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Service

Spinosad Bait Spray Applications

Nontarget Risk Assessment, March 1999

DRAFT

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I. Introduction

The fruit flies of the family Tephritidae include several species that are major pests of agriculture throughout the world and that represent a serious threat to U.S. agriculture. The U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), in cooperation with other Federal and State organizations, has conducted a number of programs to eradicate some species of fruit flies when these insect pests have been introduced. These programs generally have employed an integrated pest management approach to eradication. Many recent programs have involved application of malathion bait spray to effectively lower fly populations in the infested area followed by release of sterile flies. This approach has generally been very effective. Aerial applications of the bait spray over populated areas to control infestations of fruit flies have been controversial. Concerns about adverse health effects from exposure to malathion bait spray have been raised by residents of treated neighborhoods.

As part of APHIS ongoing effort to seek effective alternatives that pose less risk to public health and the environment, trial tests are periodically conducted with chemicals that show promise for control and appear to pose lower risk to the human environment. Research on potential program insecticides assures that the safest and most effective control strategies can be determined for future eradication efforts. An insecticide trial being considered involves analysis of applications of bait spray using Spinosad as the toxicant to fruit flies. Spinosad is a mixture of macrocyclic lactones produced by the soil actinomycete fungus, *Saccharopolyspora spinosa*. The insecticidal action of Spinosad occurs through dermal exposure or ingestion and is particularly effective against feeding stages of butterflies, moths, and flies. The tentative plan for the trials is to apply per acre a mixture of 0.008% spinosad, and 28% sugars and attractants diluted in water.

This risk assessment analyzes the potential risk of adverse effects to human health, wildlife, and environmental quality from this trial application of the Spinosad bait spray formulation. Risk assessment of the bait, Nulure®, has already been presented in the Medfly Cooperative Eradication Program Final Environmental Impact Statement-1993 (USDA, APHIS, 1993). Nulure® is considered safe to animals, birds, and fish (Miller Chemical & Fertilizer Corporation, undated). This risk assessment will focus on potential effects of the active spinosyn factors in spinosad.

II. Hazard Analysis of Active Ingredients

Spinosad (Tracer®) is a mixture of compounds (spinosyns) produced naturally by the actinomycete fungus, *Saccharopolyspora spinosa*. Applications of spinosad are registered for use on various crops and has permanent tolerances for some fruits (including citrus), nuts, vegetables, cotton, and meat. The active ingredients in spinosad are spinosyn A and spinosyn D.

Qualitative data regarding the lures and attractants have been described in the Human Health Risk Assessment APHIS Fruit Fly Programs (SERA, 1992) and in the chemical background statement on attractants (Labat-Anderson, 1992f). These reviews of the lures and attractants cover all information that is known to date. These chemicals pose low hazards and no further description is necessary to describe the hazards.

U.S. EPA has established toxicity categories based upon the median lethal dose (LD_{50}) for humans and terrestrial organisms and on the median lethal concentration (LC_{50}) for aquatic organisms. The terminology associated with these categories, as defined in Table II-1, is used throughout this document.

Table II-1: EPA Toxicity Categories

Category	Criteria
Terrestrial (mg toxicant/kg body weight)	
Severely toxic	$LD_{50} \leq 50$
Moderately toxic	$50 < LD_{50} \leq 500$
Slightly toxic	$500 < LD_{50} \leq 5{,}000$
Very slightly toxic	$5{,}000 < LD_{50} \leq 50{,}000$
Aquatic (mg toxicant/L water)	
Very highly toxic	$LC_{50} \leq 0.1$
Highly toxic	$0.1 < LC_{50} \leq 1.0$
Moderately toxic	$1.0 < LC_{50} \leq 10$
Slightly toxic	$10 < LC_{50} \leq 100$
Practically non-toxic	$LC_{50} > 100$

A. Human Health

Spinosad (Tracer®) is a mixture of compounds (macrocyclic lactones referred to as spinosyns) produced naturally by the actinomycete fungus, *Saccharopolyspora spinosa*. Applications of spinosad are registered for use on various crops and has permanent tolerances for some fruits (including citrus), nuts, vegetables, cotton, and meat.

Acute toxicity of spinosad is low by all routes of exposure. Spinosad is of very slight acute oral toxicity to mammals. The symptoms of intoxication are unique and are typified by initial flaccid paralysis followed by weak tremors and continuous movement (Thompson et al., 1995). The acute oral median lethal dose (LD_{50}) to rats is greater than 5,000 milligrams (mg) of spinosad per kilogram (kg) body weight (Dow Agrosciences, 1998; EPA, 1998a). The acute dermal LD_{50} to rats is greater than 2,800 mg/kg. The acute inhalation median lethal concentration (LC_{50}) to rats is greater than 5.18 mg per liter (L). Primary eye irritation tests in rabbits showed slight conjunctival irritation. Primary dermal irritation studies in rabbits showed slight transient erythema and edema. Spinosad was not found to be a skin sensitizer.

Subchronic and chronic studies of spinosad also indicate low hazard. The systemic NOEL for spinosad from chronic feeding of dogs was determined to be 2.68 mg/kg/day (EPA, 1998a). The LOEL for this study (8.22 mg/kg/day) was based upon vacuolated cells in glands (parathyroid) and lymphatic tissues, arteritis, and increases in serum enzymes. No studies found any evidence of neurotoxicity or neurobehavioral effects. A neuropathology NOEL was determined to be 46 mg/kg/day for male rats and 57 mg/kg/day for female rats. No evidence of carcinogenicity was found in chronic studies of mice and rats. EPA has classified the carcinogenic potential of spinosad as Group E - no evidence of carcinogenicity (EPA, 1998b).

There has been no evidence of mutagenic effects from spinosad (EPA, 1998a). Test have been negative for mouse forward mutations without metabolic activation to 25 μg/ml and with metabolic activation to 50 μg/ml. No increases in chromosomal aberrations in Chinese hamster ovary cells were observed without activation to 35 μg/ml or with activation to 500 μg/ml. No increase in frequency of micronuclei in bone marrow cells of mice were found for 2 day exposures of spinosad up to 2,000 μg/ml. No unscheduled DNA synthesis was observed in adult rat hepatocytes in vitro at concentrations of spinosad as high as 5 μg/ml.

Reproductive and developmental toxicity studies have found that these effects occur only at doses that exceed those which cause other toxic effects to the parent animal. The reproductive NOEL from a 2-generation study of rats was determined to be 10 mg/kg/day with a LOEL of 100 mg/kg/day based upon decreased litter size, decreased pup survival, decreased body weight, increased dystocia, increased vaginal post-partum bleeding, and increased dam mortality (EPA, 1998a).

The primary active ingredients in spinosad are spinosyn factor A and spinosyn factor D. All other substance in the formulated products of spinosad are of lower toxicity. Spinosyns are relatively inert and their metabolism in rats results in either parent compound or N- and O-demethylated glutathione conjugates as excretory products (EPA, 1998a). Studies have found that 95% of the spinosad residues in rats are eliminated within 24 hours.

The RRV selected for spinosad is 0.027 mg/kg/day for the general population and 0.27 mg/kg/day for occupational exposures (Table II-2). These values are based on a chronic feeding study in dogs. This study determined a NOEL to dogs of 2.68 mg/kg/day and a LOEL to dogs of 8.46 mg/kg/day based upon vacuolation in glandular cells (parathyroid) and lymphatic tissues, arteritis, and increases in serum enzymes(EPA, 1998a). The RRV values were determined by applying an uncertainty (safety) factor of 10 to the NOEL to account for inter-species variation for occupational exposures and by applying an uncertainty factor of 100 to the NOEL to account for inter-species and intra-species variation for general population exposures. There is no increased sensitivity of infants or children to spinosad over that of the general population, so it is unnecessary to apply an additional uncertainty factor of 10 for protection of this subgroup of the population.

TABLE II-2: Duration-Specific RRVs for Chemical Exposure

Chemical	Exposed Population	Acceptable Cumulative Daily Dermal and Oral Exposure (mg/kg/day)		
		Acute	Subchronic	Chronic
Spinosad	General	0.027	0.027	0.027
	Occupational	0.27	0.27	0.27

B. Non-Target Wildlife

Quantitative and qualitative risk assessments were performed for selected nontarget species exposed to spinosad as a result of APHIS fruit fly programs. This risk assessment does not address physical stressors associated with the programs or multiple exposures. There are no other compounds that have the same toxic mechanism of action as spinosad, so potential for synergism or potentiation of adverse effects is not anticipated. The risk is evaluated for each species from each chemical based on estimated exposure within the first 24 hours (terrestrial) or the first 96 hours (aquatic) after treatment or initial exposure. For purposes of this risk assessment, it was assumed that almost every species was exposed to the pesticide of concern, but the potential routes of exposure (dermal, oral, inhalation) were considered on a species basis. Pertinent data regarding the fate, transport, and persistence of spinosad are summarized in Chapter III.

APHIS used the Forest Service Cramer Barry Grim (FSCBG) model, the Groundwater Loading Effects of Agricultural Management Systems (GLEAMS) model, and also developed surface water models to estimate environmental concentrations of pesticides in soil and water (see

Appendix B in the Medfly risk assessment (APHIS, 1992)). Results of environmental fate modeling are presented in Chapter III and in Chapter 3 of the Medfly Nontarget Risk Assessment (APHIS, 1992).

APHIS developed exposure models for terrestrial and aquatic species and considered both a routine and extreme scenario. The model methodology, selected species, and scenario assumptions are presented in Chapter III and in Chapter 4 of the Medfly Nontarget Risk Assessment (APHIS, 1992). Further details are given in Appendix D of the Medfly document.

The results of the exposure analyses for each species and pesticide in each ecoregion are discussed in Chapter III and Chapter 5 of the Medfly Nontarget Risk Assessment (APHIS, 1992). Model input data are presented in Appendices E and F of the Medfly document.

The quantitative risk assessments performed for nontarget organisms and the characterization of that risk are presented in Chapter IV. Qualitative assessments were made for the use of lures and attractants. Risk assessment methods and calculations are discussed in detail in Appendices G through J of the Medfly Nontarget Risk Assessment (APHIS, 1992). It is important to bear in mind that estimated risks are to populations of nontarget organisms that actually come into contact with the chemicals used in fruit fly programs. Therefore, the discussion centers on aerial bait spray applications because these applications of chemicals are anticipated to expose more nontarget species at a greater frequency than the other uses of chemicals in fruit fly programs.

Spinosad is of very slight acute oral toxicity to mammals. The acute oral median lethal dose of spinosad to rabbits and rats was determined to be greater than 5,000 mg/kg (Borth et al., 1996; Dow Agrosciences, 1998; EPA, 1998a). The acute median lethal dose of spinosyn A to rats was found to range from 3,783 to greater than 5,000 mg/kg (Thompson et al., 1995). The acute dietary median lethal concentration of spinosad was determined for an herbivore (vole, 6,120 ppm), a granivore (mouse, 23,100 ppm), and an insectivore (shrew, 3,400 ppm) (Borth et al., 1996). The acute dermal median lethal dose to rats is greater than 2,800 mg/kg. The acute inhalation median lethal concentration to rats is greater than 5.18 mg/L.

Spinosad is practically non-toxic to birds. The acute oral median lethal dose of spinosad was greater than 2,000 mg/kg for both bobwhite quail and mallard duck (Dow Agrosciences, 1998). The acute dietary median lethal concentration to various bird species are as follows: bobwhite quail = 5,253 ppm, mallard duck = 5,156 ppm, field sparrow = 5,970 ppm, mourning dove = 17,857 ppm, and blue titmouse = 6,670 ppm (Borth et al., 1996). Although no data were located about reptiles and amphibians, it is anticipated that the acute toxicity to those species should be similar to birds and is expected to also be very low.

Spinosad acts as a contact and stomach poison against insects and it is particularly effective against caterpillars (Lepidoptera) and all stages of flies (Diptera) (Adan et al., 1996). The symptoms of intoxication are unique and are typified by initial flaccid paralysis followed by weak tremors and continuous movement of crochets and mandibles (Thompson et al., 1995). The effects occur rapidly and there is little to no recovery.

The mode of toxic action of this compound against insects has been shown to relate to the widespread excitation of isolated neurons in the central nervous system (Salgado et al., 1997). This is caused by persistent activation of nicotinic acetylcholine receptors and prolongation of acetylcholine responses. This prolonged response leads to involuntary muscle contractions and tremors. This mode of toxic action is unique to spinosad. Therefore, no known cross-resistance to other insecticides is anticipated. Under certain conditions, spinosyns have also had effects on gamma-aminobutyric acid receptors, but the contribution of these effects to symptoms have not yet been elucidated.

The toxicity of spinosad to invertebrates is dependent upon the species. The median lethal dose of spinosad to Lepidoptera (butterflies and moths) ranges from 0.022 mg/kg (very highly toxic) for the native budworm to 19 mg/kg (slightly toxic) for cotton leafworm (Sparks et al., 1995; Thompson et al., 1995). The median lethal dose to house flies is 0.9 mg/kg. The median lethal dose to yellow fever mosquitoes is 0.1 mg/kg. Ants such as the Argentine ant (LD_{50} = 185.6 mg/kg) are very tolerant of spinosad. Other Hymenoptera such as honey bees (LD_{50} = 11.5 mg/kg) and the red headed pine sawfly (LD_{50} = 2.8 mg/kg) are more sensitive (Borth et al., 1996; Thompson et al., 1995). Spinosad is slightly toxic to parasitic wasps such as *Encarsia formosa* (LD_{50} = 29.1 mg/kg). Beetles are quite tolerant of spinosad (LD_{50} ranges from 25 to greater than 200 mg/kg) as are cat fleas (LD_{50} = 120 mg/kg), green lacewings (LD_{50} > 200 mg/kg), minute pirate bugs (LD_{50} = 200 mg/kg), and German cockroaches (LD_{50} = 367 mg/kg). Onion thrips are highly susceptible to spinosad (LD_{50} = 0.11 mg/kg). Although spinosad is moderately toxic to the 2-spotted spider mite (LD_{50} = 2.1 mg/kg), it is practically nontoxic to the mite, *Phytoseiulus persimilis* (LD_{50} > 200 mg/kg). Beneficial arthropods observed to not be affected by spinosad in treated cotton fields include trichogrammatid wasps, minute pirate bugs, assassin bugs, ladybird beetles, predatory mites, fire ants, big-headed bugs, damsel bugs, green lacewings, and spiders (Peterson et al., 1996). Another field study found no adverse effects from spinosad on populations of predators, some decreases in parasitic Hymenoptera populations, and some pest species (plant bugs, cotton aphids, and spur-throated grasshoppers), but it was effective against Lepidoptera caterpillars (Murray and Lloyd, 1997).

Spinosad is slightly to moderately toxic to fish. The 96 hour median lethal concentration of spinosad determined for fish are as follows: bluegill = 5.9 mg/L, rainbow trout = 30 mg/L, carp = 5 mg/L, and sheepshead minnow = 7.9 mg/L (Borth et al., 1996). A 21 day median lethal concentration of spinosad was determined for rainbow trout to be 4.8 mg/L.

Spinosad is slightly to moderately toxic to most aquatic invertebrates. The median lethal concentration of spinosad to daphnia was determined to be 92.7 mg/L (Borth et al., 1996). Grass shrimp were more sensitive and had a 96 hour median lethal concentration for spinosad of 9.76 mg/L (Dow Agrosciences, 1998). Spinosad was found to be highly toxic to marine molluscs with a median lethal concentration of spinosad at 0.295 mg/L for eastern oyster.

Spinosad is of slight to moderate acute toxicity to algae. The median lethal concentration of spinosad was determined to be 106 mg/L for green algae and 8.09 mg/L for blue green algae (Borth et al., 1996).

C. Environmental Quality

The hazards of spinosad to environmental quality are minimal. This is largely related to environmental fate factors discussed in greater detail in the third chapter of this risk assessment. Spinosad persists for a few hours in air or water. The compound binds readily to organic matter in soil and water. This binding in soil prevents leaching to groundwater. There is also strong adsorption of spinosad to the organic matter on leaf surfaces. The photodegradation of spinosad residues occurs readily on plants and tolerances on crops are not of great concern to EPA (EPA, 1998a). The rapid breakdown and lack of movement in the environment ensure that no permanent effects can be anticipated to the quality of air, soil, and water. No adverse effects to ambient air quality standards or water quality standards would be expected for these applications.

III. Environmental Fate and Exposure Analysis

This chapter discusses estimated environmental concentrations and exposures of spinosad from bait spray applications in APHIS fruit fly programs.

The input data for the GLEAMS model for all ecoregions except the Marine Pacific Forest was presented in the Medfly Nontarget Risk Assessment (APHIS, 1992). The input parameters used in the GLEAMS model for estimating concentrations of pesticides in soil, runoff water, and groundwater in the Marine Pacific Forest Ecoregion are presented in Table III-1. The representative soil series chosen for the fruit-growing areas of Washington State was Burch loam, which has traditionally been the most productive soil series for fruit production in the region.

Table III-1. Site-Specific Hydrology and Erosion Parameters for the GLEAMS Model for the Marine Pacific Forest Ecoregion - Burch Loam at Wenatchee, WA site

Parameter	Site Model Data
Typical Soil	Loam
HYDROLOGY DATA	
Hydrological Group	B
Saturated Conductivity	0.20
Evaporation Parameter	4.5
SCS Curve no.	61
Hydraulic Slope	0.08
Soil Porosity	0.40
Field Capacity	0.26
Wilting Point	0.11
Organic Matter (%)	1
EROSION DATA	
Surface Clay	0.20
Surface Silt	0.35
Surface Sand	0.45
Clay Surface	20
Organic Matter Surface Area	1,000

Flow Profile Slope	0.02
Soil Erosion Factor	0.398
Contouring Factor	0.6

Table III-2 presents selected chemical and physical properties of spinosad used in some of the environmental fate, exposure, and risk analyses. Spinosad consists of several metabolites or factors that account for the toxic action. In particular, spinosyn factors A and D are of primary concern. The log octanol-water coefficient (log K_{ow}) at pH 7 for spinosyn A is 3.9 and for spinosyn D is 4.4. Although its value may differ slightly from formulations of spinosad, it should have similar chemical properties. Other physical and chemical properties are summarized in appendix 1.

TABLE III-2: Chemical-Specific Data Used for Toxicological Assessments[a]						
Chemical	Molecular Weight	Log K_{ow}	Log K_p	K_p (cm/hour)	Density (g/cc)	Water Solubility (mg/L)
spinosyn A	732	3.9	-4.0	0.0001	applied product = 1.09	235
spinosyn D	746	4.4	-4.5	0.00003		0.332

[a]Data taken from appendix 2, unless otherwise specified
K_{ow} = Octanol-water partition coefficient; K_p = permeability coefficient

Table III-3 briefly summarizes the output from the GLEAMS modeling by presenting the highest concentrations of spinosad in surface soil and interstitial soil water for a 2-year storm at each of the seven potential program sites.

TABLE III-3: Summary of GLEAMS Modeling for Maximum Levels of Spinosad in the Upper 1 cm of Soil (µg/g) and Interstitial Soil Water (µg/L)	
Media	Site

	Browns-ville	Gulfport	Los Angeles	Miami	Orlando	Santa Clara	Chelan County
Soil	0.0006	0.0005	0.0005	0.0006	0.0006	0.0004	0.0005
Water	0.0370	0.0466	0.0247	0.0247	0.0055	0.0028	0.0316

A. Fate of Spinosad

1. Air

Sunlight exposure to spinosad is expected to result in rapid photodegradation. This rapid breakdown of the parent compounds in sunlight indicates that residues will not persist in the atmosphere. Spinosad insecticide has low vapor pressure (not volatile) and any drift from aerial applications would be expected to readily deposit on surfaces of leaves or soil.

2. Soil

The photolysis half-life in soil is 8.68 days for spinosyn A and 9.44 days for spinosyn D (Dow Agrosciences, 1998). The aerobic soil half-life of both spinosyn Factors is 14.5 days. The rapid degradation in sunlight is anticipated to result in no persistence when residues are deposited on the soil surface from applications. The residues in the bait could persist longer (protected from sunlight), but degradation would be rapid when exposed to precipitation and weathering. Although spinosyn A is highly water soluble, it has a high octanol/water partition coefficient that results in strong adsorption to organic matter (Borth et al., 1996). Spinosyns A and D are immobile in soil and will not leach into groundwater (EPA, 1998). The half-lives in pre-sterilized soils were substantially longer than in unsterilized soils and the degradation in soils has been largely attributed to microbial action (Hale and Portwood, 1996).

The concentration of spinosad in soil after a large regional storm (2-year storm) following aerial bait spray application is shown for each of the seven ecoregions in Table III-4.

Table III-4A: Estimated Concentration of Spinosad in Soil (μg/g)		
Ecoregion 1 - California Central Valley and Coastal		
Chemical	**Soil Depth**	Occurrence of Simulated Storm Event (Post Application)

		0 Hours	24 Hours	48 Hours	72 Hours
Spinosad	0-1	0.0004	0.0001	0.0000	0.0000
	1-10	0.0000	0.0000	0.0000	0.0000
	10-20	0.0000	0.0000	0.0000	0.0000
	20-30	0.0000	0.0000	0.0000	0.0000

Table III-4B: Estimated Concentration of Spinosad in Soil (μg/g)

Ecoregion 2 - Basin and Range

Chemical	**Soil Depth**	Occurrence of Simulated Storm Event (Post Application)			
		0 Hours	24 Hours	48 Hours	72 Hours
Spinosad	0-1	0.0005	0.0002	0.0001	0.0000
	1-10	0.0000	0.0000	0.0000	0.0000
	10-20	0.0000	0.0000	0.0000	0.0003
	20-30	0.0000	0.0000	0.0000	0.0000

Table III-4C: Estimated Concentration of Spinosad in Soil (μg/g)

Ecoregion 3 - Lower Rio Grande Valley

Chemical	**Soil Depth**	Occurrence of Simulated Storm Event (Post Application)			
		0 Hours	24 Hours	48 Hours	72 Hours
Spinosad	0-1	0.0006	0.0003	0.0001	0.0000
	1-10	0.0000	0.0000	0.0000	0.0000
	10-20	0.0000	0.0000	0.0000	0.0000
	20-30	0.0000	0.0000	0.0000	0.0000

Table III-4D: Estimated Concentration of Spinosad in Soil (μg/g)

Ecoregion 4 - Southeastern and Gulf Coastal Plain

Chemical	Soil Depth	Occurrence of Simulated Storm Event (Post Application)			
		0 Hours	24 Hours	48 Hours	72 Hours
Spinosad	0-1	0.0006	0.0004	0.0001	0.0000
	1-10	0.0000	0.0000	0.0000	0.0000
	10-20	0.0000	0.0000	0.0000	0.0000
	20-30	0.0000	0.0000	0.0000	0.0000

Table III-4E: Estimated Concentration of Spinosad in Soil (μg/g)					
Ecoregion 5 - Mississippi Delta					
Chemical	**Soil Depth**	Occurrence of Simulated Storm Event (Post Application)			
		0 Hours	24 Hours	48 Hours	72 Hours
Spinosad	0-1	0.0005	0.0003	0.0001	0.0000
	1-10	0.0000	0.0000	0.0000	0.0000
	10-20	0.0000	0.0000	0.0000	0.0000
	20-30	0.0000	0.0000	0.0000	0.0000

Table III-4F: Estimated Concentration of Spinosad in Soil (μg/g)					
Ecoregion 6 - Floridian					
Chemical	**Soil Depth**	Occurrence of Simulated Storm Event (Post Application)			
		0 Hours	24 Hours	48 Hours	72 Hours
Spinosad	0-1	0.0006	0.0004	0.0001	0.0000
	1-10	0.0000	0.0000	0.0000	0.0000
	10-20	0.0000	0.0000	0.0000	0.0000
	20-30	0.0000	0.0000	0.0000	0.0000

Table III-4G: Estimated Concentration of Spinosad in Soil (μg/g)

Ecoregion 7 - Marine Pacific Forest					
Chemical	**Soil Depth**	Occurrence of Simulated Storm Event (Post Application)			
		0 Hours	24 Hours	48 Hours	72 Hours
Spinosad	0-1	0.0005	0.0002	0.0001	0.0000
	1-10	0.0000	0.0000	0.0000	0.0000
	10-20	0.0000	0.0000	0.0000	0.0000
	20-30	0.0000	0.0000	0.0000	0.0000

3. Water

Although spinosad is not applied directly to water bodies, there is potential runoff and drift of insecticidal particles. The rapid photolysis in water results in a half-life less than a day (Borth et al., 1996). Spinosyn A is water soluble (235 ppm at pH 7), but spinosyn D is of low water solubility (0.332 ppm at pH 7). The octanol/water partition coefficient for both spinosyns is high, which indicates that both compounds will adhere readily to organic matter and not remain suspended in the water.

The estimated concentration of spinosad in runoff water from non-paved areas within the watershed and the amount of runoff produced after a large regional storm (2-year storm) following an aerial bait spray application are shown in Table III-5 for the seven ecoregions.

Table III-5: Concentration of Spinosad in Runoff Water (Estimated by GLEAMS) by Ecoregion

Amount or Concentration of Chemical	24 Hours	48 Hours	72 Hours
Floridian			
2-year storm (cm)	10.16	10.16	10.16
Amount of runoff (cm)	0.27	0.19	0.19
Spinosad (μg/L)	0.0247	0.0132	0.0084
Mississippi Delta			
2-year storm (cm)	10.67	10.67	10.67
Amount of runoff (cm)	1.06	0.57	0.38
Spinosad (μg/L)	0.0466	0.0237	0.0181

Southeastern/Gulf Coastal Plains			
2-year storm (cm)	10.67	10.67	10.67
Amount of runoff (cm)	0.00	0.00	0.00
Spinosad (μg/L)	0.0000	0.0000	0.0000
Lower Rio Grande Valley			
2-year storm (cm)	8.13	8.13	8.13
Amount of runoff (cm)	0.00	0.00	0.00
Spinosad (μg/L)	0.0000	0.0000	0.0000
Basin and Range			
2-year storm (cm)	5.08	5.08	5.08
Amount of runoff (cm)	0.00	0.00	0.00
Spinosad (μg/L)	0.0000	0.0000	0.0000
California Central Valley and Coastal			
2-year storm (cm)	5.08	5.08	5.08
Amount of runoff (cm)	0.00	0.00	0.00
Spinosad (μg/L)	0.0000	0.0000	0.0000
Marine Pacific Forest			
2-year storm (cm)	5.08	5.08	5.08
Amount of runoff (cm)	0.00	0.00	0.00
Spinosad (μg/L)	0.0000	0.0000	0.0000

Estimated average daily concentrations of spinosad in water from direct aerial bait spray applications and runoff for all seven ecoregions are presented in table III-6. This information is used to determine the routine and extreme concentrations used in nontarget aquatic species exposure scenarios and the drinking water concentrations applied to nontarget terrestrial species.

Table III-6-A: Estimated Average Daily Spinosad Concentration (μg/L) From Direct Aerial Spray and Runoff into Water Bodies					
Ecoregion 1 - California Central Valley and Coastal					
Water Body Depth	**Time (hours)**				
	0	24	48	72	96
30.5 cm (1 ft)	0.102	0.068	0.045	0.030	0.020
1 m	0.031	0.021	0.014	0.009	0.006
2 m	0.016	0.010	0.007	0.005	0.003

Storm 24 hours after application	0	24	48	72	96
GLEAMS Runoff	0.00	0.00	0.00	0.00	0.00
2 m Lake	0.016	0.044	0.030	0.020	0.013
0.76 m Stream	0.041	0.070	0.046	0.031	0.020

Storm 72 hours after application	0	24	48	72	96
GLEAMS Runoff	0.00	0.00	0.00	0.00	0.00
2 m Lake	0.016	0.010	0.007	0.016	0.010
0.76 m Stream	0.041	0.000	0.000	0.045	0.030

Table III-6-B: Estimated Average Daily Spinosad Concentration (μg/L) From Direct Aerial Spray and Runoff into Water Bodies					
Ecoregion 2 - Basin and Range					
Water Body Depth	**Time (hours)**				
	0	24	48	72	96
30.5 cm (1 ft)	0.102	0.095	0.087	0.080	0.074
1 m	0.031	0.029	0.027	0.024	0.022
2 m	0.016	0.014	0.013	0.012	0.011

Storm 24 hours after application	0	24	48	72	96
GLEAMS Runoff	0.0000	0.0000	0.0000	0.0000	0.0000
2 m Lake	0.016	0.048	0.044	0.040	0.037
0.76 m Stream	0.041	0.067	0.062	0.057	0.052

Storm 72 hours after application	0	24	48	72	96
GLEAMS Runoff	0.0000	0.0000	0.0000	0.0000	0.0000
2 m Lake	0.016	0.014	0.013	0.035	0.032
0.76 m Stream	0.041	0.0000	0.0000	0.063	0.058

Table III-6-C: Estimated Average Daily Spinosad Concentration (μg/L) From Direct Aerial Spray and Runoff into Water Bodies					
Ecoregion 3 - Lower Rio Grande Valley					
Water Body Depth	**Time (hours)**				
	0	24	48	72	96
30.5 cm (1 ft)	0.102	0.066	0.042	0.027	0.017
1 m	0.031	0.020	0.013	0.008	0.005
2 m	0.016	0.010	0.006	0.004	0.003

Storm 24 hours after application	0	24	48	72	96
GLEAMS Runoff	0.0000	0.0000	0.0000	0.0000	0.0000
2 m Lake	0.016	0.050	0.032	0.021	0.013
0.76 m Stream	0.041	0.088	0.056	0.036	0.023

Storm 72 hours after application	0	24	48	72	96
GLEAMS Runoff	0.0000	0.0000	0.0000	0.0000	0.0000
2 m Lake	0.016	0.010	0.006	0.019	0.012
0.76 m Stream	0.041	0.0000	0.0000	0.063	0.040

Table III-6-D: Estimated Average Daily Spinosad Concentration (μg/L) From Direct Aerial Spray and Runoff into Water Bodies					
Ecoregion 4 - Southeastern and Gulf Coastal Plain					
Water Body Depth	**Time (hours)**				
	0	24	48	72	96
30.5 cm (1 ft)	0.102	0.095	0.087	0.080	0.074
1 m	0.031	0.029	0.027	0.024	0.022
2 m	0.016	0.014	0.013	0.012	0.011

Storm 24 hours after application	0	24	48	72	96
GLEAMS Runoff	0.0000	0.0000	0.0000	0.0000	0.0000
2 m Lake	0.016	0.043	0.040	0.037	0.034
0.76 m Stream	0.041	0.060	0.056	0.051	0.047

Storm 48 hours after application	0	24	48	72	96
GLEAMS Runoff	0.0000	0.0000	0.0000	0.0000	0.0000
2 m Lake	0.016	0.014	0.034	0.032	0.029
0.76 m Stream	0.041	0.0000	0.052	0.048	0.044

Table III-6-E: Estimated Average Daily Spinosad Concentration (μg/L) From Direct Aerial Spray and Runoff into Water Bodies

Ecoregion 5 - Mississippi Delta					
Water Body Depth	Time (hours)				
	0	24	48	72	96
30.5 cm (1 ft)	0.102	0.092	0.082	0.073	0.065
1 m	0.031	0.028	0.025	0.022	0.020
2 m	0.016	0.014	0.012	0.011	0.010

Storm 24 hours after application	0	24	48	72	96
GLEAMS Runoff	0.0000	0.037	0.0000	0.0000	0.0000
2 m Lake	0.016	0.053	0.047	0.042	0.033
0.76 m Stream	0.041	0.072	0.064	0.057	0.051

Storm 48 hours after application	0	24	48	72	96
GLEAMS Runoff	0.0000	0.0000	0.033	0.0000	0.0000
2 m Lake	0.016	0.014	0.041	0.037	0.033
0.76 m Stream	0.041	0.0000	0.062	0.055	0.049

Table III-6-F: Estimated Average Daily Spinosad Concentration (μg/L) From Direct Aerial Spray and Runoff into Water Bodies

Ecoregion 6 - Floridian

Water Body Depth	**Time (hours)**				
	0	24	48	72	96
30.5 cm (1 ft)	0.102	0.093	0.083	0.075	0.068
1 m	0.031	0.028	0.025	0.023	0.021
2 m	0.016	0.014	0.013	0.011	0.010

Storm 24 hours after application	0	24	48	72	96
GLEAMS Runoff	0.0000	0.046	0.0000	0.0000	0.0000
2 m Lake	0.016	0.053	0.048	0.043	0.039
0.76 m Stream	0.041	0.072	0.065	0.059	0.053

Storm 48 hours after application	0	24	48	72	96
GLEAMS Runoff	0.0000	0.0000	0.037	0.0000	0.0000
2 m Lake	0.016	0.014	0.041	0.037	0.033
0.76 m Stream	0.041	0.0000	0.062	0.055	0.050

Table III-6-G: Estimated Average Daily Spinosad Concentration (μg/L) From Direct Aerial Spray and Runoff into Water Bodies					
Ecoregion 7 - Marine Pacific Forest					
Water Body Depth	**Time (hours)**				
	0	24	48	72	96
30.5 cm (1 ft)	0.102	0.081	0.066	0.055	0.047
1 m	0.031	0.025	0.020	0.017	0.014
2 m	0.016	0.012	0.010	0.008	0.007

Storm 24 hours after application	0	24	48	72	96
GLEAMS Runoff	0.0000	0.0000	0.0000	0.0000	0.0000
2 m Lake	0.016	0.046	0.037	0.031	0.025
0.76 m Stream	0.041	0.069	0.054	0.044	0.036

Storm 72 hours after application	0	24	48	72	96
GLEAMS Runoff	0.0000	0.0000	0.0000	0.0000	0.0000
2 m Lake	0.016	0.012	0.010	0.025	0.021
0.76 m Stream	0.041	0.0000	0.0000	0.054	0.044

4. Plants

The rapid photodegradation of spinosad is expected to result in no persistence on leaf surfaces. The half-life on cotton was determined to be 3.4 hours. Any washoff or weathering from leaves is also anticipated to readily degrade. The degradation products are of no greater concern than the parent compounds, spinosyn A and spinosyn D (EPA, 1998). The low residues on plants are expected to become readily incorporated into the general carbon pool.

5. Humans and Animals

A study analyzed the metabolism by rats (EPA, 1998). There was 95% elimination of the residues of spinosad within 24 hours. Metabolism was minimal and the parent compounds were excreted either unchanged or as N- and O-demethylated glutathione conjugates. The metabolism resulted in compounds of comparable or lower toxicity than the parent compounds. Elimination of residues occurred through urine (34%), bile (36%), and tissues and carcass (21%). The rapid excretion of this compound in mammals accounts for the low acute toxicity. Bioconcentration potential is low. Bioconcentration factors in rainbow trout were determined to be 19 for sinosyn A and 33 for spinosyn D (Dow Agrosciences, 1998).

B. Potential Exposure

The potential exposure depends primarily on the method of application, time of application, and the rate of application. The current insecticide application rate being considered involves analysis of applications of bait spray using Spinosad as the toxicant to fruit flies. The tentative plan for the trials is to apply per acre a mixture of 48 fluid ounces of 0.008% spinosad, 28% sugars and attractants diluted in water. This amounts to 0.00028 pounds a.i. of spinosad per acre.

This risk assessment handles exposure assessment like that which would be expected from a regular operational treatment that could be applied over urban neighborhoods. This provides information about exposure and risk for an operational program if the present trial tests of spinosad should prove successful and if it is determined that the methods are to be used in the Medfly Cooperative Eradication Program or other eradication programs of fruit flies. The exposure assessment considers both aerial and ground applications of Spinosad bait spray.

The human exposure scenarios considered in this risk assessment include three general types (routine, extreme, accidental) and two specific types (pica and a toddler in a swimming pool). Routine exposure scenarios assume that the recommended application rates are used and that recommended safety precautions are followed. Furthermore, routine exposures are based on the most likely estimates of modeling parameters such as food or water consumption rates and values for skin surface exposure. Extreme exposure scenarios assume that recommended procedures and precautions are not followed and use more conservative, but still plausible, modeling parameters that increase the estimate of exposure. Accidental exposure scenarios assume some form of equipment failure or gross human error. Although accidental exposures are worst case scenarios within the context of the risk assessment, they are designed, nonetheless, to represent realistic, not catastrophic, events. A catastrophic event, such as the crash of a full airplane (although plausible), by definition requires emergency action rather than risk assessment. Pica refers to the tendency of individuals to consume unnatural food. The soil consumption scenario for pica behavior considers the toddler who ingests 10 grams of soil per day (chemical concentration in consumed soil at upper limit). The swimming pool scenario considers both the potential oral and dermal exposure of a toddler over a 4-hour daily swimming time. These scenarios are designed to cover those realistic situations that could be expected to occur if an eradication program were undertaken with spinosad bait spray.

Exposure to Spinosad bait spray involves simultaneous exposure to insecticide and bait in the formulation. Since the basic mode of toxic action of both chemicals is considered to be different and the hazards from the bait are minimal, the hazards from human exposures consider only the level of the exposure to spinosad relative to the RRV(s) for that compound. If exposure is much less than the RRV, then the risk can be considered minimal. The hazards from nontarget species exposures consider only the level of the exposure to spinosad relative to the LD_{50} for terrestrial species or the LC_{50} for aquatic species.

1. Human Occupational Exposure

The potential human occupational exposures to spinosad were determined for pilots, backpack applicators, hydraulic rig applicators, mixers/loaders, and ground personnel. The ground personnel include kytoon handlers, flaggers, and quality control crew. Calculations of exposure were done using the methods developed in the Human Health Risk Assessment, APHIS Fruit Fly Programs (SERA, 1992). The results of occupational exposure calculations for spinosad are presented in Table III-7. The highest potential occupational exposure was determined to be to the ground personnel. Routine exposures to ground personnel were calculated to be 1.1×10^{-3} mg spinosad/kg/day. Extreme scenario exposures to ground personnel were calculated to be 3.0×10^{-3} mg spinosad/kg/day.

Table III-7. Occupational Exposures to Spinosad

Group	Exposure Scenario	Dose (mg/kg/day)
Pilots	Routine	5.11×10^{-7}
	Extreme	4.68×10^{-6}
Backpack applicators	Routine	1.8×10^{-6}
	Extreme	4.5×10^{-6}
Hydraulic rig applicators	Routine	9.0×10^{-7}
	Extreme	3.4×10^{-6}
Mixers/loaders	Routine	1.1×10^{-6}
	Extreme	7.3×10^{-6}

Group	Exposure Scenario	Dose (mg/kg/day)
Ground personnel	Routine	1.1×10^{-3}
	Extreme	3.0×10^{-3}

2. General Public

The potential general public exposures to spinosad were determined for scenarios involving soil consumption, consumption of contaminated water, swimming pool exposure, consumption of contaminated vegetation, and contact with contaminated vegetation. Calculations of exposure were done using the methods developed in the Human Health Risk Assessment APHIS Fruit Fly Programs (SERA, 1992). The results of general public exposure calculations for spinosad are presented in Table III-8. This risk assessment concerns bait spray applications of spinosad only. The likelihood of public exposure to spinosad from these applications is high, particularly if aerial applications are required in residential areas. The highest potential general public exposure was determined to be for the exposure scenario of a child consuming contaminated runoff water. This had a potential exposure of 1.18×10^{-5} mg spinosad/kg/day.

Table III-8. General Population Exposures to Spinosad

Group	Exposure Scenario	Dose (mg/kg/day)
Soil consumption	Routine	1.0×10^{-8}
	Extreme	1.5×10^{-8}
	Pica	6.0×10^{-7}
Consumption of contaminated water	Runoff water	1.18×10^{-5}
	Surface water	4.9×10^{-7}
Swimming pool exposure	4 hours (toddler)	2.01×10^{-9}
Consumption of contaminated vegetation	Routine (adult)	7.66×10^{-7}
	Extreme (adult)	3.96×10^{-6}
Contact with contaminated vegetation	Routine (adult)	4.3×10^{-7}
	Extreme (adult)	1.0×10^{-6}

3. Wildlife

This chapter presents the results of the exposure analysis of specific nontarget organisms to spinosad concentrations in the environment as a result of Fruit Fly program activities. The estimated doses are based on the environmental concentrations presented in the fate section of chapter III and the exposure models and scenarios. The dose calculations for the seven ecoregions where fruit flies could occur are described in detail in Appendix E of the Medfly Nontarget Risk Assessment (APHIS, 1992). The estimated routine and extreme exposures from spinosad aerial bait spray applications in aquatic habitats are given in Table III-9.

The potential fruit fly program area consists of portions of 48 states. It is not feasible to include all species which could be exposed to pesticides used in the program activities or all ecological regions of the country. The selection of the seven ecoregions was based upon likelihood of future programs. Species at different trophic levels which are representative of the various habitats in these seven ecoregions were considered. As detailed in Appendix C of the Medfly Nontarget Risk Assessment (APHIS, 1992), a variety of organisms were used to encompass a broad range of dietary patterns, habitats, and behavior. For this risk assessment, the selection of common species that inhabit or are likely to inhabit the potential fruit fly program areas includes 18 mammals, 31 birds, 15 reptiles, 9 amphibians, 17 fish, and 34 invertebrates. Qualitative assessments involving terrestrial and aquatic plants are made whenever sufficient data are available.

For this risk assessment, a multiple-pathway terrestrial model and an aquatic exposure model developed for the Medfly Nontarget Risk Assessment (APHIS, 1992) were used. The multiple-pathway model is used to estimate exposure levels for terrestrial organisms through oral, dermal, and inhalation routes. This model provides an estimate of total does to nontarget terrestrial species and attempts to quantify numerous direct and indirect routes of exposure. Parameters estimated as model inputs were conservative. The use of a conservative estimate increases the likelihood that error will be false positive rather than false negative. Although the models are useful for predicting which species may be potentially at risk, they do not predict which species will definitely be at risk from program treatments. The U.S. EPA developed a simpler and somewhat less conservative model to estimate dose (Urban and Cook, 1986). This model is used to provide a second estimate of exposure levels for bait spray applications. For aquatic species, exposure was assumed to be completely characterized by the ambient concentrations of pesticides in the water.

The selection of species for analysis in this risk assessment was based on several criteria. All vertebrate and invertebrate classes are represented by aquatic and terrestrial species. The criteria include the different life stages for some species, species with different body sizes and food requirements, and species from different trophic levels. The range of species analyzed in this risk assessment is intended to be representative of the range of species present in each ecoregion. Consequently, estimates of potential risk for a particular species may be extrapolated to other species of common habitat, behavior, and physiology. The exposure assumptions and the species selected for the seven ecoregions where fruit flies could occur are described in detail in the

Medfly Nontarget Risk Assessment (APHIS, 1992) and the Fruit Fly Nontarget Risk Assessment APHIS, 1998).

Table III-9: Estimated Routine and Extreme Exposure Scenarios Regarding Spinosad Concentrations in Aquatic Habitats After Aerial Application (μg/L)

Aquatic Habitat	Exposure Scenario	Ecoregion						
		1	2	3	4	5	6	7
Stream	routine	0.030	0.041	0.040	0.041	0.041	0.041	0.041
	extreme	0.070	0.067	0.088	0.060	0.072	0.072	0.069
Lake	routine	0.013	0.037	0.013	0.034	0.033	0.039	0.025
	extreme	0.044	0.048	0.050	0.043	0.053	0.053	0.046
Pond	routine	0.006	0.022	0.005	0.022	0.020	0.021	0.014
	extreme	0.031	0.031	0.031	0.031	0.031	0.031	0.031
Wetland	routine	0.020	0.074	0.017	0.074	0.065	0.068	0.047
	extreme	0.102	0.102	0.102	0.102	0.102	0.102	0.102

Exposures of aquatic species to spinosad from bait spray applications are expected to be very low. The water solubility of spinosyn A assures rapid mixing in the water, but all residues will readily adsorb to organic matter and the rapid degradation of spinosad assures that only short durations of exposure (not expected to be more than several hours) are possible for given treatments. Applying the minimum depth (0.3 m) considered in analyses of bodies of water in the Nontarget Risk Assessment for the Medfly Cooperative Eradication Program (USDA, APHIS, 1992) to spinosad bait spray applications, a direct application would only result in water concentrations of 9.3×10^{-5} mg spinosad per liter. Spinosad does not bioaccumulate or bioconcentrate and the doses taken up by aquatic organisms from this low water concentration will be very low.

Dose estimates for nontarget terrestrial organisms in all ecoregions for spinosad bait spray applications are presented in Tables III-10 to III-14.

Table III-10A: Spinosad Dose Estimates for aerial bait spray applications (mg/kg) - Mammals						
Organism	Ecoregion 1		Ecoregion 2		Ecoregion 3	
	Routine	Extreme	Routine	Extreme	Routine	Extreme
Opossum	0.004	0.006	0.004	0.007	0.004	0.007
Desert Shrew	0.637	1.190	0.831	1.561	0.741	1.386
Least Shrew					0.741	1.386
E. Pipistrelle Bat					0.306	0.577
W. Pipistrelle Bat	0.264	0.497	0.349	0.657		
Desert Cottontail	0.013	0.016	0.014	0.018		
Eastern Cottontail					0.013	0.016
W.Grey Squirrel	0.024	0.044				
E. Grey Squirrel					0.028	0.051
Cotton Mouse						
White-footed Mouse					0.033	0.062
Deer Mouse	0.029	0.053	0.036	0.067		
Raccoon	0.022	0.037	0.027	0.047	0.024	0.042
Fox, Gray	0.010	0.018	0.013	0.024	0.011	0.021

Coyote/ Dog	0.003	0.005	0.003	0.006	0.003	0.005
Cat	0.008	0.015	0.010	0.018	0.009	0.017
Mule Deer	0.003	0.003	0.003	0.004		
White-tailed Deer					0.003	0.003

Table III-10B: Spinosad Dose Estimates for aerial bait spray applications (mg/kg) - Mammals

Organism	Ecoregion 4		Ecoregion 5		Ecoregion 6	
	Routine	Extreme	Routine	Extreme	Routine	Extreme
Opossum	0.003	0.006	0.004	0.007	0.004	0.007
Desert Shrew						
Least Shrew	0.521	0.968	0.396	0.733	0.459	0.856
E. Pipistrelle Bat	0.211	0.407	0.156	0.301	0.185	0.357
W. Pipistrelle Bat						
Desert Cottontail						
Eastern Cottontail	0.012	0.014	0.011	0.012	0.011	0.012
W.Grey Squirrel						
E. Grey Squirrel	0.019	0.035	0.014	0.026	0.017	0.031
Cotton Mouse	0.023	0.043	0.023	0.043	0.023	0.044

White-footed Mouse			0.024	0.045		
Deer Mouse						
Raccoon	0.018	0.030	0.014	0.023	0.016	0.027
Fox, Gray	0.008	0.014	0.007	0.011	0.007	0.013
Coyote/ Dog	0.002	0.003	0.002	0.003	0.002	0.003
Cat	0.006	0.012	0.004	0.010	0.005	0.010
Mule Deer						
White-tailed Deer	0.003	0.003	0.003	0.003	0.003	0.003

Table III-10C: Spinosad Dose Estimates for aerial bait spray applications (mg/kg) - Mammals

Organism	Ecoregion 7					
	Routine	Extreme				
Opossum	0.003	0.006				
Desert Shrew						
Least Shrew						
E. Pipistrelle Bat						
W. Pipistrelle Bat	0.211	0.407				
Desert Cottontail						

Eastern Cottontail						
W.Grey Squirrel	0.019	0.035				
E. Grey Squirrel						
Cotton Mouse						
White-footed Mouse						
Deer Mouse	0.023	0.043				
Raccoon	0.018	0.030				
Fox, Gray						
Coyote/ Dog	0.002	0.003				
Cat	0.006	0.012				
Mule Deer	0.003	0.003				
White-tailed Deer	0.003	0.003				

Table III-11A: Spinosad Dose Estimates for aerial bait spray applications (mg/kg) - Birds

Organism	Ecoregion 1		Ecoregion 2		Ecoregion 3	
	Routine	Extreme	Routine	Extreme	Routine	Extreme
Pied-billed Grebe	0.006	0.009	0.007	0.011	0.007	0.010
Great Blue Heron	0.004	0.006	0.005	0.008	0.004	0.007
Cattle Egret	0.026	0.046	0.034	0.061	0.030	0.054

Mottled Duck						
Mallard	0.005	0.010	0.006	0.013	0.006	0.012
Turkey Vulture	0.002	0.004	0.003	0.005	0.003	0.005
Red-tailed Hawk	0.008	0.015	0.010	0.019	0.009	0.017
American Kestrel	0.027	0.048	0.035	0.063		
Northern Bobwhite					0.033	0.060
Gambel's Quail			0.041	0.075		
California Quail	0.021	0.040				
Killdeer	0.077	0.141	0.101	0.187	0.089	0.164
Mourning Dove	0.019	0.036	0.025	0.047	0.022	0.041
Great Horned Owl (east/ central)						
male			0.005	0.008	0.004	0.007
female			0.005	0.008	0.004	0.007
Great Horned Owl (Pacific)						
male	0.004	0.007				
female	0.004	0.006				
Burrowing Owl	0.019	0.034	0.025	0.044	0.022	0.039
Lesser Nighthawk	0.073	0.134	0.096	0.178	0.084	0.156
Common Nighthawk					0.082	0.153

Ruby-throated Hummingbird						
Black-chinned Hummingbird	0.077	0.143	0.102	0.190	0.089	0.166
Anna's Hummingbird	0.074	0.137	0.097	0.181		
Belted Kingfisher	0.011	0.020	0.015	0.026		
Northern Flicker	0.057	0.105	0.074	0.138		
Western Kingbird	0.081	0.152	0.107	0.201	0.094	0.176
Eastern Kingbird						
American Robin	0.060	0.108	0.076	0.139	0.068	0.124
Northern Mockingbird	0.083	0.153	0.109	0.202	0.096	0.177
European Starling	0.063	0.112	0.081	0.147	0.072	0.130
Red-winged Blackbird	0.051	0.096	0.068	0.128	0.059	0.112
Eastern Meadowlark					0.093	0.171
Western Meadowlark	0.080	0.147	0.105	0.194		
House Sparrow	0.097	0.131	0.128	0.172	0.113	0.151

Table III-11B: Spinosad Dose Estimates for aerial bait spray applications (mg/kg) - Birds			
Organism	**Ecoregion 4**	**Ecoregion 5**	**Ecoregion 6**

	Routine	Extreme	Routine	Extreme	Routine	Extreme
Pied-billed Grebe	0.005	0.007	0.004	0.005	0.004	0.005
Great Blue Heron	0.003	0.004	0.002	0.003	0.002	0.004
Cattle Egret	0.020	0.035	0.015	0.026	0.017	0.030
Mottled Duck	0.003	0.009	0.002	0.006	0.002	0.007
Mallard						
Turkey Vulture	0.002	0.003	0.001	0.002	0.001	0.002
Red-tailed Hawk	0.005	0.010	0.004	0.006	0.004	0.008
American Kestrel	0.020	0.036	0.015	0.026	0.017	0.030
Northern Bobwhite	0.021	0.037	0.014	0.025	0.017	0.030
Gambel's Quail						
California Quail						
Killdeer	0.059	0.109	0.043	0.079	0.055	0.093
Mourning Dove	0.013	0.024	0.008	0.015	0.010	0.018
Great Horned Owl (east/ central)						
male	0.003	0.008	0.002	0.003	0.002	0.004
female	0.003	0.007	0.002	0.003	0.002	0.004
Great Horned Owl (Pacific)						
male						

female						
Burrowing Owl	0.015	0.026			0.013	0.022
Lesser Nighthawk						
Common Nighthawk	0.056	0.105	0.040	0.077	0.048	0.091
Ruby-throated Hummingbird	0.056	0.105	0.039	0.072	0.046	0.086
Black-chinned Hummingbird						
Anna's Hummingbird						
Belted Kingfisher	0.007	0.014	0.005	0.009	0.006	0.010
Northern Flicker	0.044	0081	0.032	0.058	0.038	0.069
Western Kingbird						
Eastern Kingbird	0.063	0.119	0.086	0.131	0.054	0.103
American Robin	0.047	0.083	0.036	0.062	0.040	0.071
Northern Mockingbird	0.083	0.153	0.046	0.083	0.054	0.099
European Starling	0.049	0.086	0.036	0.062	0.042	0.073
Red-winged Blackbird	0.038	0.071	0.026	0.049	0.031	0.059
Eastern Meadowlark	0.060	0.110	0.043	0.077	0.050	0.091

Western Meadowlark						
House Sparrow	0.074	0.145	0.053	0.067	0.063	0.079

Table III-11C: Spinosad Dose Estimates for aerial bait spray applications (mg/kg) - Birds

Organism	Ecoregion 7					
	Routine	Extreme				
Pied-billed Grebe	0.005	0.007				
Great Blue Heron	0.003	0.004				
Cattle Egret						
Mottled Duck						
Mallard						
Turkey Vulture						
Red-tailed Hawk	0.005	0.010				
American Kestrel	0.020	0.036				
Northern Bobwhite						
Gambel's Quail						
California Quail						
Killdeer	0.059	0.109				
Mourning Dove	0.013	0.024				

Great Horned Owl (east/ central)						
male	0.003	0.008				
female	0.003	0.007				
Great Horned Owl (Pacific)						
male						
female						
Burrowing Owl	0.015	0.026				
Lesser Nighthawk						
Common Nighthawk	0.056	0.105				
Ruby-throated Hummingbird						
Black-chinned Hummingbird	0.056	0.105				
Anna's Hummingbird	0.056	0.105				
Belted Kingfisher	0.007	0.014				
Northern Flicker	0.044	0.081				
Western Kingbird	0.063	0.119				
Eastern Kingbird						
American Robin	0.047	0.083				

Northern Mockingbird	0.083	0.153				
European Starling	0.049	0.086				
Red-winged Blackbird	0.038	0.071				
Eastern Meadowlark						
Western Meadowlark	0.060	0.110				
House Sparrow	0.074	0.145				

Table III-12A: Spinosad Dose Estimates for aerial bait spray applications (mg/kg) - Reptiles

Organism	**Ecoregion 1**		**Ecoregion 2**		**Ecoregion 3**	
	Routine	Extreme	Routine	Extreme	Routine	Extreme
Desert Iguana	0.023	0.035	0.024	0.037		
Side-blotched Lizard	0.113	0.207	0.137	0.251		
Carolina Anole					0.143	0.265
Eastern Fence Lizard					0.139	0.221
Western Fence Lizard	0.120	0.224	0.157	0.294		
Canyon Lizard					0.133	0.245

Gopher Snake	0.007	0.014	0.009	0.018	0.008	0.014
Garter Snake	0.003	0.049	0.036	0.063	0.028	0.056
Desert Tortoise	0.002	0.004	0.003	0.005		
Eastern Box Turtle						
Western Box Turtle			0.047	0.086	0.041	0.075
Hognose Snake			0.034	0.060	0.030	0.053

Table III-12B: Spinosad Dose Estimates for aerial bait spray applications (mg/kg) - Reptiles

Organism	Ecoregion 4		Ecoregion 5		Ecoregion 6	
	Routine	Extreme	Routine	Extreme	Routine	Extreme
Desert Iguana						
Side-blotched Lizard						
Carolina Anole	0.106	0.197	0.087	0.161	0.098	0.181
Eastern Fence Lizard	0.100	0.160	0.080	0.129	0.089	0.143
Western Fence Lizard						
Canyon Lizard						

Gopher Snake	0.005	0.141	0.007	0.187		
Garter Snake	0.020	0.039	0.015	0.029	0.017	0.034
Desert Tortoise						
Eastern Box Turtle	0.033	0.038	0.031	0.029	0.032	0.033
Western Box Turtle	0.029	0.053				
Hognose Snake	0.020	0.034	0.014	0.024	0.016	0.028

Table III-12C: Spinosad Dose Estimates for aerial bait spray applications (mg/kg) - Reptiles

Organism	**Ecoregion 7**					
	Routine	Extreme				
Desert Iguana						
Side-blotched Lizard	0.106	0.197				
Carolina Anole						
Eastern Fence Lizard						
Western Fence Lizard	0.100	0.160				
Canyon Lizard						

Gopher Snake	0.005	0.141				
Garter Snake	0.020	0.039				
Desert Tortoise						
Eastern Box Turtle						
Western Box Turtle						
Hognose Snake						

Table III-13A: Spinosad Dose Estimates for aerial bait spray applications (mg/kg) - Amphibians

Organism	Ecoregion 1		Ecoregion 2		Ecoregion 3	
	Routine	Extreme	Routine	Extreme	Routine	Extreme
Western Toad	0.191	0.356				
Woodhouse Toad			0.250	0.468		
Texas Toad					0.225	0.412
Southern Toad						
Pacific Treefrog	0.258	0.476	0.338	0.625		
Green Treefrog					0.295	0.546

Table III-13B: Spinosad Dose Estimates for aerial bait spray applications (mg/kg) - Amphibians

Organism	Ecoregion 4		Ecoregion 5		Ecoregion 6	
	Routine	Extreme	Routine	Extreme	Routine	Extreme
Western Toad						
Woodhouse Toad	0.158	0.292	0.117	0.217		
Texas Toad						
Southern Toad	0.161	0.298	0.119	0.221	0.140	0.261
Pacific Treefrog						
Green Treefrog	0.210	0.390	0.160	0.298	0.188	0.350

Table III-13C: Spinosad Dose Estimates for aerial bait spray applications (mg/kg) - Amphibians

Organism	Ecoregion 7					
	Routine	Extreme				
Western Toad	0.158	0.292				
Woodhouse Toad						
Texas Toad						
Southern Toad						
Pacific Treefrog	0.210	0.390				
Green Treefrog						

Table III-14A: Spinosad Dose Estimates for aerial bait spray applications (mg/kg) - Terrestrial Invertebrates

Organism	Ecoregion 1		Ecoregion 2		Ecoregion 3	
	Routine	Extreme	Routine	Extreme	Routine	Extreme
Earthworm	0.200	0.371	0.254	0.473	0.221	0.422
Slug	0.146	0.254	0.187	0.329	0.165	0.292
Sowbug	0.204	0.219	0.272	0.504	0.238	0.441
Spider, Orb Web	0.518	1.19	0.687	1.584	0.602	1.389
Mayfly, adult	0.245	0.441	0.327	0.588	0.286	0.515
Dragonfly, adult	0.281	0.521	0.370	0.687	0.325	0.604
Grasshopper	0.204	0.349	0.258	0.452	0.230	0.400
Lacewing, larva	1.205	2.247	1.599	2.984	1.402	2.615
Water Strider	0.263	0.518	0.345	0.682	0.304	0.600
Beetle, grub	0.235	0.503	0.307	0.660	0.271	0.582
Beetle, adult	0.524	0.943	0.666	1.179	0.601	1.087
Butterfly, Monarch	0.135	0.245	0.178	0.323	0.156	0.284
Moth, Geometer	0.209	0.382	0.277	0.507	0.156	0.445
Caterpillar	0.445	0.655	0.474	0.860	0.419	0.757
Maggot (larva)	0.298	0.641	0.396	0.854	0.347	0.747
Tachina, adult (parasitic fly)	0.349	0.644	0.464	0.856	0.405	0.750

Ant, Seed-eater	0.410	0.753	0.539	0.996	0.475	0.874
Honey Bee, Nectar forager	0.482	0.742	0.639	0.983	0.559	0.862
Parasitic Wasp	0.769	1.407	1.018	1.864	0.890	0.666

Table III-14B: Spinosad Dose Estimates for aerial bait spray applications (mg/kg) - Terrestrial Invertebrates.

Organism	Ecoregion 4		Ecoregion 5		Ecoregion 6	
	Routine	Extreme	Routine	Extreme	Routine	Extreme
Earthworm	0.157	0.268	0.120	0.192	0.133	0.217
Slug	0.124	0.214	0.099	0.166	0.113	0.194
Sowbug	0.176	0.331	0.135	0.257	0.162	0.307
Spider, Orb Web	0.367	0.870	0.244	0.595	0.290	7.037
Mayfly, adult	0.229	0.425	0.184	0.347	0.221	0.417
Dragonfly, adult	0.239	0.448	0.184	0.347	0.218	0.412
Grasshopper	0.174	0.295	0.139	0.230	0.159	0.268
Lacewing, larva	1.018	1.924	0.775	1.476	0.925	1.602
Water Strider	0.210	0.411	0.156	0.302	0.184	0.357
Beetle, grub	0.211	0.443	0.169	0.350	0.199	0.413
Beetle, adult	0.457	0.826	0.378	0.682	0.426	0.773
Butterfly, Monarch	0.118	0.214	0.092	0.168	0.108	0.199

Moth, Geometer	0.181	0.335	0.140	0.261	0.167	0.311
Caterpillar	0.305	0.547	0.236	0.417	0.275	0.492
Maggot (larva)	0.265	0.559	0.208	0.433	0.249	0.519
Tachina, adult (parasitic fly)	0.300	0.562	0.231	0.435	0.276	0.521
Ant, Seed-eater	0.339	0.624	0.257	0.471	0.303	0.560
Honey Bee, Nectar forager	0.328	0.501	0.211	0.320	0.250	0.380
Parasitic Wasp	0.666	1.231	0.516	0.958	0.613	1.143

Table III-14C: Spinosad Dose Estimates for aerial bait spray applications (mg/kg) - Terrestrial Invertebrates

Organism	Ecoregion 7					
	Routine	Extreme				
Earthworm	0.157	0.268				
Slug	0.124	0.214				
Sowbug						
Spider, Orb Web						
Mayfly, adult	0.229	0.425				
Dragonfly, adult	0.239	0.448				
Grasshopper	0.174	0.2395				

Lacewing, larva	1.018	1.924				
Water Strider	0.210	0.411				
Beetle, grub	0.211	0.443				
Beetle, adult	0.457	0.826				
Butterfly, Monarch	0.118	0.214				
Moth, Geometer	0.181	0.335				
Caterpillar	0.305	0.547				
Maggot (larva)	0.265	0.559				
Tachina, adult (parasitic fly)	0.300	0.562				
Ant, Seed-eater	0.339	0.624				
Honey Bee, Nectar forager	0.328	0.501				
Parasitic Wasp	0.666	1.231				

The potential exposures of terrestrial wildlife other than insect species to spinosad bait spray will be very low. Since the toxicity of these formulations to insects occurs primarily through ingestion and dermal contact, the exposure routes of most concern are oral and dermal. Oral exposure may occur through grooming of the body, but doses sufficient to induce toxic responses would occur primarily through feeding. There are several invertebrate species other than fruit flies that may be attracted and feed on the bait spray. In particular, the plant bugs (miridae), ground beetles (carabidae), midges and gnats (nematocerous Diptera), pomace flies, other acalypterate muscoid flies, ants (formicidae), and soil mites (Acari) are attracted to the protein hydrolysate in large numbers (Troetschler, 1983). These species are most likely to get high exposures to spinosad. Most terrestrial invertebrates are, however, not attracted to the bait or fructose in bait spray formulations. Use of spinosad bait spray makes the likelihood of non-target insect toxicity considerably less to a large number of insects than would be anticipated from use of malathion bait spray. Honey bees (CICP, 1988), lacewings (Hoy, 1982), springtails, aphids, whiteflies, tumbling flower beetles, calypterate muscoid flies, and spiders (Troetschler, 1983) are not attracted to the protein hydrolysate. Mortality to most of these species has been noted with malathion bait spray applications due to contact insecticidal activity. The exposures of these species by dermal exposures are likely to be lower as a result and the tolerance for spinosad is greater for most species except the flies, caterpillars, and honey bees. In particular, beetles, lacewings, ants, spiders, grasshoppers, roaches, true bugs, and adult Lepidoptera are less likely to be adversely affected when spinosad bait spray is applied.

IV. Risk Characterization

This chapter combines information on the exposure assessment from previous chapters with the available toxicity data to express a measure of potential effects to populations of exposed nontarget species. The methods applied to determine risk are the same as those used in the Medfly Nontarget Risk Assessment (APHIS, 1992).

A. Human Health

Characterization of risk requires that certain standards be set for determining whether an exposure will result in hazards to human health. For this risk assessment, we will refer to the maximum acceptable exposure that poses no evident risk to human health as the regulatory reference value (RRV). The RRV selected for spinosad for occupational exposures is 0.27 mg/kg/day and for general population exposures is 0.027 mg/kg/day. A safety factor of 10 was applied for occupational exposure to the NOEL to make allowance for inter-species variability between the test animal and humans. An additional safety factor of 10 was applied for general population exposure to make allowance for intra-species variability and the potential for wider ranges in sensitivity within the general population than the occupational population.

The risks to workers from potential exposure to spinosad in eradication programs are very low. The highest potential occupational exposure to spinosad occurred in the extreme exposure scenario for ground personnel. The exposure to spinosad in this scenario was 3.0×10^{-3} mg/kg/day. The RRV is approximately 100-fold greater than this exposure, so no adverse occupational effects can be expected from use of spinosad. No adverse effects to program workers can be expected when proper safety precautions are taken and proper application procedures are followed.

The risks to the general public from potential exposure to spinosad applied in the eradication programs are also very low. The highest potential exposure to spinosad occurs in the extreme scenario for a child consuming contaminated runoff water. The maximum potential exposure in this scenario to spinosad was 1.18×10^{-5} mg/kg/day. The RRV for spinosad is more than 1,000-fold greater than the exposures, so no adverse effects are anticipated to the general public, even under accidental exposure scenarios.

B. Wildlife

Ecological risk assessments, by definition, attempt to characterize effects on dynamic environments in which a great many species interact with complex and often not fully characterized interdependencies. Although the general geographic areas in which fruit fly program activities can be anticipated, the exact locations of potential treatment areas and the populations of nontarget species inhabiting these areas are not known. In an attempt to include most of the exposures which are likely to occur in these areas, this risk assessment characterizes a range of exposure scenarios to a diverse and representative group of organisms in each ecoregion.

Routine exposure scenarios express the most likely conditions resulting from the program activities. Estimates of mortality for routine exposure scenarios for Spinosad Bait Spray in the ecoregions are given in Table VI-1 for aerial bait spray applications and in VI-2 for ground bait spray applications. These estimates are based upon the determined exposure, potential for receiving that exposure, and available information about toxicity. There was information for many taxa, but data for surrogate species were applied when necessary. The susceptibility of most taxa indicated low risks, but data for surrogate species were used for some susceptible terrestrial invertebrates when toxicity values were sparse. Toxicity data (median lethal dose) for 2-spotted spider mite were applied as surrogate data for slugs, sowbugs, and spiders. Toxicity data for Colorado Potato Beetle were applied as surrogate data for grasshoppers. Toxicity data for black cutworm were applied as surrogate data for beetle grubs.

The exposure of nontarget organisms to spinosad in bait spray applications is less than to malathion. The toxicity of the active ingredients in spinosad bait spray to mammals, birds, reptiles, fish, and amphibians is less than malathion also. As a result, the potential for exposure to most taxa is negligible and no mortality is expected to mammals, birds, reptiles, fish, and amphibians from spinosad bait spray applications.

Unlike malathion formulations (toxic to all organisms by all routes of exposure), the active ingredients in spinosad formulations are only toxic to certain invertebrates primarily by dermal exposure and ingestion, so the number of nontarget invertebrate species affected by these compounds is slightly diminished. Any invertebrate organism that is attracted to and feeds upon the bait will be affected, but this is only a limited number of species and the lower toxicity to most species indicates that the number of affected organisms would be expected to be less. A small number of phytophagous invertebrates may be killed by consumption of contaminated leaves from spinosad bait spray applications. In particular, Lepidoptera caterpillars are susceptible to increased mortality. Predators in fields treated with spinosad have had very little if any mortality and these species should not be affected by spinosad bait spray applications. Since ground applications are applied specifically to host plants, the number of nontarget insects exposed will be less and it is estimated that there will be 50 per cent less mortality to populations of most nontarget species from ground applications than from aerial applications. The decreases to populations of these affected nontarget invertebrates that are not directly attracted to the bait spray would be expected to be temporary and their populations would recover after program use of spinosad bait spray ceases.

The safety of the insecticide applications to most terrestrial wildlife is considerable. The risks of adverse effects on survival of mammals, birds, reptiles, and terrestrial amphibians are very low and of a magnitude similar to that of human health risks. Label application rates of spinosad to plants produce exposures at levels below any that could be expected to cause phytotoxic responses.

The primary route of toxic action (oral) in invertebrates determines the number of species likely to be at maximum risk of adverse effects. Considerable exposure is expected for those invertebrates attracted to the protein hydrolysate. This includes plant bugs, ground beetles, midges, gnats, acalypterate muscoid flies (such as fruit flies), ants, and soil mites. Of this group, only the midges, gnats, acalypterate muscoid flies, and some mites include susceptible species. The other species are more tolerant of spinosad. Populations of the susceptible insects are likely to be lowered considerably due to the toxic action of the insecticide. The risk to most other species is much lower. Species that are not attracted to the protein hydrolysate have lower potential exposure and are at lower risk. This includes honey bees, lacewings, springtails, aphids, whiteflies, tumbling flower beetles, calypterate muscoid flies, and spiders. Many of the species that are not expected to be affected by spinosad bait spray are adversely affected by malathion bait spray through contact exposure or greater sensitivity. However, there are some species that are highly susceptible to spinosad toxicity such as honey bees. Although the baits are not attractive to these species, their greater susceptibility makes it likely that these species will have high mortality unless protection or mitigation measures are applied.

Aquatic species are at very low risk of adverse effects. The concentration of spinosad in water is several orders of magnitude less than any concentration known to adversely affect aquatic organisms. The water solubility assures that residues would not bioconcentrate in tissues, so adverse effects would not be expected from the short residual exposures. The short half-life in water assures that adverse effects from spinosad would have to occur within a few hours of application and the concentration in water is lower than would ever be expected to adversely affect these species.

Table VI-1: Mortality Estimates from Routine Exposures of Nontarget Species to Aerial Spinosad Bait Spray Applications by Ecoregion

Species	Mortality Estimate by Ecoregion						
	1	2	3	4	5	6	7
Opossum	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Shrew	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Bat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cottontail	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Squirrel	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Mouse	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Raccoon	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fox	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Coyote/Dog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Cat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Deer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Birds							
Pied-billed grebe	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great blue heron	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cattle egret	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Duck	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Turkey Vulture	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-tailed hawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American kestrel	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Quail	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Killdeer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mourning dove	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great horned owl	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Burrowing owl	<1.0	<1.0	<1.0	<1.0	N/A	<1.0	<1.0
Nighthawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hummingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Belted kingfisher	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Northern flicker	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Kingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

American robin	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Northern mockingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
European starling	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-winged blackbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Meadowlark	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
House sparrow	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Reptiles							
Desert iguana	<1.0	<1.0	N/A	N/A	N/A	N/A	N/A
Side-blotched lizard	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Carolina anole	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Eastern fence lizard	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Western fence lizard	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Canyon lizard	N/A	N/A	<1.0	N/A	N/A	N/A	N/A
Gopher snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Garter snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Desert tortoise	<1.0	<1.0	N/A	N/A	N/A	N/A	N/A
Eastern box turtle	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Western box turtle	N/A	<1.0	<1.0	<1.0	N/A	N/A	N/A
Hognose snake	N/A	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Terrestrial Amphibians							
Toad	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Tree frog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Invertebrates							
Earthworm	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Slug	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sowbug	<1.0	2.14	1.24	<1.0	<1.0	<1.0	<1.0
Spider	9.0	13.4	11.2	4.8	1.9	3.1	N/A
Mayfly	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Dragonfly	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Grasshopper	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Lacewing	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Water strider	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Beetle, grub	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Beetle, adult	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Butterfly	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Moth	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Caterpillar	100	100	100	100	100	100	100
Maggot	100	100	100	100	100	100	100
Fly	100	100	100	100	100	100	100
Ant	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Honey bee	100	100	100	100	100	100	100
Wasp	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fish (habitat)							
Golden shiner (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Golden shiner (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Speckled dace (stream)	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0

Mexican tetra (stream)	N/A	N/A	<1.0	N/A	N/A	N/A	N/A
Silvery minnow	N/A	N/A	N/A	<1.0	<1.0	N/A	N/A
Goldfish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sheepshead minnow (stream)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Sheepshead minnow (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
California killifish (stream)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
California killifish (wetland)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Swamp darter	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Mosquitofish (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mosquitofish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Rainbow trout (stream)	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Rainbow trout (lake)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Arroyo chub (stream)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Bluegill sunfish (stream)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Bluegill sunfish (lake)	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0

Bluegill sunfish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Largemouth bass (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Largemouth bass (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Channel catfish (stream)	N/A	N/A	<1.0	N/A	<1.0	<1.0	N/A
Channel catfish (lake)	N/A	N/A	N/A	N/A	<1.0	<1.0	<1.0
Yellow bullhead catfish (stream)	N/A	N/A	N/A	<1.0	<1.0	N/A	N/A
Yellow bullhead catfish (lake)	N/A	N/A	N/A	N/A	<1.0	N/A	N/A
Yellow bullhead catfish (pond)	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Longnose gar (lake)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
longnose gar (pond)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
longnose gar (wetland)	N/A	N/A	N/A	N/A	N/A	<1.0	N/A
Lake chubsucker (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Aquatic Reptiles							
Snapping turtle (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A

Western pond turtle (wetland)	<1.0	N/A	N/A	N/A	N/A	N/A	<1.0
Water snake (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Aquatic Amphibians (larval forms)							
Bullfrog (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	N/A
Tiger salamander (wetland)	<1.0	N/A	N/A	<1.0	<1.0	N/A	<1.0
Amphiuma (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Aquatic Invertebrates							
Hydra (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Leech (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Leech (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Leech (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Sponge, freshwater	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Clam, freshwater (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Snail, freshwater (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Snail, freshwater (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Scud (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Crayfish (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Crayfish (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Water flea (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dragonfly, larva (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dragonfly, larva (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dragonfly, larva (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Mayfly, larva (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mayfly, larva (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Stonefly, larva (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Caddisfly, larva (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Backswimmer (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Backswimmer (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Beetle (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mosquito, larva (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mosquito, larva (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0

Table VI-2: Mortality Estimates from Routine Exposures of Nontarget Species to Ground Spinosad Bait Spray Applications by Ecoregion							
Species	**Mortality Estimate by Ecoregion**						
	1	2	3	4	5	6	7
Opossum	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Shrew	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Bat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cottontail	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Squirrel	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Mouse	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Raccoon	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fox	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Coyote/Dog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Deer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Birds							
Pied-billed grebe	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great blue heron	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cattle egret	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Duck	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Turkey Vulture	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-tailed hawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American kestrel	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Quail	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A

Killdeer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mourning dove	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great horned owl	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Burrowing owl	<1.0	<1.0	<1.0	<1.0	N/A	<1.0	<1.0
Nighthawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hummingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Belted kingfisher	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Northern flicker	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Kingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American robin	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Northern mockingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
European starling	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-winged blackbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Meadowlark	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
House sparrow	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Reptiles							
Desert iguana	<1.0	<1.0	N/A	N/A	N/A	N/A	N/A
Side-blotched lizard	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Carolina anole	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Eastern fence lizard	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A

Western fence lizard	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Canyon lizard	N/A	N/A	<1.0	N/A	N/A	N/A	N/A
Gopher snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Garter snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Desert tortoise	<1.0	<1.0	N/A	N/A	N/A	N/A	N/A
Eastern box turtle	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Western box turtle	N/A	<1.0	<1.0	<1.0	N/A	N/A	N/A
Hognose snake	N/A	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Terrestrial Amphibians							
Toad	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tree frog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Invertebrates							
Earthworm	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Slug	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sowbug	<1.0	1.57	1.12	<1.0	<1.0	<1.0	N/A
Spider	5.0	7.2	6.1	2.9	1.5	2.1	N/A
Mayfly	13.0	13.0	13.0	13.0	13.0	13.0	13.0
Dragonfly	13.0	13.0	13.0	13.0	13.0	13.0	13.0
Grasshopper	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Lacewing	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Water strider	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Beetle, grub	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Beetle, adult	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Butterfly	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Moth	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Caterpillar	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Maggot	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Fly	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Ant	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Honey bee	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Wasp	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fish (habitat)							
Golden shiner (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Golden shiner (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Speckled dace (stream)	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Mexican tetra (stream)	N/A	N/A	<1.0	N/A	N/A	N/A	N/A
Silvery minnow	N/A	N/A	N/A	<1.0	<1.0	N/A	N/A
Goldfish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sheepshead minnow (stream)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Sheepshead minnow (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
California killifish (stream)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
California killifish (wetland)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Swamp darter	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A

Mosquitofish (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mosquitofish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Rainbow trout (stream)	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Rainbow trout (lake)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Arroyo chub (stream)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Bluegill sunfish (stream)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Bluegill sunfish (lake)	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Bluegill sunfish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Largemouth bass (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Largemouth bass (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Channel catfish (stream)	N/A	N/A	<1.0	N/A	<1.0	<1.0	N/A
Channel catfish (lake)	N/A	N/A	N/A	N/A	<1.0	<1.0	<1.0
Yellow bullhead catfish (stream)	N/A	N/A	N/A	<1.0	<1.0	N/A	N/A
Yellow bullhead catfish (lake)	N/A	N/A	N/A	N/A	<1.0	N/A	N/A

Yellow bullhead catfish (pond)	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Longnose gar (lake)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
longnose gar (pond)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
longnose gar (wetland)	N/A	N/A	N/A	N/A	N/A	<1.0	N/A
Lake chubsucker (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Aquatic Reptiles							
Snapping turtle (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Western pond turtle (wetland)	<1.0	N/A	N/A	N/A	N/A	N/A	<1.0
Water snake (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Aquatic Amphibians (larval forms)							
Bullfrog (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	N/A
Tiger salamander (wetland)	<1.0	N/A	N/A	<1.0	<1.0	N/A	<1.0
Amphiuma (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Aquatic Invertebrates							
Hydra (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Leech (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Leech (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Leech (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Sponge, freshwater	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Clam, freshwater (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Snail, freshwater (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Snail, freshwater (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Scud (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Crayfish (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Crayfish (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Water flea (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dragonfly, larva (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dragonfly, larva (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dragonfly, larva (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Mayfly, larva (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mayfly, larva (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Stonefly, larva (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Caddisfly, larva (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Backswimmer (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Backswimmer (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Beetle (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mosquito, larva (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mosquito, larva (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0

C. Environmental Quality

The risks from applications of spinosad to environmental quality are minimal. Spinosad persists for only a few hours in air or water due to rapid photodegradation. The water solubility and rapid photodegradation assure that any evidence of absorption into permeable substrates or adsorption to inert surfaces is not evident shortly after sunlight, rainfall or weathering. This rapid breakdown assures that no permanent effects can be anticipated on the quality of air, soil, and water.

V. Conclusions

Applications of Spinosad in bait spray pose low risk to program personnel, the general public, environmental quality, and most nontarget organisms. Risks are low to mammals, birds, reptiles, amphibians, fish, aquatic invertebrates, and plants. Risks are also low to most terrestrial invertebrates, but populations of those species attracted to the protein hydrolysate bait are at elevated risk. This includes acalypterate muscoid flies (such as fruit flies), plant bugs, ground beetles, midges, gnats, ants, and soil mites. Many species at high risk in eradication programs using malathion bait spray against fruit flies are not at risk in programs using spinosad bait. Nontarget invertebrates at risk of adverse effects from malathion bait spray applications and unlikely to be affected by spinosad bait spray include earthworms, slugs, grasshoppers, lacewings, water striders, beetles, ants, and parasitic wasps. A major consideration before conducting a field trial of spinosad bait spray is the determination of any endangered or threatened invertebrate species attracted to the protein hydrolysate within or adjacent to the proposed treatment area. Presence of susceptible endangered or threatened invertebrate species attracted to the bait would require measures to prevent exposure of these organisms. This could be accomplished through the use of buffers or similar measures to prevent exposure. In addition, honey bees are very sensitive to applications of spinosad, so applications should be timed to minimize potential exposure of foraging honey bees. In the absence of susceptible endangered and threatened species, applications of spinosad bait spray would not be anticipated to pose any significant adverse risks to environmental quality, human health or survival of wildlife.

VI. References

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APPENDICES

Appendix 1. Chemical and Physical Properties of Spinosad

Note: All physical properties pertain to 20-25°C temperatures unless otherwise noted.

Spinosad

Spinosyn A
CAS # 131929-60-7

Spinosyn D
CAS # 131929-63-0

Density (g/cm^2):	1.09
Henry's constant ($atm\text{-}m^3/mol$)	9.82×10^{-10} 4.87×10^{-7}
Organic Carbon Partition Coefficient (K_{oc}): (calculated by equation in Briggs, 1990)	708 (Spinosyn A) 1259 (Spinosyn D)
Octanol/Water Partition Coefficient (K_{ow}): (Log K_{ow} = 3.9 (spinosyn A), 4.4 (spinosyn D))	7943 (spinosyn A) 25118 (spinosyn D)
Plant Washoff fraction:	0.9
Soil Half-life (days):	9.4-17.3 days (spinosyn A) 14.5 days (spinosyn D)
Acqueous Photolysis Half-life (days):	<1 day
Vapor pressure (mm Hg):	2.4×10^{-10} (spinosyn A) 1.6×10^{-10} (spinosyn D)
Water Solubility (mg/L):	235 (spinosyn A) 0.329 (spinosyn D)

Attachment III.

Spinosad Tolerances

§ 180.495 Spinosad; tolerances for residues. (As of 8/14/98)

(a) *General*. Tolerances are established for residues of the insecticide Spinosad. Factor A is 2-[(6-deoxy-2,3,4-tri-*O*-methyl-α-*L*-manno-pyranosyl)oxy]-13-[[5-(dimethylamino)-tetrahydro-6-methyl-2H-pyran-2-yl]oxy]-9-ethyl-2,3,3a,5a,5b,6,9,10,11,12,13,14,16a,6b-tetradecahydro-14-methyl-1*H*-as-Indaceno[3,2-d]oxacyclododecin-7,15-dione. Factor D is 2-[(6-deoxy-2,3,4-tri-*O*-methyl-α-*L*-manno-pyranosyl)oxy]-13-[[5-(dimethylamino)-tetrahydri-6-methyl-2*H*-pyran-2-yl]oxy]-9-ethyl-2,3,3a,5a,5b,6,9,10,11,12,13,14,16a,16b-tetradecahydro-4,14-dimethyl-1*H*-as-Indaceno[3,2-d]oxacyclododecin-7,15-dione.

Commodity	Parts per million
Almonds	0.02
Almond hulls	2.0
Apples	0.2
Apple pomace, wet	0.5
Brassica (cole), leafy vegetables, greens subgroup	10.0
Brassica (cole), leafy vegetables, head and stem subgroup	2.0
Cattle, fat	0.6
Cattle, mbyp	0.2
Cattle, meat	0.04
Citrus fruits group	0.3
Citrus oil	3.0
Citrus pulp, dried	0.5
Cotton gin byproducts	1.5
Cottonseed	0.02
Fruiting vegetables (except cucurbits) group	0.4
Goat, fat	0.6
Goat, mbyp	0.2
Goat, meat	0.04
Hogs, fat	0.6
Hogs, mbyp	0.2
Hogs, meat	0.04
Horses, fat	0.6
Horses, mbyp	0.2
Horses, meat	0.04
Leafy vegetables (except Brassica vegetables) group	8.0
Milk, fat	0.5
Milk, whole	0.04
Sheep, fat	0.6
Sheep, mbyp	0.2
Sheep, meat	0.04

(b) *Section 18 emergency exemptions*. [Reserved]

(c) *Tolerances with regional registrations*. [Reserved]

(d) *Indirect or inadvertent residues*. [Reserved]

§ 180.495 Spinosad; tolerances for residues. (As of October 22, 1997)

(a) *General.* [Reserved]

(b) *Section 18 emergency exemptions.* A time-limited tolerance is established for residues of the insecticide Spinosad. Factor A is 2-[(6-deoxy-2,3,4-tri-*O*-methyl- α-*L*-manno-pyranosyl)oxy]-13-[[5-(dimethylamino)-tetrahydro-6- methyl-2*H*-pyran-2-yl]oxy]-9-ethyl-2,3,3a,5a,5b,6,9,10,11,12,13,14,16a, 6b-tetradecahydro-14-methyl-1*H*-as-Indaceno[3,2-d]oxacyclododecin-7,15- dione. Factor D is 2-[(6-deoxy-2,3,4-tri-*O*-methyl-α-*L*-manno-pyranosyl)oxy]-13-[[5-(dimethylamino)-tetrahydro-6-methyl-2*H*-pyran-2- yl]oxy]-9-ethyl-2,3,3a,5a,5b,6,9,10,11,12,13,14,16a,16b-tetradecahydro- 4,14-dimethyl-1H-as-Indaceno[3,2-d]oxacyclododecin-7,15-dione.

Commodity	Parts per million	Expiration/ revocation date
Brassica (Cole) Leafy Vegetables Crop Group (5)	10.0	9/30/98
Cottonseed	0.02	11/15/99
Fruiting Vegetables (except Cucurbits) Crop Group (8)	0.25	9/30/98
Leafy Vegetables (except Brassica vegetables) Crop Group (4)	10.0	9/30/98
Tomato paste	0.50	9/30/98

(c) *Tolerances with regional registrations.* [Reserved]

(d) *Indirect or inadvertent residues.* [Reserved]

Attachment IV.

Registrant Letter of Support

Dow AgroSciences LLC
9330 Zionsville Road
Indianapolis, IN 46268-1054

308 3E
March 18, 1999

Dow AgroSciences

Alan V. Tasker
USDA, APHIS
4700 River Road, Unit 152
Riverdale, MD 20737-1237

Dear Dr. Tasker:

SECTION 18 QUARANTINE EXEMPTION FOR USE OF NAF-550 (SPINOSAD)(FRUIT FLY BAIT) IN FLORIDA

This letter communicates the support of Dow AgroSciences LLC for a limited quarantine exemption for NAF-550 in accordance with Section 18 of the Federal Insecticide, Fungicide and Rodenticide Act, as amended, for use to control multiple species of tephritid fruit flies infesting fruit and nut trees, vines, vegetables and ornamentals. The product is intended for use by governmental agencies and in production agriculture and urban areas in eradication and prevention programs. Only ground application is authorized in urban areas.

In the future, Dow AgroSciences intents to submit a Section 3-type pesticide registration application for NAF-550 to the U.S. Environmental Protection Agency for fruit fly control.

Sincerely,

Robert D. Vatne

Robert D. Vatne
State Regulatory Manager
Regulatory Success-Americas

cc. Dr. Dennis Howard
FL Dept. of Agriculture and
Consumer Services

*Trademark of Dow AgroSciences LLC

Attachment V.

Efficacy Data

EFFICACY OF SPINOSAD VERSUS MALATHION ON THE MEDITERRANEAN FRUIT FLY IN A FLORIDA COMMERCIAL CITRUS GROVE

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ABSTRACT
A comparison of two insecticides, spinosad and malathion, applied aerially and by ground spot treatment to suppress released populations of Mediterranean fruit flies, was made in commercial citrus groves in Desoto Co., Florida. Treatments of 10% and 20% Malathion with NuLure, a hydrolyzed protein bait, were applied by air at the rate of 12 oz. per acre and Spinosad at 80 ppm was applied with in a Solulys bait by air and ground. Eight-acre treatment blocks were replicated three times. Dyed, sterile Mediterranean fruit flies were released the evening before treatment. Data was collected by trapping surviving flies in Jackson trimedlure traps and IPMT traps baited with a synthetic, three component lure. There was a substantial reduction in medflies in the aerially applied Spinosad and 10 and 20% malathion treatments.

INTRODUCTION
Invasive economic insect pests, such as the Mediterranean fruit fly, have the potential to impose major economic impact on the agricultural economy if left unchecked. Presently, the organophosphate insecticide malathion, due to its efficacy for rapid knockdown of fly populations, is used as an effective eradication tool alone or as adjunct to the Sterile Insect Technique (SIT). Increasing public concern over public health and environmental issues involving malathion has placed immediate interest on identifying alternative chemical approaches and techniques for fruit fly control and eradication. Spinosad, a naturalyte® product of Dow AgroSciences, has shown promise in laboratory and limited field testing. Direct field comparisons of spinosad and malathion applied both by air and by ground spot treatments will result in data needed to make operational decisions for future eradication programs.

MATERIALS AND METHODS

The test, at Rainbow Groves, a one square mile commercial citrus grove consisting of Hamlin, Pineapple and Valencia oranges, was conducted from November 3 - 9, 1998. The grove is located one mile west of the Highlands county line on State Road 70 in Desoto county (S35, T37, R27) Florida.

A randomized complete block experimental design was used consisting of four chemical treatments and a check consisting of bait only. Plots were about eight acres each and replicated three times. A minimum buffer of about 300 feet was maintained between each plot. Treatments consisted of the following and were also applied in the listed order:

1. Check - Solulys bait aerially applied at the rate of 48 oz. per acre.
2. Spinosad 0.008% (80ppm) in Solulys bait applied aerially at the rate of 48 oz. of mix per acre.
3. Malathion (Fyfanon 96.5%) 20% mixed with NuLure bait 80% and applied aerially at the rate of 12 oz. of mix per acre (standard malathion bait spray).
4. Malathion (Fyfanon 96.5%) 10% mixed with NuLure bait 90% and applied aerially at the rate of 12 oz. of mix per acre.
5. Spinosad 0.008% in Solulys bait applied as a foliar spray with hand-held ground equipment at the rate of about 1.5 gal. of mix per acre.

Sterile, dyed Mediterranean fruit flies obtained from the MacDill Eclosion Facility in Tampa were released late afternoon before treatments the following morning. Flies were released at two static release points in each plot. Flies were released at the rate of 7,000 per acre or 55-60,000 per eight-acre plot. Ten Jackson traps with trimedlure and 10 IPMT wet traps with the Concept's 3-component lure were placed in each plot 48 hr. after treatment. Traps were checked and data recorded at days 3 and 6 after treatment.

The experimental design was a randomized complete block with three replicates for each treatment. Each plots was separated by a buffer of at least 300 feet. The baited traps were spatially distributed throughout the central area of the plot and collected responsive, surviving flies. Data consisted of number of flies in each trap which was identified by treatment plot.

RESULTS AND DISCUSSION

Total number of flies trapped from each treatment are shown in Table 1 and the profile of results for aerial applications is shown in Fig. 1. Analysis of trapped flies using ANOVA procedure indicates that aerial treatments of 80 ppm spinosad in Solulys bait and 10 and 20% malathion in Nulure bait, all significantly reduced the sterile Medfly populations in the groves despite continuous rains initiated <24 hr. after spraying the groves. Mechanical problems with ground equipment applications forced us to discard obtained data rather than make improper inferences.

Results of this field test indicates that spinosad applied by air may provide the same measure of control for the Mediterranean fruit fly that is now achieved using malathion. The residual activity for spinosad in a bait system still has to be determined. However efficacy of the product in the short term is as good as malathion.

Further research to enhance attraction and longevity of the Solulys bait should remain a priority as well as determining the optimum formulation and application parameters for spinosad. Refinements and additional testing for foliar spot sprays applied with hand-held equipment will be incorporated into further field studies in the spring of 1999.

Table 1. Trapping Totals by Treatment Block

	Check	Malathion 20%	Malathion 10%	Spinosad 80ppm (aerial)
♂	289	59	73	23
♀	111	10	26	3
Total	400	69	99	26

Fig. 1 Interaction Bar Chart of Treatment Effect by Mean Flies Trapped