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

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

PC Code: 084001
DP Barcodes: D318301

MEMORANDUM June 20, 2005

Subject: Revised EFED risk assessment for the Dichlorvos Reregistration Eligibility Document

To: Bob McNally, Branch Chief,/Eric Olson, Chemical Review Manager
Special Review Branch
Special Review and Reregistration Division (7508C)

From: Diana Eignor
Ibrahim Abdel-Saheb
Environmental Risk Branch II
Environmental Fate and Effects Division (7507C)

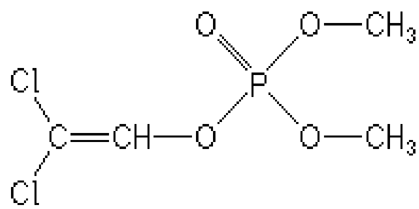
Through: Tom Bailey, Chief, ERB II
Environmental Fate and Effects Division (7507C)

EFED has completed a revised screening level ecological risk assessment for the reregistration of dichlorvos. Attached is the dichlorvos ecological risk assessment.

Risk conclusions can be found in the Executive Summary on page 4.

DICHLORVOS (DDVP)

Revised Ecological Risk Assessment



Diana Eignor
Ibrahim Abdel-Saheb

Approved By:

Thomas A. Bailey, Chief
Environmental Risk Branch 2
Environmental Fate and Effects Division

June 20, 2005

TABLE OF CONTENTS

I. EXECUTIVE SUMMARY

Dichlorvos (2,2-Dichlorovinyl dimethyl phosphate), also known as DDVP , is an organophosphate insecticide first registered for use in 1948. Dichlorvos is used in various scenarios for pest control but there are no agricultural crop uses for this chemical. Target pests are flies, gnats, mosquitoes, chiggers, ticks, cockroaches, armyworms, chinch bugs, clover mites, crickets, cutworms, grasshoppers, and sod webworms. Dichlorvos is registered for domestic indoor, terrestrial non-food, greenhouse (non-food) and domestic outdoor use. This document includes an assessment of risks to terrestrial animals resulting from the use of dichlorvos on the federal-label listed uses for dry granular bait use in animal premise areas and liquid spray use for turf and flying insects. Risks to aquatic organisms are assessed based on modeled EECs for the turf scenario.

Terrestrial Exposure

- Immediately following granular bait application, granules and/or residues are expected to be around animal premises. Birds and small mammals may be exposed from application to this site.

- Terrestrial animals may be exposed to dichlorvos resulting from application of liquid products used as a coarse spray to turf or to outdoor areas for flying insect control *(e.g.,* sites such as recreational parks and trails).

Aquatic Exposure

- Aquatic animals may be exposed to dichlorvos resulting from drift from ground spray application to the turf and outdoor flying insect sites.

- It is unlikely that aquatic organisms will be directly exposed to dry granular bait.

Risk to Terrestrial Organisms

- The chronic risk endangered species LOCs are exceeded for turf applications (both 1 and 4 applications) for birds that consume short grass, tall grass, and broadleaf plants/small insects.

- For the flying insect scenario, chronic RQs exceed endangered species for birds consuming short grass, tall grass, and broadleaf plants/small insects.

- The acute risk, acute restricted use, and acute endangered species LOCs for a small bird (20 g weight) are exceeded for the bait formulation scenario .

- The chronic LOC is exceeded for 15 g, 35 g, and 1000 g mammals that consume short grass, tall grass, and broadleaf plants/small insects in the turf scenario.

- For turf application, there are acute endangered species LOC exceedences for the 15 g and 35 g mammals that consumes short grass.

- Chronic risk to birds and mammals from the bait formulation can not be assessed at this time.

Risks to Aquatic Organisms

- The acute risk, acute restricted use, and acute endangered species LOCs for freshwater invertebrates are exceeded for turf scenarios in FL and PA for both one and four applications of dichlorvos.

- In addition, the chronic level of concern is exceeded for freshwater invertebrates [egg production and growth (length and weight) endpoint] for all of the turf scenarios (one and four applications).

II. PROBLEM FORMULATION

A. Introduction

Dichlorvos (2,2-Dichlorovinyl dimethyl phosphate), also known as DDVP , is an organophosphate insecticide first registered for use in 1948. Dichlorvos is used in various scenarios for pest control but there are no agricultural crop uses for this chemical.

The objectives of the current ecological risk assessment were to identify current registered dichlorvos uses, identify potential exposure pathways and ecological receptors, estimate exposure concentrations, identify ecological endpoints, and characterize risks for ecological receptors. This screening-level risk assessment follows the Agency's Ecological Risk Assessment Guidelines (USEPA, 2000). This document includes an assessment of risks to terrestrial animals resulting from the use of dichlorvos on the federal-label listed uses for dry granular bait use in animal premise areas and liquid spray use for turf and flying insects. Risks to aquatic organisms are assessed based on modeled EECs for the turf scenario.

B. Stressor Source and Distribution

1. <u>Chemical and Physical Properties</u>

Common Name:	Dichlorvos (DDVP)
Chemical Name:	2,2-Dichlorovinyl dimethyl phosphate
Trade Names:	Dichlorvos, DDVP, and Vapona
CAS No.	62-73-7
Molecular Formula:	$C_4 H_7 C_{l2} 0_4 P$
Molecular Weight:	220.98 g/mol
Physical state:	colorless to amber liquid with a mild chemical odor
Boiling Point:	140° C at 0.01 mm Hg
Vapor Pressure:	1.2×10^{-2} mm Hg at 20°C
Solubility:	15,000 mg/L (25 °C)
Henry's Law Const.:	5.01E-8 atm m^3/mole (measured)
Formulations:	Granules for Bait (*e.g.* Active ingredient 7.44%, Inert ingredients 92.56%)**;** Liquid (*e.g.* Active ingredient 40.2%, Inert ingredients 59.8%)

2. <u>Mode of Action</u>

Dichlorvos is an organophosphate insecticide which is a potent cholinesterase (ChE) inhibitor. Acetylcholinesterase is an enzyme necessary for the degradation of the neurotransmitter acetylcholine (ACh) and subsequent cessation of synaptic transmission. Inhibition of these enzymes results in the accumulation of ACh at cholinergic nerve endings and continual nerve stimulation, which can result in death. For non-target organisms, it causes reversible inhibition of erythrocyte acetylcholinesterase (RBC

ChE) as well as plasma butyryl ChE by binding to the active site of the enzyme.

3. Regulatory History

- Dichlorvos was first registered in 1948**.**
- DDVP is now in the Special Review process.
- EPA published a Notice of Preliminary Determination (Position Document 2/3) in the Federal Register on September 28, 1995.
- Dichlorvos is currently banned or restricted in 6 countries. The bans in Angola, Fiji, and Denmark; the cancellation in Sweden; and restrictions in Kuwait all occurred in 1999 (Source: PIC Circular X, Appendix V: Synopsis of Notifications of Control Actions, United Nations Environment Programme, December, 1999, http://www.fao.org/AG/AGP/AGPP/Pesticid/PIC/circular.htm). .
  - Angola's control action applies to the banning of the product Vapona 24 EC.
  - Dichlorvos is banned for all uses in Fiji with no remaining uses allowed because of the potential health hazard.
  - In Denmark, all authorizations for products containing dichlorvos as an active substance have been withdrawn from the market 31 December 1997 and a further use has been banned from 01 August 1998. No uses are allowed. Dichlorvos is assessed to be carcinogenic in category 3 (cars., 3 cat., 3) and the formulated products are highly acute toxic (T+ and T classified respectively) in Denmark. The products are therefore assessed to be harmful to health.
  - In Sweden , registration was cancelled (voluntarily withdrawn). This substance was restricted due to its mutagenic properties in Sweden.
  - In Kuwait, dichlorvos use is severely restricted.. Import of this chemical was stopped from June 1994. Action was taken for health reasons.
- All uses of dichlorvos in the UK were suspended 4/19/2002. See http://www.doh.gov.uk/com/dichlorvos.htm. Extant approval is for storage by any persons and for use by persons other than the approval holder or their agents of existing stocks (approvals expire 18 April 2004).
  (Source: Banned and Non-Authorized Pesticides in the UK, Pesticides Safety Directorate, June 21, 2002, http://www.pesticides.gov.uk/Blue_Book/Contents.htm.)

4. Use Characterization

Dichlorvos is an organophosphate insecticide registered for indoor, terrestrial non-food, greenhouse (non-food) and domestic indoor and outdoor use. There are no agricultural crop uses for this chemical. Although the LUIS report classifies catch basin as an aquatic non-food site for dichlorvos, it is more appropriately considered a terrestrial non-food outdoor use based on target pest (flying or resting adult mosquitoes), formulation type (resin strip), placement of strip (10 inches above water level) and mode of action (fumigant).

Target pests are flies, gnats, mosquitoes, chiggers, ticks, cockroaches and other nuisance insect pests. For the turf and ornamental uses target pests also include armyworms, chinch bugs, clover mites, crickets, cutworms, grasshoppers, and sod webworms. Formulation types include baits, liquids and impregnated materials.

The majority of dichlorvos uses are indoors; including mushroom houses, greenhouses, commercial, residential and industrial buildings, farm buildings, food handling establishments, trash receptacles, and wine cellars. Ecological risk assessments are not performed for indoor uses.

In the 1987 Dichlorvos Registration Standard, EFED addressed the two major outdoor sites, figs and mosquito adulticide/larvicide. A third major outdoor site, turf, was not considered because all registered products containing dichlorvos for that site were multiple active ingredient (MAI) products, and policy at that time was not to consider MAI products. The current assessment addresses outdoor flying insects (including mosquitoes), turf, and bait formulations used around animal premises. The mosquito larvicide and fig uses have been canceled.

For the outdoor sites listed below, EFED finds minimal potential for exposure to terrestrial and aquatic animals based on the fate properties of dichlorvos and treatment sites being small and localized. Maximum application rates and reapplication intervals for outdoor sites are listed below. No risk assessments were performed for these sites:

- Around agricultural premises/structures (liquids): (spot or band treatment only): liquid spray -0.0115 lb/1000 sq. ft^2 ; 0.5 lb ai/A; 7 day reapplication interval for commercial sites and 30 day reapplication interval for residential sites.

- Catch basin - Insect traps, impregnated resin strips (including the insecticidal strip suspended 10 inches above water in catch basin areas to control flying insects): 1 x 80g strip/1000ft^3 ; (80g strip contains 18.6% dichlorvos = 14.88g dichlorvos/strip =0.0327 lb/strip; usual control last 10 to 15 weeks.

- Manure treatment/garbage/refuse areas (liquids and baits): Dry bait: 0.046 lb/1000 ft^2 ; Liquid spray : 0.046 lb/1000 ft^2 ; 2 lb ai/A; 1 day reapplication interval.

- Direct treatment to Animals: Liquid spray: 0.0013 lb ai/animal (livestock): 0.02 g/animal (poultry); 1 day reapplication interval. (Maximum use rate for birds is from Amvac 1/12/98 letter clarifying uses); also registered labels state to spray at rate of 1 quart/1000 sq. ft. (2 lb and 4 lb/gal EC formulations; birds may be present).

The maximum application rates and reapplication intervals for outdoor sites considered in this risk assessment are listed below:

- Liquid sprays for turf and flying insects (including mosquitoes): 0.0046 lb/1000 ft^2 (0.2 lb ai/A); 1 day reapplication interval for commercial sites and 7 day reapplication interval for residential sites; ground application only; coarse sprays only . According to BEAD, a worse case scenario for turf is 4 applications with 30 day application interval and 75 applications per year for flying insect control.

- Dry bait formulations around animal premise areas: 0.0025 lb/1000 ft^2 (equivalent to 0.1 lb ai/a) Some of the labels bear directions to reapply every 3 to 5 days until control is achieved. Therefore, a worse case scenario would be 120 applications per year based on label specifications.

For the outdoor flying insect (including mosquitoes) site, some of the labels have specificity of where to apply, *e.g.,* recreational areas, trails, outdoor living areas, eating areas of drive-in restaurants, refuse areas, garbage collection/disposal areas, outdoor latrines, refuse areas around service stations, loading docks, animal feedlots, stockyards, corrals, holding pens, lawns, turf and ornamental plants. On the other hand, many of the labels have vague directions for use, *e.g.,* apply outdoors where pests are a problem. Dichlorvos does not appear to be used in this country for adult mosquito control. It is not listed in State Management recommendations for mosquito control, and the American Mosquito Control Association (AMCA) has indicated "as far as they could tell", it wasn't being used in this country. It appears a worst case scenario for insect control is around 75 applications to a given site over a year period (personal communication with Douglas Sutherland, 4/15/98). For turf use, dichlorvos would normally be applied only once or twice per season. It is possible that up to four applications may be made, but this would be unusual (Douglas Sutherland, BEAD entomologist, personal communication, 4/13/98). However, since the label does not limit the number of applications, the high end estimate of 4 applications per season is modeled in addition to 1 application per season.

5. <u>Measurement Endpoints</u>

Each assessment endpoint requires one or more "measures of ecological effect," which are defined as changes in the attributes of an assessment endpoint itself or changes in a surrogate entity or attribute in response to pesticide exposure. Ecological measurement endpoints for the screening level risk assessment are based on a suite of registrant-submitted toxicity studies, as well as open literature review (U.S. EPA. 2004a). The ECOTOX (ECOTOXicity) database is used to identify additional data from the open literature. The ECOTOX database is a user-friendly, publicly-available, quality-assured, comprehensive tool for locating toxicity data from the open literature and is maintained by the EPA Mid-Atlantic Ecology Division. However, for this risk assessment for dichlorvos, a detailed open literature search was not conducted.

Toxicity studies are usually performed on a limited number of organisms in the following broad groupings:

- Birds (mallard duck and bobwhite quail) used as surrogate species for terrestrial-phase amphibians and reptiles
- Mammals (laboratory rat)
- Freshwater fish (bluegill sunfish and rainbow trout) used as a surrogate for aquatic phase amphibians
- Freshwater invertebrates (water flea - *Daphnia magna*)
- Estuarine/marine fish (sheepshead minnow)
- Estuarine/marine invertebrates (Eastern oyster and mysid shrimp)
- Terrestrial plants (corn, onion, ryegrass, wheat, buckwheat, cucumber, soybean, sunflower, tomato, and turnip)
- Algae and aquatic plants (algae, diatoms, and duckweed)

6. <u>Endangered Species</u>

Potential risks posed by dichlorvos use on listed or endangered species must be evaluated. The potential for individual effects at exposure levels equivalent to the level of concern (LOC) is made based on the median lethal dose estimate and dose-response relationship established for the effects study corresponding to each taxonomic group for which the LOCs are exceeded.

C. Conceptual Model

A conceptual model (CM), which summarizes graphically the results of the problem formulation for evaluating risks to ecological receptors following application of dichlorvos as a dry granular bait around animal premise areas is provided in Figure 1. The CM for the application of dichlorvos as a liquid spray for turf and flying insects is presented in Figure 2. The CMs are working hypotheses about how dichlorvos is likely to reach (*i.e.*, exposure pathways) and affect ecological entities (*i.e.*, attribute changes) of concern on and adjacent to a treated area. In order for a pesticide stressor to pose an ecological risk, it must reach an ecological receptor in biologically significant concentrations. The CMs outline specifically which measures of exposure, ecological receptors, and measures of effects or measurement endpoints will be used to estimate risks from proposed reregistration uses of dichlorvos.

Based on the registered uses, dichlorvos is used on areas located in a wide diversity of ecoregions and habitats spanning the continental United States, Hawaii, Alaska, and Puerto Rico. The wide diversity of land forms and vegetation types across dichlorvos use areas also provides for a large diversity of mammals, birds, reptiles, amphibians, terrestrial invertebrates, and freshwater and estuarine/marine fish and invertebrates that could potentially be exposed.

1. Terrestrial Environment

a. Exposure

Immediately following granular bait application, granules and/or residues are expected to be around animal premises. Birds and small mammals may be exposed from application to this site. Wildlife exposure could result from mistakenly ingesting granules as seeds or ingesting them as part of incidental soil ingestion while foraging for food. Wildlife exposure could also result from a number of other exposure pathways and wildlife actions or behaviors including inhalation of dust particulates; dermal uptake via direct contact of skin with the granules and residues in soil and turf; contact with residues in puddles present in the area at the time of application or formed after a rain event; or ingestion of water from residues in puddles. Currently, terrestrial wildlife exposure for granular bait formulations are estimated via the amount of toxicant per unit area in a screening-level risk assessment. This index was developed considering these other routes of exposure; however, they are not separately accounted for in the index calculation.

Terrestrial animals may be exposed to dichlorvos resulting from application of liquid products used as a coarse spray to turf or to outdoor areas for flying insect control, including mosquitoes *(e.g.,* sites such as recreational parks and trails). Use is by ground application *(e.g.,* back-pack sprayers or truck-mounted sprayers) using coarse sprays directed to the vegetation. One day reapplication intervals are permitted for both sites, except for homeowner where it is seven days. Continuous year-round exposure is possible in some areas of the country, *e.g.,* Florida, for both sites.

Currently registered labels for turf and flying insects allow for fogging and misting, and there are no label prohibitions against aerial application. Labels do not specify maximum numbers of applications or reapplication intervals. Drift can be minimized by prohibiting aerial application, and restricting application to coarse sprays. However, for the turf site, BEAD sources indicate a typical application is only twice per year (with a thirty day reapplication interval), with four applications representing worst-case. For the flying insect (including adult mosquitoes) use, it does not appear that dichlorvos is being used in this country. BEAD sources indicate a worst case scenario for a pesticide used for adult mosquito control would be around 75 applications to a given site over a year period. There are no label restrictions for the use of granular bait. Based on the label directions to reapply every 3 to 5 days until control is achieved, a worse case scenario would be 120 applications per year.

b. Receptors of Concern

Ecological receptors of concern identified for consideration in the terrestrial environment include primary producers, represented by both upland and wetland/riparian vegetation, and primary and secondary consumers, both vertebrates and invertebrates, representing common ecological functional feeding groups (*i.e.*, herbivores and insectivores). Herbivores as used here include animals that feed on foliage (stems and leaves), seeds, and/or fruit; the term granivore is sometimes used to identify animals that feed primarily on seeds. Omnivores (*i.e.*, consumers that feed on a mixed diet of animals and plants) are also potentially exposed but are not specifically included in the receptor list for a screening level risk assessment because exposure concentrations and risk levels will fall between the exclusive feeding groups.

Based on the sources/transport pathways, exposure media, and potential receptors of concern, specific questions or risk hypotheses formulated to characterize direct effects of dichlorvos following application on areas to selected assessment endpoints is provided below.

c. Terrestrial Environment Risk Hypotheses for Dichlorvos Uses

Birds and mammals are subject to reduced survival or reduced reproduction when exposed to dichlorvos as a result of labeled use.

Upland and riparian/wetland plants are subject to adverse effects (reduced survival) when exposed to dichlorvos as a result of labeled use.

2. Aquatic Environment

a. Exposure

Aquatic animals may be exposed to dichlorvos resulting from drift from ground spray application to the turf and outdoor flying insect sites. Following a rain event, dichlorvos may reach aquatic environments from areas of spray application in sheet and channel flow runoff since dichlorvos is soluble in water. Direct exposure to aquatic animals from misapplication of the pesticide is also possible. Aquatic organisms could also be exposed to dichlorvos from groundwater that is subsequently discharged into a surface water body. Continuous year-round exposure to aquatic animals is possible in some areas of the country, *e.g.,* Florida, for both the turf and flying insect scenarios. It is unlikely that aquatic organisms will be directly exposed to dry granular bait, therefore that pathway is not evaluated.

Currently registered labels for turf and flying insects allow for fogging and misting, and there are no label prohibitions against aerial application. Labels do not specify maximum numbers of applications or reapplication intervals. Drift can be minimized by prohibiting aerial application, and restricting application to coarse sprays. However, for the turf site, BEAD sources indicate a typical application is only twice per year (with a thirty day reapplication interval), with four applications representing worst-case. For the flying insect (including adult mosquitoes) use, it does not appear that dichlorvos is being used in this country. BEAD sources indicate a worst case scenario for a pesticide used for adult mosquito control would be around 75 applications to a given site over a year period.

b. Receptors of Concern

For the aquatic ecosystem, ecological receptors include all aquatic life (fish, amphibians, invertebrates, plants) and those terrestrial animals (e.g., birds and mammals) that consume aquatic organisms. Based on the above sources/transport pathways, exposure media, and potential receptors of concern, specific questions or risk hypotheses formulated to characterize direct effects of dichlorvos application to selected assessment endpoints is provided below.

c. Aquatic Environment Risk Hypotheses for Dichlorvos Uses

Aquatic invertebrates and fish are subject to adverse effects such as reduced survival and reduced reproduction when exposed to dichlorvos as a result of labeled use.

Aquatic plants are subject to adverse effects (reduced survival) when exposed to dichlorvos as a result of labeled use.

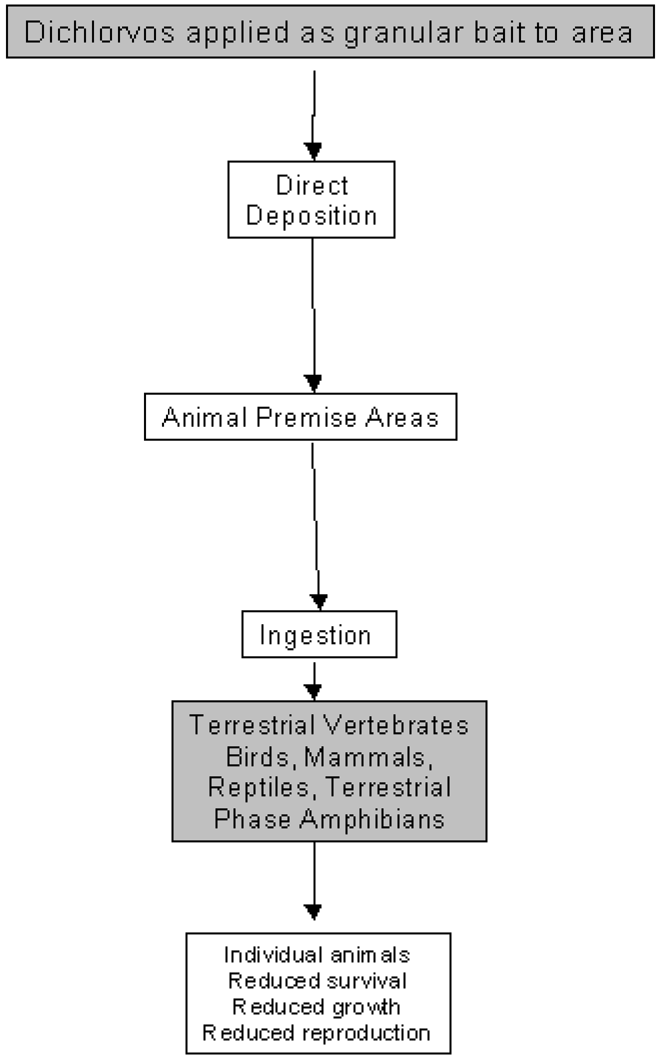


Figure 1. Ecological conceptual model for the application of dichlorvos as dry granular bait. Solid arrows indicate pathways addressed in assessment.

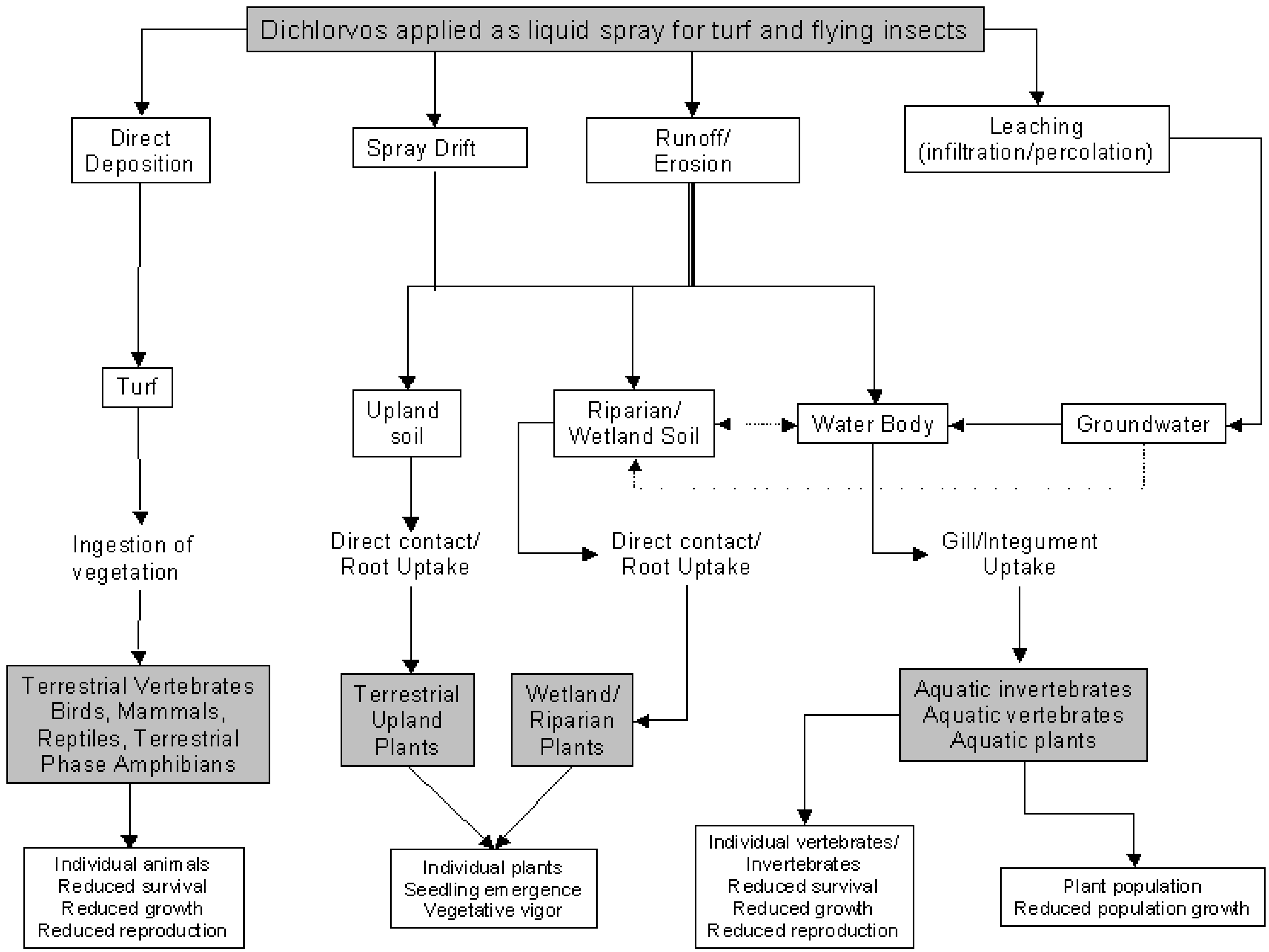

Dichlorvos applied as liquid spray for turf and flying insects
Direct Deposition
Spray Drift
Runoff/ Erosion
Leaching (infiltration/percolation)
Turf
Upland soil
Riparian/ Wetland Soil
Water Body
Groundwater
Ingestion of vegetation
Direct contact/ Root Uptake
Direct contact/ Root Uptake
Gill/Integument Uptake
Terrestrial Vertebrates Birds, Mammals, Reptiles, Terrestrial Phase Amphibians
Terrestrial Upland Plants
Wetland/ Riparian Plants
Aquatic invertebrates Aquatic vertebrates Aquatic plants
Individual animals Reduced survival Reduced growth Reduced reproduction
Individual plants Seedling emergence Vegetative vigor
Individual vertebrates/ Invertebrates Reduced survival Reduced growth Reduced reproduction
Plant population Reduced population growth

Figure 2. Ecological conceptual model for the application of dichlorvos as liquid spray. Solid arrows indicate pathways addressed in assessment.

D. Key Uncertainties and Information Gaps

The following uncertainties and information gaps were identified as part of the problem formulation:

1. Ecotoxicity Information Gaps

There are no terrestrial plant data for dichlorvos which leads to uncertainty in the evaluation of plant risk and indirect effects to other organisms. **Appendix A** at the end of this document provides the summary status of all the ecotoxicological data requirements

2. Environmental Fate Information Gaps

There are no data gaps in the environmental fate information. **Appendix B** at the end of this document provides the summary status of all the environmental fate data requirements

E. Analysis Plan

1. Specific Considerations

This document includes an assessment of risks to terrestrial animals resulting from the use of dichlorvos as a bait formulation and spray application for the turf and flying insect scenarios. Risks to aquatic organisms are assessed based on modeled EECs for liquid spray application for the turf scenario. For the flying insect scenario, current models are inappropriate to use so a quantitative assessment for flying insects can not be performed. It is likely the EECs in the surface water for the flying insect scenario would be less than the turf scenario since the treatment area would be smaller.

Ecological risk assessment is a process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors (US EPA, 1992a). This risk assessment examines the ecological risk of dichlorvos use, and attempts to determine at what level dichlorvos can be used to minimize deleterious effects on the environment. These negative effects include structural and/or functional characteristics or components of ecosystems. In order to estimate the ecological risk associated with dichlorvos use, use information, chemical and physical properties, and fate/transport data were evaluated.

2. Assessment Endpoints

Assessment endpoints are defined as "explicit expressions of the actual environmental value that is to be protected." Two criteria are used to select the appropriate ecological assessment endpoints: (1) identification of the valued attributes of the environment that are considered to be at risk, and (2) the operational definition of assessment endpoints in terms of an ecological entity (i.e., a community of fish and aquatic invertebrates) and its attributes (i.e., survival and reproduction). Therefore, the selection of assessment endpoints is based on valued entities (i.e., ecological receptors), the ecosystems potentially at risk, the migration pathways of pesticides, and the routes by which ecological receptors are exposed to pesticide-related contamination. The selection of clearly defined assessment endpoints is important because they provide direction and boundaries in the risk assessment for addressing risk management issues of concern.

a. Toxicity Endpoints

Aquatic and terrestrial non-target toxicity endpoints (animals and plants) are provided by the acute and, where appropriate, chronic toxicity data. These toxicity endpoints are compared with the environmental concentrations of dichlorvos, based on fate properties, exposure method, etc. For this assessment, the most sensitive toxicity endpoints for each surrogate taxa (ie. freshwater fish and invertebrates, estuarine/marine fish and invertebrates, aquatic plants, terrestrial plants, birds, and mammals) will be used in Risk Quotient (RQ) calculation with various exposure values.

An acute and chronic endpoint is selected from the available test data as the data sets allow. Endpoints used in this assessment are listed in **Table 1**.

Table 1. Summary of Assessment and Measurement Endpoints used in calculations

Assessment Endpoint	Measurement Endpoint
1. Survival, reproduction, and growth of **birds**	Acute oral Mallard duck LD_{50} = 7.78 mg/kg Subacute dietary Pheasant LC_{50} = 568 mg/kg Chronic Mallard Duck NOEC = 5 ppm
2. Survival, reproduction, and growth of **mammals**	Oral Rat LD_{50} = 56 mg/kg (female) Chronic Rat NOEC = 20 ppm
3. Survival and reproduction of **freshwater fish** and **invertebrates**	Acute Lake Trout LC_{50} = 183 ppb Acute Daphnia EC_{50} = 0.07 ppb Chronic Rainbow trout NOAEC = 5.2 ppb Chronic Daphnia NOEAC = 0.0058 ppb
4. Survival and reproduction of **estuarine/marine fish** and **invertebrates**	Acute Sheepshead minnow LC_{50} = 7350 ppb Chronic Sheepshead minnow NOAEC = 960 ppb Acute Mysid LC_{50} = 19.1 ppb Chronic Mysid NOAEC = 1.48 ppb
5. Perpetuation of non-target **terrestrial plants** (crops and non-crop species)	NA
6. Survival of beneficial insect populations	Honey bee (acute contact basis) LD_{50} = 0.495 µg/bee
7. Maintenance and growth of **aquatic plants** from standing crop or biomass	Acute algae 48 hr EC_{50} = 14000 ppb

LD_{50} = Lethal dose to 50% of test population
NOAEC = No observed adverse effect concentration
LOAEC = Lowest observed adverse effect concentration
LC_{50} = Lethal concentration to 50% of the test population
EC_{50}/EC_{25} = Effect concentration to 50%/25% of the test population

4. Planned Analyses

a. Fate and Exposure

Terrestrial Environment

Ingestion of granular bait used in animal premise areas represents a significant exposure pathway in terrestrial animals. In addition, terrestrial organisms may be exposed in treated areas (turf and flying insect areas) via spray applications. Therefore, the terrestrial screening-level risk assessment examined exposure to granular bait using the maximum labeled use rate. Turf use was assessed using four applications as the worse case scenario. For the flying insect scenario, weekly applications over a year period was chosen as a worst-case scenario. A terrestrial foliar dissipation half life of 0.0875 days was used in the terrestrial modeling for liquid spray. This half life was based on data from acceptable studies submitted to the Health and Effects Division (HED), titled "Dislodgeable foliar residues and exposure assessment for residential/recreational turf applications of dichlorvos (DDVP), Barcodes D248456, D248596, D255253). Only parent dichlorvos was modeled for terrestrial exposure scenarios.

Aquatic Environment

OPP generally uses computer simulation models to estimate exposure of aquatic organisms, such as plants, fish, aquatic-phase amphibians, and invertebrates, to a pesticide. These models calculate estimated environmental concentrations (EECs) in surface water using laboratory data that describe the rate at which the pesticide breaks down and how it moves into the environment. Monitoring data, if available, may also be used to determine EECs or to support the model's calculations. The PRZM-EXAMS model is initially used to calculate high-end estimates of surface water concentrations of pesticide in a generic pond. This model was used to generate EECs of dichlorvos in surface water for the turf scenarios. The User's Manual and PRZM-EXAMS Model Description can be consulted for additional information at: www.epa.gov/oppefed1/models/water/index.htm. No EECs are generated in instances where no toxicity was observed at concentrations above the active ingredient's water solubility at or above the recommended limit concentration for a particular type of study.

The Florida and Pennsylvania turf scenarios were used in the standard Pesticide Root Zone Model and Exposure Analysis Modeling System (PRZM-EXAMS) modeling. Both one application and 4 applications were modeled. The rationale for choosing four applications for turf was based on information received from BEAD indicating a worst-case scenario would probably be about four applications. The PRZM model input called "decay rate on foliage" was based on data from acceptable studies submitted to the Health and Effects Division (HED), titled "Dislodgeable foliar residues and exposure assessment for residential/recreational turf applications of dichlorvos (DDVP), Barcodes D248456, D248596, D255253).

For the flying insect (including adult mosquitoes) use, the GENEEC model is inappropriate to use. It is likely EECs found in surface water from treatment for flying insects (including adult mosquitoes) would likely be lower than EECs from treatment to turf, since the treatment area would likely be less. Since the applications for flying insect control are ground applications *(e.g.,* back-pack sprayers or truck-mounted sprayers) using coarse sprays directed to the vegetation (no fogging or misting), EFED cannot perform a quantitative assessment.

It is unlikely that aquatic organisms would be directly exposed to the dry granular bait use in animal premise areas, therefore that pathway is not evaluated.

c. Risk Quotient and Levels of Concern

Risk characterization integrates exposure and ecotoxicity data to evaluate the likelihood of adverse effects. For ecological effects, the Agency accomplishes this integration using the quotient risk method.

Risk quotients (RQs) are calculated by dividing exposure estimates by acute and chronic ecotoxicity values.

RQ = EXPOSURE / TOXICITY

RQs are then compared to the Office of Pesticide Program's levels of concern (LOCs) to assess potential risk to non-target organisms and the need to consider regulatory action. Calculation of an RQ that exceeds the LOC indicates that a particular pesticide use poses a presumed risk to non-target organisms. LOCs currently address the following categories of presumed risk:

- **acute** - potential for acute risk is high and regulatory action beyond restricted use classification may be warranted
- **acute restricted** - the potential for acute risk is high, but may be mitigated through restricted use classification
- **acute endangered species** - threatened and endangered species may be adversely affected
- **chronic risk** - the potential for chronic risk is high and regulatory action may be warranted.

The ecotoxicity values used in the acute and chronic risk quotients are endpoints derived from required laboratory toxicity studies. Ecotoxicity endpoints derived from short-term laboratory studies that assess acute effects are:

- LC_{50} - fish and birds
- LD_{50} - birds and mammals
- EC_{50} - aquatic plants and aquatic invertebrates
- EC_{25} - terrestrial plants

The NOAEC (No Observable Adverse Effect Concentration) is the endpoint used to assess chronic effects. **Table 2** gives formulas for calculating RQs and LOCs for various risk presumptions.

Table 2. Formulas for RQ calculations and LOC used for risk assessment of dichlorvos

Risk Presumption	RQ	LOC
Birds and Wild Mammals		
Acute Risk	EEC^1/LC_{50} or LD_{50}/ft^{2*} or LD_{50}/day^2	0.5
Acute Restricted Use	EEC/LC_{50} or LD_{50}/ft^2 or LD_{50}/day (or LD50<50 mg/kg)	0.2
Acute Endangered Species	EEC/LC_{50} or LD_{50}/ft^2 or LD_{50}/day	0.1
Chronic Risk	$EEC/NOAEC^5$	1.0
Aquatic Animals		
Acute Risk	EEC^3/LC_{50} or EC_{50}	0.5
Acute Restricted Use	EEC/LC_{50} or EC_{50}	0.1
Acute Endangered Species	EEC/LC_{50} or EC_{50}	0.05

Chronic Risk	EEC/NOAEC	1.0
Terrestrial and Plants Inhabiting Semi-Aquatic Areas		
Acute Risk	EEC^4/EC_{25}	1.0
Acute Endangered Use	EEC/EC_{05} or NOAEC	1.0
Aquatic Plants		
Acute Risk	EEC^3/EC_{50}	1.0
Acute Endangered Species	EEC/EC_{05} or NOAEC	1.0

[*] mg/ft^2
[1] Abbreviation for Estimate Environmental Concentration (ppm) on avian/mammalian food items
[2] mg of toxicant consumed/day
[3] EEC = ppm or ppb in water
[4] EEC = lbs ai/A
[5] No chronic risk was calculated for terrestrial animals based on the LD_{50}/ft^2 index

III. ANALYSIS

A. Exposure Characterization

1. Environmental Fate and Transport Characterization

Acceptable studies for dichlorvos are available for all guidelines. The status of the data requirements is described in **Appendix B.** Selected physical and chemical properties are summarized in **Table 3**.

Table 3. Selected physical and chemical properties of dichlorvos

Property	Value
Molecular Formula	$C_4 H_7 Cl_2 0_4 P$
Molecular Weight	220.98 g/mol
Physical State	colorless to amber liquid
Odor	mild chemical odor
Boiling point	140˚ C at 0.01 mm Hg
Vapor pressure	1.2×10^{-2} mm Hg at 20°C
Henry's Law coefficient	5.01E-8 Atm. m 3 /mol (measured)
Solubility	in water at 25˚ C= 15000 mg/L
CAS Number	62-73-7

a. Persistence

Metabolic transformation is the major mode of dissipation of dichlorvos under field conditions. Acceptable laboratory and field studies also indicate rapid dissipation through volatilization (vapor pressure = 1.2×10^{-2} mmHg). Volatility is not going to be a major route of dissipation under field conditions when the soil is moist and the pesticide is wetted in. It appears dichlorvos degrades through aerobic soil metabolism and abiotic hydrolysis as well, but is secondary to volatilization. Hydrolysis is pH dependant where the half-lives were 11.6 days at pH 5, 5.5 days at pH 7 and 21.1 hours at pH 9. Acceptable lab and field studies indicate that the major modes of dissipation of dichlorvos are volatilization (vapor pressure 1.2 x 10^{-2} torr) and microbial degradation in an aerobic soil. Dichlorvos is unstable to hydrolysis at 25˚C at pH 9. Under field conditions when the soil is moist and the pesticide is wetted, volatilization is not going to be a major route of dissipation. These mechanisms of dissipation indicate dichlorvos has low persistence in the environment.

Hydrolysis is pH dependent where the half-life is 11.65 days at pH 5, 5.19 days (124.62 hours) at pH 7, and 0.88 days (21.12 hours) at pH 9 respectively at 25˚ C. Major degradates were 2,2-dichloroacetic acid (DCA), 2,2-dichloroacetaldehyde (DAA), des-methyl dichlorvos, and glyoxylic acid. The guideline requirement for hydrolysis (163-2) is fulfilled (MRID 41723101).

Aqueous photolysis found that dichlorvos dissipated with half-lives 10.2 days in the irradiated samples and 8.9 days in the dark control samples. Major degradates of dichlorvos in the Day 15 irradiated samples were 2,2-dichloroacetaldehyde (32.7%) and des-methyl dichlorvos (17.8%) of the applied radiocarbon. Under dark condition, major degradates were 2,2-dichloroacetaldehyde (42.0%) and desmethyl dichlorvos (16.3%). The guideline requirement for photodegradation in water (163-2) is fulfilled (MRID 43326601).

Soil photolysis study showed that dichlorvos photodegraded with a half-life of 15.5 hours on a sandy loam soil surface (pH 7). Dichlorvos had a half life of 16.5 hours when incubated in darkness under similar conditions. After 72 hours of irradiation, 97% of the applied dichlorvos had dissipated from the soil by a combination of degradation and volatilization. Degradates identified in the irradiated soil were 2,2-dichloroacetic acid (26.6%) and 2,2-dichloroethanol (4.4%). The only degradation product formed under dark condition was 2,2-dichloroacetic acid of which 34% volatilized and 54.2% remained in soil. The guideline requirement for photodegradation on soil (161-3) is fulfilled (MRID 43642501).

Dichlorvos metabolized with a half-life of 10.18 hours in a sandy loam soil (pH 6.2) incubated in the dark under aerobic conditions. The major non-volatile metabolites formed during this aerobic metabolism were 2,2-dichloroacetaldehyde and dichloroethanol (each accounted for less than 12% of the initially applied radioactivity). 2,2-dichloroacetic acid accounted for up to 62.8% of the initially applied radioactivity at 48 hours post-treatment. The only volatile metabolite was 14 CO_2 which accounted for 60.8% of the initially applied radiocarbon at 360 hours post-treatment. The guideline requirement for aerobic soil metabolism (162-1) is fulfilled (MRID 41723102).

Dichlorvos metabolized with half-life of 6.3 days in sandy loam soil (pH 6.8) that was incubated in the dark under anaerobic conditions (flooding plus nitrogen atmosphere) at 25˚ C for up to 60 days . The major nonvolatile degradates in the water phase and soil extracts were 2,2-dichloroaceticacid (which accounted for up to 50.9% of the applied radioactivity at day 60), 2,2-dichloroacetaldehyde (which accounted for up to 12.6% of the applied radioactivity at day 5), and 2,2-dichloroethanol (which accounted for up to 24.7% at day 60.0). The guideline requirement for anerobic soil metabolism (162-2) is fulfilled (MRID 43835701).

Terrestrial field dissipation studies (164-1) showed that dichlorvos dissipated too rapidly within the time taken to perform the sampling process. Dichlorvos degraded rapidly to 2,2-dichloroacetic acid (DCA), which was detected only in the 0-4 inch soil. There was no dichlorvos or 2,2-dichloroethanol (DCE) detected at any soil depth. DCA residues were detected in the soil below 0-4 inches at levels similar to that of the control samples. A good mass balance of DDVP was reported in this study through air filters and cellulose cards trapping. The guideline requirement for terrestrial field dissipation (164-1) is fulfilled (MRIDs 44297701 and 44386701).

b. Mobility

Leaching/adsorption/desorption study indicated that due to the rapid degradation of dichlorvos an equilibration time for dichlorvos between the soil and solution phases could not be established. The high water solubility (10 x 10^{3} ppm) and low organic carbon coefficient (Koc = 36.9 cm^{3}/g) for dichlorvos indicate its high potential for leaching. The Koc calculation was based on Kd values reported in an acceptable soil TLC (MRID # 41354105). DDVP is not, however, persistent enough in sand to trigger any studies to assess its potential for leaching to ground water. Therefore, no groundwater concern is anticipated for dichlorvos. Under field conditions, dichlorvos dissipated rapidly through volatilization and thus, residues of dichlorvos are not likely to contaminate groundwater by leaching. The guideline requirement for leaching and adsorption/desorption (163-1) is fulfilled (MRID 41723103, 40034904, 41354105).

2. Aquatic Resource Exposure Assessment

Aquatic Organism Exposure Modeling

Dichlorvos residues can be present in water as a result of use of three pesticides: dichlorvos, naled, and trichlorfon. Dichlorvos is a degradate of naled and trichlorfon. This assessment discusses the potential for dichlorvos to contaminate water from the use of dichlorvos as the sole active ingredient. Although these estimates are only for dichlorvos, there are several dichlorvos degradates that have been identified including desmethyl dichlorvos (methyl O-(2,2-dichlorovinyl) phosphate), dichlorethanol, and dichloroacetic acid; this latter degradate is very mobile. Turf and general outdoor (flying insect) were the sites of interest. Concentrations were calculated based on a maximum application rate of 0.2 lb a.i/A for both sites.

Turf Scenario

Tier II Estimated Environmental Concentrations (EECs) for dichlorvos for the turf scenarios were estimated using EFED's aquatic models PRZM-EXAMS (EXposure Analysis Modeling System). PRZM is used to simulate pesticide transport as a result of runoff and erosion from an 10-ha agricultural field, and EXAMS considers environmental fate and transport of pesticides in surface water and predicts EECs in a standard pond (10,000-m^2 pond, 2-m deep), with the assumption that the small field is cropped at 100%. Calculations are carried out with the linkage program shell - PE4VO1.pl - which incorporates the standard scenarios developed by EFED. Additional information on these models can be found at: http://www.epa.gov/oppefed1/models/water/index.htm.and in **Appendix C**. Representative inputs for the model are shown in **Table 4**, and results are tabulated in **Table 5.** For a more detailed explanation and outputs from this model, see **Appendix C.**

Table 4. PRZM/EXAMS Input parameters

Input Parameter	Value
PC Code	84001
Molecular weught (g/mole)	220.9
Water Solubility	10000 ppm
Hydrolysis half-life (pH 7)	5.2 days
Aerobic Soil Half-life	0.42 days
Photolysis half-life	10.2 days
Aerobic Aquatic Metabolism Half-Life	No data
Kd	0.3
Soil Organic Carbon Partitioning (Koc) (1/kg)	37
Organic Carbon Percentage	0.812
Use	Turf
Application Rate (lb ai/A)	0.2
Application Date	May 15
Application Method	Ground Spray
Number of Applications/Year	turf at one application turf at four applications (at 30-day retreatment interval)

* Parameters were selected in accordance with the Proposed Interim Guidance for Input Values document, dated April 6, 2000.

Table 5. Estimated Environmental Concentrations (EECs) For Aquatic Exposure Based on PRZM/EXAMS

Site	Application Method	Application Rate (lbs ai/A)	No. Apps./ Interval Between Apps.	Initial (PEAK) EEC (ppb)	21-day average EEC (ppb)	60-day average EEC (ppb)
Turf (FL)	ground	0.2	1 app.	0.112	0.037	0.014
Turf (FL)	ground	0.2	4 apps at 30 day interval	0.169	0.061	0.036
Turf (PA)	ground	0.2	1 app.	0.112	0.037	0.014
Turf (PA)	ground	0.2	4 apps at 30 day interval	0.147	0.054	0.034

Less than 20% (4% - 17%) of Estimated Environmental Concentrations (EEC) reached aquatic media were as contribution of spray drift; the remaining (>80%) is due to runoff (**Table 5**).

Flying Insect Scenario

For the flying insect (including adult mosquitoes) use, EFED currently has no models that would be appropriate for modeling EECs. PRZM/EXAMS and the GENEEC model are inappropriate to use. It is likely EECs found in surface water from treatment for flying insects (including adult mosquitoes) would likely be lower than EECs from treatment to turf, since the treatment area would likely be less. Since the applications for flying insect control are ground applications *(e.g.,* back-pack sprayers or truck-mounted sprayers) using coarse sprays directed to the vegetation (no fogging or misting), EFED cannot perform a quantitative assessment.

Granular Bait Scenario

For the granular bait scenario in animal premise areas, it is unlikely that aquatic organisms will be directly exposed, therefore that pathway is not evaluated and a quantitative assessment is not performed.

3. Terrestrial Organism Exposure Modeling

Terrestrial wildlife exposure estimates are typically calculated for birds and mammals, emphasizing a dietary exposure route for uptake of the pesticide. For obtaining EECs for acute exposure from multiple applications and chronic exposure from both single and multiple applications of liquid dichlorvos and granular bait products, the T-REX v 1.1 (U.S. EPA. 2004b) program was used.

For the liquid spray application to turf, the maximum application rate modeled was 0.2 lb ai/A. One application and four applications (with 30 day application interval) were modeled for turf. The rationale for choosing four applications for turf was based on information received from BEAD indicating a worst-case scenario of four applications.

For liquid spray application for flying insects (including adult mosquitoes), the maximum application rate modeled was 0.2 lb ai/A. for 75 applications per year. The rationale for choosing weekly applications for mosquito control was based on information received from BEAD indicating a worst case scenario for adult mosquito control would probably be around 75 applications to a given site over a year period.

For the granular bait scenario, the maximum application rate modeled was 0.1 lb ai/A. A single application and a worse case scenario of 120 applications per year were modeled. The rationale for choosing 120 applications per year is based on label specifications bearing directions to reapply every 3 to 5 days until insect control is achieved.

A foliar dissipation half-life of 0.0875 days was used for liquid spray application scenarios based on Dichlorvos Total Residue in Turf data on studies conducted in Florida and Canada (MRID No. 44610501, and 44794901 respectively).

Terrestrial EECs were calculated using T-REX v 1.1 (U.S. EPA. 2004b) and are shown in Tables 6, 7, and 8.

Table 6. Estimated Environmental Concentrations for Modeled Scenarios for Turf (1 application and 4 applications)

	Upper Bound Kenega Value for Turf (1 application) (ppm)	Upper Bound Kenega Value for Turf (4 applications with 30 day application interval) (ppm)
Food Item		
Short Grass	19.30	19.30
Tall Grass	8.84	8.84
Broadleaf plants/sm Insects	10.85	10.85
Fruits/pods/seeds/lg insects	1.21	1.21

Predicted maximum residues are based on Hoerger and Kenaga (1972) as modified by Fletcher *et al.* (1994).

Table 7. Estimated Environmental Concentrations for Modeled Scenarios for Flying Insects (75 applications with 5 day application interval)

	Upper Bound Kenega Value for Flying Insects (75 applications with 5 day application interval) (ppm)
Food Item	
Short Grass	19.30
Tall Grass	8.84
Broadleaf plants/sm Insects	10.85
Fruits/pods/seeds/lg insects	1.21

Predicted maximum residues are based on Hoerger and Kenaga (1972) as modified by Fletcher *et al.* (1994).

Table 8. Estimated Environmental Concentrations for Modeled Scenarios for Bait (1 application)

Crop	Application method	Application rate (lbs ai/A)[3]	% Unincorporated	EEC (mg ai/ft^2)
Bait (single application)	Broadcast	0.1	100	0.08

B. Ecological Effects Characterization

In screening-level ecological risk assessments, effects characterization describes the types of effects a pesticide can produce in an organism or plant. This characterization is based on registrant-submitted studies that describe acute and chronic toxicity information for various aquatic and terrestrial animals and plants. In addition, other sources of information, including the Ecological Incident Information System (EIIS), are conducted to further refine the characterization of potential ecological effects.

Toxicity testing reported in this section does not represent all species of birds, mammals, or aquatic organisms. Only a few surrogate species for both freshwater fish and birds are used to represent all freshwater fish (2000+) and bird (680+) species in the United States. Mammalian acute studies are usually limited to Norway or New Zealand rat or the house mouse. Estuarine/marine testing is usually limited to a crustacean, a mollusk, and a fish. Also, neither reptiles nor amphibians are tested. The risk assessment assumes that avian and reptilian toxicities are similar. The same assumption is used for fish and amphibians.

1. Evaluation of Aquatic Ecotoxicity Studies

______________*a.* ***Toxicity to Freshwater Animals***

Freshwater Fish, Acute

Two freshwater fish toxicity studies using the TGAI are required for all pesticides to establish their toxicity to fish. TEP testing was required on the 1987 Standard to support the mosquito adulticide/larvacide use pattern. The preferred species are rainbow trout (a coldwater fish) and bluegill sunfish (a warmwater fish). Results of these studies are tabulated below in **Table 9**.

Table 9. Acute Toxicity Endpoints for Freshwater Fish

Species	% ai	96-hour LC50 (ppb)	Toxicity Category	MRID Author/Year	Study Classification
Rainbow trout *(Oncorhynchus mykiss)*	100	500 (24 hours only)	Highly toxic	40098001 (Mayer & Ellersieck 1986)	Supplemental
Rainbow trout *(Oncorhynchus mykiss)*	42(EC)	320 (=750 for formulated product)	Highly toxic for formulated product	43284702 (Jones 1994)	Supplemental
Lake trout *(Salvelinus namaycus*h)	100 100	187 183	Highly toxic Highly toxic	40098001 (Mayer & Ellersieck 1986)	Supplemental
Bluegill sunfish *(Lepomis macrochirus*)	98	869	Highly toxic	40094602 (Johnson 1980)	Core
Bluegill sunfish *(Lepomis macrochirus*)	42(EC)	1860 (=4300 for formulated product)	Moderately toxic for the formulated product	43284701 (Jones 1994)	Supplemental

There are no core studies available for the rainbow trout. Mayer and Ellersieck (40098001) cite a 24-hour LC50 of 500 ppb for rainbow trout. The two 96-hour lake trout LC50s of 187 ppb and 183 ppb showed 24-hour LC50s of 486 ppb and 667 ppb, respectively. The studies are classified "supplemental" because they were not performed using standard test species. Mayer and Ellersieck state (p. 9) the correlation coefficient (r) between rainbow and lake trout for acute static LC50s is 0.99. Since the results are comparable within the limits of the toxic category *(i.e.*, highly toxic), the lake trout studies will be substituted for the rainbow trout study. Since the LC50s are less than 1 ppm, dichlorvos is categorized as highly toxic to freshwater fish on an acute basis.

Two studies were performed with an emulsifiable concentrate formulation (42.3% ai). Since the TEP and TGAI demonstrated similar toxicities (on an active ingredient basis), it does not appear inerts in the EC formulation are toxic.

Freshwater Fish, Chronic

A freshwater fish early life stage toxicity test was required in the 1987 Dichlorvos Registration Standard to support the mosquito larvicide use. Results of this test are provided in **Table 10.**

Table 10. Chronic Toxicity Endpoints for Freshwater Fish

Species/Study Duration	**% ai**	**NOEC/LOAEL (ppb)**	**MATC [1] (ppb)**	**Endpoints Affected**	**MRID Author/Year**	**Study Classification**
Rainbow trout *(Oncorhynchus mykiss)* Early Life-Stage (Flow-through)	98.0	5.2/10.1	7.2	Larval survival	43788001 Davis 1995)	Core

1 defined as the geometric mean of the NOEC and LOAEL.

Freshwater Invertebrates, Acute

A freshwater aquatic invertebrate toxicity study using the TGAI is required to establish the toxicity of dichlorvos to aquatic invertebrates. TEP testing was required on the 1987 Standard to support the mosquito adulticide/larvicide use pattern. The preferred species is *Daphnia magn*a. Results are presented in **Table 11**.

Table 11. Acute Toxicity Endpoints for Freshwater Invertebrates

Species	% ai	48-hour EC50 (ppb)	Toxicity Category	MRID Author/Year	Study Classification
Waterflea *(Daphnia pule*x)	100	0.07	Very highly toxic	40098001 (Mayer & Ellersieck 1986)	Core
Waterflea *(Simocephalus serrulatu*s)	100	0.28	Very highly toxic	40098001 (Mayer & Ellersieck 1986)	Supplemental
Waterflea *(Simocephalus serrulatu*s)	100	0.26	Very highly toxic	40098001 (Mayer & Ellersieck 1986)	Supplemental

Since the EC50 values are less than 100 ppb, dichlorvos is categorized as very highly toxic to aquatic invertebrates on an acute basis. A study with the TEP was not submitted.

Freshwater Invertebrates, Chronic

A freshwater aquatic invertebrate life-cycle study was required in the 1987 Dichlorvos Registration

Standard to support the mosquito larvacide use.

Table 12. Chronic Toxicity Endpoints for Freshwater Invertebrates

Species	% ai	21-day NOEC/LOAEL (ppb)	MATC [1] (ppb)	Endpoints Affected	MRID Author/Year	Study Classification
Waterflea *(Daphnia magna)*	98.0	0.0058/0.0122	0.0084	Egg production and growth (length and weight)	43890301 (Ward and Davis 1995)	Core

1 defined as the geometric mean of the NOEC and LOAEL.

b. Toxicity to Estuarine and Marine Animals

Estuarine and Marine Fish, Acute

Acute toxicity studies with estuarine/marine fish using both TGAI and TEP were required in the 1987 Registration Standard to support the mosquito larvicide use.

Table 13. Acute Toxicity Endpoints for Estuarine and Marine Fish

Species	% ai	96-hour LC50 (ppb)	Toxicity Category	MRID Author/Year	Study Classification
Sheepshead minnow *(Cyprinodon variegatus*)	98	7350	Moderately toxic	43571403 (Jones and Davis 1994)	Core
Sheepshead minnow *(Cyprinodon variegatus*)	42.39	6146 (=14500 for formulated product)	Moderately toxic for formulated product	43571406 (Jones and Davis 1994)	Core

Since the LC50 falls in the range 1000 to 10000 ppb ai, dichlorvos is categorized as moderately toxic to estuarine/marine fish on an acute basis. One study was performed with an emulsifiable concentrate formulation (42.3% ai). Since the TEP and TGAI demonstrated similar toxicities (on an active ingredient basis), the inerts in the EC formulation are probably not toxic.

Estuarine and Marine Fish, Chronic

An estuarine fish early life stage toxicity test was required in the 1987 Dichlorvos Registration Standard to support the mosquito larvacide use.

Table 14. Chronic Toxicity Endpoints for Estuarine and Marine Fish

Species/Study Duration	% ai	NOEC/LOAEL (ppb)	MATC [1] (ppb)	Endpoints Affected	MRID Author/Year	Study Classification
Sheepshead Minnow *(Cyprinodon variegatus)*	98	960/1840	1330	Survival and length	43790401 (Ward and Davis 1995)	Core

1 defined as the geometric mean of the NOEC and LOAEL.

Estuarine and Marine Invertebrates, Acute

Acute toxicity studies with estuarine/marine invertebrates (mysid and eastern oyster) using both TGAI and TEP were required in the 1987 Registration Standard to support the mosquito larvacide use.

Table 15. Acute Toxicity Endpoints for Estuarine and Marine Invertebrates

Species/Static or Flow-through	% ai.	96-hour LC50 /EC50 (ppb)	Toxicity Category	MRID Author/Year	Study Classification
Eastern oyster (shell deposition) *(Crassostrea virginica)*	98	89100	Slightly toxic	43571404 (Jones & Davis 1994)	Core
Eastern oyster (shell deposition) *(Crassostrea virginica)*	42 (EC)	920 (2180 for formulated product)	Moderately toxic for formulated product	43571407 (Jones & Davis 1994)	Supplemental
Mysid *(Americamysis bahi*a)	98	19.1	Very highly toxic	43571405 (Jones & Davis 1994)	Core
Mysid *(Americamysis bahi*a)	42 (EC)	18.7 (44.0 for formulated product)	Very highly toxic for formulated product	43571408 (Jones & Davis 1994)	Core

Since the LC50 for the most sensitive species (mysid) is less than 1000 ppb, dichlorvos is categorized as very highly toxic to estuarine/marine animals on an acute basis. Two studies were performed with an emulsifiable concentrate formulation (42.3% ai). Based on similarity between toxicity of the TGAI and TEP for the mysid, it does not appear that the inerts in the formulation are toxic. However, in the case of the oyster, a large discrepancy exists, with toxicity of the EC formulation (on an active ingredient basis) almost 10-fold greater than that of the TGAI. No explanation for this was provided by the performing laboratory or registrant. Since both the TGAI and TEP studies were scientifically sound, they do not have to be repeated.

Estuarine and Marine Invertebrate, Chronic

An estuarine aquatic invertebrate life-cycle study was required in the 1987 Dichlorvos Registration Standard to support the mosquito larvicide use.

Table 16. Chronic Toxicity Endpoints for Estuarine and Marine Invertebrates

Species/(Static Renewal or Flow-through)	% ai	21-day NOEC/LOAEL (ppb)	MATC [1] (ppb)	Endpoints Affected	MRID Author/Year	Study Classification
Mysid *(Americamysis bahi*a)	98	1.48/3.25	2.19	Weight and length	43854301 (Ward and Davis 1996)	Core

1 defined as the geometric mean of the NOEC and LOAEL.

c. *Toxicity to Aquatic Plants*

Currently, terrestrial and aquatic plant studies are not required for pesticides other than herbicides, except on a case-by-case basis *(e.g.*,, labeling bears phytotoxicity warnings, incident data or literature that demonstrate phytotoxicity). Plant testing is not required for dichlorvos. Supplemental data are available (F.L. Mayer, 1986; 40228401) showing 48 hour EC50 values of >100000 ppb for green algae, 14000 ppb for algae (the species were not given) and 17000-28000 ppb for marine diatom.

Table 17. Toxicity Endpoints for Aquatic Plants

Species	Endpoint	MRID/Reference
Green algae	48 hr EC_{50} >100000 ppb	MRID No. 40228401 (U.S. EPA, F.L. Mayer 1986)
Algae (unknown species)	48 hr EC_{50} = 14000 ppb	MRID No. 40228401 (U.S. EPA, F.L. Mayer 1986)
Marine diatom	48 hr EC_{50} = 17000 - 28000 ppb	MRID No. 40228401 (U.S. EPA, F.L. Mayer 1986)

2. Evaluation of Terrestrial Ecotoxicity Studies

a. *Toxicity to Terrestrial Animals*

Birds, Acute and Subacute

An acute oral toxicity study using the technical grade of the active ingredient (TGAI) is required to establish the toxicity of dichlorvos to birds. The preferred test species is either mallard duck (a waterfowl) or bobwhite quail (an upland gamebird). Results of acute oral testing are tabulated in **Table 18.**

Table 18. Toxicity Endpoints for Avian Acute Oral

Species	% a.i.	LD50 (mg/kg)	Toxicity Category	MRID No. Author/Year	Study Classification
Pheasant *(Phasianus colchicus)*	93	11.3	Highly toxic	00160000 (Hudson *et al*.1984)	Core
Northern bobwhite quail *(Colinus virginianus)*	96.5	8.8	Very highly toxic	40818301 (Grimes and Aber 1988)	Core
Mallard duck *(Anas platyrhynchos)*	93	7.78	Very highly toxic	00160000 (Hudson *et al*.1984)	Core

Since the LD50 of the most sensitive species (mallard) is less than 10 mg/kg, dichlorvos is categorized as being very highly toxic to avian species on an acute oral basis.

Two subacute dietary studies using the TGAI are required to establish the toxicity of dichlorvos to birds.

The preferred test species are mallard duck and bobwhite quail. Results of subacute testing are in **Table 19.**

Table 19. Avian Subacute Dietary Toxicity Endpoints

Species	% a.i.	5-Day LC50 (ppm)1	Toxicity Category	MRID No. Author/Year	Study Classification
Pheasant *(Phasianus colchicus)*	94.8	568	Moderately toxic	00022923 (Hill *et al* 1975)	Core
Mallard duck *(Anas platyrhynchos)*	94.8	1317 (5-day old test species)	Slightly toxic	00022923 (Hill *et al* 1975)	Core
Mallard duck *(Anas platyrhynchos)*	94.8	>5000 (16-day old test species)	Practically non-toxic	00022923 (Hill *et al* 1975)	Core

Since the LC50 of the most sensitive species (pheasant) falls in the range of 501 to 1000 ppm, dichlorvos is categorized as being moderately toxic to avian species on a subacute dietary basis.

Birds, Chronic

Avian reproduction studies were required in EPA's 1987 Dichlorvos Standard to support the registered terrestrial and aquatic non-food use patterns. Results of the submitted tests are tabulated below.

Table 20. Chronic Endpoints for Avian Reproduction

Species	% a.i.	NOEC/LOAEL (ppm)	LOAEL Endpoints	MRID No. Author/Year	Study Classification
Northern bobwhite quail *(Colinus virginianus)*	98	30/100	eggs laid, viable embryos and live three week embryos, normal hatchlings, fourteen day old survivors	43981701 (Cameron 1996)	Core
Mallard duck *(Anas platyrhynchos)*	98	5/15	eggshell thickness, eggs laid, viable embryos, live three week embryos	44233401 (Redgrave and Mansell 1997)	Core

Based on (1) no adverse effects noted at the 1 and 5 ppm treatment levels, and (2) statistically significant reductions in eggshell thickness, numbers of eggs laid, numbers of eggs set, numbers of viable embryos, and numbers of live three week embryos at the 15 ppm treatment level, the NOEC for mallards exposed to dichlorvos in the diet for 20 weeks is 5 ppm and the LOAEL is 15 ppm. Based on (1) no adverse effects noted at the 12 and 30 ppm treatment levels, and statistically significant reductions in fourteen day old survivor weight, terminal male and female body weight, numbers of eggs laid, numbers of viable embryos, numbers of live three week embryos, and numbers of normal hatchlings at the 100 ppm treatment level, the NOEC for bobwhite exposed to dichlorvos in the diet for 20 weeks is 30 ppm and the LOAEL is 100 ppm.

There is some scientific literature on related organophosphates showing adverse reproductive effects to birds from short-term exposures. These effects include reduced egg production within days after initiation of dietary exposure, and effects on eggshell quality, incubation and brood rearing behavior (Bennett and Ganio 1991).

Mammals, Acute and Chronic

Wild mammal testing is required on a case-by-case basis, depending on the results of lower tier laboratory mammalian studies, intended use pattern and pertinent environmental fate characteristics. In most cases, rat or mouse toxicity values obtained from the Agency's Health Effects Division (HED) substitute for wild mammal testing. Dichlorvos human toxicity endpoints for dietary exposure and occupational/residential exposure are reported in HED's document entitled: Dichlorvos: Hazards Identification Committee Report (G. Ghali to S. Lewis dated 12/19/97). The mammalian toxicity endpoint value used for ecological risk assessment purpose is reported below.

Table 21. Mammalian Toxicity Endpoints

Species/ Study Duration	% ai	Test Type	Toxicity Value	Affected Endpoints	MRID
laboratory rat *(Rattus norvegicus*)	Dichlorvos technical % unspecified	acute oral	LD50=80 mg/kg (M) LD50=56 mg/kg (F)		0005467
laboratory rat *(Rattus norvegicus*)	Dichlorvos technical % unspecified	acute inhalation	LC50 > 0.218 mg/L		00137239
laboratory rat *(Rattus norvegicus*)	Dichlorvos technical % unspecified	acute dermal	LD50 = 107 mg/kg (M) LD50 = 75 mg/kg (F)		0005467
laboratory rat *(Rattus norvegicus*)	98.3%	2 generation reproduction	NOEC = 20 ppm	fertility, pup weight	Acc # 010174, MRID 42483901

Dichlorvos is categorized moderately toxic to small mammals on an acute oral basis and highly toxic on an acute dermal basis. In of a 2-generation reproduction study using Sprague-Dawley rats (where dichlorvos was administered in the drinking water), the reproductive toxicity NOEL was found to be 20 ppm based on reduced dams bearing litters, fertility index, pregnancy index, and pup weight on day-4.

Insects

Results of a honey bee acute contact study using the TGAI are tabulated below.

Table 22. Nontarget Insect Acute Contact Toxicity

Species	% ai	LD50 (µg/bee)	Toxicity Category	MRID Author/Year	Study Classification
Honey bee *(Apis mellifera)*	technical % unspecified	0.495	highly toxic	00036935 (Atkins *et al* 1975)	Core

An analysis of the results indicate that dichlorvos is categorized as being highly toxic to bees on an acute contact basis.
A study on the toxicity of residues on foliage to honey bees (guideline 141-2) using the typical end-use product was required for dichlorvos in the 1987 Standard to support the terrestrial non-food and domestic outdoor sites. The study submitted showed residues of dichlorvos 4E applied at 0.5 lb ai/A were practically nontoxic to honey bees at three hours posttreatment.

b. Toxicity to Terrestrial Plants

Currently, terrestrial and aquatic plant studies are not required for pesticides other than herbicides, except on a case-by-case basis *(e.g.*,, labeling bears phytotoxicity warnings, incident data or literature that demonstrate phytotoxicity). Plant testing is not required for dichlorvos.

Table 23 summarizes the most sensitive ecological toxicity endpoints for aquatic and terrestrial organisms. Discussions of the effects of dichlorvos on aquatic and terrestrial taxonomic groups are presented below.

Table 23. Toxicity Endpoints Used in the Risk Assessment

Toxicity Test/Species	Toxicity Endpoint	MRID Number and References
Avian acute oral/ Mallard duck	LD_{50} = 7.78 mg/kg	MRID # 00160000 (Hudson *et a*l.1984)
Avian subacute dietary/Pheasant	LC_{50} = 568 mg/kg	MRID # 00022923 (Hill *et al* 1975)
Avian reproduction /Mallard duck	NOEC = 5 ppm	MRID # 44233401 (Redgrave and Mansell 1997)
Mammalian acute oral/ rat	LD_{50} = 56 mg/kg (female)	MRID # 0005467
Mammalian chronic (reproduction)/rat	NOEC = 20 ppm	MRID # 42483901
Honey bee acute (acute contact basis)	LD_{50} = 0.495 µg/bee	MRID # 00036935 (Atkins *et al* 1975)
Terrestrial Plants	N/A	
Fish (freshwater) acute/ Lake trout	LC_{50} = 183 ppb	MRID # 40098001 (Mayer & Ellersieck 1986)
Fish (freshwater) chronic/Rainbow trout	NOAEC = 5.2 ppb	MRID # 43788001 (Davis 1995)
Fish (estuarine) acute/ Sheepshead minnow	LC_{50} = 7350 ppb	MRID # 43571403 (Jones and Davis 1994)
Fish (estuarine) chronic/Sheepshead minnow	NOAEC = 960 ppb	MRID # 43790401 (Ward and Davis 1995)

Toxicity Test/Species	Toxicity Endpoint	MRID Number and References
Invertebrate (freshwater) acute/*Daphnia pulex*	EC_{50} = 0.07 ppb	MRID # 40098001 (Mayer & Ellersieck 1986)
Invertebrate (freshwater) chronic/ *Daphnia magna*	NOAEC = 0.0058 ppb	MRID # 43890301 (Ward and Davis 1995)
Invertebrate (estuarine) acute/Mysid shrimp	LC_{50} = 19.1 ppb	MRID # 43571405 (Jones & Davis 1994)
Invertebrate (estuarine) chronic/ Mysid shrimp	NOAEC = 1.48 ppb	MRID # 43854301 (Ward and Davis 1996)
Aquatic plants/ Algae	EC_{50} = 14000 ppb	MRID # 40228401 (F.L. Mayer, 1986)

3. Terrestrial Field Testing

No terrestrial field testing studies are available for dichlorvos.

4. Use of the Probit Slope Response Relationship

The Agency uses the probit dose response relationship as a tool for providing additional information on the endangered and threatened animal species acute levels of concern (LOC). The acute listed species LOCs of 0.1 and 0.05 are used for terrestrial and aquatic animals, respectively. As part of the risk characterization, an interpretation of acute LOCs for listed species is discussed. This interpretation is presented in terms of the chance of an individual event (i.e., mortality or immobilization) should exposure at the estimated environmental concentration actually occur for a species with sensitivity to dichlorvos on par with the acute toxicity endpoint selected for RQ calculation. To accomplish this interpretation, the Agency uses the slope of the dose response relationship available from the toxicity study used to establish the acute toxicity measurement endpoints for each taxonomic group. The individual effects probability associated with the LOCs is based on the mean estimate of the slope and an assumption of a probit dose response relationship. In addition to a single effects probability estimate based on the mean, upper and lower estimates of the effects probability are also provided to account for variance in the slope. The upper and lower bounds of the effects probability are based on available information on the 95% confidence interval of the slope. A statement regarding the confidence in the applicability of the assumed probit dose response relationship for predicting individual event probabilities is also included. Studies with good probit fit characteristics (i.e., statistically appropriate for the data set) are associated with a high degree of confidence. Conversely, a low degree of confidence is associated with data from studies that do not statistically support a probit dose response relationship. In addition, confidence in the data set may be reduced by high variance in the slope (i.e., large 95% confidence intervals), despite good probit fit characteristics.

Individual effect probabilities are calculated based on an Excel spreadsheet tool IECV1.1 (Individual Effect Chance Model Version 1.1) developed by Ed Odenkirchen of the U.S. EPA, OPP, Environmental Fate and Effects Division (June 22, 2004). The model allows for such calculations by entering the mean slope estimate (and the 95% confidence bounds of that estimate) as the slope parameter for the spreadsheet. In addition, the LOC (0.1 for terrestrial animals and 0.05 for aquatic animals) is entered as the desired threshold.

5. Incident Data Review

There have been 6 incidents related to dichlorvos reported in the Environmental Incident Information System (EIIS) database (reported to the Agency from 1991 to 2002). Of these 6 incidents, 3 were of undetermined use, and 3 were registered uses.

Avian Incidences

Five of the incidences were terrestrial, with 4 related to bird kills. One incident involved an avian outdoor exposure from a site (apples) for which dichlorvos was never registered. Two bluebird chicks died in their nest box in the town of Redhook New York. The nest was within 300 yards of an apple orchard. The cause of death was dichlorvos poisoning (Reported by:Wildlife Pathology Unit, NY State Dept. Of Environmental Conservation Annual Report 1/1/94 -5/3/95. Ward Stone, Wildlife Pathologist. 1994 incident). Another incident involved a registered use of dichlorvos crystals in treated feed than resulted in 8 mallard ducks dying in an agricultural area. The last two incidents involved the use of dichlorvos in the home residence resulting in canary deaths (6 total deaths).

Mammalian Incidences

There is one mammalian incidence reported involving indoor exposure to animals. Amvac Chemical Corp. (Letter to Agency Dated 7/3/95) reported potential adverse effects exposure relating to a pest strip in which several exotic and wild native and non-native animals that included skunks and several fennis foxes (native of Egypt) were in a room roughly 4000 cubic feet. The room had a pest strip placed in it 3-4 days previous to control insects. The pest strip was labeled as covering 1000 cubic feet. Four fennis fox pups died. A veterinarian treated three other pups with atropine; two recovered. The foxes were the only animals that recovered. Two of the animals recovered after treating with atropine, indicating it is possible that the cause of poisoning was exposure to dichlorvos fumes.

Aquatic Incidence

One aquatic incident of undetermined use in Tennessee involving fish kills was reported affecting 379 organisms (species undetermined). No residue analysis was conducted.

Currently, no systematic or reliable mechanism exists for the accurate monitoring and reporting of wildlife kill incidents to the Agency. Moreover, before a pesticide incident can be reported or investigated, the dead animals must first be found. In the absence of monitoring following pesticide applications, kills are not likely to be noticed in agro-environments which are generally away from human activity. Even if onlookers are present, dead wildlife species, particularly small song birds and mammals, are easily overlooked, even by experienced and highly motivated observers. Even in sparse vegetative cover, wildlife carcass detection is difficult and as vegetative cover increases the difficulty in detection is exacerbated. Under some circumstances intoxicated animals may seek heavy cover before dying which decreases the probability of detection further. Poisoned birds may fly from the sites, succumbing outside of the area or scavengers may remove carcasses before they can be observed, significantly reducing the chance of detection.

Balcomb (1986) reported that songbird carcasses removal rate ranged from 62 to 92 percent in the first 24 hours following placement, with a mean loss at 24 hours of 75% (S.D. = 12.4). Overall, by the end of the 5-day monitoring period, 72 of the 78 carcasses had been removed by scavengers. In addition, the number of birds per acre alone, not considering these other factors, makes detection of kills difficult.

Best (1990) reported from 0.57 live birds per acre in the center to 2.8 live birds per acres in the perimeter of corn fields in Iowa and Illinois. Even if all the birds in a field were killed and remained on the field, the probability of observing carcasses, particularly when not systematically searching, at these densities, is not high. Research has shown that even when intense systematic searches are conducted by highly trained individuals for placed carcasses in agro-environments, recovery rates rarely exceed 50 percent (Madrigal *et al.*1996).

Even if dead animals are observed, they might not be reported to the Agency. Persons unfamiliar with the toxicity of pesticides to non-target species may fail to associate the finding with the pesticide application, especially if the two events are separated by several days and only a few birds are observed dead. Even if the association is made, the observer must be aware or have the motivation to find out where to report the incident. Therefore, the reporting of a few dead birds associated with the use of a chemical is believed to provide evidence that substantial effects may be occurring.

6. RISK CHARACTERIZATION

Risk characterization is the integration of exposure and effects characterization to determine the ecological risk from the use of dichlorvos and the likelihood of effects on aquatic life, wildlife, and plants based on varying pesticide-use scenarios. The risk characterization provides an estimation and a description of the risk; articulates risk assessment assumptions, limitations, and uncertainties; synthesizes an overall conclusion; and provides the risk managers with information to make regulatory decisions.

A. Risk Estimation - Integration of Exposure and Effects Data

Results of the exposure and toxicity effects data are used to evaluate the likelihood of adverse ecological effects on non-target species. For the assessment of dichlorvos risk, the risk quotient (RQ) method is used to compare exposure and measured toxicity values. Estimated environmental concentrations (EECs) are divided by acute and chronic toxicity values. The RQs are compared to the Agency's levels of concern (LOCs). These LOCs are the Agency's interpretive policy and are used to analyze potential risk to non-target organisms and assess the need to consider regulatory action. These criteria are used to indicate when a pesticide's directed label use has the potential to cause adverse effects on non-target organisms. **Table 2** of this document summarizes the LOCs used in this risk assessment.

1. Non-target Aquatic Animals

a. Freshwater Fish

An analysis of the results show that for single and multiple applications of dichlorvos to turf at the maximum application rate of 0.2 lb ai/A, no freshwater fish acute or chronic LOCs are exceeded. Freshwater fish risk quotients are listed in **Table 24.**

Table 24. Acute and chronic risk quotients for freshwater fish for turf scenarios (Risk Quotients for Freshwater Fish Based On a Lake Trout LC50 of 183 ppb and a Rainbow Trout NOAEL of 5.2 ppb). EEC values are calculated based on the maximum labeled application rate.

Site (No. Apps./Interval Between Apps.)	LC50 (ppb)	NOAEL (ppb)	EEC Initial/Peak (ppb)	EEC 60-day Ave. (ppb)	Acute RQ (Initial EEC/LC50)	Chronic RQ (60-day Ave. EEC/NOAEL)
FL Turf (1 app.)	183	5.2	0.112	0.014	0	0
FL Turf (4 app./30 day interval)	183	5.2	0.169	0.036	0	0
PA Turf (1 app.)	183	5.2	0.112	0.014	0	0
PA Turf (4 app./30 day interval)	183	5.2	0.147	0.034	0	0

*exceeds endangered species LOC (LOC = 0.05)
**exceeds endangered species and acute restricted use LOC (LOC = 0.1)
***exceeds endangered species, restricted use and acute risk LOC (LOC = 0.5)
****exceeds chronic LOC (LOC = 1)

b. Freshwater Invertebrates

An analysis of the results show that for single and multiple applications of dichlorvos to turf (both FL and PA scenarios) at the maximum application of 0.2 lb ai/A, the freshwater invertebrate acute endangered species, restricted use and acute risk LOC is exceeded. The chronic LOCs is exceeded for freshwater invertebrates (**Table 25**).

Table 25. Acute and Chronic Risk Quotients for Freshwater Invertebrates for turf scenarios
Risk quotients for freshwater invertebrates based on based on a waterflea EC50 of 0.07 ppb and NOAEL of 0.0058 ppb.

Site (No. Apps./Interval Between Apps.)	EC50 (ppb)	NOAEL (ppb)	EEC Initial/Peak (ppb)	EEC 21-day Ave. (ppb)	Acute RQ (Initial EEC/EC50)	Chronic RQ (21-day Ave. EEC/NOAEL
FL Turf (1 app.)	0.07	0.0058	0.112	0.037	1.6***	6.38****
FL Turf (4 app./30 day interval)	0.07	0.0058	0.169	0.061	2.41***	10.52****
PA Turf (1 app.)	0.07	0.0058	0.112	0.037	1.6***	6.38****

PA Turf (4 app./30 day interval)	0.07	0.0058	0.147	0.054	2.1***	9.31****

*exceeds endangered species LOC (LOC = 0.05)
**exceeds endangered species and acute restricted use LOC (LOC = 0.1)
***exceeds endangered species, restricted use and acute risk LOC (LOC = 0.5)
****exceeds chronic LOC (LOC = 1)

c. *Estuarine/Marine Fish*

An analysis of the estuarine/marine fish species results show that for single and multiple applications of dichlorvos to turf at the maximum application rate of 0.2 lb ai/A, no acute or chronic LOCs are exceeded. Estuarine/marine risk quotients are listed in **Table 26.**

Table 26. Acute and chronic risk quotients for estuarine/ marine fish for turf scenarios
Risk quotients for estuarine/marine fish based on a sheepshead minnow LC50 of 7350 ppb and NOAEL of 960 ppb.

Site (No. Apps./Interval Between Apps.)	LC50 (ppb)	NOAEL (ppb)	EEC Initial/Peak (ppb)	EEC 60-day Ave. (ppb)	Acute RQ (Initial EEC/LC50)	Chronic RQ (60-day Ave. EEC/NOAEL)
FL Turf (1 app.)	7350	960	0.112	0.014	0	0
FL Turf (4 app./30 day interval)	7350	960	0.169	0.036	0	0
PA Turf (1 app.)	7350	960	0.112	0.014	0	0
PA Turf (4 app./30 day interval)	7350	960	0.147	0.034	0	0

*exceeds endangered species LOC (LOC = 0.05)
**exceeds endangered species and restricted use LOC (LOC = 0.1)
***exceeds endangered species, restricted use and acute risk LOC (LOC = 0.5)
****exceeds chronic LOC (LOC = 1)

d. *Estuarine/Marine Invertebrates*

An analysis of the results show that for single and multiple applications of dichlorvos to turf at the maximum application of 0.2 lb ai/A, no acute or chronic LOCs are exceeded.

Table 27. Acute and chronic risk quotients for estuarine/ marine invertebrates for turf scenarios
Risk quotients for estuarine/marine invertebrates based on a Mysid LC50 of 19.1 ppb and NOAEL of 1.48 ppb.

Site (No. Apps./Interval Between Apps.)	LC50 (ppb)	NOAEL (ppb)	EEC Initial/Peak (ppb)	EEC 21-day Ave. (ppb)	Acute RQ (Initial EEC/LC50)	Chronic RQ (21-day Ave. EEC/NOAEL)

FL Turf (1 app.)	19.1	1.48	0.112	0.037	0.0059	0.025
FL Turf (4 app./30 day interval)	19.1	1.48	0.169	0.061	0.0088	0.041
PA Turf (1 app.)	19.1	1.48	0.112	0.037	0.0059	0.025
PA Turf (4 app./30 day interval)	19.1	1.48	0.147	0.054	0.0077	0.036

*exceeds endangered species LOC (LOC = 0.05)
**exceeds endangered species and restricted use LOC (LOC = 0.1)
***exceeds endangered species, restricted use and acute risk LOC (LOC = 0.5)
****exceeds chronic LOC (LOC = 1)

2. Non-target Terrestrial Animals

a. Liquid Formulations

For liquid formulations, risk assessments were performed for two major categories of dichlorvos outdoor uses, turf and outdoor flying insects (including mosquitoes).

i. Birds

Turf Scenarios

An analysis of the results for a single broadcast application of dichlorvos to turf at the maximum application rate of 0.2 lb ai/A, no avian acute LOC is exceeded (**Table 28**). The avian chronic level of concern is exceeded for birds that consume short grass, tall grass, and broadleaf plants/small insects.

Table 28. Avian Acute and Chronic Risk Quotients for Single Application of Dichlorvos to Turf (Dietary based RQs based on Pheasant LC50 of 568 ppm and Mallard NOAEC of 5 ppm).

Site/App. Method	App. Rate (lbs ai/A)	Food Items	Acute RQ (EEC/LC50)	Chronic RQ (EEC/NOAEC)
Turf/Spray/1 app	0.2	Short grass	0.03	3.86****
		Tall grass	0.02	1.77****
		Broadleaf plants/Small Insects	0.02	2.17****
		Fruits/Pods/Large Insects	0.00	0.24

*exceeds endangered species LOC (LOC = 0.1)
**exceeds endangered species and acute restricted use LOC (LOC = 0.2)
***exceeds endangered species, restricted use and acute risk LOC (LOC = 0.5)

****exceeds chronic LOC (LOC = 1)

An analysis of the results for four applications of dichlorvos to turf at the maximum application rate of 0.2 lb ai/A, no avian acute LOC is exceeded (**Table 29**). The avian chronic level of concern is exceeded for birds that consume short grass, tall grass, and broadleaf plants/small insects.

Table 29. Avian Acute and Chronic Risk Quotients for Four Applications of Dichlorvos to Turf (Dietary based RQs based on Pheasant LC50 of 568 ppm and Mallard NOAEC of 5 ppm).

Site/App. Method	App. Rate (lbs ai/A)	Food Items	Acute RQ (EEC/LC50)	Chronic RQ (EEC/NOAEC)
Turf/Spray/4 app with 30 day application interval	0.2	Short grass	0.03	3.86****
		Tall grass	0.02	1.77****
		Broadleaf plants/Small Insects	0.02	2.17****
		Fruits/Pods/Large Insects	0.00	0.24

*exceeds endangered species LOC (LOC = 0.1)
**exceeds endangered species and acute restricted use LOC (LOC = 0.2)
***exceeds endangered species, restricted use and acute risk LOC (LOC = 0.5)
****exceeds chronic LOC (LOC = 1)

Flying Insect Scenario

An analysis of the results for 75 applications of dichlorvos for flying insect control at the maximum application rate of 0.2 lb ai/A, no avian acute LOC is exceeded (**Table 30**). The avian chronic level of concern is exceeded for birds that consume short grass, tall grass, and broadleaf plants/small insects.

Table 30. Avian Acute and Chronic Risk Quotients for 75 Applications of Dichlorvos for Flying Insect Control (Dietary based RQs based on Pheasant LC50 of 568 ppm and Mallard NOAEC of 5 ppm).

Site/App. Method	App. Rate (lbs ai/A)	Food Items	Acute RQ (EEC/LC50)	Chronic RQ (EEC/NOAEC)
Flying Insects/Spray/75 app with 5 day application interval	0.2	Short grass	0.03	3.86****
		Tall grass	0.02	1.77****
		Broadleaf plants/Small Insects	0.02	2.17****
		Fruits/Pods/Large Insects	0.00	0.24

*exceeds endangered species LOC (LOC = 0.1)
**exceeds endangered species and acute restricted use LOC (LOC = 0.2)
***exceeds endangered species, restricted use and acute risk LOC (LOC = 0.5)

****exceeds chronic LOC (LOC = 1)

ii. Mammals

Turf Scenarios

An analysis of the results for a single broadcast application of dichlorvos to turf at the maximum application rate of 0.2 lb ai/A, the mammalian endangered species LOC is exceeded for the 15 g and 35 g mammals that consumes short grass(**Table 31**). The mammalian chronic level of concern is exceeded for 15 g, 35 g, and 1000 g mammals that consume short grass, tall grass, and broadleaf plants/small insects.

Table 31. Mammalian Acute and Chronic Risk Quotients for Single Application of Dichlorvos to Turf (Dose-based RQs based on Rat LD50 of 56 mg/kg and Rat NOAEC of 5 ppm).

	15 g mammal		35 g mammal		1000 g mammal	
	Acute RQ	Chronic RQ	Acute RQ	Chronic RQ	Acute RQ	Chronic RQ
Short grass	0.15*	8.34****	0.13*	7.16****	0.07	3.76****
Tall grass	0.07	3.82****	0.06	3.28****	0.03	1.72****
Broadleaf plants/Small Insects	0.08	4.69****	0.07	4.03****	0.04	2.12****
Fruits/Pods/Large Insects	0.01	0.52	0.01	0.45	0.00	0.24
Seeds (granivore)	0.00	0.12	0.00	0.10	0.00	0.05

*exceeds endangered species LOC (LOC = 0.1)
**exceeds endangered species and acute restricted use LOC (LOC = 0.2)
***exceeds endangered species, restricted use and acute risk LOC (LOC = 0.5)
****exceeds chronic LOC (LOC = 1)

An analysis of the results for four broadcast application of dichlorvos to turf at the maximum application rate of 0.2 lb ai/A, the mammalian endangered species LOC is exceeded for the 15 g and 35 g mammals that consume short grass(**Table 32**). The mammalian chronic level of concern is exceeded for 15 g, 35 g, and 1000 g mammals that consume short grass, tall grass, and broadleaf plants/small insects.

Table 32. Mammalian Acute and Chronic Risk Quotients for Four Applications of Dichlorvos to Turf (Dose-based RQs based on Rat LD50 of 56 mg/kg and Rat NOAEC of 5 ppm).

	15 g mammal		35 g mammal		1000 g mammal	
	Acute RQ	Chronic RQ	Acute RQ	Chronic RQ	Acute RQ	Chronic RQ
Short grass	0.15*	8.34****	0.13*	7.16****	0.07	3.76***
Tall grass	0.07	3.82****	0.06	3.28****	0.03	1.72***

Broadleaf plants/Small Insects	0.08	4.69****	0.07	4.03****	0.04	2.12***
Fruits/Pods/Large Insects	0.01	0.52	0.01	0.45	0.00	0.24
Seeds (granivore)	0.00	0.12	0.00	0.10	0.00	0.05

*exceeds endangered species LOC (LOC = 0.1)
**exceeds endangered species and acute restricted use LOC (LOC = 0.2)
***exceeds endangered species, restricted use and acute risk LOC (LOC = 0.5)
****exceeds chronic LOC (LOC = 1)

Flying Insect Scenario

An analysis of the results for 75 applications of dichlorvos for flying insect control at the maximum application rate of 0.2 lb ai/A, the mammalian endangered species LOC is exceeded for 15 g and 35 mammals consuming short grass (**Table 33**). The mammalian chronic level of concern is exceeded for mammals (15 g, 35 g, 1000 g) that consume short grass, tall grass, and broadleaf plants/small insects.

Table 33. Mammalian Acute and Chronic Risk Quotients for 75 Applications of Dichlorvos for Flying Insect Control (Dose-based RQs based on Rat LD50 of 56 mg/kg and Rat NOAEC of 5 ppm).

	15 g mammal		35 g mammal		1000 g mammal	
	Acute RQ	Chronic RQ	Acute RQ	Chronic RQ	Acute RQ	Chronic RQ
Short grass	0.15*	8.34****	0.13*	7.16****	0.07	3.76****
Tall grass	0.07	3.82****	0.06	3.28****	0.03	1.72****
Broadleaf plants/Small Insects	0.08	4.69****	0.07	4.03****	0.04	2.12****
Fruits/Pods/Large Insects	0.01	0.52	0.01	0.45	0.00	0.24
Seeds (granivore)	0.00	0.12	0.00	0.10	0.00	0.05

*exceeds endangered species LOC (LOC = 0.1)
**exceeds endangered species and acute restricted use LOC (LOC = 0.2)
***exceeds endangered species, restricted use and acute risk LOC (LOC = 0.5)
****exceeds chronic LOC (LOC = 1)

3 Non-target Terrestrial Invertebrates

Honeybee acute contact toxicity values indicate that dichlorvos is highly toxic to this insect species. Toxicity tests using residues on foliage indicate dichlorvos is practically non-toxic to honey bees.

The overall acute risk to honeybees and other non-target and beneficial insects is expected to be very high for applications of liquid products at 0.2 lb ai/a. Since dichlorvos is very highly toxic to bees (LD50)= 0.495 µg/bee, it is expected that bees, as well as other non-target and beneficial insects, could be harmed if exposed to dichlorvos during treatment.

4. Non-target Terrestrial and Aquatic Plants

As described in the analysis section, there were no registrant-submitted terrestrial plant studies so risk to terrestrial plants can not be assessed.

There are supplemental aquatic plant studies that can be used descriptively to discuss potential risk to aquatic plants. The 48 hour EC50 values of >100000 ppb for green algae, 14000 ppb for algae (the species were not given) and 17000-28000 ppb for marine diatom are reported by Mayer et al. 1986. The modeled peak EEC value for turf is 2.33 ppb. Comparisons of the toxicities and the aquatic EEC values indicate minimal aquatic plant risk.

5. Non-target Terrestrial Animals - Bait Formulations

An acute risk assessment for bait formulations was performed for dichlorvos outdoor use around animal premises. Birds and mammals may be exposed to the bait by ingesting granules. The number of lethal doses (LD50's) that are available within one square foot immediately after application can be used as a risk quotient (LD50's/ft 2) for the exposure to bait pesticides. Chronic risk assessments are not performed for bait products.

The acute risk quotients for birds and mammals are tabulated in **Table 34**. The results indicate that for applications of bait products applied at the maximum rate of 0.0025 lb/1000 ft^2, the acute avian RQs exceed endangered species, restricted use and acute risk LOCs for 20 g birds. The endangered species LOC is exceeded for 100 g birds.

Granular bait can be applied up to 120 applications (worse case scenario) with 3 day application interval. However, for the bait application, dichlorvos can only be applied to animal premise areas (soil, near buildings) and not applied directly to grass and turf. When evaluating the aerobic soil half life of 0.42 days, it becomes clear that in a 3 day application interval, the original 0.1 lbs/A of dichlorvos would have gone through approximately 7 half life cycles, leaving only approximately 0.0008 lbs/A of the original parent product. Therefore, we assume that the risk quotients calculated for 1 application at 0.1 lbs/A approximate the risk quotients for 120 applications with 3 day application interval.

Table 34. Avian and Mammalian Acute Risk Quotients for 1 application of Bait Products (based on a Mallard LD50 of 7.78 mg ai/kg and Rat LD50 of 56 mg/kg).

	Granular Bait (1 application at 0.1 lbs/A) Acute RQ (LD50/ft^2)
Avian	
20 g bird	0.959***
100 g bird	0.151*
1000 g bird	0.011
Mammals	
15 g mammal	0.042
35 g mammal	0.022
1000 g mammal	0.002

*exceeds endangered species LOC (LOC = 0.1)
**exceeds endangered species and acute restricted use LOC (LOC = 0.2)

***exceeds endangered species, restricted use and acute risk LOC (LOC = 0.5)

B. Risk Description - Interpretation of Direct Effects

1. Risks to Aquatic Animals

Summary of Major Conclusions

Acceptable data on dichlorvos indicates it is very highly toxic to freshwater fish (LC50 = 183 ppb for most sensitive species), moderately toxic to estuarine/marine fish (EC50 = 7350 ppb for the one species tested), very highly toxic to freshwater invertebrates (LC50 = 0.28 ppb for most sensitive species) and very highly toxic to estuarine invertebrates (LC50 = 19.1 ppb for most sensitive species). Chronic studies established NOAEL values of 5.2 ppb (rainbow trout), 960 ppb (sheepshead minnow), 0.0058 ppb (daphnid) and 1.48 ppb (mysid shrimp).

There is acute risk for freshwater invertebrates with RQs of 1.6 (FL turf) and 1.6 (PA turf) for one spray application. For 4 applications, the RQs are 2.41 (FL turf) and 2.1 (PA turf). These RQs exceeds the endangered species, restricted use, and acute risk LOC. In addition, the chronic level of concern is exceeded for freshwater invertebrates [egg production and growth (length and weight) endpoint] for all of the turf scenarios (one and four applications). Based on these findings, there is a potential for acute and chronic risk to freshwater invertebrates from applications to turf.

For flying insect (including adult mosquitoes) use, EFED is unable to assess risk quantitatively. It may be assumed that the exposure to dichlorvos from flying insect use would be less than that expected from turf use. However, the potential risk to freshwater and marine/estuarine invertebrates can not be quantified and therefore can not be assessed nor discounted.

Exposure to aquatic animals from bait formulations applied around animal premises is expected to be minimal because treatment sites are small and localized. Therefore, the bait formulation scenario for aquatic animals was not addressed in this risk assessment.

2. Risks to Terrestrial Animals

Summary of Major Conclusions

Based on the results of acceptable ecotoxicity studies, dichlorvos is very highly toxic to birds on an acute oral basis (LD50= 7.8 mg/kg for most sensitive species), moderately toxic to birds on a subacute dietary basis (LC50 = 568 ppm for most sensitive species) and moderately toxic to mammals on an acute oral basis (LD50 = 56-80 mg/kg). Chronic toxicity studies established NOAEL values of 5 ppm (mallard), 20 ppm (rat) and 30 ppm (bobwhite).

The chronic risk endangered species LOCs are exceeded on turf applications (both 1 and 4 applications) for birds that consume short grass, tall grass, and broadleaf plants/small insects (with RQs ranging from 1.77 to 3.86). For the flying insect scenario, no acute LOCs are exceeded. Chronic LOCs are exceeded for birds that consume short grass, tall grass, and broadleaf plants/small insects.

For mammals, for both the 1 and 4 applications of dichlorvos to turf, the chronic LOC is exceeded for 15 g, 35 g, and 1000 g mammals that consume short grass, tall grass, and broadleaf plants/small insects. For turf application, there are acute endangered species LOC exceedences for the 15 g and 35 g mammals that consumes short grass.

The acute risk, acute restricted use, and acute endangered species LOCs for a small bird (20 g weight) are exceeded for the bait formulation scenario (Acute RQ = 0.959). The endangered species OC is exceeded for the 100 g mammals with the bait scenario. Chronic risk to birds from the bait formulation can not be assessed at this time.

There is a possibility of risk to birds and small mammals from ingestion of the bait product. Dichlorvos is highly toxic to birds on an acute oral basis (LD50 <10 mg/kg). The bait products appear to be of granular consistency and sugar-based *(e.g.,* front panel of product label for EPA Reg. No. 769-568 states FLY Bait Sugar Base With DDVP). Bait product labels carry directions for use both as a dry bait (sprinkle lightly where flies congregate) and wet bait (dissolve in water). Wet baits pose a minimal risk to terrestrial animals. Avian reproduction laboratory studies found that it is difficult to keep the material in the feed for a 24 hour period. Bait products of similar granular consistency also might have a very short life in the field. Some of the labels bear directions to reapply every 3 to 5 days until control is achieved.

C. Threatened and Endangered Species Concerns

1. <u>Taxonomic Groups Potentially at Risk</u>

The Agency's levels of concern for endangered and threatened freshwater invertebrates, birds, and mammals are exceeded for dichlorvos use. A summary of the endangered species taxonomic groups potentially at risk from dichlorvos use are listed in **Table 35.** Because turf , flying insect, and bait formulation use are available in all states, the endangered species listing encompasses all dichlorvos use areas..

The preliminary risk assessment for endangered species indicates that dichlorvos exceeds the endangered species LOCs for the following combinations of analyzed uses and species:

- Freshwater invertebrates (acute): use on turf (1 application and 4 applications, both FL and PA scenarios)

- Freshwater invertebrates (chronic): use on turf (1 application and 4 applications, both FL and PA scenarios)

- Birds (chronic): use on turf (1 application and 4 applications) for birds consuming short grass, tall grass, and broadleaf plants/small insects

- Birds (chronic): use as flying insect control for birds consuming short grass, tall grass,and broadleaf plants/small insects

- Birds (acute): use as bait formulation for 20 g and 100g bird

- Mammals (acute): use on turf (1 application and 4 applications) 15 g and 35 g mammals that consumes short grass.
- Mammals (chronic): use on turf (1 application and 4 applications) 15 g, 35 g, and 1000 g mammals that consume short grass, tall grass, and broadleaf plants/small insects.

Table 35. Tabulation by taxonomic group and total states of listed species that occur in dichlorvos use areas

	Taxonomic Group										
	Birds	Mammals	Reptiles	Amphibians	Fish	Crustaceans	Arachnids	Insects	Snails	Clams	Plants
Total Unique Species	57	61	28	19	113	20	12	44	30	70	548
Total States	49	47	19	12	40	12	4	27	15	28	49

The Agency has developed the Endangered Species Protection Program to identify pesticides whose use may cause adverse impacts on endangered and threatened species, and to implement mitigation measures that address these impacts. The Endangered Species Act requires federal agencies to ensure that their actions are not likely to jeopardize listed species or adversely modify designated critical habitat. To analyze the potential of registered pesticide uses to affect any particular species, EPA puts basic toxicity and exposure data developed for REDs into context for individual listed species and their locations by evaluating important ecological parameters, pesticide use information, the geographic relationship between specific pesticide uses and species locations, and biological requirements and behavioral aspects of the particular species. This analysis will take into consideration any regulatory changes recommended in this RED that are being implemented at this time. A determination that there is a likelihood of potential impact to a listed species may result in limitations on use of the pesticide, other measures to mitigate any potential impact, or consultations with the Fish and Wildlife Service and/or the National Marine Fisheries Service as necessary.

The Endangered Species Protection Program as described in a Federal Register notice (54 FR 27984-28008, July 3, 1989) is currently being implemented on an interim basis. As part of the interim program, the Agency has developed County Specific Pamphlets that articulate many of the specific measures outlined in the Biological Opinions issued to date. The Pamphlets are available for voluntary use by pesticide applicators on EPA's website at www.epa.gov/espp. A final Endangered Species Protection Program, which may be altered from the interim program, was proposed for public comment in the Federal Register December 2, 2002.

2 .Probit Slope Analysis

The probit slope response relationship is evaluated to calculate the change of an individual event corresponding to the listed species acute LOCs. If information is unavailable to estimate a slope for a particular study, a default slope assumption of 4.5 is used as per original Agency assumptions of typical slope cited in Urban and Cook (1986).

Freshwater Invertebrates
Raw data is not provided in the daphnid acute EC50 study (MRID 40098001/ Mayer and Ellersieck 1986) to calculate a slope. RQ exceedances occur for freshwater invertebrate species for the turf scenario (1 application and 4 applications). Based on the default slope assumption of 4.5, the individual mortality associated with the minimum and maximum calculated RQ value (6.71 and 33.29) result in an estimated chance of individual mortality of 1 in 1 (100 %). The corresponding estimated chance of individual mortality associated with the listed species LOC of 0.05 is 1 in 4.17E+08.

Birds
Raw data is not provided in the mallard duck acute LD50 study (MRID 00160000/ Hudson *et al.* 1984) to calculate a slope. RQ exceedances occur for bird species for the flying insect and bait formulation scenario. Based on the default slope assumption of 4.5, the individual mortality associated with the calculated minimum and maximum RQ value (0.17 and 0.36) for flying insect scenario result in an estimated chance of individual mortality of 1 in 3.74E+03 to 1 in 4.36E+01 . For the bait scenario, RQ range of 0.151 to 0.959, result in an estimated chance of individual mortality of 1 in 9.08E+03 to 1 in 2.14 (50%). The corresponding estimated chance of individual mortality associated with the listed species LOC of 0.1 is 1 in 2.94 E+05.

Mammals
Raw data is not provided in the rat acute LD_{50} study (MRID 0005467) to calculate a slope. Therefore, the event probability was calculated for mammalian LOC based on a default slope of 4.5. RQ exceedances occur for mammalian species for the turf and flying insect scenario. The individual mortality associated with the calculated RQ values (0.13 and 0.26) for turf scenario result in an estimated chance of individual mortality of 1 in 2.99E+04 and 1 in 2.36E+02, respectively. For the flying insect scenario, RQ range of 0.33 to 1.58, result in an estimated chance of individual mortality of 1 in 6.61E+01 to 1 in 1.23E+0 (100%).

Based on an assumption of a probit dose response relationship with a mean estimated slope of 4.5, the corresponding estimated chance of individual mortality associated with the mammalian listed species LOC of 0.1 is 1 in 294,000.

It is recognized that extrapolation of very low probability events is associated with considerable uncertainty in the resulting estimates. To explore possible bounds to such estimates, the upper and lower values for the mean slope estimate can be used to calculate upper and lower estimates of the effects probability associated with the listed species LOC. However, since slope is based on a default assumption of 4.5, the 95 percent confidence intervals for the slopes are unavailable.

3. <u>Critical Habitat</u>

In the evaluation of pesticide effects on designated critical habitat, consideration is given to the physical and biological features (constituent elements) of a critical habitat identified by the FWS and NMFS as essential to the conservation of a listed species and which may require special management considerations or protection. The evaluation of impacts for a screening level pesticide risk assessment focuses on the biological features that are constituent elements and is accomplished using the screening level taxonomic analysis (risk quotients, RQs) and listed species levels of concern (LOCs) that are used to evaluate direct and indirect effects to listed organisms.

The screening level risk assessment has identified potential concerns for indirect effects on listed species for those organisms dependent upon freshwater invertebrates, birds, and mammals. In light of the potential for indirect effects, the next step for EPA, FWS, and the NMFS is to identify which listed species and critical habitat are potentially implicated.

Analytically, the identification of such species and critical habitat can occur in either of two ways. First, the agencies could determine whether the action area overlaps critical habitat or the occupied range of any listed species. If so, EPA would examine whether the pesticide's potential impacts on non-endangered species would affect the listed species indirectly or directly affect a constituent element of the critical habitat. Alternatively, the agencies could determine which listed species depend on biological resources, or have constituent elements that fall into, the taxa that may be directly or indirectly impacted by the pesticide. Then EPA would determine whether use of the pesticide overlaps with the critical habitat or the occupied range of those listed species. At present, the information reviewed by EPA does not permit use of either analytical approach to make a definitive identification of species that are potentially impacted indirectly or critical habitats that are potentially impacted directly by the use of the pesticide. EPA and the Service(s) are working together to conduct the necessary analysis.

This screening level risk assessment for critical habitat provides a listing of potential biological features that, if the are constituent elements of one or more critical habitats, would be of potential concern. These correspond to the taxa identified above as being of potential concern for indirect effects and include the following: freshwater invertebrates, birds, and mammals. This list should serve as an initial step in problem formulation for further assessment of critical habitat impacts outlined above, should additional work be necessary.

4. <u>Indirect Effect Analyses</u>

The Agency acknowledges that pesticides have the potential to exert indirect effects upon the listed organisms by, for example, perturbing forage or prey availability, altering the extent of nesting habitat, creating gaps in the food chain, etc. In conducting a screen for indirect effects, direct effect LOCs for each taxonomic group are used to make inferences concerning the potential for indirect effects upon listed species that rely upon non-endangered organisms in these taxonomic groups as resources critical to their life cycle.

Because screening-level acute RQs for freshwater invertebrates, birds, and mammals exceed the endangered species acute LOCs, the Agency uses the dose response relationship from the toxicity study used for calculating the RQ to estimate the probability of acute effects associated with an exposure equivalent to the EEC. This information serves as a guide to establish the need for and extent of additional analysis that may be performed using Services-provided "species profiles" as well as evaluations of the geographical and temporal nature of the exposure to ascertain if a "not likely to adversely affect" determination can be made. The degree to which additional analyses are performed is commensurate with the predicted probability of adverse effects from the comparison of the dose response information with the EECs. The greater the probability that exposures will produce effects on a taxa, the greater the concern for potential indirect effects for listed species dependent upon that taxa, and therefore, the more intensive the analysis on the potential listed species of concern, their locations relative to the use site, and information regarding the use scenario (e.g., timing, frequency, and geographical extent of pesticide application).

Screening-level acute RQs for aquatic invertebrates, birds, and mammals are above the non-endangered species LOCs. The Agency considers this to be indicative of a potential for adverse effects to those listed species that rely either on a specific plant species (plant species obligate) or multiple plant species (plant dependent) for some important aspect of their life cycle. The Agency may determine if listed organisms for which plants are a critical component of their resource needs are within the pesticide use area. This is accomplished through a comparison of Service-provided "species profiles" and listed species location data. If no listed organisms that are either plant species obligates or plant dependent reside within the pesticide use area, a no effect determination on listed species is made. If plant species obligate or dependent organism may reside within the pesticide use area, the Agency may consider temporal and geographical nature of exposure, and the scope of the effects data, to determine if any potential effects can be determined to not likely adversely affect a plant species obligate or dependent listed organism.

a. Aquatic Species

Indirect effects to endangered/threatened fish that depend on freshwater invertebrates as a primary source of food, as well as larger aquatic animals that rely on aquatic (freshwater) invertebrate populations as a food source may be affected by the direct or chronic effects of dichlorvos use.

b. Terrestrial Species

Although RQs were not calculated for terrestrial plants, due to dichlorvos' mode of action, use, and the lack of aquatic plant risk, this assessment concludes that plant-dependent species will not be affected indirectly from dichlorvos use.

The Agency acknowledges that pesticides have the potential to exert indirect effects upon endangered or threatened species, by, for example, perturbing forage or prey availability, altering the extent of nesting habitat, etc. The screen for indirect effects includes using direct effect LOCs for non-endangered species to infer the potential for indirect effects upon listed species that rely upon non-endangered organisms as resources critical to their life cycle.

Because at intended use rates dichlorvos may cause mortality in exposed bird and mammal populations, there are potential concerns for indirect effects on those listed terrestrial organisms that are dependant upon vertebrate species (birds, mammals, reptiles) as prey items. Additionally, indirect effects to endangered/threatened fish, invertebrates, and mammals that depend on freshwater invertebrates as a primary source of food may occur.

The high acute toxicity of dichlorvos to honeybees may lead to mortality to this and other insect-pollinators. Listed plant species dependant upon insect pollination may be indirectly affected by the loss of all or part of such insect populations. Additionally, the potential risk to bird species from dichlorvos use could also affect bird-pollinated plant species.

A potential drop in both vertebrate and invertebrate biomass associated with dichlorvos use may reduce a significant portion of the prey base. If this prey base is removed at a critical life-cycle juncture, over a large area, or it if is removed for a long enough duration, some species may have difficulty meeting energy needs. Some species may be particularly sensitive during reproductive or developmental periods.

E. Description of Assumptions, Uncertainties, Strengths, and Limitations

1. Assumptions and Limitations Related to Exposure for all Taxa

a. *Maximum Use Scenario*

This screening-level risk assessment relies on labeled statements of the maximum rate of dichlorvos application, the maximum number of applications, and the shortest interval between applications (when applicable). Together, these assumptions constitute a maximum use scenario and can overestimate risk. However, the maximum use scenario must be considered because it is a reflection of the allowable use of dichlorvos.

2. Assumptions and Limitations Related to Exposure for Aquatic Species

a. *Lack of Averaging Time for Exposure*

For an acute risk assessment, there is no averaging time for exposure. An instantaneous peak concentration, with a 1 in 10 year return frequency, is assumed. The use of the instantaneous peak assumes that instantaneous exposure is of sufficient duration to elicit acute effects comparable to those observed over more protracted exposure periods tested in the laboratory, typically 48 to 96 hours. In the absence of data regarding time-to-toxic event analyses and latent responses to instantaneous exposure, the degree to which risk is overestimated cannot be quantified.

b. *Routes of exposure*

Screening-level risk assessments pesticide application for aquatic organisms consider exposure through the gills. Other potential routes of exposure, not considered in this assessment, are discussed below:

- ***Dietary consumption***

The screening assessment does not consider the ingestion pathway. This exposure may occur through ingestion of contaminated vegetation, invertebrates, or other exposed prey items.

- ***Dermal exposure***

The screening assessment does not consider dermal exposure. Dermal exposure may occur through one potential source: contact with contaminated water. The available measured data related to aquatic wildlife dermal contact with pesticides are extremely limited.

3. Assumptions and Limitations Related to Exposure for Terrestrial Species

a. *The LD_{50}/sq. ft. Index*

The LD_{50}/sq.ft. index was developed by Felthousen (1977). The concept was based upon field observations made by DeWitt (1966) who suggested that ecological effects are expected to occur when exposure residues that equal or exceed the LD_{50} value for a pesticide, as determined from laboratory studies, are reached in the field. The index was developed, in response to the Registration Divisions' request for guidance for classifying use patterns, involving granulated formulations, baits, and seed treatments, for labeling purposes. At that time risk criteria considerations were typically based on the amount of residues likely to occur, immediately following application, in or on feed items likely to be consumed by non-target wildlife species. In so much as granular formulations, baits and seed treatments leave very little residue in or on non-target food items, a hazard index had to be developed to address theses routes of exposure. It's important to note that the LD_{50}/sq. ft. concept is an index to hazard that presumes exposure will occur on the treated areas (a deterministic assessment) rather than a tool that attempts to quantify the temporal and spatial relationship of exposure (i.e., a probabilistic assessment tool) to a non-target organism.

The LD_{50}/sq.ft. index used to predict risk to non-target wildlife species has been peer reviewed by numerous scientists, both within and outside of the Agency and, in general, has been accepted as a useful tool for addressing ecological hazard from the use of granulated formulations. In March of 1992, the Agency used this index in its "Comparative Analysis of Acute Avian Risk from Granular Pesticides" document. This document provided explanation, discussion and analysis of the index as well as specific examples of risk quotients derived from the index. In 1996 the FIFRA Science Advisory Panel (SAP) reviewed and approved the environmental assessments derived from the index for those chemicals evaluated in the corn cluster document. The SAP even suggested that the acute risk indices calculated from the index may actually underestimate risk.

Based on this long history of scientific peer review, which has repeatedly supported the use of the LD_{50}/sq. ft. risk index in ecological hazard assessments, we believe that the index is appropriate for determining and classifying ecological risk to terrestrial wildlife from the use of bait formulations.

b. Uncertainties Associated with the LD_{50}/sq. ft. Index

Risk quotients based on the LD_{50}/sq.ft. hazard index have been criticized as being too conservative and overestimating "real world" risk. It has been argued that the method greatly oversimplifies the exposure component to hazard assessment by not specifically addressing the temporal and spatial situations that non-target wildlife species experience under field conditions. Although this is somewhat correct there are still many other exposure related and toxicological factors that are not accounted for by the index which may actually underestimate risk from this method.

For example, the LD_{50}/sq.ft. index is based solely on acute mortality as derived from acute oral exposure from laboratory tests. It does not address subacute behavioral or physiological effects that may occur prior to mortality and yet can still have a profound sub-lethal effects on an organisms ability to survive and reproduce. As such, this index may underestimate ecological hazard from sub-lethal exposures. For instance, it is common in clinical observations, conducted during acute tests, to observe such symptoms as wing droop, goose-stepping ataxia, dyspnea (labored breathing), diarrhea, apnea, weight loss, salivation, convulsions and hyperactivity prior to mortality occurring. Even if an organism survives this exposure to the toxicant, these symptoms indicate the organism is under extreme stress that could greatly affect both its survival (susceptibility to disease and parasites, ability to avoid predation, nest desertion and abandonment) and ability to reproduce under actual field conditions. Necropsy data also indicate that many organisms are experiencing extreme physiological changes even though they may not die from exposure to the toxicant. Liver damage, renal failure, lesions, hemorrhage and other tissue damage are indications of severe physiological impairment that could adversely affect both the survival and reproductive capability of the organisms. These sub-lethal effects are not really addressed by the LD_{50}/sq.

ft. index. In fact, although the SAP (1996) approved the LD_{50}/sq.ft. index as a method for determining and classifying ecological risk to terrestrial wildlife from the use of granular formulations, it questioned the use of mortality as the primary end-point for addressing ecological risk. The SAP stated that, "Many chemicals evoke toxicity through the interference with the physiological state of the animal including behaviors important to continued reproduction and survival. Each chemical may have certain unique qualities that may influence their potential hazard to wildlife." These comments suggest that basing ecological hazard assessments solely on direct effects, as determined by acute indices, may be under protective for predicting indirect effects from sub-lethal exposures.

Although it is presumed that the LD_{50}/sq.ft. index accounts for acute exposure from oral, dermal and inhalation exposure, it was not intended to address exposure from drinking water where runoff, from either rain events or irrigation, to low areas may create puddles that contain very high concentrations of the pesticide. The contribution of this route of exposure to overall body burden residues is unknown but it will clearly be additive to exposure from direct consumption of the bait formualtion and/or exposure from eating contaminated vegetation.

c. The Likelihood of Wildlife Presence at Time of Application

Birds and mammals may utilize outdoor areas and animal premise areas that have been treated with dichlorvos and therefore may be exposed. Also, birds and mammals foraging for seeds, insects, and annelids (e.g., earthworms) may be unable to avoid ingesting granular bait dichlorvos. Birds may also ingest granules in treated areas when foraging for grit.

d. Significance of Wildlife Utilization of Treatment Areas

Characterizing risk to non-target wildlife from the use of dichlorvos on the areas for which it is registered, requires a clear understanding of the many limitations of identifying exactly what species are most likely to use treated areas and for what purpose. The simple fact is, wildlife utilization of animal premise areas and general outdoor areas is highly variable and difficult to predict and, as such, there is a great deal of uncertainty surrounding this issue when conducting an ecological hazard evaluation.

e. ***Routes of Exposure***

The risk assessment findings of acute risk to terrestrial animals is based on risk assessments where ingestion of contaminated food is considered as the primary route of exposure. The risk assessment did not consider the other possible routes of exposure, e.g., dermal, preening, and respiratory pathways. These other paths of exposure have been shown to contribute to acute toxicity of other organophosphate compounds (Driver *et al.* 1991). Other routes of exposure, not considered in this assessment, are discussed below:

- ***Incidental soil ingestion exposure***

This risk assessment does not consider incidental soil ingestion. Available data suggests that up to 15% of the diet can consist of incidentally ingested soil depending on the species and feeding strategy (Beyer et al., 1994).

- ***Inhalation exposure***

This risk assessment does not consider respiratory pathways. Since dichlorvos volatilizes rapidly, the inhalation route of exposure may contribute to acute toxicity. Incidence data reports avian toxicity due to inhalation exposure.

- ***Dermal Exposure***

The screening assessment does not consider dermal exposure, except as it is indirectly included in calculations of RQs based on lethal doses per unit of pesticide treated area. Dermal exposure may occur through two potential sources: (1) incidental contact with contaminated vegetation, or (2) contact with contaminated water or soil.

The available measured data related to wildlife dermal contact with pesticides are extremely limited. The Agency is actively pursuing modeling techniques to account for dermal exposure via incidental contact with vegetation.

- ***Drinking Water Exposure***

Drinking water exposure to a pesticide active ingredient may be the result of consumption of surface water or consumption of the pesticide in dew or other water on the surface of the treated area. For pesticide active ingredients with a potential to dissolve in runoff, puddles on the treated area may contain the chemical. Given its high water solubility, dichlorvos is expected to dissolve in dew and other water associated with plant surfaces. However, the likelihood of exposure to dichlorvos via drinking water is not quantified in the exposure modeling.

f. Incidental Pesticide Releases Associated with Use

This risk assessment is based on the assumption that the entire treatment area is subject to dichlorvos application at the rates specified on the label. In reality, there is the potential for uneven application of the pesticide through such plausible incidents as changes in calibration of application equipment, spillage, and localized releases.

4. Assumptions and Limitations Related to Effects Assessment

a. Age class and sensitivity of effects thresholds

It is generally recognized that test organism age may have a significant impact on the observed sensitivity to a toxicant. The screening risk assessment acute toxicity data for fish are collected on juvenile fish between 0.1 and 5 grams. Aquatic invertebrate acute testing is performed on recommended immature age classes (e.g., first instar for daphnids, second instar for amphipods, stoneflies and mayflies, and third instar for midges). Similarly, acute dietary testing with birds is also performed on juveniles, with mallard being 5-10 days old and quail 10-14 days old.

Testing of juveniles may overestimate toxicity at older age classes for pesticidal active ingredients, such as dichlorvos, that act directly because younger age classes may not have the enzymatic systems associated with detoxifying xenobiotics. The screening risk assessment has no current provisions for a generally applied method that accounts for this uncertainty. In so far as the available toxicity data may provide ranges of sensitivity information with respect to age class, the risk assessment uses the most sensitive life-stage information as the conservative screening endpoint.

b.. Use of the Most Sensitive Species Tested

Although the screening-level risk assessment relies on a selected toxicity endpoint from the most sensitive species tested, it does not necessarily mean that the selected toxicity endpoints reflect sensitivity of the most sensitive species existing in a given environment. The relative position of the most sensitive species tested in the distribution of all possible species is a function of the overall variability among species to a particular chemical. In the case of listed species, there is uncertainty regarding the relationship of the listed species' sensitivity and the most sensitive species tested.

The Agency is not limited to a base set of surrogate toxicity information in establishing risk assessment conclusions. The Agency also considers toxicity data on non-standard test species when available.

5. Assumptions Associated with the Acute LOCs

The risk characterization section of the assessment document includes an evaluation of the potential for individual effects at an exposure level equivalent to the LOC. This evaluation is based on the median lethal dose estimate and dose/response relationship established for the effects study corresponding to each taxonomic group for which the LOCs are exceeded.

6. Data Gaps and Limitations of the Risk Assessment

The following data gaps were identified:

a. Ecotoxicity Data Gaps

There is limited terrestrial and aquatic plant data for dichlorvos, which leads to uncertainty in the evaluation of plant risk.

b. Environmental Fate Information Gaps

There are no environmental fate data gaps.

Appendices A and B at the end of this document provides the summary status of all the environmental fate and ecotoxicological data requirement

REFERENCES

Bennett, R.S. and L. M. Ganio. 1991. Overview of methods for evaluating effects of pesticides on reproduction in birds. U.S.EPA, Off. Research and Development, Environ. Res. Lab., Corvallis, Oregon. 106 p.

Best, L.B., R.C. Whitmore and G.M. Booth. 1990. Use of cornfields by birds during the breeding season: the importance of edge habitat. American Midland Naturalist 123:84-99.

Driver *et al.* 1991. Routes of Uptake and their relative contribution to the toxicological response of northern bobwhite *(Colinus virginianus)* to an organophoshate pesticide. Environmental Toxicology and Chemistry Vol. 10, pp. 21-33.

Felthousen, R. 1977. Classification of Granulated Formulations. USEPA, September 9, 1977

Goh, K.S. *et al.* 1986. Dissipation of Dislodgeable Foliar Residues of Chlorpyrifos and Dichlorvos on Turf. Bull. Environ. Contam. Toxicol., 37:27-32.

Madrigal et al. 1996. Have to find the citation

Mayer, F. L. J. and Ellersieck, M. R. 1986. Manual of Acute Toxicity: Interpretation and Data Base for 410 Chemicals and 66 Species of Freshwater Animals. *Resour.Publ.No.160, U.S.Dep.Interior, Fish Wildl.Serv., Washington, DC* 505 p. (USGS Data File) (EPA MRID # 40098001).

Urban D.J. and N.J. Cook. 1986. Hazard Evaluation Division Standard Evaluation Procedure Ecological Risk Assessment. EPA 540/9-85-001. U.S. Environmental Protection Agency, Office of Pesticide Programs, Washington, DC.

U.S. EPA. 1986. Acute Toxicity Handbook of Chemicals to Estuarine Organisms*., U.S.EPA, Gulf Breeze, FL* (US EPA MRID 40228401).

U.S. EPA. 1992. Comparative Analysis of Acute Avian Risk from Granular Pesticides. March, 1992.

U.S. EPA. 2004a. Interim Guidance of the Evaluation Criteria for Ecological Toxicity Data in the Open Literature, Phases I and II. July 16, 2004

U.S. EPA. 2004b. T-REX Version 1.1. December 7, 2004

APPENDIX A. ECOLOGICAL DATA REQUIREMENTS FOR DICHLORVOS

Data Requirements	Use Pattern [1]	Does EPA Have Data to Satisfy this Requirement? (Yes, No, or Partially)	Bibliographic Citation	Must Additional Data be Submitted under FIFRA 3(c)(2)(B)?
71-1(a) Acute Avian Oral, Quail/Duck	3,8,9,11,15	Yes	40818301, 00160000	No
71-2(a) Acute Avian Diet, Quail	3,8,9,11,15	Yes	00022923	No
71-2(b) Acute Avian Diet, Duck	3,8,9,11,15	Yes	00022923	No
71-4(a) Avian Reproduction Quail	3	Yes	43981701	No
71-4(b) Avian Reproduction Duck	3	Yes	44233401	No
72-1(a) Acute Fish Toxicity Bluegill	3,8,9,11,15	Yes	40094602	No
72-1(b) Acute Fish Toxicity Bluegill (TEP)	5	Yes	43284701	No[2]
72-1(c) Acute Fish Toxicity Rainbow Trout	3,8,9,11,15	Yes	40098001	No
72-1(d) Acute Fish Toxicity Rainbow Trout (TEP)	5	Yes	43284702	No[2]
72-2(a) Acute Aquatic Invertebrate	3,8,9,11,15	Yes	40098001	No
72-3(a) Acute Est/Mar Toxicity Fish	3	Yes	43571403	No
72-3(b) Acute Est/Mar Toxicity Mollusk	3	Yes	43571404	No
72-3(c) Acute Est/Mar Toxicity Shrimp	3	Yes	43571405	No

72-3(d) Acute Est/Mar Toxicity Fish (TEP)	5	Yes	43571406	No[2]
72-3(e) Acute Est/Mar Toxicity Mollusk (TEP)	5	Yes	43571407	No[2]
72-3(f) Acute Est/Mar Toxicity Shrimp (TEP)	5	Yes	43571408	No[2]
72-4(a) Early Life Stage Fish	3	Yes	43788001, 43790401	No
72-4(b) Life Cycle Aquatic Invertebrate	3	Yes	43890301, 43854301	No
141-1 Honey Bee Acute Contact	3, 11	Yes	00036935	No
141-2 Honey bee Residue on Foliage	3, 11	Yes	43366701	No

FOOTNOTES:

1. 1 = Terrestrial Food; 2 = Terrestrial Feed; 3 = Terrestrial Non-Food; 4 = Aquatic Food; 5 = Aquatic Non-Food (Outdoor); 6 = Aquatic Non-Food (Industrial); 7 = Aquatic Non-Food (Residential); 8 = Greenhouse Food; 9 = Greenhouse Non-Food; 10 = Forestry; 11 = Residential Outdoor; 12 = Indoor Food; 13 = Indoor Non-Food; 14 = Indoor Medicinal; 15 = Indoor Residential

2. Although data are available, there is no longer an Aquatic Non-Food (Outdoor) or Terrestrial Food use for this chemical.

APPENDIX B. ENVIRONMENTAL FATE DATA REQUIREMENTS FOR DICHLORVOS

Data Requirements	Use Pattern [1]	Does EPA Have Data to Satisfy this Requirement? (Yes, No, or Partially)	Bibliographic Citation	Must Additional Data be Submitted under FIFRA 3(c)(2)(B)?
161-1 Hydrolysis	3,8,9,11	Yes	41723101	No
161-2 Photodegradation in Water	3	Yes	43326601	No
161-3 Photodegradation On Soil	1	Yes	43642501	No[2]
162-1 Aerobic Soil	3,8,9,11	Yes	41723102	No
162-2 Anaerobic Soil	1	Yes	43835701	No[2]
163-1 Leaching - Adsorption/Desorp.	3,8,9,11	Yes	41723103, 40034904	No
164-1 Soil Dissipation	3,11	Yes	44386701, 44297701	No
201-1 Droplet Size Spectrum	3	Yes		No[3]
202-1 Drift Field Evaluation	3	Yes		No[3]

FOOTNOTES:

1. 1 = Terrestrial Food; 2 = Terrestrial Feed; 3 = Terrestrial Non-Food; 4 = Aquatic Food; 5 = Aquatic Non-Food (Outdoor); 6 = Aquatic Non-Food (Industrial); 7 = Aquatic Non-Food (Residential); 8 = Greenhouse Food; 9 = Greenhouse Non-Food; 10 = Forestry; 11 = Residential Outdoor; 12 = Indoor Food; 13 = Indoor Non-Food; 14 = Indoor Medicinal; 15 = Indoor Residential

2. Although data are available, there is no longer an Aquatic Non-Food (Outdoor) or Terrestrial Food use for this chemical.

3. Amvac is a member of the Spray Drift Task Force.

APPENDIX C. PRZM/EXAMS MODELING

FLORIDA TURF 1 APPLICATION at 0.2 lbs/A

stored	as	DVPtrf1.out				
Chemical:	DDVP					
PRZM	environment:	FLturfC.txt	modified	Monday,	16 June	
EXAMS	environment:	pond298.exv	modified	Thuday,	29 August	
Metfile:	w12834.dvf	modified	Wedday,	3 July		2002

Water segment concentrations (ppb)

Year	Peak	96 Hr	21 Day	60 Day	90 Day	Yearly
1961	0.112	0.0867	0.03732	0.01389	0.009268	0.002285
1962	0.112	0.0867	0.03731	0.01389	0.009267	0.002285
1963	0.112	0.08675	0.03738	0.01392	0.009283	0.002289
1964	0.112	0.0867	0.03732	0.01389	0.009267	0.002279
1965	0.112	0.0867	0.03731	0.01389	0.009266	0.002285
1966	0.112	0.08672	0.03733	0.0139	0.009272	0.002286
1967	0.112	0.0867	0.03731	0.01389	0.009266	0.002285
1968	0.112	0.08671	0.03732	0.01389	0.009269	0.002279
1969	0.112	0.0867	0.03731	0.01389	0.009266	0.002285
1970	0.112	0.0867	0.03731	0.01389	0.009265	0.002285
1971	0.112	0.0867	0.03731	0.01389	0.009267	0.002285
1972	0.112	0.08671	0.03733	0.0139	0.00927	0.00228
1973	0.112	0.08671	0.03732	0.01389	0.009269	0.002286
1974	0.112	0.08671	0.03732	0.0139	0.009269	0.002286
1975	0.112	0.08671	0.03733	0.0139	0.00927	0.002286
1976	0.112	0.08717	0.0377	0.01404	0.009365	0.002303
1977	0.112	0.0867	0.03731	0.01389	0.009266	0.002285
1978	0.112	0.0867	0.03731	0.01389	0.009266	0.002285
1979	0.112	0.0867	0.03731	0.01389	0.009266	0.002285
1980	0.112	0.08677	0.03737	0.01391	0.00928	0.002282

1981	0.112	0.0867	0.03731	0.01389	0.009265	0.002285
1982	0.112	0.08671	0.03732	0.0139	0.009269	0.002286
1983	0.112	0.0867	0.03732	0.01389	0.009268	0.002286
1984	0.112	0.08691	0.0376	0.014	0.00934	0.002297
1985	0.1122	0.08721	0.03768	0.01403	0.009359	0.002308
1986	0.112	0.0867	0.03731	0.01389	0.009267	0.002285
1987	0.112	0.0867	0.03732	0.01389	0.009267	0.002285
1988	0.112	0.0867	0.03732	0.01389	0.009268	0.002279
1989	0.112	0.0867	0.03731	0.01389	0.009265	0.002285
1990	0.112	0.0867	0.03731	0.01389	0.009266	0.002285

Sorted	results					
Prob.	Peak	96 Hr	21 Day	60 Day	90 Day	Yearly
0.03225806	0.1122	0.08721	0.0377	0.01404	0.009365	0.002308
0.06451613	0.112	0.08717	0.03768	0.01403	0.009359	0.002303
0.09677419	0.112	0.08691	0.0376	0.014	0.00934	0.002297
0.12903226	0.112	0.08677	0.03738	0.01392	0.009283	0.002289
0.16129032	0.112	0.08675	0.03737	0.01391	0.00928	0.002286
0.19354839	0.112	0.08672	0.03733	0.0139	0.009272	0.002286
0.22580645	0.112	0.08671	0.03733	0.0139	0.00927	0.002286
0.25806452	0.112	0.08671	0.03733	0.0139	0.00927	0.002286
0.29032258	0.112	0.08671	0.03732	0.0139	0.009269	0.002286
0.32258065	0.112	0.08671	0.03732	0.0139	0.009269	0.002286
0.35483871	0.112	0.08671	0.03732	0.01389	0.009269	0.002285
0.38709677	0.112	0.08671	0.03732	0.01389	0.009269	0.002285
0.41935484	0.112	0.0867	0.03732	0.01389	0.009268	0.002285
0.4516129	0.112	0.0867	0.03732	0.01389	0.009268	0.002285
0.48387097	0.112	0.0867	0.03732	0.01389	0.009268	0.002285
0.51612903	0.112	0.0867	0.03732	0.01389	0.009267	0.002285

0.5483871	0.112	0.0867	0.03732	0.01389	0.009267	0.002285
0.58064516	0.112	0.0867	0.03731	0.01389	0.009267	0.002285
0.61290323	0.112	0.0867	0.03731	0.01389	0.009267	0.002285
0.64516129	0.112	0.0867	0.03731	0.01389	0.009267	0.002285
0.67741935	0.112	0.0867	0.03731	0.01389	0.009266	0.002285
0.70967742	0.112	0.0867	0.03731	0.01389	0.009266	0.002285
0.74193548	0.112	0.0867	0.03731	0.01389	0.009266	0.002285
0.77419355	0.112	0.0867	0.03731	0.01389	0.009266	0.002285
0.80645161	0.112	0.0867	0.03731	0.01389	0.009266	0.002285
0.83870968	0.112	0.0867	0.03731	0.01389	0.009266	0.002282
0.87096774	0.112	0.0867	0.03731	0.01389	0.009266	0.00228
0.90322581	0.112	0.0867	0.03731	0.01389	0.009265	0.002279
0.93548387	0.112	0.0867	0.03731	0.01389	0.009265	0.002279
0.96774194	0.112	0.0867	0.03731	0.01389	0.009265	0.002279
0.1	0.112	0.086896	0.037578	0.013992	0.009334	0.002296

	Average	of	yearly	averages:	0.002286	
Inputs	generated	by	pe4.pl	-	8-Aug-03	
Data	used	for	this	run:		
Output	File:	DVPtrf1				
Metfile:	w12834.dvf					
PRZM	scenario:	FLturfC.txt				
EXAMS	environment	file:	pond298.exv			
Chemical	Name:	DDVP				
Description	Variable	Name	Value	Units	Comments	
Molecular	weight	mwt	220.9	g/mol		
Henry's	Law	Const.	henry	5.01E-08	atm-m^3/mol	
Vapor	Pressure	vapr	1.20E-02	torr		
Solubility	sol	10000	mg/L			
Kd	Kd	mg/L				
Koc	Koc	37	mg/L			
Photolysis	half-life	kdp	10.2	days	Half-life	
Aerobic	Aquatic	Metabolism	kbacw	0	days	Halfife
Anaerobic	Aquatic	Metabolism	kbacs	0	days	Halfife

Aerobic	Soil	Metabolism	asm		0.42 days		Halfife
Hydrolysis:	pH		7	5.2 days	Half-life		
Method:	CAM		2 integer	See	PRZM		manual
Incorporation	Depth:	DEPI			0 cm		
Application	Rate:	TAPP			0.224 kg/ha		
Application	Efficiency:	APPEFF			0.99 fraction		
Spray	Drift	DRFT			0.01 fraction	of	application
Application	Date	Date	20-05	dd/mm	or		dd/mmm
Record	17:00	FILTRA					
	IPSCND		1				
	UPTKF						
Record	18:00	PLVKRT					
	PLDKRT		2.64				
	FEXTRC		0.5				
Flag	for	Index	Res.	Run	IR		Pond
Flag	for	runoff	calc.	RUNOFF	none		none,

FLORIDA TURF 4 APPLICATIONS, 30 DAY INTERVAL, 0.2 lbs/A

stored	as	DVPFLtrf.out				
Chemical:	DDVP					
PRZM	environment:	FLturfC.txt	modified	Monday,		16 June
EXAMS	environment:	pond298.exv	modified	Thuday,		29 August
Metfile:	w12834.dvf	modified	Wedday,		3 July	2002

Water segment concentrations (ppb)

Year	Peak	96 Hr	21 Day	60 Day	90 Day	Yearly
1961	0.114	0.09286	0.04047	0.02871	0.0284	0.009295
1962	0.1188	0.1001	0.04436	0.0302	0.0294	0.009537
1963	0.114	0.08831	0.03803	0.02781	0.02781	0.009148
1964	0.114	0.08833	0.03806	0.02782	0.02781	0.00912
1965	0.114	0.08831	0.03804	0.02781	0.02781	0.009143
1966	2.983	2.309	0.9941	0.3839	0.2653	0.06772
1967	0.114	0.08832	0.03804	0.02782	0.02781	0.009144
1968	0.1247	0.09659	0.0416	0.02954	0.02897	0.009406
1969	0.114	0.08832	0.03813	0.02785	0.02783	0.00915
1970	0.114	0.08833	0.03805	0.02782	0.02781	0.009144

1971	0.114	0.08831	0.03804	0.02782	0.02781	0.009144
1972	2.374	1.838	0.7913	0.3083	0.2149	0.05513
1973	0.114	0.08832	0.03804	0.02782	0.02781	0.009145
1974	0.114	0.08832	0.03804	0.02782	0.02781	0.009145
1975	0.114	0.08835	0.03806	0.02783	0.02782	0.009147
1976	0.114	0.08831	0.03803	0.02781	0.02781	0.009142
1977	0.114	0.08831	0.03811	0.02784	0.02782	0.009148
1978	0.114	0.08831	0.03803	0.02781	0.0278	0.009143
1979	0.114	0.08832	0.03804	0.02782	0.02781	0.009144
1980	0.114	0.08835	0.03812	0.02784	0.02784	0.009129
1981	0.114	0.08832	0.0381	0.02784	0.02782	0.009147
1982	0.1742	0.135	0.06278	0.03711	0.03401	0.01067
1983	0.114	0.08837	0.03809	0.02783	0.02782	0.009148
1984	0.1222	0.09999	0.04476	0.03035	0.0295	0.009552
1985	0.114	0.09034	0.0392	0.02825	0.0281	0.009239
1986	0.1143	0.09068	0.04065	0.02882	0.02848	0.009309
1987	0.114	0.08835	0.03806	0.02782	0.02781	0.009145
1988	0.114	0.08832	0.03804	0.02781	0.02781	0.009119
1989	0.114	0.08841	0.03808	0.02783	0.02781	0.009145
1990	0.114	0.08831	0.03803	0.02781	0.0278	0.009143

Sorted	results					
Prob.	Peak	96 Hr	21 Day	60 Day	90 Day	Yearly
0.03225806	2.983	2.309	0.9941	0.3839	0.2653	0.06772
0.06451613	2.374	1.838	0.7913	0.3083	0.2149	0.05513
0.09677419	0.1742	0.135	0.06278	0.03711	0.03401	0.01067
0.12903226	0.1247	0.1001	0.04476	0.03035	0.0295	0.009552
0.16129032	0.1222	0.09999	0.04436	0.0302	0.0294	0.009537
0.19354839	0.1188	0.09659	0.0416	0.02954	0.02897	0.009406

0.22580645	0.1143	0.09286	0.04065	0.02882	0.02848	0.009309
0.25806452	0.114	0.09068	0.04047	0.02871	0.0284	0.009295
0.29032258	0.114	0.09034	0.0392	0.02825	0.0281	0.009239
0.32258065	0.114	0.08841	0.03813	0.02785	0.02784	0.00915
0.35483871	0.114	0.08837	0.03812	0.02784	0.02783	0.009148
0.38709677	0.114	0.08835	0.03811	0.02784	0.02782	0.009148
0.41935484	0.114	0.08835	0.0381	0.02784	0.02782	0.009148
0.4516129	0.114	0.08835	0.03809	0.02783	0.02782	0.009147
0.48387097	0.114	0.08833	0.03808	0.02783	0.02782	0.009147
0.51612903	0.114	0.08833	0.03806	0.02783	0.02781	0.009145
0.5483871	0.114	0.08832	0.03806	0.02782	0.02781	0.009145
0.58064516	0.114	0.08832	0.03806	0.02782	0.02781	0.009145
0.61290323	0.114	0.08832	0.03805	0.02782	0.02781	0.009145
0.64516129	0.114	0.08832	0.03804	0.02782	0.02781	0.009144
0.67741935	0.114	0.08832	0.03804	0.02782	0.02781	0.009144
0.70967742	0.114	0.08832	0.03804	0.02782	0.02781	0.009144
0.74193548	0.114	0.08832	0.03804	0.02782	0.02781	0.009144
0.77419355	0.114	0.08831	0.03804	0.02782	0.02781	0.009143
0.80645161	0.114	0.08831	0.03804	0.02781	0.02781	0.009143
0.83870968	0.114	0.08831	0.03804	0.02781	0.02781	0.009143
0.87096774	0.114	0.08831	0.03803	0.02781	0.02781	0.009142
0.90322581	0.114	0.08831	0.03803	0.02781	0.02781	0.009129
0.93548387	0.114	0.08831	0.03803	0.02781	0.0278	0.00912
0.96774194	0.114	0.08831	0.03803	0.02781	0.0278	0.009119
0.1	0.16925	0.13151	0.060978	0.036434	0.033559	0.010558
Average	of	yearly	averages:		0.012728	

Inputs	generated	by	pe4.pl	-	8-Aug-03	
Data	used	for	this	run:		
Output	File:	DVPFLtrf				
Metfile:	w12834.dvf					
PRZM	scenario:	FLturfC.txt				
EXAMS	environment	file:	pond298.exv			
Chemical	Name:	DDVP				
Description	Variable	Name	Value	Units	Comments	
Molecular	weight	mwt	220.9	g/mol		
Henry's	Law	Const.	henry	5.01E-08	atm-m^3/mol	
Vapor	Pressure	vapr	1.20E-02	torr		
Solubility	sol	10000	mg/L			
Kd	Kd	mg/L				
Koc	Koc	37	mg/L			
Photolysis	half-life	kdp	10.2	days	Half-life	
Aerobic	Aquatic	Metabolism	kbacw	0	days	Halfife
Anaerobic	Aquatic	Metabolism	kbacs	0	days	Halfife
Aerobic	Soil	Metabolism	asm	0.42	days	Halfife
Hydrolysis:	pH	7	5.2	days	Half-life	
Method:	CAM	2	integer	See	PRZM	manual
Incorporation	Depth:	DEPI	0	cm		
Application	Rate:	TAPP	0.224	kg/ha		
Application	Efficiency:	APPEFF	0.99	fraction		
Spray	Drift	DRFT	0.01	fraction	of	application
Application	Date	Date	20-05	dd/mm	or	dd/mmm
Interval	1	interval	30	days	Set	to
Interval	2	interval	30	days	Set	to
Interval	3	interval	30	days	Set	to
Record	17:00	FILTRA				
	IPSCND	1				
	UPTKF					
Record	18:00	PLVKRT				
	PLDKRT	2.64				
	FEXTRC	0.5				
Flag	for	Index	Res.	Run	IR	Pond
Flag	for	runoff	calc.	RUNOFF	none	none,

PENNSYLVANIA TURF 1 APPLICATION at 0.2 lbs/A

stored	as	DVPtrfPA.out				
Chemical:	DDVP					
PRZM	environment:	PAturfC.txt	modified	Satday,		12 October
EXAMS	environment:	pond298.exv	modified	Thuday,		29 August
Metfile:	w14737.dvf	modified	Wedday,		3 July	2002
Water	segment	concentrations	(ppb)			

Year	Peak	96 Hr	21 Day	60 Day	90 Day	Yearly
1961	0.112	0.08672	0.03734	0.0139	0.009274	0.002287
1962	0.112	0.08672	0.03734	0.0139	0.009274	0.002287
1963	0.112	0.08672	0.03733	0.0139	0.009273	0.002287
1964	0.112	0.08671	0.03733	0.0139	0.009271	0.00228
1965	0.112	0.08671	0.03733	0.0139	0.009272	0.002287
1966	0.112	0.08672	0.03734	0.0139	0.009273	0.002287
1967	0.112	0.08672	0.03733	0.0139	0.009272	0.002287
1968	0.112	0.08672	0.03734	0.01391	0.009275	0.002281
1969	0.112	0.08671	0.03733	0.0139	0.009271	0.002286
1970	0.112	0.08672	0.03734	0.0139	0.009273	0.002287
1971	0.112	0.08672	0.03734	0.0139	0.009274	0.002287
1972	0.112	0.08672	0.03734	0.0139	0.009274	0.002281
1973	0.112	0.08672	0.03734	0.0139	0.009275	0.002287
1974	0.112	0.08672	0.03734	0.0139	0.009274	0.002287
1975	0.112	0.08673	0.03735	0.01391	0.009276	0.002288
1976	0.112	0.08672	0.03733	0.0139	0.009273	0.00228
1977	0.112	0.08671	0.03733	0.0139	0.009271	0.002286
1978	0.112	0.08672	0.03734	0.0139	0.009275	0.002287
1979	0.112	0.08678	0.03742	0.01393	0.009295	0.002292
1980	0.112	0.08672	0.03734	0.0139	0.009273	0.002281

1981	0.112	0.08671	0.03733	0.0139	0.009272	0.002287
1982	0.112	0.08672	0.03734	0.0139	0.009274	0.002287
1983	0.112	0.08686	0.03745	0.01394	0.009301	0.002294
1984	0.4776	0.3698	0.1592	0.05929	0.03955	0.009726
1985	0.112	0.08671	0.03733	0.0139	0.009272	0.002287
1986	0.112	0.08758	0.03798	0.01414	0.009435	0.002327
1987	0.112	0.08672	0.03733	0.0139	0.009272	0.002287
1988	0.112	0.08672	0.03734	0.0139	0.009274	0.002281
1989	0.112	0.08672	0.03734	0.0139	0.009275	0.002287
1990	0.112	0.08672	0.03734	0.0139	0.009273	0.002287

Sorted	results					
Prob.	Peak	96 Hr	21 Day	60 Day	90 Day	Yearly
0.03225806	0.4776	0.3698	0.1592	0.05929	0.03955	0.009726
0.06451613	0.112	0.08758	0.03798	0.01414	0.009435	0.002327
0.09677419	0.112	0.08686	0.03745	0.01394	0.009301	0.002294
0.12903226	0.112	0.08678	0.03742	0.01393	0.009295	0.002292
0.16129032	0.112	0.08673	0.03735	0.01391	0.009276	0.002288
0.19354839	0.112	0.08672	0.03734	0.01391	0.009275	0.002287
0.22580645	0.112	0.08672	0.03734	0.0139	0.009275	0.002287
0.25806452	0.112	0.08672	0.03734	0.0139	0.009275	0.002287
0.29032258	0.112	0.08672	0.03734	0.0139	0.009275	0.002287
0.32258065	0.112	0.08672	0.03734	0.0139	0.009274	0.002287
0.35483871	0.112	0.08672	0.03734	0.0139	0.009274	0.002287
0.38709677	0.112	0.08672	0.03734	0.0139	0.009274	0.002287
0.41935484	0.112	0.08672	0.03734	0.0139	0.009274	0.002287
0.4516129	0.112	0.08672	0.03734	0.0139	0.009274	0.002287
0.48387097	0.112	0.08672	0.03734	0.0139	0.009274	0.002287
0.51612903	0.112	0.08672	0.03734	0.0139	0.009274	0.002287

0.5483871	0.112	0.08672	0.03734	0.0139	0.009273	0.002287
0.58064516	0.112	0.08672	0.03734	0.0139	0.009273	0.002287
0.61290323	0.112	0.08672	0.03734	0.0139	0.009273	0.002287
0.64516129	0.112	0.08672	0.03734	0.0139	0.009273	0.002287
0.67741935	0.112	0.08672	0.03733	0.0139	0.009273	0.002287
0.70967742	0.112	0.08672	0.03733	0.0139	0.009273	0.002287
0.74193548	0.112	0.08672	0.03733	0.0139	0.009272	0.002286
0.77419355	0.112	0.08672	0.03733	0.0139	0.009272	0.002286
0.80645161	0.112	0.08671	0.03733	0.0139	0.009272	0.002281
0.83870968	0.112	0.08671	0.03733	0.0139	0.009272	0.002281
0.87096774	0.112	0.08671	0.03733	0.0139	0.009272	0.002281
0.90322581	0.112	0.08671	0.03733	0.0139	0.009271	0.002281
0.93548387	0.112	0.08671	0.03733	0.0139	0.009271	0.00228
0.96774194	0.112	0.08671	0.03733	0.0139	0.009271	0.00228
0.1	0.112	0.086852	0.037447	0.013939	0.0093	0.002294
	Average	of	yearly	averages:	0.002535	
Inputs	generated	by	pe4.pl	-	8-Aug-03	
Data	used	for	this	run:		
Output	File:	DVPtrfPA				
Metfile:	w14737.dvf					
PRZM	scenario:	PAturfC.txt				
EXAMS	environment	file:	pond298.exv			
Chemical	Name:	DDVP				
Description	Variable	Name	Value	Units	Comments	
Molecular	weight	mwt	220.9	g/mol		
Henry's	Law	Const.	henry	5.01E-08	atm-m^3/mol	
Vapor	Pressure	vapr	1.20E-02	torr		
Solubility	sol	10000	mg/L			
Kd	Kd	mg/L				
Koc	Koc	37	mg/L			
Photolysis	half-life	kdp	10.2	days	Half-life	
Aerobic	Aquatic	Metabolism	kbacw	0	days	Halfife
Anaerobic	Aquatic	Metabolism	kbacs	0	days	Halfife

Aerobic	Soil	Metabolism	asm	0.42 days		Halfife
Hydrolysis:	pH	7	5.2 days		Half-life	
Method:	CAM	2 integer	See		PRZM	manual
Incorporation	Depth:	DEPI	0 cm			
Application	Rate:	TAPP	0.224 kg/ha			
Application	Efficiency:	APPEFF	0.99 fraction			
Spray	Drift	DRFT	0.01 fraction		of	application
Application	Date	Date	20-05	dd/mm	or	dd/mmm
Record	17:00	FILTRA				
	IPSCND	1				
	UPTKF					
Record	18:00	PLVKRT				
	PLDKRT	2.64				
	FEXTRC	0.5				
Flag	for	Index	Res.	Run	IR	Pond
Flag	for	runoff	calc.	RUNOFF	none	none,

PENNSYLVANIA TURF 4 APPLICATIONS, 30 DAY INTERVAL, 0.2 lbs/A

stored	as	DVPPAtrf.out				
Chemical:	DDVP					
PRZM	environment:	PAturfC.txt	modified	Satday,		12 October
EXAMS	environment:	pond298.exv	modified	Thuday,		29 August
Metfile:	w14737.dvf	modified	Wedday,		3 July	2002
Water	segment	concentrations	(ppb)			

Year	Peak	96 Hr	21 Day	60 Day	90 Day	Yearly
1961	0.1141	0.08833	0.03807	0.02784	0.02783	0.00915
1962	0.114	0.08832	0.03805	0.02783	0.02782	0.009149
1963	0.1141	0.08865	0.03822	0.02789	0.02786	0.009159
1964	0.1141	0.08833	0.03805	0.02783	0.02782	0.009123
1965	0.114	0.08833	0.03806	0.02783	0.02782	0.009148
1966	0.114	0.08832	0.03804	0.02782	0.02781	0.009147
1967	0.1141	0.08833	0.03806	0.02783	0.02782	0.009149
1968	0.114	0.08833	0.03805	0.02783	0.02782	0.009124
1969	0.1141	0.08833	0.03807	0.02783	0.02783	0.009149
1970	0.1262	0.1047	0.04681	0.03112	0.03001	0.00969

1971	0.114	0.08832	0.03804	0.02782	0.02782	0.009148
1972	0.1142	0.09017	0.04004	0.02893	0.02856	0.009307
1973	0.114	0.08833	0.03805	0.02782	0.02782	0.009149
1974	0.1141	0.08834	0.03806	0.02783	0.02782	0.00915
1975	0.1142	0.09152	0.03976	0.02847	0.02825	0.009256
1976	0.114	0.08832	0.03805	0.02782	0.02782	0.009123
1977	0.26	0.2014	0.08673	0.04596	0.03991	0.01213
1978	0.1141	0.08834	0.03806	0.02783	0.02782	0.00915
1979	0.1141	0.08833	0.03806	0.02783	0.02782	0.009155
1980	0.114	0.08833	0.03805	0.02782	0.02782	0.009123
1981	0.1141	0.08862	0.03827	0.02792	0.02789	0.009164
1982	0.114	0.08833	0.03805	0.02782	0.02782	0.009149
1983	0.1496	0.1192	0.05453	0.03402	0.03195	0.01017
1984	0.4776	0.3698	0.1592	0.07293	0.05792	0.01657
1985	0.114	0.08833	0.03805	0.02783	0.02782	0.009148
1986	0.1141	0.08833	0.03805	0.02785	0.02784	0.009188
1987	0.114	0.08833	0.03809	0.02784	0.02784	0.009152
1988	0.1141	0.09001	0.03895	0.02816	0.02804	0.009178
1989	0.1142	0.09185	0.03993	0.02864	0.02837	0.009285
1990	0.114	0.08832	0.03805	0.02782	0.02782	0.009148

Sorted results

Prob.	Peak	96 Hr	21 Day	60 Day	90 Day	Yearly
0.03225806	0.4776	0.3698	0.1592	0.07293	0.05792	0.01657
0.06451613	0.26	0.2014	0.08673	0.04596	0.03991	0.01213
0.09677419	0.1496	0.1192	0.05453	0.03402	0.03195	0.01017
0.12903226	0.1262	0.1047	0.04681	0.03112	0.03001	0.00969
0.16129032	0.1142	0.09185	0.04004	0.02893	0.02856	0.009307
0.19354839	0.1142	0.09152	0.03993	0.02864	0.02837	0.009285

0.22580645	0.1142	0.09017	0.03976	0.02847	0.02825	0.009256
0.25806452	0.1141	0.09001	0.03895	0.02816	0.02804	0.009188
0.29032258	0.1141	0.08865	0.03827	0.02792	0.02789	0.009178
0.32258065	0.1141	0.08862	0.03822	0.02789	0.02786	0.009164
0.35483871	0.1141	0.08834	0.03809	0.02785	0.02784	0.009159
0.38709677	0.1141	0.08834	0.03807	0.02784	0.02784	0.009155
0.41935484	0.1141	0.08833	0.03807	0.02784	0.02783	0.009152
0.4516129	0.1141	0.08833	0.03806	0.02783	0.02783	0.00915
0.48387097	0.1141	0.08833	0.03806	0.02783	0.02782	0.00915
0.51612903	0.1141	0.08833	0.03806	0.02783	0.02782	0.00915
0.5483871	0.1141	0.08833	0.03806	0.02783	0.02782	0.009149
0.58064516	0.1141	0.08833	0.03806	0.02783	0.02782	0.009149
0.61290323	0.114	0.08833	0.03805	0.02783	0.02782	0.009149
0.64516129	0.114	0.08833	0.03805	0.02783	0.02782	0.009149
0.67741935	0.114	0.08833	0.03805	0.02783	0.02782	0.009149
0.70967742	0.114	0.08833	0.03805	0.02783	0.02782	0.009148
0.74193548	0.114	0.08833	0.03805	0.02783	0.02782	0.009148
0.77419355	0.114	0.08833	0.03805	0.02782	0.02782	0.009148
0.80645161	0.114	0.08833	0.03805	0.02782	0.02782	0.009148
0.83870968	0.114	0.08832	0.03805	0.02782	0.02782	0.009147
0.87096774	0.114	0.08832	0.03805	0.02782	0.02782	0.009124
0.90322581	0.114	0.08832	0.03805	0.02782	0.02782	0.009123
0.93548387	0.114	0.08832	0.03804	0.02782	0.02782	0.009123
0.96774194	0.114	0.08832	0.03804	0.02782	0.02781	0.009123
0.1	0.14726	0.11775	0.053758	0.03373	0.031756	0.010122
	Average	of	yearly	averages:	0.009561	

Inputs	generated	by	pe4.pl	-	8-Aug-03	
Data	used	for	this	run:		
Output	File:	DVPPAtrf				
Metfile:	w14737.dvf					
PRZM	scenario:	PAturfC.txt				
EXAMS	environment	file:	pond298.exv			
Chemical	Name:	DDVP				
Description	Variable	Name	Value	Units	Comments	
Molecular	weight	mwt	220.9	g/mol		
Henry's	Law	Const.	henry	5.01E-08	atm-m^3/mol	
Vapor	Pressure	vapr	1.20E-02	torr		
Solubility	sol	10000	mg/L			
Kd	Kd	mg/L				
Koc	Koc	37	mg/L			
Photolysis	half-life	kdp	10.2	days	Half-life	
Aerobic	Aquatic	Metabolism	kbacw	0	days	Halfife
Anaerobic	Aquatic	Metabolism	kbacs	0	days	Halfife
Aerobic	Soil	Metabolism	asm	0.42	days	Halfife
Hydrolysis:	pH	7	5.2	days	Half-life	
Method:	CAM	2	integer	See	PRZM	manual
Incorporation	Depth:	DEPI	0	cm		
Application	Rate:	TAPP	0.224	kg/ha		
Application	Efficiency:	APPEFF	0.99	fraction		
Spray	Drift	DRFT	0.01	fraction	of	application
Application	Date	Date	20-05	dd/mm	or	dd/mmm
Interval	1	interval	30	days	Set	to
Interval	2	interval	30	days	Set	to
Interval	3	interval	30	days	Set	to
Record	17:00	FILTRA				
	IPSCND	1				
	UPTKF					
Record	18:00	PLVKRT				
	PLDKRT	2.64				
	FEXTRC	0.5				
Flag	for	Index	Res.	Run	IR	Pond
Flag	for	runoff	calc.	RUNOFF	none	none,

APPENDIX D. TERRESTRIAL EXPOSURE AND RQ CALCULATION - T-REX MODEL

T-REX Version 1.1

December 7, 2004

The T-REX spreadsheet has been developed by the Plant, Terrestrial Biology and Exposure Technical Teams.
For information or questions concerning this spreadsheet, please contact John Ravenscroft or Edward Odenkirchen.

****NOTE**:** Please save the spreadsheet file to you ***own*** computer first. Select 'File', then 'Save As' on the menu bar. Select the destination on your own hard drive (usually set to C:). ***Do not*** modify the spreadsheet on the F: drive.

Scroll down to next section for instructions.

Introduction and Background

This spreadsheet-based model calculates the decay of a chemical applied to foliar surfaces for single or multiple applications. It uses the same principle as the batch code models FATE and TERREEC that calculate terrestrial exposure concentration estimates on plant surfaces following pesticide application. A first order decay assumption is used to determine the concentration at each day after initial application based on the concentration resulting from the initial and additional applications. The decay is calculated from the first order rate equation:

$$CT = C_i e^{-kT}$$

or in log form:

$$\ln (CT/C_i) = kT$$

Where

CT =concentration at time T = day zero.

C_i =concentration, in parts per million (PPM), present initially (on day zero) on the surfaces. C_i is calculated by multiplying the application rate, in pounds active ingredient per acre, by 240 for short grass, 110 for tall grass, and 135 for broad-leafed plants/small insects and 15 for fruits/pods/large insects based on the Kenaga nomogram (Hoerger and Kenaga, 1972) as modified by Fletcher (1994). For maximum concentrations, additional applications are converted from pounds active ingredient per acre to PPM on the plant surface and the additional mass added to the mass of the chemical still present on the surfaces on the day of application.

k = If the foliar dissipation data submitted to EFED are found scientifically valid and statistically robust for a specific pesticide, the 90% upper confidence limit of the mean half-lives should be used. When scientifically valid, statistically robust data are not available, EFED recommends the using a default half-life value of 35 days. The use of the 35-day half-life is based on the highest reported value (36.9 days), as reported by Willis and McDowell (Pesticide persistence on foliage, Environ. Contam. Toxicol, 100:23-73, 1987).

T =time, in days, since the start of the simulation. The initial application is on day 0. The simulation is designed to run for 365 days.

The spreadsheet calculates the pesticide residue concentrations on each type of surface on a daily interval for one year. The maximum concentration during the year is calculated for both maximum and mean residues.

The calculated residue concentrations are used to calculate Avian and Mammalian risk quotient (RQ) values. The maximum calculated concentration is divided by user input values for acute and chronic endpoints to give RQs for each type of plant surface.

How to use TREX

TREX has been designed to be easy to use, yet maintain a level of flexibility needed for the multitude of chemicals and use patterns encountered by risk assessors. Throughout the spreadsheet, look for small red cell tags that contain additional information; just move the cursor over them to display the comment box. With the exception of the seed treatment exposure worksheet, all necessary data can be entered into the 'Input' worksheet.

Inputs

An 'Input' worksheet has been included to increase consistency and transparency in the terrestrial exposure estimation process. The inputs used to calculate the amount of chemical present and estimate exposure are highlighted in blue, as well as consist of various drop-down menus. These inputs include the following:

Chemical name:Enter either the chemical or common name used in the assessment
Use:Enter the crop name and type of use
Formulation:Enter the state of the chemical to be used (e.g., liquid, spray, WP, flowable, etc.)
% A.I.:Enter the % A.I. for the formulation (from the label)
Application Rate:The maximum label application rate (pounds ai/acre)
Half-life:The degradation half-life for the dominant process (days)
Application Interval:The interval between repeated applications, from the label (days)
Maximum # Application per year:From the label
Concentration of Concern:For graphing purposes, choose an endpoint (mg/kg-diet) that you wish to be overlaid onto the residue graph
Choose label:From the drop-down menu, choose the label that corresponds to the Concentration of Concern

NOTE: Pushing the 'reset model' button to the right of the first set of inputs will clear ALL of the user-supplied information. This button was included to allow the user to more quickly run multiple scenarios with TREX without having to manually clear each cell.

Endpoints

TREX requires that both the chosen endpoint (entered in the blue cell) ***and*** the test species to be included (chosen from the drop-down menu options). For example, one would enter an avian LD_{50} of 500 mg/kg-bw ***and*** that this endpoint was based on a Bobwhite quail study (i.e., chosen from the drop-down menu immediately to the right of the LD_{50} input cell). For now, this requirement is limited to the avian endpoints.

Avian endpoints

Enter the endpoints in the blue cells and choose the corresponding test species from the drop-down menus.

Mammalian endpoints

For acute endpoints, enter the data in the blue cells. For chronic endpoints, enter the reported number and then choose whether this datapoint was a dose- or diet-based endpoint from the drop-down menu. The other endpoint will then be calculated and displayed in the cell below.

LD_{50} ft^{-2}

TREX includes the capability to also calculate an LD_{50} ft^{-2} with the above-supplied information. Choose from the drop-down menu provided whether or not you wish to do so. If 'yes' is chosen, the type of application method (i.e., broadcast or rows) should be entered. If 'rows' is chosen, additional input parameters will be required (i.e., row spacing, bandwidth, and % incorporation) and appear to the right. Next, input whether the application is a granular or liquid application. If 'liquid' is chosen, enter the oz. product per 1000 ft row.

To see the results, choose the LD_{50} ft^{-2} worksheet tab. The print area has been pre-set, so choose the printer button in the toolbar to print.

Terrestrial Exposures

All calculated Estimated Environmental Concentration (EEC) and RQ values are presented in yellow. Intermediate calculations are displayed in red. Users may find these intermediate values useful in their assessment, so they are presented.

Upper Bound and Mean Kenaga Residue Worksheets

Both the upper bound and mean Kenaga residues for the various food categories are provided. Each includes RQs for birds and mammals. The upper bound residue worksheet is to be used for reporting RQ values in the risk assessment, while the mean residue worksheet is solely for risk description purposes. Mean residues are calculated exactly as the maximum residues are, except the corresponding Kenaga values are 85 for Short Grass, 36 for Tall Grass, and 45 for Broad-leafed plants/small insects and 7 for fruits/pods/large insects.

In both worksheets, dose-based RQs are calculated using a body weight-adjusted LD_{50} and consumption-weighted equivalent dose. The scaling factors (USEPA, 1993) used in the consumption-weighted (EECs) are:

Avian consumption

$$F = \frac{0.648 * BW^{0.651}}{(1 - W)}$$

Mammal consumption

$$F = \frac{0.621 * BW^{0.564}}{(1 - W)}$$

These consumption-weighted EECs (i.e., EEC equivalent dose) are sorted by food source and body size. There is a corresponding table for birds and mammals.

The LD_{50} values entered on the input form are adjusted for animal class (20, 100 and 1000 g birds and 15, 35, and 1000 g mammals) using the following equations:

Avian LD_{50}

$$Adj.\,LD_{50} = LD_{50}\left(\frac{AW}{TW}\right)^{(1.15-1)}$$

Mammal LD_{50}

$$Adj.\,LD_{50} = LD_{50}\left(\frac{TW}{AW}\right)^{(0.25)}$$

The dose-based RQs are calculated by dividing the daily dose (EEC equivalent dose) by the adjusted LD_{50} for each food category and animal class.

For dietary-based RQs, the Kenaga EEC is divided by the LC_{50} (acute RQ) or the NOAEC (chronic RQ).

Graphs

Each worksheet contains a graph of the calculated residues for the first 100 days and includes the 'Concentration of Concern' overlay from the input form. These can be copy/pasted individually into a word processing program and used in the risk assessment, if desired. Additionally, graphs displaying acute and chronic LOCs for both birds and mammals are displayed in the 'Graph' worksheet.

LD_{50} ft^{-2}

LD_{50} ft^{-2} values are calculated for both broadcast and banded (granular and liquid) applications using the adjusted LD_{50} method described above. The results are presented by class for both birds and mammals for each type of application.

Seed Treatments

Due to the difference in foliar application and seed treatment uses of pesticides, this worksheet can be used as a 'stand-alone' tool for estimating avian and mammalian RQs for the various crops listed. Efforts were made to make this crop list as complete as possible; however, there may be additional crops added in the future as the need arises. Only those seed treatments needed for the assessment need to be entered. For example, if rye is not an intended use, then leave it set to zero, as this will have no impact on the RQ calculations for the other crops.

The seed treatment worksheet contains additional input cells in blue separate from those in the Input worksheet including:

Name of seed treatment formulation:	Labels for seed treatment products differ from foliar applied formulations.
Percent A.I. in formulation:	Enter % A.I. as a whole number (e.g., 24% = 24)
Test body weights:	Enter the test organism body weight from the avian and mammal studies
Application rate (fl oz./cwt):	Provided on the label

NOTE: If a liquid rate is not available for a chemical, enter the dry weight application rate in the adjoining cell. Once this is done; however, the underlying equation in that cell has been replaced. It is preferable that users input the fl oz/cwt value.

RQs are calculated using the adjusted LD_{50} for the smallest weight class of animal. Acute RQs are calculated using two methods:

Method #1: Acute RQ = mg A.I. day^{-1}/adjusted LD_{50}

Method #2: Acute RQ = mg A.I. ft^{-2}/(adjusted LD_{50} * body weight)

Chronic RQs are calculated using the equation:

Chronic RQ = mg A.I. kg^{-1} seed/NOAEL

References

Fletcher, J.S., J.E. Nellesson and T. G. Pfleeger. 1994. Literature review and evaluation of the EPA food-chain (Kenaga) nomogram, an instrument for estimating pesticide residues on plants. Environ. Tox. And Chem. 13(9):1383-1391

Hoerger, F. and E.E. Kenaga. 1972. Pesticide residues on plants: correlation of respresentative dada as a basis for estimation of their magnitude in the environment. IN: F. Coulston and F. Corte, eds., Environmental Quality and Safety: Chemistry, Toxicology and Technology. Vol 1. Georg Theime Publishers, Stuttgart, Germany. pp. 9-28

USEPA. 1993. Wildlife Exposure Factors Handbook. Volume I of II. EPA/600/R-93/187a. Office of Research and Development, Washington, D. C. 20460.

Willis and McDowell. 1987. Pesticide persistence on foliage. Environ. Contam. Toxicol. 100:23-73

TURF - 1 APPLICATION AT 0.2 LBS/A

Chemical Name:	Dichlorvos	
Use	Turf	
Formulation	Liquid spray	
Application Rate	0.0804	lbs a.i./acre
Half-life	0.0875	days
Application Interval	0	days
Maximum # Apps./Year	1	
Length of Simulation	1	year
Concentration of Concern	0.00	(ppm)
Name of Concentration of Concern	FALSE	

Endpoints

Avian	Mallard duck LD50 (mg/kg-bw)	7.78
	Mallard duck LC50 (mg/kg-diet)	568
	Bobwhite quail NOAEL (mg/kg-bw)	0
	Mallard duck NOAEC (mg/kg-diet)	5
Mammals	LD50 (mg/kg-bw)	56
	LC50 (mg/kg-diet)	0
	NOAEL (mg/kg-bw)	1
	NOAEC (mg/kg-diet)	20

EECs (ppm)	Kenaga Values
Short Grass	19.30
Tall Grass	8.84
Broadleaf plants/sm Insects	10.85
Fruits/pods/seeds/lg insects	1.21

Avian Results

Avian Class	Body Weight	% body wgt consumed	Adjusted LD50

Small	20	114	4.04
Mid	100	65	5.14
Large	1000	29	7.26

EEC equivalent dose (mg/kg-bw)	Avian Classes and Body Weights		
	small 20 g	mid 100 g	large 1000 g
Short Grass	22	13	6
Tall Grass	10	6	3
Broadleaf plants/sm Insects	12	7	3
Fruits/pods/lg insects	1	1	0

Dose-based RQs (daily dose/LD50)	Avian Acute RQs		
	20 g	100 g	1000 g
Short Grass	5.45	2.44	0.77
Tall Grass	2.50	1.12	0.35
Broadleaf plants/sm insects	3.06	1.37	0.43
Fruits/pods/lg insects	0.34	0.15	0.05

Dietary-based RQs (EEC/LC50 or NOAEC)	RQs	
	Acute	Chronic
Short Grass	0.03	3.86
Tall Grass	0.02	1.77
Broadleaf plants/sm Insects	0.02	2.17
Fruits/pods/lg insects	0.00	0.24

Mammalian Results

Mammalian Class	Body Weight	% body wgt consumed	Adjusted LD50	Adjusted NOAEL
Herbivores/ insectivores	15	95	123.08	2.20
	35	66	99.58	1.78
	1000	15	43.07	0.77
Grainvores	15	21	123.08	2.20
	35	15	99.58	1.78
	1000	3	43.07	0.77

EEC equivalent dose (mg/kg-bw)	Mammalian Classes and Body weight					
	Herbivores/ insectivores			Granivores		
	15 g	35 g	1000 g	15 g	35 g	1000 g
Short Grass	18	13	3			
Tall Grass	8	6	1			
Broadleaf plants/sm Insects	10	7	2			
Fruits/pods/seeds/lg insects	1	1	0	0	0	0

Dose-based RQs (daily dose/LD50 or NOAEL)	15 g mammal		35 g mammal		1000 g mammal	
	Acute	Chronic	Acute	Chronic	Acute	Chronic
Short Grass	0.15	8.34	0.13	7.16	0.07	3.76
Tall Grass	0.07	3.82	0.06	3.28	0.03	1.72
Broadleaf plants/sm insects	0.08	4.69	0.07	4.03	0.04	2.12
Fruits/pods/lg insects	0.01	0.52	0.01	0.45	0.00	0.24
Seeds (granivore)	0.00	0.12	0.00	0.10	0.00	0.05

Dietary-based RQs (EEC/LC50 or NOAEC)	Mammal RQs					
	Acute	Chronic				
Short Grass		0.96				
Tall Grass		0.44				
Broadleaf plants/sm insects		0.54				
Fruits/pods/seeds/lg insects		0.06				

TURF - 4 APPLICATION, 30 DAY APPLICATION INTERVALS, AT 0.2 LBS/A

Chemical Name:	Dichlorvos	
Use	Turf	
Formulation	Liquid spray	
Application Rate	0.0804	lbs a.i./acre
Half-life	0.0875	days
Application Interval	30	days
Maximum # Apps./Year	4	
Length of Simulation	1	year
Concentration of Concern	0.00	(ppm)
Name of Concentration of Concern	FALSE	

Endpoints

Avian	Mallard duck LD50 (mg/kg-bw)	7.78
	Mallard duck LC50 (mg/kg-diet)	568
	Bobwhite quail NOAEL (mg/kg-bw)	0
	Mallard duck NOAEC (mg/kg-diet)	5
Mammals	LD50 (mg/kg-bw)	56
	LC50 (mg/kg-diet)	0
	NOAEL (mg/kg-bw)	1
	NOAEC (mg/kg-diet)	20

EECs (ppm)	Kenaga Values
Short Grass	19.30
Tall Grass	8.84
Broadleaf plants/sm Insects	10.85
Fruits/pods/seeds/lg insects	1.21

Avian Results

Avian Class	Body Weight	% body wgt consume	Adjusted LD50

	d		
Small	20	114	4.04
Mid	100	65	5.14
Large	1000	29	7.26

EEC equivalent dose (mg/kg-bw)	Avian Classes and Body Weights		
	small 20 g	mid 100 g	large 1000 g
Short Grass	22	13	6
Tall Grass	10	6	3
Broadleaf plants/sm Insects	12	7	3
Fruits/pods/lg insects	1	1	0

Dose-based RQs (daily dose/LD50)	Avian Acute RQs		
	20 g	100 g	1000 g
Short Grass	5.45	2.44	0.77
Tall Grass	2.50	1.12	0.35
Broadleaf plants/sm insects	3.06	1.37	0.43
Fruits/pods/lg insects	0.34	0.15	0.05

Dietary-based RQs (EEC/LC50 or NOAEC)	RQs	
	Acute	Chronic
Short Grass	0.03	3.86
Tall Grass	0.02	1.77
Broadleaf plants/sm Insects	0.02	2.17
Fruits/pods/lg insects	0.00	0.24

Mammalian Results

Mammalian Class	Body Weight	% body wgt consumed	Adjusted LD50	Adjusted NOAEL
	15	95	123.08	2.20
Herbivores/	35	66	99.58	1.78
insectivores	1000	15	43.07	0.77
	15	21	123.08	2.20
Grainvores	35	15	99.58	1.78
	1000	3	43.07	0.77

EEC equivalent dose (mg/kg-bw)	Mammalian Classes and Body weight					
	Herbivores/ insectivores			Granivores		
	15 g	35 g	1000 g	15 g	35 g	1000 g
Short Grass	18	13	3			
Tall Grass	8	6	1			
Broadleaf plants/sm Insects	10	7	2			
Fruits/pods/seeds/lg insects	1	1	0	0	0	0

Dose-based RQs (daily dose/LD50 or NOAEL)	15 g mammal		35 g mammal		1000 g mammal	
	Acute	Chronic	Acute	Chronic	Acute	Chronic
Short Grass	0.15	8.34	0.13	7.16	0.07	3.76
Tall Grass	0.07	3.82	0.06	3.28	0.03	1.72
Broadleaf plants/sm insects	0.08	4.69	0.07	4.03	0.04	2.12
Fruits/pods/lg insects	0.01	0.52	0.01	0.45	0.00	0.24
Seeds (granivore)	0.00	0.12	0.00	0.10	0.00	0.05

Dietary-	Mammal RQs		

based RQs (EEC/LC50 or NOAEC)						
	Acute	Chronic				
Short Grass		0.96				
Tall Grass		0.44				
Broadleaf plants/sm insects		0.54				
Fruits/pods/seeds/lg insects		0.06				

FLYING INSECT - 0.2 LBS/A

Chemical Name:	Dichlor vos	
Use	Flying Insect	
Formulation	Liquid spray	
Application Rate	0.0804	lbs a.i./acre
Half-life	0.0875	days
Application Interval	5	days
Maximum # Apps./Year	75	
Length of Simulation	1	year
Concentration of Concern	0.00	(ppm)
Name of Concentration of Concern	FALSE	

Endpoints		
Avian	Mallard duck LD50 (mg/kg-bw)	7.78
	Mallard duck LC50 (mg/kg-diet)	568
	Bobwhite quail NOAEL (mg/kg-bw)	0
	Mallard duck NOAEC (mg/kg-diet)	5
Mammals	LD50 (mg/kg-bw)	56
	LC50 (mg/kg-diet)	0
	NOAEL (mg/kg-bw)	1
	NOAEC (mg/kg-diet)	20

EECs (ppm)	Kenaga Values
Short Grass	19.30
Tall Grass	8.84
Broadleaf plants/sm Insects	10.85
Fruits/pods/seeds/lg insects	1.21

Avian Results

Avian Class	Body Weight	% body wgt consume	Adjusted LD50

		d	
Small	20	114	4.04
Mid	100	65	5.14
Large	1000	29	7.26

EEC equivalent dose (mg/kg-bw)	Avian Classes and Body Weights		
	small 20 g	mid 100 g	large 1000 g
Short Grass	22	13	6
Tall Grass	10	6	3
Broadleaf plants/sm Insects	12	7	3
Fruits/pods/lg insects	1	1	0

Dose-based RQs (daily dose/LD50)	Avian Acute RQs		
	20 g	100 g	1000 g
Short Grass	5.45	2.44	0.77
Tall Grass	2.50	1.12	0.35
Broadleaf plants/sm insects	3.06	1.37	0.43
Fruits/pods/lg insects	0.34	0.15	0.05

Dietary-based RQs (EEC/LC50 or NOAEC)	RQs	
	Acute	Chronic
Short Grass	0.03	3.86
Tall Grass	0.02	1.77
Broadleaf plants/sm Insects	0.02	2.17
Fruits/pods/lg insects	0.00	0.24

Mammalian Results

Mammalian Class	Body Weight	% body wgt consumed	Adjusted LD50	Adjusted NOAEL
Herbivores/ insectivores	15	95	123.08	2.20
	35	66	99.58	1.78
	1000	15	43.07	0.77
Grainvores	15	21	123.08	2.20
	35	15	99.58	1.78
	1000	3	43.07	0.77

EEC equivalent dose (mg/kg-bw)	Mammalian Classes and Body weight					
	Herbivores/ insectivores			Granivores		
	15 g	35 g	1000 g	15 g	35 g	1000 g
Short Grass	18	13	3			
Tall Grass	8	6	1			
Broadleaf plants/sm Insects	10	7	2			
Fruits/pods/seeds/lg insects	1	1	0	0	0	0

Dose-based RQs (daily dose/LD50 or NOAEL)	15 g mammal		35 g mammal		1000 g mammal	
	Acute	Chronic	Acute	Chronic	Acute	Chronic
Short Grass	0.15	8.34	0.13	7.16	0.07	3.76
Tall Grass	0.07	3.82	0.06	3.28	0.03	1.72
Broadleaf plants/sm insects	0.08	4.69	0.07	4.03	0.04	2.12
Fruits/pods/lg insects	0.01	0.52	0.01	0.45	0.00	0.24
Seeds (granivore)	0.00	0.12	0.00	0.10	0.00	0.05

Dietary-	Mammal RQs		

based RQs (EEC/LC50 or NOAEC)						
	Acute	Chronic				
Short Grass		0.96				
Tall Grass		0.44				
Broadleaf plants/sm insects		0.54				
Fruits/pods/seeds/lg insects		0.06				

BAIT- 1 APPLICATION, 0.1 LBS/A

Chemical:	Dichlorvos			
LD50 ft-2				
INPUTS	Do not overwrite these numbers.			
Application Rate:		0.1	lbs ai/acre	
% A.I.:		0.0744		
Avian LD50 (20g):		4.04	mg/kg bw	
(100g)		5.14		
(1000g)		7.26		
Mammalian LD50 (15g):		123.08	mg/kg bw	
(35g)		99.58		
(1000g)		43.07		
Row Spacing:		0	inches	
Bandwidth:		0	inches	
Unincorporation:		100%		

Broadcast applications		
Granular		
Intermediate Calculations		
mg ai/ft2:	0.08	
LD50 ft-2		
	wgt class	
Avian	20 g	0.959
	100 g	0.151
	1000 g	0.011
Mammal	15 g	0.042
	35 g	0.022
	1000 g	0.002