# Risks of Cyfluthrin and *Beta*-Cyfluthrin 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**
**Cyfluthrin**
**PC Code: 128831**
**CAS Number: 68359-37-5**

***Beta*-Cyfluthrin**
**PC Code: 118831**
**CAS Number: 83855-46-3**

**Environmental Fate and Effects Division**
**Office of Pesticide Programs**
**Washington, D.C. 20460**

**March 28, 2013**

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# Table of Contents

# Appendices



# Attachments

# List of Tables

## List of Figures

## 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) <u>A</u>quatic <u>B</u>io<u>A</u>ccumulation <u>M</u>odel |
| kg | Kilogram(s) |
| kJ/mole | Kilojoules per mole |
| km | Kilometer(s) |
| $K_{AW}$ | Air-water Partition Coefficient |
| Kd | Solid-water Distribution Coefficient |
| KF | 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 Joaquine 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 on the Bay checkerspot butterfly (*Euphydryas editha bayensis*) (BCB), valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (VELB), California tiger salamander (*Ambystoma californiense*) [Central California Distinct Population Segment (DPS) – CTS-CC; Sonoma County DPS – CTS-SC; and Santa Barbara County DPS – CTS-SB], delta smelt (*Hypomesus transpacificus*) (DS), California clapper rail (*Rallus longirostris obsoletus*) (CCR), California freshwater shrimp (*Syncaris pacificus*) (CFWS), San Francisco garter snake (*Thamnophis sirtalis tetrataenia*) (SFGS), and tidewater goby (*Eucyclogobius newberryi)* (TG) arising from FIFRA regulatory actions regarding use of cyfluthrin (PC Code: 128831) and *beta*-cyfluthrin (PC Code: 118831) (the 'cyfluthrins') 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, DS, and TG. 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 is consistent with a suit in which cyfluthrin and *beta*-cyfluthrin were alleged to be of concern to the BCB, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG (*Center for Biological Diversity (CBD) vs. EPA et al*. (Case No. 07-2794-JCS).

## 1.2. Scope of Assessment

### 1.2.1. Uses Assessed

Cyfluthrin and *beta*-cyfluthrin are Type II synthetic pyrethroid insecticides that are registered for numerous agricultural, non-agricultural and residential uses. Both chemicals have flowable and granular uses. The use patterns across cyfluthrin and *beta*-cyfluthrin are very similar except that *beta*-cyfluthrin tends to be applied at rates approximately half of the application rates of cyfluthrin (when considering the same uses).

### 1.2.2. Environmental Fate Properties of Cyfluthrin and *Beta*-cyfluthrin

The environmental fate properties of cyfluthrin and *beta*-cyfluthrin indicate alkaline catalyzed abiotic hydrolysis, photodegradation, microbial mediated degradation, and sorption on sediment/soil are important dissipation pathways. Consideration of the environmental fate properties along with available monitoring data indicates that water and sediment runoff and spray drift are the principle potential transport mechanisms to the aquatic and terrestrial habitats. Refer to Environmental Fate Properties section (Section 2.4) for a full discussion of the fate information.

### 1.2.3. Evaluation of Degradates and Stressors of Concern

Major degradates in laboratory and field dissipation studies include FPB-acid (4-fluoro-3-phenoxybenzoic acid), FPB-ald (4-fluoro-3-phenoxybenzaldehyde) and DCVA [3-(2,2-

dichlorovinyl)-2,2-dimethyl-cyclopropanecarboxylic acid]. These degradation products are formed through deesterification of the synthetic pyrethroid, which are known to detoxify the parent pyrethroid. Refer to Environmental Fate Properties section (Section 2.4) for a full discussion of the degradation products of cyfluthrin and *beta*-cyfluthrin.

**Assessment Procedures**

The aquatic risk assessment for cyfluthrin and *beta*-cyfluthrin was conducted using environmental fate data for *beta*-cyfluthrin. *Beta*-cyfluthrin was used as surrogate of cyfluthrin because *beta*-cyfluthrin contains similar isomers as cyfluthrin [*beta*-cyfluthrin consists of four of the eight possible isomers of cyfluthrin, which are the more potent isomers (to target organisms) of cyfluthrin]. More importantly, the application rate and aquatic toxicity endpoints for cyfluthrin are similar to *beta*-cyfluthrin when they are expressed in *beta*-cyfluthrin equivalents. These data indicate that the insecticidal active isomers in *beta*-cyfluthrin and cyfluthrin are the same. A description of routine procedures for evaluating risk to the San Francisco Bay species are provided in Attachment I.

### 1.2.4. Exposure Assessment

#### 1.2.4.a. Aquatic Exposures

Tier-II aquatic exposure models are used to estimate high-end exposures of *beta*-cyfluthrin in aquatic habitats resulting from runoff and spray drift from different uses. The models used to predict aquatic estimated environmental concentrations (EECs) are the Pesticide Root Zone Model coupled with the Exposure Analysis Model System (PRZM/EXAMS). The AgDRIFT model was used to estimate the spray fraction of *beta*-cyfluthrin, which also accounts for the 150 feet spray drift buffer required for *beta*-cyfluthrin. Peak model-estimated environmental concentrations resulting from different *beta*-cyfluthrin uses range from 0.025 to 53.089 µg/L. The use of *beta*-cyfluthrin on impervious surfaces for some of the non-agricultural uses led to the highest EEC (53.089 µg/L) when compared to the other crop and non-agricultural uses. For most uses, the maximum predicted EECs were less than 0.4 µg/L. Because there are EECs higher than the water solubility of *beta*-cyfluthrin (2.3 µg/L), any EEC greater than the water solubility will be capped at the solubility limit for assessing risk. This approach was adopted to acknowledge that the water solubility is an upper bound condition for EECs. 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. There were detections (Minimum Reporting Limit (MRL)- 0.053 to 0.008 µg/L) of cyfluthrin[1] reported by NAWQA for California surface water with agricultural or urban watersheds. The maximum concentration of cyfluthrin reported by the California Department of Pesticide Regulation(CDPR) surface water database (0.498 µg/L) is roughly 107 times *lower* than the highest peak model-estimated environmental concentration (paved areas) and 2 times *higher* than typical uses of *beta*-cyfluthrin. Cyfluthrin was detected (0.011 to 0.169 µg/g) in sediment from California surface water. The maximum concentration of

[1] Non-enantiomeric analytical methods were used in the monitoring studies. These method, therefore, will detect the presence of any isomer in cyfluthrin and *beta*-cyfluthrin.

cyfluthrin reported in the CDPR sediment database (0.169 µg/g) is 4 times lower than lowest predicted cyfluthrin concentration in sediment (0.748 µg/g).

#### 1.2.4.b. Terrestrial Exposures

To estimate cyfluthrin and *beta*-cyfluthrin exposures to terrestrial species, the T-REX model is used to model foliar and granular uses. The T-HERPS model is used to allow for further characterization of dietary exposures of terrestrial-phase amphibians relative to birds. KABAM ($\underline{K}_{OW}$ (based) Aquatic BioAccumulation Model) v.1.0 is used to estimate potential bioaccumulation of cyfluthrin and *beta*-cyfluthrin residues in an aquatic food web and subsequent risks these residues pose to organisms consuming aquatic species. There are no terrestrial plant data available for cyfluthrin or *beta*-cyfluthrin; therefore, risks to terrestrial plants are qualitatively assessed. Additionally, because of the potential area of use (essentially the entire state of California for both chemicals), a spatial analysis to determine the extent of the effects area is not conducted.

### 1.2.5. 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, DS, and TG. Primary constituent elements (PCEs) were used to evaluate whether cyfluthrin and/or *beta*-cyfluthrin has the potential to modify designated critical habitat. The Agency evaluated registrant-submitted studies and data from the open literature to characterize cyfluthrin and *beta*-cyfluthrin toxicity. 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 on cyfluthrin and *beta*-cyfluthrin. Cyfluthrin and *beta*-cyfluthrin are classified as very highly toxic to aquatic organisms based on data for aquatic vertebrates and invertebrates. Cyfluthrin and *beta*-cyfluthrin are likely to partition with sediments in bodies of water and are also very highly toxic to benthic organisms. Chronic effects were also seen in all aquatic animal taxa tested (with NOAECs as low as 0.00016 µg a.i./L). There are currently limited aquatic plant data available for the cyfluthrins.

The available toxicity data suggest that cyfluthrin is practically non-toxic on an acute and sub-acute basis to avian species. There are currently no acute or sub-acute toxicity data available for *beta*-cyfluthrin and birds. However, based on the available data, cyfluthrin appears to be more toxic or equatoxic to terrestrial vertebrates than *beta*-cyfluthrin; therefore, in the absence of additional data showing otherwise, toxicity endpoints for cyfluthrin are expected to be protective of *beta*-cyfluthrin for birds. Reproductive tests with cyfluthrin resulted in a NOAEC of 250 mg a.i./kg-diet (LOAEC = 1,000 mg a.i./kg-diet based on reduction in the number of eggs laid, eggs set, fertilized eggs, 3-week viable embryos, hatchlings and 14-day survivors). For *beta*-cyfluthrin, there were no effects noted at any concentration tested in the available avian reproduction study, resulting in a NOAEC of 269 mg a.i./kg-diet.

Mammalian toxicity data suggest that cyfluthrin is highly toxic to small mammals on an acute exposure basis. *Beta*-cyfluthrin is slightly toxic to mammals on an acute-basis. Reproductive effects for cyfluthrin with rats were based on decreased pup bodyweight observed at a LOAEC of 150 mg a.i./kg-diet (15.1 mg a.i./kg/day) [NOAEC = 50 mg a.i./kg-diet ppm (5.4 mg a.i./kg/day)] in a three-generation reproduction study. There are currently no reproduction toxicity data available for rats and *beta*-cyfluthrin; however, a NOAEC of 320 mg a.i./kg/day was used based on an acute-to-chronic ratio (using acute and chronic mammalian data for cyfluthrin and acute mammalian data for *beta*-cyfluthrin).

Both cyfluthrin and *beta*-cyfluthrin are highly toxic to terrestrial invertebrates on an acute contact (and oral) basis. There are currently no terrestrial plant data available for cyfluthrin or *beta*-cyfluthrin.

#### 1.2.6. Measures of Risk

Acute and chronic risk quotients (RQs) are compared to the Agency's Levels of Concern (LOCs) to identify instances where cyfluthrin and/or *beta*-cyfluthrin 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 LOCs, the pesticide is considered to have "no effect" on the species and its designated critical habitat. Where RQs exceed LOCs, a potential to cause adverse effects or habitat modification is identified, leading to a conclusion of "may affect". If cyfluthrin or *beta*-cyfluthrin 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).

### 1.3. Summary of 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 cyfluthrin and *beta*-cyfluthrin to VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG and their designated critical habitat.

Based on the best available information, the Agency makes a Likely to Adversely Affect determination for the VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG for all uses of cyfluthrin and *beta*-cyfluthrin (see **Table 1-1**). Additionally, the Agency has determined that there is the potential for modification of the designated critical habitat for the BCB, VELB, CTS-CC, CTS-SB, DS, and TG from all uses of cyfluthrin and *beta*-cyfluthrin (**Table 1-2**). Given the LAA determinations and potential modification of designated critical habitats, a description of the baseline status and cumulative effects is provided in Attachment III.

A summary of the risk conclusions and effects determinations for cyfluthrin and *beta*-cyfluthrin and the VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG and their critical habitat, given the uncertainties discussed in Section 6 and Attachment I, is presented in **Table 1-3**. Use specific effects determinations are provided in **Table 1-4**. Although separate effects determinations are made for cyfluthrin and *beta*-cyfluthrin, the determinations are presented together since the results of the assessment were similar for both chemicals.

**Table 1-1. Determination Summary for Effects of Cyfluthrin and *Beta*-Cyfluthrin on the BCB, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG.**

| Species | Effects Determination | Basis for Determination |
|---|---|---|
| Bay checkerspot butterfly (*Euphydryas editha bayensis*) (BCB) | May Affect, Likely to Adversely Affect (LAA) (Cyfluthrin and *Beta*-Cyfluthrin) | **Potential for Direct Effects**<br>The RQs for all uses of cyfluthrin and *beta*-cyfluthrin (agricultural and non-agricultural) exceed the Agency's LOC for risk to terrestrial invertebrates (representative RQs are 822 and 23 for cyfluthrin – non-agricultural and agricultural uses, respectively; RQs for *beta*-cyfluthrin are 356 and 9 for non-agricultural and agricultural uses, respectively). The chance of mortality at the modeled EECs is ~100% for cyfluthrin and *beta*-cyfluthrin (all uses), and the potential area of effects overlaps with the species range.<br>**Potential for Indirect Effects**<br>Although not definitive, there is evidence to suggest that the use of cyfluthrin and *beta*-cyfluthrin may have adverse effects on non-target terrestrial plants (based on ecological incident data). Additionally, the area of potential effects to plants overlaps the species' range. BCB is an obligate with dwarf plantains (they are its primary food source). Therefore, in the absence of additional information to show otherwise, it is assumed that the registered uses of cyfluthrin and *beta*-cyfluthrin may adversely affect non-target terrestrial plants; and, thus, there is a potential for indirect effects to BCB from a loss of food and/or an alteration of habitat. |
| Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (VELB) | May Affect, Likely to Adversely Affect (LAA) (Cyfluthrin and *Beta*-Cyfluthrin) | **Potential for Direct Effects**<br>The RQs for all uses of cyfluthrin and *beta*-cyfluthrin (agricultural and non-agricultural) exceed the Agency's LOC for risk to terrestrial invertebrates (representative RQs are 822 and 23 for cyfluthrin – non-agricultural and agricultural uses, respectively; RQs for *beta*-cyfluthrin are 356 and 9 for non-agricultural and agricultural uses, respectively). The chance of mortality at the modeled EECs is ~100% for cyfluthrin and *beta*-cyfluthrin (all uses), and the potential area of effects overlaps with the species range.<br>**Potential for Indirect Effects**<br>Although not definitive, there is evidence to suggest that the use of cyfluthrin and *beta*-cyfluthrin may have adverse effects on non-target terrestrial plants (based on ecological incident data). Additionally, the area of potential effects to plants overlaps the species' range. VELB is an obligate with elderberry trees (they are its sole food source). Therefore, in the absence of additional information to show otherwise, it is assumed that the registered uses of cyfluthrin and *beta*-cyfluthrin may adversely affect non-target terrestrial plants; and, thus, there is a potential for indirect effects to VELB from a loss of food and/or an alteration of habitat. |

| Species | Effects Determination | Basis for Determination |
| --- | --- | --- |
| California tiger salamander (*Ambystoma californiense*) [Central California Distinct Population Segment (DPS) – CTS-CC; Sonoma County DPS – CTS-SC; and Santa Barbara County DPS – CTS-SB] | May Affect, Likely to Adversely Affect (LAA) (Cyfluthrin and *Beta*-Cyfluthrin) | **Potential for Direct Effects**<br>***Aquatic-phase (Eggs, Larvae, and Adults):***<br>RQs exceed the Agency's acute and chronic LOCs for all of the uses modeled for cyfluthrin and *beta*-cyfluthrin (for both agricultural and non-agricultural uses) and freshwater fish (which are used as a surrogate for aquatic-phase CTS) (acute RQs range from 0.37 to 34 and chronic RQs range from 1.7 to 548). Additionally, the chance of individual effects (mortality) for most uses is ~100%, there are aquatic incident reports (fish kills) for cyfluthrin, and the area of effects overlaps with the species' range (all three DPSs).<br>***Terrestrial-phase (Juveniles and Adults)***:<br>Direct effects from acute or chronic exposure are not expected for any cyfluthrin or *beta*-cyfluthrin use (agricultural or non-agricultural).<br>**Potential for Indirect Effects**<br>Based on LOC exceedances, there is the potential for indirect effects to CTS (all DPSs) from loss of prey (mammals and/or terrestrial invertebrates) and/or an alteration in habitat (loss of mammal burrows) (from all uses of cyfluthrin and *beta*-cyfluthrin – agricultural and non-agricultural uses). As discussed above, there is also a potential for effects to terrestrial plants from all uses of both chemicals. Additionally, there is an overlap of the effects areas with the species' range (all DPSs). |
| Delta smelt (*Hypomesus transpacificus*) | May Affect, Likely to Adversely Affect (LAA) (Cyfluthrin and *Beta*-Cyfluthrin) | **Potential for Direct Effects**<br>RQs exceed the Agency's acute and chronic LOCs for all of the uses modeled for cyfluthrin and *beta*-cyfluthrin (for both agricultural and non-agricultural uses) and freshwater fish (acute RQs range from 0.37 to 34 and chronic RQs range from 1.7 to 548). Additionally, the chance of individual effects (mortality) for most uses modeled is ~100%, there are aquatic incident reports (fish kills) for cyfluthrin, and the area of effects overlaps with the species' range.<br>**Potential for Indirect Effects**<br>Based on LOC exceedances for both acute and chronic exposures (all uses of cyfluthrin and *beta*-cyfluthrin), there is the potential for loss of prey (aquatic invertebrates) for the DS from the use of these chemicals. Additionally, there is a potential for alterations in water quality parameters from effects to terrestrial plants (specifically riparian habitat) from all uses (cyfluthrin and beta-cyfluthrin). There is spatial overlap of the effects areas for both cyfluthrin and *beta*-cyfluthrin (all uses) and the species' range. |
| California clapper rail (*Rallus longirostris obsoletus*) | May Affect, Likely to Adversely Affect (LAA) (Cyfluthrin and *Beta*-Cyfluthrin) | **Potential for Direct Effects**<br>Direct effects to CCR are not expected from acute exposure (considering cyfluthrin and *beta*-cyfluthrin – all uses). For cyfluthrin, all of the chronic RQs for non-agricultural uses except for the use on recreational areas exceed the Agency's LOC (RQs range from 0.06 to 12.1). For *beta*-cyfluthrin, only the non-agricultural use with the highest single application rate (*i.e.,* for agricultural structures and equipment; and animal feedlots) exceed sthe Agency's chronic LOC (RQs ranged from 0.08 to 1.32). Additionally, the area of potential effects overlaps with the species' range.<br>**Potential for Indirect Effects**<br>All of the uses of cyfluthrin and *beta*-cyfluthrin have the potential to affect potential prey items of the CCR (fish, aquatic and terrestrial invertebrates and terrestrial plants) and to modify its habitat (via effects to terrestrial plants). Due to this and the spatial overlap of effects area with the range of the CCR, there is the potential for indirect effects to the CCR from all uses (both agricultural and non-agricultural) of cyfluthrin ands *beta*-cyfluthrin. |
| California | May Affect, | **Potential for Direct Effects** |

| Species | Effects Determination | Basis for Determination |
|---|---|---|
| freshwater shrimp (*Syncaris pacificus*) | Likely to Adversely Affect (LAA) (Cyfluthrin and *Beta*-Cyfluthrin) | The RQs for all of the uses of cyfluthrin and *beta*-cyfluthrin (agricultural and non-agricultural uses) exceed the Agency's LOCs for acute and chronic exposures (acute RQs = 0.08 to 8; chronic RQs range from 3 to 767). Based on the probit analysis, there is ~100% chance of mortality if CFWS are exposed to cyfluthrin or *beta*-cyfluthrin at the modeled EECs (all uses). The potential area of effects overlaps with the range of the CFWS. |
| | | **Potential for Indirect Effects** |
| | | There is a potential for effects to terrestrial plants (specifically riparian habitat) from all uses of cyfluthrin and *beta*-cyfluthrin (agricultural and non-agricultural uses) that could alter water quality parameters. The potential area of this effect overlaps with the range of the CFWS |
| San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*) | May Affect, Likely to Adversely Affect (LAA) (Cyfluthrin and *Beta*-Cyfluthrin) | **Potential for Direct Effects** |
| | | None of the agricultural uses of cyfluthrin or *beta*-cyfluthrin are expected to result in direct effects to SFGS (using birds as a surrogate). For reptiles (using T-HERPS), only the non-agricultural uses with the highest application rates have RQs that exceed the Agency's chronic risk LOC for cyfluthrin and *beta*-cyfluthrin. The area of potential effects overlaps with the species' range. Therefore, there is a potential for direct effects to the SFGS from the non-agricultural uses of cyfluthrin and *beta*-cyfluthrin with the highest application rates. |
| | | **Potential for Indirect Effects** |
| | | There is a potential for effects to prey items (freshwater fish, freshwater invertebrates, birds, mammals, and/or terrestrial invertebrates – based on LOC exceedences) and habitat (effects to terrestrial plants – based on incident data) from all uses of cyfluthrin and *beta*-cyfluthrin. The area of potential effects with the range of the SFGS. |
| Tidewater Goby (*Eucyclogobius newberryi)* | May Affect, Likely to Adversely Affect (LAA) (Cyfluthrin and *Beta*-Cyfluthrin) | **Potential for Direct Effects** |
| | | RQs exceed the Agency's acute and chronic LOCs for all of the uses modeled for cyfluthrin and *beta*-cyfluthrin (for both agricultural and non-agricultural uses) and freshwater fish (acute RQs range from 0.37 to 34 and chronic RQs range from 1.7 to 48). Additionally, the chance of individual effects (mortality) for most uses modeled is ~100%, there are aquatic incident reports (fish kills) for cyfluthrin, and the area of effects overlaps with the species' range. |
| | | **Potential for Indirect Effects** |
| | | Based on LOC exceedances for both acute and chronic exposures (all uses of cyfluthrin and *beta*-cyfluthrin), there is the potential for loss of prey (aquatic invertebrates) for the TG from the use of these chemicals. Additionally, there is a potential for alterations in water quality parameters from effects to terrestrial plants (specifically riparian habitat) from all uses (cyfluthrin and *beta*-cyfluthrin). There is spatial overlap of the effects areas for both cyfluthrin and *beta*-cyfluthrin (all uses) and the species' range. |

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

| Designated Critical Habitat for: | Effects Determination | Basis for Determination |
|---|---|---|
| Bay checkerspot butterfly (*Euphydryas editha bayensis*) | Habitat Modification (cyfluthrin and beta-cyfluthrin – all uses) | For the BCB, there is a potential for habitat modification based on potential concentrations of cyfluthrin and *beta*-cyfluthrin (all uses) high enough to cause potential direct effects to the BCB and for potential effects to terrestrial plants (which are used for food and habitat). BCB is an obligate with dwarf plantains (they are its primary food source). The potential area of effects overlaps with the BCB range. |
| Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) | Habitat Modification (cyfluthrin and beta-cyfluthrin – all uses) | For the VELB, there is a potential for habitat modification based on potential concentrations of cyfluthrin and *beta*-cyfluthrin (all uses) high enough to cause potential direct effects to the VELB and for potential effects to terrestrial plants (which are used for food and habitat). VELB is an obligate with elderberry trees (they are its sole food source). The potential area of effects overlaps with the VELB range. |
| California tiger salamander (*Ambystoma californiense*) [Central California Distinct Population Segment (DPS)] | Habitat Modification (cyfluthrin and beta-cyfluthrin – all uses) | For the CTS-CC, there is a potential for habitat modification based on potential direct effects to aquatic-phase CTS from all of the uses of cyfluthrin and *beta*-cyfluthrin. There is also a potential for effects to CTS prey items [*e.g*., mammals (cyfluthrin only), fish, aquatic invertebrates, and terrestrial invertebrates] and habitat (*e.g*., effects to terrestrial plants from all uses of cyfluthrin and *beta*-cyfluthrin and loss of mammal burrows for all uses of cyfluthrin). The areas of potential effect overlaps with the range of the CTS-CC. |
| California tiger salamander (*Ambystoma californiense*) [Santa Barbara County (DPS)] | Habitat Modification (cyfluthrin and beta-cyfluthrin – all uses) | For the CTS-SB, there is a potential for habitat modification based on potential direct effects to aquatic-phase CTS from all of the uses of cyfluthrin and *beta*-cyfluthrin. There is also a potential for effects to CTS prey items [*e.g*., mammals (cyfluthrin only), fish, aquatic invertebrates, and terrestrial invertebrates] and habitat (*e.g*., effects to terrestrial plants from all uses of cyfluthrin and *beta*-cyfluthrin and loss of mammal burrows for all uses of cyfluthrin). The areas of potential effect overlaps with the range of the CTS-SB. |
| Delta smelt (*Hypomesus transpacificus*) | Habitat Modification (cyfluthrin and beta-cyfluthrin – all uses) | For the DS, there is a potential for concentrations of cyfluthrin and *beta*-cyfluthrin in water to be high enough to cause direct effects to the DS from all registered uses of these chemicals. Additionally, there is a potential for loss of prey (*e.g.,* aquatic invertebrates) and alteration of water quality parameters based on effects to terrestrial plants (specifically riparian habitat) from all of the uses of cyfluthrin and *beta*-cyfluthrin. The areas of potential effects overlap with the DS range. |
| Tidewater Goby (*Eucyclogobius newberryi)* | Habitat Modification (cyfluthrin and beta-cyfluthrin – all uses) | For the TG, there is a potential for concentrations of cyfluthrin and *beta*-cyfluthrin in water to be high enough to cause direct effects to the TG from all registered uses of these chemicals. Additionally, there is a potential for loss of prey (*e.g.,* aquatic invertebrates) and alteration of water quality parameters based on effects to terrestrial plants (specifically riparian habitat) from all of the uses of cyfluthrin and *beta*-cyfluthrin. The areas of potential effects overlap with the TG range. |

**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] | | Estuarine/Marine Invertebrates[4] | | Aquatic Plants[5] |
| | Acute | Chronic | Acute | Chronic | Acute | Chronic | Acute | Chronic | |
| Agricultural use (cyfluthrin) | Yes (most uses) | Yes | Yes (most uses) | Yes | Yes (most uses) | Yes | Yes | Yes | No |
| Non-agricultural Use (cyfluthrin) | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No |
| Agricultural use (*beta*-cyfluthrin) | Yes (most uses) | Yes | Yes (most uses) | Yes | Yes (most uses) | Yes | Yes | Yes | No |
| Non-agricultural Use (*beta*-cyfluthrin) | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No |

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, and 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.

**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] | Terr-estrial Plants[6] |
| | Acute | Chronic | Acute | Chronic | Acute | Chronic | Acute | Chronic | | |
| Agricultural use (cyfluthrin) | Yes | Yes | No | No | No | No | No | No | Yes | Yes |
| Non-agricultural Use (cyfluthrin) | Yes | Yes | No | Yes | No | No | No | Yes | Yes | Yes |
| Agricultural use (*beta*-cyfluthrin) | No | No | No | No | No | No | No | No | Yes | Yes |
| Non-agricultural Use (*beta*-cyfluthrin) | No | No | No | Yes | No | No | No | Yes | Yes | Yes |

1 A yes in this column indicates a potential for indirect effects to SFGS, CCR, CTS-CC, CTS-SC, 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 effects 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.

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, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, 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, VELB, CTS-SC, DS, and the federally endangered CCR, CTS-SC, CTS-SB, CFWS, SFGS, and TG arising from FIFRA regulatory actions regarding use of cyfluthrin and *beta*-cyfluthrin on agricultural and non-agricultural use 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, DS, and TG. Potential effects are evaluated in accordance with the methods described in the Agency's Overview Document (USEPA, 2004). 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 accordance with the Overview Document, provisions of the ESA, and the Services' *Endangered Species Consultation Handbook*, the assessment of effects associated with registrations of cyfluthrin and *beta*-cyfluthrin are 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 cyfluthrin and *beta*-cyfluthrin 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, VELB, CTS-SC, DS, CCR, CTS-SC, CTS-SB, CFWS, SFGS, and TG and their designated critical habitat, if applicable, 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 cyfluthrin and *beta*-cyfluthrin 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.

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 cyfluthrin and *beta*-cyfluthrin in accordance with the approved product labels for California is "the action" relevant to this ecological risk assessment.

Cyfluthrin is a Type II synthetic pyrethroid insecticide that is registered for numerous agricultural, non-agricultural and residential uses. Type II pyrethroids are characterized by the cyano moiety in their chemical structure [Type I pyrethroids do not contain this moiety, see Mechanism of Action (Section 2.4.2) for additional distinctions between the two types]. Cyfluthrin is a mixture of eight possible isomers. *Beta*-cyfluthrin is an enrichment of cyfluthrin consisting of four of the eight possible isomers of cyfluthrin, which are the more potent isomers (to target organisms) of cyfluthrin. Thus, its application rate is usually lower than that for cyfluthrin. *Beta*-cyfluthrin is registered also on numerous agricultural, non-agricultural and residential use sites. In general, the physicochemical and environmental fate properties of cyfluthrin and *beta*-cyfluthrin are expected to be similar to each other.

Although current registrations of cyfluthrin and *beta*-cyfluthrin allow for use nationwide, this ecological risk assessment and effects determinations address currently registered uses of cyfluthrin and *beta*-cyfluthrin in portions of the action area that are reasonably assumed to be biologically relevant to the BCB, VELB, CTS-SC, DS, CCR, CTS-SC, CTS-SB, CFWS, SFGS, and TG and their designated critical habitat (if applicable). Further discussion of the action area for these species and their critical habitat is provided in Section 2.7.

### 2.2.1. Evaluation of Degradates

Even though various degradates were observed in the laboratory studies (*e.g.* FPB-acid and DCVA), deesterification of the synthetic pyrethroid is known to detoxify the parent pyrethroid. It is believed that the toxicity of the resulting molecules is substantially reduced compared to the parent because they presumably have lost the neurotoxic mode of action. **Table 2-1** (see below) shows the chemical structures of cyfluthrin's (and *beta*-cyfluthrin's) major degradation products. At this time, they are not considered stressors of concern. Therefore, this assessment considers the risks associated only with parent cyfluthrin and *beta*-cyfluthrin, and does not incorporate potential risks associated with their degradates.

### 2.2.2. Evaluation of Mixtures

The Agency does not routinely include, in its risk assessments, 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 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 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).

Both cyfluthrin and *beta*-cyfluthrin have 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 (for both cyfluthrin and *beta*-cyfluthrin) is provided in **APPENDIX A**. The results of this analysis show that an assessment based on the toxicity of the single active ingredient for both cyfluthrin and *beta*-cyfluthrin is appropriate. In the case of cyfluthrin, a qualitative examination of the trends in $LD_{50}$ values, with the associated confidence intervals, across the range of percent active ingredient, reveals no definitive conclusions (for all cyfluthrin products analyzed, the data was insufficient to establish a difference in toxicity). For all cyfluthrin products analyzed, the data was insufficient to establish a difference in toxicity. For *beta*-cyfluthrin, the data was insufficient to establish a difference in toxicity for all but one product. For one product (TEMPRID SC INSECTICIDE, EPA Reg. No.: 432-1483), there were enough data to determine that the formulation was not more toxic than the a.i. to females. In all other cases, there were insufficient data to make a conclusion.

## 2.3. Previous Assessments

Cyfluthrin and *beta*-cyfluthrin were first registered in the United States in 1989 and 1995, respectively. Risk assessments conducted on cyfluthrin and *beta*-cyfluthrin, have indicated risk concerns for freshwater and estuarine/marine animals, animals living in the benthos, and terrestrial invertebrates. Slight risks to mammals (acute exposure) have also been identified for some uses.

In 2000, an assessment for the use of cyfluthrin on leafy vegetables (lettuce, mustard greens, cauliflower and broccoli), soybeans, corn (pop, field, and seed), dry peas, pigeon peas, chick peas, and lentils was conducted (USEPA, 2000). It was concluded that, "(c)yfluthrin poses a risk to freshwater and estuarine/marine fishes and invertebrates based on the highest suggested application rates for all proposed commodities based on corn (pop, seed, and field), leafy vegetables, and soybeans." In 2001, an additional risk assessment for the use of cyfluthrin on Southern peas was conducted. The conclusions for this assessment were based on the previously issued assessment from 2000 (USEPA, 2000).

In 2004, a risk assessment for several proposed new uses on tree nuts, grapes and peanuts, wheat, leafy vegetables, fruiting vegetables, cucurbits, leafy brassica, pome fruit, and stone fruit was conducted (USEPA, 2004). In the 2004 assessment, most acute, chronic, restricted use and endangered species LOCs were exceeded for aquatic organisms (freshwater and estuarine/marine fish and invertebrates). In addition, based on the risk of cyfluthrin to fish, exposed amphibians were also assumed to be at risk. Regarding the risk to terrestrial organisms, it was concluded that there were no acute or chronic risks to birds from applications of cyfluthrin. However, for small 15-35 g mammals, acute LOCs were slightly exceeded for single and multiple application scenarios. Additionally, risk to nontarget terrestrial invertebrates was assumed.

In 2006, a risk assessment was issued for the use of cyfluthrin on tobacco (USEPA, 2006). The results indicated that chronic levels of concern (LOCs) were exceeded for estuarine/marine invertebrates. For the proposed maximum application rate on tobacco, the acute or chronic RQs for benthic invertebrates did not exceed the LOCs. Also, there were no acute or chronic risks to birds or mammals from a single application of cyfluthrin to tobacco. Cyfluthrin is very highly toxic to honey bees on an acute contact basis, therefore, risk was assumed. Risks to aquatic and terrestrial plants were not assessed because data were not available.

In June and July 2007, EFED issued four risk assessments for cyfluthrin and *beta*-cyfluthrin (USEPA, 2007*a*, *b*, *c*, and *d*). One for cyfluthrin, covered its proposed use on grasses; the second risk assessment for *beta*-cyfluthrin covered its proposed use on grasses, cereal grains (except rice) and forage, fodder and straw of cereal grains; the third risk assessment covered a proposed increased application rate for alfalfa for cyfluthrin and *beta*-cyfluthrin; the fourth risk assessment was for the proposed new use of PONCHO *BETA* (EPA Reg. No. 264-1056), a product containing both chlothianidin and *beta*-cyfluthrin, as a seed treatment on sugar beets. These assessments concluded that the potential risks associated with newly proposed crops or maximum application rates were within the range of risks identified by previously issued risk assessments and overall risks should be similar as previously described.

In 2010, a problem formulation for cyfluthrin and *beta*-cyfluthrin was completed as part of the Registration Review process (USEPA, 2010). The problem formulation outlined current use patterns and toxicity/fate data and identified potential data gaps for the chemicals.

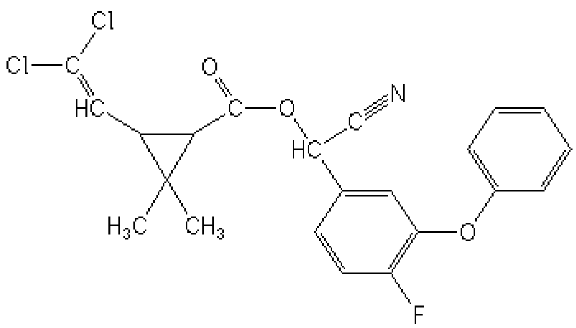
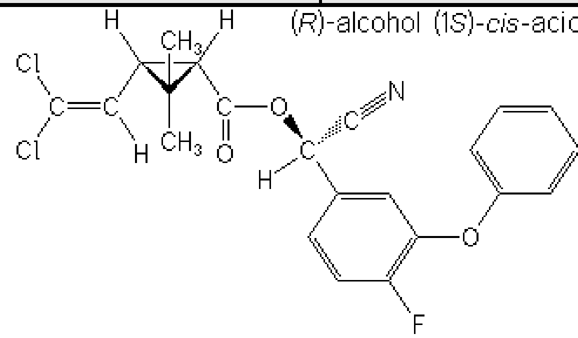
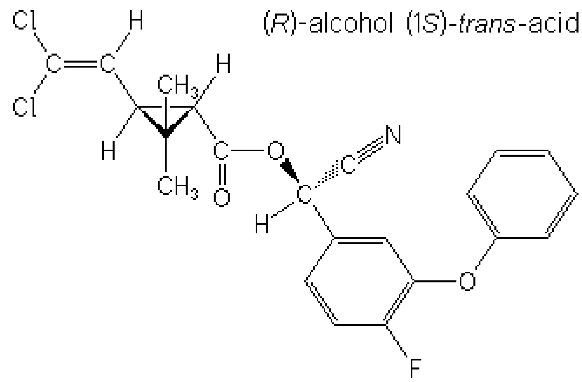
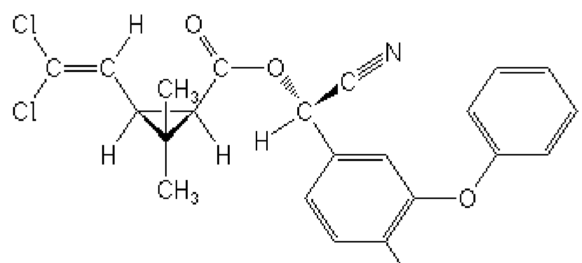
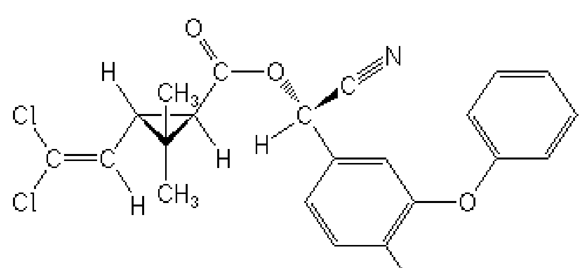
### 2.4. Environmental Fate Properties

Cyfluthrin (**Tables 2-1**) is a synthetic pyrethroid insecticide and acaricide. Its structure has three rings, two phenyl rings attached to each other by an oxygen atom, and a cyclopropyl ring. The structure of the molecule has three chiral centers that could result in a total of $2^3$ or 8 isomers, which form 4 pairs of diastereomers (I,II,III, IV). *Beta*-cyfluthrin, however, is a mixture of four of the isomers of cyfluthrin and comprise 2 pairs of diastereomers (II and IV). Chemically, it is the (R)-alcohol-(1S)-*cis*-acid, (R)-alcohol-(1S)-*trans*-acid, (S)-alcohol-(1R)-*cis*-acid and (S)-alcohol-(1R)-*trans*-acid out of eight isomeric esters. Although the physicochemical and environmental fate properties of diastereomers will be different, the extent of the differences is not large enough to alter the interpretation of the environmental fate properties of cyfluthrin and *beta*-cyfluthrin.

Cyfluthrin has a high molecular weight of 434.29 g/mol (**Table 2-2**). It also has a low water solubility (only 2.32 ppb) and a high octanol/ water partition coefficient ($K_{OW} = 9.33x10^5$). Based on its octanol/water partition coefficient, it appears that cyfluthrin has the potential to bioaccumulate/ bioconcentrate ($K_{OW} \geq 1000$) in fish and other aquatic organisms. With a vapor pressure of 1.5 x $10^{-8}$ mmHg, it is considered "non-volatile under field conditions." Due to its very low solubility (2.32 ppb), its calculated Henry's Law Constant is moderately low (3.7 x $10^{-6}$ atm-$m^3$/mol). In addition, its $C_{water}/C_{air}$ is 6612, which classifies it as "slightly volatile from a water surface" (USEPA 2008). Cyfluthrin could have a potential to volatilize slightly from wet surfaces. The potential to volatilize may be greatly attenuated in the environment by its tendency to bind to organic matter (*e.g.*, soils, sediments, or organic matter and particulate in natural water). For cyfluthrin, the log $K_{OA}$ range is 9.79 – 11.88 (calculated and EPIWEB v.4.0 estimates), the log $K_{OW}$ is 5.97 and the rate of transformation is moderate in the environment and appears to be moderate in fish (the majority of the residues observed in fish were the parent compound), with moderately rapid depuration (observed depuration DT50 of approximately 3 days). Therefore, it appears that cyfluthrin may have *a low potential* to biomagnify substantially in terrestrial food chains, based on the presumption made by Gobas *et al.* and Armitage & Gobas, in 2003 and 2007 articles, respectively.

**Table 2-1. Identification Information for Cyfluthrin and Beta-Cyfluthrin.**

| CHEMICAL | CYFLUTHRIN | | *BETA*-CYFLUTHRIN | |
|---|---|---|---|---|
| **PARAMETER** | **VALUE(S) (units)** | **SOURCE** | **VALUE(S) (units)** | **SOURCE** |
| **CAS Chemical Name** | cyano(4-fluoro-3-phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate | Cyfluthrin data sheet, at: http://www.alanwood.net/pesticides/cyfluthrin.html (accessed 04/21/10) | cyano(4-fluoro-3-phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate | *Beta*-cyfluthrin data sheet, at: http://www.alanwood.net/pesticides/*beta*-cyfluthrin.html (accessed 04/21/10) |
| **PC Code** | 128831 | OPP Databases | 118831 | OPP Databases |
| **IUPAC Chemical Name** | (*RS*)-α-cyano-4-fluoro-3-phenoxybenzyl (1*RS*,3*RS*;1*RS*,3*SR*)-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate **or** (*RS*)-α-cyano-4-fluoro-3-phenoxybenzyl (1*RS*)-*cis-trans*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate | Cyfluthrin data sheet, at: http://www.alanwood.net/pesticides/cyfluthrin.html | reaction mixture comprising the enantiomeric pair (*R*)-α-cyano-4-fluoro-3-phenoxybenzyl (1*S*,3*S*)-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate and (*S*)-α-cyano-4-fluoro-3-phenoxybenzyl (1*R*,3*R*)-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate in ratio 1:2 with the enantiomeric pair (*R*)-α-cyano-4-fluoro-3-phenoxybenzyl (1*S*,3*R*)-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate and (*S*)-α-cyano-4-fluoro-3-phenoxybenzyl (1*R*,3*S*)-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate **or** reaction mixture comprising the enantiomeric pair (*R*)-α-cyano-4-fluoro-3-phenoxybenzyl (1*S*)-*cis*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate and (*S*)-α-cyano-4-fluoro-3-phenoxybenzyl (1*R*)-*cis*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate in ratio 1:2 with the enantiomeric pair (*R*)-α-cyano-4-fluoro-3-phenoxybenzyl (1*S*)-*trans*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate and (*S*)-α-cyano-4-fluoro-3-phenoxybenzyl (1*R*)-*trans*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate | *Beta*-cyfluthrin data sheet, at: http://www.alanwood.net/pesticides/*beta*-cyfluthrin.html |

| CHEMICAL | CYFLUTHRIN | | *BETA*-CYFLUTHRIN | |
|---|---|---|---|---|
| **PARAMETER** | **VALUE(S) (units)** | **SOURCE** | **VALUE(S) (units)** | **SOURCE** |
| **Chemical Structure (from chemical's data sheet)** |  Unstated stereochemistry; It consists of 8 isomers | | (*R*)-alcohol (1*S*)-*cis*-acid  (*R*)-alcohol (1*S*)-*trans*-acid   (*S*)-alcohol (1*R*)-*cis*-acid  (*S*)-alcohol (1*R*)-*trans*-acid | |

## Table 2-2. Summary of Physiochemical Properties of Cyfluthrin and *Beta*-Cyfluthrin.

<table>
<tr><th>PARAMETER</th><th>VALUE(S) (units)</th><th>SOURCES</th></tr>
<tr><td>CAS Reg. No.</td><td>68359-37-5 (unstated stereochemistry)<br>Cyfluthrin is a mixture of all possible isomers.<br>86560-92-1 (diastereoisomer I)<br>86560-93-2 (diastereoisomer II)<br>86560-94-3 (diastereoisomer III)<br>86560-95-4 (diastereoisomer IV)<br>Beta-cyfluthrin is comprised mainly of diastereoisomers II and IV.</td><td>FAO/WHO Specifications[2] and Cyfluthrin (157)/Beta-cyfluthrin (228), Draft Review Prepared by Australian Quarantine and Inspection Service[3]</td></tr>
<tr><td>Stereochemistry</td><td>Diastereoisomer I: (1R,3R,1R + 1S,3S,1S = 1:1; cis)<br>Diastereoisomer II: (1R,3R,1S + 1S,3S,1R = 1:1; cis)<br>Diastereoisomer III: (1R,3S,1R + 1S,3R,1S = 1:1; trans)<br>Diastereoisomer IV: (1R,3S,1S + 1S,3R,1R = 1:1; trans)</td><td>FAO/WHO Specifications</td></tr>
<tr><td>Composition</td><td><table><tr><th>Diastereoisomer</th><th>Cyfluthrin</th><th>Beta-cyfluthrin</th></tr><tr><td>I</td><td>23-27%</td><td>≤2.0%</td></tr><tr><td>II</td><td>17-21%</td><td>30.0-40.0</td></tr><tr><td>III</td><td>32-36%</td><td>≤3.0%</td></tr><tr><td>IV</td><td>21-25%</td><td>57.0-67.0</td></tr></table></td><td>FAO/WHO Specifications</td></tr>
<tr><td>Molecular Formula</td><td>$C_{22}H_{18}Cl_2FNO_3$</td><td>Cyfluthrin's data sheet</td></tr>
<tr><td>Molecular Weight</td><td>434.29</td><td>TOXNET/ HSDB[4]</td></tr>
<tr><td>Melting Point</td><td>60ºC;<br>64.40 diastereoisomer I; 80.71 diastereoisomer II; 65.04 diastereoisomer III; 106.19 diastereoisomer IV</td><td>TOXNET/ HSDB<br>FAO/WHO Specifications</td></tr>
<tr><td>Boiling Point (ºC)</td><td>Not measurable; weight loss above 160°C; decomposition >220°C</td><td>FAO/WHO Specifications</td></tr>
<tr><td>pKa (20 ºC)</td><td>NA; Dissociation characteristics: cyfluthrin does not show basic or acidic characteristics in water</td><td>EC Review Report for the Active Substance Cyfluthrin and Beta-cyfluthrin[5]</td></tr>
<tr><td>Solubility (20ºC)</td><td>2.32 x $10^{-3}$ mg/L or ppm or 2.32 ppb at 20ºC<br>pH 3/pH 5: 2.5/2.2 ug/L diast. I; 2.1/1.9 ug/L diast. II; 3.2/2.2 ug/L diast. III; 4.3/2.9 ug/L diast. IV*<br>*The material used was a defined mixture of four diastereoisomeric enantiomer pairs.<br>'Not Soluble'<br>Bolded value is considered representative for cyfluthrin.</td><td>Laskowski 2002,<br>FAO/WHO Specifications<br>FAO, 2000</td></tr>
<tr><td>Vapor Pressure (20-25ºC)</td><td>1.5 x $10^{-8}$ mmHg at 25°C<br>2.1 x $10^{-9}$ mmHg at 20°C<br>@20°C 9.6 x $10^{-7}$ Pa diast. I<br>1.4 x $10^{-8}$ Pa diast II<br>2.1 x $10^{-8}$ Pa diast. III<br>8.5 x $10^{-8}$ Pa diast. IV</td><td>Laskowski 2002<br>FAO/WHO Specifications<br>USEPA, 2008</td></tr>
</table>

[2]http://www.fao.org/ag/AGP/AGPP/Pesticid/Specs/docs/Pdf/new/cyfluthr.pdf and http://www.fao.org/ag/AGP/AGPP/Pesticid/Specs/docs/Pdf/new/beta_cyf.pdf (accessed 05/05/10).
[3]http://www.fao.org/fileadmin/templates/agphome/documents/Pests_Pesticides/JMPR/Evaluation07/Cyflutrhin.pdf (accessed 05/05/10).
[4]http://toxnet.nlm.nih.gov/.
[5]http://ec.europa.eu/food/plant/protection/evaluation/existactive/list1-29_en.pdf and http://ec.europa.eu/food/plant/protection/evaluation/existactive/list1-32_en.pdf (accessed 05/05/10).

| PARAMETER | VALUE(S) (units) | SOURCES |
|---|---|---|
| | @25°C 2.1 x $10^{-6}$ Pa diast. I<br>3.4 x $10^{-7}$ Pa diast II<br>4.7 x $10^{-7}$ Pa diast. III<br>2.0 x $10^{-7}$ Pa diast. IV<br>'Non-volatile under field conditions' (≤9.98 x $10^{-7}$ mmHg) | |
| **Henry's Law Constant** | 3.7 x $10^{-6}$ atm-$m^3$/mol (estimated from vapor pressure at 25°C and water solubility at 20°) | Laskowski, 2002 |
| **Octanol-Water Partition Coefficient (20 and 22°C) $K_{OW}$ (log $K_{OW}$)** | **9.33 x $10^5$** (5.97)*<br>6.00 diast. I; 5.94 diast. II; 6.04 diast. III; 5.91 diast. IV*<br>6.18 diast. II; 6.18 diast IV at 22°C<br>*The material used was a defined mixture of four diastereoisomeric enantiomer pairs. | Laskowski, 2002<br>FAO/WHO Specifications |
| **Octanol-Air Partition Coefficient $K_{OA}$ (log $K_{OA}$)** | $K_{OA} = \frac{K_{OW}}{K_{AW}} = \frac{K_{OW}RT}{\text{Henry's Law Constant}}$ = **6.17 x $10^9$** (9.79)<br>Calculated using $K_{OW}$ = 9.33 x $10^5$ and HLC = 3.7 x $10^{-6}$ atm-$m^3$/mol; the temperature was assumed to be 25°C.<br>EPIEB est.: 1.47 x $10^{10}$ – 7.52 x $10^{11}$ (10.164-11.876) | Calculated Value<br>EPIWEB v.4.0 Estimate |
| **$K_{AW}$ (log $K_{AW}$)** | $K_{AW} = C_{air}/C_{water}$ = HLC/RT = **1.51 x $10^{-4}$** (-3.82)<br>EPIWEB estimate: $K_{AW}$ = 1.18 x $10^{-6}$ (-5.926)<br>'Slightly volatile from a water surface' | Calculated<br>EPIWEB v.4.0<br>USEPA, 2008 |
| **$C_{water}/C_{air}$** | $\frac{C_{water}}{C_{air}} = \left(\frac{S \times T \times R \times 760}{P \times GMW \times 10^6}\right)$ = 6,612 (unitless)<br>'Slightly volatile from a water surface' | Calculated<br>USEPA, 2008 |
| **OH Radical Reaction Half-life** | 0.856 days<br>(Assumptions: 12-hr days; 1.5 x $10^6$ OH/$cm^3$) | EPIWEB v.4.0 Estimate |
| **Biomagnification Potential** | Presumption: If log $K_{OA}$ > 5, log $K_{OW}$ > 2 and the rate of chemical transformation is low, the chemical may biomagnify in terrestrial food chains**<br>For cyfluthrin, log $K_{OA}$> 5, log $K_{OW}$> 2. However, its rate of transformation is moderate in the environment and appears to be moderately rapid in fish, with moderate to rapid depuration indicated. Therefore, it appears that cyfluthrin may have *a low potential to biomagnify* in terrestrial food chains. | **Gobas *et al.* 2003 and Armitage & Gobas, 2007 support this presumption utilized here only as a broad reference to determine the potential for biomagnification. |
| **Bolded** value is considered representative for cyfluthrin. | | |

Because cyfluthrin and *beta*-cyfluthrin are Type II synthetic pyrethroids that have similar structures (cyano substituted in the alpha position and both have a 2,2-dichloroethenyl, and they are 2,2-dimethyl substituted in the cyclopropane ring) and cyfluthrin includes the 4 isomers in *beta*-cyfluthrin, the environmental fate database for cyfluthrin is used as a surrogate fate database for *beta*-cyfluthrin (**Table 2-2**).

Type II pyrethroids such as cyfluthrin and *beta*-cyfluthrin characteristically show stability to photolysis. Submitted laboratory data, however, indicate that the primary routes of dissipation are aqueous and soil photolysis (4.5 and 5.6 days, respectively) and hydrolysis in alkaline media (2.1 days) (**Table 2-3**). Cyfluthrin and *beta*-cyfluthrin are moderately persistent in the environment and immobile (aerobic soil metabolism 73.5-94.8 days, aerobic aquatic metabolism 32.9-42 days). The terrestrial field dissipation data confirm the pattern observed in the laboratory studies with half-lives and $DT_{50}$'s in the range of 18-32 days, which would indicate that the chemical follows mixed routes of dissipation in the field. The $K_{OC}$ values ranged from ~73,000-180,000 mL/$g_{OC}$, indicating low mobility. Like other pyrethroids, cyfluthrin and *beta*-

cyfluthrin bind strongly to soils suggesting a low potential to leach to subsurfaces and to contaminate groundwater. The moderate persistence of the chemical, the high soil affinity and very low solubility indicate that the chemicals have a high potential to reach surface waters in runoff events accompanied by erosion occurring during periods of weeks to months after application. Residues could also reach surface waters via spray drift. Once the chemicals reach surface waters, there is potential impact to water quality, which appears to be mostly due to parent compound. The fate of cyfluthrin in anaerobic environments is uncertain. Cyfluthrin and *beta*-cyfluthrin are likely to partition with sediments in bodies of water. Since cyfluthrin may be applied repeatedly, the material may build up in sediments and affect benthic communities. Cyfluthrin and *beta*-cyfluthrin are moderately bioaccumulative with moderately rapid rates of depuration (estimated half-depuration time ≤3 days). Major metabolites observed in laboratory studies include *cis*- and *trans*-DCVA, FPB-acid and FPB-ald (**Table 2-4**, see below). These compounds result from the hydrolysis of the ester bond of the parent compounds.

***Transport***

The potential impact to water quality from the use of cyfluthrin appears to be mostly due to the parent compound. Laboratory studies show that cyfluthrin is moderately persistent under most environmental conditions making the compound available for runoff. Although the potential for mobility appears low, the likely means of cyfluthrin movement from a crop site to an adjacent body of water would be through erosion of soil, as well as spray drift. Laboratory studies predict that once the chemical reaches surface waters, it may persist for moderate periods of time (relatively stable at pH 7). Even though cyfluthrin undergoes photolysis in water, its lipophilicity and affinity with particulate matter should make it unavailable to photolysis in a short period. In addition, photolysis is expected to be limited only to clear shallow waters or the upper layers of the water column. Conclusions with respect to the mobility of these degradates are limited by the available data.

***Degradation and Metabolism***

The hydrolysis of cyfluthrin is pH dependent, occurring quickly in alkaline media (2.1 days at 9). In a supplemental study conducted on filtered Rhine River water (pH 7.7-8.3), in the dark, cyfluthrin hydrolyzed/ degraded with a half-life of 9 days. An important route of dissipation for this chemical is aqueous photolysis (non-linear half-life of 0.7 days/ linear 4.5 days in an aqueous solution under natural sunlight). The major degradates are FPB-acid (4-fluoro-3-phenoxybenzoic acid) and FPB-ald (4-fluoro-3-phenoxybenzaldehyde). Soil photodegradation is also an important route of dissipation (half-life of 5.6 days (dark control corrected)) for cyfluthrin and *beta*-cyfluthrin. The degradate FPB-ald accounts for up to 8% of the applied. It is assumed that the degradate DCVA [3-(2,2-dichlorovinyl)-2,2-dimethyl-cyclopropanecarboxylic acid] is formed in the hydrolysis and the aqueous photolysis studies. DCVA is stable to hydrolysis at pH's 4, 7 and 9 (European Commission, Appendix 2).

The aerobic soil metabolism appears to play a lesser role in the dissipation of cyfluthrin with half-lives in a loam soil and a sandy loam soil, of 73.5 and 94.8 days, respectively. There was some formation of carbon dioxide and the only fluoro-phenyl degradate detected at appreciable amounts was FPB-acid (7% of the applied). In an anaerobic soil metabolism study, using aged loam, flooded and purged with nitrogen and based on two points, a half-life of around 30 days was obtained. Two degradates detected at the end of the initial aerobic incubation, FPB-acid and cyfluthrin-amide (minor degradate), declined during the anaerobic phase. The degradate DCVA was identified in a 100-day aerobic soil metabolism study at >10% of the applied, as indicated by the European Commission (Appendix 2). In aerobic soil metabolism studies at 25°C at 40% MWHC, the DT50 range for DCVA was 12-62 days (mean 24 days, median 16 days, 2 soils, 4 isomers). It is indicated that $DT50_{FPBacid} < DT50_{DCVA}$.

In aerobic aquatic metabolism studies conducted on *beta*-cyfluthrin, based on first order linear regression analysis, the half-lives of cyfluthrin in the total systems were 32.9 and 42.0 days for two German systems, and 20.4 and 22.0 days for two Dutch systems. The quality of the results of the Dutch systems is regarded as low, and those half-lives should not be used for modeling. Three degradates were identified in the aerobic aquatic systems. In the German systems, DCVA was a maximum of 47.63% at 28 days. In the Dutch systems, FPB acid was a maximum of 44.5% at 11 days, and FPB-ald) was a maximum of 15.7% at 1 day. No anaerobic aquatic metabolism studies are available at this time.

***Sorption and Mobility***

Cyfluthrin is hydrophobic and was hardly mobile to immobile in four soils ($K_d$ range 1116 to 1793 mL/g; $K_{OC}$ range 73,000 to 180,000 mL/$g_{OC}$; measurements made at single concentrations, FAO mobility classification, FAO 2000). The chemical will bind strongly to the soil surfaces. There was a linear relationship between the soil organic carbon content and cyfluthrin $K_d$ values ($r^2 = 0.92$). The soils included German loamy sand and silty loam, and US loamy sand and clay loam. At least, some of the degradates formed from the cleavage of the carboxylate ester are expected to be more mobile than the parent. Supplemental data available to the Agency, indicates that the degradate DCVA is mobile to moderately mobile in neutral to alkaline soils ($K_{OC}$ range 14 to 356 mL/$g_{OC}$, FAO mobility classification).

Even though cyfluthrin may be applied aerially, by ground or Ultra Low Volume (ULV), and drift is possible, the chemical appears to be relatively non-volatile (vapor pressure 1.5 x $10^{-8}$ mmHg, Henry's Law Constant 3.7 x $10^{-6}$ atm-$m^3$/mol). Furthermore, cyfluthrin readily binds to soils or partitions with suspended matter and sediment. Thus, volatilization would be greatly reduced.

***Field Dissipation***

Cyfluthrin, applied on Fairmont, NC sandy soil (sand 90.8%, depth 0-6 inches, 0.33% OM), cropped with cotton, at a rate of 0.55 lb a.i./A, dissipated from the field with a half-life of 18 days ($r^2 = 0.94$, n = 8), or with a $DT_{50}$ of <32 days. Residues were detected only in the top 6" soil layer. No residues were detected below the top 6" of soil depth (sandy loam, 0.33% OM). There were two single detects of $Cl_2CA$ (≤0.012 ug/g), and eight, mostly single detects of FPBA (≤0.016 ug/g). All values were close to the analytical detection limits. Cyfluthrin dissipated from a cotton site in Fresno, California with a registrant-reported half-life of 4.3 days (using 0-7 day data; or 23.8 days if 0-14 day data are used, but the data point for 14 days was higher than for 7 days). Cyfluthrin was not detected after day 29 post-treatment. The $DT_{50}$ was *ca.* 3 days.

Residues remained in top 6 in soil layer, except for two individual samples. FPBA and DCVA were detected in this study. In other terrestrial field dissipation studies, in AZ, FL, KS, GA, OR, MS and Canada different soils, with different organic matter content showed that cyfluthrin (in the form of Baythroid 24% EC), sprayed at 1 kg a.i./ha dissipated with $DT_{50}$'s of <32 days. In these studies, soil sampling intervals, spaced by 30-32 days were inadequate and prevented accurate half-life calculations. Besides the parent, residues of DCVA and FPB-acid were detected in some studies. Cyfluthrin was detected in the 6-12" cores at levels less than 0.13 mg/Kg in five out of the seven studies.

### *Bioaccumulation*

Based on the octanol/ water partition coefficient, cyfluthrin shows a high potential to bioaccumulate ($K_{OW} = 9.33 \times 10^5$). The bioconcentration factor in whole rainbow trout was moderate (854x, whole fish). Residues were depurated at moderately rapid rates in untreated water (apparent depuration half-life of approximately ≤3 days). Accumulated residues were found mostly in non-edible tissues, and the only residue detected at high levels was the parent compound.

**Table 2-3. Summary of the Environmental Fate and Transport Properties of Cyfluthrin and *Beta*-Cyfluthrin.**

| PARAMETER | VALUE(S) (units) | SOURCE | COMMENT |
|---|---|---|---|
| Hydrolysis Half-life [pH 5, 7, 9; (25 ºC)] | Stable at pH 5, nearly stable at pH 7, $t_{1/2}$ = 2.1 days at pH 9; major degradation product FPB-ald | MRID: 00131493, 00137539, 45022101 | Supplemental data shows that the half-life was 9 days in natural waters from the Rhine river. Major product was FPB-acid. Water's pH was 7.7-8.3. |
| Aqueous Photolysis Half-life (pH 5) | $t_{1/2}$ = 4.5 days linear; $t_{1/2}$ = 0.7 days nonlinear; degradation products: FPB-acid and FPB-ald | MRID: 00149595, 45022102 | Value obtained using natural sunlight |
| Soil Photolysis Half-life | $t_{1/2}$ = 5.6 days; degradation product: FPB-ald | MRID: 00137543, 00157043 | Dark control corrected; using natural sunlight |
| Aerobic Soil Metabolism Half-life | L $t_{1/2}$ = 73.5 days SL $t_{1/2}$ = 94.8 days major degradate: FPB-acid | MRID: 00131494 | – |
| Anaerobic Soil Metabolism Half-life | $t_{1/2}$ ~ 30 days; degradate FPB-acid declined | MRID: 00131494 | Study lasted 60 days. |
| Aerobic Aquatic Metabolism Half-life | $t_{1/2}$ = 32.9 and 42.0 days for two German systems. Degradates DCVA, FPB-acid and FPB-ald | MRID: 46824101 | (20.4 & 22.0 days for two Dutch systems, but the quality of these half-lives was considered very low.) |
| Anaerobic Aquatic Metabolism Half-life | No Study Available | NA | Study is required. |

| PARAMETER | VALUE(S) (units) | SOURCE | COMMENT |
|---|---|---|---|
| Soil Partition Coefficient ($K_d$)<br>Organic Carbon Partition Coefficient ($K_{OC}$)<br>For Cyfluthrin | **Adsorption:**<br>Soil / $K_d$ / $K_{OC}$<br>German LS 1116 124000<br>US LS 1244 180300<br>US CL 1321 118000<br>German SiL 1793 73500<br>**Desorption:**<br>Soil / $K_d$ / $K_{OC}$<br>German LS 1448 161000<br>US LS 974 141000<br>US CL 1307 117000<br>German SiL 1705 69900<br><br>$K_{OC}$ in mL/$g_{OC}$ and $K_d$ in mL/g.<br>Immobile to hardly mobile.<br>There is a linear relationship between the soil organic carbon content and the $K_d$ values ($r^2$ = 0.92). | MRID: 00131495, 00137544, 45022103 | In supplemental studies, TLC data for cyfluthrin on six different soils were submitted. Using the Helling and Turner mobility classification system, cyfluthrin was classified as immobile in the six test soils. To help EFED develop a $K_d$ input for modeling, the registrant later submitted a supplemental study to the Agency which contained a single $K_d$ value for one soil of 810 mL/g. |
| Soil Partition Coefficient ($K_d$)<br>Organic Carbon Partition Coefficient ($K_{OC}$)<br>For *trans*-DCVA | **Adsorption:**<br>Soil / $K_F$ / $K_{FOC}$<br>Sand ND ND<br>Silty Clay 0.46 18<br>Sandy Loam 0.16 19<br>Sandy Loam 0.54 48<br>**Desorption:**<br>Soil / $K_F$ / $K_{FOC}$<br>Sand ND ND<br>Silty Clay 0.91 36<br>Sandy Loam 0.36 44<br>Sandy Loam 0.72 64<br>ND = Not determined | MRID: 43424901 | Provides information to partially fulfill the data requirement. |
| Terrestrial Field Dissipation Half-life | NC**:** $t_{1/2}$ (in surface soil) = 18.1 days; was only detected in top 6 in soil layer.<br>CA (Fresno) cotton site**:** $t_{1/2}$ reported to be 4.3 days (using 0-7 day data; or 23.8 days if 0-14 day data are used), cyfluthrin was not detected after day 29 post-treatment; residues remained in top 6 in soil layer, except for two individual samples. FPB-acid and DCVA were detected in this study.<br>AZ, FL, KS, GA, OR, MS, Canada**:**<br>$DT_{50}$ < 32 days | MRID: AN 259211, 44822901, 42794801 | Study 42794801 was screened only and a full review will be provided at a later time. |
| Bioaccumulation in Fish (BCF) | Maximum BCF=854X for whole fish, with moderate depuration. The only major residue was the parent. The depuration time appears to be ≤3 days. | MRID: 00143143 | – |

Abbreviations: wt=weight
[1]Half-lives were calculated using the single-first order equation and nonlinear regression, unless otherwise specified.
[2]The value may reflect both dissipation and degradation processes.

### *Transformation Products*

The fate and transport characterization is also summarized for the various degradation products formed by each process for the studies reviewed in **Table 2-4**.

**Table 2-4. Summary of Degradate Formation from Degradation of Cyfluthrin.**

| STUDY TYPE | SOURCE | DEGRADATE and MAXIMUM CONCENTRATION | | |
|---|---|---|---|---|
| | | F-PB-acid (% app) | F-PB-ald (% app) | DCVA (% app) |
| Hydrolysis | MRID: 00131493, 00137539, 45022101 | – | 11% at 35 days at pH 7, 89% at 21 days at pH 9 | – |
| Aqueous Photolysis | MRID: 00149595, 45022101, 45022102 | 37% at day 14 | 18% at day 7 | – |
| Soil Photolysis | MRID: 00137543, 00157043 | – | 18% at days 5-6 | – |
| Aerobic Soil Metabolism | MRID: 00131494 | 10% at 10 days | – | >10% in 100-day studies |
| Anaerobic Soil Metabolism | MRID: 00131494 | 10% at 30 days of aerobic incubation (time of flooding) | – | – |
| Aerobic Aquatic Metabolism | MRID: 46824101 | 44.5% at 11 days | 15.7% at 1 day | 47.63% at 28 days |
| Terrestrial Field Dissipation | MRID: AN 259211, 42794801, 44822901 | <0.07 mg/Kg in the 0-6" cores | – | 0.16 mg/Kg at 30 days |

Major degradates identified in laboratory studies are FPB-acid, FPB-ald and DCVA, which result from the rupture of the ester linkage of the synthetic pyrethroid. FPB-acid was identified in the aqueous photolysis, aerobic soil metabolism, and anaerobic soil metabolism studies at 10-37% of the applied at 10-30 days after treatment. FPB-ald was observed at significant amounts in photolysis/ photodegradation studies at 18% of the applied of the applied (5-7 days posttreatment) and in hydrolysis studies (up to 89% of the applied at pH 9, but only 11% at pH 7). DCVA was identified in supplemental aerobic soil metabolism studies (>10% of the applied). The degradate DCVA was also identified in field studies at up to 0.16 mg/Kg.

There is uncertainty with respect to the available data on the cyclopropane side of the ester linkage and cold analyses were not performed on the possible degradates resulting from the rupture of this linkage. There is evidence of the formation of DCVA, but there is no further information on the possible degradation pathways. There are limited data about the mobility and persistence of FPB-ald, FPB-acid and DCVA. While it appears that DCVA is much more mobile than the parent compound and has the potential to reach ground waters in vulnerable sites, there are limited data about its mobility. DCVA has been detected in laboratory studies at >10% of the applied.

### 2.4.1. Environmental Transport Mechanisms

Potential transport mechanisms include pesticide erosion, spray drift, and secondary drift of volatilized or soil-bound residues leading to deposition onto nearby or more distant ecosystems. Partitioning to soil during runoff and spray drift are expected to be the major routes of exposure for the cyfluthrins. Despite the fact that cyfluthrin and *beta*-cyfluthrin show a moderate Henry's Law Constant, that would suggest some potential for volatilization, and it is moderately persistent in various environmental media, the hydroxyl radical reaction half-life for the chemical is 0.86 days (EPI Suite v.4.0 estimate). The short (atmospheric) half-life suggests that the potential for atmospheric transport for cyfluthrin and *beta*-cyfluthrin is relatively low and that this source of the chemical is of low importance, compared to spray drift, runoff and/ or direct contact after application.

In general, deposition of drifting pesticides is expected to be greatest close to the site of application. Typically, computer models of spray drift (AgDRIFT and/or AGDISP) are used to determine potential exposures to aquatic and terrestrial organisms via spray drift. The distance of potential impact away from the use sites (action area) is determined by the distance required to fall below the LOC for the taxonomic group that has the largest RQ to LOC ratio; however, because both cyfluthrin and *beta*-cyfluthrin have such wide use patterns and can be used essentially anywhere in California, a quantitative spatial analysis is not conducted here.

### 2.4.2. Mechanism of Action

Cyfluthrin and *beta*-cyfluthrin (both pyrethroids) are neural toxic insecticides acting through direct contact and ingestion. The primary biological effects of cyfluthrin, *beta*-cyfluthrin and other pyrethroids on insects and vertebrates reflect an inhibition of the correct firing of neurotransmitter delivery signals from one cell to another via nerve membrane disruption effects on the voltage-gated $Na^+$ (sodium ion) channels. The pyrethroids (including cyfluthrin and *beta*-cyfluthrin) share similar modes of action, and are considered axonic poisons that affect both the peripheral and central nervous system.

Relative to physiological responses, researchers have designated two primary types of pyrethroids, Type I (*e.g.*, bifenthrin, resmethrin, permethrin) and Type II (*e.g.*, cypermethrin, deltamethrin, fenvalerate, cyfluthrin and *beta*-cyfluthrin). Type I pyrethroids act by causing nerve excitation symptoms typified by the appearance of repetitive firing of axons in the peripheral nervous system and a negatively correlated temperature reversible knockdown property (Clark & Matsumura, 1987). In insects, the type II pyrethroids predominantly cause ataxia and uncoordinated movement.

### 2.4.3. Use Characterization

Analysis of labeled use information is the critical first step in evaluating the federal action. The current labels for cyfluthrin and *beta*-cyfluthrin represent the FIFRA regulatory actions; therefore, labeled use and application rates specified on the labels 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.

Cyfluthrin and *beta*-cyfluthrin are both registered on a wide variety of agriculture and non-agricultural uses. In general, for a given crop (*i.e.*, agricultural use), the application rate for *beta*-cyfluthrin is approximately half that for cyfluthrin. For the non-agricultural uses, there is much more variation in the application rates both within and between cyfluthrin and *beta*-cyfluthrin. For the non-agricultural uses, there is also more uncertainty regarding the application rates when compared to the agricultural uses based on the labeled treatments areas ('spot' treatments versus applications on a per acre basis) and unspecified information on the registered labels (*e.g.*, see **Tables 2-5** through **2-10**). However, considering the available usage information from California (discussed below), the assumption that the application rates for non-agricultural uses and *beta*-cyfluthrin are approximately half of the application rates for cyfluthrin (non-agricultural uses) seems appropriate. Both flowable and granular formulations are registered for cyfluthrin and *beta*-cyfluthrin. For agricultural products, application methods include aerial and ground, including ULV. In addition, soil applications are possible, particularly for corn.

The flowable agricultural products cannot be applied by ground equipment within a distance of 25 ft, or by aerial equipment within a distance of 150 ft, or by ULV within a distance of 450 ft from freshwater or estuarine/marine bodies of water (*e.g.* lakes, reservoirs, rivers, permanent streams, marshes or natural ponds, estuaries and commercial fish farm ponds). Some cyfluthrin and *beta*-cyfluthrin flowable products are co-formulated with the neonicotinoid, imidacloprid (PC Code 129059), and some of the cyfluthrin flowable products are co-formulated with piperonyl butoxide (PBO) (PC Code 067501).

The buffer zone for granular agricultural products is 60 ft from adjacent bodies of water. The granular formulations also contain the organophosphate insecticide, phostebupirim (PC Code 129806).

The Label Use Information System (LUIS report) and Usage/Label Use Reports for cyfluthrin (provided by BEAD) were based on a partial listing of labels, due to the large number of labels available for review. Section 3 labels or major producers' labels, along with Special Local Needs (SLNs) labels for California, are included in the LUIS report. These data represent all of the uses of this chemical in California. For *beta*-cyfluthrin, all labels, relevant to California, were included in the LUIS report (see **APPENDIX B**).

**Tables 2-5** through **2-10** present the uses and corresponding application rates and methods of application considered in this assessment. The tables provide the use information cyfluthrin agricultural uses (flowable), cyfluthrin non-agricultural uses (flowable), cyfluthrin granular uses (both agricultural and non-agricultural uses), *beta*-cyfluthrin agricultural uses (flowable), *beta*-cyfluthrin non-agricultural uses (flowable), and *beta*-cyfluthrin granular uses (both agricultural and non-agricultural uses).

**Table 2-5. Cyfluthrin Agricultural Uses (Flowable) Assessed for California (Except Those Highlighted in Orange).**

| Site Description | Max Single Application Rate (a.i.) | Max # Applications/ Season (Unless Otherwise Specified) | Max Application Rate (a.i.)/Season | Minimum Retreatment Interval |
|---|---|---|---|---|
| ALFALFA | 0.050 lb / a | 8[1] | 0.400 lb / a | 5 d |
| BEANS, DRIED-TYPE | 0.030 lb / a | 3[1] | 0.091 lb / a | 14 d |
| BRASSICA (HEAD AND STEM) VEGETABLES | 0.057 lb / a | 4[1, 2] | 0.228 lb / a | 7 d |
| CARROT (INCLUDING TOPS) | 0.050 lb / a | 5[1, 3] | 0.250 lb / a | 7 d |
| CITRUS | 0.114 lb / a | 1[1] | 0.114 lb / a | N/A |
| CORN, FIELD | 0.050 lb / a | 4 | 0.200 lb / a | 7 d |
| CORN, POP | 0.050 lb / a | 4 | 0.200 lb / a | 7 d |
| CORN, SWEET | 0.050 lb / a | 10[1, 3] | 0.500 lb / a | 2 d |
| CORN (UNSPECIFIED) | 0.050 lb / a | 4 | 0.200 lb / a | 7 d |
| COTTON (UNSPECIFIED) | 0.057 lb / a | 10[1] | 0.571 lb / a | 3 d |
| CUCURBIT VEGETABLES | 0.050 lb / a | 4[1, 2] | 0.200 lb / a | 7 d |
| DECIDUOUS FRUIT TREES (UNSPECIFIED) | 0.119 lb / a | NS | NS | 14 d[4] |
| FRUITING VEGETABLES | 0.050 lb / a | 6[1, 3] | 0.300 lb / a | 7 d |
| GRAPES | 0.057 lb / a | 4[1, 2] | 0.228 lb / a | 14 d |
| GRASSES GROWN FOR SEED | 0.050 lb / a | 4[1] | 0.202 lb / a | 5 d |
| GRASS FORAGE/FODDER/HAY | 0.050 lb / a | 4[1, 5] | 0.202 lb / a | 5 d |
| HOPS | 0.057 lb / a | 5[1] | 0.285 lb / a | 14 d |
| LEAFY GREENS | 0.033 lb / a | 5[1] | 0.165 lb / a | 7 d |
| LEAFY VEGETABLES | 0.057 lb / a | 4[1, 6] | 0.228 lb / a | 7 d |
| LEGUME VEGETABLES | 0.057 lb / a | 2[1] | 0.114 lb / a | 14 d |
| PASTURES | 0.050 lb / a | 4[1] | 0.201 lb / a | 5 d |
| PEANUTS (UNSPECIFIED) | 0.050 lb / a | 3[1, 6] | 0.150 lb / a | 10 d |
| PEAS, DRIED-TYPE | 0.030 lb / a | 3[1] | 0.090 lb / a | 14 d |
| PEAS, SOUTHERN | 0.037 lb / a | 5[1] | 0.187 lb / a | 5 d |
| PEPPER | 0.011 lb / a | 6[3,7] | 0.066 lb / a | 7d |
| POME FRUITS | 0.050 lb / a | 1[1] | 0.050 lb / a | 14 d |
| POTATO, WHITE/IRISH | 0.050 lb / a | 6[1, 6] | 0.300 lb / a | 5 d |
| RADISH | 0.050 lb / a | 5[1, 2] | 0.250 lb / a | 7 d |
| RANGELAND | 0.050 lb / a | 4[1] | 0.202 lb / a | 5 d |
| ROOT AND TUBER VEGETABLES | 0.050 lb / a | 6[1, 6] | 0.300 lb / a | 5 d |
| SORGHUM | 0.050 lb / a | 3[1] | 0.150 lb / a | 10 d |
| SOYBEANS (UNSPECIFIED) | 0.050 lb / a | 4[1] | 0.200 lb / a | 7 d |
| STONE FRUITS | 0.050 lb / a | 2[1] | 0.100 lb / a | 14 d |
| SUGARCANE | 0.050 lb / a | 6[1] | 0.300 lb / a | 7 d |
| SUNFLOWER | 0.050 lb / a | 3[1, 2, 6] | 0.150 lb / a | 7 d |
| SWEET POTATO | 0.050 lb / a | 6[1] | 0.300 lb / a | 5 d |
| TOBACCO | 0.005 lb / a | 1 | 0.005 lb / a | NS |
| TOMATO | 0.0002 lb / 1 gal | NS | NS | 7 d |
| TREE NUTS | 0.119 lb / a | NS[8] | NS | NS |
| WHEAT | 0.043 lb / a | 2[1] | 0.086 lb / a | 3 d |

[1] Not specified on at least one label for this use; the max number of applications is calculated by dividing the max application rate/season by the max single application rate.

[2] On at least one label for this use, the rate is not provided as a 'lb a.i./acre' rate, but instead is provided as '0.0002 lb / 1 gal' and the max application rate is not specified on the label.

[3] On at least one label for this use, the rate is not provided as a 'lb a.i./acre' rate, but instead is provided as '0.0002 lb / 1 gal' and the max number of applications and max application rate are not specified on the label.

[4] On at least one label for this use the minimum application interval is not specified on the label.
[5] On at least one label for this use, the max number of applications and the max application rate per year are not specified on the label.
[6] On at least one label for this use, the max single application rate could not be calculated based on the information on the label and the max application rate per year is not specified.
[7] Not specified on at least one label for this use; the max application rate is calculated by multiplying the max single application rate by the max number of applications allowed per season.
[8] For the 'tree nuts' use, application rates are provided in a variety of ways (i.*e*., lb a.i./acre, lb a.i./inch DBH, and lb a.i./100 gal) and in most cases the max number of applications per season, the max application rate per season, and the minimum application interval are not specified on the labels.
NS = not specified on the label(s)
N/A = not applicable
The orange highlighted rows represent crops not grown in CA; therefore, they will not be assessed here.

**Table 2-6. Cyfluthrin Non-Agricultural Uses (Flowable) Assessed for California.**

| Site Description | Max Single Application Rate (a.i.) | Max # Applications/ Season (Unless Otherwise Specified) | Max Application Rate (a.i.)/Season | Minimum Retreatment Interval |
|---|---|---|---|---|
| AIRPORTS/LANDING FIELDS | 0.436 lb / a[1] | NS | NS | 7 d |
| ANIMAL HOUSING PREMISES (OUTDOOR) | 0.367 lb / a | NS | NS | 10 d |
| CATTLE FEEDLOTS | 0.367 lb / a | NS | NS | 10 d |
| COMMERCIAL/INDUSTRIAL LAWNS | 0.139 lb / a | NS | NS | |
| COMMERCIAL/INSTITUTIONAL/INDUSTRIAL PREMISES/EQUIPMENT (OUTDOOR) | 5207.14 lb / a[1] | NS | NS | NS |
| COMMERCIAL STORAGES/WAREHOUSES PREMISES | 0.165 lb / a | NS | NS | NS |
| FENCEROWS/HEDGEROWS | NDC | NS | NS | NS |
| FOREST TREES (ALL OR UNSPECIFIED) | NDC | NS | NS | NS |
| GOLF COURSE TURF | 0.134 lb / a | 6/yr | 0.804 lb / a[2] | NS |
| GREENHOUSE-EMPTY | 0.009 lb / 1 gal | NS | NS | 7 d |
| GREENHOUSES-IN USE | 0.367 lb / a | NS | NS | 10 d |
| HOUSEHOLD/DOMESTIC DWELLINGS OUTDOOR PREMISES | 0.044 lb / a[1] | NS | NS | 7 d |
| MULCH | 0.0001 lb / gal[1] | NS | NS | NS |
| NONAGRICULTURAL OUTDOOR BUILDINGS/STRUCTURES | 260.36 lb / a[1] | NS | NS | NS |
| NURSERY STOCK | 0.007 lb / plant | NS | NS | NS |
| ORNAMENTAL AND/OR SHADE TREES | 0.131 lb / a[1, 3] | NS | NS | NS |
| ORNAMENTAL GROUND COVER | 0.131 lb / a[1, 4] | NS | NS | NS |
| ORNAMENTAL HERBACEOUS PLANTS | 0.119 lb / a[1, 4] | NS | NS | NS |
| ORNAMENTAL LAWNS AND TURF | 0.193 lb / a[1] | 6/yr | NS | NS |
| ORNAMENTAL NONFLOWERING PLANTS | 0.131 lb / a[1] | NS | NS | NS |
| ORNAMENTAL WOODY SHRUBS AND VINES | 0.174 lb / a[1, 3] | NS | NS | NS |
| PATHS/PATIOS | 5207.14 lb / a[1] | NS | NS | NS |
| PAVED AREAS (PRIVATE ROADS/SIDEWALKS) | 0.004 lb /0.5 gal[1] | NS | NS | NS |
| PET LIVING/SLEEPING QUARTERS | 0.214 lb / a | NS | NS | NS |
| RECREATIONAL AREAS | 0.025 lb / a[1] | NS | NS | NS |
| RECREATION AREA LAWNS | 0.193 lb / a[3] | 6/yr | NS | NS |
| REFUSE/SOLID WASTE CONTAINERS (GARBAGE CANS) | 0.214 lb / a[3] | NS | NS | NS |

| Site Description | Max Single Application Rate (a.i.) | Max # Applications/ Season (Unless Otherwise Specified) | Max Application Rate (a.i.)/Season | Minimum Retreatment Interval |
|---|---|---|---|---|
| REFUSE/SOLID WASTE SITES (OUTDOOR) | 0.165 lb / a[3] | NS | NS | NS |
| RESIDENTIAL LAWNS | 0.193 lb / a | 6/yr | 1.158 lb / a[2] | NS |
| ROSE | 0.0003 lb / 1 gal | NS | NS | 7 d |
| SWAMPS/MARSHES/WETLANDS/STAGNANT WATER | 1.122 lb / a | NS | NS | 3 d |
| UTILITY POLES / RIGHTS-OF-WAY | 48.01 lb / a[1, 3] | NS | NS | 7 d |
| WOOD PROTECTION TREATMENT TO BUILDINGS/PRODUCTS OUTDOOR | 5207.143 lb / a[1, 3, 4] | NS | NS | NS |
| WOOD PROTECTION TREATMENT TO FOREST PRODUCTS (SEASONED) | 173.571 lb / a | NS | NS | NS |

[1] On at least one label for this use, the application rate could not be calculated based on the information available on the label.
[2] The maximum application rate per year is not specified on the label; the max application rate per year was calculated by multiplying the max single application rate by the max number of applications allowed per year.
[3] Some labels specify the application rate for this use only as 'lb a.i./inch DBH' and/or 'lb a.i./gal'.
[4] Some labels specify the application rate for this use only as 'lb a.i./mound' or "lb a.i./gal".

## Table 2-7. Cyfluthrin Agricultural and Non-Agricultural Uses (Granular) Assessed for California.

| Site Description | Max Single Application Rate (a.i.) | Max # Applications/ Season (Unless Otherwise Specified) | Max Application Rate (a.i.)/Season | Minimum Retreatment Interval |
|---|---|---|---|---|
| **CROP USES** | | | | |
| CARROT (INCLUDING TOPS) | 0.131 lb / a | NS | NS | NS |
| CORN, FIELD | .00000041 lb / linear ft | NS | 0.007 lb a | NS |
| CORN, POP | .00000041 lb / linear ft | NS | 0.007 lb a | NS |
| CORN (SILAGE) | .00000041 lb / linear ft | NS | 0.007 lb a | NS |
| CORN, SWEET | 0.131 lb / a | NS | NS | NS |
| PEPPER | 0.131 lb / a | NS | NS | NS |
| POTATO, WHITE/IRISH | 0.131 lb / a | NS | NS | NS |
| RADISH | 0.131 lb / a | NS | NS | NS |
| TOMATO | 0.131 lb / a | NS | NS | NS |
| **NON-CROP USES** | | | | |
| HOUSEHOLD/DOMESTIC DWELLINGS OUTDOOR PREMISES | 0.131 lb / a[1] | NS | NS | NS |
| MULCH | 0.174 lb / a[1] | NS | NS | NS |
| NONAGRICULTURAL OUTDOOR BUILDINGS/STRUCTURES | 0.174 lb / a[1] | NS | NS | NS |
| NONAGRICULTURAL RIGHTS-OF-WAY/FENCEROWS/HEDGEROWS | 0.174 lb / a[1] | NS | NS | NS |
| ORNAMENTAL AND/OR SHADE TREES | 0.174 lb / a[1] | NS | NS | NS |
| ORNAMENTAL GROUND COVER | 0.174 lb / a[1] | NS | NS | NS |

| Site Description | Max Single Application Rate (a.i.) | Max # Applications/ Season (Unless Otherwise Specified) | Max Application Rate (a.i.)/Season | Minimum Retreatment Interval |
|---|---|---|---|---|
| ORNAMENTAL HERBACEOUS PLANTS | 0.174 lb / a[1] | NS | NS | NS |
| ORNAMENTAL LAWNS AND TURF | 0.174 lb / a[1] | NS | NS | NS |
| ORNAMENTAL NONFLOWERING PLANTS | 0.174 lb / a[1] | NS | NS | NS |
| ORNAMENTAL WOODY SHRUBS AND VINES | 0.174 lb / a[1] | NS | NS | NS |

[1] On at least one label for this use, the rate is not provided as a 'lb a.i./acre' rate, but instead is provided as 'lb a.i./mound' and/or 'lb a.i./burrow'.
NS = not specified on the label

**Table 2-8. *Beta*-Cyfluthrin Agricultural Uses (Flowable) Assessed for California (Except Those Highlighted in Orange).**

| Site Description | Max Single Application Rate (a.i.) | Max # Applications/ Season | Max Application Rate (a.i.)/Season | Minimum Retreatment Interval |
|---|---|---|---|---|
| ALFALFA | 0.024 lb / a | 8[1] | 0.189 lb / a | 5 d |
| BARLEY | 0.020 lb / a | 2[1] | 0.041 lb / a | 3 d |
| BEANS, DRIED-TYPE | 0.022 lb / a | 2.3[1] | 0.051 lb / a | 14 d |
| BRASSICA (HEAD AND STEM) VEGETABLES | 0.027 lb / a | 4[1] | 0.108 lb / a | 7 d |
| BUCKWHEAT | 0.020 lb / a | 2[1] | 0.041 lb / a | 3 d |
| CARROT (INCLUDING TOPS) | 0.024 lb / a | 5[1] | 0.118 lb / a | 7 d |
| CITRUS | 0.054 lb / a | 1[1, 2] | 0.054 lb / a | 7 d |
| CORN, FIELD | 0.024 lb / a | 4 | 0.095 lb / a | 7 d |
| CORN, POP | 0.024 lb / a | 4 | 0.095 lb / a | 7 d |
| CORN, SWEET | 0.024 lb / a | 10[1] | 0.236 lb / a | 2 d |
| CORN (UNSPECIFIED) | 0.024 lb / a | 4 | 0.095 lb / a | 7 d |
| COTTON (UNSPECIFIED) | 0.027 lb / a | 10[1] | 0.270 lb / a | 3 d |
| CUCURBIT VEGETABLES | 0.024 lb / a | 4[1] | 0.095 lb / a | 7 d |
| FRUITING VEGETABLES | 0.033 lb / a | 4[1] | 0.122 lb / a | 7 d |
| FRUITING VEGETABLES | 0.024 lb / a | 6[1] | 0.142 lb / a | 7 d |
| GRAPES | 0.051 lb / a | 1[1] | 0.051 lb / a | 14 d |
| GRAPES | 0.027 lb / a | 4[1] | 0.108 lb / a | 14 d |
| GRASSES GROWN FOR SEED | 0.024 lb / a | 4[1] | 0.095 lb / a | 5 d |
| GRASS FORAGE/FODDER/HAY | 0.024 lb / a | 4[1] | 0.095 lb / a | 5 d |
| HOPS | 0.025 lb / a | 5[1] | 0.127 lb / a | 21 d |
| HOPS | 0.027 lb / a | 5[1] | 0.135 lb / a | 14 d |
| LEAFY GREENS | 0.024 lb / a | 4.3[1] | 0.102 lb / a | 7 d |
| LEAFY VEGETABLES | 0.027 lb / a | 4[1] | 0.108 lb / a | 7 d |
| LEGUME VEGETABLES | 0.027 lb / a | 2[1] | 0.054 lb / a | 14 d |
| OATS | 0.020 lb / a | 2[1] | 0.041 lb / a | 3 d |
| PASTURES | 0.024 lb / a | 4[1] | 0.095 lb / a | 5 d |
| PEANUTS (UNSPECIFIED) | 0.024 lb / a | 3[1] | 0.071 lb / a | 10 d |
| PEAS, DRIED-TYPE | 0.022 lb / a | 2.3[1] | 0.051 lb / a | 14 d |
| PEAS, SOUTHERN | 0.018 lb / a | 5[1] | 0.089 lb / a | 5 d |
| POME FRUITS | 0.024 lb / a | 1 | 0.024 lb / a | N/A |
| POTATO, WHITE/IRISH | 0.024 lb / a | 6[1] | 0.142 lb / a | 5 d |
| PROSO MILLET | 0.020 lb / a | 2[1] | 0.041 lb / a | 3 d |
| RADISH | 0.024 lb / a | 5[1] | 0.118 lb / a | 7 d |

| Site Description | Max Single Application Rate (a.i.) | Max # Applications/ Season | Max Application Rate (a.i.)/Season | Minimum Retreatment Interval |
|---|---|---|---|---|
| RANGELAND | 0.024 lb / a | 4[1] | 0.095 lb / a | 5 d |
| RYE | 0.020 lb / a | 2[1] | 0.041 lb / a | 3 d |
| SORGHUM | 0.024 lb / a | 3[1] | 0.071 lb / a | 10 d |
| SOYBEANS (UNSPECIFIED) | 0.024 lb / a | 4[1] | 0.095 lb / a | 7 d |
| STONE FRUITS | 0.024 lb / a | 2[1] | 0.047 lb / a | 14 d |
| SUGARCANE | 0.024 lb / a | 6[1] | 0.142 lb / a | 7 d |
| SUNFLOWER | 0.024 lb / a | 3[1] | 0.071 lb / a | 7 d |
| TEOSINTE | 0.024 lb / a | 4 | 0.095 lb / a | 7 d |
| TOBACCO | 0.024 lb / a | 1 | 0.024 lb / a | N/A |
| TOMATO | 0.033 lb / a | 1 | 0.122 lb / a | 7 d |
| TREE NUTS | 0.024 lb / a | 3.7[1] | 0.024 lb / a | 14 d |
| TRITICALE | 0.020 lb / a | 2[1] | 0.041 lb / a | 3 d |
| WHEAT | 0.020 lb / a | 2[1] | 0.041 lb / a | 3 d |

[1] Not specified on at least one label for this use; the max number of applications is calculated by dividing the max application rate/season by the max single application rate. When the calculated number is not a whole number, the final application is modeled using the appropriate fraction of the max single application rate (*e.g.,* if the max number of applications is calculated as '2.3', two applications at the maximum single application rate are modeled along with an application rate at 1/3 of the max single application rate).
[2] On at least one label for this use, the rate is not provided as a 'lb a.i./acre' rate, but instead is provided as '0.018 lb / 100 gal' and the max number of applications, max application rate, and minimum application interval are not specified on the label.
N/A = not applicable
The orange highlighted rows represent crops not grown in CA; therefore, they will not be assessed here.

**Table 2-9. *Beta*-Cyfluthrin Non-Agricultural Uses (Flowable) Assessed for California.**

| Site Description | Max Single Application Rate (a.i.) | Max # Applications/ Season | Max Application Rate (a.i.)/Season | Minimum Retreatment Interval |
|---|---|---|---|---|
| AGRICULTURAL/FARM STRUCTURES/BUILDINGS AND EQUIPMENT | 0.191 lb / a | NS | NS | NS |
| AIRPORTS/LANDING FIELDS | 0.182 lb / a | NS | NS | 10 d |
| ANIMAL FEEDLOTS | 0.191 lb / a | NS | NS | NS |
| ANIMAL HOUSING PREMISES (OUTDOOR) | 0.191 lb / a | NS | NS | 10 d |
| ANIMAL KENNELS/SLEEPING QUARTERS (COMMERCIAL) | 0.191 lb / a | NS | NS | 10 d |
| BARNS/BARNYARDS/AUCTION BARNS | 0.191 lb / a | NS | NS | NS |
| BEEF/RANGE/FEEDER CATTLE (MEAT) | 0.009 lb / animal | NS | NS | NS |
| CALVES (MEAT) | 0.005 lb / animal | NS | NS | NS |
| COMMERCIAL/INDUSTRIAL LAWNS | 0.096 lb / a | NS | NS | 7 d |
| COMMERCIAL/INSTITUTIONAL/INDUSTRIAL PREMISES/EQUIPMENT (OUTDOOR) | 0.191 lb / a | NS | NS | 10 d |
| FOOD PROCESSING PLANT PREMISES (NONFOOD CONTACT) | 0.004 lb / 1 gal | NS | NS | 7 d |
| FOOD STORES/MARKETS/SUPERMARKETS PREMISES | 0.191 lb / a | NS | NS | 10 d |
| GOLF COURSE TURF | 0.0956 lb / a | NS | NS | 7 d |
| GREENHOUSE-EMPTY | 0.191 lb / a | NS | NS | 10 d |
| HOUSEHOLD/DOMESTIC DWELLINGS OUTDOOR PREMISES | 0.192 lb / a | NS | NS | 7 d |

| Site Description | Max Single Application Rate (a.i.) | Max # Applications/ Season | Max Application Rate (a.i.)/Season | Minimum Retreatment Interval |
|---|---|---|---|---|
| NONAGRICULTURAL OUTDOOR BUILDINGS/STRUCTURES | 0.192 lb / a | NS | NS | 7 d |
| NONAGRICULTURAL RIGHTS-OF-WAY/FENCEROWS/HEDGEROWS | 0.192 lb / a | NS | NS | 7 d |
| ORNAMENTALS[1] | 0.042 lb / 100 gal[2] | NS | NS | 7 d |
| ORNAMENTAL LAWNS AND TURF | 0.096 lb / a | NS | NS | 7 d |
| PATHS/PATIOS | 0.192 lb / a[2] | NS | NS | 7 d |
| RECREATION AREA LAWNS | 0.096lb / a[2] | NS | NS | 7 d |
| RESIDENTIAL LAWNS | 0.096 lb / a[2] | NS | NS | 7 d |
| ROSE | 0.0001lb / 1 gal[2] | NS | NS | 7 d |
| UTILITY POLES / RIGHTS-OF-WAY | 23.09 lb / a | NS | NS | 10 d |
| WOOD PROTECTION TREATMENT TO BUILDINGS/PRODUCTS OUTDOOR | 24.01 lb / a | NS | NS | 7 d |

[1] Ornamentals including shade trees, ground cover, herbaceous plants, non-flowering plants, and woody shrubs and vines.
[2] On at least one label for this use, the application rate could not be calculated based on the information available on the label.
NS = not specified on the label
NDC = no dose calculated

### Table 2-10. *Beta*-Cyfluthrin Agricultural and Non-Agricultural Uses (Granular) Assessed for California.

| Site Description | Max Single Application Rate (a.i.) | Max # Applications/ Season (Unless Otherwise Specified) | Max Application Rate (a.i.)/Season | Minimum Retreatment Interval |
|---|---|---|---|---|
| **CROP USES** | | | | |
| NONE | | | | |
| **NON-CROP USES** | | | | |
| HOUSEHOLD/DOMESTIC DWELLINGS OUTDOOR PREMISES | 0.065 lb a.i./a[1] | NS | NS | NS |
| ORNAMENTAL AND/OR SHADE TREES | 0.065 lb a.i./a[1] | NS | NS | NS |
| ORNAMENTAL HERBACEOUS PLANTS | 0.065 lb a.i./a[1] | NS | NS | NS |
| ORNAMENTAL LAWNS AND TURF | 0.00006 lb/ mound | NS | NS | NS |
| ORNAMENTAL WOODY SHRUBS AND VINES | 0.065 lb a.i./a[1] | NS | NS | NS |
| RESIDENTIAL LAWNS | 0.065 lb a.i./a[1] | NS | NS | NS |

[1] On at least one label for this use, the rate is not provided as a ‘lb a.i./acre’ rate, but instead is provided as ‘lb a.i./mound’.
NS = not specified on the label

On most cyfluthrin and *beta*-cyfluthrin labels for agricultural uses, the maximum application rate is provided on a per season and not an annual basis. Based on information from BEAD, several crops for which cyfluthrin and *beta*-cyfluthrin are registered, can be grown more than one time per year in California (see **Table 2-11**). In this assessment, one crop per year is modeled. Numerous applications of the same pyrethroid over more than one season per year appear to be unlikely due to potential development of insect resistance.

**Table 2-11. Cyfluthrin and *Beta*-Cyfluthrin Crops that Can Be Grown More than One Time per Year in California.**

| Site Description | Max Number of Crops/Year |
|---|---|
| ALFALFA | Perennial crop; up to 9 cuttings per year |
| BRASSICA (HEAD AND STEM) VEGETABLES | Up to 2 |
| CORN, SWEET | Up to 3 |
| GRASSES GROWN FOR SEED | Up to 2 |
| GRASS FORAGE/FODDER/HAY | Up to 5 cuttings/year |
| LEAFY GREENS | Up to 4 |
| LEAFY VEGETABLES | Up to 4 |
| RADISH | Up to 5 |
| SORGHUM | For grain = 1; for hay = several cuttings/year |

**Figure 2-1** provides information on the intensity of national cyfluthrin usage for agricultural uses by crop reporting district based on information provided by BEAD (see **APPENDIX C** for details). The map does not contain information on non-agricultural uses. Comparable data are not currently available for *beta*-cyfluthrin.

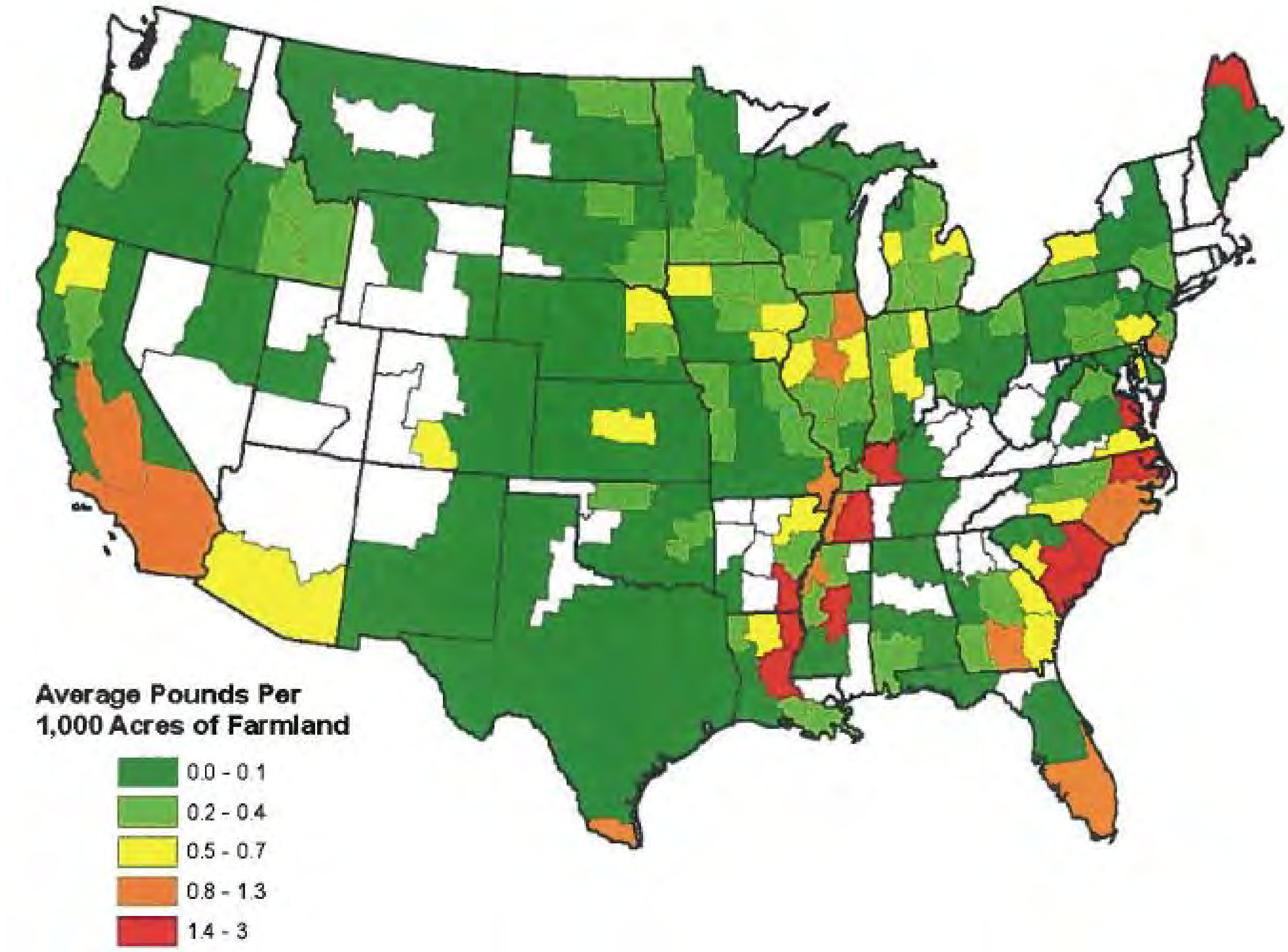



**Figure 2-1. Cyfluthrin Usage by Crop Reporting District (2007 - 2011)[6].**

California's Department of Pesticide Regulation Pesticide Use Reporting (CDPR PUR) database[7] is used to provide information on agricultural use of the cyfluthrins. 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 cyfluthrin and *beta*-cyfluthrin by county in this California-specific assessment were generated using CDPR PUR data. Eleven 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.[8] BEAD summarized these

[6] This is a map of agricultural pesticide usage at the Crop Reporting District (CRD) level prepared by BEAD. These maps are used to help visualize where the pesticide being considered is most likely to be used.
[7] 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.
[8] 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).

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 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 eleven years. The units of area treated are also provided where available (see **APPENDIX D** for more details).

A summary of cyfluthrin usage for all California use sites by year is provided below in **Table 2-12**. A summary for *beta*-cyfluthrin usage in California, by year, is provided in **Table 2-13**. For the uses with available usage data from 1999 to 2010, the 'structural pest control' use is the use with the highest amount of a.i. applied (in lb a.i.) per year for both cyfluthrin and *beta*-cyfluthrin in California. The general trend for most uses from 1999 to 2010 in California is for decreased usage (in lb a.i.) of cyfluthrin and increased usage of *beta*-cyfluthrin. This might indicate that cyfluthrin use is generally being replaced by *beta*-cyfluthrin use for most (but not all) uses. The exception to this, when considering the uses with the highest cyfluthrins usage (*i.e.*, alfalfa, corn, cotton, orange, and structural pest control) is for cotton – use of both cyfluthrin and *beta*-cyfluthrin appear to be increasing in cotton, based on available data.

**Table 2-12. Cyfluthrin Usage Data Based on CA PUR Data (1999-2010).**

| Site Name | Total Pounds 1999 | Total Pounds 2000 | Total Pounds 2001 | Total Pounds 2002 | Total Pounds 2003 | Total Pounds 2004 | Total Pounds 2005 | Total Pounds 2006 | Total Pounds 2007 | Total Pounds 2008 | Total Pounds 2009 | Total Pounds 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AIRPORT | 0.00 | 3.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ALFALFA | 5,808.7 | 4,851.8 | 6,039.3 | 6,700.86 | 5,581.10 | 4,766.53 | 4,914.97 | 4,472.90 | 1,650.3 | 904.41 | 159.87 | 443.15 |
| ALMOND | 0.00 | 0.65 | 0.00 | 0.00 | 2.83 | 0.00 | 0.28 | 0.00 | 91.01 | 14.69 | 23.18 | 688.23 |
| ANIMAL PREMISE | 743.7 | 186.46 | 186.21 | 40.88 | 57.94 | 14.32 | 6.9 | 0.20 | 0.42 | 1.13 | 5.99 | 5.24 |
| APPLE | 0.26 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 2.51 | 9.52 | 8.26 | 9.81 |
| APRICOT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.39 | 4.03 |
| ARRUGULA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.00 | 0.21 | 1.21 | 0.31 |
| BEAN, DRIED | 1.23 | 0.24 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.81 | 5.20 | 24.08 | 42.09 |
| BEAN, SUCCULENT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.13 | 0.00 | 0.00 | 0.00 |
| BEAN, UNSPECIFIED | 1.2 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.7 |
| BEET | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.39 | 1.87 | 1.44 | 1.33 | 3.89 |
| BEVERAGE CROP | 0.00 | 0.02 | 0.00 | 0.03 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BOK CHOY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.94 | 7.53 | 10.45 | 8.16 | 4.07 |
| BROCCOLI | 0.00 | 0.00 | 0.02 | 2.63 | 0.00 | 32.08 | 21.03 | 59.25 | 43.98 | 20.26 | 143.60 | 110.95 |
| BRUSSELS SPROUT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 17.47 | 10.24 | 1.56 | 0.65 |
| BUILDINGS/NON-AG OUTDROOR | 0.37 | 0.18 | 0.00 | 0.52 | 0.00 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 |
| CABBAGE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.87 | 8.60 | 13.77 | 15.96 | 9.59 | 0.00 | 4.02 |
| CANTALOUPE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 9.75 | 0.64 |
| CARROT | 232.60 | 177.06 | 185.25 | 126.67 | 78.71 | 82.30 | 93.99 | 58.41 | 40.81 | 87.17 | 4.17 | 12.50 |
| CAULIFLOWER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 15.51 | 4.82 | 14.34 | 44.20 | 26.31 | 21.39 | 26.25 |
| CELERIAC | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.87 | 0.31 | 0.00 | 0.00 | 0.00 |
| CELERY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.24 | 31.87 | 36.08 | 14.35 | 7.16 |
| CHERRY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.60 | 0.00 | 7.81 | 110.50 |
| CHICKEN | 17.40 | 30.50 | 14.80 | 3.80 | 2.80 | 0.00 | 0.00 | 0.00 | 0.00 | 2.41 | 0.00 | 0.00 |
| CHICORY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 39.35 | 0.00 | 0.00 | 0.00 | 0.00 |
| CHINESE CABBAGE (NAPPA) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.13 | 0.00 | 2.45 | 8.85 | 11.54 | 5.96 | 8.73 |
| CITRUS | 53.99 | 44.42 | 57.79 | 28.79 | 37.30 | 24.38 | 26.75 | 10.88 | 5.17 | 5.16 | 2.54 | 2.23 |
| COLLARD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 14.00 | 3.16 | 3.76 | 2.73 | 3.40 |
| COMMODITY | 2.38 | 1.71 | 1.39 | 1.06 | 0.97 | 1.48 | 0.32 | 5.81 | 2.33 | 0.32 | 0.88 | 0.05 |

| Site Name | Total Pounds 1999 | Total Pounds 2000 | Total Pounds 2001 | Total Pounds 2002 | Total Pounds 2003 | Total Pounds 2004 | Total Pounds 2005 | Total Pounds 2006 | Total Pounds 2007 | Total Pounds 2008 | Total Pounds 2009 | Total Pounds 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FUMIGATION | | | | | | | | | | | | |
| CORN (FORAGE - FODDER) | 0.00 | 1.75 | 0.00 | 0.00 | 0.00 | 97.49 | 55.78 | 5.97 | 0.00 | 4.53 | 0.00 | 0.00 |
| CORN, HUMAN CONSUMPTION | 1,628.0 | 1,006.5 | 810.64 | 1,444.35 | 1,461.97 | 1,249.70 | 1,343.09 | 1,372.08 | 1,094.1 | 236.29 | 147.94 | 391.77 |
| COTTON | 930.00 | 922.19 | 3,475.6 | 3,068.07 | 2,932.78 | 2,667.94 | 3,522.24 | 2,230.45 | 786.93 | 2,673.8 | 640.95 | 2,303.7 |
| COUNTY AG COMM | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CUCUMBER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 9.22 |
| DAIRY EQUIPMENT | 0.00 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| EGGPLANT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.31 | 0.00 | 0.00 | 0.00 | 5.72 |
| ENDIVE (ESCAROLE) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.35 | 27.21 | 11.92 | 2.25 | 5.98 |
| FOOD PROCRESSING PLANT | 1.56 | 2.91 | 3.05 | 3.59 | 2.26 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FORAGE HAY/SILAGE | 5.73 | 1.11 | 2.22 | 40.10 | 1.55 | 13.79 | 3.42 | 0.00 | 0.30 | 0.00 | 0.00 | 0.00 |
| FUMIGATION, OTHER | 2.67 | 0.92 | 4.91 | 4.72 | 20.23 | 3.10 | 2.69 | 3.98 | 4.32 | 14.12 | 4.18 | 2.61 |
| GAI LON | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 7.79 |
| GRAIN | 0.00 | 0.00 | 0.62 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| GRAPE | 86.80 | 6.49 | 6.54 | 0.19 | 2.29 | 1.69 | 0.00 | 20.73 | 66.72 | 545.62 | 206,2 | 352.26 |
| GRAPEFRUIT | 53.18 | 38.94 | 24.78 | 13.21 | 14.90 | 11.20 | 7.68 | 16.12 | 25.50 | 12.45 | 16.01 | 30.41 |
| GREENHOUSE FUMIGATION | 0.08 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| HERB, SPICE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 |
| HOUSEHOLD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.14 | 1.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| INDUSTRIAL SITE | 21.14 | 0.91 | 1.10 | 0.80 | 0.08 | 0.16 | 1.14 | 0.00 | 0.00 | 0.00 | 3.13 | 0.00 |
| KALE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.26 | 2.49 | 6.14 | 12.01 | 2.07 |
| KOHLRABI | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 |
| LANDSCAPE MAINTENANCE | 796.93 | 831.64 | 895.62 | 1,297.83 | 1,378.59 | 655.87 | 734.31 | 449.47 | 193.85 | 1,370.3 | 156.17 | 347.31 |
| LEMON | 81.33 | 124.60 | 51.69 | 143.88 | 85.91 | 60.83 | 33.97 | 84.76 | 65.30 | 10.02 | 21.33 | 32.50 |
| LETTUCE, HEAD | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 252.69 | 597.91 | 627.71 | 548.52 | 776.23 | 227.70 | 428.19 |

| Site Name | Total Pounds 1999 | Total Pounds 2000 | Total Pounds 2001 | Total Pounds 2002 | Total Pounds 2003 | Total Pounds 2004 | Total Pounds 2005 | Total Pounds 2006 | Total Pounds 2007 | Total Pounds 2008 | Total Pounds 2009 | Total Pounds 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LETTUCE, LEAF | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 144.36 | 161.95 | 317.35 | 440.25 | 419.31 | 175.75 | 156.19 |
| LIVESTOCK | 0.61 | 0.00 | 1.17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| MELON | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| MIZUNA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.00 | 0.07 | 0.00 | 1.19 |
| MUSTARD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.71 | 0.06 | 54.90 | 32.17 | 19.67 | 4.33 | 8.07 |
| N-GRNHS FLOWER | 43.54 | 27.5 | 31.77 | 22.24 | 25.13 | 17.6 | 14.55 | 11.4 | 10.24 | 7.88 | 10.04 | 12.89 |
| N-GRNHS PLANTS IN CONTAINERS | 47.91 | 30.86 | 35.95 | 39.92 | 39.65 | 35.84 | 42.31 | 40.93 | 38.94 | 31.3 | 15.72 | 18.68 |
| N-GRNHS TRANSPLANTS | 1.31 | 2.14 | 2.31 | 1.81 | 1.8 | 2.61 | 2.22 | 1.99 | 4.69 | 2.44 | 2.38 | 1.22 |
| N-OUTDR FLOWER | 19.64 | 10.72 | 13.91 | 12.03 | 7.46 | 4.30 | 16.39 | 11.39 | 20.28 | 10.63 | 8.99 | 178.3 |
| N-OUTDR PLANTS IN CONTAINERS | 298.7 | 539.86 | 507.36 | 161.11 | 245.97 | 322.64 | 281.65 | 175.54 | 198.18 | 143.79 | 224.0 | 139.53 |
| N-OUTDR TRANSPLANTS | 11.13 | 11.56 | 15.54 | 15.17 | 10.30 | 14.49 | 9.1 | 22.99 | 23.9 | 3.85 | 5.71 | 8.05 |
| NECTARINE | 5.59 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.59 | 0.00 | 0.21 | 0.96 |
| OLIVE | 3.38 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.00 | 0.07 | 0.00 |
| ORANGE | 6,570 | 2,825 | 3,481 | 3,870 | 3,823 | 3,704 | 4,345 | 4,603 | 1,911 | 1,469 | 1,454 | 1,469 |
| PARSLEY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.35 |
| PASTURELAND | 0.00 | 0.54 | 3.10 | 0.00 | 0.00 | 0.00 | 0.00 | 4.43 | 0.00 | 0.00 | 0.00 | 0.00 |
| PEACH | 1.25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.66 | 2.93 | 5.34 | 5.11 |
| PEAS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.39 |
| PECAN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.60 | 0.00 | 7.73 | 0.48 |
| PEPPER, FRUITING | 87.90 | 255.04 | 98.42 | 104.21 | 169.29 | 66.43 | 127.65 | 168.36 | 118.67 | 22.70 | 31.50 | 10.83 |
| PEPPER, SPICE | 12.19 | 4.28 | 0.99 | 1.21 | 0.00 | 0.57 | 0.44 | 0.44 | 0.65 | 2.25 | 1.97 | 0.00 |
| PISTACHIO | 1.25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 141.72 | 14.60 | 177.30 | 20.95 | 58.60 |
| PLUM | 6.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.21 | 0.93 |
| POTATO | 0.00 | 0.96 | 78.66 | 197.18 | 370.66 | 415.42 | 493.94 | 453.93 | 330.30 | 425.02 | 569.50 | 219.16 |
| POULTRY | 1.59 | 3.44 | 1.0 | 3.61 | 4.8 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.85 | 0.00 |
| PRUNE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.12 | 0.00 | 4.38 | 20.57 |
| PUBLIC HEALTH | 15.86 | 4.70 | 2.33 | 0.66 | 190.89 | 1.74 | 1.22 | 1.12 | 0.00 | 1.28 | 0.46 | 0.05 |
| RADISH | 3.69 | 6.33 | 7.56 | 16.91 | 16.68 | 17.67 | 16.97 | 9.54 | 5.93 | 0.78 | 1.31 | 1.41 |
| REGULATORY PEST | 60.14 | 14.57 | 17.56 | 4.98 | 0.04 | 0.53 | 56.11 | 7.91 | 0.80 | 0.69 | 0.07 | 0.18 |

| Site Name | Total Pounds 1999 | Total Pounds 2000 | Total Pounds 2001 | Total Pounds 2002 | Total Pounds 2003 | Total Pounds 2004 | Total Pounds 2005 | Total Pounds 2006 | Total Pounds 2007 | Total Pounds 2008 | Total Pounds 2009 | Total Pounds 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CONTROL | | | | | | | | | | | | |
| RESEARCH COMMODITY | 0.49 | 0.68 | 0.86 | 1.81 | 0.13 | 0.36 | 0.07 | 0.33 | 0.01 | 0.00 | 1.22 | 1.10 |
| RIGHTS OF WAY | 266.86 | 3.91 | 3.87 | 23.23 | 4.92 | 5.32 | 4.01 | 165.66 | 16.49 | 5.95 | 9.13 | 1.57 |
| RYEGRASS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 238.75 | 0.00 | 0.00 | 0.99 | 0.00 | 0.00 | 0.00 |
| SOIL FUMIGATION/PREPL ANT | 0.00 | 0.00 | 0.37 | 4.99 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| SORGHUM (FORAGE - FODDER) | 0.00 | 80.18 | 181.39 | 87.07 | 150.04 | 196.60 | 52.17 | 47.23 | 6.51 | 174.05 | 265.40 | 0.00 |
| SORGHUM/MILO | 0.00 | 22.72 | 97.50 | 8.62 | 0.00 | 66.55 | 246.08 | 3.96 | 0.00 | 0.00 | 3.98 | 0.00 |
| SPINACH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 8.57 | 293.03 | 114.44 | 69.28 | 52.29 |
| STORAGE AREA/BOX | 0.00 | 0.00 | 0.16 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRAWBERRY | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.00 | 0.00 |
| STRUCTURAL PEST CONTROL | 20,195 | 14,449 | 24,442 | 38,817 | 29,557 | 32,606 | 31,226 | 63,261 | 16,190 | 17,653 | 12,688 | 38,489 |
| SUDANGRASS | 1.17 | 40.31 | 119.08 | 12.62 | 9.97 | 0.00 | 0.00 | 1.99 | 0.00 | 0.00 | 0.00 | 63.28 |
| SUNFLOWER | 9.97 | 23.64 | 118.99 | 125.88 | 61.40 | 61.62 | 43.52 | 4.54 | 3.12 | 0.00 | 0.00 | 0.00 |
| SWEET POTATO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 18.10 |
| SWISS CHARD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.25 | 13.42 | 14.10 | 3.41 | 3.56 |
| TANGELO | 48.31 | 37.86 | 25.24 | 83.36 | 80.09 | 145.25 | 77.93 | 131.96 | 21.80 | 21.96 | 38.70 | 46.66 |
| TANGERINE | 88.34 | 63.45 | 40.79 | 193.08 | 105.80 | 183.07 | 318.56 | 304.92 | 662.56 | 211.54 | 282.17 | 322.77 |
| TOMATILLO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 | 0.00 | 0.00 | 0.00 |
| TOMATO | 132.22 | 129.65 | 107.61 | 194.75 | 372.72 | 152.09 | 170.07 | 128.67 | 33.98 | 182.30 | 95.41 | 210.77 |
| TOMATO, PROCESSING | 138.88 | 192.55 | 204.92 | 384.22 | 276.44 | 188.30 | 147.10 | 420.97 | 472.40 | 247.48 | 205.08 | 636.46 |
| TURF/SOD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.09 | 1.31 | 0.00 | 0.00 | 0.31 | 0.45 |
| TURKEY | 0.00 | 1.82 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.88 | 0.00 | 0.00 |
| TURNIP | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.27 | 4.16 | 3.13 | 1.84 | 2.16 |
| UNCULTIVATED AG | 0.00 | 1.40 | 0.00 | 1.42 | 0.00 | 0.22 | 4.79 | 1.57 | 0.01 | 0.00 | 0.00 | 0.00 |
| UNCULTIVATED NON-AG | 0.52 | 18.05 | 0.39 | 0.33 | 0.29 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| UNKNOWN | 9.31 | 0.02 | 0.00 | 3.80 | 1.01 | 0.00 | 0.00 | 2.21 | 0.29 | 0.12 | 0.33 | 0.37 |

| Site Name | Total Pounds 1999 | Total Pounds 2000 | Total Pounds 2001 | Total Pounds 2002 | Total Pounds 2003 | Total Pounds 2004 | Total Pounds 2005 | Total Pounds 2006 | Total Pounds 2007 | Total Pounds 2008 | Total Pounds 2009 | Total Pounds 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VEGETABLE | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| VERTEBRATE CONTROL | 2.48 | 0.87 | 2.06 | 6.29 | 3.05 | 0.75 | 1.08 | 1.80 | 7.82 | 6.20 | 4.93 | 0.22 |
| WALNUT | 1.99 | 0.00 | 0.00 | 0.00 | 14.35 | 0.00 | 0.00 | 0.00 | 1.31 | 2.70 | 149.19 | 190.12 |
| WATERMELON | 5.57 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.70 | 3.01 | 0.00 | 15.15 | 0.00 |
| WHEAT | 0.00 | 0.00 | 0.00 | 0.00 | 1.93 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

1- Based on data supplied by BEAD (USEPA, 2013).

2- Any use site reported by the CA PUR Data that is not a currently registered use is assumed to be a misreport or misuse and is not assessed here.

**Table 2-13. *Beta*-Cyfluthrin Usage Data Based on CA PUR Data.**

| Site Name | Total Pounds 1999 | Total Pounds 2000 | Total Pounds 2001 | Total Pounds 2002 | Total Pounds 2003 | Total Pounds 2004 | Total Pounds 2005 | Total Pounds 2006 | Total Pounds 2007 | Total Pounds 2008 | Total Pounds 2009 | Total Pounds 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALFALFA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 45 | 1,238 | 1,600 | 1,782 | 1,629 |
| ALMOND | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 47 | 39 | 38 | 17 |
| ANIMAL PREMISE | 0.00 | 0.00 | 412 | 507 | 415 | 647 | 1,131 | 440 | 195 | 144 | 24 | 498 |
| APPLE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4 | 18 | 11 | 16 |
| APRICOT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.12 | 10 | 2 | 15 |
| ARRUGULA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 1 | 3 | 4 |
| BARLEY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.18 |
| BEAN, DRIED | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 18 | 22 | 24 | 12 |
| BEAN, UNSPECIFIED | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.49 |
| BEET | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.23 | 1.93 |
| BERMUDAGRASS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.56 | 0.00 | 0.00 |
| BOK CHOY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.63 | 0.76 | 3.10 | 8.76 | 14.69 |
| BROCCOLI | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.22 | 14.45 | 44.02 | 34.05 | 87.71 |
| BRUSSELS SPROUT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.34 | 0.16 |
| BUILDINGS/NON-AG OUTDROOR | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 |
| CABBAGE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.79 | 18.95 | 32.01 | 31 |
| CANTALOUPE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.62 | 0.00 | 0.00 | 8.92 |
| CARROT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.70 | 1.19 | 20.64 | 6.04 | 30.55 |
| CAULIFLOWER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.83 | 7.50 | 4.93 | 7.38 | 21.62 |

| Site Name | Total Pounds 1999 | Total Pounds 2000 | Total Pounds 2001 | Total Pounds 2002 | Total Pounds 2003 | Total Pounds 2004 | Total Pounds 2005 | Total Pounds 2006 | Total Pounds 2007 | Total Pounds 2008 | Total Pounds 2009 | Total Pounds 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CELERY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.07 | 8.61 | 30.28 | 22.47 | 21.93 |
| CHERRY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.24 | 1.81 | 90.36 |
| CHICKEN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10 | 0.00 | 0.00 |
| CHINESE CABBAGE (NAPPA) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.48 | 6.72 | 4.60 | 10.69 | 19.72 |
| CHINESE GREENS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.43 |
| CITRUS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.75 | 4.08 | 3.57 | 2.09 |
| COLE CROP | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 |
| COLLARD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.11 | 2.22 | 2.75 | 6.42 |
| COMMODITY FUMIGATION | 0.00 | 0.00 | 0.00 | 0.24 | 0.00 | 0.39 | 0.16 | 0.34 | 0.93 | 0.23 | 0.00 | 0.11 |
| CORN (FORAGE - FODDER) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 9.86 | 19.68 | 27.21 | 19.50 |
| CORN, HUMAN CONSUMPTION | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 35.43 | 468.17 | 337.42 | 816.67 | 713.37 |
| COTTON | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 30.72 | 262.79 | 175.80 | 911.05 |
| CUCUMBER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.43 | 4.20 | 0.00 |
| DAIRY EQUIPMENT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.32 | 0.00 | 0.00 |
| EGGPLANT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.24 | 0.50 | 0.00 | 1.00 |
| ENDIVE (ESCAROLE) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 1.08 | 7.55 | 4.04 | 8.15 |
| FENNEL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.30 |
| FOOD PROCRESSING PLANT | 0.00 | 0.00 | 0.00 | 0.00 | 0.46 | 6 | 3 | 5 | 2 | 0.00 | 0.00 | 0.00 |
| FORAGE HAY/SILAGE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 14.95 | 19.99 | 13.45 | 29.70 |
| FUMIGATION, OTHER | 0.00 | 0.00 | 0.00 | 0.00 | 0.38 | 0.04 | 0.11 | 0.07 | 0.00 | 0.00 | 1.14 | 0.07 |
| GRAPE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 24.50 | 272.79 | 525.80 | 542.82 |
| GRAPE, WINE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 61.38 | 134.70 | 101.48 | 124.89 |
| GRAPEFRUIT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 11.83 | 17.89 | 21.29 | 15.83 |
| HERB, SPICE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 |
| HORSERADISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.23 | 0.00 |

| Site Name | Total Pounds 1999 | Total Pounds 2000 | Total Pounds 2001 | Total Pounds 2002 | Total Pounds 2003 | Total Pounds 2004 | Total Pounds 2005 | Total Pounds 2006 | Total Pounds 2007 | Total Pounds 2008 | Total Pounds 2009 | Total Pounds 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HOUSEHOLD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 |
| INDUSTRIAL SITE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| KALE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 | 0.89 | 0.53 | 2.80 |
| KOHLRABI | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.27 |
| LANDSCAPE MAINTENANCE | 0.00 | 0.13 | 370.44 | 264.68 | 377.64 | 10,959.91 | 281.63 | 1,846.05 | 951.71 | 395.57 | 240.86 | 269.15 |
| LEMON | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.01 | 13.07 | 27.72 | 32.50 | 19.71 |
| LETTUCE, HEAD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 17.99 | 17.85 | 32.74 | 50.11 | 100.55 |
| LETTUCE, LEAF | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 37.87 | 77.92 | 115.41 | 137.62 | 150.26 |
| LIME | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.27 |
| LIVESTOCK | 0.00 | 0.00 | 0.55 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| MELON | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.06 | 6.24 |
| MIZUNA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.63 | 2.86 | 1.96 |
| MUSTARD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.69 | 20.79 | 9.87 | 12.49 |
| N-GRNHS FLOWER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 | 0.07 | 0.00 |
| N-GRNHS PLANTS IN CONTAINERS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| N-GRNHS PLANTS IN CONTAINERS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.54 | 0.02 |
| N-GRNHS TRANSPLANTS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| N-OUTDR FLOWER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.02 | 0.01 |
| N-OUTDR PLANTS IN CONTAINERS | 0.00 | 0.00 | 0.00 | 0.00 | 0.48 | 10 | 1 | 0.22 | 6 | 9 | 81 | 25 |
| N-OUTDR TRANSPLANTS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 | 0.00 | 0.00 | 0.00 | 0.02 |
| NECTARINE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.57 | 11.17 | 25.68 | 70.52 |
| ORANGE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1,384.59 | 1,618.56 | 1,451.89 | 1,409.58 |
| PARSLEY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 |
| PASTURELAND | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.51 | 0.00 | 16.11 | 0.38 |
| PEACH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 18.13 | 41.25 | 45.17 | 125.06 |
| PEAR | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.21 | 0.08 | 0.08 |
| PECAN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.01 |

| Site Name | Total Pounds 1999 | Total Pounds 2000 | Total Pounds 2001 | Total Pounds 2002 | Total Pounds 2003 | Total Pounds 2004 | Total Pounds 2005 | Total Pounds 2006 | Total Pounds 2007 | Total Pounds 2008 | Total Pounds 2009 | Total Pounds 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PEPPER, FRUITING | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 | 53.31 | 66.29 | 49.83 | 41.97 |
| PISTACHIO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 352.14 | 673.87 | 678.46 | 732.92 |
| PLUM | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.81 | 2.61 | 11.06 | 38.67 |
| POTATO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 23.34 | 66.07 | 59.42 | 43.94 |
| POULTRY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.49 | 0.00 | 0.00 | 0.00 | 3 | 0.00 | 0.00 |
| PRUNE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.36 | 10.11 |
| PUBLIC HEALTH | 0.00 | 0.00 | 0.13 | 0.00 | 0.00 | 0.02 | 37.04 | 0.00 | 0.00 | 0.67 | 1.80 | 0.00 |
| PUMPKIN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.57 | 0.95 | 0.27 |
| QUINCE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.24 | 0.00 | 0.19 |
| RADISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.33 | 10.90 | 9.50 | 4.75 |
| RANGELAND | 0.00 | 0.00 | 0.00 | 0.06 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| REGULATORY PEST CONTROL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.77 | 14.58 | 2.22 | 8.18 | 15.86 |
| RESEARCH COMMODITY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.21 | 0.05 | 0.40 | 0.00 |
| RIGHTS OF WAY | 0.00 | 0.00 | 0.07 | 0.00 | 25.68 | 13.12 | 11.08 | 2,649.61 | 73.40 | 9.18 | 10 | 3.47 |
| RYEGRASS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.08 | 0.00 | 0.00 | 0.00 |
| SORGHUM (FORAGE - FODDER) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 34.42 | 9.89 | 16.60 |
| SORGHUM/MILO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.20 | 0.00 | 4.68 |
| SPINACH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.93 | 68.87 | 118.57 | 91.60 |
| SQUASH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.29 | 0.00 |
| STORAGE AREA/BOX | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 | 0.22 | 0.00 | 0.88 | 0.00 | 0.67 |
| STRUCTURAL PEST CONTROL | 0.00 | 0.07 | 1,158.66 | 2,542.88 | 2,703.12 | 4,961.77 | 4,867.80 | 11,340.22 | 8,540.97 | 6,193 | 6,255.01 | 9,016.24 |
| SUDANGRASS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.19 | 3.49 | 1.11 | 54.31 |
| SUGARCANE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.00 | 0.00 | 0.00 |
| SWISS CHARD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.66 | 2.64 | 1.81 |
| TANGELO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 40.41 | 35.43 | 35.64 | 27.45 |
| TANGERINE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 64.69 | 195.01 | 131.87 | 272.39 |
| TOMATO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 51.67 | 30.07 | 2.99 | 16.71 |
| TOMATO, | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 75.90 | 101.58 | 137.97 | 149.74 |

| Site Name | Total Pounds 1999 | Total Pounds 2000 | Total Pounds 2001 | Total Pounds 2002 | Total Pounds 2003 | Total Pounds 2004 | Total Pounds 2005 | Total Pounds 2006 | Total Pounds 2007 | Total Pounds 2008 | Total Pounds 2009 | Total Pounds 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PROCESSING | | | | | | | | | | | | |
| TURF/SOD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.26 | 0.00 |
| TURKEY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.94 | 0.00 | 0.00 |
| TURNIP | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.51 | 2.75 | 2.63 |
| UNCULTIVATED AG | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.56 | 0.00 | 0.00 |
| UNCULTIVATED NON-AG | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 | 0.00 |
| UNKNOWN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 1.87 | 1.23 |
| VERTEBRATE CONTROL | 0.00 | 0.00 | 0.35 | 1.08 | 0.00 | 2.43 | 0.44 | 1.14 | 35.42 | 2.39 | 8.11 | 0.98 |
| WALNUT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.61 | 0.00 | 1.51 | 33.34 | 21.20 |
| WHEAT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.53 | 4.24 | 0.02 |
| WHEAT (FORAGE - FODDER) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.55 | 0.00 | 0.00 | 0.00 |

1- Based on data supplied by BEAD (USEPA, 2013).
2- Any use site reported by the CA PUR Data that is not a currently registered use is assumed to be a misreport or misuse and is not assessed here.

### 2.5. Assessed Species

**Table 2-14** provides a summary of the current distribution, habitat requirements, and life history parameters for the listed species being assessed. Maps of the species' ranges and designated critical habitats (if applicable) are provided in **APPENDIX E**. More detailed life-history and distribution information can be found in Attachment III.

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 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 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 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. 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 and CTS-SC were downlisted from endangered to threatened in 2004 by the USFWS, however, the downlisting 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. CTS 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 estivation. The TG was listed as endangered in 1994 by the USFWS. The range of the TG is limited to coastal brackish water habitats along the coast of California. The DS was listed as threatened on March 5, 1993 (58 FR 12854) by the USFWS (USFWS, 2007a). 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 CFS was listed as endangered in 1988 by the USFWS. The CFS 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.

**Table 2-14. 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 | <u>Oviparous Reproduction</u>[2] <u>Breeding</u>: Spring (Mar. and Apr.) and Fall (Sept. to Nov.) <u>Ovulation and Pregnancy</u>: Late spring and early summer <u>Young</u>: Born 3-4 months after mating | <u>Juveniles</u>: frogs (Pacific tree frog, CRLF, and bullfrogs depending on size) and insects <u>Adults</u>: 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 | <u>Breeding</u>: Feb. - August <u>Nesting:</u> mid-March-Aug. <u>Lay Eggs:</u> March - July <u>Incubation</u>: 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 |
| Bay Checkerspot Butterfly (BCB) (<u>*Euphydryas editha bayensis*</u>) | Adult butterfly - 5 cm in length | Santa Clara and San Mateo Counties [Because the BCB distribution is considered a metapopulation, 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 | 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 | 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 | Obligate with dwarf plantain. Primary diet is dwarf plantain plants (may also feed on purple owl's-clover or exserted paintbrush if the dwarf plantains senesce before the larvae pupate). Adults feed on the nectar of a |

| Assessed Species | Size | Current Range | Habitat Type | Designated Critical Habitat? | Reproductive Cycle | Diet |
|---|---|---|---|---|---|---|
| | | 1998, p. II-177)]. | where larval food plants occur | | 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 | 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 California's Central Valley | Yes | The larval stage may last 2 years living within the stems of an elderberry plant. Then larvae enter the pupal stage and transform into adults. Adults emerge and are active from March to June feeding and mating, when the elderberry produces flowers. | 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 1-2 years eating the interior wood which is their sole food source. |
| 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.<br><br>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 Joaquin Valley (portions of Madera, central | 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<br>Eggs: laid in pond Dec. – Feb., hatch: after 10 to 14 days<br>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;<br>Terrestrial Phase: terrestrial invertebrates, insects, small vertebrates, and worms |

| Assessed Species | Size | Current Range | Habitat Type | Designated Critical Habitat? | Reproductive Cycle | Diet |
|---|---|---|---|---|---|---|
| | | 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).<br><br>CTS-SB are found in Santa Barbara County. | | | | |
| Tidewater Goby (TG) (*Eucyclogobius newberryi*) | 50 mm in length | Along the coast in California (from 3 miles south of the CA/OR border to 44 miles north of the US/Mexico border –there are gaps in the geographic distribution where lagoons and/or estuaries are absent) | Coastal brackish water habitats, primarily coastal lagoons, estuaries, river mouths, and marshes. They are typically found in water less than 1 m deep with salinities of less than 12 parts per thousand. | Yes | They are typically an annual species. Spawning has been observed in every month of the year except Dec. Females may lay more than 1 clutch in a year. Eggs take from 9 to 11 days to hatch. | They are generalists that eat a wide variety of invertebrates [small benthic invertebrates, crustaceans, snails, mysids, and aquatic insect larvae). Juveniles probably feed on unicellular phytoplankton or zooplankton. |
| Delta Smelt (DS) (*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 18ppt). 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 planktonic copepods, cladocerans, amphipods, and insect larvae. Larvae feed on phytoplankton; juveniles feed on zooplankton. |
| California | Up to 50 | Marin, Napa, and Sonoma | Freshwater, perennial | No | Breed once a year, | Feed on detritus (algae, |

| Assessed Species | Size | Current Range | Habitat Type | Designated Critical Habitat? | Reproductive Cycle | Diet |
|---|---|---|---|---|---|---|
| Freshwater Shrimp (CFWS) (*Syncaris pacifica*) | mm postorbital length (from the eye orbit to tip of tail) | Counties, CA | streams; they prefer quiet portions of tree-lined streams with underwater vegetation and exposed tree roots | | typically in Sept. Eggs adhere to the pleopods and are cared for for 8 – 9 months; embryos emerge during May or early June. | 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).

### 2.6. Designated Critical Habitat

Critical habitat has been designated for the BCB, VELB, CTS-CC, CTS-SB, DS, and TG. 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)).

For those species with designated critical habitats, Primary Constituent Elements (PCE) have been identified by the FWS. 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 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 PCEs for TGs are persistent, shallow aquatic habitats with salinity from 0.5 parts per thousand (ppt) to 12 ppt, that contain substrates suitable for the construction of burrows and submerged aquatic plants that provide protection. An additional PCE is the presence of sandbars that at least partially closes a lagoon or estuary during the late spring, summer, and fall. 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. And the PCEs for the VELBs include areas that contain its host plant (*i.e.,* elderberry trees).

**Table 2-15** describes the PCEs for the critical habitats designated for the VELB, CTS-CC, CTS-SB, DS, and TG.

**Table 2-15. Designated Critical Habitat PCEs for the VELB, CTS-CC, CTS-SB, DS, and TG.**

| 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 overstory 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 exserted 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 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. | |

| Species | PCEs | Reference |
|---|---|---|
| Delta Smelt | Spawning Habitat—shallow, fresh or slightly brackish backwater sloughs and edgewaters 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 cyfluthrin and/or *beta*-cyfluthrin that may alter the PCEs of the designated critical habitat for VELB, CTS-CC, CTS-SB, DS, and TG 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. Because cyfluthrin and *beta*-cyfluthrin is expected to directly impact living organisms within the action area, critical habitat analyses for cyfluthrin and *beta*-cyfluthrin are 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 are 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 cyfluthrin and *beta*-cyfluthrin 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, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG 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, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG and/or their 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 cyfluthrin and *beta*-cyfluthrin. An analysis of labeled uses and review of available product labels was completed. All special local needs (SLN) uses not specified for use in California and uses restricted to specific non-CA states and are excluded from this assessment. For those uses relevant to the assessed species, the analysis indicates that, for cyfluthrin and/or *beta*-cyfluthrin, the following agricultural uses are considered as part of the federal action evaluated in this assessment:

- Alfalfa, barley, beans (dried), brassica (head and stem vegetables), buckwheat, carrot, citrus, corn (field, pop, sweet, and unspecified), cotton, cucurbit vegetables, deciduous fruit trees, fruiting vegetables, grapes, grasses grown for seed, grass (forage, fodder, and hay), hops, leafy greens, leafy vegetables, oats, pastures, peanuts, peas (dried), peppers, pome fruits, potato (white Irish), proso millet, radish, rangeland, rye, root and tuber vegetables, sorghum, stone fruits, sugarcane, sunflower, sweet potato, teosinte, tomato, tree nuts, and wheat

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

- Agricultural/farm structures (buildings and equipment), airports (including landing fields), animal feedlots, animal housing premises (outdoor), animal kennels/sleeping quarters (commercial), barns and barnyards, cattle (beef, range, and feeder), calves, cattle feedlots, commercial/industrial lawns, commercial/industrial/institutional premises and equipment (outdoor), commercial storages/warehouse premises, fencerows/hedgerows, food processing plant premises, food stores/markets/supermarkets premises, forest trees, golf course turf, greenhouse (empty and in use), household/domestic dwelling outdoor premises, mulch, nonagricultural outdoor buildings/structures, nonagricultural rights-of-way, nursery stock, ornamentals (*e.g.*, shade trees, ground cover, herbaceous plants, lawns and turf, nonflowering plants, woody shrubs and vines), paths/patios, paved areas (private roads/sidewalks), pet living/sleeping quarters, recreational areas (including lawns), refuse/solid waste containers, refuse/solid waste sites, residential lawns, rose, swamps/marshes/wetlands/stagnant water, utility poles/rights-of-way, wood protection treatment to buildings/products (outdoor and/or seasoned).

Following a determination of the assessed uses, an evaluation of the potential "footprint" of cyfluthrin and *beta*-cyfluthrin 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. For both cyfluthrin and *beta*-cyfluthrin, these include all of the major land cover types. Therefore, potential use footprint maps were not created for cyfluthrin or *beta*-cyfluthrin, since the potential use sites include most of the state of California.

An evaluation of usage information was conducted to determine the area where use of cyfluthrin or *beta*-cyfluthrin may impact 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. A more detailed review of the county-level use information was also completed. These data suggest that both cyfluthrin and *beta*-cyfluthrin have historically been used on a wide variety of agricultural and non-agricultural use sites throughout the state of California.

### 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 2-16** identifies the taxa used to assess the potential for direct and indirect effects from the uses of cyfluthrin and *beta*-cyfluthrin 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 2-17**.

**Table 2-16. 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<br><br>Indirect (prey) | Indirect (prey/ habitat) | Indirect (habitat) | Indirect (prey) | Indirect (prey) | Indirect (prey) | n/a | n/a | Indirect (habitat) |
| California clapper rail** | Direct<br><br>Indirect (prey) | Indirect (prey) | Indirect (food/ habitat) | Indirect (prey) | Indirect (prey) | Indirect (prey) | Indirect (prey) | Indirect (prey) | Indirect (food/ habitat) |
| 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<br><br>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<br><br>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 cyfluthrin and/or Beta-cyfluthrin in aquatic organisms may result in direct effects to the San Francisco Garter Snake and the 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 2-17. Taxa and Assessment Endpoints Used to Evaluate the Potential for Use of Cyfluthrin and *Beta*-Cyfluthrin 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 –<br>-Tidewater Goby*<br>-Delta Smelt*<br>-California Tiger Salamander | Survival, growth, and reproduction of individuals via direct effects | 1a. Most sensitive fish acute $LC_{50}$ (guideline or ECOTOX)<br>1b. Most sensitive fish chronic NOAEC (guideline or ECOTOX)<br>1c. Most sensitive fish early-life stage NOAEC (guideline or ECOTOX) |
| | Indirect Effect (prey)<br>-SF Garter Snake<br>-CA Clapper Rail | Survival, growth, and reproduction of individuals or modification of critical habitat/habitat via indirect effects on aquatic prey food supply (*i.e.,* fish and aquatic-phase amphibians) | |
| 2. Freshwater Invertebrates | Direct Effect –<br>-CA FW Shrimp | Survival, growth, and reproduction of individuals via direct effects | 2a. Most sensitive freshwater invertebrate $EC_{50}$ (guideline or ECOTOX)<br>2b. Most sensitive freshwater invertebrate chronic NOAEC (guideline or ECOTOX) |
| | Indirect Effect (prey)<br>-CA FW shrimp<br>-SF Garter Snake<br>-CA Clapper Rail<br>- CA Tiger Salamander<br>-Tidewater Goby<br>-Delta Smelt | 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 –<br>-Tidewater Goby*<br>- Delta Smelt* | Survival, growth, and reproduction of individuals via direct effects | 3a. Most sensitive estuarine/marine fish $EC_{50}$ (guideline or ECOTOX)<br>3b. Most sensitive estuarine/marine fish chronic NOAEC (guideline or ECOTOX) |
| | Indirect Effect (prey)<br>-Clapper Rail | Survival, growth, and reproduction of individuals or modification of critical habitat/habitat via indirect effects on aquatic prey food supply (*i.e.,* estuarine/marine fish) | |
| 4. Estuarine/Marine Invertebrates | Indirect Effect (prey)<br>-CA Clapper Rail<br>-Tidewater Goby<br>-Delta Smelt | Survival, growth, and reproduction of individuals or modification of critical habitat/habitat via indirect effects on aquatic prey food supply (*i.e.,* estuarine/marine invertebrates) | 4a. Most sensitive estuarine/marine invertebrate $EC_{50}$ (guideline or ECOTOX)<br>4b. Most sensitive estuarine/marine invertebrate chronic NOAEC (guideline or ECOTOX) |

| 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 |
|---|---|---|---|
| 5. Aquatic Plants (freshwater/marine) | Indirect Effect (food/habitat)<br>-SF Garter Snake<br>-CA Clapper Rail<br>-CA Tiger Salamander<br>-Tidewater Goby<br>-Delta Smelt<br>-CA FW Shrimp | 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) | 5a. Vascular plant acute $EC_{50}$ (duckweed guideline test or ECOTOX vascular plant)<br>5b. Non-vascular plant acute $EC_{50}$ (freshwater algae or diatom, or ECOTOX non-vascular) |
| 6. Birds | Direct Effect<br>-SF Garter Snake<br>-CA Clapper Rail<br>-CA Tiger Salamander | Survival, growth, and reproduction of individuals via direct effects | 6a. Most sensitive bird[a] or terrestrial-phase amphibian acute $LC_{50}$ or $LD_{50}$ (guideline or ECOTOX)<br>6b. Most sensitive bird[a] or terrestrial-phase amphibian chronic NOAEC (guideline or ECOTOX) |
| | Indirect Effect (prey/rearing sites)<br>-SF Garter Snake<br>-CA Clapper Rail | Survival, growth, and reproduction of individuals or modification of critical habitat/habitat via indirect effects on terrestrial prey (birds) | |
| 7. Mammals | Direct Effect<br>None | Survival, growth, and reproduction of individuals via direct effects | 7a. Most sensitive laboratory mammalian acute $LC_{50}$ or $LD_{50}$ (guideline or ECOTOX)<br>7b. Most sensitive laboratory mammalian chronic NOAEC (guideline or ECOTOX) |
| | Indirect Effect (prey/habitat from burrows/rearing sites)<br>-SF Garter Snake<br>-CA Clapper Rail<br>-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<br>-Bay Checkerspot Butterfly<br>-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)<br>8b. Most sensitive terrestrial invertebrate chronic NOAEC (guideline or ECOTOX) |
| | Indirect Effect (prey)<br>-SF Garter Snake<br>-CA Clapper Rail<br>-CA Tiger Salamander | Survival, growth, and reproduction of individuals or modification of critical habitat/habitat via indirect effects on terrestrial prey (terrestrial invertebrates) | |
| 9. Terrestrial Plants | Indirect Effect (food/habitat) (non-obligate relationship)<br>-SF Garter Snake<br>-CA Clapper Rail<br>-SF Garter Snake<br>-CA Tiger Salamander | Survival, growth, and reproduction of individuals or modification of critical habitat/habitat via indirect effects on food and habitat (*i.e.*, riparian and upland vegetation) | 9a. Distribution of $EC_{25}$ for monocots (seedling emergence, vegetative vigor, or ECOTOX<br>9b. Distribution of $EC_{25}$ ($EC_{05}$ or NOAEC for the BCB and the VELB) for dicots (seedling emergence, vegetative vigor, or ECOTOX) |

| 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 |
|---|---|---|---|
| | -Tidewater Goby<br>-Delta Smelt | | |
| | <u>Indirect Effect (food/habitat) (obligate relationship)</u><br>-Bay Checkerspot Butterfly<br>-Valley Elderberry Longhorn Beetle | | |

Abbreviations: SF=San Francisco

*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.

** Birds are used as a surrogate for terrestrial-phase amphibians and reptiles.

### 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 cyfluthrin and *beta*-cyfluthrin 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 cyfluthrin and/or *beta*-cyfluthrin 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 cyfluthrin and/or *beta*-cyfluthrin to the environment. The following risk hypotheses are presumed in this assessment:

The labeled use of cyfluthrin and/or *beta*-cyfluthrin within the action area may:

- directly affect BCB, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG by causing mortality or by adversely affecting growth or fecundity;
- indirectly affect BCB, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG and/or modify their designated critical habitat by reducing or changing the composition of food supply;
- indirectly affect CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, 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, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG 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 CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, 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 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 cyfluthrin and *beta*-cyfluthrin release mechanisms, biological receptor types, and effects endpoints of potential concern. The conceptual models for assessing risks to the listed species considered here and the conceptual models for the aquatic and terrestrial PCE components of critical habitat are shown in Figure 2-2 and Figure 2-3. Although, the conceptual models for cyfluthrin and *beta*-cyfluthrin are combined in the diagrams, separate effects determinations will be made for each chemical. Additionally, 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 potential exposure routes to potential risks to the species considered here and modification to designated critical habitat is expected to be negligible.

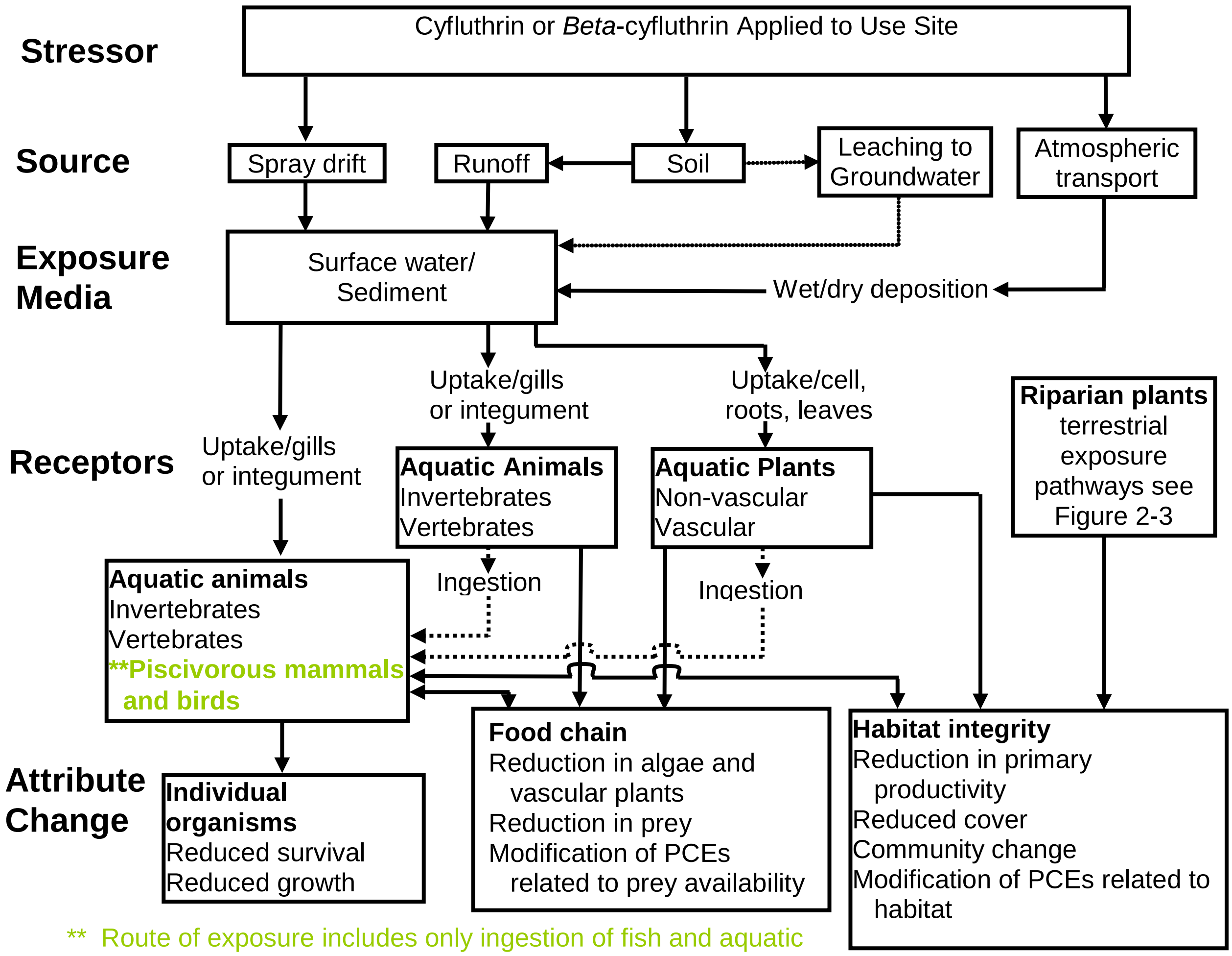



**Figure 2-2. Conceptual Model Depicting Stressors, Exposure Pathways, and Potential Effects to Aquatic Organisms from the Use of Cyfluthrin or *Beta*-Cyfluthrin.**
Dotted lines indicate exposure pathways that have a low likelihood of contributing to ecological risk.

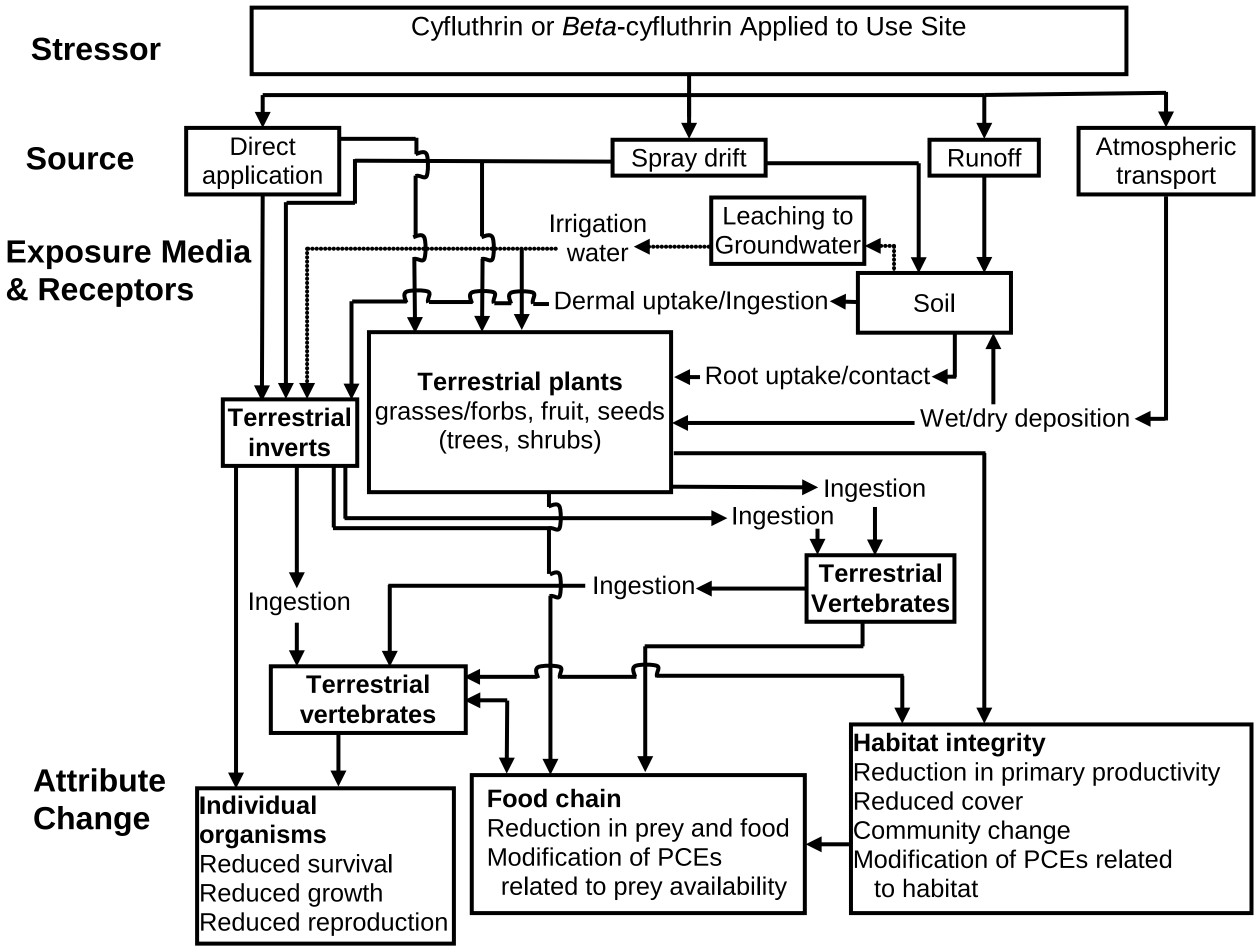



**Figure 2-3. Conceptual Model Depicting Stressors, Exposure Pathways, and Potential Effects to Terrestrial Organisms from the Use of Cyfluthrin or *Beta*-Cyfluthrin.**
Dotted lines indicate exposure pathways that have a low likelihood of contributing to ecological risk.

### 2.10. Analysis Plan

In order to address the risk hypotheses, 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 cyfluthrin and *beta*-cyfluthrin 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 cyfluthrin and *beta*-cyfluthrin is estimated using the probit dose-response slope and either the level of concern (discussed below) or actual calculated risk quotient value.

Cyfluthrin and *beta*-cyfluthrin are mixtures of eight isomers [four of the isomers are considered active: diastereoisomer II (1*R*,3*R*,1*S* + 1*S*,3*S*,1*R* = 1:1; *cis*) and diastereoisomer IV (1*R*,3*S*,1*S* + 1*S*,3*R*,1*R* = 1:1; trans)]. Cyfluthrin is ~19% (range of 17 – 21%) diastereoisomer II and ~22% (range from 21 – 25%) diastereoisomer IV, for a total of ~41% active isomers. *Beta*-cyfluthrin is ~35% (range of 30 – 40%) diastereoisomer II and ~62% (range from 57 – 67%) diastereoisomer IV, for a total of ~97% active isomers. Therefore, cyfluthrin is 42% active isomers when compared to *beta*-cyfluthrin (41/97 = 42). Therefore, the assumption is that the toxicity endpoints for *beta*-cyfluthrin should be 42% of the cyfluthrin endpoints (*e.g.*, if the cyfluthrin endpoint is 1 mg a.i./L, than the estimated *beta*-cyfluthrin endpoint would be 0.42 mg a.i./L).

The uses for cyfluthrin and *beta*-cyfluthrin overlap significantly and for the same uses, the application rates for cyfluthrin tend to be about twice the application rates of *beta*-cyfluthrin. Additionally, based on empirical versus predicted toxicity endpoints, the risk assessment was conducted by converting concentrations to a '*beta*-cyfluthrin' equivalent for aquatic organisms and terrestrial invertebrates. For aquatic organisms and terrestrial invertebrates, all of ecotoxicity endpoints are based on *beta*-cyfluthrin endpoints, if available, or cyfluthrin endpoints converted to '*beta*-cyfluthrin equivalent' endpoints. For terrestrial vertebrates and terrestrial plants, cyfluthrin and *beta*-cyfluthrin are assessed separately (see **APPENDIX F**).

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 cyfluthrin and *beta*-cyfluthrin along with available monitoring data indicate that water and sediment runoff and spray drift are the principle potential transport mechanisms to the aquatic and terrestrial habitats. Potential transport mechanisms include erosion of soil-bound residue, spray drift, and secondary drift of volatilized or soil-bound residues leading to deposition onto nearby or more distant ecosystems. Erosion of soil and spray drift are expected to be the major routes of exposure for the cyfluthrins. Despite the fact that cyfluthrin and *beta*-cyfluthrin show a moderate Henry's Law Constant, that would suggest some potential for volatilization, and it is moderately persistent in various environmental media, the hydroxyl radical reaction half-life for the chemical is 0.86 days (EPI Suite v.4.0 estimate). The short (atmospheric) half-life suggests that the potential for atmospheric transport for cyfluthrin and *beta*-cyfluthrin is relatively low and that this source of the chemical is of low importance, compared to spray drift, runoff and/ or direct contact after application

Measures of exposure are based on aquatic and terrestrial models that predict estimated environmental concentrations (EECs) of *beta*-cyfluthrin using maximum labeled application rates for aerial applications. The aquatic exposure assessment is only based on *beta*-cyfluthrin because the application rates of cyfluthrin are similar to *beta*-cyfluthrin when the application rates of cyfluthrin are normalized to lbs *beta*-cyfluthrin/A. Additionally, the aquatic toxicity data for cyfluthrin and *beta*-cyfluthrin are similar when the toxicity endpoints of cyfluthrin are normalized for the concentration of *beta*-cyfluthrin.

The models used to predict aquatic EECs are the Pesticide Root Zone Model (Version 3.12.2, May 12, 2005) coupled with the Exposure Analysis Model System (Version 2.98.04.06, April 25,2005) (PRZM/EXAMS). The AgDrift model (Version 2.01) was used to predict the spray drift fraction for a 150 feet drift buffer. Because the water solubility of *beta*-cyfluthrin is low (2.3 µg/L), any EEC greater than the water solubility is capped at the solubility limit for assessing risk. This approach was adopted to acknowledge that the water solubility is an upper bound condition for EECs.

The models used to predict terrestrial EECs on food items are the Terrestrial Residue Exposure (T-REX) and T-HERPS models. 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. Screening Tool for Inhalation Risk (STIR) is used to identify chemicals in which an inhalation exposure route may be of concern. 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 cyfluthrin and *beta*-cyfluthrin, 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 in order 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 G**). More information on standard assessment procedures is available in Attachment I.

### 2.10.4. Data Gaps

This risk assessment relies on bridging the cyfluthrin environmental fate data to *beta*-cyfluthrin. This bridging strategy assumes that cyfluthrin and *beta*-cyfluthrin have similar environmental fate properties. Because cyfluthrin and *beta*-cyfluthrin have a high sorption affinity to sediment and soil, the accumulation of residues in sediment is expected. Therefore, an understanding of the environmental fate of cyfluthrin and *beta*-cyfluthrin in sediment is important. To address this data deficiency in the exposure assessment, it is assumed that cyfluthrin and *beta*-cyfluthrin are stable to metabolism in sediment.

There are several data gaps noted for cyfluthrin and *beta*-cyfluthrin in the recent Problem Formulation conducted for Registration Review (USEPA 2010). However, for the purposes of this assessment, the primary data gaps are related to plant toxicity data. There are currently no toxicity data available for vascular aquatic plant species and cyfluthrin or *beta*-cyfluthrin. For non-vascular aquatic plants, there are only toxicity data currently available for cyfluthrin. For terrestrial plants, there are currently no data available for cyfluthrin or *beta*-cyfluthrin. Plant data (both terrestrial and aquatic) for cyfluthrin and *beta*-cyfluthrin were requested for the Registration Review of these chemicals, but they are not available for this assessment.

## 3. Exposure Assessment

Cyfluthrin and *beta*-cyfluthrin are formulated as flowable and granular products. Application equipment includes ground and aerial equipment (including ultra-low volume applications). Risks from ground boom and aerial applications are considered in this assessment because they are expected to result in the highest off-target levels of cyfluthrin and *beta*-cyfluthrin due to generally higher spray drift levels. Ground boom 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. Risks associated with granular applications will also be discussed.

### 3.1. Label Application Rates and Intervals

Cyfluthrin and *beta*-cyfluthrin labels may be categorized into two types: labels for manufacturing uses and end-use products. While technical products, which contain cyfluthrin and *beta*-cyfluthrin 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 insects. The formulated product labels legally limit cyfluthrin's and *beta*-cyfluthrin's potential use to only those sites that are specified on the labels.

Cyfluthrin and *beta*-cyfluthrin are registered for a variety of agricultural and non-agricultural uses. Currently registered agricultural and non-agricultural uses of cyfluthrin and *beta*-cyfluthrin are listed in use section, above.

The application rates and application intervals for cyfluthrin and *beta*-cyfluthrin labels are summarized in the use section above. The maximum application rate, maximum number of application per season, and minimum application interval of *beta*-cyfluthrin was used in the aquatic exposure modeling (**Table 3-1**). For the terrestrial exposure modeling, the maximum application rate was modeled separately for cyfluthrin and *beta*-cyfluthrin. Appropriate PRZM scenarios were used to represent various crops and crop groups. Many of the uses such as the non-agriculture use patterns had no specified maximum number of applications per season or minimum retreatment intervals. The maximum number of applications was estimated by dividing total maximum seasonal application rate by the maximum single application rate. For modeling other uses with no specified maximum number of application, minimum retreatment interval, or maximum seasonal rate, the maximum number of applications (10) and the minimum retreatment interval (2) on the *beta*-cyfluthrin label was used in the modeling (these parameters were also used to model the cyfluthrin uses with non-specified label information for the terrestrial exposure modeling). The modeling was conducted for a single crop season per year. Although this assumption may not be appropriate for all crops in California (*e.g.*, alfalfa, brassica, sweet corn, grasses grown for seed, grasses grown for forage, leafy greens, leafy vegetables, radish, and sorghum), a LOC exceedance for a single season was considered as adequate to conclude an LAA for the effects determination.

**Table 3-1. *Beta*-Cyfluthrin Uses, Scenarios, and Application Information (for Aquatic Modeling).**

| PRZM Scenario | Crop/Use Area | Max Single App Rate (lbs/A) | Max Number of Application per Season | Minimum Retreatment Interval |
|---|---|---|---|---|
| CA row crop RLF | Bean Dried | 0.022 | 2 | 14 |
| CA row crop RLF | Peas | 0.022 | 2 | 14 |
| CA row crop RLF | Peanuts | 0.024 | 3 | 10 |
| CA row crop RLF | Carrot | 0.024 | 5 | 7 |
| CA cole crop STD | Brassica(Head and Stem) | 0.027 | 4 | 7 |
| CA cole crop STD | Leafy Greens | 0.027 | 4 | 7 |
| CA Corn OP | Corn Field | 0.024 | 4 | 7 |
| CA Corn OP | Corn Pop | 0.024 | 4 | 7 |
| CA Corn OP | Corn Sweet | 0.024 | 10 | 2 |
| CA Corn OP | Corn Unspecified | 0.024 | 4 | 7 |
| CA wheat | Sorghum | 0.024 | 3 | 10 |
| CA wheat | Wheat | 0.02 | 2 | 3 |
| CA wheat | Triticale | 0.02 | 2 | 3 |
| CA wheat | Oats | 0.02 | 2 | 3 |
| CA wheat | Rye | 0.02 | 2 | 3 |
| CA citrus STD | Citrus | 0.054 | 1 | Not Applicable |
| CA melon RLF | Cucurbit Vegetables | 0.024 | 4 | 7 |
| CA Tomato STD | Fruiting Vegetables | 0.033 | 4 | 7 |
| CA Tomato STD | Fruiting Vegetables | 0.024 | 6 | 7 |
| CA Tomato STD | Tomatos | 0.131 | 10 | 3 |
| CA lettuce STD | Leafy Vegetable (Non-Brassica) | 0.027 | 4 | 7 |
| CA alfalfa OP | Alfalfa | 0.024 | 8 | 5 |
| CA fruit STD | Pome Fruit | 0.024 | 1 | Not Applicable |
| CA potato RLF | Potato, White/Irish | 0.024 | 6 | 5 |
| CA almond STD | Tree Nuts | 0.024 | 4 | 14 |
| CA fruit STD | Stone Fruits | 0.024 | 2 | 14 |
| CA cotton STD | Cotton | 0.027 | 10 | 3 |
| CA rangeland and hay RLF | Grass for forage/hay | 0.024 | 4 | 5 |
| CA turf RLF | Grass for seed | 0.024 | 4 | 5 |
| CA wine grapes RLF | Grapes | 0.027 | 4 | 14 |
| CA wine grapes RLF | Grapes | 0.051 | 1 | Not Applicable |
| OR Hops STD | Hops | 0.025 | 5 | 21 |

| | | | | |
|---|---|---|---|---|
| OR Hops STD | Hops | 0.027 | 5 | 14 |
| CA nursey | Oranmental Plants | 0.042 lbs/100 gal | 10 | 3 |
| CA nursey | Oranmental Plants | 0.065lbs/A | 10 | 3 |
| CA impervious surfaces | Household Premises | 0.131 | 10 | 3 |
| CA impervious surfaces | Nonagricultural Structures | 0.174 | 10 | 3 |
| CA impervious surfaces | Airport and Landing Fields | 0.182 | 10 | 10 |
| CA impervious surfaces | Commerical Premises | 0.191 | 10 | 10 |
| CA impervious surfaces | Nonagricultural Structures | 0.192 | 10 | 7 |
| CA impervious surfaces | Paved Areas | 0.192 | 10 | 7 |
| CA residential RLF | Residential Lawns | 0.096 | 10 | 7 |
| CA residential RLF | Ornamental Lawns and Turf | 0.096 | 10 | 7 |
| CA residential RLF | Recreational Area Lawns | 0.096 | 10 | 7 |
| CA turf RFL | Golf Course | 0.0956 | 10 | 7 |
| CAonionSTD | Radish | 0.024 | 5 | 7 |

1 Uses assessed based on memorandum from Pesticide Re-evaluation Division (PRD) dated [insert date of verification memo] and EFED Label Data report and associated Label Use Information Reports prepared on XXX.

## 3.2. Aquatic Exposure Assessment

### 3.2.1. Modeling Approach

The EECs 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 *beta*-cyfluthrin because the diastereomers II and IV in both *beta*-cyfluthrin and cyfluthrin are the active isomers.

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. Use-specific management practices for all of the assessed uses of *beta*-cyfluthrin were used for modeling, including application rates, number of applications per year, application intervals, buffer widths and resulting spray drift values modeled from AgDRIFT (see **Table 3-2**).

The first date of application in the PRZM/EXAMS simulation was determined using the following equation:

***First Application Date= Harvest Date-PHI- (Minimum Interval*Maximum Number of Applications)***

**Table 3-2. Summary of Applications of *Beta*-Cyfluthrin Used in PRZM/EXAMS Modeling.**

| PRZM SCENARIO | Harvest Data | Crop/Use Area | Max Apps Season | Max Seasonal Rate | Mini Retreatment Interval | PHI | First App Date |
|---|---|---|---|---|---|---|---|
| CA row crop RLF | 4/8 | Bean Dried | 2.3 | 0.051 | 14 | 7 | 3/18 |
| CA row crop RLF | 4/8 | Peas | 2.3 | 0.051 | 14 | 3 | 3/22 |
| CA row crop RLF | 4/8 | Peanuts | 3 | 0.071 | 10 | 14 | 3/15 |
| CA row crop RLF | 4/8 | Carrot | 5 | 0.118 | 7 | 0 | 3/25 |
| CA cole crop STD, | 3/1 | Brassica(Head and Stem) | 4 | 0.108 | 7 | 0 | 2/15 |
| CA cole crop STD, | 3/1 | Leafy Greens | 4.3 | 0.102 | 7 | 0 | 2/15 |
| CA Corn OP | 9/8 | Corn Field | 4 | 0.095 | 7 | 21 | 8/11 |
| CA Corn OP | 9/8 | Corn Pop | 4 | 0.095 | 7 | 21 | 8/11 |
| CA Corn OP | 9/8 | Corn Sweet | 10 | 0.236 | 2 | 0 | 9/4 |
| CA Corn OP | 9/8 | Corn Unspecified | 4 | 0.095 | 7 | 21 | 8/11 |
| CA wheat | 6/15 | Sorghum | 3 | 0.071 | 10 | 14 | 5/22 |
| CA wheat | 6/15 | Wheat | 2 | 0.041 | 3 | 0 | 6/12 |
| CA wheat | 6/15 | Triticale | 2 | 0.041 | 3 | 0 | 6/12 |
| CA wheat | 6/15 | Oats | 2 | 0.041 | 3 | 0 | 6/12 |
| CA wheat | 6/15 | Rye | 2 | 0.041 | 3 | 0 | 6/12 |
| CA citrus STD | 12/31 | Citrus | 1 | 0.054 | NA | 0 | 6/12 |
| CA melon RLF | 8/12 | Cucurbit Vegetables | 4 | 0.095 | 7 | 0 | 7/29 |
| CA Tomato STD | 9/1 | Fruiting Vegetables | 4 | 0.122 | 7 | 7 | 8/18 |
| CA Tomato STD | 9/1 | Fruiting Vegetables | 6 | 0.142 | 7 | 7 | 8/18 |
| CA Tomato STD | 9/1 | Tomatos | NS | NS | NS | 0 | 8/30 |
| CA lettuce STD | 5/12 | Leafy Vegetable (Non-Brassica) | 4 | 0.108 | 7 | 0 | 4/28 |
| CA alfalfa OP | 12/31 | Alfalfa | 8 | 0.189 | 5 | 7 | 12/19 |
| CA fruit STD | 1/16 | Pome Fruit | 1 | 0.024 | NA | 7 | 6/12 |
| CA potato RLF | 6/15 | Potato, White/Irish | 6 | 0.142 | 5 | 0 | 6/5 |
| CA almond STD | 9/13 | Tree Nuts | 3.7 | 0.024 | 14 | 14 | 8/16 |
| CA fruit STD | 8/1 | Stone Fruits | 2 | 0.047 | 14 | 7 | 7/11 |
| CA cotton STD | 11/11 | Cotton | 10 | 0.27 | 3 | 0 | 11/5 |
| CA rangeland and hay RLF | 5/1 | Grass for forage/hay | 4 | 0.095 | 5 | 7 | 4/19 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CA turf RLF | 12/31 | Grass for seed | 4 | 0.095 | 5 | 7 | 12/19 |
| CA wine grapes RLF | 8/1 | Grapes | 4 | 0.108 | 14 | 3 | 7/15 |
| CA wine grapes RLF | 8/1 | Grapes | 1 | 0.051 | NA | 3 | 6/12 |
| OR Hops STD | 9/1 | Hops | 5 | 0.135 | 21 | 7 | 8/4 |
| OR Hops STD | 9/1 | Hops | 5 | 0.135 | 14 | 7 | 8/11 |
| CA nursey | 11/1 | Oranmental Plants | NS | NS | NS | 0 | 10/30 |
| CA nursey | 11/1 | Oranmental Plants | NS | NS | NS | 0 | 10/30 |
| CA impervious surfaces | 12/31 | Nonagricultural Structures | NS | NS | NS | 0 | 12/29 |
| CA impervious surfaces | 12/31 | Airport-Landing Fields/ Commerical Premises | NS | NS | 10 | 0 | 9/12 |
| CA impervious surfaces | 12/31 | Nonagricultural Structures/Paved Areas | NS | NS | 7 | 0 | 10/15 |
| CA residential RLF | 12/31 | Residential Lawns | NS | NS | 7 | 0 | 10/15 |
| CA residential RLF | 12/31 | Ornamental Lawns and Turf/Residential Lawns/Recreatio nal Area Lawns | NS | NS | 7 | 0 | 10/15 |
| CA turf RFL | 12/31 | Golf Course | NS | NS | 7 | 0 | 10/15 |
| CAonion STD | 6/15 | Radish | 5 | 0.118 | 7 | 0 | 6/1 |

### 3.2.2. Model Inputs

The appropriate PRZM and EXAMS input parameters for *beta*-cyfluthrin 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. PRZM EXAMS Model Shell, Version (5)*, November 15, 2006. Physical and chemical properties relevant to assess the behavior of *beta*-cyfluthrin in the environment are presented in Section 2.

The input parameters for PRZM and EXAMS are in **Table 3-3**. **APPENDIX H** contains example model output files and tables showing the data used to calculate input values.

**Table 3-3. Summary of PRZM/EXAMS Environmental Fate Data Used for Aquatic Exposure Inputs for *Beta*-Cyfluthrin[1].**

| Fate Property | Value (unit) | MRID (or source) |
|---|---|---|
| Molecular Weight | 434.29 | Tox Net/HSDB |
| Henry's constant | 3.7E-6 atm-$m^3$/mol | Laskowski 2002, |
| Vapor Pressure | 1.5E-8 mm Hg | Laskowski 2002<br>FAO/WHO Specifications<br>USEPA, 2008 |
| Solubility in Water | 0.00232 mg/L | Laskowski 2002,<br>FAO/WHO Specifications<br>FAO, 2000 |
| Photolysis in Water | 4.5 days | MRID 00149595,45022102 |
| Aerobic Soil Metabolism Half-lives | 116.93 days[2] | MRID 00131494 |
| Hydrolysis Half-lives | Stable[3] | MRID 00131495,00137544, 45022103 |
| Aerobic Aquatic Metabolism Half-life (water column) | 51.45 | MRID 46824101 |
| Anaerobic Aquatic Metabolism Half-life (benthic) | Stable[4] | No Data |
| Organic-carbon water partition coefficient ($K_{OC}$, L/kg OC) or Solid-water distribution coefficient (Kd, L/kg soil) | Koc=107412 L/kg OC | MRID 00131495; 00137544; 45022103 |
| Application rate and frequency | See Table 3-1 | |
| Application intervals | See Table 3-2 | |
| Chemical Application Method (CAM) | 2 | |
| Application Efficiency | 0.095 | |
| Spray Drift Fraction | 0.017 | Accounts for 150ft drift buffer for aeria1 spray |
| Incorporation Depth | Default (4 cm) | |
| Post-harvest foliar pesticide disposition (IPSCND) | 1 | |

1 – Inputs determined in accordance with EFED "*Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides. Version 2.1*" dated October 22, 2009.
2-The half-life represent the 90% upper confidence bound on the mean half-life.
3-The hydrolysis half-life is representative for acidic and neutral environments.
4-Although the input parameter guidance recommends, in the absence of data, 2x the anaerobic soil metabolism half-life, the anaerobic aquatic metabolism rate is assumed to be stable. This assumption will provide a conservative estimate of beta-cyfluthrin concentration in sediment.

### 3.2.3. Results

The aquatic EECs for the various scenarios and application practices are listed in **Table 3-4**. Examples of PRZM-EXAMS output files are provided in **APPENDIX H**. The modeling indicates that estimated concentrations for *beta*-cyflthurin are below 1 ug/L concentrations except for applications to impervious surfaces such as airports/landing pads and paved surfaces. The highest EECs among registered crop uses are associated with sweet corn. The EEC from *beta*-cyfluthrin use on sweet corn are not expected to exceed 0.405 µg/L for peak, 0.172 µg/L for the 21-day average, and 0.017 µg/L for the 60 day average concentration. The highest EECs among non-agricultural areas are associated with paved areas. The EEC from *beta*-cyfluthrin use on paved areas are not expected to exceed 53.09 µg/L for peak, 13.04 µg/L for the 21-day average, and 12.43 µg/L for the 60 day average concentration. Because there are EECs higher than the water solubility of *beta*-cyfluthrin (2.3 µg/L), any EEC greater than the water solubility will be capped at the solubility limit for assessing risk. This approach was adopted to acknowledge that the water solubility is an upper bound condition for EECs.

**Table 3-4. Aquatic EECs (µg/L) for *Beta*-Cyfluthrin Uses in California.**

| PRZM SCENARIO | Simulation Number | Crop/Use Area | Peak | 21-Day | 60-Day |
|---|---|---|---|---|---|
| CA row crop RLF | 3 | Bean Dried | 0.029 | 0.014 | 0.013 |
| CA row crop RLF | 4 | Peas | 0.031 | 0.014 | 0.013 |
| CA row crop RLF | 6 | Peanuts | 0.043 | 0.022 | 0.021 |
| CA row crop RLF | 8 | Carrot | 0.079 | 0.038 | 0.037 |
| CA cole crop STD, | 11 | Brassica(Head and Stem) | 0.124 | 0.069 | 0.065 |
| CA cole crop STD, | 12 | Leafy Greens | 0.124 | 0.069 | 0.065 |
| CA Corn OP | 17 | Corn Field | 0.161 | 0.068 | 0.062 |
| CA Corn OP | 18 | Corn Pop | 0.161 | 0.068 | 0.062 |
| CA Corn OP | 19 | Corn Sweet | 0.405 | 0.172 | 0.017 |
| CA Corn OP | 20 | Corn Unspecified | 0.155 | 0.066 | 0.064 |
| CA wheat | 27 | Sorghum | 0.117 | 0.092 | 0.088 |
| CA wheat | 28 | Wheat | 0.041 | 0.024 | 0.023 |
| CA wheat | 29 | Triticale | 0.041 | 0.024 | 0.023 |
| CA wheat | 30 | Oats | 0.041 | 0.024 | 0.023 |
| CA wheat | 31 | Rye | 0.041 | 0.024 | 0.023 |
| CA citrus STD | 33 | Citrus | 0.047 | 0.009 | 0.008 |
| CA melon RLF | 35 | Cucurbit Vegetables | 0.032 | 0.017 | 0.015 |
| CA Tomato STD | 38 | Fruiting Vegetables | 0.047 | 0.026 | 0.024 |
| CA Tomato STD | 39 | Fruiting Vegetables | 0.042 | 0.027 | 0.026 |
| CA lettuce STD | 44 | Leafy Vegetable (Non-Brassica) | 0.176 | 0.086 | 0.083 |
| CA alfalfa OP | 46 | Alfalfa | 0.060 | 0.045 | 0.042 |
| CA fruit STD | 48 | Pome Fruit | 0.021 | 0.004 | 0.004 |
| CA potato RLF | 53 | Potato, White/Irish | 0.048 | 0.026 | 0.024 |
| CA almond STD | 55 | Tree Nuts | 0.040 | 0.023 | 0.022 |
| CA fruit STD | 57 | Stone Fruits | 0.025 | 0.009 | 0.007 |
| CA cotton STD | 59 | Cotton | 0.145 | 0.078 | 0.074 |
| CA rangeland and hay RLF | 61 | Grass for forage/hay | 0.038 | 0.023 | 0.021 |
| CA turf RLF | 63 | Grass for seed | 0.034 | 0.020 | 0.017 |

| | | | | | |
|---|---|---|---|---|---|
| CA wine grapes RLF | 65 | Grapes | 0.171 | 0.072 | 0.069 |
| CA wine grapes RLF | 66 | Grapes | 0.065 | 0.028 | 0.026 |
| OR Hops STD | 68 | Hops | 0.216 | 0.133 | 0.130 |
| OR Hops STD | 69 | Hops | 0.262 | 0.160 | 0.155 |
| CA nursey | 75 | Ornmental Plants | 3.091 (2.3)[1] | 0.992 | 0.928 |
| CA impervious surfaces | 86 | Airport and Landing Fields/Comerical Premises | 48.011 (2.3) | 12.023 (2.3) | 11.307 (2.3) |
| CA impervious surfaces | 87 | Nonagricultural Structures/Paved Areas | 53.089 (2.3) | 13.410 (2.3) | 12.434 (2.3) |
| CA residential RLF | 94 | Residential Lawns/ Ornamental Lawns/ Recreation Area Lawns | 0.214 | 0.153 | 0.150 |
| CA turf RFL | 97 | Golf Course | 0.249 | 0.172 | 0.170 |
| CAonionSTD | 98 | Radish | 0.038 | 0.022 | 0.021 |

1- The concentration represents the solubility limit for *beta*-cyfluthrin. This concentration was used to assess aquatic exposure assessment.

### 3.2.4. Existing Monitoring Data

Monitoring data were evaluated to provide information on the occurrence of *beta*-cyfluthrin and cyfluthrin in California surface waters and sediment. Data sources evaluated for monitoring data include the USGS NAWQA Monitoring Data and California Department of Pesticide Regulation Monitoring Program. These monitoring programs only provide occurrence data for cyfluthrin. Because cyfluthrin contains the 4 isomers in *beta*-cyfluthrin, it is assumed the monitoring data for cyfluthrin will be representative of occurrence data for *beta*-cyfluthrin.

#### 3.2.4.a. USGS NAWQA Surface Water Data

There were no detections of cyfluthrin in the NAWQA surface water monitoring data. The limit of quantification (LOQ) for cyfluthrin ranged from 0.008 to 0.053 µg/L (**Table 3-5**).

#### 3.2.4.a. California Department of Pesticide Regulation (CDPR) Data

The occurrence of cyfluthrin in surface water has a detection frequency of 0.45% (7 detection/1541 total samples). The limit of quantification (LOQ) for cyfluthrin ranged from 0.004 to 0.25 µg/L. The detections of cyflurthrin ranged from 0.004 to 0.498 µg/L (**Table 3-5**). The highest concentration of cyflurthrin was detected at a storm drain at Millbrook Avenue (DPR Site ID:MCC020) in Alameda County, CA.

**Table 3-5. Cyfluthrin Detections in Surface Water from the CDPR Monitoring Program.**

| County Name | Site Description | Date | Conc [ug/L] | LOQ |
|---|---|---|---|---|
| Alameda | Storm Drain at Millbrook Avenue - drains to Martin Canyon/Koopman Canyon Crk (DPR Site ID:MCC020) | 4/14/2009 | 0.498 | 0.015 |
| Placer | Storm Drain at Crocker Ranch Road - drains to Pleasant Grove Crk (DPR Site ID:PGC030) | 4/13/2009 | 0.0189 | 0.015 |
| Imperial | New River Outlet - New River Region - SWAMP station code 723NROTWM | 5/1/2006 | 0.022 | 0.004 |
| Imperial | New River at Boundary - New River Region - SWAMP station code 723NRBDRY | 5/1/2006 | 0.017 | 0.004 |
| Imperial | Salton Sea USGS2 - Salton Sea Region - SWAMP station code 728SSGS02 | 10/24/2007 | 0.004 | 0.004 |
| Imperial | Salton Sea USGS7 - Salton Sea Region - SWAMP station code 728SSGS07 | 10/24/2007 | 0.004 | 0.004 |
| Imperial | Salton Sea USGS9 - Salton Sea Region - SWAMP station code 728SSGS09 | 10/24/2007 | 0.004 | 0.004 |

The occurrence of cyfluthrin in sediment has a detection frequency of 5.81% (15 detection/258 total samples). The limit of quantification (LOQ) for cyfluthrin is 0.001 µg/g. The detections of cyflurthrin ranged from 0.0031 to 0.167 µg/g (**Table 3-6**). The highest concentration of cyflurthrin in sediment was detected at a Stormdrain Outfall Trib to Kaseberg Ck (McAnally/Thunderbird Ct) in Placer County, CA.

**Table 3-6. Cyfluthrin Detections in Sediment from the CDPR Monitoring Program.**

| County | Site Description | Date | Conc [ug/g] | LOQ | TOC[1] |
|---|---|---|---|---|---|
| Placer | Kaseberg Ck at Caragh Rd. | 9/25 | 0.161 | 0.001 | 9.15 |
| Placer | Kaseberg Ck at Country Club Blvd./McAnally | 9/24 | 0.096 | 0.001 | 6.65 |
| Placer | Kaseberg Ck at Green Grove Rd. | 9/24 | 0.169 | 0.001 | 6.99 |
| Placer | Kaseberg Ck at Timberose Rd. | 9/24 | 0.0031 | 0.001 | 2.58 |
| Placer | Kaseberg Ck at confluence w/Stormdrain Outfall Tributary | 9/24 | 0.0065 | 0.001 | 1.74 |
| Placer | Pleasant Grove Crk at Crocker Ranch, West outfall | 10/4 | 0.0052 | 0.001 | 1.8 |
| Placer | Pleasant Grove Crk at Crocker Ranch, West outfall | 11/7 | 0.0035 | 0.001 | 1.31 |
| Placer | South Branch Pleasant Grove Ck at (North Fork at Diamond Oaks Blvd.) | 10/24 | 0.027 | 0.001 | 4.8 |
| Placer | South Branch Pleasant Grove Ck at (South Fork Headwaters at Diamond Oaks Blvd.) | 10/24 | 0.048 | 0.001 | 7.52 |
| Placer | South Branch Pleasant Grove Ck at Painted Desert Rd. | 9/24 | 0.011 | 0.001 | 4.79 |
| Placer | South Branch Pleasant Grove Ck at Painted Desert Rd. | 10/24 | 0.012 | 0.001 | 1.89 |
| Placer | Stormdrain Outfall Trib to Kaseberg Ck (Aylesbury Rd.) | 9/24 | 0.09 | 0.001 | 4.61 |
| Placer | Stormdrain Outfall Trib to Kaseberg Ck (McAnally/Thunderbird Ct) | 9/24 | 0.167 | 0.001 | 6.08 |
| Placer | Stormdrain outfall trib to Pleasant Grove Crk (Crocker Ranch-East) | 10/24 | 0.0083 | 0.001 | 1.91 |
| Placer | Stormdrain outfall trib to Pleasant Grove Crk (Crocker Ranch-West) | 9/25 | 0.07 | 0.001 | 2.08 |

1- Total organic carbon content (%OC)

## 3.3. Terrestrial Animal Exposure Assessment

### 3.3.1. Exposure to Residues in Terrestrial Food Items

T-REX (Version 1.5.1) is used to calculate dietary and dose-based EECs of cyfluthrin and *beta*-cyfluthrin for birds (including terrestrial-phase amphibians and reptiles), mammals, and terrestrial invertebrates. T-REX simulates a 1-year time period. T-HERPS is 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 cyfluthrin and *beta*-cyfluthrin are considered. Terrestrial EECs were derived for the uses previously summarized in **Table 3-7**. Exposure estimates generated using T-REX and T-HERPS are for the parent alone.

Terrestrial EECs for foliar formulations of cyfluthrin and *beta*-cyfluthrin were derived for the uses summarized in **Table 3-7**. Given that no data on interception and subsequent dissipation from foliar surfaces is available for either cyfluthrin or *beta*-cyfluthrin, a default foliar dissipation half-life of 35 days is used for both chemicals based on the work of Willis and McDowell (1987). In most cases, EECs were bound for agricultural and non-agricultural uses by bounding the uses with the highest and lowest application rates (*i.e.*, not all uses were modeled). Use specific input values, including number of applications, application rate, foliar half-life and application interval are provided in **Table 3-7**. Granular uses were modeled in T-REX using the $LD_{50}/ft^2$ analysis. An example output from T-REX and T-HERPS is available in **APPENDIX I**.

**Table 3-7. Input Parameters for Foliar and Granular Applications Used to Derive Terrestrial EECs for Cyfluthrin and *Beta*-Cyfluthrin with T-REX and T-HERPS.**

| Use (Application method) | Application Rate (lbs a.i./A) | Number of Applications | Application Interval | Foliar Dissipation Half-Life |
|---|---|---|---|---|
| Cyfluthrin Foliar | | | | |
| Airports/Landing Fields | 0.436 | 10 | 7-day | 35-day |
| Recreational Areas | 0.025 | 10 | 3-day | 35-day |
| Ornamentals | 0.131 | 10 | 3-day | 35-day |
| Cotton | 0.051 | 10 | 3-day | 35-day |
| Dried Beans | 0.03 | 3 | 14-day | 35-day |
| Cyfluthrin Granular | | | | |
| Agricultural Uses | 0.131 | 10 | 3-day | N/A |
| Non-agricultural Uses | 0.174 | 10 | 3-day | N/A |
| *Beta*-Cyfluthrin Foliar | | | | |
| Agricultural/Farm Structures/Buildings and Equipment; Animal Feeding Lots | 0.191 | 10 | 3-day | 35-day |
| Non-agricultural Outdoor Buildings | 0.191 | 10 | 7-days | 35-day |
| *Beta*-Cyfluthrin Granular | | | | |
| Non-agricultural Uses | 0.061 | 10 | 3-day | N/A |

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, fruits/pods/seeds, arthropods, and seeds for granivores. Birds, including the CCR, and mammals, consume all of these items. EECs are calculated for the most sensitive dietary item and size class for birds (surrogate for terrestrial-phase 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 1286 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 6.1.1.b).

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

Upper-bound Kenaga nomogram values reported by T-REX are used for derivation of dietary EECs for assessed species of birds, terrestrial-phase amphibians, and reptiles and their potential prey (T-REX is also uses to assess risks to terrestrial invertebrates) (see **Table 3-8**). 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[9]. For birds (surrogates for amphibians and reptiles), EECs and RQs for acute dose-based and chronic dietary-based exposure are calculated as these are the most sensitive values. For mammals, EECs and RQs for acute dose based and chronic dose based exposure are calculated as these are typically the most sensitive values. If the dietary assessment results in higher RQs than the dose-based assessment, the highest dietary RQs are shown as well.

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[9] The 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, 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.

T-REX is also used to calculate EECs for terrestrial invertebrates exposed to cyfluthrin and *beta*-cyfluthrin. Available acute contact toxicity data for bees exposed to cyfluthrin and *beta*-cyfluthrin (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 a.i./g) 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.

**Table 3-8. Example Dietary-Based EECs Derived Using T-REX for Cyfluthrin and Beta-Cyfluthrin (Flowable Uses).**

| Use | App Rate (lb a.i./A, # Apps, Interval (days) | Dietary Item | | | | |
|---|---|---|---|---|---|---|
| | | Short Grass | Tall Grass | Broadleaf Plants | Fruits/Pods/ Seeds | Arthropods |
| **Cyfluthrin** | | | | | | |
| Airports/Landing Fields | 0.436, 10, 7 | 606 | 278 | 341 | 38 | 237 |
| Recreational Areas | 0.025, 10, 3 | 47 | 21 | 26 | 3 | 18 |
| Ornamentals | 0.131, 10, 3 | 244 | 112 | 137 | 15 | 96 |
| Cotton | 0.051, 10, 3 | 95 | 44 | 53 | 6 | 37 |
| Dried Beans | 0.03, 3, 14 | 17 | 8 | 9 | 1 | 7 |
| ***Beta*-Cyfluthrin** | | | | | | |
| Agricultural/Farm Structures/Buildings and Equipment; Animal Feeding Lots | 0.191, 10, 3 | 356 | 163 | 200 | 22 | 139 |
| Non-agricultural Outdoor Buildings | 0.191, 10, 7 | 266 | 122 | 149 | 17 | 104 |

The default 35-day foliar half-life is used.

#### 3.3.1.b. Dietary Exposure to Amphibians and Reptiles Derived Using T-HERPS

Birds were used as surrogate species for terrestrial-phase CTS (all DPSs) 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, one can see that, 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.

Because 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 cyfluthrin and *beta*-cyfluthrin are lacking. To quantify the potential differences in food intake between birds and terrestrial-phase CTS and other 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.

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.[10] That is why 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. The most sensitive EECs and RQs for SFGS are for the medium animal consuming small herbivorous mammals. EECs calculated using T-HERPS for the CTS and SFGS are shown in **Table 3-9**.

[10] 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 3-9. Example Dietary-Based EECs Derived Using T-HERPS for Cyfluthrin and *Beta*-Cyfluthrin (Flowable Uses).**

| Use | App Rate (lb a.i./A, # Apps, Interval (days) | Dietary Item (Excluding Those Already Reported Above in T-REX) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Sm HM | Med HM | Lg HM | Sm IM | Med IM | Lg IM | Sm TPA | Med TPA | Lg TPA |
| **Cyfluthrin** | | | | | | | | | | |
| Airports/Landing Fields | 0.436, 10, 7 | 1661 | 608 | 223 | 104 | 38 | 14 | 21 | 12 | 7 |
| Recreational Areas | 0.025, 10, 3 | 47 | 17 | 6 | 3 | 1 | 0.39 | 0.58 | 0.34 | 0.20 |
| Ornamentals | 0.131, 10, 3 | 669 | 245 | 90 | 42 | 15 | 6 | 8 | 5 | 3 |
| ***Beta*-Cyfluthrin** | | | | | | | | | | |
| Agricultural/Farm Structures/Buildings and Equipment; Animal Feeding Lots | 0.191, 10, 3 | 975 | 357 | 131 | 61 | 22 | 8 | 12 | 7 | 4 |

The default 35-day foliar half-life was used.
HM – Herbivore mammal
IM – Insectivore mammal
TPA – Terrestrial-phase amphibian

#### 3.3.1.c. Terrestrial Organism Exposure to Residues in Aquatic Food Items (KABAM)

The KABAM model ($K_{OW}$ (based) Aquatic BioAccumulation Model) version 1.0 is 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 (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.

Aquatic tissue residues were estimated using default parameters that are considered to be representative of ecological parameters that result in conservative estimates of bioaccumulation. The use of this model in this screening-level assessment is intended for qualitative characterization of potential risks and not quantitative risk assessment. A summary of the cyfluthrins-specific inputs used to estimate residue concentrations in aquatic organisms is provided in **Table 3-10.** When the modeled water concentrations (*i.e.* pore water and water) from PRZM/EXAMS resulted in concentrations that exceed the solubility limit for the cyfluthrins, the concentrations were capped at the solubility limit (2.3 µg a.i./L) in the KABAM modeling. 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 **APPENDIX J**.

**Table 3-10. Example Bioaccumulation Model Input Values for Cyfluthrin and *Beta*-Cyfluthrin.**

| Parameter | Input Value | |
|---|---|---|
| **Pesticide Name** | Cyfluthrin/*Beta*-cyfluthrin | |
| **Log $K_{OW}$** | 5.97 | |
| **$K_{OW}$** | 933,254 | |
| **$K_{OC}$** | 107,412 | |
| **Use patterns** | **Concentration in sediment pore water (ppb)** | **Total pesticide concentration in water (ppb)** |
| Paved surfaces (Cyfluthrin) | 12.6 (2.3)[1] | 24.9 (2.3)[1] |
| Sweet corn (cyfluthrin) | 0.179 | 0.333 |
| Paved surfaces (*beta*-cyfluthrin) | 6.3 (2.3)[1] | 12.4 (2.3)[1] |
| Sweet corn (*beta*-cyfluthrin) | 0.089 | 0.167 |

[1] The concentration represents the solubility limit for *beta*-cyfluthrin. This concentration was used to assess aquatic exposure assessment.

### 3.4. Terrestrial Plant Exposure Assessment

There are currently no terrestrial plant toxicity data available for cyfluthrin or *beta*-cyfluthrin. Therefore, a quantitative assessment of risk to terrestrial plants from the use of these chemicals is not possible. For this assessment, risks to terrestrial plants from the use of cyfluthrin and *beta*-cyfluthrin in California are assessed qualitatively.

## 4. Effects Assessment

This assessment evaluates the potential for cyfluthrin and *beta*-cyfluthrin to directly or indirectly affect BCB, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG 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 CTS-CC, CTS-SC, and CTS-SB are based on toxicity information for freshwater fish, while terrestrial-phase amphibian effects (CTS-CC, CTS-SC, and CTS-SB) and reptiles (SFGS) are based on avian toxicity data, given that birds are 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 to assess fish and as a surrogate for aquatic-phase amphibians), freshwater invertebrates, estuarine/marine fish, estuarine/marine invertebrates, aquatic plants, birds (used to assess birds and 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 cyfluthrin and *beta*-cyfluthrin.

### 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 information from the cyfluthrins Registration Review Problem Formulation (USEPA, 2010) as well as ECOTOX information obtained in September 2012. In order 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 K**. 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 K**. The list of citations including toxicological and/or efficacy data on target insect species not considered in this assessment is provided in **APPENDIX L**.

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 M. APPENDIX M** 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 K**.

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 cyfluthrin and *beta*-cyfluthrin. A summary of the available aquatic and terrestrial ecotoxicity information and the incident information for cyfluthrin and *beta*-cyfluthrin are provided in Sections 4.1 through 4.4.

### 4.2. Toxicity of Cyfluthrin and *Beta*-Cyfluthrin 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 aquatic species is presented below. Additional information is provided in **APPENDIX N**. All endpoints are expressed in terms of the active ingredient (a.i.) unless otherwise specified.

Numerous aquatic studies have been submitted to the Agency for cyfluthrin and *beta*-cyfluthrin. Cyfluthrin and *beta*-cyfluthrin are classified as very highly toxic to aquatic organisms based on data for aquatic vertebrates and invertebrates. Chronic effects were also seen in all aquatic animal taxa tested (with NOAECs as low as 0.00016 µg a.i./L). Several of the available aquatic toxicity studies are classified as supplemental primarily due to variability in the concentrations of the parent chemical throughout the studies (which is expected for cyfluthrin and *beta*-cyfluthrin due to their chemical properties – *e.g.*, toxicity at low concentrations, high binding potential and low water solubility limit). Unless otherwise noted, all of the supplemental studies are considered adequate for RQ calculation.

**Table 4-1. Aquatic Toxicity Profile for Cyfluthrin and *Beta*-Cyfluthrin.**

| Taxon | Species (common name) | Test Substance | % a.i. | End-point | Mean concentration (µg a.i./L) | MRID and study classification | Comment(s) |
|---|---|---|---|---|---|---|---|
| Freshwater Fish (acute) | *Oncorhynchus mykiss* (Rainbow trout) | Cyfluthrin | 97.6% | $LC_{50}$ | 0.209 [slope = 6.7 (C.I.: 4.0 – 9.4)] | 45426708 Supplemental | Classified as supplemental due to unexplained variability in recovery of the parent compound |
| | | *Beta*-cyfluthrin | 99.4% | $LC_{50}$ | 0.068 [slope = 7.6 (C.I.: 4.7 – 10.5)] | 45375002 Supplemental | Classified as supplemental due to a very high level of variability in the measured concentrations (at all levels) |
| Freshwater Fish (chronic) | *Oncorhynchus mykiss* (Rainbow trout) | Cyfluthrin | 96% | NOAEC<br>LOAEC | 0.010<br>0.018 | 00155898 Supplemental | LOAEC based on reduced growth and behavioral effects |
| | | *Beta*-cyfluthrin | N/A | NOAEC | 0.0042 | N/A (based on a '*beta*-cyfluthrin equivalent') | Based on a '*beta*-cyfluthrin equivalent' using chronic data for cyfluthrin (0.010 x 0.42 = 0.0042) (see **Appendix F** for more details) |
| Estuarine/ Marine Fish (acute) | *Cyprinodon variegatus* (Sheepshead minnow) | Cyfluthrin | 87% | $LC_{50}$ | 4.05 (slope could not be calculated) | 00146485 Acceptable | None |
| | | *Beta*-cyfluthrin | No data available | | | | |
| Estuarine/ Marine Fish (chronic) | *Cyprinodon variegatus* (Sheepshead minnow) | Cyfluthrin | 90.5% | NOAEC<br>LOAEC | 0.025<br>0.084 | 00158781 Supplemental | LOAEC based on reduced juvenile survival |
| | | *Beta*-cyfluthrin | No data available | | | | |
| Freshwater Invertebrate (acute) | *Daphnia magna* (Water Flea) | Cyfluthrin (TEMPO 2EC) | 2% | $EC_{50}$ | 0.025 (slope could not be calculated) | 41558003 Acceptable | None |
| | | *Beta*-cyfluthrin | Tech | $EC_{50}$ | 0.29 (slope could not be calculated) | 45426701 Supplemental | Classified as supplemental because the purity of the test material was not specified |
| Freshwater Invertebrate (chronic) | *Daphnia magna* (Water Flea) | Cyfluthrin | 94.7% | NOAEC<br>LOAEC | 0.0074<br>0.0157 | 00151442 Acceptable | LOAEC based on reduced growth, survival, and number of young |

| Taxon | Species (common name) | Test Substance | % a.i. | End-point | Mean concentration (µg a.i./L) | MRID and study classification | Comment(s) |
|---|---|---|---|---|---|---|---|
| | | *Beta*-cyfluthrin | N/A | NOAEC | 0.003 | N/A (based on a '*beta*-cyfluthrin equivalent') | Based on a '*beta*-cyfluthrin equivalent' using chronic data for cyfluthrin (0.0074 x 0.42 = 0.003) (see **Appendix F** for more details) |
| Estuarine/ Marine Invertebrate (acute) | *Mysidopsis bahia* (Mysid shrimp) | Cyfluthrin | 92% | $LC_{50}$ | 0.0024 (slope could not be calculated) | 40069501 Acceptable | None |
| | | *Beta*-cyfluthrin | >98% | $LC_{50}$ | 0.0022 [slope = 5.5 (C.I.: 3.7 – 7.3)] | 45426709 Acceptable | None |
| Estuarine/ Marine Invertebrate (chronic) | *Mysidopsis bahia* (Mysid shrimp) | Cyfluthrin | 97% | NOAEC<br>LOAEC | 0.00017<br>0.00040 | 00158785 Supplemental | LOAEC based on reduced growth and survival; this study is supplemental due to fluctuations in the test concentrations throughout the study. |
| | | *Beta*-cyfluthrin | N/A | NOAEC | 0.00007 | N/A (based on a '*beta*-cyfluthrin equivalent') | Based on a '*beta*-cyfluthrin equivalent' using chronic data for cyfluthrin (0.00017 x 0.42 = 0.00007) (see **Appendix F** for more details) |
| Vascular Aquatic Plant | Duckweed (*Lemna* sp.) | Cyfluthrin | No data available | | | | |
| | | *Beta*-cyfluthrin | No data available | | | | |
| Non-Vascular Aquatic Plant | Green algae (*Pseudokirchneriella subcapita*) | Cyfluthrin | 98.7% | $EC_{50}$ | >181 | 43984901 Acceptable | No effects at any concentration tested |
| | Algae (*Scenedesmus subspicatus* CHODAT) | | 95.8% | $EC_{50}$ | >2 | 48350623 Supplemental | No effects up to the limit of solubility (0.002 mg/L) |
| | | *Beta*-cyfluthrin | No data available | | | | |

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 and Aquatic-Phase Amphibians

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

Cyfluthrin technical is highly toxic to freshwater fish, with a 96-hour $LC_{50}$ of 0.21 µg a.i./L (MRID 45426708) [rainbow trout (*Oncorhynchus mykiss)*]. The NOAEC and LOAEC for this study are 0.063 and 0.10 µg a.i./L, respectively, based on mortality and sub-lethal effects (*e.g*., erratic behavior, loss of equilibrium, and labored respiration). In an acute test with cyfluthrin EC (2%), the 96-hour $LC_{50}$ was 0.295 µg a.i./L for rainbow trout (MRID 41558002). The NOAEC and LOAEC for this study were 0.20 and 0.38 µg a.i./L, respectively, based on mortality and sublethal effects (*e.g*., surfacing and erratic swimming).

*Beta*-cyfluthrin technical is also highly toxic to freshwater fish, with a 96-hour $LC_{50}$ of 0.068 µg a.i./L in the most sensitive acute test conducted also on rainbow trout (MRID 45375002). The NOAEC value for this study is <0.039 based on mortality and sublethal effects (*e.g*., loss of equilibrium, erratic swimming, and lethargy) (a LOAEC could not be calculated due to effects at all tested concentrations).

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

A freshwater fish early-life stage study for cyfluthrin technical resulted in a NOAEC of 0.010 µg a.i./L and LOAEC of 0.018 µg a.i./L for rainbow trout based on reduced growth and behavioral effects (MRID 00155898). In a fish full life cycle test with cyfluthrin, fathead minnow (*Pimephales promelas*) showed reduced survival and hatching success at 0.25 µg a.i./L, with a NOAEC of 0.14 µg a.i./L (MRID 41450401). There are currently no freshwater fish chronic toxicity data available for *beta*-cyfluthrin. A NOAEC for *beta*-cyfluthrin was estimated based on a '*beta*-cyfluthrin equivalent' by multiplying the cyfluthrin chronic endpoint by 42% (to account for the percent of active isomers in cyfluthrin compared to *beta*-cyfluthrin). This results in a NOAEC of 0.0042 µg a.i./L (0.010 x 0.42 = 0.0042) (see **APPENDIX F** for more details).

### 4.2.2. Toxicity to Freshwater Invertebrates

#### 4.2.2.a. Freshwater Invertebrates: Acute Exposure Studies

Acute toxicity values for daphnids suggest that cyfluthrin is very highly toxic to freshwater invertebrates, with a 48-hour $EC_{50}$ of 0.025 µg a.i./L using a formulated product (Tempo, 25% a.i.) (MRID 41558003) and an $EC_{50}$ of 0.141 using cyfluthrin technical (MRID 00131504). The

NOAEC and LOAEC values for the formulated product study were 0.016 and 0.04 µg a.i./L, respectively, based on mortality and abnormal behavior. An acute 48-hour study with *beta*-cyfluthrin technical resulted in a daphnid $EC_{50}$ of 0.29 µg a.i./L (MRID 45426701). The NOAEC value for this study is <0.20 based on mortality and sublethal effects (*e.g.*, lying on the bottom, surfacing, and quiescence) (a LOAEC could not be calculated because there were effects at all concentrations tested).

For freshwater benthic organisms, a 10-day toxicity study with midges (*Chironomus tentans*) has been submitted (MRID 46591507, in review). Based on preliminary results from this study, cyfluthrin is very highly toxic to freshwater benthic organisms with an $LC_{50}$ of 0.44 µg a.i./L based on mean-measured pore water concentrations and an $LC_{50}$ of 290 µg a.i./kg-sediment based on bulk sediment concentrations.

#### 4.2.2.b. Freshwater Invertebrates: Chronic Exposure Studies

In a daphnid chronic life-cycle test with cyfluthrin, the NOAEC is 0.0074 µg/L and the LOAEC is 0.0157 µg/L based on adverse effects to growth, survival and number of young (MRID 00151442). There are currently no freshwater invertebrate chronic toxicity data available for *beta*-cyfluthrin. A NOAEC for *beta*-cyfluthrin was estimated based on a '*beta*-cyfluthrin equivalent' by multiplying the cyfluthrin chronic endpoint by 42% (to account for the percent of active isomers in cyfluthrin compared to *beta*-cyfluthrin). This results in a NOAEC of 0.003 µg a.i./L (0.0074 x 0.42 = 0.003) (see **APPENDIX F** for more details).

### 4.2.3. Toxicity to Estuarine/Marine Fish

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

Acute toxicity studies indicate that cyfluthrin is very highly toxic to estuarine/marine fish, with an $LC_{50}$ of 4.05 µg a.i./L for the technical material [sheepshead minnow (*Cyprinodon variegatus*)] (MRID 00146485). The NOAEC and LOAEC values from this study are 2.16 and 3.6 µg a.i./L, respectively, based on mortality and quiescence. There are currently no data available for *beta*-cyfluthrin and estuarine/marine fish. Freshwater fish appear more sensitive to the cyfluthrins than estuarine/marine fish, therefore endpoints based on freshwater fish species are expected to be protective of estuarine/marine species.

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

The most sensitive sheepshead minnow early life stage study submitted by the registrant resulted in a 39-day NOAEC of 0.025 µg a.i./L and a LOAEC of 0.084 µg a.i./L, based on reduced juvenile survival. Again, there are currently no data available for *beta*-cyfluthrin and estuarine/marine fish. However, freshwater fish appear more sensitive to the cyfluthrins than estuarine/marine fish, therefore endpoints based on freshwater fish species are expected to be protective of fish in an estuarine/marine environment.

### 4.2.4. Toxicity to Estuarine/Marine Invertebrates

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

Estuarine/marine aquatic invertebrates are typically represented by the mysid shrimp (*Mysidopsis bahia*) and eastern oyster (*Crassostrea virginica*). Toxicity studies indicate that cyfluthrin is very highly toxic to both species. Cyfluthrin technical produced an $LC_{50}$ of 0.0024 µg a.i./L in an acute toxicity study with mysid shrimp (MRID 40069501). In this study, the NOAEC is <0.00069 based on mortality and lethargy (a LOAEC could not be calculated because there were effects at all of the concentrations tested). In a study with the eastern oyster, the 96-hour $EC_{50}$ was 2.69 µg a.i./L for cyfluthrin technical (MRID 00158783).

In an acute study with mysid shrimp, the 96-hour $LC_{50}$ is 0.0022 µg a.i./L for *beta*-cyfluthrin technical (MRID 45426709). The NOAEC and LOAEC values for this study are 0.0013 and 0.0023 µg a.i./L, respectively, based on mortality and sublethal effects (*e.g.*, erratic swimming, lethargy, loss of equilibrium, and swimming at the surface).

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

In a 28-day life cycle study with mysid shrimp and cyfluthrin, the NOAEC is 0.00017 µg a.i./L and the LOAEC is 0.00040 µg a.i./L based on adverse effects to growth and survival (MRID 00158785). There are currently no chronic estuarine/marine invertebrate toxicity data available for *beta*-cyfluthrin. A NOAEC for *beta*-cyfluthrin was estimated based on a '*beta*-cyfluthrin equivalent' by multiplying the cyfluthrin chronic endpoint by 42% (to account for the percent of active isomers in cyfluthrin compared to *beta*-cyfluthrin). This results in a NOAEC of 0.00007 µg a.i./L (0.00017 x 0.42 = 0.0042) (see **APPENDIX F** for more details).

### 4.2.5. Toxicity to Aquatic Plants

There are currently no toxicity data available for vascular aquatic plant species and cyfluthrin or *beta*-cyfluthrin. For non-vascular aquatic plants, there are only toxicity data currently available for cyfluthrin. In the available studies using technical cyfluthrin, there were no effects noted at any concentration tested resulting in non-definitive endpoints [$EC_{50}$ > 181 µg a.i./L (*Pseudokirchneriella subcapita*; MRID 43984901); EC > 2 µg a.i./L (the reported limit of solubility) (*Scenedesmus subspicatus*; MRID 48350623)].

As discussed in a recent litigation assessment for bifenthrin (USEPA 2012), there are a variety of studies available for other pyrethroids with marine diatom, green algae and duckweed (**Table 4-3).** Of the 11 acceptable or supplemental study endpoints available in the EFED Ecotoxicity database for other pyrethroids, only two have definitive values ($EC_{50}$ = 92 µg a.i./L for permethrin and $EC_{50}$ = 15,000 µg a.i./L for *gamma* cyhalothrin). The remaining nine toxicity endpoints are non-definitive (*i.e.,* > values) because sufficient effects were not observed at the highest test concentration from which to derive an $EC_{50}$. In general, these data suggest that aquatic plants are not nearly as sensitive to pyrethroids as the aquatic invertebrates described earlier, although the data are limited in terms of numbers of species and chemicals tested.

**Table 4-3. Aquatic Plant Toxicity Data for Pyrethroids.**

| Pyrethroid | Common Name | Scientific Name | Duration | $EC_{50}$ (µg a.i./L) |
|---|---|---|---|---|
| Etofenprox | Green algae | *Pseudokirchneriella subcapitata* | 72 hr | >18.8 |
| Etofenprox | Duckweed | *Lemna gibba* | 7 | >26 |
| Etofenprox | Green algae | *Pseudokirchneriella subcapitata* | 96 hr | >53 |
| Permethrin | Marine diatom | *Skeletonema costatum* | 96 hr | 92 |
| *Lambda*-Cyhalothrin | Green algae | *Pseudokirchneriella subcapitata** | 96 hr | >310 |
| Fenvalerate | Marine diatom | *Skeletonema costatum* | 96 hr | >1000 |
| Fenvalerate | Marine diatom | *Thalassiosira sp.* | 96 hr | >1000 |
| Fenvalerate | Marine algae | *Nitzschia angularis* | 96 hr | >1000 |
| *Gamma*-cyhalothrin | Green algae | *Pseudokirchneriella subcapitata** | 96 hr | >2850 |
| *Gamma*-cyhalothrin (GF-231 formulation) | Green algae | *Pseudokirchneriella subcapitata** | 72 hr | 15,000 |
| Fenvalerate | Marine algae | *Isochrysis galbana* | 96 hr | >1,000,000 |

* Formerly *Selenastrum capricornutum*

### 4.2.6 Toxicity Data for Aquatic Organisms – Open Literature Studies

None of the open literature studies identified via ECOTOX (and found to be adequate for quantitative use in risk assessment) had endpoints more sensitive than reported in the submitted aquatic toxicity studies.

Moore *et al.* 2007 (E104877) examined the use of constructed wetlands in Leflore County, MS to mitigate exposure and ecological impacts in runoff from agricultural fields. The synthetic pyrethroids cyfluthrin and lambda-cyhalothrin were used as model contaminants. Testing with *Hyalella azteca* was performed to determine the efficiency of the system. There was spatial and temporal variation of the two pyrethroids' concentrations in water, sediment and leaf litter in all three wetland constructed cells. The concentration of the pyrethroids decreased with distance from the application point, but there was no decrease in the *H. azteca* toxicity in water during the 61-day observation period even though the pyrethroids' concentrations decreased significantly. Survival in pyrethroid-contaminated sediment varied in conjunction with measured pyrethroid concentrations, but less so than with exposure to water or leaf litter. The authors stated that this confirmed that pyrethroids bound to sediments are less bioavailable than pyrethroids found in water and/or detritus. Overall, the authors concluded that the pyrethroids can move, affecting non-target aquatic organisms for weeks to months after entering a constructed wetland.

### 4.3. Toxicity of Cyfluthrin and *Beta*-Cyfluthrin to Terrestrial Organisms

**Table 4-4** 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.

**Table 4-4. Terrestrial Toxicity Profile for Cyfluthrin and *Beta*-Cyfluthrin.**

| Taxon | Species (common name) | Test Substance | % a.i. | End-point | Mean concentration | MRID and study classification | Comment(s) |
|---|---|---|---|---|---|---|---|
| Bird (acute) | *Colinus virginianus* (Bobwhite quail) | Cyfluthrin | 87% | $LD_{50}$ | >2,000 mg a.i./kg-bw (slope could not be calculated) | 00131498 Acceptable | None |
| | | *Beta*-cyfluthrin | No data available | | | | |
| Bird (sub-acute) | *Colinus virginianus* (Bobwhite quail) | Cyfluthrin | 87% | $LC_{50}$ | >5,000 mg a.i./kg-diet (slope could not be calculated) | 00131501 Acceptable | None |
| | | *Beta*-cyfluthrin | No data available | | | | |
| Bird (chronic) | *Anas platyrynchos* (Mallard duck) | Cyfluthrin | 94% | NOAEC | 250 mg a.i./kg-diet | 00145331 Supplemental | The LOAEC was reported as 250 mg a.i./kg-diet based on high percentage of eggs cracked (which upon further evaluation is not considered treatment-related); other adverse effects shown at the 1,000 and 4,000 mg/kg-diet levels include a reduction in the number of eggs laid, eggs set, fertilized eggs, 3-week viable embryos, hatchlings and 14-day survivors; classified as supplemental due to low control reproductive performance |
| | | *Beta*-cyfluthrin | 94% | NOAEC | 269 mg a.i./kg-diet | 48350615 Acceptable | No effects at any concentration tested |
| Mammal (acute) | *Rattus norvegicus* (Laboratory Rat) | Cyfluthrin | Tech-nical | $LD_{50}$ | 16.2 mg a.i./kg-bw (male) (no slope available) | 131518 Acceptable | Mixed with cremophor (solvent) |
| | | *Beta*-cyfluthrin | Tech-nical | $LD_{50}$ | 960 mg a.i./kg-bw (male) (no slope available) | 44251101 Acceptable | The $LD_{50}$ for females is 1,150 mg a.i./kg-bw |

| Taxon | Species (common name) | Test Substance | % a.i. | End-point | Mean concentration | MRID and study classification | Comment(s) |
|---|---|---|---|---|---|---|---|
| Mammal (chronic) | *Rattus norvegicus* (Laboratory Rat) | Cyfluthrin | Tech-nical | NOAEL | 50 mg a.i./kg-diet (5.4 mg a.i./kg/day) | 131532 Acceptable | LOAEL = 150 mg a.i./kg-diet (15.1 mg a.i./kg/day) based on decreased pup body weight |
| | | *Beta*-cyfluthrin | No data avail-able | NOAEL | 320 mg a.i./kg/day | N/A | Based on an ACR using acute and chronic mammalian data for cyfluthrin and acute data from *beta*-cyfluthrin (16.2/5.4 = and ACR of 3; 960/x = 3 = x = 320) |
| Terrestrial Invertebrate (acute) | *Apis mellifera* (Honey bee) | Cyfluthrin | 93% | $LD_{50}$ | 0.037 µg a.i./bee (contact) (no slope available) | 00153638 Acceptable | None |
| | | *Beta*-cyfluthrin | 98.4% | $LD_{50}$ | 0.05 µg a.i./bee (contact)<br><br>0.012 µg a.i./bee (oral)<br><br>(no slope available) | 48350616 Acceptable/ Supplemental | The acute contact portion of the study is acceptable; the oral portion is classified as supplemental because t is a non-guideline study (however, it is adequate for RQ calculation) |
| Terrestrial Plants (vegetative vigor/seedling emergence) | Variety of species | Cyfluthrin | No data available | | | | |
| | | *Beta*-cyfluthrin | No data available | | | | |

Acute toxicity to terrestrial animals is categorized using the classification system shown in **Table 4-5** (USEPA, 2004). Toxicity categories for terrestrial plants have not been defined.

**Table 4-5. 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 for cyfluthrin and *beta*-cyfluthrin is provided below in Sections 4.3.1.a 4.3.1.b.

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

The available toxicity data suggest that cyfluthrin is practically non-toxic on an acute basis to avian species based on a bobwhite quail (*Colinus virginianus*) single dose $LD_{50}$ of >2,000 mg/kg-bw (MRID 00131498) and an 8-day dietary $LC_{50}$ of >5000 mg/kg-diet for the mallard duck (*Anas platyrynchos*) and bobwhite quail (MRIDs 00131500 and 0013501, respectively). In the acute oral study with bobwhite quail there were no mortalities or sublethal effects noted at the tested concentration, resulting in a NOAEL of 2,000 mg a.i./kg-bw. In the sub-acute dietary study with the mallard duck (MRID 00131500), there was one mortality and decreased food consumption and body weight gain in the highest treatment group (5,000 mg a.i./kg-diet), resulting in a NOAEC of 2,000 mg a.i./kg-diet. In the bobwhite quail sub-acute dietary study there was reduced weight gain at the highest concentration tested (5,000 mg a.i./kg-diet) resulting in a NOAEC of 1,000 mg a.i./kg-diet.

There are currently no acute or sub-acute toxicity data available for *beta*-cyfluthrin and birds. However, based on the available data, cyfluthrin appears to be more toxic or equatoxic to terrestrial vertebrates than *beta*-cyfluthrin; therefore, in the absence of additional data showing otherwise, toxicity endpoints for cyfluthrin are expected to be protective of *beta*-cyfluthrin for birds.

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

Reproductive tests with cyfluthrin and mallard ducks resulted in reported effects at 250 mg/kg-diet (NOAEC <250 mg/kg diet). In one test conducted with mallards, a high percentage of eggs cracked were observed at 250 mg/kg diet, the lowest level tested (MRID 00145331). This effect was not seen at the higher treatment levels, however. Since this endpoint can be influenced by handling error and it was not dose-dependent, it is not considered treatment-related. Other adverse effects shown at the 1,000 and 4,000 mg/kg-diet levels include a reduction in the number of eggs laid, eggs set, fertilized eggs, 3-week viable embryos, hatchlings and 14-day survivors. Therefore, the NOAEC in this study is considered 250 mg a.i./kg-diet (LOAEC = 1,000 mg a.i./kg-diet). Due to low control reproductive performance, including low embryo viability, hatchling number and 14-day survivorship, the results of this study are classified as supplemental.

In another reproductive study conducted with cyfluthrin and mallard ducks, cyfluthrin statistically showed no adverse effects to reproduction at the highest concentration tested when compared to control birds (NOAEC = 250 mg/kg-diet) (MRID 00158782). In this study, no statistical differences in reproductive parameters between the controls and treatments were determined at any concentration tested (10, 50 and 250 mg/kg-diet). Pathological results showed an increase in egg yolk peritonitis and regressing ovary at levels as low as 10 mg/kg diet (the lowest level tested). In this study, control bird reproduction appeared to be impaired, as indicated by a low number of eggs laid, embryo viability and hatching rate compared to guideline criteria. This study is, therefore, also classified as supplemental.

Two reproductive studies were also submitted for cyfluthrin and bobwhite quail, yielding less sensitive reproductive endpoints than the mallard studies. The NOAEC = 900 and 1000 mg/kg-diet, for MRIDs 00152829 (acceptable) and 00145330 (supplemental), respectively. Effects observed include low body weight gain in males and low 14-day survivorship at 4,000 mg/kg diet level.

One avian reproduction study has been submitted for *beta*-cyfluthrin (MRID 48350615). In this study with mallard ducks, there were no effects noted at any concentration tested, resulting in a NOAEC of 269 mg a.i./kg-diet.

### 4.3.2. Toxicity to Mammals

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

Mammalian toxicity data suggest that cyfluthrin is highly toxic to small mammals on an acute exposure basis (rat acute oral $LD_{50}$ = 16.2 mg a.i./kg-bw, males) (MRID 131518). Sublethal effects included tremors, rolling movements, and disturbed respiration (concentration not noted).

In an acute oral study conducted to examine *beta*-cyfluthrin effects on rats, the $LD_{50}$ is 960 and 1,150 mg/kg-bw for males and females, respectively (MRID 44251101). In this study, the NOAEL was 583 and 723 mg a.i./kg-bw (LOAELs = 723 and 885 mg a.i./kg-bw) for males and females, respectively, based on a variety of sublethal effects including diarrhea, hypoactivity, locomotor in-coordination (males only), and salivation (males only). Based on the submitted data, *beta*-cyfluthrin appears to have lower toxicity to mammals than cyfluthrin.

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

Reproductive effects for cyfluthrin with rats were based on decreased pup bodyweight observed at a LOAEC of 150 mg a.i./kg-diet (15.1 mg a.i./kg/day) [NOAEC = 50 mg a.i./kg-diet ppm (5.4 mg a.i./kg/day)] in a three-generation reproduction study (MRID 131532). The parental NOAEC is 150 mg a.i./kg-diet (LOAEC = 450 mg a.i./kg-diet) based on reduced body weight gain. There are currently no reproduction toxicity data available for rats and *beta*-cyfluthrin. Based on acute endpoints, *beta*-cyfluthrin appears less toxic to mammals than cyfluthrin. A chronic endpoint for mammals and *beta*-cyfluthrin was calculated based on an acute-to-chronic-ratio (ACR) using acute and chronic data for cyfluthrin and acute data for *beta*-cyfluthrin. The ACR results in a NOAEL of 320 mg a.i./kg-bw for *beta*-cyfluthrin and mammals [$LD_{50}$ for cyfluthrin (16.2 mg a.i./kg-bw)/NOAEL for cyfluthrin (5.4 mg a.i./kg-bw) = an ACR of 3; $LD_{50}$ for *beta*-cyfluthrin (960 mg a.i./kg-bw)/NOAEL = 3 = NOAEL = 320 mg a.i./kg-bw].

### 4.3.3. Toxicity to Terrestrial Invertebrates

Cyfluthrin is highly toxic to non-target terrestrial invertebrates. A 48-hour acute contact study on honey bees (*Apis mellifera*) with cyfluthrin technical resulted in an $LD_{50}$ of 0.037 µg a.i./bee (MRID 00153638). The 48-hr contact and oral $LD_{50}$ values for honey bees and *beta*-cyfluthrin are 0.05 µg a.i./bee and 0.012 µg a.i./bee, respectively (MRID 48350616). Therefore, for honey bees, the cyfluthrins appear to have similar toxicities to each other on a contact basis, but may be more toxic on an acute oral than acute contact basis. Sublethal effects noted in the honey bee studies included apathy, uncontrolled motions, and dorsal positioning.

A 10-day honey bee residual toxicity study with cyfluthrin 2 EC (Baythroid) indicated that the formulated product is also highly toxic to non-target terrestrial invertebrates, with and $EC_{50}$ of 0.045 µg/bee (MRID 00162586). Additionally, the $RT_{25}$ in this study was 10 days using sprayed alfalfa, indicating that contact toxicity can be persistent (especially under dry conditions).

### 4.3.4. Toxicity to Terrestrial Plants

No terrestrial plant toxicity data have been submitted for cyfluthrin or *beta*-cyfluthrin. In addition, no such data were found in the open literature that are considered acceptable for quantitative use in risk assessment. Data from the EFED Ecotoxicity database on the toxicity of other pyrethroids to plants were available for only two pyrethroids and no definitive toxicity values are available.

## 4.4. Toxicity of Chemical Mixtures

As previously discussed, the results of available toxicity data for mixtures of cyfluthrin and *beta*-cyfluthrin with other pesticides are presented in **APPENDIX A.** In the case of cyfluthrin, a qualitative examination of the trends in $LD_{50}$ values, with the associated confidence intervals, across the range of percent active ingredient, reveals no definitive conclusions. For all cyfluthrin products analyzed, the data was insufficient to establish a difference in toxicity. For *beta*-cyfluthrin, the data was insufficient to establish a difference in toxicity for all but one product. For one product (TEMPRID SC INSECTICIDE, EPA Reg. No.: 432-1483), there were enough data to determine that the formulation was not more toxic than the a.i. to females. In all other cases, there were insufficient data to make a conclusion.

## 4.5. Incident Database Review

A review of the Ecological Incident Information System (EIIS, version 2.1), the Incident Data System (aggregate incident report), and the Avian Monitoring Information System (AIMS) for ecological incidents involving both cyfluthrin and *beta*-cyfluthrin was completed on January 16, 2013. The EIIS contains eight incident reports for cyfluthrin (five involving aquatic animals and three involving terrestrial plants) and one incident report for *beta*-cyfluthrin (involving terrestrial plants). Five of the incidents were associated with registered uses (four for cyfluthrin and the one for *beta*-cyfluthrin), two were associated with uses in which the legality of use was undetermined (both for cyfluthrin), and two incidents were associated with misuses (both for cyfluthrin). The certainty that the incidents were associated with cyfluthrin or *beta*-cyfluthrin exposure was considered highly probable for two incidents (cyfluthrin), probable for four incidents (cyfluthrin) and possible for three incidents (cyfluthrin and *beta*-cyfluthrin).

The AIMS database does not contain any bird incidents involving cyfluthrin or *beta*-cyfluthrin. IDS contains 135 aggregate incidents for cyfluthrin (133 plant incidents and two wildlife incidents) and three aggregate incidents for *beta*-cyfluthrin (two plant incidents and one wildlife incident).

The incidents for terrestrial plant, and aquatic incidents are discussed below in Sections 4.1.1 through 4.1.3. A complete list of the incidents involving the cyfluthrins is included in **APPENDIX O**.

### 4.5.1. Terrestrial Incidents

There are no terrestrial animal incident reports for cyfluthrin or *beta*-cyfluthrin in EIIS or AIMS. IDS contains three aggregate incident reports for 'wildlife' (two for cyfluthrin and one for *beta*-cyfluthrin). Since the data provided in the aggregate reports are limited, it is not possible to determine with the available information whether or not the wildlife incidents involved terrestrial or aquatic species.

### 4.5.2. Plant Incidents

***Cyfluthrin:***

IDS contains 133 aggregated incident reports for plants. The incidents occurred between 1999 and 2010. Information on the products involved in the incidents is provided, but no other data are available for the aggregate incidents.

In the EIIS, there are three cyfluthrin incidents reported for terrestrial plants (I016940-010, I001728-001, and I013550-002). In one of the incidents (I016940-010) that happened in 2005 in Imperial, CA, a crop duster experienced mechanical problems and discharged cyfluthrin and dimethoate (PC Code 035001) onto a corn field (*Zea mays*). A few days later, the corn field showed burn symptoms in 30 acres of the crop. Around 7,500 pounds of the crop were sampled for residues, and the two chemicals were found in 2,500 pounds (the grower voluntarily disposed of this portion). The analysis showed 0.15 to 7.2 ppm of cyfluthrin and 0.96 to 119.2 ppm of dimethoate. The incident lists cyfluthrin as "highly probable" for a cause of the incident that was the result of a misuse.

In an incident report from the state of Washington (I001728-001), a commercial applicator sprayed cyfluthrin in a yard in 1993, which resulted in drift to a neighbor's garden. There was damage (type and magnitude not reported) to unknown species of ornamentals. Soil samples from the neighbor's garden tested positive for cyfluthrin (levels not reported). This incident is listed as "probable" for a registered use of cyfluthrin.

In a 2001incident from Delaware (I013550-002), a potato grower aerially applied cyfluthrin, chlorothalonil (PC Code 081901) and spinosad (PC Code 110003) to 65 acres of his crop, and damage to the plants occurred within 2 days. The Department of Agriculture investigated and determined there was glyphosate (PC Code 417300) contamination in the containers. This incident is listed as "possible" for a registered use of cyfluthrin.

**Beta-*Cyfluthrin***:

IDS contains two aggregate incident reports involving *beta*-cyfluthrin for plants. One occurred in 2004 (015405-00012) and one occurred in 2008 (020032-00004). Information on the products involved in the incident is provided, but no other data are available for the aggregate incidents.

In the EIIS, there is one incident reported for terrestrial plants (I023302-035). The incident occurred in September 2011 in Illinois. In this incident 82 acres of corn (100%) treated with an application of pesticides that included thiencarbazone-methyl (PC Code 015804), isoxaflutole (PC Code 123000), *beta*-cyfluthrin, and atrazine (PC Code 080803) experienced phytotoxic effects (*i.e*., ear deformation). *Beta*-cyfluthrin is listed as a 'possible' cause of the incident and the legality of use is classified as a 'registered use'.

### 4.5.3. Aquatic Incidents

***Cyfluthrin***:

IDS contains two cyfluthrin aggregate incident reports for 'wildlife'. Since the data provided in the aggregate reports are limited, it is not possible to determine with the available information whether or not the wildlife incident involved terrestrial or aquatic species.

In the EIIS, there are five cyfluthrin incidents reported for aquatic animals (I004564-001, I003621-001, I003351-021, I013927-001, and I003351-021). In one of the aquatic incidents (I004564-001), a fishkill in two ornamental ponds occurred due to cyfluthrin use in California in 1996. Cyfluthrin dust was sprayed on the side of a building to control wasps. Around five days after application, approximately five koi fish (*Cyprinus carpio*) began to die in ponds 20-30 feet from the application site. Water samples taken 20 days after application contained 2 ppb cyfluthrin. No analyses were conducted on the fish tissues. This incident is listed as "highly probable" for a registered use of cyfluthrin.

In another incident (I003621-001) after a heavy rainfall, cyfluthrin washed into a stream where hundreds of bluegill (*Lepomis macrochirus*) were subsequently killed. The incident occurred in 1996 (the location was not specified). No water or tissue samples were taken. This incident is listed as "probable" for an intentional misuse of cyfluthrin.

Cyfluthrin was the probable cause of the death of hundreds of crayfish (Decapoda) and snails (Gastropoda) in California in 1994 (I003351-021). No other data were reported. This incident is listed as "probable" for cyfluthrin. It is unknown if the incident was due to a registered use or misuse.

Cyfluthrin was the probable cause of a fish kill in California in 2003 (I013927-001). Cyfluthrin and chlorpyrifos (PC Code 059101) were aerially applied to an agricultural field adjacent to the site of the kill. Approximately 400 fish died, including 320 flathead catfish (*Pylodictis oilvaris*), 60 grass carp (*Ctenopharyngodon idella*) and 20 largemouth bass (*Micropterus salmoides*). Two water samples were analyzed, and chlorpyrifos was found in both water samples (0.08 and 11.7 ppb) and cyfluthrin was found in one sample (0.33 ppb). Analyses of fish gills ranged from 220-390 ppb cyfluthrin and 660-2100 ppb chlorpyrifos. The report states that "there was probably some dilution of the water between the time of application of the pesticides and the time of sampling". This incident is listed as "probable" for cyfluthrin. It is unknown if the incident was due to a registered use or misuse.

Cyfluthrin was the possible cause of death to an unknown number of crayfish (Decapoda) in Lousiana in 1999 (I003351-021). Both cyfluthrin and profenofos (PC Code 111401) were aerially applied to cotton fields 100 yards from 200 acres of ponds. Water samples were taken eight hours after the application and neither chemical was found [the level of detections (LODs) were 1.4 ppb and 1.48 ppb for cyfluthrin and profenofos, respectively]. Bayer Cropscience, the registrant, said the incident may be due to low dissolved oxygen levels. This incident is listed as "possible" for a registered use of cyfluthrin.

**Beta-*Cyfluthrin***:

There are currently no aquatic pesticide incidents reported for *beta*-cyfluthrin in the available in the EIIS. IDS contains one *beta*-cyfluthrin aggregate incident report for 'wildlife'. Since the data provided in the aggregate reports are limited, it is not possible to determine with the available information whether or not the wildlife incident involved terrestrial or aquatic species.

### 4.6. 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 cyfluthrin and/or *beta*-cyfluthrin 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.

## 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, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG or for modification to their designated critical habitat from the use of cyfluthrin or *beta*-cyfluthrin in CA. The risk characterization provides an estimation (Section 5.1) and a description (Section 5.2) 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 G**). For acute exposures to the aquatic animals, as well as terrestrial invertebrates, the LOC is 0.05. For acute exposures to 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 acute exposures to plants is 1.0.

### 5.1.1. Exposures in the Aquatic Habitat

#### 5.1.1.a. Freshwater Fish and Aquatic-phase Amphibians

Acute risk to fish (and, thus, 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. All of the EECs are for *beta*-cyfluthrin and all of ecotoxicity endpoints are based on *beta*-cyfluthrin endpoints, if available, or cyfluthrin endpoints converted to '*beta*-cyfluthrin equivalent' endpoints. All EECs are capped at *beta*-cyfluthrin's solubility limit (2.3 µg a.i./L). Risk quotients for freshwater fish are shown in **Table 5-1**. All of the uses modeled, both agricultural and non-agricultural, exceed the Agency's listed species LOCs for acute and chronic exposures.

For agricultural uses, the highest EECs are for sweet corn, which results in RQs of 5.96 and 39.7 for acute and chronic exposures, respectively. The agricultural use that results in the lowest EECs is the stone fruits use. The RQs for the stone fruits use are 0.37 and 1.7 for acute and chronic exposures, respectively. Because the acute and chronic RQs for sweet corn and stone fruits bound the upper and lower range of RQs for all of the agricultural uses, and both uses exceed the Agency's LOCs, all of the agricultural uses exceed the Agency's LOCs for acute and chronic exposures. The EECs for non-agricultural uses are substantially higher than the agricultural uses. Most of the EECs for the non-agricultural uses exceed *beta*-cyfluthrin's solubility limit of 2.3 µg a.i./L. EECs at the solubility limit (2.3 µg a.i./L) result in RQs of 33.8 and 547.6 for acute and chronic exposures, respectively.

**Table 5-1. Acute and Chronic RQs for Freshwater Fish.**

| Uses/Application Rate | Species | Peak EEC (µg/L) | 60-day EEC (µg/L) | Acute RQ[1] | Chronic RQ[2] |
|---|---|---|---|---|---|
| Corn (sweet) | Rainbow trout | 0.405 | 0.167 | **5.96** | **39.7** |
| Stone fruits | | 0.025 | 0.007 | **0.37** | **1.7** |
| Non-agricultural structures and paved areas | | 2.3[3] | 2.3[3] | **33.8** | **547.6** |

LOC exceedances (acute RQ $\geq$ 0.05; chronic RQ $\geq$ 1.0) are bolded and shaded.
[1] Acute RQ = peak EEC/ 0.068 µg a.i./L ($LC_{50}$, *beta*-cyfluthrin value).
[2] Chronic RQ = 60-day EEC/ 0.0042 µg a.i./L (NOAEC, converted from cyfluthrin to a '*beta*-cyfluthrin equivalent').
[3] The EEC is capped at 2.3 µg a.i./L (*beta*-cyfluthrin's solubility limit)

Based on LOC exceedances for all of the uses modeled, both cyfluthrin and *beta*-cyfluthrin have the potential to directly affect the CTS (aquatic-phase, all DPSs), DS, and TG. Additionally, since the acute and chronic RQs exceed the LOCs, 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 (all DPSs)].

#### 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 (based on a *beta*-cyfluthrin endpoint, if available, or a cyfluthrin endpoint converted to a '*beta*-cyfluthrin equivalent' endpoint). Chronic risk is based on 1 in 10 year 21-day EECs and the lowest chronic toxicity value for freshwater invertebrates. All of the EECs are for *beta*-cyfluthrin and all of ecotoxicity endpoints are based on *beta*-cyfluthrin endpoints, if available, or cyfluthrin endpoints converted to '*beta*-cyfluthrin equivalent' endpoints. All EECs are capped at *beta*-cyfluthrin's solubility limit (2.3 µg a.i./L). Risk quotients for freshwater invertebrates are shown in **Table 5-2**.

For agricultural uses, the highest EECs are for sweet corn, which results in RQs of 1.4 and 57.3 for acute and chronic exposures, respectively. The agricultural use that results in the lowest EECs is the stone fruits use. The RQs for the stone fruits use are 0.08 and 3 for acute and chronic exposures, respectively. Therefore, all of the agricultural uses exceed the Agency's LOCs for acute and chronic exposures. The EECs for non-agricultural uses are substantially higher than the agricultural uses. Most of the EECs for the non-agricultural uses exceed *beta*-cyfluthrin's solubility limit of 2.3 µg a.i./L. EECs at the solubility limit (2.3 µg a.i./L) result in RQs of 7.9 and 766.7 for acute and chronic exposures, respectively.

**Table 5-2. Summary of Acute and Chronic RQs for Freshwater Invertebrates.**

| Uses/Application Rate | Species | Peak EEC (µg/L) | 21-day EEC (µg/L) | Acute RQ[1] | Chronic RQ[2] |
|---|---|---|---|---|---|
| Corn (sweet) | Daphnid | 0.405 | 0.172 | **1.4** | **57.3** |
| Stone fruits | | 0.025 | 0.009 | **0.08** | **3** |
| Non-agricultural structures and paved areas | | 2.3[3] | 2.3[3] | **7.93** | **766.7** |

LOC exceedances (acute RQ ≥ 0.05; chronic RQ ≥ 1.0) are bolded and shaded.
[1] Acute RQ = peak EEC / 0.29 µg a.i./L ($EC_{50}$, *beta*-cyfluthrin value).
[2] Chronic RQ = 21-day EEC /0 .003 µg a.i./L (NOAEC, converted from cyfluthrin to a '*beta*-cyfluthrin equivalent').
[3] The EEC is capped at 2.3 µg a.i./L (*beta*-cyfluthrin's solubility limit)

Based on LOC exceedances for all of the uses modeled, cyfluthrin and *beta*-cyfluthrin have the potential to directly affect the CFWS. Additionally, since the acute and chronic RQs exceed the LOCs, there is a potential for indirect effects to those listed species that rely on freshwater invertebrates during at least some portion of their life-cycle [*i.e.*, SFGS, CCR, CTS (all DPSs), and DS].

#### 5.1.1.c. 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. All of the EECs are for *beta*-cyfluthrin and all of ecotoxicity endpoints are based on cyfluthrin endpoints converted to '*beta*-cyfluthrin equivalent' endpoints (since endpoints were not available for *beta*-cyfluthrin). All EECs are capped at *beta*-cyfluthrin's solubility limit (2.3 µg a.i./L). Risk quotients are shown in **Table 5-3**.

For agricultural uses, the highest EECs are for sweet corn, which results in RQs of 0.24 and 15.2 for acute and chronic exposures, respectively. The agricultural use that results in the lowest EECs is the stone fruits use. The RQs for the stone fruits use are 0.01 and 0.64 for acute and chronic exposures, respectively. Therefore, for estuarine/marine fish, some but not all of the agricultural uses exceed the Agency's LOCs for listed species. For the Agency's acute listed species LOC to be exceeded, the peak EEC for a use needs to be ≥ 0.085 µg a.i./L. The agricultural uses that have peak EECs ≥ 0.085 µg a.i./L (and their associated RQs) are listed in **Table 5-3** [these include corn (sweet, field, pop, and 'unspecified'), brassica (leafy vegetables), sorghum, leafy vegetables (non-brassica), cotton, grapes, and hops]. Acute RQs for these uses range from 0.07 (brassica and sorghum) to 0.24 (sweet corn). All of the non-agricultural uses exceed the Agency's acute risk LOC for listed species.

For the Agency's chronic listed species LOC to be exceeded, the 60-day EEC for a use needs to be ≥ 0.011 µg a.i./L. The only use (including agricultural and non-agricultural uses) that does not exceed the Agency's listed species LOC for chronic exposure is the stone fruits use.

**Table 5-3. Summary of RQs for Estuarine/Marine Fish.**

| Uses/Application Rate | Species | Peak EEC (µg/L) | 60-day EEC (µg/L) | Acute RQ[1] | Chronic RQ[2] |
|---|---|---|---|---|---|
| Corn (sweet) | Sheepshead minnow | 0.405 | 0.167 | **0.24** | **15.2** |
| Brassica (leafy vegetables) | | 0.124 | 0.065 | **0.07** | **5.9** |
| Corn (field) | | 0.161 | 0.066 | **0.09** | **6.0** |
| Corn (pop) | | 0.161 | 0.066 | **0.09** | **6.0** |
| Corn (unspecified) | | 0.155 | 0.064 | **0.09** | **5.8** |
| Sorghum | | 0.117 | 0.088 | **0.07** | **8.0** |
| Leafy vegetables (non brassica) | | 0.176 | 0.083 | **0.10** | **7.5** |
| Cotton | | 0.145 | 0.074 | **0.09** | **6.7** |
| Grapes | | 0.171 | 0.069 | **0.10** | **6.3** |
| Hops | | 0.262 | 0.155 | **0.15** | **14.1** |
| Stone fruits | | 0.025 | 0.007 | 0.01 | 0.64 |
| Non-agricultural structures and paved areas | | 2.3[3] | 2.3[3] | **1.35** | **209.1** |

LOC exceedances (acute RQ ≥ 0.05; chronic RQ ≥ 1.0) are bolded and shaded.
[1] Acute RQ = peak EEC / 1.7 µg a.i./L ($LC_{50}$, converted from cyfluthrin to a '*beta*-cyfluthrin equivalent').
[2] Chronic RQ = 60-day EEC /0.011 µg a.i./L (NOAEC, converted from cyfluthrin to a '*beta*-cyfluthrin equivalent').
[3] The EEC is capped at 2.3 µg a.i./L (*beta*-cyfluthrin's solubility limit)

Based on LOC exceedances for all uses except stone fruits, cyfluthrin and *beta*-cyfluthrin have the potential to directly affect TG and DS. Additionally, since the acute and/or chronic RQs exceed the LOCs for all uses except stone fruits, there is a potential for indirect effects to those listed species that rely on estuarine/marine fish during at least some portion of their life-cycle (*i.e.*, CCR).

#### 5.1.1.d. 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. All of the EECs are for *beta*-cyfluthrin and all of ecotoxicity endpoints are based on *beta*-cyfluthrin endpoints, if available, or cyfluthrin endpoints converted to '*beta*-cyfluthrin equivalent' endpoints. All EECs are capped at *beta*-cyfluthrin's solubility limit (2.3 µg a.i./L). Risk quotients are shown in **Table 5-4**.

For agricultural uses, the highest EECs are for sweet corn, which results in RQs of 203 and 2,457 for acute and chronic exposures, respectively. The agricultural use that results in the lowest EECs is the stone fruits use. The RQs for the stone fruits use are 11.4 and 129 for acute and chronic exposures, respectively. Therefore, all of the agricultural uses exceed the Agency's LOCs for acute and chronic exposures. The EECs for non-agricultural uses are substantially higher than the agricultural uses. Most of the EECs for the non-agricultural uses exceed *beta*-cyfluthrin's solubility limit of 2.3 µg a.i./L. EECs at the solubility limit (2.3 µg a.i./L) result in RQs of 1,046 and 32,857 for acute and chronic exposures, respectively..

**Table 5-4. Summary of Acute and Chronic RQs for Estuarine/Marine Invertebrates.**

| Uses/Application Rate | Species | Peak EEC (µg/L) | 21-day EEC (µg/L) | Acute RQ* | Chronic RQ* |
|---|---|---|---|---|---|
| Corn (sweet) | Mysid shrimp | 0.405 | 0.172 | **202.5** | **2,457** |
| Stone fruits | | 0.025 | 0.009 | **11.4** | **128.6** |
| Non-agricultural structures and paved areas | | 2.3[3] | 2.3[3] | **1,045.5** | **32,857.1** |

LOC exceedances (acute RQ ≥ 0.05; chronic RQ ≥ 1.0) are bolded and shaded.
[1] Acute RQ = peak EEC / 0.0022 µg a.i./L ($LC_{50}$, *beta*-cyfluthrin value).
[2] Chronic RQ = 21-day EEC /0 .00007 µg a.i./L (NOAEC, converted from cyfluthrin to a '*beta*-cyfluthrin equivalent').
[3] The EEC is capped at 2.3 µg a.i./L (*beta*-cyfluthrin's solubility limit)

All of the modeled uses exceed the Agency's acute and chronic risk LOCs. Since the acute and chronic RQs exceed the LOCs, there is a potential for indirect effects to those listed species that rely on estuarine/marine invertebrates during at least some portion of their life-cycle (*i.e.*, CCR, TG, DS).

#### 5.1.1.e. Non-vascular Aquatic Plants

There are currently no definitive endpoints available for the cyfluthrins and aquatic non-vascular plants (the two available studies – both with cyfluthrin – have 'greater than' values) and there were no effects noted in the available studies. Therefore, RQs cannot be calculated here. A comparison of the available effects data to expected environmental concentrations is discussed in the 'Risk Description' section below.

#### 5.1.1.f. Aquatic Vascular Plants

There are currently no toxicity data available for cyfluthrin or *beta*-cyfluthrin and aquatic vascular plants. Therefore, RQs for aquatic vascular plants were not calculated.

### 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, potential direct effects to terrestrial species are based on foliar and granular applications of cyfluthrin and *beta*-cyfluthrin. Potential risks to birds and, thus, terrestrial-phase amphibians and reptiles 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. The exposure route modeled is via the dietary route. 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 as a refinement to RQs for amphibians if T-REX indicates potential risk to amphibians. 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.

The acute and sub-acute endpoints for cyfluthrin and birds are non-definitive and resulted in $LD_{50}$ and $LC_{50}$ values of >2,000 mg a.i./kg-bw and >5,000 mg a.i./kg-diet, respectively. There are currently no acute or sub-acute toxicity studies available for *beta*-cyfluthrin and birds. Therefore, acute and sub-acute RQs cannot be calculated for birds and the cyfluthrins. Comparison of the available effects data to expected environmental concentrations is discussed in the 'Risk Description' section below.

For chronic exposure, the NOAECs for cyfluthrin and *beta*-cyfluthrin are very similar (250 mg a.i./kg-diet and 269 mg a.i./kg-diet, respectively). Because of the similar toxicity and the generally higher application rates of cyfluthrin versus *beta*-cyfluthrin, RQs for cyfluthrin were calculated as a screen [*i.e.*, if there are no RQ exceedances for the highest application rate(s) for cyfluthrin, exceedances for *beta*-cyfluthrin would not be expected]. Only flowable applications could be modeled, because granular applications only calculate 'RQs' based on acute endpoints.

Based on the application rate for cotton (the highest agricultural application rate; 0.057 lb a.i./acre, 10 applications, 3-day application interval), there are no LOC exceedances for cyfluthrin (and, thus, *beta*-cyfluthrin) based on chronic exposure (RQs = range from 0.03 to 0.42) (**Table 5-5**). Therefore, refinements using T-HERPS are not needed for any of the agricultural uses for cyfluthrin and *beta*-cyfluthrin.

**Table 5-5. Dietary-Based Chronic RQs Derived Using T-REX for Cyfluthrin and Birds (Agricultural Uses; Flowable).**

| Use, Formulation, Type of Application | Chronic RQs for Birds (Based on Dietary Category) | | | | |
|---|---|---|---|---|---|
| | Short Grass | Tall Grass | Broadleaf Plants | Fruits/Pods/ Seeds | Arthropods |
| Cotton (flowable) | 0.42 | 0.19 | 0.24 | 0.03 | 0.17 |

Based on dietary-based EEC and Northern bobwhite quail NOAEC = 250 mg/kg-diet.

For non-agricultural uses, there are some LOC exceedances for cyfluthrin and *beta*-cyfluthrin using T-REX (see **Table 5-6**). For cyfluthrin, the highest RQs are for the airports/landing fields use (0.436 lb a.i./acre; 7-day application interval). The number of applications allowed per year is not specified on the label(s), therefore, 10 applications were modeled. For this use, all of the RQs exceed the Agency's LOC except for birds that eat fruits/seeds/pods (RQs ranged from 0.76 to 12.1). The lowest specified application rate for a non-agricultural cyfluthrin use is for recreational areas (0.025 lb a.i./acre). For this use, the maximum number of applications allowed per year and the minimum application intervals were not specified on the labels. Therefore, 10 applications made 3 days apart were modeled. For this use, the RQs approached, but did not exceed the Agency's LOC (RQs ranged from 0.06 to 0.93). Therefore, it is assumed that all of the non-agricultural uses of cyfluthrin, except the use on recreational areas, would exceed the Agency's LOC of one for birds using T-REX (at least for some dietary categories).

For *beta*-cyfluthrin, the non-agricultural use with the highest single application rate is 0.191 lb a.i./acre. The number of applications and the minimum application intervals are not specified on the labels for a few uses with this maximum application rate (*i.e.,* for agricultural structures and equipment; and animal feedlots); therefore, a maximum of 10 applications and a minimum 3-day application interval were modeled for these uses. Using these application input parameters, the RQs for birds that eat short grass exceeded the Agency's LOC of 1 (RQs ranged from 0.08 to 1.32). If the application interval is extended to 7-days (*e.g*., the non-agricultural outdoor buildings use which specifies an application rate of 0.192 lb a.i./acre and a minimum application interval of 7-days; 10 applications), none of the RQs exceed (although some approach) the Agency's LOC. Therefore, the only *beta*-cyfluthrin non-agricultural uses that potentially exceed an Agency LOC using T-REX are for agricultural structures and equipment and animal feedlots (only for birds that eat short grass).

**Table 5-6. Dietary-Based Chronic RQs Derived Using T-REX for Cyfluthrin and Beta-Cyfluthrin and Birds (Non-Agricultural Uses; Flowable).**

| Use, Formulation, Type of Application | Chronic RQs for Birds (Based on Dietary Category) | | | | |
|---|---|---|---|---|---|
| | **Short Grass** | **Tall Grass** | **Broadleaf Plants** | **Fruits/Pods/ Seeds** | **Arthropods** |
| **Cyfluthrin** | | | | | |
| Airports/Landing fields | **12.1** | **5.6** | **6.8** | 0.76 | **4.75** |
| Recreational areas | 0.93 | 0.43 | 0.52 | 0.06 | 0.36 |
| ***Beta*-Cyfluthrin** | | | | | |
| Agricultural/Farm Structures/Buildings and Equipment ; Animal feedlots | **1.3** | 0.61 | 0.74 | 0.08 | 0.52 |
| Nonagricultural Outdoor Buildings | 0.99 | 0.45 | 0.56 | 0.06 | 0.39 |

Based on dietary-based EEC and Northern bobwhite quail NOAEC = 250 mg/kg-diet (cyfluthrin).
Based on dietary-based EEC and Northern bobwhite quail NOAEC = 269 mg/kg-diet (*beta*-cyfluthrin).
Bolded numbers exceed the Agency's LOC of 1.

Because there were some LOC exceedances for birds and chronic exposure using T-REX, T-HERPS is used to refine the risk estimates for reptiles and terrestrial-phase amphibians. For terrestrial-phase amphibians and cyfluthrin, using the non-agricultural use with the highest application rate (airports/landing fields), some of the chronic RQs exceed the Agency's LOC (RQs range from 0.05 to 2.4). Because the non-agricultural use with the lowest application rate (recreational areas) had no LOC exceedances, the ornamental use was also modeled (because this represents one of the uses with the second highest application rate for non-agricultural uses; 0.131 lb a.i./acre, 3-day application interval, 10 applications). Although some of the RQs approach the Agency's LOC, there are no LOC exceedances (RQs range from 0.02 to 0.98) (see **Table 5-7**). Therefore, for cyfluthrin and amphibians, only the non-agricultural uses with the highest application rates have RQs that exceed the Agency's LOC of 1.

For *beta*-cyfluthrin, based on modeling the highest non-agricultural use rates in T-HERPS (agricultural structures), none of the non-agricultural uses have RQs for amphibians that exceed the Agency's LOC of 1 (RQs range from 0.01 to 0.47) (see **Table 5-7**).

**Table 5-7. Dietary-Based Chronic RQs Derived Using T-HERPS for Cyfluthrin and *Beta*-Cyfluthrin and Amphibians (Non-Agricultural Uses; Flowable).**

| Use, Formulation, Type of Application | Chronic RQs for Amphibians (Based on Dietary Category) | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Short Grass** | **Tall Grass** | **Broadleaf Plants/Small Insects** | **Fruits/Pods/ Seeds/Large Insects** | **Herbivorous Mammals** | **Insectivorous Mammals** | **Terrestrial-Phase Amphibian** |
| **Cyfluthrin** | | | | | | | |
| Airports/Landing fields | **2.4** | **1.1** | **1.4** | 0.15 | **2.4** | 0.15 | 0.05 |
| Ornamentals | 0.98 | 0.45 | 0.55 | 0.06 | 0.98 | 0.06 | 0.02 |
| Recreational areas | 0.19 | 0.09 | 0.1 | 0.01 | 0.19 | 0.01 | 0.00 |
| ***Beta*-Cyfluthrin** | | | | | | | |
| Agricultural/Farm Structures/Buildings and Equipment ; Animal feedlots | 0.47 | 0.20 | 0.25 | 0.04 | 0.47 | 0.04 | 0.01 |

Based on dietary-based EEC and Northern bobwhite quail NOAEC = 250 mg/kg-diet (cyfluthrin).
Based on dietary-based EEC and Northern bobwhite quail NOAEC = 269 mg/kg-diet (*beta*-cyfluthrin).
Bolded numbers exceed the Agency's LOC of 1.

For reptiles and cyfluthrin, using the non-agricultural use with the highest application rate (airports/landing fields), some of the chronic RQs exceed the Agency's LOC (RQs range from 0.04 to 2.4). Because the non-agricultural use with the lowest application rate (recreational areas) had no LOC exceedances, the ornamental use was also modeled (because this represents one of the uses with the second highest application rate for non-agricultural uses). Although some of the RQs approach the Agency's LOC, there are no LOC exceedances (RQs range from 0.02 to 0.98) (see **Table 5-8**). Therefore, for cyfluthrin and reptiles, only the non-agricultural uses with the highest application rates have RQs that exceed the Agency's LOC of 1.

For *beta*-cyfluthrin, based on modeling the highest non-agricultural use rates in T-HERPS (agricultural structures), only the RQs for reptiles that eat short grass and herbivorous mammals exceed the Agency's LOC of 1 (the RQs are 1.3 and 1.01, respectively) (see **Table 5-8**). Therefore, for *beta*-cyfluthrin and reptiles, only the non-agricultural uses with the highest application rates have RQs that exceed the Agency's LOC of 1.

**Table 5-8. Dietary-Based Chronic RQs Derived Using T-HERPS for Cyfluthrin and Beta-Cyfluthrin and Reptiles (Non-Agricultural Uses; Flowable).**

| Use, Formulation, Type of Application | Chronic RQs for Reptiles (Based on Dietary Category) | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Short Grass** | **Tall Grass** | **Broadleaf Plants/Small Insects** | **Fruits/Pods/ Seeds/Large Insects** | **Herbivorous Mammals** | **Insectivorous Mammals** | **Terrestrial-Phase Amphibian** |
| **Cyfluthrin** | | | | | | | |
| Airports/Landing fields | **2.4** | **1.1** | **1.4** | 0.15 | **1.9** | 0.12 | 0.04 |
| Ornamentals | 0.98 | 0.45 | 0.55 | 0.06 | 0.75 | 0.05 | 0.02 |
| Recreational areas | 0.19 | 0.09 | 0.10 | 0.01 | 0.14 | 0.01 | 0 |
| ***Beta*-Cyfluthrin** | | | | | | | |
| Agricultural/Farm Structures/Buildings and Equipment ; Animal feedlots | **1.3** | 0.61 | 0.74 | 0.08 | **1.01** | 0.06 | 0.02 |

Based on dietary-based EEC and Northern bobwhite quail NOAEC = 250 mg/kg-diet (cyfluthrin).
Based on dietary-based EEC and Northern bobwhite quail NOAEC = 269 mg/kg-diet (*beta*-cyfluthrin).
Bolded numbers exceed the Agency's LOC of 1.

RQs for acute exposure for birds, reptiles, and terrestrial-phase amphibians could not be calculated for cyfluthrin or *beta*-cyfluthrin because definitive toxicity endpoints were not available. For chronic exposure, none of the RQs exceed the Agency's LOC of 1 for any of the agricultural uses of cyfluthrin and *beta*-cyfluthrin. Therefore, direct effects to birds, reptiles, or terrestrial-phase amphibians are not expected from any of the agricultural uses of cyfluthrin or *beta*-cyfluthrin.

For chronic exposure to cyfluthrin from its non-agricultural uses, only the uses with the highest application rates (*e.g*., airports/landing fields) have RQs that exceed the Agency's LOC for birds, terrestrial-phase amphibians, and reptiles. For *beta*-cyfluthrin, the chronic RQs exceed the Agency's LOC only for birds that eat short grass and reptiles that eat herbivorous mammals, and only for the non-agricultural use with the highest application rate (agricultural farm buildings). Based on these results, the non-agricultural uses of cyfluthrin with the highest application rates have the potential to directly affect the CCR, SFGS, and CTS (all DPSs). For *beta*-cyfluthrin, the non-agricultural uses with the highest application rates have the potential to directly affect the SFGS. Additionally, since chronic RQs exceed the LOC for the cyfluthrin and *beta*-cyfluthrin non-agricultural uses with the highest application rates, there is a potential for indirect effects to those listed species that rely on birds, reptiles and/or terrestrial-phase amphibians during at least some portion of their life-cycle [*i.e*., CCR, SFGS, and CTS (all DPSs)].

#### 5.1.2.b. 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. Because cyfluthrin appears more toxic to mammals than *beta*-cyfluthrin, the assessments for mammals are conducted separately for cyfluthrin and *beta*-cyfluthrin.

The potential for indirect effects to the SFGS, CCR, and CTS (all DPSs) may result from direct effects to mammals due to a reduction in prey. Potential indirect effects to the SFGS and CTS may also result from direct effects to mammals due to 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.

*Beta*-cyfluthrin appears much less toxic to mammals than cyfluthrin. When modeling the use with the highest application rates (agricultural buildings) (considering both agricultural and non-agricultural uses), the only RQs that exceed any Agency LOC are the acute RQs for small and medium mammals that eat short grass. They met or exceeded the acute listed species LOC of 0.10 (RQs are 0.12 and 0.10 for small and medium mammals, respectively) (see **Table 5-9**). For granular uses of *beta*-cyfluthrin (0.061 lb a.i./acre applied 10 times; 3-day interval) all of the RQs are below the Agency's listed and non-listed species LOCs for acute exposures [all $LD_{50}/ft^2$ (equivalent to RQs) are ≤0.02]. Therefore, risks to non-listed mammals are not expected from any of the *beta*-cyfluthrin uses.

**Table 5-9. Acute and Chronic RQs Derived Using T-REX for Beta-Cyfluthrin and Mammals (Agricultural Building Use; Flowable).**

| | Dose-Based RQs | | | | | | Dietary-Based RQs |
|---|---|---|---|---|---|---|---|
| | Small mammal 15 grams | | Medium mammal 35 grams | | Large mammal 1000 grams | | Chronic |
| | Acute | Chronic | Acute | Chronic | Acute | Chronic | |
| **Short Grass** | **0.12** | 0.36 | **0.10** | 0.31 | 0.05 | 0.16 | 0.04 |
| **Tall Grass** | 0.06 | 0.17 | 0.05 | 0.14 | 0.03 | 0.08 | 0.02 |
| **Broadleaf plants** | 0.07 | 0.20 | 0.06 | 0.17 | 0.03 | 0.09 | 0.02 |
| **Fruits/pods** | 0.01 | 0.02 | 0.01 | 0.02 | 0.00 | 0.01 | <0.01 |
| **Arthropods** | 0.05 | 0.14 | 0.04 | 0.12 | 0.02 | 0.06 | 0.02 |
| **Seeds** | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | N/A |

Bolded numbers exceed the Agency's LOC for listed mammals.
The rat $LD_{50}$ of 960 mg a.i./kg-bw and estimated NOAEL of 320 mg a.i./mg-bw were used in the modeling.

For flowable cyfluthrin uses, RQs are bounded for the agricultural uses by modeling uses with the highest and lowest specified application rate (cotton and dried beans, respectively). For the cotton use, acute and chronic RQs exceed the Agency's non-listed species RQs (both acute and chronic) for a variety of size classes and dietary categories (see **Table 5-10**). For dried beans, several RQs exceed the listed species LOC (acute and chronic); however, the only RQs that exceed a non-listed species LOC are for chronic exposure [for small and medium mammals that eat short grass (RQs = 1.35 and 1.15, respectively)] (see **Table 5-11**). Therefore, for all of the flowable agricultural uses of cyfluthrin, there are some LOC exceedances for non-listed mammals.

**Table 5-10. Acute and Chronic RQs Derived Using T-REX for Cyfluthrin and Mammals (Cotton Use; Flowable; 0.051 lb a.i./acre; 10 Applications; 3-day Interval).**

| | Dose-Based RQs | | | | | | Dietary-Based RQs |
|---|---|---|---|---|---|---|---|
| | Small mammal 15 grams | | Medium mammal 35 grams | | Large mammal 1000 grams | | Chronic |
| | Acute | Chronic | Acute | Chronic | Acute | Chronic | |
| **Short Grass** | **2.84** | **8.53** | **2.43** | **7.29** | **1.30** | **3.91** | **2.12** |
| **Tall Grass** | **1.30** | **3.91** | **1.11** | **3.34** | **0.60** | **1.79** | 0.97 |
| **Broadleaf plants** | **1.60** | **4.80** | **1.37** | **4.10** | **0.73** | **2.20** | **1.20** |
| **Fruits/pods** | **0.18** | 0.53 | **0.15** | 0.46 | 0.08 | 0.24 | 0.13 |
| **Arthropods** | **1.11** | **3.34** | **0.95** | **2.86** | **0.51** | **1.53** | **0.83** |
| **Seeds** | 0.04 | 0.12 | 0.03 | 0.10 | 0.02 | 0.05 | N/A |

Bolded numbers exceed the Agency's LOCs.
The rat $LD_{50}$ of 50 mg a.i./kg-bw and estimated NOAEL of 5.4 mg a.i./mg-bw were used in the modeling.

**Table 5-11. Acute and Chronic RQs Derived Using T-REX for Cyfluthrin and Mammals (Dried Beans Use; Flowable; 0.03 lb a.i./acre; 2 Applications; 14-day Interval).**

| | Dose-Based RQs | | | | | | Dietary-Based RQs |
|---|---|---|---|---|---|---|---|
| | Small mammal 15 grams | | Medium mammal 35 grams | | Large mammal 1000 grams | | Chronic |
| | Acute | Chronic | Acute | Chronic | Acute | Chronic | |
| **Short Grass** | **0.45** | **1.35** | **0.38** | **1.15** | **0.21** | 0.62 | 0.34 |
| **Tall Grass** | **0.21** | 0.62 | **0.18** | 0.53 | 0.09 | 0.28 | 0.15 |
| **Broadleaf plants** | **0.25** | 0.76 | **0.22** | 0.65 | **0.12** | 0.35 | 0.19 |
| **Fruits/pods** | 0.03 | 0.08 | 0.02 | 0.07 | 0.01 | 0.04 | 0.02 |
| **Arthropods** | **0.18** | 0.53 | **0.15** | 0.45 | 0.08 | 0.24 | 0.13 |
| **Seeds** | 0.01 | 0.02 | 0.01 | 0.02 | 0.00 | 0.01 | 0.34 |

Bolded numbers exceed the Agency's LOCs.
The rat $LD_{50}$ of 50 mg a.i./kg-bw and estimated NOAEL of 5.4 mg a.i./mg-bw were used in the modeling.

For flowable non-agricultural uses, the highest RQs are for the airports/landing field use. When modeling this use, almost all of the RQs (acute and chronic) exceed the non-listed species LOCs for all size and dietary categories. Acute RQs range from 0.10 to 16.2 and chronic RQs range from 0.31 to 48.7 (**Table 5-12**). Because all of the agricultural uses exceed at least one Agency LOC and most of the non-agricultural uses have higher application rates (when compared to the agricultural uses), all non-agricultural uses for cyfluthrin are expected to have at least some LOC exceedances.

**Table 5-12. Acute and Chronic RQs Derived Using T-REX for Cyfluthrins and Mammals (Airport Use; Flowable; 0.436 lb a.i./acre; 10 Applications; 7-day Interval).**

| | Dose-Based RQs | | | | | | Dietary-Based RQs |
|---|---|---|---|---|---|---|---|
| | Small mammal 15 grams | | Medium mammal 35 grams | | Large mammal 1000 grams | | Chronic |
| | Acute | Chronic | Acute | Chronic | Acute | Chronic | |
| **Short Grass** | **16.23** | **48.70** | **13.87** | **41.60** | **7.43** | **22.30** | **12.13** |
| **Tall Grass** | **7.44** | **22.32** | **6.36** | **19.07** | **3.41** | **10.22** | **5.56** |
| **Broadleaf plants** | **9.13** | **27.40** | **7.80** | **23.40** | **4.18** | **12.54** | **6.82** |
| **Fruits/pods** | **1.01** | **3.04** | **0.87** | **2.60** | **0.46** | **1.39** | 0.76 |
| **Arthropods** | **6.36** | **19.08** | **5.43** | **16.29** | **2.91** | **8.73** | **4.75** |
| **Seeds** | **0.23** | 0.68 | **0.19** | 0.58 | **0.10** | 0.31 | **12.13** |

Bolded numbers exceed the Agency's LOCs.
The rat $LD_{50}$ of 50 mg a.i./kg-bw and estimated NOAEL of 5.4 mg a.i./mg-bw were used in the modeling.

For granular agricultural uses of cyfluthrin, the $LD_{50}/ft^2$ (equivalent to an RQ) exceeds the Agency's acute risk LOCs for listed and non-listed species for the small and medium size-classes. The $LD_{50}/ft^2$ s for the agricultural uses (0.131 lb a.i./acre applied 10 times with a 3-day interval) are 2.55 (15g mammal), 1.35 (35g mammal), and 0.11 (1,000g mammal). For granular non-agricultural uses of cyfluthrin, the results are similar. The $LD_{50}/ft^2$ exceeds the Agency's acute risk LOCs for listed and non-listed species for the small and medium size-classes. The $LD_{50}/ft^2$ s for the non-agricultural uses (0.174 lb a.i./acre applied 10 times with a 3-day interval) are 3.39 (15g mammal), 1.80 (35g mammal), and 0.15 (1,000g mammal).

Because no RQs exceeded the non-listed species LOC for any use (considering both agricultural and non-agricultural and flowable and granular uses), indirect effects to those listed species that rely on mammals during at least some portion of their life-cycle from the use of *beta*-cyfluthrin [*i.e.*, CCR, SFGS, and CTS (all DPSs)] are expected to be negligible. For cyfluthrin, all of the uses (both agricultural and non-agricultural) have at least some RQs that exceed an Agency LOC for non-listed species (acute and/or chronic). Therefore, there is a potential for indirect effects to those listed species that rely on mammals during at least some portion of their life-cycle from the use of cyfluthrin (both flowable and granular) [*i.e.*, CCR, SFGS, and CTS (all DPSs)].

#### 5.2.2.c 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 group (family: Scolopacidae) 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 agricultural (sweet corn) and non-agricultural use (paved areas) scenarios that produced some of the highest aquatic EECs for cyfluthrin and *beta*-cyfluthrin were modeled. Only the chronic RQs could be calculated for birds, since the available acute avian endpoints for these chemicals are non-definitive.

For the agricultural and non-agricultural uses of cyfluthrin and *beta*-cyfluthrin, none of the RQs exceed the Agency's non-listed species acute LOC or LOC for chronic exposure. For the 'fog/water shrew' category (surrogate for potential SFGS food items), only the RQs (both acute and chronic) for the cyfluthrin non-agricultural use exceed Agency's non-listed species LOCs (acute RQ = 2.0; chronic RQs = 5.9 and 1.1) (**Table 5-13**).

**Table 5-13. Bioaccumulation Acute and Chronic RQs Derived Using KABAM for Mammals, Birds, Reptiles, and Amphibians Exposed to Various Uses of the Cyfluthrins.**

| Use (Chemical) | RQs for CCR, CTS (all DPSs) and SFGS | | | |
|---|---|---|---|---|
| | Acute Dose-Based | Acute-Dietary-Based | Chronic Dose-Based | Chronic Dietary-Based |
| **CCR (Rail)** | | | | |
| **Paved Areas (Cyfluthrin)** | N/A | N/A | N/A | 0.80 |
| **Sweet Corn (Cyfluthrin** | N/A | N/A | N/A | 0.113 |
| **Paved Areas (*Beta*-Cyfluthrin)** | N/A | N/A | N/A | 0.74 |
| **Sweet Corn (*Beta*-Cyfluthrin** | N/A | N/A | N/A | 0.053 |
| **SFGS and CTS (all DPSs) (Sandpiper group)** | | | | |
| **Paved Areas (Cyfluthrin)** | N/A | N/A | N/A | 0.64 |
| **Sweet Corn (Cyfluthrin** | N/A | N/A | N/A | 0.09 |
| **Paved Areas (*Beta*-Cyfluthrin)** | N/A | N/A | N/A | 0.60 |
| **Sweet Corn (*Beta*-Cyfluthrin** | N/A | N/A | N/A | 0.042 |
| **Fog/Water Shrew** | | | | |
| **Paved Areas (Cyfluthrin)** | **1.99** | N/A | **5.9** | **1.1** |
| **Sweet Corn (Cyfluthrin** | 0.281 | N/A | 0.832 | 0.149 |
| **Paved Areas (*Beta*-Cyfluthrin)** | 0.033 | N/A | 0.099 | 0.018 |
| **Sweet Corn (*Beta*-Cyfluthrin** | 0.002 | N/A | 0.007 | 0.001 |

N/A – not applicable because adequate endpoints are not available.

Bolded numbers exceed and Agency LOC.

Therefore, there is a potential for indirect effects to the SFGS from loss of prey and the CTS (all DPSs) from loss of burrows from non-agricultural uses of cyfluthrin. Based on the KABAM modeling, there are no risks to birds or mammals feeding from aquatic trophic levels from any of the agricultural uses of cyfluthrin and *beta*-cyfluthrin or non-agricultural uses of *beta*-cyfluthrin.

#### 5.2.2.d Inhalation Risks

The Screening Tool for Inhalation Risk (STIR v. 1.0) identifies a potential for risk to birds and mammals from exposure via the inhalation route based on pesticide-specific information. It uses physical chemistry estimates of spray droplet exposure using application method and rate, as well as avian and mammalian toxicity data. The results from STIR modeling indicate that inhalation exposure of terrestrial wildlife to the cyfluthrins is not likely to be an exposure pathway of concern (see **APPENDIX P)**.

#### 5.2.2.e Terrestrial Invertebrates

In order to assess the risks of cyfluthrin and *beta*-cyfluthrin to terrestrial invertebrates, the honey bee 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 0.037 µg a.i./bee (cyfluthrin) and 0.05 µg a.i./bee (*beta*-cyfluthrin) by 1 bee/0.128g, which is based on the weight of an adult honey bee. This converts the $LD_{50}$ to a ppm value [$LD_{50}$ = 0.289 ppm (cyfluthrin) and 0.391 ppm (*beta*-cyfluthrin)] that can be directly compared to the EECs for arthropods in T-REX. EECs (for arthropods) calculated by T-REX are divided by the converted toxicity value for terrestrial invertebrates (in ppm) to calculate RQs.

RQs that exceed the LOC indicate a potential for direct effects to the BCB and the VELB from contact exposure. The potential for indirect effects to the SFGS, CCR, and CTS may result from direct acute effects to terrestrial invertebrates due to a reduction in prey. RQs for indirect effects are calculated in the same manner as those for direct effects. In order to bound the risks, RQs were calculated for the cyfluthrin and *beta*-cyfluthrin uses that had the highest and lowest application rates. For cyfluthrin, the highest EECs are associated with the airports/landing fields use (non-agricultural use) (10 applications at 0.436 lb a.i./acre; 7-day application interval) and some of the lowest are associated with the dried beans use (agricultural use) (3 applications at 0.03 lb a.i./acre; 14-day interval). Risk quotients for cyfluthrin and terrestrial invertebrates are shown in **Table 5-14**. The RQs for all of the uses modeled exceed the Agency's interim LOC of 0.05 (RQs range from 22.8 to 822).

**Table 5-14. Summary of RQs for Terrestrial Invertebrates and Cyfluthrin.**

| Use | EEC (Arthropod) | RQ |
|---|---|---|
| Airports/Landing Fields | 237.5 | **822** |
| Dried beans | 6.6 | **22.8** |

* = LOC exceedances (RQ $\geq$ 0.05) are bolded.
$LD_{50}$ = 0.289 ppm (cyfluthrin)

For *beta*-cyfluthrin, the highest EECs are associated with the agricultural structures use (non-agricultural use) (10 applications at 0.191 lb a.i./acre; 3-day application interval) and some of the lowest are associated with the wheat use (agricultural use) (2 applications at 0.02 lb a.i./acre; 3-day interval). Risk quotients for *beta*-cyfluthrin and terrestrial invertebrates are shown in **Table 5-15**. The RQs for all of the uses modeled exceed the Agency's interim LOC of 0.05 (RQs range from 9.3 to 356.5).

**Table 5-15. Summary of RQs for Terrestrial Invertebrates and *Beta*-Cyfluthrin.**

| Use | EEC (Arthropod) | RQ |
|---|---|---|
| Agricultural structures | 139.4 | **356.5** |
| Wheat | 3.65 | **9.3** |

* = LOC exceedances (RQ $\geq$ 0.05) are bolded.
$LD_{50}$ = 0.391 ppm (*beta*-cyfluthrin)
Wheat 0.02 lb a.i./acre 3-day 2 apps

Based on LOC exceedances for all of the uses modeled, cyfluthrin and *beta*-cyfluthrin do have the potential to directly affect the BCB and VELB (all uses). Additionally, since the LOCs are exceeded, 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.*, SFGS, CCR, and CTS (all DPSs)].

#### 5.2.2.f Terrestrial Plants

Generally, for indirect effects, potential effects on terrestrial vegetation are assessed using RQs from terrestrial plant seedling emergence and vegetative vigor $EC_{25}$ data as a screen. There are currently no data available for terrestrial plants and the cyfluthrins, therefore, RQs for terrestrial plants cannot be calculated here.

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

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 to cyfluthrin or *beta*-cyfluthrin (acute exposure) at the EEC actually occur for a species based on the laboratory toxicity data. 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. If an RQ for a taxon does not exceed an Agency LOC or an acute RQ could not be calculated based on the available data, the chance of individual effect is calculated using the listed species LOC. In addition to a single effects probability estimate based on the mean slope, upper and lower estimates of the effects probability (based on the 95% confidence intervals) are also provided to account for variance in the slope. If a slope for a particular taxon is not available, a default slope of 4.5 (with upper and lower bounds of 2 and 9) is used.

Based on this analysis, the chance of mortality for all aquatic animal taxa modeled [except estuarine/marine fish (agricultural use)] and terrestrial invertebrates exposed to the EECs for all uses of cyfluthrin and *beta*-cyfluthrin is ~1 in 1 (~100%) (**Table 5-16**). This is similar for mammals and agricultural and non-agricultural uses of cyfluthrin (~1 in 1 chance of mortality at the highest EECs). For birds (all cyfluthrin and *beta*-cyfluthrin uses) and mammals (*beta*-cyfluthrin uses) the chance of mortality is much less (~1 in thousands with a slope of 4.5).

**Table 5-16. Summary of Individual Effects Probabilities for Cyfluthrin and *Beta*-Cyfluthrin Exposure.**

| Taxa (Use Category/Chemical) | Acute RQ (highest) or LOC | Probit Slope[1] | Chance of Effect (~1 in…) |
|---|---|---|---|
| Freshwater Fish (Agricultural Use/Cyfluthrin and *Beta*-cyfluthrin) | 6.0 | 7.6 | 1.00 |
| | | 4.7 | 1.00 |
| | | 10.5 | 1.00 |
| Freshwater Fish (Non-Agricultural Use/Cyfluthrin and *Beta*-cyfluthrin) | 33.8 | 7.6 | 1.00 |
| | | 4.7 | 1.00 |
| | | 10.5 | 1.00 |
| Freshwater Invertebrate (Agricultural Use/Cyfluthrin and *Beta*-cyfluthrin) | 1.4 | 4.5 | 1.34 |
| | | 2 | 1.63 |
| | | 9 | 1.10 |
| Freshwater Invertebrate (Non-Agricultural Use/Cyfluthrin and *Beta*-cyfluthrin) | 7.9 | 4.5 | 1.00 |
| | | 2 | 1.00 |
| | | 9 | 1.04 |
| Estuarine/Marine Fish (Agricultural Use/Cyfluthrin and *Beta*-cyfluthrin) | 0.24 | 4.5 | 378 |
| | | 2 | 9.30 |
| | | 9 | 82,200,000 |
| Estuarine/Marine Fish (Non-Agricultural Use/Cyfluthrin and *Beta*-cyfluthrin) | 1.35 | 4.5 | 1.39 |
| | | 2 | 1.66 |
| | | 9 | 1.14 |
| Estuarine/Marine Invertebrate (Agricultural Use/Cyfluthrin and *Beta*-cyfluthrin) | 202.5 | 5.5 | 1.00 |
| | | 3.7 | 1.00 |
| | | 7.3 | 1.00 |
| Estuarine/Marine Invertebrate (Non-Agricultural Use/Cyfluthrin and *Beta*-cyfluthrin) | 32,857 | 5.5 | 1.00 |
| | | 3.7 | 1.00 |
| | | 7.3 | 1.00 |
| Birds (Agricultural and Non-Agricultural Use/Cyfluthrin and *Beta*-cyfluthrin) | 0.10 (LOC) | 4.5 | 294,000 |
| | | 2 | 44.0 |
| | | 9 | 8.86E+18 |
| Mammals (Agricultural Use/*Beta*-cyfluthrin) | 0.10 (LOC) | 4.5 | 294,000 |
| | | 2 | 44.0 |
| | | 9 | 8.86E+18 |
| Mammals (Non-Agricultural Use/*Beta*-cyfluthrin) | 0.12 | 4.5 | 5,850 |
| | | 2 | 30.5 |
| | | 9 | 1.73E+16 |
| Mammals (Agricultural Use/Cyfluthrin) | 2.8 | 4.5 | 1.11 |
| | | 2 | 1.23 |
| | | 9 | 1.00 |
| Mammals (Non-Agricultural Use/Cyfluthrin) | 16.2 | 4.5 | 1.00 |
| | | 2 | 1.01 |
| | | 9 | 1.00 |
| Terrestrial Invertebrate (Agricultural Use/*Beta*-Cyfluthrin) | 9.3 | 4.5 | 1.00 |
| | | 2 | 1.04 |

| | | | |
|---|---|---|---|
| | | 9 | 1.00 |
| Terrestrial Invertebrate (Non-Agricultural Use/*Beta*-Cyfluthrin) | 356.5 | 4.5 | 1.00 |
| | | 2 | 1.00 |
| | | 9 | 1.00 |
| Terrestrial Invertebrate (Agricultural Use/ Cyfluthrin) | 22.8 | 4.5 | 1.00 |
| | | 2 | 1.00 |
| | | 9 | 1.00 |
| Terrestrial Invertebrate (Non-Agricultural Use/ Cyfluthrin) | 822 | 4.5 | 1.00 |
| | | 2 | 1.00 |
| | | 9 | 1.00 |

[1] Default mean (4.5), upper, and lower bound slopes (2 and 9) are used when a slope is not available from the toxicity studies.

### 5.2.1. Primary Constituent Elements of Designated Critical Habitat

For cyfluthrin and *beta*-cyfluthrin 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.

## 5.3. Risk Description

The risk description synthesizes overall conclusions regarding the likelihood of adverse impacts 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 5.2.3. In Section 5.2.3, 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 cyfluthrin's and *beta*-cyfluthrin'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 cyfluthrin and *beta*-cyfluthrin. Based on the available information, the Agency makes a preliminary effects determination of 'may affect' for cyfluthrin and *beta*-cyfluthrin for the BCB, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG; and a preliminary habitat modification determination for the BCB, VELB, CTS-CC, CTS-SB, DS, and TG for both chemicals. 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 for the PCEs of their designated critical habitat.

**Table 5-17. Risk Estimation Summary for Cyfluthrin and *Beta*-Cyfluthrin - Direct and Indirect Effects and Effects to Designated Critical Habitat (PCEs) (the Results are for Both Cyfluthrin and Beta-Cyfluthrin Unless Otherwise Noted).**

| 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) | RQs exceed the non-listed species acute LOC for almost all uses (excluding a few agricultural uses) and exceed the chronic LOC for all uses | Indirect Effects: SFGS, CCR, and CTS (all DPSs) | CTS (all DPSs), TG and DS |
| | Listed Species (Yes) | RQs exceed the listed species acute and chronic LOCs for all uses | Direct Effects: CTS (all DPSs), DS, and TG | |
| Freshwater Invertebrates | Non-listed Species (Yes) | RQs exceed the non-listed species acute LOC for almost all uses (excluding a few agricultural uses) and exceed the chronic LOC for all uses | Indirect Effects: SFGS, CCR, CTS (all DPSs), and DS | CTS (all DPSs) and DS |
| | Listed Species (Yes) | RQs exceed the listed species acute and chronic LOCs for all uses | Direct Effects: CFWS | |
| Estuarine/Marine Fish | Non-listed Species (Yes) | RQs exceed the non-listed species acute LOC for almost all uses (excluding a few agricultural uses) and exceed the chronic LOC for all uses | Indirect Effects: CCR | TG and DS |
| | Listed Species (Yes) | RQs exceed the listed species acute and chronic LOCs for all uses (except the stone fruit use) | Direct Effects: TG and DS | |
| Estuarine/Marine Invertebrates | Non-listed Species (Yes) | RQs exceed the non-listed species acute and chronic LOCs for all uses | Indirect Effects: CCR, TG, and DS | TG and DS |
| | Listed Species (Yes) | RQs exceed the listed species acute and chronic LOCs for all uses | Direct Effects: Not relevant | |

| 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 |
|---|---|---|---|---|
| Vascular Aquatic Plants | RQs could not be calculated with the available data | | | |
| Non-Vascular Aquatic Plants | RQs could not be calculated with the available data | | | |
| Birds, Reptiles, and Terrestrial-Phase Amphibians | Non-listed Species (Yes) | Acute RQs could not be calculated based on available data. Chronic RQs for non-agricultural uses exceed the LOC | Indirect Effects: CCR, SFGS, and CTS (all DPSs) | CTS (all DPSs) |
| | Listed Species (Yes) | Acute RQs could not be calculated based on available data. Chronic RQs for non-agricultural uses exceed the LOC | Direct Effects: CCR, SFGS, CTS (all DPSs) (only non-agricultural uses) | |
| Mammals | Non-listed Species (Yes, for cyfluthrin only) | ***Cyfluthrin***: RQs (acute and chronic) exceed LOCs (agricultural and non-agricultural uses) **Beta-*Cyfluthrin***: No RQs exceed and Agency LOC | Indirect Effects: ***Cyfluthrin***: CCR, SFGS, and CTS (all DPSs) **Beta-*cyfluthrin***: None | CTS (all DPSs) – cyfluthrin only |
| | Listed Species (N./A) | N/A | Direct Effects: N/A | |
| Terrestrial Invertebrates | Listed Species (Yes) | RQs exceed the listed species LOC for all uses | Direct/Indirect Effects: BCB and VELB (direct); SFGS, CCR, and CTS (all DPSs) (indirect) | BCB, VELB, and CTS (all DPSs) |
| Terrestrial Plants - Monocots | RQs could not be calculated with the available data | | | |
| Terrestrial Plants - Dicots | RQs could not be calculated with the available data | | | |

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:

- Significance of Effect: 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 below. 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 cyfluthrin and *beta*-cyfluthrin. Finally, in Section 5.2.3, 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.

### 5.3.1. Direct Effects

#### 5.3.1.a. BCB and VELB

As pyrethroid insecticides, both cyfluthrin and *beta*-cyfluthrin are highly toxic to terrestrial invertebrates. Based on the current methodologies available for assessing risks to terrestrial invertebrates, only the flowable uses were quantifiably assessed. Neither the BCB nor VELB are expected to be readily exposed to granular forms of cyfluthrin or *beta*-cyfluthrin; however, if exposure does occur to either chemical in its granular form, there would be a potential for adverse effects (since the chemicals are so highly toxic to invertebrates).

Based on surrogate data from the honey bee, RQs exceed the Agency's LOC for terrestrial invertebrates indicating a potential for direct effects to the BCB and the VELB from contact exposure.  For cyfluthrin, the highest RQs are associated with the non-agricultural uses (specifically the airports/landing fields use; RQ = 822) and some of the lowest are associated with the agricultural uses (*e.g*., dried beans use; RQ = 23).  Because the RQs for these uses are expected to bound the RQs associated with all of the cyfluthrin uses, this indicates a potential risk to the BCB and VELB from all flowable uses (both agricultural and non-agricultural). Additionally, based on a probit analysis, if terrestrial invertebrates are exposed to cyfluthrin at the EECs modeled, there is an estimated 100% chance of mortality (all uses).

For *beta*-cyfluthrin, as with cyfluthrin, the highest RQs are associated with a non-agricultural use (*e.g*., agricultural structures use; RQ = 356) and some of the lowest are associated with agricultural uses (e.g., wheat use; RQ = 9).  Again, because the RQs for the uses assessed here are expected to bound the RQs associated with all of the *beta*-cyfluthrin uses, this indicates a potential risk to the BCB and VELB from all flowable uses (both agricultural and non-agricultural).  As with cyfluthrin, the chance of mortality is ~100% at the predicted EECs (all uses).

Based on LOC exceedances for all of the uses modeled and the analyses of chance of individual effects, cyfluthrin and *beta*-cyfluthrin have the potential to directly affect the BCB and VELB (all uses).

#### 5.3.1.b.  TG and DS

Cyfluthrin and *beta*-cyfluthrin are highly toxic to aquatic animals, including both freshwater and estuarine/marine fish.  Since both TG and DS can inhabit both freshwater and estuarine/marine habitats, assessments for both freshwater and estuarine/marine fish are considered when determining the potential effects of cyfluthrin and *beta*-cyfluthrin to these listed species.  As discussed previously, all of the EECs and toxicity endpoints for the aquatic animal assessments were converted to '*beta*-cyfluthrin equivalent' values.

For agricultural uses, the highest freshwater fish RQs are for sweet corn, which results in RQs of 5.96 and 39.7 for acute and chronic exposures, respectively.  The agricultural use that results in the lowest RQs is the stone fruits use (RQs = 0.37 and 1.7 for acute and chronic exposures, respectively).  Because the acute and chronic RQs for sweet corn and stone fruits bound the RQs for all of the agricultural uses, and both uses exceed the Agency's LOCs for listed species, this means that all of the agricultural uses exceed the Agency's LOCs for acute and chronic exposures to freshwater fish.  The EECs for non-agricultural uses (*e.g*., non-agricultural structures and paved areas uses) are substantially higher than the agricultural uses (RQs = 34 and 548 for acute and chronic exposures, respectively).  Additionally, there are several ecological incident reports for cyfluthrin involving freshwater fish and the chance of mortality is ~100% at the modeled EECs (all cyfluthrin and *beta*-cyfluthrin uses).

For estuarine/marine fish, some but not all of the agricultural uses exceed the Agency's LOCs for listed species.  The agricultural uses that have RQs that exceed the acute listed species LOC include corn (sweet, field, pop, and 'unspecified'), brassica (leafy vegetables), sorghum, leafy vegetables (non-brassica), cotton, grapes, and hops.  All of the non-agricultural uses exceed the Agency's acute risk LOC for listed species.  The only use (including agricultural and non-agricultural uses) that does not exceed the Agency's listed species LOC for chronic exposure is the stone fruits use. For estuarine/marine fish (both cyfluthrin and *beta*-cyfluthrin), the chance of mortality is ~100% for the non-agricultural uses and about 1 in 378 for the non-agricultural uses.

Based on LOC exceedances for all of the uses modeled (when considering both freshwater and estuarine/marine fish), the available incident data, and the chance of individual effects both cyfluthrin and *beta*-cyfluthrin (all uses) have the potential to directly affect the DS and TG.

#### 5.3.1.c. CFWS

As with other aquatic animals, cyfluthrin and *beta*-cyfluthrin are highly toxic to aquatic invertebrates. For the CFWS assessment, all of the EECs are for *beta*-cyfluthrin and all of ecotoxicity endpoints are based on *beta*-cyfluthrin endpoints, if available, or cyfluthrin endpoints converted to '*beta*-cyfluthrin equivalent' endpoints (as discussed earlier).

Based on the assessment for freshwater invertebrates, the RQs for all of the agricultural uses exceed the Agency's LOCs for acute and chronic exposures (acute RQs = 0.08 to 1.4; chronic RQs range from 3 to 57). The RQs for non-agricultural uses are substantially higher than the agricultural uses. The highest RQs for non-agricultural uses are for the non-agricultural structures and the paved areas uses (the EECs are capped at beta-cyfluthrin's solubility limit – 2.3 µg a.i./L). These uses result in RQs of 7.9 and 57 for acute and chronic exposures, respectively. Based on the probit analysis, there is ~100% chance of mortality if CFWS are exposed to cyfluthrin or *beta*-cyfluthrin at the modeled EECs (all uses).

Based on LOC exceedances and chance of individual effects for all of the uses modeled, cyfluthrin and *beta*-cyfluthrin do have the potential to directly affect the CFWS.

#### 5.3.1.d. CTS (All DPSs)

***Terrestrial-Phase:***

RQs for acute exposure for birds, reptiles, and terrestrial-phase amphibians could not be calculated for cyfluthrin or *beta*-cyfluthrin because definitive toxicity endpoints were not available. The available toxicity data suggest that cyfluthrin is practically non-toxic on an acute basis to avian species based on a bobwhite quail single dose [$LD_{50}$ of >2,000 mg/kg-bw (MRID 00131498)]. In this study there were no mortalities or sublethal effects noted at the tested concentration (NOAEL of 2,000 mg a.i./kg-bw). Sub-acute dietary studies with cyfluthrin also show low toxicity to birds [$LC_{50}$'s of >5000 mg/kg-diet for the mallard duck and bobwhite quail (MRIDs 00131500 and 0013501, respectively)]. In the sub-acute dietary study with the mallard duck (MRID 00131500), there was one mortality and decreased food consumption and body weight gain in the highest treatment group (5,000 mg a.i./kg-diet), resulting in a NOAEC of 2,000 mg a.i./kg-diet. In the bobwhite quail sub-acute dietary study, there was reduced weight gain at the highest concentration tested (5,000 mg a.i./kg-diet) resulting in a NOAEC of 1,000 mg a.i./kg-diet.

When the highest flowable cyfluthrin application rate (considering both agricultural and non-agricultural uses) is modeled (*i.e.*, airports/landing strips) in T-REX, none of the EECs exceed the NOAEL/NOAECs reported in the acute and sub-acute avian studies [the RQs based on foliar residues are expected to be higher than the granular RQs (*i.e.*, $LD_{50}/ft^2$ values)]. Therefore, the EECs for all cyfluthrin uses are below the concentration that elicited any effects (considering sub-lethal and lethal effects) in the available avian studies. Therefore, risks to birds (and, thus reptiles and terrestrial-phase amphibians) from the use of cyfluthrin is expected to be negligible.

There are currently no acute or sub-acute toxicity data available for *beta*-cyfluthrin and birds. However, based on the available data, cyfluthrin appears to be more toxic or equatoxic to terrestrial vertebrates than *beta*-cyfluthrin. Additionally, application rates for cyfluthrin are generally higher than they are for *beta*-cyfluthrin. Therefore, in the absence of additional data showing otherwise, toxicity endpoints for cyfluthrin are expected to be protective of *beta*-cyfluthrin for birds.

For chronic exposure, based on analyses using T-REX, none of the RQs exceed the Agency's LOC of 1 for any of the agricultural uses of cyfluthrin and *beta*-cyfluthrin. Therefore, direct effects to birds, reptiles, or terrestrial-phase amphibians are not expected from any of the agricultural uses of cyfluthrin or *beta*-cyfluthrin.

For chronic exposure to cyfluthrin from its non-agricultural uses (using T-HERPS), only the uses with the highest application rates (*e.g.*, airports/landing fields) have RQs that exceed the Agency's LOC for birds, terrestrial-phase amphibians, and reptiles. For *beta*-cyfluthrin, none of the chronic RQs exceed the Agency's LOC for terrestrial-phase amphibians (considering all dietary categories modeled using T-HERPS). Based on an analysis using KABAM, risk to CTS feeding from aquatic trophic levels is not indicated for any of the agricultural or non-agricultural uses of cyfluthrin or *beta*-cyfluthrin.

Based on these results, the non-agricultural uses of cyfluthrin and *beta*-cyfluthrin with the highest application rates do have the potential to directly affect the CTS (all DPSs; terrestrial-phase). Direct effects to terrestrial-phase CTS are not expected for any of the agricultural uses of cyfluthrin or *beta*-cyfluthrin.

***Aquatic-Phase***:

As discussed previously, cyfluthrin and *beta*-cyfluthrin are highly toxic to aquatic animals, including freshwater fish, which are used as a surrogate for aquatic-phase CTS. For agricultural and non-agricultural uses modeled, all of the RQs exceed the Agency's LOCs for acute and chronic exposures to freshwater fish. The chance of individual effects (i.e., mortality) is ~100% for freshwater fish at the modeled EECs for all cyfluthrin and *beta*-cyfluthrin uses. Additionally, there are several ecological incident reports for cyfluthrin involving freshwater fish.

Based on LOC exceedances for all of the uses modeled for freshwater fish, the chance of individual effects, and the available incident data, both cyfluthrin and *beta*-cyfluthrin (all uses) have the potential to directly affect aquatic-phase CTS (all DPSs).

#### 5.3.1.e. SFGS

Although RQs for acute exposure to birds, reptiles, and terrestrial-phase amphibians could not be calculated for cyfluthrin or *beta*-cyfluthrin, analyses using T-REX and the available avian toxicity data, indicate a low potential for risk to birds (and, thus, reptiles) from acute exposure to cyfluthrin or *beta*-cyfluthrin (see previous discussion). Risks from chronic exposure from agricultural uses are also expected to be low because none of the RQs for cyfluthrin or *beta*-cyfluthrin and agricultural uses exceed the Agency's chronic risk LOC.

For reptiles (using T-HERPS and KABAM), only the non-agricultural uses with the highest application rates have RQs that exceed the Agency's LOC of 1 for cyfluthrin and *beta*-cyfluthrin. Therefore, there is a potential for direct effects to the SFGS from the non-agricultural uses of cyfluthrin and *beta*-cyfluthrin with the highest application rates. Risks (direct effects) to SFGS from the agricultural uses of cyfluthrin and *beta*-cyfluthrin are not expected.

#### 5.3.1.f. CCR

Although RQs for acute exposure to birds could not be calculated for cyfluthrin or *beta*-cyfluthrin, analyses using T-REX and the available avian toxicity data, indicate a low potential for risk to birds (and, thus, reptiles) from acute exposure to cyfluthrin or *beta*-cyfluthrin (see previous discussion). Risks from chronic exposure from agricultural uses are also expected to be low (based on T-REX) because none of the RQs for cyfluthrin or *beta*-cyfluthrin and agricultural uses exceed the Agency's chronic risk LOC.

For non-agricultural uses, there are some avian LOC exceedances (chronic exposure) for cyfluthrin and *beta*-cyfluthrin using T-REX. For cyfluthrin, the highest RQs are for the airports/landing fields use (RQs range from 0.76 to 12.1). The lowest specified application rate for a non-agricultural cyfluthrin use is for recreational areas; for this use, the RQs approach, but do not exceed the Agency's LOC (chronic RQs range from 0.06 to 0.93). Therefore, it is assumed that all of the non-agricultural uses of cyfluthrin, except the use on recreational areas, would exceed the Agency's LOC of one for birds using T-REX (at least for some dietary categories).

For *beta*-cyfluthrin, the non-agricultural use with the highest single application rate (*i.e.,* for agricultural structures and equipment; and animal feedlots) does exceed the Agency's chronic LOC of 1 (RQs ranged from 0.08 to 1.32). However, this is the only *beta*-cyfluthrin non-agricultural use that exceeds an Agency LOC using T-REX (and only for birds that eat short grass). Because CCR are not expected to eat short grass, risks to CCR from any *beta*-cyfluthrin use is not expected based on the T-REX analysis. Based on the KABAM analysis, none of the RQs for agricultural or non-agricultural uses of cyfluthrin or *beta*-cyfluthrin exceed an Agency LOC for the CCR (using the rail as a surrogate).

Therefore, there is a potential for direct effects to the CCR from chronic exposure to cyfluthrin (based on T-REX) for non-agricultural uses. Based on the available data, risks (direct effects) to CCR from any of the agricultural uses of cyfluthrin and *beta*-cyfluthrin are not expected.

#### 5.3.1.g. Indirect Effects

##### i. Potential Loss of Prey

Potential for indirect effects to the listed species assessed here may result from direct effects to their potential prey/food items. For all cyfluthrin and *beta*-cyfluthrin uses modeled, the acute and chronic RQs exceed the non-listed species LOC for freshwater fish. The chance of individual effects is ~100% for all uses. Therefore, 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 (all DPSs)] (all cyfluthrin and *beta*-cyfluthrin uses).

Acute and chronic RQs for all cyfluthrin and *beta*-cyfluthrin uses also exceed the non-listed species LOC for freshwater invertebrates, and the chance of individual effects is ~100% for all uses. Therefore, there is a potential for indirect effects to those listed species that rely on freshwater invertebrates during at least some portion of their life-cycle [*i.e*., SFGS, CCR, CTS (all DPSs), and DS] (all cyfluthrin and *beta*-cyfluthrin uses).

Additionally, acute and/or chronic RQs exceed the non-listed species LOC for estuarine/marine fish for all uses modeled except stone fruits. Therefore, there is a potential for indirect effects to those listed species that rely on estuarine/marine fish during at least some portion of their life-cycle (*i.e*., CCR) (all cyfluthrin and *beta*-cyfluthrin uses except stone fruits).

All of the modeled uses for cyfluthrin and *beta*-cyfluthrin exceed the Agency's acute and chronic risk LOCs for non-listed estuarine/marine invertebrates, and the chance of individual effects is ~100% for all uses. Since the acute and chronic RQs are exceeded and there is a high chance of mortality at the predicted EECs, there is a potential for indirect effects to those listed species that rely on estuarine/marine invertebrates during at least some portion of their life-cycle (*i.e*., CCR, TG, DS) (all cyfluthrin and *beta*-cyfluthrin uses).

For birds, chronic RQs exceed the Agency's chronic risk LOC for the cyfluthrin and *beta*-cyfluthrin non-agricultural uses with the highest application rates. Therefore, there is a potential for indirect effects to those listed species that rely on birds, reptiles and/or terrestrial-phase amphibians during at least some portion of their life-cycle [*i.e*., CCR, SFGS, and CTS (all DPSs)] (only the non-agricultural uses of cyfluthrin and *beta*-cyfluthrin with the highest application rates).

For mammals, cyfluthrin appears more toxic than *beta*-cyfluthrin. Information to explain the difference in toxicity to mammals across the chemicals is not available; but it may indicate that some of the isomers considered 'non-active' in cyfluthrin, may have some activity in mammals. Because none of the RQs exceeded the non-listed species LOC for any use (considering both agricultural and non-agricultural and flowable and granular uses), indirect effects to those listed species that rely on mammals during at least some portion of their life-cycle from the use of *beta*-cyfluthrin are not expected. For cyfluthrin, all of the uses (both agricultural and non-agricultural) have at least some RQs that exceed an Agency LOC for non-listed species (acute and/or chronic), and the chance of the mortality at the modeled EECs is ~100%. Additionally, the KABAM modeling indicates a potential for indirect effects to the SFGS from loss of prey from non-agricultural uses of cyfluthrin. Therefore, there is a potential for indirect effects to those listed species that rely on mammals during at least some portion of their life-cycle from the use of cyfluthrin (both flowable and granular) [*i.e.*, CCR, SFGS, and CTS (all DPSs)] (only cyfluthrin; all uses).

Considering terrestrial invertebrates, since the LOCs are exceeded for all cyfluthrin and *beta*-cyfluthrin uses, and the chance of individual effects is ~100% for all uses, 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.*, SFGS, CCR, and CTS (all DPSs)] (all cyfluthrin and *beta*-cyfluthrin uses).

There are currently no toxicity data available for vascular aquatic plant species and cyfluthrin or *beta*-cyfluthrin. For non-vascular aquatic plants, there are only toxicity data currently available for cyfluthrin. In the available studies using technical cyfluthrin, there were no effects noted at any concentration tested resulting in non-definitive endpoints [$EC_{50}$ > 181 µg a.i./L (*Pseudokirchneriella subcapita*; MRID 43984901); EC > 2 µg a.i./L (the reported limit of solubility) (*Scenedesmus subspicatus*; MRID 48350623)]. There are a variety of studies available for other pyrethroids with marine diatom, green algae and duckweed**.** Of the 11 acceptable or supplemental study endpoints available in the EFED Ecotoxicity database for other pyrethroids, only two have definitive values ($EC_{50}$ = 92 µg a.i./L for permethrin and $EC_{50}$ = 15,000 µg a.i./L for *gamma* cyhalothrin). The remaining nine toxicity endpoints are non-definitive (*i.e.,* > values) because sufficient effects were not observed at the highest test concentration from which to derive an $EC_{50}$. All of the definitive values available are well above (orders of magnitude above) the expected aquatic EECs for cyfluthrin and *beta*-cyfluthrin. Therefore, although there is some uncertainty, indirect effects to the listed species assessed here from effects to aquatic plants are not expected from the registered uses of cyfluthrin and *beta*-cyfluthrin.

No terrestrial plant toxicity data have been submitted for cyfluthrin or *beta*-cyfluthrin. In addition, no such data were found in the open literature that are considered acceptable for quantitative use in risk assessment. Data from the EFED Ecotoxicity database on the toxicity of other pyrethroids to plants were available for only two pyrethroids and no definitive toxicity values are available. There are some terrestrial plant incident reports for cyfluthrin and *beta*-cyfluthrin.

For cyfluthrin, IDS contains 133 aggregated incident reports for plants. The incidents occurred between 1999 and 2010. Information on the products involved in the incidents is provided, but no other data are available for the aggregate incidents. The EIIS contains three cyfluthrin incidents reported for terrestrial plants (I016940-010, I001728-001, and I013550-002). One of the incidents (I016940-010) lists cyfluthrin as "highly probable" for a cause of the incident but was considered a misuse. Another plant incident (I001728-001) is listed as "probable" for a registered use of cyfluthrin. The third incident report (I013550-002), is listed as "possible" for a registered use of cyfluthrin in the EIIS; however, the Department of Agriculture investigated and determined there was glyphosate (PC Code 417300) contamination in the containers used.

For *beta*-cyfluthrin, IDS contains two aggregate incident reports involving *beta*-cyfluthrin for plants. One occurred in 2004 and one occurred in 2008. Information on the products involved in the incident is provided, but no other data are available for the aggregate incidents. There is also one terrestrial plant incident for *beta*-cyfluthrin in the EIIS (I023302-035). *Beta*-cyfluthrin is listed as a 'possible' cause of the incident and the legality of use is classified as a 'registered use'.

Although far from definitive, there is evidence to suggest that the use of cyfluthrin and *beta*-cyfluthrin may have adverse effects on non-target plants. Based on the available information, however, it is not possible to quantify the concentrations required for adverse effects or the type of damage that may result from unintentional exposure. Therefore, in the absence of additional information to show otherwise, it is assumed that the registered uses of cyfluthrin and *beta*-cyfluthrin may adversely affect non-target terrestrial plants; and, thus, there is a potential for indirect effects to those listed species that rely on terrestrial plants for food during at least some portion of their life-cycle [*i.e*., CCR, BCB, and VELB ] (all cyfluthrin and *beta*-cyfluthrin uses).

#### ii. Potential Modification of Habitat

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 streambanks. In addition, vascular aquatic plants are important as attachment sites for egg masses of aquatic species. As discussed earlier, although there is some uncertainty regarding the available data, risks to aquatic plants are not expected from the registered uses of cyfluthrin or *beta*-cyfluthrin.

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 watershed, and serving as an energy source.

As discussed previously, although far from definitive, there is evidence to suggest that the use of cyfluthrin and *beta*-cyfluthrin may have adverse effects on non-target plants; however, it is not possible to quantify the concentrations required for adverse effects or the type of damage that may result from unintentional exposure at this time. Therefore, in the absence of additional information to show otherwise, it is assumed that the registered uses of cyfluthrin and *beta*-cyfluthrin may adversely affect non-target terrestrial plants; and, thus, there is a potential for indirect effects to those listed species that rely on terrestrial plants as a component of their habitat during at least some portion of their life-cycle [*i.e*., BCB, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG] (all cyfluthrin and *beta*-cyfluthrin uses).

CTS (all DPSs) also, rely on mammals for burrows in addition to relying on them as prey items. Based on no RQs that exceed a non-listed species LOC for any use (considering both agricultural and non-agricultural and flowable and granular uses), indirect effects to CTS from the loss of mammal burrows are not expected for any *beta*-cyfluthrin use. For cyfluthrin, all of the uses (both agricultural and non-agricultural) have at least some RQs that exceed an Agency LOC for non-listed species (acute and/or chronic). Additionally, the KABAM modeling indicates a potential for indirect effects to the CTS (loss of mammal burrows) from non-agricultural uses of cyfluthrin. Therefore, there is a potential for indirect effects to CTS (all DPSs)] from the loss of mammal burrows from the use of cyfluthrin (only cyfluthrin; all uses).

### 5.3.2. Modification of Designated Critical Habitat

Based on the analyses discussed above, there is a potential for habitat modification from the use of cyfluthrin and *beta*-cyfluthrin for the critical habitats designated for the BCB, VELB, CTS-CC, CTS-SB, DS, and TG. For the BCB and VELB this is based on potential concentrations of cyfluthrin and *beta*-cyfluthrin high enough to cause potential direct effects to the BCB and VELB and for potential effects to terrestrial plants (which are used for food and habitat). For the CTS (both the Central Californian and Santa Barbara DPSs), there is a potential for habitat modification based on potential direct effects to aquatic-phase CTS from all of the uses of cyfluthrin and *beta*-cyfluthrin, and direct effects to terrestrial-phase CTS for the non-agricultural uses of cyfluthrin and *beta*-cyfluthrin. There is also a potential for effects to potential CTS prey items [*e.g*., mammals (cyfluthrin only), fish, aquatic invertebrates, and terrestrial invertebrates] and habitat (*e.g*., effects to terrestrial plants from all uses of cyfluthrin and *beta*-cyfluthrin and loss of mammal burrows for all uses of cyfluthrin). For the DS and TG, there is a potential for concentrations of cyfluthrin and *beta*-cyfluthrin in water to be high enough to cause direct effects to the DS and TG from all registered uses of these chemicals. Additionally, there is a potential for loss of prey (*e.g.,* aquatic invertebrates) and alteration of water quality parameters based on effects to terrestrial plants from all of the uses of cyfluthrin and *beta*-cyfluthrin.

### 5.3.3. Spatial Extent of Potential Effects

Since LOCs are exceeded, normally an 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, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and/or TG habitat and/or areas of occurrence and/or critical habitat, a likely to adversely affect determination is made. If the Potential Area of LAA Effects and these species' habitat and areas of occurrence and/or critical habitat do not overlap, a no effect determination is made.

However, because of the wide area of potential use for both cyfluthrin and *beta*-cyfluthrin, the chemicals could be used almost anywhere in the state of California (*e.g*., there are agricultural uses, residential uses, commercial outdoor uses, rights-of-way uses, *etc*.). Therefore, the determination of a buffer distance and downstream dilution for spatial extent of the effects determination is not needed for this assessment; the entire state of California represents the spatial extent of potential effects.

#### 5.3.3.a. Overlap of Potential Areas of LAA Effect and Habitat and Occurrence of BCB, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG

The Potential Area of LAA Effects on survival, growth, and reproduction for the BCB, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG from cyfluthrin and *beta*-cyfluthrin potentially includes the entire state of California. Therefore, there is a spatial overlap of the effects area and all of the assessed species (and their designated critical habitats) and all of the uses assessed for both cyfluthrin and *beta*-cyfluthrin. This indicates that all uses of both cyfluthrin and *beta*-cyfluthrin in California has the potential to affect the BCB, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG and to modify the critical habitat of BCB, VELB, CTS-CC, CTS-SB, DS, and TG.

### 5.4. Effects Determinations

#### 5.4.1.a. BCB and VELB

Based on LOC exceedances for all of the uses modeled (direct effects), the analyses of chance of individual effects (direct effects), the potential for indirect effects (loss of food and alteration of their habitat from potential effects to terrestrial plants), and a spatial overlap of potential effects, cyfluthrin and *beta*-cyfluthrin have the potential to directly and indirectly affect the BCB and VELB (all uses). Therefore, the Agency makes a LAA determination for the BCB and cyfluthrin (all use), the BCB and *beta*-cyfluthrin (all uses), the VELB and cyfluthrin (all uses), and the VELB and *beta*-cyfluthrin (all uses). The Agency also makes a habitat modification determination for BCB and cyfluthrin (all use), BCB and *beta*-cyfluthrin (all uses), VELB and cyfluthrin (all uses), and VELB and *beta*-cyfluthrin (all uses).

#### 5.4.1.b. TG and DS

Based on LOC exceedances for all of the uses modeled (when considering both freshwater and estuarine/marine fish) (direct effects), the available incident data, the chance of individual effects (direct and indirect effects), the potential for loss of prey (aquatic invertebrates), potential for alterations in water quality parameters from effects to terrestrial plants, and a spatial overlap of the effects areas, both cyfluthrin and *beta*-cyfluthrin (all uses) have the potential to directly and indirectly affect the DS and TG. Therefore, the Agency makes a LAA determination for DS and cyfluthrin (all use), DS and *beta*-cyfluthrin (all uses), TG and cyfluthrin (all uses), and TG and *beta*-cyfluthrin (all uses). The Agency also makes a habitat modification determination for DS and cyfluthrin (all use), DS and *beta*-cyfluthrin (all uses), TG and cyfluthrin (all uses), and TG and *beta*-cyfluthrin (all uses).

#### 5.4.1.c. CFWS

Based on LOC exceedances (direct effects), chance of individual effects, potential for alterations in water quality parameters from effects to terrestrial plants, and a spatial overlap of the effects areas for all of the uses modeled, cyfluthrin and *beta*-cyfluthrin have the potential to directly affect the CFWS. Therefore, the Agency makes a LAA determination for CFWS and cyfluthrin (all use) and CFWS and *beta*-cyfluthrin (all uses).

#### 5.4.1.d. CTS (All DPSs)

***Terrestrial-Phase:***

Direct effects to terrestrial-phase CTS (all DPSs) are not expected from any of the agricultural or non-agricultural uses of cyfluthrin or *beta*-cyfluthrin. Based on the potential for indirect effects to CTS (all DPSs) from loss of prey (amphibians, mammals, and terrestrial invertebrates), alterations in habitat (loss of mammal burrows and effects to terrestrial plants), and an overlap of the effects areas, for the uses modeled, cyfluthrin and *beta*-cyfluthrin (all uses) have the potential to affect terrestrial-phase CTS (all DPSs).

***Aquatic-Phase***:

Based on LOC exceedances (direct effects) for all of the uses modeled for freshwater fish, the chance of individual effects, the available incident data, the potential loss of prey (freshwater fish and aquatic invertebrates), a change in water quality parameters due to effects on terrestrial plants, and a spatial overlap of the effects area, both cyfluthrin and *beta*-cyfluthrin (all uses) have the potential to affect aquatic-phase CTS (all DPSs).

Based on potential effects to both terrestrial- and aquatic-phase CTS, the Agency makes a LAA determination for CTS-CC and cyfluthrin (all use); CTS-SB and cyfluthrin (all uses), CTS-SC and cyfluthrin (all uses), CTS-CC and *beta*-cyfluthrin (all uses), CTS-SB and *beta*-cyfluthrin (all uses), and CTS-SC and *beta*-cyfluthrin (all uses). The Agency also makes a habitat modification determination for CTS-CC and cyfluthrin (all use), CTS-CC and *beta*-cyfluthrin (all uses), CTS-SB and cyfluthrin (all uses), and CTS-SB and *beta*-cyfluthrin (all uses).

#### 5.4.1.e. SFGS

Risks (direct effects) to SFGS from the non-agricultural (but not the agricultural) uses of cyfluthrin and *beta*-cyfluthrin are expected based on LOC exceedances. Additionally, based on potential effects to prey items (freshwater fish, freshwater invertebrates, birds, terrestrial-phase amphibians, mammals, and/or terrestrial invertebrates) and habitat (effects to terrestrial plants) from all uses of cyfluthrin and *beta*-cyfluthrin, the chance of individual effects for some potential prey items, and an overlap of the effects area, there is a potential for effects to the SFGS from all uses of cyfluthrin and *beta*-cyfluthrin. Therefore, the Agency makes a LAA determination for SFGS and cyfluthrin (all use) and SFGS and *beta*-cyfluthrin (all uses).

#### 5.4.1.f. CCR

Based on LOC exceedances, there is a potential for direct effects to the CCR from chronic exposure to cyfluthrin (based on T-REX) for non-agricultural uses. Based on the available data, risks (direct effects) to CCR from any of the agricultural uses of cyfluthrin and *beta*-cyfluthrin are not expected. All of the uses of cyfluthrin and *beta*-cyfluthrin have the potential to affect potential prey items of the CCR (fish, aquatic and terrestrial invertebrates and terrestrial plants) and to modify its habitat (via effects to terrestrial plants). Due to this and the spatial overlap of effects, the Agency makes a LAA determination for the CCR and cyfluthrin (all uses), and the CCR and *beta*-cyfluthrin (all uses).

### 5.4.2. Addressing the Risk Hypotheses

Based on the conclusions of this assessment, none of the risk hypotheses can be rejected for either chemical considered in this assessment, meaning that the stated hypotheses represent concerns in terms of direct and indirect effects of cyfluthrin and *beta*-cyfluthrin on the BCB, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG and their designated critical habitat.

The labeled uses of cyfluthrin and *beta*-cyfluthrin may:

- directly affect BCB, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG by causing mortality or by adversely affecting growth or fecundity;
- indirectly affect BCB, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG and/or modify their designated critical habitat by reducing or changing the composition of food supply;
- indirectly affect CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, 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, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG 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 CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, 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 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).

# 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.

## 6.1. Exposure Assessment Uncertainties

### 6.1.1. Terrestrial Exposure Assessment Uncertainties

#### 6.1.1.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 Birds or Small Mammals).**

| 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 is 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.

#### 6.1.1.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 Mammal) 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.

### 6.1.2. Aquatic Exposure Modeling of Cyfluthrin and *Beta*-cyfluthrin

The aquatic exposure assessment for cyfluthrin and *beta*-cyfluthrin were conducted using environmental fate data for *beta*-cyfluthrin. *Beta*-cyfluthrin was used as a surrogate for cyfluthrin because cyfluthrin contains similar isomers as *beta*-cyfluthrin and it also has a complete environmental fate database. More importantly, the application rate and aquatic toxicity endpoints for cyfluthrin are similar to *beta*-cyfluthrin when they are expressed in *beta*-cyfluthrin equilivalents. These data suggest the insecticidal active isomers in *beta*-cyfluthrin and cyfluthrin are the same. This modeling strategy, however, assumes that the additional isomers in cyfluthrin are less toxic and persistent when compared to the isomers in *beta*-cyfluthrin.

### 6.1.3. Modeled Versus Monitoring Concentrations

The aquatic exposure modeling for cyfluthrin and *beta*-cyfluthrin were conducted using environmental fate data for *beta*-cyfluthrin. The monitoring data analysis, however, was conducted for cyfluthrin because of the lack of monitoring data for *beta*-cyfluthrin.

Tier-II aquatic exposure models are used to estimate high-end exposures of *beta*-cyfluthrin in aquatic habitats resulting from runoff and spray drift from different uses. The models used to predict aquatic EECs are the Pesticide Root Zone Model coupled with the Exposure Analysis Model System (PRZM/EXAMS). The AgDRIFT model was used to estimate the spray fraction of *beta*-cyfluthrin for 150 feet spray drift buffer. Peak model-estimated environmental concentrations resulting from different *beta*- cyfluthrin uses range from 0.025 to 53.089 µg/L (higher than the solubility limit for *beta*-cyfluthrin of 2.3 µg a.i./L). The use of *beta*-cyfluthrin on impervious surfaces led to an extremely high EEC (53.089 µg/L) when compared to the other crop and non-agricultural uses. For most uses, the maximum predicted EECs were less than 0.4 µg/L. For all RQ calculations, the EECs were capped at the solubility limit (*i.e.*, 2.3 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. There were detections (MRL-0.053 to 0.008) of cyfluthrin reported by NAWQA for California surface water with agricultural or urban watersheds. The maximum concentration of cyfluthrin reported by the California Department of Pesticide Regulation(CDPR) surface water database (0.498 µg/L) is roughly 107 times *lower* than the highest peak model-estimated environmental concentration (paved areas) and 2 times *higher* than typical uses of *beta*-cyfluthrin. Cyfluthrin was detected (0.011 to 0.169 µg/g) in sediment from California surface water. The maximum concentration of cyfluthrin reported in the CDPR sediment database (0.169 µg/g) is 4 times lower than lowest predicted cyfluthrin concentration in sediment (0.748 µg/g).

## 6.2. Effects Assessment Uncertainties

There are some general uncertainties regarding toxicity of pyrethroids. Two major factors that affect the toxicity of the pyrethroids include the presence of a synergist, such as piperonyl butoxide (PBO) and the temperature. Amweg *et al.* 2006a documented the effect of PBO on the pyrethroid permethrin's toxicity towards *Hyalella azteca* in sediment samples. It was found that PBO could increase the toxicity of permethrin in sediment up to seven-fold. Also, Amweg and Weston 2007, documented the effects of the presence of PBO in sediments containing the synthetic pyrethroid bifenthrin and other representative chemicals, which included cadmium (a metal), chlorpyrifos (an organophosphate), DDT (an organochlorine), and flouranthene (a polycyclic aromatic hydrocarbon). The presence of PBO was considered as a Toxicity Identification Evaluation (TIE) tool. The 10-day *Hyalella azteca* $LC_{50}$ was 0.26 µg/$g_{OC}$, compared to 0.12 µg/$g_{OC}$ in the presence of PBO in the overlying water, at 25 µg/L (increased toxicity by a factor of 2.2). For the other chemicals, the factor was around or less than 1 with no statistical difference in toxicity for all but chlorpyrifos. Eight field collected sediments, containing a variety of synthetic pyrethroids, or synthetic pyrethroids and chlorpyrifos (except for one sediment that contained only chlorpyrifos), that were previously tested and found to be toxic to *Hyalella azteca*, were examined with and without the presence of PBO. All the sediments exhibited higher toxicity in the presence of PBO except for the sediment that contained only chlorpyrifos.

The effect of temperature was documented by Weston *et al.*, 2009a. In an effort to identify factors affecting the toxicity identification evaluation (TIE) of the synthetic pyrethroids (TIE refers to "manipulating a sample in a manner that alters the toxicity of some toxicants but not others"), they performed sediment toxicity tests at various temperatures (13, 18, 23 and 28ºC). 10-day $LC_{50}$'s to *Hyalella azteca* were determined for four pyrethroids, (permethrin, bifenthrin, esfenvalerate and cyhalothrin), also for chlorpyrifos, cadmium and DDT (which were representative of other classes of chemicals). For the four pyrethroids, the toxicity approximately doubled when the temperature was decreased from 23 to 18ºC, and approximately tripled when the temperature was further decreased to 13ºC. The results at 28ºC were mixed, but for some of the control samples, survival was low, which could indicate that the test species was not tolerant of the change to high temperature. For DDT, there was a similar response profile with temperature, but not as pronounced as for the synthetic pyrethroids. For chlorpyrifos and cadmium, the responses with temperature were either nearly independent of temperature or opposite to the one for the pyrethroids (increasing toxicity with increasing temperature), respectively. Various field samples with known amounts of pyrethroids (some of which contained cyfluthrin), also showed similar responses to those of the tested pyrethroids (as indicated above), with a few exceptions. The authors discussed the possible repercussions of the temperature dependence of the synthetic pyrethroids during the winter season, when the temperatures of the waters and sediments are lower.

### 6.2.1. Data Gaps and Uncertainties

Although several data gaps were noted in the 'Data Gaps' section, Some of the biggest uncertainties regarding data gaps in this assessment are related to the gaps in aquatic and terrestrial plant data. Currently there are only limited data available for aquatic plants and cyfluthrin and *beta*-cyfluthrin. The available data, however, from these chemicals and other pyrethroids seem to support low toxicity to aquatic plants from the use of cyfluthrin and *beta*-cyfluthrin. But this does represent an uncertainty in this risk assessment.

There are currently no terrestrial plant data available for cyfluthrin or *beta*-cyfluthrin, and only limited data available for other pyrethroids. Although, pyrethroids are generally not assumed to be toxic to plants, there have been several terrestrial plant incidents reported for cyfluthrin and *beta*-cyfluthrin (most, but not all, are from aggregated incident reports). Although there is only limited information available on the plant incidents, they do indicate a potential for risk to non-target plants from the use of cyfluthrin and *beta*-cyfluthrin. As noted earlier, plant toxicity data have been requested as part of the Registration Review process for cyfluthrin and *beta*-cyfluthrin, however, they are not available for this assessment. The potential for risk or the potential effects cannot be quantified at this time. Therefore, since risks cannot be precluded (or quantified), risks to terrestrial plants are assumed in this assessment.

Although the risks to aquatic and terrestrial plants represent uncertainties in the risk assessment, additional data would not alter the overall risk determinations made in this assessment because none of the effects determination were made solely on the potential for effects to plants.

### 6.2.2. Use of Surrogate Species Effects Data

Guideline toxicity tests and open literature data on cyfluthrin or *beta*-cyfluthrin are not available for aquatic-phase amphibian or reptiles; therefore, freshwater fish are used as surrogate species for aquatic-phase amphibians and the CTS and birds are used as a surrogate for terrestrial-phase CTS and SFGS. 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. 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.

Additionally, there is some evidence suggesting *Hyalella* is among the more sensitive invertebrates to some pyrethroids based on water column tests (Anderson *et al.*, 2006; Maund *et al.*, 2002). Specific toxicity data for *Hyalella* and cyfluthrin and/or *beta*-cyfluthrin (that are adequate for quantitative use in risk assessment) were not found in the open literature. Therefore, there is a potential that this assessment was not based on the most sensitive aquatic invertebrate.

### 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 t 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.

## 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 cyfluthrin and *beta*-cyflutherin to VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG and their designated critical habitat.

Based on the best available information, the Agency makes a Likely to Adversely Affect determination for the VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG for all uses of cyfluthrin and *beta*-cyfluthrin (**Table 7-1**). Additionally, the Agency has determined that there is the potential for modification of the designated critical habitat for the BCB, VELB, CTS-CC, CTS-SB, DS, and TG from the use of cyfluthrin and *beta*-cyfluthrin (**Table 7-2**). Given the LAA determinations and potential modification of designated critical habitats, a description of the baseline status and cumulative effects is provided in Attachment III.

A summary of the risk conclusions and effects determinations for cyfluthrin and *beta*-cyfluthrin and the VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG 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**. Although separate effects determinations are made for cyfluthrin and *beta*-cyfluthrin, the determinations are presented together since the results of the assessment were similar for both chemicals.

**Table 7-1. Effects Determination Summary for Effects of Cyfluthrin and Beta-Cyfluthrin on the BCB, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, SFGS, and TG.**

| Species | Effects Determination | Basis for Determination |
|---|---|---|
| Bay checkerspot butterfly (*Euphydryas editha bayensis*) (BCB) | May Affect, Likely to Adversely Affect (LAA) (Cyfluthrin and *Beta*-Cyfluthrin) | **Potential for Direct Effects** |
| | | The RQs for all uses of cyfluthrin and *beta*-cyfluthrin (agricultural and non-agricultural) exceed the Agency's LOC for risk to terrestrial invertebrates (representative RQs are 822 and 23 for cyfluthrin – non-agricultural and agricultural uses, respectively; RQs for *beta*-cyfluthrin are 356 and 9 for non-agricultural and agricultural uses, respectively). The chance of mortality at the modeled EECs is ~100% for cyfluthrin and *beta*-cyfluthrin (all uses), and the potential area of effects overlaps with the species range. |
| | | **Potential for Indirect Effects** |
| | | Although not definitive, there is evidence to suggest that the use of cyfluthrin and *beta*-cyfluthrin may have adverse effects on non-target terrestrial plants (based on ecological incident data). Additionally, the area of potential effects to plants overlaps the species' range. BCB is an obligate with dwarf plantains (they are its primary food source). Therefore, in the absence of additional information to show otherwise, it is assumed that the registered uses of cyfluthrin and *beta*-cyfluthrin may adversely affect non-target terrestrial plants; and, thus, there is a potential for indirect effects to BCB from a loss of food and/or an alteration of habitat. |
| Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (VELB) | May Affect, Likely to Adversely Affect (LAA) (Cyfluthrin and *Beta*-Cyfluthrin) | **Potential for Direct Effects** |
| | | The RQs for all uses of cyfluthrin and *beta*-cyfluthrin (agricultural and non-agricultural) exceed the Agency's LOC for risk to terrestrial invertebrates (representative RQs are 822 and 23 for cyfluthrin – non-agricultural and agricultural uses, respectively; RQs for *beta*-cyfluthrin are 356 and 9 for non-agricultural and agricultural uses, respectively). The chance of mortality at the modeled EECs is ~100% for cyfluthrin and *beta*-cyfluthrin (all uses), and the potential area of effects overlaps with the species range. |
| | | **Potential for Indirect Effects** |
| | | Although not definitive, there is evidence to suggest that the use of cyfluthrin and *beta*-cyfluthrin may have adverse effects on non-target terrestrial plants (based on ecological incident data). Additionally, the area of potential effects to plants overlaps the species' range. VELB is an obligate with elderberry trees (they are its sole food source). Therefore, in the absence of additional information to show otherwise, it is assumed that the registered uses of cyfluthrin and *beta*-cyfluthrin may adversely affect non-target terrestrial plants; and, thus, there is a potential for indirect effects to VELB from a loss of food and/or an alteration of habitat. |
| California tiger salamander (*Ambystoma californiense*) [Central California Distinct Population Segment (DPS) – CTS-CC; Sonoma County DPS – CTS-SC; and Santa Barbara County DPS – CTS-SB] | May Affect, Likely to Adversely Affect (LAA) (Cyfluthrin and *Beta*-Cyfluthrin) | **Potential for Direct Effects** |
| | | ***Aquatic-phase (Eggs, Larvae, and Adults):*** RQs exceed the Agency's acute and chronic LOCs for all of the uses modeled for cyfluthrin and *beta*-cyfluthrin (for both agricultural and non-agricultural uses) and freshwater fish (which are used as a surrogate for aquatic-phase CTS) (acute RQs range from 0.37 to 34 and chronic RQs range from 1.7 to 548). Additionally, the chance of individual effects (mortality) for most uses is ~100%, there are aquatic incident reports (fish kills) for cyfluthrin, and the area of effects overlaps with the species' range (all three DPSs). |
| | | ***Terrestrial-phase (Juveniles and Adults)***: Direct effects from acute or chronic exposure are not expected for any cyfluthrin or *beta*-cyfluthrin use (agricultural or non-agricultural). |
| | | **Potential for Indirect Effects** |

| Species | Effects Determination | Basis for Determination |
|---|---|---|
| | | Based on LOC exceedances, there is the potential for indirect effects to CTS (all DPSs) from loss of prey (mammals and/or terrestrial invertebrates) and/or an alteration in habitat (loss of mammal burrows) (from all uses of cyfluthrin and *beta*-cyfluthrin – agricultural and non-agricultural uses). As discussed above, there is also a potential for effects to terrestrial plants from all uses of both chemicals. Additionally, there is an overlap of the effects areas with the species' range (all DPSs). |
| Delta smelt (*Hypomesus transpacificus*) | May Affect, Likely to Adversely Affect (LAA) (Cyfluthrin and *Beta*-Cyfluthrin) | **Potential for Direct Effects** |
| | | RQs exceed the Agency's acute and chronic LOCs for all of the uses modeled for cyfluthrin and *beta*-cyfluthrin (for both agricultural and non-agricultural uses) and freshwater fish (acute RQs range from 0.37 to 34 and chronic RQs range from 1.7 to 548). Additionally, the chance of individual effects (mortality) for most uses modeled is ~100%, there are aquatic incident reports (fish kills) for cyfluthrin, and the area of effects overlaps with the species' range. |
| | | **Potential for Indirect Effects** |
| | | Based on LOC exceedances for both acute and chronic exposures (all uses of cyfluthrin and *beta*-cyfluthrin), there is the potential for loss of prey (aquatic invertebrates) for the DS from the use of these chemicals. Additionally, there is a potential for alterations in water quality parameters from effects to terrestrial plants (specifically riparian habitat) from all uses (cyfluthrin and beta-cyfluthrin). There is spatial overlap of the effects areas for both cyfluthrin and *beta*-cyfluthrin (all uses) and the species' range. |
| California clapper rail (*Rallus longirostris obsoletus*) | May Affect, Likely to Adversely Affect (LAA) (Cyfluthrin and *Beta*-Cyfluthrin) | **Potential for Direct Effects** |
| | | Direct effects to CCR are not expected from acute exposure (considering cyfluthrin and *beta*-cyfluthrin – all uses). For cyfluthrin, all of the chronic RQs for non-agricultural uses except for the use on recreational areas exceed the Agency's LOC (RQs range from 0.06 to 12.1). For *beta*-cyfluthrin, only the non-agricultural use with the highest single application rate (*i.e.,* for agricultural structures and equipment; and animal feedlots) exceed sthe Agency's chronic LOC (RQs ranged from 0.08 to 1.32). Additionally, the area of potential effects overlaps with the species' range. |
| | | **Potential for Indirect Effects** |
| | | All of the uses of cyfluthrin and *beta*-cyfluthrin have the potential to affect potential prey items of the CCR (fish, aquatic and terrestrial invertebrates and terrestrial plants) and to modify its habitat (via effects to terrestrial plants). Due to this and the spatial overlap of effects area with the range of the CCR, there is the potential for indirect effects to the CCR from all uses (both agricultural and non-agricultural) of cyfluthrin ands *beta*-cyfluthrin. |
| California freshwater shrimp (*Syncaris pacificus*) | May Affect, Likely to Adversely Affect (LAA) (Cyfluthrin and *Beta*-Cyfluthrin) | **Potential for Direct Effects** |
| | | The RQs for all of the uses of cyfluthrin and *beta*-cyfluthrin (agricultural and non-agricultural uses) exceed the Agency's LOCs for acute and chronic exposures (acute RQs = 0.08 to 8; chronic RQs range from 3 to 767). Based on the probit analysis, there is ~100% chance of mortality if CFWS are exposed to cyfluthrin or *beta*-cyfluthrin at the modeled EECs (all uses). The potential area of effects overlaps with the range of the CFWS. |
| | | **Potential for Indirect Effects** |
| | | There is a potential for effects to terrestrial plants (specifically riparian habitat) from all uses of cyfluthrin and *beta*-cyfluthrin (agricultural and non-agricultural uses) that could alter water quality parameters. The potential area of this effect overlaps with the range of the CFWS |
| San Francisco | May Affect, | **Potential for Direct Effects** |

| Species | Effects Determination | Basis for Determination |
|---|---|---|
| Garter Snake (*Thamnophis sirtalis tetrataenia*) | Likely to Adversely Affect (LAA) (Cyfluthrin and *Beta*-Cyfluthrin) | None of the agricultural uses of cyfluthrin or *beta*-cyfluthrin are expected to result in direct effects to SFGS (using birds as a surrogate). For reptiles (using T-HERPS), only the non-agricultural uses with the highest application rates have RQs that exceed the Agency's chronic risk LOC for cyfluthrin and *beta*-cyfluthrin. The area of potential effects overlaps with the species' range. Therefore, there is a potential for direct effects to the SFGS from the non-agricultural uses of cyfluthrin and *beta*-cyfluthrin with the highest application rates. |
| | | **Potential for Indirect Effects** |
| | | There is a potential for effects to prey items (freshwater fish, freshwater invertebrates, birds, mammals, and/or terrestrial invertebrates – based on LOC exceedences) and habitat (effects to terrestrial plants – based on incident data) from all uses of cyfluthrin and *beta*-cyfluthrin. The area of potential effects with the range of the SFGS. |
| Tidewater Goby (*Eucyclogobius newberryi)* | May Affect, Likely to Adversely Affect (LAA) (Cyfluthrin and *Beta*-Cyfluthrin) | **Potential for Direct Effects** |
| | | RQs exceed the Agency's acute and chronic LOCs for all of the uses modeled for cyfluthrin and *beta*-cyfluthrin (for both agricultural and non-agricultural uses) and freshwater fish (acute RQs range from 0.37 to 34 and chronic RQs range from 1.7 to 48). Additionally, the chance of individual effects (mortality) for most uses modeled is ~100%, there are aquatic incident reports (fish kills) for cyfluthrin, and the area of effects overlaps with the species' range. |
| | | **Potential for Indirect Effects** |
| | | Based on LOC exceedances for both acute and chronic exposures (all uses of cyfluthrin and *beta*-cyfluthrin), there is the potential for loss of prey (aquatic invertebrates) for the TG from the use of these chemicals. Additionally, there is a potential for alterations in water quality parameters from effects to terrestrial plants (specifically riparian habitat) from all uses (cyfluthrin and *beta*-cyfluthrin). There is spatial overlap of the effects areas for both cyfluthrin and *beta*-cyfluthrin (all uses) and the species' range. |

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

| Designated Critical Habitat for: | Effects Determination | Basis for Determination |
|---|---|---|
| Bay checkerspot butterfly (*Euphydryas editha bayensis*) | Habitat Modification (cyfluthrin and beta-cyfluthrin – all uses) | For the BCB, there is a potential for habitat modification based on potential concentrations of cyfluthrin and *beta*-cyfluthrin (all uses) high enough to cause potential direct effects to the BCB and for potential effects to terrestrial plants (which are used for food and habitat). BCB is an obligate with dwarf plantains (they are its primary food source). The potential area of effects overlaps with the BCB range. |
| Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) | Habitat Modification (cyfluthrin and beta-cyfluthrin – all uses) | For the VELB, there is a potential for habitat modification based on potential concentrations of cyfluthrin and *beta*-cyfluthrin (all uses) high enough to cause potential direct effects to the VELB and for potential effects to terrestrial plants (which are used for food and habitat). VELB is an obligate with elderberry trees (they are its sole food source). The potential area of effects overlaps with the VELB range. |
| California tiger salamander (*Ambystoma californiense*) [Central California Distinct Population Segment (DPS)] | Habitat Modification (cyfluthrin and beta-cyfluthrin – all uses) | For the CTS-CC, there is a potential for habitat modification based on potential direct effects to aquatic-phase CTS from all of the uses of cyfluthrin and *beta*-cyfluthrin. There is also a potential for effects to CTS prey items [*e.g*., mammals (cyfluthrin only), fish, aquatic invertebrates, and terrestrial invertebrates] and habitat (*e.g*., effects to terrestrial plants from all uses of cyfluthrin and *beta*-cyfluthrin and loss of mammal burrows for all uses of cyfluthrin). The areas of potential effect overlaps with the range of the CTS-CC. |
| California tiger salamander (*Ambystoma californiense*) [Santa Barbara County (DPS)] | Habitat Modification (cyfluthrin and beta-cyfluthrin – all uses) | For the CTS-SB, there is a potential for habitat modification based on potential direct effects to aquatic-phase CTS from all of the uses of cyfluthrin and *beta*-cyfluthrin. There is also a potential for effects to CTS prey items [*e.g*., mammals (cyfluthrin only), fish, aquatic invertebrates, and terrestrial invertebrates] and habitat (*e.g*., effects to terrestrial plants from all uses of cyfluthrin and *beta*-cyfluthrin and loss of mammal burrows for all uses of cyfluthrin). The areas of potential effect overlaps with the range of the CTS-SB. |
| Delta smelt (*Hypomesus transpacificus*) | Habitat Modification (cyfluthrin and beta-cyfluthrin – all uses) | For the DS, there is a potential for concentrations of cyfluthrin and *beta*-cyfluthrin in water to be high enough to cause direct effects to the DS from all registered uses of these chemicals. Additionally, there is a potential for loss of prey (*e.g.,* aquatic invertebrates) and alteration of water quality parameters based on effects to terrestrial plants (specifically riparian habitat) from all of the uses of cyfluthrin and *beta*-cyfluthrin. The areas of potential effects overlap with the DS range. |
| Tidewater Goby (*Eucyclogobius newberryi)* | Habitat Modification (cyfluthrin and beta-cyfluthrin – all uses) | For the TG, there is a potential for concentrations of cyfluthrin and *beta*-cyfluthrin in water to be high enough to cause direct effects to the TG from all registered uses of these chemicals. Additionally, there is a potential for loss of prey (*e.g.,* aquatic invertebrates) and alteration of water quality parameters based on effects to terrestrial plants (specifically riparian habitat) from all of the uses of cyfluthrin and *beta*-cyfluthrin. The areas of potential effects overlap with the TG range. |

**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] | | Estuarine/Marine Invertebrates[4] | | Aquatic Plants[5] |
| | Acute | Chronic | Acute | Chronic | Acute | Chronic | Acute | Chronic | |
| Agricultural use (cyfluthrin) | Yes (most uses) | Yes | Yes (most uses) | Yes | Yes (most uses) | Yes | Yes | Yes | No |
| Non-agricultural Use (cyfluthrin) | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No |
| Agricultural use (*beta*-cyfluthrin) | Yes (most uses) | Yes | Yes (most uses) | Yes | Yes (most uses) | Yes | Yes | Yes | No |
| Non-agricultural Use (*beta*-cyfluthrin) | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No |

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, and 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.

**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] | Terr-estrial Plants[6] |
| | Acute | Chronic | Acute | Chronic | Acute | Chronic | Acute | Chronic | | |
| Agricultural use (cyfluthrin) | Yes | Yes | No | No | No | No | No | No | Yes | Yes |
| Non-agricultural Use (cyfluthrin) | Yes | Yes | No | Yes | No | No | No | Yes | Yes | Yes |
| Agricultural use (*beta*-cyfluthrin) | No | No | No | No | No | No | No | No | Yes | Yes |
| Non-agricultural Use (*beta*-cyfluthrin) | No | No | No | Yes | No | No | No | Yes | 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, CCR [do not need to include this column if the CCR is the only species consuming frogs] and AW.
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

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, VELB, CTS-CC, CTS-SC, CTS-SB, DS, CCR, CFWS, 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.

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