertebrates. The label language prohibiting use while bees are foraging, and that prohibiting direct application to water, unless there is an ongoing public health mosquito-borne-disease emergency, goes a long way towards managing these risks. These ecological risk assessments are complex and are still under review. Labels of the currently registered mosquito adulticide products indicate "keep out of water" statements, with an exception when existing public health threats have been identified. The use rates for the mosquito adulticides containing the pyrethrins-pyrethroids-PBO compounds are much less (6 to 40 times) than those used in agriculture.

The terrestrial risk assessments (birds and wild mammals) are presented in Appendix V and the risk assessments for aquatic species are found in Appendix VI.

## 4.2 Mosquito Adulticides, Acute Toxicity in Terrestrial Species

### 4.2.1 Avian Toxicity and Risks

The oral LD50s (median lethal dose) for the wide-area public health ULV mosquito adulticide active ingredients in birds are summarized in Table 4.1. Using EPA's toxicity categories, the pyrethrins-pyrethroids-PBO are rated practically non-toxic (Appendix III, Table 3.3). There are data gaps for acute toxicity studies in passerine birds for most of the pyrethrins-pyrethroids-PBO. These data may change the conclusions below when the data requirement is filled.

The organophosphate active ingredients range from very highly toxic to bird for chlorpyrifos and naled, to birds to slightly or moderately toxic for malathion (Table 4.1).

Because there was no evidence of etofenprox toxicity in birds following acute (oral), sub-acute or chronic dietary exposure, risk quotients were not calculated for birds (EPA 2009a). Likewise, exposure of birds to PBO in acute avian studies resulted in no adverse effects and risk quotients were not calculated (EPA 201b).

| Table 4.1 Acute Oral $LD_{50}$ mg ai/kg for Adulticide Active Ingredients in Avian Species | | | | |
|---|---|---|---|---|
| **Compound** | **Species** | **$LD_{50}$ mg ai/kg** | **EPA Toxicity Category** | **Reference** |
| **Pyrethrins-Pyrethroids and PBO** | | | | |
| Etofenprox [(a)] | Mallard duck | > 2,000 | Practically non-toxic | EPA 2009a |
| PBO | Bobwhite quail | > 2,550 | Practically non-toxic | EPA 2010b |
| | Passerine species [(b)] | No data | No Data | |
| Permethrin | Mallard duck | > 2,000 | Practically non-toxic | EPA 2011h |
| | Passerine species [(b)] | No data | No Data | |
| Phenothrin | Bobwhite quail | > 2,510 | Practically non-toxic | EPA 2008f |
| Prallethrin | Bobwhite quail | 1,171 | Slightly Toxic | EPA 2012h |
| | Passerine species [(b)] | No data | No Data | |
| Pyrethrins | Bobwhite quail | > 2,000 | Practically non-toxic | EPA 2011i |
| | Passerine species [(b)] | No data | No Data | |
| Resmethrin | Red Winged Blackbird [(c, d)] | 75 | Moderately Toxic | EPA 2012i |
| | Mallard duck [(d)] | > 18,968 | Practically non-toxic | |
| | Bobwhite quail [(d)] | > 17,915 | Practically non-toxic | |
| **Organophosphates** | | | | |
| Chlorpyrifos | House Sparrow | 10 | Very Highly Toxic | EPA 2008e |
| Malathion | Mallard duck | 1,485 | Slightly Toxic | EPA 2009g |
| | Ringed necked pheasant | 167 | Moderately Toxic | |
| Naled-DDVP | Mallard duck-DDVP | 7.8 | Very Highly Toxic | EPA 2008d, EPA 2008g |

a) No mention of a data requirement for acute toxicity in a passerine species for etofenprox (EPA 2009a).
b) Data-call-in for acute oral toxicity study in passerine birds.
c) Red wing black bird is a passerine species.
d) Study rated supplemental; EPA did not issue a data-call-in.

EPA concluded in their 2012 Environmental Fate and Effects Division (EFED) statement of the problem that use of prallethrin as an adulticide at 0.0008 lbs ai/A there would pose no acute, sub-acute or chronic risks to birds (EPA 2012h).

The acute risk quotients for permethrin (EPA 2011h), pyrethrins (EPA 2011i), and resmethrin (EPA 2012i) were calculated by using the sub-acute $LC_{50}$ for multiple applications at the highest use rates in agricultural settings are below. EPA's levels of concern for acute exposure to birds are found in Appendix V, Tables 1.3b, 1.6b, and 1.7b, respectively. Several risk quotients for resmethrin exceed the level of concern for restricted use and endangered species.

The no observable adverse effect concentrations (NOAEC) from the chronic reproductive dietary toxicity studies in birds in mg/kg feed are used in estimating chronic risks to birds. There is a data-call-in for a chronic-reproductive toxicity study in birds for phenothrin (EPA 2008f). EPA concluded in their 2012 EFED statement of the problem that use of prallethrin as an adulticide at 0.0008 lbs ai/A there would pose no chronic risks to birds (EPA 2012h).

The use scenarios in Appendix V include mosquito applications at the highest labeled rates, one time, calculated in-house without correction for EPA's Aerial Dispersion model, AGDISP, percent efficiency (EPA states that estimates from terrestrial exposure model, T-REX, not corrected for AGDISP efficiency over-estimates the Estimated Environmental Concentrations [EECs]) (EPA 2008h). Also included in Appendix V are RQ from EECs for short grass receiving a ULV mosquito adulticide application at zero day of treatment, as calculated in-house, without correction for AGDISP percent efficiency.

EPA's environmental exposure for mosquito applications in Appendix V using the highest application rates on the labels range from 278 applications (phenothrin) to 26 applications (permethrin) with variable treatment intervals. The highest agricultural use rates with the lowest re-treatment intervals scenarios are also included. With the exceptions of PBO used in an agricultural scenario at 0.5 lbs ai/A, 10x with three-day intervals and resmethrin, mosquito ULV mosquito use at 0.007 lbs ai/A, 50x with both three- and four-day intervals, chronic risks for pyrethrins-pyrethroids-PBO are within the EPA level of concern for chronic risks.

### 4.2.2 Mammalian Toxicity and Risks

In mammals, the EPA's acute toxicity ratings are practically non-toxic with the exceptions of permethrin and prallethrin which are categorized as moderately toxic (Table 4.2).

**Table 4.2 Lowest Acute Oral $LD_{50}$ mg ai/kg for Adulticide Active Ingredients in Mammals (EPA 2011h)**

| Compound | $LD_{50}$ mg ai/kg | EPA Toxicity Category | Reference |
|---|---|---|---|
| **Pyrethrins-Pyrethroids and PBO** | | | |
| Etofenprox | 42,880 | Practically Non Toxic | EPA 2009a |
| PBO | 4,570 | Practically Non Toxic | EPA 2010b |
| Permethrin | 340.5 | Moderately Toxic | EPA 2011h |
| Phenothrin | > 5,000 | Practically Non Toxic | EPA 2008f |
| Prallethrin | 640 | Moderately Toxic | EPA 2012h |

| Table 4.2 Lowest Acute Oral $LD_{50}$ mg ai/kg for Adulticide Active Ingredients in Mammals (EPA 2011h) | | | |
|---|---|---|---|
| **Compound** | **$LD_{50}$ mg ai/kg** | **EPA Toxicity Category** | **Reference** |
| Pyrethrins | 1,400 | Practically Non Toxic | EPA 2011i |
| Resmethrin | 4,639 | Practically Non Toxic | EPA 2012i |
| **Organophosphates** | | | |
| Chlorpyrifos | 97 | Moderately Toxic | EPA 2008e |
| Malathion | 1,000 | Moderately Toxic | EPA 2009g |
| Naled-DDVP | 56 [(a)] | Moderately Toxic | EPA 2008d, EPA 2008g |

a) The naled-DDVP $LD_{50}$ is for DDVP and is equal to 2.5 mmoles/kg body weight.

Using the same agricultural, multiple applications as discussed above in the avian risk section, risks to mammals from both acute and chronic exposure to the pyrethrins-pyrethroids-PBO are low. Based on the low acute toxicity of etofenprox (EPA 2009a) and phenothrin (EPA 2008f), acute risks were not assessed. EPA also concluded in their 2012 EFED statement of the problem that use of prallethrin as an adulticide at 0.0008 lbs ai/A would pose no chronic risks to mammals (EPA 2012h). EPA also concluded in their 2012 EFED statement of the problem that use of prallethrin as an adulticide at 0.0008 lbs ai/A there would pose no acute risks to mammals (EPA 2012h). Risk assessments for PBO (EPA 2005j), permethrin (EPA 2006i), pyrethrins (EPA 2006b) and resmethrin (EPA 2012i) resulted in no risk quotients higher than the levels of concern.

There are three organophosphates—chlorpyrifos, malathion and naled (and its active metabolite dichlorvos, DDVP)—registered for wide-area, public-health, mosquito-adulticiding applications. They all have many agricultural uses which are for the most part not seen on the mosquito adulticide product labels. The exception is one of the naled products, Dibrom 8 Emulsive (EPA# 5481-479), which is labeled for both types of uses.

Risk quotients for organophosphates for sub-acute and chronic exposure to birds and mammals are not included here. The status of the organophosphate environmental risk assessments is lagging behind the pyrethrins-pyrethroids-PBO assessments.

### 4.2.3 Conclusions Terrestrial Birds and Mammals

Environmental risk quotients for pyrethrins-pyrethroids-PBO in mammals and birds indicate acceptable risks in that, for the most part, they are below EPA's levels of concern for acute, sub-chronic and chronic exposures. The exceptions are for agricultural uses at much higher rates and some mosquito adulticide applications with high frequencies of use and low intervals between applications (Appendix V, Section 1.0). Given their greater toxicity and higher application rates, risks to birds and mammals from ULV mosquito adulticide applications of the organophosphates are higher than those for the pyrethrins-pyrethroids-PBO compounds (Appendix V, Section 2.0).

If wide-area, public-health adulticiding were done in Maine, given the lower rates for adult mosquito control, the lateness in the fall when pathogen positive mosquitoes have been identified and the short time between this identification and a hard freeze, the probability of more than two or three applications to the same area is nil. Therefore, risks should be in acceptable risk range for birds and mammals following an ULV mosquito adulticide application.

### 4.2.4 Risks to Terrestrial Organisms, Honeybees

Risks to honeybees and other pollinators are always a concern when using insecticides. Toxicity to invertebrates is tested in honeybees, and also categorized regarding level of toxicity. Risk assessments are not routinely performed for terrestrial invertebrates. The exception was found in the 2008 Pesticide Effects Determination for permethrin uses and risks to several threatened or endangered species (EPA 2008h). Here, EPA estimated risks to insects based on class size and to earthworms following use of granular formulations of permethrin (EPA 2008h). While risks calculated for non-target insects following mosquito ULV applications are relevant to this discussion, the risks to earthworms following granular applications are not relevant. There is a guideline for earthworm sub-chronic (28-day) toxicity testing (EPA 2012t). There were no data or data-call-ins identified for the mosquito adulticides reviewed here. This test may be performed with either the technical grade active ingredient or the formulated product (EPA 2012r).

The acute toxicity of the mosquito adulticides in bees is presented in Table 4.3. Because bees are insects and these products are insecticides, the acute toxicity to bees ranks between very highly toxic and highly toxic. The exception is the synergist PBO which has no insecticidal action of its own and an oral LD in bees of >25 ug/bee.

**Table 4.3 Acute Toxicity of the Technical Grade Active Ingredients of Mosquito Adulticides to Honeybees**

| Compound | $LD_{50}$ ug/bee | EPA Toxicity Categories | Reference |
|---|---|---|---|
| **Pyrethrins-Pyrethroids** | | | |
| Etofenprox | 0.0145 | Highly Toxic | EPA 2009a |
| Permethrin | 0.024 | Highly Toxic | EPA 2011h |
| Phenothrin | 0.0067 | Very Highly Toxic | EPA 2008f |
| Prallethrin | 0.028 | Highly Toxic | EPA 2012h |
| Pyrethrin | 0.022 | Highly Toxic | EPA 2011i |
| Resmethrin | 0.063 | Very Highly Toxic | EPA 2012i |
| **Synergist** | | | |
| PBO | > 25 | Practically Non Toxic | EPA 2010b |
| **Organophosphates** | | | |

| **Table 4.3 Acute Toxicity of the Technical Grade Active Ingredients of Mosquito Adulticides to Honeybees** | | | |
|---|---|---|---|
| **Compound** | **$LD_{50}$ ug/bee** | **EPA Toxicity Categories** | **Reference** |
| Chlorpyrifos | 0.059 | Very Highly Toxic | EPA 2008e |
| Malathion | 0.2 | Highly Toxic | EPA 2007b |
| Naled-DDVP | 0.48 | Highly Toxic | EPA 2008d, EPA 2008g |

The exception regarding risk assessments for non-target insects is a risk assessment done by EPA for permethrin in their pesticide effects determination for threatened and endangered species (EPA 2008h) discussed in detail below. The methodology used by EPA in their threatened-endangered species effects determination for permethrin was:

> "Potential risks to terrestrial invertebrates resulting from foliar spray applications of permethrin are derived using T-REX, and the most sensitive toxicity data available for terrestrial invertebrates. In the case of permethrin, the honey bee was used as a surrogate for evaluating risks of permethrin to terrestrial invertebrates. The toxicity value for terrestrial invertebrates was calculated by multiplying the lowest available acute contact $LD_{50}$ of 0.024 µg ai/bee by 1 bee/0.128g, which is based on the weight of an adult honey bee. EECs in ppm (µg ai/g of bee) calculated by T-REX for small and large insects were divided by the calculated toxicity value for terrestrial invertebrates, which is 0.1875 µg ai/g of bee, to derive RQs (EPA 2008h)."

The resulting risk quotients are presented in Table 4.4.

| **Table 4.4 Risk Quotients for Mosquito Adulticide ULV Applications Non-Target Terrestrial Invertebrates (EPA 2008h)** | | | |
|---|---|---|---|
| **Use Rate; # Applications/year (interval)** | **Small Insects** | **Large Insects** | **Level of Concern** |
| 0.003 lbs ai/yr, 52 (1 day) [a, c] | **44.27** | **4.8** | 0.5 |
| 0.00014 lbs ai/yr, 26 (1 day) [b, c] | **1.60** | **0.16** | 0.5 |

a) Pre-implementation of the 2009 Registration Eligibility Decision (EPA 2009c).
b) Post-implementation of the 2009 Registration Eligibility Decision (EPA 2009c).
c) Use rate is modified by the efficiency of the application (0.449 pre-implementation; 0.020 post-implementation) from the ADISP Model.

The acute toxicity of the pyrethrins-pyrethroids and organophosphates to bees is high or very high. This is not a surprise since these compounds are insecticides. EPA has addressed the issue of extremely high risk quotients for non-target insects with changes in the number of applications per year, increased applications efficiency (as in permethrin, Table 4.4) and bee warnings on the labels, as seen in Section 4.These directions require not using the products when bees are actively foraging. In

the presence of pathogen-infected mosquitos and a public health outbreak of mosquito-borne-viral diseases, there are exceptions to these statements. In addition by performing the applications at night and using the required ULV techniques to increase the efficacy of the adulticiding operation, the only non-target insects which would likely be impacted are those flying in the same space as the target mosquitoes.

## 4.3 Toxicity and Risks of the Mosquito Adulticide Compounds to Aquatic Organisms

### 4.3.1 Acute Toxicity

Similar to the toxicity review of the terrestrial invertebrates, the aquatic toxicity discussion will evaluate all of the insecticidal mosquito adulticides pyrethrins-pyrethroids-PBO and organophosphates together. A summary is presented in Tables 4.5 and 4.6.

The mosquito adulticides were all rated as very highly toxic in the most sensitive species of freshwater fish and invertebrates. PBO is rated as moderately toxic with an acute $LC_{50}$ of 1,900 ppb. The acute median lethal concentrations ($LC_{50}$s) in freshwater fish ranged from 0.28 ppb for resmethrin to 92 ppb for naled-DDVP (Appendix VI, Section 1.0).

The acute $EC_{50}$s for freshwater invertebrates range from 0.01 ppb for malathion to 11.6 ppb for pyrethrins. The acute $EC_{50}$ for PBO in freshwater invertebrates was 490 ppb which makes its classification, moderately toxic (Appendix VI, Section 2.0). With regard to marine fish, all compounds were rated for acute toxicity as very highly toxic with the exceptions of PBO and naled-DDVP which were rated moderately toxic. The acute $LC_{50}$s ranged from 0.96 ppb for chlorpyrifos to 1,200 ppb for naled-DDVP, and the PBO $LC_{50}$ was 3,940 ppb (Appendix VI, Section 1.0). There were very few chronic NOAECs for the mosquito adulticides in marine fish; they ranged from 0.28 for chlorpyrifos to 11 ppb for prallethrin (Appendix VI, Section 2.0).

The only two of these compounds which was ranked as highly toxic to marine invertebrates rather than very highly toxic were prallethrin, with an $EC_{50}$ of 640 ppb, and PBO, with an $EC_{50}$ of 490 ppb. The rest of the compounds were rated as very highly toxic and the EC50s ranged from 0.018 ppb for permethrin to 9.3 for naled (Appendix VI, Tables 1a to 10a).

**Table 4.5 Ranges of Acute Toxicity Endpoints ($LC_{50}$/$EC_{50}$ in ppb (ug/L water) for Aquatic Organisms and Mosquito Adulticides, Not Including PBO**

| Group | Lowest $LC_{50}$/$EC_{50}$ | Highest $LC_{50}$/$EC_{50}$ |
|---|---|---|
| Freshwater Fish | 0.28 | 9.2 |
| Freshwater Invertebrates | 0.01 | 11.6 |
| Marine Fish | 0.96 | 1,200 |
| Marine Invertebrates | 0.018 | 640 |

### 4.3.1 CHRONIC TOXICITY

Unlike toxicity categories for acute toxicity endpoints, EPA does not rate chronic toxicity. The NOAECs for these compounds in freshwater fish ranged from 0.04 ppb (calculated using the acute to chronic ratio method, see Appendix III, Section 5.2) to 23 ppb for etofenprox. There is a data-call-in for a guideline study for chronic toxicity of PBO in freshwater fish (Appendix VI, 1.2a).

The NOAECs for these compounds in marine invertebrates are also very low. The NOAECs range from 0.0026 ppb for phenothrin to 0.1 ppb for pyrethrins (Appendix VI, Section 1.0). The chronic NOAEC's for freshwater invertebrates ranged from 0.0045 ppb for naled-DDVP to 0.86 ppb for pyrethrins (Table 4.6). The chronic NOAEC for PBO was 40 ppb (Appendix VI, Section 1.0).

**Table 4.6 Ranges of Chronic No Observable Adverse Effect Concentrations (NOAEC) in ppb (ug/L water) for Aquatic Organisms and Mosquito Adulticides, not Including PBO**

| Group | Lowest NOAEC | Highest NOAEC |
|---|---|---|
| Freshwater Fish | 0.04 | 23 |
| Freshwater Invertebrates | 0.0045 | 0.86 |
| Marine Fish | 0.28 | 11 |
| Marine Invertebrates | 0.002 | 0.1 |

### 4.3.2 RISKS TO AQUATIC SPECIES FROM MOSQUITO ADULTICIDE COMPOUNDS

In an effort to gain perspective, risks to aquatic invertebrates, the most sensitive groups (Tables 4.5 and 4.6) from exposures resulting from ULV mosquito control and select agricultural scenarios will be compared for two synthetic pyrethroids—phenothrin (0.0036 lbs ai/A) and permethrin (0.007 lbs ai/A)—and the synergist PBO (0.08 lbs ai/A). The information for the scenarios, as well as the resulting estimated environmental concentrations and risk quotients, were taken from EPA's most recent environmental risk assessments. The scenarios discussed below, in addition to multiple scenarios for the other active ingredients, are presented in Appendix VI, Sections 1.0 and 2.

Because the Maine Board of Pesticides Control does not have the capabilities to run EPA's exposure models, there are some standard assumptions which most likely do not hold true for the State of Maine. These are:

- Nighttime ambient temperature of 85 F
- Relative Humidity of 90%
- Between 15 to 26 applications a season with a 1-day interval

The lack of high temperatures and high relative humidity would most likely extend the half-lives of these compounds in Maine waters. The number of applications and the frequency of treatment are most likely overestimated for Maine, given the short window of time between identification of viral-positive mosquitoes and the first hard frost.

As seen in Table 4.7, the risks to aquatic invertebrates from exposure to PBO are below the level of concern for acute risks to freshwater and marine invertebrates for a single mosquito adulticide use, assuming the direct treatment of water for PBO at 0.08 lbs ai/A. There were no chronic estimated environmental concentrations for mosquito uses found in EPA's risk assessment (EPA 2010b). From the agricultural perspective, use at 0.5 lbs ai/A, ten times per year on peppers by air, the risk quotients for acute exposure to freshwater and marine invertebrates were also below the level of concern. There is a data-call-in for a chronic marine invertebrate study and for all aquatic toxicity studies of products with PBO in combination with pyrethrins or pyrethroid compound (EPA 2010b).

Regarding permethrin risk and mosquito and agricultural applications, EPA used the acute to chronic ratio (ACR) method of estimating chronic NOAECs (see Table 4.8 and Appendix III, Section 5.2). Both the laboratory-derived NOAECs and the ACR-calculated NOAECs are included in Table 4.9. The risks to aquatic invertebrates from all permethrin uses, as calculated by EPA, exceed the levels of concern for both acute and chronic applications. The risk quotients for the mosquito use (0.007 lbs ai/A) are much lower than the Maine potato uses at 0.2 lbs ai/A (maximum label rate) or 0.11 lbs ai/A (typical application rate). This is due in part to the lower use rates and the use of different models used for estimating environmental concentrations. The risks of adverse effects on aquatic organisms from mosquito uses of phenothrin (at 0.0036 lbs ai/A) (Table 4.10) are within the acceptable level of concern for acute and chronic exposures to freshwater invertebrates and exceed the level of concern for the marine invertebrates.

**Table 4.7 PBO Mosquito and Pepper by Air or Ground and Risks to Aquatic Invertebrates (EPA 2005g) (EPA 2010b)**

| **Scenario Group** | **Duration** | **LOC** | **RQ** |
|---|---|---|---|
| **Mosquito PBO air 1 treatment direct water 0.08 lbs ai/A, RICE Model** | | | |
| Freshwater and Marine Invertebrates | Acute | 0.5 | 0.15 |
| **Peppers PBO air 10 (3) 0.5 lbs ai/A, PRZM-EXAMS** | | | |
| Freshwater and Marine Invertebrates | Acute | 0.5 | 0.31 to 0.33 |
| Freshwater invertebrates | Chronic | 1 | **5.10** |

**Table 4.8 Permethrin Mosquito and Maine Potato Use Scenarios and Risks to Aquatic Invertebrates (EPA 2011h, EPA 2006i)**

| **Scenario Group** | **Duration** | **LOC** | **RQ** |
|---|---|---|---|
| **Permethrin Mosquito ULV Air: 10 mph, 26 (4) 5% drift; 0.007 lbs ai/A, AGDISP-PRZM-EXAMS** | | | |
| Freshwater and Marine Invertebrates | Acute | 0.5 | **1.23 to 2.67** |
| Freshwater invertebrates | Chronic | 1 | 0.79 (b) to **22.14** (a) |
| Marine invertebrates | | | **2.82 (b) to 25.83 (a)** |

| **Table 4.8 Permethrin Mosquito and Maine Potato Use Scenarios and Risks to Aquatic Invertebrates (EPA 2011h, EPA 2006i)** | | | |
|---|---|---|---|
| **Scenario Group** | **Duration** | **LOC** | **RQ** |
| **Permethrin ME-potatoes Air: unknown wind speed, 5 (4) 5% drift; 0.2 lbs ai/A, PRZM-EXAMS** | | | |
| Freshwater and Marine Invertebrates | Acute | 0.5 | **136 to 296** |
| Freshwater invertebrates | Chronic | 1 | **34 (b) to 943 (a)** |
| Marine invertebrates | | | **120 (b) to 1100 (a)** |

a) Calculated using the acute-to-chronic-ratio method.
b) Results from laboratory studies.

| **Table 4.9 Phenothrin Mosquito Use Scenarios and Associated Risks to Aquatic Invertebrates (EPA 2008f)** | | | |
|---|---|---|---|
| **Scenario Group** | **Duration** | **LOC** | **RQ** |
| **Mosquito phenothrin ULV Air: 10 mph, 15 (1) 5% drift; 0.0036 lbs ai/A, AGDISP-PRZM-EXAMS** | | | |
| Freshwater and Marine Invertebrates | Acute | 0.5 | 0.02 to **3.2** |
| Freshwater and Marine Invertebrates | Chronic | 1 | 0.06 to **19.6** |

## 5.0 Label Review

Pesticide labels are legal documents and are EPA's major mechanism for assuring that the products are used in a manner that will not result in "unreasonable adverse effects to man or the environment." The statement "**It is a violation of Federal Law to use this product in a manner inconsistent with its labeling"** is required on all FIFRA Section 3 registered pesticide labels (7 USC Chapter 125, FIFRA 2008 ) (EPA 2007 to 2012). The pesticide product label language requirements are spelled out in the EPA Label Review Manual found at: http://www.epa.gov/oppfead1/labeling/lrm/ (EPA 2007 to 2012). The nature of the human health (Appendix II, Section 2.2) and environmental statements are required based on the toxicity databases for the technical grade active ingredient and the pesticide end-use product (active and inert ingredients).

One concern regarding the use of wide-area, public-health, ULV mosquito adulticides is the possibility of illegal residues on food and feed as a result of the use. The label restrictions regarding use of these products in and around agricultural areas, parallels the existence of tolerances (Appendix IV, Section 1.0). Phenothrin has a universal tolerance of 0.01 ppm on raw agricultural commodities (40 CFR 180.647, 2013) and PBO is exempt from tolerances in raw agricultural commodities (40 CFR 180.905, 2013b). There is also a universal tolerance for naled residues set at 0.05 ppm, resulting

from ULV mosquito control (40 CFR 180.215, 2013). Other products have restrictions on their labels regarding use in and around agricultural applications (Appendix VII, Section 1.5).

With the exceptions of the naled products, the signal word for the mosquito adulticides is "caution." The naled products carry "danger" labels, due to irreversible corrosive effects on skin and eyes (Appendix II, Section 2.2). The naled products are also federally restricted use products because of their corrosive nature. Three of the pyrethroid-PBO-containing products are federally restricted because of toxicity to aquatic organisms.

The requirements for personal protective equipment (PPE) for applicators parallels their toxicity/corrosivity databases (Appendix VII, Section 1.3). There are no PPE requirements on the etofenprox products. PPE requirements of long sleeve shirt, long pants, shoes and socks and chemical resistant gloves are found on most of the permethrin-PBO, both of the phenothrin-PBO and phenothrin-prallethrin-PBO, the three pyrethrins-PBO and both the resmethrin-PBO containing products. Regarding the organophosphates, the malathion label requirements are similar to the non-etofenprox containing pyrethrins and pyrethroid. The PPE requirements on both the chlorpyrifos containing product and the naled containing products are much more extensive (Appendix VII Section 1.3).

All of the public health, wide area ULV mosquito adulticide labels have environmental warnings to keep out of water because of toxicity to aquatic organisms (Appendix VII, Section 1.4).

## 6.0 CONCLUSIONS

The products registered by EPA for wide-area, public-health, mosquito ULV adulticide uses can be grouped into the pyrethrins-pyrethroids-the synergist PBO products and those containing one of the three organophosphates. The mammalian risks associated with ULV mosquito applications, both to toddlers and adults, are within EPA's level of concern. Regarding environmental risks, the most sensitive groups are the terrestrial and aquatic invertebrates. The label language prohibiting use while bees are foraging, and prohibiting direct application to water, unless there is an ongoing public health crisis, goes a long way towards managing these risks.

Major concerns are:

- Environmental modeling with ambient temperature and relative humidity found in Maine during periods of arbo-viral activity.
- Need for toxicity studies in passerine birds.
- Need for typical end-use product data for PBO in combination with pyrethrins and pyrethroids.
- High likelihood of the pyrethroids occurring in sediment and pore water in sediment areas. EPA has issued multiple data-call-ins for sediment invertebrate toxicity studies, based on the environmental fate of the compounds.
- Most of the mosquito adulticides reviewed here have labels which prohibit applications with ambient temperatures of less than 50 F.

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7 USC Chapter 125, 2008. Federal Insecticide Fungicide and Rodenticide Act

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40 CFR 156.64, 2013, Signal Words

40 CFR 156.70, 2013, Label Language Requirements

40 CFR 160, EPA Good Laboratory Practices

40 CFR 180.342, 2013, Tolerances for Chlorpyrifos

40 CFR 180.545, 2013, Tolerances for Prallethrin

40 CFR 180.111, 2013, Tolerances for Malathion

40 CFR 180.127, 2013, Tolerances for Piperonyl butoxide; post-harvest and meat-meat byproducts

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40 CFR 180.215, 2013, Tolerances for Naled

40 CFR 180.378, 2013, Tolerances for Permethrin

40 CFR 180.525, 2013, Tolerances for Resmethrin

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40 CFR 180.647, 2013, Tolerances for Phenothrin (Sumithrin)

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Bayer Environmental Services 2011d, Permanone 30-30, EPA# 432-1235, containing 30% permethrin-30% PBO, ME-2013 Label

Bayer Environmental Services 2011e, Permanone Insecticide Concentrate, EPA# 432-1250, containing 31.28% permethrin-66% PBO, EPA Label

Bayer Environmental Services 2011f, Permanone 31-66, EPA# 432-1250, containing 31.28% permethrin-66% PBO, ME-2013 Label

Bayer Environmental Services 2011g, Pyrenone Crop Spray, EPA# 432-1033, EPA Label

Bayer Environmental Services 2012a, Scourge Insecticide w/ Resmethrin/Piperonyl Butoxide 4%+12% MF FII, EPA# 432-716, containing 4.14% resmethrin-12.42% PBO, EPA Label

Bayer Environmental Services 2012b, Scourge Insecticide w/ Resmethrin/Piperonyl Butoxide 4%+12% MF FII, EPA# 432-716, containing 4.14% resmethrin-12.42% PBO ME-2013 Label

Bayer Environmental Services 2012c, Scourge Insecticide w/ Resmethrin/Piperonyl Butoxide 18% + 54% MF FII, EPA# 432-667, containing 18% resmethrin-54% PBO, EPA Label

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Univar Environmental Services 2013d, Masterline Kontrol 4-4, EPA# 73748-4, containing 4.6% permethrin-4.6% PBO, ME-2013 Label

Univar Environmental Services 2013e,Masterline Aqua Kontrol Concentrate, EPA# 73748-1, containing 20% permethrin-20% PBO, ME-2103 Label

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Wellmark International 2010d, Zenivex E20, EPA# 2724-791, containing 20% etofenprox, ME-2013 Label

# Appendix I

## 1.0 Active Ingredients; Physical and Chemical Characteristics; Guideline studies for Physical-Chemical Properties

## 2.0 Physical-Chemical Properties of Mosquito Adulticides

2.1 Summary of Physical-Chemical Characteristics

2.2 Chlorpyrifos

2.3 Etofenprox

2.4 Malathion

2.5 Naled-DDVP

2.5.1 Naled

2.5.2 DDVP

2.6 Piperonyl Butoxide (PBO)

2.7 Permethrin

2.8 Phenothrin (Sumithrin $^{TM}$)

2.9 Prallethrin

2.10 Pyrethrins

2.10.1 Chemical components of pyrethrins extract

2.10.2 Pyrethrins Extract

2.10.3 Pyrethrins I and II

2.11Resmethrin

## 3.0 Bio-concentration Factors

## 4.0 Criteria for Data-Call-ins for Sediment Toxicity Studies

## 5.0 Products With Label Directions for Wide Area Public Health Mosquito ULV Adulticide Uses

5.1 Pyrethrins-Pyrethroids-PBO

5.2 Organophosphates

## 1.0 Active Ingredients; Physical and Chemical Characteristics; Guideline studies for Physical-Chemical Properties

EPA's Office of Chemical Safety and Pollution Prevention (OCSPP), has established toxicity study guidelines for toxicity testing requirements under multiple EPA programs.

> "The OCSPP harmonized test guidelines are documents that specify methods that EPA recommends be used to generate data that is submitted to EPA to support the registration of a pesticide under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) (7 U.S.C. 136), setting of a tolerance or tolerance exemption for pesticide residues under section 408 the Federal Food, Drug and Cosmetic Act (FFDCA) (21 U.S.C. 346a), or the decision making process for an industrial chemical under the Toxic Substances Control Act (TSCA) (15 U.S.C. 2601). (EPA 2013c)"

In addition to the toxicity studies discussed below, EPA has requirements for chemical and physical properties (Appendix I), environmental fate and monitoring (Series 835) and a host of other scientific data sets. EPA requires certain studies based on the use patterns, for example if a product has no food uses, then the nature of residues in plant studies are not required. In addition to the empirical studies mentioned above EPA relies on modeling to estimate environmental concentrations (EEC) (Appendix III Section 4.0). For each active ingredient, the results of these tests and the exposure analysis (risk assessments) are combined in documents referred to as Registration Eligibility Decisions (RED).

"The Office of Chemical Safety and Pollution Prevention (OCSPP) has developed a series of harmonized test guidelines for use in the testing of pesticides and toxic substances, and the development of test data for submission to the Agency. The OCSPP Harmonized Test Guidelines are organized in the following series:

810 - Product Performance Test Guidelines
830 - Product Properties Test Guidelines
835 - Fate, Transport and Transformation Test Guidelines
860 - Residue Chemistry Test Guidelines

These documents may be obtained at:
http://www.epa.gov/ocspp/pubs/frs/home/guidelin.htm (EPA 2013b)

## 2.0 PHYSICAL-CHEMICAL PROPERTIES OF MOSQUITO ADULTICIDES

A summary of the physical-chemical properties of the active ingredients found in the wide area public health mosquito adulticides is presented in Table 2.1. The chemical identifiers, physical and chemical characteristics for each of the active ingredients are presented in tables 2.2 to 2.15.

The physical-chemical characteristics of these active ingredients along with use rates, and conditions of application are used as inputs in EPA environmental models used to estimate human exposure (Appendix II, Section 4) and ecological exposures (Appendix III, Section 4).

Differences in the physical-chemical characteristics affect bio-concentration if fish (Appendix I Table 3.1 and the likelihood of persisting in the sediment (Appendix I, Table 4.1).

| **Appendix I. Table 2.1 Physical-Chemical Properties of the Active Ingredients of Mosquito Adulticides (EPA SRC 2013)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Compound** | **CAS#** | **MW g/mole** | **Water Solubility ppb (ug/L)** | **Henry's Law Constant (atm-$m^3$/mole)** | **Vapor Pressure mmHg** | **Partition Coefficients** | | |
| | | | | | | **Log $K_{ow}$ [a]** | **$K_{OC}$ [b]** | **$K_d$ [c]** |
| | | | | | | | **liters/kg** | |
| **Pyrethrins-Pyrethroids and PBO** | | | | | | | | |
| Etofenprox | 80844-07-1 | 376.5 | 1 @ 25 C | 1.38E-08 | 2.79E-05 @ 25 C | 7.05 | 70,130 | 701.3 |
| PBO [d] | 51-03-6 | 338.45 | 14,300 @ 25 C | 2.45E-09 [a] | 5.22E-06 @ 25 C [e] | 4.75 | 2,469 | 25 |
| Permethrin | 52645-53-1 | 391.3 | 6 @ 20 C | 1.87E-06 | 2.18E-08 @ 25 C | 6.5 | 63,096 | 631 |
| Phenothrin (Sumithrin [tm]) | 10453-86-8 | 350.46 | 9.7 @ 25 C | 6.80E-06 | 1.43E-07 @ 21 C | 6.01 | 17,370 | 173 |
| Prallethrin | 23031-36-9 | 300.4 | 8,000 @ 25 C | 1.02E-07 [f] | 2.68E-05 @ 25 C [f] | 4.49 [e] | 3,457 | 35 |
| Pyrethrin I | 121-21-1 | 328.46 | 200 @ 25 C | 7.73E-07 | 5.18E-07@ 25 C [f] | 5.9 [e] | 20,820 | 208 |
| Pyrethrin II | 121-29-9 | 372.47 | 9,000 @ 25 C | 2.19E-08 | 3.98E-07 @ 25 C | 4.3 [e] | 2,333 | 23 |
| Resmethrin | 2921-88-2 | 338.45 | 300 @ 25 C | 1.33E-07 | 1.40E-04 @ 25 C | 6.14 | 100,000 | 10,000 |
| **Organophosphates** | | | | | | | | |
| Chlorpyrifos | 2921-88-2 | 350.59 | 1,200 @ 25 C | 2.93E-06 | 2.03E-05 @ 25 C [f] | 4.96 | 5,000 | 50 |
| Malathion | 121-75-5 | 330.35 | 143,000 @ 20 C | 4.89E-09 | 3.38E-06 @ 25 C | 2.36 | 229 | 2.29 |

| **Appendix I. Table 2.1 Physical-Chemical Properties of the Active Ingredients of Mosquito Adulticides (EPA SRC 2013)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Compound** | **CAS#** | **MW g/mole** | **Water Solubility ppb (ug/L)** | **Henry's Law Constant (atm-$m^3$/mole)** | **Vapor Pressure mmHg** | **Partition Coefficients** | | |
| | | | | | | **Log $K_{ow}$ [a]** | **$K_{OC}$ [b]** | **$K_d$ [c]** |
| | | | | | | | **liters/kg** | |
| Naled | 300-76-5 | 380.79 | 1,500 @ 25 C | 6.50E-05 | 2.00E-04 @ 20 C | 1.38 | 182 | 1.82 |

a) Log Kow = Log of the octanol water partition coefficient (EPA SRC 2013)
b) Koc = Soil organic carbon sorption coefficient of an active ingredient in mL/g. Pesticides vary in how tightly they are adsorbed to soil particles. Koc measures the affinity for pesticides to sorb to organic carbon. The higher the Koc value, the stronger the tendency to attach to and move with soil. Soil pH can affect the Koc of ionic and partially ionic pesticides. A pesticide with an anion as the active species would have a Koc set low to account for that pesticide's inability to sorb to soil particles. A cationic active species would tend to bind strongly with soil and therefore have a relatively high Koc. Pesticide Koc values greater than 1,000 indicate strong adsorption to soil. Pesticides with lower Koc values (less than 500) tend to move more with water than adsorbed to sediment (USDA 2013c).
c) Kd = The ratio of sorbed to solution pesticide concentrations after equilibrium of a pesticide in a water / soil slurry (USDA 2013c)
d) PBO, piperonyl butoxide is shaded in 10% is the synergist found in all pyrethroid-pyrethrins formulations, except the etofenprox products
e) Calculated after USDA 2013c assuming 1% organic matter $K_{oc} = K_d * 100$ therefore $K_{oc}/100 = K_d$ (USDA 2013c)
f) EPISUITE calculation (EPA SRC 2013)

| **Appendix I Table 2.2 Chlorpyrifos, Identifiers, Physical and Chemical Parameters** | | |
|---|---|---|
| **Parameter** | **Result** | **Reference** |
| **Chemical Name** | Chlorpyrifos | EPA SRC 2013 |
| **Chemical Class** | Organophosphate | EPA 2008e |
| **CAS#** | 2921-88-2 | EPA SRC 2013 |
| **Chemcode** | 59101 | NSPIR 2013 |
| **Molecular weight** | 350.59 | EPA SRC 2013 |
| **Melting Point** | 42 C | EPA SRC 2013 |
| **Water Solubility** | 1.2 mg/L @ 24 C | EPA SRC 2013 |
| **Vapor Pressure** | $2.03 \times 10^{-5}$ mmHg @ 25 C [(a)] | EPA SRC 2013 |
| **Henry's Law Constant** | $2.93 \times 10^{-6}$ atm-$m^3$/mole | EPA SRC 2013 |
| **Log $K_{ow}$** | 4.96 | EPA SRC 2013 |
| **$K_{oc}$** | 5,000 | EPA SRC 2013 |
| **$K_d$** | ~50 [(b)] | Calculated |
| **Bio-concentration Factor [(c)]** | 2,727 | EPA 2008e |
| **Foliar Degradation, half-life** | 35 days [(d)] | EPA 2008e |
| **Total Toxic Residues [(e)]** | Chlorpyrifos | EPA 2008e |
| | Chlorpyrifos Oxon | |

a) EPISUITE Calculation (EPA SRC 2013)

b) Calculated after USDA 2013c assuming 1% organic matter; $K_{oc} = K_d * 100$ therefore $K_{oc}/100 = K_d$ (USDA 2013c)

c) Whole fish

d) T-REX Default for Foliar Half-life (EPA 2008e)

e) The major environmental metabolite of chlorpyrifos, 3,5,6-richloro-2pyridinol (TCP) is not included in the total toxic residues (EPA 2008e)

| **Appendix I Table 2.3 Ethofenprox, Identifiers, Physical and Chemical Parameters** | | |
|---|---|---|
| **Parameter** | **Result** | **Reference** |
| **Common Name** | Etofenprox | EPA SRC 2013 |
| **Chemical class** | Synthetic Pyrethroid | EPA 2009a |
| **CAS#** | 80844-07-1 | EPA SRC 2013 |
| **EPA Chemcode** | 128965 | NSPIRS 2013 |
| **Molecular Weight** | 376.5 | EPA SRC 2013 |
| **Melting point** | 37 C | EPA SRC 2013 |
| **Water Solubility** | 0.001 mg/L @ 25 C | EPA SRC 2013 |
| **Vapor Pressure** | $2.79 \times 10^{-5}$ mmHg @ 25 C (a) | EPA SRC 2013 |
| **Henry's Law Constant** | $1.38 \times 10^{-8}$ atm-$m^3$/mole (a) | EPA SRC 2013 |
| **Log $K_{ow}$** | 7.05 | EPA SRC 2013 |
| **Koc** | 70,130 (a) | EPA SRC 2013 |
| **$K_d$** | 701.3 (b) | Calculated |
| **Bio-concentration Factor(c)** | 4,846X | EPA 2009a |
| **Aerobic water, half-life** | 20 to 62 days(d) | EPA 2009a |
| **Aerobic soil, half-life** | 6.5 to 28 days (e) | EPA 2009a |
| **Foliar Degradation, half-life** | 35 days (e) | EPA 2009a |
| **Total Toxic Residues** | Etofenprox | EPA 2009a |
| | 4' –OH | |
| | Alpha-CO | |

a) EPISUITE Calculation

b) Calculated after USDA 2013c assuming 1% organic matter $K_{oc} = K_d * 100$ therefore $K_{oc}/100 = K_d$ (USDA 2013c)

c) Whole fish

d) Depending on pH (EPA 2009a)

e) Depending on soil type (EPA 2009a)

f) T-REX default value for foliar half-life (EPA 2009a)

| Appendix I Table 2.4 Malathion, Identifiers, Physical and Chemical Parameters | | |
|---|---|---|
| **Parameter** | **Result** | **Reference** |
| **Common name** | Malathion | EPA SRC 2013 |
| **CAS#** | 121-75-5 | EPA SRC 2013 |
| **EPA Chemcode** | 57701 | NSPIRS 2013 |
| **Chemical Class** | Organophosphate | EPA 2009a |
| **Molecular weight** | 330.35 | EPA SRC 2013 |
| **Melting point** | 2.8 C | EPA SRC 2013 |
| **Water Solubility** | 143 mg/L @ 20 C | EPA SRC 2013 |
| **Vapor Pressure** | $3.38 \times 10^{-6}$ mmHg @ 25 C | EPA SRC 2013 |
| **Henry's Law Constant** | $4.89 \times 10^{-9}$ atm-$m^3$/mole | EPA SRC 2013 |
| **Log $K_{ow}$** | 2.36 | EPA SRC 2013 |
| **$K_{oc}$** | 229 | EPA SRC 2013 |
| **$K_d$** | 2.29 (a) | Calculated |
| **Bio-concentration Factor (b) Whole Fish** | 23X to 135X (c) | EPA 2009g |
| **Aerobic water, half-life** | 1 day to 2 weeks | EPA 2009g |
| **Aerobic soil, half-life** | 3 days | EPA 2009g |
| **Foliar Degradation, half-life** | 5.5 | EPA 2009g |
| **Total Toxic Residues** | Malathion | EPA 2009g |
| | Malaoxon | EPA 2009g |

a) Calculated after USDA 2013c assuming 1% organic matter $K_{oc} = K_d * 100$ therefore $K_{oc}/100 = K_d$ (USDA 2013c)

b) Whole fish

c) Different Studies (EPA 2009g)

| **Appendix I Table 2.5.1 Naled-Dichlorvos, Naled Identifiers, Physical and Chemical Parameters** | | |
|---|---|---|
| **Parameter** | **Value** | **Reference** |
| **Common Name** | Naled | EPA SRC 2013 |
| **CAS#** | 300-76-5 | EPA SRC 2013 |
| **EPA Chemcode** | 34401 | NSPIRS 2013 |
| **Chemical Class** | Organophosphate | EPA 2008d |
| **Molecular Weight** | 380.79 | EPA SRC 2013 |
| **Melting Point** | 27 C | EPA SRC 2013 |
| **Water Solubility** | 1.5 mg/L | EPA SRC 2013 |
| **Vapor Pressure** | $2 \times 10^{-4}$ mmHg @ 20 C | EPA SRC 2013 |
| **Henry's Law Constant** | $6.5 \times 10^{-5}$ atm-$m^3$/mole | EPA SRC 2013 |
| **Log $K_{ow}$** | 1.38 | EPA SRC 2013 |
| **Koc** | 182 | EPA SRC 2013 |
| **$K_d$** | 1.82 (a) | Calculated |
| **Foliar Degradation, half-life** | Not Applicable (b) | EPA 2008d |
| **Total Toxic Residues** | Naled | EPA 2008d |
| | DDVP (see Separate Table) | |

a) Calculated after USDA 2013c assuming 1% organic matter $K_{oc} = K_d * 100$ therefore $K_{oc}/100 = K_d$ (USDA 2013c)

b) T-REX model is not appropriate for estimating residues in terrestrial animal feed due to the rapid degradation of both naled and DDVP (EPA 2008d)

| **Appendix I Table 2.5.2 Dichlorvos (DDVP), Identifiers, Physical and Chemical Parameters** | | |
|---|---|---|
| **Parameter** | **Value** | **Reference** |
| **Common Name** | Dichlorvos | EPA SRC 2013 |
| **CAS#** | 62-73-7 | EPA SRC 2013 |
| **EPA Chemcode** | 84001 | NSPIRS 2013 |
| **Chemical Class** | Organophosphate | EPA 2008d |
| **Molecular Weight** | 220.98 | EPA SRC 2013 |
| **Melting point** | < - 60 C | EPA SRC 2013 |
| **Water Solubility** | 8,000 mg/L @ 20 C | EPA SRC 2013 |
| **Vapor Pressure** | 1.58 x $10^{-2}$ mmHg @ 25 C | EPA SRC 2013 |
| **Henry's Law Constant** | 5.74 x $10^{-7}$ atm-$m^3$/mole | EPA SRC 2013 |
| **Log $K_{ow}$** | 1.43 | EPA SRC 2013 |
| **Koc** | 47 | EPA SRC 2013 |
| **$K_d$** | 0.47 [(a)] | Calculated |
| **Aerobic soil, half-life** | 0.42 | EPA 2008d |
| **Foliar Degradation, half-life** | Not Applicable [(b)] | EPA 2008g |
| **Total Toxic Residues** | Naled | EPA 2008d |
| | DDVP | EPA 2008d |

a) Calculated after USDA 2013c assuming 1% organic matter $K_{oc} = K_d * 100$ therefore $K_{oc}/100 = K_d$ (USDA 2013c)

b) T-REX model is not appropriate for estimating residues in terrestrial animal feed due to the rapid degradation of both naled and DDVP (EPA 2008d)

| **Appendix I Table 2.6 Piperonyl butoxide(PBO), Identifiers, Chemical and Physical Properties** | | |
|---|---|---|
| **Parameter** | **Value** | **Reference** |
| **Common Name** | PBO | EPA SRC 2013 |
| **CAS#** | 51-03-6 | EPA SRC 2013 |
| **EPA Chemcode** | 67501 | NSPIRS 2013 |
| **Chemical Class** | Synergist | EPA 2010b |
| **Molecular weight** | 338.45 | EPA SRC 2013 |
| **Melting Point** | < 25 C | EPA SRC 2013 |
| **Water Solubility** | 14.3 mg/L @ 25 C | EPA SRC 2013 |
| **Vapor Pressure** | $5.22 \times 10^{-6}$ mm Hg @ 25C (a) | EPA SRC 2013 |
| **Henry's Law Constant** | 2.45 x 10-$^{9}$ atm-$m^3$/mole(a) | EPA SRC 2013 |
| **Log $K_{ow}$** | 4.75 | EPA SRC 2013 |
| **$K_{oc}$** | 2,469 (a) | EPA SRC 2013 |
| **$K_d$** | 24 (a) | Calculated |
| **Bio-concentration Factor (b)** | 260X | EPA 2010b |
| **Aerobic water, half-life** | 75 days | EPA 2010b |
| **Aerobic soil, half-life** | 14 days | EPA 2010b |
| **Foliar Degradation, half-life** | 35 days (c) | EPA 2006a |
| **Total Toxic Residues** | PBO-alcohol | EPA 2010b |
| | PBO-aldehyde | |
| | PBO-acid | |

a) Calculated in EPISUITE

b) Calculated after USDA 2013c assuming 1% organic matter $K_{oc} = K_d * 100$ therefore $K_{oc}/100 = K_d$ (USDA 2013c)

c) T-REX Default foliar half-life (EPA 2010b)

| **Appendix I Table 2.7 Permethrin, Identifiers, Physical and Chemical Parameters** | | |
|---|---|---|
| **Parameter** | **Value** | **Reference** |
| **Common Name** | Permethrin | EPA SRC 2013 |
| **Components** | max cis 40%; min trans 60% | NSPIRS 2013 |
| **CAS#** | 52645-53-1 | EPA SRC 2013 |
| **EPA Chemcode** | 109701 | NSPIRS 2013 |
| **Chemical Class** | Synthetic Pyrethroid | EPA 2011h |
| **Molecular Weight** | 391.30 | EPA SRC 2013 |
| **Melting point** | 34 C | EPA SRC 2013 |
| **Water Solubility** | 0.006 mg/L @ 20 C | EPA SRC 2013 |
| **Vapor Pressure** | $2.18 \times 10^{-8}$ @ 25 C | EPA SRC 2013 |
| **Henry's Law Constant** | $1.87 \times 10^{-6}$ atm-$m^3$/mole | EPA SRC 2013 |
| **Log $K_{ow}$** | 6.5 @ 20 C | EPA SRC 2013 |
| **Koc** | 63,096 | EPA SRC 2013 |
| **$K_d$** | 631 (a) | Calculated |
| **Bio-concentration Factor (b)** | 610X | EPA 2011h |
| **Foliar Degradation, half-life** | 35 days (c) | EPA 2011h |
| **Total Toxic Residues** | Permethrin | EPA 2011h |

a) Calculated after USDA 2013c assuming 1% organic matter $K_{oc} = K_d * 100$ therefore $K_{oc}/100 = K_d$ (USDA 2013c)

b) Whole fish

c) T-REX Default foliar half-life (EPA 2011h)

| **Appendix I Table 2.8 Phenothrin, (Sumithrin$^{tm}$), Identifiers, Physical and Chemical Parameters** | | |
|---|---|---|
| **Parameter** | **Value** | **Reference** |
| **Common Names** | Phenothrin | EPA SRC 2013 |
| **Mix of Isomers** | cis 25%; trans 75% | NSPIRS 2013 |
| **Cis isomer CAS#** | 51186-88-0 | NSPIRS 2013 |
| **Trans isomer CAS#** | 26046-85-5 | NSPIRS 2013 |
| **Technical Mix CAS#** | 26002-80-2 | NSPIRS 2013, Merck 2006 |
| **EPA Chemcode** | 69005 | NSPIRS 2013 |
| **Molecular Weight** | 350.46 | EPA SRC 2013 |
| **Melting Point** | < 25 C | EPA SRC 2013 |
| **Water Solubility** | 0.0097 mg/L @ 25 C | EPA SRC 2013 |
| **Vapor Pressure** | $1.43 \times 10^{-7}$ @ 21 C | EPA SRC 2013 |
| **Henry's Law Constant** | $6.8 \times 10^{-6}$ atm-$m^3$/mole | EPA SRC 2013 |
| **Log $K_{ow}$** | 6.01 | EPA SRC 2013 |
| **Koc** | 17,370 | EPA SRC 2013 |
| **$K_d$** | 173 (a) | Calculated |
| **Bio-concentration Factor (b)** | 1,805X | EPA 2008f |
| **Aerobic water, half-life** | 36.1 days | EPA 2008f |
| **Aerobic soil, half-life** | 33.28 (c) | EPA 2008f |
| **Foliar Degradation, half-life** | 1 day | EPA 2007a |
| **Total Toxic Residues** | Phenothrin | EPA 2008f |

a) Calculated after USDA 2013c assuming 1% organic matter $K_{oc} = K_d * 100$ therefore $K_{oc}/100 = K_d$ (USDA 2013c)

b) Whole fish

c) EPA used this value as input for the AGDISP, PRZM and EXAMS models

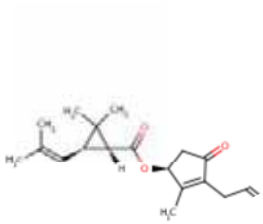
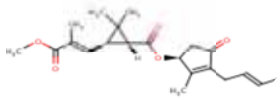
| Appendix I Table 2.9 Prallethrin, Identifiers, Physical and Chemical Parameters | | |
|---|---|---|
| **Parameter** | **Value** | **Reference** |
| **Common name** | Prallethrin | EPA SRC 2013 |
| **CAS#** | 23031-36-9 | EPA SRC 2013 |
| **EPA Chemcode** | 128722 | NSPIRS 2013 |
| **Chemical Class** | Synthetic Pyrethroids | EPA 2012h |
| **Molecular Weight** | 300.40 | EPA SRC 2013 |
| **Melting Point** | < 25 C | EPA SRC 2013 |
| **Water Solubility** | 8 mg/L @ 25 C | EPA SRC 2013 |
| **Vapor Pressure** | $2.68 \times 10^{-5}$ mmHg @ 25 C (a) | EPA SRC 2013 |
| **Henry's Law Constant** | $1.02 \times 10^{-7}$ atm-$m^3$/mole (a) | EPA SRC 2013 |
| **Log $K_{ow}$** | 4.49 | EPA SRC 2013 |
| **Koc** | 3,457 (a) | EPA SRC 2013 |
| **$K_d$** | 35 (b) | Calculated |
| **Bio-concentration Factor (c)** | 1,160X | EPA 2012h |
| **Aerobic water, half-life** | 18 days | EPA 2012h |
| **Aerobic soil, half-life** | 9 days | EPA 2012h |
| **Foliar Degradation, half-life** | 35 days (d) | EPA 2012h |
| **Total Toxic Residues** | Prallethrin | EPA 2012h |

a) Calculated in EPISUITE

b) Calculated after USDA 2013c assuming 1% organic matter $K_{oc} = K_d * 100$ therefore $K_{oc}/100 = K_d$ (USDA 2013c)

c) Whole fish

d) T-REX Default foliar half-life (EPA 2012h)

| Appendix I. Table 2.10.1 Components of Pyrethrins Extract (57-58%) | | | |
|---|---|---|---|
| **Compound** | **EPA Chemcode** | **CAS#** | **Reference** |
| Pyrethrin extracts | 69001 | 8003-34-7 | EPA 2011i |
| Pyrethrins I Mixed esters of (+)-trans-chrysanthemic acid (EPA 2011i) |  **R1** | TOXNET 2013 | |
| Pyrethrin I | 69008 | 121-21-1 | R1 = -CH=CH2 |
| Cinerin I | 69010 | 25402-06-6 | R1 = -CH3 |
| Jasmolin I | 69011 | 4466-14-2 | R1 = -CH3-CH4 |
| Pyrethrins II Mixed esters of (+)-pyrethroic acid (EPA 2011i) |  **R2** | TOXNET 2013 | |
| Pyrethrin II | 69006 | 121-29-9 | R2 = -CH=CH2 |
| Cinerin II | 68010 | 121-20-0 | R2 = -CH3 |
| Jasmolin II | 69012 | 1172-63-0 | R2 = -CH3-CH4 |
| Jasmolin II | 69012 | 1172-63-0 | R2 = -CH3-CH4 |

| **Appendix I Table 2.10.2 Pyrethrin extracts 57 to 58%, Identifiers, Physical and Chemical Parameters** | | |
|---|---|---|
| **Parameter** | **Results** | **Reference** |
| **Common Name** | Pyrethrins | EPA 2011i |
| **Components** | Mixed esters of (+)-trans-chrysanthemic acid and (69008 [(a)] + 69009 + 69011) [(b)] and (+)-pyrethroic acid 69006 + 69010 + 69012) [(c)] | NSPIRS 2013 |
| **CAS#** | 8003-34-7 | |
| **EPA Chemcode** | 69001 | |
| **Chemical Class** | Pyrethrins | EPA 2011i |
| **Molecular weights** | 316.4 to 374.5 | EPA 2011i |
| **Water Solubility** | 0.2 mg/L @ 25 C [(a)]; 9 mg/L [(b)] @ 25 C | EPA 2011i |
| **Vapor Pressure** | 2 x $10^{-5}$ to 4.8 x $10^{-7}$ mmHg range components [(a) (b)] @ 25 C | EPA 2011i |
| **Log $K_{ow}$** | 5.9 @ 25 C [(a)]; 4.3 @ 25 C [(b)] | EPA 2011i |
| **$K_{oc}$** | 100,000 [(c)] | USDA 2013c |
| **$K_d$** | 1,000 [(d)] | Calculated |
| **Bio-concentration Factor [(e)]** | 471X | EPA 2011i |
| **Aerobic soil, half-life** | 9 days | EPA 2011i |
| **Foliar Degradation, half-life** | 1 to 14 days | EPA 2011i |
| **Total Toxic Residues** | Pyrethrins I [(a)] and Pyrethrins II [(b)] | EPA 2011i |

a) EPA used environmental fate information for Pyrethrin I as the surrogate for the pyrethrin components (EPA 2011i), EPI SUITE (EPA SRC 2013) provided information on pyrethrin I CAS# 121-21-1) and pyrethrin II (CAS# 121-29-9).The specific chemical physical characteristics for pyrethrin I (CAS# 121-21-1) and pyrethrin II (CAS# 121-29-9) from EPISUITE (EPA SRC 2013) are found in the following table. Pyrethrins I; pyrethrin I, (Chemcode 69008, CAS# 121-21-1) **[(a)]**, R = -CH=CH2, cinerin I, (Chemcode 69010, CAS# 25402-06-6),R = CH3, jasmolin I, (Chemcode 69011, CAS# 4466-14-2), R = CH3-CH4

b) Pyrethrins II; pyrethrin II, (Chemcode 69006, CAS# 121-29-9), R1 = -CH=CH2 ,cinerin II, (Chemcode 68010, CAS# 121-20-0),R1 = CH3, jasmolin II, (Chemcode 69012, CAS# 1172-63-0), R1 = CH3-CH4

c) Calculated after USDA 2013c assuming 1% organic matter $K_{oc} = K_d * 100$ therefore $K_{oc}/100 = K_d$ (USDA 2013c)

d) Whole fish

| **Appendix I Table 2.10.3 Pyrethrin I and Pyrethrin II Identifiers, Physical and Chemical Parameters** | | |
|---|---|---|
| **Pyrethrin I CAS# 121-21-1)** | | |
| **Parameter** | **Results** | **Reference** |
| **EPA Chemcode** | 69008 | NSPIRS 2013 |
| **Molecular weights** | 328.46 | EPA SRC 2013 |
| **Melting Point** | 142.27 C | EPA SRC 2013 |
| **Water Solubility** | 0.2 mg/L | EPA SRC 2013 |
| **Vapor Pressure** | $5.18 \times 10^{-7}$ mmHg @ 25 C [(a)] | EPA SRC 2013 |
| **Henry's Law Constant** | $7.73 \times 10^{-7}$ atm-$m^3$/mole | EPA SRC 2013 |
| **Log $K_{ow}$** | 5.9 | EPA SRC 2013 |
| **$K_{oc}$** | 20,820 [(a)] | EPA SRC 2013 |
| **$K_d$** | 208 [(b)] | Calculated |
| **Pyrethrin II (CAS# 121-29-9)** | | |
| **EPA Chemcode** | 69006 | NSPIRS 2013 |
| **Molecular weights** | 372.47 | EPA SRC 2013 |
| **Melting Point** | 132.12 C | EPA SRC 2013 |
| **Water Solubility** | 9 mg/L @ 25 C | EPA SRC 2013 |
| **Vapor Pressure** | $3.98 \times 10^{-7}$ mmHg @ 25 C | EPA SRC 2013 |
| **Henry's Law Constant** | $2.19 \times 10^{-8}$ atm-$m^3$/mole | EPA SRC 2013 |
| **Log $K_{ow}$** | 4.3 | EPA SRC 2013 |
| **$K_{oc}$** | 2,333 [(a)] | EPA SRC 2013 |
| **$K_d$** | 23 [(b)] | EPA SRC 2013 |

a) Calculated in EPISUITE
b) Calculated after USDA 2013c assuming 1% organic matter $K_{oc} = K_d * 100$ therefore $K_{oc}/100 = K_d$ (USDA 2013c)

| **Appendix I Table 2.11 Resmethrin, Identifiers, Physical and Chemical Parameters** | | |
|---|---|---|
| **Parameter** | **Value** | **Reference** |
| **Common Name** | Resmethrin | EPA SRC 2013 |
| **CAS#** | 10453-86-8 | EPA SRC 2013 |
| **EPA Chemcode** | 97801 | NSPIRS 2013 |
| **Chemical class** | Synthetic Pyrethroid | EPA 2012i |
| **Molecular weight** | 338.45 | EPA SRC 2013 |
| **Melting point** | 32 C | EPA SRC 2013 |
| **Water Solubility** | 0.0415 mg/L @ 25C | EPA SRC 2013 |
| **Vapor Pressure** | $1.40 \times 10^{-4}$ mmHg @ 25 C | EPA SRC 2013 |
| **Henry's Law Constant** | $1.33 \times 10^{-7}$ atm-$m^3$/mole | EPA SRC 2013 |
| **Log $K_{ow}$** | 6.14 | EPA SRC 2013 |
| **Koc** | 100,000 | EPA SRC 2013 |
| **$K_d$** | 10,000 (a) | EPA SRC 2013 |
| **Bio-concentration Factor (c)** | 2,700X | EPA 2012i |
| **Aerobic soil, half-life** | 197.5 days (d) | EPA 2012i |
| **Foliar Degradation, half-life** | 35 days (e) | EPA 2012i |
| **Total Toxic Residues** | Resmethrin | EPA 2012i |

a) Calculated after USDA 2013c assuming 1% organic matter $K_{oc} = K_d * 100$ therefore $K_{oc}/100 = K_d$ (USDA 2013c)

b) Whole fish

c) Loamy sediment (EPA 2012i)

d) T-REX Default foliar half-life (EPA 2012i)

### 3.0 BIO-CONCENTRATION FACTORS

One measure of ecological persistence is the bio-concentration factors (BCF). The bio-concentration factors for the pyr-pyrd-PBO group of compounds are found in Appendix I Table 3.1. The BCFs for the organophosphates are presented in Table 3.2

**Appendix I Table 3.1 Bio-concentration Factors, Depuration Rates in Whole Fish for Mosquito Adulticide Pyrethrins, Pyrethroids and PBO**

| Compound | Bio-concentration Factor | Depuration Half-life (days) | Reference |
|---|---|---|---|
| Etofenprox | 341 | 9 to 16 | EPA 2008b |
| PBO | 260 | No data | EPA 2010b |
| Permethrin | 510 to 610 | 4.7 | EPA 2011h |
| Phenothrin | 1805 | 2.4 to 2.5 | EPA 2008f |
| Prallethrin | 708 to 1,070 | 1.3 to 2.5 | EPA 2012h |
| Pyrethrins | 471 | 1 | EPA 2011i |
| Resmethrin | 1,100 | 14 | EPA 2012i |

**Appendix I Table 3.2 Bio-concentration Factors, Depuration Rates in Whole Fish for Mosquito Adulticide Organophosphates**

| Compound | Bio-concentration Factor | Depuration Half-life (days) | Reference |
|---|---|---|---|
| Chlorpyrifos | 2,727 | No data | EPA 2008e |
| Malathion | 135 | 14 | EPA 2009g |
| Naled-DDVP | Not persistent | | EPA 2008d, EPA 2008g |

## 4.0 EPA'S CRITERIA FOR REQUIRING TOXICITY TESTING ON SEDIMENT INVERTEBRATES

EPA requires toxicity testing on sediment dwelling invertebrates when the environmental fate characteristics indicate that the compound is stable and likely to come to equilibrium in the sediment. These characteristics are found in Appendix I, Table 4.1

| **Appendix I Table 4.1 Criteria for Requiring Sediment Dwelling Invertebrate Toxicity Studies [(a)] (EPA 2009a)** | | |
|---|---|---|
| **Parameter** | **Acute** | **Chronic** |
| Half-life in sediment in aerobic soil or aquatic metabolism studies | ≤ 10 days | ≥ 10 days |
| **And one of the following conditions is met** | | |
| Log $K_{ow}$ [(b)] | ≥ 3 | ≥ 3 |
| $K_{oc}$ [(c)] | ≥ 1,000 | ≥ 1,000 |
| $K_d$ [(d)] | ≥ 50 | ≥ 50 |
| EEC [(e)] in sediment | Not applicable | > 0.1 of the acute $LC_{50}/EC_{50}$ |

a) These studies may be freshwater or marine depending on the study meeting the criteria

b) Log Kow = Log of the octanol water partition coefficient (EPA SRC 2013)

c) Koc = Soil organic carbon sorption coefficient of an active ingredient in mL/g. Pesticides vary in how tightly they are adsorbed to soil particles. Koc measures the affinity for pesticides to sorb to organic carbon. The higher the Koc value, the stronger the tendency to attach to and move with soil. Soil pH can affect the Koc of ionic and partially ionic pesticides. A pesticide with an anion as the active species would have a Koc set low to account for that pesticide's inability to sorb to soil particles. A cationic active species would tend to bind strongly with soil and therefore have a relatively high Koc. Pesticide Koc values greater than 1,000 indicate strong adsorption to soil. Pesticides with lower Koc values (less than 500) tend to move more with water than adsorbed to sediment (USDA 2013c).

d) Kd = The ratio of sorbed to solution pesticide concentrations after equilibrium of a pesticide in a water / soil slurry (USDA 2013c)

e) Estimated environmental concentration

## 5.0 PRODUCT SPECIFICS

The products identified as wide area public health mosquito adulticides registered in Maine for 2013 are found in Appendix I Tables 5.1, pyrethrins-pyrethroids-PBO and Appendix I Table 5.2 organophosphates. Copies of the most recent federally approved labels may be obtained using the first two parts of the EPA # on EPA's Pesticide Product Labels System (PPLS) at: http://oaspub.epa.gov/apex/pesticides/f?p=PPLS:1 . State approved labels may be obtained by contacting the Maine Board of Pesticides Control at 207-287-2731 or: http://www.maine.gov/dacf/php/pesticides/index.shtml or www.thinkfirstspraylast.org

**Appendix I Table 5.1 Public Health Adult Mosquito Products Containing Pyrethroids-Pyrethrins-Piperonyl Butoxide (PBO) Registered in Maine for 2013 sorted by Active Ingredient (NSPIRS 2013)**

| Brand Names | EPA REG # | Active Ingredients | References |
|---|---|---|---|
| Zenivex E4 RTU [(b)] | 2724-807 | 4% Etofenprox | Wellmark 2010a, Wellmark 2010b |
| Zenivex E20 | 2724-791 | 20% Etofenprox | Wellmark 2009a, Wellmark 2009b |
| Masterline Kontrol 2-2 | 73748-3 | 2% Permethrin<br>2% PBO [(c)] | Univar 2013a, Univar 2013b |
| Prentox Perm-X UL 4-4 | 655-898 | 4% Permethrin<br>4% PBO | Prentiss 2012a, Prentiss 2012b, |
| Masterline Kontrol 4-4 | 73748-4 | 4.6% Permethrin<br>4.6% PBO | Univar 2013c, Univar 2013d |
| Aqua-Reslin | 432-796 | 20% Permethrin<br>20% PBO | Bayer [(d)] 2013a, Bayer 2013b |
| Masterline AQUA Kontrol | 73748-1 | 20% Permethrin<br>20% PBO | Univar 2013e, Univar 2013f |
| PBO/Permethrin: Vector flex 20:20 | 53883-274 | 20.6% Permethrin<br>20.6% PBO | Control Solutions 2010a, Control Solutions 2010b |
| Omen 30-30, Permanone 30-30 | 432-1235 | 30% Permethrin<br>30% PBO | Bayer 2011c, Bayer 2011d |
| Prentox Perm-X UL 30-30 | 655-811 | 30% Permethrin<br>30% PBO | Prentiss 2012c, Prentiss 2012d |
| Masterline Kontrol 30-30 | 73748-5 | 30% Permethrin<br>30% PBO | Univar 2013g, Univar 2013h |

| **Appendix I Table 5.1 Public Health Adult Mosquito Products Containing Pyrethroids-Pyrethrins-Piperonyl Butoxide (PBO) Registered in Maine for 2013 sorted by Active Ingredient (NSPIRS 2013)** | | | |
|---|---|---|---|
| **Brand Names** | **EPA REG #** | **Active Ingredients** | **References** |
| Prentox Perm-X UL 31-66 (RUP) (h) | 655-812 | 31% Permethrin<br>66% PBO | Prentiss 2012e, Prentiss 2012f |
| Permanone 31-66 | 432-1250 | 31.28% Permethrin<br>66% PBO | Bayer 2011e, Bayer 2011f |
| Anvil 10+10 ULV | 1021-1688-8329 (h) | 10% Phenothrin (e)<br>10% PBO | Clarke (f) 2013a |
| Duet | 1021-1795-8329 (h) | 5% Phenothrin (e)<br>1% Prallethrin<br>5% PBO | Clarke 2013b |
| Pyrocide 7067 | 1021-1199 | 5% Pyrethrins<br>25% PBO | MGK 2013a (g), MGK 2013b |
| Pyrocide 7396 | 1021-1569 | 5% Pyrethrins<br>25% PBO | MGK 2013c, MGK 2013d |
| Pyrocide 7395 | 1021-1570 | 12% Pyrethrins<br>60% PBO | MGK 2012b, MGK 2012c |
| Scourge I (RUP) (h) | 432-716 | 4.14% Resmethrin<br>12.42% PBO | Bayer 2012a, Bayer 2012b |
| Scourge II (RUP) (h) | 432-667 | 18% Resmethrin<br>54% PBO | Bayer 2012c, Bayer 2012d |

a) Inert Ingredients from label and/or MSDS
b) RTU = Ready to use
c) PBO = Piperonyl butoxide, pesticide synergist
d) Bayer = Bayer Environmental EPA Company number 432
e) Phenothrin = Sumithrin
f) Clarke = Clarke Mosquito Control Products
g) MGK = McLaughlin Gormley King
h) RUP = Restricted Use Pesticide, because of aquatic toxicity, requires appropriate certification and licensing for purchase and use

| **Appendix I Table 5.2 Public Health Adult Mosquito Products Containing Organophosphate Insecticides Registered in Maine for 2013 sorted by Active Ingredient (NSPIRS 2013)** | | | |
|---|---|---|---|
| **Brand Names** | **EPA REG #** | **Active Ingredients** | **References** |
| Pyrofos 1.5 ULV[(a)] Vector Control Insecticide | 53883-251 | 19.36% Chlorpyrifos [(b)] | Control Solutions 2009a Control Solutions 2010e |
| Fyfanon ULV | 67760-34 | 96.5% Malathion | Cheminova 2011a, Cheminova 2011b |
| Dibrom 8 Emulsive (RUP) [(c)] | 5481-479 | 62% Naled | AMVAC 20012a, AMVAC 20012b |
| Trumpet EC (RUP) [(c)] | 5481-481 | 78% Naled | AMVAC 2010a, AMVAC 2010b |
| Dibrom Conc (RUP) [(c)] | 5481-480 | 87.4% Naled | AMVAC 2009a, AMVAC 2009b |

a) ULV = Ultra Low Volume
b) There are a number of other chlorpyrifos containing products registered for public health mosquito adulticide use (NSPIRS 2013)
c) RUP = Restricted Use Pesticide, because of corrosive nature for eyes and skin requires appropriate certification and licensing for purchase and use

| **Appendix I Table 5.3 Use Rates for Active Ingredients (lbs ai/A and lbs ai/A/year) for Public Health Adult Mosquito Products** | | | |
|---|---|---|---|
| **Active Ingredients** | **Rates** | | **Reference** |
| | **lbs ai/A** | **lbs ai/A/year** | |
| **Pyrethrins-Pyrethroids-PBO** | | | |
| Etofenprox | 0.007 | 0.18 | Wellmark2010a, EPA 2009a |
| Permethrin | 0.007 | 0.18 | Bayer 2011f, EPA 2009c |
| Phenothrin (Sumithrin) | 0.0036 | 1 | MGK 2012a, EPA 2007, EPA 2008 |
| PBO | 0.08 | 2 | EPA 2004b |
| Prallethrin | 0.0008 | 0.02 | Clarke Mosquito 2013b |
| Pyrethrins | 0.008 | 0.2 | MGK 2013a, EPA 2006b |
| Resmethrin | 0.007 | 0.2 | Bayer 2012a |

| **Appendix I Table 5.3 Use Rates for Active Ingredients (lbs ai/A and lbs ai/A/year) for Public Health Adult Mosquito Products** | | | |
|---|---|---|---|
| **Active Ingredients** | **Rates** | | **Reference** |
| | **lbs ai/A** | **lbs ai/A/year** | |
| **Organophosphates** | | | |
| Chlorpyrifos | 0.01 | 0.26 | Control Solutions 2009a, Control Solutions 2009b |
| Malathion (air) | 0.23 | Not Stated | Cheminova 2011a, EPA 2004a |
| Malathion (ground) | 0.11 | | |
| Naled (air and ground) | 0.1 | 10.73 | AMVAC 20012a, AMVAC 2012b |

# APPENDIX II

## HUMAN HEALTH RISK ASSESSMENT; STUDIES AND METHODOLOGY

1.0 EPA GUIDELINE REQUIREMENTS
2.0 MAMMALIAN TOXICOLOGY
2.1 EPA TOXICITY CATEGORIES; MAMMALIAN STUDIES
2.2 LABEL LANGUAGE
3.0 GOOD LABORATORY PRACTICES, ALL GUIDELINE STUDIES
4.0 EXPOSURE MODELING; MAMMALIAN RISK ASSESSMENTS
5.0 RISK ASSESSMENT; HUMAN HEALTH
5.1 NON-CANCER RISK ASSESSMENT
5.2 CANCER RISK ASSESSMENT

## 1.0 GUIDELINE STUDIES

EPA's Office of Chemical Safety and Pollution Prevention (OCSPP), has established toxicity study guidelines for toxicity testing requirements under multiple EPA programs.

> "The OCSPP harmonized test guidelines are documents that specify methods that EPA recommends be used to generate data that is submitted to EPA to support the registration of a pesticide under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) (7 U.S.C. 136), setting of a tolerance or tolerance exemption for pesticide residues under section 408 the Federal Food, Drug and Cosmetic Act (FFDCA) (21 U.S.C. 346a), or the decision making process for an industrial chemical under the Toxic Substances Control Act (TSCA) (15 U.S.C. 2601). (EPA 2013c)"

"The Office of Chemical Safety and Pollution Prevention (OCSPP) has developed a series of harmonized test guidelines for use in the testing of pesticides and toxic substances, and the development of test data for submission to the Agency. The OCSPP Harmonized Test Guidelines are organized in the following series:

810 - Product Performance Test Guidelines
830 - Product Properties Test Guidelines
835 - Fate, Transport and Transformation Test Guidelines
840 - Spray Drift Test Guidelines
850 - Ecological Effects Test Guidelines
860 - Residue Chemistry Test Guidelines
870 - Health Effects Test Guidelines
875 - Occupational and Residential Exposure Test Guidelines
880 - Biochemicals Test Guidelines
885 - Microbial Pesticide Test Guidelines
890 - Endocrine Disruptor Screening Program Test Guidelines"

To determine the toxicity profile, hazard assessment, and dose response curves for a particular pesticide, EPA's Office of Pesticides Programs (OPP) requires as series of guideline studies for toxicity testing. Acute toxicity studies are done with both the technical grade active ingredient and the end use product. Sub-chronic and chronic testing is done with the technical grade active ingredient. The harmonized finalized studies reviewed for the mosquito adulticides are found in Appendix II Table 1.1. Those studies which are still in draft form are listed in Appendix II Table 1.3.

| **Appendix II Table 1.1 OCSPP Harmonized Test Guidelines Series 870 - Health Effects Test Guidelines for Mammals[a]** |
|---|
| **Group A – Acute Toxicity Test [b]**<br>Oral (December 2002)<br>Dermal (August 1998)<br>Inhalation (August 1998)<br>Eye Irritation (August 1998)<br>Dermal Irritation (August 1998)<br>Sensitization (March 2003) (EPA 2003a) |
| **Group B – Sub-chronic Toxicity Test Guidelines [c]**<br>Dose 28-Day Oral Toxicity Study in Rodents [b] (July 2000)<br>90-Day Oral Toxicity in Rodents [b] (August 1998) and Non-rodents [d] (August 1998) (EPA 1998c)<br>Combined Repeated Dose Toxicity Study with the Reproduction/Developmental Toxicity Screening Test (July 2000) (EPA 2000b)<br>Prenatal Developmental Toxicity Study (August 1998) (EPA 1998d)<br>Reproduction and Fertility Effects (August 1998)<br>Dermal 21/28-Day (August 1998)<br>Dermal 90-Day (August 1998)<br>Inhalation 90-Day Inhalation Toxicity (August 1998) |
| **Group C – Chronic Toxicity Test Guidelines [e]**<br>Chronic Toxicity (August 1998) [b]<br>Carcinogenicity (August 1998) [f] (EPA 1998e)<br>Combined Chronic Toxicity/Carcinogenicity (August 1998) [b] |
| **Group E – Neurotoxicity Test Guidelines**<br>Acute and 28-Day Delayed Neurotoxicity of Organophosphorus Substances (August 1998) [g]<br>Neurotoxicity Screening Battery (August 1998)<br>Developmental Neurotoxicity Study (August 1998)<br>Schedule-Controlled Operant Behavior (August 1998)<br>Peripheral Nerve Function (August 1998)<br>Neurophysiology Sensory Evoked Potentials (August 1998) |

a) Last updated June 2013 (EPA 2013c) at: http://www.epa.gov/oppts/pubs/frs/home/guidelin.htm

b) Rats are the preferred species of rodent

c) Oral Studies include dosing by gavage (stomach tube), capsule, water and diet

d) Dogs are the preferred species of non-rodent

e) Chronic studies are dietary

f) Carcinogenicity studies are done in rats and mice

g) Acute and 28-Day Delayed Neurotoxicity of Organophosphorus Substances are performed in hens.

In addition to the mammalian toxicity test described in Appendix II Table 2.1 EPA also requires a battery of mutagenicity tests (Group D), and special studies for products used on companion animals (Group F).

| **Appendix II Table 1.2 OCSPP Draft Test Guidelines Series 870 - Health Effects Test Guidelines for Mammals[(a)]** |
|---|
| 870.3500 - Preliminary Developmental Toxicity Screen<br>870.3600 - Inhalation Developmental Toxicity Study<br>870.8223 - Pharmacokinetic Test<br>870.8320 - Oral/Dermal Pharmacokinetics<br>870.8340 - Oral and Inhalation Pharmacokinetic Test<br>870.8500 - Toxicokinetic Test<br>870.8600 - Developmental Neurotoxicity Screen<br>870.8700 - Subchronic Oral Toxicity Test<br><br>These documents are available at:<br>http://www.epa.gov/ocspp/pubs/frs/home/draftguidelines.htm (EPA 2013h). |

## 2.0 Mammalian Toxicity and Required Label Language

## 2.1 EPA Toxicity Categories

### 40CFR§156.62 Toxicity Category

This section establishes four Toxicity Categories for acute hazards of pesticide products, Category I being the highest toxicity category. Most human hazard, precautionary statements, and human personal protective equipment statements are based upon the Toxicity Category of the pesticide product as sold or distributed. In addition, toxicity categories may be used for regulatory purposes other than labeling, such as classification for restricted use and requirements for child-resistant packaging. In certain cases, statements based upon the Toxicity Category of the product as diluted for use are also permitted. A Toxicity Category is assigned for each of five types of acute exposure, as specified in the Appendix II Table 2.1.

| **Appendix II Table 2.1 Acute Toxicity Categories for Pesticide Products** | | | | |
|---|---|---|---|---|
| **Hazard Indicators** | **Category I** | **Category II** | **Category III** | **Category IV** |
| Oral $LD_{50}$ | Up to and including 50 mg/kg | >50 thru 500 mg/kg | >500 thru 5,000 mg/kg | >5,000 mg/kg |

| APPENDIX II TABLE 2.1 ACUTE TOXICITY CATEGORIES FOR PESTICIDE PRODUCTS | | | | |
|---|---|---|---|---|
| **Hazard Indicators** | **Category I** | **Category II** | **Category III** | **Category IV** |
| Dermal $LD_{50}$ | Up to and including 200 mg/kg | >200 thru 2000 mg/kg | >2000 thru 20,000 mg/kg | >20,000 mg/kg |
| Inhalation $LC_{50}$ | Up to and including 0.2 mg/liter | >0.2 thru 2 mg/liter | >2 thru 20 mg/liter | >20 mg/liter |
| Eye irritation | Corrosive; corneal opacity not reversible within 7 days | Corneal opacity reversible within 7 days; irritation persisting for 7 days | No corneal opacity; irritation reversible within 7 days | No irritation |
| Skin irritation | Corrosive | Severe irritation at 72 hours | Moderate irritation at 72 hours | Mild or slight irritation at 72 hours |

## 2.2 LABEL LANGUAGE

### 2.2.1 *40CFR§156.64*

"(a) Requirement. Except as provided in paragraph (a)(4), each pesticide product must bear on the front panel a signal word, reflecting the highest Toxicity Category (Category I is the highest toxicity category) to which the product is assigned by any of the five routes of exposure in Sec. 156.62. The signal word must also appear together with the heading for the human precautionary statement section of the labeling (see Sec. 156.70).

(1) **Toxicity Category I.** Any pesticide product meeting the criteria of Toxicity Category I for any route of exposure must bear on the front panel the signal word "DANGER." In addition, if the product is assigned to Toxicity Category I on the basis of its oral, inhalation or dermal toxicity (as distinct from skin and eye irritation), the word "Poison" must appear in red on a background of distinctly contrasting color, and the skull and crossbones symbol must appear in immediate proximity to the word "Poison."'

(2) **Toxicity Category II**. Any pesticide product meeting the criteria of Toxicity Category II as the highest category by any route of exposure must bear on the front panel the signal word "WARNING."

(3) **Toxicity Category III.** Any pesticide product meeting the criteria of Toxicity Category III as the highest category by any route of exposure must bear on the front panel the signal word "CAUTION."

(4) **Toxicity Category IV**. A pesticide product meeting the criteria of Toxicity Category IV by all routes of exposure is not required to bear a signal word. If a signal

word is used, it must be “CAUTION.”

### *2.2.2 §156.70 PRECAUTIONARY STATEMENTS FOR HUMAN HAZARDS.*

(a) *Requirement.* Human hazard and precautionary statements as required must appear together on the label or labeling under the general heading “Precautionary Statements” and under appropriate subheadings similar to “Humans and Domestic Animals,” “Environmental Hazards” (see subpart E of this part) and “Physical or Chemical Hazards.” The phrase “and Domestic Animals” may be omitted from the heading if domestic animals will not be exposed to the product.

(b) *Content of statements.* When data or other information show that an acute hazard may exist to humans or domestic animals, the label must bear precautionary statements describing the particular hazard, the route(s) of exposure and the precautions to be taken to avoid accident, injury or toxic effect or to mitigate the effect. The precautionary paragraph must be immediately preceded by the appropriate signal word.

(c) *Typical precautionary statements.* The table below presents typical hazard and precautionary statements. Specific statements pertaining to the hazards of the product and its uses must be approved by the Agency. With Agency approval, statements may be augmented to reflect the hazards and precautions associated with the product as diluted for use. Refer to § 156.68(b) for requirements for use dilution statements Appendix II Table 2.4).

| APPENDIX II TABLE 2.4 TYPICAL HUMAN HAZARD AND PRECAUTIONARY STATEMENTS | |
|---|---|
| **Systemic Effects (Oral, Dermal, Inhalation Acute Toxicity)** | **Irritation Effects (Skin and Eye)** |
| **Toxicity Category I** | |
| Fatal (poisonous) if swallowed [inhaled or absorbed through skin]. Do not breathe vapor [dust or spray mist]. Do not get in eyes, on skin, or on clothing. | Corrosive, causes eye and skin damage [or skin irritation]. Do not get in eyes on skin, or on clothing. Wear goggles or face shield and rubber gloves when handling. Harmful or fatal if swallowed. [Front panel first aid statement required.] |
| **Toxicity Category II** | |
| May be fatal if swallowed, [inhaled or absorbed through the skin]. Do not breathe vapors [dust or spray mist]. Do not get in eyes, on skin, or on clothing. [Appropriate first aid statement required.] | Causes eye [and skin] irritation. Do not get in eyes, on skin, or on clothing. Harmful if swallowed. [Appropriate first aid statement required.] |
| **Toxicity Category III** | |
| Harmful if swallowed [inhaled or absorbed through the skin]. Avoid breathing vapors [dust or spray mist]. Avoid contact with skin [eyes or clothing]. [Appropriate first aid statement required.] | Avoid contact with skin, eyes or clothing. |
| **Toxicity Category IV** | |
| No precautionary statements required | |
| **Sensitization** | |
| Prolonged or frequently repeated skin contact may cause allergic reactions in some individuals | |

## 3.0 Good Laboratory Practices, All Guideline Studies

Studies submitted under FIFRA in support of pesticide registration are routinely evaluated with respect to EPA's Good Laboratory Practices (GLP) and subjected to EPA audits. The GLP requirements:

> "Prescribe good laboratory practices for conducting studies that support or are intended to support applications for research or marketing permits for pesticide products regulated by the EPA. This part is intended to assure the quality and integrity of data submitted pursuant to sections 3, 4, 5, 8, 18 and 24(c) of the Federal Insecticide, Fungicide, and Rodenticide Act, as amended, and section 408 or 409 of the Federal Food, Drug and Cosmetic Act.(b) This part applies to any study described by paragraph (a) of this section which any person conducts, initiates, or supports on or after October 16, 1989. [73 FR 75597, Dec. 12, 2008] (40CFR 160)"

If EPA evaluates the data submitted are not in compliance with the GLPs, a data-call-in may be issued and the study repeated. One issue with studies found in the public scientific literature is a lack of compliance with the GLPs.

## 4.0 Exposure Modeling; Mammalian Risk Assessments

Exposure, in mg/kg body weight is calculated based on the use rates, degradation rates, dislodgable residues from foliage, skin, surface areas, dermal absorption factors, hand to mouth activity, inhalation rates and other human activities from EPA's Standard Operating Procedures for Residential Pesticide Exposure Assessment (EPA 2012c), human biometrics and behavior patterns from the Exposure Factors Handbook (EPA 2011d) and a variety of environmental models: drift form aerial applications (AgDRIFT), surface water (GENEEC, FIRST, PRZM-EXAMS) or ground water (SCI-GROW) (EPA 2013a, EPA 2012d).

EPA takes a tiered approach to risk assessment with original conservative assumptions. If the pesticide risks are above the LOC, EPA then replaces the conservative assumptions with data based assumptions. One example of this is an assumption that 100% of the crop is treated, when in reality only 50% of the crop is treated. Using their standard operating procedures for dietary and non-dietary exposure EPA has evaluated the active ingredients used in mosquito adulticides for toxicological risks to toddlers, adults and subpopulations based on age and activities. In brief, the dietary risks are evaluated using the reference dose (RfD) method and the non-dietary risks using the margin of exposure (MOE) approach. EPA's metric for the acceptable risk level, LOCs are the same for both approaches.

| **Appendix II Table 4.1 Models used in Human Health risk assessments of ULV public adulticide products from http://www.epa.gov/pesticides/science/models_pg.htm (EPA 2013a).** |
|---|
| **AQUATIC MODELS** [a] |
| **GENEEC (GENeric Estimated Environmental Concentration)**<br>GENEEC is a surface water model that is used to assess exposure of pesticides to aquatic organisms and the environment. |
| **PRZM (Pesticide Root Zone Model)**<br>PRZM is a surface water model that simulates chemical movement in soil within and immediately below the plant root zone. PRZM is often linked with EXAMS to develop refined exposure assessments of pesticide concentrations in aquatic environments. |
| **EXAMS (Exposure Analysis Modeling System)**<br>EXAMS is a surface water model that evaluates the fate, transport, and exposure concentration of pesticides. EXAMS is frequently linked with PRZM to develop refined exposure assessments of pesticide concentrations in aquatic environments. |
| **DIETARY CONSUMPTION** |
| **DEEM (Dietary Exposure Evaluation Model)**<br>DEEM provides dietary probabilistic assessments of dietary pesticide exposure. DEEM-FCID Evaluation Software Installer |
| **RESIDENTIAL EXPOSURE** |
| **Residential SOPs** [b]<br>The *Standard Operating Procedures for Residential Pesticide Exposure Assessment* (Residential SOPs) are instructions for estimating exposure resulting from the most common residential pesticide uses including lawn and garden care, foggers, and pet treatments |
| **ATMOSPHERIC DEPOSITION** |
| **AgDRIFT®** EXIT Disclaimer AgDRIFT® is an atmospheric model that predicts spray deposition patterns from aerial pesticide applications [c] |
| **AgDISP** EXIT Disclaimer AgDISP is used by OPP to predict the motion of spray material released from aircraft [d] |

a) OPP uses aquatic models to estimate pesticide concentrations in food, water, non-target organisms, residential and occupational environments. These estimated concentrations are used to assess exposure to aquatic organisms, humans, and the environment
b) Residential Standard Operating Procedures are used to estimates bystander exposure
c) AgDrift is used for agricultural applications
d) AGDISP is used for Mosquito adulticide ULV applications

## 5.0 Risk Assessment; Human Health

Risk assessment is the process by which the dose or concentration of a pesticide exposure may cause an adverse toxicological effect on populations exposed in the environment. Humans may be exposed to pesticide residues in the diet (including drinking water) or during occupational or residential activities. The setting and human behaviors are related to the type of application and human activities. The type of application is determined by the formulation of the product and the equipment used and the human metrics (body weight for age group, dermal surface area, inhalation rate etc.) and activities (how many times does a toddler put their hands in their mouths, how much grass or soil is consumed are obtained from the EPA's Exposure Factor Handbook (EPA 2011d). The other variables; fat or water solubility, half-lives in various media, stability and bio-concentration etc. are chemical specific and are found in the EPISUITE database (EPA SRU 2013). Exposure scenarios are defined by the treatment, (product, application rate, site (where is the product used) and pathways following the use resulting in human exposure (consumption; diet or incidental oral exposure, dermal or inhalation).

EPA Office of Pesticide Programs (OPP) evaluates non-cancer risks using the RfD for acute and chronic (dietary including water exposures) (EPA 2005a) for a variety of human sub-populations. These sub-populations are based on body mass and differences dietary behaviors including the amount and types of foods consume (NRC 1993, EPA 2011d). The sub-populations are:

- Infants < 1 year
- 1 to 2 years
- 3 to 5 years
- 6 to 12 years
- 13 to 19 years
- 20 to 49 years
- General population (EPA 2006A)

Given their body mass, food intake habits, high metabolic rate and immature biological systems, children from 1 to 2 years of age are usually the highest exposed and most vulnerable sub-populations (NRC 1993, EPA 2011d).The Food Quality Protection Act (FQPA) of 1996 changed the way EPA conducts their human health risk assessments. The Federal Food Drug and Cosmetic Act (FFDCA) (21 USC Chapter 9, 2102) was amended

following recommendations of the National Research Council (NRC) regarding the potential sensitivities of children to pesticide residues in the diet (NRC 1993).

### 5.1 Non-cancer Risks

The non-cancer human health risks are evaluated by comparing the most sensitive toxicological endpoint. This endpoint is identified by the dose, no observable adverse effect level (NOAEL) below the lowest dose where an adverse effect is observed (LOAEL). The NOAEL is either directly compared to the exposure dose or adjusted by uncertainty factors. In the first case, the margin of exposure (MOE) is derived and the uncertainty factors are utilized as the level of concern. In the second case, the NOAEL is divided by the uncertainty factors and a reference dose is determined (RfD).

The margin of exposure (MOE) method of risk assessment is used for acute (single exposure), short term (1 to 7 days) or intermediate term (1 to 6 months) (EPA 2012c) exposures. The MOE method of estimating risks is used for occupational and residential exposures, including bystander exposure to wide area public mosquito adulticides. The sub-populations evaluated for bystander risks to ULV mosquito control are toddlers, 15 kg (30 lbs) and adults, 70 kg (150 lbs). Similar to the dietary risks the behavior patterns and body mass makes toddlers a high risk sub-population.

### 5.2 Cancer Risks

The other type of toxicological endpoint observed in animal studies is cancer or tumor production from chronic carcinogenicity epidemiology studies or bioassays in rodents. EPA uses a weight of evidence approach for ranking chemicals, including pesticides for their carcinogenic potential (EPA 2012a). EPA uses the linear multi-stage model to determine the slope factor for likely human carcinogens, $Q1^*$. The cancer slope factor is then used along with the estimated exposure to determine the risks of increased cancer in the populations as a result of the exposure (EPA 2005a).

There are a multitude of scenarios where use of a pesticide results in exposure to a population. Each scenario is evaluated for exposure to humans (human health risks) and non-target species in the environment (ecological risks). EPA uses a variety of models to estimate exposure to various populations. Once the exposure has been characterized, the toxicity endpoint is then used to determine the environmental risks. This environmental risk is then compared to EPA's acceptable risk level, level of concern and if the environmental risks are within the level of concern, no regulatory action is needed. If the environmental risks are outside the levels of concern, then regulatory action in the form of label modifications or registration status are taken through EPA's re-registration program.

Two of the human subpopulations routinely evaluated for residential risks are toddlers,15 kg (33 lbs) following exposure via incidental oral route: playing on grass following an application including hand to mouth, object to mouth and consumption of grass, dermal and inhalation and adults (70 kg (150 lbs) via dermal and inhalation routes.

# APPENDIX III

## ECOLOGICAL STUDIES AND METHODS

1.0 EPA GUIDELINE STUDIES

2.0 ECOLOGICAL TOXICITY TESTING REQUIREMENTS

- 2.1 TERRESTRIAL SPECIES
- 2.2 AQUATIC SPECIES

3.0 GOOD LABORATORY PRACTICES

4.0 ENVIRONMENTAL FATE MODELS

5.0 RISK ASSESSMENTS METHODOLOGY

- 5.1 OVERVIEW OF AQUATIC RISK ASSESSMENT METHODOLOGY
- 5.2 METHODOLOGY; ACUTE TO CHRONIC RATIO

## 1.0 Guideline Studies, Wild Mammals and Ecological Databases

The ecological effects guidelines have been finalized and harmonized for:

Group B – Terrestrial Wildlife; Avian and Wild Mammals 850.2000 to 850.2500
Group C – Terrestrial Beneficial Insects, Invertebrates etc. 850.3000 to 850.3300

The ecological guideline studies which are still in draft form are:

850.1000 - Special Considerations for Conducting Aquatic Laboratory Studies (PDF) (13 pp, 45K)
850.1010 - Aquatic Invetebrate Acute Toxicity, Test, Freshwater Daphnids (PDF) (10 pp, 36K)
850.1020 - Gammarid Acute Toxicity Test (PDF) (11 pp, 36K)
850.1025 - Oyster Acute Toxicity Test (Shell Deposition) (PDF)(9 pp, 32K)
850.1035 - Mysid Acute Toxicity Test (PDF) (10 pp, 34K)
850.1045 - Penaeid Acute Toxicity Test (PDF) (9 pp, 32K)
850.1055 - Bivalve Acute Toxicity Test (Embryo Larval) (PDF)(7 pp, 27K)
850.1075 - Fish Acute Toxicity Test, Freshwater And Marine (PDF) (13 pp, 45K)
850.1085 - Fish Acute Toxicity Mitigated By Humic Acid (PDF) (10 pp, 35K)
850.1300 - Daphnid Chronic Toxicity Test (PDF) (12 pp, 42K)
850.1350 - Mysid Chronic Toxicity Test (PDF) (10 pp, 36K)
850.1400 - Fish Early-Life Stage Toxicity Test (PDF) (15 pp, 66K)
850.1500 - Fish Life Cycle Toxicity (PDF) (4 pp, 16K)
850.1710 - Oyster BCF (PDF) (14 pp, 50K)
850.1730 - Fish BCF (PDF) (25 pp, 74K)
850.1735 - Whole Sediment Acute Toxicity Invertebrates, Freshwater (PDF) (19 pp, 65K)
850.1740 - Whole Sediment Acute Toxicity Invertebrates, Marine (PDF) (14 pp, 50K)
850.1790 - Chironomid Sediment Toxicity Test (PDF) (16 pp, 57K)
850.1800 - Tadpole/Sediment Subchronic Toxicity Test (PDF) (15 pp, 49K)
850.1850 - Aquatic Food Chain Transfer (PDF) (4 pp, 16K)
850.1900 - Generic Freshwater Microcosm Test, Laboratory (PDF) (28 pp, 76K)
850.1925 - Site-Specific Aquatic Microcosm Test, Laboratory (PDF) (21 pp, 91K)
850.1950 - Field Testing For Aquatic Organisms (PDF) (7 pp, 21K)

These draft guidelines are available at:
http://www.epa.gov/ocspp/pubs/frs/home/draftguidelines.htm (EPA 2013h)

## 2.0 Ecological Toxicity Testing Requirements

## 2.1 Terrestrial Species Toxicity Endpoints and Toxicity Categories

The detailed ecological toxicity tests required by EPA are also listed in EPA's Office of Chemical Safety and Pollution Prevention (OCSPP) toxicity study guidelines (Appendix II Section 1.0) subject to GLPs (Appendix II Section 2.0). The groups relevant to the ecological

risks from the public health ULV mosquito adulticides are presented in Appendix III Table 4.1.

| **Appendix III Table 2.1 Ecological Groups, Surrogate Species and Selected [a] Guidelines for Environmental Risk Assessments** | | | |
|---|---|---|---|
| **Exposure** | **Guideline Requirement** | **Common Representatives** | **EPA Guidelines** |
| **Avian Species** | | | |
| Acute Oral | Passerine species | Not identified | Final 850.2100 (EPA 2012m) |
| | Upland game bird | Bobwhite quail | |
| | Water fowl | Mallard duck | |
| Sub-acute Diet | Upland game bird | Bobwhite quail | Final 850.2200 (EPA 2012j) |
| | Water fowl | Mallard duck | |
| Reproduction Diet | Upland game bird | Bobwhite quail | Final 850.2300 (EPA 2102k) |
| | Water fowl | Mallard duck | |
| **Wildlife Mammals** | | | |
| Acute oral | Mammal [b] | Rat | Final 850.2400 (EPA 2012n) |
| Chronic Diet | | | |
| **Non-target Terrestrial Invertebrates** | | | |
| Honey bee acute contact | Honeybee | Honeybee | Final 850.3020 (EPA 2012s) |

a) EPA's Final guidelines website is: http://www.epa.gov/oppts/pdfs/OCSPP-TestGuidelines_MasterList.pdf (EPA 2013c)
EPA's Draft guidelines website is: http://www.epa.gov/ocspp/pubs/frs/home/draftguidelines.htm (EPA 2013h)
b) Data used for estimating risks to wildlife mammals are generally taken from the mammalian toxicity database
c) EPA's final guidelines Series 850 Group A is reserved for aquatic and sediment dwelling fauna, aquatic microcosm and field testing guidelines (EPA 2013c)

The toxicity endpoints in ecological studies may be presented in terms of mg ai/kg body weight or ppm (mg ai/kg feed or water) or ppb (ug ai/kg feed or water). The former, mg/kg body weights are referred to a dose based endpoints. Toxicity endpoints expressed as either mg or ug per unit feed or water are referred to as concentration based endpoints.

When calculating a risk quotient, it is critical to assure that the same units are used for both the toxicity study and the estimated environmental exposure. The toxicity endpoints for terrestrial species are presented below in Appendix III Table 3.2 and the criteria for EPA's toxicity categories are found in Appendix III Table 3.3.

**Appendix III Table 2.2 EPA's Toxicity Endpoints for Terrestrial Species (EPA 2013c, EPA 2011c)**

| Group | Species | Toxicity Endpoint |
|---|---|---|
| **Acute Toxicity Endpoints** | | |
| Birds | Mallard duck, | $LD_{50}$ mg/kg body weight; 8-day $LC_{50}$ ppm in feed [(a)] |
| | Bobwhite quail | |
| Mammals | Rodent [(b)] | $LD_{50}$ mg/kg body weight |
| Non-Target Insect | Honeybees | $LD_{50}$ ug/bee |
| **Chronic Toxicity Endpoints** | | |
| Birds | Mallard duck, | NOAEC (ppm [mg/kg feed in the diet]) [(a, b)] |
| | Bobwhite quail | |
| Mammals | Rodent data [(c)] | NOAEL (mg/kg/day) or NOAEC (ppm [mg/kg feed in the diet]), [(d)] |
| Non-target insects | Honeybees | Extended residue studies |

a) Birds are used as surrogates for reptiles and the terrestrial phase of amphibians (EPA 2008g)
b) Reproductive endpoints,
c) Wild mammal toxicity data is from the mammalian toxicology database
d) The sub-chronic and chronic oral toxicity studies usually use the dietary route of exposure. For mammalian risk assessments the dietary concentrations are expressed as dose (mg/kg/day) and for ecological risk assessment the dietary concentrations (ppm diet) are used

**Appendix III Table 2.3 EPA Acute Environmental Toxicity Categories for Terrestrial Organisms (EPA 2012h)**

| Value | Category |
|---|---|
| **Acute Oral $LD_{50}$ [(a)] Mammals and Birds** | |
| Less than 10 mg ai/kg body weight | Very Highly Toxic |
| 10 to 50 mg ai/kg body weight | Highly Toxic |
| 51 to 500 mg ai/kg body weight | Moderately Toxic |
| 501 to 2000 mg ai/kg body weight | Slightly Toxic |

| **Appendix III Table 2.3 EPA Acute Environmental Toxicity Categories for Terrestrial Organisms (EPA 2012h)** | |
|---|---|
| Greater than 2000 mg ai/kg body weight | Practically Non-toxic |
| **Dietary Sub-Acute $LC_{50}$ [(b)] Birds** | |
| Less than 50 ppm (mg ai /kg diet) | Very Highly Toxic |
| 50 to 500 ppm (mg ai/kg diet) | Highly Toxic |
| 501 to1000 ppm (mg ai/kg diet) | Moderately Toxic |
| 1001 to 5000 ppm (mg ai/kg diet) | Slightly Toxic |
| Greater than 5,000 ppm (mg ai/kg diet) | Practically Non-toxic |
| **$LD_{50}$ [(a)] Acute Toxicity Bees** | |
| Less than 2 ug ai/bee | Highly Toxic |
| 2 to 10.99 ug ai/bee | Moderately Toxic |
| Greater than or equal to 11 ug ai/bee | Practically Non-toxic |

a) LD50 = median lethal dose in mg/kg body weight
b) $LC_{50}$ = median lethal concentration in ppm (mg ai/kg diet)

## 2.2 AQUATIC TOXICITY STUDY REQUIREMENTS, ENDPOINTS AND TOXICITY CATEGORIES

### 2.2.1 EPA TOXICITY GUIDELINE AQUATIC STUDIES AND ASSOCIATED TOXICITY ENDPOINTS

The guideline toxicity studies required for registration of the ULV mosquito adulticides and their associated toxicity endpoints are presented in Appendix III Table 3.4. EPA's Office of Chemical Safety and Pollution Prevention (OCSPP) toxicity study guidelines (Appendix III Section 1.0) subject to GLPs (Appendix III Section 3.0).

| **Appendix III Table 2.4 Aquatic Species Draft Guideline Studies and Toxicity Endpoints** | | | |
|---|---|---|---|
| **Toxicity Endpoint [(a)]** | **Habitat** | **Typical Species** | **Reference** |
| **Fish [(b)]** | | | |
| Acute $LC_{50}$ [(c)] | Freshwater | Rainbow trout | EPA 1996b, EPA 2013h |
| | Marine | Atlantic silverside | |
| Early life-stage NOAEC [(d)] | Freshwater | Fat headed minnow, | EPA 1996g, EPA 2013h |
| | Marine | Sheepshead minnow | |

| **Appendix III Table 2.4 Aquatic Species Draft Guideline Studies and Toxicity Endpoints** | | | |
|---|---|---|---|
| **Toxicity Endpoint [(a)]** | **Habitat** | **Typical Species** | **Reference** |
| Life cycle, NOAEC | Freshwater | Fat headed minnow | EPA 1996h, EPA 2013h |
| | Marine | Sheepshead minnow | |
| **Invertebrates** | | | |
| Acute $LC_{50}$ | Freshwater | Daphnia | EPA 1996c, EPA 2013h |
| | Marine | Mysid Shrimp | |
| Chronic toxicity NOAEC | Freshwater | Daphnia | EPA 1996e, EPA 2013h |
| | Marine | Mysid Shrimp | EPA 1996f, EPA 2013h |
| Acute $LC_{50}$ | Freshwater Sediment [(e)] | Amphipods | EPA 1996i, EPA 2013h |
| | Marine Sediment [(e)] | Amphipods | EPA 1996j, EPA 2013h |
| Sub-chronic NOAEC | Freshwater Sediment [(e)] | Chironomid | EPA 1996k, EPA 2013h |

a) Units for the mosquito adulticides are ppb (ug ai/L water)
b) Fish are used as surrogates for the aquatic phase of amphibians (EPA 2008g)
c) LC50= Median Lethal Concentration in ppb (ug ai/L water)
d) NOAEC = No Observable Adverse Effect Concentration in ppb (ug ai/L water)
e) Recent requirement for a number of the pyrethrins-pyrethroids and PBO

### 2.2.2 EPA Toxicity Categories; Ecological Studies

EPA has established toxicity categories for aquatic toxic responses in aquatic species (Appendix III Table 2.5)

| **Appendix III Table 2.5 EPA Acute $LC_{50}$ [(a)] Environmental Toxicity Categories for Aquatic Organisms (EPA 2012h)** | |
|---|---|
| **Numerical Value** | **Category** |
| Less than 0.1 ppb (mg/L water) | Very Highly Toxic |
| 0.11 to 1 ppb (mg/L water) | Highly Toxic |
| 1.1 to 10 ppb (mg/L water) | Moderately Toxic |

| **Appendix III Table 2.5 EPA Acute $LC_{50}$ [(a)] Environmental Toxicity Categories for Aquatic Organisms (EPA 2012h)** | |
|---|---|
| 10.1 to 100 ppb (mg/L water) | Slightly Toxic |
| Greater than 100 ppb (mg/L water) | Practically Non-toxic |

a) $LC_{50}$ = median lethal concentration in ppb (ug ai/L water)

## 3.0 GOOD LABORATORY PRACTICES, ALL GUIDELINE STUDIES

Studies submitted under FIFRA in support of pesticide registration are routinely evaluated with respect to EPA's Good Laboratory Practices (GLP) and subjected to EPA audits. The GLP requirements:

> "Prescribe good laboratory practices for conducting studies that support or are intended to support applications for research or marketing permits for pesticide products regulated by the EPA. This part is intended to assure the quality and integrity of data submitted pursuant to sections 3, 4, 5, 8, 18 and 24(c) of the Federal Insecticide, Fungicide, and Rodenticide Act, as amended, and section 408 or 409 of the Federal Food, Drug and Cosmetic Act.(b) This part applies to any study described by paragraph (a) of this section which any person conducts, initiates, or supports on or after October 16, 1989. [73 FR 75597, Dec. 12, 2008] (40CFR 160)"

If EPA evaluates the data submitted are not in compliance with the GLPs, a data-call-in may be issued and the study repeated. One issue with studies found in the public scientific literature is a lack of compliance with the GLPs.

## 4.0 ECOLOGICAL RISK ASSESSMENT MODELS

The models used by EPA to estimate environmental concentrations in ecological risk assessments are described in Appendix III Table .1.

| **Appendix III Table 4.1 Models used in environmental risk assessments of ULV public adulticide products from http://www.epa.gov/pesticides/science/models_pg.htm (EPA 2013a).** |
|---|
| **AQUATIC MODELS [(A)]** |
| **GENEEC (GENeric Estimated Environmental Concentration)**<br>GENEEC is a surface water model that is used to assess exposure of pesticides to aquatic organisms and the environment. |
| **PRZM (Pesticide Root Zone Model)**<br>PRZM is a surface water model that simulates chemical movement in soil within and immediately below the plant root zone. PRZM is often linked with EXAMS to develop refined exposure assessments of pesticide concentrations in aquatic environments. |

| **Appendix III Table 4.1 Models used in environmental risk assessments of ULV public adulticide products from http://www.epa.gov/pesticides/science/models_pg.htm (EPA 2013a).** |
|---|
| **EXAMS (Exposure Analysis Modeling System)** EXAMS is a surface water model that evaluates the fate, transport, and exposure concentration of pesticides. EXAMS is frequently linked with PRZM to develop refined exposure assessments of pesticide concentrations in aquatic environments. |
| **Tier I Rice Model** Tier I Rice Model is an aquatic model used to estimate surface water exposure from the use of pesticides in rice paddies. |
| **TERRESTRIAL MODELS (B)** |
| **T-REX (Terrestrial Residue Exposure)** T-REX is used by OPP to estimate pesticide concentration on avian and mammalian food items. |
| **T-HERPS** T-HERPS is a simulation model that estimates exposure to terrestrial reptiles and amphibians from pesticide use. |
| **ATMOSPHERIC MODELS (C)** |
| **AgDRIFT®** EXIT Disclaimer AgDRIFT® is an atmospheric model that predicts spray deposition patterns from aerial pesticide applications.(d) |
| **AgDISP** EXIT Disclaimer AgDISP is used by OPP to predict the motion of spray material released from aircraft. (e) |

a) OPP uses aquatic models to estimate pesticide concentrations in food, water, non-target organisms. These estimated concentrations are used to assess exposure to aquatic organisms, humans, and the environment
b) OPP uses terrestrial models to estimate pesticide concentrations on avian and mammalian food items and exposure and risk to terrestrial organisms from pesticide use.
c) OPP uses atmospheric models to predict the deposition patterns of pesticides released into the atmosphere.
d) AgDrift is used for agricultural applications
e) AGDISP is used for Mosquito adulticide ULV applications

## 5.0 RISK METHODOLOGY FOR AQUATIC RISK ASSESSMENTS

EPA uses the risk quotient methodology for estimating risks to aquatic organisms, like the avian and mammalian risks describe above the risk quotient is the ratio of the estimated environmental concentration (EEC) to the toxicity endpoint. The insecticides which may be employed in wide area public health adulticiding applications are with the exception of the synergist PBO very highly toxic to fish and invertebrates (Appendix VI Table 2a). With the exception of naled-DDVP, the units used in the aquatic risk assessments is parts per billion (ppb, ug ai/kg of water). Because of the rapid conversion of naled to DDVP, the results of the aquatic toxicity studies for the more toxic compound are expressed as umoles of

compound per Liter. The estimated environmental concentrations are expressed as total toxic residues, here again, converted to umoles/L (EPA 2008d, EPA 2008g).

EPA's data requirements for toxicity testing in aquatic species include fresh water fish, freshwater invertebrates, freshwater sediment dwelling invertebrates, marine fish, marine invertebrates and marine sediment dwelling invertebrates. The toxicity tests include acute, 96-hr $LC_{50}$s for fish and 48hr $EC_{50}$s for invertebrates and chronic early life stage or complete life cycle studies for fish and invertebrates. The metric for the chronic studies is the no observable adverse effect level (NOAEC) and the toxic endpoints may be lethality, reproduction or other endpoints.

> Estimated environmental concentration AgDRIFT (agricultural scenarios)
> AgDISP (mosquito ultra-low-volume)
> PRZM-EXAMS models (receiving body of water is the EPA's standard pond, 6 meter (6.5 ft) deep).
> RICE model assumes direct application to water 4 inches deep (Appendix III Section 4.0)

The various models have been validated for particular uses, AgDRIFT for agricultural uses and AgDISP for ULV mosquito adulticide uses. The particular model used to estimate the EEC will be identified (Appendix III Section 4.0).

### 5.1 Methodology Acute to Chronic Ratio and Chronic NOAEC in Aquatic Organisms

The following example for calculating an acute to chronic ratio (ACR) and deriving a No Observable Adverse Effect Concentrations (NOAEC) for a second species in the same group of aquatic organisms comes from Predicting the Toxicities of Chemicals to Aquatic Animal Species (EPA 2010c)

> "Acute and chronic data from guideline tests with daphnids are normally used as a surrogate for the freshwater invertebrate taxa; therefore, these data are typically available. In situations where the available toxicity data from registrant-submitted or open literature studies indicate that another tested species from the same taxonomic group, *e.g.*, the amphipod, *Gammarus* sp., is more sensitive than daphnids on an acute exposure basis, the acute value for that species (for the *Gammarus*) are used to predict acute risk to freshwater invertebrates. If chronic toxicity data are not available for the *Gammarus*, an ACR would be calculated based on the ratio of the acute to chronic toxicity data for daphnids and the ACR would be applied to the acute value for *Gammarus* to yield a corresponding chronic toxicity value.

In the following example, an ACR of 10 is derived for freshwater invertebrates based on the ratio of the acute and chronic toxicity data for daphnids (48-hr EC50 of 20 µg/L ÷ 21-day NOEC of 2 µg/L = 10); the ACR of 10 is then applied to the acute toxicity value for *Gammarus* (96-hr LC50 = 1 µg/L) to yield a predicted chronic NOEC of 0.1 µg/L (*Gammarus* LC50 of 1 µg/L ÷ ACR of 10 = 0.1 µg/L).

**Known Values**

Daphnid 48-hr EC50 = 20 µg/L
*Gammarus* 96-hr LC50 = 1 µg/L
Daphnid 21-day NOEC = 2 µg/L

**Calculated Values**

ACR = Daphnid EC50 (20 µg/L) ÷ Daphnid NOEC (2 µg/L) = 10
Predicted chronic NOEC for *Gammarus* = *Gammarus* EC50 (1 µg/L) ÷ ACR = 0.1 µg/L (EPA 2010c)"

The choice of using a laboratory derive value verses a calculated value is significant. The differences for permethrin, laboratory chronic NOAECs and the ACR calculated values are seen in Table 5.1 and are identified in the aquatic permethrin risks in Appendix VI Table 3b.

**Table 5.1 Permethrin Chronic NOAECs [(a)] and Resulting Risk Quotients using Laboratory and Derived the Acute to Chronic Ratio [(b)] (EPA 2011h)**

| | NOAEC[(a)] | | EEC [(c)] | Risk Quotients [(d)] | |
|---|---|---|---|---|---|
| Group | Laboratory | ACR | | Laboratory | ACR |
| Freshwater fish | 0.3 | 0.0515 | 0.03 | 0.1 | 0.58 |
| Freshwater invertebrates | 0.39 | 0.0014 | 0.031 | 0.79 | **22.14** |
| Marine fish | 10 | 0.1434 | 0.03 | 0.00 | 0.21 |
| Marine invertebrates | 0.011 | 0.0012 | 0.031 | **2.82** | **25.83** |

a) NOAEC = No Observable Adverse Effect Concentration in ppb (ug/L water)
b) ACR = Acute to Chronic Ratio calculated NOAEC (Appendix V page 1)
c) EEC = Estimated Environmental Concentration in ppb (ug/L water)
d) Risk quotients in bold exceed EPA's Level of Concern for chronic exposure, 1

The risk characterization for environmental stressors, including pesticides, involves identification of either median effect levels, for the lethality endpoint ($LC_{50}$) or the effectiveness endpoint ($EC_{50}$) or no observable adverse effect concentration (NOAEC). These endpoints reflect statistically determined 50% (median effect levels) levels or the dose or concentration where there are no differences between the treated animals and the controls. In the absence of chronic toxicity studies, EPA will estimate a chronic NOAEC based on the acute effects ($LC_{50}$) (EPA 1998a). If a chronic toxicity level has been calculated from the acute toxicity data, it will be so noted.

# Appendix IV

## Food and Feed Residue Issues with Mosquito Adulticides

1.0 US TOLERANCES FOR MOSQUITO ADULTICIDES

1.1 Portions of the Federal Food Drug and Cosmetic Act (FFDCA)
1.2 SUMMARIES OF THE EXISTING TOLERANCES IN THE US

2.0 MAXIMUM RESIDUE LEVELS FOR NON-US JURISDICTIONS

## 1.0 TOLERANCES IN THE UNITED STATES FOR THE ACTIVE INGREDIENTS FOUND IN THE WIDE AREA PUBLIC HEALTH ULV MOSQUITO ADULTICIDE PRODUCTS

### 1.1 Portions of the Federal Food Drug and Cosmetic Act (FFDCA) specify in § 346a:

> "Except as provided in paragraph (2) or (3), any pesticide chemical residue in or on a food shall be deemed unsafe for the purpose of section 342(a)(2)(B) of this title unless—
>
> > (A) a tolerance for such pesticide chemical residue in or on such food is in effect under this section and the quantity of the residue is within the limits of the tolerance; or
> >
> > (B) an exemption from the requirement of a tolerance is in effect under this section for the pesticide chemical residue.
>
> For the purposes of this section, the term ''food'', when used as a noun without modification, shall mean a raw agricultural commodity or processed food."

The standard of care as established by the Food Quality Protection Act (FQPA) of 1996 for tolerances is:

> "The term ''safe'', with respect to an exemption for a pesticide chemical residue, means that the Administrator has determined that there is a reasonable certainty that no harm will result from aggregate exposure to the pesticide chemical residue, including all anticipated dietary exposures and all other exposures for which there is reliable information"

### 1.2 SUMMARIES OF THE EXISTING TOLERANCES IN THE US

The status of tolerances for residues of the public health wide area ULV mosquito adulticides in food and feed are summarized in Appendix IV Section 1.2 Tables 1.1: pyrethrins-pyrethroids-PBO and 1.2: organophosphates.

**Appendix IV Table 1.1 Summary of Tolerances for Pyrethroid-Pyrethrins and PBO Active Ingredients Found in Products Labeled for Public Health Mosquito Control**

| Compound | Citation | Number of Tolerances | Low (ppm) | High ppm |
|---|---|---|---|---|
| **Etofenprox** | 40CRF180.620 | Rice only | 0.1 | 0.1 |
| **PBO**[(b)] | 40CRF180.905 | Exempt in raw agricultural commodities | | |
| | 40CRF180.127[(a)] | 64 + | 0.1 | 20 |

| **Appendix IV Table 1.1 Summary of Tolerances for Pyrethroid-Pyrethrins and PBO Active Ingredients Found in Products Labeled for Public Health Mosquito Control** | | | | |
|---|---|---|---|---|
| **Compound** | **Citation** | **Number of Tolerances** | **Low (ppm)** | **High ppm** |
| **Pyrethrins** | 40CRF180.905 | Exempt in raw agricultural commodities | | |
| | 40CRF180.128[(a)] | 62 + | 3 | 0.05 |
| **Permethrin** | 40CRF180.378 | 69 + | 0.05 | 45 |
| **Phenothrin** | 40CRF180.647 | All raw agricultural commodities, mosquito adulticide use, 0.01 ppm | | |
| **Prallethrin** | 40CFR180.545 | Food handling and storage only | | |
| **Resmethrin** | 40CRF180.525 | Food handling and storage only | | |

a) Post-harvest meat and meat byproducts

b) PBO is a pesticide synergist found in all pyrethroid-pyrethrin products with the exception of the two etofenprox products

| **Appendix IV Table 1.2 Summary of Tolerances for Organophosphate Active Ingredients Found in Products Labeled for Public Health Mosquito Control** | | | | |
|---|---|---|---|---|
| **Compound** | **Citation** | **Number of Tolerances** | **Low (ppm)** | **High ppm** |
| **Chlorpyrifos** | 40CFR180.342 | 80 + [(a)] | 0.01 | 15 |
| | | Accounts for indoor uses in food handling and storage areas | | |
| **Malathion** | 40CRF180.111 | 149 + | 0.1 | 135 |
| **Naled** | 40CRF180.215 | 38 + | 0.5 | 10 |
| | | All raw agricultural commodities, mosquito adulticide use, 0.05 ppm | | |

a) (+) indicates that the number of includes tolerance groups such as small fruits or leafy vegetables

### 2.0 Maximum Residue Levels (MRL) for other Jurisdictions

In addition to the US tolerances found in 40CFR180, three data bases evaluated for Maximum Residue Levels (MRLs) in jurisdictions identified by the Maine Wild Blueberry Commission. These were the USDA MRL Database (USDA 2013a), the Homologa database (Homologa 2013) and the Japan Chemical Research Foundation Database (Japan Chemical Research Foundation 2013).

The caveats surrounding the USDA MRL Database are:

> "Users are advised that international regulations and permissible Maximum Residue Levels (MRL) frequently change. Although this International MRL Database is updated frequently, the information in it may not be completely up-to-date or error free. Additionally, commodity nomenclature and residue definitions vary between countries, and country policies regarding deferral to international standards are not always transparent. This database is intended to be an initial reference source only, and users must verify any information obtained from it with knowledgeable parties in the market of interest prior to the sale or shipment of any products. The developers of this database are not liable for any damages, in whole or in part, caused by or arising in any way from user's use of the database http://www.mrldatabase.com (USDA 2013a)"

The USDA MRL data is presented in Table 2.1

**CODEX** ALIMENTARIS, International Food Standards has established an MRL for malathion of 10 ppm, this MRL has been adopted by Egypt, Hong Kong, Israel, South Korea, New Zealand, Philippines, Singapore, Thailand and Vietnam, Table 2.2.

Review of the other two databases Holologa and Japan Chemical Research Foundation identified several MRLs different from USDA. These data are presented in Appendix IV Table 2.2.

The Japan Chemical Research Foundation database states an MRL of 5 ppm for permethrin (JCF 2013).

| Appendix IV. Table 2.1 Maximum Residue Levels (MRLs in ppm) for Mosquito Adulticides in Low Bush Blueberries (USDA 2013a) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Jurisdiction** | **Pyrethrins-Pyrethroid-PBO** | | | | **Organophosphates** | | |
| | **Phenothrin** | **PBO** | **Pyrethrins** | **Resmethrin** | **Chlorpyrifos** | **Malathion** | **Naled** |
| **United States** | 0.01 (a) | 8 (e) | 1 (e) | 3 (b) | 0.1 (k) | 8 (e) | 0.5 (a) |
| **European Union** | 0.05 (e) | None | 1 (e) | 0.1 (e) | 0.05 (e) | 0.02 (e) | None |
| **Australia** | None | 8 (f) | 1 (f) | None | 0.01 (e) | 2 (f) | None |
| **Canada** | None | 8 (e) | 1 (e) | None | None | 8 (e) | None |
| **Egypt** | None | None | None | None | None | 10 (d, e) | None |
| **Hong Kong** | None | None | None | None | None | 10 (d, e) | None |
| **Israel** | None | None | None | None | None | 10 (d, e) | None |
| **Japan** | 0.02 (e) | 8 (e) | 1 (e) | 0.1 (e) | 1 (e) | 0.5 (e) | 0.21 (e) |
| **Korea, South** | 0.1 (j) | 0.05 (g) | 1 (e) | None | 0.5 (e) | 10 (d, e) | None |
| **Mexico** | 0.01 (a, c) | 8 (e, c) | 1 (e, c) | 3 (b, c) | 0.1 (k, c) | 8 (e, c) | 0.5 (a, c) |
| **New Zealand** | None | 8 (f) | 1 (e) | None | 0.2 (f) | 10 (d, e) | None |
| **Philippines** | None | None | None | None | None | 10 (d, e) | None |
| **Singapore** | None | None | 1 | None | 0.2 (i) | 10 (d, e) | None |
| **Taiwan** | None | None | None | None | 1 (h) | 0.01 | None |
| **Thailand** | None | None | None | None | None | 10 (d, e) | None |
| **Vietnam** | None | None | None | None | None | 10 (d, e) | None |

a) US tolerances for phenothrin and naled are universal for public health mosquito applications
b) US tolerances food handling and food storage areas

c) Mexico MRLs are the same as US tolerances
d) Malathion MRLs are from Codex
e) MRLs are for blueberries
f) MRLs are for fruit
g) MRL category is "other"
h) MRL category is "small berries"
i) MRL category is Berry Fruits
j) MRL is derived from the rice MRL
k) Chlorpyrifos tolerance in the US is for both agricultural and food handling-food storage areas

| **Appendix IV Table 2.2 Maximum Residue Levels (MRLS) for Selected (see text above) Mosquito Adulticides in Low Bush Blueberries (Homologa 2013a)** | | | |
|---|---|---|---|
| **Jurisdiction** | **Pyrethrins-Pyrethroid-PBO** | | **Organophosphates** |
| | **Etofenprox** | **Pyrethrins** | **Malathion** |
| **European Union** | 1 | 1 | 0.02 |
| **Australia** | None | 1 | 2 |
| **Codex** | None | None | 10 |
| **Japan** | 0.01 | 1 | 0.5 |
| **Korea, South** | 0.01 | None | None |
| **Mexico** | None | None | |
| **New Zealand** | None | 1 | 8 |
| **Turkey** | None | None | 0.05 |

# Appendix V

## Environmental Terrestrial Toxicity Ratings and Risk Assessments for Public Health Mosquito Adulticides

1.0 Pyrethrins-Pyrethroids and PBO
- 1.1a Etofenprox Toxicity
- 1.1b Etofenprox Risks
- 1.2a PBO Toxicity
- 1.2b PBO Risks
- 1.3a Permethrin Toxicity
- 1.3b Permethrin Risks
- 1.4a Phenothrin Toxicity
- 1.4b Phenothrin Risks
- 1.5a Prallethrin Toxicity
- 1.5b Prallethrin Risks
- 1.6a Pyrethrins (Extract 57% or 58%) Toxicity
- 1.6b Pyrethrins (Extract 57% or 58%) Risks
- 1.7a Resmethrin Toxicity
- 1.7b Resmethrin Risks

2.0 Organophosphates
- 2.1 Chlorpyrifos Acute Toxicity
- 2.2 Malathion Acute Toxicity

## TOXICITY AND RISK SUMMARY TABLES BY ACTIVE INGREDIENTS

In order to evaluate risks to birds EPA requires toxicity studies using the northern bobwhite (*Colinus virginianus*), mallard duck (*Anas platyrhynchos*). EPA has currently issued data-call-ins for acute toxicity studies in a passerine species for several of the pyrethroids. The studies are of different duration and exposure routes. They include; acute (single dose $LD_{50}$s), sub-acute dietary (5 days exposure followed by 3 days of observation) and dietary reproductive studies (Appendix III, Section 1).

The potential for effects in wild mammals, is estimated using the mammalian database developed for human health risk assessment (Appendix III, Section 1).

In section 1.0, pyrethrins-pyrethroids and PBO, there are two tables for each active ingredient. The set of tables marked “a” contain the data for the most sensitive species and EPA toxicity categories (Appendix III, Section 2) toxicity for birds and mammals. The set of Tables marked “b” summarized risks for mosquito uses and selected agricultural uses. In the “b” tables, the scenarios are defined as type of application (mosquito ULV or agricultural), the active ingredient, method of application, number of applications per year, interval between applications.

In the organophosphate section, 2.0 because there are no recent EPA environmental fate reviews for the organophosphates, tables 8, 9 and 10 contain data from the recent toxicity reviews found in the EPA EFED statement of problem formulations for these compounds.

Results from the T-REX model (Appendix III, Section 4) are estimated environmental concentrations (EEC) in ppm (mg/kg diet). The T-REX data in the following tables are for residues in short grass, the feedstuff which routinely has the highest residues.

Those risk quotients (RQ) in **bold** exceed EPA’s level of concern (LOC) for the duration of the exposure, 0.5 for acute exposures and 1 for chronic exposures.

## 1.0 PYRETHRINS-PYRETHROIDS AND PBO

**Appendix V Table 1.1a Etofenprox Toxicity to Terrestrial Organisms (EPA 2009a)**

| Group | Duration | Test | Results | EPA toxicity Category |
|---|---|---|---|---|
| Avian | Acute | LD50 | > 2,000 mg/kg body weight | Practically non-toxic |
| | Sub-Acute | LC50 | > 4,890 ppm | Practically non-toxic |
| | Chronic | NOAEC | > 1,010 ppm | Not Applicable |
| Mammal | Acute | LD50 | > 42,880 mg/kg body weight | Practically non-toxic |
| | Chronic | NOAEC | 4,900 ppm | Not Applicable |

**Appendix V Table 1.1b Etofenprox Risks to Terrestrial Organisms (EPA 2009a)**

For etofenprox, EPA did not calculate risk quotients for acute, sub-chronic or chronic exposure to birds, or acute or chronic risk to mammals based on no adverse effects ($LC_{50}$s and NOAECs are higher than the highest tested doses) observed in the toxicity studies (EPA 2009a).

| Appendix V Table 1.2a PBO Mosquito Toxicity to Terrestrial Species (EPA 2010b) | | | | |
|---|---|---|---|---|
| **Group** | **Duration** | **Test** | **Results** | **EPA toxicity Category** |
| Avian | Acute | $LD_{50}$ | > 2,250 mg/kg body weight | Practically non-toxic |
| | Sub-Acute | $LC_{50}$ | > 5,620 ppm diet | Practically non-toxic |
| | Chronic | NOAEC | >300 | Not Applicable |
| Mammals | Acute | $LC_{50}$ | 4,570 mg/kg body weight | Practically non-toxic |
| | Chronic | NOAEC | 1,000 ppm diet | Not Applicable |

| Appendix V Table 1.2b PBO Risk to Terrestrial Species from Agricultural Uses (EPA 2005g) (EPA 2010b) | | | | | | |
|---|---|---|---|---|---|---|
| **Scenario [a]** | **Duration** | **Test** | **Results $LC_{50}$** | **EEC ppm [b]** | **RQ [c]** | **LOC [d]** |
| **Avian [a]** | | | | | | |
| EPA did not calculate risk quotients for acute or sub-acute birds, based on no adverse effects ($LD_{50}$ and NOAEC are higher than the highest tested doses) observed in the toxicity studies (EPA 2010b). | | | | | | |
| Agriculture,0.5 lbs ai/A, 10 times, 3 day intervals | Chronic | NOAEC | 300 | 932 | **3.1** | 1 |
| **Mammal** | | | | | | |
| EPA acute risk quotients for mammals weighing 15, 35, and 100 gm were all below 0.1 (EPA 2005j) | | | | | | |
| Agriculture,0.5 lbs ai/A, 10 times, 3 day intervals | Chronic risk quotients for mammals exceeded the LOC when the calculation was based on size class (EPA 2005j) | | | | | |
| | Chronic | NOAEC | 1,000 | 932 [e] | 0.932 | 1 |

a) For PBO, EPA did not perform risk assessments for birds or mammals using a mosquito application scenario
b) EEC = Estimated Environmental Concentration
c) RQ = Risk Quotient, ratio of the EEC to the toxicity endpoint, Unit-less, lower the RQ the less risks
d) LOC = Level of Concern for acute and chronic risks
e) RQ when the body weight of wild mammal is assumed to be that of the test species, laboratory rat.

| Appendix V Table 1.3a Permethrin Toxicity to Terrestrial Species (EPA 2011h) | | | | |
|---|---|---|---|---|
| **Group** | **Duration** | **Test** | **Results** | **EPA Toxicity Category** |
| Avian | Acute | $LD_{50}$ | > 2,000 mg/kg body weight | Practically No-toxic |
| | | $LC_{50}$ | > 5,200 ppm | Practically No-toxic |
| | Chronic | NOAEC | 125 ppm | Not Applicable |
| Mammals | Acute | $LD_{50}$ | 152 mg/kg body weight [(a)] | Moderately Toxic |
| | Chronic | NOAEC | 125 | Not Applicable |

a) Scaled from 340.5 mg/kg/day in 8-day old rats to a 350 g standard rat (EPA 2008h)

| Appendix V Table 1.3b Permethrin (EPA 2011h, EPA 2006i) | | | | | | |
|---|---|---|---|---|---|---|
| **Scenario** | **Duration** | **Test** | **Results ppm** | **EEC ppm [(a)]** | **RQ [(b)]** | **LOC [(c)]** |
| **Avian Risks** | | | | | | |
| Acute Risk, EPA did not assess acute dietary risks from permethrin exposure to permethrin because of a lack of toxicity in the acute avian studies (EPA 2011h, EPA 2008h) | | | | | | |
| Mosquito, 0.007 lbs ai/A, 1 time [(d)] | Chronic | NOAEC | 125 | 1.68 | 0.013 | 1 |
| Mosquito, 0.003 lbs ai/A, 52 times, 1 day interval [(e)] | Chronic | NOAEC | 125 | 14.8 | 0.12 | 1 |
| Mosquito, 0.00014 lbs ai/A, 26 times, 1 day interval [(f)] | Chronic | NOAEC | 125 | 0.5 | 0.004 | 1 |
| Agriculture, 0.2 lbs ai/A, 10 times, 4 day interval [(g)] | Chronic | NOAEC | 125 | 0.88 | 0.007 | 1 |
| **Wild Mammal Risks** | | | | | | |
| Mosquito, 0.003 lbs ai/A, 52 times, 1 day interval [(e)] | Acute | $LD_{50}$ | 152 mg/kg [(h)] | Unknown [(h)] | 0.04 | 0.5 |

| Appendix V Table 1.3b Permethrin (EPA 2011h, EPA 2006i) | | | | | | |
|---|---|---|---|---|---|---|
| **Scenario** | **Duration** | **Test** | **Results ppm** | **EEC ppm [a]** | **RQ [b]** | **LOC [c]** |
| Mosquito, 0.00014 lbs ai/A, 26 times, 1 day interval [f] | Acute | $LD_{50}$ | 152 mg/kg [h] | Unknown [h] | < 0.01 | 0.5 |
| Agriculture, 0.2 lbs ai/A, 10 times, 4 day interval [g] | Acute | $LD_{50}$ | 152 mg/kg [h] | Unknown [h] | 0.04 | 0.5 |
| Mosquito, 0.007 lbs ai/A, 1 time [d] | Chronic [i] | NOAEC | 55.44 | 1.68 | 0.03 | 1 |
| Mosquito, 0.003 lbs ai/A, 52 times, 1 day interval [e] | Chronic [i] | NOAEC | 55.44 | 0.0049 | 0.27 | 1 |
| Mosquito, 0.00014 lbs ai/A, 26 times, 1 day interval [f] | Chronic [i] | NOAEC | 55.44 | 0.0002 | 0.01 | 1 |
| Agriculture, 0.2 lbs ai/A, 10 times, 4 day interval [g] | Chronic [i] | NOAEC | 55.44 | 0.0036 | 0.0006 | 1 |

a) EEC = Estimated Environmental Concentration in ppm (mg/kg feed)
b) RQ = Risk Quotient, ratio of the EEC to the toxicity endpoint, Unit-less, lower the RQ the less risks
c) LOC = Level of Concern for acute and chronic risk
d) EEC = The Estimated Environmental Concentrations (EECs) for Short grass at zero day of treatment as calculated in-house, using T-REX without correction for AGDISP percent efficiency (EPA states that estimates from T-REX not corrected for AGDISP efficiency over estimates the EECs) (EPA 2008h)
e) Mosquito application at 0.007 lbs ai/A modified for efficiency (0.449) from AGDISP model pre-implementation of the 2009 Registration Eligibility Decision requirements, feed was short grass (EPA 2008h)
f) Mosquito application at 0.007 lbs ai/A modified for efficiency (0.020) from AGDISP model post-implementation of the 2009 Registration Eligibility Decision requirements, feed was short grass (EPA 2008h)
g) Agricultural use, feed was short grass
h) Scaled from 340.5 mg/kg/day in 8-day old rats to a 350 g standard rat (EPA 2008h); not enough information was presented in EPA's risk assessments to estimate the environmental concentrations for acute exposure to mammals
i) Mouse study (EPA 2011h. EPA 2008h)

| Appendix V Table 1.4a Phenothrin Toxicity to Terrestrial Species (EPA 2008f) | | | | |
|---|---|---|---|---|
| **Group** | **Duration** | **Test** | **Results** | **EPA Toxicity Category** |
| Avian | Acute | $LD_{50}$ | > 2,510 mg/kg body weight | Practically non-toxic |
| | Sub-Acute | $LC_{50}$ | > 5,000 ppm | Practically non-toxic |
| | Chronic | NOAEC | Data Gap | Not Applicable |
| Mammal | Acute | $LD_{50}$ | > 5,000 mg/kg body weight | Practically non-toxic |
| | Chronic | NOAEC | 1,000 ppm | Practically non-toxic |

| Appendix V Table 1.4b Phenothrin Risks to Terrestrial Species | | | | | | |
|---|---|---|---|---|---|---|
| **Scenario** | **Duration** | **Test** | **Results** | **EEC [a]** | **RQ [b]** | **LOC [c]** |
| **Avian** | | | | | | |
| Mosquito; 0.0036 lbs ai/A; 278 times, 1 day interval | Due to the lack of acute toxicity of phenothrin in birds EPA did not develop acute risk quotients (EPA 2008f) | | | | | |
| Mosquito; 0.0036 lbs ai/A; 1 time [d] | Sub-acute | LC50 | 5,000 | 0.864 | 0.0018 | 0.5 |
| Mosquito; 0.0036 lbs ai/A; 278 times, 1 day interval | Chronic | There is a data gap for a reproduction study in birds | | | | |
| **Mammals** | | | | | | |
| Mosquito; 0.0036 lbs ai/A; 278 times, 1 day interval | Due to the lack of acute toxicity of phenothrin in mammals, EPA did not develop acute risk quotients (EPA 2008f) | | | | | |
| Mosquito; 0.0036 lbs ai/A; 1 time [d] | Chronic | NOAEC | 1,000 | 0.864 | 0.0008 | 1 |
| Mosquito; 0.0036 lbs ai/A; 278 times, 1 day interval | Chronic | NOAEC | 1,000 | Unknown [e] | 0.01 | 1 |

a) EEC = Estimated Environmental Concentration in ppm (mg/kg feed)
b) RQ = Risk Quotient, ratio of the EEC to the toxicity endpoint, Unit-less, lower the RQ the less risks
c) LOC = Level of Concern for acute and chronic risk

d) EEC = The Estimated Environmental Concentrations (EECs) for Short grass at zero day of treatment as calculated in-house, without correction for AGDISP percent efficiency (EPA states that estimates from T-REX not corrected for AGDISP efficiency over estimates the EECs) (EPA 2008h)
e) EEC was not presented in EPA's Risk Assessment

| Appendix V Table 1.5a Prallethrin Toxicity to Terrestrial Species (EPA 2012h) | | | | |
|---|---|---|---|---|
| **Group** | **Duration** | **Test** | **Results** | **EPA toxicity category** |
| Avian | Acute | $LD_{50}$ | 1,171 mg/kg body weight | Slightly toxic |
| | Sub-Acute | $LC_{50}$ | > 5,620 ppm | Practically Non-toxic |
| | Chronic | NOAEC | 360 ppm | Not Applicable |
| Mammals | Acute | $LD_{50}$ | 640 mg/kg body weight | Moderately toxic |
| | Chronic | NOAEC | 600 ppm | Not Applicable |

| Appendix V Table 1.5b Prallethrin Terrestrial Species Risks (EPA 2012h) | | | | | | |
|---|---|---|---|---|---|---|
| **Scenario** | **Duration** | **Test** | **Results** | **EEC [a]** | **RQ [b]** | **LOC [c]** |
| The most recent EPA environmental risk assessment did not address terrestrial organism risks (EPA 2005i) | | | | | | |
| Mosquito, 0.0008 lbs ai/A, 1 time [d] | **Avian** | | | | | |
| | Sub-acute | LC50 | 1,780 | 0.24 | 0.00001 | 0.5 |
| | **Mammals** | | | | | |
| | Chronic | NOAEC | 600 | 0.24 | 0.0004 | 1 |

a) EEC = Estimated Environmental Concentration
b) RQ = Risk Quotient, ratio of the EEC to the toxicity endpoint, Unit-less, lower the RQ the less risks
c) LOC = Level of Concern for acute and chronic risks
d) EEC = The Estimated Environmental Concentrations (EECs) for Short grass at zero day of treatment as calculated in-house, without correction for AGDISP percent efficiency (EPA states that estimates from T-REX not corrected for AGDISP efficiency over estimates the EECs) (EPA 2008h)

| Appendix V Table 1.6a Pyrethrins (Extract 57% or 58%) Toxicity to Terrestrial Species (EPA 2011i) | | | | |
|---|---|---|---|---|
| **Group** | **Duration** | **Test** | **Results** | **EPA Toxicity Category** |
| Avian | Acute | $LD_{50}$ | > 2,000 mg/kg body weight | Practically Non-toxic |
| | Sub-Acute | $LC_{50}$ | > 5,620 ppm | Practically Non-toxic |
| | Chronic | NOAEC | Data Gap | Not applicable |
| Mammals | Acute [(a)] | $LD_{50}$ | 1,400 mg/kg body weight | Slightly Toxic |
| | Chronic | NOAEL | 6.4 mg/kg body weight (500 ppm) | Not applicable |

a) Acute oral risk to mammals were assessed using the acute oral $LD_{50}$ of 700 mg/kg body weight in the 2006 risk assessment and reported as 1,400 mg/kg body weight in the 2011 statement of the problem

| Appendix V Table 1.6b Pyrethrins (Extract 57% or 58%) Risks (EPA 2011i. EPA 2006b) | | | | | | |
|---|---|---|---|---|---|---|
| **Scenario** | **Duration** | **Test** | **Results (ppm)** | **EEC [(a)]** | **RQ [(b)]** | **LOC [(b)]** |
| **Avian** | | | | | | |
| Mosquito, 0.008 lbs ai/A, 1 time [(d)] | Sub-acute | $LC_{50}$ | > 5,620 | 1.92 | 0.0003 | 0.5 |
| Agriculture, 0.05 lbs ai/A, 10 times, 1 day interval, foliar T1/2 = 1 | Sub-acute | $LC_{50}$ | > 5,620 | 23.98 | 0.004 | 0.5 |
| Agriculture, 0.05 lbs ai/A, 10 times, 1 day interval, foliar T1/2 = 14 | Sub-acute | $LC_{50}$ | > 5,620 | 97.01 | 0.02 | 0.5 |
| Agriculture, 0.05 lbs ai/A, 10 times, 3 days interval, foliar T1/2 = 1 | Sub-acute | $LC_{50}$ | > 5,620 | 13.71 | 0.002 | 0.5 |
| Agriculture, 0.05 lbs ai/A, 10 times, 3 days interval, foliar T1/2 = 14 | Sub-acute | $LC_{50}$ | > 5,620 | 67.25 | 0.012 | 0.5 |
| Mosquito, 0.008 lbs ai/A, 1 time [(d)] | Chronic | $LC_{50}$ | 500 | 1.92 | 0.004 | 1 |

| Appendix V Table 1.6b Pyrethrins (Extract 57% or 58%) Risks (EPA 2011i. EPA 2006b) | | | | | | |
|---|---|---|---|---|---|---|
| **Scenario** | **Duration** | **Test** | **Results (ppm)** | **EEC [a]** | **RQ [b]** | **LOC [b]** |
| Agriculture, 0.05 lbs ai/A, 10 times, 1 day interval, foliar T1/2 = 1 | Chronic | $LC_{50}$ | 500 | 23.98 | 0.05 | 1 |
| Agriculture, 0.05 lbs ai/A, 10 times, 1 day interval, foliar T1/2 = 14 | Chronic | $LC_{50}$ | 500 | 97.01 | 0.19 | 1 |
| Agriculture, 0.05 lbs ai/A, 10 times, 3 days interval, foliar T1/2 = 1 | Chronic | $LC_{50}$ | 500 | 13.71 | 0.03 | 1 |
| Agriculture, 0.05 lbs ai/A, 10 times, 3 days interval, foliar T1/2 = 14 | Chronic | $LC_{50}$ | 500 | 67.25 | 0.13 | 1 |
| **Mammals** | | | | | | |
| Agriculture, 0.05 lbs ai/A, 10 times, 1 day interval, foliar T1/2 = 1 | Acute [e] | $LD_{50}$ | 700 mg/kg | 23.98 | 0.06 to 0.03 [f] | 0.5 |
| Agriculture, 0.05 lbs ai/A, 10 times, 1 day interval, foliar T1/2 = 14 | Acute [e] | $LD_{50}$ | 700 mg/kg | 97.01 | | 0.5 |
| Agriculture, 0.05 lbs ai/A, 10 times, 3 days interval, foliar T1/2 = 1 | Acute [e] | $LD_{50}$ | 700 mg/kg | 13.71 | 0.01 to 0.04 [f] | 0.5 |
| Agriculture, 0.05 lbs ai/A, 10 times, 3 days interval, foliar T1/2 = 14 | Acute [e] | $LD_{50}$ | 700 mg/kg | 67.25 | | 0.5 |
| Mosquito, 0.008 lbs ai/A, 1 time [d] | Chronic [g] | NOAEC | 100 | 1.92 | 0.019 | 1 |
| Agriculture, 0.05 lbs ai/A, 10 times, 1 day interval, foliar T1/2 = 1 | Chronic [g] | NOAEC | 100 | 23.98 | 0.24 | 1 |
| Agriculture, 0.05 lbs ai/A, 10 times, 1 day interval, foliar T1/2 = 14 | Chronic [g] | NOAEC | 100 | 97.01 | 0.97 | 1 |
| Agriculture, 0.05 lbs ai/A, 10 times, 3 days interval, foliar T1/2 = 1 | Chronic [g] | NOAEC | 100 | 13.71 | 0.14 | 1 |

| Appendix V Table 1.6b Pyrethrins (Extract 57% or 58%) Risks (EPA 2011i. EPA 2006b) | | | | | | |
|---|---|---|---|---|---|---|
| **Scenario** | **Duration** | **Test** | **Results (ppm)** | **EEC [a]** | **RQ [b]** | **LOC [b]** |
| Agriculture, 0.05 lbs ai/A, 10 times, 3 days interval, foliar T1/2 = 14 | Chronic [g] | NOAEC | 100 | 67.25 | 0.67 | 1 |

a) EEC = Estimated Environmental Concentration
b) RQ = Risk Quotient, ratio of the EEC to the toxicity endpoint, Unit-less, lower the RQ the less risks
c) LOC = Level of Concern for acute and chronic risks
d) EEC = The Estimated Environmental Concentrations (EECs) for Short grass at zero day of treatment as calculated in-house, without correction for AGDISP percent efficiency (EPA states that estimates from T-REX not corrected for AGDISP efficiency over estimates the EECs) (EPA 2008h). For this scenario, choice of foliar half-life T1/2 was irrelevant
e) Acute oral risk to mammals were assessed using the acute oral $LD_{50}$ of 700 mg/kg body weight (EPA 2006b) in the 2006 risk assessment and reported as 1,400 mg/kg body weight in the 2011 statement of the problem (EPA 2011i)
f) Range for mammals weighing 15, 35 and 1,000 gms
g) Scaled from 340.5 mg/kg/day in 8-day old rats to 350 g standard laboratory rat (EPA 2008h)

| **Appendix V Table 1.7a Resmethrin Toxicity Terrestrial Species(EPA 2012i, EPA 2006d)** | | | | |
|---|---|---|---|---|
| **Terrestrial Species, Oral $LD_{50}$ / $LC_{50}$** | | | | |
| **Group** | **Duration** | **Test** | **Results** | **EPA Toxicity Category** |
| Avian | Acute [a] | $LD_{50}$ | 75 mg ai/kg body weight | Moderately toxic |
| | Sub-Acute | $LC_{50}$ | > 5,000 ppm | Practically non-toxic |
| | Chronic | NOAEC | 500 ppm | Not Applicable |
| Mammals | Acute | $LD_{50}$ | 4,639 mg ai/kg body weight | Practically non-toxic |
| | Chronic | NOAEC | 12 ppm | Not Applicable |

a) Acute toxicity study in the Passerine species, Red winged black bird was rated supplemental

| **Appendix V Table 1.7b Resmethrin Risks to Terrestrial Organisms (EPA 2012i, EPA 2006d)** | | | | | | |
|---|---|---|---|---|---|---|
| **Scenario** | **Duration** | **Test** | **Results** | **EEC [a]** | **RQ [b]** | **LOC [c]** |
| **Avian** | | | | | | |
| Mosquito, 0.007 lbs ai/A, 50 times, 3 day interval | Acute | $LD_{50}$ | 75 mg/kg | Unknown [d] | 0.49 to 0.11 [e] | 0.5 |
| Mosquito, 0.007 lbs ai/A, 50 times, 4 day interval | Acute | $LD_{50}$ | 75 mg/kg | Unknown [d] | 0.38 to 0.07 [e] | 0.5 |
| Mosquito, 0.007 lbs ai/A, 1 time [g] | Sub-acute | LC50 | 5,000 ppm | 1.68 | 0.00032 | 0.5 |
| Mosquito, 0.007 lbs ai/A, 50 times, 3 day interval | Sub-acute | LC50 | 5,000 ppm | 30 | 0.006 | 0.5 |
| Mosquito, 0.007 lbs ai/A, 50 times, 3 day interval | Chronic | NOAEC | 12 ppm | 27.6 | **2.3** | **1** |
| Mosquito, 0.007 lbs ai/A, 50 times, 4 day interval | Chronic | NOAEC | 12 ppm | 21.6 | **1.8** | **1** |

| Appendix V Table 1.7b Resmethrin Risks to Terrestrial Organisms (EPA 2012i, EPA 2006d) | | | | | | |
|---|---|---|---|---|---|---|
| **Scenario** | **Duration** | **Test** | **Results** | **EEC [a]** | **RQ [b]** | **LOC [c]** |
| Mosquito, 0.007 lbs ai/A, 25 times, 4 day interval | Chronic | NOAEC | 12 ppm | 18.6 | 0.73 | 1 |
| **Mammals** | | | | | | |
| Mosquito, 0.007 lbs ai/A, 50 times, 3 day interval | Acute | $LD_{50}$ | 4,639 mg/kg | Unknown [e] | 0.0026 to 0.0012 [h] | 0.5 |
| Mosquito, 0.007 lbs ai/A, 50 times, 4 day interval | Acute | $LD_{50}$ | 4,639 mg/kg | Unknown [e] | 0.38 to 0.07 [h] | 0.5 |
| Mosquito, 0.007 lbs ai/A, 1 time [g] | Chronic | NOAEC | 500 ppm | 1.68 | 0.01 | 1 |
| Mosquito, 0.007 lbs ai/A, 1 time [g] | Chronic | NOAEC | 500 ppm | 1.68 | 0.0032 | 1 |
| Mosquito, 0.007 lbs ai/A, 50 times, 3 day interval | Chronic | NOAEC | 500 ppm | 30 | 0.06 | 1 |

a) EEC = Estimated Environmental Concentration
b) RQ = Risk Quotient, ratio of the EEC to the toxicity endpoint, Unit-less, lower the RQ the less risks
c) LOC = Level of Concern for acute and chronic risks
d) Scenarios for mosquito control (EPA 2005a, page 97 to 99)
e) Estimated environmental concentrations were not presented for acute exposure
f) Range of risk quotients for birds weighing 20, 100, or 1,000 gms (EPA 2005a, page 97)
g) EEC = The Estimated Environmental Concentrations (EECs) for Short grass at zero day of treatment as calculated in-house, without correction for AGDISP percent efficiency (EPA states that estimates from T-REX not corrected for AGDISP efficiency over estimates the EECs) (EPA 2008h)
h) Estimated environmental concentrations were not presented for acute exposure
i) Range of risk quotients for mammal weighing 15, 35, or 1,000 gms (EPA 2005a, page 96)

## 2.0 ORGANOPHOSPHATES

| Appendix V Table 2.1 Chlorpyrifos, Acute Toxicity to Terrestrial Species (EPA 2008e) | | | | |
|---|---|---|---|---|
| **Species** | **Duration** | **Test** | **Results** | **EPA Toxicity Category** |
| Avian | Acute | $LD_{50}$ | 10 mg/kg | Very Highly Toxic |
| | Sub-acute | $LC_{50}$ | 136 ppm | Highly Toxic |
| Mammal | Acute | $LD_{50}$ | 97 mg/kg | Moderately Toxic |
| | Chronic | NOAEC | 1,330 ppm | Slightly Toxic |

| Appendix V Table 2.2 Malathion Acute Toxicity to Terrestrial Species (EPA 2004a, EPA 2009g) | | | | |
|---|---|---|---|---|
| **Species** | **Duration** | **Test** | **Results** | **EPA Toxicity Category** |
| Avian | Acute | $LD_{50}$ | 1.44 mg/kg body weight | Moderately Toxic |
| | Sub-acute | $LC_{50}$ | 2,128 ppm | Slightly Toxic |
| | Chronic | NOAEC | 110 ppm | Not Applicable |
| Mammal | Acute | $LD_{50}$ | 1,000 mg/kg body weight | Slightly Toxic |
| | Chronic | NOAEC | 240 ppm | Not Applicable |

| Appendix V Table 2.3 Naled-DDVP Acute Toxicity in Terrestrial Species (EPA 2008d, EPA 2008g) | | | | |
|---|---|---|---|---|
| **Species** | **Duration** | **Test** | **Results [(b)]** | **EPA Toxicity Category** |
| Avian | Acute | $LD_{50}$ | 7.8 mg DDVP/kg body weight<br>0.035 mmoles DDVP/kg feed | Highly Toxic |
| | Sub-acute | $LC_{50}$ | 298 ppm DDVP/kg feed<br>1.34 mmoles DDVP/kg feed | Slightly Toxic |

| Appendix V Table 2.3 Naled-DDVP Acute Toxicity in Terrestrial Species (EPA 2008d, EPA 2008g) | | | | |
|---|---|---|---|---|
| **Species** | **Duration** | **Test** | **Results [(b)]** | **EPA Toxicity Category** |
| | Chronic | NOAEC | 5 ppm DDVP/kg feed<br>0.023 mmoles DDVP/kg feed | Not Applicable |
| Mammal | Acute | $LD_{50}$ | 56 mg DDVP/kg body weight<br>2.5 mmoles DDVP/kg body weight | Moderately Toxic |
| | Chronic | NOAEC | 2.5 mg DDVP/kg feed<br>0.01 mmoles DDVP/kg feed | Not Applicable |

a) Laboratory results for the avian and mammalian studies are from the DDVP toxicity database. They were reported as ppm (mg/kg feed) expressed here as mmoles DDVP/kg feed for birds and mammals. The aquatic EEC's are based on compound (naled or DDVP) with the greatest level toxicity (lowest LC50 or NOAEC). They were reported as ppb and expressed here as micromoles TTR/L of water. Equations used were:

mg/kg feed (ppm) 1 mmole DDVP/221 mg = mmole ai/kg feed (terrestrial birds and mammals, DDVP is more toxic)

# Appendix VI

# Environmental Aquatic Toxicity and Risks Assessments for Public Health Mosquito Adulticides

**1.0 PYRETHRINS-PYRETHROIDS-PBO**

1.1a Etofenprox Toxicity

1.1b Etofenprox Aquatic Risks

1.2a PBO Toxicity

1.2b PBO Risks

1.3a Permethrin Toxicity

1.3b Permethrin Risks

1.4a Phenothrin Toxicity

1.4b Phenothrin Risks

1.5a Prallethrin Toxicity

1.5b Prallethrin Risks

1.6a Pyrethrins (Extract 57% or 58%) Toxicity

1.6b Pyrethrins (Extract 57% or 58%) Risks

1.7a Resmethrin Toxicity

1.7b Resmethrin Risks

**2.0 ORGANOPHOSPHATES**

2.1a Chlorpyrifos Toxicity

2.1b Chlorpyrifos Risks

2.2a Malathion Toxicity

2.2b Malathion Risks; Aerial Rate

2.2c Malathion Risks; Ground Use Rate

2.3a Naled-DDVP Toxicity in Aquatic Species

2.3b Naled-DDVP Risks

## TOXICITY AND RISK SUMMARY TABLES BY ACTIVE INGREDIENTS

In order to evaluate risks to birds EPA requires toxicity studies in freshwater fish and invertebrates and marine fish and invertebrates (Appendix III, Section 1). In instances where the environmental fate data indicate the compound may persist in the sediment and in sediment pore water, EPA has issued data-call-ins for toxicity studies in sediment dwelling organisms (Appendix III, Section 1 and Appendix I, Section 4.0).

In section 1.0, pyrethrins-pyrethroids and PBO, there are two tables for each active ingredient. The set of tables marked “a” contain the data for the most sensitive species and EPA toxicity categories (Appendix II, Section 2) toxicity for aquatic species. Data gaps and studies rated as supplemental have been identified (Appendix III, Section 2.0). The set of Tables marked “b” summarized risks for mosquito uses and selected agricultural uses. In the “b” tables, the scenarios are defined as type of application (mosquito ULV or agricultural), the active ingredient, method of application, number of applications per year, interval between applications and the model used to estimate the environmental concentration (EEC) (Appendix III, Section 5.0).

In the organophosphate section, 2.0 because there are no recent EPA environmental fate reviews for the organophosphates, tables 8, 9 and 10 contain data from the recent toxicity reviews found in the EPA EFED statement of problem formulations for these compounds.

In certain instances where there is data indicating that the typical test species may not be the most sensitive, EPA has used the acute to chronic ratio (ACR) to estimate the chronic toxicity value (Appendix III, Section 5.1).

Those risk quotients (RQ) in **bold** exceed EPA’s level of concern (LOC) for the duration of the exposure, 0.5 for acute exposures and 1 for chronic exposures.

| **Appendix VI Table 1.1a Aquatic Toxicity Endpoints in the Most Sensitive Species for Etofenprox Used by EPA for Aquatic Risk Assessment (EPA 2009a)** | | | | | |
|---|---|---|---|---|---|
| **Group** | **Most Sensitive Species** | **Test** | **Results (ppb)** | **EPA Toxicity Category** | **Endpoint** |
| Freshwater Fish | Rainbow trout | LC50 | 2.7 | Very Highly Toxic | Lethality |
| Freshwater Fish | Rainbow trout | NOAEC | 0.57 | Not Applicable | Calculated |
| Freshwater Fish | Zebrafish | NOAEC | 23 | Not Applicable | Lethality |
| Freshwater Invertebrates | Daphnia | EC50 | 0.17 | Very Highly Toxic | Lethality |
| Freshwater Invertebrates | Daphnia | NOAEC | 0.08 | Not Applicable | Reproduction |
| Marine Fish | Sheepshead minnow | LC50 | 16.5 | NT @ sol | Lethality |
| Marine Invertebrates | Mysid shrimp | EC50 | 0.0188 | Very Highly Toxic | Lethality |
| Marine Invertebrates | Mysid shrimp | NOAEC | 0.004 | Not Applicable | Not stated |
| Freshwater sediment invertebrates | Data gap | Acute (b) | No data | No data | No data |
| Marine sediment invertebrates | Data gap | Acute (c) | No data | No data | No data |
| Freshwater sediment invertebrates | Data gap | Chronic (a, b) | No data | No data | No data |
| Marine sediment invertebrates | Data gap | Chronic (c) | No data | No data | No data |

a) EPA rated the study supplemental
b) Data-gap identified by EPA, but a data-call-in was not stated
c) Studies not mentioned

| Appendix VI Table 1.1b Etofenprox Aquatic Risks Mosquito and Selected Agricultural Use Scenarios | | | | | |
|---|---|---|---|---|---|
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface 6.56 ft deep (ppb)** | **Surface water RQ** |
| **Mosquito, Etofenprox ULV Air: 2 mph, 25 (3) assuming 5% drift; 0.007 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |
| Freshwater fish | Acute (d) | 0.5 | 2.7 | 0.4 | 0.15 |
| Freshwater invertebrates | Acute (a, d) | 0.5 | 0.17 | 0.4 | **2.35** |
| Marine fish | Acute | 0.5 | 16.5 | 0.4 | 0.02 |
| Marine invertebrates | Acute | 0.5 | 0.0188 | 0.4 | **21.28** |
| Freshwater fish | Chronic (b) | 1 | 0.57 | 0.27 | 0.47 |
| Freshwater fish | Chronic (a, f) | 1 | 23 | 0.27 | 0.01 |
| Freshwater invertebrates | Chronic | 1 | 0.004 | 0.27 | **67.50** |
| Marine fish | Chronic (c) | 1 | Data gap | 0.27 | No data |
| Marine invertebrates | Chronic | 1 | 0.08 | 0.27 | **3.38** |
| **Mosquito; Etofenprox, ULV Air: 2 mph, 25 (3) 5% drift; 0.007 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Pore water (ppb)** | **Pore water RQ** |
| Freshwater sediment invertebrates | Acute (c) | 0.5 | no data | no data | no data |
| Marine sediment invertebrates | Acute (g) | 0.5 | no data | no data | no data |
| Freshwater sediment invertebrates | Chronic (a, c) | 1 | 3.8 | no data | no data |
| Marine sediment invertebrates | Chronic (g) | 1 | no data | no data | no data |
| **Mosquito; Etofenprox, ULV Ground: 4 mph, 25 (3) 1% drift; 0.007 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |
| Freshwater fish | Acute (d) | 0.5 | 2.7 | 0.43 | 0.16 |

| Appendix VI Table 1.1b Etofenprox Aquatic Risks Mosquito and Selected Agricultural Use Scenarios | | | | | |
|---|---|---|---|---|---|
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface 6.56 ft deep (ppb)** | **Surface water RQ** |
| Freshwater invertebrates | Acute (a, d) | 0.5 | 0.17 | 0.43 | **2.53** |
| Marine fish | Acute | 0.5 | 16.5 | 0.43 | 0.03 |
| Marine invertebrates | Acute | 0.5 | 0.0188 | 0.43 | **22.87** |
| Freshwater fish | Chronic (b) | 1 | 0.57 | 0.3 | 0.53 |
| Freshwater fish | Chronic (a, f) | 1 | 23 | 0.3 | 0.01 |
| Freshwater invertebrates | Chronic | 1 | 0.08 | 0.3 | **3.75** |
| Marine fish | Chronic (c) | 1 | Data gap | 0.3 | no data |
| Marine invertebrates | Chronic | 1 | 0.004 | 0.3 | **75.00** |
| **Mosquito; Etofenprox, ULV Ground: 4 mph, 25 (3) 1% drift; 0.007 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Pore water (ppb)** | **Pore water RQ** |
| Freshwater sediment invertebrates | Acute (c) | 0.5 | no data | no data | no data |
| Marine sediment invertebrates | Acute (g) | 0.5 | no data | no data | no data |
| Freshwater sediment invertebrates | Chronic (a, c) | 1 | 3.8 | no data | no data |
| Marine sediment invertebrates | Chronic (g) | 1 | no data | no data | no data |
| **Rice; Etofenprox, Air, 1 application, direct application to water 0.27 lbs ai/A, RICE Model** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC 4 inches deep (ppb)** | **Surface water RQ** |
| Freshwater fish | Acute (d) | 0.5 | 2.7 | 1.2 | 0.44 |
| Freshwater invertebrates | Acute (a, d) | 0.5 | 0.17 | 1.2 | **7.06** |
| Marine fish | Acute | 0.5 | 16.5 | 1.2 | 0.07 |

| Appendix VI Table 1.1b Etofenprox Aquatic Risks Mosquito and Selected Agricultural Use Scenarios | | | | | |
|---|---|---|---|---|---|
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface 6.56 ft deep (ppb)** | **Surface water RQ** |
| Marine invertebrates | Acute | 0.5 | 0.0188 | 1.2 | **63.83** |
| Freshwater fish | Chronic (b) | 1 | 0.57 | 1.18 | **2.07** |
| Freshwater fish | Chronic (a, f) | 1 | 23 | 1.18 | 0.05 |
| Freshwater invertebrates | Chronic | 1 | 0.08 | 1.19 | **14.88** |
| Marine fish | Chronic (c) | 1 | Data gap | 1.18 | no data |
| Marine invertebrates | Chronic | 1 | 0.004 | 1.18 | **295.00** |
| **Rice; Etofenprox, Air, 1 application, direct application to water 0.27 lbs ai/A, RICE Model** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Pore water (ppb)** | **Pore water RQ** |
| Freshwater sediment invertebrates | Acute (c) | 0.5 | no data | no data | no data |
| Marine sediment invertebrates | Acute (g) | 0.5 | no data | no data | no data |
| Freshwater sediment invertebrates | Chronic (a, c) | 1 | 3.8 | no data | no data |
| Marine sediment invertebrates | Chronic (g) | 1 | no data | no data | no data |

a) EPA rated the study supplemental
b) Calculated using the acute to chronic ratio method
c) Data-gap identified by EPA, but a data-call-in was not stated
d) alpha-CO metabolite of etofenprox is not toxic in freshwater fish and invertebrates at the limit of solubility
e) Data gap for the etofenprox 4'OH metabolite
f) Toxicity endpoint from laboratory studies
g) Studies not mentioned

| **Appendix VI Table 1.2a Aquatic Toxicity Endpoints in the Most Sensitive Species for PBO Used by EPA for Aquatic Risk Assessment (EPA 2010b) (a)** | | | | | |
|---|---|---|---|---|---|
| **Group** | **Most Sensitive Species** | **Test** | **Results (ppb)** | **EPA Toxicity Category** | **Endpoint** |
| Freshwater Fish | Rainbow trout | LC50 (b, e) | 1,900 | Moderately Toxic | Lethality |
| Freshwater Fish | Fathead minnow | NOAEC (d, f) | 40 | Not Applicable | Not stated |
| Freshwater Invertebrates | Daphnia | EC50 (b, e) | 510 | Moderately Toxic | Lethality |
| Freshwater Invertebrates | Daphnia | NOAEC | 30 | Not Applicable | Reproduction |
| Marine Fish | Sheepshead minnow | LC50 | 3,940 | Moderately Toxic | Lethality |
| Marine Fish | Data gap | NOAEC (d) | No data | No data | No data |
| Marine Invertebrates | Mysid shrimp | EC50 | 490 | Highly Toxic | Lethality |
| Marine Invertebrates | Data gap | NOAEC (d) | No data | No data | No data |
| Freshwater sediment invertebrates | Data gap | Acute (h) | No data | No data | No data |
| Marine sediment invertebrates | Data gap | Acute (h) | No data | No data | No data |
| Freshwater sediment invertebrates | Data gap | Chronic (c) | No data | No data | No data |
| Marine sediment invertebrates | Data gap | Chronic (c) | No data | No data | No data |

a) There is an acute study in Western Chorus frogs which was supplemental with an LC50 of 210 ppb
b) Data-call-in for typical end products containing PBO

c) Data-gap identified by EPA, but a data-call-in was not stated
d) Data-gap identified by EPA, but a data-call-in was stated
e) PBO plus other pesticides which may be co-applied
f) Data call in is for PBO major degradates
g) Studies not mentioned

| **Appendix VI Table 1.2b PBO Mosquito and Selected Agricultural Use Scenarios and Associated Risks(EPA 2005g) (EPA 2010b) (a)** | | | | | |
|---|---|---|---|---|---|
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC 4 inches (ppb)** | **Surface water RQ** |
| **Mosquito PBO air 1 treatment direct water 0.08 lbs ai/A, RICE Model** | | | | | |
| Freshwater fish | Acute (b, e) | 0.5 | 1900 | 75 | 0.04 |
| Freshwater invertebrates | Acute (b, e) | 0.5 | 510 | 75 | 0.15 |
| Marine fish | Acute | 0.5 | 3940 | 75 | 0.02 |
| Marine invertebrates | Acute | 0.5 | 490 | 75 | 0.15 |
| Freshwater fish | Chronic (f) | 1 | 40 | No Data | No Data |
| Freshwater invertebrates | Chronic | 1 | 30 | No Data | No Data |
| Marine fish | Chronic (d) | 1 | No Data | No Data | No Data |
| Marine invertebrates | Chronic (d) | 1 | No Data | No Data | No Data |
| **Mosquito PBO air 1 treatment direct water 0.08 lbs ai/A, RICE Model** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Pore water (ppb)** | **Pore water RQ** |
| Freshwater sediment invertebrates | Acute (h) | 0.5 | No Data | No Data | No Data |
| Marine sediment invertebrates | Acute (h) | 0.5 | No Data | No Data | No Data |
| Freshwater sediment invertebrates | Chronic (c) | 1 | No Data | No Data | No Data |
| Marine sediment invertebrates | Chronic (c) | 1 | No Data | No Data | No Data |

| **Appendix VI Table 1.2b PBO Mosquito and Selected Agricultural Use Scenarios and Associated Risks(EPA 2005g) (EPA 2010b) (a)** | | | | | |
|---|---|---|---|---|---|
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC 4 inches (ppb)** | **Surface water RQ** |
| **Ag Peppers PBO air 10 (3) 0.5 lbs ai/A, PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface water 6.65 ft (ppb)** | **Surface water RQ** |
| Freshwater fish | Acute (b, e) | 0.5 | 1900 | 160 | 0.08 |
| Freshwater invertebrates | Acute (b, e) | 0.5 | 510 | 160 | 0.31 |
| Marine fish | Acute | 0.5 | 3940 | 160 | 0.04 |
| Marine invertebrates | Acute | 0.5 | 490 | 160 | 0.33 |
| Freshwater fish | Chronic (f) | 1 | 40 | 144 | **3.60** |
| Freshwater invertebrates | Chronic | 1 | 30 | 153 | **5.10** |
| Marine fish | Chronic (d) | 1 | No Data | 144 | No Data |
| Marine invertebrates | Chronic (d) | 1 | No Data | 153 | No Data |
| **Ag Peppers PBO air 10 (3) 0.5 lbs ai/A, PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Pore water (ppb)** | **Pore water RQ** |
| Freshwater sediment invertebrates | Acute (h) | 0.5 | No Data | No Data | No Data |
| Marine sediment invertebrates | Acute (h) | 0.5 | No Data | No Data | No Data |
| Freshwater sediment invertebrates | Chronic (c) | 1 | No Data | No Data | No Data |
| Marine sediment invertebrates | Chronic (c) | 1 | No Data | No Data | No Data |
| **Ag Peppers PBO ground 10 (3) 0.5 lbs ai/A, PRZM-EXAMS** | | | | | |

| **Appendix VI Table 1.2b PBO Mosquito and Selected Agricultural Use Scenarios and Associated Risks(EPA 2005g) (EPA 2010b) (a)** | | | | | |
|---|---|---|---|---|---|
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC 4 inches (ppb)** | **Surface water RQ** |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface water 6.65 ft (ppb)** | **Surface water RQ** |
| Freshwater fish | Acute (b, e) | 0.5 | 1900 | 159 | 0.08 |
| Freshwater invertebrates | Acute (b, e) | 0.5 | 510 | 159 | 0.31 |
| Marine fish | Acute | 0.5 | 3940 | 159 | 0.04 |
| Marine invertebrates | Acute | 0.5 | 490 | 159 | 0.32 |
| Freshwater fish | Chronic | 1 | 40 | 140 | **3.50** |
| Freshwater invertebrates | Chronic | 1 | 30 | 152 | **5.07** |
| Marine fish | Chronic (d) | 1 | No Data | 152 | No Data |
| Marine invertebrates | Chronic (d) | 1 | No Data | 152 | No Data |
| **Ag Peppers PBO ground 10 (3) 0.5 lbs ai/A, PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Pore water (ppb)** | **Pore water RQ** |
| Freshwater sediment invertebrates | Acute (h) | 0.5 | No Data | No Data | No Data |
| Marine sediment invertebrates | Acute (h) | 0.5 | No Data | No Data | No Data |
| Freshwater sediment invertebrates | Chronic (c) | 1 | No Data | No Data | No Data |
| Marine sediment invertebrates | Chronic (c) | 1 | No Data | No Data | No Data |

a) There is an acute study in Western Chorus frogs which was supplemental with an LC50 of 210 ppb EPA rated the study supplemental
b) Data-call-in for typical end products containing PBO

c) Data-gap identified by EPA, but a data-call-in was not stated
d) Data-gap identified by EPA, but a data-call-in was stated
e) PBO plus other pesticides which may be co-applied
f) Data call in is for PBO major degradates
g) Studies not mentioned

**Appendix VI Table 1.3a Aquatic Toxicity Endpoints in the Most Sensitive Species for Permethrin Used by EPA for Aquatic Risk Assessment (EPA 2011h, 2006i)**

| Group | Most Sensitive Species | Test | Results (ppb) | EPA Toxicity Category | Endpoint |
|---|---|---|---|---|---|
| Freshwater Fish | Bluegill Sunfish | LC50 | 0.79 | Very Highly Toxic | Lethality |
| Freshwater Fish | Fathead minnow | NOAEC | 0.3 | Not Applicable | Not stated |
| Freshwater Invertebrates | Scud | EC50 | 0.0212 | Very Highly Toxic | Lethality |
| Freshwater Invertebrates | Daphnia | EC50 | 0.039 | Very Highly Toxic | Lethality |
| Freshwater Invertebrates | Daphnia | NOAEC | 0.039 | Not Applicable | Reproduction and growth |
| Marine Fish | Atlantic silverside | LC50 | 2.2 | Very Highly Toxic | Lethality |
| Marine Fish | Sheepshead minnow | NOAEC | 10 | Not Applicable | Not stated |
| Marine Invertebrates | Stone crab | EC50 | 0.018 | Very Highly Toxic | Lethality |
| Marine Invertebrates | Mysid shrimp | NOAEC | 0.011 | Not Applicable | Not stated |
| Freshwater sediment invertebrates | Data gap | Acute (a) | No data | No data | No data |

| Appendix VI Table 1.3a Aquatic Toxicity Endpoints in the Most Sensitive Species for Permethrin Used by EPA for Aquatic Risk Assessment (EPA 2011h, 2006i) | | | | | |
|---|---|---|---|---|---|
| **Group** | **Most Sensitive Species** | **Test** | **Results (ppb)** | **EPA Toxicity Category** | **Endpoint** |
| Marine sediment invertebrates | Data gap | Acute (a) | No data | No data | No data |
| Freshwater sediment invertebrates | Data gap | Chronic (b) | No data | No data | No data |
| Marine sediment invertebrates | Data gap | Chronic (b) | No data | No data | No data |

a) Data-gap identified by EPA, but a data-call-in was stated
b) Studies not mentioned

| Appendix VI Table 1.3b Permethrin Mosquito and Selected Agricultural Use Scenarios and Associated Aquatic Risks (EPA 2011h, EPA 2006i) | | | | | |
|---|---|---|---|---|---|
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface water (ppb)** | **Surface water RQ** |
| **Permethrin Mosquito ULV Air: 10 mph, 26 (4) 5% drift; 0.007 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |
| Freshwater fish | Acute | 0.5 | 0.79 | 0.048 | 0.06 |
| Freshwater invertebrates | Acute | 0.5 | 0.039 | 0.048 | **1.23** |
| Marine fish | Acute | 0.5 | 2.2 | 0.048 | 0.02 |
| Marine invertebrates | Acute | 0.5 | 0.018 | 0.048 | **2.67** |
| Freshwater fish | Chronic (c) | 1 | 0.3 | 0.03 | 0.10 |
| Freshwater fish | Chronic (a) | 1 | 0.0515 | 0.03 | 0.58 |
| Freshwater invertebrates | Chronic (c) | 1 | 0.039 | 0.031 | 0.79 |

| **Appendix VI Table 1.3b Permethrin Mosquito and Selected Agricultural Use Scenarios and Associated Aquatic Risks (EPA 2011h, EPA 2006i)** | | | | | |
|---|---|---|---|---|---|
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface water (ppb)** | **Surface water RQ** |
| Freshwater invertebrates | Chronic (a) | 1 | 0.0014 | 0.031 | **22.14** |
| Marine fish | Chronic (c) | 1 | 10 | 0.03 | 0.00 |
| Marine fish | Chronic (a) | 1 | 0.1434 | 0.03 | 0.21 |
| Marine invertebrates | Chronic (c) | 1 | 0.011 | 0.031 | **2.82** |
| Marine invertebrates | Chronic (a) | 1 | 0.0012 | 0.031 | **25.83** |
| **Permethrin Mosquito ULV Air: 10 mph, 26 (4) 5% drift; 0.007 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Pore water (ppb)** | **Pore water RQ** |
| Freshwater sediment invertebrates | Acute (d) | 0.5 | No data | No data | No data |
| Marine sediment invertebrates | Acute (d) | 0.5 | No data | No data | No data |
| Freshwater sediment invertebrates | Chronic (b) | 1 | No data | No data | No data |
| Marine sediment invertebrates | Chronic (b) | 1 | No data | No data | No data |
| **Permethrin Mosquito ULV Air: 10 mph, 26 (4) 5% drift; 0.035 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface water (ppb)** | **Surface water RQ** |
| Freshwater fish | Acute | 0.5 | 0.79 | 0.019 | 0.02 |
| Freshwater invertebrates | Acute | 0.5 | 0.039 | 0.019 | 0.49 |
| Freshwater invertebrates | Acute | 0.5 | 0.039 | 0.019 | 0.49 |
| Marine fish | Acute | 0.5 | 2.2 | 0.019 | 0.01 |
| Marine invertebrates | Acute | 0.5 | 0.018 | 0.019 | **1.06** |

| **Appendix VI Table 1.3b Permethrin Mosquito and Selected Agricultural Use Scenarios and Associated Aquatic Risks (EPA 2011h, EPA 2006i)** | | | | | |
|---|---|---|---|---|---|
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface water (ppb)** | **Surface water RQ** |
| Freshwater fish | Chronic (c) | 1 | 0.3 | 0.012 | 0.04 |
| Freshwater fish | Chronic (a) | 1 | 0.0515 | 0.012 | 0.23 |
| Freshwater invertebrates | Chronic (c) | 1 | 0.039 | 0.012 | 0.31 |
| Freshwater invertebrates | Chronic (a) | 1 | 0.0014 | 0.012 | **8.57** |
| Marine fish | Chronic (c) | 1 | 10 | 0.012 | 0.00 |
| Marine fish | Chronic (a) | 1 | 0.1434 | 0.012 | 0.08 |
| Marine invertebrates | Chronic (c) | 1 | 0.011 | 0.012 | **1.09** |
| Marine invertebrates | Chronic (a) | 1 | 0.0012 | 0.012 | **10.00** |
| **Permethrin Mosquito ULV Air: 10 mph, 26 (4) 5% drift; 0.035 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Pore water (ppb)** | **Pore water RQ** |
| Freshwater sediment invertebrates | Acute (d) | 0.5 | No data | No data | No data |
| Marine sediment invertebrates | Acute (d) | 0.5 | No data | No data | No data |
| Freshwater sediment invertebrates | Chronic (b) | 1 | No data | No data | No data |
| Marine sediment invertebrates | Chronic (b) | 1 | No data | No data | No data |
| **Permethrin Mosquito ULV Air: 10 mph, 26 (1) 5% drift; 0.007 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface water (ppb)** | **Surface water RQ** |
| Freshwater fish | Acute | 0.5 | 0.79 | 0.496 | 0.63 |
| Freshwater invertebrates | Acute | 0.5 | 0.039 | 0.496 | **12.72** |

| **Appendix VI Table 1.3b Permethrin Mosquito and Selected Agricultural Use Scenarios and Associated Aquatic Risks (EPA 2011h, EPA 2006i)** | | | | | |
|---|---|---|---|---|---|
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface water (ppb)** | **Surface water RQ** |
| Marine fish | Acute | 0.5 | 2.2 | 0.496 | 0.23 |
| Marine invertebrates | Acute | 0.5 | 0.018 | 0.496 | **27.56** |
| Freshwater fish | Chronic (c) | 1 | 0.3 | 0.268 | 0.89 |
| Freshwater fish | Chronic (a) | 1 | 0.0515 | 0.268 | **5.20** |
| Freshwater invertebrates | Chronic (c) | 1 | 0.039 | 0.385 | **9.87** |
| Freshwater invertebrates | Chronic (a) | 1 | 0.0014 | 0.385 | **275.00** |
| Marine fish | Chronic (c) | 1 | 10 | 0.268 | 0.03 |
| Marine fish | Chronic (a) | 1 | 0.1434 | 0.268 | **1.87** |
| Marine invertebrates | Chronic (c) | 1 | 0.011 | 0.385 | **35.00** |
| Marine invertebrates | Chronic (a) | 1 | 0.0012 | 0.385 | **320.83** |
| **Permethrin Mosquito ULV Air: 10 mph, 26 (1) 5% drift; 0.007 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Pore water (ppb)** | **Pore water RQ** |
| Freshwater sediment invertebrates | Acute (d) | 0.5 | No data | No data | No data |
| Marine sediment invertebrates | Acute (d) | 0.5 | No data | No data | No data |
| Freshwater sediment invertebrates | Chronic (b) | 1 | No data | No data | No data |
| Marine sediment invertebrates | Chronic (b) | 1 | No data | No data | No data |
| **Permethrin ME-potatoes Air: unknown wind speed, 5 (4) 5% drift; 0.2 lbs ai/A,PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | LOC | **Toxicity endpoint (ppb)** | **EEC Surface water (ppb)** | **Surface water RQ** |

| **Appendix VI Table 1.3b Permethrin Mosquito and Selected Agricultural Use Scenarios and Associated Aquatic Risks (EPA 2011h, EPA 2006i)** | | | | | |
|---|---|---|---|---|---|
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface water (ppb)** | **Surface water RQ** |
| Freshwater fish | Acute | 0.5 | 0.79 | 5.32 | **6.73** |
| Freshwater invertebrates | Acute | 0.5 | 0.039 | 5.32 | **136.41** |
| Marine fish | Acute | 0.5 | 2.2 | 5.32 | **2.42** |
| Marine invertebrates | Acute | 0.5 | 0.018 | 5.32 | **295.56** |
| Freshwater fish | Chronic (c) | 1 | 0.3 | 1.02 | **3.40** |
| Freshwater fish | Chronic (a) | 1 | 0.0515 | 1.02 | **19.81** |
| Freshwater invertebrates | Chronic (c) | 1 | 0.039 | 1.32 | **33.85** |
| Freshwater invertebrates | Chronic (a) | 1 | 0.0014 | 1.32 | **942.86** |
| Marine fish | Chronic (c) | 1 | 10 | 1.02 | 0.10 |
| Marine fish | Chronic (a) | 1 | 0.1434 | 1.02 | **7.11** |
| Marine invertebrates | Chronic (c) | 1 | 0.011 | 1.32 | **120.00** |
| Marine invertebrates | Chronic (a) | 1 | 0.0012 | 1.32 | **1100.00** |
| **Permethrin ME-potatoes Air: unknown wind speed, 5 (4) 5% drift; 0.2 lbs ai/A,PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Pore water (ppb)** | **Pore water RQ** |
| Freshwater sediment invertebrates | Acute (d) | 0.5 | No data | 0.56 | No data |
| Marine sediment invertebrates | Acute (d) | 0.5 | No data | 0.56 | No data |
| Freshwater sediment invertebrates | Chronic (b) | 1 | No data | 0.55 | No data |
| Marine sediment invertebrates | Chronic (b) | 1 | No data | 0.55 | No data |
| **Permethrin ME-potatoes Air: unknown wind speed, 5 (4) 5% drift; 0.11 lbs ai/A,PRZM-EXAMS** | | | | | |

| **Appendix VI Table 1.3b Permethrin Mosquito and Selected Agricultural Use Scenarios and Associated Aquatic Risks (EPA 2011h, EPA 2006i)** | | | | | |
|---|---|---|---|---|---|
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface water (ppb)** | **Surface water RQ** |
| **Group** | **Duration** | LOC | **Toxicity endpoint (ppb)** | **EEC Surface water (ppb)** | **Surface water RQ** |
| Freshwater fish | Acute | 0.5 | 0.79 | 0.61 | **0.77** |
| Freshwater invertebrates | Acute | 0.5 | 0.039 | 0.61 | **15.64** |
| Marine fish | Acute | 0.5 | 2.2 | 0.61 | 0.28 |
| Marine invertebrates | Acute | 0.5 | 0.018 | 0.61 | **33.89** |
| Freshwater fish | Chronic (c) | 1 | 0.3 | 0.08 | 0.27 |
| Freshwater fish | Chronic (a) | 1 | 0.0515 | 0.08 | **1.55** |
| Freshwater invertebrates | Chronic (c) | 1 | 0.039 | 0.12 | **3.08** |
| Freshwater invertebrates | Chronic (a) | 1 | 0.0014 | 0.12 | **85.71** |
| Marine fish | Chronic (c) | 1 | 10 | 0.08 | 0.01 |
| Marine fish | Chronic (a) | 1 | 0.1434 | 0.08 | 0.56 |
| Marine invertebrates | Chronic (c) | 1 | 0.011 | 0.12 | **10.91** |
| Marine invertebrates | Chronic (a) | 1 | 0.0012 | 0.12 | **100.00** |
| **Permethrin ME-potatoes Air: unknown wind speed, 5 (4) 5% drift; 0.11 lbs ai/A,PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Pore water (ppb)** | **Pore water RQ** |
| Freshwater sediment invertebrates | Acute (d) | 0.5 | No data | 0.04 | No data |
| Marine sediment invertebrates | Acute (d) | 0.5 | No data | 0.04 | No data |
| Freshwater sediment invertebrates | Chronic (b) | 1 | No data | 0.04 | No data |

| Appendix VI Table 1.3b Permethrin Mosquito and Selected Agricultural Use Scenarios and Associated Aquatic Risks (EPA 2011h, EPA 2006i) | | | | | |
|---|---|---|---|---|---|
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface water (ppb)** | **Surface water RQ** |
| Marine sediment invertebrates | Chronic (b) | 1 | No data | 0.04 | No data |

c) Calculated using the acute to chronic ratio method
d) Data-gap identified by EPA, but a data-call-in was stated
e) Toxicity endpoint form laboratory studies
f) Studies not mentioned

| **Appendix VI Table 1.4a Aquatic Toxicity Endpoints in the Most Sensitive Species for Phenothrin Used by EPA for Aquatic Risk Assessment (EPA 2008f)** | | | | | |
|---|---|---|---|---|---|
| **Group** | **Most Sensitive Species** | **Test** | **Results (ppb)** | **EPA Toxicity Category** | **Endpoint** |
| Freshwater Fish | Bluegill Sunfish | LC50 (a) | 15.8 | Very Highly Toxic | Lethality |
| Freshwater Fish | Trout* | NOAEC (a) | 1.1 | Not Applicable | Reproduction and growth |
| Freshwater Invertebrates | Daphnia | EC50 (b) | 4.4 | Very Highly Toxic | Lethality |
| Freshwater Invertebrates | Daphnia | LOAEC (b) | 0.81 | Not Applicable | Reproduction and growth |
| Marine Fish | Sheepshead minnow | LC50 (a) | 38.3 | Very Highly Toxic | Lethality |
| Marine Fish | Data gap | NOAEC (c) | No data | No data | No data |
| Marine Invertebrates | Mysid shrimp | EC50 (b) | 0.025 | Very Highly Toxic | Lethality |
| Marine Invertebrates | Mysid shrimp | NOAEC (b) | 0.0026 | Not Applicable | Calculated |
| Freshwater sediment invertebrates | Data gap | Acute (b, d) | No data | No data | No data |
| Marine sediment invertebrates | Data gap | Acute (b, d) | No data | No data | No data |
| Freshwater sediment invertebrates | Data gap | Chronic (b, d) | No data | No data | No data |
| Marine sediment invertebrates | Data gap | Chronic (b, d) | No data | No data | No data |

a) EPA rated the study supplemental
b) EPA used freshwater invertebrate and marine invertebrate toxicity data to estimate risks to sediment dwellers
c) Data-gap identified by EPA, but a data-call-in was not stated
d) Data-gap identified by EPA, but a data-call-in was stated

| **Appendix VI Table 1.4b Phenothrin Mosquito Use Scenarios and Associated Aquatic Risks (EPA 2008f)** | | | | | |
|---|---|---|---|---|---|
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface water (ppb)** | **Surface water RQ** |
| **Mosquito phenothrin ULV Air: 10 mph, 15 (1) 5% drift; 0.0036 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |
| Freshwater fish | Acute (a) | 0.5 | 15.8 | 0.08 | 0.01 |
| Freshwater invertebrates | Acute (b) | 0.5 | 4.4 | 0.08 | 0.02 |
| Marine fish | Acute (a) | 0.5 | 38.3 | 0.08 | 0.00 |
| Marine invertebrates | Acute (b) | 0.5 | 0.025 | 0.08 | **3.20** |
| Freshwater fish | Chronic (a) | 1 | 1.1 | 0.035 | 0.03 |
| Freshwater invertebrates | Chronic (b) | 1 | 0.81 | 0.051 | 0.06 |
| Marine fish | Chronic (c) | 1 | No data | 0.035 | No data |
| Marine invertebrates | Chronic (b) | 1 | 0.0026 | 0.051 | **19.62** |
| **Mosquito phenothrin ULV Air: 10 mph, 15 (1) 5% drift; 0.0036 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Pore water (ppb)** | **Pore water RQ** |
| Freshwater sediment invertebrates | Acute (b, d) | 0.5 | 4.4 | 0.013 | 0.00 |
| Marine sediment invertebrates | Acute (b, d) | 0.5 | 0.025 | 0.013 | **0.52** |
| Freshwater sediment invertebrates | Chronic (b, d) | 1 | 0.81 | 0.013 | 0.02 |
| Marine sediment invertebrates | Chronic (b, d) | 1 | 0.0026 | 0.013 | **5.00** |
| **Mosquito phenothrin ULV Air: 3 mph, 26 (1) 5% drift; 0.0036 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |

| **Appendix VI Table 1.4b Phenothrin Mosquito Use Scenarios and Associated Aquatic Risks (EPA 2008f)** | | | | | |
|---|---|---|---|---|---|
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface water (ppb)** | **Surface water RQ** |
| Freshwater fish | Acute (a) | 0.5 | 15.8 | 0.325 | 0.02 |
| Freshwater invertebrates | Acute (b) | 0.5 | 4.4 | 0.325 | 0.07 |
| Marine fish | Acute (a) | 0.5 | 38.3 | 0.325 | 0.01 |
| Marine invertebrates | Acute (b) | 0.5 | 0.025 | 0.196 | **7.84** |
| Freshwater invertebrates | Chronic (a) | 1 | 0.81 | 0.259 | 0.32 |
| Freshwater fish | Chronic (b) | 1 | 1.1 | 0.196 | 0.18 |
| Marine fish | Chronic (c) | 1 | No data | 0.035 | No data |
| Marine invertebrates | Chronic (b) | 1 | 0.0026 | 0.259 | **99.62** |
| **Mosquito phenothrin ULV Air: 3 mph, 26 (1) 5% drift; 0.0036 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **Pore water** | **Pore water RQ** |
| Freshwater sediment invertebrates | Acute (b, d) | 0.5 | 4.4 | 0.075 | 0.02 |
| Marine sediment invertebrates | Acute (b, d) | 0.5 | 0.025 | 0.075 | **3.00** |
| Freshwater sediment invertebrates | Chronic (b, d) | 1 | 0.81 | 0.074 | 0.09 |
| Marine sediment invertebrates | Chronic (b, d) | 1 | 0.0026 | 0.074 | **28.46** |

a) EPA rated the study supplemental
b) EPA used freshwater invertebrate and marine invertebrate toxicity data to estimate risks to sediment dwellers
c) Data-gap identified by EPA, but a data-call-in was not stated
d) Data-gap identified by EPA, but a data-call-in was stated

| **Appendix VI Table 1.5a Aquatic Toxicity Endpoints in the Most Sensitive Species for Prallethrin Used by EPA for Aquatic Risk Assessment (EPA 2012h)** | | | | | |
|---|---|---|---|---|---|
| **Group** | **Most Sensitive Species** | **Test** | **Results (ppb)** | **EPA Toxicity Category** | **Endpoint** |
| Freshwater Fish | Rainbow trout | LC50 | 12 | Very Highly Toxic | Lethality |
| Freshwater Fish | Rainbow trout | NOAEC | 3 | Not Applicable | No Effects |
| Freshwater Invertebrates | Daphnia | EC50 | 6.2 | Very Highly Toxic | Lethality |
| Freshwater Invertebrates | Daphnia | NOAEC | 0.65 | Not Applicable | Reproduction |
| Marine Fish | Sheepshead minnow | LC50 | 26 | Very Highly Toxic | Lethality |
| Marine Fish | Sheepshead minnow | NOAEC | 11 | Not Applicable | no data |
| Marine Invertebrates | Eastern oyster | EC50 | 640 | Highly Toxic | Lethality |
| Marine Invertebrates | Data gap | NOAEC (b) | No data | No data | No data |
| Freshwater sediment invertebrates | Data gap | Acute (a, b) | No data | No data | No data |
| Marine sediment invertebrates | Data gap | Acute (b) | No data | No data | No data |
| Freshwater sediment invertebrates | Data gap | Chronic (a, b) | No data | No data | No data |
| Marine sediment invertebrates | Data gap | Chronic (b) | No data | No data | No data |

a) EPA rated the study supplemental

b) Data-gap identified by EPA, but a data-call-in was stated

| Appendix VI Table 1.5b Prallethrin Mosquito Use Scenarios and Associated Aquatic Risks (EPA 2012h) | | | | | |
|---|---|---|---|---|---|
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface water (ppb)** | **Surface water RQ** |
| **Mosquito Prallethrin, 26 (7) 5%; 0.0008 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |
| Freshwater fish | Acute | 0.5 | 12 | 0.0088 | 0.00 |
| Freshwater invertebrates | Acute | 0.5 | 6.2 | 0.0088 | 0.00 |
| Marine fish | Acute | 0.5 | 26 | 0.0088 | 0.00 |
| Marine invertebrates | Acute | 0.5 | 640 | 0.0088 | 0.00 |
| Freshwater fish | Chronic | 1 | 3 | 0.0053 | 0.00 |
| Freshwater invertebrates | Chronic | 1 | 0.65 | 0.0051 | 0.01 |
| Marine fish | Chronic (b) | 1 | No data | 0.0053 | No data |
| **Mosquito Prallethrin, 26 (7) 5%; 0.0008 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Pore water (ppb)** | **Pore water RQ** |
| Freshwater sediment invertebrates | Acute (a, b) | 0.5 | 14.9 | 0.0026 | 0.00 |
| Marine sediment invertebrates | Acute (b) | 0.5 | No data | 0.0026 | No data |
| Freshwater sediment invertebrates | Chronic (a, b) | 1 | 1400 | 0.0025 | 0.00 |
| Marine sediment invertebrates | Chronic (b) | 1 | No data | 0.0025 | No data |

a) EPA rated the study supplemental
b) Data-gap identified by EPA, but a data-call-in was stated

| **Appendix VI Table 1.6a Aquatic Toxicity Endpoints in the Most Sensitive Species for Pyrethrins Used by EPA for Aquatic Risk Assessment (EPA 2011i, EPA 2006b)** | | | | | |
|---|---|---|---|---|---|
| **Group** | **Most Sensitive Species** | **Test** | **Results (ppb)** | **EPA Toxicity Category** | **Endpoint** |
| Freshwater Fish | Rainbow trout | LC50 | 5.1 | Very Highly Toxic | Lethality |
| Freshwater Fish | Fathead minnow | NOAEC | 1.9 | Not Applicable | Not stated |
| Freshwater Invertebrates | Daphnia | EC50 | 11.6 | Very Highly Toxic | Lethality |
| Freshwater Invertebrates | Daphnia | NOAEC | 0.86 | Not Applicable | Reproduction |
| Marine Fish | Sheepshead minnow | LC50 | 16 | Very Highly Toxic | Lethality |
| Marine Fish | Data gap | NOAEC | No data | No data | No data |
| Marine Invertebrates | Mysid shrimp | EC50 | 1.4 | Very Highly Toxic | Lethality |
| Marine Invertebrates | Mysid shrimp | NOAEC | 0.1 | Not Applicable | Calculated |
| Freshwater sediment invertebrates | Data gap | Acute (a, b) | No data | No data | No data |
| Freshwater sediment invertebrates | Data gap | Acute (a, b) | No data | No data | No data |
| Marine sediment invertebrates | Data gap | Chronic (a, b) | No data | No data | No data |
| Marine sediment invertebrates | Data gap | Chronic (b) | No data | No data | No data |

a) EPA used freshwater invertebrate and marine invertebrate toxicity data to estimate risks to sediment dwellers
b) Data-gap identified by EPA, but a data-call-in was stated

| Appendix VI Table 1.6b Pyrethrins (Extract 57% or 58%) Mosquito and Selected Agricultural Use Scenarios and Associated Risks (EPA 2012h) | | | | | |
|---|---|---|---|---|---|
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface water (ppb)** | **Surface water RQ** |
| **Mosquito Pyrethrins Air 26 (4) 5%; 0.008 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |
| Freshwater fish | Acute | 0.5 | 5.1 | 0.009 | 0.00 |
| Freshwater invertebrates | Acute (a) | 0.5 | 11.6 | 0.009 | 0.00 |
| Marine fish | Acute | 0.5 | 16 | 0.009 | 0.00 |
| Marine invertebrates | Acute (a) | 0.5 | 1.4 | 0.009 | 0.01 |
| Freshwater fish | Chronic | 1 | 1.9 | 0.005 | 0.00 |
| Freshwater invertebrates | Chronic | 1 | 0.86 | 0.005 | 0.01 |
| Marine fish | Chronic (b) | 1 | No data | 0.005 | No data |
| Marine invertebrates | Chronic (b) | 1 | No data | 0.005 | No data |
| **Mosquito Pyrethrins Air 26 (4) 5%; 0.008 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Pore water (ppb)** | **Pore water RQ** |
| Freshwater sediment invertebrates | Acute (a, b) | 0.5 | 11.6 | 0.002 | 0.00 |
| Freshwater sediment invertebrates | Acute (a, b) | 0.5 | 1.4 | 0.002 | 0.00 |
| Marine sediment invertebrates | Chronic (a, b) | 1 | 0.86 | 0.002 | 0.00 |
| Marine sediment invertebrates | Chronic (b) | 1 | No data | 0.002 | No data |
| **Mosquito Pyrethrins Air 26 (4) 5%; 0.0025 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |
| Freshwater fish | Acute | 0.5 | 5.1 | 0.003 | 0.00 |
| Freshwater invertebrates | Acute (a) | 0.5 | 11.6 | 0.003 | 0.00 |

| **Appendix VI Table 1.6b Pyrethrins (Extract 57% or 58%) Mosquito and Selected Agricultural Use Scenarios and Associated Risks (EPA 2012h)** | | | | | |
|---|---|---|---|---|---|
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface water (ppb)** | **Surface water RQ** |
| Marine fish | Acute | 0.5 | 16 | 0.003 | 0.00 |
| Marine invertebrates | Acute (a) | 0.5 | 1.4 | 0.003 | 0.00 |
| Freshwater fish | Chronic | 1 | 1.9 | 0.002 | 0.00 |
| Freshwater invertebrates | Chronic | 1 | 0.86 | 0.002 | 0.00 |
| Marine fish | Chronic (b) | 1 | No data | 0.002 | No data |
| Marine invertebrates | Chronic (b) | 1 | No data | 0.002 | No data |
| **Mosquito Pyrethrins Air 26 (4) 5%; 0.0025 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Pore water (ppb)** | **Pore water RQ** |
| Freshwater sediment invertebrates | Acute (a, b) | 0.5 | 11.6 | 0.002 | 0.00 |
| Freshwater sediment invertebrates | Acute (a, b) | 0.5 | 1.4 | 0.002 | 0.00 |
| Marine sediment invertebrates | Chronic (a, b) | 1 | 0.86 | 0.002 | 0.00 |
| Marine sediment invertebrates | Chronic (b) | 1 | No data | 0.002 | No data |
| **Potatoes ME Pyrethrins Air 10 (1) 5%; 0.056 lbs ai/A, PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface water (ppb)** | **Surface water RQ** |
| Freshwater fish | Acute | 0.5 | 5.1 | 1.353 | 0.27 |
| Freshwater invertebrates | Acute (a) | 0.5 | 11.6 | 1.353 | 0.12 |
| Marine fish | Acute | 0.5 | 16 | 1.353 | 0.08 |
| Marine invertebrates | Acute (a) | 0.5 | 1.4 | 1.353 | **0.97** |

| **Appendix VI Table 1.6b Pyrethrins (Extract 57% or 58%) Mosquito and Selected Agricultural Use Scenarios and Associated Risks (EPA 2012h)** | | | | | |
|---|---|---|---|---|---|
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface water (ppb)** | **Surface water RQ** |
| Freshwater fish | Chronic | 1 | 1.9 | 0.284 | 0.15 |
| Freshwater invertebrates | Chronic | 1 | 0.86 | 0.387 | 0.45 |
| Marine fish | Chronic (b) | 1 | No data | 0.284 | No data |
| Marine invertebrates | Chronic (b) | 1 | No data | 0.387 | No data |
| **Potatoes ME Pyrethrins Air 10 (1) 5%; 0.056 lbs ai/A, PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Pore water (ppb)** | **Pore water RQ** |
| Freshwater sediment invertebrates | Acute (a, b) | 0.5 | 11.6 | 0.159 | 0.01 |
| Freshwater sediment invertebrates | Acute (a, b) | 0.5 | 1.4 | 0.159 | 0.11 |
| Marine sediment invertebrates | Chronic (a, b) | 1 | 0.86 | 0.154 | 0.18 |
| Marine sediment invertebrates | Chronic (b) | 1 | No data | 0.154 | No data |
| **Potatoes ID Pyrethrins Air 10 (1) 5%; 0.056 lbs ai/A, PRZM-EXAMS** | | | | | |
| Freshwater fish | Acute | 0.5 | 5.1 | 0.366 | 0.07 |
| Freshwater invertebrates | Acute (a) | 0.5 | 11.6 | 0.366 | 0.03 |
| Marine fish | Acute | 0.5 | 16 | 0.366 | 0.02 |
| Marine invertebrates | Acute (a) | 0.5 | 1.4 | 0.366 | 0.26 |
| Freshwater fish | Chronic | 1 | 1.9 | 0.085 | 0.04 |
| Freshwater invertebrates | Chronic | 1 | 0.86 | 0.165 | 0.19 |
| Marine fish | Chronic (b) | 1 | No data | 0.085 | No data |
| Marine invertebrates | Chronic (b) | 1 | No data | 0.165 | No data |

| Appendix VI Table 1.6b Pyrethrins (Extract 57% or 58%) Mosquito and Selected Agricultural Use Scenarios and Associated Risks (EPA 2012h) | | | | | |
|---|---|---|---|---|---|
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface water (ppb)** | **Surface water RQ** |
| **Potatoes ID Pyrethrins Air 10 (1) 5%; 0.056 lbs ai/A, PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Pore water (ppb)** | **Pore water RQ** |
| Freshwater sediment invertebrates | Acute (a, b) | 0.5 | 11.6 | 0.038 | 0.00 |
| Freshwater sediment invertebrates | Acute (a, b) | 0.5 | 1.4 | 0.038 | 0.03 |
| Marine sediment invertebrates | Chronic (a, b) | 1 | 0.86 | 0.037 | 0.04 |
| Marine sediment invertebrates | Chronic (b) | 1 | No data | 0.037 | No data |

a) EPA used freshwater invertebrate and marine invertebrate toxicity data to estimate risks to sediment dwellers
b) Data-gap identified by EPA, but a data-call-in was stated

| Appendix VI Table 1.7a Aquatic Toxicity Endpoints in the Most Sensitive Species for Resmethrin Used by EPA for Aquatic Risk Assessment (EPA 2012i, 2006d) | | | | | |
|---|---|---|---|---|---|
| **Group** | **Most Sensitive Species** | **Test** | **Results (ppb)** | **EPA Toxicity Category** | **Endpoint** |
| Freshwater Fish | Rainbow trout* | LC50 (a, d) | 0.28 | Very Highly Toxic | Lethality |
| Freshwater Fish | Rainbow trout* | NOAEC (a, d) | 0.32 | Not Applicable | Not stated |
| Freshwater Invertebrates | Daphnia* | EC50 (a, d) | 3.11 | Very Highly Toxic | Lethality |
| Freshwater Invertebrates | Data gap | NOAEC (b) | No data | No data | No data |
| Marine Fish | Sheepshead minnow* | LC50 (a, d) | 11 | Very Highly Toxic | Lethality |
| Marine Fish | Sheepshead minnow* | NOAEC(a, d) | 1.9 | Not Applicable | Not stated |
| Marine Invertebrates | Pink shrimp* | EC50 (a, d) | 0.23 | Very Highly Toxic | Lethality |
| Marine Invertebrates | Data gap | NOAEC (b) | No data | No data | No data |
| Freshwater sediment invertebrates | Data gap | Acute (b, c) | No data | No data | No data |
| Marine sediment invertebrates | Data gap | Acute (b, c) | No data | No data | No data |
| Freshwater sediment invertebrates | Data gap | Chronic (b, c) | No data | No data | No data |
| Marine sediment invertebrates | Data gap | Chronic (b, c) | No data | No data | No data |

a) EPA rated the study supplemental
b) Data-gap identified by EPA, but a data-call-in was not stated
c) Data-gap identified by EPA, but a data-call-in was stated
d) Studies are supplemental, EPA is not requiring more data for risk assessment

| **Appendix VI Table 1.7b Resmethrin Mosquito Use Scenarios and Associated Risks (EPA 2012i, EPA 2006d)** | | | | | |
|---|---|---|---|---|---|
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface water (ppb)** | **Surface water RQ** |
| **Mosquito Resmethrin Air 26 (3) 5%; 0.007 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |
| Freshwater fish | Acute (a, d) | 0.5 | 0.28 | 0.014 | 0.05 |
| Freshwater invertebrates | Acute (a, d) | 0.5 | 3.11 | 0.014 | 0.00 |
| Marine fish | Acute (a, d) | 0.5 | 11 | 0.014 | 0.00 |
| Marine invertebrates | Acute (a, c) | 0.5 | 0.23 | 0.014 | 0.06 |
| Freshwater fish | Chronic (a, d) | 1 | 0.32 | 0.01 | 0.03 |
| Freshwater invertebrates | Chronic (b) | 1 | No data | 0.011 | No data |
| Marine fish | Chronic (a, d) | 1 | 1.9 | 0.01 | 0.01 |
| Marine invertebrates | Chronic (b) | 1 | No data | 0.011 | No data |
| **Mosquito Resmethrin Air 26 (3) 5%; 0.007 lbs ai/A, AGDISP-PRZM-EXAMS** | | | | | |
| **Group** | **Duration** | **LOC** | **Toxicity endpoint (ppb)** | **EEC Surface water (ppb)** | **Surface water RQ** |
| Freshwater sediment invertebrates | Acute (b, c) | 0.5 | No data | 0.006 | No data |
| Marine sediment invertebrates | Acute (b, c) | 0.5 | No data | 0.006 | No data |
| Freshwater sediment invertebrates | Chronic (b, c) | 1 | No data | 0.011 | No data |
| Marine sediment invertebrates | Chronic (b, c) | 1 | No data | 0.011 | No data |

a) EPA rated the study supplemental

b) Data-gap identified by EPA, but a data-call-in was not stated
c) Data-gap identified by EPA, but a data-call-in was stated
d) Studies are supplemental, EPA is not requiring more data for risk assessment

## 2.0 ORGANOPHOSPHATES

**Appendix VI Table 2.1a Aquatic Toxicity Endpoints in the Most Sensitive Species for Chlorpyrifos Used by EPA for Aquatic Risk Assessment (EPA 2008e)**

| Group | Most Sensitive Species | Test | Results (ppb) | EPA Toxicity Category | Endpoint |
|---|---|---|---|---|---|
| Freshwater Fish | Bluegill Sunfish | LC50 | 1.8 | Very Highly Toxic | Lethality |
| Freshwater Fish | Fathead minnow | NOAEC | 0.04 | Not Applicable | Not stated |
| Freshwater Invertebrates | Daphnia | EC50 | 0.1 | Very Highly Toxic | Lethality |
| Freshwater Invertebrates | Daphnia | NOAEC | 0.04 | Not Applicable | Not stated |
| Marine Fish | Tidewater silverside | LC50 | 0.96 | Very Highly Toxic | Lethality |
| Marine Fish | Atlantic silverside | NOAEC | 0.28 | Not Applicable | Not stated |
| Marine Invertebrates | Mysid shrimp | LC50 | 0.035 | Very Highly Toxic | Lethality |
| Marine Invertebrates | Mysid shrimp | NOAEC | 0.0046 | Not Applicable | Not stated |

| Appendix VI Table 2.1b Chlorpyrifos, Aquatic Species, Freshwater (ppb, ug ai/L water) | | | | | | |
|---|---|---|---|---|---|---|
| **Species** | **Duration** | **Test** | **Results** | **EEC [a]** | **RQ [c]** | **LOC [d]** |
| Freshwater Fish | Acute | LC50 | 1.8 | 0.4 [a] | 0.22 | 0.5 |
| | Chronic | NOAEC | 0.57 | 0.026 [a] | 0.046 | 1 |
| Freshwater Invertebrates | Acute | EC50 | 0.1 | 0.4 [a] | **4** | 0.5 |
| | Chronic | NOAEC | 0.04 | 0.026 [a] | 0.65 | 1 |
| Freshwater Fish | Acute | LC50 | 1.8 | 0.57[b] | 0.32 | 0.5 |
| | Chronic | NOAEC | 0.57 | 0.016[b] | 0.028 | 1 |
| Freshwater Invertebrates | Acute | EC50 | 0.1 | 0.57[b] | **5.7** | 0.5 |
| | Chronic | NOAEC | 0.04 | 0.016 [b] | 0.4 | 1 |
| **Aquatic Species, Marine (ppb, ug ai/L water) [a]** | | | | | | |
| **Species** | **Duration** | **Test** | **Results** | **EEC [a]** | **RQ [c]** | **LOC [d]** |
| Marine Fish | Acute | LC50 | 0.96 | 0.4[a] | 0.41 | 0.5 |
| | Chronic | NOAEC | 0.2 | 0.026[a] | **13** | 1 |
| Marine Invertebrates | Acute | EC50 | 0.03 | 0.4[a] | 0.13 | 0.5 |
| | Chronic | NOAEC | 0.0046 | 0.026[a] | **5.6** | 1 |
| Marine Fish | Acute | LC50 | 0.96 | 0.57[b] | **0.59** | 0.5 |
| | Chronic | NOAEC | 0.2 | 0.016[b] | 0.08 | 1 |
| Marine Invertebrates | Acute | EC50 | 0.03 | 0.57[b] | **19** | 0.5 |
| | Chronic | NOAEC | 0.0046 | 0.016 [b] | **3.5** | 1 |

a) EEC = Estimated Environmental Concentrations are surface water monitoring data form the National Water-Quality Assessment Program (NAWQA) (EPA 2002b, EPA 2006b).

b) In the 2008 statement of problem, EPA used the same data set, NAQWA with a lower chronic EEC, 0.016 and a higher maximum detection of 0.57 ppb
c) RQ = Risk Quotient, ratio of the EEC to the toxicity endpoint, Unit-less, lower the RQ the less risk
d) LOC = Level of Concern for acute and chronic risk

| Appendix VI Table 2.2a Aquatic Toxicity Endpoints in the Most Sensitive Species for Malathion Used by EPA for Aquatic Risk Assessment (EPA 2004a) | | | | | |
|---|---|---|---|---|---|
| **Group** | **Most Sensitive Species** | **Test** | **Results (ppb)** | **EPA Toxicity Category** | **Endpoint** |
| Freshwater Fish | Rainbow trout | LC50 | 4 | Very Highly Toxic | Lethality |
| Freshwater Fish | Rainbow trout | NOAEC | 21 | Not Applicable | Growth, survival and reproduction |
| Freshwater Invertebrates | Moina (Water flea) | LC50 | 0.01 | Very Highly Toxic | Lethality |
| Freshwater Invertebrates | Daphnia | EC50 | 1 | Very Highly Toxic | Lethality |
| Freshwater Invertebrates | Daphnia | NOAEC | 0.006 | Not Applicable | Not stated |
| Marine Fish | Sheepshead minnow | LC50 | 33 | Very Highly Toxic | Lethality |
| Marine Invertebrates | Mysid shrimp | EC50 | 2.2 | Very Highly Toxic | Lethality |

| Appendix VI Table 2.2b Malathion Acute [a] Aquatic Risks (EPA 2004a, EPA 2009g) (Cheminova 2011a) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Species** | **Test** | **Results [b]** | **EEC range [c]** | **Adj EEC [d]** | **RQ 6 ft. deep [d, e]** | **RQ 0.5 ft. deep [d, e]** | **LOC [f]** |
| **Mosquito Aerial Use Rate 0.23 lbs/A** | | | | | | | |
| Amphibian | LC50 | 0.59 | 38 to 462 | 14 to 171 | **290 [g]** | **6,400** | 0.5 |
| **Mosquito Aerial Use Rate 0.23 lbs/A** | | | | | | | |
| Freshwater Fish | LC50 | 4.1 | 38 to 462 | 14 to 171 | **3.4** | **42** | 0.5 |
| Freshwater Invertebrates | EC50 | 0.01 | 38 to 462 | 14 to 171 | **1,400** | **17,100** | 0.5 |
| **Mosquito Aerial Use Rate 0.23 lbs/A** | | | | | | | |
| Marine Fish | LC50 | 33 | 38 to 462 | 14 to 171 | 0.42 | **5.2** | 0.5 |
| Marine Invertebrates | EC50 | 2.2 | 38 to 462 | 14 to 171 | **6.4** | **78** | 0.5 |

| Appendix VI Table 2.2b Malathion Acute [a] Aquatic Risks (EPA 2004a, EPA 2009g) (Cheminova 2011a) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Species** | **Test** | **Results [b]** | **EEC range [c]** | **Adj EEC [d]** | **RQ 6 ft. deep [d, e]** | **RQ 0.5 ft. deep [d, e]** | **LOC [f]** |
| **Mosquito Ground rate 0.11 lbs/A** | | | | | | | |
| Amphibian | LC50 | 0.59 | 1.3 to 16 | 0.22 to 2.7 | **0.37** | **4.6** | 0.5 |
| **Mosquito Ground rate 0.11 lbs/A** | | | | | | | |
| Freshwater Fish | LC50 | 4.1 | 1.3 to 16 | 0.22 to 2.7 | 0.05 | **0.66** | 0.5 |
| Freshwater Invertebrates | EC50 | 0.01 | 1.3 to 16 | 0.22 to 2.7 | **22** | **270** | 0.5 |
| **Mosquito Ground rate 0.11 lbs/A** | | | | | | | |
| Marine Fish | LC50 | 33 | 1.3 to 16 | 0.22 to 2.7 | 0.007 | **0.08** | 0.5 |
| Marine Invertebrates | EC50 | 2.2 | 1.3 to 16 | 0.22 to 2.7 | **0.1** | **1.23** | 0.5 |

a) Modeling for chronic aquatic exposures was not done (EPA 2004a)
b) Laboratory Results (EPA 2009g)
c) For aerial applications, the assumptions made by EPA were that 100% of the released malathion was a direct application to the water and for ground applications the assumptions were that 20% of the use rate drifted into water. In both cases the pond depth was assumed to be either 0.5 ft. or 6 ft. The ranges reflect the EECs at 0.5 ft. deep and 6 ft. deep for acute exposures (EPA 2004a).
d) The adj EECs in the malathion table for aquatic species are with EPA's original assumptions and weighted for the current label rate of 0.23 lbs ai/A for aerial and 0.11 lbs ai/A for ground applications, respectively. The equations used:
(0.23/0.63) EEC = Adj EEC for air
(0.11/0.63) EEC = Adj EEC for ground
e) RQ = Risk Quotients, ratio of the EEC to the toxicity endpoint, the malathion RQs are based on the current label use rates for adult mosquito control Unit-less, lower the RQ the less risks
f) LOC = Level of Concern for acute and chronic risks
g) RQs in bold exceed the endangered species LOC of 0.05 for aquatic species

| **Appendix VI Table 2.2a Aquatic Toxicity Endpoints in the Most Sensitive Species for Naled-DDVP Used by EPA for Aquatic Risk Assessment (EPA 2008d, EPA 2009g)** | | | | | |
|---|---|---|---|---|---|
| **Group** | **Most Sensitive Species-Naled or DDVP** | **Test** | **Results (ppb) (umoles naled or DDVP/L) [(a)]** | **EPA Toxicity Category** | **Endpoint** |
| Freshwater Fish | Lake trout-naled | LC50 | 92 ppb (0.24 umoles naled/L) | Very Highly Toxic | Lethality |
| Freshwater Fish | Fathead minnow-naled | NOAEC | 2.9 ppb (0.008 umoles naled/L) | Not Applicable | Not stated |
| Freshwater Invertebrates | Daphnia-DDVP | EC50 | 0.066 ppb (0.0003 umoles DDVP/L) | Very Highly Toxic | Lethality |
| Freshwater Invertebrates | Daphnia-DDVP | NOAEC | 0.0045 ppb (0.00012 umoles DDVP/L) | Not Applicable | Not stated |
| Marine Fish | Sheepshead minnow-naled | LC50 | 1,200 ppb (3.1 umoles naled/L) | Moderately Toxic | Lethality |
| Marine Invertebrates | Grass shrimp-naled | EC50 | 9.3 ppb (0.024 umoles naled/L) | Very Highly Toxic | Lethality |

a) The aquatic LC50s and NOAECs are based on compound (naled or DDVP) with the greatest level toxicity (lowest LC50 or NOAEC). Equations for conversion to umoles/L used were:
Results in ug/L water (ppb) x 1 umole naled/381 ug = umole naled/L water, used if naled is more toxic
Results in ug/L water (ppb) x 1 umole DDVP/221 mg = umole DDVP/L water, used if DDVP is more toxic

| **Appendix VI Table 2.2b Naled-DDVP Aquatic Risks (EPA 2008d, EPA 2008g) Use Rate 0.1 lb ai/A (AMVAC 2012a) (a, b)** | | | | | | |
|---|---|---|---|---|---|---|
| **Aquatic Species, Freshwater** | | | | | | |
| **Species** | **Duration** | **Test** | **Results** | **EEC (b)** | **RQ (c)** | **LOC (d)** |
| Fish | Acute | LC50 | 0.24 umoles naled/L | 0.041 umoles TTR/L (d) | **0.17 (e)** | 0.5 |
| | Chronic | NOAEC | 0.008 umoles naled/L | 0.004 umoles TTR/L (d) | **0.53** | 1 |
| Invertebrates | Acute | EC50 | 0.0003 umoles DDVP/L | 0.041 umoles TTR/L (d) | **140** | 0.5 |
| | Chronic | NOAEC | 0.00012 umoles naled/L | 0.004 umoles TTR/L (d) | **94** | 1 |
| **Aquatic Species, Marine** | | | | | | |
| Fish | Acute | LC50 | 3.12 umoles naled/L | 0.041 umoles TTR/L (d) | 0.013 | 0.5 |
| Invertebrates | Acute | EC50 | 0.024 umoles naled/L | 0.041 umoles TTR/L (d) | **1.7** | 1 |

a) The aquatic LC50s and NOAECs are based on compound (naled or DDVP) with the greatest level toxicity (lowest LC50 or NOAEC). Equations for conversion to umoles/L used were:
   Results in ug/L water (ppb) x 1 umole naled/381 ug = umole naled/L water, used if naled is more toxic
   Results in ug/L water (ppb) x 1 umole DDVP/221 mg = umole DDVP/L water, used if DDVP is more toxic
b) The EECs for the aquatic species are expressed as umoles total toxic residues (naled plus DDVP) TTR/L (aquatic species). EPA estimated using the AgDRIFT, PRZM, EXAMS, and RICE.
c) RQ = Risk Quotient, ratio of the EEC to the toxicity endpoint, Unit-less, lower the RQ the lower the risks
d) RQs in bold exceed the endangered species LOC of 0.05 for aquatic species and 0.1 for terrestrial species
e) LOC = Level of Concern for acute and chronic risks

# APPENDIX VII

# LABEL INFORMATION MOSQUITO ADULTICIDES

## 1.0 LABEL LANGUAGE FOR MOSQUITO ADULTICIDES

1.1 SIGNAL WORDS FOR WIDE AREA PUBLIC HEALTH MOSQUITO PRODUCTS

1.2 HAZARDS TO HUMANS AND DOMESTIC ANIMAL FOR WIDE AREA PUBLIC HEALTH MOSQUITO PRODUCTS

1.3 PERSONAL PROTECTIVE EQUIPMENT FOR WIDE AREA PUBLIC HEALTH MOSQUITO PRODUCTS

1.4 ENVIRONMENTAL HAZARD STATEMENTS FOR WIDE AREA PUBLIC HEALTH MOSQUITO PRODUCTS

1.5 ENVIRONMENTAL RESTRICTIONS FOR USE IN AND AROUND AGRICULTURAL OPERATIONS FOR WIDE AREA PUBLIC HEALTH MOSQUITO PRODUCTS

## 1.0 LABEL LANGUAGE

For the public health mosquito adulticide the label sections summarized below are signal words, hazards to humans and domestic animals and personal protective equipment. EPA assigns mammalian toxicity categories for the technical grade active ingredients (TGAI) and the end use products offered for sale and use based on acute toxicity data. The criteria for EPA's toxicity categories are set in 40CFR156.62 and the relationship with required label language are found in Appendix II Tables 2 and 3.

Twenty-two of the twenty-eight (79 %) pyrethrins-pyrethroid-PBO and three of the five organophosphate containing (60%) products have labels statements prohibiting use when ambient air temperatures are below 50F.

### 1.1 SIGNAL WORDS FOR WIDE AREA PUBLIC HEALTH MOSQUITO PRODUCTS

Etofenprox, Permethrin-PBO, Phenothrin (Sumithrin [tm])-PBO, Phenothrin (Sumithrin [tm])-PBO-Prallethrin, Pyrethrins-PBO, Resmethrin-PBO wide area public health mosquito adulticide products containing pyrethrins, pyrethroids and PBO have "caution" signal words indicating low risks to mammals from acute exposure.

The organophosphate products containing chlorpyrifos and malathion also have "caution" signal word. The naled containing products have "danger" signal words due to irreversible corrosive effects on the skin and eyes.

### 1.2 HAZARDS TO HUMANS AND DOMESTIC ANIMAL FOR WIDE AREA PUBLIC HEALTH MOSQUITO PRODUCTS

Etofenprox, Permethrin-PBO, Phenothrin-PBO, (Anvil 10 +10-oil based), Pyrethrins-PBO, Resmethrin-PBO, have warnings for moderate eye irritation. Anvil 10 + 10 (EPA# 1021-1688-8239) also has a warning for moderate eye irritation

Phenothrin-PBO (Aqua Anvil-water based), Phenothrin (Sumithrin [tm])-PBO-Prallethrin (Duet-oil based and Aqua Duet-water based) have no eye warnings.

Technical grade chlorpyrifos is more acutely toxic than technical grade malathion . The adulticide products are a soluble concentrate containing 19.36% chlorpyrifos (1.5 lbs/gal) product and a ready to use 96.5% malathion (9.9 lbs/gal) product. Both the chlorpyrifos product and the malathion product labels have "caution" as the signal word. The different human and domestic animal hazard sections reflect the differences in potency.

The chlorpyrifos containing product, CSI 1.5 (EPA# 53883-251) human and domestic animal hazard section reads:

> "Harmful if swallowed. Avoid contact with skin or clothing. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco, or

> using the toilet. Prolonged or frequently repeated skin contact may cause allergic reactions in some individuals (Control Solutions 2009a, Control Solutions 2009b)."

The malathion containing product, Fyfanon (EPA# 6770-34) product label states:

> "Harmful by swallowing, inhalation or skin contact. Avoid contact with skin. Avoid breathing spray mist (Cheminova 2011a, Cheminova 2011b.)"

All of the naled containing products registered for use as public health mosquito adulticides are classified **RESTRICTED USE PESTICIDE DUE TO EYE AND SKIN CORROSIVITY HAZARD** and have **DANGER** signal words because of corrosiveness to eyes and skin.

Human health hazard statements include:

- "Causes irreversible eye and skin damage.
- Causes skin bums.
- May be fatal if swallowed.
- Harmful if inhaled or absorbed through the skin.
- Do not get in eyes, on skin, or on clothing.
- Do not breathe vapor or spray mist.
- Prolonged or frequently repeated skin contact may cause allergic reactions in some individuals (AMVAC 2009a, AMVAC 2010a, AMVAC 20012a.)"

### 1.3 Personal Protective Equipment for Wide Area Public Health Mosquito Products

Pyrethrins-Pyrethroids-PBO containing products registered for public health wide area mosquito control are primarily permethrin-BPO at a variety of concentrations (Appendix I Section 5). There are two products with etofenprox as the sole active ingredient, two phenothrin (Sumithrin [tm])-PBO products, one with phenothrin (Sumithrin [tm])-PBO and the other with phenothrin-PBO-prallethrin products, three pyrethrins-PBO products and two Resmethrin-PBO containing products. The personal protective equipment statements are found below.

Etofenprox containing products have no personal protective equipment requirements on the labels of the two mosquito adulticide product labels.

Ten of the eleven permethrin-PBO containing products registered for use in Maine 2013 have labels approved by EPA in 2011, 2012 and 2013 with the following personal protective equipment requirements:

> "Mixers, loaders, applicators and other handlers must wear:
- Long-sleeved shirt and long pants,
- Shoes plus socks,
- Chemical-resistant gloves for all handlers except for applicators using motorized ground equipment, pilots, and flaggers

- Chemical-resistant apron for mixers/loaders, persons cleaning equipment, and persons exposed to the concentrate"

The other permethrin product, PBO/Permethrin 20:20, (EPA# 53883-274), has no PPE requirements and the label was approved in 2010. Since the RED for permethrin was issued in 2009 (EPA 2009c), most likely the next iteration of this label would incorporate the PPE requirements from the RED.

Anvil 10 + 10 (EPA# 1021-1688-8329), hydrocarbon based, Multicide® Mosquito Adulticiding Concentrate 2705 (EPA# 1021-1688) requires applicators, mixers and loaders to wear: long-sleeve shirt and pants, shoes and socks, and chemical resistant gloves made of barrier laminate nitrile rubber, neoprene rubber or viton.

Duet (EPA#1021-1795-8329) petroleum base, Multicide Fogging Concentrate 2798 (EPA# 1021-1795) labels require applicators mixers and loaders wear: long-sleeve shirt and pants and shoes and socks.

The three pyrethrins PBO products require:

"Mixers, loaders, applicators and other handlers must wear:
- Long-sleeved shirt and long pants,
- Shoes plus socks,
- Chemical-resistant gloves

Two resmethrin products registered in Maine 2013 for adult mosquito control in public health settings are SCOURGE® Insecticide with resmethrin/piperonyl butoxide 18% + 54% MF FORMULA II (EPA# 432-667) and SCOURGE® Insecticide with SBP-1382/Piperonyl Butoxide 4%+12% MF FII (EPA# 432-716).

The personal protective equipment requirements from both labels are:

- Long-sleeved shirt and long pants
- Shoes plus socks
- Chemical-resistant gloves for all handlers except applicators.

The Scourge product label for product with the higher concentrations, (EPA# 432-667), chemical resistant gloves are require for all applicators except applicators using motorized ground equipment pilots and flaggers.

CFI 1.5 containing 19.36% chlorpyrifos (1.5 lbs/gal) (EPA# 53883-251) has the following directions for personal protective equipment:

"Personal Protective Equipment (PPE): All mixers and loaders involved in ground application must wear coveralls over long-sleeved shirt and long pants, shoes plus socks, chemical-resistant gloves, and a NIOSH-approved dust mist filtering respirator with MSHAINIOSH approval number prefix TC21C or a NIOSH-approved respirator

with any R, P, of HE filter. Applicators involved in ground ULV application must use an enclosed cab as described in the

Engineering Controls Section of this label and must wear long-sleeved shirt and long pants, shoes plus socks, and chemical-resistant gloves. Aerial applicators and pilots must use an enclosed cockpit and wear long-sleeved shirt, long pants, shoes, and socks (Control Solutions 2009a, Control Solutions 2009b.)"

Fyfanon ULV containing 96.5% malathion (9.9 lbs/gal) (EPA# 53883-34) label directions for personal protective equipment are:

"For all formulations and use patterns - mixers, loaders, applicators, flaggers, and other handlers must wear:

- Long-sleeved shirt and long pants
- Chemical-resistant gloves
- Shoes plus socks (Cheminova 2011a, Cheminova 2011b)"

Personal protective equipment from the naled product labels read:

"If engineering controls are in use:

- Protective eye wear (goggles, face shield, or safety glasses)
- Long-sleeved shirt and long pants
- Socks plus shoes
- Chemical-resistant gloves (barrier laminate, butyl rubber, nitrile rubber, or viton, selection category E) and apron when mixing or loading. See engineering controls for additional requirements

In the absence of engineering controls:

- Protective eye wear (goggles, face shield, or safety glasses)
- Coveralls over long-sleeve shirt and long pants
- Chemical-resistant gloves
- Chemical-resistant footwear plus socks
- Chemical-resistant apron if exposed to the concentrate • Chemical-resistant headgear for overhead exposure
- A respirator with an organic-vapor removing cartridge with a prefilter approved for pesticides (AMVAC 2009a, AMVAC 2010a, AMVAC 20012a.)"

### 1.4 Environmental hazard statements for Wide Area Public Health Mosquito Products

Extensive environmental hazard warnings are found on all of the pyrethrins-pyrethroid-PBO have warnings similar or identical to the Zenivex E20 (EPA# 2724-791) (Wellmark 2010c, Wellmark 2010d.)" below:

> "**This pesticide is toxic to aquatic organisms, including fish and aquatic invertebrates**. Runoff from treated areas or deposition into bodies of water may be hazardous to fish and other aquatic organisms. Do not apply over bodies (of water (lakes, rivers, permanent streams, natural ponds, commercial fish ponds, swamps, marshes or estuaries), **except when necessary to target areas where adult mosquitoes are present,** and weather conditions will facilitate movement of applied material away from water in order to minimize incidental deposition into the water body. Do not contaminate bodies of water when disposing of equipment rinsate or washwasters. [Emphasis added].
>
> **This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds**. Time applications to provide the maximum possible interval between treatment and the next period of bee activity. Do not apply to blooming crops or weeds when bees are visiting the treatment area, **except when applications are 'made to prevent or control a threat to public and/or animal health determined by a state, tribal, or local health or vector control agency on the basis of documented evidence of disease-'causing agents in vector mosquitoes or the occurrence of mosquito-borne disease in animal or human populations**, or if specifically approved by the state or tribe during a natural disaster recovery effort (Wellmark 2010c, Wellmark 2010d.)" [e**mphasis added]**.

In addition, the two Scourge products containing resmethrin and PBO are classified as restricted use products because of acute toxicity to fish (Bayer 2012a, Bayer 2012b, Bayer 2012c, Bayer 2012d). The restricted use classification means that certification and licensing are needed to purchase and use the products.

Pyrofos 1.5 ULV Vector Control Insecticide containing 19.36% the organophosphate, chlorpyrifos, (1.5 lbs/gal) (EPA# 53883-251) has the following environmental hazard statements:

> "This pesticide is toxic to fish, aquatic invertebrates, small mammals and birds. Runoff from treated areas or deposition of spray droplets into a body of water may be hazardous to fish and aquatic invertebrates. Do not apply over bodies of water (lakes, rivers, permanent streams, natural ponds, commercial fish ponds, swamps, marshes or estuaries) ~ **except when necessary to target areas where adult mosquitoes are present, (emphasis added)** and weather conditions weather facilitate movement of applied material beyond the body of water in order to minimize incidental deposition into the water body. Do not contaminate bodies of water when disposing of equipment rinsate or wash waters.
>
> This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treated area**, except 'When applications are made to prevent or control a threat to public and/or animal health determined by a state, or local health or vector control agency on the basis of documented**

> **evidence of disease causing agents in vector mosquitoes, or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or tribe during a natural disaster recovery effort** (**emphasis added)** (Control Solutions 2009a, Control Solutions 2009b**)**."

The environmental hazard section of the Fyfanon ULV containing malathion read much the same as the synthetic pyrethroids:

> "This pesticide is toxic to aquatic organisms, including fish and invertebrates. Use care when applying in or to an area which is adjacent to any body of water, and do not apply when weather conditions favor drift from target area. Poorly draining soils and soils with shallow water tables are more prone to produce runoff that contains this product. When applying as a wide area mosquito adulticide, before making the first application in a season, it is advisable to consult with the state or tribal agency charged with primary responsibility for pesticide regulation to determine if other regulatory requirements exist.
>
> This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Do not apply or allow to drift onto blooming crops or weeds while bees are actively visiting the treatment area, **except when applications are made to prevent or control a threat to public and/or animal health determined by a state, tribal or local public health or vector control agency on the basis of documented evidence of disease causing agents in vector mosquitoes or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or tribe during a natural disaster recovery effort** (**emphasis added).**
>
> When applying as a wide area mosquito adulticide, do not apply over bodies of water (lakes, rivers, permanent streams, natural ponds, commercial fish ponds, swamps, marshes or estuaries), except when necessary to target areas where adult mosquitoes are present, and weather conditions will facilitate movement of applied material away from the water in order to minimize incidental deposition into the water body. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of the EPA (Cheminova 2011a, Cheminova 2011b.)"

Another consideration not found on other public health mosquito products is: "undiluted spray droplets of Fyfanon ULV Mosquito will permanently damage vehicle paint finishes unless the aircraft used for the ultra-low volume application meets all of the specifications listed under AERIAL APPLICATION (Cheminova 2011a, Cheminova 2011b).

Regarding non-target toxicity the naled labels read:

"This pesticide is toxic to fish, aquatic invertebrates, and wildlife. Runoff from treated areas or deposition of spray droplets into a body of water may be hazardous to fish and aquatic invertebrates. Before making the first application in a season, consult with the primary State agency responsible for regulating the pesticides to determine if permits are required or regulatory mandates exist. Do not apply over bodies of water (e.g., lakes, swamps, rivers, permanent streams, natural ponds, commercial fish ponds, marshes or estuaries), **except when necessary to target areas where adult mosquitoes are present (emphasis added),** and weather conditions will facilitate movement of applied material away from the water in order to minimize incidental deposition into the water body. Do not contaminate bodies of water when disposing of equipment washwaters or rinsate (AMVAC 2009a, AMVAC 2010a, AMVAC 20012a).

This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds. To minimize hazard to bees, it is recommended that the product is not applied more than two hours after sunrise or two hours before sunset, limiting application to times when bees are least active. Do not apply this product or allow it to drift to blooming crops or weeds while bees are visiting the treatment area, except when applications are made to prevent or control a threat to public and/or animal health determined by a state, tribal or local health or vector control agency on the basis of documented evidence of disease causing agents in vector mosquitoes or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or the tribe during a: natural disaster recovery effort (AMVAC 2009a, AMVAC 2010a, AMVAC 20012a).

### 1.5 Environmental Restrictions for use in and around agricultural Operations for Wide Area Public Health Mosquito Products

Depending on the existence of US food or feed tolerances (Appendix IV), the label language for the pyrethrins-pyrethroid containing adulticides is different.

Piperonyl butoxide (PBO), is present in all of the pyrethrins-pyrethroid products with the exception of the etofenprox products. PBO is exempt from tolerance on raw agricultural commodities when used according to good agricultural practice (40 CFR 180.905).

There are no tolerances for etofenprox in raw agricultural commodities with the exception of rice (40 CFR 180.620). Etofenprox containing products have label directions to "Cover exposed drinking water in corrals, feedlots, swine lots cropland or any exposed drinking water" and "do not spray or allow drift onto pastureland, cropland or potable water sources. Given the "cover drinking water" sources for livestock and "do not spray or allow drift" statements on the etofenprox labels, food residues resulting from public health mosquito applications should not be an issue.

Permethrin has many tolerances in raw agricultural commodities (40 CFR180.378) these are for the commodities listed on the permethrin product labels. Permethrin-PBO products,

in one form or another have the following label language, “Do not spray this product on or allow it to drift onto cropland (other than crops listed) or potable water supplies (followed by the list of commodities which have tolerances for permethrin and PBO residues). In the treatment of corrals feedlots animal confinements/houses swine lots poultry ranges and zoos cover any exposed drinking water drinking fountains and animal feed before application.

Phenothrin has a universal tolerance 0.01 ppm for raw agricultural commodities (40 CFR 180.647) and PBO is exempt from tolerance (40 CFR 180.905). Prallethrin only has a universal tolerance for uses in food and feed establishments and no tolerances on raw agricultural commodities (40 CFR 180.545). Anvil 10 + 10, oil based and Aqua Anvil, water-based, have the following statement regarding use over agricultural areas: “May be applied over agricultural areas for the control of adult mosquitoes within or adjacent to the treatment areas” Because of the presence of prallethrin and the lack of tolerances, the Duet and Aqua Duet, Phenothrin-PBO-Prallethrin have the following statement regard agricultural areas: “Do not spray this product on or allow it to drift onto rangeland cropland poultry ranges or potable water supplies In treatment of corrals feed lots swine lots and zoos cover any exposed drinking water drinking water fountains and animal feed before application”

Pyrethrins are exempt from tolerance on raw agricultural commodities (40 CFR 180.905).

Pyrethrins-PBO product labels state: “This concentrate may be diluted or used as supplied for mosquito control programs involving residential, industrial, recreational and agricultural areas where adult mosquitoes are present in annoying numbers in vegetation surrounding swamps, marshes, overgrown waste areas, roadsides and pastures. Use in agricultural areas should be in such a manner as to avoid residues in excess of established tolerances for pyrethrins and PBO on crops or commodities”

Similar to prallethrin, resmethrin has a universal tolerance for uses in food and feed establishments and no tolerances on raw agricultural commodities (40 CFR 180.525.). Given the site limitations on the resmethrin containing product labels, food residues resulting from public health mosquito applications should not be an issue. The two Scourge products containing resmethrin and PBO labels state: “Scourge is designed for application as an Ultra-Low Volume (ULV) aerosol to control adult mosquitoes and flies in residential industrial urban recreational areas and other areas where the labeled pests are a problem.

There are at least 80 tolerances (40 CFR 180.342) for chlorpyrifos, given the non-crop-land statement on the chlorpyrifos label, food residues resulting from public health mosquito applications should not be an issue. Chlorpyrifos containing product, CSI 1.5 ULV (EPA# 53883-251) is designed for application either as a thermal fog or as an ultra-low volume (ULV) non-thermal aerosol (cold fog) to control adult mosquitoes in: “Outdoor residential and recreational areas and other non-cropland areas where these insects are a problem”

Malathion has tolerances in over 150 commodities (40 CFR 180.111). Given the site limitations on the malathion containing product label, food residues resulting from public health mosquito applications should not be an issue. Aerial Applications for Fyfanon ULV

are limited to “Rangeland, Pasture, and Other Uncultivated Non-Agricultural Areas (Wastelands, Roadsides). There are no such limits on ground applications.

There are 38 tolerances for naled. In addition, a universal tolerance of 0.5 part per million is established for the pesticide naled in or on all raw agricultural commodities, except those otherwise listed in this section, from use of the pesticide for area pest (mosquito and fly) control (40 CFR 180.215). Two of the three products containing naled have mosquito (and nuisance fly) uses only, Dibrom Concentrate (EPA# 5481-480) and Trumpet EC (EPA# 5481-481). The third product, Dibrom 8 Emulsive (EPA# 5481-479) has the mosquito, nuisance fly and agricultural uses on its label. The two products with no agricultural uses on their labels have the following directions regarding use over agricultural areas:

> “It is not necessary to avoid farm buildings, dairy barns, pastures, feed or forage areas. Use in agricultural areas must be in a manner as to ensure that residues do not exceed the established federal tolerance for the active ingredient in or on raw agricultural commodities resulting from use for wide area pest control. Treat shrubbery and vegetation where mosquitoes may be present. Shrubbery and vegetation around stagnant pools, marshy areas, swamps, residential areas, municipalities, woodlands, pastures, farm buildings and feedlots may be treated.”

The product with both agricultural and mosquito/ nuisance fly uses, Dibrom 8 Emulsive (EPA# 5481-479) in the section on controlling mosquitos reads:

> “It is not necessary to avoid farm buildings. Make applications during peak of infestation and repeat as necessary. See crop recommendation for use limitations near harvest. Treat shrubbery and vegetation where mosquitoes may rest. Shrubbery and vegetation around stagnant pools, marshy areas, ponds and shorelines may be treated.”