Risks of Deltamethrin 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 (*Syn caris 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*)

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List of Commonly Used Abbreviations and Nomenclature

µg/kg	Symbol for "micrograms per kilogram"
µg/L	Symbol for "micrograms per liter"
ºC	Symbol for "degrees Celsius"
AAPCO	Association of American Pesticide Control Officials
a.i.	Active Ingredient
AIMS	Avian Monitoring Information System
Acc#	Accession Number
amu	Atomic Mass Unit
BCB	Bay Checkerspot Butterfly
BCF	Bioconcentration Factor
BEAD	Biological and Economic Analysis Division
bw	Body Weight
CAM	Chemical Application Method
CARB	California Air Resources Board
AW	Alameda Whipsnake
CBD	Center for Biological Diversity
CCR	California Clapper Rail
CDPR	California Department of Pesticide Regulation
CDPR-PUR	California Department of Pesticide Regulation Pesticide Use Reporting Database
CFWS	California Freshwater Shrimp
CI	Confidence Interval
CL	Confidence Limit
CTS	California Tiger Salamander
CTS-CC	California Tiger Salamander Central California Distinct Population Segment
CTS-SB	California Tiger Salamander Santa Barbara County Distinct Population Segment
CTS-SC	California Tiger Salamander Sonoma County Distinct Population Segment
DOC	Dissolved Organic Carbon
DS	Delta Smelt
DtD	Down-the-Drain
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
E-FAST	Exposure and Fate Assessment Screening Tool
EFED	Environmental Fate and Effects Division
e.g.	Latin *exempli gratia* ("for example")
EIM	Environmental Information Management System
EPI	Estimation Programs Interface
EqP	Equilibrium Partitioning (theory)
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	K_{OW} (based) Aquatic BioAccumulation Model
kg	Kilogram(s)
kJ/mole	Kilojoules per mole
km	Kilometer(s)
K_{AW}	Air-water Partition Coefficient
K_d	Solid-water Distribution Coefficient
K_F	Freundlich Solid-Water Distribution Coefficient
K_{OC}	Organic-carbon Partition Coefficient
K_{OW}	Octanol–water Partition Coefficient
LAA	Likely to Adversely Affect
lb a.i./A	Pound(s) of active ingredient per acre
LC_{50}	50% (or Median) Lethal Concentration
LD_{50}	50% (or Median) Lethal Dose

LOAEC	Lowest Observable Adverse Effect Concentration
LOAEL	Lowest Observable Adverse Effect Level
LOC	Level of Concern
LOD	Level of Detection
LOEC	Lowest Observable Effect Concentration
LOQ	Level of Quantitation
m	Meter(s)
MA	May Affect
MATC	Maximum Acceptable Toxicant Concentration
m^2/day	Square Meters per Days
ME	Microencapsulated
mg	Milligram(s)
mg/kg	Milligrams per kilogram (equivalent to ppm)
mg/L	Milligrams per liter (equivalent to ppm)
mi	Mile(s)
mmHg	Millimeter of mercury
MRID	Master Record Identification Number
MW	Molecular Weight
n/a	Not applicable
NASS	National Agricultural Statistics Service
NAWQA	National Water Quality Assessment
NCOD	National Contaminant Occurrence Database
NE	No Effect
NLAA	Not Likely to Adversely Affect
NLCD	National Land Cover Dataset
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOAEC	No Observable Adverse Effect Concentration
NOAEL	No Observable Adverse Effect Level
NOEC	No Observable Effect Concentration
NRCS	Natural Resources Conservation Service
OPP	Office of Pesticide Programs
OPPTS	Office of Prevention, Pesticides and Toxic Substances
ORD	Office of Research and Development
PBO	Poperonyl Butoxide
PCE	Primary Constituent Element

PCO	Pest Control Operator
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
POTW	Publically Owned Treatment Works
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
PWG	Pyrethroid Working Group
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 Federally Threatened Bay Checkerspot Butterfly (BCB) (*Euphydryas editha bayensis*), Valley Elderberry Longhorn Beetle (VELB) (*Desmocerus californicus dimorphus*), California Tiger Salamander (*Ambystoma californiense*) Central California Distinct Population Segment (CTS-CC), and Delta Smelt (DS) (*Hypomesus transpacificus*), and the Federally Endangered California Clapper Rail (CCR) (*Rallus longirostris obsoletus*), California Freshwater Shrimp (CFWS) (*Syncaris* *pacifica*), California Tiger Salamander (*Ambystoma californiense*) Sonoma County Distinct Population Segment (CTS-SC) and Santa Barbara County Distinct Population Segment (CTS-SB), San Francisco Garter Snake (SFGS) (*Thamnophis sirtalis tetrataenia*), and Tidewater Goby (TG) (*Eucyclogobius newberryi*) arising from FIFRA regulatory actions regarding use of deltamethrin 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, TG, DS, CTS-CC, CTS-SB and VELB; the other species assessed (CCR, CFWS, SFGS and CTS-SC) do not have designated critical habitat. This assessment was completed in accordance with the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) *Endangered Species Consultation Handbook* (USFWS/NMFS, 1998), procedures outlined in the Agency's Overview Document (USEPA, 2004), and consistent with a suit in which deltamethrin was alleged to be of concern to the BCB, VELB, CTS (all DPS), DS, CCR, CFWS, SFGS and TG (*Center for Biological Diversity* (*CBD*) *vs. EPA et al*. (Case No. 07-2794-JCS)).

The listing date and a general description of the range of each assessed species are as follows (for additional information about the assessed species and the PCEs for the critical habitat for those species for which it applies, see **Sections 2-5 and 2-6**):

- 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 DS was listed as threatened on March 5, 1993 (58 FR 12854) by the USFWS (USFWS, 2007). DS are mainly found in the Suisun Bay and the Sacramento-San Joaquin estuary near San Francisco Bay. During spawning DS move into freshwater.
- The CCR was listed by the USFWS as an endangered species in 1970. The species is found only in California in coastal wetlands along the San Francisco estuary and Suisun Bay.
- The CFWS was listed as endangered in 1988 by the USFWS. The CFWS inhabits freshwater streams in Central California in the lower Russian River drainage and westward to the Pacific Ocean and coastal streams draining into Tomales Bay and southward into the San Pablo Bay.

- The SFGS was listed as endangered in 1967 by the USFWS. The species is endemic to the San Francisco Peninsula and San Mateo County in California in densely vegetated areas near marshes and standing open water.
- The TG was listed as endangered in 1994 by the USFWS. The range of the TG is limited to coastal brackish water habitats along the coast of California.

1.2. Scope of Assessment

1.2.1. Uses Assessed

Deltamethrin [(*S*)-cyano(3-phenoxyphenyl)methyl (1*R*,3*R*)-3-(2,2-dibromoethenyl)-2,2-dimethylcyclopropanecarboxylate] is a broad spectrum synthetic pyrethroid insecticide that targets adults and larvae of many diverse insect species. Deltamethrin was registered in 1988 and was not subject to the process of Re-registration Eligibility Decision. The Registration Review docket opened in March of 2010 (Docket ID EPA-HQ-OPP-2009-0637 in www.regulations.gov), and the Final Work Plan was issued in September 2010. Deltamethrin is currently registered for numerous diverse uses in California that span a large variety of use sites and geographical regions. Registered uses include both agricultural and non-agricultural sites, including corn, cotton, cucurbits, fruiting vegetables, bulb vegetables, various pome fruits, various root crops (e.g., carrots, potatoes, garden beets), artichoke, sorghum, soybeans, sunflowers, tree nuts, domestic dwellings, ornamental lawns and turf, and other ornamentals, caskets (and also morgues and mortuaries), carpets, commercial/institutional/industrial premises, dogs/canines (collars), eating establishments, food stores, greenhouses, hospital/medical institutions premises, household/ domestic dwellings, public building/structures, sewage systems, ships and boats, and zoos. Formulation types registered include dust, wettable powder, flowable concentrate, pressurized liquid, liquid, emulsifiable concentrate, liquid ready-to-use, granular, and water dispersible granules. The chemical structure of deltamethrin is provided in **Figure 1-1**.

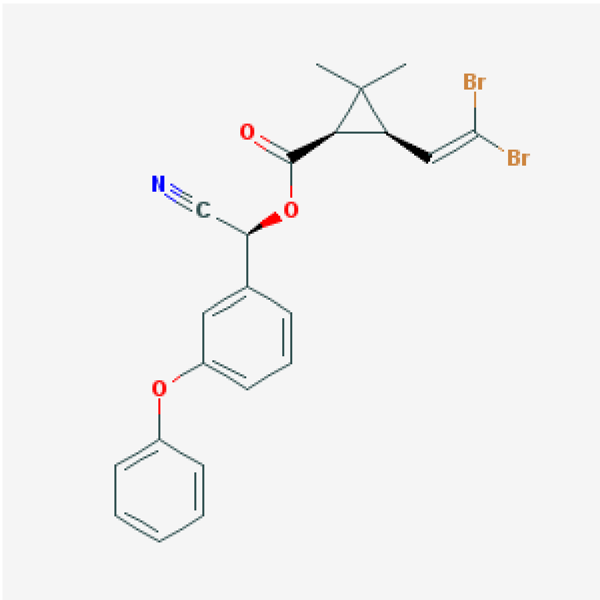


Figure 1-1. Molecular Structure of Deltamethrin

1.2.2. Environmental Fate Properties of Deltamethrin

Deltamethrin is an immobile and insoluble insecticide that is expected to partition strongly to the soil, organic matter and sediment (K_{OW} = 34,200 and K_{OC}>100,000 mL/g_{OC}; immobile, FAO 2000). Spray drift and runoff events accompanied by erosion are the main routes for the chemical to move into adjacent surface water systems (water/sediment). Deltamethrin appears to be moderately persistent in terrestrial environments (aerobic soil metabolism 20-55 days). If the chemical reaches surface waters, there is a elevated level of concern because deltamethrin is very highly toxic to most aquatic water column and benthic organisms. Deltamethrin is relatively stable at pH 5 and 7, but rapidly degraded at a pH of 9 (half-life of 2.5 days). It does not appear to photodegrade substantially in aqueous solutions or on soils. Deltamethrin is also moderately persistent in aquatic environments (aerobic aquatic metabolism half-life of 26-120 days; and anaerobic soil metabolism half-life of 32-47 days). Available terrestrial field dissipation studies appear to confirm the laboratory findings (l-2 months, except the Louisiana study, where the half-life was almost 8 months). In the fish bioconcentration study, the whole body BCF was 698. The depuration was about 50% between days 3-7 and 70-75% after 2 weeks. Due to its low vapor pressure (9.32×10^{-11} torr) and Henry's Law Constant (3.1×10^{-7} atm-m^3/mol), deltamethrin is unlikely to volatilize from either wet or dry surfaces. Furthermore, given its low mobility, it is unlikely to reach groundwater. Refer to **Section 2.4** for additional details about the environmental fate properties of deltamethrin.

The USGS NAWQA Database was accessed on 02/07/2013. Even though deltamethrin is a constituent of the national-level surface and ground waters databases, no samples are reported in California. Surface water monitoring data were accessed from the California Department of Pesticide regulation on 02/07/2013 and a total of 231 samples were analyzed for deltamethrin. Of these, 16 out of 207 surface water samples (7.7%), and 14 out of 24 sediment samples (58.3%), had positive detections of deltamethrin. The maximum surface water concentration was 0.231 µg/L, a value that slightly exceeds the solubility limit of deltamethrin (0.200 µg/L, Laskowski 2002). This slightly high concentration in monitoring data may reflect a higher solubility limit for the chemical in natural versus distilled water due to presence of organic substances in natural waters. The maximum sediment concentration was 0.046 µg/kg. The quantitation limits were variable. Refer to **Section 3.2.4** for additional details about the existing monitoring data for deltamethrin.

1.2.3. Evaluation of Degradates

Deltamethrin yielded various degradates such as 3-phenoxybenzoic acid (CAS No. 3739-38-6), 3-phenoxybenzaldehyde (CAS No. 39515-51-0), and decamethrinic acid (*cis*-3-(2,2-dibromovinyl)-2,2-dimethylcyclopropane-1-carboxylic acid; CAS No. 53179-78-5). These are the result of the breakdown of the ester bond of the parent molecule. Due to loss of the ester bridge, it is believed that the resulting molecules are not as toxic as the parent because they presumably have lost the neurotoxic mode of action. Additionally, they are less persistent than deltamethrin. The only degradate that is considered a stressor is *alpha*-R-deltamethrin. Given its structural similarity to the parent, it was assumed to have the same toxicity as deltamethrin and the total residue approach was taken in modeling exposure concentrations. This modeling strategy requires an assumption that all residues of concern have similar physical, chemical, and partitioning characteristics. Application rates for the parent pesticide are used to represent the total mass loading of pesticide and its degradation product. This modeling approach does not consider temporal occurrence of degradation products. Refer to **Section 6.1.2** for uncertainties related to exposure to deltamethrin and its chirality.

1.3. Assessment Procedures

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

1.3.1. Exposure Assessment

1.3.1.a. Aquatic Exposures

Tier-II aquatic exposure models are used to estimate high-end exposures of deltamethrin 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 v.3.12.2 coupled with the Exposure Analysis Model System v.2.98.04.06 (PRZM/EXAMS). AgDRIFT v.2.1.1 model is also used to estimate deposition of deltamethrin on aquatic habitats from spray drift. Peak model-estimated environmental concentrations resulting from different deltamethrin uses range from 7.99×10^{-5} to 2×10^{-1} µg/L (the latter value being the limit of solubility of the chemical, which is 0.200 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. The maximum concentration of deltamethrin reported by the California Department of Pesticide Regulation surface water database (0.231 µg/L) is roughly 1.2 times higher than the highest peak model-estimated environmental concentration. The NAWQA database contains no surface water monitoring data for California.

1.3.1.b. Terrestrial Exposures

To estimate deltamethrin exposures to terrestrial species, the T-REX v.1.5.1 model is used for foliar and granular uses. The AgDRIFT v.2.1.1 model is also used to estimate deposition of deltamethrin on terrestrial habitats from spray drift. The TerrPlant model is used to estimate deltamethrin exposures to terrestrial-phase habitat, including plants inhabiting semi-aquatic and dry areas, resulting from uses involving foliar deltamethrin applications. The T-HERPS v.1.1 model is used to allow for further characterization of dietary exposures of terrestrial-phase amphibians relative to birds. In conjunction with empirical measures of bioconcentration and bioaccumulation, the KABAM model ($\underline{K}_{OW}$ (based) <u>A</u>quatic <u>B</u>io<u>A</u>ccumulation <u>M</u>odel) v.1.0 is used to estimate potential bioaccumulation of deltamethrin residues in an aquatic food web and subsequent risks these residues pose to organisms consuming aquatic species.

1.3.2. Toxicity Assessment

The assessment endpoints include direct toxic effects on survival, reproduction, and growth of individuals, as well as indirect effects, such as reduction of the food source and/or modification of habitat. Federally-designated critical habitat has been established for the BCB, VELB, DS, TG, CTS-SB and CTS-CC. Primary constituent elements (PCEs) were used to evaluate whether deltamethrin has the potential to modify designated critical habitat. The Agency evaluated registrant-submitted studies and data from the open literature to characterize deltamethrin 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 deltamethrin. Deltamethrin is very highly toxic to freshwater and estuarine/marine fish and invertebrates on an acute exposure basis. Adverse effects to fish and invertebrates from chronic exposure to deltamethrin include reductions in growth and reproduction. Deltamethrin is slightly to practically non-toxic to birds on an acute oral and subacute dietary exposure basis, and is moderately toxic to mammals on an acute oral exposure basis. Deltamethrin is classified as highly toxic to honey bees on an acute contact exposure basis. With birds, no treatment related effects on survival, growth or reproduction were identified following exposure up to 450 ppm in the diet, the highest concentrations tested. For mammals, effects on birds and mammals from chronic exposure to deltamethrin include reduced survival and body weight gains in addition to neurotoxicological symptom. For aquatic plants, adverse effects were not observed at or below its reported solubility in water (0.2 ppb). Terrestrial plants were not affected at an application rate of 0.011 lb ai/A, which is the only concentration tested; however, the maximum single application rates are higher than this value.

1.3.3. Measures of Risk

Acute and chronic risk quotients (RQs) are compared to the Agency's Levels of Concern (LOCs) to identify instances where deltamethrin 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 deltamethrin use "may affect" the assessed species, and/or may cause effects to designated critical habitat, the best available additional information is considered to refine the potential for exposure and effects, and distinguish actions that are Not Likely to Adversely Affect (NLAA) from those that are Likely to Adversely Affect (LAA).

1.4. Summary of Conclusions

Based on the best available information, the Agency makes **May Affect, and Likely to Adversely Affect** determination for the BCB, VELB, CTS (all DPS), DS, CCR, CFWS, SFGS and TG from the use of deltamethrin. Additionally, the Agency has determined that there is the potential for modification of designated critical habitat of the BCB, TG, DS, CTS-CC, CTS-SB and VELB from the use of the chemical. A summary of the risk conclusions and effects determinations for each listed species assessed here and their designated critical habitat is presented in **Table 1-1** and **Table 1-2.** Use-specific determinations are provided in **Table 1-3** and **Table 1-4.** Further information on the results of the effects determination is included as part of the Risk Description in **Section 5.2**. Given the LAA determination for the BCB, VELB, CTS (all DPS), DS, CCR, CFWS, SFGS and TG and potential modification of designated critical habitat for BCB, TG, DS, CTS-CC, CTS-SB and VELB, a description of the baseline status and cumulative effects for these species is provided in Attachment II.

Table 1-1. Effects Determination Summary for Effects of Deltamethrin on the CTS (all DPS: CTS-SC, CTS-CC, CTS-SB), BCB, VELB, DS, CCR, CFWS, SFGS and TG

Species	Effects Determination	Basis for Determination
California Tiger Salamander (CTS, all DPS) (*Ambystoma californiense*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Aquatic-phase (Eggs, Larvae, and Adults): Freshwater fish (surrogate for aquatic phase amphibians) acute RQs range from from **<0.01 to 0.34** and chronic RQs ranged from **<0.01 to 11.8**. Even though none of the acute RQ values exceed the risk to non-listed species LOC (0.5), 31 out of 45 scenarios (69%) exceed the acute risk to listed species LOC (0.05) . Furthermore, about 36% of the uses (16 of 45) exceed the chronic risk LOC (1). One ecological incident has been reported for fish, which is consistent with the risk hypothesis and risk findings. The individual effects chance for acute risk is as high as 1 in 57.1. Given the number and diversity of registered uses (agricultural, industrial, commercial, public, and residential) spanning a large variety of use sites and geographical regions throughout the entire state of California, and the potential for year-round use, it is expected that deltamethrin use is likely to spatially and temporally coincide with all of the critical life-stages of the aquatic phase CTS (all DPS), and disrupt its life-cycle at various points.

Species	Effects Determination	Basis for Determination
		Terrestrial-phase (Juveniles and Adults) Based on T-REX modeling, one RQ exceeds the acute risk to non-listed species LOC (0.5) for birds on a dose-basis, but not on a dietary based RQ (ornamentals, ant mound treatment), The acute risk to listed species LOC (0.1) is exceeded by both the dose and diet-based acute RQ for this scenario, as is the chronic risk LOC (1). The range of acute dose-based RQ values across all scenarios is **<0.01 to <0.74**; the range of acute dietary based RQs is **<0.01 to <0.23**; finally, the range of chronic dietary-based RQs is **<0.01 to 2.34**. The individual effects chance for acute risk is as high as 1 in 3.60 for birds. The T-HERPS refinements for this use for terrestrial-phase amphibians results in an RQ that does not exceed the acute non-listed LOC; however, the listed species LOC and chronic LOC are both exceeded for this pesticide application scenario (acute RQ values **<0.24** to **<0.33**; chronic RQ is **2.45**). The individual effects chance for the CTS, from results from T-HERPS model refinements, is 1 in 66.1. It is noted, however, that absence label information, it was assumed that mounds would be treated up to 12 times with 7-d intervals. Although this application frequency may be unlikely, exceedance of the avian LOC is indicated even for a single application.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover and/or primary productivity Acute and chronic RQ values for freshwater fish exceeded the LOC (as indicated above for the direct effects to CTS). Acute and chronic RQ values for freshwater invertebrates exceed their respective non-listed LOC values. The acute RQ values for freshwater invertebrates (water column and benthic-dwelling) range from **0.01 to 50** (LOC=0.5) and the chronic RQ values range from **>0.21 to >7,690)** (LOC=1).
		Terrestrial prey items, riparian habitat Acute RQ values exceed the LOC for terrestrial invertebrates, ranging from **9.6 to 20,600**. (LOC=0.05). Acute and chronic RQ values exceed the LOC for mammals, which are both a prey item and a source of habitat via small mammal burrows. The acute RQs for small mammals range from **<0.01 to 6.81** (LOC=0.5) and the chronic RQs range from **<0.01** (dietary based) **to 84.5** (dose based) (LOC=1). Potential risk to terrestrial plants identified from several minor incident reports involving terrestrial plants and based on the upper bound of non-definitive RQ values that range from **<0.1 to <24.7**. There is uncertainty in the risk determination for terrestrial plants because the highest test concentrations (which did not elicit adverse effects) were well below the maximum application rates for many of the assessed uses, thus yielding the aforementioned non-definitive RQ values. Had sufficiently high concentrations been tested, actual RQ values may or may not exceed the terrestrial plant LOC.
Bay Checkerspot	May Affect,	**Potential for Direct Effects**

Species	Effects Determination	Basis for Determination
Butterfly (BCB) (*Euphydryas editha bayensis*)	Likely to Adversely Affect (LAA)	Acute RQ values for terrestrial invertebrates range from **9.6 to 20,600**, exceeding the acute risk LOC for the BCB (LOC=0.05). The individual effects probability associated with the acute RQ is 1 in 1.00 for all the application scenarios. Given the number and diversity of registered uses (agricultural, industrial, commercial, public, and residential) spanning a large variety of use sites and geographical regions throughout the entire state of California, and the potential for year-round use, it is expected that deltamethrin use is likely to spatially and temporally coincide with all of the critical life-stages of the BCB, and disrupt its life-cycle at various points.
		Potential for Indirect Effects
		Potential risk to terrestrial plants identified from several minor incident reports involving terrestrial plants and based on the upper bound of non-definitive RQ values that range from **<0.1 to <24.7**. There is uncertainty in the risk determination for terrestrial plants because the highest test concentration (0.011 lb a.i./A) which did not elicit adverse effects are well below the maximum application rates for many of the assessed uses, thus yielding an unbounded NOAEC value. Had sufficiently high concentrations been tested, the NOAEC may be substantially higher thus impacting whether or not the listed species LOC for terrestrial plants is exceeded.
Valley Elderberry Longhorn Beetle (VELB) (*Desmocerus californicus dimorphus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		As indicated for the BCB, acute RQ for terrestrial invertebrates exceed the acute risk to listed species LOC of 0.05 for all foliar applications assessed by a wide margin. The individual effects probability associated with the acute RQ is 1 in 1.00 for all the application scenarios. Given the number and diversity of registered uses (agricultural, industrial, commercial, public, and residential) spanning a large variety of use sites and geographical regions throughout the entire state of California, and the potential for year-round use, it is expected that deltamethrin use is likely to spatially and temporally coincide with all of the critical life-stages of the VELB, and disrupt its life-cycle at various points.
		Potential for Indirect Effects
		As indicated previously for the BCB, potential risks to terrestrial plants is presumed based on several minor incident reports and the upper bound of non-definitive RQ values for monocots and dicots, which range from **<0.1 to <24.7.** There is uncertainty in the risk determination for terrestrial plants because the highest test concentration (0.011 lb a.i./A) which did not elicit adverse effects are well below the maximum application rates for many of the assessed uses, thus yielding an unbounded NOAEC value. Had sufficiently high concentrations been tested, the NOAEC may be substantially higher thus impacting whether or not the listed species LOC for terrestrial plants is exceeded.
Delta Smelt	May Affect,	**Potential for Direct Effects**

Species	Effects Determination	Basis for Determination
(DS) (*Hypomesus transpacificus*)	Likely to Adversely Affect (LAA)	Acute RQs for freshwater and estuarine/marine fish range from from **<0.01 to 0.34** and chronic RQs ranged from **<0.01 to 11.8**. Even though none of the acute RQ values for freshwater and estuarine/marine fish exceed the risk to non-listed species LOC (0.5), 31 (or 69%) exceed the acute risk to listed species LOC (0.05). Furthermore, about 36% of the uses (16 of 45) exceed the chronic risk LOC (1) for freshwater fish and 27% (12 of 45) exceed the chronic LOC for estuarine/marine fish. One ecological incident has been reported for fish, which is consistent with the risk hypothesis and risk findings. The individual effects chance for acute risk is as high as 1 in 57.1. Given the number and diversity of registered uses (agricultural, industrial, commercial, public, and residential) spanning a large variety of use sites and geographical regions throughout the entire state of California, and the potential for year-round use, it is expected that deltamethrin use is likely to spatially and temporally coincide with all of the critical life-stages of the DS, and disrupt its life-cycle at various points.
		Potential for Indirect Effects
		Acute and chronic RQ values for freshwater invertebrates exceed their respective non-listed LOC values. The acute RQs for freshwater invertebrates (water column and benthic-dwelling) range from **0.01 to 50** (LOC=0.5) and the chronic RQ range from **>0.21 to >7,690)** (LOC=1). For estuarine/marine invertebrates (benthic and pelagic), acute RQs range from **0.02 to 54.1** and chronic RQs range from **0.02 to 274**, exceeding the LOCs for DS prey. As indicate previously for BCB and VELB, potential risk to terrestrial plants is presumed based on several minor incident reports involving terrestrial plants and the upper bound of non-defnitive terrestrial plant RQ values which exceed the LOC of 1.
Clapper Rail (CCR) (*Rallus longirostris obsoletus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Based on T-REX modeling, one RQ exceeds the acute risk to non-listed species LOC (0.5) for birds on a dose-basis, but not on a dietary based RQ (ornamentals, ant mound treatment), The acute risk to listed species LOC (0.1) is exceeded by both the dose and diet-based acute RQ for this scenario, as is the chronic risk LOC (1). The range of acute dose-based RQs is **<0.01 to <0.74**; the range of acute dietary based RQs is **<0.01 to <0.23**; finally, the range of chronic dietary-based RQs is **<0.01 to 2.34**. The individual effects chance for acute risk is as high as 1 in 3.60 for birds.
		Potential for Indirect Effects
		Potential indirect effects on birds (as prey to the CCR), is indicated as described above for direct effects. Potential indirect effects are also indicated based on risks to mammals (used as prey), which are described above for indirects effects on the CTS and risks to fish and aquatic invertebrates as identified for the CTS, TG, DS and CFWS. A potential for indirect effects is also indicated based on effects on terrestrial invertebrates as described above for the BCB and VELB and effects on freshwater and estuarine/marine invertebrates as indicated above for the DS and CTS. Therefore, acute and chronic RQ values exceed the non-listed species LOC for multiple taxonomic groups of prey. Potential risk to terrestrial plants identified from several minor incident reports involving terrestrial plants and exceedence of the plant LOC by the upper bounds of non-definitive RQ values that range from **<0.1 to <24.7**.
California	May Affect,	**Potential for Direct Effects**

Species	Effects Determination	Basis for Determination
Freshwater Shrimp (CFWS) (*Syncaris pacifica*)	Likely to Adversely Affect (LAA)	Acute and chronic RQ values for freshwater invertebrates exceed their respective non-listed LOC values. The acute RQs for freshwater invertebrates (water column and benthic-dwelling) range from <**0.01 to 50** (LOC=0.05) and the chronic RQ range from **>0.21 to >7,690)** (LOC=1). All uses (100%) exceed the acute risk to listed species LOC (0.05) (water column); and ,100% of the uses exceed the chronic risk LOC (1) (water column). The individual effects chance for acute risk is as high as 1 in 1. Given the number and diversity of registered uses (agricultural, industrial, commercial, public, and residential) spanning a large variety of use sites and geographical regions throughout the entire state of California, and the potential for year-round use, it is expected that deltamethrin use is likely to spatially and temporally coincide with the CFWS, and disrupt its life-cycle at various points.
		Potential for Indirect Effects
		Acute and chronic RQs for freshwater invertebrates (used as prey) exceed the non-listed species LOC as indicated above. Acute and chronic RQ values also exceed the LOCs for freshwater benthic invertebrates as shown above (acute non-listed LOC=0.5 and the chronic non-listed LOC=1). Potential risk to terrestrial plants identified from several minor incident reports involving terrestrial plants and exceedence of the plant LOC by the upper bounds of non-definitive RQ values that range from **<0.1 to <24.7**.
San Francisco Garter Snake (SFGS) (*Thamnophis sirtalis tetrataenia*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Based on T-REX modeling, one RQ exceeds the acute risk to non-listed species LOC (0.5) for birds on a dose-basis, but not on a dietary based RQ (ornamentals, ant mound treatment), The acute risk to listed species LOC (0.1) is exceeded by both the dose and diet-based acute RQ for this scenario, as is the chronic risk LOC (1). The range of acute dose-based RQs is **<0.01 to <0.74**; the range of acute dietary based RQs is **<0.01 to <0.23**; finally, the range of chronic dietary-based RQs is **<0.01 to 2.34**. The individual effects chance for acute risk is as high as 1 in 3.60 for birds. The T-HERPS refinements for snakes results in acute and chronic RQs that do not exceed any LOCs. The chance of an individual effect is estimated to be 1 in 2.51×10^{6}. Therefore, the potential for direct effects on the SFGS is considered low.
		Potential for Indirect Effects
		Acute and chronic RQ values for prey species (fish and amphibians, freshwater invertebrates, terrestrial invertebrates and small mammals all exceed their respective LOC values as indicated above. Potential risk to terrestrial plants is presumed based on several minor incident reports involving terrestrial plants and the upper bound of non-difinitive RQ values that exceed the LOC that range from **<0.1 to <24.7**.
Tidewater Goby	May Affect,	**Potential for Direct Effects**

Species	Effects Determination	Basis for Determination
(TG) (*Eucyclogobius newberryi*)	Likely to Adversely Affect (LAA)	The potential for direct effects to the TG is indicated as described previously for the DS. Given the number and diversity of registered uses (agricultural, industrial, commercial, public, and residential) spanning a large variety of use sites and geographical regions throughout the entire state of California, and the potential for year-round use, it is expected that deltamethrin use is likely to spatially and temporally coincide with the TG, and disrupt its life-cycle at various points.
		Potential for Indirect Effects
		The potential for indirects effects on the TG from reduction in prey (freshwater and estuarine/marine invertebrates), and habitat (terrestrial plants) is indicated as described previously for the DS.

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

Species	Effects Determination	Basis for Determination
California Tiger Salamander (CTS-SB and CTS-CC) (*Ambystoma californiense*)	Habitat Modification	Direct effects on the CTS-CC and CTS-SB (both terrestrial phase and aquatic phase) and effects on small mammals which provide habitat via burrows. Indirect effects via reduction in aquatic and terrestrial prey items. Potential risk to terrestrial plants identified from several minor incident reports involving terrestrial plants and potential exceedence of LOC based on the upper bounds of non-definitive RQ values.
Bay Checkerspot Butterfly (BCB) (*Euphydryas editha bayensis*)	Habitat Modification	Direct effects BCB. Potential risk resulting from effects to terrestrial plants (including its obligate host plant, the drwarf plantain) based on several minor incident reports involving terrestrial plants and exceedence of the listed species LOC for several of the application scenarios.
Valley Elderberry Longhorn Beetle (VELB) (*Desmocerus californicus dimorphus*)	Habitat Modification	Direct effects VELB. Potential risk resulting from effects to terrestrial plants (including its obligate host plant, elderberry trees) based on several minor incident reports involving terrestrial plants and exceedence of the listed species LOC for several of the application scenarios.
Delta Smelt (DS) (*Hypomesus transpacificus*)	Habitat Modification	Direct effects on DS and indirect effects on aquatic prey. Potential risk to terrestrial plants based on several minor incident reports involving terrestrial plants and potential exceedence of LOC based on the upper bounds of non-definitive RQ values.
Tidewater Goby (TG) (*Eucyclogobius newberryi*)	Habitat Modification	Direct effects on TG and indirect effects on aquatic prey. Potential risk to terrestrial plants based on several minor incident reports involving terrestrial plants and potential exceedence of LOC based on the upper bounds of non-definitive RQ values.

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												
	Freshwater Vertebrates (includes DS, TG, CTS [all DPS])[1]		Freshwater Invertebrates (includes CFWS)[2]		Freshwater Benthic Invertebrates[3]		DS, TG and Estuarine/ Marine Vertebrates[4]		Estuarine/Marine Invertebrates[5]		Estuarine/ Marine Benthic Invertebrates[5]		Vascular and non-vascular plants[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Tree nuts crop group 14 (Aerial, foliar)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Tree nut crop group 14 (Aerial, dormant)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No
Corn (field, pop) (Aerial)	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No
Corn (pop) (Dust)	No	No	Yes	No	No	Yes	No	No	Yes	Yes	Yes	No	No
Sweet corn (Aerial)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No
Sweet corn (Ground)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Sweet corn (Dust)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No
Cotton (Aerial)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Pome fruits (Aerial)	No	No	Yes	No	No	Yes	No	No	Yes	Yes	No	No	No
Cucurbits (Aerial)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No
Cucurbits (Ground)	No	No	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes	No	No
Cucurbits (Dust)	No	No	Yes	Yes	No	No	No	No	Yes	No	No	No	No
Garlic, leeks, onion, shallots (Aerial)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No
Garlic, leeks, onion, shallots (Dust)	No	No	Yes	Yes	No	Yes	No	No	Yes	No	No	No	No
Root vegetables crop subgroup 1B; Tuberous and corm vegetables crop subgroup 1C; (Aerial)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No
Same crops as described in the previous row (Dust)	No	No	Yes	Yes	No	Yes	No	No	Yes	No	No	No	No
Artichokes (Aerial)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Artichokes (Dust)	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	Freshwater Vertebrates (includes DS, TG, CTS [all DPS])[1]		Freshwater Invertebrates (includes CFWS)[2]		Freshwater Benthic Invertebrates[3]		DS, TG and Estuarine/ Marine Vertebrates[4]		Estuarine/Marine Invertebrates[5]		Estuarine/ Marine Benthic Invertebrates[5]		Vascular and non-vascular plants[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato (Aerial)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No
Eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato (Dust)	No	No	Yes	Yes	No	Yes	No	No	Yes	No	No	No	No
Sorghum (Aerial)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No
Canola, rapeseed, crambe (Aerial)	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No
Ornamental and/or Shade Trees; Ornamental Ground Cover (Ground)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Ornamental and/or Shade Trees; Ornamental Ground Cover (Dust)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	No
Ornamental Herbaceous Plants (Ground)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Ornamental Herbaceous Plants (Granular)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Ornamental sod farms (Ground)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Ornamental sod farms (Granular)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Ornamental lawns and turf (Ground)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Golf Course Turf, Recreational Area Lawns (Ground)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	Freshwater Vertebrates (includes DS, TG, CTS [all DPS])[1]		Freshwater Invertebrates (includes CFWS)[2]		Freshwater Benthic Invertebrates[3]		DS, TG and Estuarine/ Marine Vertebrates[4]		Estuarine/Marine Invertebrates[5]		Estuarine/ Marine Benthic Invertebrates[5]		Vascular and non-vascular plants[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Same crops as in the previous row (Granular)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Same crops as in the previous rows (ant mound treatment) (Ground)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Residential Lawns (Ground, six apps)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Residential Lawns (Ground, 12 apps)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Residential Lawns (Granular)	No	No	No	Yes	No	No	No	No	Yes	No	No	No	No
Household Domestic Dwellings Outdoors Premises, Paths/Patios (Ground)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Household Domestic Dwellings Outdoors Premises (Crack & crevice, and/or spot treatment)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Household Domestic Dwellings Outdoors Premises (Granular or Dust)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Wood Protection Treatment to Buildings/ Products (Crack & crevice, and/or spot treatment)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Wood Protection Treatment to Buildings/ Products (Soil drench treatment)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	Freshwater Vertebrates (includes DS, TG, CTS [all DPS])[1]		Freshwater Invertebrates (includes CFWS)[2]		Freshwater Benthic Invertebrates[3]		DS, TG and Estuarine/ Marine Vertebrates[4]		Estuarine/Marine Invertebrates[5]		Estuarine/ Marine Benthic Invertebrates[5]		Vascular and non-vascular plants[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Non-agricultural Rights-of-Way (Ground)	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No
Non-agricultural Rights-of-Way (Perimeter Treatment)	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	No	No
Paved Areas (Crack & crevice, and/or spot treatment)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Utilities, Utility Poles/Rights-of-Way (Granular)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Sewage treatment	No	No	Yes	Yes	NA	NA	No	No	Yes	No	NA	NA	No

NA = Not Available
1 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.
2 A yes in this column indicates a potential for direct effects to the CFWS and indirect effects to the CFWS, SFGS, CCR, CTS-CC, CTS-SB, CTS-SC, TG, and DS.
3 A yes in this column indicates a potential for indirect effects to CFWS, SFGS, CCR, CTS-CC, CTS-SB, CTS-SC, TG, and DS.
4 A yes in this column indicates a potential for direct effects to DS and TG and indirect effects to CCR.
5 A yes in this column indicates a potential for indirect effects to CCR, TG, and DS.
6 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 (all DPS) and Amphibians[3]		SFGS and Reptiles[4]		BCB, VELB, and Invertebrates	Dicots[6]	Monocots[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute[5]		
Canola, rapeseed, crambe	No	No	No	No	No	No	No	No	Yes	No	No
Corn (field, pop)	No	No	No	No	No	No	No	No	Yes	No	No
Cotton	No	Yes	No	No	No	No	No	No	Yes	No	No
Cucurbits, Tomato, Tamillo, Eggplant, Ground Cheery, Pepinos	No	Yes	No	No	No	No	No	No	Yes	No	No
Garlic, Leeks, Onion, Shallots	No	Yes	No	No	No	No	No	No	Yes	No	No
Pome Fruits	No	No	No	No	No	No	No	No	Yes	No	No
Potato & Root Vegetables (1B); Tuberous & Corn Vegetables (1C); Artichokes	No	Yes	No	No	No	No	No	No	Yes	No	No
Sorghum	No	No	No	No	No	No	No	No	Yes	No	No
Sweet Corn	No	Yes	No	No	No	No	No	No	Yes	No	No
Tree Nuts (foliar and dormant)	No	Yes	No	No	No	No	No	No	Yes	No	No
Commercial Outdoor Premises	No	No	No	No	No	No	No	No	Yes	No	No
Domestic Dwellings, Barns, Barnyards (incl. outdoor premises)	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas	No	No	No	No	No	No	No	No	Yes	No	No
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas (Perimeter Treatment)	No	No	No	No	No	No	No	No	Yes	No	No
Ornamental Plants (herbaceous, non-flowering, woody) Lawns and turf	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Ornamental Plants (Shade Trees, Ground Cover)	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes

Uses	Potential for Effects to Identified Taxa Found in the Terrestrial Environment										
	Small Mammals[1]		CCR and Small Birds[2]		CTS (all DPS) and Amphibians[3]		SFGS and Reptiles[4]		BCB, VELB, and Invertebrates	Dicots[6]	Monocots[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute[5]		
Ornamental Plants (Shade Trees, Ground Cover): Ant Mound Treatment	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Ornamental Sod Farms, Lawns, Turf, Recreational Areas	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Residential Lawns (1)	No	No	No	No	No	No	No	No	Yes	No	No
Residential Lawns (2)	No	No	No	No	No	No	No	No	Yes	No	No
Domestic Dwellings (inlcuding outdoor premises) (Granular)	No	N/A	No	N/A	No	N/A	No	N/A	No	No	No
Ornamental Plants (herbaceous, non-flowering, woody) (Granular)	Yes	N/A	Yes	N/A	Yes	N/A	Yes	N/A	No	Yes	Yes
Ornamental Sod Farms (Granular)	Yes	N/A	No	N/A	No	N/A	No	N/A	No	Yes	Yes
Residential Lawns (Granular)	No	N/A	No	N/A	No	N/A	No	N/A	No	No	No
Pet Living Quarters (Granular)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	No	No
Utility Poles, Utility Rights of Way (Granular)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	Yes	Yes

N/A=does not apply
1 A yes in this column indicates a potential for indirect effects to SFGS, CCR, CTS-CC, CTS-SC, CTS, and CTS-SB.
2 A yes in this column indicates a potential for direct effects to CCR and indirect effects to the CCR, SFGS, CTS-CC, CTS-SC, and CTS-SB.
3 A yes in this column indicates a potential for direct effects to CTS-CC, CTS-SC, CTS-SB, and indirect effects to CTS-CC, CTS-SC, CTS-SB, SFGS, and CCR.
4 A yes in this column indicates the potential for direct and indirect effects to SFGS, and other reptiles.
5 A yes in this column indicates a potential for direct effect to BCB and VELB and indirect effects to SFGS, CCR, CTS-CC, CTS-SC, and CTS-SB.
6 A yes in this column indicates a potential for indirect effects to BCB, VELB, SFGS, CCR, CTS-CC, CTS-SC, CTS-SB, TG, DS, and CFWS. For the BCB and VELB this is based on the listed species LOC because of the obligate relationship with terrestrial monocots and dicots. For other species, the LOC exceedances are evaluated based on the LOC for non-listed species.

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 (all DPS), 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 Bay Checkerspot Butterfly (BCB) (*Euphydryas editha bayensis*), Valley Elderberry Longhorn Beetle (VELB) (*Desmocerus californicus dimorphus*), California Tiger Salamander (*Ambystoma californiense*) Central California Distinct Population Segment (CTS-CC), and Delta Smelt (DS) (*Hypomesus transpacificus*), and the Federally Endangered California Clapper Rail (CCR) (*Rallus longirostris obsoletus*), California Freshwater Shrimp (CFWS) (*Syncaris pacifica*), California Tiger Salamander) Sonoma County Distinct Population Segment (CTS-SC) and Santa Barbara County Distinct Population Segment (CTS-SB), San Francisco Garter Snake (SFGS) (*Thamnophis sirtalis tetrataenia*), and Tidewater Goby (TG) (*Eucyclogobius newberryi*) arising from FIFRA regulatory actions regarding use of deltamethrin on a variety of crop and non-crop uses. This ecological risk assessment has been prepared consistent with a stipulated injunction in the case *Center for Biological Diversity* (*CBD*) *vs. EPA et al*. (Case No. 07-2794-JCS) entered in Federal District Court for the Northern District of California on May 17, 2010.

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

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

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

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 down-listed from endangered to threatened in 2004 by the USFWS, however, the down-listing was vacated by the U.S. District Court. Therefore, the Sonoma and Santa Barbara DPSs are currently listed as endangered while the CTS-CC is listed as threatened. 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 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 DS was listed as threatened on March 5, 1993 (58 FR 12854) by the USFWS (USFWS, 2007). DS are mainly found in the Suisun Bay and the Sacramento-San Joaquin estuary near San Francisco Bay. During spawning DS move into freshwater. The PCEs for DSs are shallow fresh or brackish backwater sloughs for egg hatching and larval viability, suitable water with adequate river flow for larval and juvenile transport, suitable rearing habitat, and unrestricted access to suitable spawning habitat.

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

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

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

The TG was listed as endangered in 1994 by the USFWS. The range of the TG is limited to coastal brackish water habitats along the coast of California. 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.

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 deltamethrin is based on an action area. The action area is the area directly or indirectly affected by the federal action, as indicated by the exceedance of the Agency's Levels of Concern (LOCs). It is acknowledged that the action area for a national-level FIFRA regulatory decision associated with a use of deltamethrin 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, TG, DS, CTS-SC, CTS-CC, CTS-SB, VELB, CCR, SFGS and CFWS and their designated critical habitat within the state of California. As part of the "effects determination," one of the following three conclusions will be reached separately for each of the assessed species in the lawsuits regarding the potential use of deltamethrin 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 deltamethrin in accordance with the approved product labels for California is "the action" relevant to this ecological risk assessment.

Deltamethrin is a Type II synthetic pyrethroid (*i.e.*, it is cyano-substituted in the alpha position). It is currently registered for numerous diverse uses in California that span a large variety of use sites and geographical regions. Potential uses include both agricultural and non-agricultural sites. It is a broad spectrum insecticide that targets adults and larvae of many diverse species.

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

2.2.1. Evaluation of Degradates

Table 2-3 shows the chemical structures of deltamethrin's major degradation products. Even though various degradates were observed in the laboratory studies (*e.g.* 3-phenoxybenzoic acid and decamethrinic acid), it was found that they were mainly the result of the rupture of the ester bond of the parent molecule. It is believed that the resulting molecules are not as toxic as the parent because they presumably have lost the neurotoxic mode of action. Furthermore, they appear to be less persistent than deltamethrin. At this time, only *alpha*-R-deltamethrin is considered a stressor. Given its structural similarity to the parent, it is assumed to have the same toxicity than deltamethrin and the total residue approach was taken. The latter degradate was a maximum of 24% of the applied at 14 days in the aerobic aquatic metabolism study and ranged from 8-17% at 28-84 days in the sediment. This is considered a conservative approach, since other isomers of deltamethrin appear to be less active than the parent, as described in **Section 6.1.2** on uncertainties related to the chirality of deltamethrin.

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).

Deltamethrin has registered products that contain multiple active ingredients. Analysis of the available open literature and acute oral mammalian LD_{50} data for multiple active ingredient products relative to the single active ingredient is provided in Appendix A. Although there t appears to be synergism in some instances, the extent is uncertain; therefore, this analysis will be based on the toxicity of the single active ingredient of deltamethrin (see notes below, and **Section 6.2.4** for uncertainties).

Deltamethrin has registered products that contain multiple active ingredients; there are 28 multi-active ingredient products containing deltamethrin, which were evaluated in the **Appendix A**. Deltamethrin can be formulated with s-bioallethrin, pyrethrins, chlorpyrifos-methyl, imiprothrin, piperonyl butoxide (PBO), oil of thyme and geraniol combination, and PBO and s-bioallethrin combination. In the case of deltamethrin, a qualitative examination of the trends in mammalian LD_{50} values, with the associated confidence intervals, across the range of percent active ingredient, reveals no definitive conclusions. In all but one instance, it was concluded that data was insufficient to establish a difference in toxicity. The exception is product with an EPA Reg. No. 66330-390 (Shooter™ Insecticide, containing deltamethrin at 0.75%, geraniol at 17.28% and thyme oil at 36.00% as the active ingredients), for which it was concluded that for females the formulation was more toxic than single active ingredient. Results from this formulated product, however, would not alter the acute risk conclusions for mammals.

There are several studies on mixture analysis in the open literature that provide information about other non-mammalian organisms (a screen of the ECOTOX database is provided in **Appendix A**). Analysis of the multi-active ingredient data on both target and non-target organisms indicates that PBO may synergize the effect of deltamethrin in several organisms, including insects and rats. PBO is a pesticide active ingredient that acts as a synergist. Synergists are chemicals that enhance the pesticidal properties of other chemicals. PBO is intended for use in combination with a wide variety of insecticides and acaricides in ratios ranging from 3:1 to 20:1 by weight. As a synergist, PBO inhibits the mixed function oxidase system of insects and reduces the oxidative breakdown of other pesticides. For example, Weston and coworkers (2006) have conducted sediment toxicity studies for synthetic pyrethroids. In one study, it was found that the presence of PBO in the overlaying water could cause an increase of the toxicity of pyrethroids present in the sediment to the amphipod *Hyalella azteca* (Weston *et al.* 2006). PBO is co-applied with pyrethrins for mosquito control. PBO concentrations of 2−4 µg/L caused a two-fold increase of the toxicity to the amphipod in sediments.

Additionally, there are studies that document synergism between organophosphate insecticides and deltamethrin. Interactions of deltamethrin and various oils are also documented. Carbaryl and carbaryl-PBO combined with deltamethrin are also compared. Finally, the joint effects of pyrethroids in sediments appear to be additive (*e.g.*, Trimble *et al.* 2009) and in rats (*e.g.*, Wolansky *et al.* 2009).

Based on a qualitative evaluation of the best available data and the Agency's existing guidance, it is reasonable to conclude that these formulations may exhibit a synergistic effect in some instances. Given that the active and inert ingredients would not be expected to have similar mechanisms of action, metabolites or toxicokinetic behavior, it is also reasonable to conclude that an assumption of dose-addition would be inappropriate in some instances. However, the limited size of the data set and the variation in co-formulated pesticides prohibits any definitive conclusions. Consequently, an assessment of deltamethrin potential effect when it is co-formulated with other active ingredients will be based on the toxicity of deltamethrin. For uncertainties related to the toxicity of chemical mixtures refer to **Section 6.2.4**.

2.3. Previous Assessments

In 2010, the Environmental Fate and Ecological Risk Assessment Problem Formulation in Support of Registration Review for Deltamethrin, was issued (USEPA 2010a). Functioning as the first stage of the risk assessment process for Registration Review, the problem formulation provides an overview of what is known at the time it is issued, about the environmental fate and ecological effects associated with deltamethrin. It also describes the ecological risk hypothesis and analysis plan for evaluating and characterizing risk to non-target species in support of the Registration Review of deltamethrin. These documents are publicly available in the docket EPA-HQ-OPP-2009-0637 in www.regulations.gov. The revision of the problem formulation included information about the potentiator piperonyl butoxide with the chemical, need for estuarine/ marine toxicity studies and a description of typical end-use product (TEP) testing. Additionally, a response to comments document was issued at the same time the problem formulation was revised based on comments from the State of California and the registrant on the preliminary Problem Formulation (USEPA 2010b). The most substantial comments resulted in a request to include a down-the-drain assessment and a request for a pilot treatability study to inform the assessment. The pilot treatability study will characterize concentrations of deltamethrin in effluent, concentrations in biosolids and resulting removal efficiency in publically owned treatment works (POTWs) based on known concentrations of deltamethrin in influent.

In 2007, EFED conducted an environmental fate and ecological risk assessment for deltamethrin use on flax, and concluded that the chemical is highly toxic to exposed aquatic organisms and to nontarget beneficial insects. Also, the assessment concluded that proposed use patterns prescribed for deltamethrin on flax have the potential for chronic exposure and harm to fish and aquatic invertebrates, including those living in or near the benthos, since deltamethrin is accumulated in the sediment. It was indicated that many use areas are expected to be located adjacent to some types of aquatic habitats, and that drift may be harmful to both beneficial insects and aquatic organisms. Based on the environmental fate properties for deltamethrin, it appears to be immobile, relatively persistent in the environment, stable to hydrolysis and photolysis, and very lipophilic.

Prior to the 2007 assessment on flax, a risk assessment was issued in 2002 for the use of the chemical on field corn, sorghum, soybeans, sunflowers, bulb vegetables, cucurbit vegetables, leafy vegetables, fruiting vegetables, carrots, potatoes, radishes, artichokes, cauliflower, broccoli, cabbage, mustard greens, tree nuts, stone fruits and pome fruits. Findings from the 2002 ecological risk assessment were similar to those described above for flax. In 1994, EFED issued an assessment for the use of the chemical on cotton. The conclusions at the time were as follows: "*Based on the available information EEB concludes that the proposed use poses serious risk to exposed, aquatic organisms or nontarget beneficial insects. Many cotton production sites are expected to be located adjacent to some type of aquatic habitat. Without further precautions against drift contamination (such as application only when/wind direction is away from nontarget aquatic habitats), EEB cannot dismiss the possibility of hazard to aquatic species located in waters adjacent to application sites. The effects of drift to populations of pollinating beneficial insects may also be extreme unless applications are made at times of low activity (foraging) for these species. Endangered species concerns must be addressed on a site by site basis in relation to the ecological risk factor involved with that particular site location (i.e. proximity to critical habitat).*"

In October 1985, the EPA formally consulted with the U.S. Fish and Wildlife Service (USFWS) on the use of tralomethrin on cotton. Tralomethrin is another synthetic pyrethroid whose major transformation product is deltamethrin, the chemical which is the subject of this assessment. Tralomethrin was recently voluntarily cancelled (refer to document ID EPA-HQ-OPP-2012-0425-0002 in www.regulations.gov). In the Agency's letter, EPA proposed certain label restrictions to protect endangered and threatened aquatic species. In response dated November 19, 1985, the USFWS indicated that it did not believe that the use of tralomethrin poses a serious problem for birds and mammals due to the chemical's low toxicity and use pattern; however, in their opinion, the chemical "is likely to jeopardize the continued existence and adversely modify associated designated critical habitats of all listed fishes and amphibians which occur in counties where cotton is grown." To preclude jeopardy, the Services recommended the EPA-proposed label restrictions. EPA had included a list of threatened or endangered species in counties where cotton is grown. Further, the USFWS added certain species of fish and amphibians and excluded freshwater mussels from Tennessee and Virginia, since they do not occur where cotton is grown in those states. None of the species in the original list proposed by EPA or later by the USFWS were from California despite that it was one of the states where the use of tralomethrin was proposed for use.

2.4. Environmental Fate Properties

Table 2-1 lists the physical-chemical properties of deltamethrin. **Table 2-2** lists the other environmental fate properties of deltamethrin, along with the major and minor degradates detected in the submitted environmental fate and transport studies. Deltamethrin has two phenyl rings attached to an oxygen atom (phenyl and phenoxy), and a cyclopropyl ring with a dibromoethenyl group. It is a Type II synthetic pyrethroid (*i.e.*, it is cyano-substituted in the alpha position). The structure of the molecule has three chiral centers that could result in a total of 8 stereoisomers. Chemically, it is the [1R, *cis*; alpha S]-isomer [alternatively, (1S)-alcohol (1R)-*cis*-acid] out of eight stereoisomeric esters of the dibromo analogue of chrysanthemic acid.

Table 2-1. Physical-chemical Properties of Deltamethrin

Property	Value and units	MRID or Source
Molecular Weight	505.2 g/mole	Laskowski, 2002
Chemical Formula	$C_{22}\ H_{19}\ Br_2\ N\ O_3$	EPI Suite v.4.1
CAS No.	52918-63-5	EPI Suite v.4.1
Relative Density Bulk Density	1.59 g/cm^3 at 20^{o}C (CV = 0.4%; technical grade) 0.550 g/cm^3 (technical grade)	MRID 47866503 European Commission (1)
Vapor Pressure	9.32 x 10^{-11} torr @ 25^{o}C [Classified as 'Non-volatile under field conditions.'] (2), (4)	Laskowski, 2002
Henry's Law Constant	3.1 x 10^{-7} atm-m^3/mole	Estimated from water solubility and vapor pressure
Water Solubility	0.000200 mg/L = 0.200 ppb @ 20^{o}C	Laskowski, 2002
Solubility in Organic Solvents	All at 20^{o}C: 5.13±0.18 mg/mL in n-octanol 292.6±3.5 mg/mL in acetone 176.7±8.5 mg/mL in o-xylene	MRID 47866503
Octanol – water partition coefficient (K_{OW})	3.42 x 10^4 @ 25^{o}C (log K_{OW} = 4.53) 9.12 x 10^6 @ 20^{o}C (log K_{OW} = 5.96)	Laskowski, 2002 MRID 47866503
Air-water partition coefficient (K_{AW})	$K_{AW} = C_{air}/C_{water}$ = Henry's Law Constant/(RT) = 1.27x10^{-5} (unitless) [Classified as 'Slightly volatile from a water surface.'] (2)	Calculated
Octanol-air partition coefficient (K_{OA})	$K_{OA} = K_{OW}/K_{AW}$ = 2.7 x 10^9 (unitless)	Calculated
$C_{water+soil}/C_{air}$	$C_{water+soil}/C_{air} = (C_{water}/C_{air})(1/r + K_d)$ = (78700) (1/6 + 3113) = 2.45x10^6 (3) [Classified as 'Non-volatile from a moist soil.'] (2), (3), (4)	Calculated
UV/visible light absorption	Maxima at 267, 271 and 278 nm Low to very low absorption at 290-300 nm; Maxima at 205, 268 and 290 nm in methanol Lower absorption coefficient (ε) at 290 nm.	European Commission (1); MRID 47866503

(1) Review report for the active substance deltamethrin, European Commission, 6504/VI/99-final, October 17, 2002, Appendix I, Identity, physical and chemical properties (July 4, 2002). Bulk density also available in Material Safety Data Sheet (MSDS) at http://www.chemicalbook.com/ProductMSDSDetailCB5266265_EN.htm (accessed 01/28/2013).
(2) For classification scheme, see USEPA, 2008. See also "Guidance for Reporting on the Environmental Fate and Transport of the Stressors of Concern in Problem Formulations," available at http://www.epa.gov/pesticides/science/efed/policy_guidance/team_authors/endangered_species_reregistration_workgroup/esa_reporting_fate.htm#I (accessed 01/16/2013).
(3) Assuming 2% organic carbon, soil to soil water ratio (w/w) = 6, and soil water to soil air (v/v) = 1.
(4) Note that all chemicals may volatilize to some extent; this classification simply indicates that the volatility potential is very low.

Deltamethrin has a very low solubility (only 0.200 ppb) and a high octanol/water partition coefficient (K_{OW} = 34,200). For K_{OW}, it would appear that deltamethrin has the potential to bioconcentrate or bioaccumulate. However, pyrethroids, such as deltamethrin, undergo substantial biotransformation *in vivo* (refer to **Table 2-2**). With a small vapor pressure (9.32 x 10^{-11} torr) a relatively small Henry's Law Constant (3.1 x 10^{-7} atm-m^3/mol), deltamethrin is not expected to volatilize substantially from dry/wet surfaces.

Table 2-2. Summary of Deltamethrin Environmental Fate Properties

Study	**Value and unit**	**Major Degradate** ***Minor Degradates****	**MRID # or Citation**	**Study Classification, Comment**
Abiotic Hydrolysis	Half-life[1] = Stable, pH 5 **Stable**, pH 7 2.5 days, pH 9	Major: BR_2CA, 3-PBAldehyde	MRID 41651038	Supplemental
Atmospheric Degradation	[Include when an air photolysis study is not available] Half-life[1] = 51.4 days, estimated for ozone reaction; 0.46 days, estimated for OH radical reaction	Not Available	EPI Suite v.4.10 Estimates	Ozone reaction @ 25°C and 7x10^{11} mol/cm^3; Hydroxyl radical reaction @ 25°C and 12-hr day; 1.5x10^6 OH/cm^3
Direct Aqueous Photolysis	Half-life[1] = 64 days, pH 5 (benzyl label) **84** days, pH 5 (gem label)	Major: 3-PBA *Minor:* *cis*-BR_2CA	MRID 42114818	Acceptable
Soil Photolysis	Half-life[1] = Stable, sandy loam	Reported R/S epimerization; *cis* and *trans*-Br2CA and 3-PBA obs	MRID 42114819	Acceptable Test material degraded both in the irradiated samples and controls.
Aerobic Soil Metabolism	Half-life[1] = Dubbs fine sandy loam (acidic) was tested at two application rates and with two radiolabels, first order half-lives as follows: for cyano and phenoxy labels, respectively: at 0.02 lb/A: **52.5**, **54.6** days, at 0.20 lb/A 50.2, 55.0 days. Memphis silt loam (acidic) was tested at two application rates and with two radiolabels, first order half-lives as follows: for cyano and phenoxy labels, respectively: at 0.02 lb/A **46.2**, **50.2** days, at 0.20 lb/A 45.6, 52.5 days. Additional study conducted with Dubbs fine sandy loam at 10-40ºC, the half-lives obtained at 25ºC were 19.7 and 24.6 days for the cyano and	Major: BR_2CA	MRID 41677404, 41677405, 42114820	Acceptable

Study	Value and unit	Major Degradate *Minor Degradates**	MRID # or Citation	Study Classification, Comment
	vinyl labels, respectively. Alkaline Arizona sandy loam (pH 8.1) half-lives **22** and **26** days			
Anaerobic Soil Metabolism	Half-life[1] = **34** days combined labels (benzyl and gem), alkaline loam	Major: BR_2CA *Minor*: 3-PB A	MRID 4211482	Acceptable
Aerobic Aquatic Metabolism	Half-life[1] = Loam sediment from the Netherlands (ditch): 6.0 days in water[2] 62.2 days in sediment[2] **25.9** days in total system Sandy loam sediment from the Netherlands (river): <1 days in water[2] 132 days in sediment[2] **120** days in total system	Major: α-R-deltamethrin, Minor: 3-PBA	MRID 44977005	Supplemental; Half-lives based on the sum of deltamethrin plus the *alpha*-R-isomer of deltamethrin.
Freundlich solid-water distribution coefficient (K_F)	K_F; 1/n = 3000 mL/g AK silt loam; 1.00 4750 mL/g GA silt loam; 1.13 960 mL/g TX sandy loam; 1.18 3790 mL/g MS silt clay loam; 1.01	N/A	MRID 41651039, 42976501	Acceptable
Organic-carbon normalized distribution coefficient (K_{OC})	K_{OC} = 317000 mL/g_{OC} AK silt loam 255000 mL/g_{OC} GA silt loam 516000 mL/g_{OC} TX sandy loam 708000 mL/g_{OC} MS silt clay loam Mean K_{OC} = **449000** ml/g_{OC}	N/A	MRID 41651039, 42976501	Acceptable Immobile (FAO 2000) K_{OC} model is appropriate to describe sorption better than K_d.
Terrestrial Field Dissipation	Dissipation Half-life[1,2] = 231 days, bare ground and cotton, LS (low organic matter) 37 days, bare ground, CA 40 days, cotton, CA 69 days, bare ground, MN 14 days, corn, MN	BR_2CA and α-R-deltamethrin detected; 3-PBA not monitored	MRID 42137505, 42773903, 42114822	Acceptable
Bioconcentration Factor (BCF)- Bluegill Sunfish **(*Lepomis macrochirus*)**	Steady State BCF= 698 L/kg wet wt whole fish 198 L/kg wet wt edible tissue 3630 L/kg wet wt non-edible tissue ---------- 50% depurated between 3-7 days, and 70-75% after 2 weeks; calculated $t_{1/2}$ = 3.55 days	The majority of the radioactivity was parent material.	MRID 41651040, 43072701, 43072702	Acceptable

Study	Value and unit	Major Degradate *Minor Degradates**	MRID # or Citation	Study Classification, Comment
WWTP Treatability Study	Lower bound wastewater treatment removal value is approximately 65%. This value includes aerobic and anaerobic digestion.	N/A	MRID 48762906	POTW treatability study of eight pyrethroids is currently in review.

Abbreviations: wt=weight
Bolded values are used in risk assessment.
*For additional information about the transformation products of deltamethrin, see **Table 2-3**.
[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.

When applied to the field, deltamethrin is likely to partition to the soil (solid) phase and organic matter, though binding is not instantaneous (K_{OW} = 34,200 and K_{OC}»100,000 mL/g_{OC}; immobile, FAO 2000). It is not expected to leach into subsurfaces. It may reach aquatic environments via spray drift or in runoff events accompanied by erosion. Deltamethrin appears to be moderately to highly persistent in terrestrial environments (aerobic soil metabolism 20-55 days; terrestrial field dissipation 14-231 days). It has the potential to persist in aquatic environments, where it may partition with the sediment and to affect benthic and epibenthic organisms (aerobic aquatic metabolism 26-120 days; anaerobic soil metabolism 34 days).

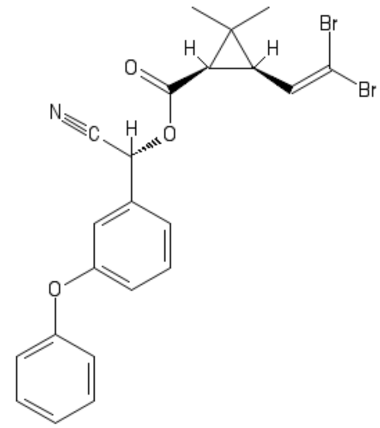
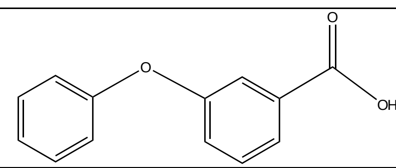
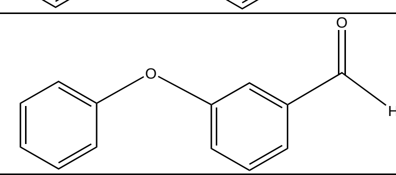
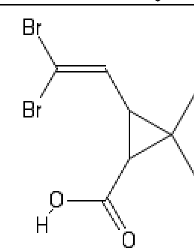
Deltamethrin is relatively stable at pH 5 and 7. However, it rapidly degraded (half-life of 2.5 days) at an alkaline pH of 9, to form Br_2CA and 3-PB aldehyde (refer to **Table 2-3**). It does not appear to photodegrade substantially in aqueous solutions (half-lives 64 & 84 days). In the soil photolysis study, considerable degradation was occurring both in the irradiated and dark controls samples. Soil photodegradation is not considered as an important route of dissipation.

In three terrestrial field dissipation studies parent appeared not to be mobile in soil and degraded in l-2 months, except the Louisiana study, where the half-life was almost 8 months. The longer half-life could fall within the range of normal field variability and the Louisiana soil was the lowest in organic matter, which could result in the lowest amount of soil binding and soil microbial degradation. No clear pattern of degradate formation and decline was seen, possibly because the low application rate and 6" sampling intervals resulted in soil dilution. Ten applications were performed at up to 0.1 lb a.i./A.

In a fish bioconcentration study, a whole body BCF of 698x was calculated from edible and visceral fish tissue results. The majority of the radioactive residue found in fish was parent, accounting for 78 and 83% of the total radioactive residue in edible and visceral fish tissues, respectively. In a study, the depuration was about 50% between days 3-7 and 70-75% after 2 weeks. The depuration results were obtained from a separate study that had been conducted prior to the final bioconcentration study.

Even though various degradates were observed in the laboratory studies (*e.g.* 3-PBA and tetramethrinic acid), it was found that they were the result of the rupture of the ester bond of the parent molecule. It is believed that the resulting molecules are not as toxic as the parent because they presumably have lost the neurotoxic mode of action. **Table 2-3** shows the chemical structures of deltamethrin's major degradation products. At this time, except for *alpha*-R-deltamethrin, they are not considered stressors. The latter degradate was 24% of the applied radioactivity in the aerobic aquatic metabolism study. The half-lives calculated for the test systems included the parent compound and the major degradate. Thus, the degradate *alpha*-R-deltamethrin is considered a stressor in this assessment.

Table 2-3. Major Transformation Products of Deltamethrin

Common Name	Chemical Name/CAS	Structure
alpha-R-deltamethrin	(*R*)-α-cyano-3-phenoxybenzyl (1*R*,3*R*)-3-(2,2-dibromovinyl)-2,2-dimethylcyclopropane-carboxylate Major product in the aerobic aquatic metabolism studies; for the aerobic aquatic metabolism study, the half-lives for the total residue were calculated. Note: *trans*-deltamethrin was observed in the soil photolysis study.	(*R*)-alcohol (1*R*)-cis acid of deltamethrin 
m-PBA or *m*-PBAc or 3-PBA or 3-PBAc	3-phenoxybenzoic acid/ (CAS No. 3739-38-6) Major product in aqueous and soil photolysis studies.	
3-PB Aldehyde	3-phenoxybenzaldehyde/ (CAS No. 39515-51-0) Major product in the hydrolysis study.	
Decamethrinic Acid or cis-Br_2CA	(lR-cis)-3(2,2-dibromoethyl)-2,2-dimethylcyclopropanecarboxylic acid/ (CAS No. 53179-78-5) Major product in soil photolysis, aerobic soil metabolism, and anaerobic soil metabolism studies.	

2.4.1. Environmental Transport Mechanisms

Potential transport mechanisms include pesticide surface water runoff (mostly as insoluble particles or bound to eroded sediment), spray drift, and secondary drift of volatilized or soil-bound residues leading to deposition onto nearby or more distant ecosystems. Surface water runoff of sediment-bound residue and spray drift are expected to be the major routes of exposure for deltamethrin. Deltamethrin can be spray applied by ground or aerially on agricultural settings. A buffer distance is label required for agricultural crops (25 ft for ground and 150 ft. for aerial applications); however, under a high-end drift scenario (*e.g.* smaller droplets and/or high wind speed), the chemical can reach adjacent bodies of water via spray drift. Due to its moderate persistence, low solubility (0.200 ppb), and high potential for binding (mean K_{OC} = 449,000 L/kg-$_{OC}$), deltamethrin would remain bound to the soils during run-off events, and the chemical would reach surface waters if the run-off event is accompanied by erosion. However, transport of the chemical when dissolved in water is not precluded but would be insignificant. A recent study suggests that dissolved organic carbon (DOC) present in sediments may facilitate desorption of sediment-sorbed pyrethroids (forming dissolved pyrethroid-DOC complexes) (Delgado-Moreno *et al.* 2010). Such enhanced desorption in the presence of DOC may enhance the mobility of pyrethroids in streams and by extension, in soils via runoff containing high amounts of DOC.

Once deltamethrin reaches surface water, the fate of the chemical is of concern since deltamethrin is highly toxic to fish and aquatic invertebrates. The Agency believes that deltamethrin, due to its high level of binding, would remain mainly bound to the sediments and would dissolve slowly into the water column. Organisms that live near the sediments may be particularly at risk. The sediments may serve as reservoirs or repositories of deltamethrin, where it may persist.

Deltamethrin is not likely to reach subsurface soil environments or ground waters. Various terrestrial field dissipation studies confirm that deltamethrin remains mostly in the uppermost soil depth (0-15 cm).

2.4.2. Mechanism of Action

Deltamethrin is classified as a Type II pyrethroid, with a cyano group at the *alpha*-carbon position, or the alcohol moiety. The primary biological effects of deltamethrin, and other pyrethroids, on insects and vertebrates reflect an inhibition of the correct firing of neurotransmitter deliver signals from one cell to another via nerve membrane inhibition of the voltage-gated Ca^{2+} channels (calcium ion channels) coupled with a stimulatory effect on the voltage-gated Na^{+} channels (sodium ion channels). The insecticidal effect of pyrethroids is characterized by a rapid "knock down," or paralysis, of insects. In insects, the type II pyrethroids predominantly cause ataxia and uncoordinated movement. All pyrethroids act as axonic poisons, affecting both the peripheral and central nervous systems, and share similar modes of action. Pyrethroids, including deltamethrin, stimulate repetitive action in the nervous system by binding to voltage-gated Na^{+} channels, prolonging the Na^{+} ion permeability during the excitatory phase of the action potential. This action leads to spontaneous depolarizations, augmented neurotransmitter secretion rate and neuromuscular block, which ultimately results in paralysis of the insect (Clark & Matsumura, 1987). A recent study by Cao et al (2011) suggests that toxicological consequences of the interaction of pyrethroids with the voltage-gated Ca^{2+} is of secondary importance compared to the voltage-gated Na^{+} channels.

2.4.3. Use Characterization

Analysis of labeled use information is the critical first step in evaluating the federal action. The current labels for deltamethrin represent the FIFRA regulatory action; therefore, labeled use and application rates specified on the label form the basis of this assessment. The assessment of use information is critical to the development of the action area and selection of appropriate modeling scenarios and inputs. The use information in this assessment was prepared by Biological and Economic Analysis Division (BEAD) and verified by the Pesticide Re-evaluation Division (PRD) and the Registration Division (RD) (refer to **Appendix B**).

2.4.3.a. Summary of Use Information

Potential national deltamethrin uses include a wide range of agricultural and non-agricultural uses, including (but not limited to) globe artichokes, canola, corn, cotton, cucurbits, eggplant, tomato, garlic, onion, apple, pear, carrot, garden beet, radish, potato, ginger, sunflowers, tree nuts domestic dwellings, ornamental and residential lawns and turf, ornamental woody shrubs and vines, paths/patios, pet living/sleeping quarters, bathroom premises, cadavers, caskets (and also morgues and mortuaries), transportation facilities, diaries and cheese processing plant premises, dogs/ canines (collars), drainage systems, eating establishments, food processing plant premises, food stores/ markets/ supermarket premises, greenhouses, hospital/ medical institutions premises, public building/ structures, sewage systems, ships and boats, and zoos.

There are over 50 active product labels; therefore, the Agency's Biological and Economic Analysis Division (BEAD) relied on the process of reviewing only "data doer" labels to collect label use data. This method relies on extracting data from the technical registrants and major end use producers and selected non-major producers labels of deltamethrin, to get representative label data from a subset (>60 labels) of all possible labels. Use data are not based on an exhaustive review of the entire population of labels. Furthermore, this assessment considered all of the mitigation measures included in the recently issued requirements (see the **Appendix L**). In summary, the mitigation measures include label language on buffers and spray drift requirements for agricultural products, and restrictions on applications to impervious surfaces for non-agricultural products.

Table 2-4 presents the uses and corresponding application rates and methods of application considered in this assessment. They are classified into agricultural and non-agricultural crops or use categories. It is noted that in **Table 2-4** some of the parameters were NS (i.e., not specified). Certain assumptions were made in those instances (refer to **Table 3-1** for further details). Furthermore, the **Table L-1** in **Appendix L** provides a summary of other uses not applicable to California and/or uses not assessed in this review, and reasons why they were not assessed.

Table 2-4. Summary of deltamethrin agricultural and non-agricultural uses assessed in California [1]

USE	SINGLE APP. RATE (lb a.i./A)	MAX. NUMBER OF APPS. AT MAX. RATE	SEASONAL APP. RATE (lb a.i./A)	MINIMUM INTERVAL BETWEEN APPS. (days)	APP. METHOD	INCORPO-RATION DEPTH (inches)	PHI

[1] PHI=pre-harvest interval, NS=not specified

USE	SINGLE APP. RATE (lb a.i./A)	MAX. NUMBER OF APPS. AT MAX. RATE	SEASONAL APP. RATE (lb a.i./A)	MINIMUM INTERVAL BETWEEN APPS. (days)	APP. METHOD	INCORPO-RATION DEPTH (inches)	PHI
Agricultural Crops							
Artichoke	0.03	5	0.15	3	Aerial, Ground Spray or Dust	0	3
Canola, crambe, rapeseed	0.0097	2	0.0199	7	Aerial or Ground Spray	0	7
Corn, field and pop	0.0236	5	0.102	21	Aerial or Ground Spray	0	21
Corn, pop	0.0229	5	0.095	21	Dust	0	21
Corn, sweet	0.03	16	0.48	Not Specified (NS)	Aerial, Ground Spray or Dust	0	1
Cotton	0.0322	10	0.322	5	Aerial or Ground Spray	0	21
Cucurbit crop group 9 (cantaloupe, chayote, Chinese waxgourd, citron melon, cucumber, gherkin, gourds, *Momordica* species, muskmelon, pumpkin, squash, watermelon)	0.03	6	0.18	3	Aerial, Ground Spray or Dust	0	3
Fruiting vegetables crop group 8 (eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato)	0.03	6	0.18	5	Aerial, Ground Spray or Dust	0	1
Bulb vegetables crop group 3 (garlic, leeks, onion, shallots)	0.03	4	0.12	5	Aerial, Ground Spray or Dust	0	1
Pome fruits crop group 11 (apple, crabapple, loquat, mayhaw, pear, oriental pear, quince)	0.0236	2	0.045	7	Aerial or Ground Spray	0	21
Root vegetables crop subgroup 1B (except sugarbeet) (carrot, celeriac, turnip-rooted chervil , chicory, edible burdock, garden beet, ginseng, horseradish, parsley (turnip-rooted), parsnip, radish, oriental radish, rutabaga, salsify, black salsify, Spanish	0.03	5	0.15	3	Aerial, Ground Spray or Dust	0	3

USE	SINGLE APP. RATE (lb a.i./A)	MAX. NUMBER OF APPS. AT MAX. RATE	SEASONAL APP. RATE (lb a.i./A)	MINIMUM INTERVAL BETWEEN APPS. (days)	APP. METHOD	INCORPO-RATION DEPTH (inches)	PHI
salsify, skirret, turnip) **Tuberous and corm vegetables crop subgroup 1C** (potato, sweet potato, arracacha, arrowroot, Chinese artichoke, Jerusalem artichoke, edible canna, bitter and sweet cassava, chayote (root), chufa, dasheen, ginger, leren, tanier, tumeric, yam bean, true yam)							
Sorghum	0.0236	2	0.0483	NS	Aerial or Ground Spray	0	14
Tree nuts crop group 14 (almond, beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, filbert, hickory nut, macadamia nut, pecan, pistachio, walnut)	0.0354	5	0.18	7	Aerial or Ground Spray (foliar or dormant)	0	21
Non-agricultural Crops or Uses							
Golf Course Turf, Recreational Area Lawns; Commercial/Industrial Lawns	0.127, 0.147, 0.0097 lb/mound	NS	NS	7	Ground; Granular, Mound treatment	0	N/A
Ornamental Sod Farms	0.127, 0.131	NS	NS	7	Ground; Granular	0	1
Ornamental Lawns and Turf	0.218, 0.147, 0.0097 lb/mound	NS	NS	NS, 7, 7	Ground, Granular, Mound treatment	0	N/A
Recreational Areas	0.0544	NS	NS	7	Ground, Crack and crevice	0	N/A
Ornamental Grasses	0.0736, 0.0039 lb/mound	NS	NS	NS, 7	Ground, Mound treatment	0	N/A
Residential Lawns	0.127, 0.131	NS	NS	7	Ground; Granular	0	N/A

USE	SINGLE APP. RATE (lb a.i./A)	MAX. NUMBER OF APPS. AT MAX. RATE	SEASONAL APP. RATE (lb a.i./A)	MINIMUM INTERVAL BETWEEN APPS. (days)	APP. METHOD	INCORPO-RATION DEPTH (inches)	PHI
Poultry Processing Plant Premises (non-food contact)	0.213	NS	NS	21	Crack & crevice, and/or spot treatment	0	N/A
Ornamental and/or Shade Trees; Ornamental Ground Cover	0.428, 0.0109 NDC, 0.049 lb/gal or NDC	NS	NS	NS, 7, 7, 21 or NS	Ground, Dust, Crack and crevice and/or spot treatment, Trunk injection or drench	0	N/A
Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines	0.218, 0.0109, 0.147, NDC	NS	NS	NS, 7, NS	Ground, Dust, Granular, Spot treatment	0	N/A
Animal Kennel Sleeping Quarters - Commercial)	0.142, 0.213	NS	NS	21	Perimeter treatment, Crack & crevice, and/or spot treatment	0	N/A
Pet Living/Sleeping Quarters	0.142, 0.213, 0.131	NS	NS	21, 21, 30	General surface spray and perimeter treatment, Crack & crevice, and/or spot treatment, Granular or dust	0	N/A
Facilities various uses: Commercial/ Institutional/ Industrial Premises/ Equipment (outdoor); Commercial Storages/ Warehouses Premises; Commercial Transportation Facilities-Non-feed/Non-food; Diaries/Cheese Processing Plant Premises (Non-food Contact); Eating Establishments; Eating Establishments – Food	0.218, Dust: 0.0109	NS	NS	21, Dust: NS	Ground, Crack & crevice and/or spot treatment, Perimeter treatment, Dust	0	N/A

USE	SINGLE APP. RATE (lb a.i./A)	MAX. NUMBER OF APPS. AT MAX. RATE	SEASONAL APP. RATE (lb a.i./A)	MINIMUM INTERVAL BETWEEN APPS. (days)	APP. METHOD	INCORPO-RATION DEPTH (inches)	PHI
Handling Establishments & Non-Food Areas (Non-Food Contact); Egg Handling Rooms and Egg Packing Plants (Commercial); Feed Mills and Feed Processing Plants; Food, Grocery, Marketing, Storage/ Distribution Facility Premise; Food Processing Plant (non-food handling areas)/(non-food contact); Food Stores/ Markets/ Supermarkets Premises; Hospital/ Medical Institutions Premises (Human/Veterinary); Household/ Domestic Dwellings (and Contents/ Premises); Industrial Construction Areas (Outdoor); Meat Processing Plant Premises (food and non-food contact); Non-agricultural Outdoor Buildings/Structures; and **Zoos**							
Barns/Barnyards/Auction Barns	0.136	NS	NS	21	Crack & crevice or spot treatment	0	N/A
Household Domestic Dwellings Outdoors Premises	0.218, 0.211, 0.196, 0.131	NS	NS	NS, 7, 21, 21, 7, NS-7	Ground, Crack & crevice or spot treatment Granular (includes perimeter treatment), Dust	0	N/A

USE	SINGLE APP. RATE (lb a.i./A)	MAX. NUMBER OF APPS. AT MAX. RATE	SEASONAL APP. RATE (lb a.i./A)	MINIMUM INTERVAL BETWEEN APPS. (days)	APP. METHOD	INCORPO-RATION DEPTH (inches)	PHI
Paths/Patios	0.113, 0.211, 0.0109	NS	NS	NS, 21, NS	General surface spray and perimeter treatment, Crack & crevice and/or spot treatment, Dust	0	N/A
Paved Areas (Private Roads/ Sidewalks)	0.113, 0.211	NS	NS	NS, 21	General surface spray and perimeter treatment, Crack & crevice and/or spot treatment	0	N/A
Non-agricultural Rights-of-Way/ Fencerows/ Hedgerows; Refuse/Solid Waste Containers and Sites (outdoor)	0.218, 0.113	NS	NS	NS	Ground, Perimeter treatment	0	N/A
Utilities, Utility Poles/Rights-of-Way	27.2,	NS	NS	NS	Granular	0	N/A
Wood Protection Treatment to Buildings/Products Outdoor	26.3, 0.209, 0.131	NS	NS	21, 21, 7	Soil drench/ treatment, Crack and crevice and/or perimeter treatment	0	N/A
Sewage Systems	$3.1x10^{-7}$ lb/linear ft or no dosage conversion	NS	NS	NS or 21	Various	N/A	N/A

This screening-level risk assessment focuses on characterizing potential ecological risks resulting from a maximum use scenario, which is determined from labeled statements of maximum application rate and number of applications with the shortest time interval between applications. The frequency at which actual uses approach this maximum use scenario may be dependent on pest pressure, timing of applications, cultural practices, and market forces. It is noted that deltamethrin may be used on crops that can be planted and/or harvested multiple times per year. **Table 2-5** shows some examples of crops with multiple harvests per year. In some instances (*e.g.*, radish and sweet corn), three crops per year are possible. In this assessment, one crop per year is assumed, unless otherwise stated. However, numerous applications of the same pyrethroid, and after repeated seasons, appear to be unlikely due to potential development of insect resistance. The exposure estimates provided in this review may be reasonably conservative with the assumption of the maximum number of applications per season and the minimum retreatment interval, in one season.

Table 2-5. Examples of Crops Planted and/or Harvested Multiple Times/Year in California

Crop	Region, number of crops or harvests/year, and remarks
Artichoke	One or two
Sweet corn	Normally, 2-3 crops/year in rotation with other crops. Southern desert regions (2), other regions (normally 2-3)
Radish	3-5 crops per year in rotation with other crops
Turf (sod farms only)	Up to 2; generally 1

2.4.3.b. Summary of National and California Usage

According to the Agency's Biological and Economic Analysis Division (BEAD), California's average pounds per 1,000 acres of farmland range from a maximum of 0.19-0.70 lbs of deltamethrin down to 0.00-0.02 lb (**Figure 2-1**).

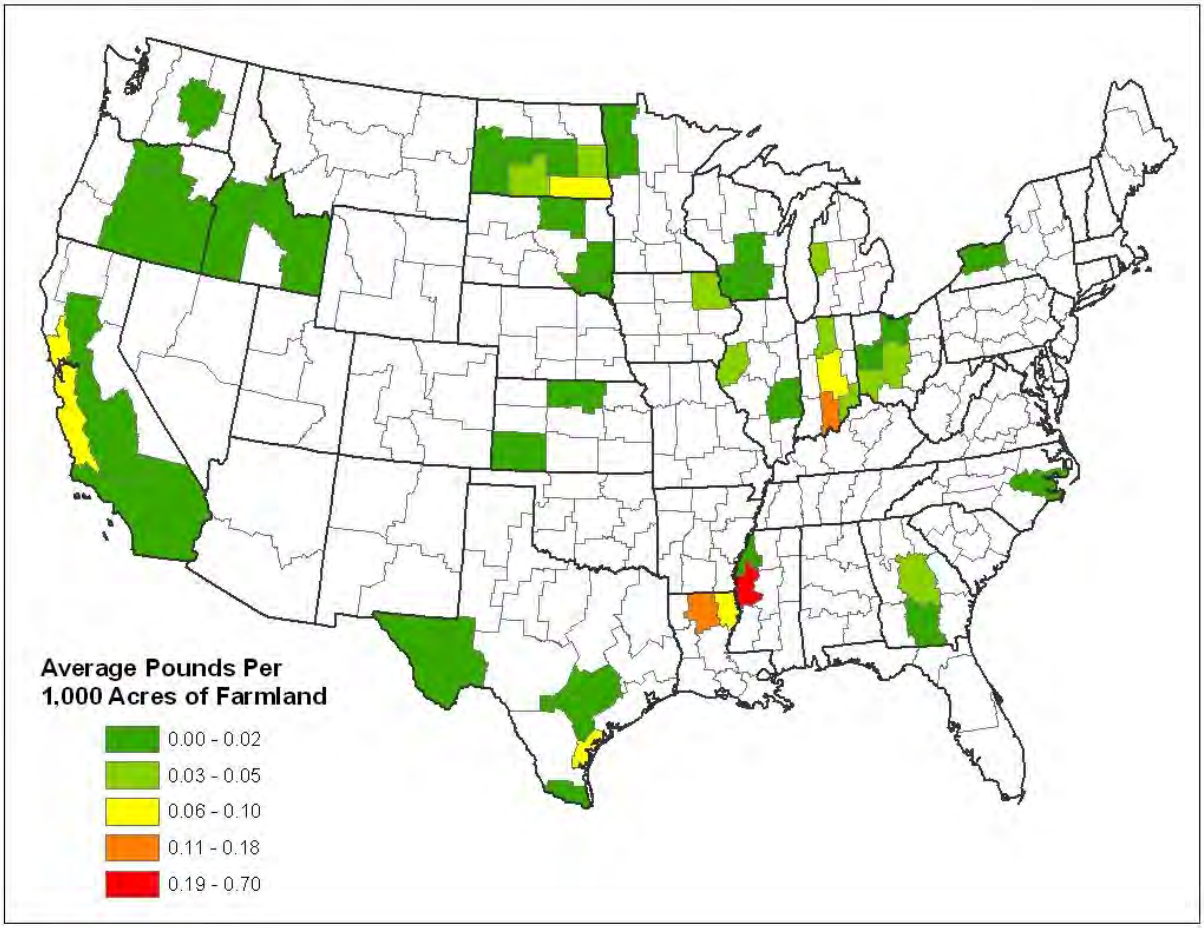


Figure 2-1. Deltamethrin Usage by Crop Reporting District (2007-2011) [2]

BEAD provided an analysis of both national- and county-level usage information (USEPA, 2012) using state-level usage data obtained from USDA-NASS[3], Doane (www.doane.com; the full dataset is not provided due to its proprietary nature) and the California's Department of

[3] This is a map of agricultural pesticide usage at the Crop Reporting District (CRD) level. CRDs are boundaries created by USDA NASS which are aggregates of counties (USDA, 2010). Pesticide usage is displayed as average pounds (for the years 2007-2011) per 1,000 acres of farmland in a CRD to normalize for the variation in farmland between CRDs. Farmland acreage was obtained from USDA (2007).

Usage is based on private market surveys of pesticide use in agriculture (Proprietary Data, 2007-2011). The survey data are limited to the states that represent the top 80-90% of acreage for the individual crops, therefore, use may be occurring in regions outside the scope of the survey. CRDs showing no usage of pesticides may be due to either the lack of pesticide use in the region or non-participation in the agricultural surveys. In addition, across the years, there may be variations in the specific crops included in the CRD survey. This may result in a lower annual average for the CRD.

[3] United States Department of Agriculture (USDA), National Agricultural Statistics Service (NASS) Chemical Use Reports provide summary pesticide usage statistics for select agricultural use sites by chemical, crop and state. See http://www.pestmanagement.info/nass/app_usage.cfm.

Pesticide Regulation Pesticide Use Reporting (CDPR PUR) database[4]. 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 deltamethrin by county in this California-specific assessment were generated using CDPR PUR data. Twelve years (1999-2010) of usage data were included in this analysis. Data from CDPR PUR were obtained for every agricultural pesticide application made on every use site at the section level (approximately one square mile) of the public land survey system.[5] BEAD summarized these data to the county level by site, pesticide, and unit treated. Calculating county-level usage involved summarizing across all applications made within a section and then across all sections within a county for each use site and for each pesticide. The county level usage data that were calculated include: average annual pounds applied, average annual area treated, and average and maximum application rate across all twelve years. The units of area treated are also provided where available.

A summary of deltamethrin usage for all California use sites is provided below in **Table 2-6**. The table shows that the use that by far has the higher application rates is landscape maintenance. Other uses with high application rates on a per acre basis include animal premise, greenhouses (flower, transplants), and walnuts.

Table 2-6. Summary of California Department of Pesticide Registration (CDPR) Pesticide Use Reporting (PUR) Data from 1999 to 2010 for Currently Registered Deltamethrin Uses[1]

Site Name	Unit Area Treated	Ave. App Rate	95th Percentile App Rate	99th Percentile App Rate	Max. Percentile App Rate
ALMOND	Acres	0.0	0.0	0.0	0.3
ANIMAL PREMISE	Acres	2.1	4.3	4.3	4.3
ANIMAL PREMISE	Cubic feet	0.0	0.0	0.0	0.0
ANIMAL PREMISE	Misc. unit	0.6	0.6	0.6	0.6
ANIMAL PREMISE	Square feet	0.0	0.0	0.0	0.0
ARTICHOKE, GLOBE	Acres	0.0	0.0	0.0	0.2
BEET	Acres	0.0	0.0	0.3	0.3
BROCCOLI	Acres	0.0	0.0	0.0	0.0
BUILDINGS/NON-AG OUTDROOR	Square feet	0.0	0.0	0.0	0.0
BUILDINGS/NON-AG OUTDROOR		0.0	0.0	0.0	0.0
CANTALOUPE	Acres	0.0	0.0	0.0	0.0
CARROT	Acres	0.0	0.0	0.0	0.0
CAULIFLOWER	Acres	0.0	0.0	0.0	0.0
CORN (FORAGE - FODDER)	Acres	0.0	0.0	0.3	0.3
CORN, HUMAN CONSUMPTION	Acres	0.0	0.0	0.0	0.0
COTTON	Acres	0.0	0.0	0.0	0.1
CUCUMBER	Acres	0.0	0.0	0.0	0.0

[4] 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..

[5] 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).

Site Name	Unit Area Treated	Ave. App Rate	95th Percentile App Rate	99th Percentile App Rate	Max. Percentile App Rate
FOOD PROCRESSING PLANT	Pounds	0.0	0.0	0.0	0.0
FOOD PROCRESSING PLANT	Square feet	0.0	0.0	0.0	0.0
INDUSTRIAL SITE	Square feet	0.0	0.0	0.0	0.0
LANDSCAPE MAINTENANCE	Acres	1.1	7.4	15.3	15.3
LEEK	Acres	0.0	0.0	0.0	0.0
MELON	Acres	0.0	0.0	0.0	0.0
N-GRNHS FLOWER	Acres	0.1	0.3	0.5	0.5
N-GRNHS PLANTS IN CONTAINERS	Square feet	0.0	0.0	0.0	0.0
N-GRNHS PLANTS IN CONTAINERS	Acres	0.0	0.1	0.1	0.1
N-GRNHS TRANSPLANTS	Acres	0.1	0.3	1.3	1.3
N-GRNHS TRANSPLANTS	Square feet	0.0	0.0	0.0	0.0
N-OUTDR FLOWER	Acres	0.1	0.1	0.3	0.3
N-OUTDR PLANTS IN CONTAINERS	Square feet	0.0	0.0	0.0	0.0
N-OUTDR PLANTS IN CONTAINERS	Acres	0.1	0.2	0.3	1.5
N-OUTDR PLANTS IN CONTAINERS	Misc. unit	0.0	0.0	0.0	0.0
N-OUTDR TRANSPLANTS	Misc. unit	0.0	0.0	0.0	0.0
N-OUTDR TRANSPLANTS	Square feet	0.0	0.0	0.0	0.0
N-OUTDR TRANSPLANTS	Acres	0.0	0.1	0.1	0.1
ONION, DRY	Acres	0.0	0.0	0.0	0.0
ORANGE	Acres	0.1	0.1	0.1	0.1
PARSLEY	Acres	0.0	0.0	0.0	0.0
PEAR	Acres	0.0	0.0	0.0	0.0
PEPPER, FRUITING	Acres	0.0	0.0	0.0	0.0
PISTACHIO	Acres	0.0	0.0	0.0	0.0
RADISH	Acres	0.0	0.0	0.0	0.0
RECREATION AREA	Acres	0.1	0.1	0.1	0.1
SQUASH	Acres	0.0	0.0	0.0	0.0
STRUCTURAL PEST CONTROL					
STRUCTURAL PEST CONTROL	Acres				
STRUCTURAL PEST CONTROL	Square feet	0.0	0.0	0.0	0.0
SWEET POTATO	Acres	0.0	0.0	0.0	0.0
TOMATO	Acres	0.0	0.0	0.0	0.0
TOMATO, PROCESSING	Acres	0.0	0.0	0.0	0.0
TURF/SOD	Square feet	0.0	0.0	0.0	0.0
TURF/SOD	Acres	0.1	0.1	0.1	0.1
TURNIP	Acres	0.0	0.0	0.0	0.0
UNCULTIVATED AG	Acres	0.0	0.0	0.0	0.0
UNCULTIVATED NON-AG	Square feet	0.0	0.0	0.0	0.0
UNCULTIVATED NON-AG	Acres	0.0	0.0	0.0	0.0
UNKNOWN	Acres	0.1	0.1	0.1	0.1
WALNUT	Acres	0.0	0.0	0.4	0.4
WATERMELON	Acres	0.0	0.0	0.0	0.0

1 Based on data supplied by BEAD (USEPA 2013). Since all values were rounded to one decimal, some of them are reported as 0.0.

Table 2-7 shows usage of deltamethrin by county, averaging 12 years. Counties that used deltamethrin averaging over 1,000 lb a.i. were Los Angeles, Riverside and San Luis Obispo.

Table 2-7. Summary of California Department of Pesticide Registration Deltamethrin by County Average of Twelve Years

County	Ave. Lb 12 years
ALAMEDA	157.97
ALPINE	0.42
AMADOR	6.88
BUTTE	21.08
CALAVERAS	6.57
COLUSA	6.32
CONTRA COSTA	317.22
DEL NORTE	0.56
EL DORADO	29.01
FRESNO	124.37
GLENN	5.76
HUMBOLDT	1.74
IMPERIAL	19.19
INYO	5.70
KERN	587.19
KINGS	8.21
LAKE	9.50
LASSEN	1.12
LOS ANGELES	1,094.77
MADERA	13.80
MARIN	20.58
MARIPOSA	4.72
MENDOCINO	6.93
MERCED	107.03
MODOC	0.32
MONO	2.23
MONTEREY	181.97
NAPA	9.94
NEVADA	8.77
ORANGE	403.77
PLACER	147.96
PLUMAS	0.57
RIVERSIDE	3439.85
SACRAMENTO	645.14
SAN BENITO	19.06
SAN BERNARDI	471.64
SAN DIEGO	645.52
SAN FRANCISC	34.64
SAN JOAQUIN	238.90

County	Ave. Lb 12 years
SAN LUIS OBISPO	1,163.28
SAN MATEO	64.48
SANTA BARBARA	38.13
SANTA CLARA	190.54
SANTA CRUZ	28.96
SHASTA	23.60
SIERRA	0.03
SISKIYOU	0.85
SOLANO	66.16
SONOMA	71.43
STANISLAUS	531.29
SUTTER	11.04
TEHAMA	6.37
TRINITY	0.32
TULARE	25.27
TUOLUMNE	12.10
VENTURA	359.20
YOLO	143.19
YUBA	8.50

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

Based on data provided by registrants of deltamethrin, it appears that for sewage treatments, the amount of active ingredient used is likely ≤50 kg on a national basis. Therefore, in this analysis, it will be assumed that 50 kg is the likely upper bound amount of a.i. used.

2.5. Assessed Species

Table 2-7 provides a summary of the current distribution, habitat requirements, and life history parameters for the listed species being assessed. More detailed life-history and distribution information can be found in **Attachment III**. See **Figure 2-2** through **2-9** for maps of the current range and designated critical habitat, if applicable, of the assessed listed species. See **Section 2.1** for information on when each species was listed and a general description of their ranges.

Table 2-7. 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

Assessed Species	Size	Current Range	Habitat Type	Designated Critical Habitat?	Reproductive Cycle	Diet
Bay Checkerspot Butterfly (BCB) (*Euphydryas editha bayensis*)	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 1998, p. II-177)].	1) Primary habitat – native grasslands on large serpentine outcrops; 2) Secondary habitat – 'islands' of smaller serpentine outcrops with native grassland; 3) Tertiary habitat – non-serpentine areas where larval food plants occur	Yes	Larvae hatch in March – May and grow to the 4th instar in about two weeks. The larvae enter into a period of dormancy (diapause) that lasts through the summer. The larvae resume activity with the start of the rainy season. Larvae pupate once they reach a weight of 300 - 500 milligrams. Adults emerge within 15 to 30 days depending on thermal conditions, feed on nectar, mate and lay eggs during a flight season that lasts 4 to 6 weeks from late February to early May	Obligate with dwarf plantain. Primary diet is dwarf plantain plants (may also feed on purple owl's-clover or exserted paintbrush if the dwarf plantains senesce before the larvae pupate). Adults feed on the nectar of a variety of plants found in association with serpentine grasslands
Valley Elderberry Longhorn Beetle (VELB) (*Desmocerus californicus dimorphus*)	Males: 1.25–2.5 cm length Females: 1.9–2.5 cm length	Central Valley of California (from Shasta County to Fresno County in the San Joaquin Valley)	Completely dependent on its host plant, elderberry (*Sambucus species*), which is a common component of the remaining riparian forests and adjacent upland habitats of 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.

Assessed Species	Size	Current Range	Habitat Type	Designated Critical Habitat?	Reproductive Cycle	Diet
California Tiger Salamander (CTS) (*Ambystoma californiense*)	Adult 14.2-80.5 g[4]	CTS-SC are primarily found on the Santa Rosa Plain in Sonoma County. CTS-CC occupies the Bay Area (central and southern Alameda, Santa Clara, western Stanislaus, western Merced, and the majority of San Benito Counties), Central Valley (Yolo, Sacramento, Solano, eastern Contra Costa, northeast Alameda, San Joaquin, Stanislaus, Merced, and northwestern Madera Counties), southern San Joaquin Valley (portions of Madera, central Fresno, and northern Tulare and Kings Counties), and the Central Coast Range (southern Santa Cruz, Monterey, northern San Luis Obispo, and portions of western San Benito, Fresno, and Kern Counties). CTS-SB are found in Santa Barbara County.	Freshwater pools or ponds (natural or man-made, vernal pools, ranch stock ponds, other fishless ponds); Grassland or oak savannah communities, in low foothill regions; Small mammal burrows	Yes	Emerge from burrows and breed: fall and winter rains Eggs: laid in pond Dec. – Feb., hatch: after 10 to 14 days Larval stage: 3-6 months, until the ponds dry out, metamorphose late spring or early summer, migrate to small mammal burrows	Aquatic Phase: algae, snails, zooplankton, small crustaceans, and aquatic larvae and invertebrates, smaller tadpoles of Pacific tree frogs, CRLF, toads; Terrestrial Phase: terrestrial invertebrates, insects, frogs, and worms
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.

Assessed Species	**Size**	**Current Range**	**Habitat Type**	**Designated Critical Habitat?**	**Reproductive Cycle**	**Diet**
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 Freshwater Shrimp (CFWS) (*Syncaris pacifica*)	Up to 50 mm postorbital length (from the eye orbit to tip of tail)	Marin, Napa, and Sonoma Counties, CA	Freshwater, perennial streams; they prefer quiet portions of tree-lined streams with underwater vegetation and exposed tree roots	No	Breed once a year, typically in Sept. Eggs adhere to the pleopods and are cared for 8 – 9 months; embryos emerge during May or early June.	Feed on detritus (algae, aquatic macrophyte fragments, zooplankton, and aufwuchs)

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

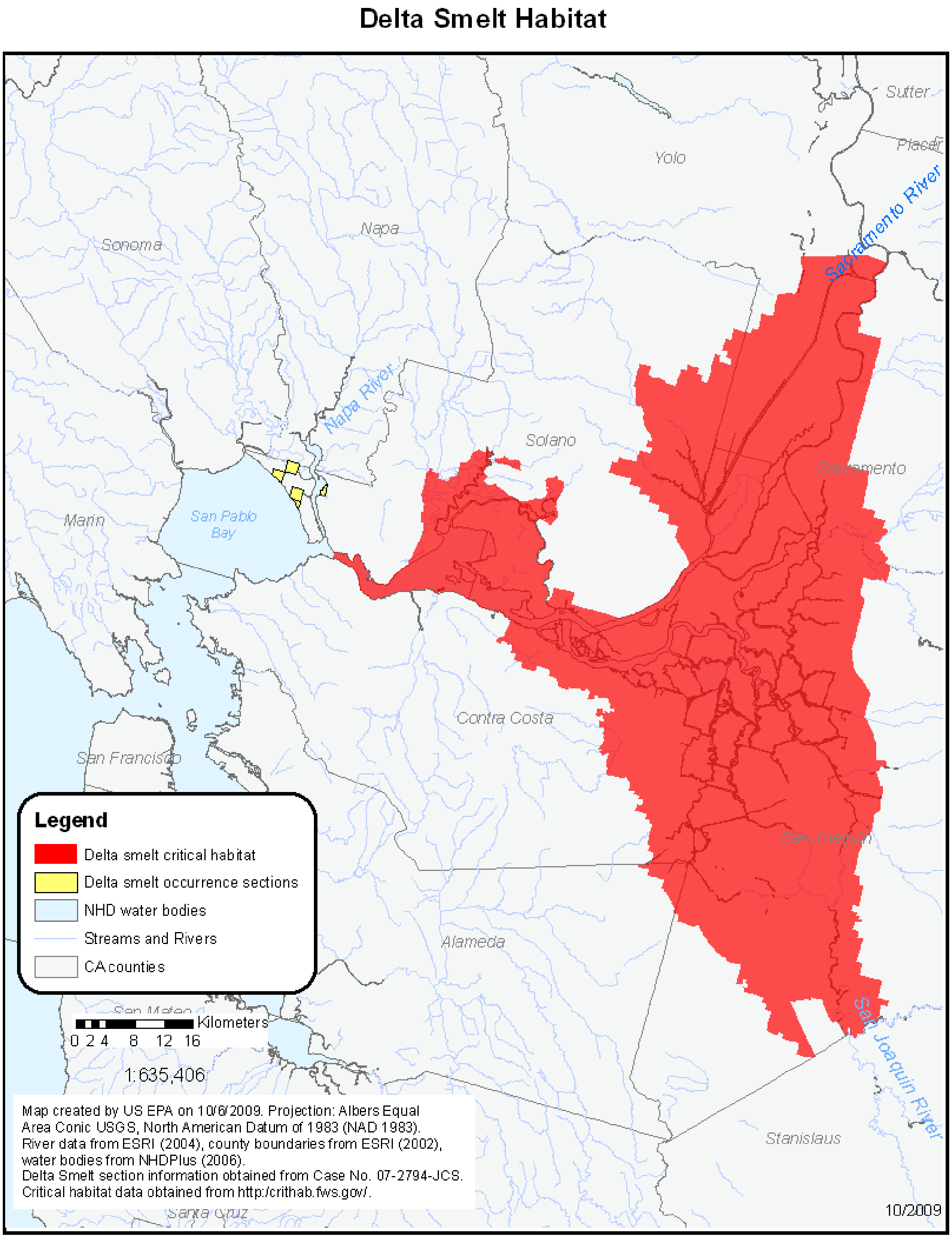


Figure 2-2. Delta Smelt Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS

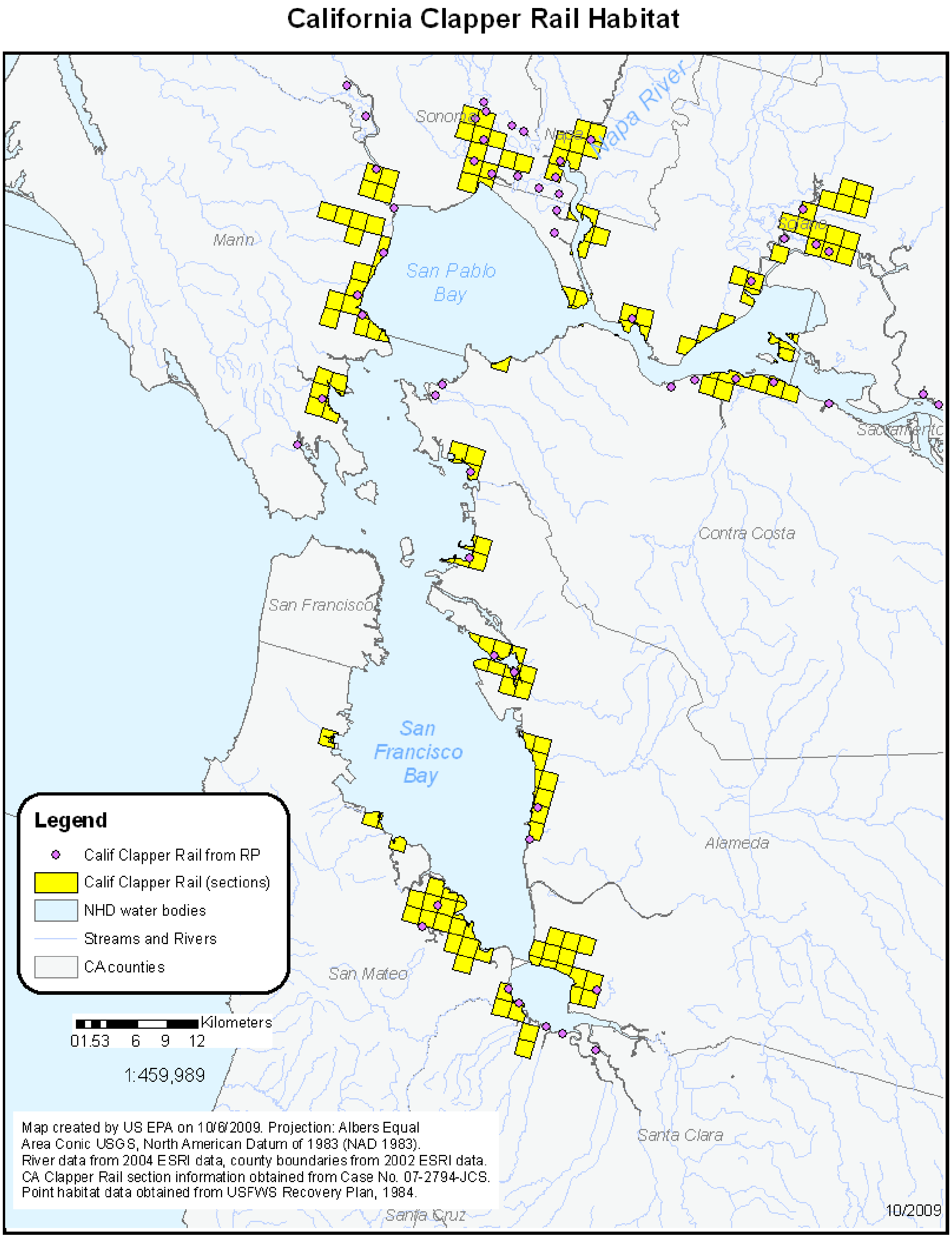


Figure 2-3. California Clapper Rail Occurrence Sections identified in Case No. 07-2794-JCS

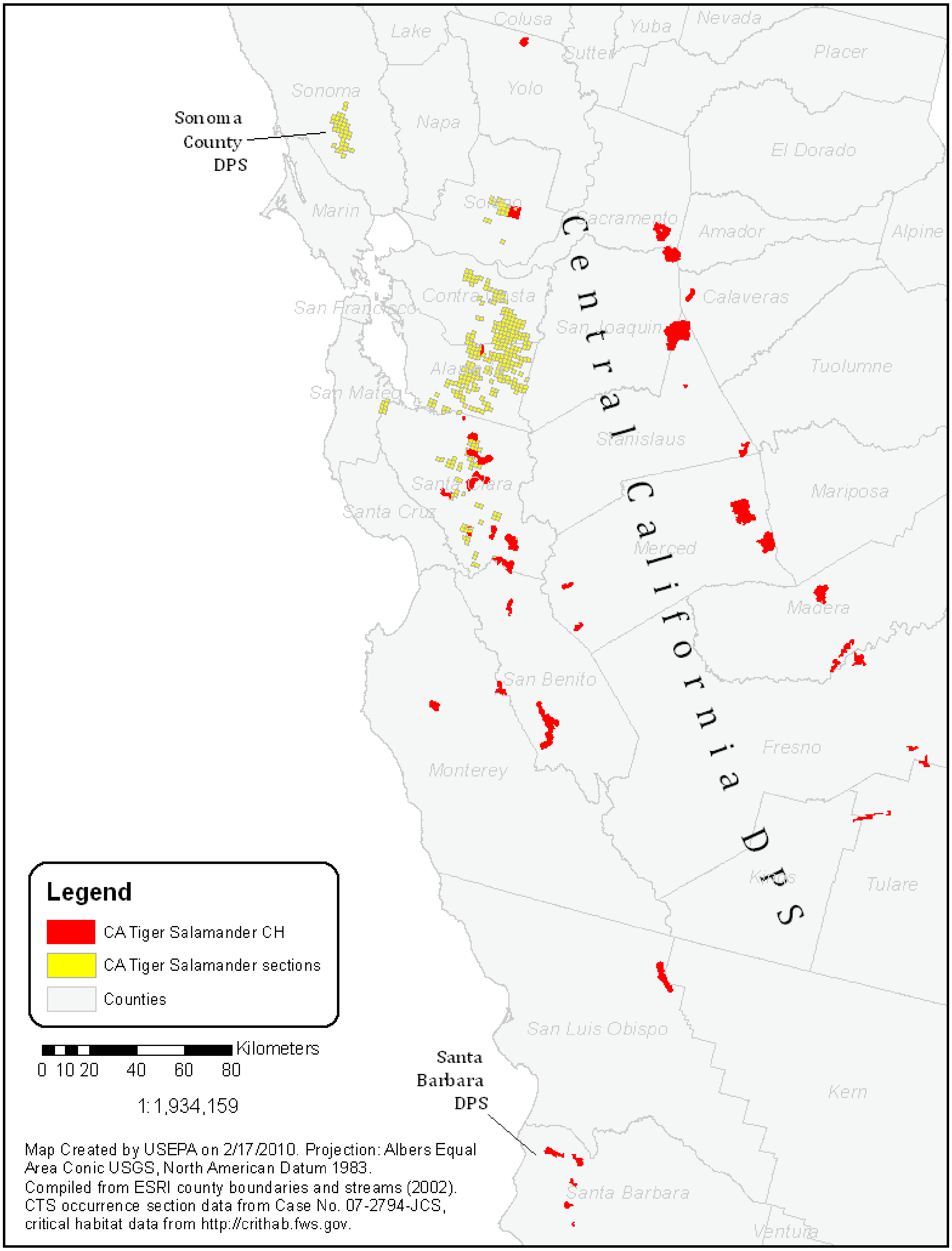


Figure 2-4. California Tiger Salamander (all DPS) Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS

Bay Checkerspot Butterfly Habitat

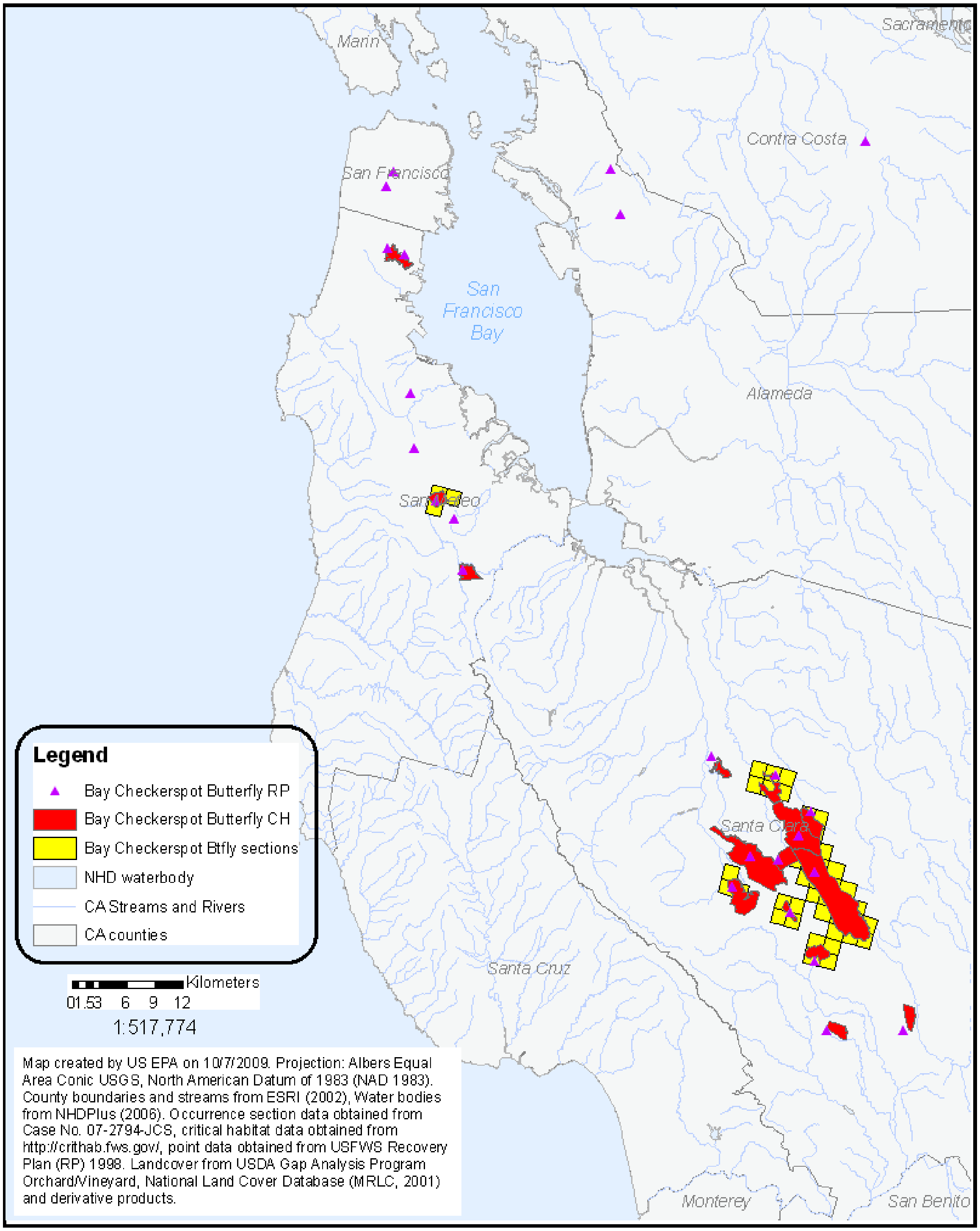


Figure 2-5. Bay Checkerspot Butterfly Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS

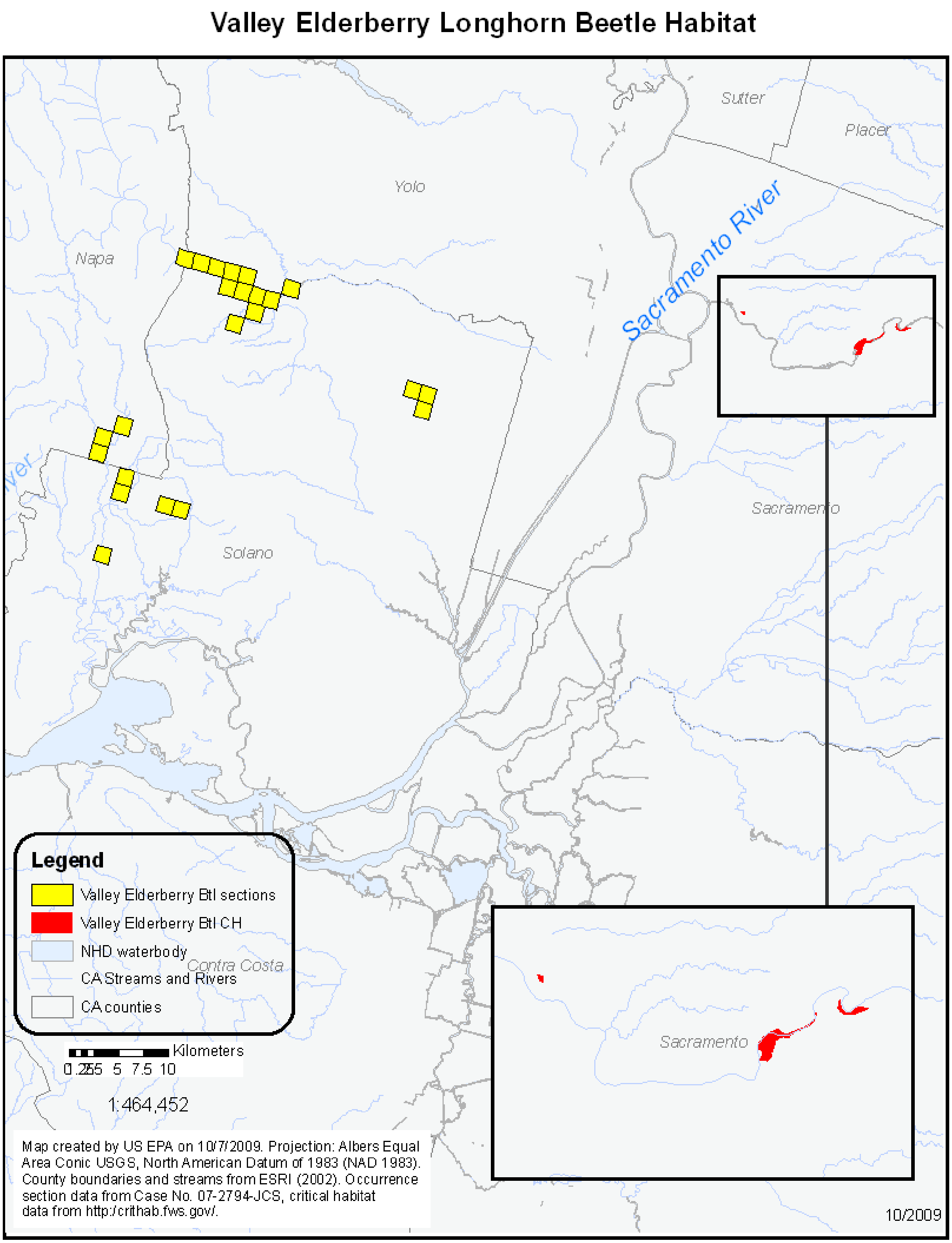


Figure 2-6. Valley Elderberry Longhorn Beetle Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS

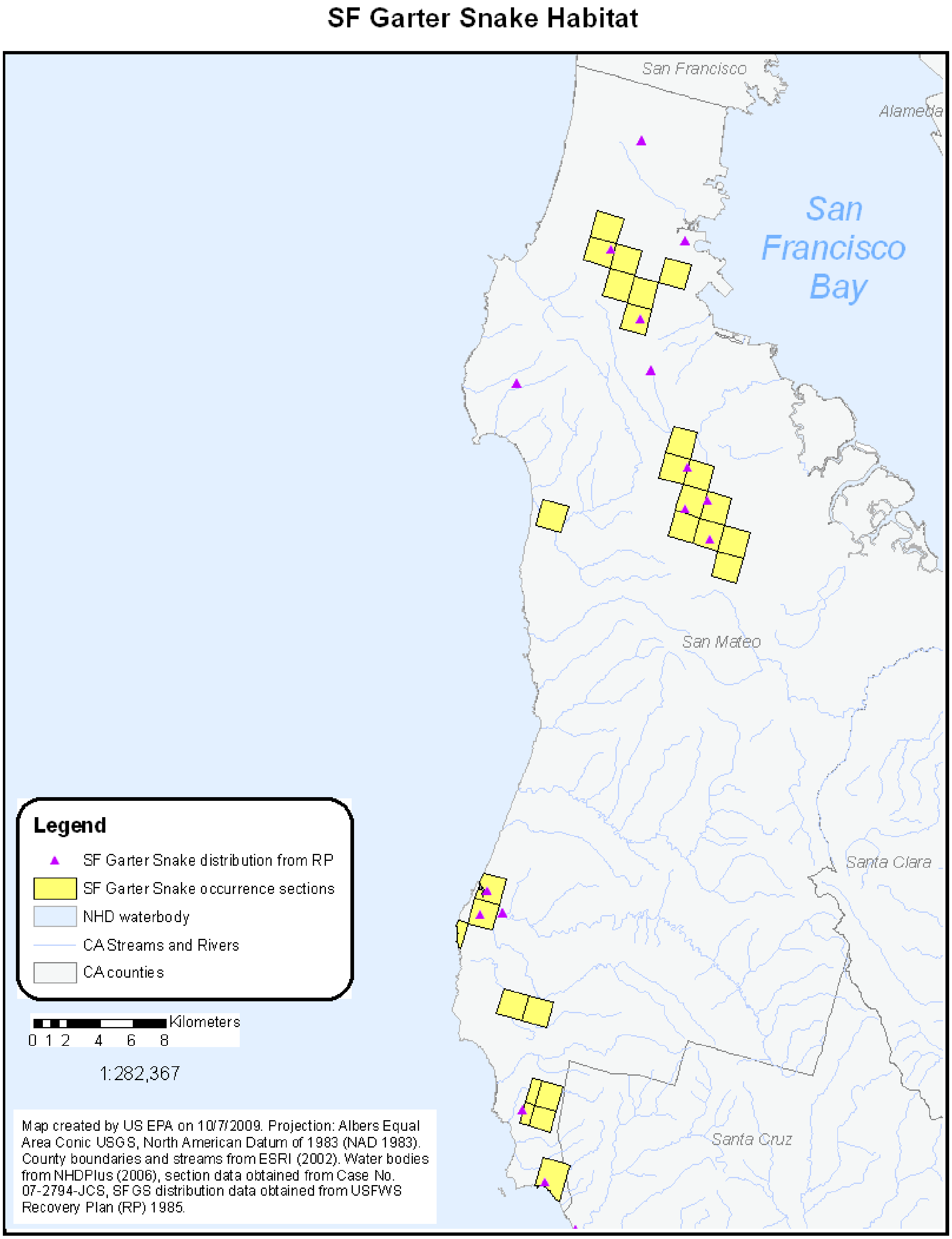


Figure 2-7. San Francisco Garter Snake Occurrence Sections identified in Case No. 07-2794-JCS

California Freshwater Shrimp Habitat

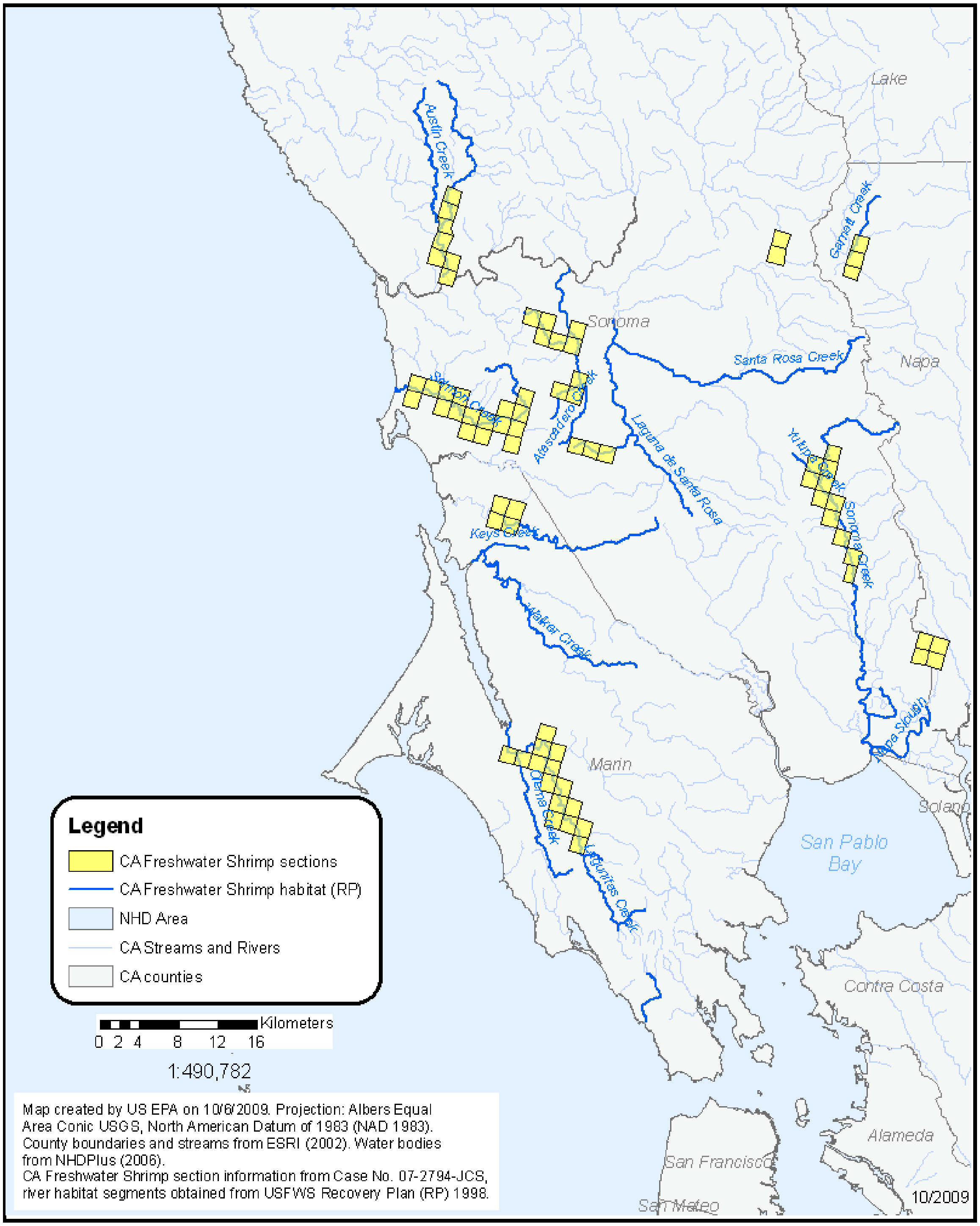


Figure 2-8. California Freshwater Shrimp Occurrence Sections identified in Case No. 07-2794-JCS

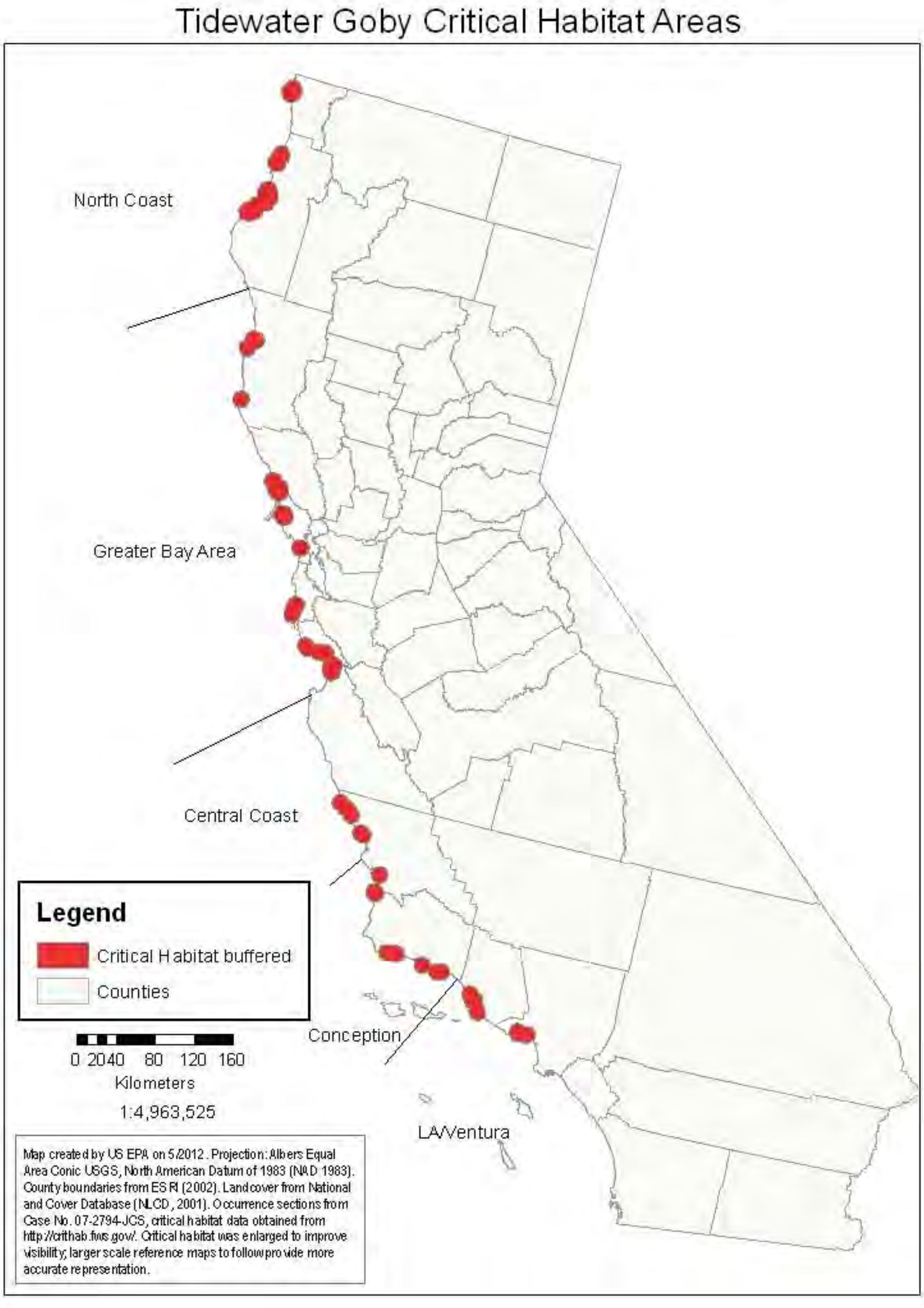


Figure 2-9. Tidewater Goby Critical Habitat identified in Case No. 07-2794-JCS

2.6. Designated Critical Habitat

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

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

Species	PCEs	Reference
California tiger salamander (CTS-CC, CTS-SB)	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	

Species	PCEs	Reference
	larval host plant and adult nectar plant survival and reproduction.[2]	
	The presence of stable holes and cracks in the soil, and surface rock outcrops that provide shelter for the larval stage of the bay checkerspot butterfly during summer diapause.[2]	
Tidewater Goby	Persistent, shallow (in the range of about 0.1-2 m), still-to-slow-moving, aquatic habitat most commonly ranging in salinity from less than 0.5 ppt to about 10-12 ppt, which provides adequate space for normal behavior and individual and population growth	65 FR 69693 69717, 2000
	Substrates (*e.g.*, sand, silt, mud) suitable for the construction of burrows for reproduction	
	Submerged and emergent aquatic vegetation, such as *Potamogeton pectinatus* and *Ruppia maritima*, that provides protection from predators	
	Presence of a sandbar(s) across the mouth of a lagoon or estuary during the late spring, summer, and fall that closes or partially closes the lagoon or estuary, thereby providing relatively stable water levels and salinity.	
Delta Smelt	Spawning Habitat—shallow, fresh or slightly brackish backwater sloughs and 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 deltamethrin that may alter the PCEs of the designated critical habitat for the BCB, TG, DS, CTS and VELB 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 deltamethrin is expected to directly impact living organisms within the action area, critical habitat analysis for deltamethrin is limited in a practical sense to those PCEs of critical habitat that are biological or that can be reasonably linked to biologically mediated processes.

2.7. Action Area and LAA Effects Determination Area

2.7.1. Action Area

The action area is used to identify areas that could be affected by the Federal action. The Federal action is the authorization or registration of pesticide use or uses as described on the label(s) of pesticide products containing a particular active ingredient. The action area is defined by the Endangered Species Act as, "all areas to be affected directly or indirectly by the Federal action and not merely the immediate 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 deltamethrin is likely to encompass considerable portions of the United States based on the large array of agricultural and/or 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, TG, DS, CTS (all DPS), VELB, CCR, SFGS and CFWS 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, TG, DS, CTS (all DPS), VELB, CCR, SFGS and CFWS 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 deltamethrin. An analysis of labeled uses and review of available product labels was completed. In addition, a distinction has been made between food use crops and those that are non-food/non-agricultural uses. For those uses relevant to the assessed species, the analysis indicates that, for deltamethrin, the following agricultural uses are considered as part of the federal action evaluated in this assessment (for additional detail, see **Tables 2-3 and 3-1**):

> Conventional agricultural crops, such as artichoke, canola, corn, cotton, cucurbit crops, tomatoes and other fruiting vegetables, onion and other bulb vegetables, apples and other pome fruits, carrots and other root crops, potatoes and other tuberous and corm vegetables, sorghum, sunflowers, and almond and other tree nut crops.

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

> Various conventional (*e.g.*, turf, nursery) and unconventional (*e.g.*, rights-of-way, residential, impervious) non-agricultural crop scenarios and uses, such as golf course turf and other types of lawns and ornamental grasses, residential lawns, ornamentals, pet living/sleeping quarters, numerous types of non-agricultural facilities, zoos, barns, paths/patios, paved areas, non-agricultural rights-of-way, fencerows/ hedgerows, wood protection treatment to building products, and sewage systems.

Following a determination of the assessed uses, an evaluation of the potential "footprint" of deltamethrin 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 deltamethrin, these land cover types include multiple types, such as Cultivated Crops, Developed High Intensity, Developed Medium Intensity, Developed Low Intensity, Developed Open Space, Pasture/Hay, Turf and Rights-of-Way. Given the diverse uses of deltamethrin, which include among others, residential, commercial, numerous agricultural crops, right-of-way, and fire ant control and ant mound treatment, the "footprint" covers the entire state of California, and mapping specific use sites does not provide information that is critical for this risk assessment. In addition, an evaluation of usage information was conducted to determine the area where use of deltamethrin may affect the assessed species. This analysis is used to characterize where predicted exposures are most likely to occur, but does not preclude use in other portions of the action area. A more detailed review of the county-level use information was also completed (refer to **Appendix L**.).

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

The AgDRIFT model (Version 2.1.1) is used to define how far from the initial area of concern an effect to a given species may be expected via spray drift (*e.g.*, the drift distance). The spray drift analysis for deltamethrin uses the most sensitive endpoint of insects and aquatic invertebrates (*i.e.*, the cotton bollworm, the amphipod *Hyalella azteca*, and the mysid shrimp). Further detail on the spray drift analysis is provided in **Section 5.2.9.a**.

2.8. Assessment Endpoints and Measures of Ecological Effect

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

2.8.1. Assessment Endpoints

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

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

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

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

Abbreviations: n/a = Not applicable; Terr. = Terrestrial; Invert. = Invertebrate; FW = Freshwater
* obligate relationship
** Consumption of residues of deltamethrin 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 2-11. Taxa and Assessment Endpoints Used to Evaluate the Potential for Use of Deltamethrin 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 – -Tidewater Goby* -Delta Smelt* -California Tiger Salamander	Survival, growth, and reproduction of individuals via direct effects	1a. 96-h acute LC_{50} for pumpkinseed sunfish, *Lepomis gibbosus* 1b. Life cycle NOAEC for fathead minnow, *Pimephales promelas*
	Indirect Effect (prey) -SF Garter Snake -CA Clapper Rail -California Tiger Salamander	Survival, growth, and reproduction of individuals via indirect effects on aquatic prey food supply (*i.e.,* fish and aquatic-phase amphibians)	
2. Freshwater Invertebrates	Direct Effect – -CA FW Shrimp	Survival, growth, and reproduction of individuals via direct effects	2a. 48-h EC_{50} for freshwater amphipod (*Gammarus fossarum*). 2b. 8-d NOAEC for water flea

Taxa Used to Assess Direct and Indirect Effects to Assessed Species and/or Modification to Critical Habitat or Habitat	**Assessed Listed Species**	**Assessment Endpoints**	**Measures of Ecological Effects**
	Indirect Effect (prey) -CA FW shrimp -SF Garter Snake -CA Clapper Rail - CA Tiger Salamander -Tidewater Goby -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)	(*Ceriodaphnia dubia*).
3. Estuarine/Marine Fish	Direct Effect – -Tidewater Goby* - Delta Smelt*	Survival, growth, and reproduction of individuals via direct effects	3a. 96-h acute LC_{50} for sheepshead minnow (*Cyprinodon variegatus)* 3b. 35-d chronic NOAEC for sheepshead minnow (*C. variegatus)*
	Indirect Effect (prey) -Clapper Rail	Survival, growth, and reproduction of individuals via indirect effects on aquatic prey food supply (*i.e.,* estuarine/marine fish)	
4. Estuarine/Marine Invertebrates	Indirect Effect (prey) -CA Clapper Rail -Tidewater Goby -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) 4b. Most sensitive estuarine/marine invertebrate chronic NOAEC (guideline or ECOTOX)
5. Aquatic Plants (freshwater/marine)	Indirect Effect (food/habitat) -SF Garter Snake -CA Clapper Rail -CA Tiger Salamander -Tidewater Goby -Delta Smelt -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} for duckweed, *Lemna gibba*) 5b. Non-vascular plant acute EC_{50} for freshwater green algae, *Pseudo-kirchneriella subcapitata*
6. Birds	Direct Effect -SF Garter Snake -CA Clapper Rail -CA Tiger Salamander	Survival, growth, and reproduction of individuals via direct effects	6a. Acute LD_{50} for bobwhite quail (*Colinus virginianus)* 6b. Acute LC_{50} for mallard duck (*Anas platyrhynchos)* 6c. 22 week NOAEC for bobwhite quail (*C. virginianus)*
	Indirect Effect (prey/rearing sites) -SF Garter Snake -CA Clapper Rail	Survival, growth, and reproduction of individuals via indirect effects on terrestrial prey (birds)	
7. Mammals	Indirect Effect (prey/habitat from burrows/rearing sites) -SF Garter Snake -CA Clapper Rail -CA Tiger Salamander	Survival, growth, and reproduction of individuals or modification of critical habitat/habitat via indirect effects on terrestrial prey (mammals) and/or burrows/rearing sites	7a. Acute LD_{50} for rat (*Rattus norvegicus)* 7b. Chronic NOAEC for rat (*R. norvegicus)*

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
8. Terrestrial Invertebrates	Direct Effect -Bay Checkerspot Butterfly -Valley elderberry longhorn beetle	Survival, growth, and reproduction of individuals via direct effects	8a. 48-h acute LD_{50} for cotton bollworm larvae *(Helicoverpa armigera)*
	Indirect Effect (prey) -SF Garter Snake -CA Clapper Rail -CA Tiger Salamander	Survival, growth, and reproduction of individuals or modification of critical habitat/habitat via indirect effects on terrestrial prey (terrestrial invertebrates)	
9. Terrestrial Plants	Indirect Effect (food/habitat) (non-obligate relationship) -SF Garter Snake -CA Clapper Rail -SF Garter Snake -CA Tiger Salamander -Tidewater Goby -Delta Smelt	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. EC_{25} and NOAEC for monocots and dicots based on seedling emergence and vegetative vigor
	Indirect Effect (food/habitat) (obligate relationship) -Bay Checkerspot Butterfly -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 deltamethrin 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 deltamethrin 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 deltamethrin to the environment. The following risk hypotheses are presumed in this assessment:

The labeled use of deltamethrin within the action area may:

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

2.9.2. Diagram

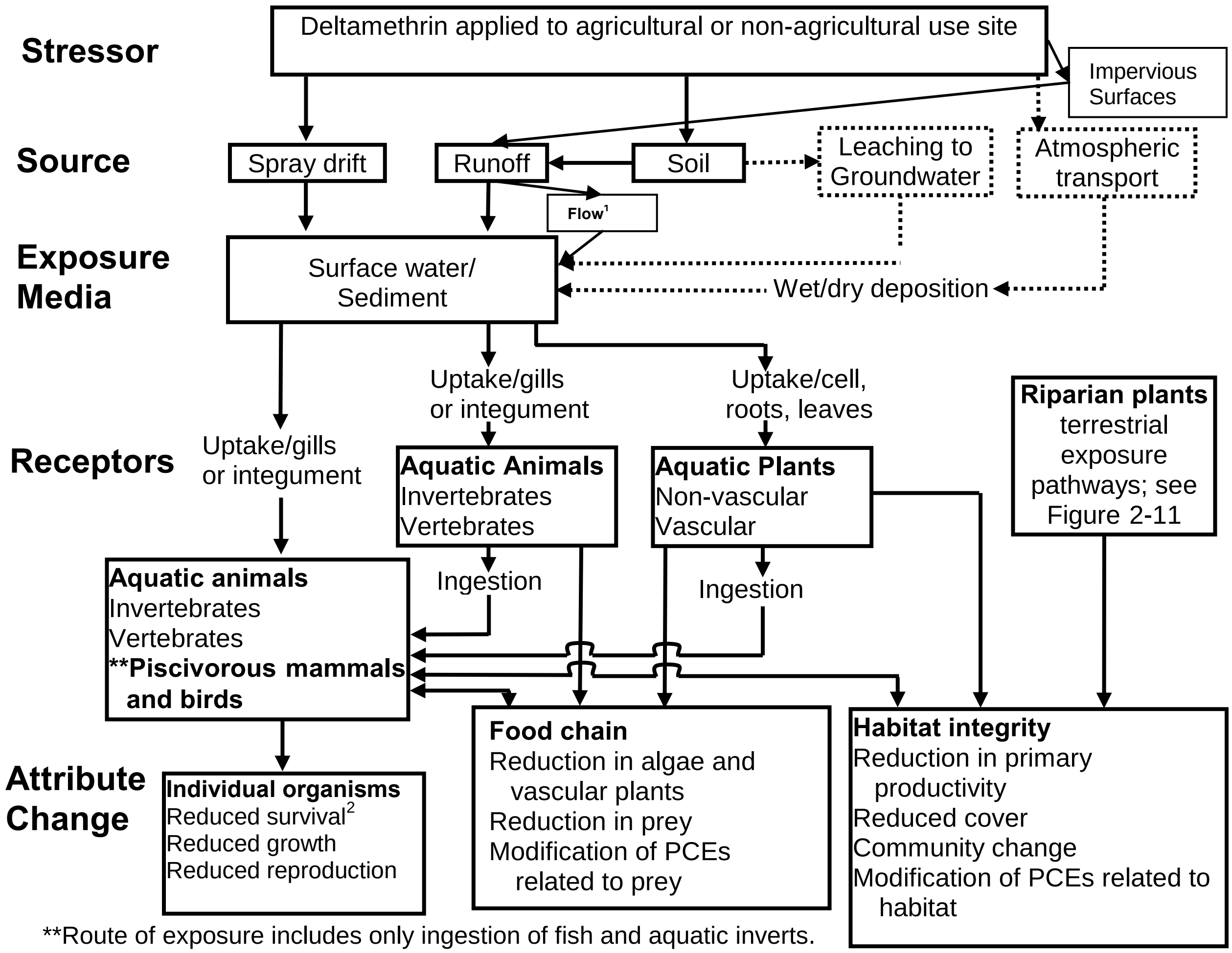
The conceptual model is a graphic representation of the structure of the risk assessment. It specifies the deltamethrin release mechanisms, biological receptor types, and effects endpoints of potential concern. The conceptual models for BCB, TG, DS, CTS (all DPS), VELB, CCR, SFGS & CFW and the conceptual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

Under the possible uses of deltamethrin, the sources and mechanisms of release of the compound are from ground or aerial spray applications (note that this conceptual model considers agricultural applications as well as certain non-agricultural and urban applications). Surface runoff (sediment-bound residues) from the areas of application is assumed to depend on factors such as topography, irrigation, and rainfall events. In urban areas, factors that affect surface runoff also include the presence of impervious surfaces and storm drain system design. Direct deposition may result in contamination of food items that may be consumed by terrestrial organisms. Spray drift results in contaminated adjacent areas, including bodies of water. Note that leaching to groundwater is not considered an important source because deltamethrin shows low mobility in soils. Deltamethrin shows a moderate Henry's Law Constant that would suggest a relatively low potential for volatilization; furthermore, the hydroxyl radical reaction half-life for the chemical is 0.46 days (EPISuite v.4.1 estimate) and indicates a short atmospheric half-life. The short atmospheric half-life suggests that the potential for atmospheric transport for deltamethrin is relatively low and that this source of the chemical is of very low importance, compared to spray drift, runoff and/or direct contact after application.

For aquatic receptors, the major point of exposure is through direct contact with the water column, sediment, and sediment pore water (gill/integument) contaminated with spray drift (from spray application) and/or runoff and flow (*e.g.*, piped storm drains) from treated areas. Indirect effects to aquatic organisms (both fish and aquatic invertebrates) can also occur through impact to various food chains (it was established earlier in this document in **Section 2-4**, that deltamethrin has the potential to bioaccumulate/bio-concentrate) , but that pyrethroids, such as deltamethrin, undergo substantial biotransformation *in vivo*. The representative aquatic receptors are certain freshwater and estuarine/marine fish, invertebrates, and in certain cases, aquatic plants. The major point of exposure for terrestrial animals is consumption of food contaminated with residues such as grass, foliage, and small insects. For plants, the point of exposure is direct contact or root uptake. The representative terrestrial receptors are mammals, birds and terrestrial plants. The attribute changes used to assess risk to terrestrial receptors depend on the type of test (*e.g.*, reduced survival, growth, or reproduction for animals and seedling emergence and vegetative vigor for plants). It should be noted, that these species do not cover all the possible species in the animal and plant kingdoms; certain taxa are considered as surrogates for other taxa. For example, fish are considered surrogates for aquatic-phase amphibians in the absence of amphibian toxicity data.

This conceptual model also shows details about biomagnification for a chemical (see piscivorous birds and mammals in **Figure 2-10**). Deltamethrin has a very high K_{ow} and according to its physicochemical and fate properties, there is a potential for bioaccumulation/bioconcentration in aquatic organisms, and biomagnification in terrestrial organisms.

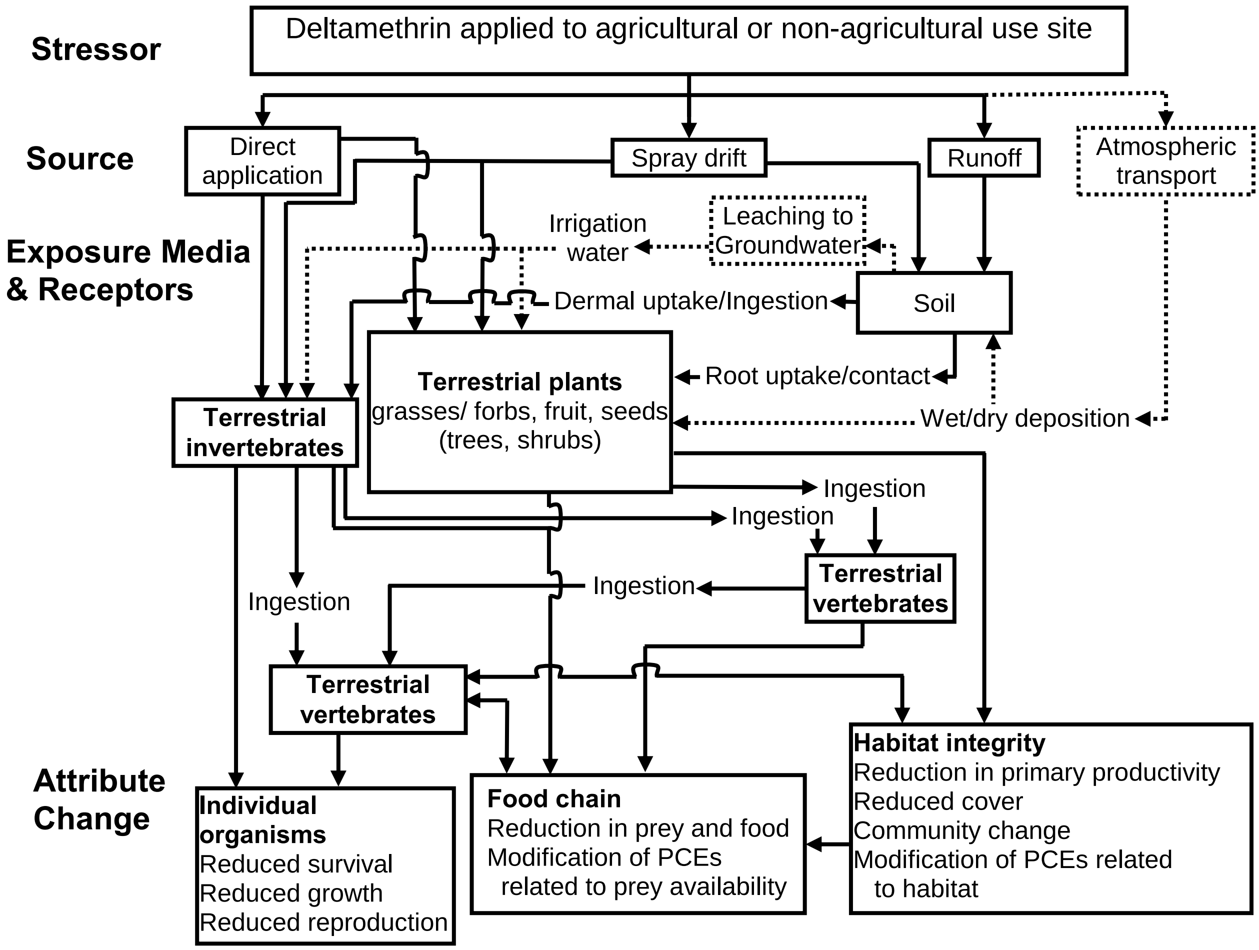
Deltamethrin shows a low solubility, a high K_{OW} and also high K_{OC} values. These properties suggest that the chemical partitions with the sediments, and with organic matter, suspended in the water bodies. Deltamethrin is likely to concentrate in the sediments, where it could persist. Such sediments could serve as repositories of the chemical for extended periods of time and could potentially be toxic to sediment dwelling organisms, affecting the food chain; however, transport of deltamethrin when dissolved in water is not precluded, especially when it occurs on impervious surfaces.



[1] May include flow across vegetation and vegetated drainage systems (*e.g.*, swales) and flow across impervious surfaces and through impervious (piped) storm drains.
[2] Immobilization is considered equivalent to mortality in toxicity tests for aquatic invertebrates.
Dotted lines indicate exposure pathways that have a low likelihood of contributing to ecological risk.

Figure 2-10. Aquatic conceptual model depicting stressors, exposure pathways, and potential effects to aquatic organisms from the use of deltamethrin on agricultural and certain non-agricultural sites.

Since pyrethroids are known to sorb to sediments, among the potential aquatic animals considered in this assessment are those associated with benthic environments. Pyrethroids are very highly toxic to aquatic invertebrates and toxicity of pyrethroid contaminated sediments to benthic organisms has been widely documented (*e.g.*, *Hyalella azteca*, refer to Amweg *et al.* 2005).



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

Figure 2-11. Terrestrial conceptual model depicting stressors, exposure pathways, and potential effects to terrestrial organisms from the use of deltamethrin on agricultural and certain non-agricultural sites.

EFED does not possess a method nor has it frequently conducted exposure assessments for the release of pesticides to domestic wastewater (in this instance, from sewage system treatment). In order to address the issue of releases to domestic wastewater, the Agency has relied on the Office of Pollution Prevention and Toxics (OPPT) consumer exposure model, Exposure and Fate Assessment Screening Tool (E-FAST, v. 2.0) (USEPA, 2007). The 'Down-the-Drain' module of E-FAST v.2.0 (herein abbreviated as 'DtD') is specifically designed to address sources of a chemical that could potentially be disposed into domestic wastewater from a DtD application. This model provides screening-level estimates of chemical residues in surface water that may result from household uses and the disposal of these consumer products into wastewater. Conceptually, the model assumes that in a given year the entire production volume of a chemical (*i.e.*, a pesticide) is parceled out on a daily basis to the entire U.S. population and converted to a mass release per capita and daily per capita release to a wastewater treatment facility (*i.e.*, g/person/day). This mass is then diluted into the average daily volume of wastewater released per person to arrive at an estimated concentration of the chemical in wastewater prior to entering a treatment facility. The chemical's concentration in untreated wastewater is then reduced by the fraction removed during wastewater treatment processes before release into a river or stream where it undergoes dilution (see **Section 3.2.2** for further details about the E-FAST's DtD module).

The conceptual diagram for potential risks of deltamethrin to aquatic organisms due to various indoor uses of the chemical that could potentially end up in a "drain" is depicted in

Figure 2-12. The stressor is the chemical of concern, *i.e.*, deltamethrin. It is noted that the transport pathway is wastewater flow, the exposure media is the treatment facility and the exposure point or route, receptor, and attribute changes for aquatic organisms are similar to those for the conceptual diagram for conventional agricultural (and other non-agricultural) applications.

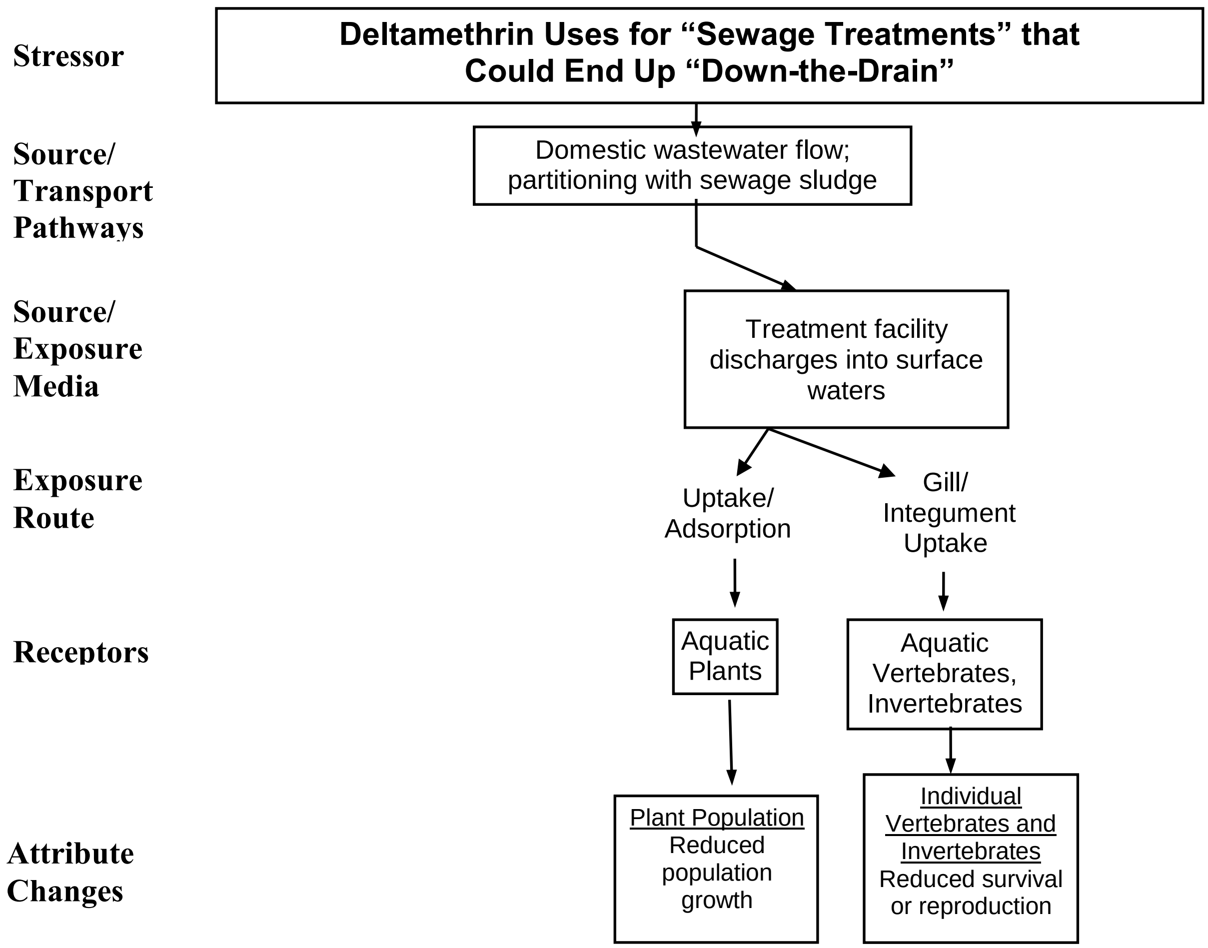


Figure 2-12. Aquatic conceptual model depicting stressors, exposure pathways, and potential effects to aquatic organisms from the use of deltamethrin for sewage treatments, that could end up in a wastewater treatment facility

2.10. Analysis Plan

In order to address the risk hypothesis, the potential for direct and indirect effects to the assessed species, prey items, and habitat is estimated based on a taxon-level approach. In the following sections, the use, environmental fate, and ecological effects of deltamethrin 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 deltamethrin is estimated using the probit dose-response slope and either the level of concern (discussed below) or actual calculated risk quotient value.

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

2.10.1. Measures of Exposure

The environmental fate properties of deltamethrin along with available monitoring data indicate that water and sediment runoff and spray drift are the principle potential transport mechanisms of deltamethrin to the aquatic and terrestrial habitats. In this assessment, transport of deltamethrin through runoff and spray drift is considered in deriving quantitative estimates of deltamethrin exposure to BCB, TG, DS, CTS (all DPS), VELB, CCR, SFGS, and CFWS, their prey and habitats. Limited air monitoring data available for deltamethrin suggests that air concentrations should be low compared to spray drift predictions (see **Section 3.2.4.d**). Since the air degradation half-life for deltamethrin due to hydroxyl radical reactions is small (~0.46 days, EPISUITE v.4.1 estimated), long-range transport of vapor phase deltamethrin is not expected. Deltamethrin, however, could move offsite sorbed to suspended particles in the air. Due to the strong tendency to sorb to soils for deltamethrin, as shown by high K_{OC} values (>100,000 L/kg-$_{OC}$), movement into groundwater is not a significant exposure pathway. Exposure via bioaccumulation is considered however as deltamethrin has been documented to bioconcentrate moderately in fish.

Measures of exposure are based on aquatic and terrestrial models that provide EECs of deltamethrin using maximum labeled application rates and methods of application. The models used to predict aquatic EECs are the Pesticide Root Zone Model coupled with the Exposure Analysis Model System (PRZM/EXAMS). The model used to predict terrestrial EECs on food items is the Terrestrial Residue Exposure (T-REX) model. The Terrestrial Herpetofaunal Exposure Residue Program Simulation (T-HERPS) model is used to allow for further characterization of dietary exposures of terrestrial-phase amphibians and reptiles relative to birds. The model used to derive EECs relevant to terrestrial and wetland plants is TerrPlant. The K_{ow} (based) Aquatic BioAccumulation Model (KABAM) is used to estimate potential bioaccumulation of hydrophobic organic pesticides in freshwater aquatic food webs and subsequent risks to mammals and birds via consumption of contaminated aquatic prey. These models are parameterized using relevant reviewed registrant-submitted environmental fate data. More information on these models and model numbers is available in **Attachment I**. The equilibrium partitioning theory (EqP) will be used to derive risk quotients for benthic organisms, as described below. More information on standard assessment procedures is available in **Attachment I**.

2.10.1.a. Estimating Exposure in the Aquatic Environment

Equilibrium Partitioning

Deltamethrin, like other pyrethroids, is a lipophilic compound that can adsorb readily to particulates and sediment (mean Koc = 449,000 L/kg-$_{OC}$), thus possibly limiting its exposure to aquatic life in the water column but increasing exposure in the benthos. Sediment can act as a reservoir for lipophilic persistent compounds, as it and suspended particulate may adsorb a percentage of deltamethrin, as indicated by its relatively high K_{OC}. Exposure of aquatic organisms to sediment contaminated with deltamethrin can result in a direct impact to aquatic life through respiration, ingestion, dermal contact, as well as indirect impact through alterations of the food chain.

To evaluate the potential for exposure in sediment relative to deltamethrin dissolved in the water column, PRZM/EXAMS has been employed to generate exposure estimates. The basis for this estimation is grounded in the Agency's Equilibrium Partitioning Sediment Guidelines (ESG) under the Clean Water Act [CWA Section 304(a)(2)] and the EqP. The EqP theory holds that a nonionic compound in the sediment partitions between sediment organic carbon, interstitial (pore) water and benthic organisms (Di Toro *et al.*, 1991, U.S. Environmental Protection Agency, 2002). At equilibrium, if the concentration in any phase is known, then the concentration in the other phases can be predicted through the organic/carbon soil partition coefficient. Since the EXAMS model employs EqP in order to predict concentrations of nonionic chemicals in pore water through the use of a chemical's K_{OC}, deltamethrin sediment exposure to benthic organisms is estimated by calculating pore water exposure values using the PRZM/EXAMS model. Although sediment concentrations can also be estimated using PRZM/EXAMS and EqP theory, Di Toro *et al.*, 1991 noted that "for nonionic organic chemicals, the concentration-response relationship for the biological effect of concern can most often be correlated with the interstitial water (pore water) concentration (μg chemical/L interstitial water)." Exposure estimates for deltamethrin dissolved in the pore water relative to the water column, and any associated uncertainties are discussed and characterized qualitatively in the "Uncertainties" section of the document (see **Section 6**).

To estimate exposure related to releases of deltamethrin from sewage treatment, the Agency will rely on the Office of Pollution Prevention and Toxics (OPPT) model, Exposure and Fate Assessment Screening Tool (EFAST, version 2.0, or EFAST2, USEPA 2007). From this model, the Agency will use the "Down-the-Drain" module, which is designed for releases to domestic wastewater treatment. It is suitable for all the sources of deltamethrin that could potentially be exposed through a "down-the-drain" scenario (DtD). The model provides screening level estimate concentrations of chemicals in surface water that may result from household uses and the disposal of consumer products into wastewater using a few simple input parameters (production volume and fraction of the chemical removed during wastewater treatment). See **Section 3.2.2** for further details.

2.10.1.b. Estimating Exposure in the Terrestrial Environment

The Screening Tool for Inhalation Risk (STIR v. 1.0) estimates inhalation-type exposure based on pesticide-specific information. It uses physical chemistry properties (e.g., vapor pressure), 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 deltamethrin is not likely to be an exposure pathway of concern (see **Appendix G)**.

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 deltamethrin, 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 C**). More information on standard assessment procedures is available in Attachment I.

2.10.4. Data Gaps

The environmental fate database is substantially complete. Two relevant fate gaps were identified in the Problem Formulation for Registration Review. They include one aerobic aquatic metabolism study conducted in a test system with a low percent organic matter and low pH. The two systems available had pH values above 8.0, which may have promoted more rapid degradation since deltamethrin is prone to hydrolysis at high pH. Additionally, there is no anaerobic aquatic metabolism study. In its absence, the anaerobic soil metabolism study was used according to the guidance to select input parameters in PRZM/EXAMS.

During the problem formulation phase of Registration Review (DP Barcode D373622, March 2010, document ID EPA-HQ-OPP-2009-0637-0003, available at www.regulations.gov), various ecotoxicity data were unavailable and confirmatory data were required for deltamethrin. At the time of the aforementioned Problem Formulation, ecotoxicity datagaps for aquatic species included:

- Saltwater fish ELS (chronic)
- Saltwater aquatic invertebrate LC (chronic)
- Freshwater and saltwater whole sediment LC (chronic)
- Non-vascular aquatic plant (algae; Tier I/II)
- Vascular aquatic plant (Tier I/II)

For terrestrial species, ecotoxicity data gaps included:

- Avian passerine oral toxicity (acute)
- Terrestrial plant seeding emergence and vegetative vigor (Tier I/II)

Among these, studies have recently been submitted to the Agency for the saltwater fish ELS, saltwater invertebrate LC, non-vascular aquatic plant, vascular aquatic plant and terrestrial plant data gaps. These studies are currently undergoing review. However, after an initial screen of these studies, it is evident that the terrestrial plant toxicity data submitted to the Agency were conducted at application rates well below the maximum U.S. rates. Furthermore, no avian passerine, chronic sediment life cycle or aquatic non-vascular plant toxicity data (for marine diatoms and bluegreen algae) have been submitted to the Agency.

3. Exposure Assessment

Deltamethrin is formulated as a dust, wettable powder, flowable concentrate, pressurized liquid, liquid, emulsifiable concentrate, liquid ready-to-use, granular, and water dispersible granules. When used on crops, applications may occur pre-plant, at plant, foliar or post-planting. Application equipment includes low and high volume sprayers, chemigation equipment, soil incorporation equipment, soil injection treatment, barrier treatment, crack and crevice and/or spot treatment, perimeter treatment, surface spray, and spreaders for dust applications. Additionally, applications could occur year round, particularly in non-agricultural settings. 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 deltamethrin 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. **Section 2.4.3** gives a summary of the use and usage of deltamethrin.

3.1. Label Application Rates and Intervals

Deltamethrin labels may be categorized into two types: labels for manufacturing uses (including technical grade deltamethrin) and end-use products. While technical products, which contain deltamethrin of higher 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 deltamethrin's potential use to only those sites that are specified on the labels.

Mitigation measures required for pyrethroid products after the Reregistration Eligibility Decision of several other synthetic pyrethroids (not including deltamethrin), are described in more detail in **Appendix L**. Succinctly, the agricultural labels for deltamethrin require a buffer zone of 10 ft around certain bodies of water to allow growth of a maintained vegetative filter strip. The agricultural products should not 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). Furthermore, droplet size should be medium (ASAE S572) or coarser for conventional applications.

One of the main restrictions imposed on general outdoor (non-agricultural) residential applications is that all outdoor applications must be limited to spot or crack-and-crevice treatments only, except for treatment to soil or vegetation around structures, applications to lawns, turf, and other vegetation, and applications to building foundations, up to a maximum height of 3 feet. Other than applications to building foundations, all outdoor applications to impervious surfaces such as sidewalks, driveways, patios, porches and structural surfaces (such as windows, doors, and eaves) are limited to spot and crack-and-crevice applications, only."

Currently registered agricultural and non-agricultural uses of deltamethrin within California being assessed are summarized in **Table 3-1**.

Table 3-1. Deltamethrin Uses, Scenarios, and Application Information

Scenario (bold font)/ Uses Represented	Method of App.	Drift/ App Efficiency	Single App Rate (lb a.i./A)	Max No. of Apps at Max Rate	Min. Interval Between Apps (days)	Day of App (day-month)	CAM	IPSCND
Agricultural use patterns								
CAalmond_WirrigSTD/ Tree nuts crop group 14 (almond, beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, filbert, hickory nut, macadamia nut, pecan, pistachio, walnut)	A (foliar)	0.036/0.95	0.0354	5	7	02-01	2	1
CAalmond_WirrigSTD/ Tree nut crops as described in the previous row	A (dormant)	0.036/0.95	0.0354	5	7	15-10	2	1
CAcornOP/ Corn (field, pop)	A	0.036/0.95	0.0236	5	21	05-04	2	1
CAcornOP/ Corn (pop)	D	0.0/1.00	0.0229	5	21	05-04	2	1
CAcornOP/ Sweet corn	A	0.036/0.95	0.03	16	Assume 7*	05-04	2	1
CAcornOP/ Sweet corn	G	0.01/0.99	0.03	16	Assume 7*	05-04	2	1
CAcornOP/ Sweet corn	D	0.0/1.00	0.03	16	Assume 7*	05-04	2	1
CAcotton_WirrigSTD/ Cotton	A	0.036/0.95	0.0322	10	5	01-08	2	1
CAfruit_WirrigSTD/ Pome fruits: Apple, crabapple, loquat, mayhaw, pear, oriental pear, quince	G	0.01/0.99	0.0225	2	7	01-02	2	1
CAMelonsRLF_V2/ Cucurbits: (cantaloupe, chayote, Chinese waxgourd, citron melon, cucumber, gherkin, gourds, *Momordica* species, muskmelon, pumpkin, squash, watermelon)	A	0.036/0.95	0.03	6	3	15-06	2	1
CAMelonsRLF_V2/ Cucurbits: as shown in the previous row	G	0.01/0.99	0.03	6	3	15-06	2	1
CAMelonsRLF_V2/ Cucurbits: as shown in the previous row	D	0.00/1.00	0.03	6	3	15-06	2	1
CAonion_WirrigSTD/ garlic, leeks, onion, shallots	A	0.036/0.95	0.03	4	5	01-02	2	1
CAonion_WirrigSTD/ garlic, leeks, onion, shallots	D	0.00/1.00	0.03	4	5	01-02	2	1

Scenario (bold font)/ Uses Represented	Method of App.	Drift/ App Efficiency	Single App Rate (lb a.i./A)	Max No. of Apps at Max Rate	Min. Interval Between Apps (days)	Day of App (day-month)	CAM	IPSCND
CAPotatoRLF_V2/ Root vegetables crop subgroup 1B (except sugarbeet) (carrot, celeriac, turnip-rooted chervil , chicory, edible burdock, garden beet, ginseng, horseradish, parsley (turnip-rooted), parsnip, radish, oriental radish, rutabaga, salsify, black salsify, Spanish salsify, skirret, turnip) Tuberous and corm vegetables crop subgroup 1C (potato, sweet potato, arracacha, arrowroot, Chinese artichoke, Jerusalem artichoke, edible canna, bitter and sweet cassava, chayote (root), chufa, dasheen, ginger, leren, tanier, tumeric, yam bean, true yam)	A	0.036/0.95	0.03	5	3	01-03	2	1
CAPotatoRLF_V2/ Same crops as described in the previous row	D	0.00/1.00	0.03	5	3	01-03	2	1
CARowCropRLF_V2/ Artichokes	A	0.036/0.95	0.03	5	3	01-02	2	1
CARowCropRLF_V2/ Artichokes	D	0/1.00	0.03	5	3	01-02	2	1
CAtomato_WirrigSTD/ (eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato)	A	0.036/0.95	0.03	6	5	15-03	2	1
CAtomato_WirrigSTD/ (eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato)	D	0.00/1.00	0.03	6	5	15-03	2	1
CAWheatRLF_V2/ Sorghum	A	0.036/0.95	0.0242	2	7	15-01	2	1
CAWheatRLF_V2/ Canola, rapeseed, crambe	A	0.036/0.95	0.0097	2	7	15-01	2	1
Non-agricultural use patterns[1]								
CAnurserySTD_V2/ Ornamental and/or Shade Trees; Ornamental Ground Cover	G	0.01/0.99	0.428	Assume 12[1]	Assume 30[1]	02-01	2	1
CAnurserySTD_V2/ Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines	D	0.00/1.00	0.0109	Assume 12[1]	7	01-04	2	1
CAnurserySTD_V2/ Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines	G	0.01/0.99	0.218	Assume 12[1]	Assume 30[1]	02-01	2	1

Scenario (bold font)/ Uses Represented	Method of App.	Drift/ App Efficiency	Single App Rate (lb a.i./A)	Max No. of Apps at Max Rate	Min. Interval Between Apps (days)	Day of App (day-month)	CAM	IPSCND
CAnurserySTD_V2/ Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines	GR	0.00/1.00	0.147	Assume 12[1]	Assume 30[1]	02-01	1	1
CArangelandhayRLF_V2/ Ornamental sod farms	G	0.01/0.99	0.127	Assume 12[1]	7	02-01	2	1
CArangelandhayRLF_V2/ Ornamental sod farms	GR	0.00/1.00	0.131	Assume 12[1]	7	02-01	1	1
CATurfRLF/ Ornamental lawns and turf (also covers Ornamental grasses and recreational areas)	G	0.01/0.99	0.218	Assume 12[1]	Assume 30[1]	02-01	2	1
CATurfRLF/ Golf Course Turf, Recreational Area Lawns, Commercial/ Industrial Lawns (all assumed to be represented by CA turf) (also covers Ornamental grasses and Recreational areas)	G	0.01/0.99	0.127	Assume 12[1]	7	02-01	2	1
CATurfRLF/ Same crops as in the previous row	GR	0.00/1.00	0.147	Assume 12[1]	7	02-01	1	1
CATurfRLF/ Same crops as in the previous row (ant mound treatment)	G	0.01/0.99	1.94[2]	Assume 12[1]	7	02-01	2	1
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	G	0.01/0.99	0.0233[3]	6[1]	7	15-01	2/4	1
				12[1]	7	02-01	2/4	1
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	GR	0.00/1.00	0.0241[3]	6[1]	7	02-01	1/4	1
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings Outdoors Premises, Paths/Patios; Barns, Barnyards/ Auction Barns	G	0.01/0.99	0.109[4]	Assume 6[1]	7	02-01	2/4	1
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings Outdoors Premises, Paths/Patios	Crack & crevice, and/or spot treatment	0.01/0.99	0.00528[4]	Assume 6[1]	21	02-01	2/4	1
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings Outdoors Premises, Paths/Patios	GR or D (includes perimeter treatment)	0.00/1.00	0.0540[4]	Assume 6[1]	7	02-01	1/4	1
CAresidentialRLF/ CAimperviousRLF/ Wood Protection Treatment to Buildings/ Products (Outdoors)	Crack and crevice and/or perimeter treatment	0.01/0.99	2.17[5]	Assume 12[1]	21	02-01	2/4	1
CAresidentialRLF/ CAimperviousRLF/ Wood Protection Treatment to Buildings/ Products (Outdoors)	Soil drench/ treatment	0.01/0.99	0.0058[5]	Assume 12[1]	7	02-01	2/4	1

Scenario (bold font)/ Uses Represented	Method of App.	Drift/ App Efficiency	Single App Rate (lb a.i./A)	Max No. of Apps at Max Rate	Min. Interval Between Apps (days)	Day of App (day-month)	CAM	IPSCND
CArightofwayRLF_V2/ CAimperviousRLF/ Non-agricultural Rights-of-Way/ Fencerows/ Hedgerows; Refuse/Solid Waste Containers and Sites (outdoor)	G	0.01/0.99	0.0218[6]	Assume 12[1]	Assume 30[1]	02-01	2/4	1
CArightofwayRLF_V2/ CAimperviousRLF/ Non-agricultural Rights-of-Way/ Fencerows/ Hedgerows; Refuse/Solid Waste Containers and Sites (outdoor); Paved Areas (Private Roads/ Sidewalks)	Perimeter treatment	0.01/0.99	0.0187[6]	Assume 12[1]	Assume 30[1]	02-01	2/4	1
CArightofwayRLF_V2/ CAimperviousRLF/ Paved Areas (Private Roads/ Sidewalks)	Crack & crevice and/or spot treatment	0.01/0.99	0.0017[6]	Assume 5[1]	21	01-09	2/4	1
CArightofwayRLF_V2/ CAimperviousRLF/ Utilities, Utility Poles/Rights-of-Way	GR	0.00/1.00	2.72[7]	Assume 2	Assume 180[1]	02-01	1/4	1
Sewage Systems	Various	Various	50 kg/yr[8]	N/A	N/A	N/A	N/A	N/A

G=ground; GR=granular; D=dust; NA=not available; N/A=not applicable

*Given the large number of applications allowed on corn, it is unlikely that all would occur at intervals of less than 7 days.

1. For the majority of the non-agricultural uses, the number of applications and intervals are not specified. With a few exceptions, 6 or 12 applications were assumed. See **Section 3.2.1** for further details.
2. According to BEAD's use profile for deltamethrin, the application rate for ant control is 0.0097 lb a.i./mound. According to a number of sources like the Mississippi State University Extension Service and University of California, ant density can be 50-200 mounds per acre, and as high as 1000 mounds per acre (http://msucares.com/pubs/publications/p2493.pdf and http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7487.html, both accessed 01/24/2013). For this assessment 200 mounds are assumed, the application rate is (0.0097 lb/mound) (200 mounds/A) = 1.94 lb a.i./A.
3. For residential lawns, it was assumed that a substantial portion of the typical home would be planted in landscaping (*e.g.*, lawn) with an estimate of 2,000 ft^2 x 4 homes in an acre (see text in **Section 3.2.1**). Thus the equivalent application rate is (0.127 lb a.i./A x 2000 ft^2 x 4 homes/A)/43,560 ft^2/A = 0.0233 lb a.i./A. For the ground application, the impervious surface receives 1% drift of pesticide, based on the label use pattern, and the ground application method. For residential lawn granular applications, similarly the equivalent application rate is (0.131 lb a.i./A x 2000 ft^2 x 4 homes/A)/43,560 ft^2/A = 0.00241 lb a.i./A. The impervious surface receives no drift of pesticide, based on the label use pattern, and the granular application method.
4. A critical assumption when modeling using the residential and impervious scenario is that 50% of a ¼ acre lot will be pervious and 50% impervious. In this instance, the pervious surface is assumed to be treated. The equivalent application rate for ground applications is (0.218 lb a.i./A)/2 = 0.109 lb a.i./A. The impervious surface receives 1% drift. Meanwhile, for crack & crevice and/or spot treatment, if 5% of the treatable area is treated, then the equivalent application rate is ([0.211 lb a.i./A)/2] x 5% = 0.00528 lb a.i./A. Both the pervious and the impervious surfaces are assumed to receive this rate. Finally, for perimeter treatment granular or dust applications, it was assumed that a 10 ft perimeter around the house that is 2000 ft^2 in area (see text in **Section 3.2.1**). The perimeter of a 2000 ft^2 house lot is assumed to be about 180 ft and the area treated is 180 ft x 10 ft = 1800 ft^2. Additionally, the garage has an area of 900 ft^2, which is assumed to be 30 ft x 30 ft. The area of the perimeter surrounding the garage is 30 ft x 4 sides x10

ft = 1200 ft^2. The total surface area to be treated is 3000 ft^2 per dwelling unit. The equivalent application rate is 0.196 lb a.i./A x 3000 ft^2 x 4 houses/A / 43,560 ft^2/A = 0.0540 lb a.i./A.

5. For deltamethrin there is no wood leachability study and 100% of the material is assumed to leach from the wood surface as a conservative assumption. Typical house lots are assumed to be constructed with wood and represent the treated area. The equivalent application rate is based on the sum of the wall area treated, plus the deck area and garage and 3 ft up the surface area can be treated. The house perimeter is 180 ft. The equivalent application rate to the pervious area is 26.3 lb a.i./A (100%) (180ft x 3 ft + 300 ft + 30 ft x 3 ft x 4 sides) x 4 dwelling units/A / 43560 ft^2/A = 2.17 lb a.i./A. There is 1% drift to pervious areas. For soil drench, a limited area is assumed to be treated (1 ft around the structure) or (0.209 lb a.i./A) (180ft x 1 ft + 30 ft x 1 ft x 4 sides) x 4 dwelling units/A/ 43560 ft^2/A = 5.8×10^{-3} lb a.i./A.
6. Not more than 10% of the watershed is covered by ROW (see **Section 3.2.1**). Thus rate is 0.218x10% = 0.0218 lb a.i./A. For the perimeter treatment, ROW within a dwelling unit, it was assumed that a typical dwelling unit (¼ acre lot) would have a driveway of approximately 25 by 30 feet or 750 ft^2 and roughly 250 ft^2 of sidewalk. This is considered the paved area. The perimeter is assumed to cover 10 ft surrounding this area, or roughly 25x10x2 + 30x10x2 + 25x10x2 +10x10x2 ft^2 = 1800 ft^2. The equivalent application rate is 0.113 lb/Ax1800x4 dwelling units per acre/43560 ft^2/A = 0.0187 lb a.i./A. For crack and crevice and/or spot treatment, it is assumed that 5% of the potential surface area is treated or 0.211 lb/Ax1800x4 du per acre/43560 ft^2/A = 0.0349 lb a.i./A, and 0.0349 lb a.i./A x 5% = 0.0017 lb a.i./A.
7. The perimeter around utility poles is likely limited. Furthermore, not more than 10% of the watershed is covered by ROW. The equivalent application rate is 27.2 lb a.i./A x 10% = 2.72 lb a.i./A.
8. Assume 50 kg a.i./year used on a national basis is an upper bound value.

3.2. Aquatic Exposure Assessment

3.2.1. Modeling Approach

Tier II modeling was used to generate screening-level Estimated Environmental Concentrations (EECs) for aquatic exposure. The EECs in surface water were generated using EFED's Tier II aquatic models: PRZM (Pesticide Root Zone Model; v3.12.2; 5/15/05) and EXAMS (EXposure Analysis Modeling System; v2.98.04.06; 4/25/05). Calculations for PRZM/EXAMS were carried out with the linkage program shell: PE5 (PRZM EXAMS Model Shell; v5.0; 11/15/06), which incorporates the standard scenarios developed by EFED. PRZM simulates fate and transport on the agricultural field, and EXAMS simulates the fate and resulting daily concentrations in a standard model water body. Simulations are run for multiple (usually 30) years, and the EECs represent peak values that are expected once every ten years, based on the thirty years of daily values generated during the simulation. Additional information on these models can be found at: http://www.epa.gov/oppefed1/models/water/index.htm (accessed 01/24/13). Aquatic exposure is modeled for the total toxic residues (parent + α-R-deltamethrin). However, the latter transformation product was identified as a major product only in the aerobic aquatic metabolism study.

Use-specific management practices for all of the assessed uses of deltamethrin were utilized for modeling, including application rates, number of applications per year, application intervals, buffer widths and resulting spray drift values modeled from AgDRIFT (*i.e.*, the buffer zones of 25 ft or 150 ft, for ground or aerial, respectively). The date of first application was developed based on several sources of information including data provided by BEAD, a summary of individual applications from the CDPR PUR data, and Crop Profiles maintained by the USDA. More detail on the crop profiles and the previous assessments may be found at: http://www.ipmcenters.org/CropProfiles/. An example output file from PRZM/EXAMS, for the crop CA melons is provided in **Appendix D**. The results of the EECs, for all the crops and scenarios, are reported in **Table 3-4**.

Aerial and Ground Applications

Since aerial and ground applications are allowed for many of the agricultural crops, two sample crop scenarios were evaluated via both methods of application, plus dust applications, using the same date of application. The two crop scenarios evaluated were sweet corn (CA corn) and cucurbit vegetables (CA melons), one of which included 16 applications per season and the other included 6 applications per season, respectively. These are considered high-end and more representative of agricultural crops. Only agricultural crops were considered because aerial applications are not included in non-agricultural labels.

Spray Drift

There are various types of formulations registered for deltamethrin. In general, they include dust, granular, and liquid applications. These applications have been modeled separately. The standard assumption for modeling dust and granular applications is different from liquid applications. The assumptions for dust and granular application is that there is no drift, while for liquid applications, the percent drift is based on modeling with AgDRIFT. For the agricultural applications, the results of modeling using the AgDRIFT Tier II Aerial mode for deltamethrin (droplet size "Medium", based on ASAE S572, and wind speed of 15 mph, as per label restrictions) indicated that the value of drift for a buffer zone of 150 ft for aerial applications and using water as the carrier, is 3.6% (as opposed to the default value of 5%).

Urban Uses

For the majority of the non-agricultural uses, the number of applications is not specified. In contrast, the maximum number of agricultural applications, at the maximum rate, ranges from 2 to 16 per season or per year. The survey of Pest Control Operators (PCOs) titled "California 2009 Urban Pesticide Use Pattern Study" (MRID 48762913), tasked by the Pyrethroid Working Group (PWG) and performed by the PWG and Meta Research, Inc., shows that PCOs provide service to residential sites more often on a monthly or bimonthly basis (80% for the total), while the commercial facilities are serviced more often monthly (83%). Thus, in general, in the absence of data, 6 or 12 applications were assumed. Further, when the interval was not specified, 30 days were assumed. For ground applications to residential lawns, both 6 and 12 applications were modeled.

At the present time, the CA impervious scenario is considered as the most suitable available modeling approach for impervious runoff[6]. The PRZM CA impervious scenario may be used in the Tier 2 coupled aquatic models PRZM/EXAMS along with the CA residential or other appropriate scenario such as CA rights-of-way (ROW) to obtain EECs (refer to **Table 3-1**). The "residential" (and various other urban) use patterns require the PRZM CA residential and CA impervious scenarios. Both scenarios are run separately. This approach assumes that no watershed is completely covered by either the ¼ acre lot (the basis for the residential scenario) or undeveloped land (the basis for the ROW scenario), for residential and ROW use patterns, respectively. By modeling a separate scenario for impervious surfaces, it is also possible to

[6] Additional information about this scenario is available at http://www.epa.gov/oppefed1/models/water/pe5_rlf.htm (accessed 01/24/2013).

estimate that amount of exposure that could occur when the pesticide is over-sprayed onto this surface. Using two scenarios in tandem requires post-processing of the modeled output in order to derive a weighted EEC that represents the contribution of both the pervious (*i.e.*, residential and ROW scenarios) and the impervious surfaces. Exposure from both scenarios can also be weighted and aggregated. The second critical assumption is that 50% of a ¼ acre lot will be pervious and 50% impervious. In addition to the footprint of the typical house, it was assumed that a typical house would have a driveway of approximately 25 by 30 feet or 750 square feet and roughly 250 square feet of sidewalk. A typical suburban home was also assumed to have roughly 300 square feet of deck space and 900 square feet of garage. Finally, it was assumed that a substantial portion of the typical home would be planted in landscaping (*e.g.*, residential lawn and/or ornamentals) with an estimate of 2,000 square feet. The sum of all these areas is 5,200 square feet. Taking a total ¼-acre lot size of 10,890 square feet and subtracting the house square footage yields a total remaining area of 5,690, or roughly 50% of the total lot untreated area. All of the previous estimates are based on professional judgment (more details in **Appendix D**).

The rights-of-way scenario is intended to represent areas including those associated with roads, power lines, and railroads in Central/Coastal California. Rights-of-way occur throughout the state. For the screening-level assessment, it was assumed that not more than 10% of the watershed is covered in rights-of-way.[7]

For additional details on the approach for urban uses, see **Appendix D. Example Output from PRZM/EXAMS, E-FAST, and AgDRIFT**.

3.2.2. Model Inputs

The appropriate PRZM and EXAMS input parameters for deltamethrin 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[8] and *PE5 User's Manual. (P)RZM (E)XAMS Model Shell, Version (5)*, November 15, 2006.[9] Input parameters can be grouped by physicochemical properties and other environmental fate data, application information, and use scenarios. Physical and chemical properties relevant to assess the behavior of deltamethrin in the environment are presented in **Table 2-1** and **Table 2-2** and application information from the label in **Table 2-3** and **Table 3-1**. The input parameters for PRZM and EXAMS are provided in **Table 3-2** below. **Appendix D** contains example model output files and tables showing the data used to calculate input values.

[7] More information about these scenarios is found at the following site accessed 01/24/2013: http://www.epa.gov/oppefed1/models/water/pe5_rlf.htm.
[8] Available at http://www.epa.gov/oppefed1/models/water/input_parameter_guidance.htm (accessed 01/24/2013).
[9] Available at http://www.epa.gov/oppefed1/models/water/pe5_user_manual.htm (accessed 01/24/2013).

Table 3-2. Summary of PRZM/EZAMS Environmental Fate Data Used for Aquatic Exposure Inputs for Deltamethrin Endangered Species Assessment

Fate Property	Value (unit)	Source/Comment[1]
Molecular Weight	505.2 g/mol	Laskowski 2002
Henry's constant	3.1 x 10^{-7} atm-m^3/mole	Calculated from vapor pressure and solubility
Vapor Pressure	9.32 x 10^{-11} torr	Laskowski 2002
Solubility in Water	0.000200 mg/L	Laskowski 2002
Photolysis in Water	84 days	MRID 42114818; Highest value available.
Aerobic Soil Metabolism Half-lives	$t_{input} = \overline{t_{1/2}} + \frac{t_{90,n-1}s}{\sqrt{n}}$ = 50.5 days	MRID 41677404, 41677405, 42114820. Represents the 90th percentile of the upper confidence bound on the mean for the following six values: 52.5, 54.6, 46.2, 50.2, 22 and 26 days; average 41.917 days; standard deviation 14.212 days; one sided student's t value $t_{90,n-1}$ = 1.476.
Hydrolysis Half-lives	Stable at pH 7	MRID 41651038
Aerobic Aquatic Metabolism Half-life (water column)	$t_{input} = \overline{t_{1/2}} + \frac{t_{90,n-1}s}{\sqrt{n}}$ = 154 days	MRID 44977005 Represents the 90th percentile of the upper confidence bound on the mean for the following two values: 25.9 and 120 days at 20°C. Corrected values at 25°C are calculated as follows $t_{1/2,input} = t_{1/2,exp}/\{2^{[(25^oC-20^oC)/10]}$: corrected values are 18.3 days and 84.9 days ; average 51.583 days; standard deviation 47.050 days; one sided student's t value $t_{90,n-1}$ = 3.078. Half-lives include α-R-deltamethrin, which was a major product in this study.
Anaerobic Aquatic Metabolism Half-life (benthic)	68 days	MRID 4211482 Twice the anaerobic soil metabolism value or 2 x 34 = 68 days. Test was performed at 25°C.
Organic-carbon water partition coefficient (K_{OC}, L/kg-$_{OC}$)	449,000	MRID 41651039, 42976501. Average of the following four values: 317000, 255000, 516000 and 708000. The K_{OC} model represents the mobility better than the K_d model (binding correlated to organic carbon content, the coefficient of variation for the K_{OC} dataset is less than for the K_d dataset).
Application rate and frequency	See **Table 3-1**	---
Application intervals	See **Table 3-1**	---
Chemical Application Method (CAM)	See **Table 3-1**	---
Application Efficiency	0.99 ground; 0.95 aerial; 1.00 dust or granular	Label

Fate Property	Value (unit)	Source/Comment[1]
Spray Drift Fraction	0.01 ground; 0.036 aerial; 0.00 dust or granular	Label. For aerial applications the default input value is 0.05; however, the spray drift fraction was calculated with AgDRIFT (Tier II Aerial), assuming a buffer zone of 150 ft, a wind speed of 15 mph, a boom height of 10 ft, and a medium spray droplet size, as per label restrictions.
Incorporation Depth	0.0 cm	Label
Post-harvest foliar pesticide disposition (IPSCND)	See **Table 3-1**	---
Foliar extraction (FEXTRC)	0.5	EFED guidance
Decay rate on foliage (PLDKRT)	0 day^{-1}	EFED guidance
Volatilization rate from foliage (PLVKRT)	0	EFED guidance
Uptake factor (UPTKF)	0	EFED guidance

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.

The Down the Drain module (DtD) was used for sewage treatment use of deltamethrin. The underlying equations used by the DtD module are shown below. They are based on the E-FAST Manual (USEPA 2007). First, the daily per capita release is defined as follows.

where,

- H_R is the daily per capita release of the chemical (g/[person•day]);
- PV is the production volume of the chemical being evaluated that is produced annually in the USA that is discharged into domestic wastewaters (kg/year); and
- Pop is the 2003 U.S. resident population (2.908×10^8 persons) (U.S. Bureau of the Census, 2004-2005).

The surface water concentration is calculated using the following general equation.

where,

- SWC is the surface water concentration (µg/L);
- Q_H is the household wastewater volume released daily (it is estimated to be 388 L per person per day, this volume was derived from an Agency database of POTWs, derived from the 1996 Clean Water Needs Survey (CWNS or Needs) data contained in the Main Facility File, it represents the 50th percentile value, which was selected by the model

developers to be used in the DtD module), it includes only domestic and residential POTWs;
- WWT is the wastewater treatment removal (percent removed prior to discharging into a body of water, %); and
- SDF is the stream dilution factor, equal to the volume of the receiving stream flow divided by the volume of the wastewater treatment facility effluent flow (i.e., SDF = SF/EF). This value is estimated by the Stream Dilution Factor Program (SDFP) for 36 industrial categories. It includes four types of flows: 1Q10, 7Q10, 30Q5 and Harmonic Mean.

For the protection of aquatic life, the developers of the model have deemed the following stream flows (SFs) suitable:
- SF_{1Q10} is the stream flow that corresponds to the single day of lowest flow over a 10-year period (*i.e.*, lowest 1-day flow during any 10-year period). The 1Q10 stream flows provide acute surface water concentrations to compare with acute concentrations of ecological concern (aquatic animals and plants); and
- SF_{7Q10} is the stream flow corresponding to seven consecutive days of lowest flow over a 10-year period (*i.e.*, lowest consecutive 7-day average flow during any 10-year period). The 7Q10 stream flows give chronic surface water concentrations to compare with chronic concentrations of concern for aquatic animals.

The input values used in the model E-FAST's Down-the-Drain (DtD) module are only a few **(Table 3-3**). In the absence of production volume, a lower and upper bound values were assumed to be 1 and 100 kg a.i./year used in sewage systems on a national basis. An example output file from the model is presented in **Appendix D. Example Output from PRZM/EXAMS, E-FAST, and AgDRIFT**.

Table 3-3. Summary of E-FAST Down-the-Drain Environmental Fate and Exposure Data Used for Aquatic Exposure Inputs for Deltamethrin Endangered Species Assessment

Parameter	Input Value	Justification/Comments
Bioconcentration Factor (BCF) Bluegill Sunfish (whole fish)	Steady State BCF= 698 L/kg wet wt	MRID 41651040, 43072701, 43072702
Production Volume (PV)	50 kg a.i./year	Assume this is an upper bound value (amount used on a national basis)
Wastewater Removal (WWT)	65%	MRID 48762906 (lower bound value used as the most conservative one); this percentage includes treatment under aerobic and anaerobic digestion.

The 10^{th} percentile exposure results are calculated based on the high-end surface water concentrations (*i.e.*, upper 10^{th} percentile). These results represent the bounding high-end exposures. These flows are used to represent small streams.

3.2.3. Results

The aquatic EECs for the various scenarios and application practices are listed in **Table 3-4**. For some of the scenarios (particularly for residential/impervious and nursery scenarios), the EECs were limited by the very low solubility of deltamethrin. The solubility limit value of 0.200 ppb was reported for all EECs that exceeded this limit. By comparison, the EEC obtained from PRZM/EXAMS is presented in parenthesis. For one of the application scenarios (wood protection), the pore water EECs were also reported at the solubility limit. The scenarios with the highest water column, pore water and sediment EECs, included the nursery (ornamentals), turf (ant mound treatment), residential lawns (ground application), household domestic dwellings, commercial facilities, and wood protection. Lower EECs were observed for dust and granular applications than ground or aerial applications. For the agricultural application scenarios, the highest peak EECs were for sorghum, represented by the CA wheat scenario. For uncertainties related to the aquatic exposure modeling and the limit of solubility of deltamethrin see **Section 6.1.2**.

Table 3-4. Water Column, Pore Water, and Sediment EECs (µg/L) for Deltamethrin Uses in California[1]

Scenario (bold font)/ Crops/Uses Represented	App Method	App Rate (lb a.i./A)	Date of First Application (dd-mm)	Number of Apps	App Interval (days)	Water Column			Pore Water		Sediment	
						Peak EEC (µg/L)	21-day average EEC (µg/L)	60-day average EEC (µg/L)	Peak EEC (µg/L)	21-day average EEC (µg/L)	Peak EEC ($\mu g/kg_{oc}$)	21-day average EEC ($\mu g/kg_{oc}$)
CAalmond_WirrigSTD/ Tree nuts crop group 14	A (foliar)	0.0354	02-01	5	7	0.0390	0.00784	0.00549	0.000812	0.000794	365	357
CAalmond_WirrigSTD/ Tree nut crop group 14	A (dormant)	0.0354	15-10	5	7	0.0369	0.00717	0.00509	0.000721	0.000701	324	315
CAcornOP/ Corn (field, pop)	A	0.0236	05-04	5	21	0.0248	0.00312	0.00294	0.000521	0.000490	234	220
CAcornOP/ Corn (pop)	D	0.0229	05-04	5	21	0.00854	0.00110	0.000733	0.000169	0.000164	76.1	73.6
CAcornOP/ Sweet corn	A	0.03	05-04	16	7	0.0793	0.0111	0.0112	0.00190	0.00187	853	840
CAcornOP/ Sweet corn	G	0.03	05-04	16	7	0.0814	0.00911	0.00656	0.00131	0.00128	587	575
CAcornOP/ Sweet corn	D	0.03	05-04	16	7	0.0404	0.00412	0.00292	0.000608	0.000588	273	264
CAcotton_WirrigSTD/ Cotton	A	0.0322	01-08	10	5	0.0352	0.0101	0.00793	0.00101	0.000958	452	430
CAfruit_WirrigSTD/ Pome fruits	A	0.0225	01-02	2	7	0.00620	0.000852	0.000457	6.44e-5	6.27e-5	28.9	28.1
CAMelonsRLF_V2/ Cucurbits	A	0.03	15-06	6	3	0.0321	0.00967	0.00452	0.000598	0.000550	268	247
CAMelonsRLF_V2/ Cucurbits	G	0.03	15-06	6	3	0.00893	0.00391	0.00269	0.000167	0.000154	74.9	69.1
CAMelonsRLF_V2/ Cucurbits	D	0.03	15-06	6	3	0.000424	5.38e-5	3.76e-5	5.79e-6	5.50e-6	2.59	2.47
CAonion_WirrigSTD/ garlic, leeks, onion, shallots	A	0.03	01-02	4	5	0.0309	0.00670	0.00334	0.000439	0.000424	197	190
CAonion_WirrigSTD/ garlic, leeks, onion, shallots	D	0.03	01-02	4	5	0.00461	0.000362	0.000241	4.18e-5	4.03e-5	18.8	18.1
CAPotatoRLF_V2/ Root vegetables crop subgroup 1B (except sugarbeet); Tuberous and corm vegetables crop subgroup 1C	A	0.03	01-03	5	3	0.0319	0.00832	0.00409	0.000522	0.000504	234	226

Scenario (bold font)/ Crops/Uses Represented	App Method	App Rate (lb a.i./A)	Date of First Application (dd-mm)	Number of Apps	App Interval (days)	Water Column			Pore Water		Sediment	
						Peak EEC (µg/L)	21-day average EEC (µg/L)	60-day average EEC (µg/L)	Peak EEC (µg/L)	21-day average EEC (µg/L)	Peak EEC ($\mu g/kg_{oc}$)	21-day average EEC ($\mu g/kg_{oc}$)
CAPotatoRLF_V2/ Root vegetables crop subgroup 1B; Tuberous and corm vegetables crop subgroup 1C	D	0.03	01-03	5	3	0.00535	0.000387	0.000255	3.92e-5	3.80e-5	17.6	17.0
CARowCropRLF_V2/ Artichokes	A	0.03	01-02	5	3	0.0421	0.0115	0.00622	0.000931	0.000913	418	410
CARowCropRLF_V2/ Artichokes	D	0.03	01-02	5	3	0.00347	0.00381	0.00237	0.000416	0.000405	187	182
CAtomato_WirrigSTD/ (eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato)	A	0.03	15-03	6	5	0.0314	0.00798	0.00477	0.000630	0.000614	283	277
CAtomato_WirrigSTD/ (eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato)	D	0.03	15-03	6	5	0.00413	0.000332	0.000196	3.72e-5	3.58e-5	16.7	16.1
CAWheatRLF_V2/ Sorghum	A	0.0242	15-01	2	7	0.0479	0.00566	0.00385	0.000691	0.000675	310	303
CAWheatRLF_V2/ Canola, rapeseed, crambe	A	0.0097	15-01	2	7	0.0193	0.00227	0.00155	0.000278	0.000272	125	122
CAnurserySTD_V2/ Ornamental and/or Shade Trees; Ornamental Ground Cover	G	0.428	02-01	12	30	0.200* (4.29)	0.200* (0.464)	0.200* (0.287)	0.0571	0.0555	25600	24500
CAnurserySTD_V2/ Ornamental and/or Shade Trees; Ornamental Ground Cover	D	0.0109	01-04	12	7	0.0340	0.00286	0.00172	0.000374	0.000360	168	162
CAnurserySTD_V2/ Ornamental Herbaceous Plants	G	0.218	02-01	12	30	0.200* (2.18)	0.200* (0.236)	0.146	0.0290	0.0282	13000	12700
CAnurserySTD_V2/ Ornamental Herbaceous Plants	GR	0.147	02-01	12	30	0.200* (1.12)	0.110	0.0753	0.0148	0.0143	6660	6400

Scenario (bold font)/ Crops/Uses Represented	App Method	App Rate (lb a.i./A)	Date of First Application (dd-mm)	Number of Apps	App Interval (days)	Water Column			Pore Water		Sediment	
						Peak EEC (µg/L)	21-day average EEC (µg/L)	60-day average EEC (µg/L)	Peak EEC (µg/L)	21-day average EEC (µg/L)	Peak EEC ($\mu g/kg_{oc}$)	21-day average EEC ($\mu g/kg_{oc}$)
CArangelandhayRLF_V2/ Ornamental sod farms	G	0.127	02-01	12	7	0.190	0.0294	0.0216	0.00379	0.00367	1700	1650
CArangelandhayRLF_V2/ Ornamental sod farms	GR	0.131	02-01	12	7	0.181	0.0287	0.0214	0.00375	0.00363	1680	1630
CATurfRLF/ Ornamental lawns and turf (also covers Ornamental grasses and recreational areas)	G	0.218	02-01	12	30	0.0820	0.0141	0.0108	0.00228	0.00223	1020	1000
CATurfRLF/ Golf Course Turf, Recreational Area Lawns, Commercial/ Industrial Lawns	G	0.127	02-01	12	7	0.0558	0.0123	0.111	0.00189	0.00185	850	830
CATurfRLF/ Same crops as in the previous row	GR	0.147	02-01	12	7	0.0539	0.00897	0.00698	0.00148	0.00145	666	651
CATurfRLF/ Same crops as in the previous row (ant mound treatment)	G	1.94	02-01	12	7	0.200* (0.852)	0.188	0.170	0.0289	0.0283	13000	12700
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	G	0.0233	15-01	6	7	0.200* (0.305)	0.200 (0.780)	0.200 (0.823)	0.0656	0.0637	29500	28600
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	G	0.0233	02-01	12	7	0.200* (0.326)	0.200 1.01	0.200 (1.06)	0.134	0.131	60100	58400
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	GR	0.0241	02-01	6	7	7.99e-5	1.23e-4	1.00e-4	1.23e-5	1.20e-5	5.51	5.39

Scenario (bold font)/ Crops/Uses Represented	App Method	App Rate (lb a.i./A)	Date of First Application (dd-mm)	Number of Apps	App Interval (days)	Water Column			Pore Water		Sediment	
						Peak EEC (µg/L)	21-day average EEC (µg/L)	60-day average EEC (µg/L)	Peak EEC (µg/L)	21-day average EEC (µg/L)	Peak EEC ($\mu g/kg_{oc}$)	21-day average EEC ($\mu g/kg_{oc}$)
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings Outdoors Premises, Paths/Patios	G	0.109	02-01	6	7	0.196	0.0265	0.0223	0.00167	0.00164	751	736
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings Outdoors Premises, Paths/Patios; Barns, Barnyards/ Auction Barns	Crack & crevice, and/or spot treatment	0.00528	02-01	6	21	0.200* (2.39)	0.200* (0.284)	0.200* (0.302)	0.0135	0.0130	6040	5840
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings Outdoors Premises, Paths/Patios	GR or D (includes perimeter treatment)	0.0540	02-01	6	7	0.200 (0.770)	0.198	0.200 (0.208)	0.0167	0.0162	7490	7280
CAresidentialRLF/ CAimperviousRLF/ Wood Protection Treatment to Buildings/ Products (Outdoors)	Crack and crevice and/or perimeter treatment	2.17	02-01	12	21	0.200* (20.9)	0.200* 2.46)	0.200* (1.97)	0.200* (0.209)	0.200* (0.203)	93800	91000
CAresidentialRLF/ CAimperviousRLF/ Wood Protection Treatment to Buildings/ Products (Outdoors)	Soil drench/ treatment	0.0058	02-01	12	7	0.200* (0.609)	0.129	0.110	0.0124	0.0120	5550	5390
CArightofwayRLF_V2/ CAimperviousRLF/ Non-agricultural Rights-of-Way/ Fencerows/ Hedgerows; Refuse/Solid Waste Containers and Sites (outdoor)	G	0.0218	02-01	12	30	0.0235	0.00333	0.00274	0.000392	0.000383	176	172

Scenario (bold font)/ Crops/Uses Represented	App Method	App Rate (lb a.i./A)	Date of First Application (dd-mm)	Number of Apps	App Interval (days)	Water Column			Pore Water		Sediment	
						Peak EEC (µg/L)	21-day average EEC (µg/L)	60-day average EEC (µg/L)	Peak EEC (µg/L)	21-day average EEC (µg/L)	Peak EEC ($\mu g/kg_{oc}$)	21-day average EEC ($\mu g/kg_{oc}$)
CArightofwayRLF_V2/ CAimperviousRLF/ Non-agricultural Rights-of-Way/ Fencerows/ Hedgerows; Refuse/Solid Waste Containers and Sites (outdoor); Paved Areas (Private Roads/ Sidewalks)	Perimeter treatment	0.0187	02-01	12	30	0.0203	0.00287	0.00236	3.38e-4	3.29e-4	152	148
CArightofwayRLF_V2/ CAimperviousRLF/ Paved Areas (Private Roads/ Sidewalks)	Crack & crevice and/or spot treatment	0.0017	01-09	5	21	0.200 (0.923)	0.125	0.109	0.0101	0.00986	4530	4430
CArightofwayRLF_V2/ CAimperviousRLF/ Utilities, Utility Poles/Rights-of-Way	GR	2.72	02-01	2	180	0.124	0.0257	0.0213	0.00246	0.00240	1100	1080
Sewage Systems	Various	50 kg/yr	N/A	N/A	N/A	0.000425	0.000425	0.000425	N/A	N/A	N/A	N/A

G=ground; GR=granular, D=dust

* EECs marked with an asterisk were set to 0.200 ppb because they exceeded the limit of solubility of deltamethrin in the aquatic modeling. They were set to 0.200 ppb (solubility from Laskowski 2002). The value in (parenthesis) was the modeled EEC, which is provided for reference only. Additional significant digits included for illustrative purposes.

1 EECs were rounded to three significant figures.

3.2.4. Existing Monitoring Data

A critical step in the process of characterizing EECs is comparing the modeled estimates with available surface water monitoring data. Included in this assessment are deltamethrin data from the USGS NAWQA program (http://infotrek.er.usgs.gov/apex/f?p=NAWQA:HOME:0) and data from the California Department of Pesticide Regulation (CDPR at http://www.cdpr.ca.gov/docs/emon/surfwtr/surfcont.htm).

3.2.4.a. USGS NAWQA Surface Water Data

The NAWQA Database was accessed at http://infotrek.er.usgs.gov/apex/f?p=NAWQA:HOME:0 on 02/07/2013 by constituent finder. Deltamethrin is a constituent of the surface waters database; however, no samples are reported in California.

3.2.4.b. USGS NAWQA Groundwater Data

The NAWQA Database was accessed at http://infotrek.er.usgs.gov/apex/f?p=NAWQA:HOME:0 on 02/07/2013 by constituent finder. Deltamethrin is a constituent of the groundwater database; however, no samples are reported in California.

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

Surface water monitoring data were accessed from the California Department of Pesticide regulation (CDPR on 02/07/2013 at http://www.cdpr.ca.gov/docs/emon/surfwtr/surfcont.htm) and all data with analysis for deltamethrin were extracted. A total of 231 samples were analyzed for deltamethrin (207 surface waters and 24 sediments). Of these, 16 surface water samples (7.7%) and 14 sediment samples (58.3%) had positive detections of deltamethrin. The maximum surface water concentration was 0.231 µg/L, a value that slightly exceeds the solubility limit of deltamethrin (0.200 µg/L, Laskowski 2002). This detection occurred in a Storm Drain at Millbrook Avenue - drains to Martin Canyon/Koopman Canyon Creek, Alameda. The maximum sediment concentration was 0.046 µg/kg, in Kaseberg Creek at Caragh Road, Placer (all sediment sampling for deltamethrin occurred in Placer and the next to the highest value was reported in Kaseberg Creek at Country Club Blvd./McAnally, Placer, at 0.017 µg/kg). The quantitation limits were variable.

3.3. Terrestrial Animal Exposure Assessment

3.3.1. Exposure to Residues in Terrestrial Food Items

T-REX (Version 1.5.1, 10/16/2012) is used to calculate dietary and dose-based EECs of deltamethrin for birds (including terrestrial-phase amphibians and reptiles), mammals, and terrestrial invertebrates. T-REX simulates a 1-year time period. T-HERPS (Version 1.1, 02.05/2010) may be used as a refinement of dietary and dose-based EECs for snakes and amphibians when risk quotients from T-REX are higher than LOCs. T-HERPS was also set up to simulate a 1-year time period. For this assessment, spray and granular applications of deltamethrin are considered. Terrestrial EECs were derived for the uses previously summarized in **Table 2-4.** Exposure estimates generated using T-REX and T-HERPS are for the parent alone.

Terrestrial EECs for foliar formulations of deltamethrin were derived for the uses summarized in **Table 3-5**. Based on the work of Willis and McDowell (1987), three foliar dissipation half life values were reported for deltamethrin (2.2-7.7 days, cotton). The 90th percentile of these values is 8.8 days, which was used for terrestrial exposure modeling with T-REX and T-HERPS. Use specific input values, including number of applications, application rate, foliar half-life and application interval are provided in **Table 3-5**. An example output from T-REX and T-HERPS is available in **Appendix E**.

Table 3-5. Input Parameters for Foliar Applications Used to Derive Terrestrial EECs for Deltamethrin with T-REX and T-HERPS

Use Category	App Rate (lb a.i./A), No. Apps, Interval (d)	Foliar Dissipation Half-Life (days)
Canola, rapeseed, crambe	0.0097, 2, 7	8.8
Corn (field, pop)	0.0236, 5, 21	8.8
Cotton	0.0322, 10, 5	8.8
Cucurbits, Tomato, Tamillo, Eggplant, Ground Cheery, Pepinos	0.03, 6, 3	8.8
Garlic, Leeks, Onion, Shallots	0.03, 4, 5	8.8
Pome Fruits	0.0225, 2, 7	8.8
Potato & Root Vegetables (1B); Tuberous & Corn Vegetables (1C); Artichokes	0.03, 5, 3	8.8
Sorghum	0.0242, 2, 7	8.8
Sweet Corn	0.03, 16, 7	8.8
Tree Nuts (foliar and dormant)	0.0354, 5, 7	8.8
Commercial Outdoor Premises	0.006936, 12, 21	8.8
Domestic Dwellings, Barns, Barnyards (incl. outdoor premises)	0.1094, 6, 7	8.8
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas	0.02188, 12, 30	8.8
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas (Perimeter Treatment)	0.00188, 12, 30	8.8
Ornamental Plants (herbaceous, non-flowering, woody) Lawns and turf	0.218, 12, 30	8.8
Ornamental Plants (Shade Trees, Ground Cover)	0.428, 12, 30	8.8
Ornamental Plants (Shade Trees, Ground Cover): Ant Mound Treatment	1.942, 12, 7	8.8
Ornamental Sod Farms, Lawns, Turf, Recreational Areas	0.127, 12, 7	8.8
Residential Lawns (1)	0.00233, 6, 7	8.8
Residential Lawns (2)	0.00233, 12, 7	8.8

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, and fruits/pods/seeds, arthropods and seeds for granivores. Birds, including the CCR, and mammals, consume all of these items. The size classes of birds represented in T-REX are small (20 g), medium (100 g), and large (1000 g). The size classes for mammals are small (15 g), medium (35 g), and large (1000 g). EECs are calculated for the most sensitive dietary item and size class for birds (surrogate for amphibians and reptiles) and mammals. For mammals and birds, the most sensitive EECs are for the smallest size class consuming short grass

In instances where RQs exceed the LOCs for reptiles (*i.e.*, SFGS) and terrestrial-phase amphibians (*i.e.*, CTS), T-HERPS is employed to estimate 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.

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

Upper-bound Kenaga nomogram values reported by T-REX are used for derivation of dietary- and dose-based EECs for the CCR, CTS, SFGS, and their potential prey (mammals) are shown in **Table 3-6**. EECs in T-REX that are applicable to direct effects to the CCR are for small (20 g, juveniles) and medium (100 g, adult) birds consuming a variety of dietary items. The most sensitive EEC for the CCR is for the small bird consuming short grass. EECs in T-REX that are applicable to assess direct effect to the terrestrial-phase CTS and SFGS are for small birds (20g) consuming short grass[10]. EECs for mammals are based on the small mammal consuming short grass, which produces the highest EEC. Complete output from T-REX v. 1.5.1 is available in **Appendix E**.

[10] The short grass EECs 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.

Table 3-6. Summary EECs Used for Estimating Risk to Birds and Mammals Derived Using T-REX ver. 1.5.1. for Deltamethrin

Use(s), Type of Application	App Rate (lb a.i./A), No. Apps, Interval (days)	EECs for CCR, CTS (all DPS), SFGS, and Birds (small birds consuming short grass)*		EECs for Mammals (small mammals consuming short grass)*	
		Dose-based EEC (mg/ kg-bw)	Dietary-based EEC (mg/ kg-diet)	Dose-based EEC (mg/ kg-bw)	Dietary-based EEC (mg/ kg-diet)
Canola, rapeseed, crambe	0.0097, 2, 7	4.13	3.63	3.46	3.63
Corn (field, pop)	0.0236, 5, 21	7.80	6.85	6.53	6.85
Cotton	0.0322, 10, 5	25.39	22.29	21.25	22.29
Cucurbits, Tomato, Tamillo, Eggplant, Ground Cheery, Pepinos	0.03, 6, 3	28.77	25.26	24.09	25.26
Garlic, Leeks, Onion, Shallots	0.03, 4, 5	19.50	17.12	16.33	17.12
Pome Fruits	0.0225, 2, 7	9.58	8.02	8.41	8.02
Potato & Root Vegetables (1B); Tuberous & Corn Vegetables (1C); Artichokes	0.03, 5, 3	26.43	22.12	23.21	22.12
Sorghum	0.0242, 2, 7	10.30	8.62	9.05	8.62
Sweet Corn	0.03, 16, 7	18.52	15.51	16.26	15.51
Tree Nuts (foliar and dormant)	0.0354, 5, 7	20.68	18.16	17.31	18.16
Commercial Outdoor Premises	0.006936, 12, 21	2.29	2.01	1.92	2.01
Domestic Dwellings, Barns, Barnyards (incl. outdoor premises)	0.1094, 6, 7	65.53	57.54	54.86	57.54
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas	0.02188, 12, 30	6.51	5.72	5.45	5.72
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas (Perimeter Treatment)	0.001878, 12, 30	0.56	0.49	0.47	0.49
Ornamental Plants (herbaceous, non-flowering, woody) Lawns and turf	0.218, 12, 30	64.88	56.97	54.32	56.97
Ornamental Plants (Shade Trees, Ground Cover)	0.428, 12, 30	127	112	107	112
Ornamental Plants (Shade Trees, Ground Cover): Ant Mound Treatment	**1.942, 12, 7**	**1198**	**1052**	**1003**	**1052**
Ornamental Sod Farms, Lawns, Turf, Recreational Areas	0.127, 12, 7	78.35	68.79	65.59	68.79
Residential Lawns (1)	0.002333, 6, 7	1.40	1.23	1.17	1.23
Residential Lawns (2)	0.002333, 12, 7	1.44	1.26	1.20	1.26

* EECs calculated using deltamethrin-specific foliar dissipation half life of 8.8 days using T-REX version 1.5.1. Bolded information corresponds to the use that produces the highest EEC.

3.3.2. Exposure to Terrestrial Invertebrates Derived Using T-REX

T-REX v. 1.5.1 is also used to calculate EECs for terrestrial invertebrates exposed to deltamethrin **(Table 3-7)**. Available acute contact toxicity data for bees and other terrestrial invertebrates exposed to deltamethrin (in units of µg a.i./organism) are converted to µg a.i./g organism by dividing this toxicity value by the weight of the organism. Dietary-based EECs calculated by T-REX for arthropods (units of µg a.i./g) are used to estimate exposure to terrestrial invertebrates. The EECs are later compared to the adjusted acute contact toxicity data for in order to derive RQs.

Arthropods are applicable to the VELB and BCB and in estimating indirect effects based on reduction in prey to the CCR, SMHM, SJKF, and CTS. The most sensitive insect is the small insect. An example output from T-REX v. 1.5.1 is available in **Appendix E**.

Table 3-7. Summary EECs Used for Estimating Risk to Terrestrial Invertebrates Derived Using T-REX ver. 1.5.1. for Deltamethrin

Use(s), Type of Application	Application Rate (lbs a.i./acre), # of app, App interval (days)	Upper Bound Arthropod Residues (ppm)*
Canola, rapeseed, crambe	0.0097, 2, 7	1.42
Corn (field, pop)	0.0236, 5, 21	2.68
Cotton	0.0322, 10, 5	8.73
Cucurbits, Tomato, Tamillo, Eggplant, Ground Cheery, Pepinos	0.03, 6, 3	9.89
Garlic, Leeks, Onion, Shallots	0.03, 4, 5	6.71
Pome Fruits	0.0225, 2, 7	3.29
Potato & Root Vegetables (1B); Tuberous & Corn Vegetables (1C); Artichokes	0.03, 5, 3	9.09
Sorghum	0.0242, 2, 7	3.54
Sweet Corn	0.03, 16, 7	6.37
Tree Nuts (foliar and dormant)	0.0354, 5, 7	7.11
Commercial Outdoor Premises	0.006936, 12, 21	0.79
Domestic Dwellings, Barns, Barnyards (incl. outdoor premises)	0.1094, 6, 7	22.54
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas	0.02188, 12, 30	2.24
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas (Perimeter Treatment)	0.001878, 12, 30	0.19
Ornamental Plants (herbaceous, non-flowering, woody) Lawns and turf	0.218, 12, 30	22.31
Ornamental Plants (Shade Trees, Ground Cover)	0.428, 12, 30	43.81
Ornamental Plants (Shade Trees, Ground Cover): Ant Mound Treatment	**1.942, 12, 7**	**412**
Ornamental Sod Farms, Lawns, Turf, Recreational Areas	0.127, 12, 7	26.94
Residential Lawns (1)	0.002333, 6, 7	0.48
Residential Lawns (2)	0.002333, 12, 7	0.49

*EECs calculated using a deltamethrin-specific foliar dissipation half life of 8.8 days using T-REX version 1.5.1. Bolded information corresponds to the use that produces the highest EEC.

For granular applications, T-REX calculates the LD_{50} ft^{-2} risk index *in lieu* of the conventional RQ. According to the T-REX manual, conceptually, an LD_{50} ft^{-2} is the amount of a pesticide estimated to kill 50% of exposed animals in each square foot of applied area. Although a square foot does not have defined ecological relevance, and any unit area could be used, risk presumably increases as the LD_{50} ft^{-2} value increases. The LD_{50} ft^{-2} value is used to estimate risk for granular formulations and row, banded, and in-furrow applications. For further details on this approach, refer to the T-REX User's Guide[11]. Besides the toxicity values which serve as inputs to the model, the following are other input parameters; type of application (*e.g.*, T-Band, In Furrow, Broadcast, Banded), bandwidth, depth of incorporation, and row spacing, **Table 3-8** shows the resulting EECs from T-REX. As shown in **Table 3-8**, only broadcast applications are applicable for deltamethrin granular uses.

Table 3-8. Deltamethrin Exposure (mg a.i. ft-2) for Birds (Surrogate for Reptiles and Terrestrial Phase Amphibians) for Granular Applications

Use	App rate (lb a.i./A)	Method of App	Row spacing (inches)	Bandwidth (inches)	% Incorp	(Exposed) mg a.i. ft^{-2}
Domestic Dwellings (including outdoor premises)	0.0054	Broadcast	N/A	N/A	0	0.06
Ornamental Plants (herbaceous, non-flowering, woody)	0.147	Broadcast	N/A	N/A	0	1.53
Ornamental Sod Farms	0.131	Broadcast	N/A	N/A	0	1.36
Residential Lawns	0.0024	Broadcast	N/A	N/A	0	0.03

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

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

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

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

[11] Available at http://www.epa.gov/oppefed1/models/terrestrial/trex/t_rex_user_guide.htm (accessed 11/08/2012).

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 deltamethrin are lacking. To quantify the potential differences in food intake between birds and terrestrial-phase CTS and amphibians, food intake equations for the iguanid lizard were used to replace the food intake equation in T-REX for birds, and additional food items of the CTS and amphibians were evaluated. These functions were encompassed in a model called T-HERPS. T-HERPS is available at: http://www.epa.gov/oppefed1/models/terrestrial/index.htm. EECs calculated using T-HERPS are shown in this Section and potential risk is further discussed in the risk characterization.

EECs in T-HERPS that are applicable to the CTS are small (2 g, juveniles) amphibians consuming small and large insects and medium (20 g) amphibians consuming small and large insects, small herbivorous and insectivorous mammals, and amphibians. The dietary item that results in the highest EEC for CTS (all DPS) is the small herbivore mammal. EECs calculated using T-HERPS for the CTS are shown in **Table 3-9**.

Table 3-9. Upper-bound Kenaga Nomogram EECs for Dietary- and Dose-based Exposures of Amphibians and Reptiles Derived Using T-HERPS for Deltamethrin

Use(s), Type of Application	App Rate (lb a.i./A, No. App, Interval (days)	EEC for Medium CTS (medium birds consuming small herbivorous mammals)	
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)
Ornamental Plants (Shade Trees, Ground Cover): Ant Mound Treatment	1.942, 12, 7	1102	2005

App=Application. Only one application scenario was calculated since for all other scenarios the RQs did not exceed any of the LOCs in T-REX.
*EECs calculated using a deltamethrin-specific foliar dissipation half life of 8.8 days using T-HERPS version 1.1.

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.[12] 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

[12] 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.

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 SFGS are shown in **Table 3-10**.

Table 3-10. Upper-bound Kenaga Nomogram EECs for Dietary- and Dose-based Exposures of Amphibians and Reptiles Derived Using T-HERPS for Deltamethrin

Use(s), Type of Application	App Rate (lb a.i./A, No. App, Interval (days)	EEC for Small SFGS (small bird consuming small insects)		EEC for Medium SFGS (medium birds consuming small herbivorous mammals)	
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)
Ornamental Plants (Shade Trees, Ground Cover): Ant Mound Treatment	1.942, 12, 7	618	2.24	1102	68.1

App = Application. Only one application scenario was calculated since for all other scenarios the RQs did not exceed any of the LOCs in T-REX.
*EECs calculated using a deltamethrin-specific foliar dissipation half life of 8.8 days using T-HERPS version 1.1.

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

The KABAM model version 1.0 was used to evaluate the potential exposure and risk of direct effects to the SFGS and CCR via bioaccumulation and biomagnification in aquatic food webs. KABAM is used to estimate potential bioaccumulation of hydrophobic organic pesticides in freshwater aquatic ecosystems and risks to mammals and birds consuming aquatic organisms which have bioaccumulated these pesticides. The bioaccumulation portion of KABAM is based upon work by Arnot and Gobas (2004) who parameterized a bioaccumulation model based on PCBs and some pesticides (*e.g.*, lindane, DDT) in freshwater aquatic ecosystems (Arnot and Gobas, 2004). KABAM relies on a chemical's 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 terrestrial-phase amphibians and reptiles) consuming aquatic organisms. Seven different trophic levels including phytoplankton, zooplankton, benthic invertebrates, filter feeders, small-sized (juvenile) forage fish, medium-sized forage fish, and larger piscivorous fish, are used to represent an aquatic food web. Importantly, chemical metabolism by biota is assumed to be zero in KABAM unless evidence indicates such metabolism is likely to affect the model predictions substantially.

The synthetic pyrethroids are widely known to be metabolized by fish and invertebrates. As a result, bioaccumulation estimates using KABAM need to account for metabolism of deltamethrin by aquatic biota. For deltamethrin, direct estimates of the metabolism rate constant (k_m) were not available. Therefore, KABAM model predictions are adjusted to reflect the depuration rate constant value via respiration (k_t) of biota where available[13]. For fish, a measured BCF of 698 L/kg wet wt is available for whole fish (MRID 41651040, 43072701, 43072702). From these studies, a k_t value of 0.195 days^{-1} was determined and used to represent the k_2 for small, medium and large fish. Since this k_t includes the effect of other potential elimination routes (fecal elimination, metabolism), rate constants for these processes were set to zero to avoid double counting for these chemical loss process (growth dilution in the BCF study was assumed to be negligible).

For benthic invertebrates, a BCF of 146 L/kg ww is available from Muir (1985) based on the freshwater midge, *Chironomus dilutus*. The mean depuration rate (k_t) determined from this study is 1.69 days^{-1}. Suitable data were not available to estimate depuration rates for other taxa considered in KABAM (e.g., phytoplankton, zooplankton, filter feeders). Therefore, KABAM results for these taxa may overestimate bioaccumulation to the extent that deltamethrin is metabolized by these taxa.

For both the CCR and SFGS, it was conservatively assumed that the diet consisted of 50% fish and 50% aquatic invertebrates. In addition, the frog (*Sorex sonomae*) and water shrews (*S. palustris*) were considered as components of the SFGS' diet. These assumptions may result in an overestimation of exposure because both species consume other food items in addition to fish and aquatic invertebrates (for the CCR) and shrews (for the SFGS). Example output from the bioaccumulation model is provided in **Appendix K**.

Four pesticide-specific inputs are required to estimate deltamethrin residue concentrations in aquatic organism tissues: 1) log K_{ow}, 2) K_{oc}, 3) aqueous concentration of deltamethrin, and 4) sediment pore water concentrations of deltamethrin. The K_{oc} and log K_{ow} are based on registrant-submitted studies (see **Section 2.4**). Deltamethrin concentrations in pore water and the water column were based on PRZM/EXAMS scenario that produced the maximum 60-day EECs (ornamental plants (shade trees, ground cover): ant mound treatment; **Table 3-11**). Additional model input parameters related to aquatic organisms (including body weight, and food and water intake) and environmental characteristics (*e.g.*, temperature, organic carbon content) are identified and explained in **Attachment I**.

Only one scenario was modeled: the one with the highest EECs that result from any of the assessed uses of deltamethrin (ornamentals, ant mound treatments).

[13] Although the depuration rate constant in BCF studies is referred to as k_2, it actually reflects the combined effect faecal elimination, metabolism and growth dilution on chemical concentrations in tissue. Therefore, these are referred to here as k_t to reflect total depuration rate.

Table 3-11. Bioaccumulation Model Input Values for Deltamethrin

Parameter	Input Value	Source
Pesticide Name	Deltamethrin	
Log K_{OW}	5.96	MRID 47866503
K_{OC}	449,000 L/kg_{OC}	MRID 41651039, 42976501
Fish k_2 (Based on fish BCF)	0.195day	MRID 41651040, 43072701, 43072702
Benthic invertebrates k_2 (based on *C. dilutus* BCF)	1.69/day	Muir (1985), midge
	Maximum EEC Scenario	
Use patterns	Ornamental Plants (Shade Trees, Ground Cover): Ant Mound Treatment (Ground, app rate 1.94 lb a.i./A)	
Concentration in sediment pore water (ppb)	Peak=0.20 ppb (capped at water solubility)	
Total pesticide concentration in water (ppb)	Peak=0.20 ppb (capped at water solubility)	

Based on KABAM, estimated concentrations of deltamethrin residues in the tissue of organisms in the different trophic levels following application on ornamentals plants (ant mound treatment) range from approximately ~200 to ~7,500 µg/kg w.w. (**Table 3-12**). Deltamethrin residues in phytoplankton, zooplankton and filter feeders were comparatively high because deltmethrin-specific bioaccumulation information was not available for these taxa. Overall, the model indicates that there is the potential for bioaccumulation in fish and aquatic invertebrates.

Table 3-12. Predicted Concentrations of Deltamethrin in Aquatic Organism Tissues at Different Trophic Levels

Trophic Level	**Estimated Total Concentration (µg/kg)**
	Ornamentals (ant mound treatment, app rate 1.94 lb a.i./A)
Phytoplankton	6,792*
Zooplankton	7,496*
Benthic Invertebrates	781
Filter Feeders	7,526*
Small Forage Fish	1,774
Medium Forage Fish	565
Large Forage Fish	224

* Suitable data were not available to estimate depuration rates for other taxa considered in KABAM (*e.g.*, phytoplankton, zooplankton, filter feeders). Therefore, KABAM results for these taxa may overestimate bioaccumulation to the extent that deltamethrin is metabolized by these taxa.

3.4. Terrestrial Plant Exposure Assessment

TerrPlant (Version 1.2.2) is used to calculate EECs for non-target plant species inhabiting dry and semi-aquatic areas. Parameter values for application rate, drift assumption and incorporation depths are based upon the use and related application method (**Table 3-13**). A runoff value of 1% is utilized based on deltamethrin's solubility, which is classified by TerrPlant as < 10 mg/L. For aerial and ground application methods, drift is assumed to be 5% and 1%, respectively. EECs relevant to terrestrial plants consider pesticide concentrations in drift and in runoff. These EECs are listed by use in **Table 3-13**. An example output from TerrPlant v.1.2.2 is available in **Appendix F**.

Table 3-13. TerrPlant Inputs and Resulting EECs for Plants Inhabiting Dry and Semi-aquatic Areas Exposed to Deltamethrin via Runoff and Drift

Crops/Uses Represented	App Method*	App Rate (lb a.i./A)	Drift Value (%)	Spray drift EEC (lbs a.i./A)	Dry area EEC (lbs a.i./A)	Semi-aquatic area EEC (lbs a.i./A)
Canola, rapeseed, crambe	A	0.0097	5	4.9E-04	0.0006	0.0015
Corn (field, pop)	A	0.0236	5	0.0012	0.0014	0.0035
Cotton	A	0.0322	5	0.0016	0.0019	0.0048
Cucurbits, Tomato, Tamillo, Eggplant, Ground Cheery, Pepinos	A	0.03	5	0.0015	0.0018	0.0045
Cucurbits, Tomato, Tamillo, Eggplant, Ground Cheery, Pepinos	G	0.03	1	3.0E-04	0.0006	0.0033
Garlic, Leeks, Onion, Shallots	A	0.03	5	0.0015	0.0018	0.0045
Pome Fruits	G	0.0225	1	2.3E-04	0.0005	0.0025
Potato & Root Vegetables (1B); Tuberous & Corn Vegetables (1C); Artichokes	A	0.03	5	0.0015	0.0018	0.0045
Sorghum	A	0.0242	5	0.0012	0.0015	0.0036
Sweet Corn	A	0.03	5	0.0015	0.0018	0.0045
Sweet Corn	G	0.03	1	3.0E-04	0.0006	0.0033
Tree Nuts (foliar and dormant)	A (foliar)	0.0354	5	0.0018	0.0021	0.0053
Commercial Outdoor Premises	G	0.006936	1	6.9E-05	0.0001	0.0008
Domestic Dwellings, Barns, Barnyards (including outdoor premises)	G	0.1094	1	0.0011	0.0022	0.0120
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas	G	0.02188	1	2.2E-04	0.0004	0.0024
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas (Perimeter Treatment)	G	0.001878	1	1.9E-05	3.8E-05	0.0002
Ornamental Plants (herbaceous, non-flowering, woody) Lawns and turf	G	0.218	1	0.0022	0.0044	0.0240
Ornamental Plants (Shade Trees, Ground Cover)	G	0.428	1	0.0043	0.0086	0.0471
Ornamental Plants (Shade Trees, Ground Cover): Ant Mound Treatment	**G**	**1.942**	**1**	**0.0194**	**0.0388**	**0.2136**
Ornamental Sod Farms, Lawns, Turf, Recreational Areas	G	0.127	1	0.0013	0.0025	0.0140

Crops/Uses Represented	App Method*	App Rate (lb a.i./A)	Drift Value (%)	Spray drift EEC (lbs a.i./A)	Dry area EEC (lbs a.i./A)	Semi-aquatic area EEC (lbs a.i./A)
Residential Lawns (1) and (2)	G	0.002333	1	2.3E-05	4.7E-05	0.0003
Domestic Dwellings (including outdoor premises)	GR	0.005404	0	0	0.0001	0.0005
Ornamental Plants (herbaceous, non-flowering, woody)	GR	0.147	0	0	0.0015	0.0147
Ornamental Sod Farms	GR	0.131	0	0	0.0013	0.0131
Residential Lawns	GR	0.002413	0	0	2.4E-05	0.0002
Pet Living Quarters	GR	0.0018	0	0	1.8E-05	0.0002
Utility Poles, Utility Rights of Way	GR	2.72	0	0	0.0272	0.2720

*A=aerial; G=ground; GR=granular. Bold information corresponds to the use that produces the hightest EEC.

4. Effects Assessment

This assessment evaluates the potential for deltamethrin to directly or indirectly affect BCB, TG, DS, CTS (all DPS), VELB, CCR, SFGS & CFWS 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 are based on toxicity information for freshwater fish, while effects to terrestrial-phase CTS and the SFGS are based on avian toxicity data, given that birds are generally used as a surrogate for terrestrial-phase amphibians and reptiles.

As described in the Agency's Overview Document (USEPA, 2004), the most sensitive endpoint for each taxon is used for risk estimation. For this assessment, evaluated taxa include freshwater fish (used as a surrogate for aquatic-phase amphibians), freshwater invertebrates, estuarine/ marine fish, estuarine/marine invertebrates, birds (used as a surrogate for terrestrial-phase amphibians and reptiles), mammals, and terrestrial invertebrates. 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 deltamethrin.

4.1. Ecotoxicity Study Data Sources

Toxicity endpoints are established based on data generated from guideline studies submitted by the registrant, and from open literature studies that meet the criteria for inclusion into the ECOTOX database maintained by EPA/Office of Research and Development (ORD) (USEPA, 2004). Open literature data presented in this assessment were obtained from ECOTOX information (June 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 I**. For the purposes of this assessment, 'target' insect species are defined as all terrestrial insects with the exception of bees, butterflies, beetles, and non-insect invertebrates (*i.e.*, soil arthropods, worms, *etc.*) which are included in the ECOTOX data presented in **Appendix I**. The list of citations including toxicological and/or efficacy data on target insect species not considered in this assessment is provided in **Appendix H**.

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

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

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

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 deltamethrin. A summary of the available aquatic and terrestrial ecotoxicity information and the incident information for deltamethrin are provided in **Sections 4.2** through **4.4**.

4.2. Toxicity of Deltamethrin to Aquatic Organisms

Table 4-1 summarizes the most sensitive aquatic toxicity endpoints, based on an evaluation of both the submitted studies and the open literature, as previously discussed. A brief summary of submitted and open literature data considered relevant to this ecological risk assessment for the BCB, TG, DS, CTS (all DPS), VELB, CCR, SFGS & CFWS is presented below. All endpoints are expressed in terms of the active ingredient (a.i.) and pertain to tests with technical grade active ingredient (TGAI) unless otherwise specified.

Table 4-1. Aquatic Toxicity Profile for Deltamethrin (TGAI)

Species (common name)	**Taxa Represented**	**Duration (hours)**	**End-point**	**Mean concentration (95% C.I.) (µg a.i./L) (1)**	**Reference (classification)**	**Acute Toxicity Classification**
Lepomis gibbosus (Pumpkinseed sunfish)	Freshwater fish and aquatic-phase amphibians	96	LC_{50}	0.58 (0.51-0.67)	00060721 (supplemental)	Very highly toxic
Pimephales promelas (Fathead Minnow)		280 (days)	NOAEC	0.017	42786801 (acceptable)	NA
			LOAEC	0.035		
Gammarus fossarum (Amphipod)	Freshwater Invertebrates (water column exposure)	48	LC_{50}	0.004 (0.0025-0.0063)	Adam *et al.* 2010; [#157388] (supplemental-quantitative)	Very highly toxic
Ceriodaphnia dubia (water flea)		8 (days)	NOAEC	0.0025	Shen *et al.* 2012; [#157482] (supplemental-quantitative)	NA
			LOAEC	0.0050		
Hyalella azteca (Amphipod)	Freshwater Invertebrates (benthic exposure)	10 (days)	NOAEC	<12 µg/kg-oc (sediment) <0.026 ng a.i./L (2) (pore water)	48593608 (in review)	NA
			LOAEC	12 µg/kg-oc (sediment) 0.026 ng ai/L (2) (pore water)		
Cyprinodon variegatus	Estuarine/ Marine Fish	96	LC_{50}	0.58 (0.35-0.90)	41651015 (acceptable)	Very highly toxic

Species (common name)	Taxa Represented	Duration (hours)	End-point	Mean concentration (95% C.I.) (µg a.i./L) [1]	Reference (classification)	Acute Toxicity Classification
(Sheepshead minnow)		35 (days)	NOAEC	0.024	48988203 (in review)	NA
			LOAEC	0.049		
Americamysis bahia (Mysid shrimp)	Estuarine/ Marine Invertebrates (water column & benthic pore water exposure)	96	LC_{50}	0.0037 (0.0016-0.0049)	42114810 (acceptable)	Very highly toxic
		35 (days)	NOAEC	0.73 ng a.i./L	48988202 (in review)	NA
			LOAEC	1.2 ng a.i./L		
Pseudo-kirchneriella subcapitata (green algae)	Non-vascular aquatic plants (freshwater)	96	EC_{50} (biomass)	17.8 mg a.i./L	48258214 (in review)	NA
			NOAEC	< 7.3 mg a.i./L		
Lemna gibba (duckweed)	Vascular aquatic plants (freshwater)	7 (days)	EC_{50}	> 0.78	48988204 (in review)	NA
			NOAEC	0.78		

NA=not applicable
(1) Units are µg a.i./L unless otherwise specified. All TGAI are ≥ 95% purity.
(2) Pore water NOAEC estimated from sediment-OC NOAEC and mean Koc of 449,000 mL/g-$_{OC}$.

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

A summary of the most sensitive acute and chronic freshwater fish toxicity endpoints available for deltamethrin technical grade active ingredient (TGAI), including data from the open literature considered acceptable for quantitative use in risk assessment, is provided below in **Sections 4.2.1.a** through **4.2.1.c**. In addition, information on the toxicity of deltamethrin formulated product(s) is also provided, in addition to open literature on the toxicity of deltamethrin to aquatic-phase amphibians (Section **4.2.1.d**).

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

The most sensitive freshwater fish species to deltamethrin (98% a.i.) is the pumpkinseed sunfish *(Lepomis gibbosus)*; the LC_{50} is 0.58 µg a.i./L (95% C.I. = 0.51-0.67 µg a.i./L), making deltamethrin very highly toxic to freshwater fish (ACC00060721; supplemental) on an acute exposure basis. No sublethal effects were documented. Although the study authors used a solvent (acetone) to facilitate dissolution of deltamethrin, it is noted that the LC_{50} exceeds the reported solubility of 0.200 µg a.i./L by about 3X. No precipitates were reported by the study authors, however, there is uncertainty in the amount of deltamethrin that was bioavailable to fish in this study since samples were apparently not centrifuged prior to analysis.

Although there is some uncertainty in the acute toxicity endpoint for pumpkinseed sunfish, similar results were reported for tests with other fish including rainbow trout (*Oncorhynchus mykiss)* with a 96-hour LC_{50} of 0.91 µg a.i./L (95% C.I. = 0.66-1.3µg a.i./L) and bluegill sunfish (*Lepomis macrochirus)* with a 96-hour LC_{50} of 1.4 µg a.i./L (95% C.I. = 1.0-1.8 µg a.i./L) (MRIDs 00158274 and 00158275). Deltamethrin EC (2.5%) is also considered to be highly toxic to the rainbow trout (*Oncorhynchus mykiss*) on an acute basis, with an LC_{50} of 0.25 µg a.i./L (95% C.I. = 0.22-0.28 µg a.i./L) which indicates the formulated product is about 3x more toxic than the TGAI for this species (MRID 41651013).

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

A chronic freshwater fish life cycle study for deltamethrin technical resulted in a 280-day NOAEC of 0.017 µg a.i./L and a LOAEC of 0.035 µg a.i./L for fathead minnow (*Pimephales promelas*) based on reduced growth of females (MRID 42786802). These results are similar to those obtained from a 36-d early life stage study with fathead minnow, which resulted in a NOAEC of 0.022 µg a.i./L and a LOAEC of 0.036 µg a.i./L based on reduced larval growth (MRID 42114814).

4.2.1.c. Freshwater Fish: Sublethal Effects and Additional Open Literature Information

No additional acceptable studies from the open literature were identified for freshwater fish that: established more sensitive acute or chronic endpoints than the data listed above; filled critical data gaps; presented a toxicity profile for under-represented taxa (*e.g.*, toxicity data for amphibians); or provided information on sub-lethal effects that could be quantitatively linked to relevant assessment endpoints (*i.e.*, survival, reproduction, and growth) at concentrations lower than the most sensitive endpoints used to quantitatively evaluate risk. Some data were identified for aquatic phase amphibians (discussed below), but these data were not considered acceptable for quantitative use.

4.2.1.d. Aquatic-phase Amphibian: Acute and Chronic Studies

No toxicity data for aquatic-phase amphibians were identified among the submitted studies or that were considered acceptable for quantitative use in this risk assessment. One study using an aquatic phase amphibian was identified in the open literature that is considered appropriate only for qualitative use (Aydin-Sinan *et al.,* 2012) due to limitations in its study design (*e.g.,* unmeasured test concentrations, use of formulated product at concentrations that greatly exceed solubility, limited information on study methods). In this study, a 7-d LC_{50} of 6.06 µg a.i./L was reported for tadpoles of the African clawed frog, *Xenopus laevis*, which is 30X above the solubility of the TGAI. This study suggests this species is about an order of magnitude less sensitive on an acute exposure basis compared to freshwater fish.

4.2.2. Toxicity to Freshwater Invertebrates

A summary of acute and chronic freshwater invertebrate data, including data published in the open literature, is provided below in **Sections 4.2.2.a** through **4.2.2.d**.

4.2.2.a. Freshwater Invertebrates (Pelagic): Acute Exposure Studies

Daphnia magna is typically used as the standard test species for freshwater invertebrates for both acute and chronic effects. For deltamethrin, however, the freshwater amphipod, *Gammarus fossarum,* is the most acutely sensitive freshwater invertebrate for which data are currently available. In this water column exposure to deltamethrin, Adam (*et al.,* 2010) report a 48-h LC_{50} of 0.004 µg a.i./L (95% C.I.= 0.0025-0.0063 µg a.i./L) for juvenile *G. fossarum*. Concentrations were verified analytically and control mortality was < 10%. By way of comparison, the registrant-submitted acute toxicity study for *D. magna* resulted in a 48-h EC_{50} of 0.57 µg a.i./L (95% C.I.= 0.0025-0.0063 µg a.i./L MRID 44928701), which is nearly 100X greater than that for *G. fossarum*. These findings are consistent with studies with other pyrethroids that have documented much greater sensitivity of amphipods compared to daphnia (*e.g.,* bifenthrin; DP Barcode D384352). Regarding the toxicity of deltamethrin formulated product, an acute toxicity test with deltamethrin EC (2.54% a.i.) resulted in a 48-h EC_{50} of 0.11 µg a.i./L95% C.I.=0.052-0.18 µg a.i./L; MRID 41651014), which indicates the EC is about a factor of 5X more toxic on an acute exposure basis to *D. magna* compared to the TGAI.

4.2.2.b. Freshwater Invertebrates (Pelagic): Chronic Exposure Studies

In a chronic, life-cycle test with the planktonic crustacean, *Ceriodaphnia dubia*, Shen *et al.* (2012) report a NOAEC of 0.0025 µg a.i./L and a LOAEC of 0.005 µg a.i./L (>98% a.i.) based on statistically-significant reductions in growth (length) of adults. Statistically-significant effects on reproduction were reported at 0.025 µg a.i./L for *C. dubia*. Similar results are seen from a registrant-submitted chronic life-cycle test with *D. magna* which produced a NOAEC of 0.0041 µg a.i./L and a LOAEC of 0.0089 µg a.i./L based on statistically-significant reductions in growth and reproductive success (MRID 42114813).

4.2.2.c. Freshwater Invertebrates (Pelagic): Sublethal Effects and Open Literature Data

No additional acceptable studies from the open literature were identified for freshwater invertebrates exposed via the water column that: (1) established more sensitive acute or chronic endpoints than the data listed above; (2) filled critical data gaps; presented a toxicity profile for under-represented taxa; or (3) provided information on sub-lethal effects that could be quantitatively linked to relevant assessment endpoints (*i.e.*, survival, reproduction, and growth) at concentrations lower than the most sensitive endpoints used to quantitatively evaluate risk.

4.2.2.d. Freshwater Invertebrates (Benthic): Sediment Exposure

Two registrant-submitted studies on the toxicity of deltamethrin to benthic freshwater invertebrates were recently completed and are currently undergoing review. These studies involved 10-d subchronic exposure of the amphipod, *H. azteca* (MRID 48593608) and the midge, *Chironomus dilutus* (MRID 48593609) to deltamethrin (TGAI, 99.8% a.i.) via spiked sediment. Growth (dry weight) was the most sensitive endpoint for *H. azteca*, with a LOAEC of 12 µg a.i./kg-$_{OC}$ and a NOAEC of <12 µg a.i./kg-$_{OC}$ (significant effects were observed at all test concentrations). The LOAEC represents a 14% reduction in mean dry weight relative to the negative controls. For the midge, results indicate that survival was more sensitive than growth, with a LOAEC and NOAEC of 609 and 374 µg a.i./kg-$_{OC}$, respectively. Based on a mean K_{OC} of 449,000 L/kg- $_{OC}$, the estimated NOAEC for porewater is <0.026 ng a.i./L for *H. azteca* and 0.83 ng a.i./L for *C. dilutus,* respectively.

4.2.3. Toxicity to Estuarine/Marine Fish

A summary of acute and chronic estuarine/marine fish toxicity data, including data published in the open literature is provided below in Sections 4.2.3.a through 4.2.3.b.

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

An acute toxicity study indicates that deltamethrin is highly toxic to estuarine/marine fish, with an LC_{50} of 0.58 (95% C.L. = 0.35-0.90) µg a.i./L for the TGAI to the sheepshead minnow, *Cyprinodon variegatus* (MRIDs 41651015). The NOAEC for survival is 0.35 µg a.i./L. A similar result is seen for the formulated product (25.4% a.i. EC) which resulted in an LC_{50} of 0.36 (95% C.I.=0.25-0.52) µg a.i./L (MRID 42114811). Although the study authors used a solvent (acetone) to facilitate dissolution of deltamethrin, it is noted that the LC_{50} exceeds the reported solubility of 0.200 µg a.i./L by about 3X. No precipitates were reported by the study authors; however, there is uncertainty in the amount of deltamethrin that was bioavailable to fish in this study since samples were apparently not centrifuged prior to analysis.

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

A 35-d early life stage study of the effects of deltamethrin TGAI on sheepshead minnow was recently submitted to the Agency (MRID 48988203) and is in review. Preliminary results indicate that growth (dry weight at 35-days) was the most sensitive endpoint, with a NOAEC and LOAEC of 0.024 and 0.049 µg a.i./L, respectively. The LOAEC represents a 7.1% reduction in dry weight relative to controls.

4.2.3.c. Estuarine/Marine Fish: Open Literature and Sublethal Effects

No additional acceptable studies from the open literature were identified for estuarine/marine fish that: (1) established more sensitive acute or chronic endpoints than the data listed above; (2) filled critical data gaps; (3) presented a toxicity profile for under-represented taxa; or (4) provided information on sub-lethal effects that could be quantitatively linked to relevant assessment endpoints (i.e., survival, reproduction, and growth) at concentrations lower than the most sensitive endpoints used to quantitatively evaluate risk.

4.2.4. Toxicity to Estuarine/Marine Invertebrates

A summary of acute and chronic E/M invertebrate data, including data published in the open literature, is provided below in **Sections 4.2.4.a** through **4.2.4.b**.

4.2.4.a. Estuarine/Marine Invertebrates (Pelagic): Acute Exposure Studies

Estuarine/marine aquatic invertebrates are represented by the mysid shrimp (*Americamysis bahia*) and eastern oyster (*Crassostrea virginica*) with toxicity studies indicating deltamethrin is very highly toxic to both. In an acute study with mysid shrimp, the 96-hour LC_{50} of 0.0037 (95% C.I.= 0.0016-0.0049) µg a.i./L for deltamethrin technical, based on mean-measured concentrations (MRID 42114810). The NOAEC was determined to be < 0.78 ng a.i./L based on erratic swimming behavior observed at all test concentrations. For the deltamethrin formulated product, an acute toxicity study with the mysid shrimp resulted in 96-hour LC_{50} = 0.0017 (95% C.I.= 0.00078-0.0044) µg a.i./L (MRID 42114812), which is not statistically different from that of the TGAI. The NOAEC from this study was determined to be < 0.57 ng a.i./L based on erratic swimming behavior observed at all test concentrations.

In studies with the eastern oyster, a 96-hour EC_{50} of 12.0 µg a.i./L for deltamethrin technical (95% C.I. could not be determined) and the 96-hour EC_{50} = 17.9 (95% C.I.=13.2-29.5) µg a.i./L for deltamethrin EC (2.48% a.i.), based on effects to shell deposition (MRIDs 41651016 and 41651017). The NOAECs from the TGAI and EC studies are 3.4 and 4.0 µg a.i./L, respectively. All effects endpoints observed for the oyster are approximately 1 order of magnitude above the solubility of the TGAI (0.200 µg a.i./L).

4.2.4.b. Estuarine/Marine Invertebrates (Pelagic): Chronic Exposure Studies

A 35-d life cycle toxicity study of the effects of deltamethrin TGAI on mysid shrimp (*A. bahia*) was recently submitted to the Agency (MRID 48988202) and is in review. Results indicate that reproduction (# young/female) was the most sensitive endpoint, with a NOAEC and LOAEC of 0.73 and 1.2 ng a.i./L, respectively. The LOAEC represents a 43% reduction in the average number of young/female relative to controls.

4.2.4.c. Estuarine/Marine Invertebrates (Pelagic): Sublethal Effects and Open Literature Data

No additional acceptable studies from the open literature were identified for estuarine/marine invertebrates that: (1) established more sensitive acute or chronic endpoints than the data listed above; (2) filled critical data gaps; (3) presented a toxicity profile for under-represented taxa; or (4) provided information on sub-lethal effects that could be quantitatively linked to relevant assessment endpoints (i.e., survival, reproduction, and growth) at concentrations lower than the most sensitive endpoints used to quantitatively evaluate risk.

4.2.4.d. Estuarine/Marine Invertebrates (Benthic): Sediment Exposure

No data on the toxicity of deltamethrin to estuarine/marine benthic invertebrates were submitted to the Agency nor were any such studies found in the open literature.

4.2.5. Toxicity to Aquatic Plants

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

Data on the toxicity of deltamethrin to aquatic vascular and non-vascular plants were recently submitted to the Agency and are currently under review. The most sensitive endpoint for aquatic non-vascular plants is reported for the green algae, *Pseudokirchneriella subcapitata* (MRID48258214). A 96-h EC_{50} (biomass) of 17.8 mg a.i./L is reported in this study using the TGAI, which is several orders of magnitude above the reported solubility of deltamethrin (0.2 µg a.i./L). The NOAEC for *P. subcapitata* was reported to be < 7.3 mg a.i./L, based on a 26% reduction in cell numbers at this treatment. Other non-vascular plants tested included *Chlorella vulgaris* with a 96-h EC_{50} of >0.32 mg a.i./L based on a limit test with the TGAI (MRID 48258213) and *Scenedesmus subspicatus* (5% a.i. EC formulation) with a 72-h EC_{50} of >1000 mg a.i./L and a NOAEC of 560 mg a.i./L (MRID 48258212).

For vascular aquatic plants, a 7-d EC_{50} value of >0.78 µg a.i./L is reported for the TGAI (> 99% purity; MRID 48988204; in review). At the highest concentration tested (0.78 µg a.i./L), no statistically significant adverse effects occurred on any of the endpoints measured (frond counts, growth rate, biomass) which yields a NOAEC of 0.78 µg a.i./L).

4.2.6. Aquatic Field/Mesocosm Studies

No aquatic field or mesocosm/microcosm studies were identified that were considered acceptable for quantitative use in risk assessment. Two available microcosm studies (MRID 42114816 and 42773904) did not evaluate effects on aquatic organisms.

4.3. Toxicity of Deltamethrin to Terrestrial Organisms

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

Table 4-3. Terrestrial Toxicity Profile for Deltamethrin

Species (common name)	Taxa Represented	Duration	Endpoint	Mean Concentration	Citation MRID	Acute Toxicity Classification
Colinus virginianus (Bobwhite quail)	Birds, terrestrial-phase amphibians, and reptiles	Single dose, 14d obs.	LD_{50}	> 2250 mg/kg bw	00158273 (acceptable)	Practically nontoxic
Anas platyrhynchos (Mallard duck)		5d treatment + 3 d obs	LC_{50}	> 4640 mg/kg diet	00060723 (acceptable)	Slightly toxic to Practically nontoxic
Colinus virginianus (Bobwhite quail); *Anas platyrhynchos* (Mallard duck)		22 weeks	NOAEC	450 mg/kg diet	42114808 and 42114809 (acceptable)	
			LOAEC	>450 mg/kg diet		
Helicoverpa armigera (Cotton bollworm larvae)	Terrestrial invertebrates	72 hr	LD_{50}	0.33 ng/organism	Tan and McCaffery, 2007; [#119631] (supplemental quantitative)	Highly toxic
Apis mellifera (Honey bee)		48 hr	LD_{50}	1.5 ng/organism	42114815 (acceptable)	Highly toxic
Multiple monocot and dicot species	Terrestrial plants (seedling emergence)	21d (Tier 1)	EC_{25} (2)	> 0.011 lb a.i./A	48258210 (in review)	NA
			NOAEC(2)	0.011 lb a.i./A		
Multiple monocot and dicot species	Terrestrial plants (vegetative vigor)	21d (Tier 1)	EC_{25} (2)	> 0.011 lb a.i./A	48258211 (in review)	NA
			NOAEC(2)	0.011 lb a.i./A		
Rattus norvegicus (Norway rat)	Mammals	Single oral dose	LD_{50}	67 mg a.i./kg-bw (male) 86 mg a.i./kg-bw (female)	00098078	Moderately toxic
		2 generation oral chronic	NOAEC	5.4 mg a.i./kg/d (male)	44398101	NA
			LOAEC	21.2 mg a.i./kg/d (male)		

(1) Test substance > 98% purity unless otherwise specified
(2) Test substance is a 2.5% EC formulation. Endpoints include plant mortality, phytotoxicity, and growth (dry weight)

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

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

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

4.3.1. Toxicity to Birds, Reptiles, and Terrestrial-Phase Amphibians

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, reptile and terrestrial-phase amphibian data, including data published in the open literature, is provided below in Sections 4.3.1.a through 4.3.1.d.

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

The available toxicity data indicates deltamethrin TGAI is practically nontoxic on an acute basis to avian species based on a bobwhite quail (*Colinus virginianus*) single dose LD_{50} >2250 mg/kg bw (MRID 00158273) and an 8-day dietary LC_{50} >4640 mg/kg diet for the mallard duck (*Anas platyrhynchos*) (MRID 00060723).

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

During two avian reproduction studies, deltamethrin TGAI showed no treatment-related adverse effects to reproduction, growth or survival measured at the highest dietary concentration tested (NOAEC = 450 mg/kg diet) for both the bobwhite quail and mallard duck (MRIDs 42114808 and 42114809).

4.3.1.c. Terrestrial-phase Amphibians: Acute and Chronic Studies

No acute or chronic toxicity studies were identified for assessing terrestrial phase amphibian exposure to deltamethrin that are considered acceptable for quantitative use in risk assessment. One study was identified that evaluated the acute and subchronic effects of deltamethrin (TGAI) on the terrestrial phase tiger salamander (*Ambystoma tigrinum*) but is considered appropriate for qualitative use only due to study design limitations. In this study, Froese *et al.* (2009) conducted a preliminary "up/down" evaluation of the acute oral toxicity of deltamethrin administered to adult tiger salamanders. Two individuals per treatment were exposed to a single oral dose ranging from 0.35 to 35 mg a.i./kg-bw via deltamethrin/corn-oil spiked diet (worms). Animals were observed for 12 days. All animals dosed at 10 mg a.i./kg-bw and above died within 4 days while no animals died at 5 mg a.i./kg-bw and below, thus inferring an acute LD_{50} between 5 and

10 mg a.i./kg-bw. Sublethal effects, including tremors, hypersalivation, ataxia were observed at doses of 1 mg a.i./kg-bw and above. Although this study is considered appropriate for risk characterization only and is not of sufficient quality for quantitative use in risk assessment, it does suggest that the tiger salamander may be more sensitive on an acute dose-basis compared to the avian surrogate species used (*e.g.*, mallard, bobwhite quail).

Froese *et al.* (2009) also evaluated the effects of deltamethrin on the tiger salamander resulting from 28-d subchronic exposures in the diet. A total of 21 animals were distributed among 4 treatments (corn oil control, 4, 40 and 400 mg a.i./kg/d) determined from dosing animals 3 times/weekly for four weeks. No statistically significant effects were observed on growth measures (body weight changes, length) nor were there indications of immunotoxic effects. Significant effects were observed on selected histopathological endpoints, although these did not adhere to a dose-response relationship.

4.3.1.d. Reptiles

No additional acceptable studies from the open literature were identified for reptiles that are considered acceptable for quantitative use in this risk assessment.

4.3.2. Toxicity to Mammals

A summary of acute and chronic mammalian data, including data published in the open literature, is provided below in **Sections 4.3.2.a** through **4.3.2.b**. A more complete analysis of toxicity data to mammals is available in **Appendix J**, which is a copy of the 2010 Health Effects Division (HED) scoping document for deltamethrin prepared in support of the registration review.

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

An acute oral toxicity study of deltamethrin TGAI administered to male and female rats in polyethylene glycol carrier resulted in LD_{50} values of 67 (95% C.I.= 53-83.9) and 86 (95% C.I.=70.6-106.2) mg a.i./kg-bw (MRID 00098078). Similar results were observed when deltamethrin was administered via sesame oil (LD_{50} = 129 for males (95% C.I. =104.9-156.6) and 139 for females (95% C.I.=114.2-168.2) mg a.i./kg-bw, respectively. Signs of intoxication included hypermoti1ity, stereotyped movements of the head, tachycardia, convulsions, motor uncoordination (in rats). Surviving rats recovered from these signs of intoxication within 3 days. This study is classified as supplemental (quantitative) because no necropsy analysis was performed.

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

In the 2-generation reproduction study, qualitative evidence of increased susceptibility was noted at 22 mg/kg/day (320 ppm in diet) as effects on the F_1 generation adult rats (MRID 44398101). In the F_1 generation, there were increased deaths in males (17/30) and females (19/30), clinical findings (*i.e.*. impaired righting reflexes, hyperactivity, splayed limbs, vocalization, and excessive salivation), and cerebral congestion and/or blood clots at the highest dose tested. The clinical findings, cerebral congestion, and blood clots were limited to the adults. Decreased body weight and body weight gains were also observed at this dose level. The NOAEC is reported at 5.4 mg a.i./kg/d (80 ppm in diet).

4.3.3. Toxicity to Terrestrial Invertebrates

A summary of acute toxicity data for relevant terrestrial invertebrates, including data published in the open literature is provided below in **Section 4.3.3.a**. No chronic toxicity data for terrestrial invertebrates considered acceptable for quantitative use in risk assessment were identified for deltamethrin.

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

As expected for a registered insecticide, deltamethrin is highly toxic to nontarget terrestrial invertebrates. An acute contact study on honeybees (*Apis mellifera*) for deltamethrin technical produced an LD_{50} = 0.0015 µg/bee (MRID 42114815). In a foliage residual study conducted with deltamethrin EC (2.5% a.i.), 100% mortality occurred in honey bees exposed to direct contact at 0.01 – 0.015 lbs EC/A (0.00025 lbs a.i./A – 0.000375 lbs a.i./A) and significant adverse effects (78% mortality) were still occurring when bees were exposed to alfalfa foliage 34 hours after treatment at the 0.015 lbs EC/A level (0.000375 lbs a.i./A) (MRID 42475905). In another foliage residual test, the RT_{25} (time required for foliar residues to achieve 25% mortality) at 0.02 lbs a.i./A was estimated to be somewhere between 2 and 8 hours after treatment (MRID 42773902).

In addition to the aforementioned registrant-submitted studies on honey bees, toxicity data from the open literature were evaluated for toxicological endpoints that are lower (more sensitive) than registrant studies. The most sensitive acute toxicity endpoint for Lepidoptera (appropriate for estimating effects to the BCB) is reported by Tan and McCaffery (2007). In their study, Tan and McCaffery (2007) evaluated the contact toxicity of deltamethrin (TGAI) to laboratory-reared (susceptible) strains of the cotton bollworm (*Heliocoverpa armigera*) following topical administration to the thoracic dorsum of 13-20 mg larvae. Three to four replicates of 10 larvae were tested at each treatment and observed for 72 hours. Mortality in controls was 0% over the duration of the study. The authors report a 72-h LD_{50} of 0.33 (95% C.I.=0.28-0.39) ng a.i./organism for the TGAI, which equates to an LD_{50} of 0.02 µg a.i./g organism based on a mean weight of larvae of 16.5 mg. No data were found for Coleoptera species (considered the most appropriate surrogate for the VELB) that are classified as acceptable for quantitative use in risk assessment.

4.3.4. Toxicity to Terrestrial Plants

Plant toxicity data from both registrant-submitted studies and studies in the scientific literature were reviewed for this assessment. Registrant-submitted studies are conducted under conditions and with species defined in EPA toxicity test guidelines. Ten species are preferred for pesticide testing (6 dicots, 4 monocots). Sublethal endpoints such as plant growth, dry weight, and biomass are evaluated for both monocots and dicots, and effects are evaluated at both seedling emergence and vegetative life stages. Guideline studies generally evaluate toxicity to ten crop species. These tests are conducted on herbaceous crop species only, and extrapolation of effects to other species, such as the woody shrubs and trees and wild herbaceous species, contributes uncertainty to risk conclusions.

For deltamethrin, seedling emergence and vegetative vigor Tier 1 studies were recently submitted to the Agency for review (MRID 48258210 and 48258211, respectively). Both studies were conducted with a single application rate of 0.011 lb a.i./A using the formulated product Decis EC 025 (2.5% a.i.). Although the study authors report that this rate was the maximum allowable rate, it is about 1/3 the maximum agricultural use rate in the U.S. (0.0354 lb a.i./A) and substantially lower than the maximum non-agricultural rate calculated for ornamentals: ant mount treatment (1.942 lb a.i./A). Following OECD Guideline 208, four dicot species were tested: lettuce (*Lactuca sativa*), oil seed rape (*Brassica napus*), cucumber (*Cucumis sativus*), and soybean (*Glycine max*). Two monocot species were also tested: oat (*Averts sativa*) and onion (*Allium cepa*). Four pots with 5 plants per pot were tested and evaluated for 21-days. Results for the vegetative vigor test indicated no statistically-significant effects on plant mortality, phytotoxicity, or growth (dry weight) for any of the 6 plants tested relative to controls. Specifically, growth of all 6 species treated with deltamethrin was similar or greater than controls for all plants tested. Results for the seeding emergence also indicate no statistically significant effects on emergence, survival and growth of the 6 plants tested.

Although these studies are currently undergoing review, results are being used in this assessment based on a preliminary review of the data because of the importance of plant toxicity data to endangered species determinations and the lack of terrestrial plant data for deltamethrin (and other pyrethroids) in general.

4.4. Toxicity of Chemical Mixtures

As previously discussed, the results of available toxicity data for mixtures of deltamethrin with other pesticides are presented in **Appendix A**. On a routine basis, the Agency does not include evaluation of mixtures of multiple pesticide active ingredients in its risk assessments. Each active ingredient is subject to individual risk assessments. Deltamethrin has at least 28 registered products that contain multiple active ingredients. It can be formulated with s-bioallethrin, pyrethrins, chlorpyrifos-methyl, imiprothrin, piperonyl butoxide (PBO), oil of thyme and geraniol combination, and PBO and s-bioallethrin combination. Analysis of the available open literature and acute oral mammalian LD_{50} data for multiple active ingredient products relative to the single active ingredient is provided in **Appendix A**. Although there appears to be synergism in some instances, the extent is uncertain; therefore, this analysis will be based on the toxicity of the single active ingredient of deltamethrin. Refer to **Section 6.2.4** for uncertainties related to chemical mixtures.

There are several studies on mixture analysis in the open literature (a screen of the ECOTOX database is provided in **Appendix A**). Analysis of the multi-active ingredient data on both target and non-target organisms indicates that PBO may synergize the effect of deltamethrin in several organisms, including rats. For example, Weston and coworkers have conducted sediment toxicity studies for synthetic pyrethroids. In one study (Weston *et al.* 2006), it was found that the presence of PBO in the overlaying water could cause an increase of the toxicity of pyrethroids present in the sediment to the amphipod *Hyalella azteca*. PBO is co-applied with pyrethrins for mosquito control. PBO concentrations of 2−4 µg/L caused a two-fold increase of the toxicity to the amphipod in sediments. Toxicity enhancement of deltamethrin by PBO of up to 7.5X was reported by Sahay et al. (1991) for the snail, *Lymnaea acwninutu*. For, the grain borer, *Prostephanus truncatus* (a target insect), deltamethrin + PBO resulted in toxicity enhancement of up to four times (Duncan 1998). Additionally, there are studies that document synergism between organophosphate insecticides and deltamethrin. Interactions of deltamethrin and various oils are also documented. Carbaryl and carbaryl-PBO combined with deltamethrin are also compared. Finally, the joint effects of pyrethroids in sediments appear to be additive (*e.g.*, Trimble *et al.* 2009).

4.5. Incident Database Review

A review of the Ecological Incident Information System (EIIS, version 2.1), the 'Aggregate Incident Reports' (v. 1.0) database, and the Avian Monitoring Information System (AIMS) for ecological incidents involving deltamethrin was completed on January 30, 2013. The results of this review are discussed below.

4.5.1. EIIS

A review of the Ecological Incident Information System (EIIS) database for ecological incidents involving deltamethrin was completed on January 30, 2013. This database consists of exposure incident reports submitted to the EPA from 1994 to present.

Incidents listed in EIIS are categorized by the likelihood that a particular pesticide is associated with that particular incident. These classifications include highly probable, probable, possible, unlikely or unrelated. "Highly probable" incidents usually require carcass residues or clear circumstances regarding the exposure. "Probable" incidents include those where residue information was not available or circumstances were less clear than those for "highly probable." "Possible" incidents occur when multiple chemicals may have been involved and the contribution of an individual chemical is not obvious. An "unlikely" incident classification is given when a given chemical is considered nontoxic to the type of organism involved or the chemical was analyzed and not detected in samples. The "unrelated" category is used for incidents confirmed not to involve pesticides. A summary is provided for all "highly probably" and "probable" reports.

The number of reports listed in the EIIS database is believed to be only a small fraction of the total incidents involving organismal mortality and damage caused by pesticides. Few resources are assigned to incident reporting. Reporting by states is only voluntary, and individuals discovering incidents may not be informed on the procedure of reporting these occurrences. Additionally, much of the database is generated from registrant-submitted incident reports. Registrants are legally required to provide detailed reports of only "major" ecological incidents involving pesticides, while "minor" incidents are reported aggregately. Because of these logistical difficulties, EIIS is most likely a minimal representation of all pesticide-related ecological incidents.

The EIIS database has records for one aquatic incident (I015407-001). In 2004, approximately 350 bull head were found dead in a small pond, approximately 1/3 of an acre in area with an average depth of 4 feet. The pond contained a small aeration pump set to run 12 hours per day. *DeltaGuard GC* was applied in conjunction with a fungicide on the putting greens of a golf course. Two days after the application, the course received rain in excess of 2" of rain. Six days after application of *DeltaGuard*, *Merit 75 + Cleay's 3336* (active ingredient imidacloprid) was applied within 30' of the pond and treatment was irrigated into the turf grass; 1.6" of rainfall occurred within 40 hours of the application. 13 days after application of deltamethrin, and 7 days after application of imidacloprid, 100 dead fish were found; a total of 350 were collected in the following 3 days. Analysis of water samples showed residues of deltamethrin were less than 0.13 ppb. This incident is classified as 'probable' with respect to the association of the fish kill and deltamethrin application, although the influence of the other active ingredient applied (imidacloprid) cannot be ruled out.

4.5.2. AIMS

Avian Monitoring system did not report any avian related incidents due to exposure to deltamethrin as of January 30, 2013.

4.5.3. Aggregate Incident Report

A review of the Aggregate Incident Report was conducted on January 30, 2013 and found 6 deltamethrin related minor plant incidents. Five incidents involve *Fire Ant Killer Granules* product and occur from 2004 to 2005. One incident involves *DECIS 5EC Insecticide* and occurred in 1999.

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 deltamethrin 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, TG, DS, CTS (all DPS), VELB, CCR, SFGS & CFWS or for modification to their designated critical habitat from the use of deltamethrin 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 C**). For acute exposures to the aquatic animals, as well as terrestrial invertebrates, the LOC is 0.05. For acute exposures to the 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.

Acute and chronic risks to aquatic organisms are estimated by calculating the ratio of exposure to toxicity using 1-in-10 year EECs in **Table 3-2** based on the label-recommended deltamethrin usage scenarios summarized in **Table 3-1** and the appropriate aquatic toxicity endpoint from **Table 4-1** Acute and chronic risks to terrestrial animals are estimated based on exposures resulting from applications of deltamethrin (**Error! Reference source not found.** through **Table -10**) and the appropriate toxicity endpoint from **Table 4-3**. Exposures are also derived for terrestrial plants, as discussed in **Section 3.4** and summarized in**Table 3-13Error! Reference ource not found.** based on the highest application rates of deltamethrin use within the action area.

5.1.1. Exposures in the Aquatic Habitat

5.1.1.a. Freshwater Fish and Aquatic-phase Amphibians

Acute risk to fish and aquatic-phase amphibians is based on 1-in-10 year peak EECs derived from PRZM/EXAMS and the lowest acute toxicity value for freshwater fish (pumpkinseed sunfish, *Lepomis gibbosus* 96-hr LC_{50}=0.58 µg/L. Chronic risk is based on the 1-in-10 year 60-day average EECs and the lowest chronic toxicity value for freshwater fish (NOAEC=0.017 µg/L for fathead minnow, *Pimephales promelas*). Risk quotients for freshwater fish are shown in **Table 5-1**. Acute RQs ranged from **<0.01 to 0.34** and chronic RQs ranged from **<0.01 to 11.8**

(0.34 and 11.8 correspond to the RQs for the EECs that were capped at the limit of solubility of deltamethrin). Sixty-nine percent (31 of 45 scenarios) of the deltamethrin uses exceeded the acute risk to listed species LOC (0.05) and 36% (16 of 45 scenarios) exceeded the chronic risk to listed species LOC (1). Therefore, deltamethrin has the potential to directly affect the CTS, TG, and DS. Additionally, since chronic RQs are exceeded, there is a potential for indirect effects to those listed species that rely on fish (and/or aquatic-phase amphibians) during at least some portion of their life-cycle (*i.e.*, SFGS, CCR, and CTS). It is stressed that the RQs were capped due to the EECs set to the limit of solubility.

Table 5-1. Acute and Chronic RQs for Freshwater Fish Exposed to Deltamethrin

Scenario/Uses	App Rate (lb a.i./A) x No. of Apps	App Method+	Peak EEC (µg/L)	60-day EEC (µg/L)	Acute RQ#	Chronic RQ#
CAalmond_WirrigSTD/ Tree nuts crop group 14	0.0354x5	A (foliar)	0.0390	0.00549	**0.07**	0.32
CAalmond_WirrigSTD/ Tree nuts crop group 14	0.0354x5	A (dormant)	0.0369	0.00509	**0.06**	0.30
CAcornOP/ Corn (field, pop)	0.0236x5	A	0.0248	0.00294	0.01	0.17
CAcornOP/ Corn (pop)	0.0229x5	D	0.00854	0.000733	0.01	0.04
CAcornOP/ Sweet corn	0.03x16	A	0.0793	0.0112	**0.14**	0.66
CAcornOP/ Sweet corn	0.03x16	G	0.0814	0.00656	**0.14**	0.39
CAcornOP/ Sweet corn	0.03x16	D	0.0404	0.00292	**0.07**	0.17
CAcotton_WirrigSTD/ Cotton	0.0322x10	A	0.0352	0.00793	**0.06**	0.47
CAfruit_WirrigSTD/ Pome fruits	0.0225x2	A	0.00620	0.000457	0.01	0.03
CAMelonsRLF_V2/ Cucurbits	0.03x6	A	0.0321	0.00452	**0.06**	0.27
CAMelonsRLF_V2/ Cucurbits	0.03x6	G	0.00893	0.00269	0.02	0.16
CAMelonsRLF_V2/ Cucurbits	0.03x6	D	0.000424	3.76e-5	<0.01	<0.01
CAonion_WirrigSTD/ garlic, leeks, onion, shallots	0.03x4	A	0.0309	0.00334	**0.05**	0.20
CAonion_WirrigSTD/ garlic, leeks, onion, shallots	0.03x4	D	0.00461	0.000241	0.01	0.01
CAPotatoRLF_V2/ Root vegetables crop subgroup 1B; Tuberous and corm vegetables crop subgroup 1C	0.03x5	A	0.0319	0.00409	**0.06**	0.24
CAPotatoRLF_V2/ Root vegetables crop subgroup 1B; Tuberous and corm vegetables crop subgroup 1C	0.03x5	D	0.00535	0.000255	0.01	0.02
CARowCropRLF_V2/ Artichokes	0.03x5	A	0.0421	0.00622	**0.07**	0.37
CARowCropRLF_V2/ Artichokes	0.03x5	D	0.00347	0.00237	0.01	0.14
CAtomato_WirrigSTD/ (eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato)	0.03x6	A	0.0314	0.00477	**0.05**	0.28
CAtomato_WirrigSTD/ (eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato)	0.03x6	D	0.00413	0.000196	0.01	0.01
CAWheatRLF_V2/ Sorghum	0.0242x2	A	0.0479	0.00385	**0.08**	0.23
CAWheatRLF_V2/ Canola, rapeseed, crambe	0.0097x2	A	0.0193	0.00155	0.03	0.09

Scenario/Uses	App Rate (lb a.i./A) x No. of Apps	App Method+	Peak EEC (µg/L)	60-day EEC (µg/L)	Acute RQ#	Chronic RQ#
CAnurserySTD_V2/ Ornamental and/or Shade Trees; Ornamental Ground Cover	0.428x12	G	0.200*	0.200*	**0.34**	**11.8**
CAnurserySTD_V2/ Ornamental and/or Shade Trees; Ornamental Ground Cover	0.0109x12	D	0.0340	0.00172	**0.06**	0.10
CAnurserySTD_V2/ Ornamental Herbaceous Plants	0.218x12	G	0.200*	0.146	**0.34**	**8.59**
CAnurserySTD_V2/ Ornamental Herbaceous Plants	0.147x12	GR	0.200*	0.0753	**0.34**	**4.43**
CArangelandhayRLF_V2/ Ornamental sod farms	0.127x12	G	0.190	0.0216	**0.33**	**1.27**
CArangelandhayRLF_V2/ Ornamental sod farms	0.131x12	GR	0.181	0.0214	**0.31**	**1.26**
CATurfRLF/ Ornamental lawns and turf (also covers Ornamental grasses and recreational areas)	0.218x12	G	0.0820	0.0108	**0.14**	0.64
CATurfRLF/ Golf Course Turf, Recreational Area Lawns, Commercial/ Industrial Lawns	0.127x12	G	0.0558	0.111	**0.10**	**6.53**
CATurfRLF/ Same crops as in the previous row	0.147x12	GR	0.0539	0.00698	**0.09**	0.41
CATurfRLF/ Same crops as in the previous row (ant mound treatment)	1.94x12	G	0.200*	0.170	**0.34**	**10.0**
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	0.0233x6	G	0.200*	0.200*	**0.34**	**11.8**
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	0.0233x12	G	0.200*	0.200*	**0.34**	**11.8**
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	0.0241x6	GR	7.99e-4	1.00e-4	<0.01	0.01
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings Outdoors Premises, Paths/Patios	0.109x6	G	0.196	0.0223	**0.34**	**1.31**
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings Outdoors Premises, Paths/Patios; Barns, Barnyards/ Auction Barns	0.00528x6	Crack & crevice, and/or spot treatment	0.200*	0.200*	**0.34**	**11.8**
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings Outdoors Premises, Paths/Patios	0.0540x6	GR or D (includes perimeter treatment)	0.200*	0.200*	**0.34**	**11.8**
CAresidentialRLF/ CAimperviousRLF/ Wood Protection Treatment to Buildings/ Products (Outdoors)	0.217x12	Crack and crevice and/or perimeter treatment	0.200*	0.200*	**0.34**	**11.8**
CAresidentialRLF/ CAimperviousRLF/ Wood Protection Treatment to Buildings/ Products (Outdoors)	0.00058x12	Soil drench/ treatment	0.200*	0.110	**0.34**	**6.47**

Scenario/Uses	App Rate (lb a.i./A) x No. of Apps	App Method+	Peak EEC (µg/L)	60-day EEC (µg/L)	Acute RQ#	Chronic RQ#
CArightofwayRLF_V2/ CAimperviousRLF/ Non-agricultural Rights-of-Way	0.0218x12	G	0.0235	0.00274	0.04	0.16
CArightofwayRLF_V2/ CAimperviousRLF/ Non-agricultural Rights-of-Way	0.0187x12	Perimeter treatment	0.0203	0.00236	0.04	0. 14
CArightofwayRLF_V2/ CAimperviousRLF/ Paved Areas (Private Roads/ Sidewalks)	0.0017x5	Crack & crevice and/or spot treatment	0.200*	0.109	**0.34**	**6.41**
CArightofwayRLF_V2/ CAimperviousRLF/ Utilities, Utility Poles/Rights-of-Way	2.72x2	GR	0.124	0.0213	**0.21**	**1.25**
Sewage Systems	50 kg/yr	Various	0.000425	0.000425	<0.01	0.03

Generally, numbers were rounded to three significant figures, except for the RQs, for which no more than two decimal places were used.
+G=ground; GR=granular, D=dust
* EECs marked with an asterisk were set to 0.200 ppb because they exceeded the limit of solubility of deltamethrin in the aquatic modeling.
# = LOC exceedances (acute RQ $\geq$ 0.05; chronic RQ $\geq$ 1.0, for listed species) are bolded and shaded.
Acute RQ = use-specific peak EEC / 0.58 ppb [for Pumpkinseed sunfish, *Lepomis gibbosus*]. Chronic RQ = use-specific 60-day EEC / 0.017 ppb [for Fathead Minnow, *Pimephales promelas*].

5.1.1.b. Freshwater Pelagic Invertebrates

Acute risk to freshwater invertebrates is based on 1-in-10 year peak EECs derived from PRZM/ EXAMS and the lowest acute toxicity value for freshwater invertebrates (amphipod *Gammarus fossarum* 48-hr LC_{50} = 0.004 µg/L). Chronic risk is based on 1-in-10 year average 21-day EECs and the lowest chronic toxicity value for freshwater invertebrates (10-d NOAEC of <0.026 ng a.i./L for the amphipod, *H. azteca*)). This chronic NOAEC is based on the pore water NOAEC from a 10-d toxicity study with *H. azteca*. This NOAEC is used for chronic RQ calculation for freshwater pelagic invertebrates because cladocerans such as *C. dubia* are typically much less sensitive to pyrethroids than other freshwater taxa such as amphipods and midge. For deltamethrin, much greater sensitivity of amphipods is evident by the fact that the 48-h LC_{50} 0f 4 ng a.i./L for the amphipod, *G. fossarum* is less than a factor of two greater than the chronic life cycle NOAEC for *C. dubia* (2.5 ng a.i./L). Furthermore, the 10-d NOAEC for the freshwater midge, *C. dilutus*, is 0.83 ng ai/L which is approximately 1/3 the NOAEC for *C. dubia.*

Risk quotients for freshwater invertebrates are shown in **Table 5-2**. Risk quotients for freshwater invertebrates range from **0.11 to 50.0** (acute) and from >**2.1 to >7,690** (chronic). The highest RQs were observed for EECs that were capped at the limit of solubility of deltamethrin. Acute risk to listed (LOC = 0.05), and non-listed species (LOC = 0.5) LOCs are exceeded for all deltamethrin uses for 100% (45 of 45), and 93% (42 of 45) of the scenarios, respectively. The chronic risk to listed and non-listed LOC (LOC = 1) is exceeded for 100% (45 of 45) of the scenarios. Therefore, there is the potential for deltamethrin to directly affect the CFWS and indirectly affect listed species that rely on freshwater invertebrates during at least some portion of their life-cycle (*i.e.*, SFGS, CCR, CTS, TG, DS, and CFWS) (**Table 5-2**).

Table 5-2. Summary of Acute and Chronic RQs for Aquatic Freshwater Invertebrates Exposed to Deltamethrin

Uses	App Rate (lb a.i./A) x No. of Apps	App Method+	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ#	Chronic RQ#
CAalmond_WirrigSTD/ Tree nuts crop group 14	0.0354x5	A (foliar)	0.0390	0.00784	**9.75**	**>302**
CAalmond_WirrigSTD/ Tree nut crop group 14	0.0354x5	A (dormant)	0.0369	0.00717	**9.23**	**>276**
CAcornOP/ Corn (field, pop)	0.0236x5	A	0.0248	0.00312	**6.20**	**>120**
CAcornOP/ Corn (pop)	0.0229x5	D	0.00854	0.00110	**2.14**	**>42.3**
CAcornOP/ Sweet corn	0.03x16	A	0.0793	0.0111	**19.8**	**>427**
CAcornOP/ Sweet corn	0.03x16	G	0.0814	0.00911	**20.4**	**>350**
CAcornOP/ Sweet corn	0.03x16	D	0.0404	0.00412	**10.1**	**>158**
CAcotton_WirrigSTD/ Cotton	0.0322x10	A	0.0352	0.0101	**8.80**	**>388**
CAfruit_WirrigSTD/ Pome fruits	0.0225x2	A	0.00620	0.000852	**1.55**	**>33**
CAMelonsRLF_V2/ Cucurbits	0.03x6	A	0.0321	0.00967	**8.03**	**>372**
CAMelonsRLF_V2/ Cucurbits	0.03x6	G	0.00893	0.00391	**2.23**	**>150**
CAMelonsRLF_V2/ Cucurbits	0.03x6	D	0.000424	5.38e-5	**0.11**	**>2.1**
CAonion_WirrigSTD/ garlic, leeks, onion, shallots	0.03x4	A	0.0309	0.00670	**7.73**	**>258**
CAonion_WirrigSTD/ garlic, leeks, onion, shallots	0.03x4	D	0.00461	0.000362	**1.15**	**>13.9**
CAPotatoRLF_V2/ Root vegetables crop subgroup 1B; Tuberous and corm vegetables crop subgroup 1C	0.03x5	A	0.0319	0.00832	**7.98**	**>320**
CAPotatoRLF_V2/ Same crops as in the previous row	0.03x5	D	0.00535	0.000387	**1.34**	**>14.9**
CARowCropRLF_V2/ Artichokes	0.03x5	A	0.0421	0.0115	**10.5**	**>442**
CARowCropRLF_V2/ Artichokes	0.03x5	D	0.00347	0.00381	**0.95**	**>147**
CAtomato_WirrigSTD/ (eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato)	0.03x6	A	0.0314	0.00798	**7.85**	**>307**
CAtomato_WirrigSTD/ (eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato)	0.03x6	D	0.00413	0.000332	**1.03**	**>12.8**
CAWheatRLF_V2/ Sorghum	0.0242x2	A	0.0479	0.00566	**12.0**	**>218**
CAWheatRLF_V2/ Canola, rapeseed, crambe	0.0097x2	A	0.0193	0.00227	**4.83**	**>87.3**
CAnurserySTD_V2/ Ornamental and/or Shade Trees	0.428x12	G	0.200*	0.200*	**50.0**	**>7690**
CAnurserySTD_V2/ Ornamental and/or Shade Trees	0.0109x12	D	0.0340	0.00286	**8.50**	**>110**
CAnurserySTD_V2/ Ornamental Herbaceous Plants	0.218x12	G	0.200*	0.200*	**50.0**	**>7690**
CAnurserySTD_V2/ Ornamental Herbaceous Plants	0.147x12	GR	0.200*	0.110	**50.0**	**>4231**
CArangelandhayRLF_V2/	0.127x12	G	0.190	0.0294	**47.5**	**>1131**

Uses	App Rate (lb a.i./A) x No. of Apps	App Method+	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ#	Chronic RQ#
Ornamental sod farms						
CArangelandhayRLF_V2/ Ornamental sod farms	0.131x12	GR	0.181	0.0287	**45.3**	**>1104**
CATurfRLF/ Ornamental lawns and turf	0.218x12	G	0.0820	0.0141	**20.5**	**>542**
CATurfRLF/ Golf Course Turf, Recreational Area Lawns	0.127x12	G	0.0558	0.0123	**14.0**	**>473**
CATurfRLF/ Same crops as in the previous row	0.147x12	GR	0.0539	0.00897	**13.5**	**>345**
CATurfRLF/ Same crops as in the previous row (ant mound treatment)	1.94x12	G	0.200*	0.188	**50.0**	**>7231**
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	0.00233x6	G	0.200*	0.200*	**50.0**	**>7690**
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	0.00233x12	G	0.200*	0.200*	**50.0**	**>7690**
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	0.00241x6	GR	0.000799	0.000123	**0.20**	**>4.73**
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings Outdoors Premises, Paths/Patios	0.109x6	G	0.196	0.0265	**49.0**	**>1020**
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings Outdoors Premises, Paths/Patios; Barns, Barnyards/ Auction Barns	0.00528x6	Crack & crevice, and/or spot treatment	0.200*	0.200*	**50.0**	**>7690**
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings Outdoors Premises, Paths/Patios	0.0540x6	GR or D (includes perimeter treatment)	0.200*	0.198	**50.0**	**>7620**
CAresidentialRLF/ CAimperviousRLF/ Wood Protection Treatment to Buildings/ Products (Outdoors)	0.217x12	Crack and crevice and/or perimeter treatment	0.200*	0.200*	**50.0**	**>7690**
CAresidentialRLF/ CAimperviousRLF/ Wood Protection Treatment to Buildings/ Products (Outdoors)	0.00058x12	Soil drench/ treatment	0.200*	0.129	**50.0**	**>4960**
CArightofwayRLF_V2/ CAimperviousRLF/ Non-agricultural Rights-of-Way/ Fencerows/ Hedgerows; Refuse/Solid Waste Containers and Sites (outdoor)	0.0218x12	G	0.0235	0.00333	**5.88**	**>128**
CArightofwayRLF_V2/ CAimperviousRLF/ Non-agricultural Rights-of-Way/ Paved Areas (Private Roads/ Sidewalks)	0.0187x12	Perimeter treatment	0.0203	0.00287	**5.08**	**>110**

Uses	App Rate (lb a.i./A) x No. of Apps	App Method+	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ#	Chronic RQ#
CArightofwayRLF_V2/ CAimperviousRLF/ Paved Areas (Private Roads/ Sidewalks)	0.0017x5	Crack & crevice and/or spot treatment	0.200*	0.125	**50.0**	**>4810**
CArightofwayRLF_V2/ CAimperviousRLF/ Utilities, Utility Poles/Rights-of-Way	2.72x2	GR	0.124	0.0257	**31.0**	**>988**
Sewage Systems	50 kg/yr	Various	0.000425	0.000425	**0.11**	**>16.3**

Generally, numbers were rounded to three significant figures, except for the RQs, for which no more than two decimal places were used.
+G=ground; GR=granular, D=dust
* EECs marked with an asterisk were set to 0.200 ppb because they exceeded the limit of solubility of deltamethrin in the aquatic modeling.
# = LOC exceedances (acute RQ $\geq$ 0.05; chronic RQ $\geq$ 1.0, for listed species) are bolded and shaded.
Acute RQ = use-specific peak EEC / 0.004 ppb [for the amphipod *G. fossarum*]. Chronic RQ = use-specific 21-day EEC / 10-d NOAEC of <2.6×10^{-5} ug a.i./L [for the amphipod, *H. azteca*]. Chronic RQ values are expressed as ">" values because the NOAEC is non-defnitive ("<").

5.1.1.c. Freshwater Benthic Invertebrates

Acute risk to freshwater benthic invertebrates is based on 1-in-10 year peak pore water EECs derived from PRZM/EXAMS and the lowest acute toxicity value for freshwater invertebrates (amphipod *Gammarus fossarum* 48-hr LC_{50}=0.004 µg/L). Chronic risk is based on 1-in-10 year average 21-day EECs and the lowest chronic toxicity value for benthic invertebrates (amphipod *H. azteca* 10 day NOAEC <0.026 ng a.i./L). Risk quotients for freshwater benthic invertebrates range from **<0.01 to 50.0** (acute) and **>0.21 to >7690** (chronic). Eighty-two percent (36 of 44) of the deltamethrin uses exceed the acute risk to listed species LOC (0.05) and 95% (42 of 44) of the uses exceeded the chronic risk LOC (1). Consequently, deltamethrin has the potential to directly affect the CFWS. Additionally, since 34% (15 of 44) of the uses exceed the acute risk to non-listed species LOC (0.5), deltamethrin uses also have the potential to indirectly affect listed species that rely on freshwater invertebrates during at least some portion of their life-cycle (*i.e.*, SFGS, CCR, CTS, TG, DS, CFWS) (**Table 5-3**). Despite the fact that two scenarios yielded non-definitive RQ values whose lower bounds are below the chronic LOC, their non-definitive nature (*i.e.*, expressed as "greater than") indicates that they have the potential to be larger and exceed the LOC.

Additionally, chronic risk to freshwater benthic invertebrates is also based on 1-in-10 year average 21-day sediment EECs derived from PRZM/EXAMS and the lowest chronic benthic/ sediment toxicity value for freshwater invertebrates (amphipod *H. azteca* 10 day NOAEC=12 $\mu g/kg_{OC}$). Chronic risk quotients for freshwater benthic invertebrates range from **>0.20 to >7580**. Since 95% (42 of 44) of the uses exceed the chronic risk to listed and non-listed species LOC (1), deltamethrin uses have the potential to directly affect listed species and to indirectly affect listed species that rely on freshwater invertebrates during at least some portion of their life-cycle (*i.e.*, SFGS, CCR, CTS, TG, DS, CFWS) (**Table 5-3**). Despite the fact that two scenarios yielded non-definitive RQ values whose lower bounds are below the chronic LOC, their non-definitive nature (*i.e.*, expressed as "greater than") indicates that they have the potential to be larger and exceed the LOC.

Table 5-3. Summary of Acute and Chronic RQs for Aquatic Freshwater Benthic Invertebrates Exposed to Deltamethrin

Uses	App Rate (lb a.i./A) x No. of Apps	App Method+	Pore Water		Sediment		Pore Water		Sediment	
			Peak EEC (µg/L)	21-day EEC (µg/L)	Peak EEC (µg/kg$_{oc}$)	21-day EEC (µg/kg$_{oc}$)	Acute RQ#	Chronic RQ#	Acute RQ#	Chronic RQ#
CAalmond_WirrigSTD/ Tree nuts crop group 14	0.0354x5	A (foliar)	0.000812	0.000794	365	357	**0.20**	**>30.5**	NA	**>29.8**
CAalmond_WirrigSTD/ Tree nut crop group 14	0.0354x5	A (dormant)	0.000721	0.000701	324	315	**0.18**	**>27.0**	NA	**>26.3**
CAcornOP/ Corn (field, pop)	0.0236x5	A	0.000521	0.000490	234	220	**0.13**	**>18.8**	NA	**>18.3**
CAcornOP/ Corn (pop)	0.0229x5	D	0.000169	0.000164	76.1	73.6	0.04	**>6.31**	NA	**>6.13**
CAcornOP/ Sweet corn	0.03x16	A	0.00190	0.00187	853	840	**0.48**	**>71.9**	NA	**>70.0**
CAcornOP/ Sweet corn	0.03x16	G	0.00131	0.00128	587	575	**0.33**	**>49.2**	NA	**>47.9**
CAcornOP/ Sweet corn	0.03x16	D	0.000608	0.000588	273	264	**0.15**	**>22.6**	NA	**>22.0**
CAcotton_WirrigSTD/ Cotton	0.0322x10	A	0.00101	0.000958	452	430	**0.26**	**>36.8**	NA	**>35.8**
CAfruit_WirrigSTD/ Pome fruits	0.0225x2	A	6.44e-5	6.27e-5	28.9	28.1	0.02	**>2.41**	NA	**>2.34**
CAMelonsRLF_V2/ Cucurbits	0.03x6	A	0.000598	0.000550	268	247	**0.15**	**>21.2**	NA	**>20.6**
CAMelonsRLF_V2/ Cucurbits	0.03x6	G	0.000167	0.000154	74.9	69.1	0.04	**>5.92**	NA	**>5.76**
CAMelonsRLF_V2/ Cucurbits	0.03x6	D	5.79e-6	5.50e-6	2.59	2.47	<0.01	>0.21	NA	>0.20
CAonion_WirrigSTD/ garlic, leeks, onion, shallots	0.03x4	A	0.000439	0.000424	197	190	**0.11**	**>16.3**	NA	**>15.8**
CAonion_WirrigSTD/ garlic, leeks, onion, shallots	0.03x4	D	4.18e-5	4.03e-5	18.8	18.1	0.01	**>1.55**	NA	**>1.51**
CAPotatoRLF_V2/ Root vegetables crop subgroup 1B (except sugarbeet); Tuberous and corm vegetables crop subgroup 1C	0.03x5	A	0.000522	0.000504	234	226	**0.13**	**>19.4**	NA	**>18.8**
CAPotatoRLF_V2/ Same crops as in the previous row	0.03x5	D	3.92e-5	3.80e-5	17.6	17.0	0.01	**>1.46**	NA	**>1.42**
CARowCropRLF_V2/ Artichokes	0.03x5	A	0.000931	0.000913	418	410	**0.23**	**>35.1**	NA	**>34.2**
CARowCropRLF_V2/ Artichokes	0.03x5	D	0.000416	0.000405	187	182	**0.10**	**>15.6**	NA	**>15.2**
CAtomato_WirrigSTD/ (eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato)	0.03x6	A	0.000630	0.000614	283	277	**0.16**	**>23.6**	NA	**>23.1**

Uses	App Rate (lb a.i./A) x No. of Apps	App Method+	Pore Water Peak EEC (µg/L)	Pore Water 21-day EEC (µg/L)	Sediment Peak EEC (µg/kg$_{oc}$)	Sediment 21-day EEC (µg/kg$_{oc}$)	Pore Water Acute RQ#	Pore Water Chronic RQ#	Sediment Acute RQ#	Sediment Chronic RQ#
CAtomato_WirrigSTD/ (eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato)	0.03x6	D	3.72e-5	3.58e-5	16.7	16.1	0.01	**>1.38**	NA	**>1.34**
CAWheatRLF_V2/ Sorghum	0.0242x2	A	0.000691	0.000675	310	303	**0.17**	**>26.0**	NA	**>25.3**
CAWheatRLF_V2/ Canola, rapeseed, crambe	0.0097x2	A	0.000278	0.000272	125	122	**0.07**	**>10.5**	NA	**>10.2**
CAnurserySTD_V2/ Ornamental and/or Shade Trees	0.428x12	G	0.0571	0.0555	25600	24500	**14.3**	**>2130**	NA	**>2040**
CAnurserySTD_V2/ Ornamental and/or Shade Trees	0.0109x12	D	0.000374	0.000360	168	162	**0.09**	**>13.8**	NA	**>13.5**
CAnurserySTD_V2/ Ornamental Herbaceous Plants	0.218x12	G	0.0290	0.0282	13000	12700	**54.5**	**>1080**	NA	**>1060**
CAnurserySTD_V2/ Ornamental Herbaceous Plants	0.147x12	GR	0.0148	0.0143	6660	6400	**3.70**	**>550**	NA	**>533**
CArangelandhayRLF_V2/ Ornamental sod farms	0.127x12	G	0.00379	0.00367	1700	1650	**0.95**	**>141**	NA	**>138**
CArangelandhayRLF_V2/ Ornamental sod farms	0.131x12	GR	0.00375	0.00363	1680	1630	**0.94**	**>140**	NA	**>136**
CATurfRLF/ Ornamental lawns and turf	0.218x12	G	0.00228	0.00223	1020	1000	**0.57**	**>85.8**	NA	**>83.3**
CATurfRLF/ Golf Course Turf, Recreational Area Lawns	0.127x12	G	0.00189	0.00185	850	830	**0.47**	**>71.2**	NA	**>69.2**
CATurfRLF/ Same crops as in the previous row	0.147x12	GR	0.00148	0.00145	666	651	**0.37**	**>55.8**	NA	**>54.3**
CATurfRLF/ Same crops as in the previous row (ant mound treatment)	1.94x12	G	0.0289	0.0283	13000	12700	**7.23**	**>1090**	NA	**>1060**
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	0.0233x6	G	0.0656	0.0637	29500	28600	**16.40**	**>2450**	NA	**>2380**
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	0.0233x12	G	0.134	0.131	60100	58400	**33.50**	**>5040**	NA	**>4870**
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	0.0241x6	GR	1.23e-5	1.20e-5	5.51	5.39	<0.01	>0.46	NA	>0.45
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings Outdoors Premises, Paths/Patios	0.109x6	G	0.00167	0.00164	751	736	**0.42**	**>63.1**	NA	**>61.3**
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings	0.00528x6	Crack & crevice, and/or spot treatment	0.0135	0.0130	6040	5840	**3.38**	**>500**	NA	**>487**

Uses	App Rate (lb a.i./A) x No. of Apps	App Method+	Pore Water		Sediment		Pore Water		Sediment	
			Peak EEC (µg/L)	21-day EEC (µg/L)	Peak EEC ($\mu g/kg_{oc}$)	21-day EEC ($\mu g/kg_{oc}$)	Acute RQ#	Chronic RQ#	Acute RQ#	Chronic RQ#
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings	0.00540x6	GR or D (includes perimeter treatment)	0.0167	0.0162	7490	7280	**4.18**	**>623.1**	NA	**>607**
CAresidentialRLF/ CAimperviousRLF/ Wood Protection Treatment to Buildings/ Products (Outdoors)	0.217x12	Crack and crevice and/or perimeter treatment	0.200*	0.200*	93800	91000	**50.0**	**>7690**	NA	**>7580**
CAresidentialRLF/ CAimperviousRLF/ Wood Protection Treatment to Buildings/ Products (Outdoors)	0.00058x12	Soil drench/ treatment	0.0124	0.0120	5550	5390	**3.10**	**>462**	NA	**>449**
CArightofwayRLF_V2/ CAimperviousRLF/ Non-agricultural Rights-of-Way	0.0218x12	G	0.000392	0.000383	176	172	**0.10**	**>14.7**	NA	**>14.3**
CArightofwayRLF_V2/ CAimperviousRLF/ Non-agricultural Rights-of-Way	0.00187x12	Perimeter treatment	3.38e-4	3.29e-4	152	148	**0.08**	**>12.67**	NA	**>12.3**
CArightofwayRLF_V2/ CAimperviousRLF/ Paved Areas	0.00017x5	Crack & crevice and/or spot treatment	0.0101	0.00986	4530	4430	**2.53**	**>379**	NA	**>369**
CArightofwayRLF_V2/ CAimperviousRLF/ Utilities, Utility Poles/Rights-of-Way	2.72x2	GR	0.00246	0.00240	1100	1080	**0.62**	**>92.3**	NA	**>90.0**

Generally, numbers were rounded to three significant figures, except for the RQs, for which no more than two decimal places were used.
+G=ground; GR=granular, D=dust
* EECs marked with an asterisk were set to 0.200 ppb because they exceeded the limit of solubility of deltamethrin in the aquatic modeling.
# = LOC exceedances (acute RQ ≥ 0.05; chronic RQ ≥ 1.0, for listed species) are bolded and shaded. For chronic RQs, despite the fact that one scenario yielded a non-definitive RQ value whose lower bound is below the chronic LOC, its non-definitive nature (*i.e.*, expressed as "greater than") indicates that it has the potential to be larger and exceed the LOC.
Acute pore water RQ = use-specific pore water peak EEC / 0.004 ppb [water column test for the amphipod *G. fossarum*]. Chronic pore water RQ = use-specific pore water 21-day EEC / 0.000026 ppb [estimated for *H. azteca* <0.000026 ppb]. Chronic sediment RQ = use-specific sediment 21-day EEC normalized for organic carbon content / 12 $\mu g/kg_{OC}$ [for *H. azteca* <12 $\mu g/kg_{OC}$].

5.1.1.d. Estuarine/Marine Fish

Acute risk to estuarine/marine fish is based on 1-in-10 year peak EECs in the standard pond and the lowest acute toxicity value for estuarine/marine fish (sheepshead minnow *C. variegatus* 96-hr LC_{50}=0.58 µg/L). Chronic risk is based on 1-in-10 year average 60-day EECs and the lowest chronic toxicity value for estuarine/marine fish is used (sheepshead minnow *C. variegatus* NOAEC=0.024 µg/L). Risk quotients ranged from **<0.01-0.34** for the scenarios modeled (acute) and from **<0.01 to 8.33** (chronic). Sixty-nine percent (31 of 45) of the deltamethrin uses exceed the acute risk to listed species LOC (0.05), none of the uses exceed the acute non-listed LOC (0.5) and 27% (12 of 45) exceed the chronic risk LOC (1). Thus, based on the potential for acute and chronic effects, deltamethrin has the potential to directly affect TG and DS. Furthermore, there is a potential for indirect effects to listed species that rely on estuarine/marine fish during at least some portion of their life-cycle (*i.e.*, CCR). Risk quotients are shown in **Table 5-4**.

Table 5-4. Summary of Acute and Chronic RQs for Estuarine/Marine Fish Exposed to Deltamethrin

Scenario/Uses	App Rate (lb a.i./A) x No. of Apps	App Method+	Peak EEC (µg/L)	60-day EEC (µg/L)	Acute RQ#	Chronic RQ#
CAalmond_WirrigSTD/ Tree nuts crop group 14	0.0354x5	A (foliar)	0.0390	0.00549	**0.07**	0.23
CAalmond_WirrigSTD/ Tree nut crop group 14	0.0354x5	A (dormant)	0.0369	0.00509	**0.06**	0.21
CAcornOP/ Corn (field, pop)	0.0236x5	A	0.0248	0.00294	0.01	0.12
CAcornOP/ Corn (pop)	0.0229x5	D	0.00854	0.000733	0.01	0.03
CAcornOP/ Sweet corn	0.03x16	A	0.0793	0.0112	**0.14**	0.47
CAcornOP/ Sweet corn	0.03x16	G	0.0814	0.00656	**0.14**	0.27
CAcornOP/ Sweet corn	0.03x16	D	0.0404	0.00292	**0.07**	0.12
CAcotton_WirrigSTD/ Cotton	0.0322x10	A	0.0352	0.00793	**0.06**	0.33
CAfruit_WirrigSTD/ Pome fruits	0.0225x2	A	0.00620	0.000457	0.01	0.02
CAMelonsRLF_V2/ Cucurbits	0.03x6	A	0.0321	0.00452	**0.06**	0.19
CAMelonsRLF_V2/ Cucurbits	0.03x6	G	0.00893	0.00269	0.02	0.11
CAMelonsRLF_V2/ Cucurbits	0.03x6	D	0.000424	3.76e-5	<0.01	<0.01
CAonion_WirrigSTD/ garlic, leeks, onion, shallots	0.03x4	A	0.0309	0.00334	**0.05**	0.14
CAonion_WirrigSTD/ garlic, leeks, onion, shallots	0.03x4	D	0.00461	0.000241	0.01	0.01
CAPotatoRLF_V2/ Root vegetables crop subgroup 1B; Tuberous and corm vegetables crop subgroup 1C	0.03x5	A	0.0319	0.00409	**0.06**	0.17
CAPotatoRLF_V2/ Same crops as described in the previous row	0.03x5	D	0.00535	0.000255	0.01	0.01
CARowCropRLF_V2/ Artichokes	0.03x5	A	0.0421	0.00622	**0.07**	0.26
CARowCropRLF_V2/ Artichokes	0.03x5	D	0.00347	0.00237	0.01	0.10
CAtomato_WirrigSTD/ (eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato)	0.03x6	A	0.0314	0.00477	**0.05**	0.20
CAtomato_WirrigSTD/ (eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato)	0.03x6	D	0.00413	0.000196	0.01	0.01
CAWheatRLF_V2/ Sorghum	0.0242x2	A	0.0479	0.00385	**0.06**	0.16
CAWheatRLF_V2/ Canola, rapeseed, crambe	0.0097x2	A	0.0193	0.00155	0.03	0.06
CAnurserySTD_V2/ Ornamental and/or Shade Trees	0.428x12	G	0.200*	0.200*	**0.34**	**8.33**

Scenario/Uses	App Rate (lb a.i./A) x No. of Apps	App Method+	Peak EEC (µg/L)	60-day EEC (µg/L)	Acute RQ#	Chronic RQ#
CAnurserySTD_V2/ Ornamental and/or Shade Trees	0.0109x12	D	0.0340	0.00172	**0.06**	0.07
CAnurserySTD_V2/ Ornamental Herbaceous Plants	0.218x12	G	0.200*	0.146	**0.34**	**6.08**
CAnurserySTD_V2/ Ornamental Herbaceous Plants	0.147x12	GR	0.200*	0.0753	**0.34**	**3.14**
CArangelandhayRLF_V2/ Ornamental sod farms	0.127x12	G	0.190	0.0216	**0.33**	0.90
CArangelandhayRLF_V2/ Ornamental sod farms	0.131x12	GR	0.181	0.0214	**0.31**	0.89
CATurfRLF/ Ornamental lawns and turf	0.218x12	G	0.0820	0.0108	**0.14**	0.45
CATurfRLF/ Golf Course Turf, Recreational Area Lawns	0.127x12	G	0.0558	0.111	**0.10**	**4.63**
CATurfRLF/ Same crops as in the previous row	0.147x12	GR	0.0539	0.00698	**0.09**	0.29
CATurfRLF/ Same crops as in the previous row (ant mound treatment)	1.94x12	G	0.200*	0.170	**0.34**	**7.08**
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	0.0233x6	G	0.200*	0.200*	**0.34**	**8.33**
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	0.0233x12	G	0.200*	0.200*	**0.34**	**8.33**
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	0.0241x6	GR	7.99e-4	1.00e-4	<0.01	<0.01
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings	0.109x6	G	0.196	0.0223	**0.34**	0.93
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings	0.00528x6	Crack & crevice, and/or spot treatment	0.200*	0.200*	**0.34**	**8.33**
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings	0.0540x6	GR or D (includes perimeter treatment)	0.200*	0.200*	**0.34**	**8.33**
CAresidentialRLF/ CAimperviousRLF/ Wood Protection Treatment to Buildings/ Products (Outdoors)	0.217x12	Crack and crevice and/or perimeter treatment	0.200*	0.200*	**0.34**	**8.33**
CAresidentialRLF/ CAimperviousRLF/ Wood Protection Treatment to Buildings/ Products (Outdoors)	0.00058x12	Soil drench/ treatment	0.200*	0.110	**0.34**	**4.58**
CArightofwayRLF_V2/ CAimperviousRLF/ Non-agricultural Rights-of-Way	0.218x12	G	0.0235	0.00274	0.04	0.11
CArightofwayRLF_V2/ CAimperviousRLF/ Non-agricultural Rights-of-Way	0.0187x12	Perimeter treatment	0.0203	0.00236	0.04	0.10

Scenario/Uses	App Rate (lb a.i./A) x No. of Apps	App Method+	Peak EEC (µg/L)	60-day EEC (µg/L)	Acute RQ#	Chronic RQ#
CArightofwayRLF_V2/ CAimperviousRLF/ Paved Areas (Private Roads/ Sidewalks)	0.0017x5	Crack & crevice and/or spot treatment	0.200*	0.109	**0.34**	**4.54**
CArightofwayRLF_V2/ CAimperviousRLF/ Utilities, Utility Poles/Rights-of-Way	2.72x2	GR	0.124	0.0213	**0.21**	0.89
Sewage Systems	50 kg/yr	Various	0.000425	0.000425	<0.01	0.02

Generally, numbers were rounded to three significant figures, except for the RQs, for which no more than two decimal places were used.
+G=ground; GR=granular, D=dust
* EECs marked with an asterisk were set to 0.200 ppb because they exceeded the limit of solubility of deltamethrin in the aquatic modeling.
# = LOC exceedances (acute RQ $\geq$ 0.05; chronic RQ $\geq$ 1.0, for listed species) are bolded and shaded.
Acute RQ = use-specific peak EEC / 0.58 ppb [for sheephead minnow, *Cyprinodon variegatus*]. Chronic RQ = use-specific 60-day EEC / 0.024 ppb (chronic NOAEC reported from data in review).

5.1.1.e. Estuarine/Marine Invertebrates

Acute risk to estuarine/marine invertebrates is based on peak EECs derived from PRZM/ EXAMS and the lowest acute toxicity value for estuarine/marine invertebrates (mysid shrimp *Americamysis bahia* 96-hr LC_{50} = 0.0037 µg/L). Chronic risk is based on 21-day average EECs and the lowest chronic toxicity value for estuarine/marine invertebrates (mysid shrimp *A. bahia* 35-day NOAEC=0.73 ng a.i./L). Risk quotients range from **0.11 to 54.1** (acute) and **0.07 to 274** (chronic). All of the deltamethrin uses exceed the acute risk to listed LOC (0.05) and 84% (38 of 45) the chronic risk LOC (1). In addition, 93% (42 of 45) of the uses exceed the acute risk to non-listed species LOC (0.5). Therefore, deltamethrin uses have the potential to indirectly affect listed species that rely on estuarine/marine invertebrates during at least some portion of their life-cycle (*i.e.*, CCR, TG, and DS). Risk quotients are shown in **Table 5-5**.

Table 5-5. Summary of Acute and Chronic RQs for Estuarine/Marine Invertebrates Exposed to Deltamethrin

Uses	App Rate (lb a.i./A) x No. of Apps	App Method+	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ#	Chronic RQ#
CAalmond_WirrigSTD/ Tree nuts crop group 14	0.0354x5	A (foliar)	0.0390	0.00784	**10.5**	**10.7**
CAalmond_WirrigSTD/ Tree nut crop group 14	0.0354x5	A (dormant)	0.0369	0.00717	**9.97**	**9.82**
CAcornOP/ Corn (field, pop)	0.0236x5	A	0.0248	0.00312	**0.84**	**4.27**
CAcornOP/ Corn (pop)	0.0229x5	D	0.00854	0.00110	**2.31**	**1.61**
CAcornOP/ Sweet corn	0.03x16	A	0.0793	0.0111	**21.4**	**15.2**
CAcornOP/ Sweet corn	0.03x16	G	0.0814	0.00911	**22.0**	**12.5**
CAcornOP/ Sweet corn	0.03x16	D	0.0404	0.00412	**10.9**	**5.64**
CAcotton_WirrigSTD/ Cotton	0.0322x10	A	0.0352	0.0101	**9.51**	**13.8**
CAfruit_WirrigSTD/ Pome fruits	0.0225x2	A	0.00620	0.000852	**1.68**	**1.17**

Uses	App Rate (lb a.i./A) x No. of Apps	App Method+	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ#	Chronic RQ#
CAMelonsRLF_V2/ Cucurbits	0.03x6	A	0.0321	0.00967	**8.68**	**13.2**
CAMelonsRLF_V2/ Cucurbits	0.03x6	G	0.00893	0.00391	**2.41**	**5.36**
CAMelonsRLF_V2/ Cucurbits	0.03x6	D	0.000424	5.38e-5	**0.11**	0.07
CAonion_WirrigSTD/ garlic, leeks, onion, shallots	0.03x4	A	0.0309	0.00670	**8.35**	**9.18**
CAonion_WirrigSTD/ garlic, leeks, onion, shallots	0.03x4	D	0.00461	0.000362	**1.25**	0.50
CAPotatoRLF_V2/ Root vegetables crop subgroup 1B (except sugarbeet); Tuberous and corm vegetables crop subgroup 1C	0.03x5	A	0.0319	0.00832	**8.62**	**11.4**
CAPotatoRLF_V2/ Same crops as in the previous row	0.03x5	D	0.00535	0.000387	**1.45**	0.53
CARowCropRLF_V2/ Artichokes	0.03x5	A	0.0421	0.0115	**11.4**	**15.8**
CARowCropRLF_V2/ Artichokes	0.03x5	D	0.00347	0.00381	**0.94**	**5.22**
CAtomato_WirrigSTD/ (eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato)	0.03x6	A	0.0314	0.00798	**8.49**	**10.9**
CAtomato_WirrigSTD/ (eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato)	0.03x6	D	0.00413	0.000332	**1.12**	0.45
CAWheatRLF_V2/ Sorghum	0.0242x2	A	0.0479	0.00566	**12.9**	**7.75**
CAWheatRLF_V2/ Canola, rapeseed, crambe	0.0097x2	A	0.0193	0.00227	**5.30**	**3.11**
CAnurserySTD_V2/ Ornamental and/or Shade Trees	0.428x12	G	0.200*	0.200*	**54.1**	**274**
CAnurserySTD_V2/ Ornamental and/or Shade Trees	0.0109x12	D	0.0340	0.00286	**9.19**	0.39
CAnurserySTD_V2/ Ornamental Herbaceous Plants	0.218x12	G	0.200*	0.200*	**54.1**	**274**
CAnurserySTD_V2/ Ornamental Herbaceous Plants	0.147x12	GR	0.200*	0.110	**54.1**	**151**
CArangelandhayRLF_V2/ Ornamental sod farms	0.127x12	G	0.190	0.0294	**51.4**	**40.3**
CArangelandhayRLF_V2/ Ornamental sod farms	0.131x12	GR	0.181	0.0287	**48.9**	**39.3**
CATurfRLF/ Ornamental lawns and turf	0.218x12	G	0.0820	0.0141	**22.2**	**19.3**
CATurfRLF/ Golf Course Turf, Recreational Area Lawns	0.127x12	G	0.0558	0.0123	**15.1**	**16.8**
CATurfRLF/ Same crops as in the previous row	0.147x12	GR	0.0539	0.00897	**14.6**	**12.3**
CATurfRLF/ Same crops as in the previous row (ant mound treatment)	1.94x12	G	0.200*	0.188	**54.1**	**258**
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	0.0233x6	G	0.200*	0.200*	**54.1**	**274**
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	0.0233x12	G	0.200*	0.200*	**54.1**	**274**
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	0.0241x6	GR	7.99e-4	1.23e-4	**0.22**	0.17

Uses	App Rate (lb a.i./A) x No. of Apps	App Method+	Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ#	Chronic RQ#
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings	0.109x6	G	0.196	0.0265	**53.0**	**36.3**
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings	0.00528x6	Crack & crevice, and/or spot treatment	0.200*	0.200*	**54.1**	**274**
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings	0.0540x6	GR or D (includes perimeter treatment)	0.200*	0.198	**54.1**	**2.71**
CAresidentialRLF/ CAimperviousRLF/ Wood Protection Treatment to Buildings/ Products (Outdoors)	0.217x12	Crack and crevice and/or perimeter treatment	0.200*	0.200*	**54.1**	**274**
CAresidentialRLF/ CAimperviousRLF/ Wood Protection Treatment to Buildings/ Products (Outdoors)	0.00058x12	Soil drench/ treatment	0.200*	0.129	**54.1**	**177**
CArightofwayRLF_V2/ CAimperviousRLF/ Non-agricultural Rights-of-Way	0.0218x12	G	0.0235	0.00333	**6.35**	**4.56**
CArightofwayRLF_V2/ CAimperviousRLF/ Non-agricultural Rights-of-Way	0.0187x12	Perimeter treatment	0.0203	0.00287	**5.49**	**3.93**
CArightofwayRLF_V2/ CAimperviousRLF/ Paved Areas (Private Roads/ Sidewalks)	0.0017x5	Crack & crevice and/or spot treatment	0.200*	0.125	**54.1**	**171.2**
CArightofwayRLF_V2/ CAimperviousRLF/ Utilities, Utility Poles/Rights-of-Way	2.72x2	GR	0.124	0.0257	**33.5**	**35.2**
Sewage Systems	50 kg/yr	Various	0.000425	0.000425	**0.11**	0.58

Generally, numbers were rounded to three significant figures, except for the RQs, for which no more than two decimal places were used.
+G=ground; GR=granular, D=dust
* EECs marked with an asterisk were set to 0.200 ppb because they exceeded the limit of solubility of deltamethrin in the aquatic modeling.
# = LOC exceedances (acute RQ $\geq$ 0.05; chronic RQ $\geq$ 1.0, for listed species) are bolded and shaded.
Acute RQ = use-specific peak EEC / 0.0037 ppb [for mysid shrimp, *Americamysis bahia*]. Chronic RQ = use-specific 21-day EEC / 0.00073 ppb [from data in review for *A. bahia*].

5.1.1.f. Estuarine/Marine Benthic Invertebrates

Acute risk to estuarine/marine benthic invertebrates is based on peak pore water EECs derived from PRZM/EXAMS and the lowest acute toxicity value for estuarine/marine invertebrates (surrogate for estuarine/marine benthic invertebrates; mysid shrimp *Americamysis bahia* 96-hr LC_{50}=0.0037 µg/L). Chronic risk is based on 21-day EECs and the lowest chronic toxicity value for estuarine/marine invertebrates (mysid shrimp *A. bahia* 35-day NOAEC=0.73 ng a.i./L).

Based on pore water concentrations, risk quotients range from **<0.01 to 54.1** (acute) and **0.05 to 274** (chronic; **Table 5-6**). Based on pore water concentrations, 84% of the deltamethrin uses (37 of 44) exceed the acute risk to listed species LOC (0.05) and 52% (23 of 44) uses exceed the chronic risk to listed and non-listed species LOC (1). In addition, 39% (17 of 44) of the uses exceed the acute risk to non-listed species LOC (0.5) indicating the potential indirect effects to listed species that rely on estuarine/marine invertebrates during at least some portion of their life-cycle (*i.e.*, CCR, TG, and DS).

Table 5-6. Summary of Acute and Chronic RQs for Estuarine/Marine Benthic Invertebrates Exposed to Deltamethrin

Uses	App Rate (lb a.i./A) x No. of Apps	App Method+	Pore Water		Pore Water	
			Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ#	Chronic RQ#
CAalmond_WirrigSTD/ Tree nuts crop group 14	0.0354x5	A (foliar)	0.000812	0.000794	**0.22**	**1.09**
CAalmond_WirrigSTD/ Tree nut crop group 14	0.0354x5	A (dormant)	0.000721	0.000701	**0.19**	0.96
CAcornOP/ Corn (field, pop)	0.0236x5	A	0.000521	0.000490	**0.14**	0.67
CAcornOP/ Corn (pop)	0.0229x5	D	0.000169	0.000164	**0.05**	0.22
CAcornOP/ Sweet corn	0.03x16	A	0.00190	0.00187	**0.51**	0.26
CAcornOP/ Sweet corn	0.03x16	G	0.00131	0.00128	**0.35**	**1.75**
CAcornOP/ Sweet corn	0.03x16	D	0.000608	0.000588	**0.16**	0.81
CAcotton_WirrigSTD/ Cotton	0.0322x10	A	0.00101	0.000958	**0.27**	**1.31**
CAfruit_WirrigSTD/ Pome fruits	0.0225x2	A	6.44e-5	6.27e-5	0.02	0.09
CAMelonsRLF_V2/ Cucurbits	0.03x6	A	0.000598	0.000550	**0.16**	0.75
CAMelonsRLF_V2/ Cucurbits	0.03x6	G	0.000167	0.000154	**0.05**	0.21
CAMelonsRLF_V2/ Cucurbits	0.03x6	D	5.79e-6	5.50e-6	<0.01	0.08
CAonion_WirrigSTD/ garlic, leeks, onion, shallots	0.03x4	A	0.000439	0.000424	**0.12**	0.58
CAonion_WirrigSTD/ garlic, leeks, onion, shallots	0.03x4	D	4.18e-5	4.03e-5	0.01	0.55
CAPotatoRLF_V2/ Root vegetables crop subgroup 1B; Tuberous and corm vegetables crop subgroup 1C	0.03x5	A	0.000522	0.000504	**0.14**	0.69
CAPotatoRLF_V2/ Same crops as in the previous row	0.03x5	D	3.92e-5	3.80e-5	0.01	0.05
CARowCropRLF_V2/ Artichokes	0.03x5	A	0.000931	0.000913	**0.25**	**1.25**
CARowCropRLF_V2/ Artichokes	0.03x5	D	0.000416	0.000405	**0.11**	0.55
CAtomato_WirrigSTD/ (eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato)	0.03x6	A	0.000630	0.000614	**0.17**	0.84
CAtomato_WirrigSTD/ (eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato)	0.03x6	D	3.72e-5	3.58e-5	0.01	0.05
CAWheatRLF_V2/ Sorghum	0.0242x2	A	0.000691	0.000675	**0.19**	0.92

Uses	App Rate (lb a.i./A) x No. of Apps	App Method+	Pore Water		Pore Water	
			Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ#	Chronic RQ#
CAWheatRLF_V2/ Canola, rapeseed, crambe	0.0097x2	A	0.000278	0.000272	**0.08**	0.37
CAnurserySTD_V2/ Ornamental and/or Shade Trees	0.428x12	G	0.0571	0.0555	**15.4**	**76.0**
CAnurserySTD_V2/ Ornamental and/or Shade Trees	0.0109x12	D	0.000374	0.000360	**0.10**	0.49
CAnurserySTD_V2/ Ornamental Herbaceous Plants	0.218x12	G	0.0290	0.0282	**7.84**	**38.6**
CAnurserySTD_V2/ Ornamental Herbaceous Plants	0.147x12	GR	0.0148	0.0143	**4.00**	**19.6**
CArangelandhayRLF_V2/ Ornamental sod farms	0.127x12	G	0.00379	0.00367	**1.02**	**5.03**
CArangelandhayRLF_V2/ Ornamental sod farms	0.131x12	GR	0.00375	0.00363	**1.01**	**4.97**
CATurfRLF/ Ornamental lawns and turf	0.218x12	G	0.00228	0.00223	**0.62**	**3.05**
CATurfRLF/ Golf Course Turf, Recreational Area Lawns	0.127x12	G	0.00189	0.00185	**0.51**	**2.53**
CATurfRLF/ Same crops as in the previous row	0.147x12	GR	0.00148	0.00145	**0.40**	**1.99**
CATurfRLF/ Same crops as in the previous row (ant mound treatment)	1.94x12	G	0.0289	0.0283	**7.81**	**38.8**
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	0.0233x6	G	0.0656	0.0637	**1.7.72**	**87.26**
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	0.0233x12	G	0.134	0.131	**36.21**	**179.5**
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	0.0241x6	GR	1.23e-5	1.20e-5	<0.01	0.02
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings	0.109x6	G	0.00167	0.00164	**0.45**	**2.25**
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings	0.00528x6	Crack & crevice, and/or spot treatment	0.0135	0.0130	**3.65**	**17.8**
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings	0.0540x6	GR or D (includes perimeter treatment)	0.0167	0.0162	**4.51**	**22.19**
CAresidentialRLF/ CAimperviousRLF/ Wood Protection Treatment to Buildings/ Products (Outdoors)	0.217x12	Crack and crevice and/or perimeter treatment	0.200*	0.200*	**54.1**	**274**
CAresidentialRLF/ CAimperviousRLF/ Wood Protection Treatment to Buildings/ Products (Outdoors)	0.00058x12	Soil drench/ treatment	0.0124	0.0120	**3.35**	**16.4**
CArightofwayRLF_V2/ CAimperviousRLF/ Non-agricultural Rights-of-Way	0.0218x12	G	0.00392	0.00383	**1.06**	**5.24**

Uses	App Rate (lb a.i./A) x No. of Apps	App Method+	Pore Water		Pore Water	
			Peak EEC (µg/L)	21-day EEC (µg/L)	Acute RQ#	Chronic RQ#
CArightofwayRLF_V2/ CAimperviousRLF/ Non-agricultural Rights-of-Way	0.00187x12	Perimeter treatment	3.38e-4	3.29e-4	0.09	0.45
CArightofwayRLF_V2/ CAimperviousRLF/ Paved Areas (Private Roads/ Sidewalks)	0.00017x5	Crack & crevice and/or spot treatment	0.00101	0.000986	**0.27**	**1.35**
CArightofwayRLF_V2/ CAimperviousRLF/ Utilities, Utility Poles/Rights-of-Way	2.72x2	GR	0.00246	0.00240	**0.66**	**3.29**

Generally, numbers were rounded to three significant figures, except for the RQs, for which no more than two decimal places were used.
+G=ground; GR=granular, D=dust
* EECs marked with an asterisk were set to 0.200 ppb because they exceeded the limit of solubility of deltamethrin in the aquatic modeling.
# = LOC exceedances (acute RQ $\geq$ 0.05; chronic RQ $\geq$ 1.0, for listed species) are bolded and shaded.
Acute pore water RQ = use-specific pore water peak EEC / 0.0037 ppb [water column test for mysid shrimp, *Mysidopsis bahia*]. Chronic pore water RQ = use-specific pore water 21-day EEC / 0.00073 ppb [from data in review for *Mysidopsis bahia*].

5.1.1.g. Vascular and Non-vascular Aquatic Plants

Acute risk to aquatic vascular plants is based on 1 in 10 year peak EECs in the standard pond and the lowest acute toxicity value EC_{50}= >0.78 µg/L (for *Lemna gibba* or duckweed). Risk quotients are shown in **Table 5-7**. RQs ranged from **<0.01 to <0.26**. None of the RQ values exceeded the LOC for aquatic vascular plants (1). Given that there are no RQs exceeding any LOCs for aquatic vascular plants, species that depend indirectly on them during at least some portion of their lifecycle should not be indirectly affected by deltamethrin due to effects on vascular plants (*i.e.*, SFGS for habitat, CCR for food/habitat, CTS for food/habitat, TG for habitat, DS for food/habitat, CFWS for food/habitat).

Acute risk to aquatic non-vascular plants is based on 1 in 10 year peak EECs in the standard pond and the lowest acute toxicity value (green algae *P. subcapitata* 96-hr EC_{50} = 17,800 µg/L or 17.8 mg a.i./L). Risk quotients are shown in **Table 5-7**. None of the RQ values exceeded the acute LOC (1). All RQs were expressed as **<0.01**. Given that there are no RQs exceeding any LOCs for aquatic non-vascular plants, species that depend indirectly on them during at least some portion of their lifecycle should not be indirectly affected by deltamethrin due to effects on non-vascular plants (*i.e.*, SFGS for habitat, CCR for food/habitat, CTS for food/habitat, TG for habitat, DS for food/habitat, CFWS for food/habitat). It is noted, however, that aquatic toxicity data are not available from all of the required taxa of non-vascular aquatic plants (e.g., diatoms, blue green algae). The uncertainty associated with these RQ findings based on this limited data set for non-vascular aquatic plants is discussed further in Section 5.2 (Risk Description).

Table 5-7. Summary of Acute RQs for Vascular and Non-Vascular Aquatic Plants

Uses	App rate (lb a.i./A) x No of Apps	Application Method+	Peak EEC (µg/L)*	RQ** Vasc Plants	RQ** Non-Vasc Plants
CAalmond_WirrigSTD/ Tree nuts crop group 14	0.0354x5	A (foliar)	0.0390	<0.05	<0.01
CAalmond_WirrigSTD/ Tree nut crop group 14	0.0354x5	A (dormant)	0.0369	<0.05	<0.01
CAcornOP/ Corn (field, pop)	0.0236x5	A	0.0248	<0.03	<0.01
CAcornOP/ Corn (pop)	0.0229x5	D	0.00854	<0.01	<0.01
CAcornOP/ Sweet corn	0.03x16	A	0.0793	<0.10	<0.01
CAcornOP/ Sweet corn	0.03x16	G	0.0814	<0.10	<0.01
CAcornOP/ Sweet corn	0.03x16	D	0.0404	<0.05	<0.01
CAcotton_WirrigSTD/ Cotton	0.0322x10	A	0.0352	<0.05	<0.01
CAfruit_WirrigSTD/ Pome fruits	0.0225x2	A	0.00620	<0.01	<0.01
CAMelonsRLF_V2/ Cucurbits	0.03x6	A	0.0321	<0.04	<0.01
CAMelonsRLF_V2/ Cucurbits	0.03x6	G	0.00893	<0.01	<0.01
CAMelonsRLF_V2/ Cucurbits	0.03x6	D	0.000424	<0.01	<0.01
CAonion_WirrigSTD/ garlic, leeks, onion, shallots	0.03x4	A	0.0309	<0.04	<0.01
CAonion_WirrigSTD/ garlic, leeks, onion, shallots	0.03x4	D	0.00461	<0.01	<0.01
CAPotatoRLF_V2/ Root vegetables crop subgroup 1B (except sugarbeet); Tuberous and corm vegetables crop subgroup 1C	0.03x5	A	0.0319	<0.04	<0.01
CAPotatoRLF_V2/ Same crops as in the previous row	0.03x5	D	0.00535	<0.01	<0.01
CARowCropRLF_V2/ Artichokes	0.03x5	A	0.0421	<0.05	<0.01
CARowCropRLF_V2/ Artichokes	0.03x5	D	0.00347	<0.01	<0.01
CAtomato_WirrigSTD/ (eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato)	0.03x6	A	0.0314	<0.04	<0.01
CAtomato_WirrigSTD/ (eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato)	0.03x6	D	0.00413	<0.01	<0.01
CAWheatRLF_V2/ Sorghum	0.0242x2	A	0.0479	<0.06	<0.01
CAWheatRLF_V2/ Canola, rapeseed, crambe	0.0097x2	A	0.0193	<0.02	<0.01
CAnurserySTD_V2/ Ornamental and/or Shade Trees	0.428x12	G	0.200*	<0.26	<0.01
CAnurserySTD_V2/ Ornamental and/or Shade Trees	0.0109x12	D	0.0340	<0.04	<0.01
CAnurserySTD_V2/ Ornamental Herbaceous Plants	0.218x12	G	0.200*	<0.26	<0.01
CAnurserySTD_V2/ Ornamental Herbaceous Plants	0.147x12	GR	0.200*	<0.26	<0.01
CArangelandhayRLF_V2/ Ornamental sod farms	0.127x12	G	0.190	<0.24	<0.01
CArangelandhayRLF_V2/ Ornamental sod farms	0.131x12	GR	0.181	<0.23	<0.01
CATurfRLF/ Ornamental lawns and turf	0.218x12	G	0.0820	<0.11	<0.01
CATurfRLF/ Golf Course Turf, Recreational Area Lawns	0.127x12	G	0.0558	<0.07	<0.01

Uses	App rate (lb a.i./A) x No of Apps	Application Method+	Peak EEC (µg/L)*	RQ** Vasc Plants	RQ** Non-Vasc Plants
CATurfRLF/ Same crops as in the previous row	0.147x12	GR	0.0539	<0.07	<0.01
CATurfRLF/ Same crops as in the previous row (ant mound treatment)	1.94x12	G	0.200*	<0.26	<0.01
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	0.0233x6	G	0.200*	<0.26	<0.01
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	0.0233x12	G	0.200*	<0.26	<0.01
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	0.0241x6	GR	7.99e-4	<0.01	<0.01
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings	0.109x6	G	0.196	<0.25	<0.01
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings	0.00528x6	Crack & crevice, and/or spot treatment	0.200*	<0.26	<0.01
CAresidentialRLF/ CAimperviousRLF/ Household Domestic Dwellings	0.0540x6	GR or D (includes perimeter treatment)	0.200	<0.26	<0.01
CAresidentialRLF/ CAimperviousRLF/ Wood Protection Treatment to Buildings/ Products (Outdoors)	0.217x12	Crack and crevice and/or perimeter treatment	0.200*	<0.26	<0.01
CAresidentialRLF/ CAimperviousRLF/ Wood Protection Treatment to Buildings/ Products (Outdoors)	0.00058x12	Soil drench/ treatment	0.200*	<0.26	<0.01
CArightofwayRLF_V2/ CAimperviousRLF/ Non-agricultural Rights-of-Way	0.0218x12	G	0.0235	<0.03	<0.01
CArightofwayRLF_V2/ CAimperviousRLF/ Non-agricultural Rights-of-Way	0.0187x12	Perimeter treatment	0.0203	<0.03	<0.01
CArightofwayRLF_V2/ CAimperviousRLF/ Paved Areas (Private Roads/ Sidewalks)	0.0017x5	Crack & crevice and/or spot treatment	0.200*	<0.26	<0.01
CArightofwayRLF_V2/ CAimperviousRLF/ Utilities, Utility Poles/Rights-of-Way	2.72x2	GR	0.124	<0.16	<0.01
Sewage Systems	50 kg/yr	Various	0.000425	<0.01	<0.01

Generally, numbers were rounded to three significant figures, except for the RQs, for which no more than two decimal places were used.
+G=ground; GR=granular, D=dust; Vasc=vascular plants
* EECs marked with an asterisk were set to 0.200 ppb because they exceeded the limit of solubility of deltamethrin in the aquatic modeling.
**LOC exceedances (RQ ≥ 1) are bolded and shaded. RQ (vascular plants) = use-specific peak EEC/ >0.78 µg/L [from data in review for *Lemna gibba* (duckweed)]. RQ (non-vascular plants) = use-specific peak EEC/ 17800 µg/L [from data in review for *Pseudokirchneriella subcapitata* (green algae)].

5.1.2. Exposures in the Terrestrial Habitat

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

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

T-HERPS is used to assess potential risk to snakes and 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.

Potential direct acute effects to the CCR, CTS (all DPS) and SFGS are evaluated using dose- and dietary-based EECs modeled in T-REX for small (20 g, juveniles) birds consuming short grass (**Table 3-6**) and acute oral (Bobwhite quail, *C. virginianus* 14-day (obs.) LD_{50} >2250 mg/kg bw), subacute dietary (Mallard duck *A. platyrhynchos* 8-day LC_{50} >4640 mg/kg diet) and chronic toxicity endpoints for avian species (Bobwhite quail *C. virginianus* 168-day NOAEC=450 mg/kg diet) (**Section 4.3.1.a** and **Section 4.3.1.b**).

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

Potential direct chronic effects to the birds (CCR), CTS (all DPS), and SFGS (surrogate for amphibians and reptiles as appropriate) are evaluated by considering dietary-based EECs modeled in T-REX and T-HERPS consuming a variety of dietary items. The specific EECs for each species are for the same size birds and same dietary items as those considered for acute exposure. Chronic effects are estimated using the lowest available NOAEC from a chronic study for birds (NOAEC=450 mg/kg diet). Dietary-based EECs are divided by toxicity values to estimate chronic dietary-based RQs.

Acute and chronic RQs for the CCR, CTS, birds, and amphibians derived using T-REX are shown in **Table 5-8.** One out of 20 application scenarios (5%) exceeds the acute risk to listed and non-listed species LOC (0.1 and 0.5, respectively) and the same scenario exceed the chronic risk to both listed and non-listed species LOC (1). The scenario with exceedances represented the ant mound treatments on ornamental plants.

Table 5-8. Acute and Chronic RQs Derived Using T-REX for Birds, Reptiles and Terrestrial-Phase Amphibians Exposed to Foliar Applications of Deltamethrin*

Use(s), Type of Application	Application Rate (lbs a.i./acre), # of app, App interval (days)	RQs for Birds and CCR, CTS (all DPS), and SFGS (20g small bird consuming short grass)		
		Acute Dose-Based	Acute Dietary Based	Chronic Dietary Based
Canola, rapeseed, crambe	0.0097, 2, 7	<0.01	<0.01	<0.01
Corn (field, pop)	0.0236, 5, 21	<0.01	<0.01	0.02
Cotton	0.0322, 10, 5	<0.02	<0.01	0.05
Cucurbits, Tomato, Tamillo, Eggplant, Ground Cheery, Pepinos	0.03, 6, 3	<0.02	<0.01	0.06
Garlic, Leeks, Onion, Shallots	0.03, 4, 5	<0.01	<0.01	0.04
Pome Fruits	0.0225, 2, 7	<0.01	<0.01	0.02
Potato & Root Vegetables (1B); Tuberous & Corn Vegetables (1C); Artichokes	0.03, 5, 3	<0.02	<0.01	0.05
Sorghum	0.0242, 2, 7	<0.01	<0.01	0.02
Sweet Corn	0.03, 16, 7	<0.01	<0.01	0.04
Tree Nuts (foliar and dormant)	0.0354, 5, 7	<0.01	<0.01	0.04
Commercial Outdoor Premises	0.006936, 12, 21	<0.01	<0.01	<0.01
Domestic Dwellings, Barns, Barnyards (incl. outdoor premises)	0.1094, 6, 7	<0.04	<0.01	0.13
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas	0.02188, 12, 30	<0.01	<0.01	0.01
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas (Perimeter Treatment)	0.001878, 12, 30	<0.01	<0.01	<0.01
Ornamental Plants (herbaceous, non-flowering, woody) Lawns and turf	0.218, 12, 30	<0.04	<0.01	0.13
Ornamental Plants (Shade Trees, Ground Cover)	0.428, 12, 30	<0.08	<0.02	0.25
Ornamental Plants (Shade Trees, Ground Cover): Ant Mound Treatment	1.942, 12, 7	**<0.74**	**<0.23**	**2.34**
Ornamental Sod Farms, Lawns, Turf, Recreational Areas	0.127, 12, 7	<0.05	<0.01	0.15
Residential Lawns (1)	0.002333, 6, 7	<0.01	<0.01	<0.01
Residential Lawns (2)	0.002333, 12, 7	<0.01	<0.01	<0.01

*LOC exceedances (acute RQ ≥ 0.1 and chronic RQ ≥ 1.0) are bolded. RQs calculated using a pyrethroid-specific foliar dissipation half life of 8.3 days using T-REX version 1.5.1.

[1]Based on dose-based EEC and Northern bobwhite quail acute oral LD_{50} >2250 mg/kg-bw

[2]Based on dose-based EEC and Mallard duck subacute dietary LC_{50} >4640 mg/kg-diet

[3]Based on dietary-based EEC and Northern bobwhite quail and Mallard duck NOAEC = 450 mg/kg-diet.

Based on a single scenario RQs exceeding listed and non-listed LOCs, deltamethrin does have the potential to directly affect SFGS, CCR, and CTS (all DPS). Additionally, since the acute and chronic RQs are exceeded for the same scenario, there is a potential for indirect effects to those listed species that rely on birds (and, thus, reptiles and/or terrestrial-phase amphibians) during at least some portion of their life-cycle (*i.e.*, SFGS and CCR). Additional discussion regarding the uncertainty associated with estimating the RQ for this scenario is discussed in **Section 5.2, Risk Description**.

Since there were exceedances of LOCs for the ant mound treatment scenario, refinements using T-HERPS were performed to represent the CTS (all DPS) (amphibian species). The CTS is represented by the medium animal consuming herviborous mammals. Results of refinements are presented in **Table 5-9**. As shown in the table, the same scenario still resulted in RQs that exceeded the acute listed and chronic listed species LOCs. Therefore, there is a potential to directly affect the CTS (all DPS). It is noted, however, that absence label information, it was assumed that mounds would be treated up to 12 times with 7-d intervals. Although this application frequency may be unlikely, exceedance of the avian chronic LOC is indicated even for a single application.

Table 5-9. Acute and Chronic RQs Derived Using T-HERPS for Deltamethrin and Terrestrial-Phase Amphibians Exposed to Deltamethrin*

Use(s), Type of Application	Application Rate (lbs a.i./acre), # of app, App interval (days)	RQs for CTS (all DPS) (medium [20g] amphibians consuming herbivorous mammals)[1]		
		Acute Dose-Based	Acute Dietary Based	Chronic Dietary Based
Ornamental Plants (Shade Trees, Ground Cover)	0.428, 12, 30	**<0.33**	**<0.24**	**2.45**

*LOC exceedances (acute RQ ≥0.1 and chronic RQ ≥1.0) are bolded. Only the scenario that resulted in RQs exceeding LOCs in T-REX is presented in this table. Further refinements are not required for scenarios with RQs that did not exceed LOCs. RQs calculated using a deltamethrin-specific foliar dissipation half life of 8.8 days using T-REX version 1.5.1.

[1]Based on dose-based EEC and Northern bobwhite quail acute oral LD_{50} >2250 mg/kg-bw

[2]Based on dose-based EEC and Mallard duck subacute dietary LC_{50} >4640 mg/kg-diet

[3]Based on dietary-based EEC and Northern bobwhite quail and Mallard duck NOAEC = 450 mg/kg-diet.

Refinements with T-HERPS for the same ant mound treatment scenario, for the snake (SFGS) are presented in **Table 5-10**. The small snake consuming small insects and the medium snake consuming herbivorous mammals are used to represent the SFGS. In this instance, the RQs did not exceed the acute listed and chronic listed species LOCs. Therefore, there is no potential to directly affect SFGS.

Table 5-10. Acute and Chronic RQs Derived Using T-HERPS for Deltamethrin and Reptiles Exposed to Deltamethrin*

se(s), Type of Application	Application Rate (lbs a.i./acre), # of app, App interval (days)	RQs for Small SFGS (small reptile consuming small insects)[1]			RQs for Medium SFGS (medium reptile consuming herbivorous mammals)[1]		
		Acute Dose-Based	Acute Dietary Based	Chronic Dietary Based	Acute Dose-Based	Acute Dietary Based	Chronic Dietary Based
Ornamental Plants (Shade Trees, Ground Cover): Ant Mound Treatment	1.942, 12, 7	<0.01	<0.01	0.09	<0.08	<0.01	0.12

*LOC exceedances (acute RQ ≥0.1 and chronic RQ ≥1.0) are bolded. Only the scenario that resulted in RQs exceeding LOCs in T-REX is presented in this table. Further refinements are not required for scenarios with RQs that did not exceed LOCs. RQs calculated using a deltamethrin-specific foliar dissipation half life of 8.8 days using T-REX version 1.5.1.

[1]Based on dose-based EEC and Northern bobwhite quail acute oral LD_{50} >2250 mg/kg-bw

[2]Based on dose-based EEC and Mallard duck subacute dietary LC_{50} >4640 mg/kg-diet
[3]Based on dietary-based EEC and Northern bobwhite quail and Mallard duck NOAEC = 450 mg/kg-diet.

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.

Potential for indirect effects to the SFGS, CCR, and CTS (all DPS) may result from direct effects to mammals due to a reduction in prey. Potential indirect effects to the SFGS and CTS (all DPS) may 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. The acute endpoint derived for mammals is for the Norway rat (*R. norvegicus* LD_{50}=67 mg/kg bw, male).

Potential direct chronic effects to the mammals are evaluated by considering dietary-based EECs modeled in T-REX consuming a variety of dietary items. The specific EECs for each species are for the same size mammals and same dietary items as those considered for acute exposure. Chronic effects are estimated using the lowest available NOAEC from a chronic reproductive study for mammals (Norway rat, *R. norvegicus*, NOAEC=5.4 mg/kg/day for males). Dietary-based EECs are divided by toxicity values to estimate chronic dietary-based RQs. All these results are summarized in **Table 5-11.**

Acute dose-based RQs exceed the listed species LOC (0.1) for 11 out of 20 (55%) application scenarios modeled. RQs ranged from **<0.01 to 6.81**. Of these scenarios, two out of 20 (10%) exceeded the acute non-listed LOC (0.5) (ornamental plants (shade trees, ground cover), and ornamental plants (shade trees, ground cover) for ant mound treatment).

Additionally, RQs for 11 out of 20 (55%) application scenarios exceeded the chronic dose-based LOC (1.0). RQs ranged from **0.04 to 84.5**. The chronic dietary-based RQs ranged from **<0.01 to 13.15**, with two scenarios for which the RQs exceeded the chronic LOC (1.0).

Based on RQs exceeding LOCs for up to 11 application scenarios (acute non-listed and chronic RQs are exceeded), there is a potential for indirect effects to those listed species that rely on mammals during at least some portion of their life-cycle (*i.e.*, SFGS, CCR, and CTS [all DPS]).

Table 5-11. Acute and Chronic RQs Derived Using T-REX for Mammals Exposed to Various Uses of Deltamethrin

Use(s), Type of Application	Application Rate (lbs a.i./acre), # of app, App interval (days)	RQs for Small Mammals (small [15g] mammals consuming short grass)		
		Acute Dose-Based[1]	Chronic Dose Based[1]	Chronic Dietary Based[1]
Canola, rapeseed, crambe	0.0097, 2, 7	0.02	0.29	0.05
Corn (field, pop)	0.0236, 5, 21	0.04	0.55	0.09
Cotton	0.0322, 10, 5	**0.14**	**1.79**	0.28

Use(s), Type of Application	Application Rate (lbs a.i./acre), # of app, App interval (days)	RQs for Small Mammals (small [15g] mammals consuming short grass)		
		Acute Dose-Based[1]	Chronic Dose Based[1]	Chronic Dietary Based[1]
Cucurbits, Tomato, Tamillo, Eggplant, Ground Cheery, Pepinos	0.03, 6, 3	**0.16**	**2.03**	0.32
Garlic, Leeks, Onion, Shallots	0.03, 4, 5	**0.11**	**1.38**	0.21
Pome Fruits	0.0225, 2, 7	0.05	0.68	0.11
Potato & Root Vegetables (1B); Tuberous & Corn Vegetables (1C); Artichokes	0.03, 5, 3	**0.15**	**1.86**	0.29
Sorghum	0.0242, 2, 7	0.06	0.73	0.11
Sweet Corn	0.03, 16, 7	**0.11**	**1.31**	0.20
Tree Nuts (foliar and dormant)	0.0354, 5, 7	**0.12**	**1.46**	0.23
Commercial Outdoor Premises	0.006936, 12, 21	0.01	0.16	0.03
Domestic Dwellings, Barns, Barnyards (incl. outdoor premises)	0.1094, 6, 7	**0.37**	**4.62**	0.72
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas	0.02188, 12, 30	0.04	0.46	0.07
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas (Perimeter Treatment)	0.001878, 12, 30	<0.01	0.04	<0.01
Ornamental Plants (herbaceous, non-flowering, woody) Lawns and turf	0.218, 12, 30	**0.37**	**4.58**	0.71
Ornamental Plants (Shade Trees, Ground Cover)	0.428, 12, 30	**0.72**	**8.99**	**1.40**
Ornamental Plants (Shade Trees, Ground Cover): Ant Mound Treatment	1.942, 12, 7	**6.81**	**84.51**	**13.15**
Ornamental Sod Farms, Lawns, Turf, Recreational Areas	0.127, 12, 7	**0.45**	**5.53**	0.86
Residential Lawns (1)	0.002333, 6, 7	<0.01	0.10	0.02
Residential Lawns (2)	0.002333, 12, 7	<0.01	0.10	0.02

*LOC exceedances (acute RQ $\geq$ 0.1 and chronic RQ $\geq$ 1.0) are bolded. RQs calculated using a deltamethrin-specific foliar dissipation half life of 8.8 days using T-REX version 1.5.1. Underlined RQs exceed the acute listed and non-listed LOC (acute non-listed LOC=0.5).

[1] RQ values based on the acute dose-, chronic dose- based and chronic dietary-based EECs and the following endpoints: acute (Norway rat, *R. norvegicus* LD_{50}=67 mg/kg bw, male) and chronic (Norway rat, *R. norvegicus)* NOAEC=5.4 mg/kg/day and LOAEC=21.2 mg/kg/d, both for males).

5.1.2.c. Terrestrial Invertebrates

In order to assess the risks of deltamethrin to terrestrial invertebrates, the cotton bollworm (larvae) was used (*Helicoverpa armigera*) as used as a surrogate for terrestrial invertebrates. The toxicity value for terrestrial invertebrates is calculated by multiplying the lowest available acute contact 72-hr LD_{50} = 0.33 ng/organism by 1 organism/16.5 mg, which is based on the mean weight of cotton bollworm larvae. EECs (µg a.i./g of bollworm) calculated by T-REX for arthropods are divided by the calculated toxicity value for terrestrial invertebrates, which is 0.020 µg a.i./g of organism. The BCB and the VELB are considered 'arthropods' in this assessment. Risk quotients are shown for the most sensitive species for arthropods in **Table 5-12.**

Based on the fact that all RQs exceeded the acute risk to listed species LOC (0.05), deltamethrin does have the potential to directly affect the BCB and VELB. Additionally, since RQs exceed the acute risk to non-listed species LOC as well, 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) due to reduction in prey.

Table 5-12. Summary of RQs for Terrestrial Invertebrates Exposed to Various Uses of Deltamethrin

Use(s), Type of Application	Application Rate (lbs a.i./acre), # of app, App interval (days)	Invertebrate RQ*
Canola, rapeseed, crambe	0.0097, 2, 7	**71.0**
Corn (field, pop)	0.0236, 5, 21	**134**
Cotton	0.0322, 10, 5	**437**
Cucurbits, Tomato, Tamillo, Eggplant, Ground Cheery, Pepinos	0.03, 6, 3	**495**
Garlic, Leeks, Onion, Shallots	0.03, 4, 5	**335**
Pome Fruits	0.0225, 2, 7	**165**
Potato & Root Vegetables (1B); Tuberous & Corn Vegetables (1C); Artichokes	0.03, 5, 3	**454**
Sorghum	0.0242, 2, 7	**177**
Sweet Corn	0.03, 16, 7	**319**
Tree Nuts (foliar and dormant)	0.0354, 5, 7	**356**
Commercial Outdoor Premises	0.006936, 12, 21	**39**
Domestic Dwellings, Barns, Barnyards (incl. outdoor premises)	0.1094, 6, 7	**1,130**
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas	0.02188, 12, 30	**112**
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas (Perimeter Treatment)	0.001878, 12, 30	**9.6**
Ornamental Plants (herbaceous, non-flowering, woody) Lawns and turf	0.218, 12, 30	**1,120**
Ornamental Plants (Shade Trees, Ground Cover)	0.428, 12, 30	**2,190**
Ornamental Plants (Shade Trees, Ground Cover): Ant Mound Treatment	1.942, 12, 7	**20,600**
Ornamental Sod Farms, Lawns, Turf, Recreational Areas	0.127, 12, 7	**1,350**
Residential Lawns (1)	0.002333, 6, 7	**24.0**
Residential Lawns (2)	0.002333, 12, 7	**24.7**

* = LOC exceedances (RQ $\geq$ 0.05) are bolded.
RQs were rounded to three significant figures. RQ is based on the arthropod EECs from T-REX and the toxicity value for terrestrial invertebrates, which is 0.33 ng/organism (0.020 µg a.i./g of organism) for *Helicoverpa armigera* (Cotton bollworm larvae).

5.1.2.d. 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. Since the BCB and the VELB have an obligate relationship with specific dicot plant species, the seedling emergence and vegetative vigor EC_{05} or the NOAEC for dicots are used to calculate RQs for indirect effects to these species via potential effects to dicots. Risk quotients are shown in **Table**

5-13 and **Table 5-14**. The EC_{25} was assumed to be >0.011 lb a.i./A for both monocot and dicot non-listed plants. Meanwhile, the NOAEC assumed to be 0.011 lb a.i./A for dicot listed plants.

Based on these results in which the RQs exceed the listed and non-listed species LOC for dicot and monocot plants for eight out of 27 scenarios (30%), since the non-listed plant RQs are exceeded, there is a potential for indirect effects to those listed species that rely on terrestrial plants during at least some portion of their life-cycle (*i.e.*, SFGS, CCR, BCB, VELB, CTS (all DPS), TG, DS, and CFWS). Additionally, deltamethrin does have the potential to indirectly affect the BCB and VELB.

Table 5-13. RQs* for Monocots Inhabiting Dry and Semi-Aquatic Areas Exposed to Deltamethrin via Runoff and Drift

Crops/Uses Represented	App Method	App Rate (lb a.i./A)	Drift Value (%)	Spray drift RQ	Dry area RQ	Semi-aquatic area RQ
Canola, rapeseed, crambe	A	0.0097	5	<0.1	<0.1	<0.13
Corn (field, pop)	A	0.0236	5	<0.11	<0.13	<0.32
Cotton	A	0.0322	5	<0.15	<0.18	<0.44
Cucurbits, Tomato, Tamillo, Eggplant, Ground Cheery, Pepinos	A	0.03	5	<0.14	<0.16	<0.41
Cucurbits, Tomato, Tamillo, Eggplant, Ground Cheery, Pepinos	G	0.03	1	<0.1	<0.1	<0.30
Garlic, Leeks, Onion, Shallots	A	0.03	5	<0.14	<0.16	<0.41
Pome Fruits	G	0.0225	1	<0.1	<0.1	<0.23
Potato & Root Vegetables (1B); Tuberous & Corn Vegetables (1C); Artichokes	A	0.03	5	<0.14	<0.16	<0.41
Sorghum	A	0.0242	5	<0.11	<0.13	<0.33
Sweet Corn	A	0.03	5	<0.14	<0.16	<0.41
Sweet Corn	G	0.03	1	<0.1	<0.1	<0.30
Tree Nuts (foliar and dormant)	A (foliar)	0.0354	5	<0.1	<0.1	<0.35
Commercial Outdoor Premises	G	0.006936	1	<0.1	<0.1	<0.1
Domestic Dwellings, Barns, Barnyards (including outdoor premises)	G	0.1094	1	<0.1	<0.20	**<1.09**
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas	G	0.02188	1	<0.1	<0.1	<0.22
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas (Perimeter Treatment)	G	0.001878	1	<0.1	<0.1	<0.1
Ornamental Plants (herbaceous, non-flowering, woody) Lawns and turf	G	0.218	1	<0.20	<0.40	**<2.18**

Crops/Uses Represented	App Method	App Rate (lb a.i./A)	Drift Value (%)	Spray drift RQ	Dry area RQ	Semi-aquatic area RQ
Ornamental Plants (Shade Trees, Ground Cover)	G	0.428	1	<0.39	<0.78	**<4.28**
Ornamental Plants (Shade Trees, Ground Cover): Ant Mound Treatment	G	1.942	1	**<1.77**	**<3.53**	**<19.42**
Ornamental Sod Farms, Lawns, Turf, Recreational Areas	G	0.127	1	<0.12	<0.23	**<1.27**
Residential Lawns (1) and (2)	G	0.002333	1	<0.1	<0.1	<0.1
Domestic Dwellings (including outdoor premises)	GR	0.005404	0	<0.1	<0.1	<0.1
Ornamental Plants (herbaceous, non-flowering, woody)	GR	0.147	0	<0.1	<0.13	**<1.34**
Ornamental Sod Farms	GR	0.131	0	<0.1	<0.12	**<1.19**
Residential Lawns	GR	0.002413	0	<0.1	<0.1	<0.1
Pet Living Quarters	GR	0.0018	0	<0.1	<0.1	<0.1
Utility Poles, Utility Rights of Way	GR	2.72	0	<0.1	**<2.47**	**<24.73**

*LOC exceedances (RQ ≥ 1) are bolded and shaded. EC_{25} assumed to be >0.011 lb ai/A for monocot non-listed plants.

Since the testing of dicot plants was performed at the same application rate and similar results were obtained, the non-listed species RQs are similar to those for monocots. For dicots, the listed-species RQ is calculated since there is an obligate relationship between the BCB and VELB with certain dicot species. The endpoints used to calculate the RQs are as shown above **Table 5-14**. **Table 5-15** summarizes the RQs for dicot plants exposed to runoff and spray drift.

Table 5-14. RQs* for Dicots Inhabiting Dry and Semi-Aquatic Areas Exposed to Deltamethrin via Runoff and Drift

Crops/Uses Represented	App Method	App Rate (lb a.i./A)	Drift Value (%)	RQ	Spray drift RQ	Dry area RQ	Semi-aquatic area RQ
Canola, rapeseed, crambe	A	0.0097	5	Non-Listed Species	<0.1	<0.1	<0.13
				Listed Species	<0.1	<0.1	0.13
Corn (field, pop)	A	0.0236	5	Non-Listed Species	<0.11	<0.13	<0.32
				Listed Species	0.11	0.13	0.32
Cotton	A	0.0322	5	Non-Listed Species	<0.15	<0.18	<0.44
				Listed Species	0.15	0.18	0.44
Cucurbits, Tomato, Tamillo, Eggplant, Ground Cheery, Pepinos	A	0.03	5	Non-Listed Species	<0.14	<0.16	<0.41
				Listed Species	0.14	0.16	0.41
Cucurbits, Tomato, Tamillo, Eggplant, Ground Cheery, Pepinos	G	0.03	1	Non-Listed Species	<0.1	<0.1	<0.30
				Listed Species	<0.1	<0.1	0.30
Garlic, Leeks, Onion, Shallots	A	0.03	5	Non-Listed Species	<0.14	<0.16	<0.41
				Listed Species	0.14	0.16	0.41
Pome Fruits	G	0.0225	1	Non-Listed Species	<0.1	<0.1	<0.23

Crops/Uses Represented	App Method	App Rate (lb a.i./A)	Drift Value (%)	RQ	Spray drift RQ	Dry area RQ	Semi-aquatic area RQ
				Listed Species	<0.1	<0.1	0.23
Potato & Root Vegetables (1B); Tuberous & Corn Vegetables (1C); Artichokes	A	0.03	5	Non-Listed Species	<0.14	<0.16	<0.41
				Listed Species	0.14	0.16	0.41
Sorghum	A	0.0242	5	Non-Listed Species	<0.11	<0.13	<0.33
				Listed Species	0.11	0.13	0.33
Sweet Corn	A	0.03	5	Non-Listed Species	<0.14	<0.16	<0.41
				Listed Species	0.14	0.16	0.41
Sweet Corn	G	0.03	1	Non-Listed Species	<0.1	<0.1	<0.30
				Listed Species	<0.1	<0.1	0.30
Tree Nuts (foliar and dormant)	A (foliar)	0.0354	5	Non-Listed Species	<0.1	<0.1	<0.35
				Listed Species	<0.1	<0.1	0.35
Commercial Outdoor Premises	G	0.006936	1	Non-Listed Species	<0.1	<0.1	<0.1
				Listed Species	<0.1	<0.1	<0.1
Domestic Dwellings, Barns, Barnyards (including outdoor premises)	G	0.1094	1	Non-Listed Species	<0.1	<0.20	**<1.09**
				Listed Species	<0.1	0.20	**1.09**
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas	G	0.02188	1	Non-Listed Species	<0.1	<0.1	<0.22
				Listed Species	<0.1	<0.1	0.22
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas (Perimeter Treatment)	G	0.001878	1	Non-Listed Species	<0.1	<0.1	<0.1
				Listed Species	<0.1	<0.1	<0.1
Ornamental Plants (herbaceous, non-flowering, woody) Lawns and turf	G	0.218	1	Non-Listed Species	<0.20	<0.40	**<2.18**
				Listed Species	0.20	0.40	**2.18**
Ornamental Plants (Shade Trees, Ground Cover)	G	0.428	1	Non-Listed Species	<0.39	<0.78	**<4.28**
				Listed Species	0.39	0.78	**4.28**
Ornamental Plants (Shade Trees, Ground Cover): Ant Mound Treatment	G	1.942	1	Non-Listed Species	**<1.77**	**<3.53**	**<19.42**
				Listed Species	**1.77**	**3.53**	**19.42**
Ornamental Sod Farms, Lawns, Turf, Recreational Areas	G	0.127	1	Non-Listed Species	<0.12	<0.23	**<1.27**
				Listed Species	0.12	0.23	**1.27**
Residential Lawns (1) and (2)	G	0.002333	1	Non-Listed Species	<0.1	<0.1	<0.1
				Listed Species	<0.1	<0.1	<0.1
Domestic Dwellings (including outdoor premises)	GR	0.005404	0	Non-Listed Species	<0.1	<0.1	<0.1
				Listed Species	<0.1	<0.1	<0.1
Ornamental Plants (herbaceous, non-flowering, woody)	GR	0.147	0	Non-Listed Species	<0.1	<0.13	**<1.34**
				Listed Species	<0.1	0.13	**1.34**
Ornamental Sod Farms	GR	0.131	0	Non-Listed Species	<0.1	<0.12	**<1.19**
				Listed Species	<0.1	0.12	**1.19**

Crops/Uses Represented	App Method	App Rate (lb a.i./A)	Drift Value (%)	RQ	Spray drift RQ	Dry area RQ	Semi-aquatic area RQ
Residential Lawns	GR	0.002413	0	Non-Listed Species	<0.1	<0.1	<0.1
				Listed Species	<0.1	<0.1	<0.1
Pet Living Quarters	GR	0.0018	0	Non-Listed Species	<0.1	<0.1	<0.1
				Listed Species	<0.1	<0.1	<0.1
Utility Poles, Utility Rights of Way	GR	2.72	0	Non-Listed Species	<0.1	**<2.47**	**<24.73**
				Listed Species	<0.1	**2.47**	**24.73**

*LOC exceedances (RQ $\geq$ 1) are bolded and shaded. EC_{25} assumed to be >0.011 lb ai/A for dicot non-listed plants. NOAEC assumed to be = 0.011 lb ai/A for dicot listed plants.

5.1.2.e. Bioaccumulation Analysis Results

The KABAM model, in conjunction with empirical measures of bioaccumulation, was used to calculate risk quotients from a bioaccumulation pathway for food items that may be consumed by listed species (**Table 5-15**). 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 RQs for bioaccumulation risk did not exceed the acute risk to listed species LOC (0.1) for mammals nor for birds/reptiles/amphibians; furthermore, the chronic risk LOC (1) was not exceeded for the highest application rate (ornamentals, ant mound treatment at 1.94 lb a.i./A) for these organisms. Therefore, no risks from potential bioaccumulation are identified for species that rely on mammals, birds, reptiles, and amphibians during at least some portion of their life cycle (*i.e.,* SFGS and CCR).

Table 5-15. Bioaccumulation Acute and Chronic Risk Quotients for Mammals, Birds, Reptiles and Amphibians Exposed to Various Uses of Deltamethrin

Use, Formulation, Type of Application	RQs for CCR, CTS (all DPS) and SFGS			
	Acute Dose-Based*	Acute Dietary-Based*	Chronic Dose-Based*	Chronic Dietary-Based*
CCR (based on Rail)				
Ornamental Plants (Shade Trees, Ground Cover): Ant Mound Treatment (Ground, app rate 1.942 lb a.i./A)	<0.01	<0.01	NA	<0.01
SFGS and CTS (all DPS): Based on Sandpiper				
Ornamental Plants (Shade Trees, Ground Cover): Ant Mound Treatment (Ground, app rate 1.942 lb a.i./A)	<0.01	<0.001	N/A	0.01
SFGS Piscivorous Mammalian prey (Based on Fog/Water Shrew)				
Ornamental Plants (Shade Trees, Ground Cover): Ant Mound Treatment (Ground, app rate 1.942 lb a.i./A)	<0.01	N/A	0.04	0.01

*RQs do not exceed the acute (0.1) or chronic LOC (1). Acute dose-, acute diet-, and chronic diet-based RQ values for CCR, SFGS and CTS base on avian acute LD_{50} of >2,250 mg ai/kg bw; an avian acute LC_{50} of > 4,640 mg/kg-diet, and a chronic avian NOAEC of 450 mg ai/kg-diet. Acute dose-, chronic dose- and chronic diet-based RQ values for Fog/Water Shrew based on following endpoints: acute (*R. norvegicus)* LD_{50}=67 mg/kg bw and chronic (*R. norvegicus)* NOAEL=5.4 mg/kg-bw/d.

5.1.3. Primary Constituent Elements of Designated Critical Habitat

For deltamethrin 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.

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

The Agency uses the probit dose-response relationship as a tool for providing additional information on the potential for acute direct effects to individual listed species and aquatic animals that may indirectly affect the listed species of concern (USEPA, 2004). As part of the risk characterization, an interpretation of acute RQs for listed species is discussed. This interpretation is presented in terms of the chance of an individual event (*i.e*., mortality or immobilization) should exposure at the EEC actually occur for a species with sensitivity to deltamethrin 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 Microsoft® Excel spreadsheet tool IECV1.1 (Individual Effect Chance Model Version 1.1) developed by the U.S. EPA, OPP, Environmental Fate and Effects Division (June 22, 2004). The model allows for such calculations by entering the mean slope estimate (and the 95% confidence bounds of that estimate) as the slope parameter for the spreadsheet. In addition, the acute RQ is entered as the desired threshold (**Table 5-16**). In the absence of probit dose-response slopes, a default value of 4.5 is used with 95% confidence bounds of 2 and 9.

Table 5-16. Summary of Individual Effect Probabilities for Deltamethrin Exposure at Scenarios that Produce RQs Exceeding the LOC

Taxa	Acute RQ (range)	Probit Slope	Chance of Effect (1 in…) (range)
Terrestrial Invertebrate LD_{50} = 0.020 µg a.i./g of organism	9.6 – 20600	3.16[2]	1.00 – 1.00
Small bird (dietary) LC_{50} > 4640 mg/kg diet	<0.01 – <0.23	4.5[1]	8.86×10^{18} – 4.91×10^{2}

Taxa	Acute RQ (range)	Probit Slope	Chance of Effect (1 in…) (range)
Small Bird LD_{50} > 2250 mg a.i./kg-bw	<0.01 – <0.74	4.5[1]	$8.86x10^{18}$ – 3.60
Medium Amphibian LD_{50} > 2250 mg a.i./kg-bw	<0.33[4]	4.5[1]	66.1
Medium Reptile LD_{50} > 2250 mg ai/kg-bw	<0.08[4]	4.5[1]	$2.51x10^{6}$
Small Mammal LD_{50} = 67 mg a.i./kg-bw	<0.01 – 6.81	4.5[1]	$8.86x10^{18}$ – 1.00
Monocot Plants EC_{25} > 0.011 lb a.i./A	<0.1 – <24.73	N/A	N/A[3]
Dicot Plants EC_{25} > 0.011 lb a.i./A	<0.1 – <24.73	N/A	N/A[3]
FW Fish LC_{50} = 0.58 µg a.i./L	<0.01 – 0.34	4.5[1]	$8.86x10^{18}$ – 57.1
FW Invertebrate EC_{50} = 0.004 µg a.i./L	0.02 – 50.0	4.5[1]	9.60E13 – 1.00
FW Benthic Invertebrate EC_{50} = 0.004 µg a.i./L	0.01 – 50.0	4.5[1]	$8.86x10^{18}$ – 1.00
FW Non-Vascular Aquatic Plants EC_{50} = 17800 µg a.i./L	<0.01	4.5[1]	N/A[3]
FW Vascular Aquatic Plants EC_{50} > 0.78 µg a.i./L	<0.01 – <0.26	N/A	N/A[3]
E/M Fish LC_{50} = 0.58 µg a.i./L	<0.01 – 0.34	4.5[1]	$8.86x10^{18}$ – 57.1
E/M Invertebrate LC_{50} = 0.0037 µg a.i./L	0.02 – 54.1	3.4[2]	$2.62x10^{8}$ – 1.00
E/M Benthic Invertebrate LC_{50} = 0.0037 µg a.i./L	<0.01 – 54.1	3.4[2]	$1.91x10^{11}$ – 1.00

[1] Default slope
[2] Species specific slope
[3] N/A=not applicable, these were limit tests.
[4] For non-vascular plants, all RQs were <0.01. Refinements with T-HERPS were performed only on one application scenario. Therefore, only one RQ is presented instead of a range in these instances.

5.2. 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 LOC. The final No Effect/May Affect determination is made after the spatial analysis is completed at the end of the risk description, **Section 5.2.9**. In **Section 5.2.9**, a discussion of any potential overlap between areas where potential usage may result in LAA effects and areas where species are expected to occur (including any designated critical habitat) is presented. If there is no overlap of the species habitat and occurrence sections with the potential area of LAA effects, a “no effect” determination is made.

If the RQs presented in the risk estimation section of the risk characterization (**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 deltamethrin’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 deltamethrin. Based on this risk estimation process described above, all species in this assessment, the BCB, CCR, CFWS, CTS (all DPS), DS, SFGS, TG, and VELB have a preliminary “may affect” determination. A summary of the risk estimation results are provided in**Error! Reference ource not found.** for direct and indirect effects to the listed species assessed here and the PCEs of their designated critical habitat.

Table 5-17. Risk Estimation Summary for Deltamethrin: Direct and Indirect Effects

Taxa	LOC Exceedance (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)	Acute RQs ranged from **<0.01 to 0.34** and chronic RQs ranged from **<0.01 to 11.8**. Even though none of the acute RQ values exceed the risk to non-listed species LOC (0.5), about 36% of the uses (16 of 45) exceed the chronic risk LOC (1).	Indirect Effects (prey items): CCR, CTS (all DPS), SFGS	CTS-CC, CTS-SB, DS, TG
	Listed Species (Yes)	Acute RQs ranged from **<0.01 to 0.34** and chronic RQs ranged from **<0.01 to 11.8**. Out of 45 uses assessed, 31 exceed the acute risk to listed species LOC (0.05) or 69%. Furthermore, 36% of the uses exceed the chronic risk LOC. The individual effects chance for acute risk is as high as 1 in 57.1.	Direct Effects: CTS (all DPS), DS, TG	
Freshwater Invertebrates (Pelagic)	Non-listed Species (Yes)	Risk quotients for freshwater invertebrates range from **0.11 to 50.0** (acute) and from **>2.1 to >7,690** (chronic). All but 3 out of 45 of the uses (93%) exceed the acute risk to non-listed species LOC (0.5) (the exceptions are residential lawn granular application, cucurbits dust application, and sewage systems), and 100% (45 of 45) of the uses exceed the chronic risk LOC (1)	Indirect Effects (prey items): CCR, CFWS, CTS (all DPS), DS, SFGS, TG	CTS-CC, CTS-SB, DS, TG
	Listed Species (Yes)	Risk quotients for freshwater invertebrates range from **0.11 to 50.0** (acute) and from **>2.1 to >7,690** (chronic). All uses (100%) exceed the acute risk to listed species LOC (0.05), and 100% (45 of 45) of the uses exceed the chronic risk LOC (1). The individual effects chance for acute risk is as high as 1 in 1.	Direct Effects: CFWS	
Freshwater Benthic Invertebrates	Non-listed Species (Yes)	Risk quotients for freshwater benthic invertebrates range from **<0.01 to 50.0** (acute) and >**0.21 to >7690** (chronic). Chronic risk quotients for freshwater benthic invertebrates, based on sediment concentrations, range from **>0.24 to >7580**. Thirty-four percent (15 of 44) of the use scenarios exceed the acute risk to non-listed species LOC (0.5). In addition, 95% (42 of 44) of the uses exceeded the chronic risk LOC (1). Uses that do not exceed the chronic risk LOC include cucurbits dust applications and residential lawns granular applications.	Indirect Effects (prey items): CCR, CFWS, CTS (all DPS), DS, SFGS, TG	CTS-CC, CTS-SB, DS, TG

Taxa	LOC Exceedance (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
	Listed Species (Yes)	Risk quotients for freshwater benthic invertebrates range from <**0.01 to 50.0** (acute) and >**0.21 to >7690** (chronic). Chronic risk quotients for freshwater benthic invertebrates, based on sediment concentrations, range from **>0.20 to >7580**. 82% (36 of 44) of the use scenarios exceed the acute risk to listed species LOC (0.05). In addition, 95% (42 of 44) of the uses exceeded the chronic risk LOC (1). Uses that do not exceed the chronic risk LOC include cucurbits dust applications and residential lawns granular applications. Despite the fact that two scenarios yielded non-definitive RQ values whose lower bounds are below the chronic LOC, their non-definitive nature (*i.e.*, expressed as "greater than") indicates that they have the potential to be larger and exceed the LOC. The individual effects chance for acute risk is as high as 1 in 1.	Direct Effects: CFWS	
Estuarine/ Marine Fish	Non-listed Species (Yes)	Risk quotients ranged from **<0.01-0.34** for the scenarios modeled (acute) and from **<0.01 to 8.33** (chronic). None of the uses exceed the acute risk to non-listed species LOC (0.5) for deltamethrin. However, the chronic risk LOC (1) is exceeded for 27% (12 of 45) of the uses.	Indirect Effects (prey items): CCR	DS, TG
	Listed Species (Yes)	Risk quotients ranged from **<0.01-0.34** for the scenarios modeled (acute) and from **<0.01 to 8.33** (chronic). Sixty-nine percent (31 of 45) of the deltamethrin uses exceed the acute risk to listed species LOC (0.05). Chronic risk LOCs are exceeded for 27% (12 of 45) of the uses. The individual effects chance for acute risk is as high as 1 in 57.1.	Direct Effects: DS, TG	
Estuarine/ Marine Invertebrates (Pelagic)	Non-listed Species (Yes)	Based on pore water concentrations, risk quotients range from **0.11 to 54.1** (acute) and **<0.07 to 274** (chronic). Ninety-three percent (42 of 45) of the uses exceed the acute risk to non-listed species LOC (0.5). Additionally, 84% (38 of 45) the chronic risk LOC (1). The individual effects chance for acute risk is as high as 1 in 1.	Indirect Effects (prey items): CCR, DS, TG	DS, TG

Taxa	LOC Exceedance (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
Estuarine/ Marine Benthic Invertebrates	Non-listed Species (Yes)	Risk quotients range from **0.02 to 54.1** (acute) and **0.02 to 274** (chronic). Thirty-nine percent (17 of 44) of the uses exceed the acute risk to non-listed species LOC (0.5). Additionally, 52% (23 of 44) the chronic risk LOC (1). The individual effects chance for acute risk is as high as 1 in 1.	Indirect Effects (prey items): CCR, DS, TG	DS, TG
Vascular Aquatic Plants	Non-listed Species (No)	RQs ranged from **<0.01 to 0.26**. Out of 45 scenarios modeled, none exceeded the vascular aquatic plant risk LOC (1).	Indirect Effects: SFGS, CCR, CTS (all DPS), TG, DS, CFWS	CTS-CC, CTS-SB, TG, DS
Non-Vascular Aquatic Plants	Non-listed Species (No)	All RQs were expressed as **<0.01**. Out of 45 scenarios modeled, none exceeded the non-vascular aquatic plant risk LOC (1).	Indirect Effects: SFGS, CCR, CTS (all DPS), TG, DS, CFWS	CTS-CC, CTS-SB, TG, DS
Birds, Reptiles, and Terrestrial-Phase Amphibians	Non-listed Species (Yes)	Based on T-REX modeling, only one RQ exceeds the acute risk to non-listed species LOC (0.5) for birds on a dose-basis, but not on a dietary based RQ. The chronic risk LOC (1) is also exceeded for the same application scenario (ornamentals, ant mound treatment), that had an acute exceedance. The range of acute dose-based RQs is **<0.01 to <0.74**; the range of acute dietary based RQs is **<0.01 to <0.23**; finally, the range of chronic dietary-based RQs is **<0.01 to 2.34**. The individual effects chance for acute risk is as high as 1 in 3.60 for birds. The T-HERPS refinements for this use for terrestrial phase amphibians results in an RQ that does not exceed the acute non-listed LOC; however, the chronic RQ does exceed the LOC (1). It is noted, however, that absence label information, it was assumed that mounds would be treated up to 12 times with 7-d intervals. Although this application frequency may be unlikely, exceedance of the chronic avian LOC is indicated even for a single application. The T-HERPS refinements for snakes results in acute and chronic RQs that do not exceed any LOCs. Out of four application scenarios involving granular applications, for none of them the LD_{50} ft^2 exceed the non-listed LOC, with values ranging from **<0.01 to 0.05**.	Indirect Effects: CCR, CTS (all DPS), SFGS	CTS-CC, CTS-SB

Taxa	LOC Exceedance (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
	Listed Species (Yes)	Based on T-REX modeling, only one acute RQ value exceeds the acute risk to listed species LOC (0.1) for birds (both dose-based and dietary based RQs) for ornamentals ant mound treatment. The chronic risk LOC (1) is also exceeded for the same application scenario that had an acute exceedance. The individual effects chance for acute risk is as high as 1 in 3.60 for birds. The T-HERPS refinements for this use for terrestrial phase amphibians (*i.e.*, CTS) results in an RQ that exceeds the acute listed LOC (acute dose-based RQ **<0.33**; acute dietary-based RQ **<0.24**); further, the chronic RQ also exceeds the LOC (1) after refinements with T-HERPS (chronic dietary-based RQ of **2.45**). The individual effects chance for acute risk is as high as 1 in 66.1 for amphibians after refinements with T-HERPS. Furthermore, the T-HERPS refinements for snakes (*i.e.*, the SFGS) results in acute and chronic RQs that do not exceed any LOCs (acute RQs ranging from **<0.01 to <0.08**; chronic RQs of **0.09 to 0.12**). The individual effects chance for acute risk is 1 in 2.51×10^6 for reptiles after refinements with T-HERPS. Out of four application scenarios involving granular applications, for none of them the LD_{50} ft^2 exceed the listed species LOC, with values ranging from **<0.01 to 0.05**.	<u>Direct Effects</u>: CCR, CTS (all DPS), SFGS	
Mammals	Non-listed Species (Yes)	Based on T-REX modeling, acute dose-based RQs exceed the non-listed species LOC (0.5) for two out of 21 (10%) application scenarios modeled. RQs ranged from **<0.01 to 6.81**. Scenarios with RQs exceeding the LOCs included ornamental plants (shade trees, ground cover), and ornamental plants (shade trees, ground cover) for ant mound treatment. Additionally, RQs for 11 out of 21 (53%) application scenarios exceeded the chronic dose-based LOC (1.0). RQs ranged from **0.04 to 84.5**. The chronic dietary-based RQs ranged from **<0.01 to 13.15**, with two scenarios for which the RQs exceeded the chronic LOC (1.0). Out of four application scenarios involving granular applications, for two the LD_{50} ft^2 exceed the non-listed LOC, with values ranging from **0.01 to 0.69**.	<u>Indirect Effects</u>: (prey items) CCR (prey items and habitat) CTS (all DPS), SFGS	CTS-CC, CTS-SB

Taxa	LOC Exceedance (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
Terrestrial Invertebrates	Non-listed Species (Yes)	All the RQs exceed the acute risk to listed and non-listed species LOCs for all 20 foliar application scenarios. RQs ranged from **9.6 to 20,600**. The individual effects chance for acute risk is as high as 1 in 1.	Indirect Effects: CCR, CTS (all DPS), SFGS	CTS-CC, CTS-SB
	Listed Species (Yes)		Direct Effects: BCB, VELB	BCB, VELB
Terrestrial Plants - Monocots	Non-listed Species[1] (Yes)	RQs exceed the non-listed species LOC for monocot plants for eight out of 26 application scenarios (31%). The RQs ranged from **<0.1 to <24.7**. The highest RQ is for semiaquatic areas for utility poles and utility rights-of-way.	Indirect Effects: SFGS, CCR, BCB, VELB, CTS (all DPS), TG, DS, CFWS	CTS-CC, CTS-SB, TG, DS, BCB, VELB
Terrestrial Plants - Dicots	Non-listed Species[1] (Yes)	Similar to the monocots, RQs exceed the non-listed species LOC for dicot plants for eight out of 26 application scenarios (31%). The RQs ranged from **<0.1 to <24.7**. The highest RQ is for semiaquatic areas for utility poles and utility rights-of-way.	Indirect Effects: SFGS, CCR, BCB, VELB, CTS (all DPS), TG, DS, CFWS	
	Listed Species (Yes)	RQs exceed the listed species LOC for dicot plants for eight out of 26 application scenarios 31%). The RQs ranged from **<0.1 to 24.7**. The highest RQ is for semiaquatic areas for utility poles and utility rights-of-way.	Indirect Effects: BCB, VELB	BCB, VELB

1. Only non-listed LOCs were evaluated because none of the assessed species have an obligate relationship with terrestrial monocots and dicots.

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 in **Sections 5.2.1** through **5.2.8**. The effects determination section for each listed species assessed will follow a similar pattern. Each will start with a discussion of the potential for direct effects, followed by a discussion of the potential for indirect effects. These discussions do not consider the spatial analysis. For those listed species that have designated critical habitat, the section will end with a discussion on the potential for modification to the critical habitat from the use of deltamethrin. Finally, in **Section 5.2.9**, a discussion of any potential overlap between areas of concern and the species (including any designated critical habitat) is presented. If there is no overlap of the species habitat and occurrence sections with the Potential Area of LAA Effects a No Effect determination is made.

5.2.1. Bay Checkerspot Butterfly

5.2.1.a. Direct Effects

RQ values, ranging from **9.6 to 20,600**, for all deltamethrin uses, using a deltamethrin-specific foliar dissipation half-life of 8.8 days, exceed the acute risk to listed species LOC (0.05) for direct effects to the BCB, resulting in a preliminary "may affect" determination. Deltamethrin is an insecticide and thus it is expected to have adverse effects on insects. Available acute toxicity data was utilized for a lepidopteran species, the cotton bollworm (*Helicoverpa armigera)*, which has a reported acute LD_{50} of 0.33 ng/organism. This species is considered a more appropriate surrogate for the BCB; however, the use of the honey bee species toxicity data (LD_{50} = 1.5 ng/organism) would not have changed the overall risk conclusions because on a per gram-organism basis, the sensitivity of the cotton bollworm and honey bee are similar (0.02 vs. 0.012 µg/g-organism, respectively). No ecological incidents were reported regarding deltamethrin use and associated impacts on non-target terrestrial invertebrates in the EIIS or Aggregate Incident Report.

The probability of an individual effect for a BCB is 1 in 1.00 (100%) for all foliar application rates and scenarios (**Table 5-16**). This probability is based on the lowest and highest acute RQs and a species specific probit slope of 3.16.

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

5.2.1.b. Indirect Effects

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

The RQ values exceed the listed species LOC for dicot plants for eight out of 28 application scenarios (29%). The RQ values ranged from **<0.1 to <24.7**. The highest RQ is for semiaquatic areas for utility poles and utility rights-of-way. It is noted that the dicot NOAEC is uncertain because it results from a limit test conducted at an application rate (0.011 lb a.i./A) that is below the maximum calculated application rate for deltamethrin upon which the listed species RQ is based (2.72 lb a.i./A). Therefore, exceedence of this unbounded NOAEC values does not necessarily mean that dicots would be adversely affected. However, in absence of additional information on the effects of deltamethrin on terrestrial plants, risk is presumed based on exceedance of this NOAEC. Identical results were obtained for monocot species, since the same unbounded NOAEC value was obtained for monocots. Little useful information is available for the toxicity of other pyrethroids to terrestrial plants. Such data were limited to one pesticide (etofenprox) which are also unbounded NOAEC values (i.e., no adverse effects at the highest test concentration). Lastly, it is noted that six minor plant incidents were reported as being associated with deltamethrin application in the Aggregate Incident Report.

Therefore, in considering these lines of evidence, a potential for indirect effects of deltamethrin on the BCB via adverse effects on terrestrial plants is identified.

5.2.1.c. Potential Modification of Habitat

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.

Based on the assessment of direct and indirect effects to the BCB above, the modification of designated critical habitat for the BCB is possible. This is due to the indications of direct effects on the BCB and indirect effects via potential impacts on terrestrial plants.

5.2.2. California Clapper Rail

5.2.2.a. Direct Effects

Out of 21 possible application rate/interval combination scenarios, one deltamethrin use resulted in RQs that exceed the acute risk to listed species LOC for direct effects to the CCR. The scenario that exceeded the listed species LOC was ornamental plants [shade trees/ground cover] ant mound treatment. On a chronic risk basis, one of the 21 scenarios yielded RQs that exceed the chronic risk LOC for direct effects to the CCR (ornamental plants [shade trees/ground cover] and ant mound treatment). It is noted that in this scenario, assumptions regarding the application frequency and re-treatment interval were made in absence of label information. However, even with a single application for this use (1.94 lb a.i./A), acute and chronic risk LOCs are exceeded. Thus, a preliminary "may affect" determination is appropriate.

No incidents involving birds and deltamethrin use have been reported to the Agency.

The maximum probability of an individual effect for a CCR based on avian toxicity data is between 1 in 3.60 (28%) for the single deltamethrin application scenario RQ that exceeded the listed species LOC (ornamental plants [shade trees/ground cover] and ant mound treatment) (**Appendix E**). This probability is based on the maximum acute RQs and a default probit slope of 4.5.

Given that acute and chronic RQ values were substantially below their respective LOCs for piscivorous birds, the potential for acute and chronic risks associated with the bioaccumulation of deltamethrin in aquatic food webs is considered low.

Although bioaccumulation and subsequent exposure via the aquatic food web is not a risk concern for the CCR, exposures through terrestrial food items exceed the acute and chronic risk to listed species LOC for one use. Therefore, there is a potential for direct effects to the CCR as a result of registered deltamethrin uses.

5.2.2.b. Indirect Effects

The CCR is a generalist and opportunistic feeder that forages at the upper end of marshes, along the ecotone between mudflat and higher vegetated zones, and in tidal sloughs. Mussels, clams, arthropods, snails, worms and small fish are its preferred foods, which it retrieves by probing and scavenging the surface while walking. The bird will only forage on mudflats or very shallow water where there is taller plant material nearby to provide protection at high tide. Although CCRs typically consume invertebrates, they have also been known to occasionally consume small birds and mammals, including the salt marsh harvest mouse. The CCR diet may contain up to 15% plant material. (Attachment III). The CCR inhabits cordgrass marshes around San Francisco Bay. CCR juveniles can disperse a sufficient distance to be found in both residential and agricultural areas east of San Francisco Bay and along the open coast.

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

Freshwater Fish

Even though none of the RQ values exceeded the acute risk to non-listed species LOC (0.5) for freshwater fish, about 34% of the uses (17 of 50) exceeded the chronic risk LOC (1) for freshwater fish. In addition, one ecological incident involving deltamethrin use and freshwater fish was reported as "probable."

Based on concerns for chronic risk to freshwater fish, indirect effects to the CCR are considered possible through adverse effects on this prey component.

Freshwater Invertebrates

All but three of the 50 assessed uses result in exposures that exceed the acute risk to non-listed LOC (0.5) for pelagic freshwater invertebrates (94%), and all but one (49 of 50; 98%) of the uses (*i.e.*, residential lawn granular application) exceed the chronic risk LOC (1).

For benthic freshwater invertebrates, 14 of the 49 (29%) use scenarios assessed exceed the acute risk to non-listed LOC (0.5) for benthic freshwater invertebrates. All but one use exceed the chronic risk LOC (1) for freshwater benthic invertebrates (98%). Uses that do not exceed the chronic risk LOC include cucurbits dust application and residential lawns granular applications The maximum probability of an individual effect for a non-listed species of freshwater (water column and benthic) invertebrates ranges up to 1 in 1 (100%) based on the maximum acute RQs and the default probit slope of 4.5.

There are no incident reports or open literature studies available on the effects of deltamethrin on freshwater invertebrates; however, incidents on invertebrates are unlikely to be noticed and reported to the Agency.

Therefore, based on potential acute and chronic risk to non-listed invertebrate species that serve as prey, indirect effects to the CCR are possible based on this prey component.

Estuarine/Marine Fish

None of the uses exceeded the acute risk to non-listed LOC (0.5) for deltamethrin for estuarine/marine fish; however, the chronic risk LOC (1) was exceeded for 12 of the 50 uses assessed (24%). No ecological incidents were reported for estuarine/marine fish. The individual effects chance for acute risk is as high as 1 in 57.1.

Based on potential chronic risk for estuarine/marine fish that serve as prey, indirect effects to the CCR are possible.

Estuarine/Marine Invertebrates

Ninety-four percent of the deltamethrin uses exceed the acute risk to non-listed LOC (0.5) for estuarine/ marine invertebrates, and 82% exceed the chronic risk LOC (1). The maximum probability of an individual effect for a non-listed species of estuarine/marine (water column and benthic) invertebrates is 1 in 1.0 based on the maximum acute RQ and the default probit slope of 4.5.

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

Considering the potential acute and chronic risk and the high likelihood of individual acute effects to estuarine/marine invertebrates that serve as prey, indirect effects to the CCR are possible.

Aquatic Plants

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

Data on the toxicity of deltamethrin to aquatic plants is limited to three species of freshwater algae and one freshwater vascular plant species. Adverse effect levels were all determined to be above the solubility of deltamethrin in water. Although no data were available on the toxicity of deltamethrin to estuarine/marine aquatic plants (either submitted to the Agency or identified in the open literature), risk to aquatic plants is considered very low in light of the available information and in considering the mode of action of deltamethrin. Therefore, indirect effects to the CCR based on this food and habitat component are not likely.

Birds

For the same reasons that are detailed in the CCR direct effects section, indirect effects to the CCR are possible based on potential risk to small avian prey items. One of the registered use (ornamental plants [shade trees/ground cover] and ant mound treatment) exceeds the acute risk to non-listed species LOC (0.5) and chronic risk LOC (1) using T-REX.

Small Mammals

Out of 21 uses evaluated using T-REX, two (10%) exceed the acute risk to non-listed species LOC and 11 (53%) of the scenarios exceed the chronic risk LOC. The probability of an individual acute effect ranges from 1 in 8.9×10^{18} to 1 in 1.0 across all uses. These probabilities are based on acute RQs and the default probit slope (4.5). Based on output from KABAM, bioaccumulation does not pose a risk for mammals eating aquatic prey.

Therefore, based on the potential acute and chronic risk to mammals combined with a relatively high likelihood of individual acute effects from some uses, indirect effects to the CCR are possible based on risk to small mammalian prey.

Terrestrial Invertebrates

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

Terrestrial Plants

As discussed previously for the BCB in **Section 5.2.1.b**, a potential exists for adverse effects of deltamethrin on terrestrial plants (monocots and dicots) based on the assessed uses. Therefore, indirect effects of deltamethrin on the CCR via adverse effects on terrestrial plants are identified.

5.2.3. California Freshwater Shrimp

5.2.3.a. Direct Effects

As summarized for indirect effects on the CCR in **Section 5.2.2.b**, 98% of the assessed uses exceed the chronic risk to listed species LOC (1) for freshwater invertebrates (water column dwelling). Exceedences also occur for the acute risk to listed species LOC (0.05). All but 1 out of 50 of the uses (98%) exceed the acute risk to listed species LOC (0.05) (the exceptions is residential lawn granular application). The maximum probability of an individual acute effect for listed species of freshwater invertebrate (water column and benthic) is high.

There are no incident reports or open literature studies available on the effects of deltamethrin on freshwater invertebrates; however, incidents on invertebrates are unlikely to be noticed and reported to the Agency.

Therefore, based on the potential acute and chronic risk to invertebrates in general and to benthic invertebrates in particular and based on the relatively high likelihood of individual acute effects on freshwater invertebrates, there is a potential for direct effects to the CFWS resulting from the assessed uses of deltamethrin.

5.2.3.b. Indirect Effects

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

Freshwater Invertebrates

For the same reasons that support the potential for direct effects on the CFWS described in **Section 5.2.3.a**, indirect effects to the CFWS are possible based on risk to freshwater invertebrate prey items. All but 3 out of 50 of the uses (94%) exceed the acute risk to non-listed species LOC (0.5).

Aquatic Plants

As summarized for indirect effects on the CCR in **Section 5.2.2.b**, deltamethrin is toxic to aquatic plants at levels that only exceed its solubility in water. Therefore, in considering the mode of action of deltamethrin and lack of exceedences of the aquatic plant LOC, indirect effects to the CFWS based on this food and habitat component are not considered likely.

Terrestrial Plants

As discussed previously for the BCB in **Section 5.2.1.b**, six minor plant incidents are reported for application of pesticides containing deltamethrin based on a search of the Aggregate Incident System. Furthermore, the upper bounds of non-definitive RQs for non-listed terrestrial plants are exceeded for 29% of the application scenarios assessed. Although effects on terrestrial plants are not expected based on the mode of action of deltamethrin, the minor incidents in combination with exceedences of the LOCs for terrestrial plants suggest a potential for indirect effects of deltamethrin on the CFWS via adverse effects on terrestrial plants.

5.2.4. California Tiger Salamander (All DPS)

5.2.4.a. Direct Effects

Aquatic-phase

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

As described previously for effects on freshwater fish (**Section 5.2.2.b**), the 33% of the assessed uses result in exposures that exceed the chronic risk to listed species LOC (1). Furthermore, 69% of the acute RQ values exceed the acute risk to listed species LOC (0.05). The maximum probability of an individual effect for listed freshwater fish is 1 in 57.

No incidents were reported for aquatic-phase amphibians; however, such incidents may not be readily observed. As discussed previously, one incident has been reported for freshwater fish that serve as surrogates for aquatic-phase amphibians.

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

Terrestrial-phase

Potential for direct effects to the terrestrial-phase CTS are assessed based on direct acute and chronic risk to birds as a surrogate because of a lack of toxicity data for terrestrial-phase amphibians. Acute and chronic RQs exceeded listed species LOCs for one of the application scenarios for deltamethrin for direct effects to the terrestrial-phase CTS, resulting in a preliminary "may affect" determination.

A refinement of the acute and chronic risks posed to the terrestrial-phase CTS was performed using the T-HERPS model. Avian RQ values used as screening surrogates for terrestrial-phase amphibians likely overestimate risks to amphibians because of the higher energy requirements of birds over amphibians of the same body weight, which results in a higher daily food intake rate value and a resultant higher dose-based exposure for birds than would likely occur for an amphibian of the same body weight. The T-HERPS model refines the EEC and RQ values based on the dietary intake rate of an amphibian, rather than a dietary intake rate of a bird. Acute and chronic risk to listed species LOCs are exceeded for one use (i.e., the same use for which the RQs exceeded the listed species LOC in T-REX). Model results from T-HERPS are from the most sensitive applicable RQs, *i.e*., medium amphibians (20 g) consuming herbivorous mammals.

The probability of an individual effect for a CTS based on avian toxicity data for the scenario for which the RQ exceeded the listed species LOC is 1 in 66.1 (1.5%) for deltamethrin (**Table 5-16**).

Given the exceedance of the LOCs using a deltamethrin-specific foliar dissipation half-life of 8.8 days, which was used for risk estimation because it is specific to deltamethrin, and based on the weight of evidence presented here, direct effects to the terrestrial-phase CTS as a result of one deltamethrin use are possible.

5.2.4.b. Indirect Effects

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

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

CTS through potential modification of habitat are evaluated based on the effects of deltamethrin on aquatic plants, terrestrial plants, and small mammals (**Attachment III**).

Freshwater Invertebrates

For the same reasons that support the potential for direct effects on the CFWS described in **Section 5.2.3.a**, the potential for adverse effects of deltamethrin on freshwater invertebrate prey items has been identified. Therefore, the evidence suggests that indirect effects to the CTS are possible based on potential acute and chronic risk to the freshwater invertebrate prey.

Freshwater Fish/Amphibians

As described in **Section 5.2.2.b,** chronic risks to freshwater fish (surrogate for aquatic-phase amphibians) are identified based on the assessed uses. In addition, one ecological incident involving deltamethrin use and freshwater fish was reported as "probable." Based on output from KABAM, bioaccumulation of deltamethrin in aquatic food webs does not pose a risk for amphibians eating aquatic prey.

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

Terrestrial Invertebrates

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

Small Mammals

As described in **Section 5.2.2.b,** acute and chronic risks to small mammals were identified. The probability of an individual acute effect ranges from 1 in 8.9×10^{18} to 1 in 1.0 across all uses assessed. Therefore, the potential for indirect effects to the CTS is identified based on risk to small mammalian prey and a potential reduction in small mammal burrows.

Aquatic Plants

As summarized for indirect effects on the CCR in **Section 5.2.2.b**, deltamethrin is toxic to aquatic plants at levels that only exceed its solubility in water. Therefore, in considering the mode of action of deltamethrin and lack of exceedences of the aquatic plant LOC, indirect effects to the CTS based on this food and habitat component are not considered likely.

Terrestrial Plants

As discussed previously for the BCB in **Section 5.2.1.b,** there is a potential of deltamethrin to cause adverse effects on terrestrial plants. Therefore, a potential for indirect effects of deltamethrin on the CTS via adverse effects on terrestrial plants is identified.

5.2.4.c. Modification of Designated Critical Habitat

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

5.2.5. Delta Smelt

5.2.5.a. Direct Effects

For direct effects on the DS, the most sensitive freshwater or estuarine/marine fish are used. Available data indicates that freshwater and estuarine/marine fish have similar sensitivity on an acute basis. The LC_{50} is 0.58 µg a.i./L in both instances. On a chronic basis, freshwater fish (NOAEC = 0.017 µg a.i./L) are more sensitive than estuarine/marine fish (NOAEC = 0.024 µg a.i./L). The DS inhabits both types of aquatic habitats. Acute RQs for freshwater fish ranged from **<0.01 to 0.34** and chronic RQs ranged from **<0.01 to 11.8**. Out of 50 uses assessed, 35 exceed the acute risk to listed species LOC (0.05) or 70%. Furthermore, 33% of the uses exceed the chronic risk LOC. The maximum probability of an individual acute effect for listed freshwater and estuarine/marine fish is 1 in 57.1 based on the maximum acute RQs (0.34) and the freshwater and estuarine/marine fish default slope (4.5). In addition, one probable ecological incident involving freshwater fish was associated with deltamethrin use.

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

5.2.5.b. Indirect Effects

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

Freshwater Invertebrates

For the same reasons that support the potential for direct effects on the CFWS described in **Section 5.2.3.a**, the assessed uses of deltamethrin may result in indirect effects to the DS based on risk to freshwater invertebrate prey items.

Estuarine/Marine Invertebrates

For the same reason as discussed in **Section 5.2.2.b** for indirect effects to the CCR, indirect effects to the DS via potential reduction in estuarine/marine invertebrate prey are possible given exceedence of acute non-listed and chronic LOCs and the high probabilities of individual effects.

Aquatic Plants

As summarized for indirect effects on the CCR in **Section 5.2.2.b**, deltamethrin is toxic to aquatic plants at levels that only exceed its solubility in water. Therefore, in considering the mode of action of deltamethrin and lack of exceedences of the aquatic plant LOC, indirect effects to the DS based on this food and habitat component are not considered likely.

Terrestrial Plants

As discussed previously for the BCB in **Section 5.2.1.b,** there is a potential of deltamethrin to cause adverse effects on terrestrial plants. Therefore, a potential for indirect effects of deltamethrin on the CTS via adverse effects on terrestrial plants is identified.
Therefore, a potential for indirect effects of deltamethrin on the DS via adverse effects on terrestrial plants is identified.

5.2.5.c. Modification of Designated Critical Habitat

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

5.2.6. San Francisco Garter Snake

5.2.6.a. Direct Effects

Potential direct effects to the SFGS are assessed based on direct acute and chronic toxicity effects to birds as a surrogate because of a lack of toxicity data for reptiles. One acute RQ and chronic RQs for deltamethrin use exceeds the risk to listed species LOCs for direct effects to the SFGS, when assessed using T-REX, resulting in a preliminary “may affect” determination.

Given that there is an exceedance of acute risk to listed species and chronic risk LOCs for birds (as described in **Section 5.1.2),** refinements using T-HERPS were employed to model a reptile instead of a bird for the single scenario with RQs exceeding the listed species LOCs. After refinements, no RQs exceed the acute or chronic risk to listed species LOC.

The maximum probability of an individual acute effect for a SFGS is 1 in 2.51×10^6 (<0.01%) based on the maximum RQ and a default slope of 4.5 (**Appendix E** and **Table 5-16**).

Based on output from KABAM, bioaccumulation of deltamethrin is not expected to pose a risk for reptiles eating aquatic prey.

Based on the weight of evidence presented here, direct effects to the SFGS as a result of deltamethrin uses appear highly unlikely.

5.2.6.b. Indirect Effects

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

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

Freshwater Fish and Aquatic-phase Amphibians

As described in **Section 5.2.2.b,** chronic risks to freshwater fish are identified based on the assessed uses. In addition, one ecological incident involving deltamethrin use and freshwater fish was reported as "probable." Based on output from KABAM, bioaccumulation of deltamethrin in aquatic food webs does not pose a risk for amphibians eating aquatic prey.

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

Freshwater Invertebrates

For the same reasons that support the potential for direct effects on the CFWS described in **Section 5.2.3.a**, indirect effects to the SFGS are possible based on risk to freshwater invertebrate prey items.

Birds, Terrestrial-phase Amphibians, and Reptiles

For the same reasons that are detailed in the CCR direct effects section, indirect effects to the SFGS are possible based on risk to small avian prey for one application scenario.

Small Mammals

As described in **Section 5.2.2.b,** acute and chronic risks to small mammals were identified. The probability of an individual acute effect ranges from 1 in 8.9×10^{18} to 1 in 1.0 across all uses assessed. Therefore, the potential for indirect effects to the SFGS is identified based on risk to small mammalian prey and a potential reduction in small mammal burrows.

Terrestrial Invertebrates

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

Aquatic Plants

As discussed in **Section 5.2.2.b** for the CCR, indirect effects to SFGS through impacts on aquatic plants are considered not likely given the mode of action of pyrethroids, extremely low solubility of deltamethrin and low toxicity of deltamethrin to aquatic plants.

Terrestrial Plants

As discussed previously for the BCB in **Section 5.2.1.b,** there is a potential of deltamethrin to cause adverse effects on terrestrial plants. Therefore, a potential for indirect effects of deltamethrin on the SFGS via adverse effects on terrestrial plants is identified.

5.2.7. Tidewater Goby

5.2.7.a. Direct Effects

For direct effects on the TG, the most sensitive freshwater or estuarine/marine fish are used. Available data indicates that freshwater and estuarine/marine fish have similar sensitivity on an acute basis. The LC_{50} is 0.58 µg a.i./L in both instances. On a chronic basis, freshwater fish (NOAEC = 0.017 µg a.i./L) are more sensitive than estuarine/marine fish (NOAEC = 0.024 µg a.i./L). The DS inhabits both types of aquatic habitats. Acute RQs for freshwater fish ranged from **<0.01 to 0.34** and chronic RQs ranged from **<0.01 to 11.8**. Out of 50 uses assessed, 35 exceed the acute risk to listed species LOC (0.05) or 70%. Furthermore, 33% of the uses exceed the chronic risk LOC. The maximum probability of an individual acute effect for listed freshwater and estuarine/marine fish is1 in 57.1 based on the maximum acute RQs (0.34) and the freshwater and estuarine/marine fish default slope (4.5). In addition, one probable ecological incident involving freshwater fish was associated with deltamethrin use.

No incidents were reported for estuarine/marine fish. However, one incident was reported for freshwater fish (classified as ‘probable’).

Based on the lines of evidence, direct effects to the TG are considered possible.

5.2.7.b. Indirect Effects

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

Freshwater Invertebrates

For the same reasons that support the potential for direct effects on the CFWS described in **Section 5.2.3.a**, indirect effects to the TG are possible based on risk to freshwater invertebrate prey items.

Estuarine/Marine Invertebrates

For the same reason as discussed in **Section 5.2.2.b** for indirect effects to the CCR, indirect effects to the TG via potential reduction in estuarine/marine invertebrate prey are possible given exceedence of acute non-listed and chronic LOCs and the high probabilities of individual effects.

Aquatic Plants

As summarized for indirect effects on the CCR in **Section 5.2.2.b**, deltamethrin is toxic to aquatic plants at levels that only exceed its solubility in water. Therefore, in considering the mode of action of deltamethrin and lack of exceedences of the aquatic plant LOC, indirect effects to the TG based on this food and habitat component are not considered likely.

Terrestrial Plants

As discussed previously for the BCB in **Section 5.2.1.b,** there is a potential of deltamethrin to cause adverse effects on terrestrial plants. Therefore, a potential for indirect effects of deltamethrin on the TG via adverse effects on terrestrial plants is identified.
Therefore, a potential for indirect effects of deltamethrin on the TG via adverse effects on terrestrial plants is identified.

5.2.7.c. Modification of Designated Critical Habitat

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

5.2.8. Valley Elderberry Longhorn Beetle

5.2.8.a. Direct Effects

RQ values, ranging from **9.6 to 20,600**, for <u>all</u> deltamethrin uses, using a deltamethrin-specific foliar dissipation half-life of 8.8 days, exceed the acute risk to listed species LOC (0.05) for direct effects to the VELB, resulting in a preliminary "may affect" determination. Deltamethrin is an insecticide and thus it is expected to have adverse effects on insects. Available acute toxicity data was utilized for a lepidopteran species, the cotton bollworm (*Helicoverpa armigera)*, which has a reported acute LD_{50} of 0.33 ng/organism. This species is considered a reasonable surrogate for the BCB; however, the use of the honey bee species toxicity data (LD_{50} = 1.5 ng/organism) would not have changed the overall risk conclusions because on a per gram-organism basis, the sensitivity of the cotton bollworm and honey bee are similar (0.02 *vs.* 0.012 µg/g-organism, respectively). No ecological incidents were reported regarding deltamethrin use and associated impacts on non-target terrestrial invertebrates in the EIIS or Aggregate Incident Report.

The probability of an individual effect for a VELB is 1 in 1.00 (100%) for all foliar application rates and scenarios (**Table 5-16**). This probability is based on the lowest and highest acute RQs and a species specific probit slope of 3.16.

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

5.2.8.b. Indirect Effects

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

As discussed previously for the BCB in **Section 5.2.1.b**, a potential exists for adverse effects of deltamethrin on terrestrial plants (monocots and dicots) based on the assessed uses. Therefore, indirect effects of deltamethrin on the VELB are possible. As discussed previously for the BCB in **Section 5.2.1.b**, a potential exists for adverse effects of deltamethrin on terrestrial plants (monocots and dicots) based on the assessed uses. Therefore, indirect effects of deltamethrin on the VELB via adverse effects on terrestrial plants are identified.

5.2.8.c. Modification of Designated Critical Habitat

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

5.2.9. Spatial Extent of Potential Effects

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

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

5.2.9.a. Spray Drift

To determine terrestrial habitats of concern from deltamethrin exposures through spray drift, it is necessary to estimate the distance that spray applications can drift from the treated area and still be present at concentrations that exceed LOCs. Ground applications of deltamethrin granular formulations are expected to result in negligible drift. For the flowable uses, a quantitative analysis of spray drift distances was completed using AgDRIFT (v. 2.1.1) using agricultural input values, according to the labels for ground applications (*i.e.*, low boom (required 4 ft), ASAE droplet size distribution = Medium, 90th data percentile) and aerial applications (*i.e.*, ASAE Medium, boom height 10 ft, wind speed 15 mph). Only agricultural uses applied with ground boom or aerial spray equipment are modeled. The sample label mainly used was Decis® 0.2EC. Only organisms/ scenarios that exceeded the acute risk to listed species LOCs are modeled. It is noted that the buffer distances estimated with AgDRIFT do not include loadings due to runoff and only include spray drift. Furthermore, potential degradation of deltamethrin is not included in the analysis, although it represents single applications. The results are summarized in **Table 5-18, Table 5-19,** and **Table 5-20**).

Insects are the most sensitive group and buffer distances are out of range for all the scenarios (>2,608 ft for aerial applications) (**Table 5-18**). For these uses, conventional ground methods of application can also be used. Buffer distances for mammals were not calculated since the application rate at RQ=0.5 is greater than any of the single application rates. For birds, there were no exceedances of LOCs for any of the agricultural applications; therefore, no buffer zones were calculated.

Table 5-18. Terrestrial Organisms Buffers for Deltamethrin Calculated with AgDRIFT

Use	Single App Rate (lb a.i./A)	Fraction of Applied			Buffer Distance (ft)		
		Insect	Birds	Mammal	Insect	Birds	Mammal
		1.06×10^{-5}	N/A	0.322	N/A	N/A	N/A
Canola, rapeseed, crambe	0.0097 (A)	0.00109	N/C	N/C	>2608	N/C	N/C
Corn (field, pop)	0.0236 (A)	4.49×10^{-4}	N/C	N/C	>2608	N/C	N/C
Cotton	0.0322 (A)	3.29×10^{-4}	N/C	N/A	>2608	N/C	N/A
Cucurbits, Tomato, Tamillo, Eggplant, Ground Cheery, Pepinos	0.03 (A)	3.53×10^{-4}	N/C	N/A	>2608	N/C	N/A
Garlic, Leeks, Onion, Shallots	0.03 (A)	3.53×10^{-4}	N/C	N/A	>2608	N/C	N/A
Pome Fruits	0.0225 (A)	4.71×10^{-4}	N/C	N/C	>2608	N/C	N/C
Potato & Root Vegetables (1B); Tuberous & Corn Vegetables (1C); Artichokes	0.03 (A)	3.53×10^{-4}	N/C	N/A	>2608	N/C	N/A
Sorghum	0.0242 (A)	4.38×10^{-4}	N/C	N/C	>2608	N/C	N/C
Sweet Corn	0.03 (A)	3.53×10^{-4}	N/C	N/A	>2608	N/C	N/A
Tree Nuts (foliar and dormant)	0.0354 (A)	2.99×10^{-4}	N/C	N/A	>2608	N/C	N/A

N/C = not calculated because acute RQ did not exceed LOC.

For freshwater and estuarine/marine fish, buffer zones at the acute risk to listed species LOC (0.05) range from 0 ft for the ground application on sweet corn to 335 ft for aerial applications at 0.03 lb a.i./A (**Table 5-19**). In 2008, EPA issued a memo to all pyrethroid registrants requiring that aquatic buffers be added to all pyrethroid labels. These buffer distances, which protect bodies of water against drift, were considered when calculating the EECs in this assessment. For aerial applications, the required buffer zone is 150 ft while for ground applications, it is 25 ft.

Table 5-19. Freshwater and Estuarine/Marine Fish Buffers Distances for Deltamethrin, Calculated with AgDRIFT

Use	Single App Rate (lb ai/A)	Freshwater Fish (ft) Initial Average Concentration (ng a.i./L)			Estuarine/Marine Fish (ft) Initial Average Concentration (ng a.i./L)		
		(290) (Acute)	(58) (Acute restricted)	(29) (Acute listed)	(290) (Acute)	(58) (Acute restricted)	(29) (Acute listed)
Tree nuts crop group 14	0.0354 (A)	N/C	N/C	299	N/C	N/C	299
Corn (field, pop)	0.0236 (A)	N/C	N/C	N/C	N/C	N/C	N/C
Sweet corn	0.03 (A)	N/C	N/C	335	N/C	N/C	335
Sweet corn	0.03 (G)	N/C	N/C	0	N/C	N/C	0
Cotton	0.0322 (A)	N/C	N/C	358	N/C	N/C	358
Pome fruits	0.0225 (A)	N/C	N/C	N/C	N/C	N/C	N/C
Cucurbits	0.03 (A)	N/C	N/C	335	N/C	N/C	335
Cucurbits	0.03 (G)	N/C	N/C	N/C	N/C	N/C	N/C
Garlic, leeks, onion, shallots	0.03 (A)	N/C	N/C	335	N/C	N/C	335
Root vegetables crop subgroup 1B (except sugarbeet) and subgroup 1C	0.03 (A)	N/C	N/C	335	N/C	N/C	335
Artichokes	0.03 (A)	N/C	N/C	335	N/C	N/C	335
Eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato	0.03 (A)	N/C	N/C	335	N/C	N/C	335
Sorghum	0.0242 (A)	N/C	N/C	272	N/C	N/C	272
Canola, rapeseed, crambe	0.0097 (A)	N/C	N/C	N/C	N/C	N/C	N/C

N/C = not calculated because acute RQ did not exceed LOC

Invertebrates are the most sensitive aquatic group. Buffer distances for freshwater and estuarine/marine invertebrates at the acute risk to listed species LOC (0.05) are >2,608 ft for aerial applications or >1000 for ground applications (**Table 5-20**).

Table 5-20. Freshwater and Estuarine/Marine Benthic and Non-Benthic Invertebrate Buffers Distances for Deltamethrin, Calculated with AgDRIFT

Use	Single App Rate (lb ai/A)	Freshwater Invertebrate (ft) Initial Average Concentration (ng ai/L)			Estuarine/Marine Invertebrate (ft) Initial Average Concentration (ng ai/L)		
		(2) (Acute)	(0.4) (Acute restricted)	(0.2) (Acute listed)	(1.85) (Acute)	(0.37) (Acute restricted)	(0.18) (Acute listed)
Tree nuts crop gp 14	0.0354 (A)	>2608	>2608	>2608	>2608	>2608	>2608
Corn (field, pop)	0.0236 (A)	>2608	>2608	>2608	>2608	>2608	>2608
Sweet corn	0.03 (A)	>2608	>2608	>2608	>2608	>2608	>2608
Sweet corn	0.03 (G)	413	>1000	>1000	456	>1000	>1000
Cotton	0.0322 (A)	>2608	>2608	>2608	>2608	>2608	>2608
Pome fruits	0.0225 (A)	>2608	>2608	>2608	>2608	>2608	>2608
Cucurbits	0.03 (A)	>2608	>2608	>2608	>2608	>2608	>2608
Cucurbits	0.03 (G)	413	>1000	>1000	456	>1000	>1000

Use	Single App Rate (lb ai/A)	Freshwater Invertebrate (ft)			Estuarine/Marine Invertebrate (ft)		
		Initial Average Concentration (ng ai/L)			Initial Average Concentration (ng ai/L)		
		(2) (Acute)	(0.4) (Acute restricted)	(0.2) (Acute listed)	(1.85) (Acute)	(0.37) (Acute restricted)	(0.18) (Acute listed)
Garlic, leeks, onion, shallots	0.03 (A)	>2608	>2608	>2608	>2608	>2608	>2608
Root vegetables crop subgp 1B (except sugarbeet) and subgp 1C	0.03 (A)	>2608	>2608	>2608	>2608	>2608	>2608
Artichokes	0.03 (A)	>2608	>2608	>2608	>2608	>2608	>2608
Eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato	0.03 (A)	>2608	>2608	>2608	>2608	>2608	>2608
Sorghum	0.0242 (A)	>2608	>2608	>2608	>2608	>2608	>2608
Canola, rapeseed, crambe	0.0097 (A)	>2608	>2608	>2608	>2608	>2608	>2608

N/C = not calculated because acute RQ did not exceed LOC

5.3. Effects Determinations

5.3.1. Bay Checkerspot Butterfly

It is possible for deltamethrin to directly affect the BCB based on RQs exceeding the acute risk to listed species LOC for terrestrial invertebrates. Indirect effects from adverse effects on terrestrial plants are considered possible given the current exceedences of the terrestrial plant LOC by multiple scenarios and some minor incident reports involving terrestrial plants. Therefore, the Agency makes a **may affect, and likely to adversely affect** determination based on the potential for direct effects to the BCB and a **habitat modification** determination for its designated critical habitat also based on direct effects to the BCB.

5.3.2. California Clapper Rail

It is possible for deltamethrin to directly affect the CCR based on RQs exceeding the chronic risk LOC for birds. Indirect effects from affected prey are also possible based on RQs exceeding the risk to listed and non-listed species LOCs for birds, mammals, terrestrial invertebrates, freshwater and estuarine/marine fish, freshwater and estuarine/marine invertebrates, and terrestrial plants. Effects are not expected from modifications to the aquatic plant community. Deltamethrin uses extend across the state of California, thus use is expected to occur within the CCR range.

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

5.3.3. California Freshwater Shrimp

It is possible for deltamethrin to directly affect the CFWS based on RQs exceeding risk to listed species LOCs for freshwater invertebrates. Indirect effects from affected prey are also possible based on RQs exceeding the risk to listed and non-listed species LOCs for freshwater invertebrates. Indirect effects on habitat from adverse effects on terrestrial plants are considered possible based on exceedences of terrestrial plant LOC value.. Indirect effects are not expected from changes to the aquatic plant community. Deltamethrin uses extend across the state of California, thus use is expected to occur within the CFWS range.

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

5.3.4. California Tiger Salamander (All 3 DPS)

It is possible for deltamethrin to directly affect the CTS based on RQs exceeding risk to listed species LOCs for terrestrial-phase amphibians (using avian surrogate species data) and based on RQs exceeding the risk to listed species LOCs for aquatic-phase amphibians (using freshwater fish surrogate species data). Indirect effects from affected prey are also possible based on RQs exceeding risk to listed and non-listed species LOCs for terrestrial-phase amphibians (using avian surrogate species data), mammals, terrestrial invertebrates, freshwater invertebrates and freshwater fish. Indirect effects from affected habitat are possible because the RQs exceed the risk to listed and non-listed species LOCs for mammal burrow availability. Small mammals are essential in creating the underground habitat that juvenile and adult CTS depend upon for food, shelter, and protection from the elements and predation. Indirect effects on habitat from adverse effects to aquatic plants are not anticipated. However, indirect effects from adverse effects on terrestrial plants are considered possible given the existence of minor incident reports involving terrestrial plants and exceedences of terrestrial plant LOC for several uses. Deltamethrin uses extend across the state of California, thus use is expected to occur within the CTS range.

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

5.3.5. Delta Smelt

It is possible for deltamethrin to directly affect the DS based on RQs exceeding the risk to listed species LOCs for freshwater and estuarine/marine fish. One incent for freshwater fish has been reported as being associated with deltamethrin use with probable causality classification. Indirect effects from affected prey are also possible based on RQs exceeding the risk to listed and non-listed species LOCs for freshwater and estuarine/marine invertebrates. Indirect effects from adverse effects to aquatic plants are not expected. However, indirect effects from adverse effects on terrestrial plants are considered possible given the availability of six minor incident reports involving terrestrial plants. Deltamethrin uses extend across the state of California, thus use is expected to occur within the DS range.

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

5.3.6. San Francisco Garter Snake

It is possible for deltamethrin to indirectly affect the SFGS based on effects on its prey (but not direct effects on SFGS). Specifically, RQs exceed the risk to listed and non-listed, mammals, terrestrial invertebrates, freshwater fish/aquatic-phase amphibians, and freshwater invertebrates. Small mammals are essential in creating the underground habitat that SFGS depend upon for shelter, and aestivation. Indirect effects on habitat from adverse effects to terrestrial plants are also possible given LOC exceedences for terrestrial plants and six reported minor incidences involving terrestrial plants. Deltamethrin uses extend across the state of California, thus use is expected to occur within the SFGS range.

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

5.3.7. Tidewater Goby

It is possible for deltamethrin to directly affect the TG based on RQs exceeding the risk to listed species LOCs for freshwater and estuarine/marine fish. One incent for freshwater fish has been reported as being associated with deltamethrin use with probable causality classification. Indirect effects from affected prey are also possible based on RQs exceeding the risk to listed and non-listed species LOCs for freshwater and estuarine/marine invertebrates. Indirect effects from adverse effects to aquatic plants are not expected. However, indirect effects from adverse effects on terrestrial plants are considered possible given the availability of six minor incident reports involving terrestrial plants. Deltamethrin uses extend across the state of California, thus use is expected to occur within the TG range.

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

5.3.8. Valley Elderberry Longhorn Beetle

It is possible for deltamethrin to directly affect the VELB based on RQs exceeding the acute risk to listed species LOC for terrestrial invertebrates. Indirect effects from adverse effects on terrestrial plants are considered possible given the current exceedences of the terrestrial plant LOC by multiple scenarios and some minor incident reports involving terrestrial plants. Therefore, the Agency makes a **may affect, and likely to adversely affect** determination based on the potential for direct effects to the VELB and a **habitat modification** determination for its designated critical habitat also based on direct effects to the VELB.

5.3.9. Addressing the Risk Hypotheses

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

The labeled use of deltamethrin may:

- … directly affect the BCB, CCR, CFWS, CTS (all DPS), DS, TG, and VELB by causing acute mortality or by adversely affecting chronic growth or fecundity;
- … indirectly affect the BCB, CCR, CFWS, CTS (all DPS), DS, SFGS, TG, and VELB and/or affect their designated critical habitat by reducing or changing the composition of the food supply;
- … indirectly affect none of the assessed species and their designated critical habitat by reducing or changing the composition of the aquatic plant community in the species' current range, thus, affecting primary productivity and/or cover;
- … indirectly affect the BCB and VELB by reducing or changing the composition of the terrestrial plant community in the species' current range;
- … not indirectly affect the CTS (all DPS) and SFGS and their designated critical habitat by reducing or changing aquatic habitat in their current range (via modification of water quality parameters, habitat morphology, and/or sedimentation).

6. Uncertainties

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

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 Bird or Small Mammal)

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

[1] The percents of the maximum RQ shown here for birds are based on the Agency's default avian scaling factor of 1.15.

[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 Mammals) and Size Class (Medium Amphibian or Snake)

Dietary Items	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			
Amphibians: Acute Dose Based EECs and RQs				
Size Class	Small, 2 g	Mid, 20 g	Large, 200 g	
Broadleaf plants/sm Insects	5%	3%	2%	
Fruits/pods/seeds/lg insects	0.5%	0.3%	0.2%	
Small herbivore mammals	N/A	100%	37%	
Small insectivore mammals	N/A	6%	2%	
Small amphibians	N/A	2%	1%	
Snakes: Acute Dose-Based EECs and RQs				
Size Class	Small, 2 g	Mid, 20 g	Mid, 200 g[1]	Large, 800 g
Broadleaf plants/sm Insects	3%	2%	1%	1%
Fruits/pods/seeds/lg insects	0.4%	0.2%	0.1%	0.1%
Small herbivore mammals	N/A	100%	40%	23%
Small insectivore mammals	N/A	6%	3%	1%
Small amphibians	N/A	2%	2%	1%
Amphibians and Snakes: Acute and Chronic Dietary-based EECs and RQs for all Size Classes				
	Amphibians	Snakes		
Broadleaf plants/sm Insects	56%	73%		
Fruits/pods/seeds/lg insects	6%	8%		
Small herbivore mammals	100%	100%		
Small insectivore mammals	6%	6%		
Small amphibians	2%	2%		

[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 Deltamethrin

Uncertainties Associated With the Solubility Limit

There is uncertainty associated with the deltamethrin limit of solubility value, derived from a study by Grelet (1990) (cited by Laskowsky, 2002). Since in PRZM/EXAMS the EECs exceeded 0.200 ppb for some of the samples, they were reported at the limit of solubility.

Surface water monitoring data were accessed from the CDPR on 02/07/2013 and a total of 231 samples were analyzed for deltamethrin. Of these, 16 out of 207 surface water samples (7.7%), and 14 out of 24 sediment samples (58.3%), had positive detections of deltamethrin. The maximum surface water concentration was 0.231 µg/L, a value that slightly exceeds the solubility limit of deltamethrin (0.200 µg/L, Laskowski 2002).

Even though they are expected to be lower than the water column EECs, a few of the pore water peak and 21-day EECs were also capped at the limit of solubility. Both pore water and sediment EECs were obtained from EXAMS. In these instances, for benthic organisms, the sediment EECs appeared to be more indicative of the relative potential of certain applications of deltamethrin to cause higher or lower impact on sediments.

Uncertainties Related to Fate Data Gaps

The environmental fate database is substantially complete. Two relevant fate gaps were identified in the Problem Formulation for Registration Review. They include one aerobic aquatic metabolism study conducted in a test system with a low percent organic matter and low pH. The two systems available had pH values above 8.0, which may have promoted more rapid degradation since deltamethrin is prone to hydrolysis at high pH. As a result, the aerobic aquatic metabolism half-lives may have been underestimated and not been conservative.

Additionally, there is no anaerobic aquatic metabolism study. In its absence, the anaerobic soil metabolism study was used according to the guidance to select input parameters in PRZM/EXAMS.

Deltamethrin's degradation is possibly a function of the reduction/oxidation (redox) potential, with the chemical likely being more stable in negative redox potential environments, similar to other synthetic pyrethroids. In general, static waters with low aeration could show higher EECs than predicted by PRZM/EXAMS. In addition, deltamethrin's EECs may be different than actually predicted if the temperature is different than 25°C, which is the temperature used frequently in laboratory studies.

Urban Use Uncertainties

For the aquatic exposure of urban uses (*i.e.*, where impervious surfaces are present), EFED relied extensively on the CA residential, CA rights-of-way and CA impervious scenarios. Certain assumptions were needed for the modeling, regarding the equivalent application rates, and in general, six or twelve applications were modeled, based on a survey of pesticide applicators in CA (see below). For some of the scenarios, for comparison, multiple (6 or 12) applications were modeled. As expected, the EECs increased with the number of applications. A survey that the Pyrethroid Working Group made in California in 2009 indicated that commercial operators service their residential customers on a monthly or every other month basis (thus 6 applications were simulated), while the commercial sector is serviced almost always on a monthly basis (MRID 48762913). This study was performed in response to the reevaluation of a number of synthetic pyrethroids in California.

Chirality of Deltamethrin

Day & Maguire (1990) found that parent deltamethrin was the most toxic of four isomers of deltamethrin to *D. magna*. However, even though deltamethrin transformed to other isomers in the environment, detoxification was only partial since one of the isomers was also toxic to the species. Maguire (1990) also found that deltamethrin undergoes various isomerizations in the environment and when exposed to sunlight. Ye *et al.* (2010) indicated that there is a different fate profile for the *cis*- and *trans*-isomers of deltamethrin. The *trans*-isomers degrade faster than the *cis*-isomers. There is uncertainty in, both the degree of degradation and toxicity in time for deltamethrin, since the individual stereoisomers were not evaluated in the environmental fate or ecological effects studies. In the aqueous photolysis study, parent compound and one of the isomers, which is formed, were summed to calculate the half-life.

Aquatic Modeling Uncertainties

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

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

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

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

E-FAST's Down-the-Drain Modeling Uncertainties

The "down-the-drain" module of E-FAST is a model that provides screening-level estimate concentrations of chemicals in surface waters. There is uncertainty regarding the resultant EECs because the model does not account for degradation, metabolism, binding or partitioning of a chemical with the sediment. Deltamethrin is stable to hydrolysis and degrades at a moderate rate in aquatic environments (25.9-120 days under aerobic aquatic metabolism; 34 days under anaerobic soil metabolism); however, it binds strongly with soils and sediments. It is expected to partition with organic matter in sewage matter. The main uncertainty in the DtD assessment is related to the usage, which was assumed to range from 10-1000 kg a.i./year on a national basis.

Impact of Vegetative Setback

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

6.1.3. Exposure in Estuarine/marine Environments

In this assessment, it was assumed that the EECs that exceeded the solubility of deltamethrin in water were actually at the limit of solubility (*i.e.*, if the EEC>0.200 ppb, it was assumed to be equal to 0.200 ppb). In saline environments, the solubility of deltamethrin may be greater than or lower than in water, which constitutes an uncertainty in the RQ values. As mentioned in the previous section, it appears that deltamethrin's degradation is possibly a function of the redox potential, with the chemical being more stable in negative redox potential environments, similar to other synthetic pyrethroids. In general, static waters with low aeration could show higher EECs than predicted by PRZM/EXAMS.

Uncertainties regarding dilution and chemical transformations in estuaries

PRZM/EXAMS modeled EECs are intended to represent exposure of aquatic organisms in relatively small ponds and low-order streams. Therefore it is likely that EECs generated from the PRZM/EXAMS model will over-estimate potential concentrations in larger receiving water bodies such as estuaries, embayments, and coastal marine areas because chemicals in runoff water (or spray drift, *etc.*) should be diluted by a much larger volume of water than would be found in the 'typical' EXAMS pond. However, as chemical constituents in water draining from freshwater streams encounter brackish or other near-marine-associated conditions, there is potential for important chemical transformations to occur. Many chemical compounds can undergo changes in mobility, toxicity, or persistence when changes in pH, E_h (redox potential), salinity, dissolved oxygen (DO) content, or temperature are encountered. For example, desorption and re-mobilization of some chemicals from sediments can occur with changes in salinity (Jordan *et al.*, 2008; Means, 1995; Swarzenski *et al.*, 2003), changes in pH (*e.g.*, Wood and Baptista 1993; Parikh et al. 2004; Fernandez et al. 2005), E_h changes (Velde and Church, 1999; Wood and Baptista, 1993), and other factors. Thus, although chemicals in discharging rivers may be diluted by large volumes of water within receiving estuaries and embayments, the hydrochemistry of the marine-influenced water may negate some of the attenuating impact of the greater water volume; for example, the effect of dilution may be confounded by changes in chemical mobility (and/or bioavailability) in brackish water. In addition, freshwater contributions from discharging streams and rivers do not instantaneously mix with more saline water bodies. In these settings, water will commonly remain highly stratified, with fresh water lying atop denser, heavier saline water – meaning that exposure to concentrations found in discharging stream water may propagate some distance beyond the outflow point of the stream (especially near the water surface). Therefore, it is not assumed that discharging water will be rapidly diluted by the entire water volume within an estuary, embayment, or other coastal aquatic environment. PRZM/EXAMS model results should be considered consistent with concentrations that might be found near the head of an estuary unless there is specific information – such as monitoring data – to indicate otherwise. Conditions nearer to the mouth of a bay or estuary, however, may be closer to a marine-type system, and thus more subject to the notable buffering, mixing, and diluting capacities of an open marine environment. Conversely, tidal effects (pressure waves) can propagate much further upstream than the actual estuarine water, so discharging river water may become temporarily partially impounded near the mouth (discharge point) of a channel, and resistant to mixing until tidal forces are reversed.

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

6.1.4. Modeled Versus Monitoring Concentrations

In order to account for uncertainties associated with modeling, available monitoring data were compared to PRZM/EXAMS estimates of peak EECs for the different uses. As discussed above, several data values were available from CDPR for deltamethrin concentrations measured in surface waters receiving runoff from agricultural areas. The specific use patterns (*e.g.*, application rates and timing, crops) associated with the agricultural areas are unknown, however, they are assumed to be representative of potential deltamethrin use areas.

Peak model-estimated environmental concentrations (EECs) resulting from different deltamethrin uses range from 7.99×10^{-5} to 0.200 µg/L in the water column (up to the limit of solubility of deltamethrin). Of 49 scenarios modeled (22 agricultural and 27 non-agricultural scenarios), 11 peak water column EECs were capped at the limit of solubility of deltamethrin. The peak model-estimated non-normalized sediment EECs resulting from different deltamethrin uses range from 0.0220 to 3,752 µg/Kg; meanwhile the organic carbon normalized sediment EECs resulting from different deltamethrin uses range from 0.551 to 93,800 µg/Kg_{oc}. These estimates are compared and supplemented with analysis of available California surface water monitoring data from Cal DPR. The maximum concentration of deltamethrin, reported by the California Department of Pesticide Regulation surface water database was 0.231 µg/L. This value is roughly 1.2 times higher than the highest peak model-estimated environmental concentration and slightly exceeds the limit of solubility of the chemical in water. The maximum sediment concentration was 0.046 µg/kg. It appears that PRZM/EXAMS provided suitable conservative EECs for deltamethrin exposure.

6.2. Effects Assessment Uncertainties

6.2.1. Data Gaps and Uncertainties

Data gaps in the ecotoxicity profile for deltamethrin are noted for the following taxa:

1. Avian (Passerine) acute oral toxicity;
2. Whole sediment invertebrate life cycle (freshwater and estuarine/marine);
3. Aquatic non-vascular plants (selected taxa); and
4. Terrestrial plants (selected monocots and dicots).

Passerine Acute Toxicity. The lack of toxicity data with passerine species leads to uncertainty in the assessment of acute risk to birds (CCR) and by extension, terrestrial-phase amphibians (CTS) and reptiles (SFGS). Specifically, this uncertainty relates to the potential for greater sensitivity of passerine species compared to the currently tested avian species (bobwhite quail, mallard) due to their smaller size and differences related to toxicokinetics and toxicodynamics. For one pyrethroid in particular (formulated beta cyfluthrin), Addy-Orduna *et al.* (2011) found that canary (*Serinus sp.*; Passeriformes) was 13X more sensitive on an acute oral basis compared to the eared dove (*Zenaida auriculata;* Columbiformes). If deltamethrin is similarly more toxic to passerine species, a greater number of uses may exceed the acute risk to listed species LOC for birds. However, this would not alter the overall risk determination to these species, which is LAA.

Whole Sediment Invertebrate Life Cycle Toxicity. Based on the toxicity, exposure and persistence of deltamethrin, chronic (life cycle) whole sediment toxicity tests would be required. These tests have been requested as part of the ongoing registration review of deltamethrin but were not submitted in time for this assessment. The current assessment relies on 10-d (subchronic) tests with the amphipod, *Hyalella azteca*. Since reproduction is not assessed in the 10-d study, the chronic risks to benthic invertebrates may be underestimated in this assessment. This uncertainty, however, would not impact the overall LAA determination for direct effects to CFWS or listed species that depend on benthic invertebrates because the LOC was already exceeded based on the 10-d toxicity study results.

Aquatic non-vascular plants (selected taxa). Toxicity data for aquatic non-vascular plants were not available for saltwater species (*e.g., Skeletonema costatum*) or blue-green algae (*e.g., Anabaena flos-aquae*). To the extent that these taxa are more sensitive than currently tested species of green algae, risks to aquatic plants may be underestimated. It is noted, however, that these taxa would have to be several orders of magnitude more sensitive than green algae, *Pseudokirchneriella subcapitata*, in order to impact the risk assessment findings for non-vascular plants, which is considered highly unlikely.

Terrestrial plants (selected monocots and dicots). Terrestrial plant toxicity data were available for only 4 dicot and 2 monocot species. Typically, data are required for 6 species of dicots and 4 species of monocots. To the extent that these other species of dicots or monocots are more sensitive than currently tested species, risks to terrestrial plants may be underestimated. It is further noted that the highest test concentration of deltamethrin evaluated in the terrestrial plant toxicity tests for the terrestrial plants (0.011 lb a.i./A) is substantially lower than the maximum rate determined for the California uses (1.94 lb a.i./A). Because no adverse effects were observed in the terrestrial plant toxicity studies, there is uncertainty regarding the effect of deltamethrin at higher application rate. Therefore, in this assessment, the upper bounds of the non-definitive RQs were used to evaluate the potential effects on terrestrial plants as a conservative approach to address this uncertainty. This may lead to overestimation of the potential risk to terrestrial plants from the assessed uses of deltamethrin.

6.2.2. Use of Surrogate Species Effects Data

Guideline toxicity tests and open literature data on deltamethrin are not available for aquatic-phase amphibian; therefore, freshwater fish are used as surrogate species for aquatic-phase amphibians and the CTS. The available open literature information on deltamethrin toxicity to aquatic-phase amphibians shows that acute toxicity to aquatic-phase amphibians (7-d LC50 = 6.06 µg a.i./L; Aydin-Sinan *et al.,* 2012) is about 10 times less sensitive than freshwater fish (96-h LC_{50} = 0.58 µg a.i./L). Therefore, endpoints based on freshwater fish ecotoxicity data are assumed to be protective of potential direct effects to aquatic-phase amphibians including the CTS, and extrapolation of the risk conclusions from the most sensitive tested species to the aquatic-phase CTS is likely to overestimate the potential risks to those species. Efforts are made to select the organisms most likely to be affected by the type of compound and usage pattern; however, there is an inherent uncertainty in extrapolating across phyla. In addition, the Agency's LOCs are intentionally set very low, and conservative estimates are made in the screening level risk assessment to account for these uncertainties.

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. To the extent to which sublethal effects are not considered in this assessment, the potential direct and indirect effects of deltamethrin on listed species may be underestimated.

6.2.4. Synergism with PBO and Toxicity of Chemical Mixtures

Available information discussed in Section 4.4 indicates that deltamethrin toxicity may be enhanced in the presence of PBO, which is among selected product formulations. This toxicity enhancement has been reported up to 7.5X for the pond snail, *Lymnaea acwninutu* and up to 4X for the grain borer, *Prostephanus truncatus*. Should these toxicity enhancements be representative of listed species considered in this assessment, then selected uses of deltamethrin formulations that contain PBO may result in RQ values that are greater than those calculated here by similar magnitudes.

It is expected that the toxic effect of deltamethrin in combination with other pesticides used in the environment is likely to be a function of many factors including, but not necessarily limited to: (1) the exposed species, (2) the co-contaminants in the mixture, (3) the ratio of deltamethrin and co-contaminant concentrations, (4) differences in the pattern and duration of exposure among contaminants, and (5) the differential effects of other physical/chemical characteristics of the receiving waters (*e.g.* organic matter present in sediment and suspended water). Quantitatively predicting the combined effects of all these variables on mixture toxicity to any given taxa with confidence is beyond the capabilities of the available data and methodologies, such as modeling with PRZM/EXAMS. The focus of this assessment is on the parent material, deltamethrin. Based on a qualitative evaluation of the best available data and the Agency's existing guidance, it is reasonable to conclude that these formulations may exhibit a synergistic effect in some instances. Given that the active and inert ingredients would not be expected to have similar mechanisms of action, metabolites or toxicokinetic behavior, it is also reasonable to conclude that an assumption of dose-addition would be inappropriate in some instances. However, the limited size of the data set and the variation in co-formulated pesticides prohibits any definitive conclusions.

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 deltamethrin to CTS (all DPS: CTS-SC, CTS-CC, CTS-SB), BCB, VELB, DS, CCR, CFWS, SFGS and TG and the designated critical habitat of BCB, TG, DS, CTS-CC, CTS-SB and VELB.

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

A summary of the risk conclusions and effects determinations for CTS (all DPS: CTS-SC, CTS-CC, CTS-SB), BCB, VELB, 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.**

Table 7-1. Effects Determination Summary for Effects of Deltamethrin on the CTS (all DPS: CTS-SC, CTS-CC, CTS-SB), BCB, VELB, DS, CCR, CFWS, SFGS and TG

Species	Effects Determination	Basis for Determination
California Tiger Salamander (CTS, all DPS) (*Ambystoma californiense*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Aquatic-phase (Eggs, Larvae, and Adults): Freshwater fish (surrogate for aquatic phase amphibians) acute RQs range from from **<0.01 to 0.34** and chronic RQs ranged from **<0.01 to 11.8**. Even though none of the acute RQ values exceed the risk to non-listed species LOC (0.5), 31 out of 45 scenarios (69%) exceed the acute risk to listed species LOC (0.05) . Furthermore, about 36% of the uses (16 of 45) exceed the chronic risk LOC (1). One ecological incident has been reported for fish, which is consistent with the risk hypothesis and risk findings. The individual effects chance for acute risk is as high as 1 in 57.1. Given the number and diversity of registered uses (agricultural, industrial, commercial, public, and residential) spanning a large variety of use sites and geographical regions throughout the entire state of California, and the potential for year-round use, it is expected that deltamethrin use is likely to spatially and temporally coincide with all of the critical life-stages of the aquatic phase CTS (all DPS), and disrupt its life-cycle at various points.
		Terrestrial-phase (Juveniles and Adults) Based on T-REX modeling, one RQ exceeds the acute risk to non-listed species LOC (0.5) for birds on a dose-basis, but not on a dietary based RQ (ornamentals, ant mound treatment), The acute risk to listed species LOC (0.1) is exceeded by both the dose and diet-based acute RQ for this scenario, as is the chronic risk LOC (1). The range of acute dose-based RQ values across all scenarios is **<0.01 to <0.74**; the range of acute dietary based RQs is **<0.01 to <0.23**; finally, the range of chronic dietary-based RQs is **<0.01 to 2.34**. The individual effects chance for acute risk is as high as 1 in 3.60 for birds. The T-HERPS refinements for this use for terrestrial-phase amphibians results in an RQ that does not exceed the acute non-listed LOC; however, the listed species LOC and chronic LOC are both exceeded for this pesticide application scenario (acute RQ values **<0.24** to **<0.33**; chronic RQ is **2.45**). The individual effects chance for the CTS, from results from T-HERPS model refinements, is 1 in 66.1. It is noted, however, that absence label information, it was assumed that mounds would be treated up to 12 times with 7-d intervals. Although this application frequency may be unlikely, exceedance of the avian LOC is indicated even for a single application.
		Potential for Indirect Effects
		Aquatic prey items, aquatic habitat, cover and/or primary productivity Acute and chronic RQ values for freshwater fish exceeded the LOC (as indicated above for the direct effects to CTS). Acute and chronic RQ values for freshwater invertebrates exceed their respective non-listed LOC values. The acute RQ values for freshwater invertebrates (water column and benthic-dwelling) range from **0.01 to 50** (LOC=0.5) and the chronic RQ values range from **>0.21 to >7,690)** (LOC=1).

Species	Effects Determination	Basis for Determination
		Terrestrial prey items, riparian habitat Acute RQ values exceed the LOC for terrestrial invertebrates, ranging from **9.6 to 20,600**. (LOC=0.05). Acute and chronic RQ values exceed the LOC for mammals, which are both a prey item and a source of habitat via small mammal burrows. The acute RQs for small mammals range from **<0.01 to 6.81** (LOC=0.5) and the chronic RQs range from **<0.01** (dietary based) **to 84.5** (dose based) (LOC=1). Potential risk to terrestrial plants identified from several minor incident reports involving terrestrial plants and based on the upper bound of non-definitive RQ values that range from **<0.1 to <24.7**. There is uncertainty in the risk determination for terrestrial plants because the highest test concentrations (which did not elicit adverse effects) were well below the maximum application rates for many of the assessed uses, thus yielding the aforementioned non-definitive RQ values. Had sufficiently high concentrations been tested, actual RQ values may or may not exceed the terrestrial plant LOC.
Bay Checkerspot Butterfly (BCB) (*Euphydryas editha bayensis*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** Acute RQ values for terrestrial invertebrates range from **9.6 to 20,600**, exceeding the acute risk LOC for the BCB (LOC=0.05). The individual effects probability associated with the acute RQ is 1 in 1.00 for all the application scenarios. Given the number and diversity of registered uses (agricultural, industrial, commercial, public, and residential) spanning a large variety of use sites and geographical regions throughout the entire state of California, and the potential for year-round use, it is expected that deltamethrin use is likely to spatially and temporally coincide with all of the critical life-stages of the BCB, and disrupt its life-cycle at various points. **Potential for Indirect Effects** Potential risk to terrestrial plants identified from several minor incident reports involving terrestrial plants and based on the upper bound of non-definitive RQ values that range from **<0.1 to <24.7**. There is uncertainty in the risk determination for terrestrial plants because the highest test concentration (0.011 lb a.i./A) which did not elicit adverse effects are well below the maximum application rates for many of the assessed uses, thus yielding an unbounded NOAEC value. Had sufficiently high concentrations been tested, the NOAEC may be substantially higher thus impacting whether or not the listed species LOC for terrestrial plants is exceeded.
Valley Elderberry Longhorn Beetle (VELB) (*Desmocerus californicus dimorphus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** As indicated for the BCB, acute RQ for terrestrial invertebrates exceed the acute risk to listed species LOC of 0.05 for all foliar applications assessed by a wide margin. The individual effects probability associated with the acute RQ is 1 in 1.00 for all the application scenarios. Given the number and diversity of registered uses (agricultural, industrial, commercial, public, and residential) spanning a large variety of use sites and geographical regions throughout the entire state of California, and the potential for year-round use, it is expected that deltamethrin use is likely to spatially and temporally coincide with all of the critical life-stages of the VELB, and disrupt its life-cycle at various points. **Potential for Indirect Effects**

Species	Effects Determination	Basis for Determination
		As indicated previously for the BCB, potential risks to terrestrial plants is presumed based on several minor incident reports and the upper bound of non-definitive RQ values for monocots and dicots, which range from **<0.1 to <24.7.** There is uncertainty in the risk determination for terrestrial plants because the highest test concentration (0.011 lb a.i./A) which did not elicit adverse effects are well below the maximum application rates for many of the assessed uses, thus yielding an unbounded NOAEC value. Had sufficiently high concentrations been tested, the NOAEC may be substantially higher thus impacting whether or not the listed species LOC for terrestrial plants is exceeded.
Delta Smelt (DS) (*Hypomesus transpacificus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** Acute RQs for freshwater and estuarine/marine fish range from from **<0.01 to 0.34** and chronic RQs ranged from **<0.01 to 11.8**. Even though none of the acute RQ values for freshwater and estuarine/marine fish exceed the risk to non-listed species LOC (0.5), 31 (or 69%) exceed the acute risk to listed species LOC (0.05). Furthermore, about 36% of the uses (16 of 45) exceed the chronic risk LOC (1) for freshwater fish and 27% (12 of 45) exceed the chronic LOC for estuarine/marine fish. One ecological incident has been reported for fish, which is consistent with the risk hypothesis and risk findings. The individual effects chance for acute risk is as high as 1 in 57.1. Given the number and diversity of registered uses (agricultural, industrial, commercial, public, and residential) spanning a large variety of use sites and geographical regions throughout the entire state of California, and the potential for year-round use, it is expected that deltamethrin use is likely to spatially and temporally coincide with all of the critical life-stages of the DS, and disrupt its life-cycle at various points. **Potential for Indirect Effects** Acute and chronic RQ values for freshwater invertebrates exceed their respective non-listed LOC values. The acute RQs for freshwater invertebrates (water column and benthic-dwelling) range from **0.01 to 50** (LOC=0.5) and the chronic RQ range from **>0.21 to >7,690)** (LOC=1). For estuarine/marine invertebrates (benthic and pelagic), acute RQs range from **0.02 to 54.1** and chronic RQs range from **0.02 to 274**, exceeding the LOCs for DS prey. As indicate previously for BCB and VELB, potential risk to terrestrial plants is presumed based on several minor incident reports involving terrestrial plants and the upper bound of non-defnitive terrestrial plant RQ values which exceed the LOC of 1.
Clapper Rail (CCR) (*Rallus longirostris obsoletus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects** Based on T-REX modeling, one RQ exceeds the acute risk to non-listed species LOC (0.5) for birds on a dose-basis, but not on a dietary based RQ (ornamentals, ant mound treatment), The acute risk to listed species LOC (0.1) is exceeded by both the dose and diet-based acute RQ for this scenario, as is the chronic risk LOC (1). The range of acute dose-based RQs is **<0.01 to <0.74**; the range of acute dietary based RQs is **<0.01 to <0.23**; finally, the range of chronic dietary-based RQs is **<0.01 to 2.34**. The individual effects chance for acute risk is as high as 1 in 3.60 for birds. **Potential for Indirect Effects**

Species	Effects Determination	Basis for Determination
		Potential indirect effects on birds (as prey to the CCR), is indicated as described above for direct effects. Potential indirect effects are also indicated based on risks to mammals (used as prey), which are described above for indirects effects on the CTS and risks to fish and aquatic invertebrates as identified for the CTS, TG, DS and CFWS. A potential for indirect effects is also indicated based on effects on terrestrial invertebrates as described above for the BCB and VELB and effects on freshwater and estuarine/marine invertebrates as indicated above for the DS and CTS. Therefore, acute and chronic RQ values exceed the non-listed species LOC for multiple taxonomic groups of prey. Potential risk to terrestrial plants identified from several minor incident reports involving terrestrial plants and exceedence of the plant LOC by the upper bounds of non-definitive RQ values that range from **<0.1 to <24.7**.
California Freshwater Shrimp (CFWS) (*Syncaris pacifica*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Acute and chronic RQ values for freshwater invertebrates exceed their respective non-listed LOC values. The acute RQs for freshwater invertebrates (water column and benthic-dwelling) range from <**0.01 to 50** (LOC=0.05) and the chronic RQ range from **>0.21 to >7,690)** (LOC=1). All uses (100%) exceed the acute risk to listed species LOC (0.05) (water column); and ,100% of the uses exceed the chronic risk LOC (1) (water column). The individual effects chance for acute risk is as high as 1 in 1. Given the number and diversity of registered uses (agricultural, industrial, commercial, public, and residential) spanning a large variety of use sites and geographical regions throughout the entire state of California, and the potential for year-round use, it is expected that deltamethrin use is likely to spatially and temporally coincide with the CFWS, and disrupt its life-cycle at various points.
		Potential for Indirect Effects
		Acute and chronic RQs for freshwater invertebrates (used as prey) exceed the non-listed species LOC as indicated above. Acute and chronic RQ values also exceed the LOCs for freshwater benthic invertebrates as shown above (acute non-listed LOC=0.5 and the chronic non-listed LOC=1). Potential risk to terrestrial plants identified from several minor incident reports involving terrestrial plants and exceedence of the plant LOC by the upper bounds of non-definitive RQ values that range from **<0.1 to <24.7**.
San Francisco Garter Snake (SFGS) (*Thamnophis sirtalis tetrataenia*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Based on T-REX modeling, one RQ exceeds the acute risk to non-listed species LOC (0.5) for birds on a dose-basis, but not on a dietary based RQ (ornamentals, ant mound treatment), The acute risk to listed species LOC (0.1) is exceeded by both the dose and diet-based acute RQ for this scenario, as is the chronic risk LOC (1). The range of acute dose-based RQs is **<0.01 to <0.74**; the range of acute dietary based RQs is **<0.01 to <0.23**; finally, the range of chronic dietary-based RQs is **<0.01 to 2.34**. The individual effects chance for acute risk is as high as 1 in 3.60 for birds. The T-HERPS refinements for snakes results in acute and chronic RQs that do not exceed any LOCs. The chance of an individual effect is estimated to be 1 in 2.51×10^6. Therefore, the potential for direct effects on the SFGS is considered low.
		Potential for Indirect Effects

Species	Effects Determination	Basis for Determination
		Acute and chronic RQ values for prey species (fish and amphibians, freshwater invertebrates, terrestrial invertebrates and small mammals all exceed their respective LOC values as indicated above. Potential risk to terrestrial plants is presumed based on several minor incident reports involving terrestrial plants and the upper bound of non-difinitive RQ values that exceed the LOC that range from **<0.1 to <24.7**.
Tidewater Goby (TG) (*Eucyclogobius newberryi*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		The potential for direct effects to the TG is indicated as described previously for the DS. Given the number and diversity of registered uses (agricultural, industrial, commercial, public, and residential) spanning a large variety of use sites and geographical regions throughout the entire state of California, and the potential for year-round use, it is expected that deltamethrin use is likely to spatially and temporally coincide with the TG, and disrupt its life-cycle at various points.
		Potential for Indirect Effects
		The potential for indirects effects on the TG from reduction in prey (freshwater and estuarine/marine invertebrates), and habitat (terrestrial plants) is indicated as described previously for the DS.

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

Species	Effects Determination	Basis for Determination
California Tiger Salamander (CTS-SB and CTS-CC) (*Ambystoma californiense*)	Habitat Modification	Direct effects on the CTS-CC and CTS-SB (both terrestrial phase and aquatic phase) and effects on small mammals which provide habitat via burrows. Indirect effects via reduction in aquatic and terrestrial prey items. Potential risk to terrestrial plants identified from several minor incident reports involving terrestrial plants and potential exceedence of LOC based on the upper bounds of non-definitive RQ values.
Bay Checkerspot Butterfly (BCB) (*Euphydryas editha bayensis*)	Habitat Modification	Direct effects BCB. Potential risk resulting from effects to terrestrial plants (including its obligate host plant, the drwarf plantain) based on several minor incident reports involving terrestrial plants and exceedence of the listed species LOC for several of the application scenarios.
Valley Elderberry Longhorn Beetle (VELB) (*Desmocerus californicus dimorphus*)	Habitat Modification	Direct effects VELB. Potential risk resulting from effects to terrestrial plants (including its obligate host plant, elderberry trees) based on several minor incident reports involving terrestrial plants and exceedence of the listed species LOC for several of the application scenarios.
Delta Smelt (DS) (*Hypomesus transpacificus*)	Habitat Modification	Direct effects on DS and indirect effects on aquatic prey. Potential risk to terrestrial plants based on several minor incident reports involving terrestrial plants and potential exceedence of LOC based on the upper bounds of non-definitive RQ values.
Tidewater Goby (TG) (*Eucyclogobius newberryi*)	Habitat Modification	Direct effects on TG and indirect effects on aquatic prey. Potential risk to terrestrial plants based on several minor incident reports involving terrestrial plants and potential exceedence of LOC based on the upper bounds of non-definitive RQ values.

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												
	Freshwater Vertebrates (includes DS, TG, CTS [all DPS])[1]		Freshwater Invertebrates (includes CFWS)[2]		Freshwater Benthic Invertebrates[3]		DS, TG and Estuarine/ Marine Vertebrates[4]		Estuarine/Marine Invertebrates[5]		Estuarine/ Marine Benthic Invertebrates[5]		Vascular and non-vascular plants[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Tree nuts crop group 14 (Aerial, foliar)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Tree nut crop group 14 (Aerial, dormant)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No
Corn (field, pop) (Aerial)	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No
Corn (pop) (Dust)	No	No	Yes	No	No	Yes	No	No	Yes	Yes	Yes	No	No
Sweet corn (Aerial)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No
Sweet corn (Ground)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Sweet corn (Dust)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No
Cotton (Aerial)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Pome fruits (Aerial)	No	No	Yes	No	No	Yes	No	No	Yes	Yes	No	No	No
Cucurbits (Aerial)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No
Cucurbits (Ground)	No	No	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes	No	No
Cucurbits (Dust)	No	No	Yes	Yes	No	No	No	No	Yes	No	No	No	No
Garlic, leeks, onion, shallots (Aerial)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No
Garlic, leeks, onion, shallots (Dust)	No	No	Yes	Yes	No	Yes	No	No	Yes	No	No	No	No
Root vegetables crop subgroup 1B; Tuberous and corm vegetables crop subgroup 1C; (Aerial)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No
Same crops as described in the previous row (Dust)	No	No	Yes	Yes	No	Yes	No	No	Yes	No	No	No	No
Artichokes (Aerial)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Artichokes (Dust)	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	Freshwater Vertebrates (includes DS, TG, CTS [all DPS])[1]		Freshwater Invertebrates (includes CFWS)[2]		Freshwater Benthic Invertebrates[3]		DS, TG and Estuarine/ Marine Vertebrates[4]		Estuarine/Marine Invertebrates[5]		Estuarine/ Marine Benthic Invertebrates[5]		Vascular and non-vascular plants[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato (Aerial)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No
Eggplant, ground-cherry, pepinos, peppers, tomatillo, tomato (Dust)	No	No	Yes	Yes	No	Yes	No	No	Yes	No	No	No	No
Sorghum (Aerial)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No
Canola, rapeseed, crambe (Aerial)	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No
Ornamental and/or Shade Trees; Ornamental Ground Cover (Ground)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Ornamental and/or Shade Trees; Ornamental Ground Cover (Dust)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	No
Ornamental Herbaceous Plants (Ground)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Ornamental Herbaceous Plants (Granular)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Ornamental sod farms (Ground)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Ornamental sod farms (Granular)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Ornamental lawns and turf (Ground)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Golf Course Turf, Recreational Area Lawns (Ground)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	Freshwater Vertebrates (includes DS, TG, CTS [all DPS])[1]		Freshwater Invertebrates (includes CFWS)[2]		Freshwater Benthic Invertebrates[3]		DS, TG and Estuarine/ Marine Vertebrates[4]		Estuarine/Marine Invertebrates[5]		Estuarine/ Marine Benthic Invertebrates[5]		Vascular and non-vascular plants[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Same crops as in the previous row (Granular)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Same crops as in the previous rows (ant mound treatment) (Ground)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Residential Lawns (Ground, six apps)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Residential Lawns (Ground, 12 apps)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Residential Lawns (Granular)	No	No	No	Yes	No	No	No	No	Yes	No	No	No	No
Household Domestic Dwellings Outdoors Premises, Paths/Patios (Ground)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Household Domestic Dwellings Outdoors Premises (Crack & crevice, and/or spot treatment)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Household Domestic Dwellings Outdoors Premises (Granular or Dust)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Wood Protection Treatment to Buildings/ Products (Crack & crevice, and/or spot treatment)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Wood Protection Treatment to Buildings/ Products (Soil drench treatment)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	Freshwater Vertebrates (includes DS, TG, CTS [all DPS])[1]		Freshwater Invertebrates (includes CFWS)[2]		Freshwater Benthic Invertebrates[3]		DS, TG and Estuarine/ Marine Vertebrates[4]		Estuarine/Marine Invertebrates[5]		Estuarine/ Marine Benthic Invertebrates[5]		Vascular and non-vascular plants[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Non-agricultural Rights-of-Way (Ground)	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No
Non-agricultural Rights-of-Way (Perimeter Treatment)	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	No	No
Paved Areas (Crack & crevice, and/or spot treatment)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Utilities, Utility Poles/Rights-of-Way (Granular)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Sewage treatment	No	No	Yes	Yes	NA	NA	No	No	Yes	No	NA	NA	No

NA = Not Available

1 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.

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

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

4 A yes in this column indicates a potential for direct effects to DS and TG and indirect effects to CCR.

5 A yes in this column indicates a potential for indirect effects to CCR, TG, and DS.

6 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 (all DPS) and Amphibians[3]		SFGS and Reptiles[4]		BCB, VELB, and Invertebrates	Dicots[6]	Monocots[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute[5]		
Canola, rapeseed, crambe	No	No	No	No	No	No	No	No	Yes	No	No
Corn (field, pop)	No	No	No	No	No	No	No	No	Yes	No	No
Cotton	No	Yes	No	No	No	No	No	No	Yes	No	No
Cucurbits, Tomato, Tamillo, Eggplant, Ground Cheery, Pepinos	No	Yes	No	No	No	No	No	No	Yes	No	No
Garlic, Leeks, Onion, Shallots	No	Yes	No	No	No	No	No	No	Yes	No	No
Pome Fruits	No	No	No	No	No	No	No	No	Yes	No	No
Potato & Root Vegetables (1B); Tuberous & Corn Vegetables (1C); Artichokes	No	Yes	No	No	No	No	No	No	Yes	No	No
Sorghum	No	No	No	No	No	No	No	No	Yes	No	No
Sweet Corn	No	Yes	No	No	No	No	No	No	Yes	No	No
Tree Nuts (foliar and dormant)	No	Yes	No	No	No	No	No	No	Yes	No	No
Commercial Outdoor Premises	No	No	No	No	No	No	No	No	Yes	No	No
Domestic Dwellings, Barns, Barnyards (incl. outdoor premises)	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas	No	No	No	No	No	No	No	No	Yes	No	No
Non-Agr. Rights-of-Way, Fencerows, Hedgerows, Solid Waste Sites, Paved Areas (Perimeter Treatment)	No	No	No	No	No	No	No	No	Yes	No	No
Ornamental Plants (herbaceous, non-flowering, woody) Lawns and turf	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes

Uses	Potential for Effects to Identified Taxa Found in the Terrestrial Environment										
	Small Mammals[1]		CCR and Small Birds[2]		CTS (all DPS) and Amphibians[3]		SFGS and Reptiles[4]		BCB, VELB, and Invertebrates	Dicots[6]	Monocots[6]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute[5]		
Ornamental Plants (Shade Trees, Ground Cover)	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Ornamental Plants (Shade Trees, Ground Cover): Ant Mound Treatment	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Ornamental Sod Farms, Lawns, Turf, Recreational Areas	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Residential Lawns (1)	No	No	No	No	No	No	No	No	Yes	No	No
Residential Lawns (2)	No	No	No	No	No	No	No	No	Yes	No	No
Domestic Dwellings (inlcuding outdoor premises) (Granular)	No	N/A	No	N/A	No	N/A	No	N/A	No	No	No
Ornamental Plants (herbaceous, non-flowering, woody) (Granular)	Yes	N/A	Yes	N/A	Yes	N/A	Yes	N/A	No	Yes	Yes
Ornamental Sod Farms (Granular)	Yes	N/A	No	N/A	No	N/A	No	N/A	No	Yes	Yes
Residential Lawns (Granular)	No	N/A	No	N/A	No	N/A	No	N/A	No	No	No
Pet Living Quarters (Granular)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	No	No
Utility Poles, Utility Rights of Way (Granular)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	Yes	Yes

N/A=does not apply

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

2 A yes in this column indicates a potential for direct effects to CCR and indirect effects to the CCR, SFGS, CTS-CC, CTS-SC, and CTS-SB.

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

4 A yes in this column indicates the potential for direct and indirect effects to SFGS, and other reptiles.

5 A yes in this column indicates a potential for direct effect to BCB and VELB and indirect effects to SFGS, CCR, CTS-CC, CTS-SC, and CTS-SB.

6 A yes in this column indicates a potential for indirect effects to BCB, VELB, SFGS, CCR, CTS-CC, CTS-SC, CTS-SB, TG, DS, and CFWS. For the BCB and VELB this is based on the listed species LOC because of the obligate relationship with terrestrial monocots and dicots. For other species, the LOC exceedances are evaluated based on the LOC for non-listed species.

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 the CTS (all DPS: CTS-SC, CTS-CC, CTS-SB), BCB, VELB, 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.

8. References

A bibliography of ECOTOX references, identified by the letter E followed by a number, is located in Appendix H.

Adam, O., F. Degiorgi, G. Crini, P.M. Badot. 2010. High sensitivityof *Gammarus sp.* juveniles to deltamethrin: Outcomes for risk assessment. Ecotoxicology and Environmental Safety 73 (2010), 1402-1407.

Amweg, E.L., D.P, Weston, and N.M. Ureda. 2005. Use and toxicity of pyrethroid pesticides in the Central Valley, California, USA. *Environ. Toxicol & Chem.*, 24 (4), pp. 966–972.

Arnot, J. A., & Gobas, F. A. P. C. 2004. A food web bioaccumulation model for organic chemicals in aquatic ecosystems. *Environmental Toxicology and Chemistry, 23*(10), 2343-2355.

Cao, Z., Shafer, T., Murray, T. 2011. Mechanisms of Pyrethroid Insecticide-Induced Stimulation of Calcium Influx in Neocortical Neurons. J Pharmacol Exp Ther. 336: 197–205.

Clark, J.M and F. Matsumura. 1987. The action of two classes of pyrethroids on the inhibition of brain Na-Ca and Ca + Mg ATP hydrolyzing activities of the American cockroach, *Comp. Biochem. Physiol. C.* 86 (1987) (1), pp. 135–145.

Cover Jr., J. F., & Boyer, D. M. 1988. Captive reproduction of the San Francisco garter snake, *Thamnophis sirtalis tetrataenia*. *Herpetol. Rev., 19*, 29-33.

Day, K. E. and Maguire, R. J. (1990), Acute toxicity of isomers of the pyrethroid insecticide deltamethrin and its major degradation products to *Daphnia magna*. Environmental Toxicology and Chemistry, 9: 1297–1300. doi: 10.1002/etc.5620091009.

Day, K.E. 1991. Effects of dissolved organic carbon on accumulation and acute toxicity of fenvalerate, deltamethrin and cyhalothrin to *Daphnia magna* (Straus). Environ. Tox. Chem. 10:91-101.

Delgado- Moreno, L, L. W u and J. Gan. 2010. Effect of Dissolved Organic Carbon on Sorption of Pyrethroids to Sediments. Environ. Sci. Technol. *44* (22), 8473–8478.

DiToro, D.M., C.S. Zarba, D.J. Hansen, W.J. Berry, R.C. Swartz, C.E. Cowan, S.P. Pavlou, H.E. Allen, N.A. Thomas, P.R. Paquin. 1991. Technical basis for establishing sediment quality criteria for nonionic organic chemicals using equilibrium partitioning. Environ. Toxicol. Chem. 10:1541-1583.

Duncan, S. 1998. *The Evaluation of Synergistic Action in the Laboratory and Field*. pp 173-198 In: Piperonyl Butoxide. Academic Press. London..

Fellers, G. M., McConnell, L. L., Pratt, D., & Datta, S. 2004. Pesticides in Mountain Yellow-Legged Frogs (*Rana Mucosa*) from the Sierra Nevada Mountains of California. *Environmental Toxicology and Chemistry, 23*(9), 2170-2177.

Food and Agriculture Organization of the United Nations. FAO PESTICIDE DISPOSAL SERIES 8. Assessing Soil Contamination: A Reference Manual. Appendix 2. Parameters of pesticides that influence processes in the soil. Editorial Group, FAO Information Division: Rome, 2000. http://www.fao.org/DOCREP/003/X2570E/X2570E00.htm.

Jordan, T. E., Cornwell, J. C., Walter, R. B., & Anderson, J. T. 2008. Changes in phosphorus biogeochemistry along an estuarine salinity gradient. *Limnology and Oceanography 53*(1), 172-184.

King, R. B. 2002. Predicted and observed maximum prey size - snake size allometry. *Functional Ecology, 16*, 766-772.

Laskowski, D.A., 2002. Physical and chemical properties of pyrethroids. Rev. Environ. Contam. Toxicol. 2002; 174:49-170.
LeNoir, J. S., McConnell, L. L., Fellers, G. M., Cahill, T. M., & Seiber, J. N. 1999. Summertime Transport of Current-use pesticides from California's Central Valley to the Sierra Nevada Mountain Range, USA. *Environmental Toxicology and Chemistry, 18*(12), 2715-2722.
Maguire, R.J. 1990. Chemical and photochemical isomerization of deltamethrin. *J. Agric. Food Chem.*, **1990**, *38* (7), pp 1613–1617.
Maguire, R.J. 1992. Aquatic environmental fate of deltamethrin. War. Sci. Tech. 25 (11) 99-102, 1992.
McConnell, L. L., LeNoir, J. S., Datta, S., & Seiber, J. N. 1998. Wet deposition of current-use pesticides in the Sierra Nevada mountain range, California, USA. *Environmental Toxicology and Chemistry, 17*(10), 1908-1916.
Means, J. C. 1995. Influence of salinity upon sediment-water partitioning of aromatic hydrocarbons. *Marine Chemistry, 51*(1), 3-16.
Muir, D.C.G., Rawn, G.P., Townsend, B.E., Lockhart, W.L. Greenhalgh, R. 1985. Bioconcentration of cypermethrin, deltamethrin, fenvalerate and permethrin by *Chironomus tentans* larvae in sediment and water. Environ. Tox. Chem. 4:51-61.
Muir, D.C.G., Hobden, B.R., Servos, M.R. 1994. Bioconcentration of pyrethroid insecticides and DDT by rainbow trout: uptake, depuration, and effect of dissolved organic carbon. Aq. Toxicol. 29:223-240.
Sahay N, Singh O, Agarwal R. 1991. Synergistic effect of piperonyl butoxide on the toxicity of synthetic pyrethroids in the snail, *Lymnaea (Radix) acwninutu.* J Med. Appl. Malacol. 3: 107-111.
Shen, M.F., A. Kumar, S.Y. Ding, and S. Grocke. 2012. Comparative study on the toxicity of pyrethroids, α-cypermethrin and deltamethrin to *Ceriodaphnia dubia*. Ecotoxicology and Environmental Safety 78 (2012) 9-13.
Sparling, D. W., Fellers, G. M., & McConnell, L. L. 2001. Pesticides and amphibian population declines in California, USA. *Environmental Toxicology and Chemistry, 20*(7), 1591-1595.
Swarzenski, P. W., Porcelli, D., Andersson, P. S., & Smoak, J. M. 2003. The behavior of U- and Th-series nuclides in the estuarine environment. Reviews in Mineralogy and Geochemistry *REviews in Mineralogy and Geochemistry, 52*(1), 577-606.
Tan, J. and A.R. McCaffery. 2007. Efficacy of various pyrethroid structures against a highly metabolically resistant isogenic strain of *Helicoverpa armigera* (Lepidoptera: Noctuidae) from China. *Pest Manag Sci* 63:960–968 (2007).
Trenham, P. C., Shaffer, H. B., Koenig, W. D., & Stromberg, M. R. 2000. Life history and demographic variation in the California Tiger Salamander (*Ambystoma californiense*). *Copeia, 2*, 365-377.
Trimble, A.J., D.P. Weston, J.B. Belden, and M.J. Lydy. 2009. Identification and Evaluation of Pyrethroid Insecticide Mixtures in Urban Sediments. Environmental Toxicology and Chemistry, Vol. 28, No. 8, pp. 1687–1695, 2009.
USEPA. 1993. *Wildlife Exposure Handbook*. Office of Research and Development, United States Environmental Protection Agency. Available at http://www.epa.gov/ncea/pdfs/toc2-37.pdf (Accessed June 19, 2009).
USEPA. 1998. *Guidelines for Ecological Risk Assessment*. United States Environmental Protection Agency (USEPA). Risk Assessment Forum. Office of Research and

Development. Available at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=12460 (Accessed June 19, 2009).

USEPA. 2002. Technical Basis for the derivation of Equilibrium Partitioning Sediment Guidelines (ESGs) for the Protection of Benthic Organisms: Nonionic Organics [Draft]. EPA Document No. 822R02041. October 2002.

USEPA. 2004. *Overview of the Ecological Risk Assessment Process in the Office of Pesticide Programs*. United States Environmental Protection Agency (USEPA). Environmental Fate and Effects Division. Office of Pesticide Programs. Available at http://www.epa.gov/espp/consultation/ecorisk-overview.pdf (Accessed June 19, 2009).

USEPA, 2007. Exposure and Fate Assessment Screening Tool (E-FAST) Version 2.0 Documentation Manual. Prepared for the USEPA, Office of Pollution Prevention and Toxics. Prepared by Versar, Inc., Springfield, VA. This manual can be found at the following website: http://www.epa.gov/oppt/exposure/pubs/efast.htm (accessed February 25, 2013).

USEPA, 2008. *OPPTS 835.6100 Terrestrial Field Dissipation*. EPA 712-C-08-020. October 2008. Office of Prevention, Pesticides, and Toxic Substances. United States Environmental Protection Agency. Available at http://www.epa.gov/ocspp/pubs/frs/publications/Test_Guidelines/series835.htm (accessed 01/16/2013).

USEPA. 2010a. EFED Revised Registration Review Problem Formulation for Deltamethrin. Memorandum from the Environmental Fate and Effects Division to Pesticide Re-evaluation Division dated March 23, 2010. DP Barcode D368590, Document ID EPA-HQ-OPP-2009-0637-0003 at www.regulations.gov (accessed January 15, 2013).

USEPA. 2010b. Deltamethrin Final Work Plan. Memorandum from the Environmental Fate and Effects Division to Pesticide Re-evaluation Division dated September 13 2010, Document ID EPA-HQ-OPP-2009-0637-0019 at www.regulations.gov (accessed January 15, 2013).

USEPA. 2012. Cyfluthrin and Deltamethrin Revised Use Intensity Maps by Crop Reporting District (PC codes: 128831, 097805). Memorandum from Monisha Kaul, through Arnet Jones, to Rochelle Richardson, dated December 5, 2012.

USEPA. 2013. County-Level Usage for Beta-Cyfluthrin; Cyfluthrin; Deltamethrin; Fenpropathrin; Fipronil; Strychnine; Phenothrin; Oxyfluorfen; Fluvalinate; Tetramethrin; Ethoprop; Dimethoate; and Esfenvalerate in California in Support of a San Francisco Bay Endangered Species Assessment; Memorandum from Monisha Kaul, through Arnet Jones, to Rochelle Richardson, dated February 21, 2013.

USFWS/NMFS. 1998. *Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act. Final Draft*. United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). Available at http://www.fws.gov/endangered/consultations/s7hndbk/s7hndbk.htm (Accessed June 19, 2009).

USFWS. 2003. *Evaluation of the Clean Water Act Section 304(a) Human Health Criterion for Methylmercury: Protection for Threatened and Endangered Wildlife in California*. October 2003. Environmental Contaminants Division. Sacramento Fish and Wildlife Office. United States Fish and Wildlife Service. Available at http://www.fws.gov/sacramento/ec/Methylmercury%20Criterion%20Evaluation%20Final%20Report%20October%202003.pdf (Accessed January 25, 2010).

USFWS/NMFS/NOAA.2004. 50 CFR Part 402. Joint Counterpart Endangered Species Act Section 7 Consultation Regulations; Final Rule. *Federal Register* Volume 69. Number 20.Pages 47731-47762. August 5, 2004.

Velde, B., & Church, T. 1999. Rapid clay transformations in Delaware salt marshes. *Applied Geochemistry, 14*(5), 559-568.

Weston, D.P., Amweg, E. L.; Mekebri, A.; Ogle, R. S., and Lydy, M. J. 2006. Aquatic Effects of Aerial Spraying for Mosquito Control over an Urban Area. 2006; 40, 5817-5822.

Wood, T. M., & Baptista, A. M. 1993. A model for diagnostic analysis of estuarine geochemistry. *Water Resources Research 29*(1), 51-71.

Ye, J., M. Zhao, J. Liu, and W. Liu. 2010. Enantioselectivity in environmental risk assessment of modern chiral pesticides. Environmental Pollution1 58 (2010) 2371-2383.

9. MRID List

097805 Deltamethrin Chemistry/Fate Bibliography MRID-Doc# Match

161-1 Hydrolysis

MRID	Citation Reference
41651038	Smith, A. (1990) Determination of Aqueous Hydrolysis Rate Constant and Half-Life of Deltamethrin: Lab Project Number: SLI 90-4- 3310: 1719 0190 6128 715. Unpublished study prepared by Spring- born Laboratories, Inc. 57 p.

161-2 Photodegradation-water

MRID	Citation Reference
42114818	Wang, W.; Reynolds, J. (1991) Aqueous Photolysis of ?Carbon 14| Deltamethrin: Lab Project Number: RPT0065: XBL 90035. Unpub- lished study prepared by XenoBiotic Labs, Inc. 81 p.
40254101	Bowman, B.; Carpenter, M. (1987) Determination of Photodegradation of [Carbon 14]-Deltamethrin in Aqueous Solution: ABC Final #35491. Unpublished study prepared by Analytical Bio-Chemistry Laboratories, Inc. 53 p.

161-3 Photodegradation-soil

MRID	Citation Reference
42146	Holmstead, R.L.; Casida, J.E.; Ruzo, L.O. (1976?) Photochemical Re- actions of Pyrethroid Insecticides. (Unpublished study received Aug 22, 1977 under 10182-3; prepared by **Univ. of California, Dept. of Entomological Sciences,** Pesticide Chemistry and Toxi- cology Laboratory, submitted by ICI Americas, Inc., Wilmington, Del.; CDL:096330-A)

98112	Ruzo, L.O.; Holmstead, R.L.; Casida, J.E. (1977) Pyrethroid photo- chemistry: Decametrhin. **Journal of Agricultural and Food Chem- istry 25(6):1385-1394.** (Also~In~unpublished submission received Mar 25, 1982 under 2E2663; submitted by American Hoechst Corp., Somerville, N.J.; CDL:070742-D)
42114819	Wang, W.; Reynolds, J. (1991) Soil Photolysis of ?Carbon 14| Delta- methrin: Lab Project Number: RPT 0064: XBL 90034. Unpublished study prepared by XenoBiotic Labs, Inc. 84 p.

162-1 Aerobic soil metabolism

MRID	Citation Reference
41677404	Kaufman, D.; Kayser, A.; Russell, B. et al. (1990) Degradation of ?Carbon-14|-phenoxy and ?Carbon-14|-cyano-Decamethrin in Soil. Unpublished study prepared by USDA, AEQI/SEA-AR/BARC-West. 29 p.
41677405	Kaufman, D.; Kayser, A.; Russell, B. (1990) The Effect of Soil Tem- perature on the Degradation of ?Carbon-14|-cyano-Decamethrin in Soil. Unpublished study prepared by USDAAEQI/SEA-AR/BARC West. 20 p.
42114820	Wang, W. (1991) Aerobic Soil Metabolism of ?Carbon 14| Deltamethrin : Lab Project Number: RPT 0050: XBL 89097. Unpublished study prepared by XenoBiotic Labs, Inc. 109 p.

162-2 Anaerobic soil metabolism

MRID	Citation Reference
42114821	Wang, W. (1991) Anaerobic Metabolosm of ?Cabon 14| Deltamethrin: Lab project Number: RPT 0051: XBL 89098. Unpublished study pre- pared by XenoBiotic Labs, Inc. 114 p.

162-3 Anaerobic aquatic metab.

MRID	Citation Reference
44977005	Muttzall, P. (1993) Deltamethrin: Water/Sediment Biodegradation of (benzyl-(carbon-14)) Deltamethrin: Lab Project Number: MTB-90-0057-01: A50953. Unpublished study prepared by AgrEvo USA Co. 60 p.

162-4 Aerobic aquatic metab.

MRID	Citation Reference
44977005	Muttzall, P. (1993) Deltamethrin: Water/Sediment Biodegradation of (benzyl-(carbon-

14)) Deltamethrin: Lab Project Number: MTB-90-0057-01: A50953. Unpublished study prepared by AgrEvo USA Co. 60 p.

163-1 Leach/adsorp/desorption

MRID	Citation Reference
58861	Kaufman, D.D.; Russell, B.A.; Helling, C.S.; et al. (1978) Movement of Decamethrin, Cypermethrin, Permethrin and Their Degradation Products in Soil. (Unpublished study received Nov 13, 1980 under 8340-EX-6; prepared by U.S. Dept. of Agriculture, Agricultural Environmental Quality Institute, Pesticide Degradation Laboratory and Univ. of Maryland, Botany Dept., submitted by American Hoechst Corp., Somerville, N.J.; CDL:099744-H)
58905	Hu, H.C.; Migliacci, J.S.; Ferraro, C.F. (1977) Technical Report: Vapor Pressure of FMC 45498: Report No. CGP-77-10. (Unpublished study received Nov 13, 1980 under 8340-EX-6; submitted by Amer- ican Hoechst Corp., Somerville, N.J.: CDL:099740-C)
99038	Kaufman, D.D.; Russell, B.A.; Helling, C.S.; et al. (1981) Movement of cypermethrin, decamethrin, permethrin, and their degradation products in soil**. Journal of Agricultural and Food Chemistry 29 (2):239-245.** (Also~In~unpublished submission received Dec 30, 1981 under 10182-64; submitted by ICI Americas, Inc., Wilming- ton, Del.; CDL:070559-S)
41651039	Smith, A. (1990) Determination of the Adsorption and Desorption Coefficients of Deltamethrin: Lab Project Number: 90-4-3311: 1719 0190 6129 710. Unpublished study prepared by Springborn Laboratories, Inc. 44 p.
42475907 Same as 99038	Kaufman, D.; Russell, B.; Helling, C. et al. (1981) Movement of cypermethrin, decamethrin, permethrin, and their degradation products in soil. Journal of Agricultural and Food Chemistry 29(2):239-245.
42475908	Wang, W. (1991) Adsorption and Desorption of ?Carbon 14|-Br2CA in Five Soils: Lab Project Number: XBL 91061: RPT0076. Unpublished study prepared by Xenobiotic Laboratories Inc. 73 p.
42976501	Christensen, K. (1993) Deltamethrin-Determination of the Sorption and Desorption Properties: Lab Project Number: 1719. 0393.6232.710: 93-8-4912. Unpublished study prepared by Springborn Labs, Inc. 76 p.
44977006	Reynolds, J. (1992) Deltamethrin: Adsorption and Desorption of (carbon)-14-m-Phenoxybenzoic Acid in Four Soils: Lab Project Number: 92022: RPT00109: A71037. Unpublished study prepared by Xenobiotic Labs., Inc. 63 p.

164-1 Terrestrial field dissipation

MRID	Citation Reference
42114822	Mayasich, J.; Czarnecki, J. (1991) Determination of the Dissipation and Mobility of alpha-R, cis-and trans-Deltamethrin, and Br?2|CA Residues in a Minnesota Cornfield: Lab Project Number: 89-1815: 89-0063. Unpublished study prepared by Agri-Growth Research, Inc. and En-Cas Analytical Labs. 36 p.

42137505	Mayasich, J.; Czarnecki, J. (1991) Determination of the Dissipation and Mobility of alpha-R-, cis-and trans-deltamethrin, and Br2CA Residues in Louisiana Cotton Field: Lab Project Number: 89/0064 HOE: JAC1989047. Unpublished study prepared by EN-CAS Analyti- cal Labs., in cooperation with Jensen Ag. Consultant, Inc. 459 p.
42773903	Grigor, A.; McDonell, J. (1993) Deltamethrin: Field Dissipation Study in Cotton and Bareground in California: Lab Project Number: HRAV 90-0090: 90-0091: 90-0090. Unpublished study prepared by ChemAlysis Inc. and Research for Hire. 537 p.

164-2 Aquatic field dissipation

MRID	Citation Reference
42773904	Fackler, P. (1991) Tralomethrin and Deltamethrin--Comparative Environmental Fate During an Aquatic Microcosm Test: Lab Project Number: 90-10-3506: 1719.0590.6132.310. Unpublished study prepared by Springborn Labs., Inc. 264 p.

165-1 Confined rotational crop

MRID	Citation Reference
42114823	Erstfeld, K.; Larson, J.; Lange, B. (1991) C-14 Deltamethrin: Con- fined Accumulation in Rotational Crops--30 and 120 Day Experi- ments: Lab Project Number: 89-0101: EF-89-30: HLA 6187-114. Unpublished study prepared by Pan-Agricultural Labs, Inc. and Hazleton Labs, Inc. 311 p.

165-4 Bioaccumulation in fish

MRID	Citation Reference
41651040	Fackler, P. (1990) Deltamethrin: Bioconcentrationand Elimination of ?Carbon 14|-Residues by Bluegill (Lepomis macrochirus): Lab Pro- ject Number: SLI 89-11-3143: 1719 0789 6115 140. Unpublished study prepared by Springborn Laboratories, Inc. 55 p.
42475909	Fackler, P. (1992) Supplemental Information to the Study "(Deltamethrin)-Biocentration and Elimination of ?Carbon 14|-residues by Bluegill (Lepomis macrochirus)" (EPA MRID No. 41651040): Lab Project Number: 1719-0789-6115-140. Unpublished study prepared by Springborn Laboratories Inc. 13 p.
42773904	Fackler, P. (1991) Tralomethrin and Deltamethrin--Comparative Environmental Fate During an Aquatic Microcosm Test: Lab Project Number: 90-10-3506: 1719.0590.6132.310. Unpublished study prepared by Springborn Labs., Inc. 264 p.
42976502	Fischer, R. (1993) Deltamethrin--Bioaccumulation in Fish Metabolite Identification Status Report: Lab Project Number: ECOFI.385. Unpublished study prepared by Hoechst-Roussel Agri-Vet Co. 6 p.
43072701	Schocken, M. (1993) Deltamethrin--Bioconcentration Exposure with Bluegill Sunfish

	(Lepomis macrochirus) and Identification of Resulting Metabolites: Lab Project Number: 1719.0393.6231.140: #93-11-5038: 93-0017. Unpublished study prepared by Springborn Laboratories, Inc. 82 p.
43072702	Schocken, M.; Grandy, K. (1993) Issues Related to Maintaining Consistent, Nominal Concentrations of Deltamethrin in Aquatic Toxicology and Bioconcentration Studies: Lab Project Number: 90-4-3307: 90-12-3597. Unpublished study prepared by Springborn Laboratories, Inc. 16 p.

Non Guideline Selections

89998	Chapman, R.A.; Tu, C.M.; Harris, C.R.; et al. (1981) Peristence of five pyrethroid insecticides in sterile and natural, mineral and organic soil. **Bulletin of Environmental Contamination and Toxi- cology 26:513-519**. (Also in unpublished submission received Dec 30, 1981 under 10182-64; submitted by ICI Americas, Inc., Wil- mington, Del.; CDL:070559-I)
97456	Tu, C.M. (1980) Influence of five pyrethroid insecticides on mi- crobial populations and activities in soil**. Microbial Ecology 5:321-327.** (Also~In~unpublished submission received Mar 17, 1982 under 59-200; submitted by Burroughs Wellcome Co., Research Triangle Park, N.C.; CDL:247048-D)
42316902	James, J.; Grigor, A. (1991) Analytical Method for the Determination of (1R-cis)-3-(2,2-dibromoethenyl)-2,2-dimethylcyclopropane carboxylic acid (Br2CA) in Soil Samples by High Performance Liquid Chromatography (HPLC): Lab Project Number: ENC-4/91: 900405. Unpublished study prepared by EN-CAS Analytical Laboratories and ChemAlysis, Inc. 75 p.
44119802	Duguet, J.; Dartigues, V. (1988) Evaluating Possibilities of Leaching of Deltamethrin and TCMTB (Insecticide and Fuungicide (sic) for Protecting Wood) by Rain Water or by Soaking in Water. Unpublished study prepared by IRG Secretariat. 8 p.
44396504	Ritter, A.; Williams, W.; Cheplick, J. (1997) Tier 1 and Tier 2: Modeling of Pyrethroid Exposure to Aquatic Nontarget Organisms Associated with Use on Cotton: Lab Project Number: WEI 794.01: PWG. Unpublished study prepared by Waterborne Environmental, Inc. (WEI). 80 p.
46051301	Ritter, A.; Williams, W. (2003) Tier 2 Modeling of Pyrethroid Compounds Exposure to Aquatic Nontarget Organisms Associated with Use on Cotton: Final Report. Project Number: WEI/794/03. Unpublished study prepared by Waterborne Environmental, Inc. (WEI). 180 p.

097805 Deltamethrin Eco Effects Bibliography MRID-Doc# Matchup

71-1 Avian Single Dose Oral Toxicity

MRID	Citation Reference
73758	Fink, R.; Beavers, J.B. (1977) Final Report: Acute Oral LD50--Mal- lard Duck: Project No. 125-109. (Unpublished study received Dec 28, 1977 under 279-EX-68; prepared by Wildlife International, Ltd., submitted by FMC Corp., Philadelphia, Pa.;

	CDL:232536-H)
158273	Beavers, J. (1986) Deltamethrin: An Acute Oral Toxicity Study with the Bobwhite: Final Report: Project No. 125-131. Unpublished study prepared by Wildlife International Ltd. 15 p.
162970	Hinken, C. (1986) Deltamethrin: A Dietary LC50 Study with the Bobwhite: Final Report: Project No. 125-132. Unpublished study prepared by Wildlife International Ltd. 17 p.
162971	Hinken, C. (1986) Deltamethrin: A Dietary LC50 Study with the Mallard: Final Report: Project No. 125-133. Unpublished study prepared by Wildlife International Ltd. 18 p.

71-2 Avian Dietary Toxicity

MRID	Citation Reference
60723	Fink, R.; Beavers, J.B. (1977) Final Report: Eight-Day Dietary LC50--Mallard Duck: Project No. 125-108. (Unpublished study re- ceived Dec 28, 1977 under 279-EX-68; prepared by Wildlife Inter- national, Ltd., submitted by FMC Corp., Philadelphia, Pa.; CDL: 232536-I)
73759	Fink, R.; Beavers, J.B. (1977) Final Report: Eight-Day Dietary LC50--Bobwhite Quail: Project No. 125-107. (Unpublished study received Dec 28, 1977 under 279-EX-68; prepared by Wildlife In- ternational, Ltd., submitted by FMC Corp., Philadelphia, Pa.; CDL:232536-J)
162970	Hinken, C. (1986) Deltamethrin: A Dietary LC50 Study with the Bobwhite: Final Report: Project No. 125-132. Unpublished study prepared by Wildlife International Ltd. 17 p.
162971	Hinken, C. (1986) Deltamethrin: A Dietary LC50 Study with the Mallard: Final Report: Project No. 125-133. Unpublished study prepared by Wildlife International Ltd. 18 p.

71-4 Avian Reproduction

MRID	Citation Reference
42114808	Beavers, J.; Lattin, A.; Smith, G. et al. (1991) Deltamethrin: A One-Generation Reproduction Study with the Northern Bobwhite (Colinus virginianus): Lab Project Number: 125-147. Unpublished study prepared by Wildlife Int. Ltd. 36 p.
42114809	Beavers, J.; Lattin, A.; Smith, G. et al. (1991) Deltamethrin: A One-Generation Reproduction Study with the Mallard (Anas platyr- ynchos): Lab Project Number: 125-148. Unpublished study pre- pared6 by Wildlife Int. Ltd. 36 p.

72-1 Acute Toxicity to Freshwater Fish

MRID	Citation Reference
60720	Knauf, ?; Schulze, ? (1977) Decamethrine (Techn. Active Ingredient) Effect

on~Cyprinus carpio~(Carp): Report No. 15/77; HOE 9235/A; Report No. A10564. (Translation; unpublished study received Dec 28, 1977 under 279-EX-68; prepared by Farbwerke Hoechst, AG, W. Germany, submitted by FMC Corp., Philadelphia, Pa.; CDL: 232536-E)

60721 Knauf, ?; Schulze, ? (1977) Decamethrine (Techn. Active Ingredient) Effect on~Lepomis gibbosus~(Blue Gill Sunfish): Report No. 16/ 77; HOE 9236/A; Report No. A10565. (Translation; unpublished study received Dec 28, 1977 under 279-EX-68; prepared by Farb- werke Hoechst, AG, W. Germany, submitted by FMC Corp., Philadel- phia, Pa.; CDL:232536-F)

60724 or 104077 Waltersdorfer, ?; Schulze, ? (1976) Decis 2-5: Effect on~Salmo~ ?~gairdneri~(Rainbow Trout): Report No. 35/76; HOE-3576/A; Re- port No. A09444. (Translation; unpublished study received Dec 28, 1977 under 279-EX-68; prepared by Farbwerke Hoechst, AG, W. Germany, submitted by FMC Corp., Philadelphia, Pa.; CDL: 232536-K)

60725 Waltersdorfer, ?; Schulze, ? (1976) Decis 2-5: Effect on~Cyprinus~ ?~carpio~(Carp): Report No. 32/76; HOE-3276/A; Report No. A09440. (Translation; unpublished study received Dec 28, 1977 under 279-EX-68; prepared by Farbwerke Hoechst, AG, W. Ger- many, submitted by FMC Corp., Philadelphia, Pa.; CDL:232536-L)

60726 Waltersdorfer, ?; Schulze, ? (1976) Decis 2-5: Effect on~Lebistes~ ?~reticulatus~(Guppy): Report No. 42/76; HOE-4276/A; Report No. A09442. (Translation; unpublished study received Dec 28, 1977 under 279-EX-68; prepared by Farbwerke Hoechst, AG, W. Ger- many, submitted by FMC Corp., Philadelphia, Pa.; CDL:232536-M)

60727 Waltersdorfer, ?; Schulze, ? (1976) Decis 2-5: Effect on Lepomis gibbosus: Report No. 27/76; HOE-2776/A; Report No. A09443. (Translation; unpublished study received Dec 28, 1977 under 279- EX-68; prepared by Farbwerke Hoechst, AG, W. Germany, submitted by FMC Corp., Philadelphia, Pa.; CDL:232536-N)

104075 Knauf (1977) **Decamethrine** (Techn. Active Ingredient): Effect on Cyprinus carpio (Carp): A10564. (Translation; unpublished study received Jan 17, 1979 under 279-EX-73; prepared by Hoechst Aktiengesellschaft, W. Ger., submitted by FMC Corp., Philadel- phia, PA; CDL:236788-F)

104077 Knauf; Waltersdorfer; Schulze (1976) Decis 2-5, Effect on ... (Rainbow trout): **A09444.** (Translation; unpublished study received Jan 17, 1979 under 279-EX-73; prepared by Hoechst Aktiengesellschaft, W. Ger., submitted by FMC Corp., Phila- delphia, PA; CDL:236788-L)

104078 Knauf; Waltersdorfer; Schulze (1976) Decis 2-5: Effect on ... (Carp): **A09440.** (Translation; unpublished study received Jan 17, 1979 under 279-EX-73; prepared by Hoechst Aktiengesell- Schaft, W. Ger., submitted by FMC Corp., Philadelphia, PA; CDL:236788-M)

104079 Knauf; Waltersdorfer; Schulze (1976) Decis 2-5 Effect on ... (Guppy): **A09442.** (Translation; unpublished study received Jan 17, 1979 under 279-EX-73; prepared by Hoechst Aktiengesell- schaft, submitted by FMC Corp., Philadelphia, PA; CDL:236788-N)

104080 Knauf, Waltersdorfer, Schulze (1976) Decis 2-5 Effect on Lepomis Gibbosus: **A09443.** (Translation; unpublished study received Jan 17, 1979 under 279-EX-73; prepared by Hoechst Aktiengesell- schaft, W. Ger., submitted by FMC Corp., Philadelphia, PA; CDL:236788-O)

158274 McAllister, W.; Bowman, J. (1986) Acute Toxicity of Deltamethrin to Rainbow Trout

	(Salmo gairdneri): Static Acute Toxicity Report #33981. Unpublished study prepared by Analytical Bio-Chemistry Laboratories, Inc. 53 p.
158275	McAllister, W.; Swigert, J.; Bowman, J. (1986) Acute Toxicity of Deltamethrin to Bluegill Sunfish (Lepomis macrochirus): Static Acute Toxicity Report #33980. Unpublished study prepared by Analytical Bio-Chemistry Laboratories, Inc. 47 p.
41651012	Sousa, J. (1990) Acute Toxicity of Decis 2.5 EC (IS-002A) to Blue- gill (Lepomes macrochirus) under Flow-through Conditions: Lab Project Number: SLI 90-01-3192: 1719.0889.6113.105. Unpublished study prepared by Springborn Laboratories, Inc. 60 p.
41651013	Sousa, J. (1990) Acute Toxicity of Decis 2.5 EC (IS-002A) to Rain- bow Trout (Oncorhynchus mykiss) under Flow-through Conditions: Lab Project Number: SLI 90-04-3281: 1719.0789.6112.108: 89-0139. Unpublished study prepared by Springborn Laboratories, Inc. 58 p.
43073903	Bettencourt, M. (1993) HR 20900--Acute Toxicity to Bluegill Sunfish (Lepomis macrochirus) Under Flow-through Conditions: Lab Project Number: 1719.1092.6210.105: 93-3-4669. Unpublished study prepared by Springborn Labs, Inc. 67 p.
43073904	Bettencourt, M. (1993) HR 20900--Acute Toxicity to Rainbow Trout (Oncorhynchus mykiss) Under Flow-through Conditions: Lab Project Number: 1719.1092.6211.108: 93-4-4723. Unpublished study prepared by Springborn Labs, Inc. 68 p.
141973	Mulla, M.; Navvab-Gojrati, H.; Darwazeh, H. (1978) Toxicity of mos- quito larvicidal pyrethroids to four species of freshwater fish- es. **Environmental Entomology 7(3):428-430.**

72-2 Acute Toxicity to Freshwater Invertebrates

MRID	Citation Reference
60722	Smolikowski, S. (19??) Toxicity of Decis on~Daphnia magna~: PRO- 77.08.03/A. (Translation from French; unpublished study re- ceived Dec 28, 1977 under 279-EX-68; prepared by Produits Chimiques Industriels et Agricoles, France, submitted by FMC Corp., Philadelphia, Pa.; CDL:232536-G)
104076	Smolikowski, S. (1977) Toxicity of Decis on Daphnia Magna: Ref. **PRO-77.08.03/A.** (Translation; unpublished study received Jan 17, 1979 under 279-EX-73; prepared by Procida, Fr.; sub- mitted by FMC Corp., Philadelphia, PA; CDL:236788-H)
158276	Forbis, A.; Frazier, S. (1986) Acute Toxicity of Deltamethrin to Daphnia magna: Static Acute Toxicity Report #33982. Unpublished study prepared by Analytical Bio-Chemistry Laboratories, Inc. 37 p.
41651014	McNamara, P. (1990) Acute Toxicity of Decis 2.5 EC (IS-002A) to Daphnids (Daphnia magna) During a 48-Hour Static Renewal Expo- sure: Lab Project Number: 90-6-3344: 1719.0789.6114.115: 90- 0116. Unpublished study prepared by Springborn Laboratories, Inc. 54 p.
43073905	Bettencourt, M. (1993) HR 20900--Acute Toxicity to Daphnids (Daphnia magna) Under Flow-through Conditions: Lab Project Number: 1719.1092.6215.115: 93-3-4658. Unpublished study prepared by Springborn Labs, Inc. 70 p.

44928701	Putt, A. (1999) Deltamethrin ((14-carbon)-labelled)--Acute Toxicity to Daphnids (Daphnia magna) Under Flow-Through Conditions: Lab Project Number: C003959: 10824.6141: 031799/OECD/FT-DAPHNIA/AGREVO. Unpublished study prepared by Springborn Laboratories, Inc. 59 p. Relates to L0000453.
45048601	Putt, A. (2000) Decis EC 25 g/L--Acute Toxicity to Gammarids (Gammarus fasciatus) under Flow-Through Conditions: Lab Project Number: 10824.6150: C006608. Unpublished study prepared by Springborn Labs., Inc. 55 p. Relates to L0000519. {OPPTS 850.1020}

72-3 Acute Toxicity to Estuarine/Marine Organisms

MRID	Citation Reference
41651015	Sousa, J. (1990) Acute Toxicity of Deltamethrin-Active Ingredient to Sheepshead Minnow (Cyprinodon variegatus) under Flow-through Conditions: Lab Project Number: 90-01-3190: 1719.0889.6118.505: 89-0151. Unpublished study prepared by Springborn Laboratories, Inc. 54 p.
41651016	Dionne, E. (1990) Acute Toxicity of Deltamethrin-Active Ingredient to Eastern Oyster (Crassostrea virginica) under Flow through Conditions: Lab Project Number: 89-11-3148: 1719.0889.6122.504: 89-0153. Unpublished study prepared by Springborn Laboratories, Inc. 61 p.
41651017	Dionne, E. (1990) Acute Toxicity of Decis 2.5 EC (IS-002A) to East- ern Oysters (Crassostrea virginica) under Flow-through Condi- tions: Lab Project Number: SLI 90-1-3214: 1719.0889.6123.504: 89-0175. Unpublished study prepared by Springborn Laboratories, Inc. 51 p.
42114810	Lelievre, M. (1991) Deltamethrin: Acute Toxicity to Mysid Shrimp (Mysidopsis bahia) under Static Renewal Conditions: Lab Project Number: 91-7-3826: 1719.0889.6120.510. Unpublished study pre- pared by Springborn Labs, Inc. 49 p.
42114811	Lelievre, M. (1991) (IS-002A): Acute Toxicity to Sheepshead Minnow under (Cyprinondon variegatus) Static Conditions: Lab Project Number: 91-23668: 1719.0889.6119.500. Unpublished study pre- pared by Springborn Labs, Inc. 55 p.
42114812	Lelievre, M. (1991) (IS-002A): Acute Toxicity to Mysid Shrimp (Mys- idopsis bahia) under Static Renewal Conditions: Lab Project Num- ber: 91-3-3681; 1719.0889.6121.510. Unpublished study prepared by Springborn Labs, Inc. 54 p.
43073906	Bettencourt, M. (1993) HR 20900--Acute Toxicity to Sheepshead (Cyprinodon variegatus) Under Flow-through Conditions: Lab Project Number: 1719.1092.6214.505: 93-4-4739. Unpublished study prepared by Springborn Labs, Inc. 68 p.
43073907	Dionne, E. (1993) HR 20900--Acute Toxicity to Eastern Oyster (Crassostrea virginia) Under Flow-through Conditions: Lab Project Number: 1719.1092.6213.504: 93-2-4646. Unpublished study prepared by Springborn Labs, Inc. 66 p.
43073908	Bettencourt, M. (1993) HR 20900--Acute Toxicity to Mysid Shrimp (Mysidopsis bahia) Under Flow-through Conditions: Lab Project Number: 1719.1092.6212.515: 93-11-5056. Unpublished study prepared by Springborn Labs, Inc. 83 p.
43821101	Fischer, R.; Schupner, J. (1995) **Supplement 1 to: HR 20900**-- Acute Toxicity to Eastern Oyster (Crassostrea virginia (sic)) Under Flow-Through Conditions: Lab

Project Number: **93-2-4646**. Unpublished study prepared by Springborn Labs, Inc. 17 p.

72-4 Fish Early Life Stage/Aquatic Invertebrate Life Cycle Study

MRID	Citation Reference
42114813	McNamara, P. (1991) Deltamethrin--The Chronic Toxicity to Daphnia magna under Folw-through Conditions: Lab Project Number: 90-06- 3353: 1719.0889.6124.130. Unpublished study prepared by Spring- born Labs, Inc. 70 p.
42114814	Sousa, J. (1991) Deltamethrin: Toxicity Test with Fathead Minnow (Pimephales promelas) Embyros and Larvae: Lab Project Number 90- 11-3353: 1719.0889.6125.120. Unpublished study prepared by Springborn Labs, Inc. 70 p.
43208801	McNamara, P. (1994) (Deltamethrin)-The Chronic Toxicity to Daphnia magna Under Flow-Through Conditions: Raw Data: Supplement to Study **MRID #42114813**: Lab Project Number: 90-06-3353: 1719.0889.6124.130. Unpublished study prepared by Springborn Labs., Inc. 224 p.
45202908	Gorge, G.; Nagel, R. (1990) Toxicity of lindane, atrazine, and deltamethrin to early life stages of zebrafish (Brachydanio rerio). **Ecotoxicology and Environmental Safety 20:246-255.**

72-5 Life cycle fish

MRID	Citation Reference
42786801	Dionne, E. (1993) Deltamethrin: The Chronic Toxicity to the Fathead Minnow (Pimephales promelas) During a Full Life-Cycle Exposure: Lab Project Number: 1719.0891.6187.122: 93-1-4607. Unpublished study prepared by Springborn Labs, Inc. 450 p.

72-7 Simulated or Actual Field Testing

MRID	Citation Reference
42114816	Fackler, P. (1991) Tralomethrin and Deltamethrin: Comparative En- vironmental Fate During an Aquatic Microcosm Test: Lab Project Number: 90-10-3506: 1719.0590.6132.310. Unpublished study pre- pared by Springborn Labs, Inc. 36 p.
44396503	Giddings, J. (1997) Aquatic Mesocosm and Field Studies with Cotton Pyrethroids: Observed Effects and Their Ecological Significance: Lab Project Number: 97-6-7014: 13656.0497.6100.900. Unpublished study prepared by Springborn Labs., Inc. 102 p.

121-1 Phytotoxicity- Efficacy-safety to plants

MRID	Citation Reference

43519101	Kirkland, R. (1993) Evaluation of Phytotoxicity of Deltamethrin SC and 0.05% Dust to Greenhouse Ornamentals: Lab Project Number: BIO/158/92: 158/92: 158/93. Unpublished study prepared by Bio Research. 41 p.

122-2 Aquatic plant growth

MRID	Citation Reference
44977003	Giddings, J. (1990) Deltamethrin: LX165-08 (Deltamethrin Technical), Toxicity to the Freshwater Green Alga Selenastrum capricornutum: Lab Project Number: A47090. Unpublished study prepared by Springborn Labs., Inc. 40 p.
44977004	Giddings, J. (1990) Deltamethrin: LX165-09 (Deltamethrin IS-002A): Toxicity to the Freshwater Green Alga Selenastrum capricornutum: Lab Project Number: A47092. Unpublished study prepared by Springborn Labs., Inc. 41 p.
43741301	Vukich, J. (1995) Letter sent to Office of Pesticide Programs dated July 21, 1995: Summary of results of a study on the toxicity of DECIS 0.2 EC to the freshwater alga Selenastrum capricornutum. Prepared by AgrEvo USA Co. 2 p.

141-1 Honey bee acute contact

MRID	Citation Reference
42114815	Hoxter, K.; Lynn, S. (1991) Deltamethrin Technical: An Acute Con- tact Toxicity Study with the Honey Bee: Lab Project Number: 125- 151B. Unpublished study prepared by Wildlife International Ltd. 16 p.

141-2 Honey bee residue on foliage

MRID	Citation Reference
42475905	Atkins, E.; Kellum, D.; Neuman, K. (1976) Effects of Pesticides on Apiculture ?1976 Annual Report|: Lab Project Number: 1499. Unpublished study prepared by University of California Riverside. 36 p.
42773902	Mayer, D. (1992) Deltamethrin/Honey Bees Toxicity of Residues on Foliage: Lab Project Number: WSU 92-003. Unpublished study prepared by Washington State University. 54 p.
47699408	Ramirez-Romero, R.; Chaufaux, J.; Pham-Delegue, M. (2005) Effects of Cry1Ab Protoxin, Deltamethrin and Imidacloprid on the Foraging Activity and the Learning Performances of the Honeybee Apis mellifera, a Comparative Approach. **Apidologie 36(4): 601-611.**

Non Guideline Selections

45245501 Soderlund, D.; Clark, J.; Mullin, L. et al. (2000) Pyrethroid Insecticides: Is there a Common Mechanism of Mammalian Toxicity?: Lab Project Number: PWG FQPA 2000-01. Unpublished study prepared by Pyrethroid Working Group. 144 p.

46051301 Ritter, A.; Williams, W. (2003) Tier 2 Modeling of Pyrethroid Compounds Exposure to Aquatic Nontarget Organisms Associated with Use on Cotton: Final Report. Project Number: WEI/794/03. Unpublished study prepared by Waterborne Environmental, Inc. (WEI). 180 p.

47506603 Hall, L.; Killen, W.; Anderson, R.; et. al. (2008) An Assessment of Benthic Communities with Concurrent Physical Habitat, Pyrethroid, and Metals Analysis in and Urban and Residential Stream in California in 2006 and 2007-Pyrethroid: Assessment. Project Number: T001523/08. Unpublished study prepared by Wye Research and Education Center and Northern Illinois University. 229 p.