Risks of *Lambda*-Cyhalothrin Use to Federally Threatened

Bay Checkerspot Butterfly (*Euphydryas editha bayensis*), Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*), California Tiger Salamander (*Ambystoma californiense*) Central California Distinct Population Segment, and Delta Smelt (*Hypomesus transpacificus*),

And the Federally Endangered California Clapper Rail (*Rallus longirostris obsoletus*), California Freshwater Shrimp (*Syncaris pacificus*), California Tiger Salamander (*Ambystoma californiense*) Sonoma County Distinct Population Segment and Santa Barbara County Distinct Population Segment, San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*), and Tidewater Goby (*Eucyclogobius newberryi)*

Pesticide Effects Determinations
PC Code: 128897
CAS Number: 91465-08-6

Environmental Fate and Effects Division
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September 30, 2012

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List of Commonly Used Abbreviations and Nomenclature

µg/kg	Symbol for "micrograms per kilogram"
µg/L	Symbol for "micrograms per liter"
ºC	Symbol for "degrees Celsius"
AAPCO	Association of American Pesticide Control Officials
a.i.	Active Ingredient
AIMS	Avian Monitoring Information System
Acc#	Accession Number
amu	Atomic Mass Unit
BCB	Bay Checkerspot Butterfly
BCF	Bioconcentration Factor
BEAD	Biological and Economic Analysis Division
bw	Body Weight
CAM	Chemical Application Method
CARB	California Air Resources Board
AW	Alameda Whipsnake
CBD	Center for Biological Diversity
CCR	California Clapper Rail
CDPR	California Department of Pesticide Regulation
CDPR-PUR	California Department of Pesticide Regulation Pesticide Use Reporting Database
CFWS	California Freshwater Shrimp
CI	Confidence Interval
CL	Confidence Limit
CTS	California Tiger Salamander
CTS-CC	California Tiger Salamander Central California Distinct Population Segment
CTS-SB	California Tiger Salamander Santa Barbara County Distinct Population Segment
CTS-SC	California Tiger Salamander Sonoma County Distinct Population Segment
DS	Delta Smelt
EC	Emulsifiable Concentrate
EC_{05}	5% Effect Concentration
EC_{25}	25% Effect Concentration
EC_{50}	50% (or Median) Effect Concentration

ECOTOX	EPA managed database of Ecotoxicology data
EEC	Estimated Environmental Concentration
EFED	Environmental Fate and Effects Division
e.g.	Latin *exempli gratia* (“for example”)
EIM	Environmental Information Management System
EPI	Estimation Programs Interface
ESU	Evolutionarily significant unit
et al.	Latin *et alii* (“and others”)
etc.	Latin *et cetera* (“and the rest” or “and so forth”)
EXAMS	Exposure Analysis Modeling System
FIFRA	Federal Insecticide Fungicide and Rodenticide Act
FQPA	Food Quality Protection Act
ft	Feet
GENEEC	Generic Estimated Exposure Concentration model
HPLC	High Pressure Liquid Chromatography
IC_{05}	5% Inhibition Concentration
IC_{50}	50% (or median) Inhibition Concentration
i.e.	Latin for *id est* (“that is”)
IECV1.1	Individual Effect Chance Model Version 1.1
KABAM	$\underline{K}_{OW}$ (based) Aquatic BioAccumulation Model
kg	Kilogram(s)
kJ/mole	Kilojoules per mole
km	Kilometer(s)
K_{AW}	Air-water Partition Coefficient
Kd	Solid-water Distribution Coefficient
K_F	Freundlich Solid-Water Distribution Coefficient
K_{OC}	Organic-carbon Partition Coefficient
K_{OW}	Octanol–water Partition Coefficient
LAA	Likely to Adversely Affect
lb a.i./A	Pound(s) of active ingredient per acre
LC_{50}	50% (or Median) Lethal Concentration
LD_{50}	50% (or Median) Lethal Dose
LOAEC	Lowest Observable Adverse Effect Concentration
LOAEL	Lowest Observable Adverse Effect Level
LOC	Level of Concern
LOD	Level of Detection

LOEC	Lowest Observable Effect Concentration
LOQ	Level of Quantitation
m	Meter(s)
MA	May Affect
MATC	Maximum Acceptable Toxicant Concentration
m^2/day	Square Meters per Days
ME	Microencapsulated
mg	Milligram(s)
mg/kg	Milligrams per kilogram (equivalent to ppm)
mg/L	Milligrams per liter (equivalent to ppm)
mi	Mile(s)
mmHg	Millimeter of mercury
MRID	Master Record Identification Number
MW	Molecular Weight
n/a	Not applicable
NASS	National Agricultural Statistics Service
NAWQA	National Water Quality Assessment
NCOD	National Contaminant Occurrence Database
NE	No Effect
NLAA	Not Likely to Adversely Affect
NLCD	National Land Cover Dataset
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOAEC	No Observable Adverse Effect Concentration
NOAEL	No Observable Adverse Effect Level
NOEC	No Observable Effect Concentration
NRCS	Natural Resources Conservation Service
OPP	Office of Pesticide Programs
OPPTS	Office of Prevention, Pesticides and Toxic Substances
ORD	Office of Research and Development
PCE	Primary Constituent Element
pH	Symbol for the negative logarithm of the hydrogen ion activity in an aqueous solution, dimensionless
pKa	Symbol for the negative logarithm of the acid dissociation constant, dimensionless
ppb	Parts per Billion (equivalent to µg/L or µg/kg)

ppm	Parts per Million (equivalent to mg/L or mg/kg)
PRD	Pesticide Re-Evaluation Division
PRZM	Pesticide Root Zone Model
ROW	Right of Way
RQ	Risk Quotient
SFGS	San Francisco Garter Snake
SJKF	San Joaquin Kit Fox
SLN	Special Local Need
SMHM	Salt Marsh Harvest Mouse
TG	Tidewater Goby
T-HERPS	Terrestrial Herpetofaunal Exposure Residue Program Simulation
T-REX	Terrestrial Residue Exposure Model
UCL	Upper Confidence Limit
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VELB	Valley Elderberry Longhorn Beetle
WP	Wettable Powder
wt	Weight

1. Executive Summary

1.1. Purpose of Assessment

The purpose of this assessment is to evaluate potential direct and indirect effects of *lambda*-cyhalothrin (PC Code: 128897) on the bay checkerspot butterfly (*Euphydryas editha bayensis*) (BCB); delta smelt (*Hypomesus transpacificus*) (DS); valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (VELB); California tiger salamander (*Ambystoma californiense*) Central California Distinct Population Segment (CTS-CC), Sonoma County Distinct Population Segment (CTS-SC), and Santa Barbara County Distinct Population Segment (CTS-SB); California clapper rail (*Rallus longirostris obsoletus*) (CCR); California freshwater shrimp (*Syncaris pacificus*) (CFWS); San Francisco garter snake (*Thamnophis sirtalis tetrataenia*) (SFGS); and the tidewater goby (*Eucyclogobius newberryi*) (TG); arising from FIFRA regulatory actions regarding the use of *lambda*-cyhalothrin on agricultural and non-agricultural sites. In addition, this assessment evaluates whether these actions can be expected to result in modification of designated critical habitat for the BCB, VELB, CTS-CC, CTS-SB, TG, and DS; the other assessed species do not have designated critical habitats. This assessment was completed in accordance with the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) *Endangered Species Consultation Handbook* (USFWS/NMFS, 1998), procedures outlined in the Agency's Overview Document (USEPA, 2004), and consistent with a suit in which *lambda*-cyhalothrin was alleged to be of concern to the BCB, DS, VELB, CTS-CC, CCR, CFWS, CTS-SC, CTS-SB, SFGS, and TG (*Center for Biological Diversity (CBD) vs. EPA et al*. (Case No. 07-2794-JCS).

Below are brief descriptions of when each San Francisco Bay species being assessed was listed and a short description of their associated Primary Constituent Element (PCEs) (when applicable).

The BCB was listed as threatened in 1987 by the USFWS. The species primarily inhabits native grasslands on serpentine outcrops around the San Francisco Bay Area in California. The PCEs for BCBs are areas on serpentinite-derived soils that support the primary larval host plant (*i.e.*, dwarf plantain) and at least one of the species' secondary host plants. Additional BCB PCEs include the presence of adult nectar sources, aquatic features that provide moisture during the spring drought and areas that provide adequate shelter during the summer diapause.

The VELB was listed as threatened in 1980 by the USFWS. The species is found in areas with elderberry shrubs throughout California's Central Valley and associated foothills on the east and the watershed of the Central Valley on the west. The PCEs for the VELBs include areas that contain its host plant (*i.e.,* elderberry trees).

The DS was listed as threatened on March 5, 1993 (58 FR 12854) by the USFWS (USFWS, 2007). DS are mainly found in the Suisun Bay and the Sacramento-San Joaquin estuary near San Francisco Bay. During spawning DS move into freshwater. The PCEs for DSs are shallow fresh or brackish backwater sloughs for egg hatching and larval viability, suitable water with adequate river flow for larval and juvenile transport, suitable rearing habitat, and unrestricted access to suitable spawning habitat.

There are currently three CTS Distinct Population Segments (DPSs): the Sonoma County (SC) DPS, the Santa Barbara (SB) DPS, and the Central California (CC) DPS. Each DPS is considered separately in the risk assessment as they occupy different geographic areas. The main difference in the assessment will be in the spatial analysis. The CTS-SB was listed by the USFWS as endangered in 2000, the CTS-SC in 2002, and the CTS-CC as threatened in 2004. The CTS-SB and CTS-SC were down listed from endangered to threatened in 2004 by the USFWS, however, the down listing was vacated by the U.S. District Court. Therefore, the Sonoma and Santa Barbara DPSs are currently listed as endangered while the CTS-CC is listed as threatened. All CTS populations utilize vernal pools, semi-permanent ponds, and permanent ponds, and the terrestrial environment in California. The aquatic environment is essential for breeding and reproduction and mammal burrows are also important habitat for aestivation. The PCEs for the CTS are standing bodies of freshwater sufficient for the species to complete the aquatic portion of its life cycle that are adjacent to barrier-free uplands that contain small mammal burrows. An additional PCE is upland areas between sites (as described above) that allow for dispersal of the species.

The CCR was listed by the USFWS as an endangered species in 1970. The species is found only in California in coastal wetlands along the San Francisco estuary and Suisun Bay.

The CFWS was listed as endangered in 1988 by the USFWS. The CFWS inhabits freshwater streams in Central California in the lower Russian River drainage and westward to the Pacific Ocean and coastal streams draining into Tomales Bay and southward into the San Pablo Bay.

The SFGS was listed as endangered in 1967 by the USFWS. The species is endemic to the San Francisco Peninsula and San Mateo County in California in densely vegetated areas near marshes and standing open water.

The TG was listed as endangered on March 7, 1994 (59 FR 5494) by the USFWS. The animals are benthic in nature and all life stages are found in lagoons, estuaries, and marshes in areas of low to moderate salinity[1]. The TG also occurs in freshwater streams up gradient and tributary to brackish habitats (68920 FR Vol 71, No 228).

1.2. Scope of Assessment

1.2.1. Uses Assessed

Lambda-cyhalothrin [(R)-cyano(3-phenoxyphenyl)(methyl)(1S,3S)-*rel*-3-[(1Z)-2-chloro-3,3,3-trifluoro-1-propenyl]-2,2-dimethylcyclopropanecarboxylate is a non-systemic Type II synthetic pyrethroid insecticide that is currently registered for use on a variety of field, fruit, and vegetable crops; in food handling establishments; non-agricultural areas (right-of-ways); on outdoor ornamental plants (including lawns, turf, and cut flowers); and in and around the home. Targeted pests include aphid, caterpillar, and beetle pests on a wide variety of crops and public health pests such as mosquitoes and cockroaches. Formulation types registered include: dust, emulsifiable concentrate, flowable concentrate, granular, impregnated collar/tag, impregnated

[1] USFWS 2011. http://www.fws.gov/arcata/es/fish/Goby/goby.html

material (e.g., tarps for building sites), liquid ready-to-use, microencapsulated, pelleted/tablet, pressurized liquid, soluble concentrate/solid, and wettable powder. All pyrethroids act as axonic poisons, affecting both the peripheral and central nervous systems and cause a rapid "knock down," or paralysis, of insects. Although current registrations of *lambda*-cyhalothrin allow for use nationwide, this ecological risk assessment and effects determination addresses currently registered uses of *lambda*-cyhalothrin in California only. Uses in California comprise the full range of agricultural and non-agricultural registrations and all types of formulations for *lambda*-cyhalothrin. Applications to crops can be made aerially, with an attractant (e.g., pheromone trap), by chemigation, to cracks and crevices, by dust, as an ear tag, by injection, by trunk drench, by ground spray, by soil in furrow treatment, as a spot treatment, and by T-banding.

1.2.2. Environmental Fate Properties of *Lambda*-Cyhalothrin

Lambda-cyhalothrin is moderately persistent in the environment and degrades relatively slowly through a combination of biotic and abiotic mechanisms. It tends to bind to organic matter (*e.g.,* soils, sediments, or organic matter and particulates in water) and is not expected to be very mobile; leaching into groundwater is not expected to be an important environmental fate process. *Lambda*-cyhalothrin could reach adjacent surface waters via spray drift and/or runoff events accompanied by erosion. In aquatic environments, it partitions with the sediment and is expected to persist for long periods of time (several months). The sediments could serve as repositories of *lambda*-cyhalothrin in dynamic equilibrium with the pore water and with the surface water. *Lambda*-cyhalothrin is highly bioaccumulative in fish (4,600x in the whole body), and its depuration rate is considered moderately slow (half-depuration time of around 9 days). More information regarding the fate of *lambda*-cyhalothrin can be found in Section 2.4.

1.2.3. Evaluation of Degradates and Stressors of Concern

Major degradation products of *lambda*-cyhalothrin include Compounds Ia and Ib, Compound IV, Compound V and Compound XV (for structures see Table 2-3). Degradate toxicity data are not available for this assessment. However, Compounds Ia and Ib, Compound IV, Compound V occur as a result of the ester bond breakage of the parent molecule resulting in significantly decreased toxicity of those degradates relative to the parent compound. Compound XV, however, is structurally similar to the parent compound, and QSAR-based (Quantitative Structure Activity Relationship) modeling in the program ECOSAR (version 1.0) (Ecological Structure Activity Relationships) supports similar toxicity. Within the pyrethroid ECOSAR class, toxicity values were in the same order of magnitude for fish, daphnids, and green algae [Parent EC/LC_{50} = 0.002 mg/L, Compound XV EC/LC_{50} = 0.004 mg/L, for all three organisms]. This assessment was performed on the parent *lambda*-cyhalothrin only because 1) there were little data for the degradate of concern (Compound XV) which would have contributed uncertainty to the conclusions of the risk assessment; and 2) evaluating the parent only was sufficient to identify risk to all of the assessed species and resulted in much greater certainty in those conclusions. The degradate of concern (Compound XV) and uncertainties associated with this approach are discussed in Section 6.1.8.

1.3. Assessment Procedures

A description of routine procedures for evaluating risk to the San Francisco Bay Species is provided in Attachment I.

1.3.1. Exposure Assessment

1.3.1.a. Aquatic Exposures

Tier-II aquatic exposure models are used to estimate high-end exposures of *lambda*-cyhalothrin in aquatic habitats resulting from runoff and spray drift from different uses. The models used to predict aquatic estimated environmental concentrations (EECs) are Pesticide Root Zone Model (PRZM) coupled with the Exposure Analysis Modeling System (EXAMS). The AgDRIFT model is also used to estimate deposition of *lambda*-cyhalothrin on aquatic habitats from spray drift. Peak model-estimated environmental concentrations resulting from different *lambda*-cyhalothrin uses ranged from 0.0008 to 15.89 µg ai/L. These estimates are supplemented with an analysis of available California surface water monitoring data from the U. S. Geological Survey's National Water Quality Assessment (NAWQA) program and the California Department of Pesticide Regulation. Concentrations of *lambda*-cyhalothrin reported by NAWQA for California surface waters with agricultural watersheds are less than the limit of quantitation (LOQ), which ranged from 0.004 to 0.018 µg ai/L. However, the maximum concentration of *lambda*-cyhalothrin reported by the California Department of Pesticide Regulation surface water database (0.14 µg/L) is roughly two orders of magnitude lower than the peak EEC, but within the range of modeled concentrations. It should be noted that the majority (93%) of the peak surface water EEC values were $\leq$ 1 µg ai/L which were in line with the monitoring values. In addition, the maximum detected sediment concentration of 0.315 µg/g (~0.024 µg/L) was also within the range of the calculated pore water concentrations. It should be understood monitoring sampling may not have been frequent enough to capture peak concentrations, or in vulnerable watersheds, or during the time when the pesticide had recently been applied.

1.3.1.b. Terrestrial Exposures

To estimate *lambda*-cyhalothrin exposures to terrestrial species, the Terrestrial Reside Exposure (T-REX) model is used for foliar, granular, and soil in-furrow uses. The Terrestrial Herpetofaunal Exposure Residue Program Simulation (T-HERPS) model is used to allow for further characterization of dietary exposures of reptiles and terrestrial-phase amphibians relative to birds. The AgDRIFT model is used to estimate deposition of *lambda*-cyhalothrin on terrestrial habitats from spray drift. The K_{OW}-based Aquatic Bioaccumulation Model (KABAM) v.1.0 is used to estimate potential bioaccumulation of *lambda*-cyhalothrin residues in an aquatic food web and the subsequent risks these residues pose to organisms consuming aquatic species.

1.3.2. Toxicity Assessment

The assessment endpoints include direct toxic effects on survival, reproduction, and growth of individuals, as well as indirect effects, such as reduction of the food source and/or modification of habitat. Federally-designated critical habitat has been established for the BCB, VELB, CTS-

CC, CTS-SB, TG, and DS. Primary constituent elements (PCEs) were used to evaluate whether *lambda*-cyhalothrin has the potential to modify designated critical habitat. The Agency evaluated registrant-submitted studies and data from the open literature to characterize the toxicity of *lambda*-cyhalothrin. The most sensitive toxicity value available from acceptable or supplemental studies for each taxon relevant for estimating potential risks to the assessed species and/or their designated critical habitat was used.

Section 4 summarizes the ecotoxicity data available for *lambda*-cyhalothrin. *Lambda*-cyhalothrin is highly toxic to freshwater and estuarine/marine invertebrates, very highly toxic to freshwater fish (surrogate for aquatic-phase amphibians), and highly toxic to estuarine/marine fish on an acute exposure basis. The chronic NOAECs for freshwater and estuarine/marine invertebrates are 0.00198 µg ai/L (based on number of young per female and adult survival) and 0.00022 µg ai/L (based on reproduction), respectively. The chronic NOAECs for freshwater and estuarine/marine fish are 0.031 µg ai/L (based on F_1 survival at 28 days, F_0 length at 56 days, male length and weigh at 300 days, and F_1 weight and length at 31 days) and 0.25 µg ai/L (based on weight), respectively.

Lambda-cyhalothrin is practically non-toxic to avian species (surrogate for terrestrial-phase amphibians and reptiles) on an acute oral and subacute dietary exposure basis, and moderately toxic to mammals on an acute oral exposure basis. The avian reproductive NOAEL is 5 mg ai/kg-diet (based on residues in the egg, liver and fat, number of eggs laid and set, egg fertility, and early embryonic mortalities) and the mammalian two-generation reproductive NOAEL is 1.5 mg ai/kg-day (30 mg ai/kg-diet) (based on decreased parental and pup body weight and body weight gain). It is classified as highly toxic to terrestrial invertebrates on an acute contact exposure basis (LD_{50} = 0.038µg ai/bee).

Aquatic non-vascular plants exposed to *lambda*-cyhalothrin have an EC_{50} of >300 mg ai/L. No ecotoxicity information is available for terrestrial plants, although efficacy studies from the open literature suggest it is not toxic to plants at field application rates of up to 0.02 lb a.i./A. These rates are at the lower end of registered agricultural uses and well below some of the residential uses (up to 2 lb ai/A).

1.3.3. Measures of Risk

Acute and chronic risk quotients (RQs) are compared to the Agency's Levels of Concern (LOCs) to identify instances where *lambda*-cyhalothrin use has the potential to adversely affect the assessed species or adversely modify their designated critical habitat. When RQs for a particular type of effect are below the LOCs, the pesticide is considered to have "no effect" on the species and its designated critical habitat. Where RQs exceed the LOCs, a potential to cause adverse effects or habitat modification is identified, leading to a conclusion of "may affect". If *lambda*-cyhalothrin use "may affect" the assessed species, and/or may cause effects to designated critical habitat, the best available additional information is considered to refine the potential for exposure and effects, and distinguish actions that are Not Likely to Adversely Affect (NLAA) from those that are Likely to Adversely Affect (LAA).

1.4. Summary of Conclusions

Based on the best available information, the Agency makes a **Likely to Adversely Affect** determination for the BCB, CCR, CFWS, CTS (all DPS), DS, SFGS, TG, and VELB, from the use of *lambda*-cyhalothrin. Additionally, the Agency has determined that there is the potential for modification of the designated critical habitat for the BCB, CTS-CC and CTS-SB, DS, TG, and VELB from the use of the chemical. A description of the baseline status and cumulative effects for San Francisco Bay listed species is provided in Attachment III.

A summary of the risk conclusions and effects determinations for each listed species assessed here and their designated critical habitat is presented in Table 1-1 and Table **1-2**. Use-specific determinations are provided in Table 1-3 and Table 1-4.

Table 1-1. Effects Determination Summary for Effects of *Lambda*-Cyhalothrin on the BCB, CCR, CFWS, CTS (all DPS), DS, SFGS, TG, and VELB

Species	Effects Determination	Basis for Determination
Bay Checkerspot Butterfly (*Euphydryas editha bayensis*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** ***Terrestrial*** There is the potential for *lambda*-cyhalothrin to directly affect the BCB based on the RQs exceeding the interim listed species terrestrial invertebrate LOC (acute) for all uses. Four major incidents were reported for terrestrial invertebrates. The probability of an individual effect is 1. **Potential for Indirect Effects** ***Terrestrial food items, habitat*** There is the potential for indirect effects to plant food and habitat sources because quantitative terrestrial plant toxicity data were not available. Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal.
Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus)*	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** ***Terrestrial*** There is the potential for *lambda*-cyhalothrin to directly affect the VELB based on RQs exceeding the interim listed terrestrial invertebrate LOC (acute) for all uses. Four major incidents were reported for terrestrial invertebrates. The probability of an individual effect is 1. **Potential for Indirect Effects** ***Terrestrial food items, habitat*** There is the potential for *lambda*-cyhalothrin to result in adverse effects to non-target terrestrial invertebrates, thus native pollinators of the elderberry also are likely to be negatively affected by *lambda*-cyhalothrin use and result in impaired plant reproduction. The elderberry plant serves as an obligate host for the VELB. There is the potential for indirect effects to plant food and habitat sources because quantitative terrestrial plant toxicity data were not available. Several

Species	Effects Determination	Basis for Determination
		plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible.
California Tiger Salamander (All 3 DPS) (*Ambystoma californiense)*	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Aquatic-phase (eggs, larvae, and adults) and terrestrial-phase (juveniles and adults) There is the potential for *lambda*-cyhalothrin to directly affect the CTS based on RQs exceeding the listed species LOCs (acute and chronic) for terrestrial-phase amphibians (using avian surrogate species data) and based on RQs exceeding the listed species LOCs (acute and chronic) for aquatic-phase amphibians (using freshwater fish surrogate species data). There were no major incidents reported for amphibians. The probability of an individual effect is between 491 and 1710.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover, and primary productivity and terrestrial prey items, habitat There is the potential for indirect effects from affected prey based on RQs exceeding listed and non-listed species LOCs (acute and chronic) for terrestrial invertebrates, freshwater invertebrates, and freshwater fish. Indirect effects from affected habitat are possible because the RQs exceed the listed and non-listed species LOCs (acute and chronic) for small mammals which could affect burrow availability. Small mammals are essential in creating the underground habitat that juvenile and adult CTS depend upon for food, shelter, and protection from the elements and predation. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal. Indirect effects toaquatic plants are not anticipated.
California Clapper Rail (*Rallus longirostris obsoletus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Terrestrial There is the potential for *lambda*-cyhalothrin to directly affect the CCR based on RQs exceeding the listed species LOCs (acute and chronic) for avian species. There were no major incidents reported for birds. The probability of an individual effect is between 11 and 22.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover, and primary productivity and terrestrial prey items, riparian habitat There is the potential for indirect effects from affected prey based on RQs exceeding the listed and non-listed LOCs (acute and chronic) for birds, mammals, terrestrial invertebrates, freshwater and estuarine/marine fish, and freshwater and estuarine/marine invertebrates. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not

Species	Effects Determination	Basis for Determination
		available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal. Indirect effects toaquatic plants are not anticipated.
California Freshwater Shrimp (*Syncaris pacifica*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Aquatic There is the potential for *lambda*-cyhalothrin to directly affect the CFWS based on RQs exceeding the listed species LOCs for freshwater invertebrates on an acute and chronic basis. There were three major incidents reported for freshwater invertebrates. The probability of an individual effect is between 1 and 7.
		Potential for Indirect Effects
		Aquatic prey items, habitat, cover, and primary productivity and terrestrial prey items, riparian habitat Indirect effects from affected prey are also possible based on RQs exceeding the listed and non-listed species LOCs for freshwater invertebrates. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal. Indirect effects toaquatic plants are not anticipated.
Delta Smelt (*Hypomesus transpacificus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Aquatic There is the potential for *lambda*-cyhalothrin to directly affect the DS based on RQs exceeding the listed species LOCs for freshwater and estuarine/marine fish on an acute and chronic basis. There were four major incidents reported for freshwater fish. The probability of an individual effect is between 1 and 58,500 for freshwater fish and 1 and 265,000,000 for estuarine/marine fish.
		Potential for Indirect Effects
		Aquatic prey items, habitat, cover, and primary productivity and terrestrial riparian habitat Indirect effects from affected prey are also possible based on RQs (acute and chronic) exceeding the listed and non-listed species LOCs for freshwater and estuarine/marine invertebrates There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible.

Species	Effects Determination	Basis for Determination
		In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal. Indirect effects toaquatic plants are not anticipated.
San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Terrestrial There is the potential for *lambda*-cyhalothrin to directly affect the SFGS based on RQs exceeding the listed species LOCs for reptiles (using avian surrogate species data), on an acute and chronic basis. There were no major incidents reported for reptiles. The probability of an individual effect is between 648 and 2490.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover, and primary productivity and terrestrial prey items, riparian habitat There is the potential for indirect effects from affected prey based on RQs exceeding the listed and non-listed LOCs (acute and chronic) for terrestrial-phase amphibians and reptiles (using avian surrogate species data), mammals, terrestrial invertebrates, freshwater fish/aquatic-phase amphibians, and freshwater invertebrates. Indirect effects from affected habitat are possible because the RQs exceeded the listed and non-listed species LOCs for mammals, for burrow availability. Small mammals are essential in creating the underground habitat that CTS depend upon for shelter, and aestivation. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal. Indirect effects toaquatic plants are not anticipated.
Tidewater Goby (*Eucyclogobius newberryi*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Aquatic There is the potential for *lambda*-cyhalothrin to directly affect the TG based on RQs exceeding the listed species LOCs (acute and chronic) for freshwater and estuarine/marine fish on an acute and chronic basis. There were four major incidents reported for freshwater fish. The probability of an individual effect is between 1 and 58,500 for freshwater fish and 1 and 265,000,000 for estuarine/marine fish.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover, and primary productivity and Terrestrial riparian habitat Indirect effects from affected prey are also possible based on RQs exceeding the listed and non-listed LOCs for freshwater and estuarine/marine invertebrates. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for

Species	Effects Determination	Basis for Determination
		other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal. Indirect effects toaquatic plants are not anticipated.

Table 1-2. Effects Determination Summary for the Critical Habitat Impact Analysis

Designated Critical Habitat for:	Effects Determination	Basis for Determination
Bay Checkerspot Butterfly	Habitat Modification	There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal.
California Tiger Salamander Central California Distinct Population Segment	Habitat Modification	Habitat effects are possible because the RQs exceeded the LOCs for mammal burrow availability. Small mammals are essential in creating the underground habitat that juvenile and adult CTS depend upon for food, shelter, and protection from the elements and predation. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal.
California Tiger Salamander Santa Barbara County Distinct Population Segment	Habitat Modification	Habitat effects are possible because the RQs exceeded the LOCs for mammal burrow availability. Small mammals are essential in creating the underground habitat that juvenile and adult CTS depend upon for food, shelter, and protection from the elements and predation. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal.
Delta Smelt	Habitat Modification	There is the potential for indirect effects to the DS because of a reduction in the food supply, based on direct and indirect effects to aquatic invertebrates. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not

		available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal.
Tidewater Goby	Habitat Modification	There is the potential for indirect effects to the DS because of a reduction in the food supply, based on direct and indirect effects to aquatic invertebrates. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal.
Valley Elderberry Longhorn Beetle	Habitat Modification	There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. The VELB has an obligate relationship with the elderberry. Indirect effects may occur because of the direct effects to terrestrial invertebrates, which may affect pollination and seed dispersal of the elderberry. Based on the information provided in the VELB Status and Life History document prepared by the Fish and Wildlife Services, any human disturbance that adversely affects the beetle results in modification of critical habitat (1980 Federal Register Vol. 45, No. 155).

Table 1-3. Use Specific Summary of the Potential for Adverse Effects to Aquatic Taxa

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	DS, TG and Estuarine/ Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Freshwater Benthic Invertebrates[6]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Agricultural/ farm premises (crack and crevice)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Alfalfa (aerial)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Alfalfa (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Almond (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Almond (trunk drench)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, trees (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Nectarine, peach, cherry trees trunk drench (trunk drench)	No	No	No	No	Yes	Yes	No	Yes	Yes[7]	Yes	No	No	No
Apple trees (trunk drench)	No	No	No	No	Yes	Yes	No	Yes	Yes[7]	No	No	No	No
Animal housing premises, paths/patios (crack and crevice)	Yes[7]	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Household/ domestic	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	DS, TG and Estuarine/ Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Freshwater Benthic Invertebrates[6]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
dwellings, outdoor premises (crack and crevice)													
Apricot, loquat, mayhaw, plum, quince (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Bean, groundcherry, pea, pepino, pepper (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Eggplant (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Barley (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Barley (G)/ 2 app @ 0.031 lb ai/A (7-days)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Bell pepper, catjang (Jerusalem/marble pea) (aerial)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Bell pepper, catjang (Jerusalem/ marble	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	DS, TG and Estuarine/ Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Freshwater Benthic Invertebrates[6]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
pea)(ground)													
Mustard cabbage (gai choy, pak-choi) (ground)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Brassica (head and stem) vegetables (aerial)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Brassica (head and stem) vegetables (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Tomato, tomatillo (ground)	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Broccoli, cauliflower (ground)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Cabbage, kohlrabi (ground)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Mustard (ground)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Brussels sprouts (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Brussels sprouts (ground)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Buckwheat, oat, rye (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Buckwheat, oat, rye (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Canola/rape	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	DS, TG and Estuarine/ Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Freshwater Benthic Invertebrates[6]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	**Chronic**	**Acute**	**Chronic**	**Acute**	**Chronic**	**Acute**	**Chronic**	**Acute**	**Chronic**	**Acute**	**Chronic**	
(aerial)													
Canola/rape (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Grass forage/fodder /hay, pastures, rangeland (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Grass forage/fodder /hay, pastures, rangeland (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Cereal grains, triticale, wheat (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Cereal grains, triticale, wheat (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Cole crops (aerial)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Cole crops (ground)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Onion (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Onion (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Commercial/ industrial lawns, ornamental lawns and turf, recreation area lawns (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Commercial/ industrial	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	DS, TG and Estuarine/ Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Freshwater Benthic Invertebrates[6]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
lawns, ornamental lawns and turf, recreation area lawns (spot treatment)													
Conifers (plantations/ nurseries) (ground)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Conifers (seed orchard) (ground)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Corn (field) (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Corn (field) (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Corn (field, pop) (in-furrow)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Corn (sweet) (in-furrow)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Corn (sweet) (dust)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Corn (sweet) (aerial)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Cotton (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Cotton (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Cucurbit vegetables (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Cucurbit vegetables	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	DS, TG and Estuarine/ Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Freshwater Benthic Invertebrates[6]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
(ground)													
Ear tags	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Filbert, pecan, walnut (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Filbert, pecan, walnut (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Filbert, pecan, walnut (dust)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Forest plantings (ground)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Fruiting vegetables (aerial)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Fruiting vegetables (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Garlic (aerial)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Golf course turf, ornamental sod farm (ground)	No	No	Yes[7]	No	Yes	Yes	Yes[7]	Yes	Yes	Yes	Yes[7]	Yes	No
Golf course turf, ornamental sod farm (mound)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Grasses grown for seed (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Legume vegetables (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Legume vegetables	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	DS, TG and Estuarine/ Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Freshwater Benthic Invertebrates[6]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
(ground)													
Peanuts, root and tuber vegetables (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Peanuts, root and tuber vegetables (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Lettuce (aerial)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Lettuce (ground)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Nonagricultural uncultivated areas/soils (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Ornamental and/or shade trees (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Ornamental and/or shade trees, ground cover, herbaceous plants, non-flowering plants, woody shrubs and vines, rose (dust)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Paved areas (private roads/ sidewalks (ground)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	DS, TG and Estuarine/ Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Freshwater Benthic Invertebrates[6]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Pome and stone fruit (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Pome and stone fruit (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Potato (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Potato (ground)	No	No	Yes[7]	No	Yes	Yes	Yes[7]	Yes	Yes	Yes	Yes[7]	Yes	No
Recreational areas (banding)	No	No	Yes[7]	No	Yes	Yes	Yes[7]	Yes	Yes	Yes	Yes[7]	Yes	No
Recreational areas (crack and crevice/spot treatment)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Residential lawns (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Residential lawns (mound)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Rice (ground)	Yes[7]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Seed orchard trees (ground)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Sorghum (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Sorghum (ground)	Yes[7]	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Soybean (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Soybean (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Tree nuts (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Tree nuts (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Sunflower (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	DS, TG and Estuarine/ Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Freshwater Benthic Invertebrates[6]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Sunflower (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Right-of-way (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Airports/ landing fields	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Golf course turf, ornamental sod farm (granular spot treatment)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Grasses grown for seed (granular spot treatment)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Nonagricultural uncultivated areas/soil (granular band/broadcast/ perimeter/spot treatment)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Nonagricultural uncultivated areas/soil (granular mound treatment)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

1 A yes in this column indicates a potential for direct effects to DS and TG and indirect effects to CCR.
2 A yes in this column indicates a potential for direct effects to DS, TG and indirect effects to SFGS, and CCR. A yes also indicates a potential for direct and indirect effects for the CTS-CC, CTS-SC, and CTS-SB.
3 A yes in this column indicates a potential for direct effects to the CFWS and indirect effects to the CFWS, SFGS, CCR, CTS-CC, CTS-SB, CTS-SC, TG, and DS.
4 A yes in this column indicates a potential for indirect effects to CCR, TG, and DS.

5 A yes in this column indicates a potential for indirect effects to SFGS, CCR, CTS-CC, CTS-SC, CTS-SB, TG, DS, and CFWS.
6 A yes in this column indicates a potential for indirect effects to CFWS, SFGS, CCR, CTS-CC, CTS-SB, CTS-SC, TG, and DS.
7 No indirect effects are expected (prey or habitat).

Table 1-4. Use Specific Summary of the Potential for Adverse Effects to Terrestrial Taxa

Uses	Potential for Effects to Identified Taxa Found in the Terrestrial Environment										
	Small Mammals[1]		CCR and Small Birds[2]		CTS-CC, CTS-SC, CTS-SB and Amphibians[3]		SFGS and Reptiles[4]		BCB, VELB, and Invertebrates (Acute)[5]	Dicots[6]	Monocots[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic			
Agricultural/farm premises, crack and crevice/surface spray/perimeter treatment	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Alfalfa, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Almond, ground dust and spray	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, ground dust and spray	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Almond, nectarine, peach, cherry, trunk drench	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Apple, trunk drench	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Animal housing premises, paths/patios, barrier treatment/crack and crevice	Yes	Yes	Yes[7]	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Household/domestic dwellings outdoor premises, barrier treatment/crack and crevice	Yes	Yes	Yes	Yes	Yes[7]	Yes	Yes[7]	Yes	Yes	Yes	Yes
Apricot, bean, eggplant, groundcherry, loquat, mayhaw, pea, pepino, pepper, plum,	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes

Uses	Potential for Effects to Identified Taxa Found in the Terrestrial Environment										
	Small Mammals[1]		CCR and Small Birds[2]		CTS-CC, CTS-SC, CTS-SB and Amphibians[3]		SFGS and Reptiles[4]		BCB, VELB, and Invertebrates (Acute)[5]	Dicots[6]	Monocots[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic			
quince, ground spray/dust											
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut, ground spray/dust	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Barley, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Bell pepper, catjang (Jerusalem/marble pea) (aerial/ground spray/dust)	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Mustard cabbage (gai choy, pak-choi), ground spray/dust	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Brassica (head and stem) vegetables, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Tomato, tomatillo, ground spray/dust	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Broccoli, cauliflower, ground spray/dust	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Cabbage, kohlrabi, ground spray/dust	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Mustard	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Brussels sprouts, ground spray	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Brussels sprouts, dust	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Buckwheat, oat, rye, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Canola/rape, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Grass forage/fodder /hay, pastures, rangeland,	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes

Uses	Potential for Effects to Identified Taxa Found in the Terrestrial Environment										
	Small Mammals[1]		CCR and Small Birds[2]		CTS-CC, CTS-SC, CTS-SB and Amphibians[3]		SFGS and Reptiles[4]		BCB, VELB, and Invertebrates (Acute)[5]	Dicots[6]	Monocots[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic			
aerial/ground											
Cereal grains, triticale, wheat, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Cole crops, aerial/ground/dust	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Onion, aerial/ground/dust	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Commercial/ industrial lawns, ornamental lawns and turf, recreation area lawns, ground	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Commercial/ industrial lawns, ornamental lawns and turf, recreation area lawns, mound/spot treatment	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Conifers (plantations/ nurseries), ground	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Conifers (seed orchard), ground	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Corn (field), aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Corn (field, pop), soil in furrow/T-banding	No	No	No	No	No	No	No	No	Yes	Yes	Yes
Corn (sweet), soil in furrow/T-banding	No	No	No	No	No	No	No	No	Yes	Yes	Yes
Corn (sweet), dust	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Corn (sweet), spray	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Cotton, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Cucurbit vegetables, aerial/ground	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Ear tags	No	No	No	Yes	No	No	No	No	No	No	No
Filbert, pecan, walnut, aerial/ground	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes

Uses	Potential for Effects to Identified Taxa Found in the Terrestrial Environment										
	Small Mammals[1]		CCR and Small Birds[2]		CTS-CC, CTS-SC, CTS-SB and Amphibians[3]		SFGS and Reptiles[4]		BCB, VELB, and Invertebrates (Acute)[5]	Dicots[6]	Monocots[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic			
Filbert, pecan, walnut, dust	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Forest plantings, ground	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Fruiting vegetables, aerial/ground	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Garlic	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Golf course turf, ornamental sod farm, ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Golf course turf, ornamental sod farm, mound	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Grasses grown for seed, ground	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Legume vegetables, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Peanuts, root and tuber vegetables, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Lettuce, aerial/ground	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Nonagricultural uncultivated areas/soils, aerial	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Ornamental and/or shade trees, ground	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Ornamental and/or shade trees, ground cover, herbaceous plants, non flowering plants, woody shrubs and vines, rose, ground/dust/	Yes	Yes	Yes[7]	Yes	Yes[7]	Yes	Yes[7]	Yes	Yes	Yes	Yes
Paved areas (private roads/sidewalks),	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes

Uses	Potential for Effects to Identified Taxa Found in the Terrestrial Environment										
	Small Mammals[1]		CCR and Small Birds[2]		CTS-CC, CTS-SC, CTS-SB and Amphibians[3]		SFGS and Reptiles[4]		BCB, VELB, and Invertebrates (Acute)[5]	Dicots[6]	Monocots[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic			
barrier/perimeter treatment											
Pome and stone fruit, aerial/ground	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Potato, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Recreational areas, band treatment	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Recreational areas, crack and crevice/spot treatment	Yes	Yes	Yes	Yes	Yes[7]	Yes	Yes[7]	Yes	Yes	Yes	Yes
Rice, ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Seed orchard trees, ground	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Sorghum, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Soybean, aerial/ground	No	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Tree nuts, aerial/ground	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Sunflower, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Right-of-way, ground	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Airports/landing fields, ground granular	Yes[7]	No	No	No	No	No	No	No	No	Yes	Yes
Golf course turf, ornamental sod farm, granular spot treatment	Yes[7]	No	No	No	No	No	No	No	No	Yes	Yes
Grasses grown for seed, granular spot treatment	Yes[7]	No	No	No	No	No	No	No	No	Yes	Yes
Nonagricultural uncultivated areas/soil, granular band/broadcast/ perimeter/spot treatment	Yes[7]	No	No	No	No	No	No	No	No	Yes	Yes
Nonagricultural uncultivated areas/soil, granular mound	Yes[7]	No	No	No	No	No	No	No	No	Yes	Yes

Uses	Potential for Effects to Identified Taxa Found in the Terrestrial Environment										
	Small Mammals[1]		CCR and Small Birds[2]		CTS-CC, CTS-SC, CTS-SB and Amphibians[3]		SFGS and Reptiles[4]		BCB, VELB, and Invertebrates (Acute)[5]	Dicots[6]	Monocots[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic			
treatment											
Residential lawns, granular ground	Yes[7]	No	No	No	No	No	No	No	No	Yes	Yes
Residential lawns, granular mound treatment	Yes[7]	No	No	No	No	No	No	No	No	Yes	Yes

1 A yes in this column indicates a potential for indirect effects to SFGS, CCR, CTS-CC, CTS-SC, CTS, and CTS-SB.
2 A yes in this column indicates a potential for direct effects to CCR and indirect effects to the CCR, SFGS, CTS-CC, CTS-SC, and CTS-SB.
3 A yes in this column indicates a potential for direct effects to CTS-CC, CTS-SC, CTS-SB, and indirect effects to CTS-CC, CTS-SC, CTS-SB, SFGS, and CCR.
4 A yes in this column indicates the potential for direct and indirect effects to SFGS, and other reptiles.
5 A yes in this column indicates a potential for direct effect to BCB and VELB and indirect effects to SFGS, CCR, CTS-CC, CTS-SC, and CTS-SB.
6 A yes in this column indicates a potential for indirect effects to BCB, VELB, SFGS, CCR, CTS-CC, CTS-SC, CTS-SB, TG, DS, and CFWS. For the BCB and VELB this is based on the listed species LOC because of the obligate relationship with terrestrial monocots and dicots. For other species, the LOC exceedances are evaluated based on the LOC for non-listed species.
7 No indirect effects are expected (prey and habitat).

Based on the conclusions of this assessment, a formal consultation with the U. S. Fish and Wildlife Service under Section 7 of the Endangered Species Act should be initiated. When evaluating the significance of this risk assessment's direct/indirect and adverse habitat modification effects determinations, it is important to note that pesticide exposures and predicted risks to the listed species and its resources (*i.e.*, food and habitat) are not expected to be uniform across the action area. In fact, given the assumptions of drift, pesticide exposure and associated risks to the species and its resources are expected to decrease with increasing distance away from the treated field or site of application. Evaluation of the implication of this non-uniform distribution of risk to the species would require information and assessment techniques that are not currently available. Examples of such information and methodology required for this type of analysis would include the following:

- Enhanced information on the density and distribution of federally threatened BCB, DS, VELB, and CTS-CC, and federally endangered CCR, CFWS, CTS-SC, CTS-SB, SFGS, and TG life stages within the action area and/or applicable designated critical habitat. This information would allow for quantitative extrapolation of the present risk assessment's predictions of individual effects to the proportion of the population extant within geographical areas where those effects are predicted. Furthermore, such population information would allow for a more comprehensive evaluation of the significance of potential resource impairment to individuals of the assessed species.
- Quantitative information on prey base requirements for the assessed species. While existing information provides a preliminary picture of the types of food sources utilized by the assessed species, it does not establish minimal requirements to sustain healthy individuals at varying life stages. Such information could be used to establish biologically relevant thresholds of effects on the prey base, and ultimately establish geographical limits to those effects. This information could be used together with the density data discussed above to characterize the likelihood of adverse effects to individuals.
- Information on population responses of prey base organisms to the pesticide. Currently, methodologies are limited to predicting exposures and likely levels of direct mortality, growth or reproductive impairment immediately following exposure to the pesticide. The degree to which repeated exposure events and the inherent demographic characteristics of the prey population play into the extent to which prey resources may recover is not predictable. An enhanced understanding of long-term prey responses to pesticide exposure would allow for a more refined determination of the magnitude and duration of resource impairment, and together with the information described above, a more complete prediction of effects to individual species and potential modification to critical habitat.

2. Problem Formulation

Problem formulation provides a strategic framework for the risk assessment. By identifying the important components of the problem, it focuses the assessment on the most relevant life history stages, habitat components, chemical properties, exposure routes, and endpoints. The structure of this risk assessment is based on guidance contained in U.S. EPA's *Guidance for Ecological*

Risk Assessment (USEPA, 1998), the Services' *Endangered Species Consultation Handbook* (USFWS/NMFS, 1998) and is consistent with procedures and methodology outlined in the Overview Document (USEPA, 2004) and reviewed by the U.S. Fish and Wildlife Service and National Marine Fisheries Service (USFWS/NMFS/NOAA, 2004).

2.1. Purpose

The purpose of this endangered species assessment is to evaluate potential direct and indirect effects on individuals of the federally threatened BCB, DS, VELB, and CTS-CC, and federally endangered CCR, CFWS, CTS-SC, CTS-SB, SFGS, and TG arising from FIFRA regulatory actions regarding agricultural and non-agricultural uses of *lambda*-cyhalothrin. This ecological risk assessment has been prepared consistent with a stipulated injunction in the case *Center for Biological Diversity (CBD) vs. EPA et al*. (Case No. 07-2794-JCS) entered in Federal District Court for the Northern District of California on May 17, 2010.

In this assessment, direct and indirect effects to the BCB, DS, VELB, CTS-CC, CCR, CFWS, CTS-SC, CTS-SB, SFGS, and TG and potential modification to designated critical habitat for the BCB, DS, VELB, CTS-CC, CTS-SB, and TG are evaluated in accordance with the methods described in the Agency's Overview Document (USEPA, 2004).

The BCB was listed as threatened in 1987 by the USFWS. The species primarily inhabits native grasslands on serpentine outcrops around the San Francisco Bay Area in California. The PCEs for BCBs are areas on serpentinite-derived soils that support the primary larval host plant (*i.e*., dwarf plantain) and at least one of the species' secondary host plants. Additional BCB PCE's include the presence of adult nectar sources, aquatic features that provide moisture during the spring drought and areas that provide adequate shelter during the summer diapause.

The VELB was listed as threatened in 1980 by the USFWS. The species is found in areas with elderberry shrubs throughout California's Central Valley and associated foothills on the east and the watershed of the Central Valley on the west. The PCEs for the VELBs include areas that contain its host plant (*i.e.,* elderberry trees).

The DS was listed as threatened on March 5, 1993 (58 FR 12854) by the USFWS (USFWS, 2007). DS are mainly found in the Suisun Bay and the Sacramento-San Joaquin estuary near San Francisco Bay. During spawning DS move into freshwater. The PCEs for DSs are shallow fresh or brackish backwater sloughs for egg hatching and larval viability, suitable water with adequate river flow for larval and juvenile transport, suitable rearing habitat, and unrestricted access to suitable spawning habitat.

There are currently three CTS Distinct Population Segments (DPSs): the Sonoma County (SC) DPS, the Santa Barbara (SB) DPS, and the Central California (CC) DPS. Each DPS is considered separately in the risk assessment as they occupy different geographic areas. The main difference in the assessment will be in the spatial analysis. The CTS-SB was listed by the USFWS as endangered in 2000, the CTS-SC in 2002, and the CTS-CC as threatened in 2004. The CTS-SB and CTS-SC were down listed from endangered to threatened in 2004 by the USFWS, however, the down listing was vacated by the U.S. District Court. Therefore, the

Sonoma and Santa Barbara DPSs are currently listed as endangered while the CTS-CC is listed as threatened. All CTS populations utilize vernal pools, semi-permanent and permanent ponds, and the terrestrial environment in California. The aquatic environment is essential for breeding and reproduction and mammal burrows are also important habitat for aestivation. The PCEs for CTSs are standing bodies of freshwater sufficient for the species to complete the aquatic portion of its life cycle that are adjacent to barrier-free uplands that contain small mammal burrows. An additional PCE is upland areas between sites (as described above) that allow for dispersal of the species.

The CCR was listed by the USFWS as an endangered species in 1970. The species is found only in California in coastal wetlands along the San Francisco estuary and Suisun Bay.

The CFWS was listed as endangered in 1988 by the USFWS. The CFWS inhabits freshwater streams in Central California in the lower Russian River drainage and westward to the Pacific Ocean and coastal streams draining into Tomales Bay and southward into the San Pablo Bay.

The SFGS was listed as endangered in 1967 by the USFWS. The species is endemic to the San Francisco Peninsula and San Mateo County in California in densely vegetated areas near marshes and standing open water.

The TG was listed as endangered on March 7, 1994 (59 FR 5494) by the USFWS. The animals are benthic in nature and all life stages are found in lagoons, estuaries, and marshes in areas of low to moderate salinity[2]. The TG also occurs in freshwater streams up gradient and tributary to brackish habitats (68920 FR Vol 71, No 228).

In accordance with the Overview Document, provisions of the ESA, and the Services' *Endangered Species Consultation Handbook*, the assessment of effects associated with registrations of *lambda*-cyhalothrin is based on an action area. The action area is the area directly or indirectly affected by the federal action, as indicated by the exceedance of the Agency's Levels of Concern (LOCs). It is acknowledged that the action area for a national-level FIFRA regulatory decision associated with a use of *lambda*-cyhalothrin may potentially involve numerous areas throughout the United States and its Territories. However, for the purposes of this assessment, attention will be focused on relevant sections of the action area including those geographic areas associated with locations of the BCB, DS, VELB, CTS-CC, CCR, CFWS, CTS-SC, CTS-SB, SFGS, and TG and their designated critical habitat within the state of California. As part of the "effects determination," one of the following three conclusions will be reached separately for each of the assessed species in the lawsuits regarding the potential use of *lambda*-cyhalothrin in accordance with current labels:

- "No effect";
- "May affect, but not likely to adversely affect"; or
- "May affect and likely to adversely affect".

Additionally, for habitat and PCEs, a "No Effect" or a "Habitat Modification" determination is made.

[2] USFWS 2011. http://www.fws.gov/arcata/es/fish/Goby/goby.html

A description of routine procedures for evaluating risk to the San Francisco Bay Species is provided in Attachment I.

2.2. Scope

The end result of the EPA pesticide registration process (*i.e.*, the FIFRA regulatory action) is an approved product label. The label is a legal document that stipulates how and where a given pesticide may be used. Product labels (also known as end-use labels) describe the formulation type (*e.g.*, liquid or granular), acceptable methods of application, approved use sites, and any restrictions on how applications may be conducted. Thus, the use or potential use of *lambda*-cyhalothrin in accordance with the approved product labels for California is "the action" relevant to this ecological risk assessment.

Lambda-cyhalothrin is a non-systemic insecticide that is applied to numerous field and orchard crops; non-cultivated land; turf and other ornamentals; building exteriors; and other non-agricultural uses. Applications include ground and aerial spray, dust, and chemigation applications to agricultural crops; outdoor crack and crevice treatments; sprays to lawns and ornamentals, trunk drenches to orchard crops; spot treatments to ant mounds; tree injections; and perimeter applications. Common pests are aphids, caterpillars, and beetles on a wide variety of crops, and mosquitoes and cockroaches in public health settings.

Although current registrations of *lambda*-cyhalothrin allow for use nationwide, this ecological risk assessment and effects determination addresses currently registered uses of *lambda*-cyhalothrin in portions of the action area that are reasonably assumed to be biologically relevant to the BCB, DS, VELB, CTS-CC, CCR, CFWS, CTS-SC, CTS-SB, SFGS, and TG and their designated critical habitat. Further discussion of the action area for the BCB, DS, VELB, CTS-CC, CCR, CFWS, CTS-SC, CTS-SB, SFGS, and TG and their critical habitat is provided in Section 2.7.

2.2.1. Evaluation of Degradates and Other Stressors of Concern

Major degradation products of *lambda*-cyhalothrin include Compounds Ia and Ib, Compound IV, Compound V and Compound XV (for structures see Table 2-3). Degradate toxicity data are not available for this assessment. However, Compounds Ia and Ib, Compound IV, Compound V occur as a result of the ester bond breakage of the parent molecule resulting in significantly decreased toxicity of those degradates relative to the parent compound. Compound XV, however, is structurally similar to the parent compound, and QSAR-based (Quantitative Structure Activity Relationship) modeling in the program ECOSAR (version 1.0) (Ecological Structure Activity Relationships) supports similar toxicity. Within the pyrethroid ECOSAR class, toxicity values were in the same order of magnitude for fish, daphnids, and green algae [Parent EC/LC_{50} = 0.002 mg/L, Compound XV EC/LC_{50} = 0.004 mg/L, for all three organisms]. This assessment was performed on the parent *lambda*-cyhalothrin only because 1) there were little data for the degradate of concern (Compound XV) which would have contributed uncertainty to the conclusions of the risk assessment; and 2) evaluating the parent only was sufficient to identify risk to all of the assessed species and resulted in much greater certainty in those conclusions. The degradate of concern (Compound XV) and uncertainties associated with this approach are discussed in Section 6.1.8.

2.2.2. Evaluation of Mixtures

The Agency does not routinely include an evaluation of mixtures of active ingredients, either those mixtures of multiple active ingredients in product formulations or those in the applicator's tank, in its risk assessments. In the case of the product formulations of active ingredients (that is, a registered product containing more than one active ingredient), each active ingredient is subject to an individual risk assessment for a regulatory decision regarding the active ingredient on a particular use site. If effects data are available for a formulated product containing more than one active ingredient, they may be used qualitatively or quantitatively in accordance with the Agency's Overview Document and the Services' Evaluation Memorandum (USEPA, 2004; USFWS/NMFS/NOAA, 2004).

Lambda-cyhalothrin has 31 registered products that contain multiple active ingredients. Analysis of the available open literature and acute oral mammalian LD_{50} data for multiple active ingredient products relative to the single active ingredient is provided in Appendix A. This data set is limited and a qualitative analysis does not support any broad conclusions about the interactive nature of *lambda*-cyhalothrin in combination with other pesticides.

In the case of *lambda*-cyhalothrin, a very simple analysis of potential enhanced toxicity of the active ingredient in the presence of other chemicals was conducted by simply evaluating statistical differences between the LD_{50} values based on 95% confidence intervals. Differences in the LD_{50} values via this comparison were noted; however, a conclusive analysis of the nature of the interaction (e.g., additivity, synergism) would require a much more extensive analysis. More specifically, *lambda*-cyhalothrin is co-formulated with piperonyl butoxide, a known synergist when combined with pyrethroids, in three of the products (ear tags and pour ons). When all of the 31 registered product LD_{50}s, and associated confidence intervals, are adjusted for the percent *lambda*-cyhalothrin (a conservative assumption that attributes all of the observed toxicity of the formulated product to *lambda*-cyhalothrin), the adjusted 95% confidence intervals of the formulated product do not overlap with the TGAI *lambda*-cyhalothrin LD_{50} in eight instances (registration numbers: 100-1276, 100-1320, 100-1334, 100-1336, 100-1366, 100-1367, 100-1402, and 62719-615) indicating that the products may be more toxic than *lambda*-cyhalothrin technical. In two instances, the adjusted 95% confidence intervals for the formulated product overlap with the *lambda*-cyhalothrin technical toxicity values, indicating they are likely the same. For all other formulated products, the LD_{50} was non-definitive, thus there are no confidence intervals and the toxicity values cannot be compared (Appendix A).

In contrast, one open literature study (Wang et al. 2005) examined the effects of a number of chemicals mixed with abamectin, a known synergist for many chemicals; it was found that there were no significant increases in toxicological effects when *lambda*-cyhalothrin and abamectin were mixed. Another open literature study (Hardke et al. 2005) found that *lambda*-cyhalothrin (insecticide) mixed with glyphosate (herbicide) resulted in significantly lower phytotoxicity damage than glyphosate alone. Although the target organisms (insects versus plants) are not the same, this study documents an instance where mixing *lambda*-cyhalothrin with another chemical decreases the efficacy of the other chemical. Measurements of *lambda*-cyhalothrin's efficacy were not performed in this study. Given the limited data that are available for *lambda*-cyhalothrin mixtures, this assessment is based on the toxicity of *lambda*-cyhalothrin only; however, acute toxicity to mammals will be analyzed for the product with the highest mammal oral toxicity – Cobalt Advanced (adjusted LD_{50} = 2.6 mg ai/kg-bw versus *lambda*-cyhalothrin technical LD_{50} = 56 mg ai/kg-bw) in Section 5.3.

2.3. Previous Assessments

The most recent comprehensive EPA review of *lambda*-cyhalothrin was issued in November 2010, with the development of the Problem Formulation Scoping Document (D379543) in support of Registration Review for *lambda*-cyhalothrin and *gamma*-cyhalothrin. *Lambda*-cyhalothrin is very highly toxic to fish, aquatic invertebrates, and terrestrial invertebrates (including beneficial insects and pollinators). The document identified several data gaps including uncertainties about the ecological risks to benthic aquatic organisms via sediment exposure, aquatic invertebrates via water column exposure, and chronic exposures to fish and aquatic plants. Data were also not available for passerine birds and terrestrial plants. Uncertainties were identified for several fate properties including anaerobic soil and anaerobic aquatic metabolism and the persistence of *lambda*-cyhalothrin in the environment. The bioconcentration factor for *lambda*-cyhalothrin is 4600x in fish with moderate depuration.

A number of new use risk assessments were performed between 2002 and 2008. Most notable was a risk assessment in 2002 for several new uses of *lambda*-cyhalothrin (peas and beans (succulent and dried), fruiting vegetables, canola, sugarcane, sorghum, wheat, wheat hay and other small grains, peanut, pome fruits, stone fruits, tree nuts, tobacco, termite barrier, non-cropland, and conifers and deciduous trees (plantations, nurseries, and seed orchards) (USEPA 2002 -D262918+). Listed and non-listed species LOCs were exceeded for freshwater fish and invertebrates, and estuarine invertebrates. Listed species LOCs were exceeded for estuarine/marine fish. Chronic listed and non-listed species LOCs were exceeded for birds, but acute risks were not identified. *Lambda*-cyhalothrin presented acute and chronic risks to mammals, in addition to being highly toxic to honeybees.

In 2006, a risk assessment on cereal grains, cucurbit vegetables, grass forage, fodder and hay, wild rice, and tuberous and corm vegetables was performed (USEPA 2006 -D324224+). The terrestrial assessment resulted in similar conclusions to the 2002 assessment; however, the aquatic assessment yielded higher EECs and highlighted particular risks towards benthic communities and aquatic invertebrates via water column exposure. For aquatic plants, the RQs were well below the LOC.

In November of 2008, the Agency issued an incremental assessment for the use of *lambda*-cyhalothrin on non-bearing citrus orchards (USEPA 2008 -D355940). It relied extensively on the 2002 and 2006 risk assessments for the chemical.

Other reviews were issued for *lambda*-cyhalothrin prior to 2002. These included uses on rice, cotton, turf and ornamentals, uses in and around buildings, soybeans, and sunflowers.

A FIFRA Scientific Advisory Panel (SAP) in 1999 (http//www.epa.gov/scipoly/sap/meetings/1999/022399_mtg.htm#materials) examined the sediment toxicity and fate of synthetic pyrethroids. The Panel supported the method of using data from a few pyrethroids to extrapolate information on the toxicity of other pyrethroids. The SAP recommended that the Agency reconsider Koc as a measure of the binding potential of synthetic pyrethroids to sediment and soil because the use of Kd alone limits extrapolation to experimental conditions while Koc "allows one to estimate partitioning across a wide variety of soil/sediment types" (USEPA 1999). The Panel indicated that the bioconcentration data for *Daphnia* and *Hyalella* should be sufficient to predict bioconcentration of pyrethroids in lieu of the biota-sediment accumulation factor. Finally, the SAP indicated that use of a solid phase micro extraction (SPME) method to determine the dissolved concentration in water could be used to account for sorption of pyrethroids to organic carbon and colloids present in the water column in the measurement of bioconcentration factors.

In 2009, OPP presented a "Proposed Common Mechanism Grouping for the Pyrethrins and Synthetic Pyrethroids" to a FIFRA SAP, relative to human health effects. OPP proposed two subgroups based on Type I or Type II effects related to sodium current tails and neurobehavioral impact, with esfenvalerate and fenpropathrin showing symptoms of both types. The Panel indicated that substances with mixed characteristics could be included in both groups (see p. 18 of SAP minutes, USEPA 2009). *Lambda*-cyhalothrin is a Type II synthetic pyrethroid; it is cyano substituted in the alpha position. Information on the SAP is available in the docket (with non-copyright material available at http://www.regulations.gov) under EPA-HQ-OPP-2008-0489.

2.4. Environmental Fate Properties

Table 2-1 lists the physical-chemical properties of *lambda*-cyhalothrin. Table 2-2 lists the other environmental fate properties of *lambda*-cyhalothrin.

For background, *lambda*-cyhalothrin is a mixture of isomers of cyhalothrin. *Lambda*-cyhalothrin's structure has three rings, two phenyl rings attached to each other by an oxygen atom (phenyl and phenoxy), and a cyclopropyl ring. The chemistry of cyhalothrin may be dictated by its ester moiety. The structure of the molecule has three chiral centers and a double bond which raise the number of possible isomers to $2^4 = 16$. However, *lambda*-cyhalothrin consists only of two of these isomers. *Lambda*-cyhalothrin has a 2-chloro-3,3,3-trifluoropropenyl group and it is 2,2-dimethyl substituted in the cyclopropane ring. Chemically, it is the (S)-alcohol (Z)-(1R)-*cis* acid and the (R)-alcohol (Z)-(1S)-*cis* acid out of 16 isomeric esters. *Gamma*-cyhalothrin is a single isomer out of 16 possibilities of its structure, and one of the two isomers in *lambda*-cyhalothrin. Chemically, it is the (S)-alcohol (Z)-(1R)-*cis* acid out of 16 isomeric esters. Cyhalothrin consists of four of the 16 possible isomers in its structure, of which two of them appear in *lambda*-cyhalothrin and one appears in *gamma*-cyhalothrin. Cyhalothrin is not a registered pesticide in the U.S. In general, the physicochemical and environmental fate properties of cyhalothrin, *lambda*-cyhalothrin and *gamma*-cyhalothrin may be expected to be similar to each other.

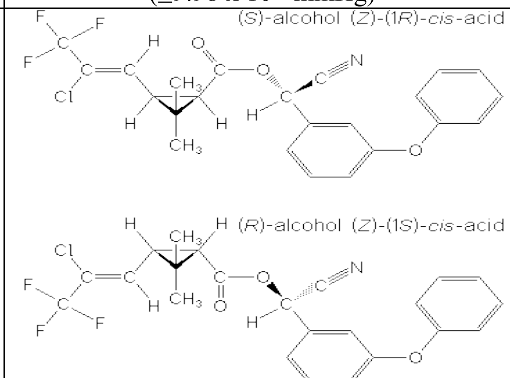
Lambda-cyhalothrin has a molecular weight of 449.9 g/mol. It has a low water solubility (5 µg/L) and a high octanol/water partition coefficient (log Kow ~ 7). Based on the latter, it appears that *lambda*-cyhalothrin has the potential to bioaccumulate in fish and other aquatic organisms. With a vapor pressure of 9.98 x 10^{-7} mmHg, it is considered non-volatile under field conditions and is unlikely to volatilize from dry or wet surfaces. The potential to volatilize may be further attenuated in the environment by its tendency to bind to organic matter (e.g., soils, sediments, or organic matter and particulate in natural water).

Lambda-cyhalothrin is moderately persistent in the environment and degrades slowly through a combination of biotic and abiotic mechanisms. It is stable to relatively stable in acidic and neutral water, but hydrolyzes in a matter of several days to weeks under alkaline conditions (half-life 13 days at pH 9). *Lambda*-cyhalothrin has very little degradation in soil (~13% applied radioactivity degraded over 35 days), biodegrading at moderate rates (half-live of several weeks) in both aerobic and anaerobic soil conditions. In aquatic conditions, *lambda*-cyhalothrin may biodegrade at moderate rates under aerobic conditions (half-life on the order of about 21-53 days), but more slowly under anaerobic conditions (half-life of 142 days). Half-lives of 12-33 days were observed in the field for *lambda*-cyhalothrin with the majority of the residues remaining in the uppermost soil layer. Given the low mobility observed in laboratory studies and in the field, it is expected to have little mobility in the environment and, therefore, leaching into groundwater is not expected to be an important environmental fate process. Nevertheless, *lambda*-cyhalothrin could reach adjacent surface waters via spray drift or runoff events accompanied by erosion. In aquatic environments, it partitions to sediment and is expected to be persistent for long periods of time (several months). The sediments could serve as repositories of *lambda*-cyhalothrin in dynamic equilibrium with the pore water and with the surface water.

To serve as a surrogate for *lambda*-cyhalothrin, cyhalothrin was found to have a high bioconcentration factor in fish (4,600x in the whole body), and its depuration rate is considered moderately slow (half-depuration time of around 9 days). It is noted that its predicted depuration rate based on Kow alone would be much longer (i.e., 30 to > 300 days), thus suggesting that biological metabolism processes occurring in fish tissue may be contributing to its faster depuration. Depuration rate will vary by organism; fish are expected to have a greater metabolism than invertebrates and mussels. Biotransformation in biota is typical for synthetic pyrethroids. Considering the log K_{OA}, the log Kow ranging from 5 to 7, the moderate rate of transformation in the environment and in fish, the high bioconcentration factors and a moderately low rate of depuration, it appears that *lambda*-cyhalothrin may have some potential to biomagnify in terrestrial food chains under certain circumstances *(i.e.,* if biotransformation rates are sufficiently slow), based on the presumption made by Gobas et al. (2003) and Armitage and Gobas (2007) as they relate to poorly metabolized chemicals. Even though EFED has not adopted an official reference or guideline to distinguish chemicals that biomagnify, Gobas et al. (2003) and Armitage and Gobas' (2007) presumption was utilized here as a general or broad reference to establish the potential for biomagnification in terrestrial food chains for these chemicals.

Although various degradates were observed in the laboratory studies, the majority of degradates resulted from the rupture of the ester bond of the parent molecule. It is believed that the resulting molecules are not as toxic as the parent because they presumably have lost the neurotoxic mode of action. Table 2-3 and Table 2-4 show the chemical structures of *lambda*-cyhalothrin's major degradation products along with the major and minor degradates detected in the submitted environmental fate and transport studies, respectively.

Table 2-1. Physical-Chemical Properties of *Lambda*-Cyhalothrin

Property	Parent Compound	
	Value and units	MRID or Source
Molecular Weight	449.86 g/mole	TOXNET/ HSDB[1]
Molecular Formula	$C_{23}H_{19}ClF_3NO_3$	TOXNET/ HSDB[1]
Vapor Pressure	1.56 X 10^{-9} mmHg at 20°C Non-volatile under field conditions (≤9.98 x 10^{-7} mmHg)	Laskowski 2002[2]
Chemical Structure		--
Henry's Law Constant	1.9 X 10^{-7} atm-m^3/mole at 20ºC	Laskowski 2002[2]
Water Solubility	0.005 mg/L at pH 6.5 and 20ºC	MRID 00151580
Octanol – water partition coefficient (K_{OW})	1 x 10^7 @ 25ºC	Laskowski 2002[2]
Air-water partition coefficient (K_{AW})	$K_{AW} = C_{air}/C_{water}$ = HLC/RT 7.9 x 10^{-6} (-5.1) 6.05 x 10^{-5} (-4.22); EPIWEB v. 4.0 estimate 'Non-volatile'	Calculated Values EPIWEB v.4.0
Octanol-air partition coefficient (K_{OA}) (log K_{OA})	$K_{OA} = \frac{K_{OW}}{K_{AW}} = \frac{K_{OW}RT}{\text{Henry's Law Constant}}$ 1.3 x 10^{12} (12.1) (*lambda*-cyhalothrin) 1.282 x 10^{10} – 1.043 x 10^{11} (10.108-11.018) ; EPIWEB estimate	Calculated Values EPIWEB v.4.0 Estimate

[1] Hazardous Substances Data Bank at http://toxnet.nlm.nih.gov/

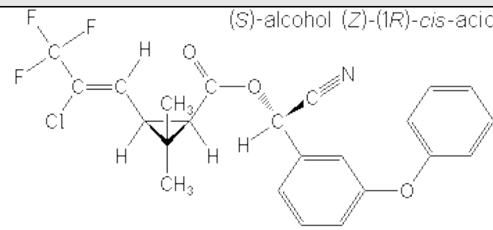
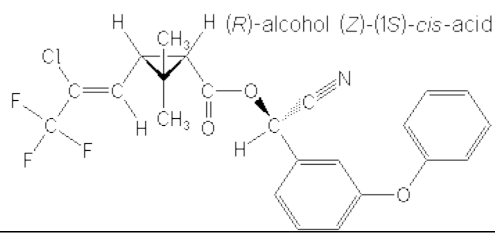
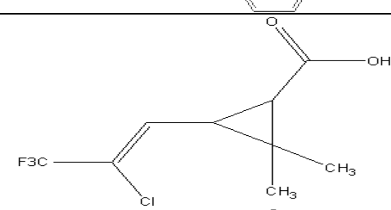
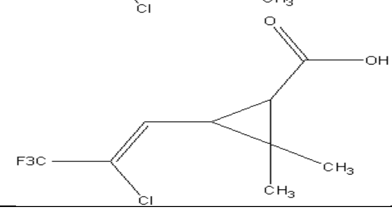
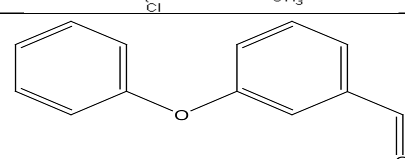
[2] Laskowski, D.A., 2002. Physical and chemical properties of pyrethroids. Rev. Environ. Contam. Toxicol. 2002; 174:49-170.

Table 2-2. Summary of *Lambda*-Cyhalothrin Environmental Fate Properties

Parameters	Parent Compound	
	Value	**Source/MRID**
Hydrolysis $T_{1/2}$	pH 5 stable pH 7 stable pH 9 13 days	00151604 (S)
Aqueous Photolysis (pH 5) $T_{1/2}$	Reviewer calculated linear half-lives: 29.5 days* (phenyl label) 36.9 days* (cyclopropyl)	44861501 *Half-lives are uncertain. Test substance did not remain in solution throughout the study.
Soil Photolysis $T_{1/2}$	Fairly stable loam, only 13-16% degraded after *ca.* 35 days. Compound II was a minor product.	40052405 (A)
Aerobic Soil Metabolism $T_{1/2}$	Reported DT_{50} 31, 55, 26 days sandy loam 102 days loamy sand *12.2 days loam 14.5 days silt loam	00151607 (A) 44861504 (A) 45447410 (S)
Anaerobic Soil Metabolism $T_{1/2}$	flooded DT_{50} 110 days for cyhalothrin 107 days for *lambda*-cyhalothrin	00151607 (A) 44861504 (A)
Aerobic aquatic metabolism $T_{1/2}$	21.1 days sand 34.1 days sandy loam 52.9 days loam	44861506 (A) 44367402 (S)
Anaerobic aquatic metabolism $T_{1/2}$	142 days silty clay	44367401 (S)
Soil-Water Distribution Coefficient **(K_d in mL/g)** **Mean K_d (*lambda*-cyhalothrin) = 4,350 mL/g**	Sandy Loam 3810 Loamy Sand 1970 Silty Clay Loam 5880 Loamy Sand 2100 Silty Clay Loam 4490 Sandy Loam 6890 Sandy Loam 7610 Loamy Sand 3470 Sand 2400 Sandy Loam 4870	44861503(A)
Organic Carbon Normalized Soil-Water Distribution Coefficient **(K_{OC} in mL/g_{OC})** **Mean K_{OC} (*lambda*-cyhalothrin) = 333,200 mL/g_{OC}**	Sandy Loam 346,000 Loamy Sand 200,000 Silty Clay Loam 298,000 Loamy Sand 724,000 Silty Clay Loam 209,000 Sandy Loam 270,000 Sandy Loam 305,000 Loamy Sand 352,000 Sand 518,000 Sandy Loam 110,000	44861503 (A)
Aged Adsorption/ Desorption	In aged batch equilibrium study (up to 8 weeks of incubation in darkness at 4 and 20°C, sandy loam), ≥97.6% of the applied radioactivity remained adsorbed after 24 hr of equilibration. However, it was >80% for soil incubated under ambient light and subject to wet/ dry cycles.	44861509 (S)
Column Leaching	The aged (30 days) residues of cyhalothrin and *lambda*-cyhalothrin were immobile in two soil columns (loamy sand and sandy loam). All residues were within the upper 0-5 cm soil depth.	00151608 (A)
Terrestrial Field Dissipation $T_{1/2}$	IL Clay Loam 33 days (~18-21% AR remained at 279 days) MS Silty Loam 12 days In IL & MS most of the AR in the 0-5 & 5-10 cm depth (1 lb/gal EC ^{14}C-PP321, 2 labels).	40052407(A)

Parameters	Parent Compound	
	Value	**Source/MRID**
Aquatic Field Dissipation $T_{1/2}$	MS (rice) 0.4-1.8 days CA (rice) 1.0-1.8 days ($T_{1/2}$ from water, no data on soil/ sediment)	44367403(S) 44367404 (S) Artificial pond
Dissipation in Aquatic Microcosm $T_{1/2}$	17 hours water layer, 34 hours total system	44861508 (S) (water pH 9.83)
Bioconcentration in Fish	Cyhalothrin: 4600x whole fish (carp); DT_{50} ~9 days depuration. 77-79% of the radioactivity eliminated after 28 days. ~50-70% of the residues were cyhalothrin and ~10-19% was Compound Ia.	00152744(A) 00152745(A)
Half-lives based on single first order equation. A = Acceptable Study Classification S = Supplemental Study Classification		

Table 2-3. Major Transformation Products of *Lambda*-Cyhalothrin

Common Name	Chemical Name	Structure
Lambda-Cyhalothrin	Parent	 
Compounds Ia and Ib	**Ia**: (1*RS*)-*cis*-3-(*ZE*)-2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethylcyclopropanecarboxylic acid **<u>and</u>** **Ib**: (1*RS*)-*trans*-3-(*ZE*)-2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropanecarboxylic acid	 
Compound IV	3-Phenoxybenzaldehyde	

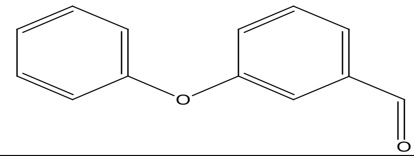
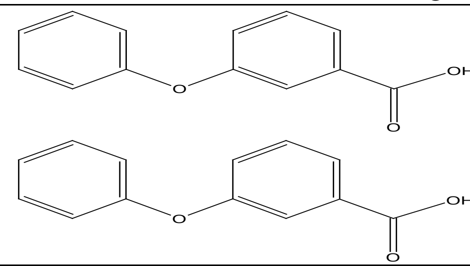
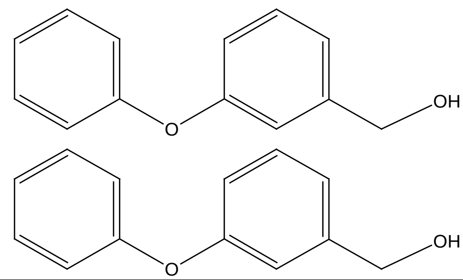
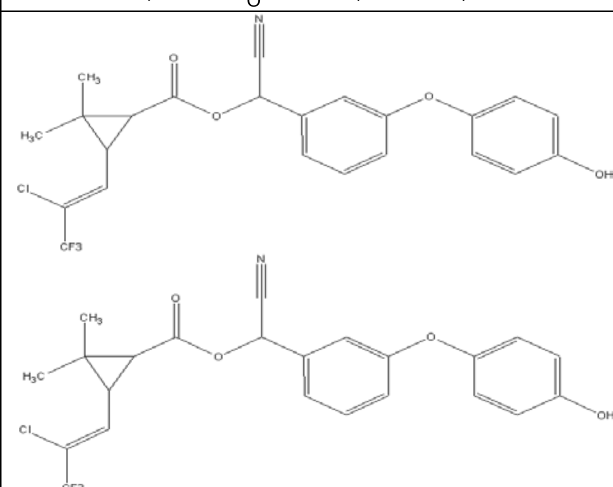
		
Compound V	3-Phenoxybenzoic acid	
Compound VI	3-Phenoxybenzenemethanol	
Compound XV	1α(S*),3α(*Z*)-(±)-cyano-[3-(4'-hydroxyphenoxy)phenylmethyl]-3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethylcyclo-propanecarboxylate	

Table 2-4. Summary of Degradate Formation for *Lambda*-Cyhalothrin

	DEGRADATE and MAXIMUM CONCENTRATION (% of the applied)			
STUDY TYPE	**Compound Ia[5] and/ or Compound Ib[6]**	**Compound IV[7]**	**Compound V[8]**	**Metabolite XV[9]**
Hydrolysis (1)	at pH 9, Ia 68% at 30 days			
Aqueous Photolysis (1)	(Ia 13.7% at 31 days) (cyclopropane ring) (Ib 7.1% at 31 days) (cyclopropane ring)	Minor product	25.0% at 31 days	
Soil Photolysis			Minor product	
Aerobic Soil Metabolism (2)	Minor product			12.5% at 63 days
Anaerobic Soil Metabolism	Ia 10.8% at 30 days post flooding.			11.1% at time of flooding (30 days)

STUDY TYPE	DEGRADATE and MAXIMUM CONCENTRATION (% of the applied)			
	Compound Ia[5] and/ or Compound Ib[6]	Compound IV[7]	Compound V[8]	Metabolite XV[9]
Aerobic Aquatic Metabolism	Ia 11.4% in the water and 10.6% in the sediment of the SL sediment system at 30 days (total 22.0%).		Minor product	Minor product.
Anaerobic Aquatic Metabolism	Ia 0.023 ppm at 365 days water; 0.008 ppm at 182 days soil (information was not provided as percent of the applied)		0.010 ppm at 91 days in water; 0.039 ppm at 120 days in soil (information was not provided as percent of the applied)	Minor product.
Degradation in Aquatic Microcosm (3)	Ia 40.6% at 4 days in water; it was minor in the sediment			
Bioaccumulation in Fish	Ia 22% in muscle and viscera			

(1). Hydrolysis: Isomerization was rapid in the pH 9 solution and moderate in pH 7 solution. It did not occur in the pH 5 solution. Isomerization also occurred in the aqueous photolysis study.
(2). 3-(4-Hydroxyphenoxy)-benzaldehyde was a major product in the sandy loam (12.2% at 17 days, *gamma*-cyhalothrin study).
(3). In the TFD study conducted with *lambda*-cyhalothrin, transformation products monitored at the two sites were reported to be at low levels (<7%).
[5] (1*RS*)-cis-3(*ZE*)-2-chloro-3,3,3-trifluro-1-propenyl)-2,2-dimethylcylopropanecarboxylate.
[6] (1*RS*)-trans-3-(*ZE*)-2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropane-carboxylic acid.
[7] 3-phenoxybenzaldehyde
[8] 3-PBA or 3-phenoxybenzoic acid
[9] (1*R*) *cis* α-(*S*) *cis* α-(*R*) α-cyano-3-(4-hydroxyphenoxy) benzyl 3-(Z-2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropanecarboxylate

2.4.1. Environmental Transport Mechanisms

Potential transport mechanisms include pesticide surface water runoff, spray drift, and secondary drift of volatilized or soil-bound residues leading to deposition onto nearby or more distant ecosystems. Furthermore, soil-bound *lambda*-cyhalothrin may undergo secondary drift with dust storms, that may cause its deposit in nearby or distant ecosystems. Surface water runoff, runoff events accompanied with erosion and spray drift are expected to be the major routes of exposure for *lambda*-cyhalothrin. Given its high tendency to sorb to soil (as evidenced by its high Kd/Koc values), *lambda*-cyhalothrin is expected to reach water bodies primarily sorbed to sediment. With its relative persistence, *lambda*-cyhalothrin may accumulate in sediment with repeated applications, where it may be a reservoir for exposure for benthic organisms. *Lambda*-cyhalothrin has a low vapor pressure (1.56 X 10^{-9} mmHg at 20°C) and Henry's Law constant (1.9 X 10^{-7} atm-m^3/mole at 20ºC); thus, volatilization from water and soil surfaces is expected to be very low. *Lambda*-cyhalothrin's potential for volatilization is also reduced significantly because it adsorbs strongly to soils and suspended solids or sediment in the water column.

2.4.2. Mechanism of Action

Lambda-cyhalothrin is a neurotoxin that acts through direct contact and ingestion. The insecticidal effect of pyrethroids is characterized by a rapid "knock down," or paralysis, of insects. All pyrethroids act as axonic poisons, affecting both the peripheral and central nervous systems, and share similar modes of action. The primary biological effects of *lambda*-

cyhalothrin on insects and vertebrates reflect an inhibition of the correct firing of neurotransmitter delivery signals from one cell to another. Specifically, this involves nerve membrane inhibition of the voltage-gated Ca^{2+} (calcium ion) channels coupled with a stimulatory effect on the voltage-gated Na^{+} (sodium ion) channels (Matsumura, 1985).

2.4.3. Use Characterization

Analysis of labeled use information is the critical first step in evaluating the federal action. The current labels for *lambda*-cyhalothrin represent the FIFRA regulatory action; therefore, labeled use and application rates specified on the label form the basis of this assessment. The assessment of use information is critical to the development of the action area and selection of appropriate modeling scenarios and inputs.

Lambda-cyhalothrin is a pyrethroid insecticide that is currently registered on numerous field and orchard crops; non-cultivated land; turf and other ornamentals; building exteriors; and other non-agricultural uses. Applications include ground and aerial spray, dust, and chemigation applications to agricultural crops; outdoor crack and crevice treatments; sprays to lawns and ornamentals, trunk drenches to orchard crops; spot treatments to ant mounds; tree injections; and perimeter applications. The use profile is based on the current, federally registered uses (Section 3). There are several hundred registered labels for *lambda*-cyhalothrin and, as a representative sample, only labels from the major data providers (“data doers”) were reviewed. Information was collected on the maximum one time application rate, number of applications allowed per year, the minimum time between treatments, and the application type. A summary of the registered use patterns, target pests, formulation types, and application methods is provided below.

Food (Vegetative): *Lambda*-cyhalothrin is registered for use on almond, apple, apricot, barley, beans (asparagus, moth, mung, rice, scarlet runner, lima, snap, tepary, urd), beech nut, bell pepper, brassica (head and stem) vegetables, Brazil nut, broccoli (Chinese), brussels sprouts, buckwheat, butternut, cabbage (Chinese), canola/rape, cashew, catjang (Jerusalem/marble pea), cauliflower, cereal grains, cherry, chestnut, chinquapin, cole crops, corn (pop, sweet), crabapple, cucurbit vegetables, eggplant, filbert (hazelnut), fruiting vegetables, garlic, groundcherry (strawberry tomato/tomatillo), hickory nut, Japanese plum, kohlrabi, legume vegetables, lettuce (head and leaf), loquat, macadamia nut (bushnut), mayhaw, mustard, mustard cabbage (gai choy, pak-choi), nectarine, oat, olive, onion, pea, peach, peanuts, pear, pecan, pepino (melon pear), pepper, plum, pome fruit, potato (white/Irish), prune, quince, root and tuber vegetables, rice (domestic and wild), rye, sorghum, soybean, stone fruit, sugarcane, sunflower, tomatillo, tomato, tree nuts, triticale, walnut (English/black), and wheat.

Food (Animal Products): Lambda-cyhalothrin is registered for use on beef/range/feeder cattle, calves, and dairy cattle (non-lactating).

Other Agriculture, Non-food: Lambda-cyhalothrin is registered for use on agricultural/farm premises, alfalfa, corn (field), cotton, grasses grown for seed, grass forage/fodder/hay, ornamental sod farm (turf), pastures, rangeland, seed orchard trees, tobacco, and dairy farm milk handling facilities/equipment.

Residential: Lambda-cyhalothrin is registered for household/domestic dwellings outdoor premises, indoor premises, contents; ornamental and/or shade trees, ground cover, herbaceous plants, lawns and turf, non-flowering plants, woody shrubs and vines; paths/patios; paved areas (private roads/sidewalks); pet living/sleeping quarters; rose; and residential lawns.

Public Health: *Lambda*-cyhalothrin is registered for use animal housing premises (outdoor, indoor), animal kennels/sleeping quarters (commercial), commercial/institution/industrial premise/equipment (indoor, outdoor), commercial storages/warehouses premises, commercial transportation facilities (non-feed/non-food), drainage systems, eating establishments, eating establishments food handling areas (non-food contact), food processing plant premises (non-food contact), food stores/markets/supermarkets premises, hospitals/medical institutions premises (human/veterinary), meat processing plant premises, and refuse/solid waste containers (garbage cans, indoor).

Other Nonfood: *Lambda*-cyhalothrin is registered for use on airports/landing fields, commercial/industrial lawns, conifers (plantations/nurseries), conifers (seed orchard), fencerows/hedgerows, forest plantings (reforestation programs, tree farms, tree plantations, etc.), golf course turf, greenhouse (empty), industrial/construction areas (outdoors), non-agricultural outdoor buildings/structures, non-agricultural rights-of-way/fencerows/hedgerow, non-agricultural areas/soils, non-feed/non-food storage areas (empty), recreational areas, recreation area lawns, utilities, utility poles/rights-of-way), and wood protection treatment to buildings/products (indoors, outdoors).

Target pests: *Lambda*-cyhalothrin is a broad-spectrum, insecticide registered for use on most major aphid, caterpillar, and beetle pests on a wide variety of crops and for public health pests such as mosquitoes and cockroaches in non-agricultural uses (USEPA, 2010).

Formulation types: Dust, emulsifiable concentrate, flowable concentrate, granular, impregnated collar/tag, impregnated material, liquid-ready to use, microencapsulated, pelleted/tablet, pressurized liquid, soluble concentrate/solid, and wettable powder.

Method: *Lambda*-cyhalothrin may be applied in the following ways: crack and crevice, outdoor surface spray, perimeter treatment, soil broadcast, broadcast, chemigation, dust, spray, trunk drench, barrier treatment, ear tag, mound treatment, spot treatment, soil in-furrow treatment, T-banding, injection treatment, impregnated covering, band treatment, attractant, tree injection, and wood surface treatment.

The following uses are not being considered in this assessment (Table 2-5). These uses have been excluded because no outdoor exposure is expected that could affect listed (threatened or endangered) species.

Table 2-5. *Lambda*-Cyhalothrin Use Sites for Which No Risk Assessment Will Be Performed

Use Site	Justification
Animal housing premises (indoor)	Indoor use
Animal kennels/sleeping quarters (commercial)	Indoor use
Black-eyed pea/cow pea	Crop not grown in CA
Commercial/institution/industrial premise/equipment (indoor)	Indoor use
Commercial/institution/industrial premise/equipment (outdoor)	Negligible environmental exposure – pesticide is applied to machinery and in industrial/commercial settings that are not routinely expected to come into contact with non-target species
Commercial storages/warehouses premises	Indoor use
Dairy farm milk handling facilities/equipment	Indoor use
Drainage systems	Negligible environmental exposure – applied to dry sewers and other drainage systems that are contained and water is not present
Eating establishments	Indoor use
Eating establishments food handling areas (nonfood contact)	Indoor use
Fencerows/hedgerows	Negligible environmental exposure – injection into fencerow/hedgerow via spray can (drill hole and spray); chemical is not mobile
Food processing plant premises (nonfood contact)	Indoor use
Food stores/markets/supermarkets premises	Indoor use
Greenhouse-empty	Indoor use
Hospitals/medical institutions premises (human/veterinary)	Indoor use
Household/domestic dwellings	Indoor use
Household/domestic dwellings contents	Indoor use
Household/domestic dwellings indoor premises	Indoor use
Industrial/construction areas (outdoor)	Negligible environmental exposure – applications in voids, trenches, or under tarps as part of a construction site
Meat processing plant premises (nonfood contact)	Indoor use
Nonagricultural outdoor buildings/structures	Indoor use
Non feed/nonfood storage areas-empty	Indoor use
Olive	Negligible environmental exposure – pheromone bait that is specific to one olive fly pest (non-listed)

Use Site	Justification
Pet living/sleeping quarters	Indoor use
Refuse/solid waste sites (indoor)	Indoor use
Sugarcane	Crop not grown in CA
Tobacco	Crop not grown in CA
Utilities	Negligible environmental exposure – injections into poles via spray can; chemical is not mobile
Utility poles	Negligible environmental exposure; injections into poles via spray can (drill hole and spray); chemical is not mobile
Wood protection treatment to buildings/products	Negligible environmental exposure; injections into wood (drill hole and apply); chemical is not mobile
Wood protection treatment to buildings/products indoors	Indoor use

Table 2-6 presents the uses and corresponding application rates and methods of application considered in this assessment. In some instances, labels presented ambiguous information regarding application rates and timing. For these gaps, information was taken from other similar labels or uses, or conservative estimates (see footnotes in table).

Table 2-6. *Lambda*-Cyhalothrin Uses Assessed for California

Use	Max application Rate	Max crop cycle application rate (application interval)	Number of crop cycles per year	Application method
Agricultural/ farm premises	0.2212 lb ai/A[1]	0.5187 lb ai/A[2] 7 days[3]	1	Crack and crevice
	0.2212 lb ai/A			Outdoor surface spray (ground)
				Perimeter treatment
Airports/landing fields	0.08 lb ai/A	4 lb ai/A[4] 7 days[3]	1	Soil broadcast (ground)
Alfalfa	0.038 lb ai/A	0.119 lb ai/A (10 days)	9	Broadcast (aerial, ground) Chemigation
Almond Apple Cherry Crabapple Nectarine Peach Pear Plum Prune	0.1 lb ai/A[5]	6 apps per year (almond) – 0.6 lb ai/A[6] 9 apps per year (apple, cherry, crabapple, nectarine, peach, pear, plum, prune) – 0.9 lb ai/A[7]	1	Dust (ground)
	0.1 lb ai/A	0.1 lb ai/A (1 app per year - almond) (10 days – cherry, nectarine, peach, pear, plum, prune)		Spray (ground)
	0.1536 lb ai/100 gal	(5 days – almond, nectarine, peach) 0.18 lb		Trunk drench

Use	Max application Rate	Max crop cycle application rate (application interval)	Number of crop cycles per year	Application method
	0.06 lb ai/A[8]	ai/A[9] 3 apps per year (5 days-cherry) 0.18 lb ai/A[9]		
	0.0416 lb ai/100 gal (apple only) 0.06 lb ai/A[8]	1 app per year		
Animal housing premises (outdoor) Paths/patios Household/domestic dwellings outdoor premises	0.2762 lb ai/A (all uses)	4 lb ai/A[4] (21 days)	1	Barrier treatment Crack and crevice
	(household only) 2 lb ai/A[4]	4 lb ai/A[4] 7 days[3]		Crack and crevice
				Injection treatment
Apricot Beans (asparagus, succulent) Beech nut Brazil nut Butternut Cashew Chestnut Chinquapin Eggplant Groundcherry (strawberry tomato/tomatillo) Hickory nut Loquat Macadamia nut (bushnut) Mayhaw (hawthorn) Pea Pepino (melon pear) Pepper Plum, Japanese Quince	0.0239 lb ai/A	9 apps per year (apricot, beans, eggplant, groundcherry, loquat, mayhaw, pea, pepino, pepper, plum, quince) – 0.2151 lb ai/A[11] 6 apps per year (beech nut, brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut) – 0.1434 lb ai/A[12]	1	Broadcast (ground)
	0.0239 lb ai/A[10]			Dust
Barley	0.031 lb ai/A	0.062 lb ai/A	1	Spray (aerial, ground) Chemigation
Beef/range/feeder cattle (meat) Calves (meat) Dairy cattle (non-lactating)	0.0042 lb ai/animal	N/A (when needed)	N/A	Ear tag
Bell pepper Catjang (Jerusalem/marble pea) Mustard cabbage (gai choy, pak-choi)	0.03 lb ai/A[13]	Bell pepper – 12 apps per year – 0.36 lb ai/A[13] Mustard – 8 apps per year – 0.24 lb ai/A[13]	1	Broadcast (ground), aerial, chemigation
	0.03 lb ai/A[13]			Dust (bell pepper only)
Brassica (head and stem)	0.031 lb ai/A	8 apps per year	3	Spray(aerial,

Use	Max application Rate	Max crop cycle application rate (application interval)	Number of crop cycles per year	Application method
vegetables		(3 per crop cycle) - 0.24 lb ai/A (7 days)		ground) Chemigation
Broccoli (chinese) Cabbage (chinese) Cauliflower Kohlrabi Mustard Tomatillo Tomato	0.0294 lb ai/A	9 apps per year – 0.2646 lb ai/A[15]	1 (tomato, tomatillo) 2 (broccoli, cauliflower) 3 (cabbage, kohlrabi) 4 (mustard)	Broadcast (ground)
	0.0294 lb ai/A[14]			Dust
Brussels sprouts	0.038 lb ai/A	(10 days) 3 apps per year	1	Broadcast (ground)
	0.038 lb ai/A[16]	9 apps per year – 0.342 lb ai/A[17]		Dust
Buckwheat Oat Rye	0.03 lb ai/A	0.06 lb ai/A (3 days)	1	Spray (aerial, ground) Chemigation
Canola/rape Grass forage/fodder/hay Pastures Rangeland	0.0311 lb ai/A	0.0934 lb ai/A (5 days-canola/rape) (N/A- grass forage) (30 days- pastures, rangeland)	1	Broadcast (aerial, ground) Chemigation
Cereal grains Triticale Wheat	0.0311 lb ai/A	0.0622 lb ai/A (3 days)	1	Broadcast (aerial, ground) Chemigation
Cole crops Onion	0.0311 lb ai/A	0.249 lb ai/A	3	Broadcast (aerial, ground) Chemigation
	Onion 0.0311 lb ai/A[18]	9 apps per year – 0.2799 lb ai/A[19]		Dust
Commercial/ industrial lawns Ornamental lawns and turf Recreation area lawns	0.1585 lb ai/A	0.4153 lb ai/A (7 days)	1	Broadcast (ground)
	0.004 lb ai/2.5 gal (commercial only) 0.06 lb ai/A[8]			Mound treatment
	0.004 lb ai/gal (commercial only) 0.06 lb ai/A[8]			Spot treatment
Conifers (plantations/nurseries)	0.0401 lb ai/A	0.24 lb ai/A	1	Broadcast (ground)
Conifers (seed orchard)	0.156 lb ai/A	0.504 lb ai/A	1	Spray (ground)
Corn (field)	0.042 lb ai/A	0.129 lb ai/A (10 days)	1	Broadcast (aerial, ground)
Corn (field, pop)	0.0934 lb ai/A	0.1245 lb ai/A	1	Soil in furrow

Use	Max application Rate	Max crop cycle application rate (application interval)	Number of crop cycles per year	Application method
Corn (sweet)		0.498 lb ai/A (4 days)	3	treatment T-banding (soil treatment)
	0.042 lb ai/A[20]	5 apps per crop cycle – 0.21 lb ai/A[21]		Dust
	0.03 lb ai/A[13]	16 apps per year (6 per crop cycle) – 0.48 lb ai/A[13]		Spray (aerial, ground, chemigation)
Cotton	0.042 lb ai/A	0.126 lb ai/A (10 days) 3 apps per year	1	Broadcast (aerial, ground) Chemigation
Cucurbit vegetables	0.0311 lb ai/A	0.1864 lb ai/A (5 days)	1	Broadcast (aerial, ground) Chemigation
Filbert (hazelnut) Pecan Walnut (English/black)	0.057 lb ai/A	0.158 lb ai/A (10 days)	1	Broadcast (aerial) Spray (ground)
	0.057 lb ai/A[22]	6 apps per year – 0.342 lb ai/A[23]		Dust
Forest plantings (reforestation programs)(tree farms, tree plantations, etc.)	0.0511 lb ai/A	0.2381 lb ai/A (7 days)	1	Broadcast (ground)
Forest trees (all or unspecified) Nonagricultural rights-of-way	2 lb ai/A[4]	4 lb ai/A[4] 7 days[3]	1	Injection treatment
Fruiting vegetables	0.0311 lb ai/A	0.3735 lb ai/A (5 days)	1	Broadcast (aerial, ground) Chemigation
Garlic	0.0311 lb ai/A	0.246 lb ai/A	1	Broadcast (aerial, ground) Chemigation
Golf course turf Ornamental sod farm (turf)	0.068 lb ai/A[13]	0.068 lb ai/A	1	Broadcast (ground)
	0.0025 lb ai/2.5 gal (except ornamental) 0.0688 lb ai/A[13]	0.3542 lb ai/A (7 days)		Mound treatment
	0.00000703 lb ai/anthill (except ornamental) 0.06 lb ai/A[8]	0.36 lb ai/A		Spot treatment
Grasses grown for seed	0.1306 lb ai/A	0.3423 lb ai/A (7 days)	1	Broadcast (ground)
	0.00000703 lb ai/anthill 0.06 lb ai/A[8]	0.36 lb ai/A (7 days)	1	Spot treatment
Legume vegetables	0.0311 lb ai/A	0.1245 lb ai/A (5 days-	1	Broadcast (aerial,

Use	Max application Rate	Max crop cycle application rate (application interval)	Number of crop cycles per year	Application method
Peanuts Root and tuber vegetables		legume) (7 days- peanuts, root and tubers)		ground) Chemigation
Lettuce	0.0311 lb ai/A	0.3112 lb ai/A (5 days)	2	Broadcast (aerial, ground) Chemigation
Nonagricultural uncultivated areas/soils	0.0792 lb ai/A[24]	0.2075 lb ai/A	1	Broadcast (aerial, ground) Chemigation
	0.0792 lb ai/A	0.36 lb ai/A 7 days[3]		Band treatment Broadcast (ground) Perimeter treatment
	0.0001 lb ai/mound 0.06 lb ai/A[8]			Mound treatment
	0.00000928 lb ai/anthill 0.06 lb ai/A[8]			Spot treatment
Ornamental and/or shade trees	0.0396 lb ai/100 gal 0.162 lb ai/A[2]	0.4153 lb ai/A (7 days)	1	Broadcast (ground)
	1.3 lb ai/A	4 lb ai/A[4] 7 days[25]		Spray (ground)
	N/A			Tree injection
Ornamental groundcover Ornamental herbaceous plants Ornamental non flowering plants Ornamental woody shrubs and vines Rose	1.2 lb ai/A (except groundcover, rose, and non flowering)[26]	3.6 lb ai/A[13] 7 days[3]	1	Dust
	1.2 lb ai/A			Spray (ground)
				Broadcast (ground) (rose only)
Paved areas (private roads/ sidewalks)	0.069 lb ai/A[4]	0.36 lb ai/A[13] 7 days[3] (preconstruction)	1	Barrier treatment Perimeter treatment
Pome fruits Stone fruits	0.0415 lb ai/A	0.2075 lb ai/A	1	Broadcast (aerial, ground) Chemigation

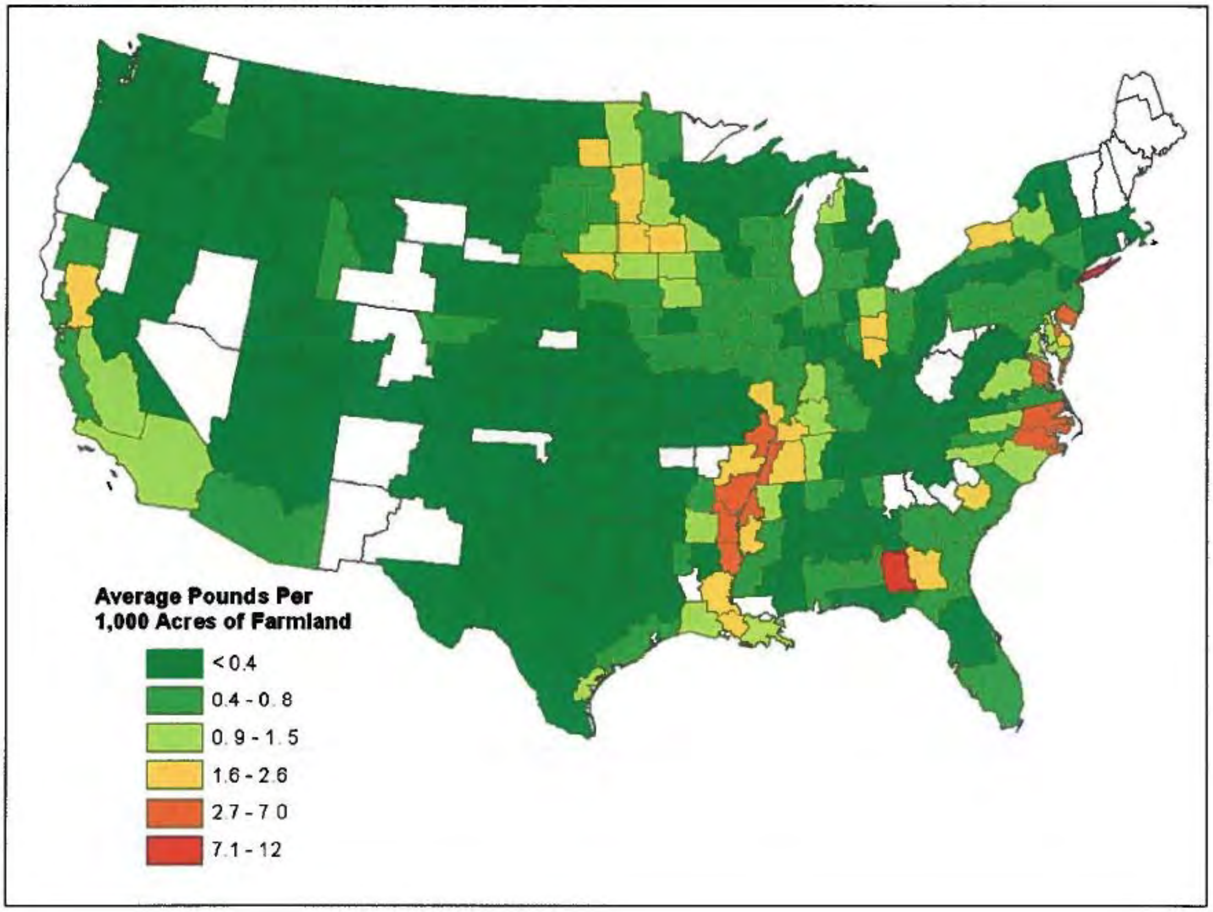
Use	Max application Rate	Max crop cycle application rate (application interval)	Number of crop cycles per year	Application method
Potato, white/Irish	0.0239 lb ai/A	0.0879 lb ai/A (7 days)	1	Broadcast (aerial, ground) Chemigation
Recreational areas	0.0291 lb ai/A	4 lb ai/A[4] 7 days[3]	1	Band treatment
	2 lb ai/A[4]			Crack and crevice Spot treatment Injection treatment
Residential lawns	0.078 lb ai/A[27]	6 apps per year – 0.468 lb ai/A[27]	1	Broadcast (granular ground)
	1.9 lb ai/A[13]	1.9 lb ai/A[13]		Mound treatment (granular)
Rice Rice (wild)	0.0415 lb ai/A	0.1245 lb ai/A (5 days)	1	Broadcast (ground) Chemigation
Seed orchard trees	0.162 lb ai/A	0.5187 lb ai/A	1	Spray (ground)
Sorghum	0.038 lb ai/A	0.077 lb ai/A (10 days	1	Broadcast (aerial,
				ground) Chemigation
Soybean	0.038 lb ai/A	0.059 lb ai/A (14 days)	1	Broadcast (aerial, ground) Chemigation Conservation tillage (ground)
Tree nuts	0.0415 lb ai/A	0.166 lb ai/A (5days)	1	Broadcast (aerial, ground) Chemigation
Sunflower	0.038 lb ai/A	0.114 lb ai/A (10 days) 3 apps per year	1	Broadcast (aerial, ground)
Right-of-ways	0.06 lb ai/A[28]	0.36 lb ai/A[28] 7 days[3]	1	Soil treatment

[1]used perimeter treatment rate; [2]used seed orchard trees rate (100-1097); [3]used golf course turf application interval (100-1088); [4]used residential lawn rate (9688-274); [5]used spray application rate; [6]used 6 times 0.1 lb ai/A; [7]used 9 times 0.1lb ai/A; [8]used rate from PRD Verification Memo; [9]used 3 times 0.06 lb ai/A; [10]used broadcast application rate; [11]used 9 time 0.0239 lb ai/A; [12]used 6 times 0.0239 lb ai/A; [13]personal communication from registrant; [14]used broadcast application rate; [15]used 9 times 0.0294 lb ai/A; [16]used broadcast application rate; [17]used 9 times 0.038 lb ai/A; [18]used broadcast application rate; [19]used 9 times 0.0311 lb ai/A; [20]used broadcast application rate; [21]used 5 times 0.042 lb ai/A; [22]used broadcast application rate; [23]used 6 times 0.057 lb ai/A; [24]used band/broadcast treatment rate; [25]used broadcast application interval; [26]used spray/broadcast application rate; [27]used application rate from 100-1239; used 2 times 2lb ai/A; [28]used spot treatment application rate from nonagricultural;

Many *lambda*-cyhalothrin product labels specify application rates on a per crop cycle basis (not on a per year basis). Information from the Agency's Biological and Economic Analysis Division (BEAD) indicates that many crops can be grown more than one time per year in California (USEPA, 2007a). Examples of crops that may be grown multiple times in a calendar year that can be treated by *lambda*-cyhalothrin include alfalfa, brassica, broccoli, cabbage, cauliflower, cole crops, corn (sweet), kohlrabi, lettuce, mustard, and onion (USEPA 2007a). The cropping seasons range between two and nine cycles per year. Multiple crop cycles were considered using multiple applications with a 120-day retreatment interval, except for alfalfa and mustard, in which a 40-day and 90-day retreatment interval was assumed, respectively. For all other labeled uses, it was assumed that a maximum seasonal application specified on the label was equivalent to a maximum annual application.

The following map (Figure 2-1) depicts agricultural pesticide usage at the Crop Reporting District (CRD) level (USEPA 2012b). CRDs are boundaries created by USDA National Agricultural Statistical Service (NASS) that are aggregates of counties. Pesticide usage is displayed as average pounds (for the years 2006-2010) per 1000 acres of farmland in a CRD to normalize for the variation in farmland between CRDs. Usage is based on private market surveys of pesticide use in agriculture and the survey data are limited to the states that represent the top 80-90% of acreage for the individual crops. Therefore, use may be occurring in regions outside the scope of the survey. CRDs showing no usage of pesticides may be from a lack of pesticide use in that region or non-participation in the agricultural surveys. In addition, across the years, there may be variations in the specific crops included in the CRD survey. This may result in a lower annual average for the CRD. The map shows that use in reporting counties in California range from < 0.4 to 2.6 lb ai/1000 acres of farmland.

Figure 2-1. ***Lambda*-Cyhalothrin Use in Total Pounds per County** (USDA 2006-2010, NASS Crop Reporting Districts; http://www.ers.usda.gov/briefing/arms/resourceregions/resourceregions.htm#nass)



BEAD (USEPA 2012a) provided an analysis of California usage, which was derived from California's Department of Pesticide Regulation Pesticide Use Reporting (CDPR PUR) database.[3] CDPR PUR is considered a more comprehensive source of usage data than USDA-NASS or EPA proprietary databases, and thus the usage data reported for *lambda*-cyhalothrin by county in this California-specific assessment were generated using CDPR PUR data. Twelve years (1999-2010) of usage data were included in this analysis. Data from CDPR PUR were obtained for every agricultural pesticide application made on every use site at the section level (approximately one square mile) of the public land survey system.[4] BEAD summarized these data to the county level by site, pesticide, and unit treated. Calculating county-level usage involved summarizing across all applications made within a section and then across all sections

[3] The California Department of Pesticide Regulation's Pesticide Use Reporting database provides a census of pesticide applications in the state. See http://www.cdpr.ca.gov/docs/pur/purmain.htm.

[4] Most pesticide applications to parks, golf courses, cemeteries, rangeland, pastures, and along roadside and railroad rights of way, and postharvest treatments of agricultural commodities are reported in the database. The primary exceptions to the reporting requirement are home-and-garden use and most industrial and institutional uses (http://www.cdpr.ca.gov/docs/pur/purmain.htm).

within a county for each use site and for each pesticide. The county level usage data that were calculated include: average annual pounds applied, average annual area treated, and average and maximum application rate across all twelve years. The units of area treated are also provided where available. Between 1999 and 2010, annual use of *lambda*-cyhalothrin in California ranged from approximately 22,000 to 49,000 pounds active ingredient per year.

A summary of *lambda*-cyhalothrin usage for all California use sites is provided below in Table 2-7. Structural pest control, tomato (processing), rice, lettuce (leaf), lettuce (head), almond, and alfalfa had the highest usage with greater than 1000 lb ai/year.

Table 2-7. Summary of California Department of Pesticide Registration (CDPR) Pesticide Use Reporting (PUR) Data from 1999 to 2010 for Currently Registered *Lambda*-Cyhalothrin Uses[1]

Site Name	Average Annual Pounds Applied	Average Application Rate (lbs a.i./A)	Maximum Application Rate (lbs a.i./A)
Alfalfa	3554	0.028	N/A
Almond	1557	0.03	4.2
Animal premise	5.3	1	10.1
Apple	130	0.046	0.3
Apricot	82	0.03	0.25
Artichoke, globe	0.65	0.063	0.1
Avocado	0.1	0.023	0.023
Barley	0.64	0.027	0.03
Bean, dried	575	0.029	3.9
Bean, succulent	128	0.029	0.5
Bean, unspecified	156	0.035	0.1
Bermudagrass	1.7	0.028	0.03
Beverage crop	0.0004	0.000007	0.00001
Bok choy	2.1	0.029	0.07
Broccoli	363	0.029	0.5
Brussels sprout	32	0.029	0.3
Buildings/non-ag outdoor	0.00004	0.0005	0.0005
Cabbage	106	0.027	0.4
Canola (rape)	1.84	0.029	0.03
Cantaloupe	2.7	0.024	0.07
Cauliflower	148	0.027	0.88
Celery	3.14	0.28	0.09
Cherry	191	0.044	5
Chicory	0.01	0.03	0.03
Chinese cabbage	28	0.028	0.4
Chinese greens	0.105	0.026	0.03
Christmas tree	0.01	0.033	0.033
Commodity fumigation	0.13	N/A	N/A
Corn (forage, fodder)	183	0.03	0.47

Site Name	Average Annual Pounds Applied	Average Application Rate (lbs a.i./A)	Maximum Application Rate (lbs a.i./A)
Corn (human consumption)	862	0.034	3.7
Cotton	538	0.034	0.6
County ag comm	0.14	N/A	N/A
Cucumber	2.4	0.028	0.03
Dairy equipment	0.86	0.068	0.1
Eggplant	0.52	0.027	0.03
Endive (escarole)	0.83	0.097	0.3
Food processing plant	0.021	0.0003	0.001
Forage hay/silage	0.8	0.03	0.03
Fumigation (other)	0.16	N/A	N/A
Gai choy	0.24	0.03	0.04
Gai lon	10	0.028	0.46
Garbanzos	0.2	0.03	0.03
Garlic	30	0.033	0.27
Grape, wine	0.14	0.08	0.15
Grass, seed	0.02	0.023	0.023
Greenhouse flower	6.8	0.048	0.65
Greenhouse transplants	0.56	0.05	0.65
Household	0.03	0.000003	0.000003
Industrial site	0.034	0.012	0.003
Kale	3.4	2	7.9
Kohlrabi	0.09	0.026	0.03
Landscape maintenance	118	0.013	0.034
Lettuce, head	2265	0.04	4
Lettuce, leaf	1782	0.03	4
Melon	2.3	0.029	0.06
Mustard	0.10	0.13	0.3
Nectarine	12	0.038	0.35
Oat (forage/fodder)	0.77	0.05	0.15
Olive	0.0056	0.0006	0.002
Onion, dry	500	0.033	6.3
Onion, green	28	6.63	32.8
Orchard floor	1.09	0.5	0.6
Outdoor flower	6.0	0.062	0.47
Outdoor plants (containers)	37	0.044	1.5
Outdoor transplants	24	0.055	3
Pastureland	1.5	0.026	0.03
Peach	281	0.031	3.4
Pear	28	0.034	0.25
Peas	25	0.027	0.033
Pecan	1.5	0.033	0.04

Site Name	Average Annual Pounds Applied	Average Application Rate (lbs a.i./A)	Maximum Application Rate (lbs a.i./A)
Pepper, fruiting	53	0.029	2.4
Pepper, spice	5.8	0.028	0.03
Pistachio	952	0.064	4.2
Plants in containers (greenhouse)	5.7	0.048	1.6
Plum	12	0.029	0.08
Potato	18	0.036	0.067
Prune	42	0.028	0.48
Public health	2.6	N/A	N/A
Pumpkin	1.9	0.031	0.15
Quince	1.01	0.035	0.065
Radish	0.09	0.047	0.065
Rappini	0.09	0.027	0.03
Regulatory pest control	6.4	0.002	0.002
Research commodity	4.5	0.042	0.046
Rice	2121	0.031	3.9
Rice, wild	21	0.029	0.05
Rights-of-way	9.9	0.22	1.7
Rye	0.12	0.03	0.03
Ryegrass	0.39	0.031	0.031
Shallot	0.001	0.03	0.03
Shingi ku	0.04	0.014	0.014
Soil fumigation/preplant	1.45	0.028	0.026
Sorghum (forage/fodder)	23	0.028	0.21
Sorghum/milo	3.01	0.03	0.03
Soybean	3.72	0.03	0.04
Soybean grain	0.03	0.03	0.03
Spinach	7.72	0.25	3
Squash	1.26	0.098	0.07
Squash, summer	2.2	0.19	2.9
Squash, winter	0.04	0.031	0.031
Stone fruit	0.02	0.031	0.031
Strawberry	1.45	0.075	0.1
Structural pest control	10312	0.031	0.033
Sudangrass	47	0.03	3.6
Sugar beet	0.16	0.02	0.03
Sunflower	166	0.028	0.5
Sweet potato	1.43	0.027	0.03
Tomatillo	13	0.062	3.1
Tomato	132	0.029	0.48
Tomato (processing)	1783	0.03	3.9
Turf/sod	29	0.039	0.2

Site Name	Average Annual Pounds Applied	Average Application Rate (lbs a.i./A)	Maximum Application Rate (lbs a.i./A)
Uncultivated ag	4.9	0.03	0.06
Uncultivated non-ag	0.2	0.036	0.078
Unknown	4.01	0.029	0.1
Vegetable	0.01	0.063	0.063
Vegetables, leafy	0.1	0.023	0.024
Vertebrate control	0.8	0.029	0.032
Walnut	343	0.032	3.3
Watermelon	2.94	0.03	0.04
Wheat	47	0.032	0.28
Wheat (forage, fodder)	4.7	0.026	0.03

1- Based on data supplied by BEAD (USEPA 2012a).

2.5. Assessed Species

Table 2-8 provides a summary of the current distribution, habitat requirements, and life history parameters for the listed species being assessed. More detailed life-history and distribution information can be found in Attachment II. See Figure 2-2 through 2-9 for maps of the current range and designated critical habitat, if applicable, of the assessed listed species. See Section 2.1 for information on when each species was listed and a general description of their ranges.

Table 2-8. Summary of Current Distribution, Habitat Requirements, and Life History Information for the Assessed Listed Species[1]

Assessed Species	Size	Current Range	Habitat Type	Designated Critical Habitat?	Reproductive Cycle	Diet
San Francisco Garter Snake (SFGS) (*Thamnophis sirtalis tetrataenia*)	Adult (46-131 cm in length), Females – 227 g, Males – 113 g; Juveniles – 2 g (Cover Jr. and Boyer, 1988) (18–20 cm in length)	San Mateo County	Densely vegetated freshwater ponds near open grassy hillsides; emergent vegetation; rodent burrows	No	Oviparous Reproduction[2] Breeding: Spring (Mar. and Apr.) and Fall (Sept. to Nov.) Ovulation and Pregnancy: Late spring and early summer Young: Born 3-4 months after mating	Juveniles: frogs (Pacific tree frog, CRLF, and bullfrogs depending on size) and insects Adults: primarily frogs (mainly CRLFs; also bullfrogs, toads); to a lesser extent newts; freshwater fish and invertebrates; insects and small mammals
California Clapper Rail (CCR) (*Rallus longirostris obsoletus)*	250 - 350 g Juveniles ~50 g[3]	Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma counties	Tidal marsh habitat	No	Breeding: Feb. - August Nesting: mid-March-Aug. Lay Eggs: March - July Incubation: 23 to 29 days; Leave nest: 35 to 42 days after hatch; Juveniles fledge at ten weeks and can breed during the spring after they hatch	Opportunistic feeders: freshwater and estuarine invertebrates, seeds, worms, mussels, snails, clams, crabs, insects, and spiders; occasionally consume small birds and mammals, dead fish, up to 15% plant material
Tidewater goby *(Eucyclogobius newberryi*)	Up to 50 mm in length	Lagoons, estuaries and salt marshes along the coast of California, 5 km south of the California/ Oregon border and 71 km north of the California/Mexico border	Shallow (0.1 – 2 m), still-to-slow moving, aquatic habitat most commonly ranging in salinity from 0.5 to 10 ppt.	Yes	They spawn in slightly brackish water between 2 and 27 ppt. They have been observed spawning in every month of the year except December; reproduction peaks in late April to July	They feed mainly on macroinvertebrates such as mysid shrimp, gammarid amphipods, ostracods and aquatic insects such as chironomid larvae. Small TG (four to eight mm SL) probably feed on

Assessed Species	Size	Current Range	Habitat Type	Designated Critical Habitat?	Reproductive Cycle	Diet
						unicellular phytoplankton or zooplankton similar to many other early stage larval fishes.
Bay Checkerspot Butterfly (BCB) (*Euphydryas editha bayensis*)	Adult butterfly - 5 cm in length	Santa Clara and San Mateo Counties [the BCB distribution is considered a metapopulation, thus any site with appropriate habitat in the vicinity of its historic range (Alameda, Contra Costa, San Francisco, San Mateo, and Santa Clara counties) should be considered potentially occupied by the butterfly (USFWS 1998, p. II-177)].	1) Primary habitat – native grasslands on large serpentine outcrops; 2) Secondary habitat – 'islands' of smaller serpentine outcrops with native grassland; 3) Tertiary habitat – non-serpentine areas where larval food plants occur	Yes	Larvae hatch in March – May and grow to the 4th instar in about two weeks. The larvae enter into a period of dormancy (diapause) that lasts through the summer. The larvae resume activity with the start of the rainy season. Larvae pupate once they reach a weight of 300 - 500 milligrams. Adults emerge within 15 to 30 days depending on thermal conditions, feed on nectar, mate and lay eggs during a flight season that lasts 4 to 6 weeks from late February to early May	Obligate with dwarf plantain. Primary diet is dwarf plantain plants (may also feed on purple owl's-clover or exerted paintbrush if the dwarf plantains senesce before the larvae pupate). Adults feed on the nectar of a variety of plants found in association with serpentine grasslands
Valley Elderberry Longhorn Beetle (VELB) (*Desmocerus californicus dimorphus*)	Males: 1.25–2.5 cm length Females: 1.9–2.5 cm length	Central Valley of California (from Shasta County to Fresno County in the San Joaquin Valley)	Completely dependent on its host plant, elderberry (*Sambucus species*), which is a common component of the remaining riparian forests and adjacent upland habitats of	Yes	The larval stage may last 2 years living within the stems of an elderberry plant. Then larvae enter the pupa stage and transform into adults. Adults emerge and are active from March to June feeding and mating, when the elderberry	Obligates with elderberry trees (*Sambucus* sp). Adults eat the elderberry foliage until about June when they mate. Upon hatching the larvae tunnel into the tree where they will spend

Assessed Species	Size	Current Range	Habitat Type	Designated Critical Habitat?	Reproductive Cycle	Diet
			California's Central Valley		produces flowers.	1-2 years eating the interior wood which is their sole food source.
Delta Smelt (*Hypomesus transpacificus*)	Up to 120 mm in length	Suisun Bay and the Sacramento-San Joaquin estuary (known as the Delta) near San Francisco Bay, CA	The species is adapted to living in fresh and brackish water. They typically occupy estuarine areas with salinities below 2 parts per thousand (although they have been found in areas up to 18 parts per thousand). They live along the freshwater edge of the mixing zone (saltwater-freshwater interface).	Yes	They spawn in fresh or slightly brackish water upstream of the mixing zone. Spawning season usually takes place from late March through mid-May, although it may occur from late winter (Dec.) to early summer (July-August). Eggs hatch in 9 – 14 days.	They primarily eat copepods, cladocerans, amphipods, and insect larvae. Larvae feed on phytoplankton; juveniles feed on zooplankton.
California Tiger Salamander (CTS) (*Ambystoma californiense*)	Adult 14.2-80.5 g[4]	CTS-SC are primarily found on the Santa Rosa Plain in Sonoma County. CTS-CC occupies the Bay Area (central and southern Alameda, Santa Clara, western Stanislaus, western Merced, and the majority of San Benito Counties), Central Valley (Yolo, Sacramento, Solano, eastern Contra Costa, northeast Alameda, San Joaquin, Stanislaus, Merced, and northwestern Madera Counties), southern San	Freshwater pools or ponds (natural or man-made, vernal pools, ranch stock ponds, other fishless ponds); Grassland or oak savannah communities, in low foothill regions; Small mammal burrows	Yes	Emerge from burrows and breed: fall and winter rains Eggs: laid in pond Dec. – Feb., hatch: after 10 to 14 days Larval stage: 3-6 months, until the ponds dry out, metamorphose late spring or early summer, migrate to small mammal burrows	Aquatic Phase: algae, snails, zooplankton, small crustaceans, and aquatic larvae and invertebrates, smaller tadpoles of Pacific tree frogs, CRLF, toads; Terrestrial Phase: terrestrial invertebrates, insects, frogs, and worms

Assessed Species	Size	Current Range	Habitat Type	Designated Critical Habitat?	Reproductive Cycle	Diet
		Joaquin Valley (portions of Madera, central Fresno, and northern Tulare and Kings Counties), and the Central Coast Range (southern Santa Cruz, Monterey, northern San Luis Obispo, and portions of western San Benito, Fresno, and Kern Counties). CTS-SB are found in Santa Barbara County.				
California Freshwater Shrimp (CFWS) (*Syncaris pacifica*)	Up to 50 mm postorbital length (from the eye orbit to tip of tail)	Marin, Napa, and Sonoma Counties, CA	Freshwater, perennial streams; they prefer quiet portions of tree-lined streams with underwater vegetation and exposed tree roots	No	Breed once a year, typically in Sept. Eggs adhere to the pleopods and are cared for 8 – 9 months; embryos emerge during May or early June.	Feed on detritus (algae, aquatic macrophyte fragments, zooplankton, and aufwuchs)

[1] For more detailed information on the distribution, habitat requirements, and life history information of the assessed listed species, see Attachment II.
[2] Oviparous = eggs hatch within the female's body and young are born live.
[3] No data on juvenile CCR body weights are available at this time. As a surrogate for CCR juveniles, data on captive 21-day king rails were averaged for the juvenile body weight. King rails make an appropriate proxy for the CCR in the absence of information. The birds were once considered the same species by taxonomists, are members of the same genus (*Rallus*), and occasionally interbreed where habitats overlap.
[4] See Page 369 of Trenham *et al.* (Trenham *et al.*, 2000).

Figure 2-2. Bay Checkerspot Butterfly Critical Habitat and Occurrence Sections Identified in Case No. 07-2794-JCS.

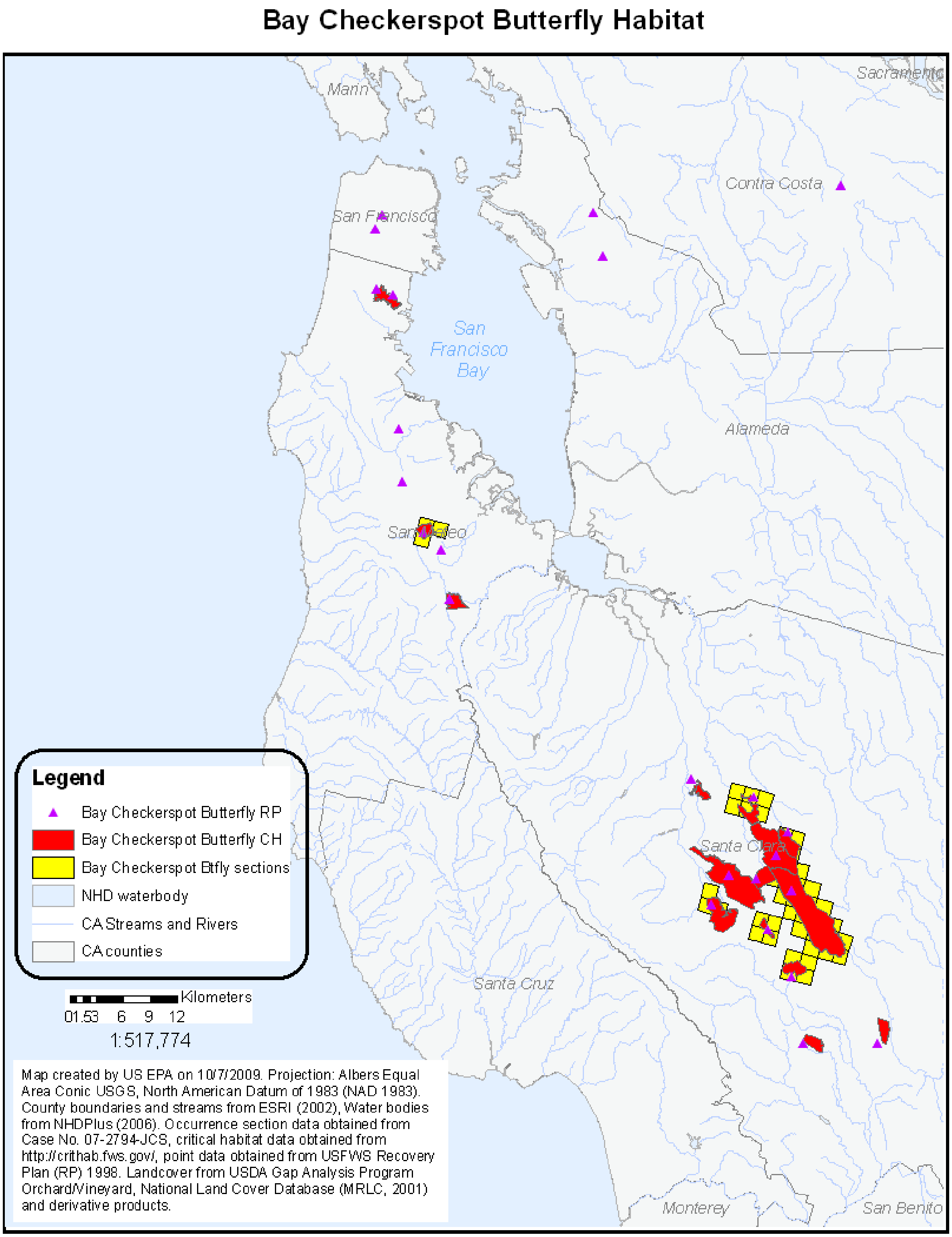


Figure 2-3. California Clapper Rail Habitat and Occurrence Sections Identified in Case No. 07-2794-JCS.

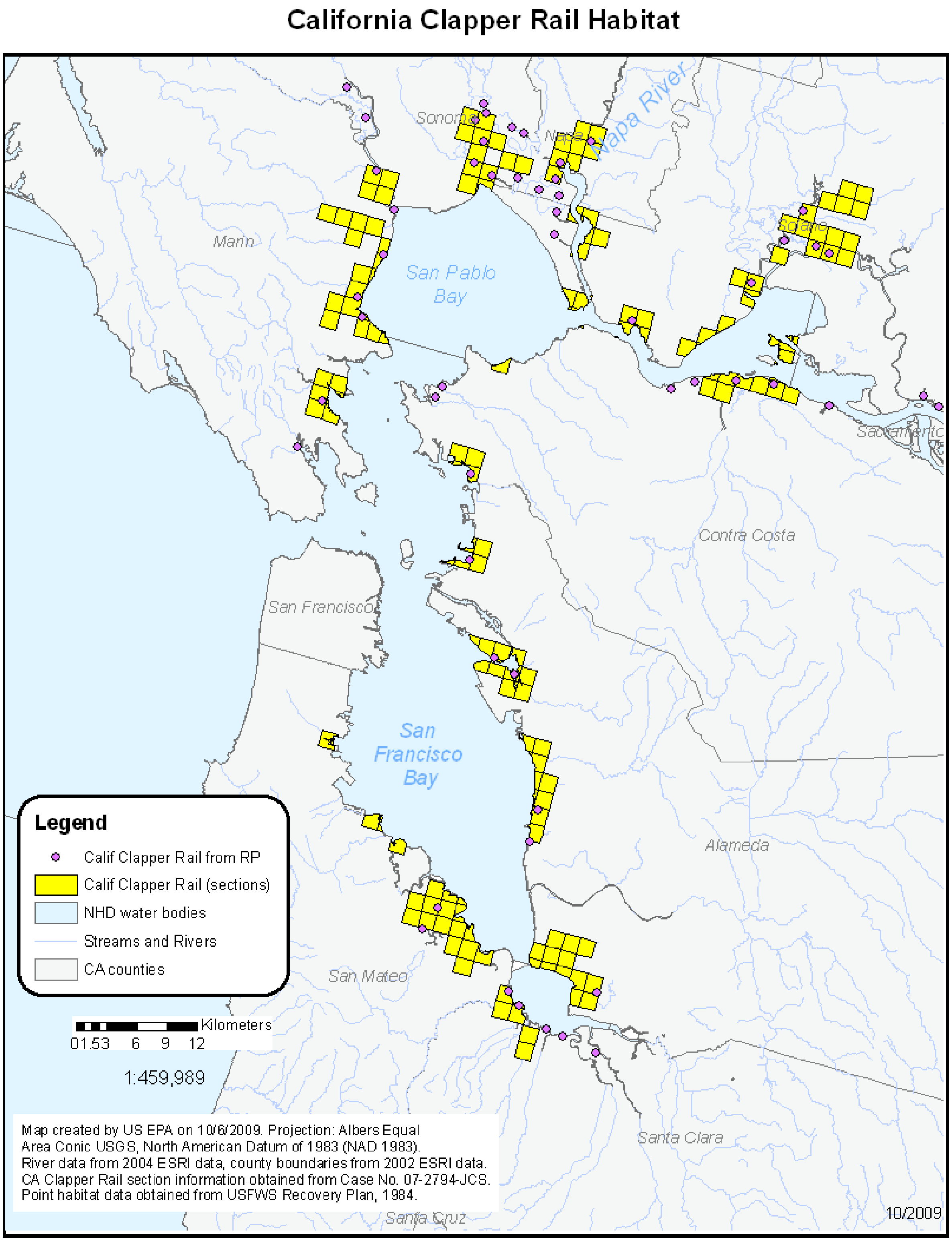


Figure 2-4. California Freshwater Shrimp Habitat and Occurrence Sections identified in Case No. 07-2794-JCS.

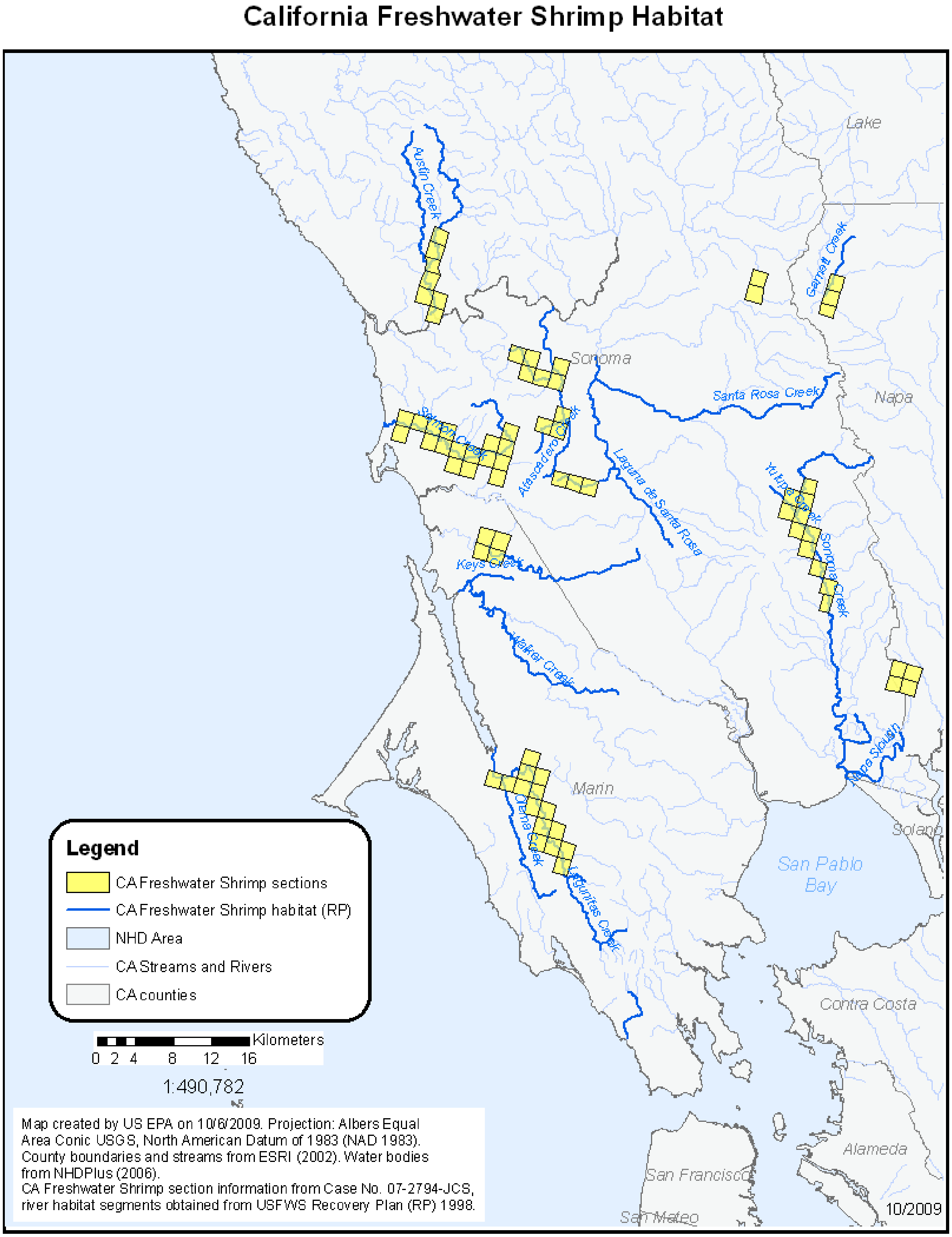


Figure 2-5. California Tiger Salamander Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS.

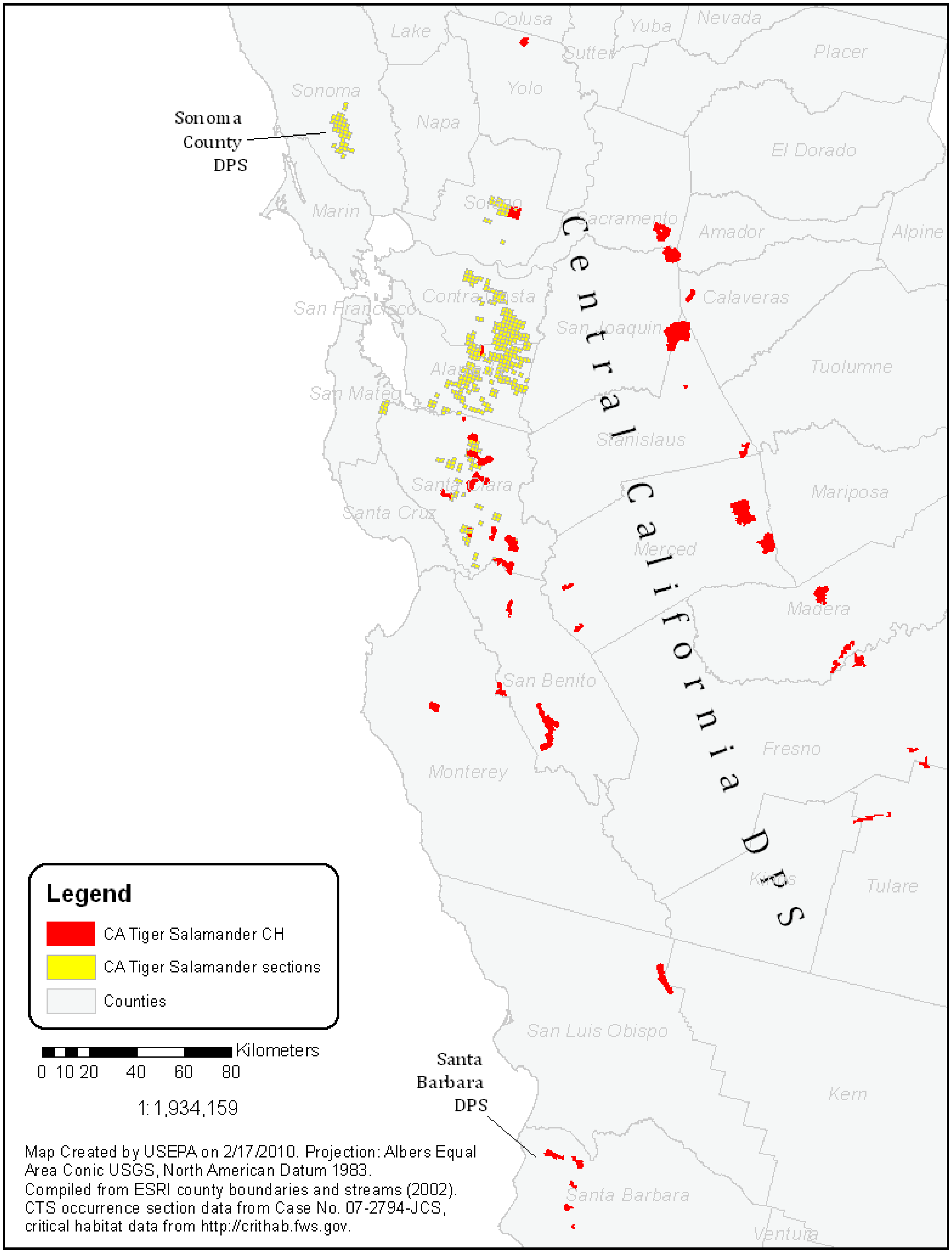


Figure 2-6. Delta Smelt Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS.

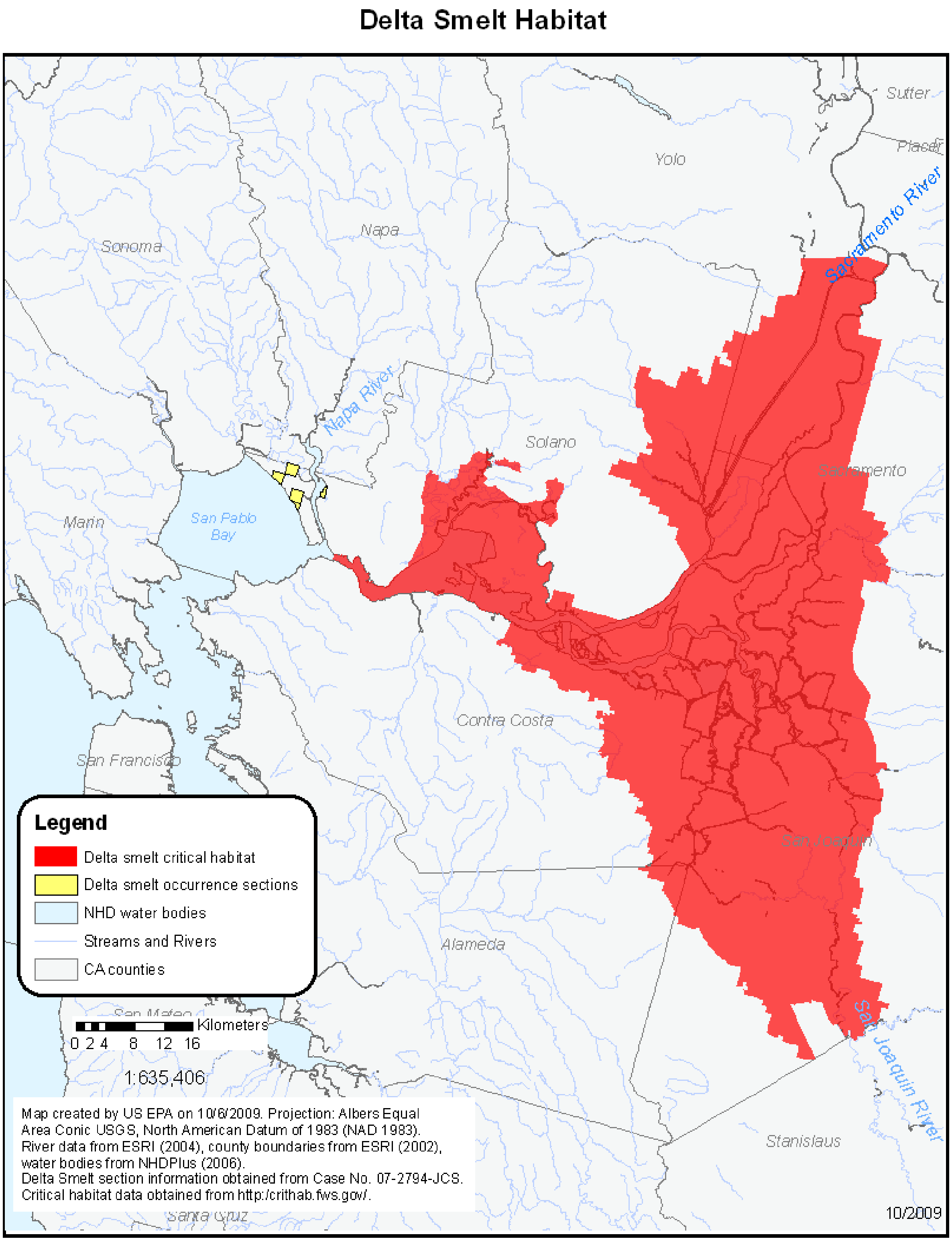


Figure 2-7. San Francisco Garter Snake Habitat and Occurrence Sections identified in Case No. 07-2794-JCS.

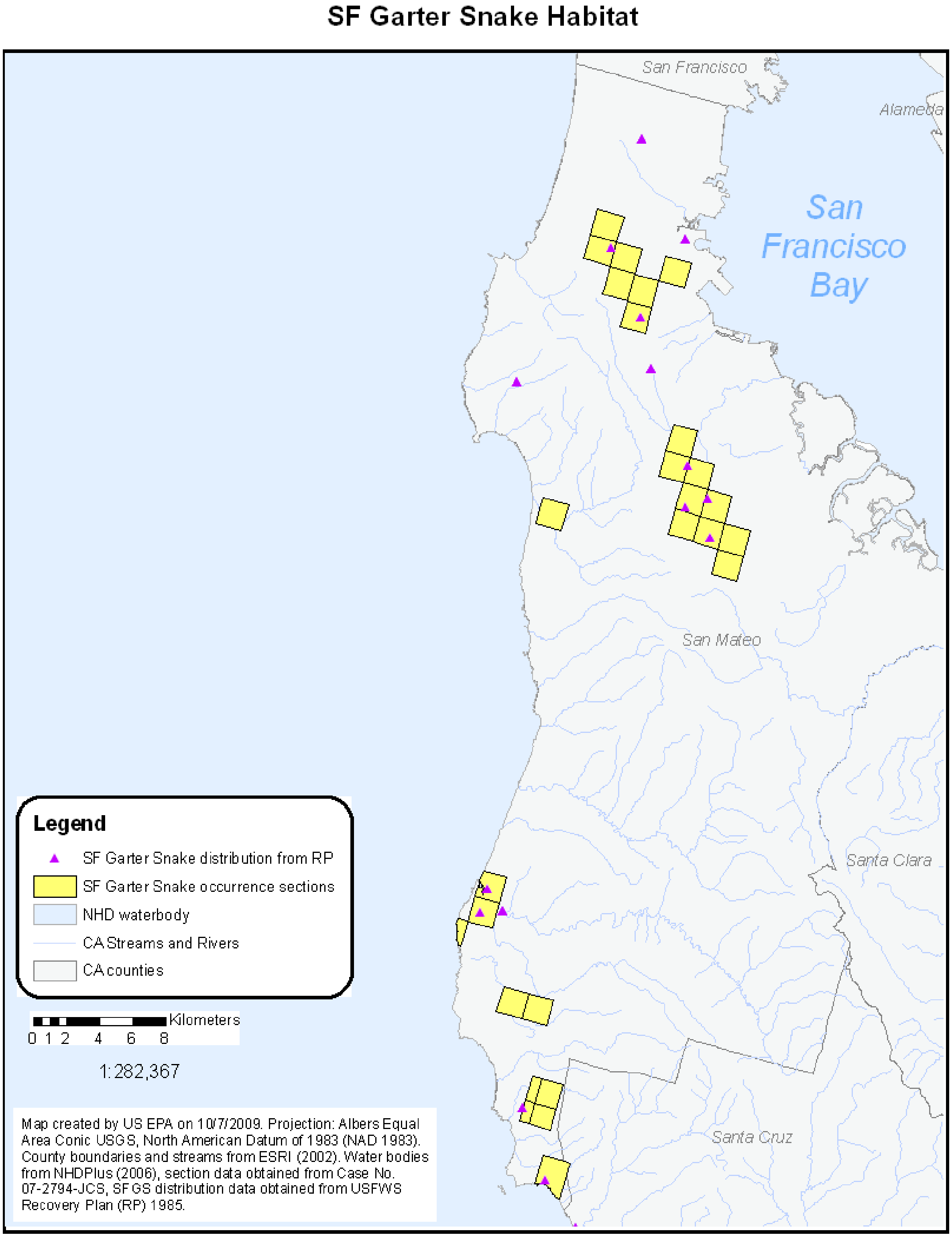


Figure 2-8. Tidewater Goby Critical Habitat identified in Case No. 07-2794-JCS.

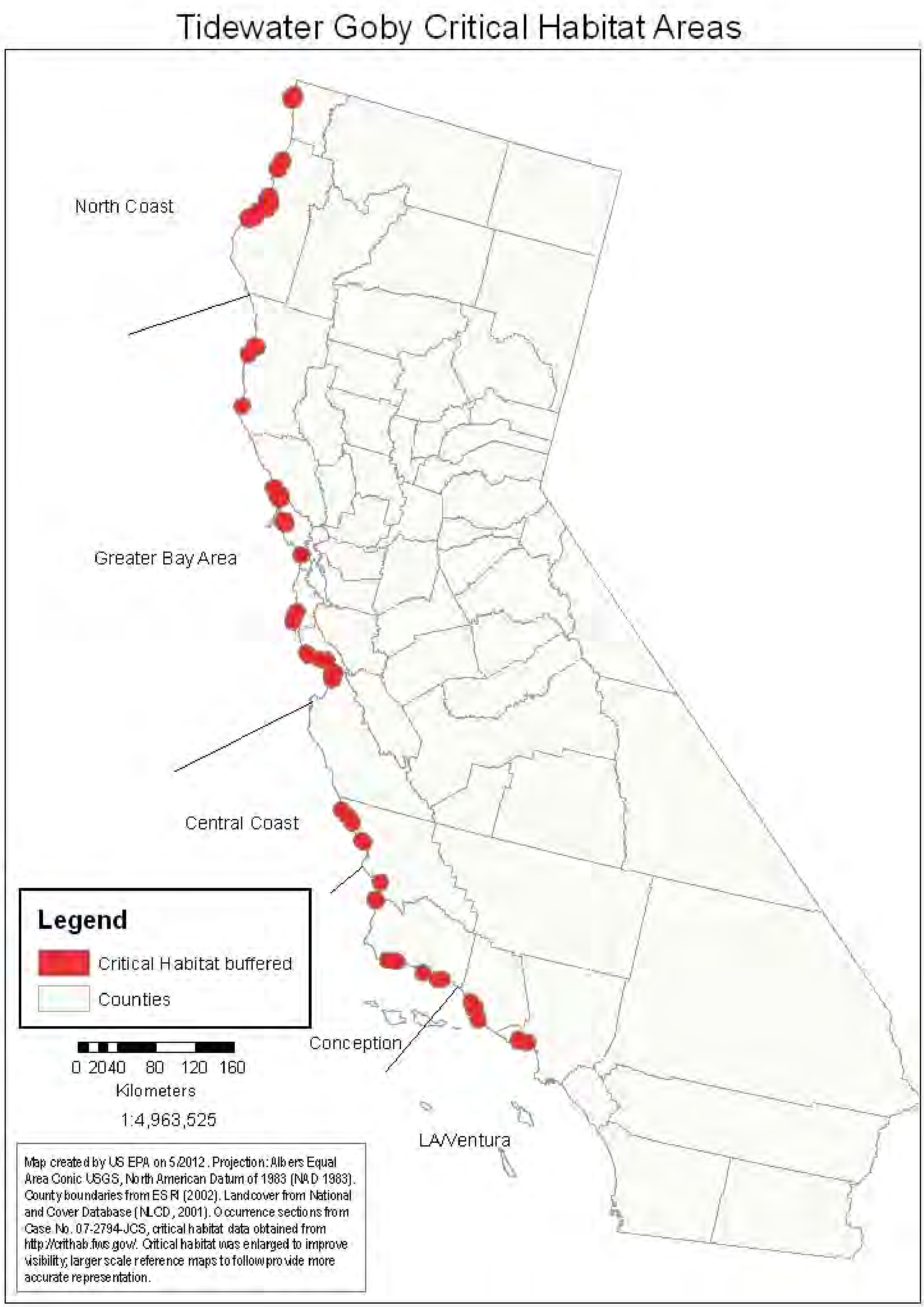
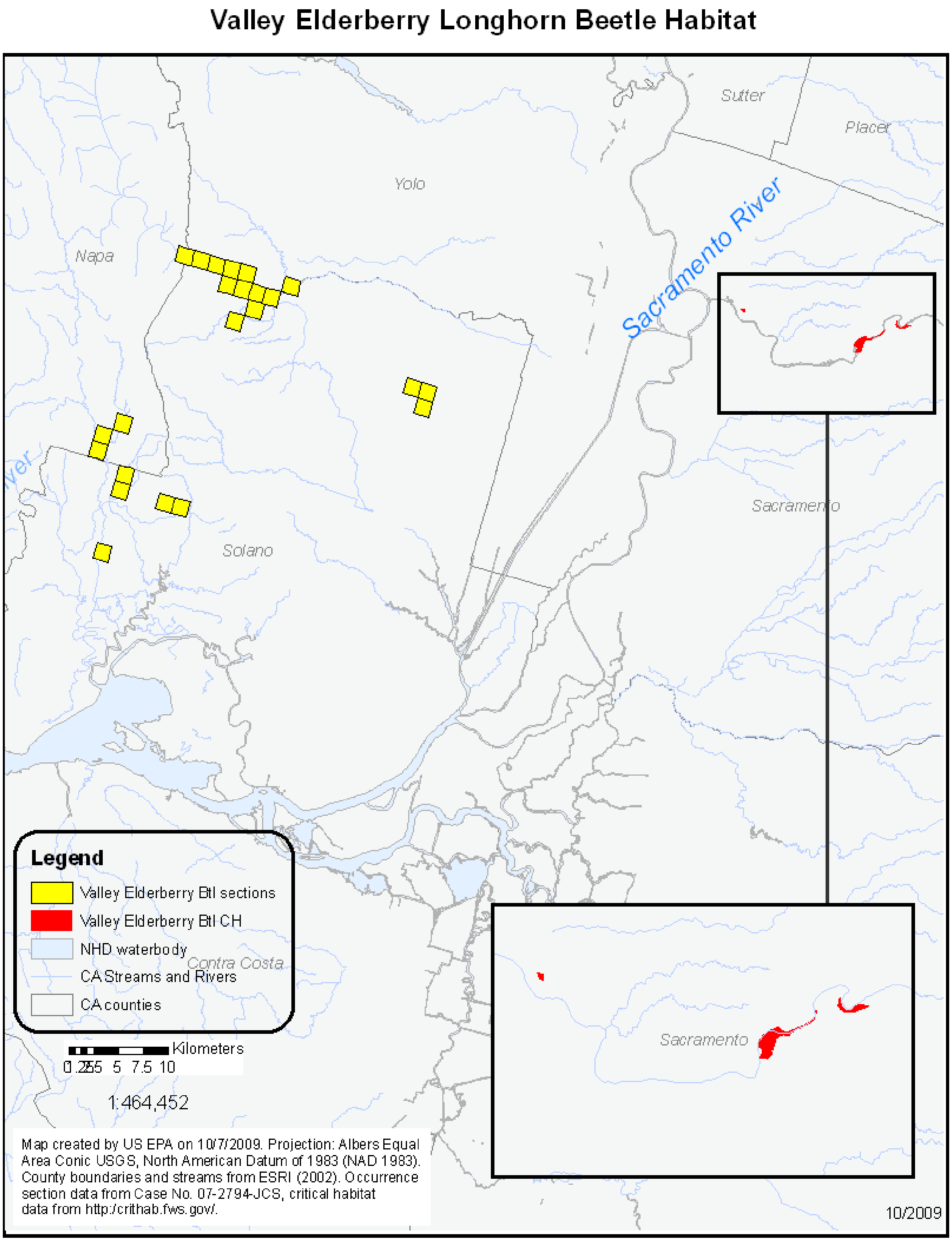


Figure 2-9. Valley Elderberry Longhorn Beetle Critical Habitat and Occurrence Sections Identified in Case No. 07-2794-JCS.



2.6. Designated Critical Habitat

Critical habitat has been designated for the BCB, VELB, DS, TG, CTS-CC, and CTS-SB. Risk to critical habitat is evaluated separately from risk to effects on the species. 'Critical habitat' is defined in the ESA as the geographic area occupied by the species at the time of the listing where the physical and biological features necessary for the conservation of the species exist, and there is a need for special management to protect the listed species. It may also include areas outside the occupied area at the time of listing if such areas are 'essential to the conservation of the species. Critical habitat designations identify, to the extent known using the best scientific and commercial data available, habitat areas that provide essential life cycle needs of the species or areas that contain certain primary constituent elements (PCEs) (as defined in 50 CFR 414.12(b)). Table 2-9 describes the PCEs for the critical habitats designated for the BCB, VELB, DS, TG, CTS-CC, and CTS-SB.

Table 2-9. Designated Critical Habitat PCEs for the BCB, VELB, DS, TG, CTS-CC, and CTS-SB [1].

Species	PCEs	Reference
California tiger salamander	Standing bodies of fresh water, including natural and man-made (*e.g.*, stock) ponds, vernal pools, and dune ponds, and other ephemeral or permanent water bodies that typically become inundated during winter rains and hold water for a sufficient length of time (*i.e.*, 12 weeks) necessary for the species to complete the aquatic (egg and larval) portion of its life cycle[2]	FR Vol. 69 No. 226 CTS, 68584, 2004
	Barrier-free uplands adjacent to breeding ponds that contain small mammal burrows. Small mammals are essential in creating the underground habitat that juvenile and adult California tiger salamanders depend upon for food, shelter, and protection from the elements and predation	
	Upland areas between breeding locations (PCE 1) and areas with small mammal burrows (PCE 2) that allow for dispersal among such sites	
Valley Elderberry Longhorn Beetle	Areas that contain the host plant of this species [*i.e.*, elderberry trees (*Sambucus* sp.)] (a dicot)	43 FR 35636 35643, 1978
Bay Checkerspot Butterfly	The presence of annual or perennial grasslands with little to no over story that provide north/south and east/west slopes with a tilt of more than 7 degrees for larval host plant survival during periods of atypical weather (*e.g.*, drought).	66 FR 21449 21489, 2001
	The presence of the primary larval host plant, dwarf plantain (*Plantago erecta*) (a dicot) and at least one of the secondary host plants, purple owl's-clover or exerted paintbrush, are required for reproduction, feeding, and larval development.	
	The presence of adult nectar sources for feeding.	
	Aquatic features such as wetlands, springs, seeps, streams, lakes, and ponds and their associated banks, that provide moisture during periods of spring drought; these features can be ephemeral, seasonal, or permanent.	
	Soils derived from serpentinite ultramafic rock (Montara, Climara, Henneke, Hentine, and Obispo soil series) or similar soils (Inks, Candlestick, Los Gatos, Fagan, and Barnabe soil series) that provide areas with fewer aggressive, nonnative plant species for	

Species	PCEs	Reference
	larval host plant and adult nectar plant survival and reproduction.[2]	
	The presence of stable holes and cracks in the soil, and surface rock outcrops that provide shelter for the larval stage of the bay checkerspot butterfly during summer diapause.[2]	
Tidewater Goby	Persistent, shallow (in the range of about 0.1-2 m), still-to-slow-moving, aquatic habitat most commonly ranging in salinity from less than 0.5 ppt to about 10-12 ppt, which provides adequate space for normal behavior and individual and population growth	65 FR 69693 69717, 2000
	Substrates (*e.g.*, sand, silt, mud) suitable for the construction of burrows for reproduction	
	Submerged and emergent aquatic vegetation, such as *Potamogeton pectinatus* and *Ruppia maritima*, that provides protection from predators	
	Presence of a sandbar(s) across the mouth of a lagoon or estuary during the late spring, summer, and fall that closes or partially closes the lagoon or estuary, thereby providing relatively stable water levels and salinity.	
Delta Smelt	Spawning Habitat—shallow, fresh or slightly brackish backwater sloughs and edge waters to ensure egg hatching and larval viability. Spawning areas also must provide suitable water quality (*i.e.*, low "concentrations of pollutants) and substrates for egg attachment (*e.g.*, submerged tree roots and branches and emergent vegetation).	59 FR 65256 65279, 1994
	Larval and Juvenile Transport—Sacramento and San Joaquin Rivers and their tributary channels must be protected from physical disturbance and flow disruption. Adequate river flow is necessary to transport larvae from upstream spawning areas to rearing habitat in Suisun Bay. Suitable water quality must be provided so that maturation is not impaired by pollutant concentrations.	
	Rearing Habitat—Maintenance of the 2 ppt isohaline and suitable water quality (low concentrations of pollutants) within the Estuary is necessary to provide delta smelt larvae and juveniles a shallow protective, food-rich environment in which to mature to adulthood.	
	Adult Migration— Unrestricted access to suitable spawning habitat in a period that may extend from December to July. Adequate flow and suitable water quality may need to be maintained to attract migrating adults in the Sacramento and San Joaquin River channels and their associated tributaries. These areas also should be protected from physical disturbance and flow disruption during migratory periods.	

[1] These PCEs are in addition to more general requirements for habitat areas that provide essential life cycle needs of the species such as, space for individual and population growth and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, rearing (or development) of offspring; and habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.
[2] PCEs that are abiotic, including, physical-chemical water quality parameters such as salinity, pH, and hardness are not evaluated.

More detail on the designated critical habitat applicable to this assessment can be found in Attachment II. Activities that may destroy or adversely modify critical habitat are those that alter the PCEs and jeopardize the continued existence of the species. Evaluation of actions related to use of *lambda*-cyhalothrin that may alter the PCEs of the designated critical habitat for the BCB, VELB, DS, TG, CTS-CC, and CTS-SB form the basis of the critical habitat impact analysis.

As previously noted in Section 2.1, the Agency believes that the analysis of direct and indirect effects to listed species provides the basis for an analysis of potential effects on the designated critical habitat. Since *lambda*-cyhalothrin is expected to directly affect living organisms within the action area, critical habitat analysis for *lambda*-cyhalothrin is limited in a practical sense to those PCEs of critical habitat that are biological or that can be reasonably linked to biologically mediated processes.

2.7. Action Area and LAA Effects Determination Area

2.7.1. Action Area

The action area is used to identify areas that could be affected by the Federal action. The Federal action is the authorization or registration of pesticide use or uses as described on the label(s) of pesticide products containing a particular active ingredient. The action area is defined by the Endangered Species Act as, "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR §402.2). Based on an analysis of the Federal action, the action area is defined by the actual and potential use of the pesticide and areas where that use could result in effects. Specific measures of ecological effect for the assessed species that define the action area include any direct and indirect toxic effect to the assessed species and any potential modification of its critical habitat, including reduction in survival, growth, and fecundity as well as the full suite of sublethal effects available in the effects literature. It is recognized that the overall action area for the national registration of *lambda-cyhalothrin* is likely to encompass considerable portions of the United States based on the large array of agricultural and non-agricultural uses. However, the scope of this assessment limits consideration of the overall action area to those portions that may be applicable to the protection of the BCB, CCR, CFWS, CTS-CC, CTS-SC, CTS-SB, DS, SFGS, TG, and VELB and their designated critical habitat within the state of California. For this assessment, the entire state of California is considered the action area. The purpose of defining the action area as the entire state of California is to ensure that the initial area of consideration encompasses all areas where the pesticide may be used now and in the future, including the potential for off-site transport via spray drift and downstream dilution that could influence the San Francisco Bay Species. Additionally, the concept of a state-wide action area takes into account the potential for direct and indirect effects and any potential modification to critical habitat based on ecological effect measures associated with reduction in survival, growth, and reproduction, as well as the full suite of sublethal effects available in the effects literature.

It is important to note that the state-wide action area does not imply that direct and/or indirect effects and/or critical habitat modification are expected to or are likely to occur over the full extent of the action area, but rather to identify all areas that may potentially be affected by the action. The Agency uses more rigorous analysis including consideration of available land cover data, toxicity data, and exposure information to determine areas where BCB, CCR, CFWS, CTS-CC, CTS-SC, CTS-SB, DS, SFGS, TG, and VELB and designated critical habitat may be affected or modified via endpoints associated with reduced survival, growth, or reproduction.

2.7.2. LAA Effects Determination Area

A stepwise approach is used to define the Likely to Adversely Affect (LAA) Effects Determination Area. An LAA effects determination applies to those areas where it is expected that the pesticide's use will directly or indirectly affect the species and/or modify its designated critical habitat using EFED's standard assessment procedures (see Attachment I) and effects endpoints related to survival, growth, and reproduction. This is the area where the "Potential Area of LAA Effects" (initial area of concern + drift distance or downstream dilution distance) overlaps with the range and/or designated critical habitat for the species being assessed. If there is no overlap between the potential area of LAA effects and the habitat or occurrence areas, a no effect determination is made. The first step in defining the LAA Effects Determination Area is to understand the federal action. The federal action is defined by the currently labeled uses for *lambda*-cyhalothrin. An analysis of labeled uses and review of available product labels was completed. In addition, a distinction has been made between food use crops and those that are non-food/non-agricultural uses. For those uses relevant to the assessed species, the analysis indicates that, for *lambda*-cyhalothrin, the following agricultural uses are considered as part of the federal action evaluated in this assessment:

- Brassicas
- Cereal grains
- Corn
- Cucurbits
- Fruiting vegetables
- Legume vegetables
- Leafy vegetables
- Livestock
- Orchard crops (fruits and nuts)
- Potato/root crops
- Sunflower

(see Table 2-6 for more detail)

In addition, the following non-food and non-agricultural uses are considered:

- Forestry
- Lawns and turf (commercial, golf course, recreational, residential)
- Ornamental plants
- Outdoor residential settings
- Rights-of-way
- Uncultivated ag areas
- Uncultivated non-ag areas

(see Table 2-6 for more detail)

Following a determination of the assessed uses, an evaluation of the potential "footprint" of *lambda*-cyhalothrin use patterns (*i.e.*, the area where pesticide application may occur) is determined. This "footprint" represents the initial area of concern, based on an analysis of available land cover data for the state of California. The initial area of concern is defined as all land cover types and the stream reaches within the land cover areas that represent the labeled uses described above. Given the diverse uses of lambda-cyhalothrin (residential, commercial, agricultural, and forestry), the "footprint" covers the entire state of California, thus mapping specific use sites does not provide information that is critical for this risk assessment.

Once the initial area of concern is defined, the next step is to define the potential boundaries of the Potential Area of LAA Effects by determining the extent of offsite transport via spray drift and runoff where exposure of one or more taxonomic groups to the pesticide will result in exceedances of the listed species LOCs.

The AgDRIFT model (Version 2.1) is used to define how far from the initial area of concern an effect to a given species may be expected via spray drift (*e.g.*, the drift distance). The spray drift analysis for *lambda*-cyhalothrin uses the most sensitive endpoint of invertebrates in both terrestrial (honeybee) and aquatic systems (*Hyalella*). Further detail on the spray drift analysis is provided in Section 5.6.9.a.

An evaluation of usage information was conducted to determine the area where use of *lambda*-cyhalothrin may affect the assessed species. This analysis is used to characterize where predicted exposures are most likely to occur, but does not preclude use in other portions of the action area.

2.8. Assessment Endpoints and Measures of Ecological Effect

For more information on the assessment endpoints, measures of ecological effect, see Attachment I.

2.8.1. Assessment Endpoints

A complete discussion of all the toxicity data available for this risk assessment, including resulting measures of ecological effect selected for each taxonomic group of concern, is included in Section 4 of this document. Table 2-10 identifies the taxa used to assess the potential for direct and indirect effects from the uses of *lambda*-cyhalothrin for each listed species assessed here. The specific assessment endpoints used to assess the potential for direct and indirect effects to each listed species are provided in Table 2-11.

Table 2-10. Taxa Used in the Analyses of Direct and Indirect Effects for the Assessed Listed Species

Listed Species	Birds	Mammals	Terr. Plants	Terr. Inverts.	FW Fish	FW Inverts.	Estuarine /Marine Fish	Estuarine /Marine Inverts.	Aquatic Plants
San Francisco garter snake**	Direct Indirect (prey)	Indirect (prey/ habitat)	Indirect (habitat)	Indirect (prey)	Indirect (prey)	Indirect (prey)	n/a	n/a	Indirect (habitat)
California clapper rail**	Direct Indirect	Indirect (prey)	Indirect (food/ habitat)	Indirect (prey)	Indirect (prey)	Indirect (prey)	Indirect (prey)	Indirect (prey)	Indirect (food/ habitat)

Listed Species	Birds	Mammals	Terr. Plants	Terr. Inverts.	FW Fish	FW Inverts.	Estuarine /Marine Fish	Estuarine /Marine Inverts.	Aquatic Plants
	(prey)								
Bay checkerspot butterfly	n/a	n/a	Indirect (food/ habitat) *	Direct	n/a	n/a	n/a	n/a	n/a
Valley elderberry longhorn beetle	n/a	n/a	Indirect (food/ habitat) *	Direct	n/a	n/a	n/a	n/a	n/a
California tiger salamander	Direct	Indirect (prey/ habitat)	Indirect (habitat)	Indirect (prey)	Direct Indirect (prey)	Indirect (prey)	n/a	n/a	Indirect (food/ habitat)
Tidewater goby	n/a	n/a	Indirect (habitat)	n/a	Direct***	Indirect (prey)	Direct***	Indirect (prey)	Indirect (habitat)
Delta smelt	n/a	n/a	Indirect (habitat)	n/a	Direct***	Indirect (prey)	Direct***	Indirect (prey)	Indirect (food/ habitat)
California freshwater shrimp	n/a	n/a	Indirect (food/ habitat)	n/a	n/a	Direct Indirect (prey)	n/a	n/a	Indirect (food/ habitat)

Abbreviations: n/a = Not applicable; Terr. = Terrestrial; Invert. = Invertebrate; FW = Freshwater
* obligate relationship
** Consumption of residues of *lambda*-cyhalothrin in aquatic organisms may result in direct effects to the San Francisco Garter Snake and the California Clapper Rail.
***The most sensitive fish species across freshwater and estuarine/marine environments is used to assess effects for these species because they may be found in freshwater or estuarine/marine environments.

Table 2-11. Taxa and Assessment Endpoints Used to Evaluate the Potential for Use of *Lambda*-Cyhalothrin to Result in Direct and Indirect Effects to the Assessed Listed Species or Modification of Critical Habitat

Taxa Used to Assess Direct and Indirect Effects to Assessed Species and/or Modification to Critical Habitat or Habitat	Assessed Listed Species	Assessment Endpoints	Measures of Ecological Effects
1. Freshwater Fish and Aquatic-Phase Amphibians	Direct Effect – -CA Tiger Salamander -Delta Smelt -Tidewater Goby	Survival, growth, and reproduction of individuals via direct effects	1a. Most sensitive fish acute LC_{50} (guideline or ECOTOX) 1b. Most sensitive fish chronic NOAEC (guideline or ECOTOX) 1c. Most sensitive aquatic-phase amphibian acute LC_{50} (guideline or ECOTOX)
	Indirect Effect (prey) -SF Garter Snake -CA Clapper Rail	Survival, growth, and reproduction of individuals or modification of habitat via indirect effects on	

Taxa Used to Assess Direct and Indirect Effects to Assessed Species and/or Modification to Critical Habitat or Habitat	Assessed Listed Species	Assessment Endpoints	Measures of Ecological Effects
		aquatic prey food supply (*i.e.*, fish and aquatic-phase amphibians)	
2. Freshwater Invertebrates	Direct Effect – -CA FW Shrimp	Survival, growth, and reproduction of individuals via direct effects	2a. Most sensitive freshwater invertebrate EC_{50} (guideline or ECOTOX) 2b. Most sensitive freshwater invertebrate chronic NOAEC (guideline or ECOTOX)
	Indirect Effect (prey) -CA FW shrimp -SF Garter Snake -CA Clapper Rail -CA Tiger Salamander -Delta Smelt -Tidewater Goby	Survival, growth, and reproduction of individuals or modification of critical habitat/habitat via indirect effects on aquatic prey food supply (*i.e.*, freshwater invertebrates)	
3. Estuarine/Marine Fish	Direct Effect – -Delta Smelt -Tidewater Goby	Survival, growth, and reproduction of individuals via direct effects	3a. Most sensitive estuarine/marine fish EC_{50} (guideline or ECOTOX) 3b. Most sensitive estuarine/marine fish chronic NOAEC (guideline or ECOTOX)
	Indirect Effect (prey) -CA Clapper Rail	Survival, growth, and reproduction of individuals or modification of habitat via indirect effects on aquatic prey food supply (*i.e.*, estuarine/marine fish)	
4. Estuarine/Marine Invertebrates	Direct Effect – None	NA	4a. Most sensitive estuarine/marine invertebrate EC_{50} (guideline or ECOTOX) 4b. Most sensitive estuarine/marine invertebrate chronic NOAEC (guideline or ECOTOX)
	Indirect Effect (prey) -CA Clapper Rail -Delta Smelt -Tidewater Goby	Survival, growth, and reproduction of individuals or modification of habitat via indirect effects on aquatic prey food supply (*i.e.*, estuarine/marine invertebrates)	
5. Aquatic Plants (freshwater/marine)	Direct Effect – None	NA	5a. Vascular plant acute EC_{50} (duckweed guideline test or ECOTOX vascular plant) 5b. Non-vascular plant acute EC_{50}

Taxa Used to Assess Direct and Indirect Effects to Assessed Species and/or Modification to Critical Habitat or Habitat	Assessed Listed Species	Assessment Endpoints	Measures of Ecological Effects
	Indirect Effect (food/habitat) -SF Garter Snake -CA Clapper Rail -CA Tiger Salamander -CA FW Shrimp -Delta Smelt -Tidewater Goby	Survival, growth, and reproduction of individuals or modification of critical habitat/habitat via indirect effects on habitat, cover, food supply, and/or primary productivity (*i.e.*, aquatic plant community)	(freshwater algae or diatom, or ECOTOX non-vascular)
6. Birds	Direct Effect -SF Garter Snake -CA Clapper Rail -CA Tiger Salamander	Survival, growth, and reproduction of individuals via direct effects	6a. Most sensitive bird* or terrestrial-phase amphibian acute LC_{50} or LD_{50} (guideline or ECOTOX) 6b. Most sensitive bird* or terrestrial-phase amphibian chronic NOAEC (guideline or ECOTOX)
	Indirect Effect (prey/rearing sites) -SF Garter Snake -CA Clapper Rail	Survival, growth, and reproduction of individuals or modification of habitat via indirect effects on terrestrial prey (birds)	
7. Mammals	Direct Effect – None	Survival, growth, and reproduction of individuals via direct effects	7a. Most sensitive laboratory mammalian acute LC_{50} or LD_{50} (guideline or ECOTOX) 7b. Most sensitive laboratory mammalian chronic NOAEC (guideline or ECOTOX)
	Indirect Effect (prey/habitat from burrows/rearing sites) -SF Garter Snake -CA Clapper Rail -CA Tiger Salamander	Survival, growth, and reproduction of individuals or modification of critical habitat/habitat via indirect effects on terrestrial prey (mammals) and/or burrows/rearing sites	
8. Terrestrial Invertebrates	Direct Effect -Bay Checkerspot Butterfly -Valley elderberry longhorn beetle	Survival, growth, and reproduction of individuals via direct effects	8a. Most sensitive terrestrial invertebrate acute EC_{50} or LC_{50} (guideline or ECOTOX) 8b. Most sensitive terrestrial invertebrate chronic NOAEC (guideline or ECOTOX)
	Indirect Effect (prey) -SF Garter Snake -CA Clapper Rail -CA Tiger Salamander	Survival, growth, and reproduction of individuals or modification of critical habitat/habitat via indirect effects on terrestrial prey (terrestrial invertebrates)	

Taxa Used to Assess Direct and Indirect Effects to Assessed Species and/or Modification to Critical Habitat or Habitat	Assessed Listed Species	Assessment Endpoints	Measures of Ecological Effects
9. Terrestrial Plants	Direct Effect – None	NA	9a. Distribution of EC_{25} for monocots (seedling emergence, vegetative vigor, or ECOTOX 9b. Distribution of EC_{25} (EC_{05} or NOAEC for the BCB and the VELB) for dicots (seedling emergence, vegetative vigor, or ECOTOX)
	Indirect Effect (food/habitat) (non-obligate relationship) -SF Garter Snake -CA Clapper Rail -CA Tiger Salamander -Delta Smelt -Tidewater Goby		
	Indirect Effect (food/habitat) (obligate relationship) -Bay Checkerspot Butterfly -Valley Elderberry Longhorn Beetle		

Abbreviations: SF=San Francisco; NA=Not Applicable
* Birds are used as a surrogate for terrestrial-phase amphibians and reptiles. Fish are used as a surrogate for aquatic-phase amphibians.

2.8.2. Assessment Endpoints for Designated Critical Habitat

As previously discussed, designated critical habitat is assessed to evaluate actions related to the use of *lambda*-cyhalothrin that may alter the PCEs of the assessed species' designated critical habitat. PCEs for the assessed species were previously described in Section 2.6. Actions that may modify critical habitat are those that alter the PCEs and jeopardize the continued existence of the assessed species. Therefore, these actions are identified as assessment endpoints. It should be noted that evaluation of PCEs as assessment endpoints is limited to those of a biological nature (*i.e.*, the biological resource requirements for the listed species associated with the critical habitat) and those for which *lambda*-cyhalothrin effects data are available.

Assessment endpoints used to evaluate potential for direct and indirect effects are equivalent to the assessment endpoints used to evaluate potential effects to designated critical habitat. If a potential for direct or indirect effects is found, then there is also a potential for effects to critical habitat. Some components of these PCEs are associated with physical abiotic features (*e.g.*, presence and/or depth of a water body, or distance between two sites), which are not expected to be measurably altered by use of pesticides.

2.9. Conceptual Model

2.9.1. Risk Hypotheses

Risk hypotheses are specific assumptions about potential adverse effects (*i.e.,* changes in assessment endpoints) and may be based on theory and logic, empirical data, mathematical models, or probability models (USEPA, 1998). For this assessment, the risk is stressor-linked, where the stressor is the release of *lambda*-cyhalothrin to the environment. The following risk hypotheses are presumed in this assessment:

The labeled use of *lambda*-cyhalothrin within the action area may:

- directly affect BCB, CCR, CFWS, CTS-CC, CTS-SC, CTS-SB, DS, SFGS, TG, and VELB by causing mortality or by adversely affecting growth or fecundity;
- indirectly affect BCB, CCR, CFWS, CTS-CC, CTS-SC, CTS-SB, DS, SFGS, TG, and VELB and/or modify their designated critical habitat by reducing or changing the composition of food supply;
- indirectly affect CCR, CFWS, CTS (all DPS), DS, SFGS, and TG and/or modify their designated critical habitat by reducing or changing the composition of the aquatic plant community in the species' current range, thus affecting primary productivity and/or cover;
- indirectly affect BCB, CCR, CFWS, CTS (all DPS), DS, SFGS, TG, and VELB and/or modify their designated critical habitat by reducing or changing the composition of the terrestrial plant community in the species' current range;
- indirectly affect CCR, CFWS, CTS (all DPS), DS, SFGS, and TG and/or modify their designated critical habitat by reducing or changing aquatic habitat in their current range (via modification of water quality parameters, habitat morphology, and/or sedimentation);
- indirectly affect CTS (all DPS) and SFGS and/or modify their designated critical habitat by reducing or changing terrestrial habitat in their current range (via reduction in small burrowing mammals leading to reduction in underground refugia/cover).

2.9.2. Diagram

The conceptual model is a graphic representation of the structure of the risk assessment. It specifies the *lambda*-cyhalothrin release mechanisms, biological receptor types, and effects endpoints of potential concern. The conceptual models for BCB, CCR, CFWS, CTS-CC, CTS-SC, CTS-SB, DS, SFGS, TG, and VELB and the conceptual models for the aquatic and terrestrial PCE components of critical habitat are shown in Figure 2-10 and Figure 2-11. Although the conceptual models for direct/indirect effects and modification of designated critical habitat PCEs are shown on the same diagrams, the potential for direct/indirect effects and modification of PCEs will be evaluated separately in this assessment. Exposure routes shown in dashed lines are not quantitatively considered because the contribution of those exposure routes to potential risks to BCB, CCR, CFWS, CTS-CC, CTS-SC, CTS-SB, DS, SFGS, TG, and VELB and modification to designated critical habitat is expected to be negligible.

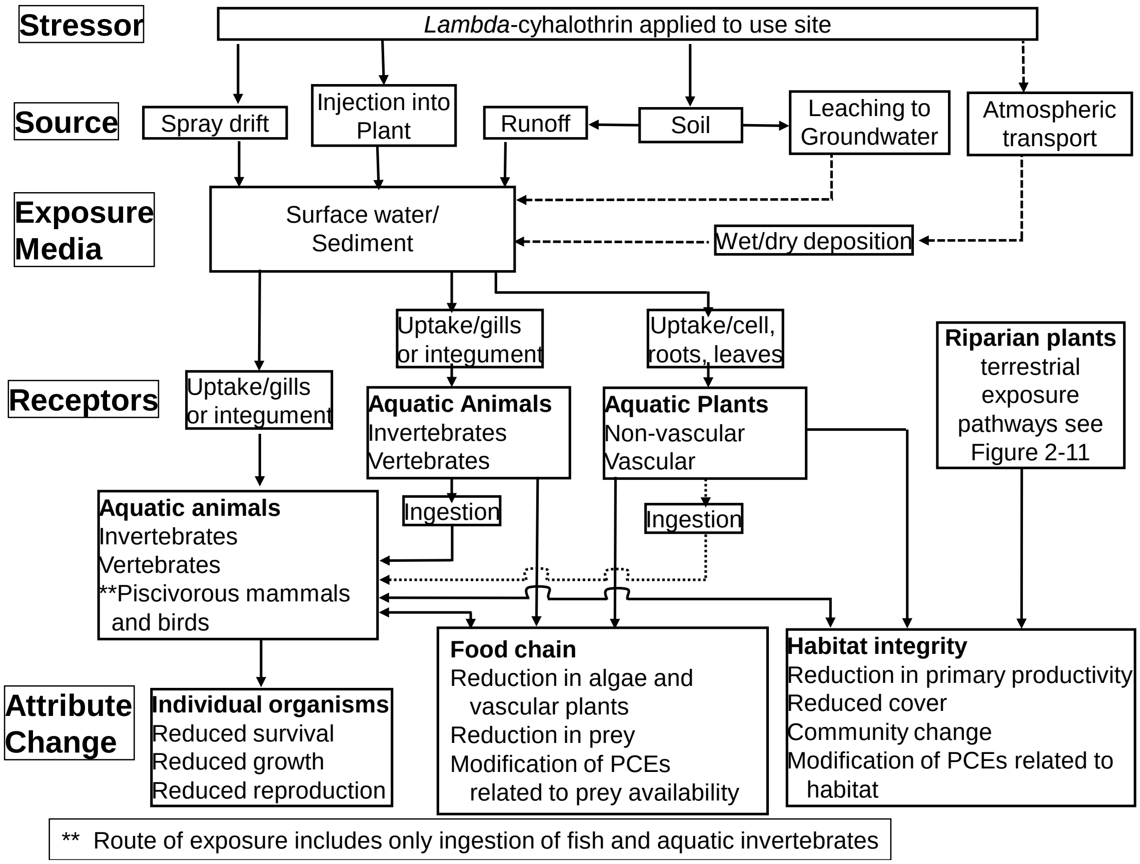


Figure 2-10. Conceptual Model Depicting Stressors, Exposure Pathways, and Potential Effects to Aquatic Organisms from the Use of *Lambda*-Cyhalothrin

Dotted lines indicate exposure pathways that have a low likelihood of contributing to ecological risk.

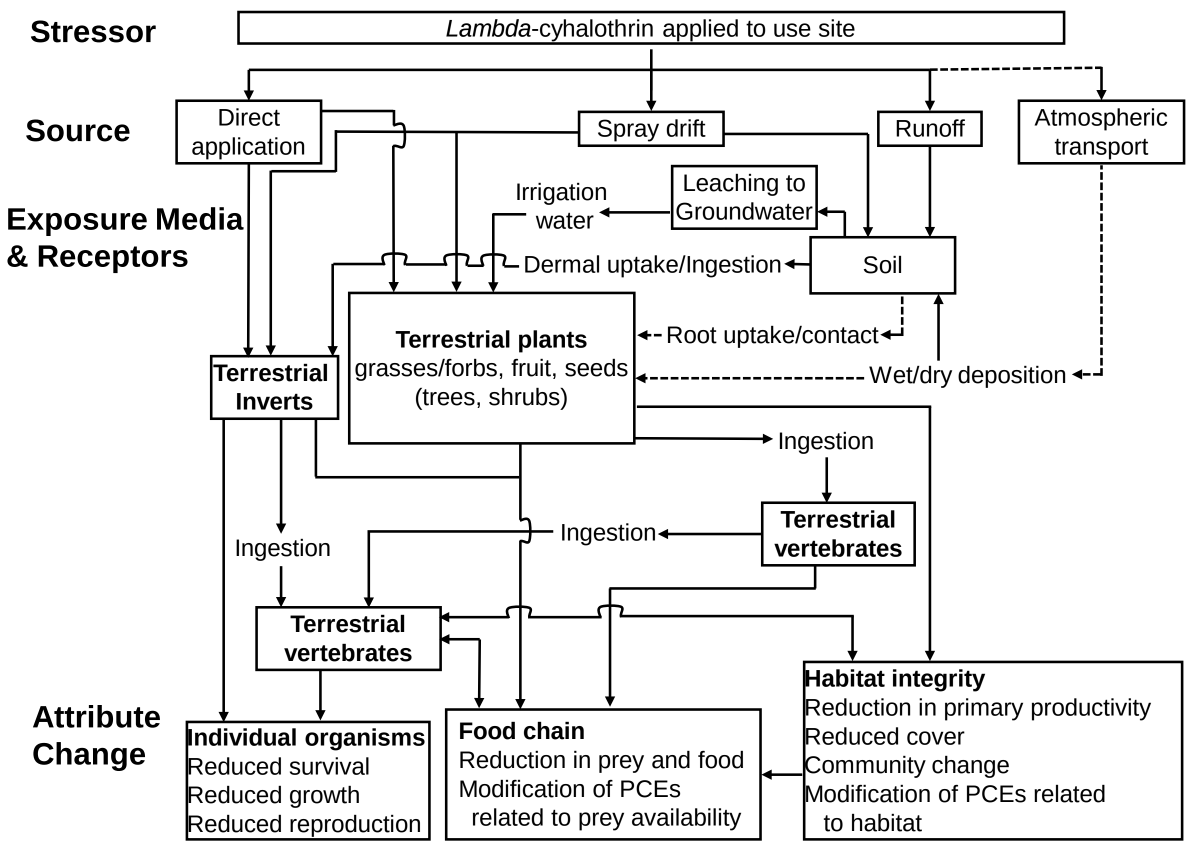


Figure 2-11. Conceptual Model Depicting Stressors, Exposure Pathways, and Potential Effects to Terrestrial Organisms from the Use of *Lambda*-Cyhalothrin
Dotted lines indicate exposure pathways that have a low likelihood of contributing to ecological risk.

In addition to the traditional exposure pathways identified in Figure 2-10 and, Figure 2-11, the ear tag pathway is considered separately. Ear tags may fall off of animals directly into aquatic habitats. Birds may be exposed to *lambda*-cyhalothrin via ear tags through dermal contact with the animal or by ingestion as the active ingredient disperses from the ear tag to the animal's skin.

2.10. Analysis Plan

To address the risk hypothesis, the potential for direct and indirect effects to the assessed species, prey items, and habitat is estimated based on a taxon-level approach. In the following sections, the use, environmental fate, and ecological effects of *lambda*-cyhalothrin are characterized and integrated to assess the risks. This is accomplished using a risk quotient (ratio of exposure concentration to effects concentration) approach. Although risk is often defined as the likelihood and magnitude of adverse ecological effects, the risk quotient-based approach does not provide a quantitative estimate of likelihood and/or magnitude of an adverse effect. However, as outlined in the Overview Document (USEPA, 2004), the likelihood of effects to individual organisms from particular uses of *lambda*-cyhalothrin is estimated using the probit dose-response slope and either the level of concern (discussed below) or actual calculated risk quotient value.

Descriptions of routine procedures for evaluating risk to the San Francisco Bay Species are provided in Attachment I.

2.10.1. Measures of Exposure

The environmental fate properties of *lambda*-cyhalothrin along with available monitoring data indicate that water and sediment runoff and spray drift are the principle potential transport mechanisms of *lambda*-cyhalothrin to the aquatic and terrestrial habitats. *Lambda*-cyhalothrin is a non-systemic chemical and applications via injection or drench also pose likely exposure pathways. Exposure via bioaccumulation is considered as studies have indicated a high bioaccumulation factor for *lambda*-cyhalothrin (MRIDs 00152744, 00152745). In this assessment, transport of *lambda*-cyhalothrin through runoff and spray drift and direct spray onto the food items of birds, mammals, and insects is considered in deriving quantitative estimates of *lambda*-cyhalothrin exposure to BCB, CCR, CFWS, CTS-CC, CTS-SC, CTS-SB, DS, SFGS, TG, and VELB, their prey and habitats. Given l*ambda*-cyhalothrin's low vapor pressure and Henry's Law constants, atmospheric and long-range transport in the vapor phase is unlikely. In addition, the chemical's high sorption coefficient's indicate that movement into groundwater is not a significant exposure pathway.

Measures of exposure are based on aquatic and terrestrial models that predict estimated environmental concentrations (EECs) of *lambda*-cyhalothrin using maximum labeled application rates and methods of application. Aquatic EECs are predicted using the Pesticide Root Zone Model coupled with the Exposure Analysis Model System (PRZM/EXAMS). In addition, the Tier I Rice Model was utilized to model rice. The model used to predict terrestrial EECs on food items is the Terrestrial Residue Exposure (T-REX) model. The Terrestrial Herpetofaunal Exposure Residue Program Simulation (T-HERPS) model is used to allow for further characterization of dietary exposures of terrestrial-phase amphibians and reptiles relative to birds. The K_{OW} (based) Aquatic BioAccumulation Model (KABAM) is used to estimate potential bioaccumulation of hydrophobic organic pesticides in freshwater aquatic food webs and subsequent risks to mammals and birds via consumption of contaminated aquatic prey. These models are parameterized using relevant reviewed registrant-submitted environmental fate data. More information on these models is available in Attachment I.

2.10.2. Measures of Effect

Data identified in Section 2.8 are used as measures of effect for direct and indirect effects. Data were obtained from registrant submitted studies or from literature studies identified by ECOTOX. More information on the ECOTOXicology (ECOTOX) database and how toxicological data is used in assessments is available in Attachment I.

2.10.3. Integration of Exposure and Effects

Risk characterization is the integration of exposure and ecological effects characterization to determine the potential ecological risk from agricultural and non-agricultural uses of *lambda*-cyhalothrin, and the likelihood of direct and indirect effects to the assessed species in aquatic and terrestrial habitats. The exposure and toxicity effects data are integrated to evaluate the risks of adverse ecological effects on non-target species. The risk quotient (RQ) method is used to compare exposure and measured toxicity values. EECs are divided by acute and chronic toxicity values. The resulting RQs are then compared to the Agency's levels of concern (LOCs) (USEPA, 2004)(see Appendix C). More information on standard assessment procedures is available in Attachment I.

2.10.4. Data Gaps

There are no terrestrial plant toxicity data available from registrant-submitted studies. Open literature sources were consulted, but plant data were mainly included as part of insect control efficacy studies. At best, these studies can be used to provide qualitative information about the effects of *lambda*-cyhalothrin on plants. There are a number of plant incidents in OPP's Incident Data System (IDS) and Ecological Incident Information System (EIIS). Few details are provided about the incidents, making the likelihood that they were caused by *lambda*-cyhalothrin unclear. In addition, plant data for other pyrethroids are not available. Plant data were requested in the 2010 Problem Formulation (USEPA 2010) to reduce the uncertainty of *lambda*-cyhalothrin effects on plants.

There are no benthic invertebrate sediment toxicity data available for *lambda*-cyhalothrin. In lieu of this, data from freshwater and estuarine/marine invertebrates are used as surrogate toxicity values for benthic invertebrates. Benthic organisms may be more or less sensitive to *lambda*-cyhalothrin than non-benthic invertebrates, thus using non-benthic invertebrates as a surrogate may over- or under-estimate risk. The 2010 Problem Formulation (USEPA 2010) requested data on benthic invertebrates in an effort to reduce this uncertainty.

3. Exposure Assessment

Risks from ground sprayers and aerial applications are considered in this assessment because they are expected to result in the highest off-target levels of *lambda*-cyhalothrin given generally higher spray drift levels. Ground and aerial modes of application tend to use lower volumes of application applied in finer sprays than applications coincident with sprayers and spreaders and thus have a higher potential for off-target movement via spray drift. Ear tags (impregnated material), drenches, dust, and band sprayers (T-banding, soil in-furrow treatments) are also assessed as these methods of application result in complete environmental exposure pathways.

3.1. Label Application Rates and Intervals

Lambda-cyhalothrin labels may be categorized into two types: labels for manufacturing uses (including technical grade *lambda*-cyhalothrin and its formulated products) and end-use products. While technical products, which contain *lambda*-cyhalothrin of high purity, are not used directly in the environment, they are used to make formulated products, which can be applied in specific areas to control a wide variety of arthropods (*e.g.*, one label lists the following target pests: ants, armyworms, beetles, centipedes, cockroaches, crickets, cutworms, earwigs, European crane flies, firebrats, fleas, grasshoppers, green june beetles, Japanese beetle, leafhoppers, millipedes, mites, palmetto bugs, pillbugs, silverfish, sod webworms, sowbugs, spider mites, spittle bugs, springtails, ticks, waterbugs, billbugs, chinch bugs, dung beetles, hyperodes weevils, and mole crickets). The formulated product labels legally limit *lambda*-cyhalothrin's potential use to only those sites that are specified on the labels.

Many *lambda*-cyhalothrin labels include an environmental hazard statement about its toxicity towards fish, aquatic invertebrates, and honeybees. For terrestrial uses, *lambda*-cyhalothrin should not be applied directly to water or to areas where surface water is present or to intertidal areas below the mean high water mark. It should not be applied when weather conditions favor drift from treated areas. It should not be applied in a manner that allows it to come into contact with blooming crops or weeds if bees are visiting the treatment area. Some labels also contain information about *lambda*-cyhalothrin's toxicity to mammals. In 2008, registrants were required to add aquatic buffer zones to all *lambda*-cyhalothrin labels. Buffers are 10 to 25 feet, depending on the label. However, based on a cursorary review of labels, it was found that not all labels contained the buffer language. Consequently, buffers were not incorporated into the aquatic analyses, as a conservative approach. As a mitigation option, buffers were modeled, (10 and 25 ft, as specified on the labels) for a subset of uses. These results are described in Section 5.

Currently registered agricultural and non-agricultural uses of *lambda*-cyhalothrin within California include a wide array of fruiting and leafy vegetable crops, orchard crops (fruits and nuts), corn, grains, root crops, uncultivated agricultural areas, commercial and residential lawn and building perimeter uses, and ornamentals (trees, bushes, woody vines. The uses being assessed are summarized in Table 3-1.

Table 3-1. *Lambda*-Cyhalothrin Uses, Scenarios, and Application Information for Aquatic Scenarios

Proposed Label Use	PRZM/EXAMS Scenario[1] (first app date)	Method[1]	Application Rate (interval between applications)
Agricultural/farm premises	CA Residential[3] CA Impervious (Jan 02 – surface spray)	CC	2 app @ 0.2212 lb a.i./acre 1 app @ 0.0763 lb a.i./acre (7-day interval)
Alfalfa	CA Alfalfa (Dec 10 – foliar)	A	3 app @ 0.38 lb a.i./acre (10-day interval)
		G	
Almond	CA Almond (July 26 – dust)	D	6 app @ 0.1 lb a.i./acre (7-day interval)
	CA Almond (Aug 20 – trunk drench)	T	3 app @ 0.06 lb a.i./acre (5-day interval)

Proposed Label Use	PRZM/EXAMS Scenario[1] (first app date)	Method[1]	Application Rate (interval between applications)
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, trees	CA Fruit (May 23 – dust)	D	9 app @ 0.1 lb a.i./acre (7-day interval)
Nectarine, peach, cherry trees trunk drench	CA Fruit (July 8– trunk drench)	T	3 app @ 0.06 lb a.i./acre (5-day interval)
Apple Trees	CA Fruit (July 18– trunk drench)	T	1 app @ 0.06 lb a.i./acre
Animal housing premises, Paths/patios	CA Residential[3] CA Impervious (Jan 02 – surface spray)	CC	14 app @ 0.0762 lb a.i./acre 1 app @ 0.1132 lb a.i./acre (21-day interval)
Household/domestic dwellings, outdoor premises	CA Residential[3] CA Impervious (Jan 02 – surface spray)	CC	2 app @ 2.0 lb a.i./acre (7-day interval)
Apricot, loquat, mayhaw, plum, quince	CA Fruit (May 23 – dust)	D	9 app @ 0.0239 lb a.i./acre (7-day interval)
Bean, groundcherry, pea, pepino, pepper	CA Row Crop (Jan 15 – dust)	D	9 app @ 0.0239 lb a.i./acre (7-day interval)
Eggplant	CA Melons (June 06 – dust)	D	9 app @ 0.0239 lb a.i./acre (7-day interval)
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut	CA Almond (July 26 – dust)	D	6 app @ 0.0239 lb a.i./acre (7-day interval)
Barley	CA Wheat (May25 – foliar)	A	2 app @ 0.031 lb a.i./acre (7-day interval)
		G	
Bell pepper, catjang (Jerusalem/marble pea)	CA Row Crop (Jan 22 – foliar, dust)	A	12 app @ 0.03 lb a.i./acre (7-day interval)
		D	
Mustard cabbage (gai choy, pak-choi)	CA Cole Crop (Jan 25– dust)	D	8 app @ 0.03 lb a.i./acre (5-day interval)
Brassica (head and stem) vegetables	CA Cole Crop (Jan 01– foliar)	A	8 app @ 0.031 lb a.i./acre (3 crop cycles of 120 days; 7-day interval per crop cycle)
		G	
Tomato, tomatillo	CA Tomato (July 2– dust)	D	9 app @ 0.0294 lb a.i./acre (7-day interval)
Broccoli, cauliflower, ground spray/dust	CA Cole Crop (Jan 1– dust)	D	9 app @ 0.0294 lb a.i./acre (2 crop cycles of 120 days; 7-day interval per crop cycle)
Cabbage, kohlrabi	CA Cole Crop (Jan 1 – dust)	D	9 app @ 0.0294 lb a.i./acre (3 crop cycles of 120 days; 7-day interval per crop cycle; max. 26 apps./year)[2]
Mustard	CA Cole Crop (Jan 1 – dust)	D	9 app @ 0.0294 lb a.i./acre (4 crop cycles of 90 days; 7-day interval per crop cycle; max. 26 apps./year)[2]

Proposed Label Use	PRZM/EXAMS Scenario[1] (first app date)	Method[1]	Application Rate (interval between applications)
Brussels sprouts	CA Lettuce (April 21 – foliar, dust)	G	3 app @ 0.038 lb a.i./acre (10-day interval)
		D	9 app @ 0.038 lb a.i./acre (10-day interval)
Buckwheat, oat, rye	CA Wheat (May29 – foliar)	A	2 app @ 0.03 lb a.i./acre (3-day interval)
		G	
Canola/rape	CA Wheat (May 22 – foliar)	A	3 app @ 0.0311 lb a.i./acre (5-day interval)
		G	
Grass forage/fodder/hay, pastures, rangeland	CA Range land and Hay (Feb 24 – foliar)	A	3 app @ 0.0311 lb a.i./acre (30-day interval)
		G	
Cereal grains, triticale, wheat	CA Wheat (May 29 – foliar)	A	2 app @ 0.0311 lb a.i./acre (3-day interval)
		G	
Cole crops	CA Cole Crop (Jan 11 – foliar, dust)	A	8 app @ 0.0311 lb a.i./acre (7-day interval)
		D	
Onion	CA Onion (April 19 – foliar, dust)	A	9 app @ 0.0311 lb a.i./acre (7-day interval)
		D	
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns	CA Turf (Dec 23 – foliar)	G	2 app @ 0.1585 lb a.i./acre 1 app @ 0.0983 lb a.i./acre (7-day interval)
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns	CA Turf (Nov 18 – spot trt)	ST	7 app @ 0.06 lb a.i./acre (7-day interval)
Conifers (plantations/nurseries)	CA Nursery (Sept 26 – foliar)	G	6 app @ 0.0401 lb a.i./acre (7-day interval)
Conifers (seed orchard)	CA Nursery (Oct 10 – foliar)	G	3 app @ 0.156 lb a.i./acre 1 app @ 0.036 lb a.i./acre (7-day interval)
Corn (field)	CA Corn (Aug 18 – foliar)	A	3 app @ 0.042 lb a.i./acre (10-day interval)
		G	
Corn (field, pop)	CA Corn (Sept 3 – band, furrow)	B,F	2 app @ 0.0934 lb a.i./acre (4-day interval)
Corn (sweet)	CA Corn (Aug 18– band, furrow)	B,F	6 app @ 0.0934 lb a.i./acre (4-day interval)
Corn (sweet)	CA Corn (April 20 – dust)	D	5 app @ 0.042 lb a.i./acre (3 crop cycles of 120 days; 10-day interval per crop cycle)

Proposed Label Use	PRZM/EXAMS Scenario[1] (first app date)	Method[1]	Application Rate (interval between applications)
Corn (sweet)	CA Corn (April 10 – foliar)	A	6 app @ 0.03 lb a.i./acre (3 crop cycles of 90 days; 10-day interval per crop cycle; max. 16 apps./ year)
Cotton	CA Cotton (Oct 1 – foliar)	A	3 app @ 0.042 lb a.i./acre (10-day interval)
		G	
Cucurbit vegetables	CA Melon (July 7– foliar)	A	6 app @ 0.0311 lb a.i./acre (5-day interval)
		G	
Filbert, pecan, walnut	CA Almond (August 10 – foliar)	A	2 app @ 0.057 lb a.i./acre 1 app @ 0.044 lb a.i./acre (10-day interval)
		G	
Filbert, pecan, walnut	CA Almond (July 11 – dust)	D	6 app @ 0.057 lb a.i./acre (10-day interval)
Forest plantings	CA Forestry (Nov 3 – foliar)	G	4 app @ 0.0511 lb a.i./acre 1 app @ 0.0337 lb a.i./acre (7-day interval)
Fruiting vegetables	CA Row Crop (Jan 23 – foliar)	A	12 app @ 0.0311 lb a.i./acre (5-day interval)
		G	
Garlic	CA Garlic (May 28 – foliar)	A	8 app @ 0.0311 lb a.i./acre (7-day interval)
Golf course turf, ornamental sod farm	CA Turf (Dec 30 – foliar)	G	1 app @ 0.068 lb a.i./acre
Golf course turf, ornamental sod farm	CA Turf (Nov 25 – mound)	M	6 app @ 0.06 lb a.i./acre (7-day interval)
Grasses grown for seed	CA Turf (Dec 16 – foliar)	G	2 app @ 0.1306 lb a.i./acre 1 app @ 0.0811 lb a.i./acre (7-day interval)
Legume vegetables	CA Row Crop (March 3 – foliar)	A	4 app @ 0.0311 lb a.i./acre (5-day interval)
		G	
Peanuts, root and tuber vegetables	CA Row Crop (Feb 26 – foliar)	A	4 app @ 0.0311 lb a.i./acre (7-day interval)
		G	
Lettuce	CA Lettuce (Feb 6 – foliar)	A	10 app @ 0.0311 lb a.i./acre (2 crop cycles of 120 days; 5-day interval per crop cycle)
		G	
Nonagricultural uncultivated areas/soils	CA Right of Way[3] (Oct 18 – foliar)	A	2 app @ 0.0792 lb a.i./acre 1 app @ 0.0432 lb a.i./acre (7-day interval)
Ornamental and/or shade trees	CA Nursery (Oct 17 – foliar)	G	2 app @ 0.162 lb a.i./acre 1 app @ 0.0913 lb a.i./acre

Proposed Label Use	PRZM/EXAMS Scenario[1] (first app date)	Method[1]	Application Rate (interval between applications)
			(7-day interval)
Ornamental and/or shade trees, ground cover, herbaceous plants, non-flowering plants, woody shrubs and vines, rose	CA Nursery (Oct 17 – dust)	D	3 app @ 1.2 lb a.i./acre (7-day interval)
Paved areas (private roads/sidewalks)	CA Impervious (Nov 25 – barrier/perimeter trt)	PT	6 app @ 0.069 lb a.i./acre (7-day interval)
Pome and stone fruit	CA Fruit (June 20 – foliar)	A G	5 app @ 0.0415 lb a.i./acre (7-day interval)
Potato	CA Potato (May 11 – foliar)	A G	3 app @ 0.0239 lb a.i./acre 1 app @ 0.0162 lb a.i./acre (7-day interval)
Recreational areas	CA Turf (Jan 1 – band)	B	26 app @ 0.033 lb a.i./acre (7-day interval)
Recreational areas	CA Turf (Dec 23 –surface spray)	CC ST	2 app @ 2.0 lb a.i./acre (7-day interval)
Residential lawns	CA Residential[3] (Nov 25 – granular)	O	6 app @ 0.078 lb a.i./acre (7-day interval)
Residential lawns	CA Residential[3] (Dec 30 – mound)	M	1 app @ 1.9 lb a.i./acre
Rice	Tier 1 Rice Model	R	3 app @ 0.0415 lb a.i./acre (5-day interval)
Seed orchard trees	CA Nursery (Oct 10 – foliar)	G	3 app @ 0.162 lb a.i./acre 1 app @ 0.0327 lb a.i./acre (7-day interval)
Sorghum	CA Wheat (May 22 – foliar)	A G	2 app @ 0.038 lb a.i./acre (10-day interval)
Soybean	CA Row Crop (March 4– foliar)	A G	1 app @ 0.038 lb a.i./acre 1 app @ 0.021 lb a.i./acre (14-day interval)
Tree nuts	CA Almond (Aug 15– foliar)	A G	4 app @ 0.0415 lb a.i./acre (5-day interval)
Sunflower	CA Corn (Aug 18– foliar)	A G	3 app @ 0.038 lb a.i./acre (10-day interval)
Right-of-Way	CA Right of Way[3] (Sept 27– foliar)	G	6 app @ 0.06 lb a.i./acre (7-day interval)
Airports/landing fields	CA Impervious (Jan 22 – granular)	O	26 app @ 0.08 lb a.i./acre (7-day interval)

Proposed Label Use	PRZM/EXAMS Scenario[1] (first app date)	Method[1]	Application Rate (interval between applications)
Golf course turf, ornamental sod farm (granular spot treatment)	CA Turf (Nov 25 – granular)	O	6 app @ 0.0688 lb a.i./acre (7-day interval)
Grasses grown for seed (granular spot treatment)	CA Turf (Nov 25 – granular)	O	6 app @ 0.06 lb a.i./acre (7-day interval)
Nonagricultural uncultivated areas/soil (granular band/broadcast/ perimeter/spot treatment)	CA Right of Way[3] (Oct 4 – granular)	O	5 app @ 0.0792 lb a.i./acre (7-day interval)
Nonagricultural uncultivated areas/soil (granular mound treatment)	CA Right of Way[3] (Sept 27 – granular)	O	6 app @ 0.06 lb a.i./acre (7-day interval)

[1] A = foliar aerial application modeled as 95% application efficiency, 5% spray drift; G = foliar ground application modeled as 99% application efficiency, 1% spray drift; C = chemigation modeled as 100% application efficiency, 0% spray drift; D = dust modeled as ground application 99% application efficiency, 1% spray drift; M = mound application modeled as 100% application efficiency and 0% spray drift; T = trunk drench modeled as 100% application efficiency and 0% spray drift; CC = crack and crevice modeled as 100% application efficiency and 0% spray drift; ST = spot treatment modeled as 100% application efficiency and 0% spray drift; B = Banded applications modeled as 100% application efficiency and 0% spray drift; F = Furrow applications modeled as 100% application efficiency and 0% spray drift; PT = perimeter treatment modeled as 100% application efficiency and 0% spray drift; O = Granular applications modeled as 100% application efficiency and 0% spray drift; R = Tier 1 Rice Model was utilized.
[2] Due to the PRZM/EXAMS model restriction of 26 total applications allowed, the maximum of 26 applications was modeled.
[3] Spreadsheet post-processing was utilized for the Right of Way (ROW) and Residential Scenarios.

3.2. Aquatic Exposure Assessment

3.2.1. Modeling Approach

The EECs (Estimated Environmental Concentrations) are calculated using the EPA Tier II PRZM (Pesticide Root Zone Model) and EXAMS (Exposure Analysis Modeling System) with the EFED Standard Pond environment. PRZM is used to simulate pesticide transport as a result of runoff and erosion from an agricultural field, and EXAMS estimates environmental fate and transport of pesticides in surface water. Aquatic exposure is modeled for the parent *lambda*-cyhalothrin. The most recent PRZM/EXAMS linkage program (PE5, PE Version 5, dated Nov. 15, 2006) was used for all surface water simulations. Linked crop-specific scenarios and meteorological data were used to estimate exposure resulting from use on crops and turf. In addition, *lambda*-cyhalothrin labels include a number of non-agricultural uses. These uses are represented by the residential, turf, rights-of-way, and impervious surface scenarios.

Residential and rights-of-way (ROW) scenarios were developed specifically for the San Francisco Bay region using the conceptual approach developed for the Barton Springs salamander atrazine endangered species risk assessment (U.S. EPA, 2006). The San Francisco area was selected to be representative of urbanized areas with California Red Legged Frog (CRLF) habitat present in the general vicinity. The conceptual model for both scenarios integrates simultaneous modeling of the individual use scenario with an impervious scenario. This approach assumes that no watershed is completely covered by either the ¼ acre lot (the basis for the residential scenario) or undeveloped land (the basis for the ROW scenario) for residential and ROW use patterns; therefore, differential amounts of runoff will occur within the watershed. The impervious scenario was developed to represent the paved areas within a watershed not including roads, parking lots, sidewalks, and buildings outside the ¼ acre lot (the ¼ acre lot scenario accounts for impervious surfaces such as buildings within the represented area). By modeling a separate scenario for impervious surfaces, it is also possible to estimate that amount of exposure that could occur when the pesticide is over sprayed onto this surface. In previous endangered species risk assessments, the amount of modeled overspray was assumed to be 1% of the labeled application rate. Further details on how this value was derived and characterization of alternative assumptions are provided in the Barton Springs salamander endangered species risk assessment for atrazine (U.S. EPA, 2006).

In general, the majority of occupied areas [including core areas, designated critical habitat, and occurrence data from California Natural Diversity Database (CNDDB)] are located in areas where the percentage of impervious surface is less than 20%. However, a few selected areas with higher percentages of impervious surface (*e.g.*, San Francisco Bay region) were evaluated to determine a representative value for residential settings. The conceptual model for the ROW scenario assumes that the watershed is represented by equal portions of impervious and pervious surface (50%). Based on geospatial data, it is evident that the occupied areas with the highest percentage of impervious cover are urban areas outside the occupied areas, and, in general, the occupied areas have impervious surface of less than 50%. Therefore, for purposes of modeling, it is assumed that a representative percentage of impervious cover is 50%. In general, as the percentage of impervious surface increases, the overall exposure resulting from applications to the pervious surface decreases because less mass is applied within the watershed. Additional information on the impact of this assumption has been previously characterized in the Barton Springs salamander endangered species risk assessment for atrazine (U.S. EPA, 2006).

Use-specific management practices for all of the assessed uses of *lambda*-cyhalothrin were used for modeling, including application rates, number of applications per year, application intervals, buffer widths, and resulting spray drift values modeled from AgDRIFT and the first application date for each use. The date of first application was developed based on several sources of information including data provided by BEAD, a summary of individual applications from the California Department of Pesticide Regulation Pesticide Use Reporting (CDPR PUR) data, and Crop Profiles maintained by the USDA.

To estimate aquatic exposure values from rice use patterns, the Tier I Rice Model was employed. The model relies on an equilibrium partitioning concept to provide conservative estimates of EECs resulting from application of pesticides to rice paddies. When a pesticide is applied to a rice paddy, the model assumes that it will instantaneously partition between a water phase and a sediment phase. The model does not account for pesticide degradation, mass transfer between the aqueous phase and the sediment, volatilization, dilution, or other dissipation processes.

For the crack and crevice applications, the standard post-processing of the residential and impervious scenarios was utilized along with previously established fractions for percent lot treated (3.3% housing perimeter; 3.4% building perimeter). These fractions were utilized in previous litigation (fipronil, dicofol) assessments.

For the perimeter treatment application, 100% of the application rate was modeled to generate EECs then multiplied by 5.68% which represents the fraction of treated impervious surface in an urban watershed. This fraction was utilized in a previous (carbaryl) litigation assessment.

Exposures from ear tags were analyzed without PRZM/EXAMS. See Section 5 for a description of the risk analysis.

3.2.2. Model Inputs

The appropriate PRZM and EXAMS input parameters for *lambda*-cyhalothrin and related compounds were selected from the environmental fate data submitted by the registrant and in accordance with US EPA-OPP EFED water model parameter selection guidelines, *Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides. Version 2.1*, October 22, 2009 and *PE5 User's Manual. (P)RZM (E)XAMS Model Shell, Version (5)*, November 15, 2006. Input parameters can be grouped by physical-chemical properties and other environmental fate data, application information, and use scenarios. Physical and chemical properties relevant to assess the behavior of *lambda*-cyhalothrin and related compounds in the environment are presented in Table 2-1 and Table 2-2 and application information from the label in Table 2-6 and Table 3-1. The input parameters for PRZM and EXAMS are in Table 3-2. Appendix D contains an example model output file and table showing the data used to calculate input values.

Table 3-2. Summary of PRZM/EXAMS Environmental Fate Data Used for Aquatic Exposure Inputs for *Lambda*-Cyhalothrin Endangered Species Assessment[1]

Parameter (units)	Value(s)	Sources	Comments
Scenario	Refer to Table 3-1	---	---
Application Rate	Refer to Table 3-1	---	Rate in lb a.i./A
Day of Application (day-month)	Refer to Table 3-1	---	Based on BEAD information
Number of Applications Allowed	Refer to Table 3-1	---	Based on BEAD information
Interval between Applications (days)	Refer to Table 3-1	---	Based on BEAD information
K_{OC} (ml/g_{OC})	K_{OC} = 333,200	MRID: 44861503	Mean of 8 values available (346000, 200000, 298000, 724000, 209000, 270000, 305000, 352000, 518000, 110000). The K_{OC} model was utilized as per the 1999 SAP recommendation.
Aerobic Soil Metabolism (days)	$t_{input} = \overline{t_{1/2}} + \frac{(t_{90,n-1} s)}{\sqrt{n}}$ t_{input} = 60.6 days	MRID: 00151607 MRID: 44861504 MRID: 45447410	Represents the 90th percentile of the upper confidence bound on the mean of 6 *lambda*-cyhalothrin half-life values of 31, 55, 26, 102, 12.2, and 14.5 days.
Method of Application	Aerial (foliar) Ground (foliar) Chemigation, Ground Spray	---	---
Application Efficiency (fraction)	0.95 (aerial) 0.99 (ground, dust) 1.00 (chemigation, ground spray apps, granular)	---	Input Parameter Guidance v.2.1, dated October 22, 2009

Parameter (units)	Value(s)	Sources	Comments
Spray Drift (fraction)	0.05 (aerial) 0.01 (ground, dust) 0.00 (chemigation, ground spray apps, granular)	---	Input Parameter Guidance v.2.1, dated October 22, 2009
Solubility in Water (mg/L)	5.00 x 10^{-3}	Laskowski 2002	---
Aerobic Aquatic Metabolism (days)	$t_{input} = \overline{t_{1/2}} + \frac{(t_{90,n-1}s)}{\sqrt{n}}$ t_{input} = 53.4 days	MRID: 44861506 MRID: 44367402	Represents the 90th percentile of the upper confidence bound on the mean of 3 *lambda*-cyhalothrin half-life values of 21.1, 34.1 and 52.9 days.
Anaerobic Aquatic Metabolism (days)	426	MRID: 44367401	3x the single available anaerobic aquatic metabolism half-life value of 142 days (*lambda*-cyhalothrin).
Hydrolysis at pH 7	0	MRID: 00151604 & 45447409	Relatively stable at pH 7
Aqueous Photolysis (days)	13	MRID: 46394702	Environmental photo transformation half-life for *gamma*-cyhalothrin was utilized since the *lambda*-cyhalothrin half-life values were uncertain due to solubility issues with the compound.
Molecular Weight (g/mole)	449.86	TOXNET/ HSDB[2]	---
Vapor Pressure (torr at 20ºC)	1.56 x 10^{-9}	Laskowski 2002	---
Henry's Law Constant (atm-m^3/mol at 20ºC)	1.9 x 10^{-7}	Laskowski 2002	---
Chemical Application Method (CAM)	2 (aerial) 2 (ground) 1 (chemigation, ground spray)	foliar applied foliar applied soil applied	---
IPSCND, Condition for disposition of pesticide remaining on foliage after harvest	Varied on type of crop	PRZM-3 manual[3]	Page 5-14 for details

[1]Data were selected according to EFED Guidance on Input Parameters v.2.1, dated October 22, 2009.
[2]TOXNET/ HSDB at http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB (accessed 7/9/10)
[3] PRZM-3, A Model for Predicting Pesticide and Nitrogen Fate in the Crop Root and Unsaturated Soil Zones: Users Manual for Release 3.0. May 2005.

3.2.3. Results

The aquatic EECs for the various scenarios and application practices are listed in Table 3-3 and Table 3-4. The example output from PRZM-EXAMS is provided in Appendix D. EECs were calculated for surface water (used in RQ calculations for fish and invertebrates) and pore water (used in RQ calculations for benthic invertebrates). Peak EECs ranged from 0.0008 to 15.89 µg ai/L for surface water and 0.00002 to 121.0 µg ai/L for pore water. In instances where the solubility limit was exceeded (5 µg ai/L), the solubility limit was used for RQ calculation in lieu of the EEC.

Table 3-3. *Lambda*-Cyhalothrin EECs (µg/L) for Surface Water in California

Proposed Label Use	PRZM/EXAMS Scenario[1] (first app date)	Method[1]	Application Rate (interval between applications)	Peak EEC (µg/L)	21-day EEC (µg/L)	60-day EEC (µg/L)
Surface Water Concentrations						
Agricultural/farm premises	CA Residential CA Impervious (Jan 02 – surface spray)	CC	2 app @ 0.2212 lb a.i./acre 1 app @ 0.0763 lb a.i./acre (7-day interval)	0.058	0.007	0.004
Alfalfa	CA Alfalfa (Dec 10 – foliar)	A	3 app @ 0.38 lb a.i./acre (10-day interval)	0.66	0.14	0.08
		G		0.14	0.03	0.02
Almond	CA Almond (July 26 – dust)	D	6 app @ 0.1 lb a.i./acre (7-day interval)	0.07	0.02	0.02
	CA Almond (Aug 20 – trunk drench)	T	3 app @ 0.06 lb a.i./acre (5-day interval)	0.008	0.003	0.002
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, trees	CA Fruit (May 23 – dust)	D	9 app @ 0.1 lb a.i./acre (7-day interval)	0.05	0.02	0.02
Nectarine, peach, cherry trees trunk drench	CA Fruit (July 8– trunk drench)	T	3 app @ 0.06 lb a.i./acre (5-day interval)	0.0023	0.0003	0.0002
Apple Trees	CA Fruit (July 18– trunk drench)	T	1 app @ 0.06 lb a.i./acre	0.0008	0.0001	0.0001
Animal housing premises, Paths/patios	CA Residential CA Impervious (Jan 02 – surface spray)	CC	14 app @ 0.0762 lb a.i./acre 1 app @ 0.1132 lb a.i./acre (21-day interval)	0.050	0.009	0.006
Household/domestic dwellings, outdoor premises	CA Residential CA Impervious (Jan 02 – surface spray)	CC	2 app @ 2.0 lb a.i./acre (7-day interval)	0.831	0.099	0.062
Apricot, loquat, mayhaw, plum, quince	CA Fruit (May 23 – dust)	D	9 app @ 0.0239 lb a.i./acre (7-day interval)	0.012	0.004	0.004
Bean, groundcherry, pea, pepino, pepper	CA Row Crop (Jan 15 – dust)	D	9 app @ 0.0239 lb a.i./acre (7-day interval)	0.05	0.01	0.01
Eggplant	CA Melons (June 06 – dust)	D	9 app @ 0.0239 lb a.i./acre (7-day interval)	0.010	0.004	0.003
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut	CA Almond (July 26 – dust)	D	6 app @ 0.0239 lb a.i./acre (7-day interval)	0.018	0.005	0.004
Barley	CA Wheat (May25 – foliar)	A	2 app @ 0.031 lb a.i./acre (7-day interval)	0.070	0.016	0.011
		G		0.029	0.010	0.007
Bell pepper, catjang (Jerusalem/marble pea)	CA Row Crop (Jan 22 – foliar, dust)	A	12 app @ 0.03 lb a.i./acre (7-day interval)	0.098	0.042	0.040
		D		0.073	0.016	0.015
Mustard cabbage (gai choy, pak-choi)	CA Cole Crop (Jan 25– dust)	D	8 app @ 0.03 lb a.i./acre (5-day interval)	0.121	0.028	0.026
Brassica (head and stem) vegetables	CA Cole Crop (Jan 01– foliar)	A	8 app @ 0.031 lb a.i./acre (3 crop cycles of 120 days;	0.090	0.036	0.031

Proposed Label Use	PRZM/EXAMS Scenario[1] (first app date)	Method[1]	Application Rate (interval between applications)	Peak EEC (µg/L)	21-day EEC (µg/L)	60-day EEC (µg/L)
		G	7-day interval per crop cycle)	0.082	0.020	0.017
Tomato, tomatillo	CA Tomato (July 2– dust)	D	9 app @ 0.0294 lb a.i./acre (7-day interval)	0.018	0.005	0.005
Broccoli, cauliflower, ground spray/dust	CA Cole Crop (Jan 1– dust)	D	9 app @ 0.0294 lb a.i./acre (2 crop cycles of 120 days; 7-day interval per crop cycle)	0.181	0.044	0.044
Cabbage, kohlrabi	CA Cole Crop (Jan 1 – dust)	D	9 app @ 0.0294 lb a.i./acre (3 crop cycles of 120 days; 7-day interval per crop cycle; max. 26 apps./year) [2]	0.157	0.055	0.051
Mustard	CA Cole Crop (Jan 1 – dust)	D	9 app @ 0.0294 lb a.i./acre (4 crop cycles of 90 days; 7-day interval per crop cycle; max. 26 apps./year) [2]	0.144	0.048	0.046
Brussels sprouts	CA Lettuce (April 21 – foliar, dust)	G	3 app @ 0.038 lb a.i./acre (10-day interval)	0.135	0.021	0.018
		D	9 app @ 0.038 lb a.i./acre (10-day interval)	0.213	0.036	0.033
Buckwheat, oat, rye	CA Wheat (May29 – foliar)	A	2 app @ 0.03 lb a.i./acre (3-day interval)	0.069	0.015	0.010
		G		0.028	0.009	0.007
Canola/rape	CA Wheat (May 22 – foliar)	A	3 app @ 0.0311 lb a.i./acre (5-day interval)	0.082	0.023	0.017
		G		0.042	0.015	0.012
Grass forage/fodder/hay, pastures, rangeland	CA Rangeland and Hay (Feb 24 – foliar)	A	3 app @ 0.0311 lb a.i./acre (30-day interval)	0.055	0.009	0.008
		G		0.011	0.002	0.002
Cereal grains, triticale, wheat	CA Wheat (May 29 – foliar)	A	2 app @ 0.0311 lb a.i./acre (3-day interval)	0.071	0.016	0.011
		G		0.029	0.010	0.007
Cole crops	CA Cole Crop (Jan 11 – foliar, dust)	A	8 app @ 0.0311 lb a.i./acre (7-day interval)	0.127	0.047	0.042
		D		0.117	0.029	0.027
Onion	CA Onion (April 19 – foliar, dust)	A	9 app @ 0.0311 lb a.i./acre (7-day interval)	0.064	0.021	0.020
		D		0.015	0.005	0.005
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns	CA Turf (Dec 23 – foliar)	G	2 app @ 0.1585 lb a.i./acre 1 app @ 0.0983 lb a.i./acre (7-day interval)	0.054	0.008	0.006
Commercial/industrial lawns, ornamental lawns and turf, recreation area	CA Turf (Nov 18 – spot trt)	ST	7 app @ 0.06 lb a.i./acre (7-day interval)	0.019	0.004	0.003

Proposed Label Use	PRZM/EXAMS Scenario[1] (first app date)	Method[1]	Application Rate (interval between applications)	Peak EEC (µg/L)	21-day EEC (µg/L)	60-day EEC (µg/L)
lawns						
Conifers (plantations/nurseries)	CA Nursery (Sept 26 – foliar)	G	6 app @ 0.0401 lb a.i./acre (7-day interval)	0.468	0.069	0.052
Conifers (seed orchard)	CA Nursery (Oct 10 – foliar)	G	3 app @ 0.156 lb a.i./acre 1 app @ 0.036 lb a.i./acre (7-day interval)	1.00	0.148	0.111
Corn (field)	CA Corn (Aug 18 – foliar)	A	3 app @ 0.042 lb a.i./acre (10-day interval)	0.078	0.020	0.016
		G		0.056	0.011	0.009
Corn (field, pop)	CA Corn (Sept 3 – band, furrow)	B,F	2 app @ 0.0934 lb a.i./acre (4-day interval)	0.080	0.014	0.011
Corn (sweet)	CA Corn (Aug 18– band, furrow)	B,F	6 app @ 0.0934 lb a.i./acre (4-day interval)	0.219	0.039	0.031
Corn (sweet)	CA Corn (April 20 – dust)	D	5 app @ 0.042 lb a.i./acre (3 crop cycles of 120 days; 10-day interval per crop cycle)	0.357	0.067	0.054
Corn (sweet)	CA Corn (April 10 – foliar)	A	6 app @ 0.03 lb a.i./acre (3 crop cycles of 90 days; 10-day interval per crop cycle; max. 16 apps./ year)	0.197	0.058	0.053
Cotton	CA Cotton (Oct 1 – foliar)	A	3 app @ 0.042 lb a.i./acre (10-day interval)	0.073	0.015	0.011
		G		0.018	0.004	0.004
Cucurbit vegetables	CA Melon (July 7– foliar)	A	6 app @ 0.0311 lb a.i./acre (5-day interval)	0.059	0.020	0.014
		G		0.012	0.004	0.003
Filbert, pecan, walnut	CA Almond (August 10 – foliar)	A	2 app @ 0.057 lb a.i./acre 1 app @ 0.044 lb a.i./acre (10-day interval)	0.098	0.020	0.014
		G		0.021	0.005	0.004
Filbert, pecan, walnut	CA Almond (July 11 – dust)	D	6 app @ 0.057 lb a.i./acre (10-day interval)	0.027	0.009	0.009
Forest plantings	CA Forestry (Nov 3 – foliar)	G	4 app @ 0.0511 lb a.i./acre 1 app @ 0.0337 lb a.i./acre (7-day interval)	0.298	0.064	0.053
Fruiting vegetables	CA Row Crop (Jan 23 – foliar)	A	12 app @ 0.0311 lb a.i./acre (5-day interval)	0.111	0.047	0.043
		G		0.087	0.018	0.017
Garlic	CA Garlic (May 28 – foliar)	A	8 app @ 0.0311 lb a.i./acre (7-day interval)	0.070	0.026	0.024
Golf course turf, ornamental sod farm	CA Turf (Dec 30 – foliar)	G	1 app @ 0.068 lb a.i./acre	0.022	0.002	0.002
Golf course turf, ornamental sod farm	CA Turf (Nov 25 – mound)	M	6 app @ 0.06 lb a.i./acre (7-day interval)	0.017	0.004	0.003

Proposed Label Use	PRZM/EXAMS Scenario[1] (first app date)	Method[1]	Application Rate (interval between applications)	Peak EEC (µg/L)	21-day EEC (µg/L)	60-day EEC (µg/L)
Grasses grown for seed	CA Turf (Dec 16 – foliar)	G	2 app @ 0.1306 lb a.i./acre 1 app @ 0.0811 lb a.i./acre (7-day interval)	0.050	0.012	0.008
Legume vegetables	CA Row Crop (March 3 – foliar)	A	4 app @ 0.0311 lb a.i./acre (5-day interval)	0.060	0.020	0.015
		G		0.035	0.006	0.005
Peanuts, root and tuber vegetables	CA Row Crop (Feb 26 – foliar)	A	4 app @ 0.0311 lb a.i./acre (7-day interval)	0.060	0.018	0.015
		G		0.034	0.006	0.005
Lettuce	CA Lettuce (Feb 6 – foliar)	A	10 app @ 0.0311 lb a.i./acre (2 crop cycles of 120 days; 5-day interval per crop cycle)	0.245	0.086	0.081
		G		0.223	0.048	0.044
Nonagricultural uncultivated areas/soils	CA Right of Way (Oct 18 – foliar)	A	2 app @ 0.0792 lb a.i./acre 1 app @ 0.0432 lb a.i./acre (7-day interval) [3]	0.048	0.014	0.009
Ornamental and/or shade trees	CA Nursery (Oct 17 – foliar)	G	2 app @ 0.162 lb a.i./acre 1 app @ 0.0913 lb a.i./acre (7-day interval)	0.062	0.018	0.015
Ornamental and/or shade trees, ground cover, herbaceous plants, non-flowering plants, woody shrubs and vines, rose	CA Nursery (Oct 17 – dust)	D	3 app @ 1.2 lb a.i./acre (7-day interval)	7.42	1.08	0.81
Paved areas (private roads/sidewalks)	CA Impervious (Nov 25 – barrier/perimeter trt)	PT	6 app @ 0.069 lb a.i./acre (7-day interval)	0.812	0.069	0.043
Pome and stone fruit	CA Fruit (June 20 – foliar)	A	5 app @ 0.0415 lb a.i./acre (7-day interval)	0.077	0.020	0.016
		G		0.016	0.005	0.004
Potato	CA Potato (May 11 – foliar)	A	3 app @ 0.0239 lb a.i./acre 1 app @ 0.0162 lb a.i./acre (7-day interval)	0.042	0.009	0.007
		G		0.009	0.002	0.002
Recreational areas	CA Turf (Jan 1 – band)	B	26 app @ 0.033 lb a.i./acre (7-day interval)	0.010	0.002	0.002
Recreational areas	CA Turf (Dec 23 –surface spray)	CC ST	2 app @ 2.0 lb a.i./acre (7-day interval)	0.218	0.045	0.037
Residential lawns	CA Residential (Nov 25 – granular)	O	6 app @ 0.078 lb a.i./acre (7-day interval) [3]	0.071	0.010	0.007
Residential lawns	CA Residential (Dec 30 – mound)	M	1 app @ 1.9 lb a.i./acre[3]	0.400	0.061	0.031
Rice	Tier 1 Rice Model	R	3 app @ 0.0415 lb a.i./acre (5-day interval)	0.360	0.360	0.360
Seed orchard trees	CA Nursery (Oct 10 – foliar)	G	3 app @ 0.162 lb a.i./acre 1 app @ 0.0327 lb a.i./acre (7-day interval)	1.210	0.175	0.128

Proposed Label Use	PRZM/EXAMS Scenario[1] (first app date)	Method[1]	Application Rate (interval between applications)	Peak EEC (µg/L)	21-day EEC (µg/L)	60-day EEC (µg/L)
Sorghum	CA Wheat (May 22 – foliar)	A	2 app @ 0.038 lb a.i./acre (10-day interval)	0.085	0.019	0.014
		G		0.036	0.012	0.009
Soybean	CA Row Crop (March 4– foliar)	A	1 app @ 0.038 lb a.i./acre 1 app @ 0.021 lb a.i./acre (14-day interval)	0.064	0.010	0.007
		G		0.016	0.003	0.003
Tree nuts	CA Almond (Aug 15– foliar)	A	4 app @ 0.0415 lb a.i./acre (5-day interval)	0.077	0.023	0.015
		G		0.017	0.006	0.004
Sunflower	CA Corn (Aug 18– foliar)	A	3 app @ 0.038 lb a.i./acre (10-day interval)	0.071	0.019	0.015
		G		0.051	0.010	0.008
Right-of-Way	CA Right of Way (Sept 27– foliar)	G	6 app @ 0.06 lb a.i./acre (7-day interval) [3]	0.054	0.009	0.007
Airports/landing fields	CA Impervious (Jan 22 – granular)	O	26 app @ 0.08 lb a.i./acre (7-day interval)	15.89[4]	2.11	1.74
Golf course turf, ornamental sod farm (granular spot treatment)	CA Turf (Nov 25 – granular)	O	6 app @ 0.0688 lb a.i./acre (7-day interval)	0.019	0.004	0.003
Grasses grown for seed (granular spot treatment)	CA Turf (Nov 25 – granular)	O	6 app @ 0.06 lb a.i./acre (7-day interval)	0.017	0.004	0.003
Nonagricultural uncultivated areas/soil (granular band/broadcast/ perimeter/spot treatment)	CA Right of Way (Oct 4 – granular)	O	5 app @ 0.0792 lb a.i./acre (7-day interval) [3]	0.059	0.009	0.006
Nonagricultural uncultivated areas/soil (granular mound treatment)	CA Right of Way (Sept 27 – granular)	O	6 app @ 0.06 lb a.i./acre (7-day interval) [3]	0.009	0.002	0.002

[1] A = foliar aerial application modeled as 95% application efficiency, 5% spray drift; G = foliar ground application modeled as 99% application efficiency, 1% spray drift; C = chemigation modeled as 100% application efficiency, 0% spray drift; D = dust modeled as ground application 99% application efficiency, 1% spray drift; M = mound application modeled as 100% application efficiency and 0% spray drift; T = trunk drench modeled as 100% application efficiency and 0% spray drift; CC = crack and crevice modeled as 100% application efficiency and 0% spray drift; ST = spot treatment modeled as 100% application efficiency and 0% spray drift; B = Banded applications modeled as 100% application efficiency and 0% spray drift; F = Furrow applications modeled as 100% application efficiency and 0% spray drift; PT = perimeter treatment modeled as 100% application efficiency and 0% spray drift; O = Granular applications modeled as 100% application efficiency and 0% spray drift; R = Tier 1 Rice Model was utilized.

[2] Due to the PRZM/EXAMS model restriction of 26 total applications allowed, the maximum of 26 applications was modeled.

[3] Spreadsheet post-processing was utilized for the Right of Way (ROW) and Residential Scenarios.

[4] Solubility limit will be used in the calculation of RQs because the EEC exceeded the solubility limit (5 µg ai/L).

Table 3-4. Lambda-Cyhalothrin EECs (µg/L) for Pore Water in California

Proposed Label Use	PRZM/EXAMS Scenario[1] (first app date)	Method[1]	Application Rate (interval between applications)	Peak EEC (µg/L)	21-day EEC (µg/L)	60-day EEC (µg/L)
Pore Water Concentrations						
Agricultural/farm premises	CA Residential CA Impervious (Jan 02 – surface spray)	CC	2 app @ 0.2212 lb a.i./acre 1 app @ 0.0763 lb a.i./acre (7-day interval)	9.13[4]	9.10	9.01
Alfalfa	CA Alfalfa (Dec 10 – foliar)	A	3 app @ 0.38 lb a.i./acre (10-day interval)	0.023	0.023	0.022
		G		0.007	0.007	0.007
Almond	CA Almond (July 26 – dust)	D	6 app @ 0.1 lb a.i./acre (7-day interval)	0.005	0.005	0.005
	CA Almond (Aug 20 – trunk drench)	T	3 app @ 0.06 lb a.i./acre (5-day interval)	0.001	0.001	0.001
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, trees	CA Fruit (May 23 – dust)	D	9 app @ 0.1 lb a.i./acre (7-day interval)	0.004	0.004	0.004
Nectarine, peach, cherry trees trunk drench	CA Fruit (July 8– trunk drench)	T	3 app @ 0.06 lb a.i./acre (5-day interval)	6.56E-5	6.52E-5	6.49E-5
Apple Trees	CA Fruit (July 18– trunk drench)	T	1 app @ 0.06 lb a.i./acre	2.00E-5	2.00E-5	2.00E-5
Animal housing premises, Paths/patios	CA Residential CA Impervious (Jan 02 – surface spray)	CC	14 app @ 0.0762 lb a.i./acre 1 app @ 0.1132 lb a.i./acre (21-day interval)	18.09[4]	17.97	17.80
Household/domestic dwellings, outdoor premises	CA Residential CA Impervious (Jan 02 – surface spray)	CC	2 app @ 2.0 lb a.i./acre (7-day interval)	121.0[4]	121.0	120.0
Apricot, loquat, mayhaw, plum, quince	CA Fruit (May 23 – dust)	D	9 app @ 0.0239 lb a.i./acre (7-day interval)	0.001	0.001	0.001
Bean, groundcherry, pea, pepino, pepper	CA Row Crop (Jan 15 – dust)	D	9 app @ 0.0239 lb a.i./acre (7-day interval)	0.003	0.003	0.003
Eggplant	CA Melons (June 06 – dust)	D	9 app @ 0.0239 lb a.i./acre (7-day interval)	0.001	0.001	0.001
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut	CA Almond (July 26 – dust)	D	6 app @ 0.0239 lb a.i./acre (7-day interval)	0.001	0.001	0.001
Barley	CA Wheat (May25 – foliar)	A	2 app @ 0.031 lb a.i./acre (7-day interval)	0.003	0.003	0.003
		G		0.002	0.002	0.002
Bell pepper, catjang (Jerusalem/marble pea)	CA Row Crop (Jan 22 – foliar, dust)	A	12 app @ 0.03 lb a.i./acre (7-day interval)	0.011	0.011	0.011
		D		0.004	0.004	0.004
Mustard cabbage (gai choy, pak-choi)	CA Cole Crop (Jan 25– dust)	D	8 app @ 0.03 lb a.i./acre (5-day interval)	0.007	0.007	0.007
Brassica (head and stem) vegetables	CA Cole Crop (Jan 01– foliar)	A	8 app @ 0.031 lb a.i./acre (3 crop cycles of 120 days;	0.009	0.009	0.009

Proposed Label Use	PRZM/EXAMS Scenario[1] (first app date)	Method[1]	Application Rate (interval between applications)	Peak EEC (µg/L)	21-day EEC (µg/L)	60-day EEC (µg/L)
		G	7-day interval per crop cycle)	0.005	0.005	0.005
Tomato, tomatillo	CA Tomato (July 2– dust)	D	9 app @ 0.0294 lb a.i./acre (7-day interval)	0.001	0.001	0.001
Broccoli, cauliflower, ground spray/dust	CA Cole Crop (Jan 1– dust)	D	9 app @ 0.0294 lb a.i./acre (2 crop cycles of 120 days; 7-day interval per crop cycle)	0.011	0.011	0.011
Cabbage, kohlrabi	CA Cole Crop (Jan 1 – dust)	D	9 app @ 0.0294 lb a.i./acre (3 crop cycles of 120 days; 7-day interval per crop cycle; max. 26 apps./year) [2]	0.015	0.015	0.015
Mustard	CA Cole Crop (Jan 1 – dust)	D	9 app @ 0.0294 lb a.i./acre (4 crop cycles of 90 days; 7-day interval per crop cycle; max. 26 apps./year) [2]	0.013	0.013	0.013
Brussels sprouts	CA Lettuce (April 21 – foliar, dust)	G	3 app @ 0.038 lb a.i./acre (10-day interval)	0.005	0.005	0.005
		D	9 app @ 0.038 lb a.i./acre (10-day interval)	0.010	0.010	0.010
Buckwheat, oat, rye	CA Wheat (May29 – foliar)	A	2 app @ 0.03 lb a.i./acre (3-day interval)	0.003	0.003	0.002
		G		0.002	0.002	0.002
Canola/rape	CA Wheat (May 22 – foliar)	A	3 app @ 0.0311 lb a.i./acre (5-day interval)	0.004	0.004	0.004
		G		0.003	0.003	0.003
Grass forage/fodder/hay, pastures, rangeland	CA Rangeland and Hay (Feb 24 – foliar)	A	3 app @ 0.0311 lb a.i./acre (30-day interval)	0.002	0.002	0.002
		G		0.001	0.001	0.001
Cereal grains, triticale, wheat	CA Wheat (May 29 – foliar)	A	2 app @ 0.0311 lb a.i./acre (3-day interval)	0.003	0.003	0.003
		G		0.002	0.002	0.002
Cole crops	CA Cole Crop (Jan 11 – foliar, dust)	A	8 app @ 0.0311 lb a.i./acre (7-day interval)	0.012	0.012	0.011
		D		0.007	0.007	0.007
Onion	CA Onion (April 19 – foliar, dust)	A	9 app @ 0.0311 lb a.i./acre (7-day interval)	0.005	0.005	0.004
		D		0.001	0.001	0.001
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns	CA Turf (Dec 23 – foliar)	G	2 app @ 0.1585 lb a.i./acre 1 app @ 0.0983 lb a.i./acre (7-day interval)	0.002	0.002	0.002
Commercial/industrial lawns, ornamental lawns and turf, recreation area	CA Turf (Nov 18 – spot trt)	ST	7 app @ 0.06 lb a.i./acre (7-day interval)	0.001	0.001	0.001

Proposed Label Use	PRZM/EXAMS Scenario[1] (first app date)	Method[1]	Application Rate (interval between applications)	Peak EEC (µg/L)	21-day EEC (µg/L)	60-day EEC (µg/L)
lawns						
Conifers (plantations/nurseries)	CA Nursery (Sept 26 – foliar)	G	6 app @ 0.0401 lb a.i./acre (7-day interval)	0.014	0.014	0.014
Conifers (seed orchard)	CA Nursery (Oct 10 – foliar)	G	3 app @ 0.156 lb a.i./acre 1 app @ 0.036 lb a.i./acre (7-day interval)	0.031	0.031	0.031
Corn (field)	CA Corn (Aug 18 – foliar)	A	3 app @ 0.042 lb a.i./acre (10-day interval)	0.005	0.005	0.004
		G		0.003	0.003	0.003
Corn (field, pop)	CA Corn (Sept 3 – band, furrow)	B,F	2 app @ 0.0934 lb a.i./acre (4-day interval)	0.003	0.003	0.003
Corn (sweet)	CA Corn (Aug 18– band, furrow)	B,F	6 app @ 0.0934 lb a.i./acre (4-day interval)	0.009	0.009	0.009
Corn (sweet)	CA Corn (April 20 – dust)	D	5 app @ 0.042 lb a.i./acre (3 crop cycles of 120 days; 10-day interval per crop cycle)	0.016	0.016	0.016
Corn (sweet)	CA Corn (April 10 – foliar)	A	6 app @ 0.03 lb a.i./acre (3 crop cycles of 90 days; 10-day interval per crop cycle; max. 16 apps./year)	0.016	0.016	0.016
Cotton	CA Cotton (Oct 1 – foliar)	A	3 app @ 0.042 lb a.i./acre (10-day interval)	0.003	0.003	0.003
		G		0.001	0.001	0.001
Cucurbit vegetables	CA Melon (July 7– foliar)	A	6 app @ 0.0311 lb a.i./acre (5-day interval)	0.003	0.003	0.003
		G		0.001	0.001	0.001
Filbert, pecan, walnut	CA Almond (August 10 – foliar)	A	2 app @ 0.057 lb a.i./acre 1 app @ 0.044 lb a.i./acre (10-day interval)	0.003	0.003	0.003
		G		0.001	0.001	0.001
Filbert, pecan, walnut	CA Almond (July 11 – dust)	D	6 app @ 0.057 lb a.i./acre (10-day interval)	0.002	0.002	0.002
Forest plantings	CA Forestry (Nov 3 – foliar)	G	4 app @ 0.0511 lb a.i./acre 1 app @ 0.0337 lb a.i./acre (7-day interval)	0.016	0.016	0.016
Fruiting vegetables	CA Row Crop (Jan 23 – foliar)	A	12 app @ 0.0311 lb a.i./acre (5-day interval)	0.011	0.011	0.011
		G		0.005	0.005	0.005
Garlic	CA Garlic (May 28 – foliar)	A	8 app @ 0.0311 lb a.i./acre (7-day interval)	0.006	0.006	0.006
Golf course turf, ornamental sod farm	CA Turf (Dec 30 – foliar)	G	1 app @ 0.068 lb a.i./acre	0.0005	0.0005	0.0005
Golf course turf, ornamental sod farm	CA Turf (Nov 25 – mound)	M	6 app @ 0.06 lb a.i./acre (7-day interval)	0.001	0.001	0.001

Proposed Label Use	PRZM/EXAMS Scenario[1] (first app date)	Method[1]	Application Rate (interval between applications)	Peak EEC (µg/L)	21-day EEC (µg/L)	60-day EEC (µg/L)
Grasses grown for seed	CA Turf (Dec 16 – foliar)	G	2 app @ 0.1306 lb a.i./acre 1 app @ 0.0811 lb a.i./acre (7-day interval)	0.003	0.002	0.002
Legume vegetables	CA Row Crop (March 3 – foliar)	A	4 app @ 0.0311 lb a.i./acre (5-day interval)	0.004	0.004	0.004
		G		0.001	0.001	0.001
Peanuts, root and tuber vegetables	CA Row Crop (Feb 26 – foliar)	A	4 app @ 0.0311 lb a.i./acre (7-day interval)	0.004	0.004	0.004
		G		0.001	0.001	0.001
Lettuce	CA Lettuce (Feb 6 – foliar)	A	10 app @ 0.0311 lb a.i./acre (2 crop cycles of 120 days; 5-day interval per crop cycle)	0.023	0.023	0.023
		G		0.013	0.013	0.013
Nonagricultural uncultivated areas/soils	CA Right of Way (Oct 18 – foliar)	A	2 app @ 0.0792 lb a.i./acre 1 app @ 0.0432 lb a.i./acre (7-day interval) [3]	21.59[4]	21.48[4]	21.42[4]
Ornamental and/or shade trees	CA Nursery (Oct 17 – foliar)	G	2 app @ 0.162 lb a.i./acre 1 app @ 0.0913 lb a.i./acre (7-day interval)	0.004	0.004	0.004
Ornamental and/or shade trees, ground cover, herbaceous plants, non-flowering plants, woody shrubs and vines, rose	CA Nursery (Oct 17 – dust)	D	3 app @ 1.2 lb a.i./acre (7-day interval)	0.227	0.226	0.211
Paved areas (private roads/sidewalks)	CA Impervious (Nov 25 – barrier/perimeter trt)	PT	6 app @ 0.069 lb a.i./acre (7-day interval)	0.012	0.012	0.012
Pome and stone fruit	CA Fruit (June 20 – foliar)	A	5 app @ 0.0415 lb a.i./acre (7-day interval)	0.004	0.004	0.004
		G		0.001	0.001	0.001
Potato	CA Potato (May 11 – foliar)	A	3 app @ 0.0239 lb a.i./acre 1 app @ 0.0162 lb a.i./acre (7-day interval)	0.001	0.001	0.001
		G		0.0004	0.0004	0.0003
Recreational areas	CA Turf (Jan 1 – band)	B	26 app @ 0.033 lb a.i./acre (7-day interval)	0.0005	0.0005	0.0005
Recreational areas	CA Turf (Dec 23 –surface spray)	CC ST	2 app @ 2.0 lb a.i./acre (7-day interval)	0.010	0.010	0.010
Residential lawns	CA Residential (Nov 25 – granular)	O	6 app @ 0.078 lb a.i./acre (7-day interval) [3]	14.12[4]	14.08[4]	13.96[4]
Residential lawns	CA Residential (Dec 30 – mound)	M	1 app @ 1.9 lb a.i./acre[3]	61.14[4]	59.55[4]	13.96[4]
Rice	Tier 1 Rice Model	R	3 app @ 0.0415 lb a.i./acre (5-day interval)	0.360	0.360	0.360
Seed orchard trees	CA Nursery (Oct 10 – foliar)	G	3 app @ 0.162 lb a.i./acre 1 app @ 0.0327 lb a.i./acre (7-day interval)	0.036	0.036	0.034

Proposed Label Use	PRZM/EXAMS Scenario[1] (first app date)	Method[1]	Application Rate (interval between applications)	Peak EEC (µg/L)	21-day EEC (µg/L)	60-day EEC (µg/L)
Sorghum	CA Wheat (May 22 – foliar)	A	2 app @ 0.038 lb a.i./acre (10-day interval)	0.004	0.003	0.003
		G		0.003	0.003	0.002
Soybean	CA Row Crop (March 4– foliar)	A	1 app @ 0.038 lb a.i./acre 1 app @ 0.021 lb a.i./acre (14-day interval)	0.002	0.002	0.002
		G		0.001	0.001	0.001
Tree nuts	CA Almond (Aug 15– foliar)	A	4 app @ 0.0415 lb a.i./acre (5-day interval)	0.004	0.004	0.003
		G		0.001	0.001	0.001
Sunflower	CA Corn (Aug 18– foliar)	A	3 app @ 0.038 lb a.i./acre (10-day interval)	0.004	0.004	0.004
		G		0.003	0.003	0.003
Right-of-Way	CA Right of Way (Sept 27– foliar)	G	6 app @ 0.06 lb a.i./acre (7-day interval) [3]	18.11[4]	18.03[4]	17.94[4]
Airports/landing fields	CA Impervious (Jan 22 – granular)	O	26 app @ 0.08 lb a.i./acre (7-day interval)	0.450	0.447	0.445
Golf course turf, ornamental sod farm (granular spot treatment)	CA Turf (Nov 25 – granular)	O	6 app @ 0.0688 lb a.i./acre (7-day interval)	0.001	0.001	0.001
Grasses grown for seed (granular spot treatment)	CA Turf (Nov 25 – granular)	O	6 app @ 0.06 lb a.i./acre (7-day interval)	0.001	0.001	0.001
Nonagricultural uncultivated areas/soil (granular band/broadcast/ perimeter/spot treatment)	CA Right of Way (Oct 4 – granular)	O	5 app @ 0.0792 lb a.i./acre (7-day interval) [3]	15.59[4]	15.48[4]	15.39[4]
Nonagricultural uncultivated areas/soil (granular mound treatment)	CA Right of Way (Sept 27 – granular)	O	6 app @ 0.06 lb a.i./acre (7-day interval) [3]	5.13[4]	5.12[4]	5.11[4]

[1] A = foliar aerial application modeled as 95% application efficiency, 5% spray drift; G = foliar ground application modeled as 99% application efficiency, 1% spray drift; C = chemigation modeled as 100% application efficiency, 0% spray drift; D = dust modeled as ground application 99% application efficiency, 1% spray drift; M = mound application modeled as 100% application efficiency and 0% spray drift; T = trunk drench modeled as 100% application efficiency and 0% spray drift; CC = crack and crevice modeled as 100% application efficiency and 0% spray drift; ST = spot treatment modeled as 100% application efficiency and 0% spray drift; B = Banded applications modeled as 100% application efficiency and 0% spray drift; F = Furrow applications modeled as 100% application efficiency and 0% spray drift; PT = perimeter treatment modeled as 100% application efficiency and 0% spray drift; O = Granular applications modeled as 100% application efficiency and 0% spray drift; R = Tier 1 Rice Model was utilized.

[2] Due to the PRZM/EXAMS model restriction of 26 total applications allowed, the maximum of 26 applications was modeled.

[3] Spreadsheet post-processing was utilized for the Right of Way (ROW) and Residential Scenarios.

[4] Solubility limit will be used in the calculation of RQs because the EEC exceeded the solubility limit (5 µg ai/L).

3.2.4. Existing Monitoring Data

A critical step in the process of characterizing EECs is comparing the modeled estimates with available surface water monitoring data. Included in this assessment are *lambda*-cyhalothrin data from the USGS NAWQA program (http://water.usgs.gov/nawqa) and data from the California Department of Pesticide Regulation (CDPR).

3.2.4.a. USGS NAWQA Surface Water Data

Surface water monitoring data from the USGS NAWQA program was accessed on August 01, 2012, and all data for California were evaluated. A total of 516 surface water samples were analyzed for *lambda*-cyhalothrin. There were no detects above the limit of quantitation (LOQ), which ranged from 0.004 to 0.018 μg ai/L.

3.2.4.b. USGS NAWQA Groundwater Data

Groundwater monitoring data from the USGS NAWQA program was accessed on August 01, 2012 and all data for California were evaluated. A total of 406 groundwater samples were analyzed for *lambda*-cyhalothrin. Concentrations are less than the limit of quantitation (LOQ), which ranged from 0.004 to 0.014 μg ai/L.

3.2.4.c. California Department of Pesticide Regulation (CDPR) Data

Surface water and groundwater monitoring data from the California Department of Pesticide Regulation (CDPR) program were accessed on August 01, 2012. A total of 259 sediment and 1777 surface water samples were analyzed for *lambda*-cyhalothrin. Of these samples, 24 (9.3%) sediment samples had positive detections located in Imperial, Stanislaus, and Placer counties. The maximum sediment concentration detected was 0.315 μg ai/g located in Imperial County.

In addition, 8 (0.5%) surface water samples had positive detections of *lambda*-cyhalothrin. The maximum surface water concentration detected was 0.14 μg/L located Del Puerto Creek at Vineyard Avenue, which is a tributary to the San Joaquin River in Stanislaus County.

3.2.4.d. Atmospheric Monitoring Data

The Western Contaminants Assessment Project publication and Western Canada Reports were searched for l*ambda*-cyhalothrin; however, no data were available. Given l*ambda*-cyhalothrin's low vapor pressure and Henry's Law constants, atmospheric and long-range transport is unlikely.

3.3. Terrestrial Animal Exposure Assessment

3.3.1. Exposure to Residues in Terrestrial Food Items

T-REX (Version 1.5) is used to calculate dietary and dose-based EECs of *lambda*-cyhalothrin for birds (including terrestrial-phase amphibians and reptiles), mammals, and terrestrial invertebrates. T-REX simulates a 1-year time period. T-HERPS may be used as a refinement of dietary and dose-based EECs for snakes and amphibians when risk quotients from T-REX are higher than LOCs. T-HERPS was also set up to simulate a 1-year time period. For this assessment, spray and granular applications of *lambda*-cyhalothrin are considered. Trunk drench, dust, crack and crevice, spot treatments, perimeter treatments, and mound applications were modeled by T-REX as well in cases where application rates were reported in pounds of active ingredient per acre.

T-REX was used to evaluate the risks from all uses except ear tags (see Section 5 for a description of the risk analysis). Evaluation of aerial/ground spray applications and T-banding/in-furrow treatments is straightforward and no special considerations were necessary. Granular formulations are assessed based on the exposure expected in a square foot (LD_{50}/ft^2). Dust applications are applied in a manner similar to foliar applications; *lambda*-cyhalothrin is "dusted" onto the crop. Trunk drenches are applications of *lambda*-cyhalothrin that are applied directly to the trunk of tree to control insects; no translocation occurs. Consequently, trunk drenches were treated as a normal "foliar application" in T-REX, although the applications are made to tree trunks. Spot treatments, crack and crevice, band treatments, and perimeter treatments were lumped together for analysis, also using T-REX. Risks from these uses are limited to the areas that receive treatment (these treatments usually encompass a small area and are not applied on a per acre basis). Finally, mound treatments for ants were assessed separately from the other "spot treatments" because anthills may be distributed more uniformly in a landscape, making it possible that *lambda*-cyhalothrin would be applied on a per acre basis. Terrestrial EECs were derived for the uses previously summarized in Table 2-6. Exposure estimates generated using T-REX and T-HERPS are for the parent alone.

Terrestrial EECs for foliar formulations of *lambda*-cyhalothrin were derived for the uses summarized in Table 3-5. Given that no data on interception and subsequent dissipation from foliar surfaces are available for *lambda*-cyhalothrin, a default foliar dissipation half-life of 35 days is used, based on the work of Willis and McDowell (1987). Use specific input values, including number of applications, application rate, foliar half-life and application interval are provided in Table 3-5. An example output from T-REX and T-HERPS is available in Appendix E.

Table 3-5. Input Parameters for Foliar, Trunk Drench, T-Banding, Soil In Furrow, Crack and Crevice, Spot Treatment, Mound Treatment, Perimeter Treatment, Band Treatment Applications Used to Derive Terrestrial EECs for *Lambda*-Cyhalothrin with T-REX and T-HERPS

Use (Application method)	Application Rate (lbs a.i./A)	Number of Applications	Application Interval	Foliar Dissipation Half-Life
Agricultural/farm premises (crack and crevice, outdoor surface spray, perimeter treatment)	0.2212	2 at 0.2212 lb ai/A 1 at 0.0763 lb ai/A	7 days	35 days
Airports/landing fields (soil broadcast – granular)	0.08	50	7 days	35 days
Alfalfa (aerial/ground spray, chemigation)	0.038	3	10 days	35 days
Almond, apple, cherry,	Dust and	Almonds – 6	7 days	35 days

Use (Application method)	Application Rate (lbs a.i./A)	Number of Applications	Application Interval	Foliar Dissipation Half-Life
crabapple, nectarine, peach, pear, plum, prune (dust, spray, trunk drench)	spray 0.1	Others - 9		
	Trunk drench 0.06	Almond, nectarine, peach, cherry – 3	5 days	
		Apple - 1	n/a	
Animal housing premises (outdoor), paths/patios, household/domestic dwellings outdoor premises (barrier treatment, crack and crevice)	Animal/paths 0.2762	14 at 0.2762 lb ai/A 1 at 0.1332	21 days	35 days
	Household 2	2	7 days	
Apricot, beans, eggplant, ground cherry (strawberry tomato/tomatillo), loquat, mayhaw, pea, pepino, pepper, Japanese plum, quince (ground spray, dust)	0.0239	9	7 days	35 days
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut (ground spray, dust)		6		
Barley (aerial/ground spray, chemigation)	0.031	2	7 days	35 days
Beef/range/feeder cattle, calves, dairy cattle (ear tag)	0.0042 lb ai/animal	n/a	n/a	n/a
Bell pepper, catjang (Jerusalem/marble pea), mustard cabbage (gai choy, pak-choi)(ground spray, dust)	0.03	Bell pepper (catjang, Jerusalem/marble pea) - 12	7 days	35 days
		Mustard cabbage- 8		
Brassica (head and stem) vegetables (aerial/ground spray, chemigation)	0.031	3 per crop cycle – 3 crop cycles per year, max of 8 per year	7 days	35 days
Broccoli, cabbage, cauliflower, kohlrabi, mustard, tomatillo, tomato (ground spray, dust)	0.0294	9 per crop cycle – 1 crop cycle (tomato, tomatillo), 2 crop cycles (broccoli, cauliflower), 3 crop cycles (cabbage, kohlrabi), 4 crop cycles (mustard)	7 days	35 days
Brussels sprouts (ground spray, dust)	0.038	Spray - 3	10 days	35 days
		Dust - 9		

<table>
<tr><th>Use (Application method)</th><th>Application Rate (lbs a.i./A)</th><th>Number of Applications</th><th>Application Interval</th><th>Foliar Dissipation Half-Life</th></tr>
<tr><td>Buckwheat, oat, rye (aerial/ground spray, chemigation)</td><td>0.03</td><td>2</td><td>3 days</td><td>35 days</td></tr>
<tr><td rowspan="2">Canola/rape, grass forage/fodder/hay, pastures, rangeland (aerial/ground spray, chemigation)</td><td rowspan="2">0.0311</td><td rowspan="2">3</td><td>Canola/rape – 5 days</td><td rowspan="2">35 days</td></tr>
<tr><td>Pastures, rangeland, grass forage – 30 days</td></tr>
<tr><td>Cereal grains, triticale, wheat (aerial/ground spray, chemigation)</td><td>0.0311</td><td>2</td><td>3 days</td><td>35 days</td></tr>
<tr><td rowspan="2">Cole crops, onion (aerial/ground spray, chemigation, dust)</td><td rowspan="2">0.0311</td><td>Cole crops - 8</td><td rowspan="2">7 days</td><td rowspan="2">25 days</td></tr>
<tr><td>Onion - 9</td></tr>
<tr><td rowspan="3">Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns (ground spray, mound treatment, spot treatment)</td><td>Spray – 0.1585</td><td>2 at 0.1585 lb ai/A
1 at 0.0983 lb ai/A</td><td rowspan="3">7 days</td><td rowspan="3">35 days</td></tr>
<tr><td>Mound – 0.06</td><td>7</td></tr>
<tr><td>Spot – 0.06</td><td>7</td></tr>
<tr><td>Conifers (plantations/nurseries) (ground spray)</td><td>0.0401</td><td>6</td><td>7 days</td><td>35 days</td></tr>
<tr><td>Conifers (seed orchard) (ground spray)</td><td>0.156</td><td>3 at 0.156 lb ai/A
1 at 0.036 lb ai/A</td><td>7 days</td><td>35 days</td></tr>
<tr><td>Corn (field) (aerial/ground spray)</td><td>0.042</td><td>3</td><td>10 days</td><td>35 days</td></tr>
<tr><td>Corn (field, pop) (soil in furrow, T-banding)</td><td>0.0934</td><td>1 at 0.0934 lb ai/A
1 at 0.0311 lb ai/A</td><td>4 days</td><td>35 days</td></tr>
<tr><td rowspan="3">Corn (sweet) (soil in furrow, T-banding, dust, spray)</td><td>Soil – 0.0934</td><td>5 at 0.0934 lb ai/A
1 at 0.031 lb ai/A</td><td>4 days</td><td rowspan="3">35 days</td></tr>
<tr><td>Dust – 0.042</td><td>5</td><td rowspan="2">10 days</td></tr>
<tr><td>Spray – 0.03</td><td>6 apps per crop cycle
3 crop cycles per year
Max of 16 apps per year</td></tr>
<tr><td>Cotton (aerial/ground spray, chemigation)</td><td>0.042</td><td>3</td><td>10 days</td><td>35 days</td></tr>
<tr><td>Cucurbit vegetables (aerial/ground spray, chemigation)</td><td>0.0311</td><td>6</td><td>5 days</td><td>35 days</td></tr>
<tr><td>Filbert, pecan, walnut (aerial/ground spray, dust)</td><td>0.057</td><td>Spray
2 at 0.057 lb ai/A
1 at 0.044 lb ai/A</td><td>10 days</td><td>35 days</td></tr>
</table>

Use (Application method)	Application Rate (lbs a.i./A)	Number of Applications	Application Interval	Foliar Dissipation Half-Life
		Dust - 6		
Forest plantings (ground spray)	0.0511	4 at 0.0511 1 at 0.0337	7 days	35 days
Fruiting vegetables (aerial/ground spray, chemigation)	0.0311	12	5 days	35 days
Garlic	0.0311	8	7 days	35 days
Golf course turf, ornamental sod farm (ground spray, mound treatment, granular spot treatment)	Spray – 0.068	1	7 days	35 days
	Mound – 0.06	6		
	Granular – 0.0688	6		
Grasses grown for seed (ground spray, granular spot treatment)	Spray - 0.1306	2 at 0.1306 lb ai/A 1 at 0.0811 lb ai/A	7 days	35 days
	Granular - 0.06	6		
Legume vegetables, peanuts, root and tuber vegetables (aerial/ground spray, chemigation)	0.0311	4	Legumes – 5 days	35 days
			Peanuts, roots and tubers – 7 days	
Lettuce (aerial/ground spray, chemigation)	0.0311	10 per crop cycle – 2 crop cycles per year	5 days	35 days
Nonagricultural uncultivated areas/soils (aerial/ground spray, chemigation; granular – band treatment, ground broadcast, perimeter, mound, spot)	Spray – 0.0792	2 at 0.0792 lb ai/A 1 at 0.0491 lb ai/A	7 days	35 days
	Granular band, broadcast, perimeter – 0.0792	4 at 0.0792 lb ai/A 1 at 0.0432 lb ai/A		
	Granular spot and mound – 0.06	6		
Ornamental and/or shade trees (ground spray and broadcast)	Spray – 0.162	2 at 0.162 lb ai/A 1 at 0.0913 lb ai/A	7 days	35 days
	Broadcast – 1.2	3		
Ornamental ground cover, herbaceous plants, non flowering plants, woody shrubs and vines, rose (dust, ground spray); dust only for herbaceous plants and woody shrubs/vines	1.2	3	7 days	35 days

Use (Application method)	Application Rate (lbs a.i./A)	Number of Applications	Application Interval	Foliar Dissipation Half-Life
Paved areas (private roads/sidewalks) (barrier, perimeter treatment)	0.069	5	7 days	35 days
Pome and stone fruit (aerial/ground spray)	0.0415	5	7 days	35 days
Potato (aerial/ground spray, chemigation)	0.0239	3 at 0.0239 lb ai/A 1 at 0.0162 lb ai/A	7 days	35 days
Recreational areas (band treatment, crack and crevice, spot treatment)	Band - 0.0291	52	7 days	35 days
	Others - 2	2		
Residential lawns (granular broadcast, granular mound)	Broadcast – 0.078	6	7 days	35 days
	Mound– 1.9	1		
Rice (ground spray, chemigation)	0.0415	3	5 days	35 days
Seed orchard trees (ground spray)	0.162	3 at 0.162 lb ai/A 1 at 0.0327	7 days	35 days
Sorghum (aerial/ground spray, chemigation)	0.038	2	10 days	35 days
Soybean (aerial/ground spray, chemigation)	0.038	1 at 0.038 lb ai/A 1 at 0.021 lb ai/A	14 days	35 days
Tree nuts (aerial/ground spray, chemigation)	0.0415	4	Tree nuts – 5 days	35 days
Sunflower (aerial/ground spray)	0.038	3	10 days	35 days
Right-of-way (soil treatment)	0.06	6	7 days	35 days

n/a = Not applicable

Organisms consume a variety of dietary items and may exist in a variety of sizes at different life stages. T-REX estimates exposure for the following dietary items: short grass, tall grass, broadleaf plants/small insects, and fruits/pods/seeds/large insects, and seeds for granivores. Birds, including the CCR, and mammals consume all of these items. The size classes of birds represented in T-REX are small (20 g), medium (100 g), and large (1000 g). The size classes for mammals are small (15 g), medium (35 g), and large (1000 g). EECs are calculated for the most sensitive dietary item and size class for birds (surrogate for amphibians and reptiles) and mammals. For mammals and birds, the most sensitive EECs are for the smallest size class consuming short grass.

For foliar applications of liquid formulations, T-HERPS estimates exposure for the following dietary items: broadleaf plants/small insects, fruits/pods/seeds/large insects, small herbivore mammals, small insectivore mammals, and small amphibians. Snakes and amphibians may consume all of these items. The default size classes of amphibians represented in T-HERPS are small (2 g), medium (20 g), and large (200 g). The default vertebrate prey size that the medium and large amphibians can consume is 13 g and 133 g, respectively (small amphibians are not expected to eat vertebrate prey). The default size classes for snakes are small (2 g), medium (20 g), and large (800 g). The default vertebrate prey size that medium and large snakes can consume is 25 g and 291 g, respectively (small snakes are not expected to eat vertebrate prey). EECs are calculated for the most sensitive dietary item and size class for amphibians and snakes. For both amphibians and reptiles, the most sensitive EECs and RQs are for a 20-gram animal that consumes small herbivore mammals. If dietary RQs are more sensitive than acute dose based RQs for acute exposures, they are shown as well. Dietary based EECs and RQs are used to characterize risk from chronic exposure. The percentages of the EECs for the different dietary items are discussed in the discussion on uncertainties (see Section 6.1.3.b).

3.3.1.a. Dietary Exposure to Mammals, Birds, and Amphibians Derived Using T-REX

Upper-bound Kenaga nomogram values reported by T-REX are used for derivation of dietary EECs for the BCB, CCR, CFWS, CTS-CC, CTS-SC, CTS-SB, DS, SFGS, TG, and VELB, and their potential prey (
Table 3-6). EECs in T-REX that are applicable to direct effects to the CCR are for small (20 g, juveniles) and medium (100 g, adult) birds consuming a variety of dietary items. The most sensitive EEC for the CCR is for the small bird consuming short grass. EECs in T-REX that are applicable to assess direct effect to the terrestrial-phase CTS and SFGS are for small birds (20g) consuming short grass[5].

For birds (surrogates for amphibians and reptiles), EECs and RQs are calculated for acute dose based, and sub-chronic and chronic dietary based exposure. For mammals, EECs and RQs for acute dose based, dietary-based, and chronic dose based exposure are calculated. The most sensitive RQs are used in the assessment.

Granular formulations of *lambda*-cyhalothrin are assessed separately in T-REX and yield RQs based on the exposure expected in a square foot (LD_{50}/ft^2).

[5] Short grass EECs and RQs are used for reptiles and amphibians to represent a conservative screen. It is not being assumed that amphibians and snakes eat short grass. Rather, the result of modeling the 20 gram bird consuming short grass is more conservative than modeling an alternative diet for amphibians and snakes and is, therefore, a valid conservative screen and is protective of these species. If the short grass assessment does not result in LOC exceedances, there is a high confidence that effects are unlikely to occur.

Table 3-6. Upper-bound Kenaga Nomogram EECs for Dietary- and Dose-Based Exposures of Birds, Mammals, and Terrestrial Invertebrates Derived Using T-REX for *Lambda*-Cyhalothrin

Use(s), Type of Application	App Rate (lb ai/A) and Interval	EECs for CCR, CTS (all DPS), SFGS, and Birds (small birds consuming short grass)		EECs for Mammals (small mammals consuming short grass)		EECs for Arthropods
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	EEC (mg ai/kg-bw)
Agricultural/farm premises, crack and crevice/surface spray/perimeter treatment	2 at 0.2212, 1 at 0.0763 7 days	104.76	119.31	104.76	99.88	41.03
Alfalfa, aerial/ground	3 at 0.038 10 days	22.74	25.90	22.74	21.68	8.91
Almond, ground dust and spray	6 at 0.1 7 days	104.70	119.24	104.70	99.82	41.01
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, ground dust and spray	9 at 0.1 7 days	132.16	150.52	132.16	126.00	51.76
Almond, nectarine, peach, cherry, trunk drench	3 at 0.06 5 days	39.26	44.71	39.26	37.43	15.37
Apple, trunk drench	1 at 0.06 n/a	14.40	16.40	14.40	13.73	5.64
Animal housing premises, paths/patios, barrier treatment/crack and crevice	14 at 0.2762, 1 at 0.1332 21 days	194.25	221.23	194.25	185.20	76.08
Household/domestic dwellings outdoor premises, barrier treatment/crack and crevice	2 at 2 7 days	897.86	1022.58	897.86	856.04	351.66
Apricot, bean, eggplant, groundcherry, loquat, mayhaw, pea, pepino, pepper, plum, quince, ground spray/dust	9 at 0.0239 7 days	31.59	35.97	31.59	30.11	12.37
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut,	6 at 0.0239 7 days	25.02	28.50	25.02	23.86	9.80

Use(s), Type of Application	App Rate (lb ai/A) and Interval	EECs for CCR, CTS (all DPS), SFGS, and Birds (small birds consuming short grass)		EECs for Mammals (small mammals consuming short grass)		EECs for Arthropods
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	EEC (mg ai/kg-bw)
ground spray/dust						
Barley, aerial/ground	2 at 0.031 7 days	13.92	15.85	13.92	13.27	5.45
Bell pepper, catjang (Jerusalem/marble pea) (aerial/ground spray/dust)	12 at 0.03 7 days	45.08	51.34	45.08	42.98	17.66
Mustard cabbage (gai choy, pak-choi), ground spray/dust	8 at 0.03	37.27	42.45	37.27	35.54	14.60
Brassica (head and stem) vegetables, aerial/ground	3 crop cycles of 120 days; 3 at 0.031 per crop cycle; max 8 apps per year 7 days	20.26	23.07	20.26	19.31	8.20
Tomato, tomatillo, ground spray/dust	9 at 0.0294 7 days	38.85	44.25	38.85	37.04	15.22
Broccoli, cauliflower, ground spray/dust	2 crop cycles of 120 days; 9 at 0.0294 7 days	39.89	45.43	39.89	38.03	15.68
Cabbage, kohlrabi, ground spray/dust	3 crop cycles of 120 days[1] 9 at 0.0294 7 days	43.15	49.15	43.15	41.14	16.90
Mustard	4 crop cycles of 90 days[2] 9 at 0.0294 7 days	47.22	53.78	47.22	45.02	18.49

Use(s), Type of Application	App Rate (lb ai/A) and Interval	EECs for CCR, CTS (all DPS), SFGS, and Birds (small birds consuming short grass)		EECs for Mammals (small mammals consuming short grass)		EECs for Arthropods
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	EEC (mg ai/kg-bw)
Brussels sprouts, ground spray	3 at 0.038 10 days	22.74	25.90	22.74	21.68	8.91
Brussels sprouts, dust	9 at 0.038 10 days	42.22	48.09	42.22	40.25	16.54
Buckwheat, oat, rye, aerial/ground	2 at 0.03 3 days	13.98	15.93	13.98	13.33	5.48
Canola/rape, aerial/ground	3 at 0.0311 5 days	20.35	23.17	20.35	19.40	7.97
Grass forage/fodder/hay, pastures, rangeland, aerial/ground	3 at 0.0311 30 days	13.86	15.78	13.86	13.21	5.43
Cereal grains, triticale, wheat, aerial/ground	2 at 0.0311 3 days	14.50	16.51	14.50	13.82	5.68
Cole crops, aerial/ground/dust	8 at 0.0311 7 days	38.64	44.01	38.64	36.84	15.13
Onion, aerial/ground/dust	9 at 0.0311 7 days	41.10	46.81	41.10	39.19	16.10
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns, ground	2 at 0.1585, 1 at 0.0983 7 days	85.54	97.42	85.54	81.55	33.50
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns, mound/spot treatment	7 at 0.06 7 days	69.09	78.68	69.09	65.87	27.06
Conifers (plantations/nurseries), ground	6 at 0.0401 7 days	41.98	47.82	41.98	40.03	16.44
Conifers (seed orchard), ground	3 at 0.156, 1 at 0.036 7 days	98.41	112.08	98.41	93.82	38.54
Corn (field), aerial/ground	3 at 0.042 10 days	25.13	28.62	25.13	23.96	9.84
Corn (field, pop), soil	2 at	43.12	49.11	43.12	41.12	No exposure

Use(s), Type of Application	App Rate (lb ai/A) and Interval	EECs for CCR, CTS (all DPS), SFGS, and Birds (small birds consuming short grass)		EECs for Mammals (small mammals consuming short grass)		EECs for Arthropods
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	EEC (mg ai/kg-bw)
in furrow/T-banding[3]	0.0934, 4 days Rows 30 inches apart; banding 7 inches					
Corn (sweet), soil in furrow/T-banding[3]	6 at 0.0934, 4 days Rows 40 inches apart[4]; banding 7 inches	111.34	126.81	111.34	106.16	No exposure
Corn (sweet), dust	3 crop cycles per year 5 apps at 0.042 per crop cycle 10 days	36.81	41.92	36.81	35.09	10.30
Corn (sweet), spray	3 crop cycles per year[5] 6 apps of 0.03 per crop cycle; max 16 apps per year 10 days	29.60	33.72	29.60	28.22	11.59
Cotton, aerial/ground	3 at 0.042 10 days	25.13	28.62	25.13	23.96	9.84
Cucurbit vegetables, aerial/ground	6 at 0.0311	35.47	40.39	35.47	33.81	13.89

Use(s), Type of Application	App Rate (lb ai/A) and Interval	EECs for CCR, CTS (all DPS), SFGS, and Birds (small birds consuming short grass)		EECs for Mammals (small mammals consuming short grass)		EECs for Arthropods
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	EEC (mg ai/kg-bw)
	5 days					
Filbert, pecan, walnut, aerial/ground	2 at 0.057, 1 at 0.044 10 days	30.99	35.29	30.99	29.54	12.14
Filbert, pecan, walnut, dust	6 at 0.057 10 days	52.94	60.29	52.94	50.47	20.73
Forest plantings, ground	4 at 0.0511, 1 at 0.0337 7 days	43.19	49.19	43.19	41.18	16.92
Fruiting vegetables, aerial/ground	12 at 0.0311 5 days	55.04	62.69	55.04	52.48	21.56
Garlic	8 at 0.0311 7 days	38.64	44.01	38.64	36.84	15.13
Golf course turf, ornamental sod farm, ground	1 at 0.068,	16.32	18.59	16.32	15.56	6.39
Golf course turf, ornamental sod farm, mound	6 at 0.06 7 days	62.82	71.55	62.82	59.89	24.60
Grasses grown for seed, ground	2 at 0.1306, 1 at 0.0811 7 days	70.50	80.30	70.50	67.22	27.61
Legume vegetables, aerial/ground	4 at 0.0311 5 days	25.89	29.49	25.89	24.69	10.14
Peanuts, root and tuber vegetables, aerial/ground	4 at 0.0311 7 days	24.54	27.95	24.54	23.40	9.61
Lettuce, aerial/ground	2 crop cycles of 120 days 10 at 0.0311 5 days	51.65	58.83	51.65	49.25	20.23
Nonagricultural	2 at	41.32	47.06	41.32	39.40	16.18

Use(s), Type of Application	App Rate (lb ai/A) and Interval	EECs for CCR, CTS (all DPS), SFGS, and Birds (small birds consuming short grass)		EECs for Mammals (small mammals consuming short grass)		EECs for Arthropods
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	EEC (mg ai/kg-bw)
uncultivated areas/soils, aerial	0.0792, 1 at 0.0432 7 days					
Ornamental and/or shade trees, ground	2 at 0.162, 1 at 0.0913 7 days	85.22	97.06	85.22	81.26	33.38
Ornamental and/or shade trees, ground cover, herbaceous plants, non flowering plants, woody shrubs and vines, rose, ground/dust/	3 at 1.2 7 days	756.98	862.13	756.98	721.72	296.48
Paved areas (private roads/sidewalks), barrier/perimeter treatment	6 at 0.069 7 days	72.24	82.28	72.24	68.88	28.30
Pome and stone fruit, aerial/ground	5 at 0.0415 7 days	38.47	43.81	38.47	36.68	15.07
Potato, aerial/ground	3 at 0.0239, 1 at 0.0162 7 days	17.01	19.38	17.01	16.22	6.66
Recreational areas, band treatment	52 at 0.0291 7 days	53.91	61.40	53.91	51.40	21.12
Recreational areas, crack and crevice/spot treatment	2 at 2 7 days	897.86	1022.58	897.86	856.04	351.66
Rice, ground	3 at 0.0415 5 days	27.15	30.92	27.15	25.89	10.63
Seed orchard trees, ground	3 at 0.162, 1 at 0.0327 7 days	102.19	116.39	102.19	97.43	40.03
Sorghum, aerial/ground	2 at 0.038 10 days	16.60	18.91	16.60	15.83	6.50
Soybean, aerial/ground	1 at 0.038, 1 at 0.021	11.95	13.61	11.95	11.39	4.68

Use(s), Type of Application	App Rate (lb ai/A) and Interval	EECs for CCR, CTS (all DPS), SFGS, and Birds (small birds consuming short grass)		EECs for Mammals (small mammals consuming short grass)		EECs for Arthropods
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	EEC (mg ai/kg-bw)
	14 days					
Tree nuts, aerial/ground	4 at 0.0415 5 days	34.55	39.35	34.55	32.94	13.53
Sunflower, aerial/ground	3 at 0.038 10 days	22.74	25.90	22.74	21.68	8.91
Right-of-way, ground	6 at 0.06 7 days	62.82	71.55	62.82	59.89	24.60

n/a = not applicable
[1]An interval of 60 days was used between crop cycles
[2]Only 30 applications were modeled because of limitations with T-REX; an interval of 30 days was used between crop cycles
[3]Application exceeds the seasonal maximum because of limitations on T-REX
[4]University of California and USDA 2004
[5]An interval of 90 days was used between crop cycles

3.3.2. Exposure to Terrestrial Invertebrates Derived Using T-REX

T-REX is also used to calculate EECs for terrestrial invertebrates exposed to *lambda*-cyhalothrin (Table 3-6). Available acute contact toxicity data for bees exposed to *lambda*-cyhalothrin (in units of µg a.i./bee), are converted to µg a.i./g (of bee) by multiplying by 1 bee/0.128 g. Dietary-based EECs calculated by T-REX for arthropods (units of µg a.i./g-bw) are used to estimate exposure to terrestrial invertebrates. The EECs are later compared to the adjusted acute contact toxicity data for bees in order to derive RQs.

Arthropods are applicable to the VELB and BCB and in estimating indirect effects based on reduction in prey to the CCR and CTS. An example output from T-REX v. 1.5 is available in Appendix E.

3.3.2.a. Dietary Exposure to Amphibians and Reptiles Derived Using T-HERPS

Birds are used as surrogate species for terrestrial-phase CTS and SFGS. Terrestrial-phase amphibians and reptiles are poikilotherms indicating that their body temperature varies with environmental temperature. Birds are homeotherms indicating that their temperature is regulated, constant, and largely independent of environmental temperatures). As a consequence, the caloric requirements of terrestrial-phase amphibians and reptiles are markedly lower than birds. Therefore, on a daily dietary intake basis, birds consume more food than terrestrial-phase amphibians. This can be seen when comparing the caloric requirements for free living iguanid lizards (used in this case as a surrogate for terrestrial phase amphibians) to song birds (USEPA, 1993):

$$\text{iguanid FMR (kcal/day)} = 0.0535\ (\text{bw g})^{0.799}$$

$$\text{passerine FMR (kcal/day)} = 2.123\ (\text{bw g})^{0.749}$$

With relatively comparable slopes to the allometric functions, given a comparable body weight, the free-living metabolic rate (FMR) of birds can be 40 times higher than reptiles, though the requirement differences narrow with high body weights.

Given that the existing risk assessment process is driven by the dietary route of exposure, a finding of safety for birds, with their much higher feeding rates and, therefore, higher potential dietary exposure is reasoned to be protective of terrestrial-phase amphibians consuming similar dietary items. For this not to be the case, terrestrial-phase amphibians would have to be 40 times more sensitive than birds for the differences in dietary uptake to be negated. However, existing dietary toxicity studies in terrestrial-phase amphibians for *lambda*-cyhalothrin are lacking. To quantify the potential differences in food intake between birds and terrestrial-phase CTS and amphibians, food intake equations for the iguanid lizard were used to replace the food intake equation in T-REX for birds, and additional food items of the CTS and amphibians were evaluated. These functions were encompassed in a model called T-HERPS. T-HERPS is available at: http://www.epa.gov/oppefed1/models/terrestrial/index.htm. EECs calculated using T-HERPS are shown in this section and potential risk is further discussed in the risk characterization.

EECs in T-HERPS that are applicable to the CTS are small (2 g, juveniles) amphibians consuming small and large insects and medium (20 g) amphibians consuming small and large insects, small herbivorous and insectivorous mammals, and amphibians. The dietary item that results in the highest EEC for CTS (all DPS) is the small herbivore mammal. EECs were only calculated for amphibians in cases where the bird EECs resulted in RQs that exceeded the LOC. In cases where this did not occur, the bird EECs were considered conservative and protective of amphibians. EECs calculated using T-HERPS for the CTS are shown in Table 3-7.

Table 3-7. Upper-Bound Kenaga Nomogram EECs for Dietary- and Dose-Based Exposures of Amphibians Derived Using T-HERPS for *Lambda*-Cyhalothrin

Use(s), Type of Application	App Rate (lb a.i./A, # App, Interval (days)	EEC for Medium CTS (medium amphibian consuming small herbivorous mammals)	
		Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)
Agricultural/farm premises, crack and crevice/surface spray/perimeter treatment	2 at 0.2212[2] 7 days	n/a	272
Alfalfa, aerial/ground	3 at 0.038	n/a	62

Use(s), Type of Application	App Rate (lb a.i./A, # App, Interval (days)	EEC for Medium CTS (medium amphibian consuming small herbivorous mammals)	
		Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)
	10 days		
Almond, ground dust and spray	6 at 0.1 7 days	n/a	287
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, ground dust and spray	9 at 0.1 7 days	n/a	362
Almond, nectarine, peach, cherry, trunk drench	3 at 0.06 5 days	n/a	108
Apple, trunk drench	1 at 0.06 n/a	n/a	39
Animal housing premises, paths/patios, barrier treatment/crack and crevice	14 at 0.2762[2] 21 days	130	532
Household/domestic dwellings outdoor premises, barrier treatment/crack and crevice	2 at 2 7 days	601	2459
Apricot, bean, eggplant, groundcherry, loquat, mayhaw, pea, pepino, pepper, plum, quince, ground spray/dust	9 at 0.0239 7 days	n/a	87
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut, ground spray/dust	6 at 0.0239 7 days	n/a	69
Barley, aerial/ground	2 at 0.031 7 days	n/a	38
Bell pepper, catjang (Jerusalem/marble pea) (aerial/ground spray/dust)	12 at 0.03 7 days	n/a	123
Mustard cabbage (gai choy, pak-choi), ground spray/dust	8 at 0.03 7 days	n/a	102
Brassica (head and stem) vegetables, aerial/ground	3 at 0.031[3] 7 days	n/a	54

Use(s), Type of Application	App Rate (lb a.i./A, # App, Interval (days)	EEC for Medium CTS (medium amphibian consuming small herbivorous mammals)	
		Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)
Tomato, tomatillo, ground spray/dust	9 at 0.0294 7 days	n/a	106
Broccoli, cauliflower, ground spray/dust	9 at 0.0294[3] 7 days	n/a	106
Cabbage, kohlrabi, ground spray/dust	9 at 0.0294[3] 7 days	n/a	106
Mustard	9 at 0.0294[3] 7 days	n/a	106
Brussels sprouts, ground spray	3 at 0.038 10 days	n/a	62
Brussels sprouts, dust	9 at 0.038 10 days	n/a	116
Buckwheat, oat, rye, aerial/ground	2 at 0.03 3 days	n/a	38
Canola/rape, aerial/ground	3 at 0.0311 5 days	n/a	56
Grass forage/fodder/hay, pastures, rangeland, aerial/ground	3 at 0.0311 30 days	n/a	38
Cereal grains, triticale, wheat, aerial/ground	2 at 0.0311 3 days	n/a	40
Cole crops, aerial/ground/dust	8 at 0.0311 7 days	n/a	106
Onion, aerial/ground/dust	9 at 0.0311 7 days	n/a	113
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns, ground	3 at 0.1585[1] 7 days	n/a	274
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns, mound/spot treatment	7 at 0.06 7 days	n/a	189
Conifers (plantations/nurseries),	6 at 0.0401	n/a	115

Use(s), Type of Application	App Rate (lb a.i./A, # App, Interval (days)	EEC for Medium CTS (medium amphibian consuming small herbivorous mammals)	
		Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)
ground	7 days		
Conifers (seed orchard), ground	3 at 0.156[2] 7 days	n/a	270
Corn (field), aerial/ground	3 at 0.042 10 days	n/a	69
Corn (sweet), dust	5 apps at 0.042[3] 10 days	n/a	97
Corn (sweet), spray	6 apps of 0.03[3] 10 days	n/a	76
Cotton, aerial/ground	3 at 0.042 10 days	n/a	69
Cucurbit vegetables, aerial/ground	6 at 0.0311 5 days	n/a	97
Filbert, pecan, walnut, aerial/ground	3 at 0.057[1] 10 days	n/a	93
Filbert, pecan, walnut, dust	6 at 0.057 10 days	n/a	145
Forest plantings, ground	5 at 0.0511[1] 7 days	n/a	130
Fruiting vegetables, aerial/ground	12 at 0.0311 5 days	n/a	151
Garlic	8 at 0.0311 7 days	n/a	106
Golf course turf, ornamental sod farm, ground	1 at 0.068	n/a	45
Golf course turf, ornamental sod farm, mound	6 at 0.06 7 days	n/a	172
Grasses grown for seed, ground	3 at 0.1306 7 days	n/a	226
Legume vegetables, aerial/ground	4 at 0.0311 5 days	n/a	71
Peanuts, root and	4 at 0.0311	n/a	67

Use(s), Type of Application	App Rate (lb a.i./A, # App, Interval (days)	EEC for Medium CTS (medium amphibian consuming small herbivorous mammals)	
		Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)
tuber vegetables, aerial/ground	7 days		
Lettuce, aerial/ground	10 at 0.0311[3] 5 days	n/a	136
Nonagricultural uncultivated areas/soils, aerial	3 at 0.0792[1] 7 days	n/a	137
Ornamental and/or shade trees, ground	3 at 0.162[1] 7 days	n/a	280
Ornamental and/or shade trees, ground cover, herbaceous plants, non flowering plants, woody shrubs and vines, rose, ground/dust	3 at 1.2 7 days	507	2073
Paved areas (private roads/sidewalks), barrier/perimeter treatment	6 at 0.069 7 days	n/a	198
Pome and stone fruit, aerial/ground	5 at 0.0415 7 days	n/a	105
Potato, aerial/ground	4 at 0.0239[1] 7 days	n/a	52
Recreational areas, band treatment	52 at 0.0291 7 days	n/a	148
Recreational areas, crack and crevice/spot treatment	2 at 2 7 days	600	2459
Rice, ground	3 at 0.0415 5 days	n/a	74
Seed orchard trees, ground	3 at 0.162[2] 7 days	n/a	280
Sorghum, aerial/ground	2 at 0.038 10 days	n/a	45
Soybean, aerial/ground	2 at 0.038[1] 14 days	n/a	44
Tree nuts, aerial/ground	4 at 0.0415 5 days	n/a	95

Use(s), Type of Application	App Rate (lb a.i./A, # App, Interval (days)	EEC for Medium CTS (medium amphibian consuming small herbivorous mammals)	
		Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)
Sunflower, aerial/ground	3 at 0.038 10 days	n/a	62
Right-of-way, ground	6 at 0.06 7 days	n/a	172

n/a = not applicable because the RQ did not exceed the LOC for the screening-level T-REX analysis
App=Application
[1]Seasonal maximum is slightly exceeded because T-HERPS cannot accommodate variable application rates
[2]Seasonal maximum is slightly under-represented because T-HERPS cannot accommodate variable application rates
[3]Only one crop cycle was modeled because T-HERPS cannot accommodate variable application intervals

T-REX may underestimate exposure to snakes when birds are used as a surrogate and are assumed to eat similar dietary items because of the large meal size a snake may consume on a single day.[6] Thus, birds consuming short grass in T-REX are used as the screen to determine whether further refinement in T-HERPS is needed for snakes. T-HERPS was modified (version 1.1) to estimate exposure to snakes based on the maximum size prey item they could consume and is used to refine a risk estimate when LOCs are exceeded for small birds consuming short grass based on RQs estimated in T-REX. The following allometric equation developed by King 2002 was used to estimate the maximum size prey items for snakes (King, 2002).

$$\text{Prey Size} = \text{Snake Mass}^{1.015}$$

The 95% confidence limits on the coefficient are 0.959 and 1.071 (King, 2002). The upper limit was used in T-HERPS to estimate exposure to snakes.

EECs in T-HERPS that are applicable to the SFGS are small (2 g, juveniles) snakes consuming small and large insects and medium (20 g) snakes consuming small and large insects, small herbivorous and insectivorous mammals, and amphibians (USEPA, 1993). The most sensitive EECs and RQs for SFGS are for the medium animal consuming small herbivorous mammals. EECs were only calculated for reptiles in cases where the bird EECs resulted in RQs that exceeded the LOC. In cases where this did not occur, the bird EECs were considered conservative and protective of reptiles. EECs calculated using T-HERPS for the SFGS are shown in Table 3-8.

[6] When examining the same application rates and types, RQs calculated in T-REX for small birds consuming short grass are higher than or equal to the highest RQs estimated in T-HERPs for medium snakes consuming small herbivore mammals. Therefore, RQs calculated in T-REX for the small birds consuming short grass may be used as a screen for examining risk to snakes.

Table 3-8. Upper-Bound Kenaga Nomogram EECs for Dietary- and Dose-Based Exposures of Reptiles Derived Using T-HERPS for *Lambda*-Cyhalothrin

Use(s), Type of Application	App Rate (lb a.i./A, # App, Interval (days)	EEC for Small SFGS (small reptile consuming small insects)		EEC for Medium SFGS (medium reptile birds consuming small herbivorous mammals)	
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)
Agricultural/farm premises, crack and crevice/surface spray/perimeter treatment	2 at 0.2212[2] 7 days	223	n/a	76	n/a
Alfalfa, aerial/ground	3 at 0.038 10 days	51	n/a	17	n/a
Almond, ground dust and spray	6 at 0.1 7 days	235	n/a	80	n/a
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, ground dust and spray	9 at 0.1 7 days	297	n/a	101	n/a
Almond, nectarine, peach, cherry, trunk drench	3 at 0.06 5 days	88	n/a	30	n/a
Apple, trunk drench	1 at 0.06 n/a	32	n/a	11	n/a
Animal housing premises, paths/patios, barrier treatment/crack and crevice	14 at 0.2762[2] 21 days	436	458	149	184
Household/domestic dwellings outdoor premises, barrier treatment/crack and crevice	2 at 2 7 days	2017	2119	688	851
Apricot, bean, eggplant, groundcherry, loquat, mayhaw, pea, pepino, pepper, plum, quince, ground spray/dust	9 at 0.0239 7 days	71	n/a	24	n/a
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut, ground spray/dust	6 at 0.0239 7 days	56	n/a	7	n/a
Barley, aerial/ground	2 at 0.031	31	n/a	11	n/a

Use(s), Type of Application	App Rate (lb a.i./A, # App, Interval (days)	EEC for Small SFGS (small reptile consuming small insects)		EEC for Medium SFGS (medium reptile birds consuming small herbivorous mammals)	
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)
	7 days				
Bell pepper, catjang (Jerusalem/marble pea) (aerial/ground spray/dust)	12 at 0.03 7 days	101	n/a	35	n/a
Mustard cabbage (gai choy, pak-choi), ground spray/dust	8 at 0.03 7 days	84	n/a	29	n/a
Brassica (head and stem) vegetables, aerial/ground	3 at 0.031[3] 7 days	44	n/a	15	n/a
Tomato, tomatillo, ground spray/dust	9 at 0.0294 7 days	87	n/a	30	n/a
Broccoli, cauliflower, ground spray/dust	9 at 0.0294[3] 7 days	87	n/a	30	n/a
Cabbage, kohlrabi, ground spray/dust	9 at 0.0294[3] 7 days	87	n/a	30	n/a
Mustard	9 at 0.0294[3] 7 days	87	n/a	30	n/a
Brussels sprouts, ground spray	3 at 0.038 10 days	51	n/a	17	n/a
Brussels sprouts, dust	9 at 0.038 10 days	95	n/a	32	n/a
Buckwheat, oat, rye, aerial/ground	2 at 0.03 3 days	31	n/a	11	n/a
Canola/rape, aerial/ground	3 at 0.0311 5 days	46	n/a	16	n/a
Grass forage/fodder/hay, pastures, rangeland, aerial/ground	3 at 0.0311 30 days	31	n/a	11	n/a
Cereal grains, triticale, wheat, aerial/ground	2 at 0.0311 3 days	33	n/a	11	n/a

Use(s), Type of Application	App Rate (lb a.i./A, # App, Interval (days)	EEC for Small SFGS (small reptile consuming small insects)		EEC for Medium SFGS (medium reptile birds consuming small herbivorous mammals)	
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)
Cole crops, aerial/ground/dust	8 at 0.0311 7 days	87	n/a	30	n/a
Onion, aerial/ground/dust	9 at 0.0311 7 days	92	n/a	32	n/a
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns, ground	3 at 0.1585[1] 7 days	224	n/a	77	n/a
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns, mound/spot treatment	7 at 0.06 7 days	155	n/a	53	n/a
Conifers (plantations/nurseries), ground	6 at 0.0401 7 days	94	n/a	32	n/a
Conifers (seed orchard), ground	3 at 0.156[2] 7 days	221	n/a	75	n/a
Corn (field), aerial/ground	3 at 0.042 10 days	56	n/a	19	n/a
Corn (sweet), dust	5 apps at 0.042[3] 10 days	79	n/a	27	n/a
Corn (sweet), spray	6 apps of 0.03[3] 10 days	63	n/a	21	n/a
Cotton, aerial/ground	3 at 0.042 10 days	56	n/a	19	n/a
Cucurbit vegetables, aerial/ground	6 at 0.0311 5 days	80	n/a	27	n/a
Filbert, pecan, walnut, aerial/ground	3 at 0.057[1] 10 days	77	n/a	26	n/a
Filbert, pecan, walnut, dust	6 at 0.057 10 days	119	n/a	41	n/a
Forest plantings,	5 at	106	n/a	36	n/a

Use(s), Type of Application	App Rate (lb a.i./A, # App, Interval (days)	EEC for Small SFGS (small reptile consuming small insects)		EEC for Medium SFGS (medium reptile birds consuming small herbivorous mammals)	
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)
ground	0.0511[1] 7 days				
Fruiting vegetables, aerial/ground	12 at 0.0311 5 days	124	n/a	42	n/a
Garlic	8 at 0.0311 7 days	87	n/a	30	n/a
Golf course turf, ornamental sod farm, ground	1 at 0.068	37	n/a	13	n/a
Golf course turf, ornamental sod farm, mound	6 at 0.06 7 days	141	n/a	48	n/a
Grasses grown for seed, ground	3 at 0.1306 7 days	185	n/a	63	n/a
Legume vegetables, aerial/ground	4 at 0.0311 5 days	58	n/a	20	n/a
Peanuts, root and tuber vegetables, aerial/ground	4 at 0.0311 7 days	55	n/a	6	n/a
Lettuce, aerial/ground	10 at 0.0311[3] 5 days	112	n/a	38	n/a
Nonagricultural uncultivated areas/soils, aerial	3 at 0.0792[1] 7 days	112	n/a	38	n/a
Ornamental and/or shade trees, ground	3 at 0.162[1] 7 days	230	n/a	78	n/a
Ornamental and/or shade trees, ground cover, herbaceous plants, non flowering plants, woody shrubs and vines, rose, ground/dust	3 at 1.2 7 days	1701	1786	580	718
Paved areas (private roads/sidewalks), barrier/perimeter	6 at 0.069 7 days	162	n/a	55	n/a

Use(s), Type of Application	App Rate (lb a.i./A, # App, Interval (days)	EEC for Small SFGS (small reptile consuming small insects)		EEC for Medium SFGS (medium reptile birds consuming small herbivorous mammals)	
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)
treatment					
Pome and stone fruit, aerial/ground	5 at 0.0415 7 days	86	n/a	29	n/a
Potato, aerial/ground	4 at 0.0239[1] 7 days	42	n/a	14	n/a
Recreational areas, band treatment	52 at 0.0291 7 days	121	n/a	41	n/a
Recreational areas, crack and crevice/spot treatment	2 at 2 7 days	2017	2119	688	851
Rice, ground	3 at 0.0415 5 days	61	n/a	21	n/a
Seed orchard trees, ground	3 at 0.162[2] 7 days	230	n/a	78	n/a
Sorghum, aerial/ground	2 at 0.038 10 days	37	n/a	13	n/a
Soybean, aerial/ground	2 at 0.038[1] 14 days	36	n/a	12	n/a
Tree nuts, aerial/ground	4 at 0.0415 5 days	78	n/a	26	n/a
Sunflower, aerial/ground	3 at 0.038 10 days	51	n/a	17	n/a
Right-of-way, ground	6 at 0.06 7 days	141	n/a	48	n/a

n/a = not applicable because the RQ did not exceed the LOC for the screening-level T-REX analysis
App=Application
[1]Seasonal maximum is slightly exceeded because T-HERPS cannot accommodate variable application rates
[2]Seasonal maximum is slightly under-represented because T-HERPS cannot accommodate variable application rates
[3]Only the first crop cycle was modeled because T-HERPS cannot accommodate variable application intervals

3.3.2.b. Terrestrial Organism Exposure to Residues in Aquatic Food Items (KABAM)

The KABAM model (K_{OW} (based) Aquatic BioAccumulation Model) version 1.0 was used to evaluate the potential exposure and risk of direct effects to the SFGS and CCR via bioaccumulation and biomagnification in aquatic food webs. KABAM is used to estimate potential bioaccumulation of hydrophobic organic pesticides in freshwater aquatic ecosystems and risks to mammals and birds consuming aquatic organisms which have bioaccumulated these pesticides. The bioaccumulation portion of KABAM is based upon work by Arnot and Gobas (2004) who parameterized a bioaccumulation model based on PCBs and some pesticides (*e.g.*, lindane, DDT) in freshwater aquatic ecosystems (Arnot and Gobas, 2004). KABAM relies on a chemical's octanol-water partition coefficient (K_{OW}) to estimate uptake and elimination constants through respiration and diet of organisms in different trophic levels. Pesticide tissue residues are calculated for different levels of an aquatic food web. The model then uses pesticide tissue concentrations in aquatic animals to estimate dose- and dietary-based exposures and associated risks to mammals and birds (surrogate for amphibians and reptiles) consuming aquatic organisms. Seven different trophic levels including phytoplankton, zooplankton, benthic invertebrates, filter feeders, small-sized (juvenile) forage fish, medium-sized forage fish, and larger piscivorous fish, are used to represent an aquatic food web.

As a pyrethroid, *lambda*-cyhalothrin is known to be metabolized extensively by fish and invertebrates. Consequently, the depuration rate constant value (k_2) available from the fish bioaccumulation study (BCF = 4600x; k2 = 0.0765) was used in the model (fish only) rather than the values automatically calculated by KABAM. A BCF for invertebrates (*Chironomus riparius* BCF = 2000x) based on exposure in the water column was available from the open literature (Hamer et al. 1999) and used to calculate a k_2 for invertebrates (k2 = 3.8) filter feeders, and zooplankton. Parameters for phytoplankton were not modified.

For both the CCR and SFGS, it was conservatively assumed that the diet consisted of 50% fish and 50% aquatic invertebrates. In addition, the fog and water shrews were considered as components of the SFGS' diet; these are the only two possible mammalian prey for this species. These assumptions may result in an overestimation of exposure because both species consume other food items in addition to fish and aquatic invertebrates (for the CCR) and shrews (for the SFGS). Example output from the bioaccumulation model is provided in Appendix F.

Four pesticide-specific inputs are required to estimate *lambda*-cyhalothrin residue concentrations in aquatic organism tissues: 1) log K_{OW}, 2) K_{OC}, 3) aqueous concentration of *lambda*-cyhalothrin, and 4) sediment pore water concentrations of *lambda*-cyhalothrin. The K_{OC} and Log K_{OW} are based on registrant-submitted studies (see Section 2.4). *Lambda*-cyhalothrin concentrations in pore water and the water column were based on PRZM/EXAMS scenarios adapted specifically for California (Table 3-9). The 21-day EECs are used based on the time to steady state as indicated in MRID 00152744. Additional model input parameters related to aquatic organisms (including body weight, and food and water intake) and environmental characteristics (*e.g.*, temperature, organic carbon content) are identified and explained in Attachment I.

Two scenarios were modeled: the highest EECs that result from any of the assessed uses of *lambda*-cyhalothrin (airports/landing fields granular application), and a scenario that resulted in

EECs typical of many of the agricultural *lambda*-cyhalothrin uses that were assessed in this document (almond dust application).

Table 3-9. Bioaccumulation Model Input Values for *Lambda*-Cyhalothrin

Parameter	Input Value	Source
Pesticide Name	*Lambda*-cyhalothrin	
Log K_{OW}	7	Laskowski, 2002
K_{OC}	333,200	MRID 44861503
Fish k_2 (Based on fish BCF)	0.0765/day	MRID 00152744
Invertebrate k_2	3.8/day	Hamer et al. 1999
Benthic invertebrates k_2 (based on invertebrate BCF)	0.849/day	Hamer et al. 1999
Zooplankton k2 (based on invertebrate BCF)	21/day	Hamer et al. 1999
Use patterns	Airports/landing fields (granular) (50 app @ 0.08 lb ai/A – 7-days)	Almond dust (ground) (6 app @ 0.1 lb ai/A – 10-days)
Concentration in sediment pore water (ppb)	0.447	0.005
Total pesticide concentration in water (ppb)	2.11	0.02

Based on the bioaccumulation model, estimated concentrations of *lambda*-cyhalothrin residues in the tissue of organisms in the different trophic levels following application on airport/landing fields and almond groves range from 10 to 10^6 µg/kg (Table 3-10). Phytoplankton values are high because chemical specific bioaccumulation information was not available for *lambda*-cyhalothrin and phytoplankton. Overall, the model indicates that there is the potential for some bioaccumulation in fish and aquatic invertebrates. The results are relatively consistent as compared with the bioaccumulation studies of *lambda*-cyhalothrin on fish and *Chironomus riparius*.

Table 3-10. Predicted Concentrations of *Lambda*-Cyhalothrin in Aquatic Organism Tissues at Different Trophic Levels

Trophic Level	Estimated Total Concentration (µg/kg)	
	Airports/landing fields (O)/ 50 app @ 0.08 lb ai/A (7-days)	**Almond dust (ground) (6 app @ 0.1 lb ai/A – 10-days)**
Phytoplankton	259,267	2,458
Zooplankton	5,775	55
Benthic Invertebrates	13,479	128
Filter Feeders	1,348	13
Small Forage Fish	21,852	208
Medium Forage Fish	12,086	115
Large Forage Fish	5,738	54

3.4. Terrestrial Plant Exposure Assessment

Terrestrial plant exposure is not assessed because toxicity data are not available. See Section 5 for characterization of the risk.

4. Effects Assessment

This assessment evaluates the potential for *lambda*-cyhalothrin to directly or indirectly affect BCB, CCR, CFWS, CTS-CC, CTS-SC, CTS-SB, DS, SFGS, TG, and VELB or modify their designated critical habitat. Assessment endpoints for the effects determination for each assessed species include direct toxic effects on the survival, reproduction, and growth, as well as indirect effects, such as reduction of the prey base or modification of its habitat. In addition, potential modification of critical habitat is assessed by evaluating effects to the PCEs, which are components of the critical habitat areas that provide essential life cycle needs of each assessed species. Direct effects to the aquatic-phase tiger salamander are based on toxicity information for freshwater fish, while terrestrial-phase amphibian effects (tiger salamander) and reptiles (San Francisco garter snake) are based on avian toxicity data, given that birds are generally used as a surrogate for terrestrial-phase amphibians and reptiles.

As described in the Agency's Overview Document (USEPA, 2004), the most sensitive endpoint for each taxon is used for risk estimation. For this assessment, evaluated taxa include freshwater fish (used as a surrogate for aquatic-phase amphibians), freshwater invertebrates, estuarine/marine fish, estuarine/marine invertebrates, aquatic plants, birds (used as a surrogate for terrestrial-phase amphibians and reptiles), mammals, terrestrial invertebrates, and terrestrial plants. Acute (short-term) and chronic (long-term) toxicity information is characterized based on registrant-submitted studies and a comprehensive review of the open literature on *lambda*-cyhalothrin.

4.1. Ecotoxicity Study Data Sources

Toxicity endpoints are established based on data generated from guideline studies submitted by the registrant, and from open literature studies that meet the criteria for inclusion into the ECOTOX database maintained by EPA/Office of Research and Development (ORD) (USEPA, 2004). Open literature data presented in this assessment were obtained from ECOTOX information (March 2012). To be included in the ECOTOX database, papers must meet the following minimum criteria:

(1) the toxic effects are related to single chemical exposure;
(2) the toxic effects are on an aquatic or terrestrial plant or animal species;
(3) there is a biological effect on live, whole organisms;
(4) a concurrent environmental chemical concentration/dose or application rate is reported; and
(5) there is an explicit duration of exposure.

Open literature toxicity data for other 'target' insect species (not including bees, butterflies, beetles, and non-insect invertebrates including soil arthropods and worms), which include efficacy studies, are not currently considered in deriving the most sensitive endpoint for terrestrial insects. Efficacy studies do not typically provide endpoint values that are useful for risk assessment (*e.g*., NOAEC, EC_{50}, *etc.*), but rather are intended to identify a dose that maximizes a particular effect (*e.g*., EC_{100}). Therefore, efficacy data and non-efficacy toxicological target insect data are not included in the ECOTOX open literature summary table provided in Appendix I. For the purposes of this assessment, 'target' insect species are defined as all terrestrial insects with the exception of bees, butterflies, beetles, and non-insect invertebrates (*i.e*., soil arthropods, worms, *etc*.) which are included in the ECOTOX data presented in Appendix I. The list of citations including toxicological and/or efficacy data on target insect species not considered in this assessment is provided in Appendix H.

Data that pass the ECOTOX screen are evaluated along with the registrant-submitted data, and may be incorporated qualitatively or quantitatively into this endangered species assessment. In general, effects data in the open literature that are more conservative than the registrant-submitted data are considered. The degree to which open literature data are quantitatively or qualitatively characterized for the effects determination is dependent on whether the information is relevant to the assessment endpoints (*i.e*., survival, reproduction, and growth) identified in Section 2.8. For example, endpoints such as behavior modifications are likely to be qualitatively evaluated, because quantitative relationships between modifications and reduction in species survival, reproduction, and/or growth are not available. Although the effects determination relies on endpoints that are relevant to the assessment endpoints of survival, growth, or reproduction, it is important to note that the full suite of sublethal endpoints potentially available in the effects literature (regardless of their significance to the assessment endpoints) are considered, as they are relevant to the understanding of the area with potential effects, as defined for the action area.

Citations of all open literature not considered as part of this assessment because they were either rejected by the ECOTOX screen or accepted by ECOTOX but not used (*e.g*., the endpoint is less sensitive) are included in Appendix H**.** Appendix H also includes a rationale for rejection of those studies that did not pass the ECOTOX screen and those that were not evaluated as part of this endangered species risk assessment.

A detailed spreadsheet of the available ECOTOX open literature data, including the full suite of lethal and sublethal endpoints is presented in Appendix I. Appendix J includes a summary of the human health effects data for *lambda*-cyhalothrin.

In addition to registrant-submitted and open literature toxicity information, other sources of information, including use of the acute probit dose response relationship to establish the probability of an individual effect and reviews of ecological incident data, are considered to further refine the characterization of potential ecological effects associated with exposure to *lambda*-cyhalothrin. A summary of the available aquatic and terrestrial ecotoxicity information and the incident information for *lambda*-cyhalothrin are provided in Sections 4.2 through 4.5.

4.2. Toxicity of *Lambda*-Cyhalothrin to Aquatic Organisms

Table 4-1 summarizes the most sensitive aquatic toxicity endpoints, based on an evaluation of both the submitted studies and the open literature, as previously discussed. A brief summary of submitted and open literature data considered relevant to this ecological risk assessment for the BCB, CCR, CFWS, CTS-CC, CTS-SC, CTS-SB, DS, SFGS, TG, and VELB is presented below. Additional information is provided in Appendix G. All endpoints are expressed in terms of the active ingredient (a.i.) unless otherwise specified. For freshwater fish and freshwater invertebrates, the most sensitive species for acute exposures (fish – golden orfe; invertebrate – *Hyalella*) differed from the most sensitive species for chronic exposures. This is an artifact of chronic studies not being available for the golden orfe and *Hyalella*. Thus, an acute-to-chronic ratio (ACR) was employed to estimate the chronic toxicity value, based on the acute-chronic toxicity relationship for a pair of less sensitive species.

$ACR = LC_{50\ species\ x} / NOAEC_{species\ x} = LC_{50\ species\ y} / NOAEC_{\ species\ y}$

The ACR for freshwater fish is based on sheepshead minnow. An estuarine/marine fish was used because acute and chronic data for a single freshwater fish species were unavailable. All units are in µg ai/L.

$0.807_{(sheepshead\ minnow)} / 0.25_{(sheepshead\ minnow)} = 0.078_{(golden\ orfe)} / NOAEC_{(golden\ orfe)} = 0.024$

The ACR for freshwater invertebrates is based on *Daphnia*; all units are in µg ai/L.

$0.36_{(Daphnia)} / 0.00198_{(Daphnia)} = 0.0014_{(Hyalella)} / NOAEC_{(Hyalella)} = 0.000008$

Table 4-1. Aquatic Toxicity Profile for *Lambda*-Cyhalothrin

Assessment Endpoint	Acute/ Chronic	Species TGAI/TEP % a.i.	Toxicity Value Used in Risk Assessment	Citation or MRID # (Author, Date)[1]	Comment
Freshwater fish (surrogate for aquatic-phase amphibians)	Acute	Golden orfe (*Leuciscus idus*) TGAI – 87.7%	96-hr LC_{50} = 0.078 µg ai/L	44584001	Supplemental because the fish was not a typical guideline species Sub-lethal effects: quiescence, sounding, erratic swimming, spiraling, loss of balance, rapid respiration, and gulping air
	Chronic	Golden orfe (*Leuciscus idus*)	NOAEC = 0.024 µg ai/L	N/A	Calculated based on the ACR method
		Fathead minnow (*Pimephales promelas*) TGAI – 97%	NOAEC = 0.031 µg ai/L	41519001	Supplemental because of some minor methodological problems (including some slight contamination of the controls) LOAEC = 0.062 µg ai/L

Assessment Endpoint	Acute/ Chronic	Species TGAI/TEP % a.i.	Toxicity Value Used in Risk Assessment	Citation or MRID # (Author, Date)[1]	Comment
					Endpoints based on: F_1 survival at 28 days, F_0 length at 56 days, male length and weight at 300 days, and F_1 weight and length at 31 days
Freshwater invertebrates	Acute	Scud (*Hyalella azteca*) TEP – 13.1%	EC_{50} = 0.0014 µg ai/L	48911001, E74235	Acceptable for quantitative use. *Lambda*-cyhalothrin was the sole active ingredient in the formulation. No sub-lethal effects were reported.
	Chronic	Scud (*Hyalella azteca*)	NOEL = 0.000008 µg ai/L[3]	N/A	Calculated based on the ACR method
		Waterflea (*Daphnia magna*) TGAI – 96.6%	NOEL = 0.00198 µg ai/L	41217501	Supplemental because only one vessel per treatment level was sampled to verify concentrations. LOEL = 0.0035 µg ai/L Endpoints based on the number of young per female and adult survival
Estuarine/ marine fish	Acute	Sheepshead minnow (*Cyprinodon variegatus*) TGAI – 96%	96-hr LC_{50} = 0.807 µg ai/L	00153506	Acceptable Sub-lethal effects: quiescence, loss of balance, weakness, hyper excitability, and rapid respiration
	Chronic	Sheepshead minnow (*Cyprinodon variegatus*) TGAI – 96.6%	NOEC = 0.25 µg ai/L	00152732	Acceptable LOEC = 0.38 µg ai/L Endpoints based on weight
Estuarine/ marine invertebrates	Acute	Mysid shrimp (*Americamysis bahia*) TGAI – 97%	96-hr LC_{50} = 0.0049 µg ai/L[4]	00152729	Acceptable No sub-lethal effects were reported.
	Chronic	Mysid shrimp (*Americamysis bahia*) TGAI – 97%	NOEL = 0.00022 µg ai/L[4]	073989	Supplemental because reproductive success could not be calculated LOEL = 0.49 ng ai/L

Assessment Endpoint	Acute/ Chronic	Species TGAI/TEP % a.i.	Toxicity Value Used in Risk Assessment	Citation or MRID # (Author, Date)[1]	Comment
					Endpoints based on reproduction.
Aquatic plants	Vascular	Not available	Not available	Not available	Not available
	Non-vascular	Green algae (*Pseudokirchneriella subcapitata*) TGAI – 96.5%	EC_{50} > 310 µg ai/L[2]	00152731	Supplemental because of low recovery rates of *lambda*-cyhalothrin in the extraction from water at the end of the experiment Endpoint based on growth rate of the algae

1-ECOTOX references are designated with an E followed by the ECOTOX reference number.
[2]Endpoint is above the limit of solubility (5 µg ai/L)
[3]Used as a surrogate for freshwater benthic invertebrates
[4]Used as a surrogate for estuarine/marine benthic invertebrates

Toxicity to fish and aquatic invertebrates is categorized using the system shown in Table 4-2 (USEPA, 2004). Toxicity categories for aquatic plants have not been defined.

Table 4-2. Categories of Acute Toxicity for Fish and Aquatic Invertebrates

LC_{50} (mg/L)	Toxicity Category
< 0.1	Very highly toxic
> 0.1 - 1	Highly toxic
> 1 - 10	Moderately toxic
> 10 - 100	Slightly toxic
> 100	Practically nontoxic

4.2.1. Toxicity to Freshwater Fish

A summary of acute and chronic freshwater fish data is provided below in Sections 4.2.1.a through 4.2.1.b.

4.2.1.a. Freshwater Fish: Acute Exposure (Mortality) Studies

The most sensitive freshwater fish species was the golden orfe (*Leuciscus idus)*; the LC_{50} was 0.078 µg ai/L, making *lambda*-cyhalothrin very highly toxic to freshwater fish (MRID 44584001). Sub-lethal effects included quiescence, sounding, erratic swimming, spiraling, loss of balance, rapid respiration, labored respiration, swimming cessation, light discoloration, surfacing, irregular respiration, and gulping air. Similar sub-lethal effects were documented in the other studies as well. For rainbow trout (3 studies), sub-lethal effects included: loss of equilibrium, quiescence, change in color, spiraling, rapid respiration, weakness, surfacing, coughing, and sounding. Sub-lethal effects to the bluegill sunfish (3 studies) included: sounding, loss of balance, quiescence, darkening of color, spiraling, and rapid and irregular respiration.

4.2.1.b. Freshwater Fish: Chronic Exposure (Growth/Reproduction) Studies

There is one acceptable chronic toxicity study for fish that is available. The study was performed as a full life cycle test with the fathead minnow (*Pimephales promelas*) and yielded a NOEL of 0.031 µg ai/L (MRID 41519001). The NOEL was based on F_1 survival at 28 days, F_0 length at 56 days, male length and weigh at 300 days, and F_1 weight and length at 31 days. There was some slight contamination of the controls when measurements were performed, but this was thought to have been minor and not to have affected the experiment. Given that the most sensitive acute toxicity value is for the golden orfe, the ACR method was used to calculate a NOEL of 0.024 µg ai/L, which is used in the assessment.

4.2.2. Toxicity to Freshwater Invertebrates

A summary of acute and chronic freshwater invertebrate data, including data published in the open literature, is provided below in Sections 4.2.2.a through 4.2.2.c. All data are based on water column exposures. Sediment exposure data are not available and are considered a data gap.

4.2.2.a. Freshwater Invertebrates: Acute Exposure Studies

The most sensitive freshwater invertebrate that was tested was an amphipod (*Gammarus pulex*) using surface water. The LC_{50} was 0.00668 µg ai/L, making *lambda*-cyhalothrin very highly toxic to amphipods (MRID 00152730). The waterflea (*Daphnia magna*) is the most commonly tested freshwater invertebrate. Three waterflea studies were available with LC_{50}s ranging from 0.09 to 0.36 µg ai/L. This places *lambda*-cyhalothrin in the toxicity category of "very highly toxic" to the waterflea. No sub-lethal effects were documented for any of the freshwater invertebrates that were tested.

Acute toxicity data are available for benthic invertebrates (scud) from the open literature (see 4.2.2.c).

4.2.2.b. Freshwater Invertebrates: Chronic Exposure Studies

One chronic study with the waterflea (*Daphnia magna*) was available for freshwater invertebrates. The full life cycle test yielded a NOEL of 0.00198µg ai/L and a LOEL of 0.0035 µg ai/L. The toxicity endpoints were based on the number young per female (60% decrease at the LOEL) and adult survival (7% decrease at the LOEL) (MRID 41217501). However, given that the most sensitive acute value was based on the amphipod, the ACR method was used to derive a NOEC of 0.000008 µg ai/L, which is used in the assessment.

No data are available for the chronic effects of *lambda*-cyhalothrin on freshwater benthic invertebrates. In lieu of this, the ACR for the scud chronic value is used as a surrogate for freshwater benthic species.

4.2.2.c. Freshwater Invertebrates: Open Literature Data

A search of the open literature produced one study with an acute freshwater invertebrate endpoint that was lower than those submitted to EPA in support of pesticide registration. The study investigated the toxicity of Karate™, a typical end-use product of which *lambda*-cyhalothrin is the sole active ingredient, on an array of freshwater invertebrates that are commonly found in ditches (MRID 48911001). The most sensitive freshwater invertebrate in this study was the scud (*Hyalella azteca*) with an EC_{50} of 1.4 ng ai/L. This categorizes *lambda*-cyhalothrin as very highly toxic to scuds (a freshwater benthic invertebrate). All other organisms in the study (e.g., waterflea, common backswimmer, amphipod, flatworm) yielded EC_{50}s that warranted this classification as well. No sub-lethal effects were reported.

4.2.3. Toxicity to Estuarine/Marine Fish

A summary of acute and chronic estuarine/marine fish data is provided below in Sections 4.2.3.a through 4.2.3.b.

4.2.3.a. Estuarine/Marine Fish: Acute Exposure Studies

There is one study with the sheepshead minnow (*Cyprinodon variegatus*) that tests the acute toxicity of *lambda*-cyhalothrin to marine/estuarine fish. Based on the study, *lambda*-cyhalothrin is very highly toxic to estuarine/marine fish, with an LC_{50} of 0.807 µg ai/L (MRID 00153506). Sub-lethal effects included quiescence, loss of balance, weakness, hyper excitability, and rapid respiration. Many of these same effects were also documented for freshwater fish.

4.2.3.b. Estuarine/Marine Fish: Chronic Exposure Studies

The sheepshead minnow was used to test the chronic toxicity of *lambda*-cyhalothrin to estuarine/marine fish. The NOEC derived from this study was 0.25 µg ai/L and was based on the endpoint of “weight” (9% decrease at the LOEL) (MRID 00152732). No other sub-lethal effects were documented.

4.2.4. Toxicity to Estuarine/Marine Invertebrates

A summary of acute and chronic estuarine/marine invertebrate data is provided below in Sections 4.2.4.a through 4.2.4.b.

4.2.4.a. Estuarine/Marine Invertebrates: Acute Exposure Studies

The most sensitive endpoint for acute toxicity was a study with the mysid shrimp (*Americamysis bahia*). The LC_{50} was 0.0049 µg ai/L, indicating that *lambda*-cyhalothrin is very highly toxic to the mysid shrimp (MRID 00152729). No sub-lethal effects were reported. A second study was performed with larvae of the Pacific oyster (*Crassostrea gigas*). This study reported no mortality or sub-lethal effects. The resulting LC_{50} was > 0.59 mg ai/L indicating that *lambda*-cyhalothrin is far less toxic to Pacific oyster larvae than mysid shrimp (MRID 00152728).

However, the LC_{50} is still low enough to place *lambda*-cyhalothrin in the "highly toxic" category.

No data are available for the acute effects of *lambda*-cyhalothrin on estuarine/marine benthic invertebrates. In lieu of this, the mysid shrimp acute endpoint is used a surrogate for benthic species.

4.2.4.b. Estuarine/Marine Invertebrates: Chronic Exposure Studies

A chronic life cycle toxicity study evaluated the effects of *lambda*-cyhalothrin on the mysid shrimp. The study yielded a NOEL of 0.22 ng ai/L (Accession Number 073989). The endpoint was based on reproduction effects; however, the "reproductive" endpoint could not be determined because raw data were not included with the study's report.

No data are available for the chronic effects of *lambda*-cyhalothrin on estuarine/marine benthic invertebrates. In lieu of this, the mysid shrimp chronic value is used as a surrogate.

4.2.5. Toxicity to Aquatic Plants

Aquatic plant toxicity studies are used as one of the measures of effect to evaluate whether *lambda*-cyhalothrin may affect primary production. Aquatic plants may also serve as dietary items of CCR, CTS (all DPS), CFWS, DS, and TG and habitat components for the SFGS, CCR, CTS (all DPS), CFWS, DS and TG. In addition, freshwater vascular and non-vascular plant data are used to evaluate a number of the PCEs associated with the critical habitat impact.

One study is available for aquatic plants. The study focuses on green algae (*Pseudokirchneriella subcapitata*), a non-vascular aquatic plant. The EC_{50} was determined to be > 310 µg ai/L, the highest concentration tested. The endpoint was based on the growth rate of the algae, and no other sub-lethal effects were noted (MRID 00152731). Data are available for two non-vascular plant studies with *gamma*-cyhalothrin. Both studies were conducted with green algae and yielded toxicity values of EC_{50} > 2850 and EC_{50} = 15000 µg ai/L (MRIDs 45447406 and 454477407, respectively).

Other pyrethroids were reviewed to determine the level of toxicity from related chemicals. Only two pyrethroids, in addition to *lambda*-cyhalothrin, were found to have aquatic plant toxicity data. Fenvalerate had data for two marine algae and two diatoms. The EC_{50}s were > 1000 µg ai/L, indicating low toxicity. Permethrin had an EC_{50} of 92 µg ai/L for a marine diatom. This value is more sensitive than *lambda*-cyhalothrin; however, permethrin is a Class I pyrethroid whereas *lambda*-cyhalothrin and fenvalerate are Class II pyrethroids and thus expected to be more similar in their toxicological effects.

4.3. Toxicity of *Lambda*-Cyhalothrin to Terrestrial Organisms

Table 4-3 summarizes the most sensitive terrestrial toxicity endpoints, based on an evaluation of both the submitted studies and the open literature. A brief summary of submitted and open literature data considered relevant to this ecological risk assessment is presented below. Additional information is provided in Appendix G.

Table 4-3. Terrestrial Toxicity Profile for *Lambda*-Cyhalothrin

Endpoint	Acute/ Chronic	Species	Toxicity Value Used in Risk Assessment	Citation MRID/ ECOTOX reference No.	Comment
Birds (surrogate for terrestrial-phase amphibians and reptiles)	Acute	Mallard duck (*Anas platyrhynchos*) TGAI – 96%	LD_{50} = 3950 mg ai/kg-bw	00151594	Acceptable Sub-lethal effects: slight loss of weight on the first days after dosing
	Acute	Northern bobwhite quail (*Colinus virginianus*) TGAI – 89.2%	LC_{50} = 2354 mg ai/kg-diet	00151118	Supplemental because EPA's re-calculated LC_{50} did not match that of the registrant Sub-lethal effects: slight weigh loss
	Chronic	Mallard duck (*Anas platyrhynchos*) TGAI – 96.3%	NOEL = 5 mg ai/kg-diet LOEL = 15 mg ai/kg-diet	41512101	Acceptable Endpoint based on: chemical residues in the egg, liver and fat, number of eggs laid and set, egg fertility, and early embryonic mortalities
Mammals	Acute	Rat (*Rattus norvegicus*) TGAI	LD_{50} = 56 mg ai/kg-bw	Accession Number 259805	Acceptable
	Chronic	Rat (*Rattus norvegicus*) TGAI	NOAEL = 30 ppm (1.5 mg ai/kg-bw/day LOAEL – 100 ppm (5 mg ai/kg-bw/day)	00154802	Acceptable Endpoints based on decreased mean body weight to parents and their offspring
Terrestrial invertebrates	Acute Contact	Honeybee (*Apis mellifera*) TGAI – 96%	LD_{50} = 0.038µg ai/bee	Accession Number 40052409	Acceptable No sub-lethal effects were reported.
Terrestrial plants	n/a	Seedling Emergence Monocots	Not available	Not available	Not available
	n/a	Seedling Emergence Dicots	Not available	Not available	Not available
	n/a	Vegetative Vigor	Not available	Not available	Not available

Endpoint	Acute/ Chronic	Species	Toxicity Value Used in Risk Assessment	Citation MRID/ ECOTOX reference No.	Comment
		Monocots			
	n/a	Vegetative Vigor Dicots	Not available	Not available	Not available

n/a: not applicable; ND = not determined; bw = body weight

Acute toxicity to terrestrial animals is categorized using the classification system shown in Table 4-4 (USEPA, 2004). Toxicity categories for terrestrial plants have not been defined.

Table 4-4. Categories of Acute Toxicity for Avian and Mammalian Studies

Toxicity Category	Oral LD_{50}	Dietary LC_{50}
Very highly toxic	< 10 mg/kg	< 50 mg/kg-diet
Highly toxic	10 - 50 mg/kg	50 - 500 mg/kg-diet
Moderately toxic	51 - 500 mg/kg	501 - 1000 mg/kg-diet
Slightly toxic	501 - 2000 mg/kg	1001 - 5000 mg/kg-diet
Practically non-toxic	> 2000 mg/kg	> 5000 mg/kg-diet

4.3.1. Toxicity to Birds

As specified in the Overview Document, the Agency uses birds as a surrogate for reptiles and terrestrial-phase amphibians when toxicity data for each specific taxon are not available (USEPA, 2004). A summary of acute and chronic bird data is provided below in Sections 4.3.1.a through 4.3.1.b.

4.3.1.a. Birds: Acute Exposure (Mortality) Studies

Two mallard duck (*Anas platyrhynchos*) studies have been performed to evaluate the acute toxicity of *lambda*-cyhalothrin to birds. One study yielded an LD_{50} of 3950 mg ai/kg-bw (MRID 0015194). This places *lambda*-cyhalothrin in the “slightly toxic” to birds toxicity category. The other study found *lambda*-cyhalothrin to be practically non-toxic (LD_{50} > 5000 mg ai/kg-bw), but noted a sub-lethal effect of a slight loss in weight for the first days after dosing (MRID 00150854).

Subacute dietary studies were also performed to establish a dietary toxicity for *lambda*-cyhalothrin. The most sensitive endpoint was derived from a northern bobwhite quail (*Colinus virginianus*) study. The LC_{50} from the study was found to be 2354 mg ai/kg-diet (MRID 00151118). A slight weight loss was observed as a sub-lethal effect. There were three other dietary studies that were performed: one additional study with the bobwhite quail and two studies with the mallard duck (*Anas platyrhynchos*). The latter included subdued behavior, unsteadiness, and a decrease in body weight as sub-lethal effects.

4.3.1.b. Birds: Chronic Exposure (Growth, Reproduction) Studies

A chronic reproductive study with the mallard duck (*Anas platyrhynchos*) produced the most sensitive endpoint. The NOEL was determined to be 5 mg ai/kg-diet and was based on *lambda*-cyhalothrin residues that were detected in the eggs (MRID 41512101). Other effects in the mallard duck were residues in the liver and fat, number of eggs laid and set, egg fertility, and early embryonic mortalities. The bobwhite quail study exhibited no effects up to 50 mg ai/kg-diet (MRID 00153505).

4.3.2. Toxicity to Mammals

A summary of acute and chronic mammalian data, including data published in the open literature, is provided below in Sections 4.3.2.a through 4.3.2.b. A more complete analysis of toxicity data to mammals is available in Appendix J, which is a copy of the most recent risk assessment conducted by the Health Effects Division (HED) (USEPA 2007b).

4.3.2.a. Mammals: Acute Exposure (Mortality) Studies

The oral toxicity of *lambda*-cyhalothrin was determined to be LD_{50} = 56 mg ai/kg-bw in the rat (*Rattus norvegicus*). This categorizes *lambda*-cyhalothrin as moderately toxic to mammals on an acute oral basis.

4.3.2.b. Mammals: Chronic Exposure (Growth, Reproduction) Studies

In the 90-day reproduction study with the rat (*Rattus norvegicus*), *lambda*-cyhalothrin yielded a NOAEL of 1.5 mg ai/kg-bw/day (30 mg ai/kg-diet), LOAEL of 5 mg ai/kg-bw/day (100 mg ai/kg-diet) for systemic effects in the parent/offspring. Specifically, these effects were a decrease in body weight. Reproductive effects (decreased body weight gain, food consumption and food efficiency) were also observed, but these were at a higher concentration (NOAEL = 100 mg ai/kg-diet; LOAEL > 100 mg ai/kg-diet.

4.3.3. Toxicity to Terrestrial Invertebrates

A summary of acute terrestrial invertebrate data is provided below in Section 4.3.3.a.

4.3.3.a. Terrestrial Invertebrates: Acute Exposure (Mortality) Studies

The acute contact toxicity to insects was measured with honeybees (*Apis mellifera*). The 48-hour contact LD_{50} was determined to be 0.038 µg ai/bee (Accession number 40052409). This categorizes *lambda*-cyhalothrin as highly toxic to honeybees. The same study also calculated an oral LD_{50} of 0.909 µg ai/bee. A non-guideline study (MRID 40436303) documented possible repellency effects of *lambda*-cyhalothrin to honeybees through treat and non-treated simulated honeydew. A honeybee foliage acute toxicity test (MRID 4043602) established that it would be safe for honeybees to re-enter the field from 24 to 96 hours after application of *lambda*-cyhalothrin, depending on the application rate. Application rates were 0.013 and 0.031 lb ai/A.

4.3.4. Toxicity to Terrestrial Plants

No registrant-submitted plant toxicity data were available for this assessment. In lieu of registrant-submitted studies, the body of open literature was reviewed for relevant plant toxicity data. Two product efficacy studies were evaluated (Table 4-5). Both tested the formulation Karate™ and neither documented any adverse effects of the insecticide on plants (wheat and groundnuts). Application rates up to 0.004 lb ai/A (groundnut) and 0.025 lb ai/A (wheat) were tested. These studies can be used to provide qualitative information for the risk assessment (*e.g.*, they cannot be used to calculate RQs).

In addition, the EPA's inventory of ecotoxicity studies for other pyrethroids was searched to identify terrestrial plant studies that could be used as surrogates for *lambda*-cyhalothrin data. Both Class I and Class II pyrethroids were searched; however, terrestrial plant data were not available for any of the chemicals.

Table 4-5. Plant Toxicity Data from the Open Literature for *Lambda*-Cyhalothrin

ECOTOX Number	Crop	NOEC (lb ai/A)	Classification
E88129	Wheat (*Triticum aestivum*)	0.025	Qualitative
E89623	Groundnut (*Arachis hypogaea*)	0.004	Qualitative

4.4. Incident Database Review

A review of the Ecological Incident Information System (EIIS, version 2.1.1), the 'Aggregate Incident Reports' (v. 1.0) database, and the Avian Monitoring Information System (AIMS) for ecological incidents involving *lambda*-cyhalothrin was completed on July 10, 2012. The results of this review for terrestrial, plant, and aquatic incidents are discussed below in Sections 4.4.1 through 4.4.3. A complete list of the incidents involving *lambda*-cyhalothrin including associated uncertainties is included in Appendices K and L.

4.4.1. Terrestrial Animal Incidents

The EIIS database had records for four terrestrial incidents. All incidents involved honeybees. The first incident (probable certainty) occurred in Canada in June of 2010. The incident was classified as a misuse of the chemical on canola/rapeseed. Four to seven million bees were killed when applications took place during the middle of the day. A second incident occurred in July of 2011 in California. It was classified with "possible" certainty to have caused mortality in 92 hives that were adjacent to pistachio, nut, and cotton fields treated with *lambda*-cyhalothrin. Dimethoate and methoxyfenozide were also applied during a similar time frame, thus they may have contributed to the incident. A third incident occurred in April 2011 in Slovenia. It was classified with "possible" certainty to have caused mortality (by ingestion) in bees in the vicinity of a *lambda*-cyhalothrin-treated area. Approximately 2500 bees were affected; a number of other pesticides were detected in bee tissue samples: coumaphos, pendimethalin, clothianidin, 2-phenylphenol, methiocarb, and thiacloprid; *lambda*-cyhalothrin was not detected. A fourth incident took place in June 2012 in New York. The incident was listed with "possible" certainty to have been caused by the application of *lambda*-cyhalothrin to wheat fields. Twenty-two colonies were reported to have experienced mortality. Twenty-two minor incidents to fish and wildlife were reported in the IDS database; it is uncertain how many of these affected terrestrial wildlife versus fish. No incidents were reported in the AIMS database.

4.4.2. Plant Incidents

The EIIS database had records for three terrestrial plant incidents. The first incident occurred in May of 2003 in Iowa. It was classified with "possible" certainty to have been caused by the application of *lambda*-cyhalothrin on cotton. Plant damage was reported on 78 acres of cotton, caused by direct treatment of *lambda*-cyhalothrin. The second incident occurred in June 2003 in Kentucky. It was a misuse on tobacco that was classified as "possible" to have been caused by *lambda*-cyhalothrin. Plant damage occurred on 200 acres of tobacco. The third incident (I016036-006) occurred in June 2004 in California. It was classified with "possible" certainty as to have been caused by the application of *lambda*-cyhalothrin on almonds. *Lambda*-cyhalothrin reportedly drifted to a nearby basil field causing crop damage. Residue testing revealed concentrations of *lambda*-cyhalothrin from 0.07 to 0.27 ppm on foliage. Bifenazate was also being sprayed on almond orchards in the vicinity of the incident. The IDS database reported 77 minor incidents to plants.

4.4.3. Aquatic Incidents

The EIIS database had records for nine aquatic organism incidents. The first incident occurred in August 1991 in Georgia. It was classified with "probable" certainty to have been caused by the application of *lambda*-cyhalothrin to cotton. *Lambda*-cyhalothrin spray affected an adjacent pond in a residential area and caused mortality in an unknown number of fish (species not specified). A second incident occurred in July of 1991 in Georgia. The incident was classified with "possible" certainty to have been caused by the aerial application of *lambda*-cyhalothrin on cotton near a pond. Runoff entered a pond approximately 20 to 50 yards from the field and killed 250 catfish, hundreds of bream, and many large-mouthed bass. The pesticide, dicrotophos, was also used on the field. A third incident occurred in August 1994 in North Carolina. It was classified with "possible" certainty to have caused the death of 200 bass in a pond near a cotton field. A fourth incident occurred in January 1997 in Indiana. A pond was affected after a rainstorm and it was suspected that turnover in the pond caused the mortalities. The number of species, magnitude of the incident, and details about the application of *lambda*-cyhalothrin were not available. Tefluthrin, in addition to *lambda*-cyhalothrin, was involved in the incident. A fifth incident occurred in May 1998 in Louisiana. It was classified with "probable" certainty to have been caused by the aerial application of *lambda*-cyhalothrin to corn. Drift contaminated a pond/canal and causing mortality in 90 to 100 acres of crayfish farming. A sixth incident occurred in June 1998 in Missouri. *Lambda*-cyhalothrin was accidentally applied to a zoo fish tank and caused ("probable" certainty) the death of 16 fish (unknown species). A seventh incident occurred in May 1998 in Louisiana. *Lambda*-cyhalothrin was intentionally (misuse) applied to a pond resulting (with "probable" certainty) the mortality of an unknown number of crayfish in a 4 acre and 35 acre pond. Samples confirmed the presence of *lambda*-cyahlothin in pond water at 0.04 to 0.93 ppb. An eighth incident occurred in May of 1997 in Indiana. It was classified with "possible" certainty to have been caused turnover in a pond. *Lambda*-cyhalothrin and tefluthrin were involved. Dead fish were reported three days after a 3-inch rain. A nineth incident was listed as "highly probable" to have occurred as the result of *lambda*-cyhalothrin exposure. This incident involved the aerial application (registered use) of Karate to cotton in Wilson County, Texas in 2004. An unreported number of crayfish were observed to be dead. The listed route of exposure was through spray drift. Twenty-two minor incidents to fish and wildlife were reported in the IDS database; it is uncertain how many of these affected fish versus terrestrial wildlife.

5. Risk Characterization

Risk characterization is the integration of the exposure and effects characterizations. Risk characterization is used to determine the potential for direct and/or indirect effects to the BCB, CCR, CFWS, CTS-CC, CTS-SC, CTS-SB, DS, SFGS, TG, and VELB or for modification to their designated critical habitat from the use of *lambda*-cyhalothrin in California. The risk characterization provides an estimation (Section 5.1) and a description (Section 5.6) of the likelihood of adverse effects; articulates risk assessment assumptions, limitations, and uncertainties; and synthesizes an overall conclusion regarding the likelihood of adverse effects to the assessed species or their designated critical habitat (*i.e.*, "no effect," "likely to adversely affect," or "may affect, but not likely to adversely affect"). In the risk estimation section, risk quotients are calculated using standard EFED procedures and models. In the risk description section, additional analyses may be conducted to help characterize the potential for risk.

5.1. Risk Estimation

Risk is estimated by calculating the ratio of exposure to toxicity. This ratio is the risk quotient (RQ), which is then compared to pre-established acute and chronic levels of concern (LOCs) for each category evaluated (Appendix C). For acute exposures to the listed aquatic animals, as well as terrestrial invertebrates, the LOC is 0.05. For acute exposures to the listed birds (and, thus, reptiles and terrestrial-phase amphibians) and mammals, the LOC is 0.1. The LOC for chronic exposures to animals, as well as exposures to plants is 1.0.

Acute and chronic risks to aquatic organisms are estimated by calculating the ratio of exposure to toxicity using 1-in-10 year EECs in Table 3-3 and Table 3-4 based on the label-recommended *lambda*-cyhalothrin usage scenarios summarized in Table 3-1 and the appropriate aquatic toxicity endpoint from Table 4-1. Acute and chronic risks to terrestrial animals are estimated based on exposures resulting from applications of *lambda*-cyhalothrin (
Table 3-6 through Table 3-8) and the appropriate toxicity endpoint from Table 4-3.

5.1.1. Exposures in the Aquatic Habitat

5.1.1.a. Freshwater Fish and Aquatic-phase Amphibians

Acute risk to fish and aquatic-phase amphibians is based on 1-in-10 year peak EECs in the standard pond and the lowest acute toxicity value for freshwater fish. Chronic risk is based on the 1-in-10 year 60-day EECs and the lowest chronic toxicity value for freshwater fish. Risk quotients for freshwater fish are shown in Table 5-1. Acute RQs ranged from 0.0103 to 64 and chronic RQs ranged from 0.004 to 208. Ninety-eight percent of the *lambda*-cyhalothrin uses exceeded the acute risk to listed species LOC (0.05) and 29% exceeded the chronic risk to listed species LOC (1). Therefore, *lambda*-cyhalothrin has the potential to directly affect the CTS, TG, and DS. Additionally, since 69% of the uses exceeded the acute non-listed species RQs (0.5) and chronic RQs are exceeded, there is a potential for indirect effects to those listed species that rely on fish (and/or aquatic-phase amphibians) during at least some portion of their life-cycle (*i.e.*, SFGS, CCR, and CTS).

Table 5-1. Acute and Chronic RQs for Freshwater Fish (Based on Surface Water EECs)

Uses/Application Rate	Peak EEC (µg/L)	60-day EEC (µg/L)	Acute RQ*	Chronic RQ*
Agricultural/farm premises (CC)/ 2 app @ 0.2212 and 1 app @ 0.0763 lb ai/A (7-days)	0.058	0.004	**0.74***	0.17
Alfalfa (A)/ 3 app @ 0.38 lb ai/A (10-days)	0.66	0.08	**8.5***	**3.3***
Alfalfa (G)/ 3 app @ 0.38 lb ai/A (10 days)	0.14	0.02	**1.8***	0.83
Almond (G)/ 6 app @0.1 lb ai/A (7-days)	0.07	0.02	**0.90***	0.83
Almond (T)/ 3 app 0.06 lb ai/A (5-days)	0.008	0.002	**0.10***	0.08
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, trees (G)/ 9 app @ 0.1 lb ai/A (7-days)	0.05	0.02	**0.64***	0.83
Nectarine, peach, cherry trees trunk drench (T)/ 3 app @ 0.06 lb ai/A (5 days)	0.0023	0.0002	0.0295	0.008
Apple trees (T)/ 1 app @ 0.06 lb ai/A	0.0008	0.0001	0.0103	0.004
Animal housing premises, paths/patios (CC)/ 14 app @ 0.0762 and 1 app @ 0.1132 lb ai/A (21-days)	0.050	0.006	**0.64***	0.25
Household/domestic dwellings, outdoor premises (CC)/ 2 app @ 2.0 lb ai/A (7-days)	0.831	0.062	**11***	**2.6***
Apricot, loquat, mayhaw, plum, quince (G)/ 9 app @ 0.0239 lb ai/A (7-days)	0.012	0.004	**0.15***	0.17
Bean, groundcherry, pea, pepino, pepper (G)/ 9 app @ 0.0239 lb ai/A (7-days)	0.05	0.01	**0.64***	0.42
Eggplant (G)/ 9 app @ 0.0239 lb ai/A (7-days)	0.010	0.003	**0.13***	0.13
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut (G)/ 6 app @ 0.0239 lb ai/A (7-days)	0.018	0.004	**0.23***	0.17
Barley (A)/ 2 app @ 0.031 lb ai/A (7-days)	0.070	0.011	**0.90***	0.46
Barley (G)/ 2 app @ 0.031 lb ai/A (7-days)	0.029	0.007	**0.37***	0.29
Bell pepper, catjang (Jerusalem/marble pea) (A)/ 12 app @ 0.03 lb ai/A (7-days)	0.098	0.040	**1.3***	**1.7***
Bell pepper, catjang (Jerusalem/marble pea)(G)/ 12 app @ 0.03 lb ai/A (7-days)	0.073	0.015	**0.94***	0.63
Mustard cabbage (gai choy, pak-choi) (G)/ 8 app @ 0.03 lb ai/A (5-days)	0.121	0.026	**1.6***	**1.1***
Brassica (head and stem) vegetables (A)/ 8 app@ 0.031 lb ai/A (3 crop cycles of 120 days; 7-day interval within crop cycle)	0.090	0.031	**1.2***	**1.3***
Brassica (head and stem) vegetables (G)/ 8 app@ 0.031 lb ai/A (3 crop cycles of 120 days;	0.082	0.017	**0.94***	0.71

Uses/Application Rate	Peak EEC (µg/L)	60-day EEC (µg/L)	Acute RQ*	Chronic RQ*
7-day interval within crop cycle)				
Tomato, tomatillo (G)/ 9 app @ 0.0294 lb ai/A (7-days)	0.018	0.005	**0.23***	0.21
Broccoli, cauliflower (G)/ 9 app @ 0.0294 lb ai/A (2 crop cycles of 120 days; 7-day interval within crop cycle)	0.181	0.044	**2.3***	**1.8***
Cabbage, kohlrabi (G)/ 9 app @ 0.0294 lb ai/A (3 crop cycles of 120 days; 7-day interval within crop cycle)	0.157	0.051	**2.0***	**2.1***
Mustard (G)/ 9 app @ 0.0294 lb ai/A (4 crop cycles of 90 days; 7-day interval within crop cycle)	0.144	0.046	**1.8***	**1.9***
Brussels sprouts (G)/ 3 app @ 0.038 lb ai/A (10-days)	0.135	0.018	**1.7***	0.75
Brussels sprouts (G)/ 9 app @ 0.038 lb ai/A (10-days)	0.213	0.033	**2.7***	**1.4***
Buckwheat, oat, rye (A)/ 2 app @ 0.03 lb ai/A (3-days)	0.069	0.010	**0.88***	0.42
Buckwheat, oat, rye (G)/ 2 app @ 0.03 lb ai/A (3-days)	0.028	0.007	**0.36***	0.29
Canola/rape (A)/ 3 app @ 0.0311 lb ai/A (5-days)	0.082	0.017	**1.1***	0.71
Canola/rape (g)/ 3 app @ 0.0311 lb ai/A (5-days)	0.042	0.012	**0.54***	0.50
Grass forage/fodder/hay, pastures, rangeland (A)/ 3 app @0.0311 lb ai/A (30-days)	0.055	0.008	**0.71***	0.33
Grass forage/fodder/hay, pastures, rangeland (G)/ 3 app @ 0.0311 lb ai/A (30-days)	0.011	0.002	**0.14***	0.08
Cereal grains, triticale, wheat (A)/ 2 app @ 0.0311 lb ai/A (3-days)	0.071	0.011	**0.91***	0.46
Cereal grains, triticale, wheat (G)/ 2 app @ 0.0311 lb ai/A (3-days)	0.029	0.007	**0.37***	0.29
Cole crops (A)/ 8 app @ 0.0311 lb ai/A (7-days)	0.127	0.042	**1.6***	**1.8***
Cole crops (G)/ 8 app @ 0.0311 lb ai/A (7-days)	0.117	0.027	**1.5***	**1.1***
Onion (A)/ 9 app @ 0.0311 lb ai/A (7-days)	0.064	0.020	**0.82***	0.83
Onion (G)/ 9 app @ 0.0311 lb ai/A (7-days)	0.015	0.005	**0.19***	0.21
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns (G)/ 2 app @ 0.1585, 1 app @ 0.0983 lb ai/A (7-days)	0.054	0.006	**0.69***	0.25
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns (ST)/ 7 app @ 0.06 lb ai/A (7-days)	0.019	0.003	**0.24***	0.13
Conifers (plantations/nurseries) (G)/ 6 app @ 0.0401 lb ai/A (7-days)	0.468	0.052	**6***	**2.2***
Conifers (seed orchard) (G)/ 3 app @ 0.156 and 1 app @ 0.036 lb ai/A (7-days)	1.00	0.111	**13***	**4.6***
Corn (field) (A)/ 3 app @ 0.042 lb ai/A (10-days)	0.078	0.016	**1***	0.67
Corn (field) (G)/ 3 app @ 0.042 lb ai/A (10-days)	0.056	0.009	**0.72***	0.38

Uses/Application Rate	Peak EEC (µg/L)	60-day EEC (µg/L)	Acute RQ*	Chronic RQ*
Corn (field, pop) (B,F)/ 2 app @ 0.0934 lb ai/A (4-days)	0.080	0.011	**1.0***	0.46
Corn (sweet) (B, F)/ 6 app @ 0.0934 lb ai/A (4-days)	0.219	0.031	**2.8***	**1.3***
Corn (sweet) (D)/ 5 app @ 0.042 lb ai/A (3 crop cycles of 120 days; 10-day interval per crop cycle)	0.357	0.054	**4.6***	**2.3***
Corn (sweet) (A)/ 6 app @ 0.03 lb ai/A (3 crop cycles of 120 days; 10-day interval per crop cycle)	0.197	0.053	**2.5***	**2.2***
Cotton (A)/ 3 app @ 0.042 lb ai/A (10-days)	0.073	0.011	**0.94***	0.46
Cotton (G)/ 3 app @ 0.042 lb ai/A (10-days)	0.018	0.004	**0.23***	0.17
Cucurbit vegetables (A)/ 6 app @ 0.0311 lb ai/A (5-days)	0.059	0.014	**0.76***	0.58
Cucurbit vegetables (G)/ 6 app @ 0.0311 lb ai/A (5-days)	0.012	0.003	**0.15***	0.13
Filbert, pecan, walnut (A)/ 2 app @ 0.057 and 1 app @ 0.044 lb ai/A (10-days)	0.098	0.020	**1.3***	0.83
Filbert, pecan, walnut (G)/ 2 app @ 0.057 and 1 app @ 0.044 lb ai/A (10-days)	0.021	0.004	**0.27***	0.17
Filbert, pecan, walnut (D)/ 6 app @ 0.057 lb ai/A (10-days)	0.027	0.009	**0.35***	0.38
Forest plantings (G)/ 4 app @ 0.0511 and 1 app @ 0.0337 lb ai/A (7-days)	0.298	0.053	**3.8***	**2.2***
Fruiting vegetables (A)/ 12 app @ 0.0311 lb ai/A (5-days)	0.111	0.043	**1.4***	**1.8***
Fruiting vegetables (G)/ 12 app @ 0.0311 lb ai/A (5-days)	0.087	0.017	**1.1***	0.71
Garlic (A)/ 8 app @ 0.0311 lb ai/A (7-days)	0.070	0.024	**0.90***	**1***
Golf course turf, ornamental sod farm (G)/ 1 app @ 0.068 lb ai/A	0.022	0.002	**0.28***	0.08
Golf course turf, ornamental sod farm (M)/ 6 app @ 0.06 lb ai/A (7-days)	0.017	0.003	**0.22***	0.13
Grasses grown for seed (G)/ 2 app @ 0.1306 and 1 app @ 0.0811 lb ai/A (7-days)	0.050	0.008	**0.57***	0.33
Legume vegetables (A)/ 4 app @ 0.0311 lb ai/A (5-days)	0.060	0.015	**0.77***	0.63
Legume vegetables (G)/ 4 app @ 0.0311 lb ai/A (5-days)	0.035	0.005	**0.45***	0.21
Peanuts, root and tuber vegetables (A)/ 4 app @ 0.0311 lb ai/A (7-days)	0.060	0.015	**0.77***	0.63
Peanuts, root and tuber vegetables (G)/ 4 app @ 0.0311 lb ai/A (7-days)	0.034	0.005	**0.44***	0.21
Lettuce (A)/ 10 app @ 0.0311 lb ai/A (2 crop cycles of 120 days; 5-day interval per crop cycle)	0.245	0.081	**3.1***	**3.4***
Lettuce (G)/ 10 app @ 0.0311 lb ai/A (2 crop cycles of 120 days; 5-day interval per crop cycle)	0.223	0.044	**2.9***	**1.8***
Nonagricultural uncultivated areas/soils (A)/ 2	0.048	0.009	**0.62***	0.38

Uses/Application Rate	Peak EEC (µg/L)	60-day EEC (µg/L)	Acute RQ*	Chronic RQ*
app @ 0.0792 and 1 app @ 0.0432 lb ai/A (7-days)				
Ornamental and/or shade trees (G)/ 2 app @ 0.162 and 1 app @ 0.0913 lb ai/A (7-days)	0.062	0.015	**0.79***	0.63
Ornamental and/or shade trees, ground cover, herbaceous plants, non-flowering plants, woody shrubs and vines, rose (D)/ 3 app @ 1.2 lb ai/A (7-days)	5.0 (7.42)[1]	0.81	**64***	**34***
Paved areas (private roads/sidewalks) (PT)/ 6 app @ 0.069 lb ai/A (7-days)	0.812	0.043	**10***	**1.8***
Pome and stone fruit (A)/ 5 app @ 0.0415 lb ai/A (7-days)	0.077	0.016	**1.0***	0.67
Pome and stone fruit (G)/ 5 app @ 0.0415 lb ai/A (7-days)	0.016	0.004	**0.21***	0.17
Potato (A)/ 3 app @ 0.0239 and 1 app @ 0.0162 lb ai/A (7-days)	0.042	0.007	**0.54***	0.29
Potato (G)/ 3 app @ 0.0239 and 1 app @ 0.0162 lb ai/A (7-days)	0.009	0.002	**0.12***	0.08
Recreational areas (B)/ 26 app@ 0.033 lb ai/A (7-days)	0.010	0.002	**0.13***	0.08
Recreational areas (CC, ST)/ 2 app @ 2.0 lb ai/A (7-days)	0.218	0.037	**2.79***	**1.5***
Residential lawns (O)/ 6 app @ 0.078 lb ai/A (7-days)	0.071	0.007	**0.91***	0.29
Residential lawns (M)/ 1 app @ 1.9 lb ai/A	0.400	0.031	**5.1***	**1.3***
Rice ®/ 3 app @ 0.0415 lb ai/A (5-days)	0.36	0.36	**4.62***	**15***
Seed orchard trees (G)/ 3 app @ 0.0162 and 1 app @ 0.0327 lb ai/A (7-days)	1.21	0.128	**15.51***	**5.3***
Sorghum (A)/ 2 app @ 0.038 lb ai/A (10-days)	0.085	0.014	**1.09***	0.58
Sorghum (G)/ 2 app @ 0.038 lb ai/A (10-days)	0.036	0.009	**0.46***	0.38
Soybean (A)/ 1 app @ 0.038 and 1 app @ 0.021 lb ai/A (14-days)	0.064	0.007	**0.82***	0.29
Soybean (G)/ 1 app @ 0.038 and 1 app @ 0.021 lb ai/A (14-days)	0.016	0.003	**0.21***	0.13
Tree nuts (A)/ 4 app @ 0.0415 lb ai/A (5-days)	0.077	0.015	**0.99***	0.63
Tree nuts (G)/ 4 app @ 0.0415 lb ai/A (5-days)	0.017	0.004	**0.22***	0.17
Sunflower (A)/ 3 app @ 0.038 lb ai/A (10-days)	0.071	0.015	**0.91***	0.63
Sunflower (G)/ 3 app @ 0.038 lb ai/A (10-days)	0.051	0.008	**0.65***	0.33
Right-of-way (G)/ 6 app @ 0.06 lb ai/A (7-days)	0.054	0.007	**0.69***	0.29
Airports/landing fields (O)/ 26 app @ 0.08 lb ai/A (7-days)	5.0 (15.89)[1]	1.74	**64***	**73***
Golf course turf, ornamental sod farm (granular spot treatment) (O)/ 6 app @ 0.06 lb ai/A (7-days)	0.019	0.003	**0.24***	0.13
Grasses grown for seed (granular spot treatment) (O)/ 6 app @ 0.06 lb ai/A (7-days)	0.017	0.003	**0.22***	0.13
Nonagricultural uncultivated areas/soil (granular band/broadcast/perimeter/spot treatment) (O)/ 5	0.059	0.006	**0.76***	0.25

Uses/Application Rate	Peak EEC (µg/L)	60-day EEC (µg/L)	Acute RQ*	Chronic RQ*
app @ 0.0792 lb ai/A (7-days)				
Nonagricultural uncultivated areas/soil (granular mound treatment) (O)/ 6 app @ 0.06 lb ai/A (7-days)	0.009	0.002	**0.12***	0.08
* = LOC exceedances (acute RQ > 0.05; chronic RQ > 1.0) are bolded. Acute RQ = use-specific peak EEC / 0.078 µg ai/L (golden orfe). Chronic RQ = use-specific 60-day EEC / 0.024 µg ai/L (ACR based on sheepshead minnow). [1]Calculated EEC exceeded limit of solubility (5 µg ai/L), thus limit of solubility was used instead. A = foliar aerial application G = foliar ground application C = chemigation D = dust application M = mound application T = trunk drench CC = crack and crevice ST = spot treatment B = banded applications F = furrow applications PT = perimeter treatment O = granular applications R = rice				

5.1.1.b. Freshwater Invertebrates

Acute risk to freshwater invertebrates is based on 1-in-10 year peak EECs in the standard pond and the lowest acute toxicity value for freshwater invertebrates. Chronic risk is based on 1-in-10 year 21-day EECs and the lowest chronic toxicity value for freshwater invertebrates. Risk quotients for freshwater invertebrates ranged from 0.57 to 3571 (acute) and from 13 to 263,750 (chronic). Acute listed (LOC = 0.05), non-listed (LOC = 0.5) and chronic (LOC = 1) LOCs were exceeded for all *lambda*-cyhalothrin uses. Therefore, there is the potential for *lambda*-cyhalothrin to directly affect the CFWS and indirectly affect listed species that rely on freshwater invertebrates during at least some portion of their life-cycle (*i.e.*, SFGS, CCR, CTS, TG, DS, and CFWS) (Table 5-2).

Table 5-2. Summary of Acute and Chronic RQs for Aquatic Invertebrates (Based on Surface Water EECs)

Uses/Application Rate	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
Agricultural/farm premises (CC)/ 2 app @ 0.2212 and 1 app @ 0.0763 lb ai/A (7-days)	0.058	0.007	**41***	**875***
Alfalfa (A)/ 3 app @ 0.38 lb ai/A (10-days)	0.66	0.14	**471***	**17500***
Alfalfa (G)/ 3 app @ 0.38 lb ai/A (10 days)	0.14	0.03	**100***	**3750***
Almond (G)/ 6 app @0.1 lb ai/A (7-days)	0.07	0.02	**50***	**2500***
Almond (T)/ 3 app 0.06 lb ai/A (5-days)	0.008	0.003	**5.7***	**375***
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, trees (G)/ 9 app @ 0.1 lb	0.05	0.02	**36***	**2500***

Uses/Application Rate	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
ai/A (7-days)				
Nectarine, peach, cherry trees trunk drench (T)/ 3 app @ 0.06 lb ai/A (5 days)	0.0023	0.0003	**1.64***	**38***
Apple trees (T)/ 1 app @ 0.06 lb ai/A	0.0008	0.0001	**0.57***	**13***
Animal housing premises, paths/patios (CC)/ 14 app @ 0.0762 and 1 app @ 0.1132 lb ai/A (5-days)	0.050	0.009	**36***	**1125***
Household/domestic dwellings, outdoor premises (CC)/ 2 app @ 2.0 lb ai/A (7-days)	0.831	0.099	**594***	**12375***
Apricot, loquat, mayhaw, plum, quince (G)/ 9 app @ 0.0239 lb ai/A (7-days)	0.012	0.004	**8.6***	**500***
Bean, groundcherry, pea, pepino, pepper (G)/ 9 app @ 0.0239 lb ai/A (7-days)	0.05	0.01	**36***	**1250***
Eggplant (G)/ 9 app @ 0.0239 lb ai/A (7-days)	0.010	0.004	**7.1***	**500***
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut (G)/ 6 app @ 0.0239 lb ai/A (7-days)	0.018	0.005	**13***	**625***
Barley (A)/ 2 app @ 0.031 lb ai/A (7-days)	0.070	0.016	**50***	**2000***
Barley (G)/ 2 app @ 0.031 lb ai/A (7-days)	0.029	0.010	**21***	**1250***
Bell pepper, catjang (Jerusalem/marble pea) (A)/ 12 app @ 0.03 lb ai/A (7-days)	0.098	0.042	**70***	**5250***
Bell pepper, catjang (Jerusalem/marble pea)(G)/ 12 app @ 0.03 lb ai/A (7-days)	0.073	0.016	**52***	**2000***
Mustard cabbage (gai choy, pak-choi) (G)/ 8 app @ 0.03 lb ai/A (5-days)	0.121	0.028	**86***	**3500***
Brassica (head and stem) vegetables (A)/ 8 app@ 0.031 lb ai/A (3 crop cycles of 120 days; 7-day interval within crop cycle)	0.090	0.036	**64***	**4500***
Brassica (head and stem) vegetables (G)/ 8 app@ 0.031 lb ai/A (3 crop cycles of 120 days; 7-day interval within crop cycle)	0.082	0.020	**59***	**2500***
Tomato, tomatillo (G)/ 9 app @ 0.0294 lb ai/A (7-days)	0.018	0.005	**13***	**625***
Broccoli, cauliflower (G)/ 9 app @ 0.0294 lb ai/A (2 crop cycles of 120 days; 7-day interval within crop cycle)	0.181	0.044	**129***	**5500***
Cabbage, kohlrabi (G)/ 9 app @ 0.0294 lb ai/A (3 crop cycles of 120 days; 7-day interval within crop cycle)	0.157	0.055	**112***	**6875***
Mustard (G)/ 9 app @ 0.0294 lb ai/A (4 crop cycles of 90 days; 7-day interval within crop cycle)	0.144	0.046	**103***	**5750***
Brussels sprouts (G)/ 3 app @ 0.038 lb ai/A (10-days)	0.135	0.021	**96***	**2625***
Brussels sprouts (G)/ 9 app @ 0.038 lb ai/A (10-days)	0.213	0.036	**152***	**4500***
Buckwheat, oat, rye (A)/ 2 app @ 0.03 lb ai/A (3-days)	0.069	0.015	**49***	**1875***
Buckwheat, oat, rye (G)/ 2 app @ 0.03 lb ai/A	0.028	0.009	**20***	**1125***

Uses/Application Rate	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
(3-days)				
Canola/rape (A)/ 3 app @ 0.0311 lb ai/A (5-days)	0.082	0.023	**59***	**2875***
Canola/rape (g)/ 3 app @ 0.0311 lb ai/A (5-days)	0.042	0.015	**30***	**1875***
Grass forage/fodder/hay, pastures, rangeland (A)/ 3 app @0.0311 lb ai/A (30-days)	0.055	0.009	**39***	**1125***
Grass forage/fodder/hay, pastures, rangeland (G)/ 3 app @ 0.0311 lb ai/A (30-days)	0.011	0.002	**7.9***	**250***
Cereal grains, triticale, wheat (A)/ 2 app @ 0.0311 lb ai/A (3-days)	0.071	0.016	**51***	**2000***
Cereal grains, triticale, wheat (G)/ 2 app @ 0.0311 lb ai/A (3-days)	0.029	0.010	**21***	**1250***
Cole crops (A)/ 8 app @ 0.0311 lb ai/A (7-days)	0.127	0.047	**91***	**5875***
Cole crops (G)/ 8 app @ 0.0311 lb ai/A (7-days)	0.117	0.029	**84***	**3625***
Onion (A)/ 9 app @ 0.0311 lb ai/A (7-days)	0.064	0.021	**46***	**2625***
Onion (G)/ 9 app @ 0.0311 lb ai/A (7-days)	0.015	0.005	**11***	**625***
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns (G)/ 2 app @ 0.1585, 1 app @ 0.0983 lb ai/A (7-days)	0.054	0.008	**39***	**1000***
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns (ST)/ 7 app @ 0.06 lb ai/A (7-days)	0.019	0.004	**14***	**500***
Conifers (plantations/nurseries) (G)/ 6 app @ 0.0401 lb ai/A (7-days)	0.468	0.069	**334***	**8625***
Conifers (seed orchard) (G)/ 3 app @ 0.156 and 1 app @ 0.036 lb ai/A (7-days)	1.00	0.148	**714***	**18500***
Corn (field) (A)/ 3 app @ 0.042 lb ai/A (10-days)	0.078	0.020	**56***	**2500***
Corn (field) (G)/ 3 app @ 0.042 lb ai/A (10-days)	0.056	0.011	**40***	**1375***
Corn (field, pop) (B,F)/ 2 app @ 0.0934 lb ai/A (4-days)	0.080	0.014	**57***	**1750***
Corn (sweet) (B, F)/ 6 app @ 0.0934 lb ai/A (4-days)	0.219	0.039	**156***	**4875***
Corn (sweet) (D)/ 5 app @ 0.042 lb ai/A (3 crop cycles of 120 days; 10-day interval per crop cycle)	0.357	0.067	**255***	**8375***
Corn (sweet) (A)/ 6 app @ 0.03 lb ai/A (3 crop cycles of 120 days; 10-day interval per crop cycle)	0.197	0.058	**141***	**7250***
Cotton (A)/ 3 app @ 0.042 lb ai/A (10-days)	0.073	0.015	**52***	**1875***
Cotton (G)/ 3 app @ 0.042 lb ai/A (10-days)	0.018	0.004	**13***	**500***
Cucurbit vegetables (A)/ 6 app @ 0.0311 lb ai/A (5-days)	0.059	0.020	**42***	**2500***
Cucurbit vegetables (G)/ 6 app @ 0.0311 lb ai/A (5-days)	0.012	0.004	**8.6***	**500***

Uses/Application Rate	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
Filbert, pecan, walnut (A)/ 2 app @ 0.057 and 1 app @ 0.044 lb ai/A (10-days)	0.098	0.020	**70***	**2500***
Filbert, pecan, walnut (G)/ 2 app @ 0.057 and 1 app @ 0.044 lb ai/A (10-days)	0.021	0.005	**15***	**625***
Filbert, pecan, walnut (D)/ 6 app @ 0.057 lb ai/A (10-days)	0.027	0.009	**19***	**1125***
Forest plantings (G)/ 4 app @ 0.0511 and 1 app @ 0.0337 lb ai/A (7-days)	0.298	0.064	**213***	**8000***
Fruiting vegetables (A)/ 12 app @ 0.0311 lb ai/A (5-days)	0.111	0.047	**79***	**5875***
Fruiting vegetables (G)/ 12 app @ 0.0311 lb ai/A (5-days)	0.087	0.018	**62***	**2250***
Garlic (A)/ 8 app @ 0.0311 lb ai/A (7-days)	0.070	0.026	**50***	**3250***
Golf course turf, ornamental sod farm (G)/ 1 app @ 0.068 lb ai/A	0.022	0.002	**16***	**250***
Golf course turf, ornamental sod farm (M)/ 6 app @ 0.06 lb ai/A (7-days)	0.017	0.004	**12***	**500***
Grasses grown for seed (G)/ 2 app @ 0.1306 and 1 app @ 0.0811 lb ai/A (7-days)	0.050	0.012	**36***	**1500***
Legume vegetables (A)/ 4 app @ 0.0311 lb ai/A (5-days)	0.060	0.020	**43***	**2500***
Legume vegetables (G)/ 4 app @ 0.0311 lb ai/A (5-days)	0.035	0.006	**25***	**750***
Peanuts, root and tuber vegetables (A)/ 4 app @ 0.0311 lb ai/A (7-days)	0.060	0.018	**43***	**2250***
Peanuts, root and tuber vegetables (G)/ 4 app @ 0.0311 lb ai/A (7-days)	0.034	0.006	**24***	**750***
Lettuce (A)/ 10 app @ 0.0311 lb ai/A (2 crop cycles of 120 days; 5-day interval per crop cycle)	0.245	0.086	**175***	**10750***
Lettuce (G)/ 10 app @ 0.0311 lb ai/A (2 crop cycles of 120 days; 5-day interval per crop cycle)	0.223	0.048	**159***	**6000***
Nonagricultural uncultivated areas/soils (A)/ 2 app @ 0.0792 and 1 app @ 0.0432 lb ai/A (7-days)	0.048	0.014	**34***	**1750***
Ornamental and/or shade trees (G)/ 2 app @ 0.162 and 1 app @ 0.0913 lb ai/A (7-days)	0.062	0.018	**44***	**2250***
Ornamental and/or shade trees, ground cover, herbaceous plants, non-flowering plants, woody shrubs and vines, rose (D)/ 3 app @ 1.2 lb ai/A (7-days)	5.0 (7.42)[1]	1.08	**3574***	**135000***
Paved areas (private roads/sidewalks) (PT)/ 6 app @ 0.069 lb ai/A (7-days)	0.812	0.069	**580***	**8625***
Pome and stone fruit (A)/ 5 app @ 0.0415 lb ai/A (7-days)	0.077	0.020	**55***	**2500***
Pome and stone fruit (G)/ 5 app @ 0.0415 lb ai/A (7-days)	0.016	0.005	**11***	**625***
Potato (A)/ 3 app @ 0.0239 and 1 app @ 0.0162 lb ai/A (7-days)	0.042	0.009	**30***	**1125***
Potato (G)/ 3 app @ 0.0239 and 1 app @	0.009	0.002	**6.4***	**250***

Uses/Application Rate	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
0.0162 lb ai/A (7-days)				
Recreational areas (B)/ 26 app@ 0.033 lb ai/A (7-days)	0.010	0.002	**7.1***	**250***
Recreational areas (CC, ST)/ 2 app @ 2.0 lb ai/A (7-days)	0.218	0.045	**155.71***	**5625***
Residential lawns (O)/ 6 app @ 0.078 lb ai/A (7-days)	0.071	0.010	**51***	**1250***
Residential lawns (M)/ 1 app @ 1.9 lb ai/A	0.400	0.061	**286***	**7625***
Rice ®/ 3 app @ 0.0415 lb ai/A (5-days)	0.36	0.36	**257.14***	**45000***
Seed orchard trees (G)/ 3 app @ 0.0162 and 1 app @ 0.0327 lb ai/A (7-days)	1.21	0.175	**864.29***	**21875***
Sorghum (A)/ 2 app @ 0.038 lb ai/A (10-days)	0.085	0.019	**60.71***	**2375***
Sorghum (G)/ 2 app @ 0.038 lb ai/A (10-days)	0.036	0.012	**25.71***	**1500***
Soybean (A)/ 1 app @ 0.038 and 1 app @ 0.021 lb ai/A (14-days)	0.064	0.01	**45.71***	**1250***
Soybean (G)/ 1 app @ 0.038 and 1 app @ 0.021 lb ai/A (14-days)	0.016	0.003	**11.43***	**375***
Tree nuts (A)/ 4 app @ 0.0415 lb ai/A (5-days)	0.077	0.023	**55.00***	**2875***
Tree nuts (G)/ 4 app @ 0.0415 lb ai/A (5-days)	0.017	0.006	**12.14***	**750***
Sunflower (A)/ 3 app @ 0.038 lb ai/A (10-days)	0.071	0.019	**50.71***	**2375***
Sunflower (G)/ 3 app @ 0.038 lb ai/A (10-days)	0.051	0.01	**36.43***	**1250***
Right-of-way (G)/ 6 app @ 0.06 lb ai/A (7-days)	0.054	0.009	**39***	**1125***
Airports/landing fields (O)/ 50 app @ 0.08 lb ai/A (7-days)	5.0 (15.89)[1]	2.11	**3571***	**263750***
Golf course turf, ornamental sod farm (granular spot treatment) (O)/ 6 app @ 0.06 lb ai/A (7-days)	0.019	0.004	**25.00***	**500***
Grasses grown for seed (granular spot treatment) (O)/ 6 app @ 0.06 lb ai/A (7-days)	0.017	0.004	**155.71***	**500***
Nonagricultural uncultivated areas/soil (granular band/broadcast/perimeter/spot treatment) (O)/ 5 app @ 0.0792 lb ai/A (7-days)	0.059	0.009	**42***	**1125***
Nonagricultural uncultivated areas/soil (granular mound treatment) (O)/ 6 app @ 0.06 lb ai/A (7-days)	0.009	0.002	**6.4***	**250***

* = LOC exceedances (acute RQ ≥ 0.05; chronic RQ ≥ 1.0) are bolded. Acute RQ = use-specific peak EEC / 0.0014 µg ai/L (scud). Chronic RQ = use-specific 21-day EEC / 0.000008 µg ai/L (ACR based on waterflea).
[1]Calculated EEC exceeded limit of solubility (5 µg ai/L), thus limit of solubility was used instead.
A = foliar aerial application
G = foliar ground application
C = chemigation

Uses/Application Rate	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
D = dust application M = mound application T = trunk drench CC = crack and crevice ST = spot treatment B = banded applications F = furrow applications PT = perimeter treatment O = granular applications R = rice				

5.1.1.c. Freshwater Benthic Invertebrates

Acute risk to freshwater benthic invertebrates is based on 1-in-10 year peak pore water EECs in the standard pond and the lowest acute toxicity value for freshwater invertebrates. Chronic risk is based on 1-in-10 year 21-day EECs and the lowest chronic toxicity value for freshwater invertebrates (surrogate for benthic invertebrates). Risk quotients for freshwater benthic invertebrates ranged from 0.014 to 3571 (acute) and 2.5 to 625,000. Ninety-eight percent of the *lambda*-cyhalothrin uses exceeded the acute LOC (0.05) and all of the uses exceeded the chronic LOC (1). Consequently, *lambda*-cyhalothrin has the potential to directly affect the CFWS. Additionally, since 95% of the uses exceeded the acute non-listed species LOC (0.5), *lambda*-cyhalothrin uses also have the potential to indirectly affect listed species that rely on freshwater invertebrates during at least some portion of their life-cycle (*i.e.*, SFGS, CCR, CTS, TG, DS, CFWS) (Table 5-3).

Table 5-3. Summary of Acute and Chronic RQs for Freshwater Benthic Invertebrates (Based on Pore Water EECs)

Uses/Application Rate	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
Agricultural/farm premises (CC)/ 2 app @ 0.2212 and 1 app @ 0.0763 lb ai/A (7-days)	5.0 (9.13)[4]	5.0 (9.10)[4]	**3571***	**625000***
Alfalfa (A)/ 3 app @ 0.38 lb ai/A (10-days)	0.023	0.023	**16***	**2875***
Alfalfa (G)/ 3 app @ 0.38 lb ai/A (10 days)	0.007	0.007	**5.0***	**875***
Almond (G)/ 6 app @0.1 lb ai/A (7-days)	0.005	0.005	**3.6***	**625***
Almond (T)/ 3 app 0.06 lb ai/A (5-days)	0.001	0.001	**0.71***	**125***
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, trees (G)/ 9 app @ 0.1 lb ai/A (7-days)	0.004	0.004	**2.9***	**500***
Nectarine, peach, cherry trees trunk drench (T)/ 3 app @ 0.06 lb ai/A (5 days)	0.0000656	0.0000652	0.047	**8.2***
Apple trees (T)/ 1 app @ 0.06 lb ai/A	0.00002	0.00002	0.014	**2.5***
Animal housing premises, paths/patios (CC)/ 14 app @ 0.0762 and 1 app @ 0.1132 lb ai/A (5-days)	5.0 (18.09)[4]	5.0 (17.97)[4]	**3571***	**625000***
Household/domestic dwellings, outdoor	5.0 (121.0)[4]	5.0	**3571***	**625000***

Uses/Application Rate	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
premises (CC)/ 2 app @ 2.0 lb ai/A (7-days)		(121.0)[4]		
Apricot, loquat, mayhaw, plum, quince (G)/ 9 app @ 0.0239 lb ai/A (7-days)	0.001	0.001	**0.71***	**125***
Bean, groundcherry, pea, pepino, pepper (G)/ 9 app @ 0.0239 lb ai/A (7-days)	0.003	0.003	**2.1***	**375***
Eggplant (G)/ 9 app @ 0.0239 lb ai/A (7-days)	0.001	0.001	**0.71***	**125***
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut (G)/ 6 app @ 0.0239 lb ai/A (7-days)	0.001	0.001	**0.71***	**125***
Barley (A)/ 2 app @ 0.031 lb ai/A (7-days)	0.003	0.003	**2.1***	**375***
Barley (G)/ 2 app @ 0.031 lb ai/A (7-days)	0.002	0.002	**1.4***	**250***
Bell pepper, catjang (Jerusalem/marble pea) (A)/ 12 app @ 0.03 lb ai/A (7-days)	0.011	0.011	**7.9***	**1375***
Bell pepper, catjang (Jerusalem/marble pea)(G)/ 12 app @ 0.03 lb ai/A (7-days)	0.004	0.004	**2.9***	**500***
Mustard cabbage (gai choy, pak-choi) (G)/ 8 app @ 0.03 lb ai/A (5-days)	0.007	0.007	**5***	**875***
Brassica (head and stem) vegetables (A)/ 8 app@ 0.031 lb ai/A (3 crop cycles of 120 days; 7-day interval within crop cycle)	0.009	0.009	**6.4***	**1125***
Brassica (head and stem) vegetables (G)/ 8 app@ 0.031 lb ai/A (3 crop cycles of 120 days; 7-day interval within crop cycle)	0.005	0.005	**3.6***	**625***
Tomato, tomatillo (G)/ 9 app @ 0.0294 lb ai/A (7-days)	0.001	0.001	**0.71***	**125***
Broccoli, cauliflower (G)/ 9 app @ 0.0294 lb ai/A (2 crop cycles of 120 days; 7-day interval within crop cycle)	0.011	0.011	**7.9***	**1375***
Cabbage, kohlrabi (G)/ 9 app @ 0.0294 lb ai/A (3 crop cycles of 120 days; 7-day interval within crop cycle)	0.015	0.015	**11***	**1875***
Mustard (G)/ 9 app @ 0.0294 lb ai/A (4 crop cycles of 90 days; 7-day interval within crop cycle)	0.013	0.013	**9.3***	**1625***
Brussels sprouts (G)/ 3 app @ 0.038 lb ai/A (10-days)	0.005	0.005	**3.6***	**625***
Brussels sprouts (G)/ 9 app @ 0.038 lb ai/A (10-days)	0.010	0.010	**7.1***	**1250***
Buckwheat, oat, rye (A)/ 2 app @ 0.03 lb ai/A (3-days)	0.003	0.003	**2.1***	**375***
Buckwheat, oat, rye (G)/ 2 app @ 0.03 lb ai/A (3-days)	0.002	0.002	**1.4***	**250***
Canola/rape (A)/ 3 app @ 0.0311 lb ai/A (5-days)	0.004	0.004	**2.9***	**500***
Canola/rape (g)/ 3 app @ 0.0311 lb ai/A (5-days)	0.003	0.003	**2.1***	**375***
Grass forage/fodder/hay, pastures, rangeland (A)/ 3 app @0.0311 lb ai/A (30-days)	0.002	0.002	**1.4***	**250***
Grass forage/fodder/hay, pastures, rangeland (G)/ 3 app @ 0.0311 lb ai/A (30-days)	0.001	0.001	**0.71***	**125***

Uses/Application Rate	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
Cereal grains, triticale, wheat (A)/ 2 app @ 0.0311 lb ai/A (3-days)	0.003	0.003	**2.1***	**375***
Cereal grains, triticale, wheat (G)/ 2 app @ 0.0311 lb ai/A (3-days)	0.002	0.002	**1.4***	**250***
Cole crops (A)/ 8 app @ 0.0311 lb ai/A (7-days)	0.012	0.012	**8.6***	**1500***
Cole crops (G)/ 8 app @ 0.0311 lb ai/A (7-days)	0.007	0.007	**5.0***	**875***
Onion (A)/ 9 app @ 0.0311 lb ai/A (7-days)	0.005	0.005	**3.6***	**625***
Onion (G)/ 9 app @ 0.0311 lb ai/A (7-days)	0.001	0.001	**0.71***	**125***
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns (G)/ 2 app @ 0.1585, 1 app @ 0.0983 lb ai/A (7-days)	0.002	0.002	**1.4***	**250***
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns (ST)/ 7 app @ 0.06 lb ai/A (7-days)	0.001	0.001	**0.71***	**125***
Conifers (plantations/nurseries) (G)/ 6 app @ 0.0401 lb ai/A (7-days)	0.014	0.014	**10***	**1750***
Conifers (seed orchard) (G)/ 3 app @ 0.156 and 1 app @ 0.036 lb ai/A (7-days)	0.031	0.031	**22***	**3875***
Corn (field) (A)/ 3 app @ 0.042 lb ai/A (10-days)	0.005	0.005	**3.6***	**625***
Corn (field) (G)/ 3 app @ 0.042 lb ai/A (10-days)	0.003	0.003	**2.1***	**375***
Corn (field, pop) (B,F)/ 2 app @ 0.0934 lb ai/A (4-days)	0.003	0.003	**2.1***	**375***
Corn (sweet) (B, F)/ 6 app @ 0.0934 lb ai/A (4-days)	0.009	0.009	**6.4***	**1125***
Corn (sweet) (D)/ 5 app @ 0.042 lb ai/A (3 crop cycles of 120 days; 10-day interval per crop cycle)	0.016	0.016	**11***	**2000***
Corn (sweet) (A)/ 6 app @ 0.03 lb ai/A (3 crop cycles of 120 days; 10-day interval per crop cycle)	0.016	0.016	**11***	**2000***
Cotton (A)/ 3 app @ 0.042 lb ai/A (10-days)	0.003	0.003	**2.1***	**375***
Cotton (G)/ 3 app @ 0.042 lb ai/A (10-days)	0.001	0.001	**0.77***	**125***
Cucurbit vegetables (A)/ 6 app @ 0.0311 lb ai/A (5-days)	0.003	0.003	**2.1***	**375***
Cucurbit vegetables (G)/ 6 app @ 0.0311 lb ai/A (5-days)	0.001	0.001	**0.77***	**125***
Filbert, pecan, walnut (A)/ 2 app @ 0.057 and 1 app @ 0.044 lb ai/A (10-days)	0.003	0.003	**2.1***	**375***
Filbert, pecan, walnut (G)/ 2 app @ 0.057 and 1 app @ 0.044 lb ai/A (10-days)	0.001	0.001	**0.77***	**125***
Filbert, pecan, walnut (D)/ 6 app @ 0.057 lb ai/A (10-days)	0.002	0.002	**1.4***	**250***
Forest plantings (G)/ 4 app @ 0.0511 and 1 app @ 0.0337 lb ai/A (7-days)	0.016	0.016	**11***	**2000***
Fruiting vegetables (A)/ 12 app @ 0.0311 lb ai/A (5-days)	0.011	0.011	**7.9***	**1375***
Fruiting vegetables (G)/ 12 app @ 0.0311 lb	0.005	0.005	**3.6***	**625***

Uses/Application Rate	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
ai/A (5-days)				
Garlic (A)/ 8 app @ 0.0311 lb ai/A (7-days)	0.006	0.006	**4.3***	**750***
Golf course turf, ornamental sod farm (G)/ 1 app @ 0.068 lb ai/A	0.0005	0.0005	**0.36***	**63***
Golf course turf, ornamental sod farm (M)/ 6 app @ 0.06 lb ai/A (7-days)	0.001	0.001	**0.77***	**125***
Grasses grown for seed (G)/ 2 app @ 0.1306 and 1 app @ 0.0811 lb ai/A (7-days)	0.003	0.002	**1.4***	**250***
Legume vegetables (A)/ 4 app @ 0.0311 lb ai/A (5-days)	0.004	0.004	**2.9***	**500***
Legume vegetables (G)/ 4 app @ 0.0311 lb ai/A (5-days)	0.001	0.001	**0.77***	**125***
Peanuts, root and tuber vegetables (A)/ 4 app @ 0.0311 lb ai/A (7-days)	0.004	0.004	**2.9***	**500***
Peanuts, root and tuber vegetables (G)/ 4 app @ 0.0311 lb ai/A (7-days)	0.001	0.001	**0.77***	**125***
Lettuce (A)/ 10 app @ 0.0311 lb ai/A (2 crop cycles of 120 days; 5-day interval per crop cycle)	0.023	0.023	**16***	**2875***
Lettuce (G)/ 10 app @ 0.0311 lb ai/A (2 crop cycles of 120 days; 5-day interval per crop cycle)	0.013	0.013	**9.3***	**1625***
Nonagricultural uncultivated areas/soils (A)/ 2 app @ 0.0792 and 1 app @ 0.0432 lb ai/A (7-days)	5.0 (21.59)[1]	5.0 (21.48)[1]	**3571***	**625000***
Ornamental and/or shade trees (G)/ 2 app @ 0.162 and 1 app @ 0.0913 lb ai/A (7-days)	0.004	0.004	**2.9***	**500***
Ornamental and/or shade trees, ground cover, herbaceous plants, non-flowering plants, woody shrubs and vines, rose (D)/ 3 app @ 1.2 lb ai/A (7-days)	0.227	0.226	**162***	**28250***
Paved areas (private roads/sidewalks) (PT)/ 6 app @ 0.069 lb ai/A (7-days)	0.012	0.012	**8.6***	**1500***
Pome and stone fruit (A)/ 5 app @ 0.0415 lb ai/A (7-days)	0.004	0.004	**2.9***	**500***
Pome and stone fruit (G)/ 5 app @ 0.0415 lb ai/A (7-days)	0.001	0.001	**0.77***	**125***
Potato (A)/ 3 app @ 0.0239 and 1 app @ 0.0162 lb ai/A (7-days)	0.001	0.001	**0.77***	**125***
Potato (G)/ 3 app @ 0.0239 and 1 app @ 0.0162 lb ai/A (7-days)	0.0004	0.0004	**0.29***	**50***
Recreational areas (B)/ 26 app@ 0.033 lb ai/A (7-days)	0.0005	0.0005	**0.36***	**63***
Recreational areas (CC, ST)/ 2 app @ 2.0 lb ai/A (7-days)	0.010	0.010	**7.14***	**1250***
Residential lawns (O)/ 6 app @ 0.078 lb ai/A (7-days)	5.0 (14.12)[1]	5.0 (14.08)[1]	**3571***	**625000***
Residential lawns (M)/ 1 app @ 1.9 lb ai/A	5.0 (61.14)[1]	5.0 (59.55)[1]	**3571***	**625000***
Rice ®/ 3 app @ 0.0415 lb ai/A (5-days)	0.360	0.360	**257.14***	**45000***

Uses/Application Rate	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
Seed orchard trees (G)/ 3 app @ 0.0162 and 1 app @ 0.0327 lb ai/A (7-days)	0.036	0.036	**25.71***	**4500***
Sorghum (A)/ 2 app @ 0.038 lb ai/A (10-days)	0.004	0.003	**2.86***	**375***
Sorghum (G)/ 2 app @ 0.038 lb ai/A (10-days)	0.003	0.003	**2.14***	**375***
Soybean (A)/ 1 app @ 0.038 and 1 app @ 0.021 lb ai/A (14-days)	0.002	0.002	**1.43***	**250***
Soybean (G)/ 1 app @ 0.038 and 1 app @ 0.021 lb ai/A (14-days)	0.001	0.001	**0.71***	**125***
Tree nuts (A)/ 4 app @ 0.0415 lb ai/A (5-days)	0.004	0.004	**2.86***	**500***
Tree nuts (G)/ 4 app @ 0.0415 lb ai/A (5-days)	0.001	0.001	**0.71***	**125***
Sunflower (A)/ 3 app @ 0.038 lb ai/A (10-days)	0.004	0.004	**2.86***	**500***
Sunflower (G)/ 3 app @ 0.038 lb ai/A (10-days)	0.003	0.003	**2.14***	**375***
Right-of-way (G)/ 6 app @ 0.06 lb ai/A (7-days)	5.0 (18.11)[1]	(18.03)[1]	**3571***	**625000***
Airports/landing fields (O)/ 26 app @ 0.08 lb ai/A (7-days)	0.450	0.447	**321***	**55875***
Golf course turf, ornamental sod farm (granular spot treatment) (O)/ 6 app @ 0.06 lb ai/A (7-days)	0.001	0.001	**0.71***	**125***
Grasses grown for seed (granular spot treatment) (O)/ 6 app @ 0.06 lb ai/A (7-days)	0.001	0.001	**0.71***	**125***
Nonagricultural uncultivated areas/soil (granular band/broadcast/perimeter/spot treatment) (O)/ 5 app @ 0.0792 lb ai/A (7-days)	5.0 (15.59)[1]	5.0 (15.48)[1]	**3571***	**625000***
Nonagricultural uncultivated areas/soil (granular mound treatment) (O)/ 6 app @ 0.06 lb ai/A (7-days)	5.0 (5.13)[1]	5.0 (5.12)[1]	**3571***	**625000***

* = LOC exceedances (acute RQ ≥ 0.05; chronic RQ ≥ 1.0) are bolded. Acute RQ = use-specific peak EEC / 0.0014 µg ai/L (scud). Chronic RQ = use-specific 21-day EEC / 0.000008 µg ai/L (ACR based on waterflea).
[1]Calculated EEC exceeded limit of solubility (5 µg ai/L), thus limit of solubility was used instead.
A = foliar aerial application
G = foliar ground application
C = chemigation
D = dust application
M = mound application
T = trunk drench
CC = crack and crevice
ST = spot treatment
B = banded applications
F = furrow applications
PT = perimeter treatment
O = granular applications
R = rice

5.1.1.d. Estuarine/Marine Fish

Acute risk to estuarine/marine fish is based on 1-in-10 year peak EECs in the standard pond and the lowest acute toxicity value for estuarine/marine fish. Chronic risk is based on 1-in-10 year

60-day EECs and the lowest chronic toxicity value for estuarine/marine fish is used. Risk quotients ranged from 0.0010 to 6.2 (acute) and 0.0004 to 3.2 (chronic). Sixty-eight percent of the *lambda*-cyhalothrin uses exceed the acute LOC (0.05) and 2% exceed the chronic LOC (1). Thus, *lambda*-cyhalothrin has the potential to directly affect TG and DS. Additionally, since 7% of the uses exceeded the acute non-listed species LOC (0.5), there is a potential for indirect effects to listed species that rely on estuarine/marine fish during at least some portion of their life-cycle (*i.e*., CCR) (Table 5-4).

Table 5-4. Summary of RQs for Estuarine/Marine Fish (Based on Surface Water EECs)

Uses/Application Rate	Peak EEC (µg/L)	60-day EEC (µg/L)	Acute RQ*	Chronic RQ*
Agricultural/farm premises (CC)/ 2 app @ 0.2212 and 1 app @ 0.0763 lb ai/A (7-days)	0.058	0.004	**0.07***	0.016
Alfalfa (A)/ 3 app @ 0.38 lb ai/A (10-days)	0.66	0.08	**0.82***	0.32
Alfalfa (G)/ 3 app @ 0.38 lb ai/A (10 days)	0.14	0.02	**0.17***	0.50
Almond (G)/ 6 app @0.1 lb ai/A (7-days)	0.07	0.02	**0.09***	0.08
Almond (T)/ 3 app 0.06 lb ai/A (5-days)	0.008	0.002	0.01	0.008
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, trees (G)/ 9 app @ 0.1 lb ai/A (7-days)	0.05	0.02	**0.06***	0.08
Nectarine, peach, cherry trees trunk drench (T)/ 3 app @ 0.06 lb ai/A (5 days)	0.0023	0.0002	0.0029	0.0008
Apple trees (T)/ 1 app @ 0.06 lb ai/A	0.0008	0.0001	0.0010	0.0004
Animal housing premises, paths/patios (CC)/ 14 app @ 0.0762 and 1 app @ 0.1132 lb ai/A (5-days)	0.050	0.006	**0.06***	0.024
Household/domestic dwellings, outdoor premises (CC)/ 2 app @ 2.0 lb ai/A (7-days)	0.831	0.062	**1.0***	0.25
Apricot, loquat, mayhaw, plum, quince (G)/ 9 app @ 0.0239 lb ai/A (7-days)	0.012	0.004	0.015	0.016
Bean, groundcherry, pea, pepino, pepper (G)/ 9 app @ 0.0239 lb ai/A (7-days)	0.05	0.01	**0.062***	0.04
Eggplant (G)/ 9 app @ 0.0239 lb ai/A (7-days)	0.010	0.003	0.012	0.012
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut (G)/ 6 app @ 0.0239 lb ai/A (7-days)	0.018	0.004	0.022	0.016
Barley (A)/ 2 app @ 0.031 lb ai/A (7-days)	0.070	0.011	**0.087***	0.044
Barley (G)/ 2 app @ 0.031 lb ai/A (7-days)	0.029	0.007	0.036	0.028
Bell pepper, catjang (Jerusalem/marble pea) (A)/ 12 app @ 0.03 lb ai/A (7-days)	0.098	0.040	**0.12***	0.16
Bell pepper, catjang (Jerusalem/marble pea)(G)/ 12 app @ 0.03 lb ai/A (7-days)	0.073	0.015	**0.09***	0.06
Mustard cabbage (gai choy, pak-choi) (G)/ 8 app @ 0.03 lb ai/A (5-days)	0.121	0.026	**0.15***	0.10
Brassica (head and stem) vegetables (A)/ 8 app@ 0.031 lb ai/A (3 crop cycles of 120 days; 7-day interval within crop cycle)	0.090	0.031	**0.11***	0.12
Brassica (head and stem) vegetables (G)/ 8 app@ 0.031 lb ai/A (3 crop cycles of 120 days;	0.082	0.017	**0.10***	0.07

Uses/Application Rate	**Peak EEC (µg/L)**	**60-day EEC (µg/L)**	**Acute RQ***	**Chronic RQ***
7-day interval within crop cycle)				
Tomato, tomatillo (G)/ 9 app @ 0.0294 lb ai/A (7-days)	0.018	0.005	0.022	0.02
Broccoli, cauliflower (G)/ 9 app @ 0.0294 lb ai/A (2 crop cycles of 120 days; 7-day interval within crop cycle)	0.181	0.044	**0.22***	0.18
Cabbage, kohlrabi (G)/ 9 app @ 0.0294 lb ai/A (3 crop cycles of 120 days; 7-day interval within crop cycle)	0.157	0.051	**0.19***	0.20
Mustard (G)/ 9 app @ 0.0294 lb ai/A (4 crop cycles of 90 days; 7-day interval within crop cycle)	0.144	0.046	**0.18***	0.18
Brussels sprouts (G)/ 3 app @ 0.038 lb ai/A (10-days)	0.135	0.018	**0.17***	0.072
Brussels sprouts (G)/ 9 app @ 0.038 lb ai/A (10-days)	0.213	0.033	**0.26***	0.13
Buckwheat, oat, rye (A)/ 2 app @ 0.03 lb ai/A (3-days)	0.069	0.010	**0.086***	0.04
Buckwheat, oat, rye (G)/ 2 app @ 0.03 lb ai/A (3-days)	0.028	0.007	0.035	0.028
Canola/rape (A)/ 3 app @ 0.0311 lb ai/A (5-days)	0.082	0.017	**0.10***	0.068
Canola/rape (g)/ 3 app @ 0.0311 lb ai/A (5-days)	0.042	0.012	**0.052***	0.048
Grass forage/fodder/hay, pastures, rangeland (A)/ 3 app @0.0311 lb ai/A (30-days)	0.055	0.008	**0.068***	0.032
Grass forage/fodder/hay, pastures, rangeland (G)/ 3 app @ 0.0311 lb ai/A (30-days)	0.011	0.002	0.014	0.008
Cereal grains, triticale, wheat (A)/ 2 app @ 0.0311 lb ai/A (3-days)	0.071	0.011	**0.088***	0.044
Cereal grains, triticale, wheat (G)/ 2 app @ 0.0311 lb ai/A (3-days)	0.029	0.007	0.036	0.028
Cole crops (A)/ 8 app @ 0.0311 lb ai/A (7-days)	0.127	0.042	**0.16***	0.17
Cole crops (G)/ 8 app @ 0.0311 lb ai/A (7-days)	0.117	0.027	**0.14***	0.11
Onion (A)/ 9 app @ 0.0311 lb ai/A (7-days)	0.064	0.020	**0.079***	0.08
Onion (G)/ 9 app @ 0.0311 lb ai/A (7-days)	0.015	0.005	0.019	0.02
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns (G)/ 2 app @ 0.1585, 1 app @ 0.0983 lb ai/A (7-days)	0.054	0.006	**0.07***	0.02
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns (ST)/ 7 app @ 0.06 lb ai/A (7-days)	0.019	0.003	0.024	0.012
Conifers (plantations/nurseries) (G)/ 6 app @ 0.0401 lb ai/A (7-days)	0.468	0.052	**0.58***	0.21
Conifers (seed orchard) (G)/ 3 app @ 0.156 and 1 app @ 0.036 lb ai/A (7-days)	1.00	0.111	**1.24***	0.44
Corn (field) (A)/ 3 app @ 0.042 lb ai/A (10-days)	0.078	0.016	**0.10***	0.06
Corn (field) (G)/ 3 app @ 0.042 lb ai/A (10-days)	0.056	0.009	**0.07***	0.04

Uses/Application Rate	Peak EEC (µg/L)	60-day EEC (µg/L)	Acute RQ*	Chronic RQ*
Corn (field, pop) (B,F)/ 2 app @ 0.0934 lb ai/A (4-days)	0.080	0.011	**0.10***	0.04
Corn (sweet) (B, F)/ 6 app @ 0.0934 lb ai/A (4-days)	0.219	0.031	**0.27***	0.12
Corn (sweet) (D)/ 5 app @ 0.042 lb ai/A (3 crop cycles of 120 days; 10-day interval per crop cycle)	0.357	0.054	**0.44***	0.22
Corn (sweet) (A)/ 6 app @ 0.03 lb ai/A (3 crop cycles of 120 days; 10-day interval per crop cycle)	0.197	0.053	**0.24***	0.21
Cotton (A)/ 3 app @ 0.042 lb ai/A (10-days)	0.073	0.011	**0.09***	0.04
Cotton (G)/ 3 app @ 0.042 lb ai/A (10-days)	0.018	0.004	0.02	0.02
Cucurbit vegetables (A)/ 6 app @ 0.0311 lb ai/A (5-days)	0.059	0.014	**0.07***	0.06
Cucurbit vegetables (G)/ 6 app @ 0.0311 lb ai/A (5-days)	0.012	0.003	0.015	0.012
Filbert, pecan, walnut (A)/ 2 app @ 0.057 and 1 app @ 0.044 lb ai/A (10-days)	0.098	0.020	**0.121***	0.080
Filbert, pecan, walnut (G)/ 2 app @ 0.057 and 1 app @ 0.044 lb ai/A (10-days)	0.021	0.004	0.026	0.016
Filbert, pecan, walnut (D)/ 6 app @ 0.057 lb ai/A (10-days)	0.027	0.009	0.033	0.036
Forest plantings (G)/ 4 app @ 0.0511 and 1 app @ 0.0337 lb ai/A (7-days)	0.298	0.053	**0.369***	0.212
Fruiting vegetables (A)/ 12 app @ 0.0311 lb ai/A (5-days)	0.111	0.043	**0.138***	0.172
Fruiting vegetables (G)/ 12 app @ 0.0311 lb ai/A (5-days)	0.087	0.017	**0.108***	0.068
Garlic (A)/ 8 app @ 0.0311 lb ai/A (7-days)	0.070	0.024	**0.087***	0.096
Golf course turf, ornamental sod farm (G)/ 1 app @ 0.068 lb ai/A	0.022	0.002	0.027	0.008
Golf course turf, ornamental sod farm (M)/ 6 app @ 0.06 lb ai/A (7-days)	0.017	0.003	0.021	0.012
Grasses grown for seed (G)/ 2 app @ 0.1306 and 1 app @ 0.0811 lb ai/A (7-days)	0.050	0.008	**0.062***	0.032
Legume vegetables (A)/ 4 app @ 0.0311 lb ai/A (5-days)	0.060	0.015	**0.074***	0.060
Legume vegetables (G)/ 4 app @ 0.0311 lb ai/A (5-days)	0.035	0.005	0.043	0.020
Peanuts, root and tuber vegetables (A)/ 4 app @ 0.0311 lb ai/A (7-days)	0.060	0.015	**0.074***	0.060
Peanuts, root and tuber vegetables (G)/ 4 app @ 0.0311 lb ai/A (7-days)	0.034	0.005	0.042	0.020
Lettuce (A)/ 10 app @ 0.0311 lb ai/A (2 crop cycles of 120 days; 5-day interval per crop cycle)	0.245	0.081	**0.304***	0.324
Lettuce (G)/ 10 app @ 0.0311 lb ai/A (2 crop cycles of 120 days; 5-day interval per crop cycle)	0.223	0.044	**0.276***	0.176
Nonagricultural uncultivated areas/soils (A)/ 2	0.048	0.009	**0.06***	0.04

Uses/Application Rate	Peak EEC (µg/L)	60-day EEC (µg/L)	Acute RQ*	Chronic RQ*
app @ 0.0792 and 1 app @ 0.0432 lb ai/A (7-days)				
Ornamental and/or shade trees (G)/ 2 app @ 0.162 and 1 app @ 0.0913 lb ai/A (7-days)	0.062	0.015	**0.077***	0.060
Ornamental and/or shade trees, ground cover, herbaceous plants, non-flowering plants, woody shrubs and vines, rose (D)/ 3 app @ 1.2 lb ai/A (7-days)	5.0 (7.42)[1]	0.81	**6.2***	**3.240***
Paved areas (private roads/sidewalks) (PT)/ 6 app @ 0.069 lb ai/A (7-days)	0.812	0.043	**1.0***	0.17
Pome and stone fruit (A)/ 5 app @ 0.0415 lb ai/A (7-days)	0.077	0.016	**0.095***	0.064
Pome and stone fruit (G)/ 5 app @ 0.0415 lb ai/A (7-days)	0.016	0.004	0.020	0.016
Potato (A)/ 3 app @ 0.0239 and 1 app @ 0.0162 lb ai/A (7-days)	0.042	0.007	**0.052***	0.028
Potato (G)/ 3 app @ 0.0239 and 1 app @ 0.0162 lb ai/A (7-days)	0.009	0.002	0.011	0.008
Recreational areas (B)/ 26 app@ 0.033 lb ai/A (7-days)	0.010	0.002	0.01	0.008
Recreational areas (CC, ST)/ 2 app @ 2.0 lb ai/A (7-days)	0.218	0.037	**0.270***	0.148
Residential lawns (O)/ 6 app @ 0.078 lb ai/A (7-days)	0.071	0.010	**0.09***	0.04
Residential lawns (M)/ 1 app @ 1.9 lb ai/A	0.400	0.031	**0.50***	0.12
Rice ®/ 3 app @ 0.0415 lb ai/A (5-days)	0.360	0.360	**0.446***	**1.440***
Seed orchard trees (G)/ 3 app @ 0.0162 and 1 app @ 0.0327 lb ai/A (7-days)	1.210	0.128	**1.499***	0.512
Sorghum (A)/ 2 app @ 0.038 lb ai/A (10-days)	0.085	0.014	**0.105***	0.056
Sorghum (G)/ 2 app @ 0.038 lb ai/A (10-days)	0.036	0.009	0.045	0.036
Soybean (A)/ 1 app @ 0.038 and 1 app @ 0.021 lb ai/A (14-days)	0.064	0.007	**0.079***	0.028
Soybean (G)/ 1 app @ 0.038 and 1 app @ 0.021 lb ai/A (14-days)	0.016	0.003	0.020	0.012
Tree nuts (A)/ 4 app @ 0.0415 lb ai/A (5-days)	0.077	0.015	**0.095***	0.060
Tree nuts (G)/ 4 app @ 0.0415 lb ai/A (5-days)	0.017	0.004	0.021	0.016
Sunflower (A)/ 3 app @ 0.038 lb ai/A (10-days)	0.071	0.015	**0.088***	0.060
Sunflower (G)/ 3 app @ 0.038 lb ai/A (10-days)	0.051	0.008	**0.063***	0.032
Right-of-way (G)/ 6 app @ 0.06 lb ai/A (7-days)	0.054	0.007	**0.07***	0.03
Airports/landing fields (O)/ 26 app @ 0.08 lb ai/A (7-days)	0.009	0.002	0.01	0.008
Golf course turf, ornamental sod farm (granular spot treatment) (O)/ 6 app @ 0.06 lb ai/A (7-days)	0.019	0.003	0.024	0.012
Grasses grown for seed (granular spot treatment) (O)/ 6 app @ 0.06 lb ai/A (7-days)	0.017	0.003	0.021	0.012
Nonagricultural uncultivated areas/soil (granular band/broadcast/perimeter/spot treatment) (O)/ 5	0.059	0.006	**0.073***	0.024

Uses/Application Rate	Peak EEC (µg/L)	60-day EEC (µg/L)	Acute RQ*	Chronic RQ*
app @ 0.0792 lb ai/A (7-days)				
Nonagricultural uncultivated areas/soil (granular mound treatment) (O)/ 6 app @ 0.06 lb ai/A (7-days)	0.009	0.002	0.01	0.008

* = LOC exceedances (acute RQ > 0.05; chronic RQ > 1.0) are bolded. Acute RQ = use-specific peak EEC / 0.807 µg ai/L (sheepshead minnow). Chronic RQ = use-specific 60-day EEC / 0.25 µg ai/L (sheepshead minnow).
[1]Calculated EEC exceeded limit of solubility (5 µg ai/L), thus limit of solubility was used instead.
A = foliar aerial application
G = foliar ground application
C = chemigation
D = dust application
M = mound application
T = trunk drench
CC = crack and crevice
ST = spot treatment
B = banded applications
F = furrow applications
PT = perimeter treatment
O = granular applications
R = rice

5.1.1.e. Estuarine/Marine Invertebrates

Acute risk to estuarine/marine invertebrates is based on peak EECs in the standard pond and the lowest acute toxicity value for estuarine/marine invertebrates. Chronic risk is based on 21-day EECs and the lowest chronic toxicity value for estuarine/marine invertebrates. Risk quotients ranged from 0.16 to 1020 (acute) and 0.45 to 9591 (chronic). All of the *lambda*-cyhalothrin uses exceed the acute listed LOC (0.05) and 99% of the uses exceed the chronic LOC (1). In addition, 98% of the uses exceed the non-listed species LOC (0.5); therefore, *lambda*-cyhalothrin uses have the potential to indirectly affect listed species that rely on estuarine/marine invertebrates during at least some portion of their life-cycle (*i.e.*, CCR, TG, and DS) (Table 5-5).

Table 5-5. Summary of Acute and Chronic RQs for Estuarine/Marine Invertebrates (Based on Surface Water EECs)

Uses/Application Rate	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
Agricultural/farm premises (CC)/ 2 app @ 0.2212 and 1 app @ 0.0763 lb ai/A (7-days)	0.058	0.007	**12***	**32***
Alfalfa (A)/ 3 app @ 0.38 lb ai/A (10-days)	0.66	0.14	**135***	**636***
Alfalfa (G)/ 3 app @ 0.38 lb ai/A (10 days)	0.14	0.03	**29***	**136***
Almond (G)/ 6 app @0.1 lb ai/A (7-days)	0.07	0.02	**14***	**91***
Almond (T)/ 3 app 0.06 lb ai/A (5-days)	0.008	0.003	**1.6***	**14***
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, trees (G)/ 9 app @ 0.1 lb ai/A (7-days)	0.05	0.02	**10***	**91***

Uses/Application Rate	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
Nectarine, peach, cherry trees trunk drench (T)/ 3 app @ 0.06 lb ai/A (5 days)	0.0023	0.0003	**0.47***	**1.36***
Apple trees (T)/ 1 app @ 0.06 lb ai/A	0.0008	0.0001	**0.16***	0.45
Animal housing premises, paths/patios (CC)/ 14 app @ 0.0762 and 1 app @ 0.1132 lb ai/A (5-days)	0.050	0.009	**10***	**41***
Household/domestic dwellings, outdoor premises (CC)/ 2 app @ 2.0 lb ai/A (7-days)	0.831	0.099	**170***	**450***
Apricot, loquat, mayhaw, plum, quince (G)/ 9 app @ 0.0239 lb ai/A (7-days)	0.012	0.004	**2.4***	**18***
Bean, groundcherry, pea, pepino, pepper (G)/ 9 app @ 0.0239 lb ai/A (7-days)	0.05	0.01	**10***	**45***
Eggplant (G)/ 9 app @ 0.0239 lb ai/A (7-days)	0.010	0.004	**2.0***	**18***
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut (G)/ 6 app @ 0.0239 lb ai/A (7-days)	0.018	0.005	**3.7***	**23***
Barley (A)/ 2 app @ 0.031 lb ai/A (7-days)	0.070	0.016	**14***	**73***
Barley (G)/ 2 app @ 0.031 lb ai/A (7-days)	0.029	0.010	**5.9***	**45***
Bell pepper, catjang (Jerusalem/marble pea) (A)/ 12 app @ 0.03 lb ai/A (7-days)	0.098	0.042	**20***	**191***
Bell pepper, catjang (Jerusalem/marble pea)(G)/ 12 app @ 0.03 lb ai/A (7-days)	0.073	0.016	**15***	**73***
Mustard cabbage (gai choy, pak-choi) (G)/ 8 app @ 0.03 lb ai/A (5-days)	0.121	0.028	**25***	**127***
Brassica (head and stem) vegetables (A)/ 8 app@ 0.031 lb ai/A (3 crop cycles of 120 days; 7-day interval within crop cycle)	0.090	0.036	**18***	**164***
Brassica (head and stem) vegetables (G)/ 8 app@ 0.031 lb ai/A (3 crop cycles of 120 days; 7-day interval within crop cycle)	0.082	0.020	**17***	**91***
Tomato, tomatillo (G)/ 9 app @ 0.0294 lb ai/A (7-days)	0.018	0.005	**3.7***	**23***
Broccoli, cauliflower (G)/ 9 app @ 0.0294 lb ai/A (2 crop cycles of 120 days; 7-day interval within crop cycle)	0.181	0.044	**37***	**200***
Cabbage, kohlrabi (G)/ 9 app @ 0.0294 lb ai/A (3 crop cycles of 120 days; 7-day interval within crop cycle)	0.157	0.055	**32***	**250***
Mustard (G)/ 9 app @ 0.0294 lb ai/A (4 crop cycles of 90 days; 7-day interval within crop cycle)	0.144	0.048	**29***	**218***
Brussels sprouts (G)/ 3 app @ 0.038 lb ai/A (10-days)	0.135	0.021	**28***	**95***
Brussels sprouts (G)/ 9 app @ 0.038 lb ai/A (10-days)	0.213	0.036	**43***	**164***
Buckwheat, oat, rye (A)/ 2 app @ 0.03 lb ai/A (3-days)	0.069	0.015	**14***	**68***
Buckwheat, oat, rye (G)/ 2 app @ 0.03 lb ai/A (3-days)	0.028	0.009	**5.7***	**41***

Uses/Application Rate	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
Canola/rape (A)/ 3 app @ 0.0311 lb ai/A (5-days)	0.082	0.023	**17***	**105***
Canola/rape (g)/ 3 app @ 0.0311 lb ai/A (5-days)	0.042	0.015	**8.6***	**68***
Grass forage/fodder/hay, pastures, rangeland (A)/ 3 app @0.0311 lb ai/A (30-days)	0.055	0.009	**11***	**41***
Grass forage/fodder/hay, pastures, rangeland (G)/ 3 app @ 0.0311 lb ai/A (30-days)	0.011	0.002	**2.2***	**9.1***
Cereal grains, triticale, wheat (A)/ 2 app @ 0.0311 lb ai/A (3-days)	0.071	0.016	**14***	**73***
Cereal grains, triticale, wheat (G)/ 2 app @ 0.0311 lb ai/A (3-days)	0.029	0.010	**5.9***	**45***
Cole crops (A)/ 8 app @ 0.0311 lb ai/A (7-days)	0.127	0.047	**26***	**214***
Cole crops (G)/ 8 app @ 0.0311 lb ai/A (7-days)	0.117	0.029	**24***	**132***
Onion (A)/ 9 app @ 0.0311 lb ai/A (7-days)	0.064	0.021	**13***	**95***
Onion (G)/ 9 app @ 0.0311 lb ai/A (7-days)	0.015	0.005	**3.1***	**23***
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns (G)/ 2 app @ 0.1585, 1 app @ 0.0983 lb ai/A (7-days)	0.054	0.008	**11***	**36***
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns (ST)/ 7 app @ 0.06 lb ai/A (7-days)	0.019	0.004	**3.9***	**18***
Conifers (plantations/nurseries) (G)/ 6 app @ 0.0401 lb ai/A (7-days)	0.468	0.069	**96***	**314***
Conifers (seed orchard) (G)/ 3 app @ 0.156 and 1 app @ 0.036 lb ai/A (7-days)	1.00	0.148	**204***	**673***
Corn (field) (A)/ 3 app @ 0.042 lb ai/A (10-days)	0.078	0.020	**16***	**91***
Corn (field) (G)/ 3 app @ 0.042 lb ai/A (10-days)	0.056	0.011	**11***	**50***
Corn (field, pop) (B,F)/ 2 app @ 0.0934 lb ai/A (4-days)	0.080	0.014	**16***	**64***
Corn (sweet) (B, F)/ 6 app @ 0.0934 lb ai/A (4-days)	0.219	0.039	**45***	**177***
Corn (sweet) (D)/ 5 app @ 0.042 lb ai/A (3 crop cycles of 120 days; 10-day interval per crop cycle)	0.357	0.067	**73***	**305***
Corn (sweet) (A)/ 6 app @ 0.03 lb ai/A (3 crop cycles of 120 days; 10-day interval per crop cycle)	0.197	0.058	**40***	**264***
Cotton (A)/ 3 app @ 0.042 lb ai/A (10-days)	0.073	0.015	**15***	**68***
Cotton (G)/ 3 app @ 0.042 lb ai/A (10-days)	0.018	0.004	**4***	**18***
Cucurbit vegetables (A)/ 6 app @ 0.0311 lb ai/A (5-days)	0.059	0.020	**12***	**91***
Cucurbit vegetables (G)/ 6 app @ 0.0311 lb ai/A (5-days)	0.012	0.004	**2***	**18***
Filbert, pecan, walnut (A)/ 2 app @ 0.057 and	0.098	0.020	**20***	**91***

Uses/Application Rate	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
1 app @ 0.044 lb ai/A (10-days)				
Filbert, pecan, walnut (G)/ 2 app @ 0.057 and 1 app @ 0.044 lb ai/A (10-days)	0.021	0.005	**4***	**23***
Filbert, pecan, walnut (D)/ 6 app @ 0.057 lb ai/A (10-days)	0.027	0.009	**6***	**41***
Forest plantings (G)/ 4 app @ 0.0511 and 1 app @ 0.0337 lb ai/A (7-days)	0.298	0.064	**61***	**291***
Fruiting vegetables (A)/ 12 app @ 0.0311 lb ai/A (5-days)	0.111	0.047	**23***	**214***
Fruiting vegetables (G)/ 12 app @ 0.0311 lb ai/A (5-days)	0.087	0.018	**18***	**82***
Garlic (A)/ 8 app @ 0.0311 lb ai/A (7-days)	0.070	0.026	**14***	**118***
Golf course turf, ornamental sod farm (G)/ 1 app @ 0.068 lb ai/A	0.022	0.002	**4***	**9***
Golf course turf, ornamental sod farm (M)/ 6 app @ 0.06 lb ai/A (7-days)	0.017	0.004	**3***	**18***
Grasses grown for seed (G)/ 2 app @ 0.1306 and 1 app @ 0.0811 lb ai/A (7-days)	0.050	0.012	**10***	**55***
Legume vegetables (A)/ 4 app @ 0.0311 lb ai/A (5-days)	0.060	0.020	**12***	**91***
Legume vegetables (G)/ 4 app @ 0.0311 lb ai/A (5-days)	0.035	0.006	**7***	**27***
Peanuts, root and tuber vegetables (A)/ 4 app @ 0.0311 lb ai/A (7-days)	0.060	0.018	**12***	**82***
Peanuts, root and tuber vegetables (G)/ 4 app @ 0.0311 lb ai/A (7-days)	0.034	0.006	**7***	**27***
Lettuce (A)/ 10 app @ 0.0311 lb ai/A (2 crop cycles of 120 days; 5-day interval per crop cycle)	0.245	0.086	**50***	**391***
Lettuce (G)/ 10 app @ 0.0311 lb ai/A (2 crop cycles of 120 days; 5-day interval per crop cycle)	0.223	0.048	**46***	**218***
Nonagricultural uncultivated areas/soils (A)/ 2 app @ 0.0792 and 1 app @ 0.0432 lb ai/A (7-days)	0.048	0.014	**9.8***	**64***
Ornamental and/or shade trees (G)/ 2 app @ 0.162 and 1.081 app @ 0.0913 lb ai/A (7-days)	0.062	0.018	**13***	**82***
Ornamental and/or shade trees, ground cover, herbaceous plants, non-flowering plants, woody shrubs and vines, rose (D)/ 3 app @ 1.2 lb ai/A (7-days)	5.0 (7.42)[1]	1.08	**1020***	**4909***
Paved areas (private roads/sidewalks) (PT)/ 6 app @ 0.069 lb ai/A (7-days)	0.812	0.069	**166***	**314***
Pome and stone fruit (A)/ 5 app @ 0.0415 lb ai/A (7-days)	0.077	0.020	**16***	**91***
Pome and stone fruit (G)/ 5 app @ 0.0415 lb ai/A (7-days)	0.016	0.005	**3***	**23***
Potato (A)/ 3 app @ 0.0239 and 1 app @ 0.0162 lb ai/A (7-days)	0.042	0.009	**9***	**41***

Uses/Application Rate	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
Potato (G)/ 3 app @ 0.0239 and 1 app @ 0.0162 lb ai/A (7-days)	0.009	0.002	**2***	**9***
Recreational areas (B)/ 26 app@ 0.033 lb ai/A (7-days)	0.010	0.002	**2.0***	**9.1***
Recreational areas (CC, ST)/ 2 app @ 2.0 lb ai/A (7-days)	0.218	0.045	**44.5***	**204.5***
Residential lawns (O)/ 6 app @ 0.078 lb ai/A (7-days)	0.071	0.010	**14***	**45***
Residential lawns (M)/ 1 app @ 1.9 lb ai/A	0.400	0.061	**82***	**277***
Rice ®/ 3 app @ 0.0415 lb ai/A (5-days)	0.360	0.360	**73.5***	**1636.4***
Seed orchard trees (G)/ 3 app @ 0.0162 and 1 app @ 0.0327 lb ai/A (7-days)	1.210	0.175	**246.9***	**795.5***
Sorghum (A)/ 2 app @ 0.038 lb ai/A (10-days)	0.085	0.019	**17.3***	**86.4***
Sorghum (G)/ 2 app @ 0.038 lb ai/A (10-days)	0.036	0.012	**7.3***	**54.5***
Soybean (A)/ 1 app @ 0.038 and 1 app @ 0.021 lb ai/A (14-days)	0.064	0.010	**13.1***	**45.5***
Soybean (G)/ 1 app @ 0.038 and 1 app @ 0.021 lb ai/A (14-days)	0.016	0.003	**3.3***	**13.6***
Tree nuts (A)/ 4 app @ 0.0415 lb ai/A (5-days)	0.077	0.023	**15.7***	**104.5***
Tree nuts (G)/ 4 app @ 0.0415 lb ai/A (5-days)	0.017	0.006	**3.5***	**27.3***
Sunflower (A)/ 3 app @ 0.038 lb ai/A (10-days)	0.071	0.019	**14.5***	**86.4***
Sunflower (G)/ 3 app @ 0.038 lb ai/A (10-days)	0.051	0.010	**10.4***	**45.5***
Right-of-way (G)/ 6 app @ 0.06 lb ai/A (7-days)	0.054	0.009	**11***	**41***
Airports/landing fields (O)/ 26 app @ 0.08 lb ai/A (7-days)	5.0 (15.89)[1]	2.11	**1020***	**9591***
Golf course turf, ornamental sod farm (granular spot treatment) (O)/ 6 app @ 0.06 lb ai/A (7-days)	0.019	0.004	**3.9***	**18.2***
Grasses grown for seed (granular spot treatment) (O)/ 6 app @ 0.06 lb ai/A (7-days)	0.017	0.004	**3.5***	**18.2***
Nonagricultural uncultivated areas/soil (granular band/broadcast/perimeter/spot treatment) (O)/ 5 app @ 0.0792 lb ai/A (7-days)	0.059	0.009	**12***	**41***
Nonagricultural uncultivated areas/soil (granular mound treatment) (O)/ 6 app @ 0.06 lb ai/A (7-days)	0.009	0.002	**1.8***	**9.1***
* = LOC exceedances (acute RQ ≥ 0.05; chronic RQ ≥ 1.0) are bolded. Acute RQ = use-specific peak EEC / 0.0049 µg ai/L (mysid shrimp). Chronic RQ = use-specific 21-day EEC / 0.00022 µg ai/L (mysid shrimp). [1]Calculated EEC exceeded limit of solubility (5 µg ai/L), thus limit of solubility was used instead. A = foliar aerial application G = foliar ground application C = chemigation				

Uses/Application Rate	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
D = dust application M = mound application T = trunk drench CC = crack and crevice ST = spot treatment B = banded applications F = furrow applications PT = perimeter treatment O = granular applications R = rice				

5.1.1.f. Estuarine/Marine Benthic Invertebrates

Acute risk to estuarine/marine benthic invertebrates is based on peak pore water EECs in the standard pond and the lowest acute toxicity value for estuarine/marine invertebrates (surrogate for estuarine/marine benthic invertebrates). Chronic risk is based on 21-day EECs and the lowest chronic toxicity value for estuarine/marine invertebrates (surrogate for estuarine/marine benthic invertebrates). Risk quotients ranged from 0.004 to 1,020 (acute) and 0.09 to 22,727 (chronic). Ninety-eight percent of the *lambda*-cyhalothrin exceeded the acute listed LOC (0.05) and chronic LOC (1). In addition, 67% of the uses exceeded the non-listed acute LOC (0.5) indicating the potential for indirect effects to listed species that rely on estuarine/marine invertebrates during at least some portion of their life-cycle (*i.e.*, CCR, TG, and DS) (Table 5-6).

Table 5-6. Summary of Acute and Chronic RQs for Estuarine/Marine Benthic Invertebrates (Based on Pore Water EECs)

Uses/Application Rate	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
Agricultural/farm premises (CC)/ 2 app @ 0.2212 and 1 app @ 0.0763 lb ai/A (7-days)	5.0 (9.13)[4]	5.0 (9.10)[4]	**1020***	**22727***
Alfalfa (A)/ 3 app @ 0.38 lb ai/A (10-days)	0.023	0.023	**4.7***	**105***
Alfalfa (G)/ 3 app @ 0.38 lb ai/A (10 days)	0.007	0.007	**1.4***	**32***
Almond (G)/ 6 app @0.1 lb ai/A (7-days)	0.005	0.005	**1.0***	**23***
Almond (T)/ 3 app 0.06 lb ai/A (5-days)	0.001	0.001	**0.20***	**4.5***
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, trees (G)/ 9 app @ 0.1 lb ai/A (7-days)	0.004	0.004	**0.82***	**18***
Nectarine, peach, cherry trees trunk drench (T)/ 3 app @ 0.06 lb ai/A (5 days)	0.0000656	0.0000652	0.01	0.30
Apple trees (T)/ 1 app @ 0.06 lb ai/A	0.00002	0.00002	0.004	0.09
Animal housing premises, paths/patios (CC)/ 14 app @ 0.0762 and 1 app @ 0.1132 lb ai/A (5-days)	5.0 (18.09)[4]	5.0 (17.97)[4]	**1020***	**22727***
Household/domestic dwellings, outdoor premises (CC)/ 2 app @ 2.0 lb ai/A (7-days)	5.0 (121.0)[4]	5.0 (121.0)[4]	**1020***	**22727***
Apricot, loquat, mayhaw, plum, quince (G)/ 9 app @ 0.0239 lb ai/A (7-days)	0.001	0.001	**0.20***	**4.5***

Uses/Application Rate	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
Bean, groundcherry, pea, pepino, pepper (G)/ 9 app @ 0.0239 lb ai/A (7-days)	0.003	0.003	**0.61***	**14***
Eggplant (G)/ 9 app @ 0.0239 lb ai/A (7-days)	0.001	0.001	**0.20***	**4.5***
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut (G)/ 6 app @ 0.0239 lb ai/A (7-days)	0.001	0.001	**0.20***	**4.5***
Barley (A)/ 2 app @ 0.031 lb ai/A (7-days)	0.003	0.003	**0.61***	**14***
Barley (G)/ 2 app @ 0.031 lb ai/A (7-days)	0.002	0.002	**0.41***	**9.1***
Bell pepper, catjang (Jerusalem/marble pea) (A)/ 12 app @ 0.03 lb ai/A (7-days)	0.011	0.011	**2.2***	**50***
Bell pepper, catjang (Jerusalem/marble pea)(G)/ 12 app @ 0.03 lb ai/A (7-days)	0.004	0.004	**0.82***	**18***
Mustard cabbage (gai choy, pak-choi) (G)/ 8 app @ 0.03 lb ai/A (5-days)	0.007	0.007	**1.4***	**32***
Brassica (head and stem) vegetables (A)/ 8 app@ 0.031 lb ai/A (3 crop cycles of 120 days; 7-day interval within crop cycle)	0.009	0.009	**1.8***	**40.9***
Brassica (head and stem) vegetables (G)/ 8 app@ 0.031 lb ai/A (3 crop cycles of 120 days; 7-day interval within crop cycle)	0.005	0.005	**1.02***	**22.7***
Tomato, tomatillo (G)/ 9 app @ 0.0294 lb ai/A (7-days)	0.001	0.001	**0.20***	**4.5***
Broccoli, cauliflower (G)/ 9 app @ 0.0294 lb ai/A (2 crop cycles of 120 days; 7-day interval within crop cycle)	0.011	0.011	**2.24***	**50***
Cabbage, kohlrabi (G)/ 9 app @ 0.0294 lb ai/A (3 crop cycles of 120 days; 7-day interval within crop cycle)	0.015	0.015	**3.1***	**68***
Mustard (G)/ 9 app @ 0.0294 lb ai/A (4 crop cycles of 90 days; 7-day interval within crop cycle)	0.013	0.013	**2.7***	**59***
Brussels sprouts (G)/ 3 app @ 0.038 lb ai/A (10-days)	0.005	0.005	**1.0***	**23***
Brussels sprouts (G)/ 9 app @ 0.038 lb ai/A (10-days)	0.010	0.010	**2.0***	**45***
Buckwheat, oat, rye (A)/ 2 app @ 0.03 lb ai/A (3-days)	0.003	0.003	**0.61***	**14***
Buckwheat, oat, rye (G)/ 2 app @ 0.03 lb ai/A (3-days)	0.002	0.002	**0.41***	**9.1***
Canola/rape (A)/ 3 app @ 0.0311 lb ai/A (5-days)	0.004	0.004	**0.82***	**18***
Canola/rape (g)/ 3 app @ 0.0311 lb ai/A (5-days)	0.003	0.003	**0.61***	**14***
Grass forage/fodder/hay, pastures, rangeland (A)/ 3 app @0.0311 lb ai/A (30-days)	0.002	0.002	**0.41***	**9.1***
Grass forage/fodder/hay, pastures, rangeland (G)/ 3 app @ 0.0311 lb ai/A (30-days)	0.001	0.001	**0.20***	**4.5***
Cereal grains, triticale, wheat (A)/ 2 app @ 0.0311 lb ai/A (3-days)	0.003	0.003	**0.61***	**14***
Cereal grains, triticale, wheat (G)/ 2 app @ 0.0311 lb ai/A (3-days)	0.002	0.002	**0.41***	**9.1***
Cole crops (A)/ 8 app @ 0.0311 lb ai/A (7-days)	0.012	0.012	**2.4***	**55***

Uses/Application Rate	**Peak EEC (µg/L)**	**21-day EEC (µg/L)**	**Acute RQ***	**Chronic RQ***
Cole crops (G)/ 8 app @ 0.0311 lb ai/A (7-days)	0.007	0.007	**1.4***	**32***
Onion (A)/ 9 app @ 0.0311 lb ai/A (7-days)	0.005	0.005	**1.0***	**23***
Onion (G)/ 9 app @ 0.0311 lb ai/A (7-days)	0.001	0.001	**0.20***	**4.5***
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns (G)/ 2 app @ 0.1585, 1 app @ 0.0983 lb ai/A (7-days)	0.002	0.002	**0.41***	**9.09***
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns (ST)/ 7 app @ 0.06 lb ai/A (7-days)	0.001	0.001	**0.20***	**4.5***
Conifers (plantations/nurseries) (G)/ 6 app @ 0.0401 lb ai/A (7-days)	0.014	0.014	**2.86***	**63.6***
Conifers (seed orchard) (G)/ 3 app @ 0.156 and 1 app @ 0.036 lb ai/A (7-days)	0.031	0.031	**6.3***	**140.9***
Corn (field) (A)/ 3 app @ 0.042 lb ai/A (10-days)	0.005	0.005	**1.02***	**22.7***
Corn (field) (G)/ 3 app @ 0.042 lb ai/A (10-days)	0.003	0.003	**0.61***	**13.6***
Corn (field, pop) (B,F)/ 2 app @ 0.0934 lb ai/A (4-days)	0.003	0.003	**0.61***	**13.6***
Corn (sweet) (B, F)/ 6 app @ 0.0934 lb ai/A (4-days)	0.009	0.009	**1.84***	**40.9***
Corn (sweet) (D)/ 5 app @ 0.042 lb ai/A (3 crop cycles of 120 days; 10-day interval per crop cycle)	0.016	0.016	**3.3***	**73***
Corn (sweet) (A)/ 6 app @ 0.03 lb ai/A (3 crop cycles of 120 days; 10-day interval per crop cycle)	0.016	0.016	**3.27***	**72.7***
Cotton (A)/ 3 app @ 0.042 lb ai/A (10-days)	0.003	0.003	**0.61***	**13.64***
Cotton (G)/ 3 app @ 0.042 lb ai/A (10-days)	0.001	0.001	**0.204***	**4.55***
Cucurbit vegetables (A)/ 6 app @ 0.0311 lb ai/A (5-days)	0.003	0.003	**0.61***	**13.6***
Cucurbit vegetables (G)/ 6 app @ 0.0311 lb ai/A (5-days)	0.001	0.001	**0.204***	**4.55***
Filbert, pecan, walnut (A)/ 2 app @ 0.057 and 1 app @ 0.044 lb ai/A (10-days)	0.003	0.003	**0.61***	**13.6***
Filbert, pecan, walnut (G)/ 2 app @ 0.057 and 1 app @ 0.044 lb ai/A (10-days)	0.001	0.001	**0.204***	**4.5***
Filbert, pecan, walnut (D)/ 6 app @ 0.057 lb ai/A (10-days)	0.002	0.002	**0.41***	**9.1***
Forest plantings (G)/ 4 app @ 0.0511 and 1 app @ 0.0337 lb ai/A (7-days)	0.016	0.016	**3.27***	**72.7***
Fruiting vegetables (A)/ 12 app @ 0.0311 lb ai/A (5-days)	0.011	0.011	**2.24***	**50***
Fruiting vegetables (G)/ 12 app @ 0.0311 lb ai/A (5-days)	0.005	0.005	**1.02***	**22.7***
Garlic (A)/ 8 app @ 0.0311 lb ai/A (7-days)	0.006	0.006	**1.22***	**27.3***
Golf course turf, ornamental sod farm (G)/ 1 app @ 0.068 lb ai/A	0.0005	0.0005	**0.102***	**2.3***
Golf course turf, ornamental sod farm (M)/ 6 app @ 0.06 lb ai/A (7-days)	0.001	0.001	**0.204***	**4.5***
Grasses grown for seed (G)/ 2 app @ 0.1306 and 1 app @ 0.0811 lb ai/A (7-days)	0.003	0.002	**0.61***	**9.1***

Uses/Application Rate	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
Legume vegetables (A)/ 4 app @ 0.0311 lb ai/A (5-days)	0.004	0.004	**0.82***	**18.2***
Legume vegetables (G)/ 4 app @ 0.0311 lb ai/A (5-days)	0.001	0.001	**0.204***	**4.5***
Peanuts, root and tuber vegetables (A)/ 4 app @ 0.0311 lb ai/A (7-days)	0.004	0.004	**0.82***	**18.2***
Peanuts, root and tuber vegetables (G)/ 4 app @ 0.0311 lb ai/A (7-days)	0.001	0.001	**0.204***	**4.5***
Lettuce (A)/ 10 app @ 0.0311 lb ai/A (2 crop cycles of 120 days; 5-day interval per crop cycle)	0.023	0.023	**4.7***	**104.5***
Lettuce (G)/ 10 app @ 0.0311 lb ai/A (2 crop cycles of 120 days; 5-day interval per crop cycle)	0.013	0.013	**2.7***	**59.1***
Nonagricultural uncultivated areas/soils (A)/ 2 app @ 0.0792 and 1 app @ 0.0432 lb ai/A (7-days)	5.0 (21.59)[1]	5.0 (21.48)[1]	**1020***	**22727***
Ornamental and/or shade trees (G)/ 2 app @ 0.162 and 1 app @ 0.0913 lb ai/A (7-days)	0.004	0.004	**0.82***	**18.2***
Ornamental and/or shade trees, ground cover, herbaceous plants, non-flowering plants, woody shrubs and vines, rose (D)/ 3 app @ 1.2 lb ai/A (7-days)	0.227	0.226	**46.3***	**1027***
Paved areas (private roads/sidewalks) (PT)/ 6 app @ 0.069 lb ai/A (7-days)	0.012	0.012	**2.4***	**55***
Pome and stone fruit (A)/ 5 app @ 0.0415 lb ai/A (7-days)	0.004	0.004	**0.82***	**18.2***
Pome and stone fruit (G)/ 5 app @ 0.0415 lb ai/A (7-days)	0.001	0.001	**0.204***	**4.5***
Potato (A)/ 3 app @ 0.0239 and 1 app @ 0.0162 lb ai/A (7-days)	0.001	0.001	**0.204***	**4.5***
Potato (G)/ 3 app @ 0.0239 and 1 app @ 0.0162 lb ai/A (7-days)	0.0004	0.0004	**0.08***	**1.8***
Recreational areas (B)/ 26 app@ 0.033 lb ai/A (7-days)	0.0005	0.0005	**0.10***	**2.3***
Recreational areas (CC, ST)/ 2 app @ 2.0 lb ai/A (7-days)	0.010	0.010	**2.04***	**9273***
Residential lawns (O)/ 6 app @ 0.078 lb ai/A (7-days)	5.0 (14.12)[1]	5.0 (14.08)[1]	**1020***	**22727***
Residential lawns (M)/ 1 app @ 1.9 lb ai/A	5.0 (61.14)[1]	5.0 (59.55)[1]	**1020***	**22727***
Rice ®/ 3 app @ 0.0415 lb ai/A (5-days)	0.360	0.360	**73.47***	**333955***
Seed orchard trees (G)/ 3 app @ 0.0162 and 1 app @ 0.0327 lb ai/A (7-days)	0.036	0.036	**7.35***	**33409***
Sorghum (A)/ 2 app @ 0.038 lb ai/A (10-days)	0.004	0.003	**0.82***	**3728***
Sorghum (G)/ 2 app @ 0.038 lb ai/A (10-days)	0.003	0.003	**0.61***	**2773***
Soybean (A)/ 1 app @ 0.038 and 1 app @ 0.021 lb ai/A (14-days)	0.002	0.002	**0.41***	**1864***
Soybean (G)/ 1 app @ 0.038 and 1 app @ 0.021 lb ai/A (14-days)	0.001	0.001	**0.20***	**909***
Tree nuts (A)/ 4 app @ 0.0415 lb ai/A (5-days)	0.004	0.004	**0.82***	**3727***
Tree nuts (G)/ 4 app @ 0.0415 lb ai/A (5-days)	0.001	0.001	**0.20***	**9098***

Uses/Application Rate	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ*	Chronic RQ*
Sunflower (A)/ 3 app @ 0.038 lb ai/A (10-days)	0.004	0.004	**0.82***	**3727***
Sunflower (G)/ 3 app @ 0.038 lb ai/A (10-days)	0.003	0.003	**0.61***	**2772***
Right-of-way (G)/ 6 app @ 0.06 lb ai/A (7-days)	5.0 (18.11)[1]	5.0 (18.03)[1]	**1020***	**22727***
Airports/landing fields (O)/ 50 app @ 0.08 lb ai/A (7-days)	0.450	0.447	**92***	**2032***
Golf course turf, ornamental sod farm (granular spot treatment) (O)/ 6 app @ 0.06 lb ai/A (7-days)	0.001	0.001	**0.20***	**909***
Grasses grown for seed (granular spot treatment) (O)/ 6 app @ 0.06 lb ai/A (7-days)	0.001	0.001	**0.20***	**909***
Nonagricultural uncultivated areas/soil (granular band/broadcast/perimeter/spot treatment) (O)/ 5 app @ 0.0792 lb ai/A (7-days)	5.0 (15.59)[1]	5.0 (15.48)[1]	**1020***	**22727***
Nonagricultural uncultivated areas/soil (granular mound treatment) (O)/ 6 app @ 0.06 lb ai/A (7-days)	5.0 (5.13)[1]	5.0 (5.12)[1]	**1020***	**22727***

* = LOC exceedances (acute RQ $\geq$ 0.05; chronic RQ $\geq$ 1.0) are bolded. Estuarine/marine benthic invertebrate data were not available; freshwater invertebrate data were used instead. Acute RQ = use-specific peak EEC / 0.0049 µg ai/ (mysid shrimp) L. Chronic RQ = use-specific 21-day EEC / 0.00022 µg ai/L (mysid shrimp).
[1]Calculated EEC exceeded limit of solubility (5 µg ai/L), thus limit of solubility was used instead.
A = foliar aerial application
G = foliar ground application
C = chemigation
D = dust application
M = mound application
T = trunk drench
CC = crack and crevice
ST = spot treatment
B = banded applications
F = furrow applications
PT = perimeter treatment
O = granular applications
R = rice

5.1.1.g. Non-vascular Aquatic Plants

Acute RQs for aquatic non-vascular plants could not be calculated because the toxicity value is non-definitive. See Section 5 for a characterization of the risk.

5.1.1.h. Vascular Aquatic Plants

Acute risk to aquatic vascular plants could not be calculated because toxicity data are not available. See Section 5 for a characterization of the risk.

5.1.2. Exposures in the Terrestrial Habitat

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5.1.2.a. Birds (surrogate for Reptiles and Terrestrial-phase Amphibians)

As previously discussed in Section 3.3, potential direct effects to terrestrial species are based on foliar, granular, and in-furrow applications of *lambda*-cyhalothrin. Potential risks to birds and, thus, reptiles and terrestrial-phase amphibians are evaluated using T-REX, acute and chronic toxicity data for the most sensitive bird species for which data are available, and the most sensitive dietary item and size class for that species. For terrestrial-phase amphibians, the most sensitive RQ in T-REX is for the small bird consuming small insects. For birds, the most sensitive RQ in T-REX is for the small bird consuming short grass.

T-HERPS is used to assess potential risk to snakes and amphibians as a refinement to the RQs if T-REX indicates potential risk to birds. Small snakes and amphibians only consume insects while medium and large snakes and amphibians consume small and large insects, mammals, and amphibians. The most sensitive RQ for snakes and amphibians are for medium snakes consuming small herbivore mammals.

Potential direct acute effects to the CCR, CTS (all DPS), and SFGS are evaluated using dose- and dietary-based EECs modeled in T-REX for small (20 g, juveniles) birds consuming short grass (
Table 3-6) and acute oral and subacute dietary toxicity endpoints for avian species (Table 4-3).

Potential direct acute effects to the CTS, and SFGS are evaluated by considering dose- and dietary-based EECs modeled in T-HERPS for medium amphibians and/or snakes consuming small herbivorous mammals (
Table 3-8 and Table 3-9) and acute oral and subacute dietary toxicity endpoints for avian species (Table 4-3).

Potential indirect effects to the CCR, SFGS, and CTS may result from direct acute effects to birds and/or amphibians because of a reduction in prey. RQs for indirect effects are calculated in the same manner as those for direct effects. The most sensitive EEC calculated in T-REX is for small birds consuming short grass.

Potential direct chronic effects to the birds, CTS (all DPS) and SFGS (surrogate for amphibians and reptiles) are evaluated by considering dietary-based EECs modeled in T-REX and T-HERPS consuming a variety of dietary items. The specific EECs for each species are for the same size birds and same dietary items as those considered for acute exposure. Chronic effects are estimated using the lowest available NOAEC from a chronic study for birds. Dietary-based EECs are divided by toxicity values to estimate chronic dietary-based RQs.

Acute and chronic RQs for the CCR, CTS, birds, and amphibians derived using the foliar analysis of T-REX are shown in Table 5-7. Four uses – animal housing premises, paths/patios barrier and crack and crevice treatment; household/domestic dwellings outdoor premises barrier and crack and crevice treatment; ornamental and/or shade trees, ground cover, herbaceous plants, non flowering plants, woody shrubs and vines, and rose ground and dust application; and recreational areas crack and crevice and spot treatment– exceeded the acute dose- and dietary-based acute listed species LOC of 0.1. All uses exceeded the chronic LOC of 1. Thus, *lambda*-cyhalothrin uses have the potential to directly affect SFGS, CCR, and CTS. Additionally, since the acute non-listed species LOC (0.5) is exceeded for two of the uses and the chronic RQs are exceeded for all uses, there is a potential for indirect effects to those listed species that rely on birds (and, thus, reptiles and/or terrestrial-phase amphibians) during at least some portion of their life-cycle (*i.e.*, SFGS and CCR).

Table 5-7. Acute and Chronic RQs Derived Using T-REX for *Lambda*-Cyhalothrin and Birds, Reptiles, and Amphibians

Use, Formulation, Type of Application	RQs for Birds and CCR, CTS (all DPS), and SFGS (small bird consuming short grass)		
	Acute Dose-Based[6]	Acute Dietary Based[7]	Chronic Dietary Based[8]
Agricultural/farm premises, crack and crevice/surface spray/perimeter treatment	0.06	0.03	**20.95***
Alfalfa, aerial/ground	0.01	0.01	**4.55***
Almond, ground dust and spray	0.06	0.03	**20.94***
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, ground dust and spray	0.07	0.03	**26.43***
Almond, nectarine, peach, cherry, trunk drench	0.02	0.01	**7.85***
Apple, trunk drench	0.01	<0.01	**2.88***
Animal housing premises, paths/patios, barrier treatment/crack and crevice	**0.11***	0.05	**38.85***
Household/domestic dwellings outdoor premises, barrier treatment/crack and crevice	**0.50***	**0.23***	**179.57***
Apricot, bean, eggplant, groundcherry, loquat, mayhaw, pea, pepino, pepper, plum, quince, ground spray/dust	0.02	0.01	**6.32***
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut, ground spray/dust	0.01	0.01	**5.00***
Barley, aerial/ground	0.01	<0.01	**2.78***
Bell pepper, catjang (Jerusalem/marble pea) (aerial/ground spray/dust)	0.03	0.01	**9.02***
Mustard cabbage (gai choy, pak-choi), ground spray/dust	0.02	0.01	**7.45***
Brassica (head and stem) vegetables, aerial/ground	0.01	0.01	**4.19***
Tomato, tomatillo, ground spray/dust	0.02	0.01	**7.77***
Broccoli, cauliflower, ground spray/dust	0.02	0.01	**8.00***
Cabbage, kohlrabi, ground spray/dust	0.02	0.01	**8.63***
Mustard	0.03	0.01	**9.15***
Brussels sprouts, ground spray	0.01	0.01	**4.55***
Brussels sprouts, dust	0.02	0.01	**8.44***
Buckwheat, oat, rye, aerial/ground	0.01	<0.01	**2.80***
Canola/rape, aerial/ground	0.01	0.01	**4.07***
Grass forage/fodder/hay, pastures, rangeland, aerial/ground	0.01	<0.01	**2.77***
Cereal grains, triticale, wheat, aerial/ground	0.01	<0.01	**2.90***
Cole crops, aerial/ground/dust	0.02	0.01	**7.73***
Onion, aerial/ground/dust	0.02	0.01	**8.22***
Commercial/industrial lawns, ornamental lawns and turf,	0.05	0.02	**17.11***

Use, Formulation, Type of Application	RQs for Birds and CCR, CTS (all DPS), and SFGS (small bird consuming short grass)		
	Acute Dose-Based[6]	Acute Dietary Based[7]	Chronic Dietary Based[8]
recreation area lawns, ground			
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns, mound/spot treatment	0.04	0.02	**13.82***
Conifers (plantations/nurseries), ground	0.02	0.01	**8.40***
Conifers (seed orchard), ground	0.05	0.02	**19.68***
Corn (field), aerial/ground	0.01	0.01	**5.03***
Corn (sweet), dust	0.02	0.01	**7.36***
Corn (sweet), spray	0.02	0.01	**5.92***
Cotton, aerial/ground	0.01	0.01	**5.03***
Cucurbit vegetables, aerial/ground	0.02	0.01	**7.09***
Filbert, pecan, walnut, aerial/ground	0.02	0.01	**6.20***
Filbert, pecan, walnut, dust	0.03	0.01	**10.59***
Forest plantings, ground	0.02	0.01	**8.64***
Fruiting vegetables, aerial/ground	0.03	0.01	**11.01***
Garlic	0.02	0.01	**7.73***
Golf course turf, ornamental sod farm, ground	0.01	<0.01	**3.26***
Golf course turf, ornamental sod farm, mound	0.03	0.02	**12.56***
Grasses grown for seed, ground	0.04	0.02	**14.10***
Legume vegetables, aerial/ground	0.01	0.01	**5.18***
Peanuts, root and tuber vegetables, aerial/ground	0.01	0.01	**4.91***
Lettuce, aerial/ground	0.03	0.01	**10.33***
Nonagricultural uncultivated areas/soils, aerial	0.02	0.01	**8.26***
Ornamental and/or shade trees, ground	0.05	0.02	**17.04***
Ornamental and/or shade trees, ground cover, herbaceous plants, non flowering plants, woody shrubs and vines, rose, ground/dust	**0.42***	**0.19***	**151.40***
Paved areas (private roads/sidewalks), barrier/perimeter treatment	0.04	0.02	**14.45***
Pome and stone fruit, aerial/ground	0.02	0.01	**7.69***
Potato, aerial/ground	0.01	<0.01	**3.40***
Recreational areas, band treatment	0.03	0.01	**10.78***
Recreational areas, crack and crevice/spot treatment	**0.50***	**0.23***	**179.57***
Rice, ground	0.02	0.01	**5.43***
Seed orchard trees, ground	0.06	0.03	**20.44***
Sorghum, aerial/ground	0.01	<0.01	**3.32***
Soybean, aerial/ground	0.01	<0.01	**2.39***
Tree nuts, aerial/ground	0.02	0.01	**6.91***
Sunflower, aerial/ground	0.01	0.01	**4.55***
Right-of-way, ground	0.03	0.02	**12.56***

n/a = not applicable
LOC exceedances (acute RQ $\geq$ 0.1 and chronic RQ $\geq$ 1.0) are bolded.
[1]An interval of 60 days was used between crop cycles
[2]Only 30 applications were modeled because of limitations with T-REX; an interval of 30 days was used between crop cycles
[3]Application exceeds the seasonal maximum because of limitations on T-REX
[4]University of California and USDA 2004
[5]An interval of 90 days was used between crop cycles
[1]Based on dose-based EEC and mallard duck acute oral LD_{50} = 3950 mg/kg-bw

[2]Based on dose-based EEC and mallard duck subacute dietary LC_{50} =3948 mg/kg-diet
[3]Based on dietary-based EEC and northern bobwhite quail NOAEC = 5 mg/kg-diet.

Granular applications were calculated using the LD_{50}/ft^2 feature in T-REX. The analysis considers the exposure to a chemical based on foraging activity within a square foot area. None of the uses exceeded the acute listed species LOC (0.1); therefore, direct or indirect effects to listed species are not expected, based on granular uses (Table 5-8).

Table 5-8. LD_{50}/ft^2 RQs for Birds, Reptiles, and Amphibians for in Furrow/Soil Treatments and Granular Applications

Use, Formulation, Type of Application	RQs for Birds and CCR, CTS (all DPS), and SFGS (small bird consuming short grass)
	Acute Dose-Based
Corn (field, pop), soil in furrow/T-banding[3]	<0.01
Corn (sweet), soil in furrow/T-banding[1]	<0.01
Airports/landing fields, ground granular	0.02
Golf course turf, ornamental sod farm, granular spot treatment	0.02
Grasses grown for seed, granular spot treatment	0.02
Nonagricultural uncultivated areas/soil, granular band/broadcast/ perimeter/spot treatment	0.02
Nonagricultural uncultivated areas/soil, granular mound treatment	0.02
Residential lawns, granular ground	0.02
Residential lawns, granular mound treatment	0.01

[1]University of California and USDA 2004

5.1.2.b. Terrestrial-phase Amphibians

Given that RQs exceeded the acute listed LOC (0.1) for four uses and the chronic LOC (1) for all of the uses when birds were used as a surrogate for amphibians in T-REX, T-HERPS was used to refine the assessment. Acute and chronic RQs were only calculated for those uses that exceeded the listed species LOC in T-REX. The results for the CTS were similar in T-HERPS as in T-REX: three uses – household/domestic dwellings outdoor premises barrier and crack and crevice treatment; ornamental and/or shade trees, ground cover, herbaceous plants, non flowering plants, woody shrubs and vines, and rose ground and dust application; and recreational areas crack and crevice and spot treatment – exceeded the acute listed species dose- and dietary-based LOC of 0.1. All uses exceeded the chronic LOC of 1 (Table 5-9). Thus, three *lambda*-cyhalothrin uses have the potential to directly affect CTS on an acute basis. All uses have the potential to directly affect CTS on a chronic basis. Additionally, since the chronic LOC is exceeded for all uses, there is a potential for indirect effects to those listed species that rely on amphibians during at least some portion of their life-cycle (*i.e.*, SFGS and CCR).

Table 5-9. Acute and Chronic RQs Derived Using T-HERPS for *Lambda*-Cyhalothrin and Amphibians

Use, Formulation, Type of Application	RQs for CTS (all DPS) (medium amphibian consuming herbivore mammals)		
	Acute Dose-Based	**Acute Dietary Based**	**Chronic Dietary Based**
Agricultural/farm premises, crack and crevice/surface spray/perimeter treatment	n/a	n/a	**66***
Alfalfa, aerial/ground	n/a	n/a	**15***
Almond, ground dust and spray	n/a	n/a	**7***
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, ground dust and spray	n/a	n/a	**9***
Almond, nectarine, peach, cherry, trunk drench	n/a	n/a	**26***
Apple, trunk drench	n/a	n/a	**10***
Animal housing premises, paths/patios, barrier treatment/crack and crevice	0.03	0.05	**130***
Household/domestic dwellings outdoor premises, barrier treatment/crack and crevice	**0.15***	**0.23***	**601***
Apricot, bean, eggplant, groundcherry, loquat, mayhaw, pea, pepino, pepper, plum, quince, ground spray/dust	n/a	n/a	**21***
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut, ground spray/dust	n/a	n/a	**17***
Barley, aerial/ground	n/a	n/a	**9***
Bell pepper, catjang (Jerusalem/marble pea) (aerial/ground spray/dust)	n/a	n/a	**30***
Mustard cabbage (gai choy, pak-choi), ground spray/dust	n/a	n/a	**25***
Brassica (head and stem) vegetables, aerial/ground	n/a	n/a	**13***
Tomato, tomatillo, ground spray/dust	n/a	n/a	**26***
Broccoli, cauliflower, ground spray/dust	n/a	n/a	**26***
Cabbage, kohlrabi, ground spray/dust	n/a	n/a	**26***
Mustard	n/a	n/a	**26***
Brussels sprouts, ground spray	n/a	n/a	**15***
Brussels sprouts, dust	n/a	n/a	**28***
Buckwheat, oat, rye, aerial/ground	n/a	n/a	**9***
Canola/rape, aerial/ground	n/a	n/a	**14***
Grass forage/fodder/hay, pastures, rangeland,	n/a	n/a	**9***

Use, Formulation, Type of Application	RQs for CTS (all DPS) (medium amphibian consuming herbivore mammals)		
	Acute Dose-Based	Acute Dietary Based	Chronic Dietary Based
aerial/ground			
Cereal grains, triticale, wheat, aerial/ground	n/a	n/a	**10***
Cole crops, aerial/ground/dust	n/a	n/a	**26***
Onion, aerial/ground/dust	n/a	n/a	**28***
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns, ground	n/a	n/a	**67***
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns, mound/spot treatment	n/a	n/a	**46***
Conifers (plantations/nurseries), ground	n/a	n/a	**28***
Conifers (seed orchard), ground	n/a	n/a	**66***
Corn (field), aerial/ground	n/a	n/a	**28***
Corn (sweet), dust	n/a	n/a	**24***
Corn (sweet), spray	n/a	n/a	**19***
Cotton, aerial/ground	n/a	n/a	**17***
Cucurbit vegetables, aerial/ground	n/a	n/a	**24***
Filbert, pecan, walnut, aerial/ground	n/a	n/a	**23***
Filbert, pecan, walnut, dust	n/a	n/a	**35***
Forest plantings, ground	n/a	n/a	**32***
Fruiting vegetables, aerial/ground	n/a	n/a	**37***
Garlic	n/a	n/a	**26***
Golf course turf, ornamental sod farm, ground	n/a	n/a	**11***
Golf course turf, ornamental sod farm, mound	n/a	n/a	**42***
Grasses grown for seed, ground	n/a	n/a	**55***
Legume vegetables, aerial/ground	n/a	n/a	**17***
Peanuts, root and tuber vegetables, aerial/ground	n/a	n/a	**16***
Lettuce, aerial/ground	n/a	n/a	**33***
Nonagricultural uncultivated areas/soils, aerial	n/a	n/a	**33***
Ornamental and/or shade trees, ground	n/a	n/a	**68***
Ornamental and/or shade trees, ground cover, herbaceous plants, non flowering plants, woody shrubs and vines, rose, ground/dust	**0.13***	**0.19***	**507***
Paved areas (private roads/sidewalks),	n/a	n/a	**48***

Use, Formulation, Type of Application	RQs for CTS (all DPS) (medium amphibian consuming herbivore mammals)		
	Acute Dose-Based	Acute Dietary Based	Chronic Dietary Based
barrier/perimeter treatment			
Pome and stone fruit, aerial/ground	n/a	n/a	**26***
Potato, aerial/ground	n/a	n/a	**13***
Recreational areas, band treatment	n/a	n/a	**36***
Recreational areas, crack and crevice/spot treatment	**0.15***	**0.23***	**601***
Rice, ground	n/a	n/a	**18***
Seed orchard trees, ground	n/a	n/a	**68***
Sorghum, aerial/ground	n/a	n/a	**11***
Soybean, aerial/ground	n/a	n/a	**11***
Tree nuts, aerial/ground	n/a	n/a	**23***
Sunflower, aerial/ground	n/a	n/a	**15***
Right-of-way, ground	n/a	n/a	**42***

n/a = RQ not calculated
LOC exceedances (acute RQ $\geq$ 0.1 and chronic RQ $\geq$ 1.0) are bolded.

5.1.2.c. Reptiles

Given that RQs exceeded the acute listed LOC (0.1) for four uses and the chronic LOC (1) for all of the uses when birds were used as a surrogate for reptiles in T-REX, T-HERPS was used to refine the assessment. Acute and chronic RQs were only calculated for those uses that exceeded the LOC in T-REX. The results for the SFGS was similar in T-HERPS as in T-REX: three uses – household/domestic dwellings outdoor premises barrier and crack and crevice treatment; ornamental and/or shade trees, ground cover, herbaceous plants, non flowering plants, woody shrubs and vines, and rose ground and dust application; and recreational areas crack and crevice and spot treatment – exceeded the acute dose- and dietary-based LOC of 0.1. All uses exceeded the chronic LOC of 1 (Table 5-10). Consequently, three *lambda*-cyhalothrin uses have the potential to directly affect SFGS on an acute basis. All uses exceeded the chronic LOC (1) and therefore have the potential to directly affect SFGS on a chronic basis. Additionally, since the chronic LOC is exceeded for all uses, there is a potential for indirect effects to those listed species that rely on reptiles during at least some portion of their life-cycle.

Table 5-10. Acute and Chronic RQs Derived Using T-HERPS for *Lambda*-Cyhalothrin and Reptiles

Use, Formulation, Type of Application	RQs[1] for SFGS (medium reptile consuming herbivore mammals)		
	Acute Dose-Based[6]	Acute Dietary Based[7]	Chronic Dietary Based[8]
Agricultural/farm premises, crack and crevice/surface spray/perimeter treatment	n/a	n/a	**51***
Alfalfa, aerial/ground	n/a	n/a	**12***
Almond, ground dust and spray	n/a	n/a	**54***
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, ground dust and spray	n/a	n/a	**68***

Use, Formulation, Type of Application	RQs[1] for SFGS (medium reptile consuming herbivore mammals)		
	Acute Dose-Based[6]	Acute Dietary Based[7]	Chronic Dietary Based[8]
Almond, nectarine, peach, cherry, trunk drench	n/a	n/a	**20***
Apple, trunk drench	n/a	n/a	**7***
Animal housing premises, paths/patios, barrier treatment/crack and crevice	0.05	0.04	**99***
Household/domestic dwellings outdoor premises, barrier treatment/crack and crevice	**0.22***	**0.17***	**459***
Apricot, bean, eggplant, groundcherry, loquat, mayhaw, pea, pepino, pepper, plum, quince, ground spray/dust	n/a	n/a	**16***
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut, ground spray/dust	n/a	n/a	**13***
Barley, aerial/ground	n/a	n/a	**7***
Bell pepper, catjang (Jerusalem/marble pea) (aerial/ground spray/dust)	n/a	n/a	**23***
Mustard cabbage (gai choy, pak-choi), ground spray/dust	n/a	n/a	**19***
Brassica (head and stem) vegetables, aerial/ground	n/a	n/a	**10***
Tomato, tomatillo, ground spray/dust	n/a	n/a	**20***
Broccoli, cauliflower, ground spray/dust	n/a	n/a	**20***
Cabbage, kohlrabi, ground spray/dust	n/a	n/a	**20***
Mustard	n/a	n/a	**20***
Brussels sprouts, ground spray	n/a	n/a	**12***
Brussels sprouts, dust	n/a	n/a	**22***
Buckwheat, oat, rye, aerial/ground	n/a	n/a	**7***
Canola/rape, aerial/ground	n/a	n/a	**10***
Grass forage/fodder/hay, pastures, rangeland, aerial/ground	n/a	n/a	**7***
Cereal grains, triticale, wheat, aerial/ground	n/a	n/a	**7***
Cole crops, aerial/ground/dust	n/a	n/a	**20***
Onion, aerial/ground/dust	n/a	n/a	**21***
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns, ground	n/a	n/a	**51***
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns, mound/spot treatment	n/a	n/a	**35***
Conifers (plantations/nurseries), ground	n/a	n/a	**21***
Conifers (seed orchard), ground	n/a	n/a	**50***
Corn (field), aerial/ground	n/a	n/a	**13***
Corn (sweet), dust	n/a	n/a	**18***
Corn (sweet), spray	n/a	n/a	**14***
Cotton, aerial/ground	n/a	n/a	**13***
Cucurbit vegetables, aerial/ground	n/a	n/a	**18***
Filbert, pecan, walnut, aerial/ground	n/a	n/a	**17***
Filbert, pecan, walnut, dust	n/a	n/a	**27***
Forest plantings, ground	n/a	n/a	**24***

Use, Formulation, Type of Application	RQs[1] for SFGS (medium reptile consuming herbivore mammals)		
	Acute Dose-Based[6]	Acute Dietary Based[7]	Chronic Dietary Based[8]
Fruiting vegetables, aerial/ground	n/a	n/a	**28***
Garlic	n/a	n/a	**20***
Golf course turf, ornamental sod farm, ground	n/a	n/a	**8***
Golf course turf, ornamental sod farm, mound	n/a	n/a	**32***
Grasses grown for seed, ground	n/a	n/a	**42***
Legume vegetables, aerial/ground	n/a	n/a	**13***
Peanuts, root and tuber vegetables, aerial/ground	n/a	n/a	**13***
Lettuce, aerial/ground	n/a	n/a	**25***
Nonagricultural uncultivated areas/soils, aerial	n/a	n/a	**26***
Ornamental and/or shade trees, ground	n/a	n/a	**52***
Ornamental and/or shade trees, ground cover, herbaceous plants, non flowering plants, woody shrubs and vines, rose, ground/dust	**0.18***	**0.15***	**387***
Paved areas (private roads/sidewalks), barrier/perimeter treatment	n/a	n/a	**37***
Pome and stone fruit, aerial/ground	n/a	n/a	**20***
Potato, aerial/ground	n/a	n/a	**10***
Recreational areas, band treatment	n/a	n/a	**28***
Recreational areas, crack and crevice/spot treatment	**0.22***	**0.17***	**459***
Rice, ground	n/a	n/a	**14***
Seed orchard trees, ground	n/a	n/a	**52***
Sorghum, aerial/ground	n/a	n/a	**8***
Soybean, aerial/ground	n/a	n/a	**8***
Tree nuts, aerial/ground	n/a	n/a	**18***
Sunflower, aerial/ground	n/a	n/a	**12***
Right-of-way, ground	n/a	n/a	**32***

n/a = RQ not calculated
LOC exceedances (acute RQ $\geq$ 0.1 and chronic RQ $\geq$ 1.0) are bolded.
[1]Highest RQ is reported.

5.1.2.d. Mammals

Potential risks to mammals are evaluated using T-REX, acute and chronic mammalian toxicity data, and a variety of body-size and dietary categories. The potential for indirect effects to the SFGS, CCR, and CTS may result from direct effects to mammals because of a reduction in prey. Potential indirect effects to the SFGS and CTS may result from direct effects to mammals because of effects to habitat or a reduction in rearing sites. RQs for indirect effects are calculated in the same manner as those for direct effects. The most sensitive EECs calculated in T-REX are for small mammals consuming short grass.

Potential direct chronic effects to the mammals are evaluated by considering dietary-based EECs modeled in T-REX consuming a variety of dietary items. The specific EECs for each species are for the same size mammals and same dietary items as those considered for acute exposure. Chronic effects are estimated using the lowest available NOAEC from a chronic reproductive study for mammals. Dietary-based EECs are divided by toxicity values to estimate chronic dietary-based RQs.

EECs for acute dose-based and chronic dietary-based exposures, based on foliar applications, are presented in Table 5-11. All uses, except for soybean, exceeded the acute listed species LOC (0.1). Similarly, all uses, except soybean, sweet corn (spray), cotton, and sorghum, exceeded the chronic LOC (1). Twenty-three percent of uses exceeded the acute non-listed species LOC (0.5) and 93% of the uses exceeded the chronic LOC (1), thus, there is a potential for indirect effects from *lambda*-cyhalothrin to listed species that rely on mammals during at least some portion of their life-cycle (*i.e*., SFGS, CCR, and CTS).

Table 5-11. Acute and Chronic RQs Derived Using T-REX for *Lambda*-Cyhalothrin and Mammals

Use, Formulation, Type of Application	RQs for Small Mammals (small mammals consuming short grass)	
	Acute Dose-Based[6]	Chronic Dietary-Based[7]
Agricultural/farm premises, crack and crevice/surface spray/perimeter treatment	**0.81***	**3.49***
Alfalfa, aerial/ground	**0.18***	0.76
Almond, ground dust and spray	**0.81***	**3.49***
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, ground dust and spray	**1.02***	**4.41***
Almond, nectarine, peach, cherry, trunk drench	**0.30***	**1.31***
Apple, trunk drench	**0.11***	0.48
Animal housing premises, paths/patios, barrier treatment/crack and crevice	**1.50***	**6.47***
Household/domestic dwellings outdoor premises, barrier treatment/crack and crevice	**6.96***	**29.93***
Apricot, bean, eggplant, groundcherry, loquat, mayhaw, pea, pepino, pepper, plum, quince, ground spray/dust	**0.24***	**1.05***
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut, ground spray/dust	**0.19***	0.83
Barley, aerial/ground	**0.11***	0.46
Bell pepper, catjang (Jerusalem/marble pea) (aerial/ground spray/dust)	**0.35***	**1.50***
Mustard cabbage (gai choy, pak-choi), ground spray/dust	**0.29***	**1.24***
Brassica (head and stem) vegetables, aerial/ground	**0.16***	0.70
Tomato, tomatillo, ground spray/dust	**0.30***	**1.30***
Broccoli, cauliflower, ground spray/dust	**0.31***	**1.33***
Cabbage, kohlrabi, ground spray/dust	**0.33***	**1.44***
Mustard	**0.35***	**1.52***
Brussels sprouts, ground spray	**0.18***	0.76

Use, Formulation, Type of Application	RQs for Small Mammals (small mammals consuming short grass)	
	Acute Dose-Based[6]	Chronic Dietary-Based[7]
Brussels sprouts, dust	**0.33***	**1.41***
Buckwheat, oat, rye, aerial/ground	**0.11***	0.47
Canola/rape, aerial/ground	**0.16***	0.68
Grass forage/fodder/hay, pastures, rangeland, aerial/ground	**0.11***	0.46
Cereal grains, triticale, wheat, aerial/ground	**0.11***	0.48
Cole crops, aerial/ground/dust	**0.30***	**1.29***
Onion, aerial/ground/dust	**0.32***	**1.37***
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns, ground	**0.66***	**2.85***
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns, mound/spot treatment	**0.54***	**2.30***
Conifers (plantations/nurseries), ground	**0.33***	**1.40***
Conifers (seed orchard), ground	**0.76***	**3.28***
Corn (field), aerial/ground	**0.19***	0.84
Corn (sweet), dust	**0.29***	**1.23***
Corn (sweet), spray	**0.23***	0.99
Cotton, aerial/ground	**0.19***	0.84
Cucurbit vegetables, aerial/ground	**0.27***	**1.18***
Filbert, pecan, walnut, aerial/ground	**0.24***	**1.03***
Filbert, pecan, walnut, dust	**0.41***	**1.76***
Forest plantings, ground	**0.33***	**1.44***
Fruiting vegetables, aerial/ground	**0.43***	**1.83***
Garlic	**0.30***	**1.29***
Golf course turf, ornamental sod farm, ground	**0.13***	0.54
Golf course turf, ornamental sod farm, mound	**0.49***	**2.09***
Grasses grown for seed, ground	**0.55***	**2.35***
Legume vegetables, aerial/ground	**0.20***	0.86
Peanuts, root and tuber vegetables, aerial/ground	**0.19***	0.82
Lettuce, aerial/ground	**0.40***	**1.72***
Nonagricultural uncultivated areas/soils, aerial	**0.32***	**1.38***
Ornamental and/or shade trees, ground	**0.66***	**2.84***

Use, Formulation, Type of Application	RQs for Small Mammals (small mammals consuming short grass)	
	Acute Dose-Based[6]	Chronic Dietary-Based[7]
Ornamental and/or shade trees, ground cover, herbaceous plants, non flowering plants, woody shrubs and vines, rose, ground/dust/	**5.86***	**25.23***
Paved areas (private roads/sidewalks), barrier/perimeter treatment	**0.56***	**2.41***
Pome and stone fruit, aerial/ground	**0.30***	**1.28***
Potato, aerial/ground	**0.13***	0.57
Recreational areas, band treatment	**0.42***	**1.80***
Recreational areas, crack and crevice/spot treatment	**6.96***	**29.93***
Rice, ground	**0.21***	0.91
Seed orchard trees, ground	**0.79***	**3.41***
Sorghum, aerial/ground	**0.13***	0.55
Soybean, aerial/ground	0.09	0.40
Tree nuts, aerial/ground	**0.27***	**1.15***
Sunflower, aerial/ground	**0.18***	0.76
Right-of-way, ground	**0.49***	**2.09***

n/a = not applicable
LOC exceedances (acute RQ $\geq$ 0.1 and chronic RQ $\geq$ 1.0) are bolded.
[1]An interval of 60 days was used between crop cycles
[2]Only 30 applications were modeled because of limitations with T-REX; an interval of 30 days was used between crop cycles
[3]Application exceeds the seasonal maximum because of limitations on T-REX
[5]An interval of 90 days was used between crop cycles
[6]Based on dose-based EEC and rat acute oral LD_{50} = 56 mg/kg-bw
[7]Based on dietary-based EEC and rat NOAEC = 30 mg/kg-diet.

None of the in-furrow soil treatments exceeded the acute listed LOC (0.1); however, all granular uses exceeded the acute LOC (Table 5-12). To further refine the assessment for the granular treatments, the mass of granules that would need to be consumed to reach the LD_{50} (adjusted for mammal body weight) was estimated. The equations and calculations are available in Appendix M. In all cases, it was estimated that a mammal would have to consume 1.8 to 2 times its body weight (small mammal) or 0.63 to 0.71 times its body weight (medium sized mammal) to achieve the $LD_{50.}$ These scenarios appear unlikely; thus there are direct or indirect effects to listed mammals from the granular uses are expected to be minimial.

Table 5-12. LD_{50}/ft^2 RQs for Mammals for in furrow/soil treatments and granular applications

Use, Formulation, Type of Application	RQs for Small Mammals (small mammals consuming short grass)
	Acute Dose-Based
Corn (field, pop), soil in furrow/T-banding[3]	0.02
Corn (sweet), soil in furrow/T-banding[3]	0.03
Airports/landing fields, ground granular	**0.45***
Golf course turf, ornamental sod farm, granular spot treatment	**0.39***
Grasses grown for seed, granular spot treatment	**0.34***
Nonagricultural uncultivated areas/soil, granular band/broadcast/ perimeter/spot treatment	**0.45***
Nonagricultural uncultivated areas/soil, granular mound treatment	**0.34***
Residential lawns, granular ground	**0.44***
Residential lawns, granular mound treatment	**0.46***

[4]University of California and USDA 2004

5.1.2.e. Terrestrial Invertebrates

To assess the risks of *lambda*-cyhalothrin to terrestrial invertebrates, the honeybee is used as a surrogate for terrestrial invertebrates. The toxicity value for terrestrial invertebrates is calculated by multiplying the lowest available acute contact LD_{50} of 0.038 µg a.i./bee by 1 bee/0.128g, which is based on the weight of an adult honey bee. EECs (µg a.i./g of bee) calculated by T-REX for arthropods are divided by the calculated toxicity value for terrestrial invertebrates, which is 0.30 µg a.i./g of bee. Risk quotients are shown for the arthropods, in Table 5-13.

Potential indirect effects to the SFGS, CCR, and CTS may result from direct acute effects to terrestrial invertebrates because of a reduction in prey. RQs for indirect effects are calculated in the same manner as those for direct effects.

Results of the RQ calculations for terrestrial invertebrates are presented in Table 5-13. All uses exceeded the acute listed species LOC (0.05). Thus, *lambda*-cyhalothrin has the potential to directly affect the BCB and VELB. Additionally, given that all the uses exceed the acute non-listed LOC (0.5), there is a potential for indirect effects to those listed species that rely on terrestrial invertebrates during at least some portion of their life-cycle (*i.e.*, CCR, CTS, and SFGS).

Table 5-13. Summary of RQs for Terrestrial Invertebrates

Use	Arthropod RQ*
Agricultural/farm premises, crack and crevice/surface spray/perimeter treatment	**137***
Alfalfa, aerial/ground	**39.7***
Almond, ground dust and spray	**41.01***
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, ground dust and spray	**137***

Use	Arthropod RQ*
Almond, nectarine, peach, cherry, trunk drench	**51.2***
Apple, trunk drench	**18.8***
Animal housing premises, paths/patios, barrier treatment/crack and crevice	**254***
Household/domestic dwellings outdoor premises, barrier treatment/crack and crevice	**1172***
Apricot, bean, eggplant, groundcherry, loquat, mayhaw, pea, pepino, pepper, plum, quince, ground spray/dust	**41.2***
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut, ground spray/dust	**32.7***
Barley, aerial/ground	**18.2***
Bell pepper, catjang (Jerusalem/marble pea) (aerial/ground spray/dust)	**59***
Mustard cabbage (gai choy, pak-choi), ground spray/dust	**49***
Brassica (head and stem) vegetables, aerial/ground	**27.3***
Tomato, tomatillo, ground spray/dust	**50.7***
Broccoli, cauliflower, ground spray/dust	**52.3***
Cabbage, kohlrabi, ground spray/dust	**56.3***
Mustard	**61.6***
Brussels sprouts, ground spray	**29.7***
Brussels sprouts, dust	**55.1***
Buckwheat, oat, rye, aerial/ground	**18.3***
Canola/rape, aerial/ground	**26.6***
Grass forage/fodder/hay, pastures, rangeland, aerial/ground	**18.1***
Cereal grains, triticale, wheat, aerial/ground	**18.9***
Cole crops, aerial/ground/dust	**50.4***
Onion, aerial/ground/dust	**53.7***
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns, ground	**112***
Commercial/industrial lawns, ornamental lawns and turf, recreation area lawns, mound/spot treatment	**90.2***
Conifers (plantations/nurseries), ground	**54.8***
Conifers (seed orchard), ground	**128***
Corn (field), aerial/ground	**32.8***
Corn (sweet), dust	**34.3***
Corn (sweet), spray	**38.6***
Cotton, aerial/ground	**32.8***
Cucurbit vegetables, aerial/ground	**46.3***
Filbert, pecan, walnut, aerial/ground	**40.5***
Filbert, pecan, walnut, dust	**69.1***
Forest plantings, ground	**56.4***
Fruiting vegetables, aerial/ground	**71.9***
Garlic	**50.4***
Golf course turf, ornamental sod farm, ground	**21.3***
Golf course turf, ornamental sod farm, mound	**82***
Grasses grown for seed, ground	**92***
Legume vegetables, aerial/ground	**33.8***
Peanuts, root and tuber vegetables, aerial/ground	**32***
Lettuce, aerial/ground	**67.4***
Nonagricultural uncultivated areas/soils, aerial	**53.9***
Ornamental and/or shade trees, ground	**111***
Ornamental and/or shade trees, ground cover, herbaceous plants, non flowering plants,	**988***

Use	Arthropod RQ*
woody shrubs and vines, rose, ground/dust/	
Paved areas (private roads/sidewalks), barrier/perimeter treatment	**94.3***
Pome and stone fruit, aerial/ground	**50.2***
Potato, aerial/ground	**22.2***
Recreational areas, band treatment	**70.4***
Recreational areas, crack and crevice/spot treatment	**1172***
Rice, ground	**35.4***
Seed orchard trees, ground	**133***
Sorghum, aerial/ground	**21.7***
Soybean, aerial/ground	**15.6***
Tree nuts, aerial/ground	**45.1***
Sunflower, aerial/ground	**29.7***
Right-of-way, ground	**82***

LOC exceedances (RQ $\geq$ 0.05) are bolded.

5.1.2.f. Terrestrial Plants

Toxicity data are not available for terrestrial plants; the potential for indirect effects to listed species because of effects to plants is discussed in Sections 5.2.1 through 5.2.8.

5.2. Bioaccumulation Analysis Results

KABAM was used to calculate risk quotients from a bioaccumulation pathway for food items that may be consumed by listed species. The rail was used to represent the CCR. The sandpiper was used to represent the SFGS and CTS because its body size was the same as these organisms (0.02 kg). The fog/water shrew category was used to represent a piscivorous mammalian food item that may be consumed by the SFGS. The RQs for bioaccumulation risk did not exceed the acute listed species LOC (0.01) for mammals or birds/reptiles/amphibians; however the chronic LOC (1) was exceeded for the highest application rate (airports/landing field –0.08 lb ai/A) for these organisms. This indicates that there may be direct chronic risks to the CCR, CTS (all DPS), and CTS at the highest *lambda*-cyhalothrin application rates. Although the acute non-listed species LOC (0.5) was not exceeded, the chronic LOC (1) was exceeded; therefore, there may be risks to species that rely on mammals, birds, reptiles, and amphibians during at least some portion of their life cycle (*i.e.,* SFGS and CCR). This is only applicable to the higher application rates of *lambda*-cyhalothrin.

Table 5-14. Bioaccumulation Risk Quotients for Mammals, Birds, Reptiles and Amphibians for *Lambda*-Cyhalothrin

Use, Formulation, Type of Application	RQs for CCR, CTS (all DPS) and SFGS			
	Acute Dose-Based	Acute Dietary-Based	Chronic Dose-Based	Chronic Dietary-Based
CCR				
Airports/landing fields (granular)/ 50 app @ 0.08 lb ai/A (7-days)	0.004	0.004	N/A	**3.5***
Almond dust (ground) (6 app @ 0.1 lb ai/A – 10-	<0.001	<0.001	N/A	0.034

Use, Formulation, Type of Application	RQs for CCR, CTS (all DPS) and SFGS			
	Acute Dose-Based	**Acute Dietary-Based**	**Chronic Dose-Based**	**Chronic Dietary-Based**
days)				
SFGS and CTS (all DPS)				
Airports/landing fields (O)/ 50 app @ 0.08 lb ai/A (7-days)	0.006	0.003	N/A	**2.46***
Almond dust (ground) (6 app @ 0.1 lb ai/A – 10-days)	<0.001	<0.001	N/A	0.023
Fog/Water Shrew				
Airports/landing fields (O)/ 50 app @ 0.08 lb ai/A (7-days)	0.067	N/A	**2.5***	0.449
Almond dust (ground) (6 app @ 0.1 lb ai/A – 10-days)	0.001	N/A	0.024	0.004

*Exceeds the chronic LOC of 1.

5.3. Toxicity of Chemical Mixtures

As previously discussed, the results of available toxicity data for mixtures of *lambda*-cyhalothrin with other pesticides are presented in Appendix A. Table A.1 (Appendix A) compares the toxicity of *lambda*-cyhalothrin technical with the toxicity (adjusted for % ai) of registered mixture products. When the product LD_{50}s, and associated confidence intervals, are adjusted for the percent *lambda*-cyhalothrin (a conservative assumption that attributes all of the observed toxicity of the formulated product to *lambda*-cyhalothrin), the adjusted 95% confidence intervals of the formulated product do not overlap with the TGAI *lambda*-cyhalothrin LD_{50} in eight instances. This indicates that these mixtures may be more toxic than *lambda*-cyhalothrin technical. In two instances, the adjusted 95% confidence intervals for the formulated product overlap with the TGAI *lambda*-cyhalothrin toxicity values, indicating that these two mixtures are likely of similar toxicity to *lambda*-cyhalothrin technical. For all other formulated products, the LD_{50} was non-definitive, thus there are no confidence intervals and the toxicity values cannot be compared. This suggests that in some instances, the combination of active ingredients that are contained within a mixture enhance the toxicity of the compound. Table 5-15 displays the EECs and RQs for the labeled uses of Cobalt Advanced – the *lambda*-cyhalothrin and chloropyrifos mixture that appeared to be most toxic to mammals based on an adjusted oral LD_{50} (see Appendix A for entire listing). When compared with the RQs calculated with toxicity data from *lambda*-cyhalothrin technical, Cobalt Advanced produces higher RQs, indicating a risk at least as high as *lambda*-cyhalothrin.

Table. 5-15. EECs and RQs for Small Mammals (Consuming Short Grass) for Cobalt Advanced

Use(s), Type of Application	App Rate (lb ai/A) and Interval	Dose-based EEC (Cobalt)	Acute RQ (Cobalt)	Acute RQ (*lambda*-cyhalothrin technical)
Alfalfa	3 at 0.038 10 days	21.68	**3.79***	**0.18***

Apple tree trunk	1 at 0.06	13.73	**2.40***	**0.11***
Brussels sprout	3 at 0.038 10 days	21.68	**3.79***	**0.18***
Conifer and deciduous trees (plantations, nurseries, and seed orchards)	6 at 0.0401 7 days	40.03	**7.01***	**0.33***
Corn (spray)	3 crop cycles per year 5 apps at 0.042 per crop cycle 10 days	35.09	**6.14***	**0.23***
Corn (T-banding)	6 at 0.0934, 4 days Rows 40 inches apart[1]; banding 7 inches	106.84	**18.70***	0.03
Cotton	3 at 0.042 10 days	23.96	**4.19***	**0.19***
Sorghum	2 at 0.038 10 days	15.83	**2.77***	**0.13***
Soybean	1 at 0.038, 1 at 0.021 14 days	11.39	**1.99***	0.09
Sunflower	3 at 0.038 10 days	21.68	**3.79***	**0.18***
Tree fruits and almond spray	9 at 0.1 7 days	12.6	**2.21***	**0.27***
Tree fruits and almond trunk spray	3 at 0.06 5 days	37.43	**6.55***	**0.30***
Tree nuts spray	6 at 0.0239 7 days	23.86	**4.18***	**0.27***
Wheat	2 at 0.0311 3 days	13.82	**2.42***	**0.11***

*RQ exceeds LOC of 0.1.
[1]University of California and USDA 2004

As part of the ECOTOX open literature search, studies on mixtures were reviewed to determine if they contained information relevant for the risk assessment. No studies tested mixture products that are currently registered by EPA; however, there were six studies that tested mixtures of *lambda*-cyhalothrin with other active ingredients (e.g., tank mixtures). Of these, two presented results relevant to this risk assessment. Wang et al. 2005 examined the synergistic effects of a number of chemicals mixed with abamectin; it was found that there were no significant increases in toxicological effects when *lambda*-cyhalothrin and abamectin were mixed. Hardke et al. 2005 found that *lambda*-cyhalothrin (insecticide) mixed with glyphosate (herbicide) resulted in significantly lower phytotoxicity damage than glyphosate alone. Although the target organisms (insects versus plants) are not the same, this study does document an instance where mixing *lambda*-cyhalothrin with another chemical decreases the efficacy of the other chemical. Measurements of *lambda*-cyhalothrin's efficacy were not performed in this study.

5.4. Use of Probit Slope Response Relationship to Provide Information on the Endangered Species Levels of Concern

The Agency uses the probit dose response relationship as a tool for providing additional information on the potential for acute direct effects to individual listed species and aquatic animals that may indirectly affect the listed species of concern (USEPA, 2004). As part of the risk characterization, an interpretation of acute RQs for listed species is discussed. This interpretation is presented in terms of the chance of an individual event (*i.e.*, mortality or immobilization) should exposure at the EEC actually occur for a species with sensitivity to *lambda*-cyhalothrin on par with the acute toxicity endpoint selected for RQ calculation. To accomplish this interpretation, the Agency uses the slope of the dose response relationship available from the toxicity study used to establish the acute toxicity measures of effect for each taxonomic group that is relevant to this assessment. The individual effects probability associated with the acute RQ is based on the mean estimate of the slope and an assumption of a probit dose response relationship. In addition to a single effects probability estimate based on the mean, upper and lower estimates of the effects probability are also provided to account for variance in the slope, if available.

Individual effect probabilities are calculated based on an Excel spreadsheet tool IECV1.1 (Individual Effect Chance Model Version 1.1) developed by the U.S. EPA, OPP, Environmental Fate and Effects Division (June 22, 2004). The model allows for such calculations by entering the mean slope estimate (and the 95% confidence bounds of that estimate) as the slope parameter for the spreadsheet. In addition, the acute RQ is entered as the desired threshold (Table 5-16).

Table 5-16. Summary of Individual Effect Probabilities for *Lambda*-Cyhalothrin Exposure at Scenarios that Produce RQs that Exceed the LOC

Taxa	Acute RQ (range)	Probit Slope	Chance of Effect (1 in…) (range)
Terrestrial Invertebrate LD_{50} = 0.30 µg a.i./g bee	18.1-1172	4.5 (Default slope)	1-1
Small Bird LD_{50} = 2051 mg ai/kg-bw	0.42-0.50	4.5 (Default slope)	11-22
Medium Amphibian LD_{50} = 3950 mg ai/kg-bw	0.19-0.23	4.5 (Default slope)	491-1710
Medium Reptile LD_{50} = 3950 mg ai/kg-bw	0.18-0.22	4.5 (Default slope)	648-2490
Small Mammal LD_{50} = 123 mg/kg-bw	0.11-6.96	4.5 (Default slope)	1-125000
FW Fish LC_{50} = 0.078 µg ai/L	0.12-64	4.5 (Default slope)	1-58500
FW Invertebrate EC_{50} = 1.4 ng ai/L	0.57-3571	4.5 (Default slope)	1-7
FW Benthic Invertebrate EC_{50} = 1.4 ng ai/L	0.71-3571	4.5 (Default slope)	1-4
E/M Fish LC_{50} = 0.807 µg ai/L	0.052-6.2	4.5 (Default slope)	1-265000000
E/M Invertebrate LC_{50} = 0.0049 µg ai/L	0.16-1020	4.5 (Default slope)	1-5850
E/M Benthic Invertebrate LC_{50} = 0.0049 µg ai/L	0.08-1020	4.5 (Default slope)	1-2510000

5.5. Ear Tag Assessment

For terrestrial exposures based on ear tag uses of *lambda*-cyhalothrin (e.g., CCR), a screening-level assessment of the potential magnitude of exposure in comparison with toxicological endpoints was conducted. Typically, an assessment of the mass of material per unit area and the acute oral dose (LD_{50}) is used to establish an index of potential acute avian toxic risk (LD_{50}/ft^2). The screening level assessment for acute avian effects in the case of pesticide application to livestock is based on the index of LD_{50}/animal. Magpies were chosen as a model species because they are known to forage for insects on the backs of cows. According to the product label (Saber Extra Insecticide Ear Tags – 773-75), there are two ear tags per cow, thus the total *lambda*-cyhalothrin mass per animal is 1.9 g (0.95 g ai/ear tag). If this mass is assumed to be 100 % available to a magpie (weight 170 g), the total available mass of *lambda*-cyhalothrin would be 0.011 g ai/g of bird or 11 g ai/kg or 11,000 mg ai/kg. The most sensitive LD_{50} (based on limited registrant-submitted data) is 3950 mg ai/kg-bw (mallard duck). Thus, the potential avian acute index would be 2780 LD_{50}/animal, which is below the most sensitive $LD_{50,}$ however; chronic toxicity may be a concern (NOAEC = 5 mg ai/kg-diet).

For aquatic exposures, ear tags were assessed by considering the number of tags that would need to fall into a pond to result in concentrations of *lambda*-cyhalothrin that would be toxic to aquatic organisms. The assessment is based on an assumption of 100% availability of the *lambda*-cyhalothrin in an ear tag to surface water once the tag is immersed. With this assumption regarding availability, one ear tag dropping into the EFED standard farm pond (20,000,000 L volume), would result in a theoretical water concentration of 0.0000000475 g/L or 0.0475 ug/L. Since the LC_{50} for freshwater fish is 0.078 µg ai/L (golden orfe) and the chronic NOEL is 0.024 µg ai/L (ACR for golden orfe), it would take only two ear tags (i.e., one cow) to trigger acute risk concerns and one ear tag to trigger chronic concerns.

Similar calculations were performed to evaluate potential risk to aquatic invertebrates. Given the theoretical water concentration 0.0475 ug/L, it would take only one ear tag to trigger acute and chronic risk concerns, since the LC_{50} for freshwater invertebrates (the most sensitive freshwater organisms tested) is 0.0014 µg ai/L (scud) and the chronic NOAEC is 0.000008 µg ai/L (ACR for scud).

5.5.1. Primary Constituent Elements of Designated Critical Habitat

For *lambda*-cyhalothrin use, the assessment endpoints for designated critical habitat PCEs involve the same endpoints as those being assessed relative to the potential for direct and indirect effects to the listed species assessed here. Therefore, the effects determinations for direct and indirect effects are used as the basis of the effects determination for potential modification to designated critical habitat.

5.6. Risk Description

The risk description synthesizes overall conclusions regarding the likelihood of adverse effects leading to a preliminary effects determination (*i.e.*, "no effect," "may affect, but not likely to adversely affect," or "likely to adversely affect") for the assessed species and the potential for modification of their designated critical habitat based on analysis of risk quotients and a comparison to the Level of Concern. The final No Effect/May Affect determination is made after the spatial analysis is completed at the end of the risk description, Section 5.6.9. In Section 5.6.9, a discussion of any potential overlap between areas where potential usage may result in LAA effects and areas where species are expected to occur (including any designated critical habitat) is presented. If there is no overlap of the species habitat and occurrence sections with the Potential Area of LAA Effects, a No Effect determination is made.

If the RQs presented in the Risk Estimation (Section 5.1) show no direct or indirect effects for the assessed species, and no modification to PCEs of the designated critical habitat, a preliminary "no effect" determination is made, based on *lambda*-cyhalothrin's use within the action area. However, if LOCs for direct or indirect effect are exceeded or effects may modify the PCEs of the critical habitat, the Agency concludes a preliminary "may affect" determination for the FIFRA regulatory action regarding *lambda*-cyhalothrin. Based on this risk estimation process described above, all species in this assessment, the BCB, CCR, CFWS, CTS (all DPS), DS, SFGS, TG, and VELB have a preliminary "may affect" determination. A summary of the risk estimation results are provided in Table 5-17 for direct and indirect effects to the listed species assessed here and the PCEs of their designated critical habitat.

Table 5-17. Risk Estimation Summary for *Lambda*-Cyhalothrin - Direct and Indirect Effects

Taxa	LOC Exceedances (Yes/No)	Description of Results of Risk Estimation	Assessed Species Potentially Affected	Species Associated with a Designated Critical Habitat that May Be Modified by the Assessed Action
Freshwater Fish and Aquatic-phase Amphibians	Non-listed Species (Yes)	More than half of the uses exceeded the non-listed acute LOC (0.5). About 30% of the uses exceeded the chronic LOC (1). These uses include: mustard cabbage (ground); cabbage, kohlrabi (ground); mustard (ground); airports/landing fields (ground); seed orchard trees (ground); rice (ground); recreational areas (crack and crevice/spot treatment); residential lawns (mound); paved areas (ground); ornamental and/or shade trees, ground over, herbaceous plants, non-flowering plants, woody shrubs and vines, roses (dust); lettuce (aerial and ground); garlic (aerial); fruiting vegetables (aerial); forest plantings (ground); sweet corn (aerial, dust, and in furrow); conifers (plantations/nurseries) (ground); conifer seed orchard (ground); cole crops (aerial and ground); Brussels sprouts (dust); broccoli, cauliflower (ground); brassica	Indirect Effects (prey items): CCR, CTS (all DPS), SFGS	CTS-CC, CTS-SB, DS, TG

Taxa	LOC Exceedances (Yes/No)	Description of Results of Risk Estimation	Assessed Species Potentially Affected	Species Associated with a Designated Critical Habitat that May Be Modified by the Assessed Action
		head and stem vegetables (aerial); bell pepper, catjang (aerial); household/domestic dwellings, outdoor premises (ground); alfalfa (aerial).		
	Listed Species (Yes)	All but two of the uses (trunk drench for cherry, peach, nectarine, and apple) exceeded the acute listed species LOC (0.05). Approximately 30% of the uses exceeded the chronic LOC (listed in the above row).	Direct Effects: CTS (all DPS), DS, TG	
Freshwater Invertebrates (Non-Benthic)	Non-listed Species (Yes)	All uses exceeded the acute non-listed LOC (0.5) and chronic LOC (1).	Indirect Effects (prey items): CCR, CFWS, CTS (all DPS), DS, SFGS, TG	CTS-CC, CTS-SB, DS, TG
	Listed Species (Yes)	All uses exceeded the acute listed LOC (0.05) and chronic LOC (1).	Direct Effects: CFWS	
Freshwater Benthic Invertebrates	Non-listed Species (Yes)	All but five uses [nectarine, apple, peach, cherry trunk drench; golf course turf, ornamental sod farm (ground); potato (ground); recreational areas (banding)] exceeded the acute non-listed LOC (0.5). All uses exceeded the chronic LOC (1).	Indirect Effects (prey items): CCR, CFWS, CTS (all DPS), DS, SFGS, TG	CTS-CC, CTS-SB, DS, TG
	Listed Species (Yes)	All but two uses (nectarine, apple, peach, cherry trunk drench) exceeded the acute listed LOC (0.05). All uses exceeded the chronic LOC.	Direct Effects: CFWS	
Estuarine/Marine Fish	Non-listed Species (Yes)	Ten uses exceeded the acute non-listed LOC (0.5) for *lambda*-cyhalothrin. These uses are: alfalfa (aerial); household/ domestic dwellings, outdoor premises (ground); conifer plantations and nurseries (ground); conifer seed orchards (ground); ornamental and/or shade trees, ground cover, herbaceous plants, non-flowering	Indirect Effects (prey items): CCR	DS, TG

Taxa	LOC Exceedances (Yes/No)	Description of Results of Risk Estimation	Assessed Species Potentially Affected	Species Associated with a Designated Critical Habitat that May Be Modified by the Assessed Action
		plants, woody shrubs and vines, roses (dust); paved areas (ground); residential lawns (mound); seed orchard trees (ground). The chronic LOC (1) was exceeded for two uses: rice (ground); ornamental and/or shade trees, ground cover, herbaceous plants, non-flowering plants, woody shrubs and vines, rose (dust).		
	Listed Species (Yes)	Approximately 65% of the uses exceeded the acute LOC (0.05). Chronic LOCs were exceeded for six uses (see row above).	Direct Effects: DS, TG	
Estuarine/Marine Invertebrates (Non-Benthic)	Non-listed Species (Yes)	All but two uses (nectarine, peach, cherry, apple trunk drench) exceeded the acute non-listed species LOC (0.5). Only one use did not exceed the chronic LOC (1) (apple trunk drench).	Indirect Effects (prey items): CCR, DS, TG	DS, TG
Estuarine/Marine Benthic Invertebrates	Non-listed Species (Yes)	Most uses exceeded the acute non-listed species LOC (0.5). All but two uses (nectarine, cherry, peach, and apple trunk drench) exceeded the chronic LOC (1).	Indirect Effects (prey items): CCR, DS, TG	DS, TG
Birds, Reptiles, and Terrestrial-Phase Amphibians	Non-listed Species (Yes)	Based on T-REX modeling, acute RQs exceeded the non-listed species LOC (0.5) for two uses for birds (household/domestic dwellings outdoor premises barrier and crack and crevice treatment; and recreational areas crack and crevice and spot treatment). The T-HERPS refinements for these uses resulted in RQs that did not exceed the non-listed species LOC for reptiles and terrestrial-phase amphibians. All of the "spray" uses exceeded the chronic LOC (1) for birds, reptiles, and terrestrial-phase amphibians (T-REX and T-HERPS modeling). The following non-spray uses did not: corn (field, sweet, pop) (soil in-furrow/T-banding); airports/landing fields (granular); golf course turf, ornamental sod farm (granular); grasses grown for seed	Indirect Effects: CCR, CTS (all DPS), SFGS	CTS-CC, CTS-SB

Taxa	LOC Exceedances (Yes/No)	Description of Results of Risk Estimation	Assessed Species Potentially Affected	Species Associated with a Designated Critical Habitat that May Be Modified by the Assessed Action
		(granular); nonagricultural uncultivated areas/soil (granular band and mound); residential lawns (granular ground and mound).		
	Listed Species (Yes)	Based on T-REX modeling and T-HERPS refinements, acute RQs exceeded the listed LOC (0.1) for three uses (animal housing premises paths/patios barrier treatment – birds only; household/domestic dwellings outdoor premises barrier and crack and crevice treatment; ornamental and/or shade trees, ground cover, herbaceous plants, non flowering plants, woody shrubs and vines, and rose ground and dust application; and recreational areas crack and crevice and spot treatment). Chronic RQs were exceeded as described in the row above.	<u>Direct Effects</u>: CCR, CTS (all DPS), SFGS	
Mammals	Non-listed Species (Yes)	Based on T-REX modeling, acute RQs exceeded the non-listed LOC (0.5) for a number of uses (seed orchard trees; recreational areas, crack and crevice spot treatment; paved areas; ornamental and/or shade trees, ground cover, herbaceous plants, non flowering plants, woody shrubs and vines, and rose ground and dust application; ornamental and/or shade trees, ground; conifers (seed orchard); commercial/industrial lawns, ornamental lawns and turf, recreation area lawns, mound/spot treatment/ground; animal housing premises, paths/patios, barrier treatment/crack and crevice; household/ domestic dwellings outdoor premises barrier and crack and crevice treatment; apple, cherry, crabapple, nectarine, peach, pear, plum, prune, ground dust and spray; almond, ground dust and spray; and agricultural/farm premises, crack and crevice/surface spray/perimeter treatment). With the exception of alfalfa; apple trunk drench; beechnut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut; barley; brassica head and stem vegetables; Brussels sprouts (ground spray); buckwheat, oat, rye; canola/rape; grass forage/ fodder/hay, pastures, rangeland; cereal grains, triticale, wheat;	<u>Indirect Effects</u>: (prey items) CCR (prey items and habitat) CTS (all DPS), SFGS	CTS-CC, CTS-SB

Taxa	LOC Exceedances (Yes/No)	Description of Results of Risk Estimation	Assessed Species Potentially Affected	Species Associated with a Designated Critical Habitat that May Be Modified by the Assessed Action
		field corn; sweet corn (spray, soil-in-furrow); cotton; golf course turf ornamental sod farm (ground and granular); legume vegetables; peanuts, root and tuber vegetables; potato; rice; sunflower; airports/landing fields (granular); grasses grown for seed (granular); nonagricultural uncultivated areas/soil (granular); residential lawns (granular); sorghum; and soybean, all other uses exceeded the chronic LOC (1).		
	Listed Species (Yes)	Based on T-REX modeling, acute RQs exceeded the listed LOC (0.1) for all uses except soybean and the in-furrow corn treatments. See above row for the uses that exceeded the chronic LOC.	<u>Direct Effects</u>: None	
Terrestrial Invertebrates	Listed Species (Yes)	RQs exceeded the listed and non-listed species LOC for all uses.	<u>Direct Effects:</u> BCB, VELB	BCB, VELB
	Non-listed Species (Yes)		<u>Indirect Effects</u>: CCR, CTS (all DPS), SFGS	CTS-CC, CTS-SB

Following a preliminary "may affect" determination, additional information is considered to refine the potential for exposure at the predicted levels based on the life history characteristics (*i.e.*, habitat range, feeding preferences, *etc*.) of the assessed species. Based on the best available information, the Agency uses the refined evaluation to distinguish those actions that "may affect, but are not likely to adversely affect" from those actions that are "likely to adversely affect" the assessed species and its designated critical habitat.

The criteria used to make determinations that the effects of an action are "not likely to adversely affect" the assessed species or modify its designated critical habitat include the following:

- <u>Significance of Effect</u>: Insignificant effects are those that cannot be meaningfully measured, detected, or evaluated in the context of a level of effect where "take" occurs for even a single individual. "Take" in this context means to harass or harm, defined as the following:

- Harm includes significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering.
- Harass is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering.

- Likelihood of the Effect Occurring: Discountable effects are those that are extremely unlikely to occur.
- Adverse Nature of Effect: Effects that are wholly beneficial without any adverse effects are not considered adverse.

A description of the risk and effects determination for each of the established assessment endpoints for the assessed species and their designated critical habitat is provided in Sections 5.2.1 through 5.2.8. The effects determination section for each listed species assessed will follow a similar pattern. Each will start with a discussion of the potential for direct effects, followed by a discussion of the potential for indirect effects. These discussions do not consider the spatial analysis. For those listed species that have designated critical habitat, the section will end with a discussion on the potential for modification to the critical habitat from the use of *lambda*-cyhalothrin. Finally, in Section 5.6.9, a discussion of any potential overlap between areas of concern and the species (including any designated critical habitat) is presented. If there is no overlap of the species habitat and occurrence sections with the Potential Area of LAA Effects, a No Effect determination is made.

5.6.1. Bay Checkerspot Butterfly

5.6.1.a. Direct Effects

RQs for all *lambda*-cyhalothrin uses exceed the LOC (0.05) for direct effects to the BCB, resulting in a preliminary "may affect" determination. *Lambda*-cyhalothrin is an insecticide and thus it is expected to have adverse effects on insects. However, it should be noted that there is uncertainty regarding the use of honeybee data as a surrogate for lepidopteran species (Hoang et al. 2011).

Four incidents involving terrestrial invertebrates (honeybees) were reported for *lambda*-cyhalothrin in the EIIS database. All reported large numbers of dead bees and the loss or partial loss of hives (22 to 92 hives) as a result of *lambda*-cyhalothrin applications. One of the incidents involved *lambda*-cyhalothrin and another insecticide/acaricide, but the other three involved *lambda*-cyhalothrin only. Of these, one of them was a misuse because the application occurred during bee flight activity.

There were two non-guideline studies on honeybees that were submitted to the Agency. One of the studies (MRID 40436303) documented possible repellency effects of *lambda*-cyhalothrin to honeybees. Honeybee response was observed via a choice test with simulated honeydew. The results indicated that honeybees preferred the honeydew samples without *lambda*-cyhalothrin. A honeybee foliage acute toxicity test (MRID 4043602) established LT_{50} values for two typical *lambda*-cyhalothrin application rates – 0.013 and 0.031 lb ai/A). LT_{50}s ranged from 4 to 12 hours at the lower application rate to 23 hours at the higher application rate. Likewise, the NOEL was identified as 24 to 96 hours, depending on the application rate. These results suggest that honeybees, and possibly other insects, may experience adverse effects up to 4 days after an application of *lambda*-cyhalothrin is made (0.031 lb ai/A rate).

No open literature studies were available specifically for *lambda*-cyhalothrin on insects.

The probability of an individual effect for a BCB is high: 1 in 1 (100%) for all application rates (Appendix N). These probabilities are calculated based on the acute RQs and the default probit slope of 4.5.

Based on the weight of evidence presented here, there is a potential for direct effects to the BCB as a result of *lambda*-cyhalothrin uses.

5.6.1.b. Indirect Effects

The BCB relies on terrestrial dicot plants exclusively for both food and habitat and has an obligate relationship with dicots (dwarf plaintain species). Eggs are laid on a native plantain which the larvae feed upon; if this food is not sufficient for development, the larvae may move onto owl's clover. The adult butterflies live on nectar, feeding on a variety of plants. The BCB inhabits grasslands on serpentine soils, such as the Montara soil series; populations now remain only in San Mateo and Santa Clara counties.

No plant toxicity data are available from registrant-submitted studies. In lieu of this, the Pesticide Ecotoxicity Database (maintained by EFED) was consulted for information on terrestrial plant data for other pyrethroids. Terrestrial plant studies were not available for any of the other pyrethroids. Studies from open literature also were consulted. Two product efficacy studies were evaluated. Both tested the formulation Karate™ and neither documented any adverse effects of the insecticide on plants (wheat and groundnuts). Application rates up to 0.004 lb ai/A (groundnut) and 0.025 lb ai/A (wheat) were tested; the maximum application rate for *lambda*-cyhalothrin is 2 lb ai/A. In addition, four incidents were identified in the EIIS; three incidents were listed as possibly being caused by *lambda*-cyhalothrin and one was listed as unlikely. Additional information was not available, although *lambda*-cyhalothrin was the only pesticide used in three of the reported incidents. Twenty-six plant incidents were recorded in the IDS; however, no additional information was available. Given the reported incidents for terrestrial plants and the lack of toxicity information, effects to non-target plants, including the obligate host – dwarf plantain speces – cannot be precluded. Therefore, there is the potential for indirect effects to the BCB.

5.6.1.c. Modification of Designated Critical Habitat

Based on the assessment of direct and indirect effects to the BCB above, the modification of designated critical habitat for the BCB is possible.

5.6.2. California Clapper Rail

5.6.2.a. Direct Effects

Three *lambda*-cyhalothrin uses resulted in acute RQs that exceed the LOC for direct effects to the CCR. All *lambda*-cyhalothrin "spray" uses yielded chronic RQs that exceed the LOCs for direct effects to the CCR. Thus, a preliminary "may affect" determination is appropriate.

No incidents involving birds have been reported. No open literature studies on the effects of *lambda*-cyhalothrin on birds or terrestrial-phase amphibians have been identified. The only sub-lethal effect reported from registrant-submitted studies was a slight loss in weight during the first days immediately following the consumption of *lambda*-cyhalothrin. Recovery occurred by the end of the study.

The probability of an individual effect for a CCR based on avian toxicity data is between 1 in 11 (9%) and 1 in 22 (4.5%) for the three *lambda*-cyhalothrin application rates (animal housing premises paths/patios barrier treatment – birds only; household/domestic dwellings outdoor premises barrier and crack and crevice treatment; ornamental and/or shade trees, ground cover, herbaceous plants, non flowering plants, woody shrubs and vines, and rose ground and dust application; and recreational areas crack and crevice and spot treatment) with RQs above the LOC (Appendix N). These probabilities are calculated based on acute RQs and the default probit slope of 4.5.

At higher application rates, bioaccumulation posed a risk for birds eating aquatic prey; however, those application rates also exceeded acute LOCs; thus the prey would likely die before bioaccumulation occurred. At lower application rates (< 0.1 lb ai/A), bioaccumulation does not pose risks to piscivorous birds.

Based on the weight of evidence presented here, there is a potential for direct effects to the CCR as a result of *lambda*-cyhalothrin uses.

5.6.2.b. Indirect Effects

The CCR is a generalist and opportunistic feeder that forages at the upper end of marshes, along the ecotone between mudflat and higher vegetated zones, and in tidal sloughs. Mussels, clams, arthropods, snails, worms and small fish are its preferred foods, which it retrieves by probing and scavenging the surface while walking. The bird will only forage on mudflats or very shallow water where there is taller plant material nearby to provide protection at high tide. Although CCRs typically consume invertebrates, they have also been known to occasionally consume small birds and mammals, including the salt marsh harvest mouse. The CCR diet may contain up to 15% plant material.

Indirect effects to the CCR via loss of prey species and plant foods are evaluated using toxicity data and other information gathered on freshwater fish, freshwater invertebrates, estuarine/marine fish, estuarine/marine invertebrates, aquatic plants, birds, small mammals, terrestrial invertebrates, and terrestrial plants.

The CCR inhabits cordgrass marshes around San Francisco Bay. CCR juveniles can disperse a sufficient distance to be found in both residential and agricultural areas east of SF Bay and along the open coast.

Freshwater Fish

Approximately 65% of the scenarios yielded acute RQs that exceeded the acute non-listed species LOC (0.5) and about 30% of the scenarios exceeded the chronic LOC (1). The probability of an individual effect for a non-listed species is between 1 in 5.24×10^{18} and 1 in 1 (100%).

For a summary of reported incident information to freshwater fish, see Section 5.2.5.a.

Indirect effects to the CCR are possible based on this prey component.

Freshwater Invertebrates

Acute RQs exceed the non-listed species LOC (0.5) for all uses for freshwater invertebrates and most uses for freshwater benthic invertebrates. Chronic RQs were exceeded for all of the freshwater benthic and non-benthic invertebrates. The probability of an individual effect for a non-listed species freshwater invertebrate is between 1 in 7 (14%) and 1 in 1 (100%). The probability of an individual effect for a non-listed species of freshwater benthic invertebrates is between 1 in 2.75×10^{16} and 1 in 1 (100%).

There were three incidents reported specifically for a freshwater invertebrate (crayfish) in the EIIS database. Detailed information was only available for one of them. The incident was listed as "highly probable" to have occurred as the result of *lambda*-cyhalothrin exposure. It involved the aerial application (registered use) of Karate to cotton in Wilson County, Texas in 2004. An unreported number of crayfish were observed to be dead. The listed route of exposure was through spray drift.

Therefore, indirect effects to the CCR are possible based on this prey component.

Estuarine/Marine Fish

Ten of the *lambda*-cyhalothrin uses exceed the acute non-listed LOC (0.5) and two of the uses exceed the chronic LOC (1) for estuarine/marine fish. The probability of an individual effect for a non-listed species is between 1 in 1.28×10^{41} and 1 in 1 (100%).

Based on the weight of evidence presented here, indirect effects to the CCR are possible based on this prey component.

Estuarine/Marine Invertebrates

Acute RQs exceeded the non-listed species LOC (0.5) for all but two of the estuarine/marine invertebrate scenarios and for more than 50% of the estuarine/marine benthic invertebrate use scenarios. Chronic RQs exceeded the chronic LOC (1.0) for all but one estuarine/marine invertebrates use scenarios and all but two scenarios for estuarine/marine benthic invertebrates. The probability of an individual effect for a non-listed species of estuarine/marine invertebrates is between 1 in 5850 and 1 in 1 (100%). The probability of an individual effect for a non-listed species of estuarine/marine benthic invertebrates is between 1 in 5.25×10^{26} and 1 in 1 (100%).

There are no incident reports or open literature studies available on the effects of *lambda*-cyhalothrin on estuarine/marine invertebrates or estuarine/marine benthic invertebrates; however, incidents on invertebrates are unlikely to be noticed and reported to the Agency.

Considering the weight of evidence, indirect effects to the CCR based on this prey component are possible.

Aquatic Plants

Toxicity data were not available for vascular aquatic plants, thus non-vascular plants were used as a surrogate. The non-vascular plant EC_{50} was greater than 310 µg ai/L. RQs cannot be calculated from a non-definitive value; however, 310 µg ai/L is much greater than the largest peak surface water EEC (179.7 µg ai/L). Another Class II pyrethroid, fenvalerate, had algae and diatom toxicity values of > 1000 µg ai/L, thus lending support that Class II pyrethroids are not very toxic to aquatic plants. Based on these lines of evidence, it is unlikely that there would be adverse effects to aquatic plants from the maximum use rate of *lambda*-cyhalothrin.

Indirect effects to the CCR based on this food and habitat component are not likely.

Birds

For the same reasons that are detailed in the CCR direct effects section, indirect effects to the CCR are possible based on risk to small avian prey. Two of the registered uses exceeded the non-listed species LOC (0.5) in T-REX. The probability of an individual effect for a non-listed avian species ranges from less than 1 in 8.86×10^{18} to 1 in 11 (9%).

Small Mammals

Many use scenarios produced acute and chronic RQs that exceed both the listed and non-listed species LOCs. The probability of an individual effect ranges from 1 in 791,000 (0.00012%) to 1 in 1 (100%) for all uses. These probabilities are based on acute LOCs and the default probit slope (4.5). At higher application rates, bioaccumulation posed a risk to mammals; however, those application rates also exceeded acute LOCs; thus the prey would likely die before bioaccumulation occurred. At lower application rates (< 0.1 lb ai/A), bioaccumulation does not pose risks to mammals.

Therefore, indirect effects to the CCR are possible based on risk to small mammalian prey.

Terrestrial Invertebrates

For the same reasons that are detailed in the BCB and VELB direct effects sections, indirect effects to the CCR are possible, based on risk to terrestrial invertebrate prey.

Terrestrial Plants

No plant toxicity data are available from registrant-submitted studies. In lieu of this, the Pesticide Ecotoxicity Database (maintained by EFED) was consulted for information on terrestrial plant data for other pyrethroids. Terrestrial plant studies were not available for any of the other pyrethroids. Studies from open literature also were consulted. Two product efficacy studies were evaluated. Both tested the formulation Karate™ and neither documented any adverse effects of the insecticide on plants (wheat and groundnuts). Application rates up to 0.004 lb ai/A (groundnut) and 0.025 lb ai/A (wheat) were tested. In addition, four incidents were identified in the EIIS; three incidents were listed as possibly being caused by *lambda*-cyhalothrin and one was listed as unlikely. Additional information was not available, although *lambda*-cyhalothrin was the only pesticide being used in three of the cases. Twenty-six plant incidents were recorded in the IDS, but there was no additional information available.

Given the uncertainty and dearth of data for terrestrial plants, effects to non-target plants cannot be precluded, thus there is the potential for indirect effects to the CCR.

5.6.3. California Freshwater Shrimp

5.6.3.a. Direct Effects

Acute and chronic RQs exceeded the listed species LOCs (acute = 0.05, chronic = 1) for all use scenarios, resulting in a preliminary "may affect" determination. The probability of an individual effect for listed freshwater invertebrates ranged from 1 in 1 (100%) to 1 in 7 (14%). These probabilities were calculated based on acute RQs and the default probit slope of 4.5. The ear tag use screening assessment indicated it would take only one ear tag to trigger acute and chronic risk concerns.

There were three incidents reported specifically for a freshwater invertebrate (crayfish) in the EIIS database. Detailed information was only available for one of them. The incident was listed as "highly probable" to have occurred as the result of *lambda*-cyhalothrin exposure. It involved the aerial application (registered use) of Karate to cotton in Wilson County, Texas in 2004. An unreported number of crayfish were observed to be dead. The listed route of exposure was through spray drift.

Based on the weight of evidence, direct effects are possible to the CFWS.

5.6.3.b. Indirect Effects

The CFWS relies on aquatic and terrestrial plants for both food and habitat. The CFWS feeds on decomposing vegetation and other detritus, consuming minute diverse particles conveyed by currents to downstream pools, which includes zooplankton. The CFWS is found only in low elevation perennial streams or intermittent streams with perennial pools in the northern San Francisco Bay Area. Freshwater shrimp require low gradient streams with diverse habitat structure including undercut banks, exposed roots, woody debris and overhanging vegetation. Indirect effects to the CFWS via loss of food and habitat are evaluated using toxicity data and other information gathered on freshwater invertebrates, aquatic plants, and terrestrial plants.

Freshwater Invertebrates

Acute RQs exceed the non-listed species LOC (0.5) for all uses for freshwater invertebrates and most uses for freshwater benthic invertebrates. Chronic RQs were exceeded for all of the freshwater benthic and non-benthic invertebrates. The probability of an individual effect for a non-listed species freshwater invertebrate is between 1 in 7 (14%) and 1 in 1 (100%). The probability of an individual effect for a non-listed species of freshwater benthic invertebrates is between 1 in 2.75 x 10^{16} and 1 in 1 (100%). In addition, the reasons outlined in the CFWS direct effect section also are applicable.

Therefore, indirect effects to the CFWS are possible based on risk to freshwater invertebrate prey items.

Aquatic Plants

Toxicity data were not available for vascular aquatic plants, thus non-vascular plants were used as a surrogate. The non-vascular plant EC_{50} was greater than 310 µg ai/L. RQs cannot be calculated from a non-definitive value; however, 310 µg ai/L is much greater than the largest peak surface water EEC (179.7 µg ai/L). Another Class II pyrethroid, fenvalerate, had algae and diatom toxicity values of > 1000 µg ai/L, thus lending support that Class II pyrethroids are not very toxic to aquatic plants. Based on these lines of evidence, it is unlikely that there would be adverse effects to aquatic plants from the maximum use rate of *lambda*-cyhalothrin.

Indirect effects to the CFWS based on this food and habitat component are not likely.

Terrestrial Plants

No plant toxicity data are available from registrant-submitted studies. In lieu of this, the Pesticide Ecotoxicity Database (maintained by EFED) was consulted for information on terrestrial plant data for other pyrethroids. Terrestrial plant studies were not available for any of the other pyrethroids. Studies from open literature also were consulted. Two product efficacy studies were evaluated. Both tested the formulation Karate™ and neither documented any adverse effects of the insecticide on plants (wheat and groundnuts). Application rates up to 0.004 lb ai/A (groundnut) and 0.025 lb ai/A (wheat) were tested. In addition, four incidents were identified in the EIIS; three incidents were listed as possibly being caused by *lambda*-cyhalothrin and one was listed as unlikely. Additional information was not available, although *lambda*-cyhalothrin was the only pesticide being used in three of the cases. Twenty-six plant incidents were recorded in the IDS, but there was no additional information available.

Given the uncertainty and dearth of data for terrestrial plants, effects to non-target plants cannot be precluded, thus there is the potential for indirect effects to the CFWS.

5.6.4. California Tiger Salamander (All DPS)

5.6.4.a. Direct Effects

Aquatic-phase

The aquatic-phase includes life stages of the CTS that are obligatory aquatic organisms, including eggs and larvae. It also includes submerged terrestrial-phase juveniles and adults, which spend a portion of their time in water bodies that may receive runoff and spray drift containing *lambda*-cyhalothrin.

All but two scenarios yielded acute RQs that exceeded the listed species LOC (0.05) and about 30% of the scenarios exceeded the chronic LOC (1). The probability of an individual effect for listed aquatic-phase amphibians was between 1 in 1 (100%) to 1 in 299,000 (0.0003%). These probabilities were calculated based on acute RQs and the default probit slope (4.5). The ear tag screening assessment indicated it would take only two ear tags (i.e., one cow) to trigger acute risk concerns and one ear tag to trigger chronic concerns.

No incidents were reported for aquatic-phase amphibians.

Based on the lines of evidence, direct effects to the aquatic-phase CTS are possible.

Terrestrial-phase

Potential for direct effects to the terrestrial-phase CTS are assessed based on direct acute and chronic toxicity effects to birds as a surrogate because of a lack of toxicity data for terrestrial-phase amphibians. Three acute RQs and all chronic RQs for *lambda*-cyhalothrin uses exceed the listed species LOC for direct effects to the terrestrial-phase CTS, resulting in a preliminary "may affect" determination.

A refinement of the acute and chronic risks posed to the terrestrial-phase CTS was performed using the T-HERPS model. Avian RQ values used as screening surrogates for terrestrial-phase amphibians likely overestimate risks to amphibians because of the higher energy requirements of birds over amphibians of the same body weight, which results in a higher daily food intake rate value and a resultant higher dose-based exposure for birds than would occur for an amphibian of the same body weight. The T-HERPS model refines the EEC and RQ values based on the dietary intake rate of an amphibian, rather than a dietary intake rate of a bird. Acute RQs show a slight decrease when modeled in T-HERPS, but remain above the listed species LOC for two of the uses that posed acute risks to birds. Chronic RQ values increased under the T-HERPS model, still exceeding the LOC for all uses. Model results from T-HERPS are from the most sensitive RQs, medium amphibians (20 g) consuming herbivorous mammals.

The probability of an individual effect for a CTS based on avian toxicity data is between 1 in 491 (0.2%) and 1 in 1710 (0.06%) for the full range of *lambda*-cyhalothrin application rates (Table 4-7). These probabilities are calculated based on acute RQs and the default probit slope of 4.5.

No incidents were reported specifically for terrestrial-phase amphibians, but there were 22 minor fish and wildlife incidents in the IDS. It is uncertain if any of these pertained to amphibians.

Based on the weight of evidence presented here, direct effects to the terrestrial-phase CTS as a result of *lambda*-cyhalothrin uses are possible.

5.6.4.b. Indirect Effects

CTS larvae are only able to eat small crustaceans, algae, and mosquito larvae. When they are large enough, they begin to consume aquatic insects, invertebrates and tadpoles of Pacific treefrogs, California red-legged frogs, western toads, and spadefoot toads. The terrestrial-phase CTS feeds on terrestrial invertebrates, insects, frogs, worms, and small mammals. Indirect effects to the CTS via loss of prey species are evaluated using toxicity data and other information gathered on freshwater invertebrates, freshwater fish, terrestrial invertebrates, and small mammals.

The CTS inhabits low elevation vernal pools and seasonal ponds and associated grassland, oak savannah, and coastal scrub plant communities. Juvenile and adult CTS spend the dry summer and fall months in the burrows of California ground squirrels (*Spermophilus beecheyi*) and Botta's pocket gopher (*Thomomys bottae*). The CTS cannot dig their own burrows; as a result, their presence is associated with active burrows of these small mammals. Indirect effects to the CTS through potential modification of habitat are evaluated based on the effects of *lambda*-cyhalothrin on aquatic plants, terrestrial plants, and small mammals.

Freshwater Invertebrates

Acute RQs exceed the non-listed species LOC (0.5) for all uses for freshwater invertebrates and most uses for freshwater benthic invertebrates. Chronic RQs were exceeded for all of the freshwater benthic and non-benthic invertebrates. The probability of an individual effect for a non-listed species freshwater invertebrate is between 1 in 7 (14%) and 1 in 1 (100%). The probability of an individual effect for a non-listed species of freshwater benthic invertebrates is between 1 in 2.75×10^{16} and 1 in 1 (100%).

For a summary of reported incident information to freshwater invertebrates, see Section 5.2.3.a.

The evidence suggest that indirect effects to the CTS are possible based on this prey component.

Freshwater Fish/Amphibians

Approximately 65% of the scenarios yielded acute RQs that exceeded the acute non-listed species LOC (0.5) and about 30% of the scenarios exceeded the chronic LOC (1). The probability of an individual effect for a non-listed species of fish is between 1 in 5.24×10^{18} and

1 in 1 (100%). At higher application rates, bioaccumulation posed a risk for amphibians (using birds as a surrogate) eating aquatic prey; however, those application rates also exceeded acute LOCs; thus the prey would likely die before bioaccumulation occurred. At lower application rates (< 0.1 lb ai/A), bioaccumulation does not pose risks to amphibians.

For a summary of reported incident information to freshwater fish, see Section 5.2.5.a.

Considering the lines of evidence, indirect effects to the CTS are possible based on this prey component.

Terrestrial Invertebrates

For the same reasons that are detailed in the BCB and VELB direct effects sections, indirect effects to the CTS are possible based on risk to terrestrial invertebrate prey.

Small Mammals

Mammals are part of the CTS diet. In addition, juvenile and adult CTS rely on the burrows of small mammals for habitat in the dry summer and fall months. Many use scenarios produced acute and chronic RQs that exceed both the listed and non-listed species LOCs. The probability of an individual effect ranges from 1 in 791,000 (0.00012%) to 1 in 1 (100%) for all uses. These probabilities are based on acute LOCs and the default probit slope (4.5). At higher application rates, bioaccumulation posed a risk to mammals; however, those application rates also exceeded acute LOCs; thus the prey would likely die before bioaccumulation occurred. At lower application rates (< 0.1 lb ai/A), bioaccumulation does not pose risks to mammals. Therefore, indirect effects are anticipated to the CTS based on risk to small mammalian prey and a reduction in small mammal burrows.

Aquatic Plants

Aquatic plants serve several important functions in aquatic ecosystems. Non-vascular aquatic plants are primary producers and provide the autochthonous energy base for aquatic ecosystems. Vascular plants provide structure, rather than energy, to the system, as attachment sites for many aquatic invertebrates, and refugia for juvenile organisms, such as fish and frogs. Emergent plants help reduce sediment loading and provide stability to nearshore areas and lower stream banks. In addition, vascular aquatic plants are important as attachment sites for egg masses of aquatic species.

Toxicity data were not available for vascular aquatic plants, thus non-vascular plants were used as a surrogate. The non-vascular plant EC_{50} was greater than 310 µg ai/L. RQs cannot be calculated from a non-definitive value; however, 310 µg ai/L is much greater than the largest peak surface water EEC (179.7 µg ai/L). Another Class II pyrethroid, fenvalerate, had algae and diatom toxicity values of > 1000 µg ai/L, thus lending support that Class II pyrethroids are not very toxic to aquatic plants. Based on these lines of evidence, it is unlikely that there would be adverse effects to aquatic plants from the maximum use rate of *lambda*-cyhalothrin.

Indirect effects to the CTS based on this food and habitat component are not likely.

Terrestrial Plants

Terrestrial plants serve several important habitat-related functions for the listed assessed species. In addition to providing habitat and cover for invertebrate and vertebrate prey items of the listed assessed species, terrestrial vegetation also provides shelter and cover from predators while foraging. Upland vegetation, including grassland and woodlands, provides cover during dispersal. Riparian vegetation helps to maintain the integrity of aquatic systems by providing bank and thermal stability, serving as a buffer to filter out sediment, nutrients, and contaminants before they reach the water, and serving as an energy source.

No plant toxicity data are available from registrant-submitted studies. In lieu of this, the Pesticide Ecotoxicity Database (maintained by EFED) was consulted for information on terrestrial plant data for other pyrethroids. Terrestrial plant studies were not available for any of the other pyrethroids. Studies from open literature also were consulted. Two product efficacy studies were evaluated. Both tested the formulation Karate™ and neither documented any adverse effects of the insecticide on plants (wheat and groundnuts). Application rates up to 0.004 lb ai/A (groundnut) and 0.025 lb ai/A (wheat) were tested. In addition, four incidents were identified in the EIIS; three incidents were listed as possibly being caused by *lambda*-cyhalothrin and one was listed as unlikely. Additional information was not available, although *lambda*-cyhalothrin was the only pesticide being used in three of the cases. Twenty-six plant incidents were recorded in the IDS, but there was no additional information available.

Given the uncertainty and dearth of data for terrestrial plants, effects to non-target plants cannot be precluded, thus there is the potential for indirect effects to the CTS.

5.6.4.c. Modification of Designated Critical Habitat

Based on the assessment of direct and indirect effects to the CTS, the modification of designated critical habitat for the CTS-CC and CTS-SB may occur. There is no designated critical habitat for the CTS-SC.

5.6.5. Delta Smelt

5.6.5.a. Direct Effects

All but two uses exceed the acute LOC for listed species and nearly a third of the uses exceed the chronic LOC for freshwater fish. More than half of *lambda*-cyhalothrin uses exceed the acute LOC and five of the uses exceed the chronic LOC for estuarine/marine fish. The probability of an individual effect for listed freshwater fish ranged from 1 in 1 (100%) to 1 in 299,000 (0.0003%). The probability of an individual effect for listed estuarine/marine fish ranged from 1 in 265,000,000 to 1 in 1 (100%). These probabilities were calculated based on acute RQs and the default probit slope (4.5). The ear tag screening assessment indicated that it would take only two ear tags (i.e., one cow) to trigger acute risk concerns and one ear tag to trigger chronic concerns.

There were four incidents involving fish that were reported in the EIIS database. The incidents caused mortality in bream (hundreds), catfish (250), bass (many, 200), and unknown fish (16); they were reported as "probable" and "possible" to have been caused by the application of *lambda*-cyhalothrin. Twenty-two minor incidents to fish and wildlife were reported in the IDS database; it is uncertain how many of these affected fish versus terrestrial wildlife.

Based on the weight of evidence, direct effects to the DS are possible; therefore, a preliminary "may affect" determination is made.

5.6.5.b. Indirect Effects

As discussed in Attachment II, the diet of DS is composed primarily of zooplankton, particularly copepods. Therefore, freshwater and estuarine/marine invertebrates as well as unicellular aquatic plants are considered as prey groups for determining indirect effects to the DS caused by direct effects to its prey.

Freshwater Invertebrates

Acute RQs exceed the non-listed species LOC (0.5) for all uses for freshwater invertebrates and most uses for freshwater benthic invertebrates. Chronic RQs were exceeded for all of the freshwater benthic and non-benthic invertebrates. The probability of an individual effect for a non-listed species freshwater invertebrate is between 1 in 7 (14%) and 1 in 1 (100%). The probability of an individual effect for a non-listed species of freshwater benthic invertebrates is between 1 in 2.75×10^{16} and 1 in 1 (100%).

For a summary of reported incident information to freshwater invertebrates, see Section 5.2.3.a.

Therefore, indirect effects to the DS are possible based on this prey component.

Estuarine/Marine Invertebrates

Acute RQs exceeded the non-listed species LOC (0.5) for all but two of the estuarine/marine invertebrate scenarios and for more than 50% of the estuarine/marine benthic invertebrate use scenarios. Chronic RQs exceeded the chronic LOC (1.0) for all but one estuarine/marine invertebrates use scenarios and all but two scenarios for estuarine/marine benthic invertebrates. The probability of an individual effect for a non-listed species of estuarine/marine invertebrates is between 1 in 5850 and 1 in 1 (100%). The probability of an individual effect for a non-listed species of estuarine/marine benthic invertebrates is between 1 in 5.25×10^{26} and 1 in 1 (100%).

There are no incident reports or open literature studies available on the effects of *lambda*-cyhalothrin on estuarine/marine invertebrates or estuarine/marine benthic invertebrates; however, incidents on invertebrates are unlikely to be noticed and reported to the Agency.

Based on the weight of evidence, indirect effects to the DS based on this prey component are possible.

Aquatic Plants

Toxicity data were not available for vascular aquatic plants, thus non-vascular plants were used as a surrogate. The non-vascular plant EC_{50} was greater than 310 µg ai/L. RQs cannot be calculated from a non-definitive value; however, 310 µg ai/L is much greater than the largest peak surface water EEC (179.7 µg ai/L). Another Class II pyrethroid, fenvalerate, had algae and diatom toxicity values of > 1000 µg ai/L, thus lending support that Class II pyrethroids are not very toxic to aquatic plants. Based on these lines of evidence, it is unlikely that there would be adverse effects to aquatic plants from the maximum use rate of *lambda*-cyhalothrin.

Indirect effects to the DS based on this food and habitat component are not likely.

Terrestrial Plants

No plant toxicity data are available from registrant-submitted studies. In lieu of this, the Pesticide Ecotoxicity Database (maintained by EFED) was consulted for information on terrestrial plant data for other pyrethroids. Terrestrial plant studies were not available for any of the other pyrethroids. Studies from open literature also were consulted. Two product efficacy studies were evaluated. Both tested the formulation Karate™ and neither documented any adverse effects of the insecticide on plants (wheat and groundnuts). Application rates up to 0.004 lb ai/A (groundnut) and 0.025 lb ai/A (wheat) were tested. In addition, four incidents were identified in the EIIS; three incidents were listed as possibly being caused by *lambda*-cyhalothrin and one was listed as unlikely. Additional information was not available, although *lambda*-cyhalothrin was the only pesticide being used in three of the cases. Twenty-six plant incidents were recorded in the IDS, but there was no additional information available.

Given the uncertainty and dearth of data for terrestrial plants, effects to non-target plants cannot be precluded, thus there is the potential for indirect effects to the DS.

5.6.5.c. Modification of Designated Critical Habitat

Based on the assessment of direct and indirect effects to the DS, the modification of designated critical habitat for the DS is possible.

5.6.6. San Francisco Garter Snake

5.6.6.a. Direct Effects

Potential direct effects to the SFGS are assessed based on direct acute and chronic toxicity effects to birds as a surrogate because of a lack of toxicity data for reptiles. Three acute RQs and all chronic RQs for *lambda*-cyhalothrin uses exceed the listed species LOC for direct effects to the SFGS, resulting in a preliminary "may affect" determination.

See Section 5.6.4.a for a description of the refinement of terrestrial acute and chronic risks conducted using the T-HERPS model.

The probability of an individual effect for a SFGS based on avian toxicity data is between 1 in 2490 (0.04%) and 1 in 648 (0.15%) for the full range of *lambda*-cyhalothrin application rates (Appendix N). These probabilities are calculated based on acute RQs and the default probit slope of 4.5.

At higher application rates, bioaccumulation posed a risk for reptiles eating aquatic prey; however, those application rates also exceeded acute LOCs; thus the prey would likely die before bioaccumulation occurred. At lower application rates, bioaccumulation does not pose risks to reptiles.

Based on the weight of evidence presented here, direct effects to the SFGS as a result of *lambda*-cyhalothrin uses are possible.

5.6.6.b. Indirect Effects

Adult SFGS feed primarily on California red-legged frogs and juvenile bullfrogs. Newborn and juvenile snakes prey upon Pacific tree frogs. Small mammals, reptiles, amphibians, terrestrial and aquatic invertebrates, and some fish species may also be consumed by the SFGS if they can be captured in shallow water. Indirect effects to the SFGS via loss of prey species are evaluated using toxicity data and other information gathered on freshwater fish, freshwater invertebrates, birds, small mammals, and terrestrial invertebrates.

The SFGS inhabits densely vegetated ponds near open hillsides where it can sun, feed, and find cover in rodent burrows as well as forage extensively in aquatic habitats. Freshwater habitats include natural and manmade (*e.g.* stock) ponds, slow moving streams, vernal pools and other ephemeral or permanent water bodies which typically support inundation during winter rains. Upland habitats are within 200 ft of the mean high water mark of such aquatic habitats.

Freshwater Fish and Aquatic-phase Amphibians

Approximately 65% of the scenarios yielded acute RQs that exceeded the acute non-listed species LOC (0.5) and about 30% of the scenarios exceeded the chronic LOC (1). The probability of an individual effect for a non-listed species is between 1 in 5.24×10^{18} and 1 in 1 (100%). At higher application rates, bioaccumulation posed a risk for amphibians reptiles (based on birds as a surrogate) eating aquatic prey; however, those application rates also exceeded acute LOCs; thus the prey would likely die before bioaccumulation occurred. At lower application rates, bioaccumulation does not pose risks to amphibians.

For a summary of reported incident information to freshwater fish, see Section 5.6.5.a.

Based on the lines of evidence, indirect effects to the CCR are possible based on this prey component.

Freshwater Invertebrates

Acute RQs exceed the non-listed species LOC (0.5) for all uses for freshwater invertebrates and most uses for freshwater benthic invertebrates. Chronic RQs were exceeded for all of the freshwater benthic and non-benthic invertebrates. The probability of an individual effect for a non-listed species freshwater invertebrate is between 1 in 7 (14%) and 1 in 1 (100%). The probability of an individual effect for a non-listed species of freshwater benthic invertebrates is between 1 in 2.75×10^{16} and 1 in 1 (100%).

For a summary of reported incident information to freshwater invertebrates, see Section 5.6.3.a.

Therefore, indirect effects to the SFGS are possible based on this prey component.

Birds, Terrestrial-phase Amphibians, and Reptiles

For the same reasons that are detailed in the SFGS and terrestrial-phase CTS direct effects sections, indirect effects to the SFGS are possible, based on this prey component. Two of the registered uses exceeded the non-listed species LOC (0.5) in T-REX. The probability of an individual effect for a non-listed avian species ranges from less than 1 in 8.86×10^{18} to 1 in 11 (9%).

Small Mammals

The SFGS consumes small mammals as part of its diet. In addition, it relies on the burrows of small mammals for shelter and aestivation when ponds become dry. They may also forage for amphibians in the rodent burrows during the summer. Many use scenarios produced acute and chronic RQs that exceed both the listed and non-listed species LOCs. The probability of an individual effect ranges from 1 in 791,000 (0.00012%) to 1 in 1 (100%) for all uses. These probabilities are based on acute LOCs and the default probit slope (4.5). At higher application rates, bioaccumulation posed a risk to mammals; however, those application rates also exceeded acute LOCs; thus the prey would likely die before bioaccumulation occurred. At lower application rates (< 0.1 lb ai/A), bioaccumulation does not pose risks to mammals.

Therefore, indirect effects are anticipated to the SFGS based on risk to small mammalian prey and a reduction in small mammal burrows.

Terrestrial Invertebrates

For the same reasons that are detailed in the BCB and VELB direct effects sections, indirect effects to the SFGS are possible, based on risk to terrestrial invertebrate prey.

Aquatic Plants

Toxicity data were not available for vascular aquatic plants, thus non-vascular plants were used as a surrogate. The non-vascular plant EC_{50} was greater than 310 µg ai/L. RQs cannot be calculated from a non-definitive value; however, 310 µg ai/L is much greater than the largest peak surface water EEC (179.7 µg ai/L). Another Class II pyrethroid, fenvalerate, had algae and diatom toxicity values of > 1000 µg ai/L, thus lending support that Class II pyrethroids are not very toxic to aquatic plants. Based on these lines of evidence, it is unlikely that there would be adverse effects to aquatic plants from the maximum use rate of *lambda*-cyhalothrin.

Indirect effects to the SFGS based on this food and habitat component are not likely.

Terrestrial Plants

Terrestrial plants serve several important habitat-related functions for the listed assessed species. In addition to providing habitat and cover for invertebrate and vertebrate prey items of the listed assessed species, terrestrial vegetation also provides shelter and cover from predators while foraging. Upland vegetation including grassland and woodlands provides cover during dispersal. Riparian vegetation helps to maintain the integrity of aquatic systems by providing bank and thermal stability, serving as a buffer to filter out sediment, nutrients, and contaminants before they reach the water, and serving as an energy source.

No plant toxicity data are available from registrant-submitted studies. In lieu of this, the Pesticide Ecotoxicity Database (maintained by EFED) was consulted for information on terrestrial plant data for other pyrethroids. Terrestrial plant studies were not available for any of the other pyrethroids. Studies from open literature also were consulted. Two product efficacy studies were evaluated. Both tested the formulation Karate™ and neither documented any adverse effects of the insecticide on plants (wheat and groundnuts). Application rates up to 0.004 lb ai/A (groundnut) and 0.025 lb ai/A (wheat) were tested. In addition, four incidents were identified in the EIIS; three incidents were listed as possibly being caused by *lambda*-cyhalothrin and one was listed as unlikely. Additional information was not available, although *lambda*-cyhalothrin was the only pesticide being used in three of the cases. Twenty-six plant incidents were recorded in the IDS, but there was no additional information available.

Given the uncertainty and dearth of data for terrestrial plants, effects to non-target plants cannot be precluded, thus there is the potential for indirect effects to the SFGS.

5.6.7. Tidewater Goby

5.6.7.a. Direct Effects

All but two uses exceed the acute LOC for listed species and nearly a third of the uses exceed the chronic LOC for freshwater fish. More than half of *lambda*-cyhalothrin uses exceed the acute LOC and five of the uses exceed the chronic LOC for estuarine/marine fish. The probability of an individual effect for listed freshwater fish ranged from 1 in 299,000 (0.0003%) to 1 in 1 (100%). The probability of an individual effect for listed estuarine/marine fish ranged from 1 in 265,000,000 to 1 in 1 (100%). These probabilities were calculated based on acute RQs and the default probit slope (4.5). The ear tag screening assessment indicated that it would take only two ear tags (i.e., one cow) to trigger acute risk concerns and one ear tag to trigger chronic concerns.

No incidents were reported for estuarine/marine fish.

Based on the lines of evidence, direct effects to the TG are possible; therefore, a preliminary "may affect" determination is made.

5.6.7.b. Indirect Effects

As discussed in Attachment II, the diet of the TG consists of macroinvertebrates such as mysid, shrimp, gammarid amphipods, ostracods, and aquatic insects. Food items of the smallest TGs, which are 4-8 mm (0.2-0.3 in.) in size, have not been examined, but they likely feed on unicellular phytoplankton or zooplankton like many other early stage larval fishes (Attachment II). Therefore, freshwater and estuarine/marine invertebrates as well as unicellular aquatic plants are considered as prey groups for determining indirect effects to the TG caused by direct effects to its prey.

Freshwater Invertebrates

Acute RQs exceed the non-listed species LOC (0.5) for all uses for freshwater invertebrates and most uses for freshwater benthic invertebrates. Chronic RQs were exceeded for all of the freshwater benthic and non-benthic invertebrates. The probability of an individual effect for a non-listed species freshwater invertebrate is between 1 in 7 (14%) and 1 in 1 (100%). The probability of an individual effect for a non-listed species of freshwater benthic invertebrates is between 1 in 2.75×10^{16} and 1 in 1 (100%).

For a summary of reported incident information to freshwater invertebrates, see Section 5.6.3.a.

Therefore, indirect effects to the TG are possible based on this prey component.

Estuarine/Marine Invertebrates

Acute RQs exceeded the non-listed species LOC (0.5) for all but two of the estuarine/marine invertebrate scenarios and for more than 50% of the estuarine/marine benthic invertebrate use scenarios. Chronic RQs exceeded the chronic LOC (1.0) for all but one estuarine/marine invertebrates use scenarios and all but two scenarios for estuarine/marine benthic invertebrates. The probability of an individual effect for a non-listed species of estuarine/marine invertebrates is between 1 in 5850 and 1 in 1 (100%). The probability of an individual effect for a non-listed species of estuarine/marine benthic invertebrates is between 1 in 5.25×10^{26} and 1 in 1 (100%).

There are no incident reports or open literature studies available on the effects of *lambda*-cyhalothrin on estuarine/marine invertebrates or estuarine/marine benthic invertebrates; however, incidents on invertebrates are unlikely to be noticed and reported to the Agency.

Based on the weight of evidence, indirect effects to the TG based on this prey component are possible.

Aquatic Plants

Toxicity data were not available for vascular aquatic plants, thus non-vascular plants were used as a surrogate. The non-vascular plant EC_{50} was greater than 310 µg ai/L. RQs cannot be calculated from a non-definitive value; however, 310 µg ai/L is much greater than the largest peak surface water EEC (179.7 µg ai/L). Another Class II pyrethroid, fenvalerate, had algae and diatom toxicity values of > 1000 µg ai/L, thus lending support that Class II pyrethroids are not very toxic to aquatic plants. Based on these lines of evidence, it is unlikely that there would be adverse effects to aquatic plants from the maximum use rate of *lambda*-cyhalothrin.

Indirect effects to the TG based on this food and habitat component are not likely.

Terrestrial Plants

No plant toxicity data are available from registrant-submitted studies. In lieu of this, the Pesticide Ecotoxicity Database (maintained by EFED) was consulted for information on terrestrial plant data for other pyrethroids. Terrestrial plant studies were not available for any of the other pyrethroids. Studies from open literature also were consulted. Two product efficacy studies were evaluated. Both tested the formulation Karate™ and neither documented any adverse effects of the insecticide on plants (wheat and groundnuts). Application rates up to 0.004 lb ai/A (groundnut) and 0.025 lb ai/A (wheat) were tested. In addition, four incidents were identified in the EIIS; three incidents were listed as possibly being caused by *lambda*-cyhalothrin and one was listed as unlikely. Additional information was not available, although *lambda*-cyhalothrin was the only pesticide being used in three of the cases. Twenty-six plant incidents were recorded in the IDS, but there was no additional information available.

Given the uncertainty and dearth of data for terrestrial plants, effects to non-target plants cannot be precluded, thus there is the potential for indirect effects to the TG.

5.6.7.c. Modification of Designated Critical Habitat

Based on the assessment of direct and indirect effects to the TG, the modification of designated critical habitat for the TG is possible.

5.6.8. Valley Elderberry Longhorn Beetle

5.6.8.a. Direct Effects

RQs for all *lambda*-cyhalothrin uses exceed the LOC (0.05) for direct effects to the VELB, resulting in a preliminary “may affect” determination. *Lambda*-cyhalothrin is an insecticide and thus it is expected to have adverse effects on insects.

Four incidents involving terrestrial invertebrates (honeybees) were reported for *lambda*-cyhalothrin in the EIIS database. All reported large number of dead bees the loss or partial loss of hives (22 to 92 hives) as a result of *lambda*-cyhalothrin applications. One of the incidents involved *lambda*-cyhalothrin and another insecticide/acaricide, but the other three involved *lambda*-cyhalothrin only. Of these, one of them was a misuse because the application occurred during bee flight activity.

No open literature studies were available; however, there were two non-guideline studies that were submitted to the Agency. One of the studies (MRID 40436303) documented possible repellency effects of *lambda*-cyhalothrin to honeybees. Honeybee response was observed via a choice test with simulated honeydew. The results indicated that honeybees preferred the honeydew samples without *lambda*-cyhalothrin. A honeybee foliage acute toxicity test (MRID 4043602) established LT_{50} values for two typical *lambda*-cyhalothrin application rates – 0.013 and 0.031 lb ai/A). LT_{50}s ranged from 4 to 12 hours at the lower application rate to 23 hours at the higher application rate. Likewise, the NOEL was identified as 24 to 96 hours, depending on the application rate. These results suggest that honeybees, and possibly other insects, may experience adverse effects up to 4 days after an application of *lambda*-cyhalothrin is made (0.031 lb ai/A rate).

The probability of an individual effect for a VELB is high: 1 in 1 (100%) for all application rates (Appendix N). These probabilities are calculated based on the acute RQs and the default probit slope of 4.5.

Based on the weight of evidence presented here, there is a potential for direct effects to the VELB as a result of *lambda*-cyhalothrin uses.

5.6.8.b. Indirect Effects

The VELB is associated with riparian elderberry trees during its entire life cycle and relies on these trees for both food and habitat. The VELB has an obligate relationship with the elderberry trees. Females lay their eggs on the bark and larvae hatch and burrow into the stems. The larval stage may last 2 years, after which the larvae enter the pupa stage and transform into adults.

No plant toxicity data are available from registrant-submitted studies. In lieu of this, the Pesticide Ecotoxicity Database (maintained by EFED) was consulted for information on terrestrial plant data for other pyrethroids. Terrestrial plant studies were not available for any of the other pyrethroids. Studies from open literature also were consulted. Two product efficacy studies were evaluated. Both tested the formulation Karate™ and neither documented any adverse effects of the insecticide on plants (wheat and groundnuts). Application rates up to 0.004 lb ai/A (groundnut) and 0.025 lb ai/A (wheat) were tested. In addition, four incidents were identified in the EIIS; three incidents were listed as possibly being caused by *lambda*-cyhalothrin and one was listed as unlikely. Additional information was not available, although *lambda*-cyhalothrin was the only pesticide being used in three of the cases. Twenty-six plant incidents were recorded in the IDS, but there was no additional information available.

Given the uncertainty and dearth of data for terrestrial plants, effects to non-target plants cannot be precluded, thus there is the potential for indirect effects to the VELB.

5.6.8.c. Modification of Designated Critical Habitat

Based on the assessment of direct and indirect effects to the VELB above, the modification of designated critical habitat for the VELB is possible.

5.6.9. Spatial Extent of Potential Effects

Since LOCs are exceeded, analysis of the spatial extent of potential LAA effects is needed to determine where effects may occur in relation to the treated site. If the potential area of usage and subsequent Potential Area of LAA Effects overlaps with BCB, CCR, CFWS, CTS (all DPS), DS, SFGS, TG, and VELB habitat or areas of occurrence and/or critical habitat, a likely to adversely affect determination is made. If the Potential Area of LAA Effects and BCB, CCR, CFWS, CTS (all DPS), DS, SFGS, TG, and VELB habitat and areas of occurrence and/or critical habitat do not overlap, a no effect determination is made.

To determine this area, the footprint of *lambda*-cyhalothrin's use pattern is identified, using corresponding land cover data, see Section 2.7. However, given *lambda*-cyhalothrin's highly diverse and extensive use patterns, the footprint of registered uses covers the whole state of California. Therefore, a spatial analysis of the extent of the chemical's effects on the assessed listed species of concern was not conducted. Likewise, the downstream dilution analysis is not expected to provide additional useful information because of the widespread use of *lambda*-cyhalothrin, and was not performed.

5.6.9.a. Spray Drift

To determine terrestrial habitats of concern from *lambda*-cyhalothrin exposures through spray drift, it is necessary to estimate the distance that spray applications can drift from the treated area and still be present at concentrations that exceed levels of concern. Ground applications of *lambda*-cyhalothrin granular formulations are expected to result in negligible drift. For the flowable uses, a quantitative analysis of spray drift distances was completed using AgDRIFT (v. 2.11) using default inputs for ground applications (*i.e.*, high boom, ASAE droplet size distribution = Very Fine to Fine, 90th data percentile) and aerial applications (*i.e.*, ASAE Very Fine to Fine). Only agricultural uses applied with ground boom or aerial spray equipment are modeled. Only organisms/scenarios that exceeded the acute listed species LOCs are modeled (Table 5-18, 5-19, and 5-20).

Table 5-18. Terrestrial Organisms Buffers for *Lambda*-Cyhalothrin Calculated with AgDRIFT

Use	Single application Rate (lb ai/A)	Fraction of Applied		Buffer Distance (ft)	
		Insect	Mammal	Insect	Mammal
Alfalfa, aerial	0.038	0.0013	0.56	>1,000	0
Alfalfa, ground	0.038	0.0013	0.56	>1,000	6.56
Almond, ground dust and spray	0.1	0.0012	0.12	>1,000	22.97
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, ground dust and spray	0.1	0.0004	0.10	>1,000	26.25
Apricot, bean, eggplant, groundcherry,	0.0239	0.0012	0.42	>1,000	6.56

Use	Single application Rate (lb ai/A)	Fraction of Applied		Buffer Distance (ft)	
		Insect	Mammal	Insect	Mammal
loquat, mayhaw, pea, pepino, pepper, plum, quince, ground spray/dust					
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut, ground spray/dust	0.0239	0.0015	0.53	961.27	6.56
Barley, aerial	0.031	0.0027	0.91	>1,000	0
Barley, ground	0.031	0.0027	0.91	652.88	3.28
Bell pepper, catjang (Jerusalem/marble pea), aerial	0.03	0.0008	0.29	>1,000	59.05
Bell pepper, catjang (Jerusalem/marble pea), ground spray/dust	0.03	0.0008	0.29	>1,000	9.84
Mustard cabbage (gai choy, pak-choi), ground spray/dust	0.03	0.0010	0.34	>1,000	9.84
Brassica (head and stem) vegetables, aerial	0.031	0.0018	0.63	>1,000	0
Brassica (head and stem) vegetables, ground	0.031	0.0018	0.63	853.01	3.28
Tomato, tomatillo, ground spray/dust	0.0294	0.0010	0.33	>1,000	9.84
Broccoli, cauliflower, ground spray/dust	0.0294	0.0010	0.32	>1,000	9.84
Cabbage, kohlrabi, ground spray/dust	0.0294	0.0009	0.30	>1,000	9.84
Mustard, ground	0.0294	0.0008	0.29	>1,000	9.84
Brussels sprouts, ground spray	0.038	0.0017	0.56	885.82	6.56
Brussels sprouts, dust	0.038	0.0009	0.30	>1,000	9.84
Buckwheat, oat, rye, aerial	0.03	0.0027	0.91	>1,000	0
Buckwheat, oat, rye, ground	0.03	0.0027	0.91	652.88	3.28
Canola/rape, aerial	0.0311	0.0019	0.63	>1,000	0
Canola/rape, ground	0.0311	0.0019	0.63	823.48	3.28
Grass forage/fodder/hay, pastures, rangeland, aerial	0.0311	0.0028	0.91	>1,000	0
Grass forage/fodder/hay, pastures, rangeland, ground	0.0311	0.0028	0.91	636.48	3.28
Cereal grains, triticale,	0.0311	0.0026	0.91	>1,000	0

Use	Single application Rate (lb ai/A)	Fraction of Applied		Buffer Distance (ft)	
		Insect	Mammal	Insect	Mammal
wheat, aerial					
Cereal grains, triticale, wheat, ground	0.0311	0.0026	0.91	669.28	3.28
Cole crops, aerial	0.0311	0.0010	0.33	>1,000	39.37
Cole crops, ground/dust	0.0311	0.0010	0.33	>1,000	9.84
Onion, aerial	0.0311	0.0009	0.31	>1,000	49.21
Onion, ground/dust	0.0311	0.0009	0.31	>1,000	9.84
Conifers (plantations/nurseries), ground	0.0401	0.0009	0.30	>1,000	9.84
Conifers (seed orchard), ground	0.156	0.0004	0.13	>1,000	22.97
Corn (field), aerial	0.042	0.0015	0.53	>1,000	0
Corn (field), ground	0.042	0.0015	0.53	961.27	6.56
Corn (sweet), dust	0.042	0.0015	0.34	961.27	9.84
Corn (sweet), spray	0.03	0.0013	0.43	>1,000	6.56
Cotton, aerial	0.042	0.0015	0.53	>1,000	0
Cotton, ground	0.042	0.0015	0.53	961.27	6.56
Cucurbit vegetables, aerial	0.0311	0.0011	0.37	>1,000	22.97
Cucurbit vegetables, ground	0.0311	0.0011	0.37	>1,000	6.56
Filbert, pecan, walnut, aerial	0.057	0.0012	0.42	>1,000	13.12
Filbert, pecan, walnut, ground	0.057	0.0012	0.42	>1,000	6.56
Filbert, pecan, walnut, dust	0.057	0.0007	0.24	>1,000	13.12
Forest plantings, ground	0.0511	0.0009	0.30	>1,000	9.84
Fruiting vegetables, aerial	0.0311	0.0007	0.23	>1,000	98.42
Fruiting vegetables, ground	0.0311	0.0007	0.23	>1,000	13.12
Garlic, ground	0.0311	0.0010	0.33	>1,000	9.84
Grasses grown for seed, ground	0.1306	0.0005	0.18	>1,000	16.4
Legume vegetables, aerial	0.0311	0.0015	0.50	>1,000	3.28
Legume vegetables, ground	0.0311	0.0015	0.50	961.27	6.56
Peanuts, root and tuber vegetables, aerial	0.0311	0.0016	0.53	>1,000	0
Peanuts, root and tuber vegetables, ground	0.0311	0.0016	0.53	921.9	6.56
Lettuce, aerial	0.0311	0.0007	0.25	>1,000	85.3
Lettuce, ground	0.0311	0.0007	0.25	>1,000	13.12
Nonagricultural uncultivated areas/soils, aerial	0.0792	0.0009	0.31	>1,000	49.21

Use	Single application Rate (lb ai/A)	Fraction of Applied		Buffer Distance (ft)	
		Insect	Mammal	Insect	Mammal
Pome and stone fruit, aerial	0.0415	0.0010	0.33	>1,000	39.37
Pome and stone fruit, ground	0.0415	0.0010	0.33	>1,000	9.84
Potato, aerial	0.0239	0.0022	0.77	>1,000	0
Potato, ground	0.0239	0.0022	0.77	748.02	3.28
Rice, ground	0.0415	0.0014	0.48	>1,000	6.56
Seed orchard trees, ground	0.162	0.0004	0.13	>1,000	22.97
Sorghum, aerial	0.038	0.0023	0.77	>1,000	0
Sorghum, ground	0.038	0.0023	0.77	728.34	3.28
Soybean, aerial	0.038	0.0032	n/a	>1,000	n/a
Soybean, ground	0.038	0.0032	n/a	580.7	n/a
Tree nuts, aerial	0.0415	0.0011	0.37	>1,000	22.97
Tree nuts, ground	0.0415	0.0011	0.37	>1,000	6.56
Sunflower, aerial	0.038	0.0017	0.56	>1,000	0
Sunflower, ground	0.038	0.0017	0.56	885.82	6.56

n/a = not calculated because acute RQ did not exceed LOC

Insects are the most sensitive group and buffer distances range from 580 to >1000 ft. Buffer distances for mammals range from 0 to 98 ft. Many of the calculated buffer distances for mammals are less than 25 ft. This may be a mitigation measure that could be employed to protect listed species. Aquatic buffers of 10 and 25 ft are being implemented for all pyrethroids, although these buffers were not yet listed on all the *lambda*-cyhalothrin labels that were assessed here.

Table 5-19. Freshwater and Estuarine/Marine Fish Buffers for *Lambda*-Cyhalothrin Calculated with AgDRIFT

Use	Single application Rate (lb ai/A)	Freshwater Fish Buffer Distance (ft)			Estuarine/Marine Fish Buffer Distance (ft)		
		Initial Average Concentration (µg ai/L) (ng ai/L)			Initial Average Concentration (µg ai/L) (ng ai/L)		
		0.039 (39) (Acute)	0.0078 (7.8) (Acute restricted)	0.0039 (3.9) (Acute listed)	0.40 (400) (Acute)	0.081 (81) (Acute restricted)	0.040 (40) (Acute listed)
Alfalfa, aerial	0.38	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000
Alfalfa, ground	0.38	744.74	>1,000	>1,000	55.77	413.38	731.62
Almond, apple, cherry, crabapple, nectarine, peach, pear, plum, prune, trees, ground	0.1	229.66	905.5	>1,000	0	85.3	223.09
Apricot, loquat, mayhaw, plum, quince, bean, groundcherry, pea, pepino, pepper, eggplant, beech nut, Brazil nut, butternut, cashew, chestnut,	0.0239	22.97	275.59	521.65	0	3.28	19.68

Use	Single application Rate (lb ai/A)	Freshwater Fish Buffer Distance (ft)			Estuarine/Marine Fish Buffer Distance (ft)		
		Initial Average Concentration (µg ai/L) (ng ai/L)			Initial Average Concentration (µg ai/L) (ng ai/L)		
		0.039 (39) (Acute)	0.0078 (7.8) (Acute restricted)	0.0039 (3.9) (Acute listed)	0.40 (400) (Acute)	0.081 (81) (Acute restricted)	0.040 (40) (Acute listed)
chinquapin, hickory nut, macadamia nut, potato, ground							
Barley, brassica (head and stem) vegetables, aerial	0.031	>1,000	>1,000	>1,000	9.84	725.06	>1,000
Barley, brassica (head and stem) vegetables, ground	0.031	39.37	357.61	639.76	0	6.56	36.09
Bell pepper, catjang (Jerusalem/marble pea), buckwheat, oat, rye, corn (sweet), aerial	0.03	>1,000	>1,000	>1,000	3.28	685.69	>1,000
Bell pepper, catjang (Jerusalem/marble pea), mustard cabbage (gai choy, pak-choi), buckwheat, oat, rye, ground	0.03	36.09	344.48	623.35	0	6.56	32.81
Tomato, tomatillo, broccoli, cauliflower, cabbage, kohlrabi, mustard, ground	0.0294	32.81	337.92	613.51	0	6.56	32.81
Brussels sprouts, sorghum, soybean, sunflower, ground	0.038	55.77	429.78	744.74	0	9.84	55.77
Canola/rape, grass forage/fodder/hay, pastures, rangeland, cereal grains, triticale, wheat, cole crops, onion, cucurbit vegetables, fruiting vegetables, garlic, legume vegetables, peanuts, root and tuber vegetables, lettuce, aerial	0.0311	>1,000	>1,000	>1,000	9.84	731.62	>1,000
Canola/rape, grass forage/fodder/hay, pastures, rangeland, cereal grains, triticale, wheat, cole crops, onion, cucurbit vegetables, fruiting vegetables, legume	0.0311	39.37	357.61	643.04	0	6.56	36.09

Use	Single application Rate (lb ai/A)	Freshwater Fish Buffer Distance (ft)			Estuarine/Marine Fish Buffer Distance (ft)		
		Initial Average Concentration (µg ai/L) (ng ai/L)			Initial Average Concentration (µg ai/L) (ng ai/L)		
		0.039 (39) (Acute)	0.0078 (7.8) (Acute restricted)	0.0039 (3.9) (Acute listed)	0.40 (400) (Acute)	0.081 (81) (Acute restricted)	0.040 (40) (Acute listed)
vegetables, peanuts, root and tuber vegetables, lettuce, ground							
Conifers (plantations/nurseries), ground	0.0401	62.34	449.47	774.27	0	13.12	59.05
Conifers (seed orchard), ground	0.156	357.61	>1,000	>1,000	6.56	164.04	351.05
Corn (field), cotton, aerial	0.042	>1,000	>1,000	>1,000	65.62	>1,000	>1,000
Corn (field), cotton, ground	0.042	68.9	469.15	800.52	0	13.12	65.62
Filbert, pecan, walnut, aerial	0.057	>1,000	>1,000	>1,000	137.79	>1,000	>1,000
Filbert, pecan, walnut, ground	0.057	111.55	600.39	994.08	0	29.53	108.27
Forest plantings, ground	0.0511	95.14	551.17	921.9	0	22.97	91.86
Grasses grown for seed, ground	0.1306	301.83	>1,000	>1,000	3.28	127.95	295.27
Pome and stone fruit, tree nuts, aerial	0.0415	>1,000	>1,000	>1,000	65.62	>1,000	>1,000
Pome and stone fruit, rice, tree nuts, ground	0.0415	65.62	462.59	793.95	0	13.12	65.62
Potato, aerial	0.0239	>1,000	>1,000	>1,000	0	475.72	>1,000
Seed orchard trees, ground	0.0162	6.56	177.16	370.73	0	0	6.56
Sorghum, soybean, sunflower aerial	0.038	55.77	429.78	744.74	0	9.84	55.77

Table 5-20. Freshwater and Estuarine/Marine Benthic and Non-Benthic Invertebrate Buffers for *Lambda*-Cyhalothrin Calculated with AgDRIFT

Use	Single application Rate (lb ai/A)	Freshwater Benthic and Non-Benthic Invertebrate Buffer Distance (ft)			Estuarine/Marine Benthic and Non-Benthic Invertebrate Buffer Distance (ft)		
		Initial Average Concentration (µg ai/L) (ng ai/L)			Initial Average Concentration (µg ai/L) (ng ai/L)		
		0.0007 (.7) (Acute)	0.00014 (.14) (Acute restricted)	0.00007 (.07) (Acute listed)	0.0025 (2.5) (Acute)	0.00049 (.49) (Acute restricted)	0.00025 (.25) (Acute listed)
Alfalfa, aerial	0.38	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000
Alfalfa, ground	0.38	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000
Almond, apple, cherry, crabapple, nectarine,	0.1	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000

Use	Single application Rate (lb ai/A)	Freshwater Benthic and Non-Benthic Invertebrate Buffer Distance (ft)			Estuarine/Marine Benthic and Non-Benthic Invertebrate Buffer Distance (ft)		
		Initial Average Concentration (µg ai/L) (ng ai/L)			Initial Average Concentration (µg ai/L) (ng ai/L)		
		0.0007 (.7) (Acute)	0.00014 (.14) (Acute restricted)	0.00007 (.07) (Acute listed)	0.0025 (2.5) (Acute)	0.00049 (.49) (Acute restricted)	0.00025 (.25) (Acute listed)
peach, pear, plum, prune, trees, ground							
Apricot, loquat, mayhaw, plum, quince, bean, groundcherry, pea, pepino, pepper, eggplant, beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut, potato, ground	0.0239	>1,000	>1,000	>1,000	734.9	>1,000	>1,000
Barley, brassica (head and stem) vegetables, aerial	0.031	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000
Barley, brassica (head and stem) vegetables, ground	0.031	>1,000	>1,000	>1,000	885.82	>1,000	>1,000
Bell pepper, catjang (Jerusalem/marble pea), buckwheat, oat, rye, corn (sweet), aerial	0.03	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000
Bell pepper, catjang (Jerusalem/marble pea), mustard cabbage (gai choy, pak-choi), buckwheat, oat, rye, ground	0.03	>1,000	>1,000	>1,000	866.13	>1,000	>1,000
Tomato, tomatillo, broccoli, cauliflower, cabbage, kohlrabi, mustard, ground	0.0294	>1,000	>1,000	>1,000	853.9	>1,000	>1,000
Brussels sprouts, sorghum, soybean, sunflower, ground	0.038	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000
Canola/rape, grass forage/fodder/hay, pastures, rangeland, cereal grains, triticale, wheat, cole crops, onion, cucurbit vegetables, fruiting vegetables, garlic, legume vegetables, peanuts, root and tuber	0.0311	>1,000	>1,000	>1,000	889.1	>1,000	>1,000

Use	Single application Rate (lb ai/A)	Freshwater Benthic and Non-Benthic Invertebrate Buffer Distance (ft)			Estuarine/Marine Benthic and Non-Benthic Invertebrate Buffer Distance (ft)		
		Initial Average Concentration (µg ai/L) (ng ai/L)			Initial Average Concentration (µg ai/L) (ng ai/L)		
		0.0007 (.7) (Acute)	0.00014 (.14) (Acute restricted)	0.00007 (.07) (Acute listed)	0.0025 (2.5) (Acute)	0.00049 (.49) (Acute restricted)	0.00025 (.25) (Acute listed)
vegetables, lettuce, aerial							
Canola/rape, grass forage/fodder/hay, pastures, rangeland, cereal grains, triticale, wheat, cole crops, onion, cucurbit vegetables, fruiting vegetables, legume vegetables, peanuts, root and tuber vegetables, lettuce, ground	0.0311	>1,000	>1,000	>1,000	889.1	>1,000	>1,000
Conifers (plantations/nurseries), ground	0.0401	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000
Conifers (seed orchard), ground	0.156	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000
Corn (field), cotton, aerial	0.042	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000
Corn (field), cotton, ground	0.042	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000
Filbert, pecan, walnut, aerial	0.057	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000
Filbert, pecan, walnut, ground	0.057	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000
Forest plantings, ground	0.0511	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000
Grasses grown for seed, ground	0.1306	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000
Pome and stone fruit, tree nuts, aerial	0.0415	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000
Pome and stone fruit, rice, tree nuts, ground	0.0415	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000
Potato, aerial	0.0239	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000
Seed orchard trees, ground	0.0162	>1,000	>1,000	>1,000	544.61	>1,000	>1,000
Sorghum, soybean, sunflower aerial	0.038	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000

Invertebrates are the most sensitive aquatic group. Buffer distances for freshwater and estuarine/marine invertebrates at the acute LOC (0.05) are >1000 ft. Buffer distances for freshwater fish at the acute LOC (0.05) range from 370 to >1000 ft. Buffer distances for estuarine/marine fish at the acute LOC (0.05) range from 6.6 to >1000 ft. In 2008, EPA issued a memo requiring that aquatic buffers be added to all pyrethroid labels. This action is in the process of being implemented; however, the modeled scenarios indicate that the 10 to 25 ft aquatic buffers that appear on labels may not be sufficient to protect listed species in the case of most *lambda*-cyhalothrin uses.

As a refinement, several scenarios were modeled that incorporated the restrictions that are being added to *lambda*-cyhalothrin labels. Many labels require a medium course droplet size and 10 or 25 foot buffers around aquatic areas. Five pesticide application scenarios were chosen to represent the breadth of *lambda*-cyhalothrin application rates. Table 5-21 compares a no buffer situation with 10 and 25 foot buffers. Risk quotients were calculated for freshwater fish and invertebrates. As a result of the mitigation efforts, EECs and RQs are lower when buffers are employed. However, in all instances, the buffer was not sufficient to reduce an RQ that was to a value that was below the LOC (acute = 0.05; chronic = 1).

Table 5-21. EECs for *Lambda*-Cyhalothrin Buffer Mitigation Scenarios

Proposed Label Use	PRZM/ EXAMS Scenario[1] (first app date)	Method	Application Rate (interval between applications)	Peak EEC (µg/L)	21-day EEC (µg/L)	60-day EEC (µg/L)	FW fish acute RQ	FW Fish chronic RQ	FW invert acute RQ	FW invert chronic RQ
Surface Water Concentrations										
Alfalfa	CA Alfalfa (Dec 10 – foliar)	Aerial EEC	3 app @ 0.38 lb a.i./acre (10-day interval)	1.34	0.27	0.16	**17***	**6.7***	**957***	**33750***
		10 ft. buffer		1.14	0.23	0.14	**15***	**5.8***	**814***	**28750***
		25 ft. buffer		0.96	0.19	0.12	**12***	**5.0***	**686***	**23750***
Corn (sweet)	CA Corn (April 10 – foliar)	Aerial EEC	6 app @ 0.03 lb a.i./acre (3 crop cycles of 90 days; 10-day interval per crop cycle; max. 16 apps./ year)	0.22	0.09	0.09	**2.8***	**3.8***	**157***	**11250***
		10 ft. buffer		0.21	0.08	0.08	**2.7***	**3.3***	**150***	**10000***
		25 ft. buffer		0.21	0.07	0.07	**2.7***	**2.9***	**150***	**8750***
Cotton	CA Cotton (Oct 1 – foliar)	Aerial EEC	3 app @ 0.042 lb a.i./acre (10-day interval)	0.15	0.03	0.02	**1.9***	0.83	**107***	**37508***
		10 ft. buffer		0.13	0.03	0.02	**1.7***	0.83	**93***	**2500***
		25 ft. buffer		0.11	0.02	0.02	**1.4***	0.83	**79***	**2500***
Lettuce	CA Lettuce (Feb 6 – foliar)	Aerial EEC	10 app @ 0.0311 lb a.i./acre (2 crop cycles of 120 days; 5-day interval per crop cycle)	0.28	0.14	0.13	**3.6***	**5.4***	**200***	**17500***
		10 ft. buffer		0.27	0.12	0.12	**3.5***	**5***	**193***	**15000***
		25 ft. buffer		0.26	0.11	0.10	**3.3***	**4.2***	**186***	**13750***
Potato	CA Potato (May 11 – foliar)	Aerial EEC	3 app @ 0.0239 lb a.i./acre	0.08	0.02	0.01	**1.0***	0.42	**57***	**2500***
		10 ft. buffer	1 app @ 0.0162 lb a.i./acre (7-day interval)	0.07	0.02	0.01	**0.90***	0.42	**50***	**2500***

Proposed Label Use	PRZM/ EXAMS Scenario[1] (first app date)	Method	Application Rate (interval between applications)	Peak EEC (µg/L)	21-day EEC (µg/L)	60-day EEC (µg/L)	FW fish acute RQ	FW Fish chronic RQ	FW invert acute RQ	FW invert chronic RQ
		25 ft. buffer		0.06	0.01	0.01	**0.77***	0.42	**43***	**1250***
*Indicates the RQ is greater than the LOC (acute = 0.05; chronic = 1).										

5.7. Effects Determinations

5.7.1. Bay Checkerspot Butterfly

It is possible for *lambda*-cyhalothrin to directly affect the BCB based on RQs exceeding the listed species LOCs for terrestrial invertebrates. Four major incidents were reported for terrestrial invertebrates. Indirect effects from effects on food and habitat structure are anticipated because risks to terrestrial plants cannot be precluded (lack of terrestrial plant toxicity data). Several plant incidents have been reported, indicating possible adverse effects on plants. The BCB has an obligate relationship with plaintains and anything that negatively affects the plantain will adversely affect the BCB. *Lambda*-cyhalothrin uses extend across the state of California and use is expected to occur within the BCB's range.

Therefore, the Agency makes a **may affect, and likely to adversely affect** determination based on the potential for direct effects to the BCB and a **habitat modification** determination for the designated critical habitat of the BCB.

5.7.1. California Clapper Rail

It is possible for *lambda*-cyhalothrin to directly affect the CCR based on RQs exceeding the listed and non-listed species LOCs for birds. Indirect effects from affected prey are also possible based on RQs exceeding the listed and non-listed species LOCs for birds, mammals, terrestrial invertebrates, freshwater and estuarine/marine fish, and freshwater and estuarine/marine invertebrates. Four incidents have been reported for freshwater fish and three incidents for freshwater invertebrates. Indirect effects on habitat are anticipated from modifications to the terrestrial plants in the environment. Several plant incidents have been reported, indicating possible adverse effects on plants. Effects are not expected from modifications to the aquatic plant environmental structure. *Lambda*-cyhalothrin uses extend across the state of California, thus use is expected to occur within the CCR range.

Therefore, the Agency makes a **may affect, and likely to adversely affect** determination for the CCR. The CCR does not have a designated critical habitat.

5.7.2. California Freshwater Shrimp

It is possible for *lambda*-cyhalothrin to directly affect the CFWS based on RQs exceeding listed species LOCs for freshwater invertebrates. Three incidents have been reported for freshwater invertebrates. Indirect effects from affected prey are also possible based on RQs exceeding the listed and non-listed species LOCs for freshwater invertebrates. Indirect effects from habitat modification are anticipated from effects to terrestrial plants. Several plant incidents have been reported, indicating possible adverse effects on plants. Indirect effects are not expected from changes to the aquatic plant community. *Lambda*-cyhalothrin uses extend across the state of California, thus use is expected to occur within the CFWS range.

Therefore, the Agency makes a **may affect, and likely to adversely affect** determination for the CFWS. The CFWS does not have a designated critical habitat.

5.7.3. California Tiger Salamander (All 3 DPS)

It is possible for *lambda*-cyhalothrin to directly affect the CTS based on RQs exceeding listed species LOCs for terrestrial-phase amphibians (using avian surrogate species data) and based on RQs exceeding the listed species LOCs for aquatic-phase amphibians (using freshwater fish surrogate species data). Indirect effects from affected prey are also possible based on RQs exceeding listed and non-listed species LOCs for terrestrial-phase amphibians (using avian surrogate species data), mammals, terrestrial invertebrates, freshwater invertebrates and freshwater fish. Four incidents for freshwater fish and three incidents for freshwater invertebrates have been reported. Indirect effects from affected habitat are possible because the RQs exceeded the listed and non-listed species LOCs for mammal burrow availability. Small mammals are essential in creating the underground habitat that juvenile and adult CTS depend upon for food, shelter, and protection from the elements and predation. Indirect effects on habitat from terrestrial plants are also anticipated. Several plant incidents have been reported, indicating possible adverse effects on plants. Effects from changes to the aquatic plant community are not anticipated. *Lambda*-cyhalothrin uses extend across the state of California, thus use is expected to occur within the CTS range.

Therefore, the Agency makes a **may affect, and likely to adversely affect** determination for the CTS (all DPS) and a **habitat modification determination** for the designated critical habitat of the CTS-CC, and CTS-SB based on the potential for direct and indirect effects and effects to the PCEs of critical habitat. The CTS-SC does not have a designated critical habitat.

5.7.4. Delta Smelt

It is possible for *lambda*-cyhalothrin to directly affect the DS based on RQs exceeding the listed species LOCs for freshwater and estuarine/marine fish. Four incidents for freshwater fish have been reported. Indirect effects from affected prey are also possible based on RQs exceeding the listed and non-listed species LOCs for freshwater and estuarine/marine invertebrates. Three incidents on freshwater invertebrates have been reported. Indirect effects terrestrial plant modifications to the habitat are expected. Several plant incidents have been reported, indicating possible adverse effects on plants. Effects are not anticipated from changes to the aquatic plant community. *Lambda*-cyhalothrin uses extend across the state of California, thus use is expected to occur within the DS range.

Therefore, the Agency makes a **may affect, and likely to adversely affect** determination for the DS and a **habitat modification** determination for the designated critical habitat of the DS.

5.7.5. San Francisco Garter Snake

It is possible for *lambda*-cyhalothrin to directly affect the SFGS based on RQs exceeding the listed species LOCs for reptiles (using avian surrogate species data). Indirect effects from affected prey are also possible based on RQs exceeding the listed and non-listed LOCs for terrestrial-phase amphibians (using avian surrogate species data), reptiles, mammals, terrestrial invertebrates, freshwater fish/aquatic-phase amphibians, and freshwater invertebrates. Four freshwater fish and three freshwater invertebrate incidents have been reported. Indirect effects from affected habitat are possible because the RQs exceeded the listed and non-listed species LOCs for mammal burrow availability. Small mammals are essential in creating the underground habitat that CTS depend upon for shelter, and aestivation. Indirect effects on habitat from terrestrial plants are also anticipated. Several plant incidents have been reported, indicating possible adverse effects on plants. Effects from changes to the aquatic plant community are not expected. *Lambda*-cyhalothrin uses extend across the state of California, thus use is expected to occur within the SFGS range.

Therefore, the Agency makes a **may affect, and likely to adversely affect** determination for the SFGS. The SFGS does not have a designated critical habitat.

5.7.6. Tidewater Goby

It is possible for *lambda*-cyhalothrin to directly affect the TG based on RQs exceeding the listed species LOCs for freshwater and estuarine/marine fish. Four incidents affecting freshwater fish have been reported. Indirect effects from affected prey are also possible based on RQs exceeding the listed and non-listed species LOCs for freshwater and estuarine/marine invertebrates. Three incidents for freshwater invertebrates have been reported. Indirect effects from effects on habitat are anticipated from modifications to the terrestrial plant community. Several plant incidents have been reported, indicating possible adverse effects on plants. Effects on habitat from changes to the aquatic plants in the environment are not expected. *Lambda*-cyhalothrin uses extend across the state of California, thus use is expected to occur within the TG range.

Therefore, the Agency makes a **may affect, and likely to adversely affect** determination for the TG and a **habitat modification** determination for the designated critical habitat of the TG.

5.7.7. Valley Elderberry Longhorn Beetle

It is possible for *lambda*-cyhalothrin to directly affect the VELB based on RQs exceeding the listed species LOCs for terrestrial invertebrates. Indirect effects on food and habitat structure are anticipated because of potential risks to terrestrial plants and insects. Several plant incidents have been reported, indicating possible adverse effects on plants. The VELB has an obligate relationship with the elderberry and thus it is expected that negative effects to plants and/or insects (pollinators, seed dispersers) will adversely affect the VELB. *Lambda*-cyhalothrin uses extend across the state of California, thus use is expected to occur within the VELB range.

Therefore, the Agency makes a **may affect, and likely to adversely affect** determination based on the potential for direct effects to the VELB and a **habitat modification** determination for the designated critical habitat of the VELB.

5.7.8. Addressing the Risk Hypotheses

To conclude this risk assessment, it is necessary to address the risk hypotheses defined in Section 2.9.1. Based on the conclusions of this assessment, some of the hypotheses can be rejected. The following statements modify the hypotheses based on the results of this risk assessment for direct and indirect effects of *lambda*-cyhalothrin on the BCB, CCR, CFWS, CTS (all DPS), DS, SFGS, TG, and VELB and their designated critical habitat.

The labeled use of *lambda*-cyhalothrin may:

- … directly affect the BCB, CCR, CFWS, CTS (all DPS), DS, SFGS, TG, and VELB by causing acute mortality or by adversely affecting chronic growth or fecundity;
- … indirectly affect the BCB, CCR, CFWS, CTS (all DPS), DS, SFGS, TG, and VELB and/or affect their designated critical habitat by reducing or changing the composition of the food supply;
- … indirectly affect none of the assessed species and their designated critical habitat by reducing or changing the composition of the aquatic plant community in the species' current range, thus, affecting primary productivity and/or cover;
- … indirectly affect all of the assessed species and their designated critical habitat by reducing or changing the composition of the terrestrial plant community in the species' current range;
- … indirectly affect the CTS (all DPS) and SFGS and affect their designated critical habitat by reducing or changing aquatic habitat in their current range (via modification of water quality parameters, habitat morphology, and/or sedimentation).

6. Uncertainties

Uncertainties that apply to most assessments completed for the San Francisco Bay Species Litigation are discussed in Attachment I. This section describes additional uncertainties specific to this assessment.

Many product labels for *lambda*-cyhalothrin lack specific application rate information. OPP models rely on application rates being reported in lb ai/A, knowledge of the minimum application interval, and a maximum seasonal/yearly application rate (or maximum number of applications per year at the highest rate). In many instances, labels did not contain these specifics. Some application methods, such as crack and crevice, trunk drench, and mound applications, do not lend themselves to rates in pounds of active ingredient per acre. In other instances, labels stated that reapplications could be made as needed, or did not stipulate any information about the timing of reapplications. For all of these cases, best professional judgement was used to fill in the blanks, often from similar uses on other labels. Final application rates were shared with the registrants and any input received was incorporated into the assessment. However, given the uncertainties with some of the application rates, it is possible that some rates may be overly conservative (e.g., 2 lb ai/A at 7 day intervals) and thus may have led to overly conservative RQs.

6.1. Exposure Assessment Uncertainties

6.1.1. Maximum Use Scenario

The screening-level risk assessment focuses on characterizing potential ecological risks resulting from a maximum use scenario, which is determined from labeled statements of maximum application rate and number of applications with the shortest time interval between applications. The frequency at which actual uses approach this maximum use scenario may be dependent on pest resistance, timing of applications, cultural practices, and market forces.

6.1.2. Usage Uncertainties

County-level usage data were obtained from California's Department of Pesticide Regulation Pesticide Use Reporting (CDPR PUR) database. CDPR PUR documentation indicates that errors in the data may include the following: a misplaced decimal; incorrect measures, area treated, or units; and reports of diluted pesticide concentrations. In addition, it is possible that the data may contain reports for pesticide uses that have been cancelled. The CPDR PUR data do not include home owner applied pesticides; therefore, residential uses are not likely to be reported. As with all pesticide usage data, there may be instances of misuse and misreporting. The Agency made use of the most current, verifiable information; in cases where there were discrepancies, the most conservative information was used.

6.1.3. Terrestrial Exposure Assessment Uncertainties

6.1.3.a. T-REX

Organisms consume a variety of dietary items and may exist in a variety of sizes at different life stages. For foliar applications of liquid formulations, T-REX estimates exposure for the following dietary items: short grass, tall grass, broadleaf plants/small insects, fruits/pods/seeds/large insects, and seeds for granivores. Birds (used as a surrogate for amphibians and reptiles), including the CCR, and mammals consume all of these items. The size classes of birds represented in T-REX are the small (20 g), medium (100 g), and large (1000 g). The size classes for mammals are small (15 g), medium (35 g), and large (1000 g). EECs are calculated for the most sensitive dietary item and size class for birds (surrogate for amphibians and reptiles) and mammals. Table 6-1 shows the percentages of the EECs and RQs of the various dietary classes for each size class as compared to the most sensitive dietary class (short grass) and size class (small mammal or bird). This information could be used to further characterize potential risk that is specific to the diet of birds and mammals. For example, if a mammal only consumes broadleaf plants and small insects and the RQ was 100 for small mammals consuming short grass, the RQ for small mammals that only consumed broadleaf plants and small insects would be 56 (100 x 0.56).

Table 6-1. Percentage of EEC or RQ for the Specified Dietary Items and Size Classes as Compared to the EEC or RQ for The Most Sensitive Dietary Items (Short Grass) and Size Class (Small Bird or Small Mammal)

Dietary Items	Percentage of EECs or RQs for the Specified Dietary Items and Size Class as compared to the EEC or RQ for Small Birds[1] or Small Mammals Consuming Short Grass					
Birds: Dose Based EECs and RQs						
Size Class	Small, 20 g		Mid, 100 g		Large, 1000 g	
	EEC	RQ	EEC	RQ	EEC	RQ
Short Grass	100%	100%	57%	45%	26%	14%
Tall Grass	46%	46%	26%	21%	12%	7%
Broadleaf plants/small Insects	56%	56%	32%	25%	14%	8%
Fruits/pods/seeds/large insects	6%	6%	4%	3%	2%	1%
Granivores	1%	1%	1%	1%	0.4%	0.2%
Mammals: Dose-Based EECs and RQs						
Size Class	Small, 15 g		Mid, 35 g		Large, 1000 g	
	EEC	RQ	EEC	RQ	EEC	RQ
Short Grass	100%	100%	69%	85%	16%	46%
Tall Grass	46%	46%	32%	39%	7%	21%
Broadleaf plants/small Insects	56%	56%	39%	48%	9%	26%
Fruits/pods/seeds/large insects	6%	6%	4%	5%	1%	3%
Granivores	1%	1%	1%	1%	0.2%	0.6%
Mammals and Birds: Dietary-based EECs and RQs for all Size Classes[2]						
Short Grass	100%					
Tall Grass	46%					
Broadleaf plants/sm Insects	56%					
Fruits/pods/seeds/lg insects	6%					

[1] The percents of the maximum RQ shown here for birds are based on the Agency's default avian scaling factor of 1.15. The percents of the maximum RQ shown here for birds are based on the specific scaling factor of XX for CHEM X (Mineau *et al*. 1996).
[2] Percentages for dose-based chronic EECs and RQs for mammals are equivalent to the acute dose-based EECs and RQs.

In the risk assessment, RQs were only calculated for the most sensitive dietary class relevant to the organisms assessed. For most organisms, not enough data are available to conclude that birds or mammals may not exclusively feed on a dietary class for at least some time period. However, most birds and mammals consume a variety of dietary items and thus the RQ will overestimate risk to those organisms. For example, the CCR is estimated to consume only 15% plant material (USFWS, 2003). Additionally, some organisms will not feed on all of the dietary classes. For example, many amphibians would only consume insects and not any plant material.

6.1.3.b. T-HERPS

For foliar applications of liquid formulations, T-HERPS estimates exposure for the following dietary items: broadleaf plants/small insects, fruits/pods/seeds/large insects, small herbivore mammals, small insectivore mammals, and small amphibians. Snakes and amphibians may consume all of these items. The default size classes of amphibians represented in T-HERPS are small (2 g), medium (20 g), and large (200 g). The default vertebrate prey size that the medium and large amphibians can consume is 13 g and 133 g, respectively (small amphibians are not expected to eat vertebrate prey). The default size classes for snakes are small (2 g), medium (20 g), and large (800 g). The default vertebrate prey size that medium and large snakes can consume is 25 g and 1,286 g, respectively (small snakes are not expected to eat vertebrate prey). EECs are calculated for the most sensitive dietary item and size class for amphibians and snakes. Table 6-2 shows the percentages of the EECs and RQs of the various dietary classes for each size class as compared to the most sensitive dietary class (herbivorous mammal) and size class [medium (20 g) amphibian or snake]. This information could be used to further characterize potential risk that is specific to the diet of amphibians and snakes.

Table 6-2. Percentage of EEC or RQ for the Specified Dietary Class as Compared to the EEC or RQ for The Most Sensitive Dietary Class (Small Herbivore Mammals) and Size Class (Medium Amphibian or Snake)

<table>
<tr><th>Dietary Items</th><th colspan="4">Percentage of EECs or RQs for the Specified Dietary Items and Size Class as compared to the EEC or RQ for Medium Amphibians or Snakes Consuming Small Herbivore Mammals</th></tr>
<tr><td colspan="5">Amphibians: Acute Dose Based EECs and RQs</td></tr>
<tr><td>Size Class</td><td>Small, 2 g</td><td>Mid, 20 g</td><td colspan="2">Large, 200 g</td></tr>
<tr><td>Broadleaf plants/sm Insects</td><td>5%</td><td>3%</td><td colspan="2">2%</td></tr>
<tr><td>Fruits/pods/seeds/lg insects</td><td>0.5%</td><td>0.3%</td><td colspan="2">0.2%</td></tr>
<tr><td>Small herbivore mammals</td><td>N/A</td><td>100%</td><td colspan="2">37%</td></tr>
<tr><td>Small insectivore mammals</td><td>N/A</td><td>6%</td><td colspan="2">2%</td></tr>
<tr><td>Small amphibians</td><td>N/A</td><td>2%</td><td colspan="2">1%</td></tr>
<tr><td colspan="5">Snakes: Acute Dose-Based EECs and RQs</td></tr>
<tr><td>Size Class</td><td>Small, 2 g</td><td>Mid, 20 g</td><td>Mid, 200 g[1]</td><td>Large, 800 g</td></tr>
<tr><td>Broadleaf plants/sm Insects</td><td>3%</td><td>2%</td><td>1%</td><td>1%</td></tr>
<tr><td>Fruits/pods/seeds/lg insects</td><td>0.4%</td><td>0.2%</td><td>0.1%</td><td>0.1%</td></tr>
<tr><td>Small herbivore mammals</td><td>N/A</td><td>100%</td><td>40%</td><td>23%</td></tr>
<tr><td>Small insectivore mammals</td><td>N/A</td><td>6%</td><td>3%</td><td>1%</td></tr>
<tr><td>Small amphibians</td><td>N/A</td><td>2%</td><td>2%</td><td>1%</td></tr>
<tr><td colspan="5">Amphibians and Snakes: Acute and Chronic Dietary-based EECs and RQs for all Size Classes</td></tr>
<tr><td></td><td colspan="2">Amphibians</td><td colspan="2">Snakes</td></tr>
<tr><td>Broadleaf plants/sm Insects</td><td colspan="2">56%</td><td colspan="2">73%</td></tr>
<tr><td>Fruits/pods/seeds/lg insects</td><td colspan="2">6%</td><td colspan="2">8%</td></tr>
<tr><td>Small herbivore mammals</td><td colspan="2">100%</td><td colspan="2">100%</td></tr>
<tr><td>Small insectivore mammals</td><td colspan="2">6%</td><td colspan="2">6%</td></tr>
<tr><td>Small amphibians</td><td colspan="2">2%</td><td colspan="2">2%</td></tr>
</table>

[1]To provide more information, a 200 g snake (eating a 291 g prey item) was also modeled (in addition to the default body sizes).

In the risk assessment, RQs were only calculated for the most sensitive dietary class relevant to the organisms assessed. For most organisms, not enough data are available to conclude that amphibians or snakes may not exclusively feed on a dietary class for at least some time period. However, most amphibians and snakes consume a variety of dietary items and thus the RQ will overestimate risk to those organisms. Additionally, some organisms will not feed on all of the dietary classes. For example, many amphibians would only consume insects and not any plant material.

6.1.4. Aquatic Exposure Modeling of *Lambda*-Cyhalothrin

The standard ecological water body scenario (EXAMS pond) used to calculate potential aquatic exposure to pesticides is intended to represent conservative estimates, and to avoid underestimating the actual exposure. The standard scenario consists of application to a 10-hectare field bordering a 1-hectare, 2-meter deep (20,000 m^3) pond with no outlet. Exposure estimates generated using the EXAMS pond is intended to represent a wide variety of vulnerable water bodies that occur at the top of watersheds including prairie pot holes, playa lakes, wetlands, vernal pools, man-made and natural ponds, and intermittent and lower order streams. As a group, there are factors that make these water bodies more or less vulnerable than the EXAMS pond. Static water bodies that have larger ratios of pesticide-treated drainage area to water body volume would be expected to have higher peak EECs than the EXAMS pond. These water bodies will be either smaller in size or have larger drainage areas. Smaller water bodies have limited storage capacity and thus may overflow and carry pesticide in the discharge, whereas the EXAMS pond has no discharge. As watershed size increases beyond 10-hectares, it becomes increasingly unlikely that the entire watershed is planted with a single crop that is all treated simultaneously with the pesticide. Headwater streams can also have peak concentrations higher than the EXAMS pond, but they likely persist for only short periods of time and are then carried and dissipated downstream.

The Agency acknowledges that there are some unique aquatic habitats that are not accurately captured by this modeling scenario and modeling results may, therefore, under- or over-estimate exposure, depending on a number of variables. For example, some organisms may inhabit water bodies of different size and depth and/or are located adjacent to larger or smaller drainage areas than the EXAMS pond. However, the Services agree that the existing EXAMS pond represents the best currently available approach for estimating aquatic exposure to pesticides (USFWS/NMFS 2004).

The standard pond pH was assumed to be neutral (pH=7). *Lambda*-cyhalothrin degrades faster in high pH water in which case, the EECs could be less than those predicted by PRZM/EXAMS. On the other hand, *lambda*-cyhalothrin's degradation is possibly a function of the redox potential, with the chemical being more stable in negative redox potential environments. In general, static waters with low aeration could show higher EECs than predicted by PRZM/EXAMS. In addition, *lambda*-cyhalothrin's EECs may be different than actually predicted if the temperature is different than 20-25°C, which is the temperature used frequently in laboratory studies.

In general, the linked PRZM/EXAMS model produces estimated aquatic concentrations that are expected to be exceeded once within a ten-year period. The Pesticide Root Zone Model is a process or "simulation" model that calculates what happens to a pesticide in an agricultural field on a day-to-day basis. It considers factors such as rainfall and plant transpiration of water, as well as how and when the pesticide is applied. It has two major components: hydrology and chemical transport. Water movement is simulated by the use of generalized soil parameters, including field capacity, wilting point, and saturation water content. The chemical transport component can simulate pesticide application on the soil or on the plant foliage. Dissolved, adsorbed, and vapor-phase concentrations in the soil are estimated by simultaneously considering the processes of pesticide uptake by plants, surface runoff, erosion, decay, volatilization, foliar wash-off, advection, dispersion, and retardation.

Uncertainties associated with each of these individual components add to the overall uncertainty of the modeled concentrations. Additionally, model inputs from the environmental fate degradation studies are chosen to represent the upper confidence bound on the mean values that are not expected to be exceeded in the environment approximately 90 percent of the time. Mobility input values are chosen to be representative of conditions in the environment. The natural variation in soils adds to the uncertainty of modeled values. Factors such as application date, crop emergence date, and canopy cover can also affect estimated concentrations, adding to the uncertainty of modeled values. Factors within the ambient environment such as soil temperatures, sunlight intensity, antecedent soil moisture, and surface water temperatures can cause actual aquatic concentrations to differ for the modeled values.

Unlike spray drift, tools are currently not available to evaluate the effectiveness of a vegetative setback on runoff and loadings. The effectiveness of vegetative setbacks is highly dependent on the condition of the vegetative strip. For example, a well established, healthy vegetative setback can be a very effective means of reducing runoff and erosion from agricultural fields. Alternatively, a setback of poor vegetative quality or a setback that is channelized can be ineffective at reducing loadings. Until such time as a quantitative method to estimate the effect of vegetative setbacks on various conditions on pesticide loadings becomes available, the aquatic exposure predictions are likely to overestimate exposure where healthy vegetative setbacks exist and underestimate exposure where poorly developed, channelized, or bare setbacks exist.

To account for uncertainties associated with modeling, available monitoring data were compared to PRZM/EXAMS estimates of peak EECs for the different uses. As discussed above, several data values were available from NAWQA for *lambda*-cyhalothrin's concentrations measured in surface waters receiving runoff from agricultural areas. The specific use patterns (e.g. application rates and timing, crops) associated with the agricultural areas are unknown; however, they are assumed to be representative of potential *lambda*-cyhalothrin use areas. The majority (93%) of the surface water EEC values were ≤ 1 µg/L, which were in line with the monitoring values. It appears that modeling provides suitable conservative estimates of exposure concentration (EECs).

6.1.5. Exposure in Estuarine/Marine Environments

PRZM-EXAMS modeled EECs are intended to represent exposure of aquatic organisms in relatively small ponds and low-order streams. Therefore, it is likely that EECs generated from the PRZM-EXAMS model will over-estimate potential concentrations in larger receiving water bodies such as estuaries, embayments, and coastal marine areas because chemicals in runoff water (or spray drift, etc.) should be diluted by a much larger volume of water than would be found in the 'typical' EXAMS pond. However, as chemical constituents in water draining from freshwater streams encounter brackish or other near-marine-associated conditions, there is potential for important chemical transformations to occur. Many chemical compounds can undergo changes in mobility, toxicity, or persistence when changes in pH, Eh (redox potential), salinity, dissolved oxygen (DO) content, or temperature are encountered. For example, desorption and re-mobilization of some chemicals from sediments can occur with changes in salinity (Jordan *et al.*, 2008; Means, 1995; Swarzenski *et al.*, 2003), changes in pH (*e.g.*, Wood and Baptista 1993; Parikh et al. 2004; Fernandez et al. 2005), Eh changes (Velde and Church, 1999; Wood and Baptista, 1993), and other factors. Thus, although chemicals in discharging rivers may be diluted by large volumes of water within receiving estuaries and embayments, the hydrochemistry of the marine-influenced water may negate some of the attenuating impact of the greater water volume; for example, the effect of dilution may be confounded by changes in chemical mobility (and/or bioavailability) in brackish water. In addition, freshwater contributions from discharging streams and rivers do not instantaneously mix with more saline water bodies. In these settings, water will commonly remain highly stratified, with fresh water lying atop denser, heavier saline water – meaning that exposure to concentrations found in discharging stream water may propagate some distance beyond the outflow point of the stream (especially near the water surface). Therefore, it is not assumed that discharging water will be rapidly diluted by the entire water volume within an estuary, embayment, or other coastal aquatic environment.

PRZM-EXAMS model results should be considered consistent with concentrations that might be found near the head of an estuary unless there is specific information – such as monitoring data – to indicate otherwise. Conditions nearer to the mouth of a bay or estuary, however, may be closer to a marine-type system, and thus more subject to the notable buffering, mixing, and diluting capacities of an open marine environment. Conversely, tidal effects (pressure waves) can propagate much further upstream than the actual estuarine water, so discharging river water may become temporarily partially impounded near the mouth (discharge point) of a channel, and resistant to mixing until tidal forces are reversed.

The Agency does not currently have sufficient information regarding the hydrology and hydrochemistry of estuarine aquatic habitats to develop alternate scenarios for assessed listed species that inhabit these types of ecosystems. The Agency acknowledges that there are unique brackish and estuarine habitats that may not be accurately captured by PRZM-EXAMS modeling results, and may, therefore, under- or over-estimate exposure, depending on the aforementioned variables.

6.1.6. Modeled Versus Monitoring Concentrations

Peak model-estimated environmental concentrations resulting from different *lambda*-cyhalothrin uses range from 0.0008 to 15.89 µg/L, with the majority (93%) of EEC values ≤ 1 µg/L. These estimates are supplemented with analysis of available California surface water monitoring data from U. S. Geological Survey's National Water Quality Assessment (NAWQA) program and the California Department of Pesticide Regulation. Concentrations of *lambda*-cyhalothrin reported by NAWQA for California surface waters with agricultural watersheds are less than the limit of quantitation (LOQ) which ranged from 0.004 to 0.018 µg/L. However, the maximum concentration of *lambda*-cyhalothrin reported by the California Department of Pesticide Regulation surface water database (0.14 µg/L) is roughly 100 times lower than the highest peak model-estimated environmental concentration. However, the majority (93%) of the surface water EEC values were ≤ 1 µg/L were in line with the monitoring values. It appears that modeling provides suitable conservative estimates of exposure concentration (EECs).

6.1.7. Degradate Modeling

Compound XV was determined to be similar in structure to the parent, *lambda*-cyhalothrin. No toxicity data were available for this compound, but ECOSAR modeling indicated its toxicity would be in the same order of magnitude as *lambda*-cyhalothrin. Given that these chemicals are expected to be similar in their toxicity, modeling *lambda*-cyhalothrin alone should have been protective of all organisms. If Compound XV were slightly more toxic than its parent, the RQ would be expected to increase; however, it is unlikely that this would affect the overall conclusion of the assessment, given the large number of RQs that exceeded the LOCs.

6.2. Effects Assessment Uncertainties

6.2.1. Data Gaps and Uncertainties

Terrestrial plant toxicity data were not available. In lieu of this, two *lambda*-cyhalothrin efficacy studies were used to support the premise that the pesticide is not harmful to plants at field application rates. The EPA inventory of studies for other pyrethroids was searched for terrestrial plant data, but no toxicity information was available. In addition, plant incident data were reviewed. In most cases, details from the plant incidents were lacking and definitive evidence linking *lambda*-cyhalothrin exposure to the plant damage was not present. In absence of definitive data, risks to plants were assumed.

Toxicity data also were not available for aquatic vascular plants, thus toxicity data from non-vascular plants were used as a surrogate (see Section 6.2.2).

Pyrethroids sorb to sediments and thus potentially pose greater risks to benthic organisms than other chemicals. Data were not available for freshwater and estuarine/marine benthic invertebrates, thus toxicity data from freshwater invertebrates and estuarine/marine invertebrates were used as surrogates (see Section 6.2.2).

6.2.2. Use of Surrogate Species Effects Data

Guideline toxicity tests and open literature data on *lambda*-cyhalothrin are not available for aquatic-phase amphibians; therefore, freshwater fish are used as surrogate species for aquatic-phase amphibians and the CTS. Endpoints based on freshwater fish ecotoxicity data are assumed to be protective of potential direct effects to aquatic-phase amphibians including the CTS, and extrapolation of the risk conclusions from the most sensitive tested species to the aquatic-phase CTS is likely to overestimate the potential risks to those species. Efforts are made to select the organisms most likely to be affected by the type of compound and usage pattern; however, there is an inherent uncertainty in extrapolating across phyla. In addition, the Agency's LOCs are intentionally set very low, and conservative estimates are made in the screening level risk assessment to account for these uncertainties.

Similarly, toxicity data for aquatic vascular plants were not available. Toxicity data from aquatic non-vascular plants were used as a surrogate. Depending on the differences in sensitivity between aquatic vascular and non-vascular plants, these data may over or underestimate the risk to aquatic vascular plants.

Data also were not available for benthic organisms – freshwater or estuarine/marine. In lieu of this, toxicity data from other freshwater or estuarine/marine organisms were used as surrogates. In the case of freshwater invertebrates, acute toxicity data from *Hyalella* were available. This organism is commonly used for sediment toxicity testing. *Daphnia* data were used for chronic effects to freshwater benthic invertebrates, in the form of an acute-to-chronic ratio; *Daphnia* is usually less sensitive than freshwater benthic organisms. Mysid shrimp acute and chronic data were used a surrogates for estuarine/marine benthic invertebrates.

6.2.3. Sublethal Effects

When assessing acute risk, the screening risk assessment relies on the acute mortality endpoint as well as a suite of sublethal responses to the pesticide, as determined by the testing of species response to chronic exposure conditions and subsequent chronic risk assessment. Consideration of additional sublethal data in the effects determination is exercised on a case-by-case basis and only after careful consideration of the nature of the sublethal effect measured and the extent and quality of available data to support establishing a plausible relationship between the measure of effect (sublethal endpoint) and the assessment endpoints. However, the full suite of sublethal effects from valid open literature studies is considered for the characterization purposes.

Open literature studies were consulted for sublethal effects; however, studies mainly focused on mortality and sublethal effects were either absent or not reported for *lambda*-cyhalothrin. To the extent to which sublethal effects are not considered in this assessment, the potential direct and indirect effects of *lambda*-cyhalothrin on listed species may be underestimated.

7. Risk Conclusions

In fulfilling its obligations under Section 7(a)(2) of the Endangered Species Act, the information presented in this endangered species risk assessment represents the best data currently available to assess the potential risks of *lambda*-cyhalothrin to BCB, CCR, CFWS, CTS (all DPS), DS, SFGS, TG, and VELB and their designated critical habitat.

Based on the best available information, the Agency makes a **Likely to Adversely Affect** determination for the CTS (all DPS) and SFGS. Additionally, the Agency has determined that there is the potential for modification of the designated critical habitat for the CTS-CC and CTS-SB from the use of the chemical. Given the LAA determination for BCB, CCR, CFWS, CTS (all DPS), DS, SFGS, TG, and VELB and potential modification of designated critical habitat for the CTS-CC and CTS-SB, a description of the baseline status and cumulative effects is provided in Attachment III.

A summary of the risk conclusions and effects determinations for the BCB, CCR, CFWS, CTS (all DPS), DS, SFGS, TG, and VELB and their critical habitat, given the uncertainties discussed in Section 6 and Attachment I, is presented in Table 7-1 and Table 7-2. Use specific effects determinations are provided in Table 7-3 and Table 7-4.

Table 7-1. Effects Determination Summary for Effects of *Lambda*-Cyhalothrin on the BCB, CCR, CFWS, CTS (all DPS), DS, SFGS, TG, and VELB

Species	Effects Determination	Basis for Determination
Bay Checkerspot Butterfly (*Euphydryas editha bayensis*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** ***Terrestrial*** There is the potential for *lambda*-cyhalothrin to directly affect the BCB based on the RQs exceeding the interim listed species terrestrial invertebrate LOC (acute) for all uses. Four major incidents were reported for terrestrial invertebrates. The probability of an individual effect is 1. **Potential for Indirect Effects** ***Terrestrial food items, habitat*** There is the potential for indirect effects to plant food and habitat sources because quantitative terrestrial plant toxicity data were not available. Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal.
Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus)*	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** ***Terrestrial*** There is the potential for *lambda*-cyhalothrin to directly affect the VELB based on RQs exceeding the interim listed terrestrial invertebrate LOC (acute) for all uses. Four major incidents were reported for terrestrial invertebrates. The probability of an individual effect is 1. **Potential for Indirect Effects** ***Terrestrial food items, habitat*** There is the potential for *lambda*-cyhalothrin to result in adverse effects to non-target terrestrial invertebrates, thus native pollinators of the elderberry also are likely to be negatively affected by *lambda*-cyhalothrin use and result in impaired plant reproduction. The elderberry plant serves as an obligate host for the VELB. There is the potential for indirect effects to plant food and habitat sources because quantitative terrestrial plant toxicity data were not available. Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible.
California Tiger Salamander (All 3 DPS) (*Ambystoma californiense)*	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** ***Aquatic-phase (eggs, larvae, and adults) and terrestrial-phase (juveniles and adults)*** There is the potential for *lambda*-cyhalothrin to directly affect the CTS based on RQs exceeding the listed species LOCs (acute and chronic) for terrestrial-phase amphibians (using avian surrogate species data) and based on RQs exceeding the

Species	Effects Determination	Basis for Determination
		listed species LOCs (acute and chronic) for aquatic-phase amphibians (using freshwater fish surrogate species data). There were no major incidents reported for amphibians. The probability of an individual effect is between 491 and 1710.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover, and primary productivity and terrestrial prey items, habitat There is the potential for indirect effects from affected prey based on RQs exceeding listed and non-listed species LOCs (acute and chronic) for terrestrial invertebrates, freshwater invertebrates, and freshwater fish. Indirect effects from affected habitat are possible because the RQs exceed the listed and non-listed species LOCs (acute and chronic) for small mammals which could affect burrow availability. Small mammals are essential in creating the underground habitat that juvenile and adult CTS depend upon for food, shelter, and protection from the elements and predation. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal. Indirect effects toaquatic plants are not anticipated.
California Clapper Rail (*Rallus longirostris obsoletus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Terrestrial There is the potential for *lambda*-cyhalothrin to directly affect the CCR based on RQs exceeding the listed species LOCs (acute and chronic) for avian species. There were no major incidents reported for birds. The probability of an individual effect is between 11 and 22.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover, and primary productivity and terrestrial prey items, riparian habitat There is the potential for indirect effects from affected prey based on RQs exceeding the listed and non-listed LOCs (acute and chronic) for birds, mammals, terrestrial invertebrates, freshwater and estuarine/marine fish, and freshwater and estuarine/marine invertebrates. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal. Indirect effects toaquatic plants are not anticipated.
California	May Affect,	**Potential for Direct Effects**

Species	Effects Determination	Basis for Determination
Freshwater Shrimp (*Syncaris pacifica*)	Likely to Adversely Affect (LAA)	***Aquatic*** There is the potential for *lambda*-cyhalothrin to directly affect the CFWS based on RQs exceeding the listed species LOCs for freshwater invertebrates on an acute and chronic basis. There were three major incidents reported for freshwater invertebrates. The probability of an individual effect is between 1 and 7.
		Potential for Indirect Effects
		Aquatic prey items, habitat, cover, and primary productivity and terrestrial prey items, riparian habitat Indirect effects from affected prey are also possible based on RQs exceeding the listed and non-listed species LOCs for freshwater invertebrates. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal. Indirect effects toaquatic plants are not anticipated.
Delta Smelt (*Hypomesus transpacificus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Aquatic There is the potential for *lambda*-cyhalothrin to directly affect the DS based on RQs exceeding the listed species LOCs for freshwater and estuarine/marine fish on an acute and chronic basis. There were four major incidents reported for freshwater fish. The probability of an individual effect is between 1 and 58,500 for freshwater fish and 1 and 265,000,000 for estuarine/marine fish.
		Potential for Indirect Effects
		Aquatic prey items, habitat, cover, and primary productivity and terrestrial riparian habitat Indirect effects from affected prey are also possible based on RQs (acute and chronic) exceeding the listed and non-listed species LOCs for freshwater and estuarine/marine invertebrates There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal. Indirect effects toaquatic plants are not anticipated.
San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Terrestrial There is the potential for *lambda*-cyhalothrin to directly affect the SFGS based on RQs exceeding the listed species LOCs for reptiles (using avian surrogate species data), on an acute and chronic basis. There were no major incidents

Species	Effects Determination	Basis for Determination
		reported for reptiles. The probability of an individual effect is between 648 and 2490.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover, and primary productivity and terrestrial prey items, riparian habitat There is the potential for indirect effects from affected prey based on RQs exceeding the listed and non-listed LOCs (acute and chronic) for terrestrial-phase amphibians and reptiles (using avian surrogate species data), mammals, terrestrial invertebrates, freshwater fish/aquatic-phase amphibians, and freshwater invertebrates. Indirect effects from affected habitat are possible because the RQs exceeded the listed and non-listed species LOCs for mammals, for burrow availability. Small mammals are essential in creating the underground habitat that CTS depend upon for shelter, and aestivation. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal. Indirect effects toaquatic plants are not anticipated.
Tidewater Goby (*Eucyclogobius newberryi*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Aquatic There is the potential for *lambda*-cyhalothrin to directly affect the TG based on RQs exceeding the listed species LOCs (acute and chronic) for freshwater and estuarine/marine fish on an acute and chronic basis. There were four major incidents reported for freshwater fish. The probability of an individual effect is between 1 and 58,500 for freshwater fish and 1 and 265,000,000 for estuarine/marine fish.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover, and primary productivity and Terrestrial riparian habitat Indirect effects from affected prey are also possible based on RQs exceeding the listed and non-listed LOCs for freshwater and estuarine/marine invertebrates. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal. Indirect effects toaquatic plants are not anticipated.

Species	Effects Determination	Basis for Determination
Bay Checkerspot Butterfly (*Euphydryas editha bayensis*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Terrestrial There is the potential for *lambda*-cyhalothrin to directly affect the BCB based on the RQs exceeding the interim listed species terrestrial invertebrate LOC (acute) for all uses. Four major incidents were reported for terrestrial invertebrates. The probability of an individual effect is 1.
		Potential for Indirect Effects
		Terrestrial food items, habitat There is the potential for indirect effects to plant food and habitat sources because quantitative terrestrial plant toxicity data were not available. Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal.
Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus)*	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Terrestrial There is the potential for *lambda*-cyhalothrin to directly affect the VELB based on RQs exceeding the interim listed terrestrial invertebrate LOC (acute) for all uses. Four major incidents were reported for terrestrial invertebrates. The probability of an individual effect is 1.
		Potential for Indirect Effects
		Terrestrial food items, habitat There is the potential for *lambda*-cyhalothrin to result in adverse effects to non-target terrestrial invertebrates, thus native pollinators of the elderberry also are likely to be negatively affected by *lambda*-cyhalothrin use and result in impaired plant reproduction. The elderberry plant serves as an obligate host for the VELB. There is the potential for indirect effects to plant food and habitat sources because quantitative terrestrial plant toxicity data were not available. Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible.
California Tiger Salamander (All 3 DPS) (*Ambystoma californiense)*	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Aquatic-phase (eggs, larvae, and adults) and terrestrial-phase (juveniles and adults) There is the potential for *lambda*-cyhalothrin to directly affect the CTS based on RQs exceeding the listed species LOCs (acute and chronic) for terrestrial-phase amphibians (using avian surrogate species data) and based on RQs exceeding the listed species LOCs (acute and chronic) for aquatic-phase amphibians (using freshwater fish surrogate species data). There were no major incidents reported for amphibians. The probability of an individual effect is between 491 and 1710.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover, and primary productivity and terrestrial prey items, habitat There is the potential for indirect effects from affected prey based on RQs exceeding listed and non-listed species LOCs (acute and chronic) for terrestrial

Species	Effects Determination	Basis for Determination
		invertebrates, freshwater invertebrates, and freshwater fish. Indirect effects from affected habitat are possible because the RQs exceed the listed and non-listed species LOCs (acute and chronic) for small mammals which could affect burrow availability. Small mammals are essential in creating the underground habitat that juvenile and adult CTS depend upon for food, shelter, and protection from the elements and predation. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal. Indirect effects toaquatic plants are not anticipated.
California Clapper Rail (*Rallus longirostris obsoletus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Terrestrial There is the potential for *lambda*-cyhalothrin to directly affect the CCR based on RQs exceeding the listed species LOCs (acute and chronic) for avian species. There were no major incidents reported for birds. The probability of an individual effect is between 11 and 22.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover, and primary productivity and terrestrial prey items, riparian habitat There is the potential for indirect effects from affected prey based on RQs exceeding the listed and non-listed LOCs (acute and chronic) for birds, mammals, terrestrial invertebrates, freshwater and estuarine/marine fish, and freshwater and estuarine/marine invertebrates. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal. Indirect effects toaquatic plants are not anticipated.
California Freshwater Shrimp (*Syncaris pacifica*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Aquatic There is the potential for *lambda*-cyhalothrin to directly affect the CFWS based on RQs exceeding the listed species LOCs for freshwater invertebrates on an acute and chronic basis. There were three major incidents reported for freshwater invertebrates. The probability of an individual effect is between 1 and 7.
		Potential for Indirect Effects
		Aquatic prey items, habitat, cover, and primary productivity and terrestrial prey

Species	Effects Determination	Basis for Determination
		items, riparian habitat Indirect effects from affected prey are also possible based on RQs exceeding the listed and non-listed species LOCs for freshwater invertebrates. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal. Indirect effects toaquatic plants are not anticipated.
Delta Smelt (*Hypomesus transpacificus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Aquatic There is the potential for *lambda*-cyhalothrin to directly affect the DS based on RQs exceeding the listed species LOCs for freshwater and estuarine/marine fish on an acute and chronic basis. There were four major incidents reported for freshwater fish. The probability of an individual effect is between 1 and 58,500 for freshwater fish and 1 and 265,000,000 for estuarine/marine fish.
		Potential for Indirect Effects
		Aquatic prey items, habitat, cover, and primary productivity and terrestrial riparian habitat Indirect effects from affected prey are also possible based on RQs (acute and chronic) exceeding the listed and non-listed species LOCs for freshwater and estuarine/marine invertebrates There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal. Indirect effects toaquatic plants are not anticipated.
San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Terrestrial There is the potential for *lambda*-cyhalothrin to directly affect the SFGS based on RQs exceeding the listed species LOCs for reptiles (using avian surrogate species data), on an acute and chronic basis. There were no major incidents reported for reptiles. The probability of an individual effect is between 648 and 2490.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover, and primary productivity and terrestrial prey items, riparian habitat There is the potential for indirect effects from affected prey based on RQs exceeding the listed and non-listed LOCs (acute and chronic) for terrestrial-phase amphibians and reptiles (using avian surrogate species data), mammals,

Species	Effects Determination	Basis for Determination
		terrestrial invertebrates, freshwater fish/aquatic-phase amphibians, and freshwater invertebrates. Indirect effects from affected habitat are possible because the RQs exceeded the listed and non-listed species LOCs for mammals, for burrow availability. Small mammals are essential in creating the underground habitat that CTS depend upon for shelter, and aestivation. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal. Indirect effects toaquatic plants are not anticipated.
Tidewater Goby (*Eucyclogobius newberryi*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** ***Aquatic*** There is the potential for *lambda*-cyhalothrin to directly affect the TG based on RQs exceeding the listed species LOCs (acute and chronic) for freshwater and estuarine/marine fish on an acute and chronic basis. There were four major incidents reported for freshwater fish. The probability of an individual effect is between 1 and 58,500 for freshwater fish and 1 and 265,000,000 for estuarine/marine fish. **Potential for Indirect Effects** ***Aquatic prey items, aquatic habitat, cover, and primary productivity and Terrestrial riparian habitat*** Indirect effects from affected prey are also possible based on RQs exceeding the listed and non-listed LOCs for freshwater and estuarine/marine invertebrates. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal. Indirect effects toaquatic plants are not anticipated.

Table 7-2. Effects Determination Summary for the Critical Habitat Impact Analysis

Designated Critical Habitat for:	Effects Determination	Basis for Determination
Bay Checkerspot Butterfly	Habitat Modification	There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible.

		In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal.
California Tiger Salamander Central California Distinct Population Segment	Habitat Modification	Habitat effects are possible because the RQs exceeded the LOCs for mammal burrow availability. Small mammals are essential in creating the underground habitat that juvenile and adult CTS depend upon for food, shelter, and protection from the elements and predation. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal.
California Tiger Salamander Santa Barbara County Distinct Population Segment	Habitat Modification	Habitat effects are possible because the RQs exceeded the LOCs for mammal burrow availability. Small mammals are essential in creating the underground habitat that juvenile and adult CTS depend upon for food, shelter, and protection from the elements and predation. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal.
Delta Smelt	Habitat Modification	There is the potential for indirect effects to the DS because of a reduction in the food supply, based on direct and indirect effects to aquatic invertebrates. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal.
Tidewater Goby	Habitat Modification	There is the potential for indirect effects to the DS because of a reduction in the food supply, based on direct and indirect effects to aquatic invertebrates. There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. In addition, indirect effects to plants may result from effects on the organisms that plants depend on for pollination and seed dispersal.

Valley Elderberry Longhorn Beetle	Habitat Modification	There is the potential for indirect effects on habitat from adverse effects to terrestrial plants (conservative assumption given that plant data were not available). Several plant incidents have been reported, indicating possible adverse effects of *lambda*-cyhalothrin on plants. Plant data are not available for other pyrethroids, thus extrapolation from one pyrethroid to another is not possible. The VELB has an obligate relationship with the elderberry. Indirect effects may occur because of the direct effects to terrestrial invertebrates, which may affect pollination and seed dispersal of the elderberry. Based on the information provided in the VELB Status and Life History document prepared by the Fish and Wildlife Services, any human disturbance that adversely affects the beetle results in modification of critical habitat (1980 Federal Register Vol. 45, No. 155).

Table 7-3. Use Specific Summary of the Potential for Adverse Effects to Aquatic Taxa

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	DS, TG and Estuarine/ Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Freshwater Benthic Invertebrates[6]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Agricultural/ farm premises (crack and crevice)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Alfalfa (aerial)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Alfalfa (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Almond (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Almond (trunk drench)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, trees (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Nectarine, peach, cherry trees trunk drench (trunk drench)	No	No	No	No	Yes	Yes	No	Yes	Yes[7]	Yes	No	No	No
Apple trees (trunk drench)	No	No	No	No	Yes	Yes	No	Yes	Yes[7]	No	No	No	No
Animal housing premises, paths/patios (crack and crevice)	Yes[7]	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Household/ domestic dwellings,	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	DS, TG and Estuarine/ Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Freshwater Benthic Invertebrates[6]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
outdoor premises (crack and crevice)													
Apricot, loquat, mayhaw, plum, quince (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Bean, groundcherry, pea, pepino, pepper (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Eggplant (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Barley (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Barley (G)/ 2 app @ 0.031 lb ai/A (7-days)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Bell pepper, catjang (Jerusalem/marble pea) (aerial)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Bell pepper, catjang (Jerusalem/ marble pea)(ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	DS, TG and Estuarine/ Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Freshwater Benthic Invertebrates[6]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Mustard cabbage (gai choy, pak-choi) (ground)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Brassica (head and stem) vegetables (aerial)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Brassica (head and stem) vegetables (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Tomato, tomatillo (ground)	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Broccoli, cauliflower (ground)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Cabbage, kohlrabi (ground)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Mustard (ground)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Brussels sprouts (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Brussels sprouts (ground)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Buckwheat, oat, rye (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Buckwheat, oat, rye (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Canola/rape (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	DS, TG and Estuarine/ Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Freshwater Benthic Invertebrates[6]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Canola/rape (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Grass forage/fodder /hay, pastures, rangeland (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Grass forage/fodder /hay, pastures, rangeland (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Cereal grains, triticale, wheat (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Cereal grains, triticale, wheat (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Cole crops (aerial)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Cole crops (ground)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Onion (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Onion (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Commercial/ industrial lawns, ornamental lawns and turf, recreation area lawns (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Commercial/ industrial lawns,	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	DS, TG and Estuarine/ Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Freshwater Benthic Invertebrates[6]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
ornamental lawns and turf, recreation area lawns (spot treatment)													
Conifers (plantations/ nurseries) (ground)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Conifers (seed orchard) (ground)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Corn (field) (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Corn (field) (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Corn (field, pop) (in-furrow)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Corn (sweet) (in-furrow)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Corn (sweet) (dust)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Corn (sweet) (aerial)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Cotton (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Cotton (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Cucurbit vegetables (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Cucurbit vegetables (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	DS, TG and Estuarine/ Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Freshwater Benthic Invertebrates[6]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Ear tags	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Filbert, pecan, walnut (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Filbert, pecan, walnut (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Filbert, pecan, walnut (dust)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Forest plantings (ground)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Fruiting vegetables (aerial)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Fruiting vegetables (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Garlic (aerial)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Golf course turf, ornamental sod farm (ground)	No	No	Yes[7]	No	Yes	Yes	Yes[7]	Yes	Yes	Yes	Yes[7]	Yes	No
Golf course turf, ornamental sod farm (mound)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Grasses grown for seed (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Legume vegetables (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Legume vegetables (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	DS, TG and Estuarine/ Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Freshwater Benthic Invertebrates[6]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Peanuts, root and tuber vegetables (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Peanuts, root and tuber vegetables (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Lettuce (aerial)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Lettuce (ground)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Nonagricultural uncultivated areas/soils (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Ornamental and/or shade trees (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Ornamental and/or shade trees, ground cover, herbaceous plants, non-flowering plants, woody shrubs and vines, rose (dust)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Paved areas (private roads/ sidewalks (ground)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Pome and stone	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	DS, TG and Estuarine/ Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Freshwater Benthic Invertebrates[6]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
fruit (aerial)													
Pome and stone fruit (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Potato (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Potato (ground)	No	No	Yes[7]	No	Yes	Yes	Yes[7]	Yes	Yes	Yes	Yes[7]	Yes	No
Recreational areas (banding)	No	No	Yes[7]	No	Yes	Yes	Yes[7]	Yes	Yes	Yes	Yes[7]	Yes	No
Recreational areas (crack and crevice/spot treatment)	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Residential lawns (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Residential lawns (mound)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Rice (ground)	Yes[7]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Seed orchard trees (ground)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Sorghum (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Sorghum (ground)	Yes[7]	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Soybean (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Soybean (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Tree nuts (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Tree nuts (ground)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Sunflower (aerial)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Sunflower	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	DS, TG and Estuarine/ Marine Vertebrates[1]		DS, TG, CTS-CC, SC, and SB DPS, and Freshwater Vertebrates[2]		CFWS and Freshwater Invertebrates[3]		Freshwater Benthic Invertebrates[6]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
(ground)													
Right-of-way (ground)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Airports/ landing fields	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Golf course turf, ornamental sod farm (granular spot treatment)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Grasses grown for seed (granular spot treatment)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes[7]	Yes	No
Nonagricultural uncultivated areas/soil (granular band/broadcast/ perimeter/spot treatment)	Yes[7]	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Nonagricultural uncultivated areas/soil (granular mound treatment)	No	No	Yes[7]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

1 A yes in this column indicates a potential for direct effects to DS and TG and indirect effects to CCR.
2 A yes in this column indicates a potential for direct effects to DS, TG and indirect effects to SFGS, and CCR. A yes also indicates a potential for direct and indirect effects for the CTS-CC, CTS-SC, and CTS-SB.
3 A yes in this column indicates a potential for direct effects to the CFWS and indirect effects to the CFWS, SFGS, CCR, CTS-CC, CTS-SB, CTS-SC, TG, and DS.
4 A yes in this column indicates a potential for indirect effects to CCR, TG, and DS.
5 A yes in this column indicates a potential for indirect effects to SFGS, CCR, CTS-CC, CTS-SC, CTS-SB, TG, DS, and CFWS.

6 A yes in this column indicates a potential for indirect effects to CFWS, SFGS, CCR, CTS-CC, CTS-SB, CTS-SC, TG, and DS.
7 No indirect effects are expected.

Table 7-4. Use Specific Summary of the Potential for Adverse Effects to Terrestrial Taxa

Uses	Potential for Effects to Identified Taxa Found in the Terrestrial Environment										
	Small Mammals[1]		CCR and Small Birds[2]		CTS-CC, CTS-SC, CTS-SB and Amphibians[3]		SFGS and Reptiles[4]		BCB, VELB, and Invertebrates (Acute)[5]	Dicots[6]	Monocots[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic			
Agricultural/farm premises, crack and crevice/surface spray/perimeter treatment	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Alfalfa, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Almond, ground dust and spray	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Apple, cherry, crabapple, nectarine, peach, pear, plum, prune, ground dust and spray	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Almond, nectarine, peach, cherry, trunk drench	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Apple, trunk drench	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Animal housing premises, paths/patios, barrier treatment/crack and crevice	Yes	Yes	Yes[7]	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Household/domestic dwellings outdoor premises, barrier treatment/crack and crevice	Yes	Yes	Yes	Yes	Yes[7]	Yes	Yes[7]	Yes	Yes	Yes	Yes
Apricot, bean, eggplant, groundcherry, loquat, mayhaw, pea, pepino, pepper, plum, quince, ground spray/dust	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, hickory nut, macadamia nut, ground spray/dust	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Barley, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Bell pepper, catjang (Jerusalem/marble pea) (aerial/ground spray/dust)	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes

Uses	Potential for Effects to Identified Taxa Found in the Terrestrial Environment										
	Small Mammals[1]		CCR and Small Birds[2]		CTS-CC, CTS-SC, CTS-SB and Amphibians[3]		SFGS and Reptiles[4]		BCB, VELB, and Invertebrates (Acute)[5]	Dicots[6]	Monocots[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic			
Mustard cabbage (gai choy, pak-choi), ground spray/dust	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Brassica (head and stem) vegetables, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Tomato, tomatillo, ground spray/dust	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Broccoli, cauliflower, ground spray/dust	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Cabbage, kohlrabi, ground spray/dust	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Mustard	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Brussels sprouts, ground spray	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Brussels sprouts, dust	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Buckwheat, oat, rye, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Canola/rape, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Grass forage/fodder/hay, pastures, rangeland, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Cereal grains, triticale, wheat, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Cole crops, aerial/ground/dust	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Onion, aerial/ground/dust	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Commercial/ industrial lawns, ornamental lawns and turf, recreation area lawns, ground	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Commercial/ industrial lawns, ornamental lawns and turf, recreation area lawns, mound/spot treatment	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Conifers (plantations/ nurseries), ground	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Conifers (seed orchard), ground	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Corn (field), aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Corn (field, pop), soil in furrow/T-banding	No	No	No	No	No	No	No	No	Yes	Yes	Yes

Uses	Potential for Effects to Identified Taxa Found in the Terrestrial Environment										
	Small Mammals[1]		CCR and Small Birds[2]		CTS-CC, CTS-SC, CTS-SB and Amphibians[3]		SFGS and Reptiles[4]		BCB, VELB, and Invertebrates (Acute)[5]	Dicots[6]	Monocots[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic			
Corn (sweet), soil in furrow/T-banding	No	No	No	No	No	No	No	No	Yes	Yes	Yes
Corn (sweet), dust	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Corn (sweet), spray	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Cotton, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Cucurbit vegetables, aerial/ground	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Ear tag	No	No	No	Yes	No	No	No	No	No	No	No
Filbert, pecan, walnut, aerial/ground	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Filbert, pecan, walnut, dust	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Forest plantings, ground	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Fruiting vegetables, aerial/ground	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Garlic	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Golf course turf, ornamental sod farm, ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Golf course turf, ornamental sod farm, mound	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Grasses grown for seed, ground	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Legume vegetables, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Peanuts, root and tuber vegetables, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Lettuce, aerial/ground	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Nonagricultural uncultivated areas/soils, aerial	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Ornamental and/or shade trees, ground	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Ornamental and/or shade trees, ground cover, herbaceous plants, non flowering plants, woody shrubs and vines, rose, ground/dust/	Yes	Yes	Yes[7]	Yes	Yes[7]	Yes	Yes[7]	Yes	Yes	Yes	Yes
Paved areas (private roads/sidewalks), barrier/perimeter treatment	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes

Uses	Potential for Effects to Identified Taxa Found in the Terrestrial Environment										
	Small Mammals[1]		CCR and Small Birds[2]		CTS-CC, CTS-SC, CTS-SB and Amphibians[3]		SFGS and Reptiles[4]		BCB, VELB, and Invertebrates (Acute)[5]	Dicots[6]	Monocots[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic			
Pome and stone fruit, aerial/ground	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Potato, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Recreational areas, band treatment	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Recreational areas, crack and crevice/spot treatment	Yes	Yes	Yes	Yes	Yes[7]	Yes	Yes[7]	Yes	Yes	Yes	Yes
Rice, ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Seed orchard trees, ground	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Sorghum, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Soybean, aerial/ground	No	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Tree nuts, aerial/ground	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Sunflower, aerial/ground	Yes[7]	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Right-of-way, ground	Yes[7]	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Airports/landing fields, ground granular	Yes[7]	No	No	No	No	No	No	No	No	Yes	Yes
Golf course turf, ornamental sod farm, granular spot treatment	Yes[7]	No	No	No	No	No	No	No	No	Yes	Yes
Grasses grown for seed, granular spot treatment	Yes[7]	No	No	No	No	No	No	No	No	Yes	Yes
Nonagricultural uncultivated areas/soil, granular band/broadcast/ perimeter/spot treatment	Yes[7]	No	No	No	No	No	No	No	No	Yes	Yes
Nonagricultural uncultivated areas/soil, granular mound treatment	Yes[7]	No	No	No	No	No	No	No	No	Yes	Yes
Residential lawns, granular ground	Yes[7]	No	No	No	No	No	No	No	No	Yes	Yes
Residential lawns, granular mound treatment	Yes[7]	No	No	No	No	No	No	No	No	Yes	Yes

1 A yes in this column indicates a potential for indirect effects to SFGS, CCR, CTS-CC, CTS-SC, CTS, and CTS-SB.
2 A yes in this column indicates a potential for direct effects to CCR and indirect effects to the CCR, SFGS, CTS-CC, CTS-SC, and CTS-SB.
3 A yes in this column indicates a potential for direct effects to CTS-CC, CTS-SC, CTS-SB, and indirect effects to CTS-CC, CTS-SC, CTS-SB, SFGS, and CCR.
4 A yes in this column indicates the potential for direct and indirect effects to SFGS, and other reptiles.
5 A yes in this column indicates a potential for direct effect to BCB and VELB and indirect effects to SFGS, CCR, CTS-CC, CTS-SC, and CTS-SB.

6 A yes in this column indicates a potential for indirect effects to BCB, VELB, SFGS, CCR, CTS-CC, CTS-SC, CTS-SB, TG, DS, and CFWS. For the BCB and VELB this is based on the listed species LOC because of the obligate relationship with terrestrial monocots and dicots. For other species, the LOC exceedances are evaluated based on the LOC for non-listed species.
7 No indirect effects are expected.

Based on the conclusions of this assessment, a formal consultation with the U. S. Fish and Wildlife Service under Section 7 of the Endangered Species Act should be initiated.

When evaluating the significance of this risk assessment's direct/indirect and adverse habitat modification effects determinations, it is important to note that pesticide exposures and predicted risks to the listed species and its resources (*i.e.*, food and habitat) are not expected to be uniform across the action area. In fact, given the assumptions of drift and downstream transport (*i.e.*, attenuation with distance), pesticide exposure and associated risks to the species and its resources are expected to decrease with increasing distance away from the treated field or site of application. Evaluation of the implication of this non-uniform distribution of risk to the species would require information and assessment techniques that are not currently available. Examples of such information and methodology required for this type of analysis would include the following:

- Enhanced information on the density and distribution of BCB, CCR, CFWS, CTS (all DPS), DS, SFGS, TG, and VELB life stages within the action area and/or applicable designated critical habitat. This information would allow for quantitative extrapolation of the present risk assessment's predictions of individual effects to the proportion of the population extant within geographical areas where those effects are predicted. Furthermore, such population information would allow for a more comprehensive evaluation of the significance of potential resource impairment to individuals of the assessed species.
- Quantitative information on prey base requirements for the assessed species. While existing information provides a preliminary picture of the types of food sources utilized by the assessed species, it does not establish minimal requirements to sustain healthy individuals at varying life stages. Such information could be used to establish biologically relevant thresholds of effects on the prey base, and ultimately establish geographical limits to those effects. This information could be used together with the density data discussed above to characterize the likelihood of adverse effects to individuals.
- Information on population responses of prey base organisms to the pesticide. Currently, methodologies are limited to predicting exposures and likely levels of direct mortality, growth or reproductive impairment immediately following exposure to the pesticide. The degree to which repeated exposure events and the inherent demographic characteristics of the prey population play into the extent to which prey resources may recover is not predictable. An enhanced understanding of long-term prey responses to pesticide exposure would allow for a more refined determination of the magnitude and duration of resource impairment, and together with the information described above, a more complete prediction of effects to individual species and potential modification to critical habitat.

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