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

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

Pesticide Effects Determinations
PC Code: 128825
CAS Number: 82657-04-3

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

December 27, 2012

Primary Authors:
José L. Meléndez, Chemist
Hannah Yingling, Biologist
Keith Sappington, Senior Advisor

Secondary Review:
Justin Housenger, Biologist
Michael Barrett, Ph.D., Senior Scientist

Branch Chief, Environmental Risk Branch V:
Mah, T. Shamim, Ph.D.

Table of Contents

Appendices

Attachments

List of Tables

List of Figures

List of Commonly Used Abbreviations and Nomenclature

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

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

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

ppb	Parts per Billion (equivalent to µg/L or µg/kg)
ppm	Parts per Million (equivalent to mg/L or mg/kg)
PRD	Pesticide Re-Evaluation Division
PRZM	Pesticide Root Zone Model
ROW	Right of Way
RQ	Risk Quotient
SFGS	San Francisco Garter Snake
SJKF	San Joaquine Kit Fox
SLN	Special Local Need
SMHM	Salt Marsh Harvest Mouse
TG	Tidewater Goby
T-HERPS	Terrestrial Herpetofaunal Exposure Residue Program Simulation
T-REX	Terrestrial Residue Exposure Model
TRR	Total Residue Recovered
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 bifenthrin 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 bifenthrin 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

Bifenthrin was first registered in 1989 and was not subject to the process of Re-registration Eligibility Decision. The Registration Review docket was opened in the Summer of 2010 and the Final Amended Work Plan was issued in the Summer of 2011. Bifenthrin ((2-methyl[1,1′-biphenyl]-3-yl)methyl (1*R*,3*R*)-*rel*-3-[(1*Z*)-2-chloro-3,3,3-trifluoro-1-propen-1-yl]-2,2-dimethylcyclopropanecarboxylate) 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. It is a broad spectrum insecticide that targets adults and larvae of many diverse species. The chemical structure of bifenthrin is provided in **Figure 1-1.**

Formulation types registered include emulsifiable concentrate, flowable concentrate, granular, wettable powder, liquid, pressurized liquid, liquid ready-to-use, dust and bait/solid. They vary widely in terms of percentage of active ingredient (*e.g.*, <0.01% or >27% A.I.). Bifenthrin can be applied via multiple methods, which include aerosols, barrier treatment, band treatment, broadcast, brush-on, chemigation, crack-and-crevice and/or spot treatment, directed spray, drench, dust, foliar application, soil incorporated treatment, and wood surface treatment among many others.

Potential bifenthrin uses include a range of agricultural, nursery, home garden, ornamental, turf, and residential uses. Currently, labeled uses of bifenthrin include both agricultural and residential use patterns.

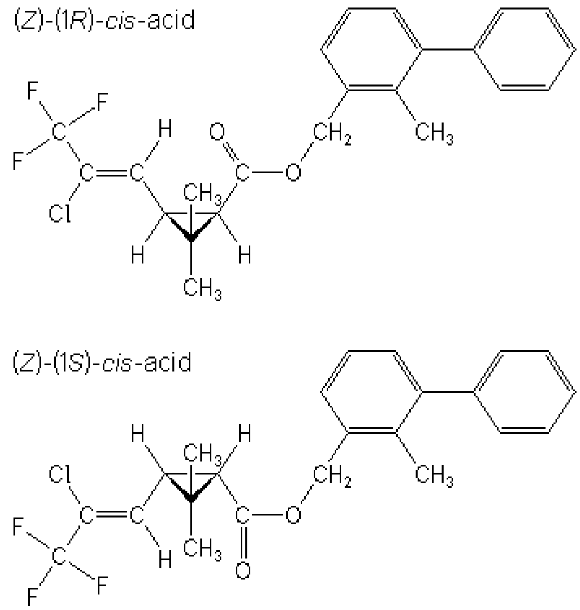


Figure 1-1. Molecular Structure of Bifenthrin

1.2.2. Environmental Fate Properties of Bifenthrin

Bifenthrin is a persistent pyrethroid in the environment, stable to hydrolysis and photolysis, slow to biodegrade and bioaccumulative. This assessment considered only parent bifenthrin as the stressor of concern. The very low water solubility (0.014 ppb) and lipophilic nature of bifenthrin (as evidenced by its high octanol-water partition coefficient (K_{OW} = 3.00 x 10^6) and organic carbon partition coefficient (K_{OC} >100,000 L/Kg_{OC}), leads to strong soil adsorption and a tendency to partition to sediment in aquatic systems. The high K_{OW} suggests that bifenthrin will bioconcentrate in aquatic organisms. This is confirmed by the bioconcentration study in fish, where the bioconcentration factors (BCFs) ranged from 2140 L/kg for edible portion to 8720 L/kg for the non-edible portion. Bifenthrin has a low vapor pressure (1.80 x 10^{-7} mmHg) and a moderate Henry's law constant (7.2 x 10^{-3} atm-m^3/mol). Given the fact that bifenthrin adsorbs strongly to soil particles and to organic matter, volatilization from water and soil surfaces should be reduced. Furthermore, the hydroxyl radical reaction half-life for bifenthrin is ~0.4 days (EPISUITE v.4.1 estimate), which appears to preclude the potential for long-range transport.

It appears that a major route of degradation for bifenthrin is aerobic metabolism (half-life range 97-250 days). Bifenthrin is relatively stable in anaerobic soil. No major metabolites were observed (>10% of the applied) in any of the laboratory studies. Bifenthrin is immobile in soils tested. Field studies show a pattern consistent with the laboratory studies, with relatively high persistence and low mobility of the chemical in soil. In aquatic environments, it appears that residues of bifenthrin persisted in pond water and sediment for at least 12 months of monitoring.

Surface water runoff and spray drift are expected to be the major routes of exposure for bifenthrin and a buffer distance is required in the agricultural labels. For aerial applications the buffer distance is 150 ft while for ground applications it is 25 ft from bodies of water. In addition, bifenthrin may be available for runoff for several weeks to several months after application. Due to its low solubility and high level of binding, it appears that bifenthrin would remain bound to the soils during run-off events, and that 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 possible as well.

The main uncertainties of the fate database are related to the extremely low aqueous solubility of bifenthrin. For uncertainties related to the environmental fate database, refer to **Section 6.2.1**. For additional environmental fate and transport information about bifenthrin, refer to **Section 2.4**.

1.2.3. Evaluation of Degradates and Stressors of Concern

The available environmental fate studies for bifenthrin show that it is a persistent insecticide and no degradates exceeding 10% of the applied radioactivity were identified in any of the studies. Therefore, the only stressor of concern is the parent compound, bifenthrin.

1.3. Assessment Procedures

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

1.3.1. Exposure Assessment

1.3.1.a. Aquatic Exposures

Modeling Estimates
Tier 2 aquatic exposure models are used to estimate high-end exposures of bifenthrin in aquatic habitats resulting from runoff and spray drift from different uses. The models used to predict aquatic estimate environmental concentrations (EECs) are the Pesticide Root Zone Model coupled with the Exposure Analysis Model System (PRZM/EXAMS). AgDRIFT model is also used to estimate deposition of bifenthrin on aquatic habitats from spray drift. Peak model-EECs resulting from different bifenthrin uses range 1.29×10^{-4} to 0.014 µg/L in the water column; further, they ranged 1.11×10^{-5} to 0.014 µg/L in the pore water (in both instances up to the limit of solubility of bifenthrin). The peak model-estimated non-normalized sediment EECs resulting from different bifenthrin uses range from 0.105 to 1,580 µg/Kg; meanwhile, the organic carbon normalized sediment EECs resulting from different bifenthrin uses range from 2.63 to 39,500 µg/Kg_{OC}.

Monitoring
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 CDPR. Even though bifenthrin has sampling in the NAWQA surface water database, no samples are reported specifically in California. Surface water monitoring data from CDPR shows that of a total of 1,838 samples, 105 surface water samples (6.6%) and 24 sediment samples (9.3%) had positive detections of

bifenthrin. The maximum surface water concentration was 5.209 µg/L; the maximum detected sediment concentration was 0.437 µg/kg.

1.3.1.b. Terrestrial Exposures

To estimate bifenthrin exposures to terrestrial species resulting from uses involving bifenthrin applications, the T-REX model is used for foliar, granular, and seed treatment uses. AgDRIFT model is also used to estimate deposition of bifenthrin on terrestrial habitats from spray drift. The T-HERPS model is used to allow for further characterization of dietary exposures of terrestrial-phase amphibians relative to birds. KABAM (K_{OW} (based) Aquatic BioAccumulation Model) v.1.0 is used to estimate potential bioaccumulation of bifenthrin residues in an aquatic food web (with incorporation of bifenthrin metabolism rates) 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, TG, DS, CTS-CC, CTS-SB and VELB. Primary constituent elements (PCEs; see **Table 2-9**) were used to evaluate whether bifenthrin has the potential to modify designated critical habitat. The Agency evaluated registrant-submitted studies and data from the open literature to characterize bifenthrin 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.

Bifenthrin technical is very highly toxic to freshwater fish, with a 96-hour LC_{50} = 0.15 µg a.i./L. No chronic freshwater fish study is available for bifenthrin. In the absence of chronic toxicity data for fish, a conservative, "read across" data bridging approach was taken (see **Section 4.2.2.b** and **Section 5.2.2.b**). For freshwater and estuarine/marine fish, a chronic NOAEC of 0.0004 µg/L was assumed based on data from a full life cycle study for tefluthrin. Acute toxicity values for amphipods suggest that bifenthrin technical is very highly toxic to freshwater invertebrates with a 96-hour EC_{50} = 0.0019 µg ai/L (Weston & Jackson 2009). In an amphipod chronic sediment toxicity test with bifenthrin, the 10-d NOAEC for reduction in growth is 0.00017 µg/L based on pore water and 40 µg a.i./kg_{OC} based on a sediment organic carbon basis.

Acute toxicity studies indicate that bifenthrin is very highly toxic to estuarine/marine fish, with an LC_{50} = 17.5 µg ai/L for the technical material. No chronic estuarine/marine fish study is available for bifenthrin. In an acute study with mysid shrimp, the 96-hour LC_{50} = 0.0040 µg ai/L for bifenthrin technical; based on these data, bifenthrin is classified as very highly toxic to estuarine/marine invertebrates on an acute exposure basis. Chronic toxicity is represented by the amphipod *Leptocheirus plumulosus* with a 28-d NOAEC = 0.005 µg a.i./L and 28-d NOAEC = 1220 µg a.i/kg_{OC}. Observed effects were significantly reduced amphipod growth and survival.

The available toxicity data suggest that bifenthrin is slightly toxic on an acute oral and subacute dietary exposure basis to avian species based on a bobwhite quail (*Colinus virginianus*) single dose LD_{50} = 1800 mg/kg bw and an 8-day dietary LC_{50} = 1280 mg/kg diet for the mallard duck (*Anas platyrhynchos*). Bifenthrin showed no adverse effects to reproduction at the highest concentration tested (NOAEC = 75 mg/kg diet) in the two one-generation chronic studies conducted on the bobwhite quail and mallard duck. Mammalian toxicity data suggest that this compound is moderately toxic to small mammals on an acute oral exposure basis (rat LD_{50} = 53.8 mg/kg). Reproductive effects were based on decreased maternal body weight noted at an LOAEC of 60 ppm (NOAEC = 30 ppm).

As expected for a registered insecticide, bifenthrin is very highly toxic to non-target terrestrial invertebrates. An acute contact toxicity study on honeybees (*Apis mellifera*) for formulated bifenthrin (0.8EC) produced an LD_{50} = 0.015 µg/bee (Atkins, 1981).

Data on the effects of bifenthrin on aquatic and terrestrial plants are lacking. However, three ecological incidences involving terrestrial plants are reported in the Ecological Incidence Information System (EIIS), only one of which is classified as probable. In addition, over 5,600 minor incidents are reported in the Incident Data System (IDS) that involve terrestrial plants (the vast majority involve turf grass in which bifenthrin is co-applied with fertilizer).

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 bifenthrin 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 bifenthrin use "may affect" the assessed species, and/or may cause effects to designated critical habitat, the best available additional information is considered to refine the potential for exposure and effects, and distinguish actions that are Not Likely to Adversely Affect (NLAA) from those that are Likely to Adversely Affect (LAA).

1.4. Summary of Conclusions

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

Table 1-1. Effects Determination Summary for Effects of Bifenthrin 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 **<0.01 to 0.09** (LOC = 0.05) and chronic RQs range from **0.01 to 3.5,** (LOC = 1) exceeding the listed species LOC for direct effects to CTS; Five ecological incidents reported for fish are consistent with the risk hypothesis and risk findings. The individual effects probability associated with the acute RQ ranges from 1 in $1.20x10^{12}$ to 1 in $8.97x10^{3}$. 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 bifenthrin 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): Avian acute RQs determined using T-REX range from **0.01 to 0.2** (LOC=0.05) and chronic RQs range from **0.03 to 3.0** (LOC=1)**,** exceeding the listed species LOC for direct effects to terrestrial-phase CTS. Refinement of these RQs using T-HERPS resulted in acute RQs ranging from **0.1 to 0.2** (LOC=0.1) and chronic RQs ranging from **1.0 to 3.1** (LOC=1). Further, use of a pyrethroid-specific foliar dissipation half-life also exceeded LOCs with acute RQs ranging from **0.02 to 0.2** (LOC=0.1) and chronic RQs ranging from **0.7 to 3.1** (LOC=1). The individual effects probability associated with the acute RQ ranges from 1 in $1.00x10^{16}$ to 1 in $1.42x10^{6}$. 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 bifenthrin use is likely to spatially and temporally coincide with all of the critical life-stages of the terrestrial phase CTS (all DPS), and disrupt its life-cycle at various points.
		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 RQs for freshwater invertebrates (water column and benthic-dwelling) range from **0.07 to 7.4** (LOC=0.5) and the chronic RQ range from **0.2 to 82** (LOC=1). 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 1.84** (LOC=0.5) and the chronic RQs range from **0.06** (dietary based) **to 39** (dose based) (LOC=1).

Species	Effects Determination	Basis for Determination
		Terrestrial prey items, riparian habitat Acute RQ values exceed the LOC for terrestrial invertebrates, ranging from **6.3 to 812** (LOC=0.05). Potential risk to terrestrial plants identified from numerous minor incident reports involving terrestrial plants.
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 **6.3 to 812**, exceeding the acute risk LOC for the BCB (LOC=0.05). Refinements using a pyrethroid specific foliar dissipation half-life yielded RQs that also exceeded the acute risk LOC, with values ranging from **6.3-812** (LOC=0.05). The individual effects probability associated with the acute RQ is 1 in 1.00 for all scenarios assessed. Four ecological incidents have been reported with bees, the most recent of which occurred in 2012. 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 bifenthrin 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 numerous minor incident reports involving terrestrial plants.
Valley Elderberry Longhorn Beetle (VELB) (*Desmocerus californicus dimorphus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Acute RQ values range from **6.3 to 812**, exceeding the acute risk LOC for the VELB (LOC=0.05). Refinements using a pyrethroid specific foliar dissipation half-life yielded RQs that also exceeded the acute risk LOC, with values ranging from **6.3-812** (LOC=0.05). The individual effects probability associated with the acute RQ is 1 in 1.00 (100%) for all scenarios assessed. Four ecological incidents have been reported with bees, the most recent of which occurred in 2012. 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 bifenthrin 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
		Potential risk to terrestrial plants identified from numerous minor incident reports involving terrestrial plants.
Delta Smelt	May Affect,	**Potential for Direct Effects**

Species	Effects Determination	Basis for Determination
(DS) (*Hypomesus transpacificus*)	Likely to Adversely Affect (LAA)	Freshwater fish acute RQs range from **<0.01 to 0.09** (LOC=0.05) and chronic RQs range from **0.01 to 3.5** (LOC=1)**,** exceeding listed species LOC for direct effects to the DS; Five ecological incidents reported for fish are consistent with the risk hypothesis and risk findings. The individual effects probability associated with the acute RQ ranges from 1 in $1.20x10^{12}$ to 1 in $8.97x10^{3}$. 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 bifenthrin 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
		Freshwater invertebrate acute RQs range from **0.07 to 7.4** (LOC=0.5) and chronic RQs range from **0.22 to 82** (LOC=1)**,** exceeding non-listed species LOC for indirect effects to the DS. Estuarine invertebrate acute RQs range from **0.03 to 3.5** (LOC=0.5) and chronic RQs range from **0.19 to 70** (LOC=1)**,** exceeding the non-listed species LOC for DS prey. Acute and chronic RQ values also exceed the LOCs for freshwater (acute RQs range from **0.01 to 7.37**, LOC=0.5; while the chronic RQs range from **0.07 to 974**, LOC=1) and estuarine/ marine (acute RQs range from **<0.01 to 3.53**, LOC=0.5; while the chronic RQs range from **0.02 to 32**, LOC=1) benthic invertebrates. Potential risk to terrestrial plants identified from numerous minor incident reports involving terrestrial plants.
Clapper Rail (CCR) (*Rallus longirostris obsoletus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Avian acute RQs determined using T-REX range from **0.01 to 0.2** (LOC=0.1) and chronic RQs range from **0.03 to 3.0** (LOC=1)**,** exceeding listed species LOC for direct effects to terrestrial-phase CTS. Refinement of these RQs using a pyrethroid-specific foliar dissipation half-life also resulted in the LOC being exceeded. The acute RQ values, using a pyrethroid-specific foliar dissipation half-life range from **0.04 to 0.11** (LOC=0.1) and the chronic RQs were **0.7-3.0** (LOC=1) when evaluating only the uses that exceeded the LOCs with the T-REX default half-life. The individual effects probability associated with the acute RQ ranges from 1 in $1.00x10^{16}$ to 1 in $1.44x10^{2}$. 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 bifenthrin use is likely to spatially and temporally coincide with the CCR life-cycle and breeding season.
		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), with acute and chronic RQ values that exceed the non-listed species LOCs. The acute RQs for small mammals range from **0.01 -1.84** (LOC=0.5) and the chronic RQs range from **0.06** (dietary based) **to 39** (dose based) (LOC=1). A potential for indirect effects is also indicated based on effects on terrestrial invertebrates (acute RQs values ranging from **6.3-812**, LOC=0.05); based on effects on freshwater fish with acute RQs range from **<0.01 to 0.09** (LOC=0.5, therefore the acute non-listed LOC is not exceeded), and chronic RQs range from **0.01 to 3.5** (LOC=1); based on effects on estuarine/ marine fish (acute RQ **<0.01** in all instances (LOC=0.5, therefore it is not exceeded for non-listed estuarine/marine fish), but chronic RQs range from **0.01-3.5** (LOC=1); based on effects on freshwater invertebrates (acute RQs range from **0.07 to 7.4** (LOC=0.5); chronic RQs range from **0.22 to 82** (LOC=1); and effects on estuarine/marine invertebrates with acute RQs range from **0.03 to 3.5** (LOC=0.5) and chronic RQs range from **0.19 to 70** (LOC=1). Therefore, acute and chronic RQ values exceed the non-listed species LOC for multiple taxa. Potential risk to terrestrial plants identified from numerous minor incident reports involving terrestrial plants.
California Freshwater Shrimp (CFWS) (*Syncaris pacifica*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Freshwater invertebrate acute RQs range from **<0.07 to 7.4** (LOC=0.05) and chronic RQs range from **0.22 to 82** (LOC=1)**,** exceeding the listed species LOC for direct effects to the CFWS. Acute and chronic RQ values also exceed the LOCs for freshwater benthic invertebrates with acute RQs ranging from **0.01 to 7.37** (LOC=0.05) while the chronic RQs range from **0.07 to 974** (LOC=1). The individual effects probability associated with the acute RQ ranges from 1 in 9.88x10^6 to 1 in 1.00 (100%). 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 permethrin 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 numerous minor incident reports involving terrestrial plants.
San Francisco	May Affect,	**Potential for Direct Effects**

Species	Effects Determination	Basis for Determination
Garter Snake (SFGS) (*Thamnophis sirtalis tetrataenia*)	Likely to Adversely Affect (LAA)	Avian acute RQs (birds are used as surrogate for reptiles) determined using T-REX range from **0.01 to 0.2** (LOC=0.1) and chronic RQs range from **0.03 to 3.0** (LOC=1)**,** exceeding the listed species LOC for direct effects to the SFGS. Refinement of these RQs using T-HERPS (acute RQs ranging from **<0.01 to 0.14** and chronic RQs ranging from **0.59-2.3**, same LOCs) and pyrethroid-specific foliar dissipation rate (acute RQs ranging from **<0.01-0.14** and chronic RQs ranging from **0.56-2.3**, same LOCs) also resulted the LOC being exceeded. The individual effects probability associated with the acute RQ ranges from 1 in 1.00x10^{16} to 1 in 9.27x10^{6}. 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 permethrin use is likely to spatially and temporally coincide with the SFGS breeding season in the spring and fall, and disrupt its life-cycle at various points.
		Potential for Indirect Effects
		Acute and chronic RQ values for prey species (other reptiles, fish and amphibians, freshwater invertebrates, terrestrial invertebrates and small mammals all exceed their respective LOC values as indicated above. Potential risk to terrestrial plants identified from numerous minor incident reports involving terrestrial plants.
Tidewater Goby (TG) (*Eucyclogobius newberryi*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Freshwater fish acute RQs range from **<0.01 to 0.09** (LOC=0.05) and chronic RQs range from **0.01 to 3.5** (LOC=1)**,** exceeding listed species LOC for direct effects to the TG; five ecological incidents reported for fish are consistent with the risk hypothesis and risk findings. The individual effects probability associated with the acute RQ ranges from 1 in 1.20x10^{12} to1 in 8.97x10^{3}. 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 permethrin use is likely to spatially and temporally coincide with the TG, and disrupt its life-cycle at various points
		Potential for Indirect Effects
		Freshwater invertebrate acute RQs range from **0.07 to 7.4** (LOC=0.5) and chronic RQs range from **0.22 to 82** (LOC=1)**,** exceeding non-listed species LOC for indirect effects to the DS. Estuarine/marine invertebrate acute RQs range from **0.03 to 3.5** (LOC=0.5) and chronic RQs range from **0.19 to 70** (LOC=1), exceeding the non-listed species LOC for DS prey. Acute and chronic RQ values also exceed the LOCs for freshwater benthic invertebrates (acute RQs range from **0.01 to 7.37**, LOC=0.5; while the chronic RQs range from **0.07 to 974**, LOC=1) and estuarine/ marine benthic invertebrates (acute RQs range from **<0.01 to 3.53**, LOC=0.5; while the chronic RQs range from **0.02 to 32.15**, LOC=1). Potential risk to terrestrial plants identified from numerous minor incident reports involving terrestrial plants.

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 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 numerous minor incident reports involving terrestrial plants.
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 numerous minor incident reports involving terrestrial plants.
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 numerous minor incident reports involving terrestrial plants.
Delta Smelt (DS) (*Hypomesus transpacificus*)	Habitat Modification	Direct effects on DS and indirect effects on aquatic prey. Potential risk to terrestrial plants identified from numerous minor incident reports involving terrestrial plants.
Tidewater Goby (TG) (*Eucyclogobius newberryi*)	Habitat Modification	Direct effects on TG and indirect effects on aquatic prey. Potential risk to terrestrial plants identified from numerous incident reports involving terrestrial plants.

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])[2]		Freshwater Invertebrates (includes CFWS)[3]		Freshwater Benthic Invertebrates[6]		DS, TG and Estuarine/ Marine Vertebrates[1]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
AGRICULTURAL USE PATTERNS													
Alfalfa, clover (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Tree nut crops (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Tree nut crops (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Tree nut (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Citrus crops (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Head and stem brassica vegetables (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Head and stem brassica vegetables (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Corn, sweet corn (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Corn (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Sweet corn (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Cotton (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Pears, mayhaw, fruits (unspecified) (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Fruits (unspecified), Small Fruits (unspecified) (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Apple, stone fruits, deciduous fruits (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Apple, stone fruits, deciduous fruits (GR)	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No
Grapes (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Lettuce, leafy petiole vegetables (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Lettuce (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Spinach (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Cucurbit vegetables (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Cucurbit vegetables (GR)	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No
Tuberous and corm vegetables (aerial)	Yes	Yes	Yes	Yes	Yes	Yes	No	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])[2]		Freshwater Invertebrates (includes CFWS)[3]		Freshwater Benthic Invertebrates[6]		DS, TG and Estuarine/ Marine Vertebrates[1]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Tuberous and corm vegetables (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Root crops (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Artichokes (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Peppers (bell and non-bell); Succulent peas and beans (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Dried peas and beans (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Succulent peas and beans; Dried beans (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Peppers (bell and non-bell) (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Agricultural crops/soils (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Strawberry (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Strawberry (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Beets, garden beets (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Tomato and tomatillo, Eggplant, Ground cherry, Pepino (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Eggplant (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Canola, rapeseed, crambe (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Canola, rapeseed, crambe (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Caneberries (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Bushberries (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Hops (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Herbs & Spices (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
NON-AGRICULTURAL USE PATTERNS													

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	Freshwater Vertebrates (includes DS, TG, CTS [all DPS])[2]		Freshwater Invertebrates (includes CFWS)[3]		Freshwater Benthic Invertebrates[6]		DS, TG and Estuarine/ Marine Vertebrates[1]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Forest Trees: Conifers (plantations/ nurseries); Conifers (seed orchard) (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Forest trees (unspecified), Softwoods (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Christmas tree plantations (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Christmas tree plantations (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Nursery stock (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Mulch, Potting Soil/ Top Soil (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Nursery Stock; Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	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])[2]		Freshwater Invertebrates (includes CFWS)[3]		Freshwater Benthic Invertebrates[6]		DS, TG and Estuarine/ Marine Vertebrates[1]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba (G, pressure liquid)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Roses (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Sod farms, ornamental sod farms (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Sod farms, ornamental sod farms (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Agricultural Right-of-Ways/ Fencerows/ Hedgerows (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Non-agricultural uncultivated areas (soils); Livestock/Livestock Feed Lots, Poultry Feedlots/Poultry Processing Plant Premises (non-food contact), Poultry Litter (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Non-agricultural uncultivated areas (soils) (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Golf course turf (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	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])[2]		Freshwater Invertebrates (includes CFWS)[3]		Freshwater Benthic Invertebrates[6]		DS, TG and Estuarine/ Marine Vertebrates[1]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Golf Course Turf plus Ornamental Grasses; Ornamental Lawns and Turf; Ornamental Sod Farms; Recreational Areas; Recreational Area Lawns; plus Airports/Landing Fields (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Ornamental Grasses; Ornamental Lawns and Turf; Ornamental Sod Farms; Recreational Areas; Recreational Area Lawns (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Airports/Landing fields (PT, directed spray)	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No
Paths/Patios (PT)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Residential Lawns; Commercial/ Industrial Lawns, plus Paths/ Patios, plus Urban Areas, Wide Area/ General Outdoor Treatment (Public Health Use) (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Residential lawns (GR)	No	No	Yes	No	No	No	No	No	No	No	Yes	No	No
Residential lawns (PT)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Animal Feedlots, Animal Housing Premises, Animal Kennel (Sleeping Quarters), Pet Living/ Sleeping Quarters (G, CC, spot treatment)	No	No	Yes	Yes	Yes	No	No	No	Yes	Yes	No	No	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	Freshwater Vertebrates (includes DS, TG, CTS [all DPS])[2]		Freshwater Invertebrates (includes CFWS)[3]		Freshwater Benthic Invertebrates[6]		DS, TG and Estuarine/ Marine Vertebrates[1]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Urban and rural structures and buildings, Farm Premises (Agricultural), Barnyards/ Auction Barns, Seed Houses/ Stores/ Storage Areas/ Ware-houses (Barrier Trt)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Urban and rural structures and buildings (GR)	No	No	Yes	Yes	No	No	No	No	Yes	Yes	No	No	No
Urban and rural structures and buildings (PT, surface/space spray)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Urban and rural structures and buildings (CC, brush on, void trt, foam application)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Urban and rural structures and buildings (soil treatment, trenching)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Farm Premises (Agricultural), Barnyards/ Auction Barns, Seed Houses/ Stores/Storage Areas/ Warehouses (CC, spot trt, PT, directed spray)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Wood Protection Treatment to Buildings/ Products (Outdoors) (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	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])[2]		Freshwater Invertebrates (includes CFWS)[3]		Freshwater Benthic Invertebrates[6]		DS, TG and Estuarine/ Marine Vertebrates[1]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Wood Protection Treatment to Buildings/ Products (Outdoors) (G, void treatment)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Right-of-Way (G)	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No
Right-of-Way (GR)	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No
Paved Areas (Private Roads/ Sidewalks) (PT)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Refuse/Solid Waste Sites (outdoors) (PT, surface spray)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Utilities, Utility Poles/Rights-of-Way (PT)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Utility Poles/Rights-of-Way (GR)	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No

A=aerial; G=ground; GR=granular; PT=perimeter treatment; CC=crack & crevice

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

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

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

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

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

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

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]		
AGRICULTURAL USE PATTERNS, LIQUID FORMULATIONS											
Agricultural crops/ soils	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Alfalfa, Clover	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Artichokes	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Beets, garden beets	Yes	Yes	No	Yes	No	Yes	No	No	Yes	Yes	Yes
Bushberries	Yes	Yes	No	Yes	No	Yes	No	No	Yes	Yes	Yes
Caneberries	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Canola, rapeseed, crambe	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Citrus crops	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Corn	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Cotton	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Cucurbits	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Deciduous Fruits, Apple, Stone Fruits	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Dried Peas and Beans	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Fruits (unspecified)	Yes	Yes	No	Yes	No	Yes	No	No	Yes	Yes	Yes
Grapes	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Head and Stem Brassica; Lettuce, Leafy Petiole Vegetables	Yes	Yes	No	Yes	No	Yes	No	No	Yes	Yes	Yes
Hops	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Pears, Mayhaw, Fruits (unspecified), Strawberry	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Peppers, Succulent Peans and Beans; Tomato & Tomatillo; Eggplant, Ground Cherry, Pepino	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Root Crops	Yes	Yes	No	Yes	No	Yes	No	No	Yes	Yes	Yes
Spinach	Yes	Yes	No	Yes	No	Yes	No	No	Yes	Yes	Yes
Sweet corn	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Tree Nut Crops (1)	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Tuberous and Corn Vegetables	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
SEED TREATMENTS											

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]		
Beans; brassica (head and stem vegetables); canola/ rape/crambe; corn (field, pop, sweet); cotton; cucurbits; lettuce and leafy vegetables; succulent peas; pepper and eggplant (ST)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
GRANULAR APPLICATIONS											
Corn (field), sweet corn, cucurbit vegetables, succulent peas and beans, head and stem brassica vegetables, lettuce, eggplant, cotton, bell and non-bell peppers, root crops (GR)	Yes	N/A	No	N/A	No	N/A	No	N/A	No	Yes	Yes
Field corn, sweet corn (at plant) (GR, T-band)	No	N/A	No	N/A	No	N/A	No	N/A	No	Yes	Yes
Sweet corn (GR, in-furrow)	No	N/A	No	N/A	No	N/A	No	N/A	No	Yes	Yes
Tuberous & corm vegetables (GR)	No	N/A	No	N/A	No	N/A	No	N/A	No	Yes	Yes
Canola (GR)	No	N/A	No	N/A	No	N/A	No	N/A	No	Yes	Yes
Turf; ornamentals (various including Christmas trees, containerized), parks, recreational parks, around institutional, public, commercial and industrial buildings, golf courses, sod farms (GR)	Yes	N/A	Yes	N/A	Yes	N/A	Yes	N/A	No	Yes	Yes
NON-AGRICULTURAL USE PATTERNS											
Agricultural Right-of-Ways/ Fencerows/ Hedgerows	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Airports/ Landing Fields	No	No	No	No	No	No	No	No	Yes	Yes	Yes
Christmas Tree Plantations, Golf Course 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]		
Farm Premises/Buildings	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Forest Tree Plantations	Yes	Yes	No	Yes	No	Yes	No	No	Yes	Yes	Yes
Forest Trees - unspecified, softwoods	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Non-agricultural Uncultivated Areas	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Nursery Stock	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Ornamental & Shade Trees (1)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ornamental & Shade Trees (2)	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Ornamental Grasses	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Pave Area Perimeters	Yes	Yes	No	Yes	No	Yes	No	No	Yes	Yes	Yes
Refuse/Solid Waste Sites (outdoors)	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Residential Lawns (1)	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Residential Lawns (2)	No	No	No	No	No	No	No	No	Yes	Yes	Yes
Residential Lawns (3)	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Right of Way (1)	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Right of Way (2)	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Roses	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Sod farms, ornamental sod farms	Yes	Yes	No	Yes	No	Yes	No	No	Yes	Yes	Yes

A=aerial; G=ground; GR=granular; ST=seed treatment

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, TG, DS, CTS (all DPS as follows: CTS-SC, CTS-CC, CTS-SB), VELB, CCR, SFGS and CFWS 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 bifenthrin 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 bifenthrin 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 bifenthrin 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 bifenthrin 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 bifenthrin in accordance with the approved product labels for California is “the action” relevant to this ecological risk assessment.

Bifenthrin is a Type I synthetic pyrethroid (*i.e.*, it is not 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 bifenthrin allow for use nationwide, this ecological risk assessment and effects determination addresses currently registered uses of bifenthrin 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

Bifenthrin is a persistent chemical and no major (≥10% of the applied radioactivity) degradates were observed in any of the available environmental fate studies. Therefore, no potential degradates were included in this assessment.

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).

Bifenthrin has 90 registered products that contain multiple active ingredients. There are no registered co-formulated products containing bifenthrin and piperonyl butoxide (PBO), a known synergist, but there is one product that is co-formulated with the synergist MGK 264. Analysis of the available open literature and acute oral mammalian LD_{50} data for multiple active ingredient products relative to the single active ingredient is provided in **Appendix A**. This data set is limited and a qualitative analysis does not support any broad conclusions about the interactive nature of bifenthrin in combination with other pesticides. In the case of bifenthrin, 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 instances where there is sufficient data, it was concluded that the formulation is no more toxic than the single active ingredient. Additionally, there were several products for which the data was insufficient to establish a difference in toxicity.

There are several studies on mixture analysis in the open literature (**Appendix A)**. Four of them are highlighted in this summary as examples of the broad range of responses of mixtures of bifenthrin. Zhang *et al.* (2008) evaluated the toxicity of 50:50 mixtures of bifenthrin and dichlorvos and phoxim done through feeding the silkworm (*Bombyx mori*) with treated mulberry leaves, *Morus albus* (L.). Based on their analysis, it was concluded that bifenthrin: dichlorvos and bifenthrin: phoxim mixtures had additive effects. In another study (Wang *et al.* 2009), the acute toxicity of the organophosphate insecticide monocrotophos (MCP) to *Daphnia magna* was determined alone and in mixtures with bifenthrin. Using a toxic unit (TU) approach, it was determined that the TU for the mixture of bifenthrin and MCP was 1.2, suggesting a limited antagonistic effect against *D. magna*, since the value was close to unity. In another study (Zhang *et al.* 2010), for a series of pesticides and their 50:50 mixtures, toxicity tests were conducted to the zebrafish (*Brachydanio rerio*). It was concluded that the bifenthrin: dichlorvos mixture shows antagonism, while the bifenthrin: phoxim mixture shows additive effects. Weston and coworkers conducted several 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.

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 bifenthrin potential effect when it is co-formulated with other active ingredients will be based on the toxicity of bifenthrin.

2.3. Previous Assessments

Recent risk assessments conducted on bifenthrin indicated risk concerns for freshwater and estuarine/marine organisms. In addition, there were risk concerns for organisms living in the benthos (organisms residing in the sediment layer, mainly invertebrates).

In 2012, EFED issued an assessment of the use of bifenthrin in two new products used as dog shampoos to control fleas and ticks (D395907, D395908). One of the products contains 0.05% a.i., and the other contains 0.05% a.i. and 0.01% Nylar (pyriproxyfen). It is noted that these products have not yet been approved and are, therefore, not included in this review. Exposure to non-target terrestrial species is not expected, and therefore risk to birds, mammals, terrestrial-phase amphibians and reptiles is precluded. However, there is the possibility of exposure to aquatic organisms and in the absence of additional information, it was assumed that bifenthrin occurs at the limit of solubility of the chemical, which appears to be a highly conservative assumption. The aquatic risks were as shown in the 2007 review described below (see below D336608+, 2007). These uses were not assessed in this review since the products have not been approved for use in the USA.

In 2010, the Preliminary and Revised EFED Registration Review Problem Formulation for Bifenthrin were issued (USEPA 2010a and USEPA 2010b, respectively). 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 bifenthrin. 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 bifenthrin. These documents are publicly available in the docket EPA-HQ-OPP-2010-0384 in www.regulations.gov. The revision of the problem formulation was due to numerous comments from stakeholders (particularly from the state of California) mainly regarding the urban (both outdoor and indoor) uses of this chemical. One of the main changes was to the conceptual model (*i.e.*, risk hypothesis and conceptual diagram), which was revised to stress the fact that bifenthrin is applied over impervious surfaces when used in urban environments. Based on a comprehensive review of the data that were available, additional environmental fate and ecological effects studies were requested to confirm the available data or provide new data.

In 2008, the Agency issued an assessment for the use of bifenthrin on bushberry (Crop Subgroup 13-B) and leafy petiole (Crop Subgroup 4-B) (D341634+). The 2008 assessment was based on previously issued assessments, since the use rates (maximum 0.5 lb a.i./A/season) were at or below the maximum rate for previously approved uses.

In 2007, EFED issued an assessment for bifenthrin for the use on mayhaw, vegetable roots (except sugar beets), peanut, soybean, and fruiting vegetables (Crop Subgroup B) (D336608+). The seasonal rates for these crops ranged from 0.2 to 0.5 lb a.i./A/season, with single application rates of 0.1 lb a.i./A and retreatment intervals from 7 to 30 days. The review concluded that assessed uses had the potential for chronic risk to fish and aquatic invertebrates, including those living in or near the benthos; however, potential risks to birds and mammals was considered minimal. Finally, although risk to terrestrial plants could not be quantified due to a lack of chemical-specific data, risk to plants was considered minimal (based on bifenthrin's mode of action).

In 2006, a risk assessment was issued for the use of the chemical on leafy brassica greens, peas and beans (dry), tobacco, cilantro, okra and tuberous and corm vegetables (Group 1C) (D310879). The assessment was also based on previously issued assessments for the chemical and similar conclusions were made.

In 2005, the EFED issued the assessment for the use of bifenthrin for wood preservation (D290992). For this use, risks to birds, mammals and plants were expected to be small (precluded), due to lack of exposure; however, aquatic organisms were presumed to be potentially exposed, since bifenthrin could leach from the wood into the soil, be transported via runoff events accompanied with erosion, and reach adjacent bodies of water. Railroad (crossroad) ties located in the standard pond watershed were used as a representative scenario. It was assumed that 100% of the applied bifenthrin leached at once from the crossties. However, bifenthrin is immobile, hydrophobic, and has an extremely low solubility in water; it appears that it would be tightly bound to wood, and that the assumption is conservative. At the time, the registrant was required to perform a Wood Preservative Leaching Study, following the American Wood Preservers' Association's Standard Method of Determining the Leachability of Wood Preservatives (E11-97) or equivalent. This study was later submitted to the Agency and found to be acceptable. It was noted that on average only 6% of the applied leached from the crossties.

2.4. Environmental Fate Properties

Table 2-1 lists the physical-chemical properties of bifenthrin. **Table 2-2** lists the other environmental fate properties of bifenthrin, along with the degradates detected in the submitted environmental fate and transport studies. Bifenthrin has three rings, two phenyl rings attached to each other, and a cyclopropyl ring. It is a Type I synthetic pyrethroid (*i.e.*, it is <u>not</u> cyano-substituted in the alpha position).

Table 2-1. Physical-chemical Properties of Bifenthrin

Property	Parent Compound	
	Value and units	MRID or Source
Molecular Weight	422.9 g/mole	Laskowski, 2002
Chemical Formula	$C_{23}H_{22}ClF_3O_2$	Bifenthrin data sheet[1]
Density/ Specific Gravity	1.212 g/mL at 25°C/4°C	HSDB[2]
Vapor Pressure	1.80×10^{-7} torr at 25°C (by extrapolation) Classified as 'Non-volatile under field conditions.'	Laskowski, 2002 USEPA, 2008
Henry's Law Constant	7.2×10^{-3} atm-m^3/mole @ 22-25°C	Estimated from water solubility and vapor pressure
Water Solubility	0.0000140 mg/L @ 22°C	MRID 132518 Or Acc No.251725 (Laskowski, 2002)

[1] Available at http://www.alanwood.net/pesticides/bifenthrin.html (accessed 07/03/2012).
[2] Available at http://toxnet.nlm.nih.gov/ (accessed 07/05/2012).

Property	Parent Compound	
	Value and units	MRID or Source
Octanol – water partition coefficient (K_{OW})	3.00 x 10^6 @ 20^{o}C	Laskowski, 2002
C_{water}/C_{air}	$\frac{C_{water}}{C_{air}} = \left(\frac{S \times T \times R \times 760}{P \times GMW \times 10^6}\right)$ = 3133 (unitless) Classified as 'volatile from a water surface.'[(1)]	Calculated USEPA, 2008
Air-water partition coefficient (K_{AW})	$K_{AW} = C_{air}/C_{water} = 3.19x10^{-4}$	Calculated
Octanol-air partition coefficient (K_{OA})	$K_{OA} = \frac{K_{OW}}{K_{AW}} = \frac{K_{OW}RT}{\text{Henry's Law Constant}}$ = 9.4 x 10^9	Calculated
UV/visible light absorption	λ_{max} = 250 nm in neutral, acidic and alkaline solutions; at λ≥290 nm, the tail of the peak at 250 nm results in significant absorption in the range 290 to *ca.* 300 nm.	*EFSA Scientific Report* (2008) 186, 1-109; Conclusion on the peer review of bifenthrin
Volatization Flux	5.07x10^{-5} µg/cm^2-hr at 25ºC at 14 days	41220601
$C_{water+soil}/C_{air}$	$C_{water+soil}/C_{air} = (C_{water}/C_{air})(1/r + K_d)$ = (3133) (1/6 + 3591) = 1.13x10^7 Classified as 'non-volatile from a moist soil.'[3]	Calculated USEPA, 2008

(1) As explained in Section 2.4.1, the high sorption coefficient and short hydroxyl radical half life are expected to strongly limit exposure to bifenthrin via volatilization.

Bifenthrin is persistent in the environment, relatively stable to hydrolysis and photolysis and is slow to biodegrade. The very low water solubility (0.014 µg/L at 22^{o}C) [4] and lipophilic nature of bifenthrin (as evidenced by its high K_{ow} and K_{oc} values), leads to strong soil adsorption and a tendency to partition to sediment in aquatic systems. Bifenthrin has a low vapor pressure and a moderate Henry's law constant. Given the fact that bifenthrin adsorbs strongly to soil particles and to organic matter, volatilization from water and soil surfaces should be low. The hydroxyl radical reaction half-life for bifenthrin is ~0.4 days (EPISUITE v.4.1 estimate), which appears to preclude the potential for long-range transport.

The major route of degradation for bifenthrin is through aerobic soil metabolism (half-life range 97-250 days); however, the compound is relatively stable in anaerobic soil. Bifenthrin is immobile in the four soils tested (K_{OC} >100,000 L/kg_{OC}, FAO classification). Field studies show a pattern consistent with the laboratory studies, with relatively high persistence (half-lives ranging from 78 to 345 days in 10 field trials), and low mobility of the chemical in soil. In aquatic environments, residues of bifenthrin persist in pond water and sediment for extended periods (for at least 12 months of monitoring). Due to bifenthrin's persistence, no major metabolites were observed (>10% of the applied) in any of the laboratory studies.

Bifenthrin has an extremely low solubility (only 0.014 ppb) and a high K_{OW} of 3.00x10^6. The K_{OW} value predicts that bifenthrin has the potential to bioaccumulate in aquatic food webs. This is confirmed by the bioconcentration study in fish, where the bioconcentration factors (BCFs) ranged from 2140 L/kg for edible portion to 8720 L/kg for the non-edible portion. For bifenthrin, the log of the octanol-air partition coefficient (K_{OA} = 7.01; calculated) coupled with a

3 Assuming 2% organic carbon, soil to soil water ratio (w/w) = 6, and soil water to soil air (v/v) = 1.
4 Uncertainties related to the very low value of the solubility of bifenthrin are discussed in **Section 6**.

high K_{OW} and a slow rate of transformation in the environment (based on high persistence demonstrated in the environmental fate studies) (see **Table 2-2**), it appears that bifenthrin may have *a potential* to biomagnify terrestrial food chains, based on the presumption made by Gobas *et al.* (2003) and Armitage & Gobas (2007). It is noted, however, that the metabolism of bifenthrin in vivo by terrestrial organisms would reduce this potential for biomagnification and therefore, would need to be considered in order for a definitive conclusion to be reached. Even though the Agencyhas not adopted an official reference or guideline to distinguish chemicals that biomagnify, Gobas *et al.* and Armitage & Gobas' presumption is utilized here as a general or broad reference to identify the potential for biomagnification in terrestrial food chains. .

Table 2-2. Summary of Bifenthrin Environmental Fate Properties

Study	Value and unit	Major Degradate *Minor Degradates*	MRID # (or Citation)	Study Classification, Comment
Abiotic Hydrolysis	No evidence of degradation, relatively stable at all three pHs (5, 7, 9) and in unbuffered (pH 7.5) solution.	N/A	00132539	Supplemental. The study was conducted in the presence of a high concentration of the cosolvent acetonitrile.
Atmospheric Degradation	Half-life[1] = 0.36 days (hydroxyl) 7.04 days (ozone)	N/A	N/A	Estimated EPISUITE v.4.1[5]
Direct Aqueous Photolysis	No evidence of degradation, relatively stable. Natural sunlight was used.	N/A	00163084	Supplemental. In unbuffered solution, and conducted in the presence of a high concentration of the cosolvent acetonitrile.
Soil Photolysis	$t_{1/2}$ = 147 days cyclopropyl $t_{1/2}$ = 98.5 days phenyl labels Silt loam. Corrected $t_{1/2}$'s are 147 days and 106 days, respectively (No significant degradation in dark control for cyclopropyl label.)	*trans*-bifenthrin reached up to around 3.1% of the applied	00163085	Acceptable. Natural sunlight in Princeton, New Jersey on August to October, 1985.

[5] In order to make these estimates, there are certain assumptions made by the module of EPISUITE, which represent a typical hydroxyl and ozone reaction in the atmosphere (refer to AOPWIN module at http://www.epa.gov/opptintr/exposure/pubs/episuite.htm accessed 12/04/2012).

Study	Value and unit	Major Degradate *Minor Degradates*	MRID # (or Citation)	Study Classification, Comment
Aerobic Soil Metabolism	Half-life[1] = 132 days, SL, cyclopropyl label 116 days, SL, phenyl label 250 days, SiL, cyclopropyl label 155 days, SiL, phenyl label 128 days, SiCL, cyclopropyl label <u>97 days, SiCL, phenyl label</u> SL=sandy loam; SiL=silt loam; SiCL=silty clay loam	$^{14}CO_2$ was 6-29% and non-extracted residues were 14-25% AR	Acc No: 073174, 073225, 141502, 251278, 251728, 254401, 254411, 264642, 532540; MRID 00132540, 00141202, 00152266	Acceptable. There is a discrepancy between labels (phenyl label degraded faster in all instances). The studies were conducted separately.
Anaerobic Soil Metabolism	Relatively stable. Slow metabolism was observed after anaerobic conditions were established. 75-79% of the recovered was bifenthrin at 61 days, sandy loam.	N/A	00163088	Supplemental. Samples were harvested only a few times. Sampling performed only at 0 (29 days after aerobic incubation and flooding), 31 and 61 days.
Solid-water distribution coefficient (K_d)	K_d = 992 L/kg, sand (0.76% OC) 4192 L/kg, sandy loam (1.76% OC) 5430 L/kg, silty loam (1.80% OC) 3690 L/kg, clay loam (1.34% OC)	N/A	Acc. No. 254411 or MRID 00141203	Supplemental. Study was performed at only one concentration. No Freundlich correlations are available. The K_{OC} model represents the mobility better than the K_d model (binding correlated to organic carbon content and the coefficient of variation for the K_{OC} dataset is lower than for the K_d dataset).
Organic-carbon normalized distribution coefficient (K_{OC})	Mean K_{OC} = 236,750 L/kg_{OC} 131,000 L/kg_{OC}, sand 239,000 L/kg_{OC}, sandy loam 302,000 L/kg_{OC}, silty loam 275,000 L/kg_{OC}, clay loam			
Volatility from Soil (Laboratory)	The mean volatility for day 14 was $5.07x10^{-5}$ µg/cm^2-hr at 25ºC and $1.48x10^{-4}$ µg/cm^2-hr at 40ºC, soil texture sand	N/A	41220601	Supplemental. The maximum volatiles were 1.1% at 25ºC and 5.1% at 40ºC, of the recovered, after 14 days.
Terrestrial Field Dissipation	Dissipation Half-life[1,2] = <u>Site Half-lives</u> Champaign, IL 192 days Fresco, CA 345 Madera, CA 155 Imperial County, CA 228 Tifton, GA 122 Marion, AR 78 Fresno, CA 193 Champaign, IL 118 Champaign, IL 126 Marion, AR 121 Fresno, CA DT_{50} = 35 days	N/A	Acc No 264642 or MRID 00163091; MRIDs 42339203, 42339201, 42334167, 41673103, 41673101, 41671302	Acceptable

Study	Value and unit	Major Degradate *Minor Degradates*	MRID # (or Citation)	Study Classification, Comment
Aquatic Field Dissipation	Pond study was conducted, due to the high toxicity demonstrated for bifenthrin, in Dallas County, Orville, AL: Residues of bifenthrin were found in the sediment and water of the pond during the 12 months period after application; in the sediment, there was no clear discernible pattern of decay.	N/A	MRIDs 40981803, 40981805, 40981808, 40981812, 40981814, 40981815, 40981816, 40981817, 40981818, 40981819.	Supplemental. Residues in fish tissues were orders of magnitude higher than the concentration in water. The study provides useful qualitative information.
Bioconcentration Factor (BCF) – Bluegill Sunfish	Steady State BCF= 6,090 L/kg wet wt whole fish 2,140 L/kg wet wt edible tissue 8,720 L/kg wet wt non-edible tissue Depuration half-lives 32.3 and 38.0 days, for the edible and inedible tissues, respectively.[1]	Parent 66.8-70.2% TRR; 4'-OH-bifenthrin 3.2-3.6% TRR; Un-extracted 21.4-23.4% TRR	Acc. No. 264642 or MRID: 163094, 163095	Supplemental. Depuration was slow with 43-53% of the residues still remaining in the fish tissue after 42 days of depuration.
Bioaccumulation in Aquatic Non-Target Organisms	BCFs seemed to be independent of the application rates: *Daphnia magna* – 270-440x; *Asellus* (water exposure) – 71-82x; *Asellus* (water and soil exposure) – 120-180x; *Pimephales promela* – 45-63x; *Corbicula* (aqueous phase) – 41-74x; *Corbicula* (soil phase) – 92-140x.	Not Available	MRID 42529902	Supplemental. It was noted that the water concentrations greatly exceeded the limit of solubility of bifenthrin, suggesting that dissolved organic matter might have been present in the water.
Bioaccumulation in Aquatic Non-Target Organisms	*Daphnia magna* BCFs ~ 2,500-4,600 L/kg (water) BCFs ~ 800-4,300 L/kg (water plus suspended solids at 0-200 mg/L)	Not Available	Yang *et al.* 2006	Supplemental.
Bioconcentration in Aquatic Non-Target Organisms	*Hyalella azteca* BCF = 1180 ± 542 L/kg	Not Available	Holzer 2011	Supplemental Ref. No. 156712

Abbreviations: wt=weight, TRR=total residue recovered, OC=organic carbon
[1]Half-lives were calculated using the single-first order (SFO) equation and nonlinear regression, unless otherwise specified. [2]The value may reflect both dissipation and degradation processes.

2.4.1. Environmental Transport Mechanisms

Potential transport mechanisms include pesticide surface water runoff, spray drift, and secondary drift of volatilized or soil-bound residues leading to deposition onto nearby or more distant ecosystems. Surface water runoff of sediment-bound residue and spray drift are expected to be the major routes of exposure for bifenthrin. Bifenthrin can be spray applied by ground or aerially on agricultural settings. A buffer distance is label required for agricultural crops (150 ft. for aerial applications that do not use ULV); 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 persistence, low solubility (0.014 ppb), and high potential for binding (K_{OC} values ranging from 131,000 to 302,000 L/kg-$_{OC}$), bifenthrin 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. It was also noted that the desorption coefficients were much higher than the adsorption ones, which indicate that such desorption would be minimal. However, 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 bifenthrin reaches surface water, the fate of the chemical is of concern since bifenthrin is highly toxic to fish and aquatic invertebrates. The Agency believes that bifenthrin, 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 bifenthrin, where it may persist, as shown in an aquatic field dissipation study.

Bifenthrin is not likely to reach subsurface soil environments or ground waters. Various terrestrial field dissipation studies confirm that bifenthrin remains mostly in the uppermost soil depth.

With a relatively low vapor pressure of 1.80×10^{-7} mmHg, and due to its very low solubility (0.014 ppb), its calculated Henry's Law Constant is moderately high (7.2×10^{-3} atm-m^3/mol). In addition, its C_{water}/C_{air} is 3133, which indicates that it is "volatile from a water surface" (USEPA 2008). Although the vapor pressure is marginally low, the Henry's law constant suggests that there could be acute exposure only during application of the chemical. However, there are two main reasons why bifenthrin does not seem to be persistent in air. As indicated in **Table 2-1**, the hydroxyl radical reaction half-life for bifenthrin is ~0.36 days (EPISuite v.4.1 estimated). Therefore, chronic atmospheric exposure, or transport are precluded, and any concerns would likely be restricted to acute exposures. Finally, bifenthrin's potential for volatilization should be reduced significantly because it sorbs strongly to soils, suspended solids, particulate, sediment, and organic matter in the water column.

The theoretical maximum concentration of bifenthrin in air[6], based on its vapor pressure, is 4.1 µg/m^3. Only one air monitoring study for bifenthrin, performed by the California Air Resources Board (CARB 2001), is available. Both, "application" (*i.e.*, close to the site of the applications) and "ambient" (*i.e.*, farther away from the site of application) monitoring were conducted –

[6] Calculated using the equation $C_s = (VP)(MW)(10^3 \text{ L/m}^3)(10^6 \text{ µg/g})/[(760)(V_m)]$, where C_s is the air concentration at saturation (µg/m^3), VP is the vapor pressure in mmHg, MW is the molecular weight (g/mol), and V_m is the volume occupied by a gas at 25°C, and a pressure of 1 atm, according to the ideal gas constant, which is 24.45 L/mol.

measured concentrations were well below the theoretical maximum. The maximum air concentration from the CARB monitoring results was only 0.270 µg/m^3 (270 ng/m^3), which was "observed at the east sampling site, during the 1st sampling period (application) of 2.7 hours." For the ambient monitoring, "the highest bifenthrin concentration, 17 ng/m^3 (0.97 pptv), was observed at the Helm Elementary School (HES) sampling site in Helm on July 15, 1999."[7]

2.4.2. Mechanism of Action

Bifenthrin is a neurotoxic insecticide acting through direct contact and ingestion. The insecticidal effect of pyrethroids is characterized by a rapid "knock down," or paralysis, of insects. All pyrethroids act as axonic poisons, affecting both the peripheral and central nervous systems, and share similar modes of action. The primary biological effects of bifenthrin and other pyrethroids on insects reflect an inhibition of the correct firing of neurotransmitter delivery signals from one cell to another via nerve membrane inhibition of the voltage-gated Ca^{2+} (calcium ion) channels coupled with a stimulatory effect on the voltage-gated Na^+ (sodium ion) channels. Pyrethroids have also been shown to suppress *gamma*-aminobutiric acid (GABA) and glutamate receptor-channel complexes and voltage-activated Ca^{2+} channels, but the toxicological significance of these actions is uncertain (Clark & Matsumura, 1987).

2.4.3. Use Characterization

Summary of Use Information

Analysis of labeled use information is the critical first step in evaluating the federal action. The current labels for bifenthrin 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.

Potential national bifenthrin uses include a wide range of agricultural (in/on food/feed crops); nursery uses; home garden uses; ornamental uses; turf uses; indoor/outdoor industrial, commercial, and residential uses; fire ant control; and wood protection. Currently, labeled uses of bifenthrin include both agricultural, such as peas and beans, head and stem brassica vegetables, canola, cucurbit vegetables, lettuce, caneberries, artichoke, pears, peppers, eggplants, spinach, grapes, leafy brassica greens, tuberous and corm vegetables, okra, strawberries, tree nut crops, garden beets and other root crops, soybeans, fruiting vegetables, mayhaw, leafy petiole vegetables, bushberries, and non-crop and non-agricultural uses, such as turf (*e.g.*, residential and golf courses), conifers (plantations/ nurseries), ornamentals and residential. According to some of the labels, in California, applications of bifenthrin on various crops are not allowed [*e.g.*, dried peas and beans (although applications on succulent peas and beans are allowed), leafy brassica and turnip greens, cilantro and coriander, tobacco and okra].

There are 432 active product labels (370 Section 3 labels and 62 Special Local Needs); 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

[7] pptv = parts per trillion – volume

from the technical registrants and major end use producers and selected non-major producers labels of bifenthrin, to get representative label data from a subset (>185 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 M**). 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 2-3 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. Furthermore, the **Table 2-5** provides a summary of other uses not applicable to California and/or uses not assessed in this review (see below).

Table 2-3. Summary of bifenthrin agricultural and non-agricultural uses assessed in California, and other use information not applicable to California [8]

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 [9]							
Alfalfa (Instructions for use in California)	0.1	1/CC; (assume 5 CC/yr) [10]	Assume 0.5	Assume 45 [11]	Ground or aerial	0	N/A
Clover (Instructions for use in California)	0.1	2	0.2	7	Ground or aerial	0	N/A
Tree nut crop: almond, beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, filbert (hazelnut), hickory nut, macadamia nut (bush nut), pistachio, walnut (black and English)	0.216	~3	0.54	15	Ground or aerial	0	7 (21 pecans)
Tree Nuts	0.21; 0.4	1	0.21; 0.4	N/A	Ground spray, soil treatment, drench; granular	0	N/A

[8] NDC=no dosage conversion; CC=crop cycle; GR=granular; App=applications; NMT=not more than; PHI=pre-harvest interval

[9] Some of the products and/or crops are prohibited in coastal counties. The combinations presented in this table reflect uses allowed in California.

[10] Assume 5 cuttings/year, separated by 45 days each. For further reference see http://www.epa.gov/oppefed1/models/water/met_ca_alfalfa.htm, accessed 08/22/2012.

[11] A 45-day interval was assumed following that one application is allowed per crop cycle and only 5 applications are allowed per year.

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
Citrus	0.25, 0.5	2, 1	0.5	Early and late season N/A	Ground (the product should not contact fruit or foliage) Ground (to bare soil beneath the grove)	0	1
Head and Stem Brassica Vegetables including: broccoli, Chinese broccoli, Brussels sprouts, cauliflower, cavalo broccolo, kohlrabi, cabbage, Chinese cabbage (napa), Chinese mustard cabbage (gai choy)	0.1 at plant or foliar	5	0.5	7	Ground, aerial or granular	0	7
Field corn (grain and silage), popcorn, field corn grown for seed, at plant use	0.1	1	See the following rows (use on field corn)	Do not apply to soil where there is > 30% cover of crop residue remaining.	In furrow, granular	Assume 1 inch (same as sweet corn)	N/A
Field corn (grain and silage), popcorn, field corn grown for seed [pre-emergence (PRE) or pre-plant incorporated (PPI)]	0.062; 0.040	1	See the next row	N/A	PPI; PRE	PPI= no deeper than 3 in. PRE= not specified	N/A
Field corn (grain and silage), popcorn, field corn grown for seed, foliar use	0.1	3	0.3 including at plant, PPI, PRE, and foliar	Not specified, assume 3 (same as cotton)	Ground, aerial or granular	0	30
Sweet corn, sweet corn grown for seed-at plant use	0.1	1	0.1	Do not apply to soil where there is > 30% cover of crop residue remaining.	In furrow; granules must be incorporated into the top 1"	0-1	N/A
Sweet corn (grain and silage), sweet corn grown for seed, foliar use	0.1	2	0.2	Assume 3 (same as cotton)	Ground, aerial or granular	0	1
Cotton	0.1	5	0.5	3	Ground, aerial or ULV	0	14
Pears	0.2	~3	0.5 (0.45 after petal fall)	30	Ground or aerial	0	14
Mayhaw	0.1	2	0.2	7	Foliar	0	30

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
Fruits (unspecified)	0.2, 0.4	2, 1	0.4	Assume 7, which is the same interval than for small fruits	Ground, granular	0	N/A
Small Fruits	0.1011	~4	0.3746	7	Ground	0	N/A
Deciduous Fruit Trees (unspecified), **Apple, Stone Fruits, Tree Nuts**	0.21; 0.4	1	0.21; 0.4	N/A	Ground spray, soil treatment, drench; granular	0	N/A
Grapes	0.1	1	0.1	N/A	Ground or aerial	0	30
Lettuce, head	At plant or foliar 0.1	5; or 2 GR	0.5; 0.2 GR	7	Ground or aerial; granular	0	7
Leafy Petiole Vegetables: celery, cardoon, Chinese celery, celtuce, Florence fennel, rhubarb, Swiss chard	0.1	5	0.5	7	Ground or aerial	0	7
Spinach	At plant or foliar 0.1	4	0.4	7	Ground or aerial	0	40
Cucurbits: chayote, citron melon, cucumber, gherkin, edible gourd (various), muskmelon (various, for example cantaloupe and pineapple melon), pumpkin, summer squash (various), winter squash (various), watermelon (includes hybrids)	At plant or foliar 0.1	3	0.3	7	Ground, or granular	0	3
Tuberous and corm vegetables: potato, sweet potato, arracacha, arrowroot, Chinese artichoke, Jerusalem artichoke, edible canna, cassava, chufa, dasheen, ginger, leren, tanier, turmer, yam bean, true yam	0.3 at plant; 0.15 lay-by; 0.1 foliar	NMT 2 foliar applications	0.5 including soil applications	21 for foliar applications	In furrow, lay-by and foliar treatment by ground, aerial; and granular app only at plant	0	21
Root Crops: burdock, carrots, celeriac, turnip rooted chervil, chicory, ginseng, horseradish, turnip rooted parsley, parsnip, radish, oriental radish, rutabaga, salsify, black salsify, Spanish salsify, skirret, turnip	0.1	5	0.5	7	Foliar; and granular app only at plant	0	21
Garden Beets	0.1	4	0.4	7	Foliar	0	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
Succulent peas and beans[12]: Pea (*Pisum spp.*) dwarf pea, edible-pod pea, English pea, garden pea, green pea, snow pea, sugar snap pea, Pigeon pea, Bean (*Phaseolus spp.*) broadbean (succulent), lima bean (green), runner bean, snap bean, wax bean, Bean (*Vigna spp.*) asparagus bean, blackeyed pea, Chinese longbean, cowpea, mothpea, Southern pea, yardlong pea, Jackbean Soybean (immature seed), Sword bean	At plant or foliar 0.1	2 (only 1 GR app allowed)	0.2 including at-plant plus foliar applications	Not specified, assume 7 (same than for dried peas and beans)	Ground, aerial or granular	0	3
Dried peas and beans[13]: bean (Lupinus); bean (Phaseoulus) field, kidney, lima, navy, pinto, tepary; bean (Vigna) adzuki, blackeyed, catjang, cowpea, crowder pea, moth, mung, rice, southern, urd; broad bean (dry); chickpea; guar; lablab bean; lentil; pea (Piscum), field pea; pigeon pea	At plant or foliar 0.1; 0.1 (CA)	3; 1 (CA)	0.2 a.i. to peas, or 0.3 a.i. to beans/ A/season including at plant + foliar applications; 0.1 (CA)	7	Ground or aerial; Ground or granular (CA)	0	14
Caneberries including blackberries, bingleberries, dewberries, lowberries, marion-berries, olallie-berries, young-berries, loganberrie, raspberries	0.1	2	0.2	One pre-bloom and one post-bloom, assume 14	Ground or aerial	0	3
Bushberries: highbush and lowbush blueberries, currant, elderberry, gooseberry, huckleberry	0.1	5	0.5	7	Ground or aerial	0	1
Artichoke	0.1	5	0.5	15	Ground or aerial	0	5
Hops	0.1	3	0.3	21	Ground or aerial	0	14
Strawberries	0.216	~3	0.54	7	Ground or aerial	0	0
Fruiting Vegetables[14]: Eggplant, Peppers (bell and non-bell), Ground cherry, Pepino	At plant or foliar 0.1	2	0.2	7	Ground, aerial or granular	0	7
Fruiting Vegetables: Tomato, Tomatillo	At plant or foliar 0.1	Assume 2	Assume 0.2	7	Ground	0	1

[12] Blackeyed peas are not grown in California.
[13] Some crop/label combinations are not allowed in California, see notes in the table.
[14] For granular applications on eggplant, the retreatment interval and the PHI are 9 days (both cases).

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
Herbs & Spices: Angelica/Balm/ Basil, Bay, Sweet Bay/Borage/ Burnet/ Catnip/Chervil/Chive/ Costmary/Dill/Horehound/ Hyssop/Lavender/Marigold, Pot/ Marjoram/Oregano/Nasturtium, Garden/Parsley/Pennyroyal/ Potting Soil-Top Soil/Rosemary/ Sage/Savory, Summer/Tansy/ Tarragon/Thyme/Wintergreen/ Woodruff/Wormwood	0.0006 lb/ft^3; [15] 0.4	NS; 1	NS; 0.4	NS; N/A	Soil incorporated (Potted granular app); Granular, soil media treatment	Assume 4 inches	N/A
Agricultural Crops/Soils (unspecified)	0.1189	~3	0.2497	21	Ground	0	NS
Canola, Crambe, Rapeseed	0.04	2	0.08	14	Ground, aerial or granular	0	35
Seed Treatments:[16] Beans, Brassica (Head and Stem) Vegetables, Canola/ Rape/Field Corn/Sweet Corn/Cotton/ Crambe/Cucurbit Vegetables/Dill/Eggplant/ Lettuce	0.075/lb seed[17]	1	NA	N/A	Seed treatment	NA	N/A
Non-agricultural Crops or Uses[18]							
Forest Trees - unspecified, softwoods, conifers; **Christmas Tree Plantations**; **Conifers** (plantations/nurseries)/ **Conifers** (seed orchard)	0.1091, 0.2 for conifers; 0.2, 0.4; 0.205	~3; 1; 3	0.3174, 0.6 for conifers; 0.2 & 0.4; 0.614	Assume 30; N/A; 30	Ground (soil drench); Ground, granular; Ground	0	N/A
Golf Course Turf	0.2, 0.4	1	0.2, 0.4	N/A	Ground, Granular or bait/solid	0	N/A
Sod Farms/Ornamental Sod Farms	0.218, 0.4	2, 1	0.4	7, N/A	Ground or aerial, Granular	0	1

[15] The application rate on a unit lb a.i./A is not specified. Assumed to be 0.4 lb a.i./A.
[16] Bifenthrin is not systemic and it is assumed that the use of the chemical on crops under spray conditions provides higher estimated exposure concentrations than the seed treatments.
[17] The application rate on a unit per acre is not specified.
[18] It is noted that for certain of these uses the application rates appear to be unusually high. Application rates shown in this table appear as shown in BEAD's use tables. Assumptions regarding these applications are detailed in **Section 3.1**.

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
Nursery Stock	NDC (assume 0.1), 0.4	NS (assume 1), 1	NDC (assume 0.1), 0.4	N/A	Soil drench, Bait/Solid	0	N/A
Mulch, Potting Soil/Top Soil	0.211, 0.0006 lb/cu ft, assume 0.211[19]	1, Assume 1	0.211, Assume 0.211	N/A	Granular, Granular soil media treatment	0	N/A
Right-of-Way	0.21, 0.2	1, ~3	0.21, 0.5	N/A. Assume 7	Ground, Granular, soil treatments	0	N/A
Agricultural Right-of-Ways/ Fencerows/Hedgerows	0.21[20]	1	0.21	N/A	Ground	0	N/A
Non-agricultural uncultivated areas (soils)	0.23, 0.2	2-3	Assume 0.5, 0.5	Assume 56 (around 2-month intervals)	Ground, Granular	0	N/A
Livestock/Livestock Feed Lots, Poultry Feedlots/Poultry Processing Plant Premises (non-food contact), Poultry Litter	0.23	Assume 3	Assume 0.5	NS-56	Ground perimeter treatment, crack & crevice, outdoor general surface spray, void treatment, spot treatment, directed spray	0	N/A
Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.3, 0.4, 0.95	Assume 3, 1, 1	Assume 0.9, 0.4, Assume 0.95	Assume 30, N/A, N/A	Ground, Granular and Bait/ Solid, Pressurized liquid	0	N/A
Rose	0.1	Assume 5	0.5	7	Ground	0	N/A
Ornamental Grasses; Ornamental Lawns and Turf; Ornamental Sod Farms; Recreational Areas; Recreational Area Lawns	0.236, 0.4	Assume 2, 1	Assume 0.47, 0.4	Assume 30, N/A	Ground, Granular Bait/ Solid	0	N/A

[19] The application rate on a unit lb a.i./A is not specified. It is assumed to be similar than for mulch.
[20] The application rate on a unit per acre is not specified for this use (*i.e.*, it is 0.015 lb a.i./ft of depth). It is assumed to be similar to agricultural rights-of-way.

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
Residential Lawns	0.232, 0.4, 2.3	2, ~2, Assume 1	0.464, 0.5 2.3	Assume 56, Assume 56, N/A	Ground, Bait/Solid & Granular, Spray, includes perimeter treatment	0	N/A
Commercial/Industrial Lawns	0.232, 0.4	2, ~2	0.464, 0.5	Assume 56	Ground, Bait/Solid & Granular	0	N/A
Airports/Landing Fields	0.4, 0.2112	1, 1	0.4[21], 0.2112[22]	N/A, N/A	Granular, perimeter treatment, Spot treatment, crack & crevice, directed spray	0	N/A
Animal Feedlots, Animal Housing Premises, Animal Kennel (Sleeping Quarters), Pet Living/Sleeping Quarters	0.2325	Assume 2	Assume 0.47	Assume 56	Spot treatment, crack & crevice, directed spray, outdoor general surface spray, wall treatment, brush on	0	N/A
Facilities various uses (as shown in the footnote)[23]	30.5, 0.4, 0.230, 89.1	Assume 1, 1, Assume 2, 1	Assume 30.5, 0.4, Assume 0.46, Assume 89.1	NS, N/A, 7, N/A	Barrier treatment, Bait/Solid or Granular, Crack & crevice, outdoor general surface spray, perimeter treatment, space spray, brush on, void treatment, foam application, Soil treatment (trenching)	N/A	N/A

[21] The broadcast granular application is assumed to occur to the turf area within and around the airport. It is assumed to be represented by the CA turf scenario (see golf course turf above).
[22] The spot treatment and crack and crevice directed spray is assumed to be similar to the applications on other impervious surfaces such like residential.
[23] Uses as follows: 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)/ Diary Farm Milk Storage Rooms/Houses/Sheds/ Eating Establishments (food and non-food areas)/Egg Handling Rooms/Egg Packing Plants (Commercial)/Feed Mills/Feed Processing Plants/Food/ Grocery/Marketing/Storage/ Distribution Facility Premise/ Food Processing Plant Equipment (food contact)/(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

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
Farm Premises (Agricultural), Barnyards/Auction Barns, Seed Houses/Stores/Storage Areas/ Warehouses	0.230, 22.5	Assume 2 Assume 1	0.460, 22.5	Assume 56 N/A	Spot treatment, crack & crevice, directed spray, perimeter treatment, Barrier treatment	0	N/A
Paths/Patios	22.3, 0.23	Assume 1, Assume 2	Assume 22.3, Assume 0.46	N/A, Assume 56	Perimeter treatment, soil treatment (surface), barrier treatment, Spot treatment, crack & crevice, outdoor general surface spray, space spray	0	N/A
Paved Areas (Private Roads/ Sidewalks)	23	NS	NS	NS-28	Outdoor general surface spray, perimeter treatment	0	N/A
Refuse/Solid Waste Sites (outdoor)	2.3	Assume 1	Assume 2.3	N/A	Perimeter treatment, outdoor general surface spray	0	N/A
Urban Areas, Wide Area/ General Outdoor Treatment (Public Health Use)	0.24	NS	NS	28	Outdoor treatment	0	N/A
Utilities, Utility Poles/Rights-of-Way	22	Assume 1	Assume 22	N/A	Various, represented by perimeter treatment[24]	0	N/A
Utility Poles/Rights-of-Way	1	Assume 1	Assume 1	N/A	Broadcast (granular)	0	N/A
Wood Protection Treatment to Buildings/Products Outdoor	22.5, 29.9 23.3, 0.24 43.4	Assume 1, Assume 1, Assume 1, Assume 2, Assume 1	Assume 22.5, Assume 29.9 Assume 23.3, Assume 0.48, 43.4	N/A or Assume 56	Barrier treatment, Broadcast, soil treatment, Perimeter treatment, Outdoor general surface spray, Void treatment	0	N/A

Areas (Outdoor)/ Meat Processing Plant Premises (food and non-food contact)/ Non-agricultural Outdoor Buildings/Structures/ Public Buildings/Structures/ Storage Areas (empty or full).

[24] Additionally: Soil treatment, soil treatment (rodding, surface, trenching), dust, crack & crevice and/or spot treatment, dust, injection treatment, soil injection treatment, barrier treatment, spray, and void treatment.

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
Wood Protection Treatment to Forest Products (seasoned)	0.2	NS	NS	14	Crack & crevice	0	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 bifenthrin may be used on crops that can be planted and/or harvested multiple times per year. **Table 2-4** shows some examples of crops with multiple harvests per year. In some instances (*e.g.*, cabbage, Chinese cabbage, spinach, 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 2-4. 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
Broccoli, broccoli raab and Chinese broccoli	Imperial (1), Coastal valleys (2), San Joaquin Valley (2); Chinese broccoli may be harvested multiple times per year
Cabbage and Chinese cabbage	Up to 3 depending on region and variety
Cauliflower	Coastal region (2 or more crops/year); desert and San Joaquin Valley (l), rotate to lettuce
Celery	2.5 crops/acre/year
Sweet corn	Normally, 2-3 crops/year in rotation with other crops. Southern desert regions (2), other regions (normally 2-3)
Swiss chard	May have multiple harvests
Lettuce	Central coast, central valley, San Joaquin Valley (up to 2), Other regions (1)
Radish	3-5 crops per year in rotation with other crops
Spinach	2-3 crops per year may be planted back to back. Processing spinach may be cut multiple times for 1-2 crops per year. Normally, fresh spinach harvest the whole plant.
Turf (sod farms only)	Up to 2; generally 1

Furthermore, there are uses to treat seeds for which only terrestrial exposure will be assessed since the aquatic exposure due to foliar applications is expected to be higher than exposure due to seed treatment. These uses include beans, brassica (head and stem) vegetables (includes several crops), canola/rape, corn (field, pop, sweet), cotton, crambe, cucurbit vegetables (various crops), eggplant, lettuce (head), succulent peas and pepper. The application rate is the same for all the seed treatments, *i.e*., 0.075 lb/100 lb seed, although the field application rate will vary according to the crop-specific seeding rates.

In addition, some of the uses were not assessed in this review, either because the crops are not grown in California, the uses are not allowed in the state, or low or no exposure is expected to wildlife due to use indoors (see **Appendix M).**

Summary of California Usage

The Agency's Biological and Economic Analysis Division (BEAD) provides an analysis of both national- and county-level usage information[25] using state-level usage data obtained from USDA-NASS[26], Doane (www.doane.com; the full dataset is not provided due to its proprietary nature) and the California's Department of Pesticide Regulation Pesticide Use Reporting (CDPR PUR) database[27]. 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 bifenthrin 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.[28] 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 bifenthrin usage for all California use sites is provided below in **Table 2-5**. According to the usage summary in **Table 2-5**, by far, the use with the highest amount of bifenthrin applied used is structural pest control, followed by tomato and tomato for processing. A summary of bifenthrin usage for all California use sites is provided below in **Table M1** and for California counties in **Table M2** (refer to **Appendix M**).

---

[25] Memorandum from M. Kaul, through A. Jones to R. Richardson, dated Feb. 23, 2012 (USEPA 2012a).
[26] United States Depart 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.
[27] 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.
[28] 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).

Table 2-5. Summary of California Department of Pesticide Registration (CDPR) Bifenthrin by Site Name, and Average of Five Years

SITE NAME	TOTAL LB 2006	TOTAL LB 2007	TOTAL LB 2008	TOTAL LB 2009	TOTAL LB 2010	AVERAGE LB-FIVE YEARS	UNIT AREA TRTD
ALFALFA	1,050.70	1,067.75	1,391.98	743.43	464.58	37617.23	Acres
ALMOND	3,903.78	9,311.37	10,085.75	13,657.61	146,409.21	36673.55	Acres
ANIMAL PREMISE	0.00	0.00	0.00	0.00	0.00	0.00	Acres
ANIMAL PREMISE	0.00	0.00	0.00	0.00	0.01	389.06	Misc. unit
ARTICHOKE, GLOBE	106.03	552.91	396.20	347.50	542.65	390.45	Acres
BARLEY	0.00	6.95	0.00	0.00	0.00	1053.30	Acres
BEAN, DRIED	115.22	237.29	126.27	1,584.55	3,196.20	1368.18	Acres
BEAN, SUCCULENT	98.32	551.89	138.65	148.96	643.53	345.22	Acres
BEAN, UNSPECIFIED	0.00	53.68	8.05	0.09	82.90	39.59	Acres
BEET	0.00	0.00	0.00	0.00	53.21	12.16	Acres
BLACKBERRY	0.00	1.90	0.10	4.40	1.20	8.07	Acres
BOK CHOY	0.00	0.00	0.00	15.30	17.43	6.72	Acres
BOYSENBERRY	0.00	0.00	0.85	0.00	0.00	537.84	Acres
BROCCOLI	213.00	162.40	242.90	820.13	1,249.94	537.67	Acres
BRUSSELS SPROUT	0.00	0.00	0.00	0.00	0.00	232.97	Acres
CABBAGE	116.34	524.81	145.22	176.26	202.20	246.19	Acres
CANOLA (RAPE)	0.00	0.00	0.00	0.00	66.12	2752.58	Acres
CANTALOUPE	1,708.99	1,609.57	1,371.90	3,648.56	5,357.77	2739.36	Acres
CARDOON	0.00	0.00	0.00	0.00	0.00	94.65	Acres
CARROT	86.42	65.42	62.70	125.10	133.59	218.25	Acres
CAULIFLOWER	78.44	92.18	127.67	89.12	230.61	126.36	Acres
CELERY	0.00	0.00	0.00	0.00	13.79	3.28	Acres
CHICORY	0.00	0.00	2.61	0.00	0.00	8.86	Acres
CHINESE CABBAGE (NAPPA)	0.00	0.02	10.50	8.50	22.66	8.42	Acres
CHRISTMAS TREE	0.42	0.00	0.00	0.00	0.00	0.82	Acres
CILANTRO	0.00	0.00	0.00	0.00	3.69	0.74	Acres
CITRUS	0.00	0.00	0.00	0.00	0.00	41.11	Acres
CLOVER	121.13	56.90	20.58	6.91	0.00	42.03	Acres
COLLARD	0.00	0.00	2.10	2.53	0.00	1.56	Acres
COMMODITY FUMIGATION	0.00	3.16	0.00	0.00	0.00	7839.07	
CORN (FORAGE - FODDER)	5,125.97	13,492.89	5,532.39	5,726.66	9,314.31	12272.72	Acres
CORN, HUMAN CONSUMPTION	671.64	4,738.78	1,576.04	6,270.89	8,914.06	4434.28	Acres
CORN, HUMAN CONSUMPTION	0.00	0.00	0.00	0.00	0.00	14609.25	Square feet
COTTON	4,213.11	5,031.91	8,843.35	25,930.12	29,027.77	14610.92	Acres
COTTON (FORAGE - FODDER)	0.00	2.00	0.00	6.33	0.00	1.70	Acres
COUNTY AG COMM	0.00	0.00	0.16	0.00	0.00	916.18	
CUCUMBER	257.50	422.86	73.79	605.33	3,221.29	916.15	Acres
DAIRY EQUIPMENT	0.00	0.00	0.00	0.00	0.00	0.00	Acres
DAIRY EQUIPMENT	0.00	0.00	0.00	0.00	0.00	0.01	Misc. unit
DATE	0.00	0.03	0.00	0.00	0.00	7.82	Misc. unit
EGGPLANT	0.93	2.28	5.27	12.27	18.33	7.82	Acres
FOOD PROCRESSING PLANT	0.00	0.00	0.00	0.00	0.00	0.00	Square feet
FUMIGATION, OTHER	0.00	0.00	0.00	0.00	0.00	0.00	
GAI LON	0.00	0.00	0.00	0.00	0.00	1.44	Acres

SITE NAME	TOTAL LB 2006	TOTAL LB 2007	TOTAL LB 2008	TOTAL LB 2009	TOTAL LB 2010	AVERAGE LB-FIVE YEARS	UNIT AREA TRTD
GRAPE	0.00	0.00	1.20	0.00	6.00	18.09	Acres
GRAPE, WINE	0.00	8.64	0.00	42.47	32.15	17.24	Acres
GRAPEFRUIT	0.00	0.00	0.00	2.96	0.00	0.59	Acres
GREENHOUSE FUMIGATION	0.00	0.00	0.00	0.00	0.00	0.00	Square feet
GREENHOUSE FUMIGATION	0.00	0.00	0.00	0.00	0.00	0.00	Acres
GREENHOUSE FUMIGATION	0.00	0.00	0.00	0.00	0.00	0.00	Cubic feet
INDUSTRIAL SITE	0.00	0.00	0.00	0.00	0.00	0.00	Square feet
JOJOBA BEAN	0.00	0.00	0.00	0.00	0.00	1.46	Acres
KALE	0.00	0.00	0.00	0.00	7.31	1.70	Acres
KOHLRABI	0.00	0.00	0.42	0.79	0.00	8.93	Acres
LANDSCAPE MAINTENANCE	0.84	0.33	5.55	36.56	0.14	2737.01	Acres
LANDSCAPE MAINTENANCE	2,364.60	3,977.13	2,042.91	2,326.71	2,930.30	2728.47	
LANDSCAPE MAINTENANCE	0.13	0.06	0.28	0.12	0.13	1.73	Square feet
LEMON	0.00	2.11	0.00	0.00	5.84	702.39	Acres
LETTUCE, HEAD	172.62	716.70	692.61	826.69	1,095.40	724.24	Acres
LETTUCE, LEAF	0.00	0.00	37.53	3.07	76.61	2844.82	Acres
MELON	1,588.75	1,444.00	2,855.48	2,545.93	5,672.74	2821.38	Acres
N-GRNHS FLOWER	0.00	0.00	0.00	0.00	0.00	19.33	
N-GRNHS FLOWER	17.05	25.88	27.72	13.26	12.71	19.33	Acres
N-GRNHS FLOWER	0.00	0.00	0.00	0.00	0.00	7.41	Misc. unit
N-GRNHS FLOWER	2.88	17.46	7.12	7.22	2.40	7.41	Square feet
N-GRNHS PLANTS IN CONTAINERS	0.00	0.00	0.00	0.00	0.00	72.32	
N-GRNHS PLANTS IN CONTAINERS	68.73	106.51	72.44	56.87	57.07	72.39	Acres
N-GRNHS PLANTS IN CONTAINERS	0.01	0.00	0.21	0.12	0.02	37.91	Misc. unit
N-GRNHS PLANTS IN CONTAINERS	38.90	42.08	28.45	29.65	50.11	37.84	Square feet
N-GRNHS TRANSPLANTS	0.00	0.00	0.00	0.00	0.00	2.28	
N-GRNHS TRANSPLANTS	4.11	4.69	0.27	0.93	1.39	7.12	Acres
N-GRNHS TRANSPLANTS	7.97	1.77	1.44	11.94	1.11	4.85	Square feet
N-OUTDR FLOWER	0.00	0.00	0.00	0.00	0.00	1.76	Misc. unit
N-OUTDR FLOWER	0.44	2.68	1.98	1.24	2.44	1.76	Square feet
N-OUTDR FLOWER	0.00	0.00	0.00	0.00	0.01	8.74	
N-OUTDR FLOWER	5.02	15.07	15.30	6.81	1.51	8.74	Acres
N-OUTDR PLANTS IN CONTAINERS	0.00	0.00	0.00	0.00	0.00	596.80	
N-OUTDR PLANTS IN CONTAINERS	717.08	1,037.58	531.41	379.91	318.02	605.70	Acres
N-OUTDR PLANTS IN CONTAINERS	0.00	44.50	0.00	0.00	0.00	31.57	Cubic feet
N-OUTDR PLANTS IN CONTAINERS	15.23	41.11	9.75	11.00	36.23	116.77	Misc. unit
N-OUTDR PLANTS IN CONTAINERS	60.71	114.29	179.57	49.18	66.76	157.40	Square feet
N-OUTDR TRANSPLANTS	93.96	88.91	45.68	49.50	38.43	63.30	Acres
N-OUTDR TRANSPLANTS	0.00	0.00	0.01	0.00	0.00	0.97	Misc. unit

SITE NAME	TOTAL LB 2006	TOTAL LB 2007	TOTAL LB 2008	TOTAL LB 2009	TOTAL LB 2010	AVERAGE LB-FIVE YEARS	UNIT AREA TRTD
N-OUTDR TRANSPLANTS	1.52	1.01	1.34	0.43	0.57	0.98	Square feet
N-OUTDR TRANSPLANTS	0.00	0.04	0.00	0.00	0.00	3.76	
OAT (FORAGE - FODDER)	0.00	0.00	0.00	0.00	18.74	3.87	Acres
ONION, DRY	0.00	0.00	0.00	0.60	0.00	0.86	Acres
ONION, GREEN	0.00	0.00	0.00	3.72	0.00	33.03	Acres
ORANGE	0.00	6.04	77.47	77.90	0.00	32.28	Acres
PARSLEY	0.00	0.00	0.00	0.00	0.00	23.41	Acres
PEAR	21.00	54.42	29.56	4.20	7.89	205.20	Acres
PEAS	0.00	0.00	265.62	485.59	157.75	188.29	Acres
PECAN	9.35	14.65	8.50	0.00	0.00	633.25	Acres
PEPPER, FRUITING	110.88	317.22	939.48	1,082.61	683.57	631.51	Acres
PEPPER, SPICE	0.00	4.53	0.00	0.33	18.92	11052.59	Acres
PISTACHIO	0.00	0.00	4,604.78	7,746.39	42,887.99	11057.60	Acres
PUBLIC HEALTH	16.24	9.17	13.15	3.74	6.54	852.24	
PUMPKIN	266.41	1,569.06	177.28	847.23	1,352.35	844.56	Acres
RADISH	0.00	0.00	0.00	0.00	10.47	36.21	Acres
RASPBERRY	9.33	20.13	25.11	38.36	77.63	127.27	Acres
REGULATORY PEST CONTROL	72.42	197.53	27.66	25.43	142.74	93.16	
REGULATORY PEST CONTROL	0.00	0.00	0.00	0.00	0.01	0.06	Acres
REGULATORY PEST CONTROL	0.00	0.00	0.00	0.00	0.30	0.06	Cubic feet
REGULATORY PEST CONTROL	0.00	0.00	0.00	0.00	0.00	0.00	Misc. unit
REGULATORY PEST CONTROL	0.00	0.00	0.00	0.00	0.00	3.00	Square feet
RESEARCH COMMODITY	0.00	0.51	0.00	14.45	0.05	3.00	Acres
RESEARCH COMMODITY	0.00	0.00	0.00	0.00	0.00	14.93	Square feet
RESEARCH COMMODITY	6.95	12.09	10.04	32.66	12.92	15.07	
RIGHTS OF WAY	0.00	0.03	0.63	0.02	0.00	132.29	Acres
RIGHTS OF WAY	60.65	358.50	190.99	21.97	28.67	132.16	
SAFFLOWER	0.00	0.00	0.00	0.00	0.00	0.04	Acres
SESAME, SEED	0.00	0.00	0.00	0.00	0.20	13.97	
SOIL FUMIGATION/PREPLANT	0.00	44.00	0.06	0.71	24.87	650.41	Acres
SOIL FUMIGATION/PREPLANT	1,215.18	1,232.44	485.04	178.45	71.29	647.12	Cubic feet
SOIL FUMIGATION/PREPLANT	2.30	39.99	0.00	0.00	10.90	103.74	Misc. unit
SOIL FUMIGATION/PREPLANT	23.60	72.40	9.00	112.22	248.26	96.17	Square feet
SOYBEAN	0.00	0.00	0.00	15.37	0.00	3.27	Acres
SPINACH	0.00	0.00	0.99	0.00	0.00	480.89	Acres
SQUASH	202.00	625.54	162.95	435.85	977.14	498.33	Acres
SQUASH, SUMMER	11.40	13.37	33.79	23.28	6.32	110.65	Acres
SQUASH, WINTER	27.00	329.45	1.47	91.86	15.31	97.37	Acres
SQUASH, ZUCCHINI	2.15	3.48	0.00	0.00	16.15	3459.57	Acres
STRAWBERRY	1,981.51	2,629.88	4,304.87	4,486.60	3,873.22	3455.42	Acres
STRAWBERRY	0.00	1.00	0.00	0.00	0.00	0.20	Misc. unit
STRAWBERRY	0.00	0.00	0.00	0.00	0.00	0.90	Square feet
STRUCTURAL PEST CONTROL	1.08	0.13	0.27	3.03	0.00	57214.34	Acres
STRUCTURAL PEST CONTROL	85,406.33	44,750.12	54,126.71	46,795.88	54,988.16	57215.65	
SUNFLOWER	0.00	0.00	0.00	0.00	11.05	4.61	Acres
TANGERINE	0.00	0.00	2.40	0.00	9.62	540.30	Acres

SITE NAME	TOTAL LB 2006	TOTAL LB 2007	TOTAL LB 2008	TOTAL LB 2009	TOTAL LB 2010	AVERAGE LB-FIVE YEARS	UNIT AREA TRTD
TOMATO	0.16	656.58	154.40	893.03	985.30	537.89	Acres
TOMATO	0.00	0.00	0.00	0.00	0.00	10573.08	Square feet
TOMATO, PROCESSING	3.81	4,139.93	14,373.56	14,015.98	20,332.11	10575.81	Acres
TURF/SOD	4.59	0.00	5.34	2.53	1.21	2.77	Acres
TURF/SOD	0.00	0.00	0.00	0.17	0.00	9.59	Misc. unit
UNCULTIVATED AG	3.46	0.11	4.10	30.29	9.81	10.03	Acres
UNCULTIVATED NON-AG	0.00	0.00	0.00	1.36	1.02	0.48	Acres
UNCULTIVATED NON-AG	0.00	0.00	0.00	0.00	0.00	0.26	
UNKNOWN	0.00	1.11	0.17	0.00	0.00	11.39	
UNKNOWN	0.00	0.00	9.44	4.96	41.29	70.14	Acres
UNKNOWN	64.40	0.00	135.00	95.59	0.00	59.00	Cubic feet
VEGETABLE	0.00	0.00	0.00	0.00	0.00	0.00	Acres
VEGETABLE	0.00	0.00	0.00	0.00	0.00	0.96	Square feet
VERTEBRATE CONTROL	0.16	1.32	1.28	1.62	0.43	2.30	
VERTEBRATE CONTROL	0.00	0.00	0.00	5.50	1.20	2329.98	Acres
WALNUT	759.56	2,479.85	2,403.97	2,730.68	3,269.13	2328.64	Acres
WALNUT	0.00	0.00	0.00	0.00	0.03	1264.11	Misc. unit
WATERMELON	510.91	1,324.24	445.44	1,253.08	2,786.88	1266.19	Acres
WHEAT	0.00	2.59	0.00	0.00	7.83	4.24	Acres
WHEAT (FORAGE - FODDER)	0.00	0.00	0.00	10.78	0.00	2.16	Acres

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 2-1** 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 2-6. Summary of Current Distribution, Habitat Requirements, and Life History Information for the Assessed Listed Species[1]

Assessed Species	Size	Current Range	Habitat Type	Designated Critical Habitat?	Reproductive Cycle	Diet
San Francisco Garter Snake (SFGS) (*Thamnophis sirtalis tetrataenia*)	Adult (46-131 cm in length), Females – 227 g, Males – 113 g; Juveniles – 2 g (Cover Jr. and Boyer, 1988) (18–20 cm in length)	San Mateo County	Densely vegetated freshwater ponds near open grassy hillsides; emergent vegetation; rodent burrows	No	Oviparous Reproduction[2] Breeding: Spring (Mar. and Apr.) and Fall (Sept. to Nov.) Ovulation and Pregnancy: Late spring and early summer Young: Born 3-4 months after mating	Juveniles: frogs (Pacific tree frog, CRLF, and bullfrogs depending on size) and insects Adults: primarily frogs (mainly CRLFs; also bullfrogs, toads); to a lesser extent newts; freshwater fish and invertebrates; insects and small mammals
California Clapper Rail (CCR) (*Rallus longirostris obsoletus)*	250 - 350 g Juveniles ~50 g[3]	Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma counties	Tidal marsh habitat	No	Breeding: Feb. - August Nesting: mid-March-Aug. Lay Eggs: March - July Incubation: 23 to 29 days; Leave nest: 35 to 42 days after hatch; Juveniles fledge at ten weeks and can breed during the spring after they hatch	Opportunistic feeders: freshwater and estuarine invertebrates, seeds, worms, mussels, snails, clams, crabs, insects, and spiders; occasionally consume small birds and mammals, dead fish, up to 15% plant material

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 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).

Delta Smelt Habitat

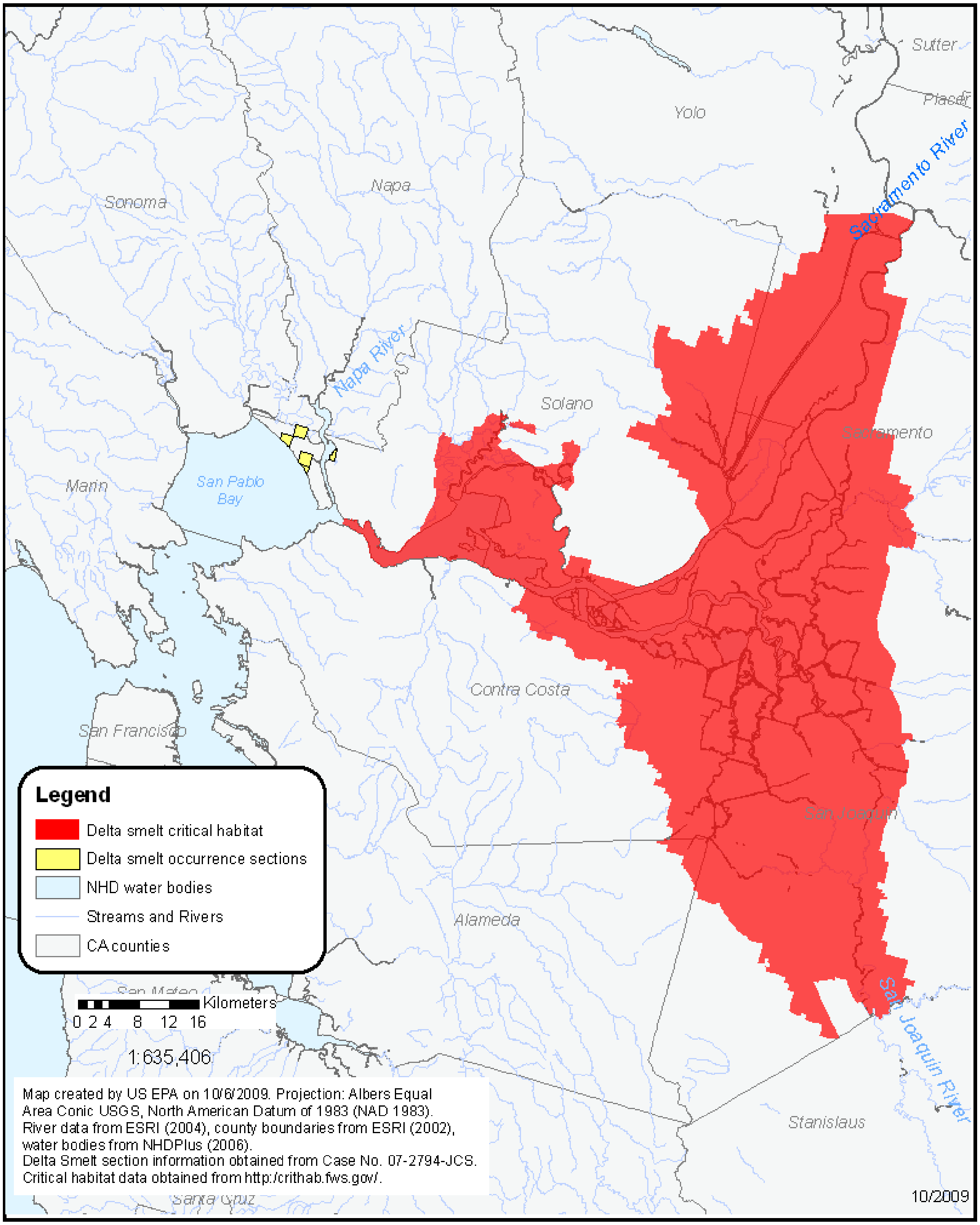


Figure 2-1. Delta Smelt Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS.

California Clapper Rail Habitat

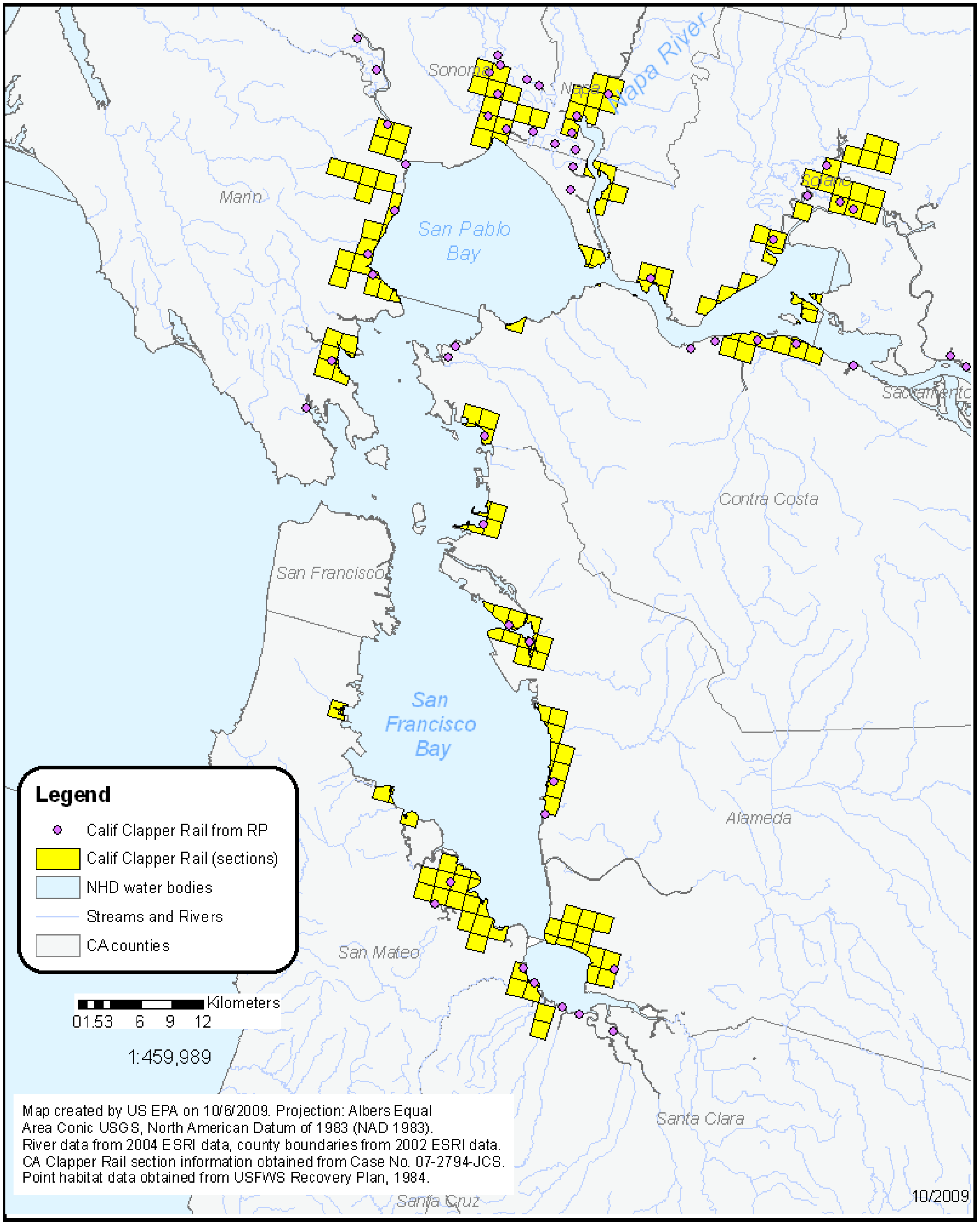


Figure 2-2. California Clapper Rail Occurrence Sections identified in Case No. 07-2794-JCS.

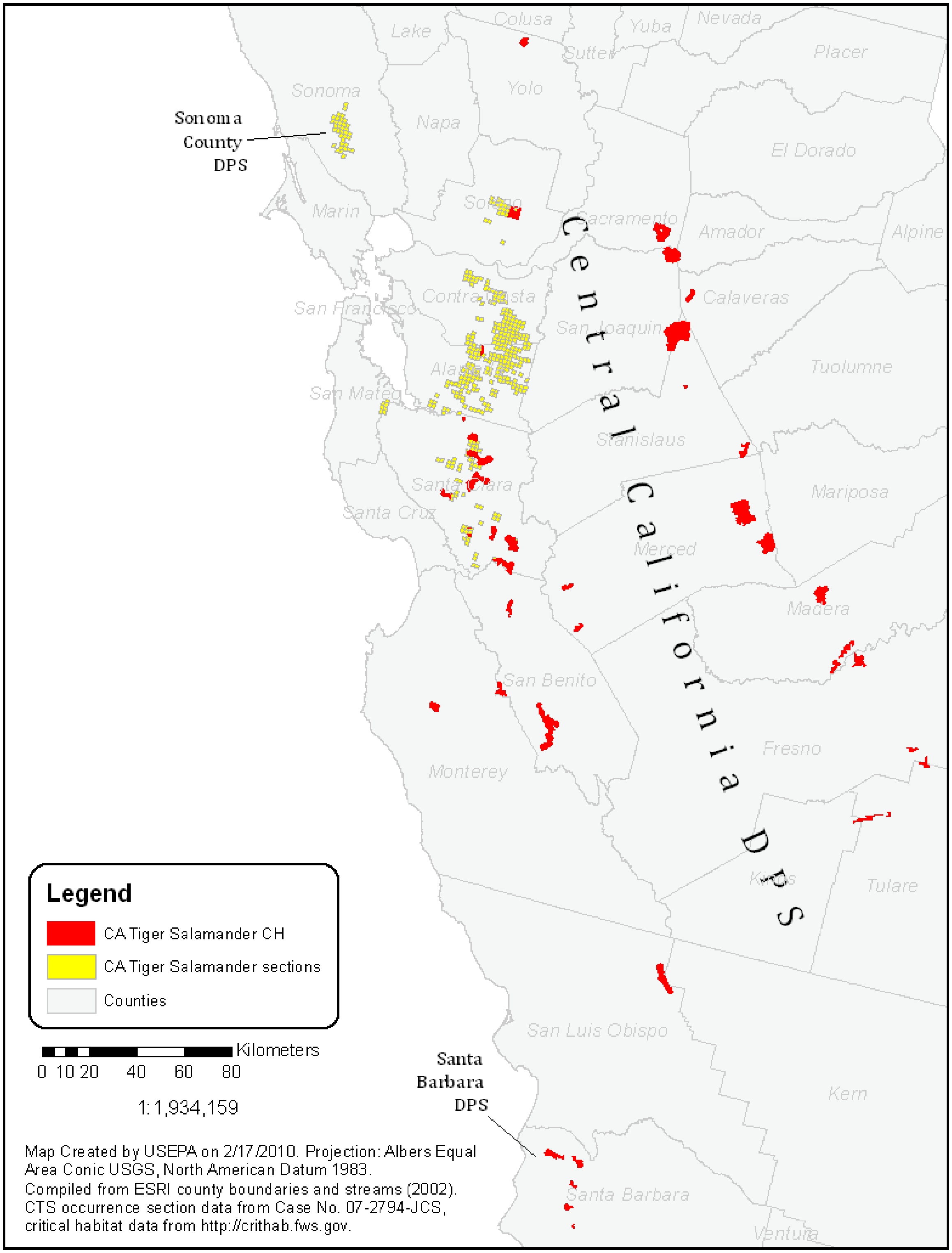


Figure 2-3. California Tiger Salamander Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS.

Bay Checkerspot Butterfly Habitat

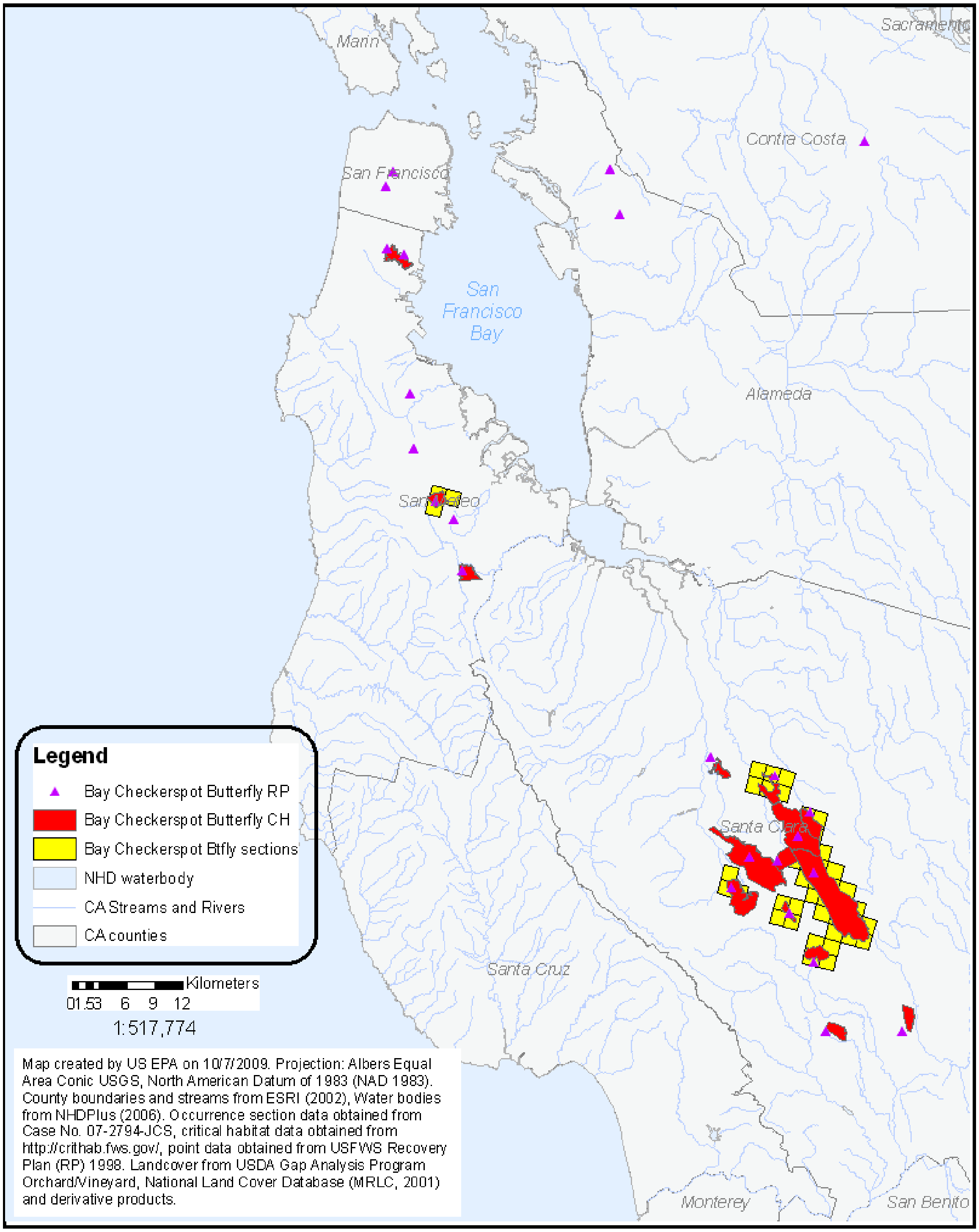


Figure 2-4. Bay Checkerspot Butterfly Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS.

Valley Elderberry Longhorn Beetle Habitat

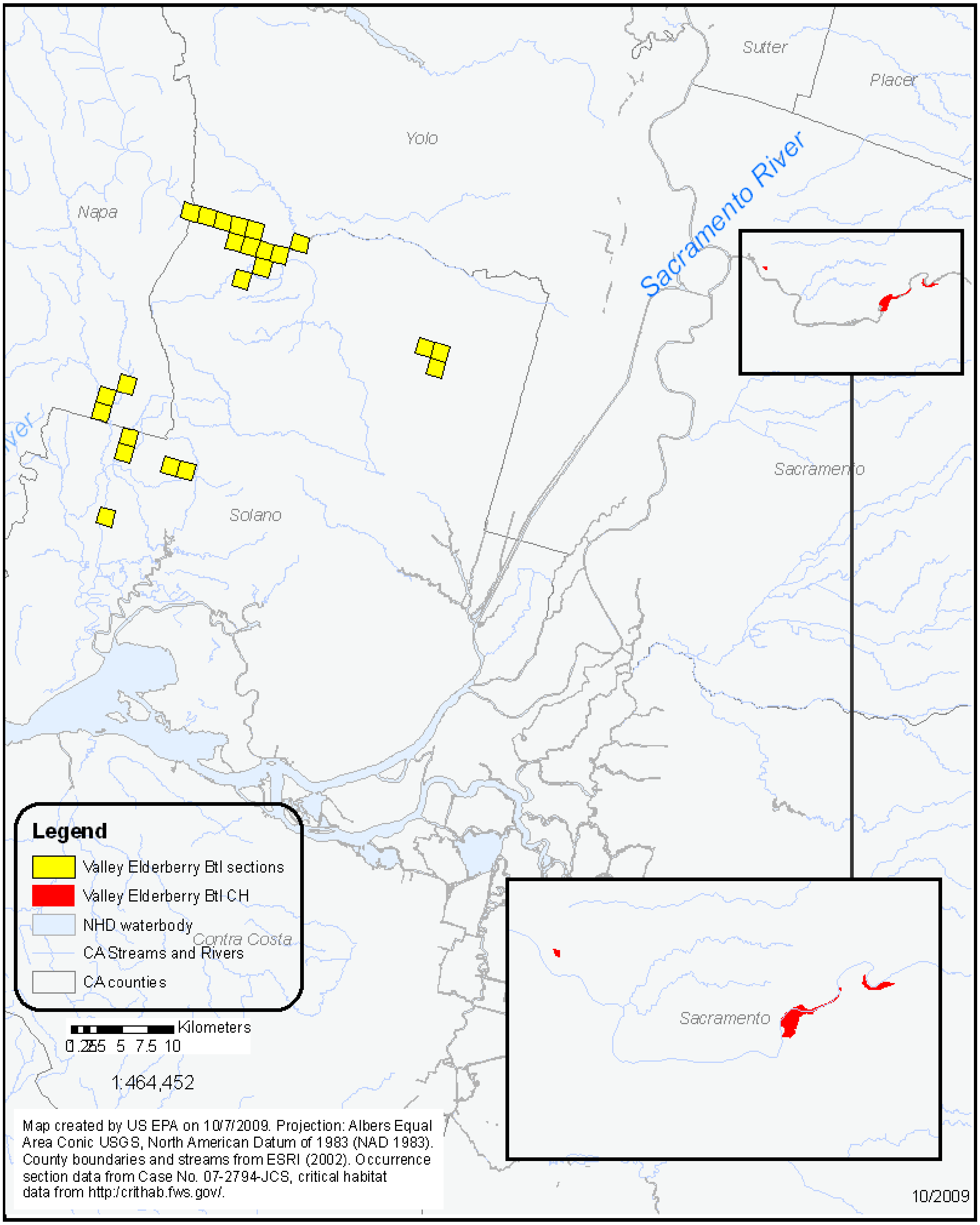


Figure 2-5. Valley Elderberry Longhorn Beetle Critical Habitat and Occurrence Sections identified in Case No. 07-2794-JCS.

SF Garter Snake Habitat

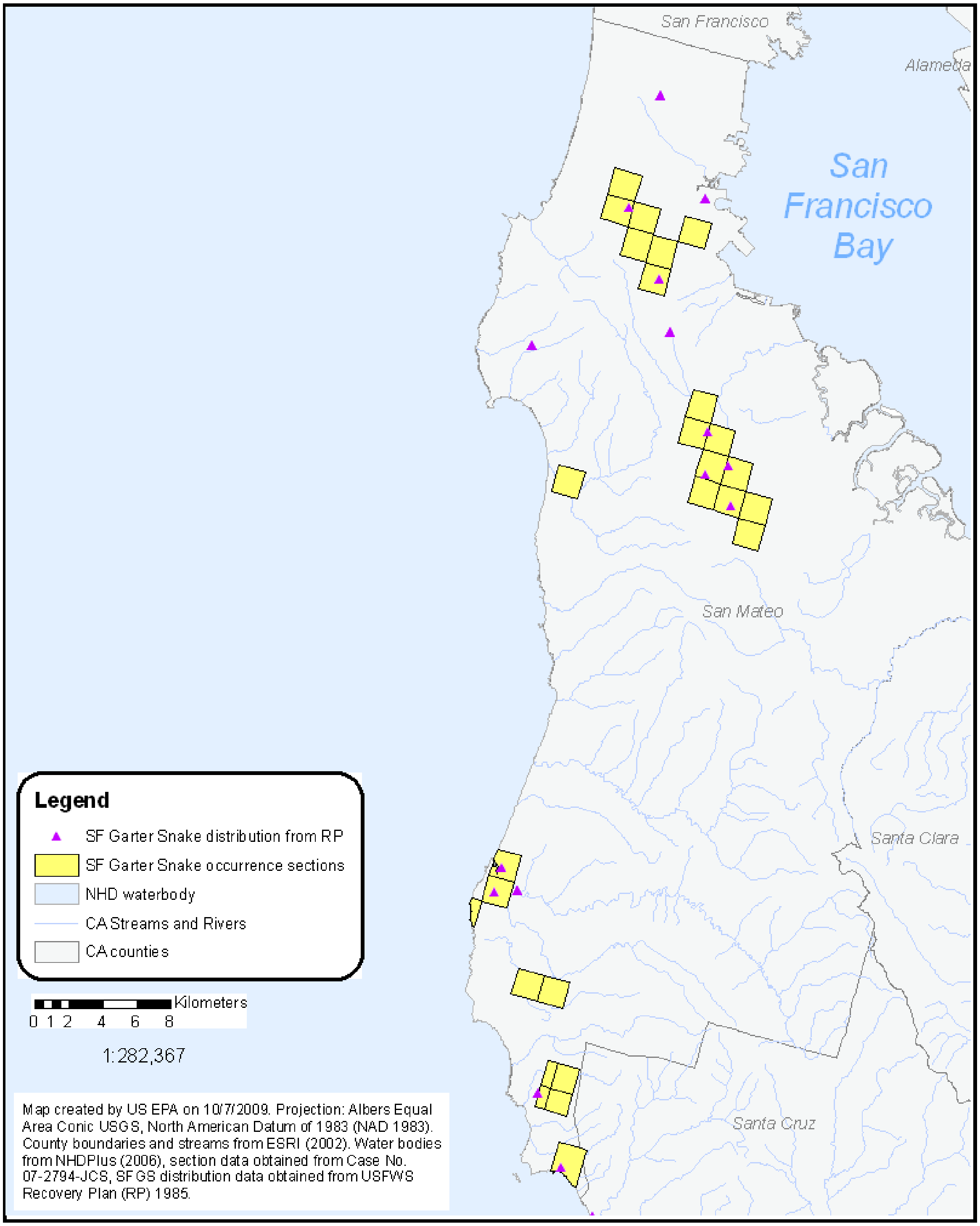


Figure 2-6. San Francisco Garter Snake Occurrence Sections identified in Case No. 07-2794-JCS.

California Freshwater Shrimp Habitat

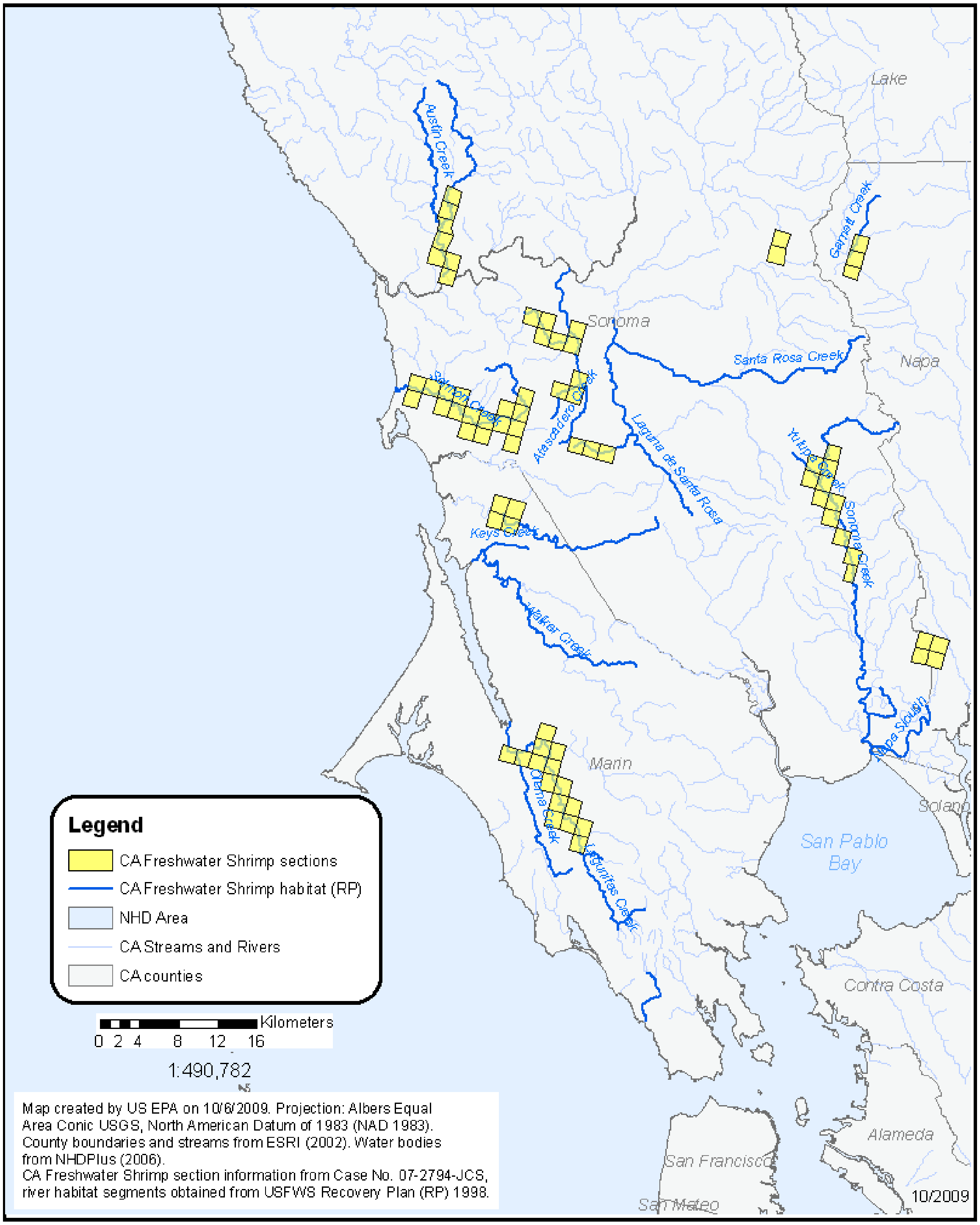


Figure 2-7. California Freshwater Shrimp Occurrence Sections identified in Case No. 07-2794-JCS.

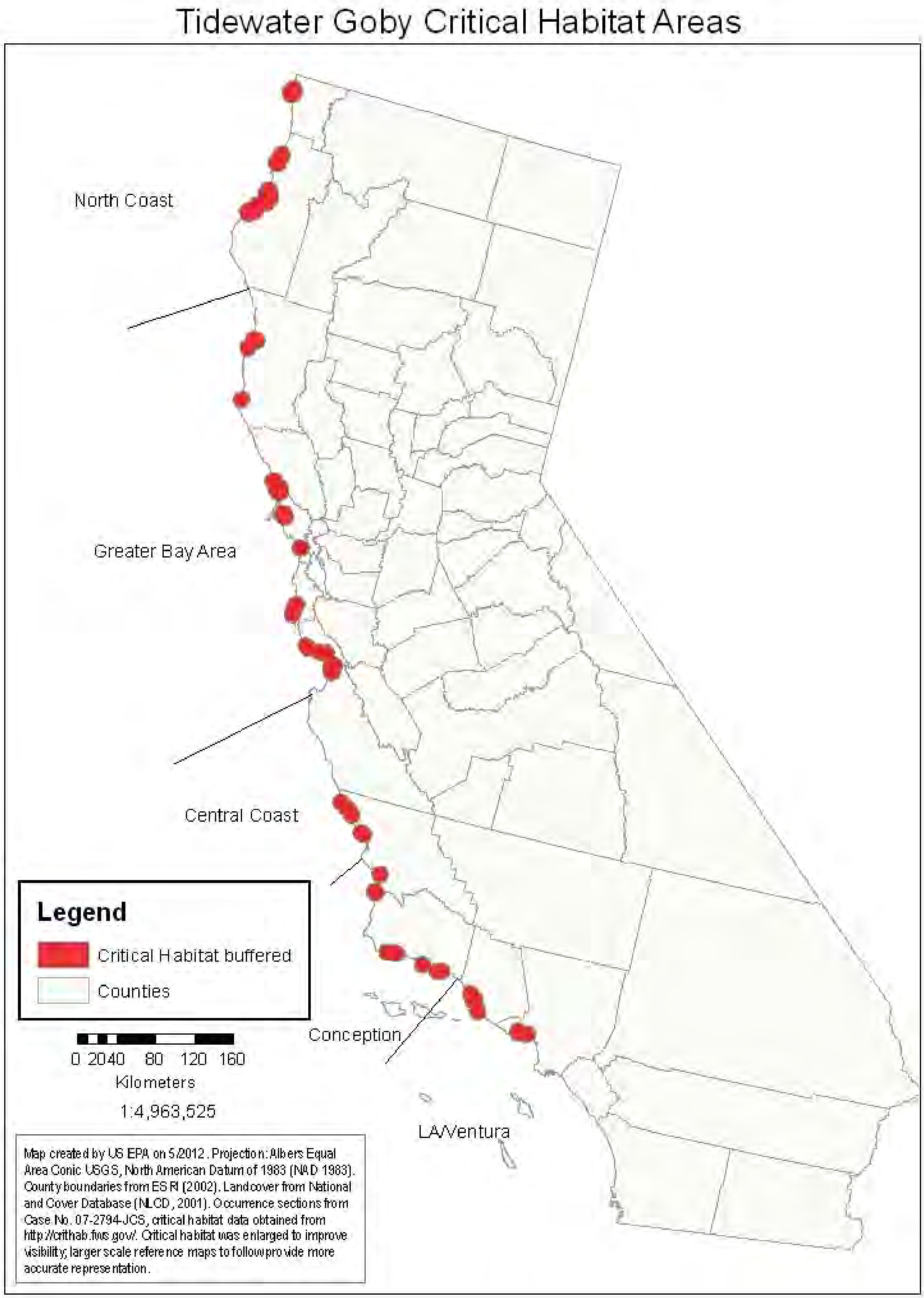


Figure 2-8. Tidewater Goby Critical Habitat identified in Case No. 07-2794-JCS.

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 2-8** describes the PCEs for the critical habitats designated for the BCB, TG, DS, CTS-CC, CTS-SB, and VELB.

Table 2-7. 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)	

Species	PCEs	Reference
	that provide areas with fewer aggressive, nonnative plant species for larval host plant and adult nectar plant survival and reproduction.[2]	
	The presence of stable holes and cracks in the soil, and surface rock outcrops that provide shelter for the larval stage of the bay checkerspot butterfly during summer diapause.[2]	
Tidewater Goby	Persistent, shallow (in the range of about 0.1-2 m), still-to-slow-moving, aquatic habitat most commonly ranging in salinity from less than 0.5 ppt to about 10-12 ppt, which provides adequate space for normal behavior and individual and population growth	65 FR 69693 69717, 2000
	Substrates (*e.g.*, sand, silt, mud) suitable for the construction of burrows for reproduction	
	Submerged and emergent aquatic vegetation, such as *Potamogeton pectinatus* and *Ruppia maritima*, that provides protection from predators	
	Presence of a sandbar(s) across the mouth of a lagoon or estuary during the late spring, summer, and fall that closes or partially closes the lagoon or estuary, thereby providing relatively stable water levels and salinity.	
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 bifenthrin 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 bifenthrin is expected to directly impact organisms living within the action area, critical habitat analysis for bifenthrin 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 bifenthrin is likely to encompass considerable portions of the United States based on the large array of agricultural and non-agricultural uses. However, the scope of this assessment limits consideration of the overall action area to those portions that may be applicable to the protection of the BCB, TG, DS, CTS (CTS-SC, CTS-CC, CTS-SB), 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: CTS-SC, CTS-CC, CTS-SB), VELB, CCR, SFGS and CFWS, and designated critical habitat may be affected or modified via endpoints associated with reduced survival, growth, or reproduction.

2.7.2. LAA Effects Determination Area

A stepwise approach is used to define the Likely to Adversely Affect (LAA) Effects Determination Area. An LAA effects determination applies to those areas where it is expected that the pesticide's use will directly or indirectly affect the species and/or modify its designated critical habitat using EFED's standard assessment procedures (see Attachment I) and effects endpoints related to survival, growth, and reproduction. This is the area where the "Potential Area of LAA Effects" (initial area of concern + drift distance or downstream dilution distance) overlaps with the range and/or designated critical habitat for the species being assessed. If there is no overlap between the potential area of LAA effects and the habitat or occurrence areas, a no effect determination is made. The first step in defining the LAA Effects Determination Area is to understand the federal action. The federal action is defined by the currently labeled uses for bifenthrin. An analysis of labeled uses and review of available product labels was completed. Several of the currently labeled uses are special local needs (SLN) uses not specified for use in California or are restricted to specific states and are excluded from this assessment. 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 bifenthrin the following broad agricultural uses are considered as part of the federal action evaluated in this assessment:

- Conventional agricultural crops, such as alfalfa, almond, citrus, cole crops, corn, sweet corn, cotton, various pome and stone fruits, lettuce and leafy petiole vegetables, spinach, cucurbit vegetables, tuberous and corm vegetables, root crops, sod farms, artichokes, peppers, peas and beans and other row crops, strawberries, beets, tomato, tomatillo and various other fruiting vegetables, eggplant, canola, caneberries, bushberries, hops, and various herbs and spices.

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

- Various conventional and unconventional crops and uses, such as forestry uses, rights-of-way, paved areas (sidewalks, private roads), livestock and poultry feedlots and premises, golf courses, ornamental sod and airport fields, recreational area lawns, industrial lawns, residential lawns paths and patios, animal feedlots and sleeping quarters, numerous urban and rural buildings and structures, farm premises and farmyards, storage areas, warehouses, seed houses, wood protection to buildings outdoors, and various kinds of ornamental plants, such as herbaceous plants and roses.

Further details on the uses assessed, PRZM scenarios, and application information (*i.e.*, application rates, number of applications and intervals), is provided in **Table 3-1**. **Section 2.4.3** details the use and usage of bifenthrin in California.

Following a determination of the assessed uses, an evaluation of the potential "footprint" of bifenthrin 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 bifenthrin, these land cover types include multiple land cover types (*e.g.*, Developed, Open Space; Developed, Low Intensity; Developed, Medium Intensity; Developed, High Intensity; Forested Upland; Deciduous Forest; Evergreen Forest; Mixed Forest; Planted/Cultivated; Pasture/Hay; Cultivated Crops). Given the diverse uses of bifenthrin, which include among others, residential, commercial, numerous agricultural crops, right-of-way, fire ant control, and forestry, 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 bifenthrin 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 M. Additional Use and Usage Information for Bifenthrin**).

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 bifenthrin uses the most sensitive endpoint of insects and aquatic invertebrates (*i.e.*, honeybee and *Hyalella azteca*). 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 and 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 2-9** identifies the taxa used to assess the potential for direct and indirect effects from the uses of bifenthrin 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 2-10**.

Table 2-8. 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	Direct	Indirect	Indirect	Indirect	Indirect	Indirect	n/a	n/a	Indirect

Listed Species	Birds	Mammals	Terr. Plants	Terr. Inverts.	FW Fish	FW Inverts.	Estuarine/ Marine Fish	Estuarine/ Marine Inverts.	Aquatic Plants
garter snake**	Indirect (prey)	(prey/ habitat)	(habitat)	(prey)	(prey)	(prey)			(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
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 bifenthrin 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 2-9. Taxa and Assessment Endpoints Used to Evaluate the Potential for Use of Bifenthrin 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 rainbow trout (*Oncorhynchus mykiss)* 1b. Estimated chronic NOAEC for rainbow trout
	Indirect Effect (prey) -SF Garter Snake -CA Clapper Rail	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. 96-h EC_{50} for freshwater amphipod (*Hyalella azteca*). 2b. 21-d NOAEC for water flea (*Daphnia magna*).
	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)	
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. Estimated chronic NOAEC for freshwater fish
	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. 96-h EC_{50} for mysid shrimp (*Americamysis bahia)* 4b. Estimated chronic NOAEC for mysid shrimp.

Taxa Used to Assess Direct and Indirect Effects to Assessed Species and/or Modification to Critical Habitat or Habitat	**Assessed Listed Species**	**Assessment Endpoints**	**Measures of Ecological Effects**
5. Aquatic Plants (freshwater/marine)	Indirect Effect (food/habitat) -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)	No bifenthrin-specific data available; aquatic plant toxicity data for other pyrethroids are used for risk characterization.
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. 168-d 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)*
8. Terrestrial Invertebrates	Direct Effect -Bay Checkerspot Butterfly -Valley elderberry longhorn beetle	Survival, growth, and reproduction of individuals via direct effects	8a. 96-h LD_{50} for honey bee (*Apis mellifera)*
	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)	No terrestrial plant data were available; terrestrial plant toxicity data for other pyrethroids are used for risk characterization.

Taxa Used to Assess Direct and Indirect Effects to Assessed Species and/or Modification to Critical Habitat or Habitat	Assessed Listed Species	Assessment Endpoints	Measures of Ecological Effects
	Indirect Effect (food/habitat) (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 bifenthrin 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 bifenthrin 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 bifenthrin to the environment. The following risk hypotheses are presumed in this assessment:

The labeled use of bifenthrin 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

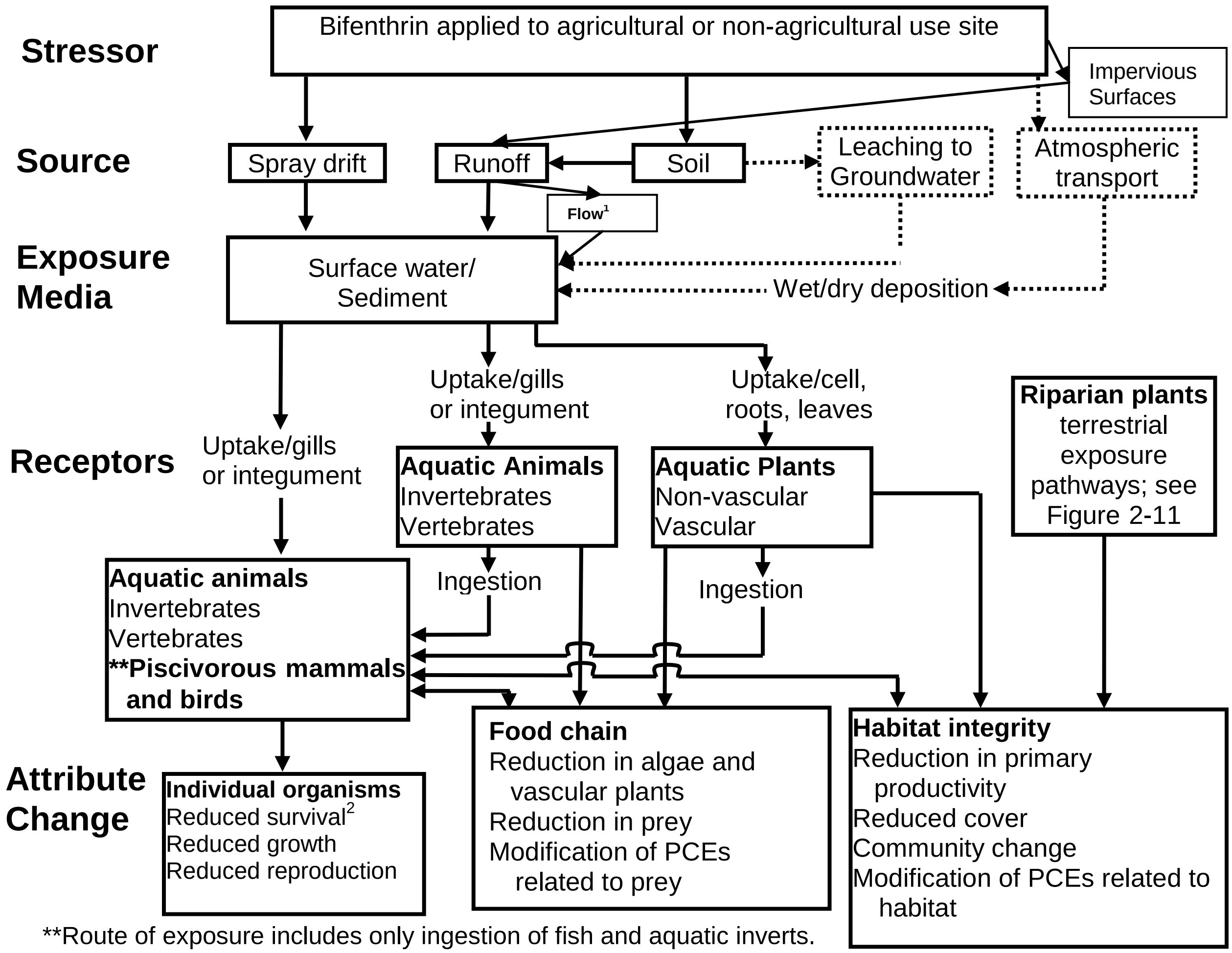
The conceptual model is a graphic representation of the structure of the risk assessment. It specifies the bifenthrin release mechanisms, biological receptor types, and effects endpoints of potential concern. The conceptual models for BCB, TG, DS, CTS, VELB, CCR, SFGS & CFW and the conceptual models 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, VELB, CCR, SFGS & CFW and modification to designated critical habitat is expected to be negligible.

Under the possible uses of bifenthrin, 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 bifenthrin shows low mobility in soils. Bifenthrin shows a moderate Henry's Law Constant that would suggest some potential for volatilization; however, the hydroxyl radical reaction half-life for the chemical is 0.36 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 bifenthrin 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 bifenthrin has the potential to bioaccumulate/bio-concentrate). 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**). Bifenthrin 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.

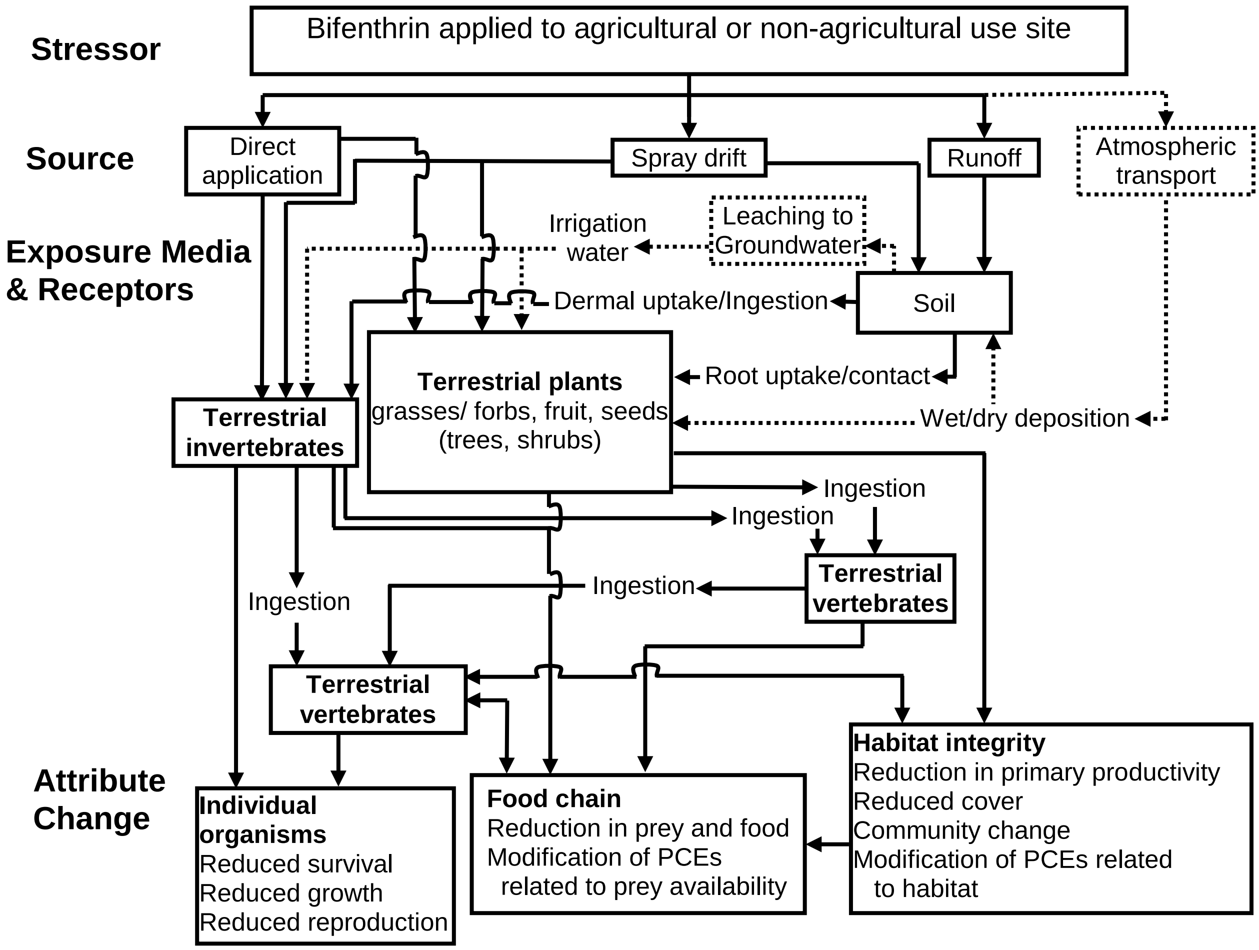
Bifenthrin shows a very low solubility, a very high K_{ow} and also high K_{oc} values. These properties suggest that the chemical partitions with the sediments, and with organic matter, suspended in the water bodies. Bifenthrin is likely to concentrate in the sediments, where it could persist. Such 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 bifenthrin 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 bifenthrin 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 bifenthrin on agricultural and certain non-agricultural sites.

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 bifenthrin 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 bifenthrin 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 bifenthrin along with available monitoring data indicate that water and sediment runoff and spray drift are the principle potential transport mechanisms of bifenthrin to the aquatic and terrestrial habitats. In this assessment, transport of bifenthrin through runoff and spray drift is considered in deriving quantitative estimates of bifenthrin exposure to BCB, TG, DS, CTS (all DPS), VELB, CCR, SFGS, and CFWS, their prey and habitats. Limited air monitoring data available for bifenthrin 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 bifenthrin due to hydroxyl radical reactions is small (~0.4 days, EPISUITE v.4.1 estimated), long-range transport of vapor phase bifenthrin is not expected. Bifenthrin, however, could move offsite sorbed to suspended particles in the air. Due to the strong tendency to sorb to soils for bifenthrin, 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 bifenthrin has been documented to bioconcentrate in fish.

Measures of exposure are based on aquatic and terrestrial models that provide EECs of bifenthrin 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 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

Bifenthrin, like other pyrethroids, is a lipophilic compound that can adsorb readily to particulates and sediment (mean Koc = 236,750 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 bifenthrin, as indicated by its relatively high K_{OC}. Exposure of aquatic organisms to sediment contaminated with bifenthrin 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 sedimentrelative to bifenthrin 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, 2000). 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}, bifenthrin 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 bifenthrin 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).

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 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 bifenthrin is not likely to be an exposure pathway of concern (see **Appendix N)**.

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 bifenthrin, 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

During the problem formulation phase of Registration Review (DP Barcode D384352, December 2010, document ID EPA-HQ-OPP-2010-0384-0033, available at www.regulations.gov), unavailable and confirmatory data were required for bifenthrin. Among them, terrestrial and aquatic plant, chronic fish, freshwater and estuarine/marine aquatic invertebrate, and freshwater and estuarine/marine sediment toxicity studies were required. Additionally, various fate-related confirmatory studies were required due to uncertainties found in the original studies, including hydrolysis, aqueous photolysis, and aerobic and anaerobic soil and aquatic metabolism.

3. Exposure Assessment

Bifenthrin can be formulated as emulsifiable concentrate, water soluble bags, emulsifiable concentrate, and liquid fertilizer ready emulsifiable concentrate. These kinds of formulations illustrate the variety of formulations available for bifenthrin. The chemical may be applied by ground, air or ULV methods, pre-transplant soil application, at transplant water treatment application, and foliar application. There are also granular formulations for use on corn at It is acknowledged that the different formulations for bifenthrin (liquid, granules) may result in different exposure results, and the various label restrictions are designed to mitigate exposure to non-target organisms. Application equipment includes low and high volume sprayers, chemigation equipment, soil incorporation equipment, soil treatment sub-slab injection, foam applicators, barrier treatment, crack and crevice and/or spot treatment, perimeter treatment, surface spray, and spreaders for granular applications. Additionally, applications could occur year round in non-agricultural settings, and pre- and post-bloom, when needed, or crop specific, in 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 bifenthrin due to generally higher spray drift levels. Ground boom and aerial modes of application tend to use lower volumes applied in finer sprays than applications coincident with sprayers and spreaders and thus have a higher potential for off-target movement via spray drift; agricultural and non-agricultural uses are evaluated consistent with the label requirements. **Section 2.4.3** gives a summary of the use and usage of bifenthrin.

3.1. Label Application Rates and Intervals

Bifenthrin labels may be categorized into two types: labels for manufacturing uses (including technical grade bifenthrin and its formulated products) and end-use products. While technical products, which contain bifenthrin of high purity, are not used directly in the environment, they are used to make formulated products, which can be applied in specific areas to control insects. The formulated product labels legally limit bifenthrin's potential use to only those sites that are specified on the labels.

Mitigation measures required for pyrethroid products after the reregistration of several other synthetic pyrethroids (not including bifenthrin), are described in more detail in **Appendix M**. Succinctly, the agricultural labels for bifenthrin 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.

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 bifenthrin within California being assessed are summarized in **Table 3-1**.

Table 3-1. Bifenthrin Uses, Scenarios, and Application Information [1]

Scenario (bold font)/ Uses Represented	Method of App.	Drift/ App Effic	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								
CAalfalfa_WirrigOP/ Alfalfa, Clover[2]	A	0.036/0.95	0.1	5	45	01-03	2	1
CAalmond_WirrigSTD/ Tree nut crops: almond, beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, filbert (hazelnut), hickory nut, macadamia nut (bush nut), pistachio, walnut (black and English)	A & G	0.036/0.95 and 0.01/0.99	0.18[3]	3	15	15-06	2	1
CAalmond_WirrigSTD/ Tree nuts	GR	0.00/1.00	0.4	1	N/A	01-09	2	1
CAcitrus_WirrigSTD/ Citrus crops	G	0.01/0.99	0.5	1	N/A	01-02	2	1
CAColeCropRLF_V2/ Head and Stem Brassica Vegetables: including broccoli, Chinese broccoli, Brussels sprouts, cauliflower, cavalo broccolo, kohlrabi, cabbage, Chinese cabbage (napa), Chinese mustard cabbage (gai choy)	A	0.036/0.95	0.1	5	7	01-02	2	1
CAColeCropRLF_V2/ Head and Stem Brassica Vegetables (same crops as in previous row)	GR	0.00/1.00	0.1	5	7	01-02	2	1
CAcornOP/ Corn, Sweet corn (granular app in furrow, DEPI=1 inch)	GR	0.00/1.00	0.1	1	N/A	15-03	4	1
CAcornOP/ Corn[4]	A	0.036/0.95	0.1	3	3	15-08	2	1
CAcornOP/ Sweet corn[5]	A	0.036/0.95	0.1	2	3	01-08	2	1
CAcotton_WirrigSTD/ Cotton	A	0.036/0.95	0.1	5	3	01-10	2	1
CAfruit_WirrigSTD/ Pears, Mayhaw[6], Fruits (unspecified)	A	0.036/0.95	0.167[7]	3	7	01-04[8]	2	1

Scenario (bold font)/ Uses Represented	Method of App.	Drift/ App Effic	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
CAfruit_WirrigSTD/ Fruits (unspecified), Small Fruits (unspecified)	G	0.01/0/99	0.2[9]	2	7	15-05	2	1
CAfruit_WirrigSTD/ Deciduous Fruits, Apple, Stone Fruits	G	0.01/0.99	0.21	1	N/A	15-04	2	1
CAfruit_WirrigSTD/ Deciduous Fruits, Apple, Stone Fruits	GR	0.00/1.00	0.4	1	N/A	15-05	2	1
CAgrapes_WirrigSTD/ Grapes	A	0.036/0.95	0.1	1	N/A	15-04	2	1
CAlettuceSTD/ Lettuce, Leafy petiole vegetables: Swiss chard, celery cardoon, Chinese celery, celtuce, Florence fennel, rhubarb	A	0.036/0.95	0.1	5	7	15-04	2	1
CAlettuceSTD/ Lettuce	GR	0.00/1.00	0.1	2	7	01-04	2	1
CAlettuceSTD/ Spinach	A	0.036/0.95	0.1	4	7	15-03	2	1
CAMelonsRLF_V2/ Cucurbits: chayote, citron melon, cucumber, gherkin, edible ghourd (various), muskmelon (various, for example cantaloupe and pineapple melon), pumpkin, summer squash (various), winter squash (various), watermelon (includes hybrids)	A	0.036/0.95	0.1	3	7	15-07	2	1
CAMelonsRLF_V2/ Cucurbits: same crops as above	GR	0.00/1.00	0.1	3	7	15-07	2	1
CA potato/ Tuberous and corm vegetables: Potato, sweet potato, arracacha, arrowroot, Chinese artichoke, Jerusalem artichoke, edible canna, cassava, chufa, dasheen, ginger, leren, tanier, turmer, yam bean, true yam	A	0.036/1.00	0.3 at plant, then 0.1x2	3	21	01-02[10]	2	1
CAPotatoRLF_V2/ Same crops as described in the previous row	GR	0.00/1.00	0.3 at plant	1	N/A	01-02[11]	2	1
CAPotatoRLF_V2/ Root Crops: burdock, carrots, celeriac, turnip rooted chervil, chicory, ginseng, horseradish, turnip rooted parsley, parsnip, radish, oriental radish, rutabaga, salsify, black salsify, Spanish salsify, skirret, turnip	G	0.01/0.99	0.1	5	7	01-05	2	1
CARowCropRLF_V2/ Artichokes	A	0.036/0.95	0.1	5	15	15-01	2	1
CARowCropRLF_V2/ Peppers (bell and non-bell); and Succulent Peas and Beans: Pea (*Pisum spp.*) dwarf pea, edible-pod pea, English pea, garden pea, green pea, snow pea, sugar snap pea, Pigeon pea, Bean (*Phaseolus spp.*) broadbean (succulent), lima bean (green), runner bean, snap bean, wax bean, Bean (*Vigna spp.*) asparagus bean, blackeyed pea (not grown in CA), Chinese longbean, cowpea, mothpea, Southern pea, yardlong pea, Jackbean Soybean (immature seed), Sword bean	A	0.036/0.95	0.1	2	7	15-01	2	1

Scenario (bold font)/ Uses Represented	Method of App.	Drift/ App Effic	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
CARowCropRLF_V2/ Dried peas and beans: bean (Lupinus); bean (Phaseoulus) field, kidney, lima, navy, pinto, tepary; bean (Vigna) adzuki, blackeyed, catjang, cowpea, crowder pea, moth, mung, rice, southern, urd; broad bean (dry); chickpea; guar; lablab bean; lentil; pea (Piscum), field pea; pigeon pea[12]	G	0.01/0.99	0.1	1	N/A	15-01	2	1
CARowCropRLF_V2/ Succulent peas and beans; Dried beans (same crops as in the previous rows, at plant)	GR default incorporation depth (4 cm)	0.00/1.00	0.1	1	N/A	15-01	1	1
CARowCropRLF_V2/ Peppers (bell and non-bell)	GR	0.00/1.00	0.1	2	7	15-01	2	1
CARowCropRLF_V2/ Agricultural crops/soils (represented by CA row crops)	G	0.01/0.99	0.0832[13]	3	21	15-02	2	1
CAStrawberry-noplasticRLF_V2/ Strawberry	A & G	0.036/0.95 and 0.01/0.99	0.167[14]	3	7	01-02	2	1
CAsugarbeet_WirrigOP/ Beets, garden beets	A	0.036/0.95	0.1	4	7	01-05	2	1
CAtomato_WirrigSTD/ Tomato and tomatillo, Eggplant, Ground cherry, Pepino	A	0.036/0.95	0.1	2	7	01-08	2	1
CAtomato_WirrigSTD/ Eggplant	GR	0.00/1.00	0.1	2	9	01-08	2	1
CAWheatRLF_V2/ Canola, rapeseed, crambe	A	0.036/0.95	0.04	2	14	15-01	2	1
CAWheatRLF_V2/ Canola, rapeseed, crambe	GR	0.00/1.00	0.04	2	14	15-01	2	1
CAWineGrapesRLF_V2/ Caneberries: including blackberries, bingleberrie dewberries lowberries marion-berries olallie-berries young-berries loganberrie raspberries	A	0.036/0.95	0.1	2	14	01-07	2	1
CAWineGrapesRLF_V2/ Bushberries: highbush and lowbush blueberries, currant, elderberry, gooseberry, huckleberry	A	0.036/0.95	0.1	5	7	15-06	2	1
ORhopsSTD/ Hops	A	0.036/0.95	0.1	3	21	15-06	2	1
ORmintSTD/ Herbs & Spices: Angelica, Balm, Basil, Bay, Sweet Bay, Borage, Burnet, Catnip, Chervil, Chive, Costmary, Dill, Horehound, Hyssop, Lavender, Marigold, Pot, Marjoram, Oregano, Nasturtium, Garden, Parsley, Pennyroyal, Potting Soil-Top Soil, Rosemary, Sage, Savory, Summer, Tansy, Tarragon, Thyme, Wintergreen, Woodruff, Wormwood	GR default incorporation depth (4 cm)	0.00/1.00	0.4	1	N/A	01-04	1	1
CAnurserySTD_V2/ Herbs & Spices: same crops as in previous row, but represented by the nursery scenario	GR default incorporation depth (4 cm)	0.00/1.00	0.4	1	N/A	15-02	1	1

Scenario (bold font)/ Uses Represented	Method of App.	Drift/ App Effic	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
Non-agricultural use patterns [15]								
CAForestryRLF/ Forest Trees - conifers; Conifers (plantations/ nurseries); Conifers (seed orchard)	G	0.01/0.99	0.205	3	30	01-08	2	1
CAForestryRLF/ Forest Trees - unspecified, softwoods	G	0.01/0.99	0.1058[16]	3	30	01-08	2	1
CAForestryRLF/ Christmas Tree Plantations	G	0.01/0.99	0.2	1	N/A	01-03	2	1
CAForestryRLF/ Christmas Tree Plantations	GR	0.00/1.00	0.4	1	N/A	01-03	2	1
CAnurserySTD_V2/ Nursery Stock	Drench	0.01/0.99	0.1	1	N/A	15-10	2	1
CAnurserySTD_V2/ Mulch, Potting Soil/Top Soil (assumed to be represented by CA nursery and to occur at plant)	GR	0.00/1.00	0.211	1	N/A	15-02	2	1
CAnurserySTD_V2/ Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	G	0.01/0.99	0.3	3	30	15-08	2	1
CAnurserySTD_V2/ Nursery Stock plus Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	GR	0.00/1.00	0.4	1	N/A	01-03	2	1
CAnurserySTD_V2/ Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	Pressure liquid	0.01/0.99	0.95	1	N/A	15-10	2	1
CAnurserySTD_V2/ Roses	G	0.01/0.99	0.1	5	7	15-09	2	1
CArangelandhayRLF_V2/ Sod farms, ornamental sod farms	A	0.039/0.95	0.2 [17]	2	7	15-11	2	1
CArangelandhayRLF_V2/ Sod farms, ornamental sod farms	GR	0.00/1.00	0.4	1	N/A	15-11	2	1
CArangelandhayRLF_V2/ Agricultural Right-of-Ways/ Fencerows/ Hedgerows[18]	G	0.01/0.99	0.21	1	N/A	01-01	2	1
CArangelandhayRLF_V2/ Non-agricultural uncultivated areas (soils); Livestock/Livestock Feed Lots, Poultry Feedlots/Poultry Processing Plant Premises (non-food contact), Poultry Litter[19]	G	0.01/0.99	0.167 [20]	3	Assume 56	01-08	2	1
CArangelandhayRLF_V2/ Non-agricultural uncultivated areas (soils)	GR	0.00/1.00	0.167 [21]	3	Assume 56	01-08	2	1

Scenario (bold font)/ Uses Represented	Method of App.	Drift/ App Effic	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
CATurfRLF/ Golf Course Turf	G	0.01/0.99	0.2	1	N/A	15-12	2	1
CATurfRLF/ Golf Course Turf plus Ornamental Grasses; Ornamental Lawns and Turf; Ornamental Sod Farms; Recreational Areas; Recreational Area Lawns; plus Airports/Landing Fields (all assumed to be represented by CA turf)	GR	0.00/1.00	0.4	1	N/A	01-10	2	1
CATurfRLF/ Ornamental Grasses; Ornamental Lawns and Turf; Ornamental Sod Farms; Recreational Areas; Recreational Area Lawns (all assumed to be represented by CA turf)	G	0.01/0.99	0.232	2	56	15-10	2	1
CAresidentialRLF/ CAimperviousRLF/ Airports/ Landing Fields	Perimeter treatment, directed spray	0.01/0.99	0.0096 [22]	1	N/A	15-10	2/4	1
CAresidentialRLF/ CAimperviousRLF/ Paths/Patios	Perimeter treatment	0.01/0.99	0.369 [23]	1	N/A	15-10	2/4	1
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns; Commercial/ Industrial Lawns, plus Urban Areas, Wide Area/ General Outdoor Treatment (Public Health Use)	G	0.01/0.99	0.06 [24]	2	56	15-10	2/4	1
				6	56	01-03	2/4	1
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	GR	0.00/1.00	0.00735 [25]	1	N/A	01-10	2/4	1
CAresidentialRLF/ CAimperviousRLF/ Residential Lawns	Perimeter treatment	0.01/0.99	0.0634 [26]	1	N/A	15-10	2/4	1
				6	56	01-03	2/4	1
CAresidentialRLF/ CAimperviousRLF/ Animal Feedlots, Animal Housing Premises, Animal Kennel (Sleeping Quarters), Pet Living/ Sleeping Quarters	Spot treatment, crack & crevice, directed spray, outdoor general surface spray, wall treatment, brush on	0.01/0.99	0.0038 [27]	2	56	15-10	2/4	1
CAresidentialRLF/ CAimperviousRLF/ Urban and rural structures and buildings (as shown in the footnote[28]), plus the following: Farm Premises (Agricultural), Barnyards/ Auction Barns, Seed Houses/ Stores/Storage Areas/ Warehouses	Barrier treatment	0.01/0.99	0.969 [29]	1	N/A	15-10	2/4	1
CAresidentialRLF/ CAimperviousRLF/ Urban and rural structures and buildings (as shown in the footnote)	GR or Bait/ Solid	0.00/1.00	0.0421 [30]	1	N/A	15-10	2/4	1
CAresidentialRLF/ CAimperviousRLF/ Urban and rural structures and buildings (as shown in the footnote)	Outdoor general surface spray, perimeter treatment, space spray	0.01/0.99	9.44 [31]	1	N/A	15-10	2/4	1

Scenario (bold font)/ Uses Represented	Method of App.	Drift/ App Effic	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
CAresidentialRLF/ CAimperviousRLF/ Urban and rural structures and buildings (as shown in the footnote)	Crack & crevice, brush on, void treatment, foam application	0.01/0.99	0.00125 [32]	1	N/A	15-10	2/4	1
CAresidentialRLF/ CAimperviousRLF/ Urban and rural structures and buildings (as shown in the footnote)	Soil treatment (trenching)	0.00/1.00	0.00244 [33]	2	7	15-01	2/4	1
CAresidentialRLF / CAimperviousRLF/ Farm Premises (Agricultural), Barnyards/ Auction Barns, Seed Houses/ Stores/Storage Areas/ Warehouses	G (Spot treatment, crack & crevice, directed spray, perimeter treatment)	0.01/0.99	0.0317 [34]	2	7	15-01	2/4	1
CAresidentialRLF/ CAimperviousRLF/ Wood Protection Treatment to Buildings/ Products (Outdoors)	G	0.01/0.99	1.59×10^{-4} [35]	2	56	15-10	2/4	1
CAresidentialRLF/ CAimperviousRLF/ Wood Protection Treatment to Buildings/ Products (Outdoors)	G[36] (void treatment)	0.01/0.99	0.0287 [37]	1	N/A	15-10	2/4	1
CArightofwayRLF_V2/ CAimperviousRLF/ Right-of-Way	G	0.01/0.99	0.021 [38]	1	N/A	15-11	2/4	1
CArightofwayRLF_V2/ CAimperviousRLF/ Right-of-Way	GR	0.00/1.00	0.0167 [39]	3	7	15-08	2/4	1
CArightofwayRLF_V2/ CAimperviousRLF/ Paved Areas (Private Roads/ Sidewalks)	Perimeter treatment	0.01/0.99	0.38 [40]	1	N/A	15-11	2/4	1
CArightofwayRLF_V2/ CAimperviousRLF/ Refuse/Solid Waste Sites (outdoors)	Perimeter treatment, general surface spray	0.01/0.99	0.23 [41]	1	N/A	15-11	2/4	1
CArightofwayRLF_V2/ CAimperviousRLF/ Utilities, Utility Poles/Rights-of-Way	Perimeter treatment	0.01/0.99	2.2 [42]	1	N/A	15-11	2/4	1
CArightofwayRLF_V2/ CAimperviousRLF/ Utility Poles/Rights-of-Way	GR	0.00/1.00	0.1 [43]	1	N/A	15-11	2/4	1

1. CAM: 1 = soil applied, default incorporation depth (4 cm), linearly decreasing with depth; 2 = linear foliar based on crop canopy; 4 = soil applied, user defined incorporation depth, uniform with depth. IPSCND: 1 = surface applied; 2 = completely removed; 3 = left as is on foliage; A = aerial or G = ground (flowable, foliar, or liquid formulations); GR = granular. Uses assessed based on memorandum from Pesticide Re-evaluation Division (PRD) dated August 6, 2012 and EFED Label Data report and associated Label Use Information Reports prepared on July 17, 2012. (Information emailed by Rafael Prieto (BEAD) on 07/17/2012 to EFED.)
2. For clover, two applications per season are allowed. It is assumed that the alfalfa scenario also covers clover.

3. The maximum single application rate for nut crops is 0.216 lb/A. The maximum seasonal rate was divided into three applications, to arrive at an application rate of 0.18 lb/A.
4. Not allowed in coastal counties.
5. Not allowed in coastal counties.
6. For mayhaw, two applications at 0.1 lb a.i./A are allowed.
7. The seasonal application rate of 0.5 lb a.i./A was divided into 3 applications. 0.45 lb/A allowed after petal fall.
8. According to the label 0.45 lb/A should be applied after petal fall; therefore, run started at maturity or 01-04.
9. The seasonal application rate for small fruits is 0.375 lb a.i./A.
10. First application occurs at plant.
11. First application occurs at plant.
12. Some crop/label combinations are not allowed in California.
13. The maximum single application rate for this crop is 0.112 lb/A; the seasonal rate was divided into 3 applications.
14. The maximum single application rate for this crop is 0.216 lb/A; the seasonal rate was divided into 3 applications.
15. Refer to text following this table and Appendix D for additional information regarding the assumptions of a typical house lot. Furthermore, equivalent application rates were calculated with the aid of the "Impervious Surface Coefficients User's Guide and Calculator" (dated 12/31/2010) available at http://www.oehha.ca.gov/ecotox/iscug123110.html (accessed 08/22/2012). For all the runs that involve the impervious scenario, CAM = 4, and the depth of incorporation DEPI = 0.1 cm. Non-agricultural uses of bifenthrin occur only via ground methods of application, except for sod farms (represented by CA rangeland hay).
16. The maximum single application rate for this crop is 0.1091 lb/A; the seasonal rate was divided into 3 apps.
17. The maximum single application rate for this crop is 0.218 lb a.i./A; the seasonal rate of 0.4 lb a.i./A was divided into two applications at 0.2 lb a.i./A.
18. Use is considered to be better represented by CA rangeland hay, due to agricultural use pattern.
19. For "Livestock/Livestock Feed Lots, Poultry Feedlots/Poultry Processing Plant Premises (non-food contact), Poultry Litter", the applications modeled are ground perimeter treatment, crack & crevice, outdoor general surface spray, void treatment, spot treatment, directed spray. The entire watershed is unlikely to be treated at the maximum rate.
20. The maximum single application rate for this crop is 0.5 lb/A; the seasonal rate was divided into 3 applications.
21. The maximum single application rate for this crop is 0.5 lb/A; the seasonal rate was divided into 3 applications.
22. The airport is assumed to have a runway that is 2000 ft x 70 ft (140,000 ft^2) and the surface area of the airport's structure is assumed to be around one third the area of the runway or around 190 ft x 190 ft (36,100 ft^2). The entire airport is within the watershed of the ecological pond, which is 10 ha. The area treated covers up to 10 ft perimeter around the runway and of the airport (2000x10x2 + 70x10 x2 + 190x10x4) ft = 49,000 ft^2. Thus the application rate is 0.2112 lb a.i./A x 49,000/ 1,076,391 = 0.0096 lb a.i./A. Applications to building foundations, up to a maximum height of 3 feet, are not included, since these are not perimeter treatments.
23. Similar to what has been done in past assessments, it was assumed that a typical house would have a driveway of approximately 25 by 30 feet (the maximum perimeter treated area is 10 ft around the driveway, is 25x10x2 + 30x10x2 = 1100 ft^2) plus roughly 250 square feet of sidewalk that is 10 ft wide or 25x10x2 + 10x10x2 = 700 ft^2; total area treated = 1800 ft^2 per house). The equivalent application rate is 22.3x1800 ft^2x4 houses per acre/435,600 ft^2/A = 0.369 lb/A (see text in **Section 3.2.1**, for additional details on the assumptions of typical house lots).
24. It was assumed that a substantial portion of the typical area is landscaped (*e.g.*, industrial lawn) with an estimate of ¼ of the total area of the watershed has a potential to be treated (commercial lawns). The equivalent application rate is 0.24x¼= 0.06 lb a.i./A.
25. It was assumed that a substantial portion of the typical home would be planted in landscaping (*e.g.*, residential 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 0.4 lb a.i./A x 2000 ft^2 x 4 homes per acre/435,600 ft^2/A = 0.00735 lb a.i./A.

The impervious surface receives a negligible amount of pesticide, based on the label use pattern, and the granular application method.

26. 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 the house 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 2.3 lb a.i./A x 3000 ft^2 x 4 houses/A / 435,600 ft^2/A = 0.0634 lb a.i./A.
27. It was assumed that the area treated is similar to the one for paths/patios, although it is possible that this is overestimation (see footnote above). The equivalent application rate is 0.2325 lb a.i./A x 4 x 1800 ft^2 x 4 houses/A/435,600 ft^2/A = 0.0038 lb/A.
28. May include multiple types of facilities: 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)/Diary Farm Milk Storage Rooms/Houses/Sheds/ Eating Establishments (food and non-food areas)/Egg Handling Rooms/Egg Packing Plants (Commercial)/Feed Mills/Feed Processing Plants/ Food/Grocery/Marketing/ Storage/Distribution Facility Premise/Food Processing Plant Equipment (food contact)/(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/ Public Buildings/Structures/ Storage Areas (empty or full).
29. "Rural" facilities have an impervious surface coefficient of 4%; meanwhile, the impervious surface coefficient for the category of "retail" is 86%. Urban and rural facilities are assumed to cover 50% of the 10 ha watershed. The barrier is assumed to cover 3 ft vertical measure, of the walls treated. Assuming that there are 15 facilities of equal size in the watershed, they would be 1,076,391(0.50)/15 ft^2 = 35880 ft^2 each one in area, and the treated area will be approximately 190 ft x 3 ft treated x 4 sides = 2,280 ft^2. The equivalent application rate will be 30.5 lb a.i./A x 2280 ft^2 x 15 facilities/1,076,391 ft^2 = 0.969 lb a.i./A. There is 1% drift towards the pervious area.
30. The area treated is assumed to cover the perimeter, or 10 ft surrounding the structures. Using the same assumptions than in the previous footnote, the treated area will be approximately 190 ft x 10 ft treated x 4 sides = 7600 ft^2. The equivalent application rate will be 0.4 lb a.i./A x 7600 ft^2 x 15 facilities/ 1,076,391 ft^2 = 0.0421 lb a.i./A. The application is negligible to the impervious surface (for granules).
31. The area to be treated is the same than for the previous footnote. The equivalent application rate will be 89.1 lb a.i./A x 7600 ft^2 x 15 facilities/1,076,391 ft^2 = 9.44 lb a.i./A.
32. Similar to the previous footnote, the treated area will be approximately 7600 ft^2. If 5% of the area is treated (*i.e.*, for crack & crevice), the equivalent application rate will be 0.2363 lb a.i./A x 5%/100 x 7600 ft^2 x 15 facilities/1,076,391 ft^2 = 0.00125 lb a.i./A. A similar rate is assumed for both impervious and pervious surfaces.
33. Post-construction application occurs by trenching or coarse fan spray at low pressures to structure foundations. It appears that only a fraction of the applied would be available for drift (for spray applications) and runoff. It is assumed that only 1 ft around the facility is treated. Assuming the same perimeter than in the previous footnotes, the area treated is 190 ft x 1 ft x 4 sides = 760 ft^2, and the equivalent application rate will be 0.230 lb a.i./A x 756 ft^2 x 15/1,076,391 ft^2 = 0.00242 lb a.i./A.
34. Similar to the previous footnotes on urban and rural facilities, there are 15 facilities of equal size in the watershed 190 ft each side. The area treated per facility is 10 ft perimeter and 3 ft up, 190 ft x (10+3) ft x 4 sides = 9880 ft^2. The equivalent application rate is 0.230 lb/A x 9880 ft^2 x 15 facilities/1,076,391 ft^2 = 0.0317 lb a.i./A.
35. A wood leachability study shows that a maximum of 6% of the chemical leaches from the treated area. 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 0.24 lb a.i./A (0.06) (180x3 + 300 + 30x3x4) ft^2 x 4 du/A / 435,500 ft^2/A = 1.59×10^{-4} lb a.i./A. There is 1% drift to pervious areas.
36. Barrier treatment (22.5 lb/A), broadcast or soil treatment (29.9 lb/A), perimeter treatment (23.3 lb/A), and void treatment (43.4 lb/A).

37. Similar to the previous comment, the equivalent rate is 43.4 lb a.i./A 0.06 x 1200 ft^2 x 4 homes/A/435,500 ft^2/A = 0.0287 lb a.i./A. The pervious area receives 1% drift.
38. The application rate for the agricultural ROW (fencerows/hedgerows) is stated as 0.015 lb a.i./ft of depth. It is assumed to be similar/equivalent to non-agricultural ROW. Not more than 10% of the watershed is covered by ROW (see **Section 3.2.1**). Thus rate is 0.21x10% = 0.021 lb a.i./A.
39. The maximum single application rate for this granular application is 0.2. The seasonal rate was divided into 3 applications. Not more than 10% of the watershed is covered by ROW. Thus rate is 0.167x10% = 0.0167 lb a.i./A. Since this is a granular application, there is negligible drift towards the impervious surface area.
40. For this type of 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 23 lb/Ax1800x4 du per acre/435,600 ft^2/A = 0.38 lb a.i./A.
41. Not more than 10% of the watershed is covered by ROW. The equivalent application rate is 2.3 lb/Ax0.10= 0.23 lb a.i./A.
42. 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 22 lb a.i./A x 10/100 = 2.2 lb a.i./A.
43. Not more than 10% of the watershed is covered by ROW. The equivalent application rate is 1 lb a.i./A x 0.10 = 0.1 lb a.i./A. There is negligible drift towards the impervious area since these are granular applications

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

Use-specific management practices for all of the assessed uses of bifenthrin 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 citrus is provided in **Appendix D**. The results of the EECs, for all the crops and scenarios, are reported in **Table 3-3**.

Aerial and Ground Applications
Since aerial and ground applications are allowed for many of the agricultural crops, two sample crops were evaluated via both methods of application and the same date of application. The two crops evaluated were almonds and strawberries, one of which yielded very high EECs for both the water column and the pore water, while the other one had smaller or intermediate EECs for the pore water. 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 bifenthrin. In general, they include granular and liquid applications. These applications have been modeled separately. The standard assumption for modeling granular applications is different from liquid applications. The assumptions for 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 Tier II Aerial mode for bifenthrin (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
At the present time, the CA impervious scenario is considered as the most suitable available modeling approach for impervious runoff[29]. The PRZM CA impervious scenario may be used in the Tier 2 coupled aquatic models PRZM/EXAMS along with a 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 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. All of the previous estimates are based on professional judgment, and are not derived from the "American Housing Survey of the U.S.: 2009," from the Census Bureau (AHS) data (more details in **Appendix D.**

[29] Additional information about this scenario is available at http://www.epa.gov/oppefed1/models/water/pe5_rlf.htm (accessed 12/17/2012).

PRZM/EXAMS and AgDRIFT). 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.

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 no more than 10% of the watershed is covered in rights-of-way.[30]

For additional details on the approach for urban uses, see **Appendix D. PRZM/EXAMS and AgDRIFT**.

3.2.2. Model Inputs

The appropriate PRZM and EXAMS input parameters for bifenthrin 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[31] and *PE5 User's Manual. (P)RZM (E)XAMS Model Shell, Version (5)*, November 15, 2006.[32] Input parameters can be grouped by physical-chemical properties and other environmental fate data, application information, and use scenarios. Physical and chemical properties relevant to assess the behavior of bifenthrin 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 3-3** below. **Appendix D** contains example model output files and tables showing the data used to calculate input values.

Table 3-3. Summary of PRZM/EZAMS Environmental Fate Data Used for Aquatic Exposure Inputs for Bifenthrin Endangered Species Assessment [33]

Fate Property	Value (unit)	Source/Comment[1]
Molecular Weight	422.9 g/mol	Laskowski 2002
Henry's constant	7.2×10^{-3} atm-m^3/mole	Calculated
Vapor Pressure	1.80×10^{-7} torr	Laskowski 2002
Solubility in Water	0.000014 mg/L	Laskowski 2002 (MRID 00132518, Acc. No. 251725)
Photolysis in Water	Stable	MRID 00163084

[30] More information about these scenarios is found at the following site accessed10/03/2012: http://www.epa.gov/oppefed1/models/water/pe5_rlf.htm.
[31] Available at http://www.epa.gov/oppefed1/models/water/input_parameter_guidance.htm (accessed 09/11/2012).
[32] Available at http://www.epa.gov/oppefed1/models/water/pe5_user_manual.htm (accessed 09/11/2012).
[33] 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.

Fate Property	Value (unit)	Source/Comment[1]
Aerobic Soil Metabolism Half-lives	$t_{input} = \overline{t_{1/2}} + \frac{t_{90,n-1}s}{\sqrt{n}} =$ 179.0 days	Acc No: 073174, 073225, 141502, 251278, 251728, 254401, 254411, 264642, 532540; MRID 00132540, 00141202, 00152266. Represents the 90th percentile of the upper confidence bound on the mean for the following six values: 97, 116, 155, 128, 132, 250 days; average 146.333 days; standard deviation 54.254 days; one sided student's t value $t_{90,n-1}$ = 1.476.
Hydrolysis Half-lives	Stable	MRID 00132539
Aerobic Aquatic Metabolism Half-life (water column)	358.1 days	The chemical shows insignificant hydrolysis. The input value is twice the aerobic soil metabolism input half-life (2 x 179.0251 days). Tests were performed at 25±3^{0}C.
Anaerobic Aquatic Metabolism Half-life (benthic)	Stable	MRID 00163088. No study available; however, the anaerobic soil metabolism study indicates relative stability of the chemical under the test conditions.
Organic-carbon water partition coefficient (K_{OC}, L/kg-OC)	236,750	Accession No. 254411; MRID 00141203; Average of the following four values: 131000, 239000, 302000 and 275000. 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 granular	Label
Spray Drift Fraction	0.01 ground; 0.036 aerial; 0.00 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 (exceptions in **Table 3-1**)	Label. Exceptions occur for applications to impervious scenario and for a few soil incorporated applications.
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

3.2.3. Results

The aquatic EECs for the various scenarios and application practices are listed in **Table 3-4**. Example output results from PRZM/EXAMS are provided in **Appendix D**. For many of the scenarios, the EECs were limited by the very low solubility of bifenthrin. The solubility limit value of 0.0144 ppb was reported for all EECs that exceeded this limit. For all but a few of the residential and rights-of-way scenarios, the peak EEC was the limit of solubility. There were a few exceptions due to the low equivalent application rate estimated for specific uses. For some of the scenarios, the pore water EECs were also reported at the solubility limit of 0.0144 ppb. The sediment EECs, corrected for organic carbon content, reflected the variability of results. The scenarios with the highest sediment EECs, in excess of 30,000 $\mu g/kg_{OC}$, included the nursery (ornamentals) ground and pressure liquid application, and urban & rural structures perimeter treatment. The lowest sediment EECs were noted for urban & rural structures granular applications and residential lawn granular applications. For uncertainties related to the aquatic exposure modeling and the limit of solubility of bifenthrin see **Section 6.1.2**.

Table 3-2. Water Column, Pore Water, and Sediment EECs (µg/L) for Bifenthrin Uses in California[1]

Scenario (bold font)/ Application Method	Crops/Uses Represented	Application Rate (lb a.i./A)	Date of First Application (dd-mm)	Number of Applications	Application 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 ($\mu g/kg_{oc}$)
Agricultural Use Patterns												
CA alfalfa/ A	Alfalfa, Clover	0.1	01-03	5	45	0.014	0.014	0.014	0.014	0.014	4,600	4,600
CA almond/ A	Tree nut crops: almond, beech nut, Brazil nut, butternut, cashew, chestnut, chinquapin, filbert (hazelnut), hickory nut, macadamia nut (bush nut), pistachio, walnut (black and English)	0.18	15-06	3	15	0.014	0.014	0.014	0.014	0.014	5,050	5,030
CA almond/ G	Tree nut crops (same crops as above)	0.18	15-06	3	15	0.014	0.014	0.014	0.0117	0.0116	2,780	2,750
CA almond/ GR	Tree nuts	0.4	01-09	1	N/A	0.014	0.014	0.014	0.0115	0.0114	2,730	2,700
CA citrus/ G	Citrus crops	0.5	01-02	1	N/A	0.014	0.014	0.014	0.00748	0.00744	1,770	1,770
CA cole crop/ A	Head and Stem Brassica Vegetables: including broccoli, Chinese broccoli, Brussels sprouts, cauliflower, cavalo broccolo, kohlrabi, cabbage, Chinese cabbage (napa), Chinese mustard cabbage (gai choy)	0.1	01-02	5	7	0.014	0.014	0.014	0.014	0.014	9,280	9,230
CA cole crop/ GR	Head and Stem Brassica Vegetables (same crops as in previous row)	0.1	01-02	5	7	0.014	0.014	0.014	0.014	0.014	7,080	7,030
CA corn/ (GR app in furrow/ GR)	Corn, Sweet corn	0.1	15-03	1	N/A	0.014	0.014	0.014	0.00587	0.00584	1,390	1,380

Scenario (bold font)/ Application Method	Crops/Uses Represented	Application Rate (lb a.i./A)	Date of First Application (dd-mm)	Number of Applications	Application 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 ($\mu g/kg_{oc}$)
CA corn/ A	Corn	0.1	15-08	3	3	0.014	0.014	0.014	0.014	0.014	8,230	8,200
CA corn/ A	Sweet corn	0.1	01-08	2	3	0.014	0.014	0.014	0.014	0.014	5,480	5,450
CA cotton/ A	Cotton	0.1	01-10	5	3	0.014	0.014	0.014	0.014	0.014	5,280	5,250
CA fruit/ A	Pears, Mayhaw, Fruits (unspecified)	0.167	01-04	3	7	0.014	0.014	0.014	0.014	0.014	3,430	3,425
CA fruit/ G	Fruits (unspecified), Small Fruits (unspecified)	0.2	15-05	2	7	0.014	0.014	0.0123	0.00408	0.00405	965	958
CA fruit/ G	Deciduous Fruits, Apple, Stone Fruits	0.21	15-04	1	N/A	0.014	0.014	0.00663	0.00216	0.00214	510	508
CA fruit/ GR	Deciduous Fruits, Apple, Stone Fruits	0.4	15-05	1	N/A	0.014	0.00456	0.00364	0.00125	0.00125	298	295
CA grape/ A	Grapes	0.1	15-04	1	N/A	0.014	0.014	0.0104	0.00335	0.00333	793	790
CA lettuce/ A	Lettuce, Leafy petiole vegetables: Swiss chard, celery cardoon, Chinese celery, celtuce, Florence fennel, rhubarb	0.1	15-04	5	7	0.014	0.014	0.014	0.014	0.014	12,400	12,350
CA lettuce/ GR	Lettuce	0.1	01-04	2	7	0.014	0.014	0.014	0.014	0.014	3,950	3925
CA lettuce/ A	Spinach	0.1	15-03	4	7	0.014	0.014	0.014	0.00989	0.00986	2,340	2,330

Scenario (bold font)/ Application Method	Crops/Uses Represented	Application Rate (lb a.i./A)	Date of First Application (dd-mm)	Number of Applications	Application 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 ($\mu g/kg_{oc}$)
CA melon/ A	Cucurbits: chayote, citron melon, cucumber, gherkin, edible ghourd (various), muskmelon (various, for example cantaloupe and pineapple melon), pumpkin, summer squash (various), winter squash (various), watermelon (includes hybrids)	0.1	15-07	3	7	0.014	0.014	0.014	0.00838	0.00833	1,990	1,970
CA melon/ GR	Cucurbits: same crops as above	0.1	15-03	3	7	0.014	0.00270	0.00230	0.000759	0.000756	180	179
CA potato/ A	Tuberous and corm vegetables: Potato, sweet potato, arracacha, arrowroot, Chinese artichoke, Jerusalem artichoke, edible canna, cassava, chufa, dasheen, ginger, leren, tanier, turmer, yam bean, true yam	0.3 at plant, then 0.1x2	01-02	3	21	0.014	0.014	0.014	0.014	0.014	4,050	4,050
CA potato/ GR	Same crops as described in the previous row	0.3 at plant	01-02	1	N/A	0.014	0.0133	0.0107	0.00409	0.00408	968	965
CA potato/ G	Root Crops: burdock, carrots, celeriac, turnip rooted chervil, chicory, ginseng, horseradish, turnip rooted parsley, parsnip, radish, oriental radish, rutabaga, salsify, black salsify, Spanish salsify, skirret, turnip	0.1	01-05	5	7	0.014	0.014	0.014	0.00638	0.00636	1,510	1,510
CA row crop/ A	Artichokes	0.1	15-01	5	15	0.014	0.014	0.014	0.014	0.014	5,580	5,550

Scenario (bold font)/ Application Method	Crops/Uses Represented	Application Rate (lb a.i./A)	Date of First Application (dd-mm)	Number of Applications	Application 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 ($\mu g/kg_{oc}$)
CA row crop/ A	Peppers (bell and non-bell); and Succulent Peas and Beans: Pea (*Pisum spp.*) dwarf pea, edible-pod pea, English pea, garden pea, green pea, snow pea, sugar snap pea, Pigeon pea, Bean (*Phaseolus spp.*) broadbean (succulent), lima bean (green), runner bean, snap bean, wax bean, Bean (*Vigna spp.*) asparagus bean, blackeyed pea (not grown in CA), Chinese longbean, cowpea, mothpea, Southern pea, yardlong pea, Jackbean Soybean (immature seed), Sword bean	0.1	15-01	2	7	0.014	0.014	0.014	0.0101	0.0101	2,400	2,390
CA row crop/ G	Dried peas and beans: bean (Lupinus); bean (Phaseoulus) field, kidney, lima, navy, pinto, tepary; bean (Vigna) adzuki, blackeyed, catjang, cowpea, crowder pea, moth, mung, rice, southern, urd; broad bean (dry); chickpea; guar; lablab bean; lentil; pea (Piscum), field pea; pigeon pea	0.1	15-01	1	N/A	0.014	0.0125	0.0109	0.00389	0.00387	923	915
CA row crop/ GR at plant, assume default incorporation depth)	Succulent peas and beans; Dried beans (same crops as in the previous rows)	0.1	15-01	1	N/A	0.014	0.014	0.014	0.00634	0.00631	1,500	1,490

Scenario (bold font)/ Application Method	Crops/Uses Represented	Application Rate (lb a.i./A)	Date of First Application (dd-mm)	Number of Applications	Application 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 ($\mu g/kg_{oc}$)
CA row crops/ GR	Peppers (bell and non-bell)	0.1	15-01	2	7	0.014	0.014	0.014	0.00638	0.00636	1,510	1,510
CA row crops/ G	Agricultural crops/ soils (represented by CA row crops)	0.0832	15-02	3	21	0.014	0.014	0.014	0.00789	0.00781	1,870	1,850
CA strawberry/ A	Strawberry	0.167	01-02	3	7	0.014	0.014	0.014	0.0131	0.0131	3,130	3,100
CA strawberry/ G	Strawberry	0.167	01-02	3	7	0.014	0.014	0.014	0.00513	0.00510	1,220	1,210
CA sugar beet/ A	Beets, garden beets	0.1	01-05	4	7	0.014	0.014	0.014	0.014	0.014	4,550	4,550
CA tomato/ A	Tomato and tomatillo, Eggplant, Ground cherry, Pepino	0.1	01-08	2	7	0.014	0.014	0.014	0.00636	0.00632	1,510	1,500
CA tomato/ GR	Eggplant	0.1	01-08	2	9	0.014	0.00500	0.00432	0.00152	0.00152	360	360
CA wheat/ A	Canola, rapeseed, crambe	0.04	15-01	2	14	0.014	0.014	0.014	0.014	0.014	3,380	3,380
CA wheat/ GR	Canola, rapeseed, crambe	0.04	15-01	2	14	0.014	0.014	0.014	0.0129	0.0129	3,080	3,050
CA wine grape/ A	Caneberries: including blackberries, bingleberrie dewberries lowberries marion-berries olallie-berries young-berries loganberrie raspberries	0.1	01-07	2	14	0.014	0.014	0.014	0.014	0.014	4,380	4,350
CA wine grape/ A	Bushberries: highbush and lowbush blueberries, currant, elderberry, gooseberry, huckleberry	0.1	15-06	5	7	0.014	0.014	0.014	0.014	0.014	10,630	10,600
OR hop/ A	Hops	0.1	15-06	3	21	0.014	0.014	0.014	0.014	0.014	7,550	7,530

Scenario (bold font)/ Application Method	Crops/Uses Represented	Application Rate (lb a.i./A)	Date of First Application (dd-mm)	Number of Applications	Application 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 ($\mu g/kg_{oc}$)
OR mint/ GR	Herbs & Spices: Angelica, Balm, Basil, Bay, Sweet Bay, Borage, Burnet, Catnip, Chervil, Chive, Costmary, Dill, Horehound, Hyssop, Lavender, Marigold, Pot, Marjoram, Oregano, Nasturtium, Garden, Parsley, Pennyroyal, Potting Soil-Top Soil, Rosemary, Sage, Savory, Summer, Tansy, Tarragon, Thyme, Wintergreen, Woodruff, Wormwood	0.4	01-04	1	N/A	0.014	0.014	0.014	0.0104	0.0104	2,470	2,460
CA nursery/ GR	Herbs & Spices (same crops as in previous row)	0.4	15-02	1	N/A	0.014	0.014	0.014	0.014	0.014	13,500	13,400
Non-Agricultural Crops and Uses[2]												
CA forestry/ G	Forest Trees - conifers; Conifers (plantations/ nurseries); Conifers (seed orchard)	0.205	01-08	3	30	0.014	0.014	0.014	0.014	0.014	26,000	25,800
CA forestry/ G	Forest Trees - unspecified, softwoods	0.1058	01-08	3	30	0.014	0.014	0.014	0.014	0.014	13,400	13,300
CA forestry/ G	Christmas Tree Plantations	0.2	01-03	1	N/A	0.014	0.014	0.014	0.014	0.014	7,500	7,480
CA forestry/ GR	Christmas Tree Plantations	0.4	01-03	1	N/A	0.014	0.014	0.014	0.014	0.014	14,380	14,300
CA nursery/ Drench	Nursery Stock	0.1	15-10	1	N/A	0.014	0.014	0.014	0.014	0.014	4,130	4,100
CA nursery/ GR	Mulch, Potting Soil/Top Soil (assumed to be represented by CA nursery)	0.211	15-02	1	N/A	0.014	0.014	0.014	0.014	0.014	7,100	7,050

Scenario (bold font)/ Application Method	Crops/Uses Represented	Application Rate (lb a.i./A)	Date of First Application (dd-mm)	Number of Applications	Application 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 ($\mu g/kg_{oc}$)
CA nursery/ G	Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.3	15-08	3	30	0.014	0.014	0.014	0.014	0.014	34,500	34,500
CA nursery/ GR	Nursery Stock plus Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.4	01-03	1	N/A	0.014	0.014	0.014	0.014	0.014	11,550	11,500
CA nursery/ Pressure liquid	Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.95	15-10	1	N/A	0.014	0.014	0.014	0.014	0.014	39,200	38,980
CA nursery/ G	Roses	0.1	15-09	5	7	0.014	0.014	0.014	0.014	0.014	19,980	19,850
CA rangeland hay/ A	Sod farms, ornamental sod farms	0.2	15-11	2	7	0.014	0.014	0.014	0.014	0.014	4,850	4,800
CA rangeland hay/ GR	Sod farms, ornamental sod farms	0.4	15-11	1	N/A	0.014	0.014	0.014	0.0107	0.0106	2530	2,500
CA rangeland hay/ G	Agricultural Right-of-Ways/ Fencerows/ Hedgerows	0.21	01-01	1	N/A	0.014	0.014	0.014	0.00674	0.00671	1,595	1,590

Scenario (bold font)/ Application Method	Crops/Uses Represented	Application Rate (lb a.i./A)	Date of First Application (dd-mm)	Number of Applications	Application 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 ($\mu g/kg_{oc}$)
CA rangeland hay/ G	Non-agricultural uncultivated areas (soils); Livestock/ Livestock Feed Lots, Poultry Feedlots/ Poultry Processing Plant Premises (non-food contact), Poultry Litter	0.167	01-08	3	56	0.014	0.014	0.014	0.014	0.014	3,650	3,550
CA rangeland hay/ GR	Non-agricultural uncultivated areas (soils)	0.167	01-08	3	56	0.014	0.014	0.014	0.0120	0.0117	2,850	2,780
CA turf/ G	Golf Course Turf	0.2	15-12	1	N/A	0.014	0.00902	0.00667	0.00262	0.00260	620	615
CA turf/ GR	Golf Course Turf plus Ornamental Grasses; Ornamental Lawns and Turf; Ornamental Sod Farms; Recreational Areas; Recreational Area Lawns	0.4	01-10	1	N/A	0.014	0.00836	0.00653	0.00249	0.00248	590	588
CA turf/ G	Ornamental Grasses; Ornamental Lawns and Turf; Ornamental Sod Farms; Recreational Areas; Recreational Area Lawns	0.232	15-10	2	56	0.014	0.014	0.014	0.00594	0.00591	1,940	1,940
CA residential/ CA impervious/ Perimeter treatment, directed spray	Airports/ Landing Fields	0.0096	15-10	1	N/A	0.00687	9.73×10^{-4}	7.93×10^{-4}	0.0108	0.0108	2,570	2,560
CA residential/ CA impervious/ Perimeter treatment	Paths/Patios	0.369	15-10	1	N/A	0.014	0.014	0.014	0.00603	0.00600	1,430	1,420
CA residential/	Residential Lawns; Commercial/ Industrial	0.06	15-10	2	56	0.014	0.00770	0.00679	0.00186	0.00183	440	433

Scenario (bold font)/ Application Method	Crops/Uses Represented	Application Rate (lb a.i./A)	Date of First Application (dd-mm)	Number of Applications	Application 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 (µg/kg$_{oc}$)	21-day average EEC (µg/kg$_{oc}$)
CA impervious/ G	Lawns, <u>plus</u> Paths/ Patios, <u>plus</u> Urban Areas, Wide Area/ General Outdoor Treatment (Public Health Use)		01-03	6	56	0.014	0.0137	0.0123	0.00405	0.00403	959	954
CA residential/ CA impervious/ GR	Residential Lawns	0.00735	01-10	1	N/A	1.29×10^{-4}	3.72×10^{-5}	3.49×10^{-5}	1.11×10^{-5}	1.10×10^{-5}	2.63	2.61
CA residential/ CA impervious/ Perimeter treatment	Residential Lawns	0.0634	15-10	1	N/A	0.014	0.00640	0.0522	0.00104	0.00103	245	244
CA residential/ CA impervious/ Perimeter treatment (cont.)	Residential Lawns	0.0634	01-03	6	56	0.014	0.014	0.0130	0.00428	0.00426	1010	1010
CA residential/ CA impervious/ Spot treatment, crack & crevice, directed spray, outdoor general surface spray, wall treatment, brush on	Animal Feedlots, Animal Housing Premises, Animal Kennel (Sleeping Quarters), Pet Living/ Sleeping Quarters	0.0038	15-10	2	56	0.00345	4.92×10^{-4}	4.33×10^{-4}	1.19×10^{-4}	1.17×10^{-4}	28.1	27.7
CA residential/ CA impervious/ Barrier treatment	Urban and rural structures and buildings (as shown in the footnote[3]), <u>plus</u> the following: Farm Premises (Agricultural), Barnyards/ Auction Barns, Seed Houses/ Stores/Storage Areas/ Warehouses	0.969	15-10	1	N/A	0.014	0.014	0.014	0.014	0.014	3,750	3,740

Scenario (bold font)/ Application Method	Crops/Uses Represented	Application Rate (lb a.i./A)	Date of First Application (dd-mm)	Number of Applications	Application 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 ($\mu g/kg_{oc}$)
CA residential/ CA impervious/ GR or Bait/ Solid	Urban and rural structures and buildings (as shown in the footnote[3])	0.0421	15-10	1	N/A	7.01×10^{-4}	2.17×10^{-4}	2.04×10^{-4}	6.44×10^{-5}	6.42×10^{-5}	15.3	15.2
CA residential/ CA impervious/ Outdoor general surface spray, perimeter treatment, space spray	Urban and rural structures and buildings (as shown in the footnote[3])	9.44	15-10	1	N/A	0.014	0.014	0.014	0.014	0.014	36,500	36,400
CA residential/ CA impervious/ Crack & crevice, brush on, void treatment, foam application	Urban and rural structures and buildings (as shown in the footnote[3])	0.00125	15-10	1	N/A	0.014	0.0102	0.00804	0.00141	0.00141	334	333
CA residential/ CA impervious/ Soil treatment (trenching)	Urban and rural structures and buildings (as shown in the footnote[3])	0.00244	15-01	2	7	0.014	0.00582	0.00471	0.00111	0.00111	263	262
CA residential/ CA impervious/ G: Spot treatment, crack & crevice, directed spray, perimeter treatment	Farm Premises (Agricultural), Barnyards/ Auction Barns, Seed Houses/ Stores/Storage Areas/ Warehouses	0.0317	15-01	2	7	0.014	0.00612	0.00491	0.00110	0.00109	260	258
CA residential/ CA impervious/ G	Wood Protection Treatment to Buildings/ Products (Outdoors)	1.59×10^{-4}	15-10	2	56	0.014	0.014	0.014	0.00982	0.00980	2,330	2,320

Scenario (bold font)/ Application Method	Crops/Uses Represented	Application Rate (lb a.i./A)	Date of First Application (dd-mm)	Number of Applications	Application 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 ($\mu g/kg_{oc}$)
CA residential/ CA impervious/ G (void treatment)	Wood Protection Treatment to Buildings/ Products (Outdoors)	0.0287	15-10	1	N/A	0.014	0.014	0.014	0.014	0.014	7,660	7,630
CA right-of-way/ CA impervious/ G	Right-of-Way	0.021	15-11	1	N/A	0.014	0.00260	0.00213	$5.20x10^{-4}$	$5.17x10^{-4}$	123	122
CA right-of-way/ CA impervious/ GR	Right-of-Way	0.0167	15-08	3	7	0.00513	0.00180	0.00157	$5.57x10^{-4}$	$5.54x10^{-4}$	132	131
CA right-of-way/ CA impervious/ Perimeter treatment	Paved Areas (Private Roads/ Sidewalks)	0.38	15-11	1	N/A	0.014	0.014	0.014	0.00938	0.00934	2,220	2,210
CA right-of-way/ CA impervious/ Perimeter treatment, general surface spray	Refuse/Solid Waste Sites (outdoors)	0.23	15-11	1	N/A	0.014	0.014	0.014	0.00568	0.00565	1,350	1,340
CA right-of-way/ CA impervious/ Perimeter treatment	Utilities, Utility Poles/Rights-of-Way	2.2	15-11	1	N/A	0.014	0.014	0.014	0.014	0.014	12,900	12,800

Scenario (bold font)/ Application Method	Crops/Uses Represented	Application Rate (lb a.i./A)	Date of First Application (dd-mm)	Number of Applications	Application 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 ($\mu g/kg_{oc}$)
CA right-of-way/ CA impervious/ GR	Utility Poles/Rights-of-Way	0.1	15-11	1	N/A	0.014	0.00460	0.00396	0.00134	0.0133	317	316

1. All EECs rounded to three significant figures; A=aerial; G=ground; GR=granular application methods; N/A=not applicable; NA=not available. All EECs rounded to three significant figures.
2. For assumptions regarding the application rate, see **Table 3-1**.
3. May include various types of facilities: 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)/Diary Farm Milk Storage Rooms/Houses/Sheds/ Eating Establishments (food and non-food areas)/Egg Handling Rooms/Egg Packing Plants (Commercial)/Feed Mills/Feed Processing Plants/ Food/Grocery/Marketing/ Storage/Distribution Facility Premise/Food Processing Plant Equipment (food contact)/(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/ Public Buildings/Structures/ Storage Areas (empty or full).

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 bifenthrin 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). In addition, air monitoring data for bifenthrin are summarized.

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 09/12/2012 by constituent finder. Even though bifenthrin has sampling in the surface water database, 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 09/12/2012 by constituent finder. A total of 93 groundwater samples were reported for bifenthrin in California and there were no detects in the database (reported as <0.0053 µg/L).

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 09/12/2012 at http://www.cdpr.ca.gov/docs/emon/surfwtr/surfcont.htm) and all data with analysis for bifenthrin were extracted. A total of 1,838 samples were analyzed for bifenthrin (1,581 surface waters and 257 sediments). Of these, 105 surface water samples (6.6%) and 24 sediment samples (9.3%) had positive detections of bifenthrin. The maximum surface water concentration was 5.209, µg/L, a value that exceeds the solubility limit of bifenthrin, in Storm Drain at Millbrook Avenue - drains to Martin Canyon/Koopman Canyon Crk, Alameda (see also uncertainties related to the solubility of bifenthrin in **Section 6.1.2**). Additionally, three other concentrations were above 1 ppb. The maximum sediment concentration was 0.437 µg/kg, in Kaseberg Creek, at Green Grove Road, Placer (the next to the highest value was also reported in Placer, 0.413 µg/kg). The quantitation limits were variable.

3.2.4.d. Atmospheric Monitoring Data

There is only very limited air monitoring data for bifenthrin. One air monitoring study for bifenthrin, performed by the California Air Resources Board (CARB 2001), is available. Both, "application" (close to the site of the applications) and "ambient" (farther away from the site of application) monitoring were conducted. The maximum air concentration from the CARB monitoring results was 0.270 $\mu g/m^3$ (270 ng/m^3), which was "observed at the east sampling site, during the 1st sampling period (application) of 2.7 hours." For the ambient monitoring, "the highest bifenthrin concentration, 17 ng/m^3 (0.97 pptv), was observed at the Helm Elementary School (HES) sampling site in Helm on July 15, 1999."

3.3. Terrestrial Animal Exposure Assessment

3.3.1. Exposure to Residues in Terrestrial Food Items

T-REX (Version 1.5.1) is used to calculate dietary and dose-based EECs of bifenthrin for birds (including terrestrial-phase amphibians and reptiles), mammals, and terrestrial invertebrates. T-REX simulates a 1-year time period. For terrestrial-phase amphibians (*e.g.*, CTS) and reptiles (SFGS), T-HERPS v.1.1 is used to refine exposure assessment based on consumption rates that are representative of herpivores. For this assessment, spray, granular and seed treatment applications of bifenthrin are considered. Terrestrial EECs were derived for the uses previously summarized in **Table 3-1**. Exposure estimates generated using T-REX and T-HERPS are for the parent alone.

For foliar applications, T-REX and T-HERPS input values for each use category are provided in **Table 3-3**. As shown in **Table 3-3**,, bifenthrin uses from **Table 3-1** withd the same application rate, number of applications and application interval were combined into a single use category (*e.g.*, pears, mayhaw, fruits (unspecified) uses were combined with strawberry uses). For comparative purposes, the total annual application rate is also shown. Given that no data on interception and subsequent dissipation from foliar surfaces are available for bifenthrin, a default foliar dissipation half-life of 35 days is used based on the work of Willis and McDowell (1987). However, for risk characterization purposes, a foliar dissipation half-life of 8.3 days was derived for the pyrethroid class of insecticides and applied in the terrestrial exposure modeling. Since foliar dissipation data were unavailable for bifenthrin, this alternative foliar dissipation half-life was based on the half-lives of several other pyrethroids as reported by Willis and McDowell (1987). Data included only half-lives for total residue (T) and did not include the dislodgeable residue half-lives (D) from Willis & McDowell (1987). The selected value (8.3 days) represents the 90th percentile of the upper confidence bound on the mean of 16 values from seven different synthetic pyrethroids (the mean value is 6.55 days, and standard deviation is 5.06 days). Complete results of T-REX and T-HERPS modeling, including derivation of pyrethroid-specific foliar dissipation half life, are also provided in **Appendix E**. T-REX, T-HERPS, and IEC Results.

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

Uses	App. Method	App. Rate (lb ai/A)	# Apps.	Interval (d)	Total Annual Rate (lb ai/A)
Agricultural Uses					
Agricultural crops/ soils	Ground	0.0832	3	21	0.25
Alfalfa, Clover	Aerial	0.1	5	45	0.5
Artichokes	Aerial	0.1	5	15	0.5
Beets, garden beets	Aerial	0.1	4	7	0.4
Bushberries	Aerial	0.1	5	7	0.5
Caneberries	Aerial	0.1	2	14	0.2
Canola, rapeseed, crambe	Aerial	0.04	2	14	0.08
Citrus crops	Ground	0.5	1	N/A	0.5
Corn	Aerial	0.1	3	3	0.3
Cotton	Aerial	0.1	5	3	0.5
Cucurbits:	Aerial	0.1	3	7	0.3

Uses	App. Method	App. Rate (lb ai/A)	# Apps.	Interval (d)	Total Annual Rate (lb ai/A)
Deciduous Fruits, Apple, Stone Fruits	Ground	0.21	1	N/A	0.21
Dried Peas and Beans	Ground	0.1	1	N/A	0.1
Fruits (unspecified)	Ground	0.2	2	7	0.4
Grapes	Aerial	0.1	1	N/A	0.1
Head and Stem Brassica; Lettuce, Leafy Petiole Vegetables	Aerial	0.1	5	7	0.5
Hops	Aerial	0.1	3	21	0.3
Pears, Mayhaw, Fruits (unspecified), Strawberry	Aerial	0.167	3	7	0.50
Peppers, Succulent Peans and Beans; Tomato & Tomatillo; Eggplant, Ground Cherry, Pepino	Aerial	0.1	2	7	0.2
Root Crops	Ground	0.1	5	7	0.5
Spinach	Aerial	0.1	4	7	0.4
Sweet corn	Aerial	0.1	2	3	0.2
Tree Nut Crops	Aerial and ground	0.18	3	15	0.54
Tuberous and Corn Vegetables	Aerial	0.3 at plant, then 0.1x2	3	21	0.5
Non-Agricultural Uses					
Agricultural Right-of-Ways/ Fencerows/ Hedgerows	Ground	0.21	1	N/A	0.21
Airports/ Landing Fields	Ground (perimeter treatment)	0.0096	1	N/A	0.0096
Christmas Tree Plantations, Golf Course Turf	Ground	0.2	1	N/A	0.2
Farm Premises/Buildings	Ground (spot, crack, crevice, perimeter)	0.0317	2	7	0.0634
Forest Tree Plantations	Ground	0.205	3	30	0.615
Forest Trees - unspecified, softwoods	Ground	0.106	3	30	0.317
Non-agricultural Uncultivated Areas	Ground	0.167	3	56	0.50
Nursery Stock	Drench	0.1	1	N/A	0.1
Ornamental & Shade Trees (1)	Ground	0.95	1	N/A	0.95
Ornamental & Shade Trees (2)	Ground	0.3	3	30	0.9
Ornamental Grasses	Ground	0.232	2	56	0.464
Pave Area Perimeters	Ground (perimeter treatment)	0.38	1	N/A	0.38
Refuse/Solid Waste Sites (outdoors)	Ground	0.23	1	N/A	0.23
Residential Lawns	Ground	0.0634	1	N/A	0.0634
Residential Lawns	Ground (perimeter treatment)	0.06	2	56	0.12
Right of Way	Ground	0.021	1	N/A	0.021

Uses	App. Method	App. Rate (lb ai/A)	# Apps.	Interval (d)	Total Annual Rate (lb ai/A)
Roses	Ground	0.1	5	7	0.5
Sod farms, ornamental sod farms	Ground	0.2	2	7	0.4

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

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. The percentages of the EECs for the different dietary items are discussed in the section on uncertainties (see **Section 6.1.1.b**).

For seed treatments, the available labels indicate a maximum application rate of 4.6 fl oz/100 lb seed for all seed treatment uses. The percent a.i. for the seed treatment product evaluated is 19.5%. The following is a list of seed treatment use categories:

- Beans
- Brassica (head and stem vegetables)
- Canola/rape/ crambe
- Corn (field, pop, sweet)
- Cotton
- Cucurbits
- Lettuce and leafy vegetables
- Succulent peas
- Pepper and Eggplant

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 3-4**. 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[34]. 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**.

Table 3-4. Upper-bound Kenaga Nomogram EECs for Dietary- and Dose-based Exposures of Birds and Mammals Derived Using T-REX for Foliar Applications of Bifenthrin

Use(s), Type of Application	App Rate (lb a.i./A), # Apps, Interval (d)	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)
Agricultural Uses					
Agricultural crops/ soils	0.0832, 3, 21	47.64	41.83	39.89	41.83
Alfalfa, Clover	0.1, 5, 45	45.80	40.22	38.34	40.22
Artichokes	0.1, 5, 15	82.27	72.24	68.87	72.24
Beets, garden beets	0.1, 4, 7	89.88	78.92	75.24	78.92
Bushberries	0.1, 5, 7	105.6	92.70	88.38	92.70
Caneberries	0.1, 2, 14	48.05	42.19	40.22	42.19
Canola, rapeseed, crambe	0.04, 2, 14	19.22	16.88	16.09	16.88
Citrus crops	0.5, 1	136.7	120.0	114.4	120.0
Corn	0.1, 3, 3	77.36	67.93	64.76	67.93
Cotton	0.1, 5, 3	121.8	106.9	102.0	106.9
Cucurbits:	0.1, 3, 7	71.84	63.08	60.14	63.08
Deciduous Fruits, Apple, Stone Fruits	0.21, 1	57.40	50.40	48.05	50.40
Dried Peas and Beans	0.1, 1	27.33	24.00	22.88	24.00
Fruits (unspecified)	0.2, 2, 7	102.3	89.79	85.60	89.79
Grapes	0.1, 1	27.33	24.00	22.88	24.00
Head and Stem Brassica; Lettuce, Leafy Petiole Vegetables	0.1, 5, 7	105.6	92.70	88.38	92.70
Hops	0.1, 3, 21	57.26	50.28	47.94	50.28

[34] 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.

Use(s), Type of Application	App Rate (lb a.i./A), # Apps, Interval (d)	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)
Pears, Mayhaw, Fruits (unspecified), Strawberry	0.167, 3, 7	119.98	105.35	100.44	105.35
Peppers, Succulent Peans and Beans; Tomato & Tomatillo; Eggplant, Ground Cherry, Pepino	0.1, 2, 7	51.13	44.89	42.80	44.89
Root Crops	0.1, 5, 7	105.6	92.70	88.38	92.70
Spinach	0.1, 4, 7	89.88	78.92	75.24	78.92
Sweet corn	0.1, 2, 3	53.09	46.62	44.44	46.62
Tree Nut Crops (1)	0.18, 3, 15	112.9	99.15	94.53	99.15
Tuberous and Corn Vegetables	0.3 at plant, then 0.1x2, 3, 21	82.00	72.00	68.65	72.00
Non-Agricultural Uses					
Agricultural Right-of-Ways/ Fencerows/ Hedgerows	0.21, 1	57.40	50.40	48.05	50.40
Airports/ Landing Fields	0.0096, 1	2.62	2.30	2.20	2.30
Christmas Tree Plantations, Golf Course Turf	0.2, 1	54.67	48.00	45.76	48.00
Farm Premises/Buildings	0.0317, 2, 7	16.21	14.23	13.57	14.23
Forest Tree Plantations	0.205, 3, 30	104.0	91.35	87.10	91.35
Forest Trees - unspecified, softwoods	0.1058, 3, 30	53.70	47.15	44.95	47.15
Non-agricultural Uncultivated Areas	0.167, 3, 56	65.67	57.66	54.98	57.66
Nursery Stock	0.1, 1	27.33	24.00	22.88	24.00
Ornamental & Shade Trees (1)	0.95, 1	259.7	228.00	217.4	228.0
Ornamental & Shade Trees (2)	0.3, 3, 30	152.3	133.7	127.5	133.7
Ornamental Grasses	0.232, 2, 56	84.33	74.05	70.60	74.05
Pave Area Perimeters	0.38, 1	103.9	91.20	86.95	91.20
Refuse/Solid Waste Sites (outdoors)	0.23, 1	62.87	55.20	52.63	55.20
Residential Lawns (1)	0.0634, 1,	17.33	15.22	14.51	15.22
Residential Lawns (3)	0.06, 2, 56	21.81	19.15	18.26	19.15
Right of Way (1)	0.021, 1	5.74	5.04	4.81	5.04
Roses	0.1, 5, 7	105.6	92.70	88.38	92.70
Sod farms, ornamental sod farms	0.2, 2, 7	102.3	89.79	85.60	89.79

* EECs calculated using default foliar dissipation half life of 35 days using T-REX version 1.5.1.

For seed treatments according to the uses summarized above, the maximum application rate on the label corresponds to **0.058 lb ai/100 lb seed**. T-REX (v 1.5.1) was used to estimate EECs to small (20g) birds and small mammals (15g) using the following as inputs:

- Application rate (4.6 fl oz/100 lb seed)

- % a.i. (19.5%) (only one label appears to be used for seed treatment, EPA Reg. No. 279-3245)
- Density (8.33 lb/gal)
- Maximum crop-specific seeding rates (varying from 30.6 lb/A for canola/rape to 411 lb/A for garden peas)

Notably, seeding rates vary widely both within a crop category and across crop categories. Within a crop category, the maximum rate available from T-REX was used. Results for the seed treatment EECs are shown in **Table 3-5**. Since the concentration of bifenthrin per 100 lb of treated seed remains the same, only the estimated application rate (lb a.i./A) and LD_{50}/ft^2 vary across application scenarios.

Table 3-5. Bifenthrin EECs for birds and mammals for seed treatment uses

Seed Treatment Use Category	T-REX Seed Treatment Scenario	Max Appl. Rate (lbs ai/A)*	Max Seed Appl. Rate (mg ai/kg seed)**	Avian Nagy Dose (mg ai/kg-bw/day)**	Mammalian Nagy Dose (mg ai/kg-bw/day)**	Available A.I. (mg ai ft-2)*
Beans	beans, lima	0.095	583.75	147.74	123.68	1.00
Brassica (head and stem vegetables)	cabbage	0.042				0.44
Canola/rape/ crambe	corn, all or unspecified	0.019				0.20
Corn (field, pop, sweet)	canola	0.018				0.19
Cotton	cotton, all or unspecified	0.09				0.91
Cucurbits	cucumber	0.01				0.07
Lettuce and leafy vegetables	kale for market	0.06				0.61
Succulent peas	pea, garden	0.24				2.50
Pepper and Eggplant	peppers, all	0.10				1.04

* based on label rate of 4.6 fl oz per 100 lb seed (19.5% a.i.) and maximum crop-specific seeding rates identified in T-REX (v. 1.5.1).
** Since according to the labels, the maximum application rate to seeds remains the same, dose-based EECs do not change across application scenarios.

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[35]. 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 3-6**

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

shows the resulting EECs from T-REX. As shown in **Table 3-6**, EECs appear to be higher for broadcast applications. The reason is that in-furrow and banded applications have a higher level of incorporation, indicating fewer granules exposed per unit area.

Table 3-6. Bifenthrin 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}
Corn (field), sweet corn, cucurbit vegetables, succulent peas and beans, head and stem brassica vegetables, lettuce, eggplant, cotton, bell and non-bell peppers, root crops	0.1	Broadcast	N/A	N/A	0	1.04
Field corn, sweet corn	0.1	T-Band	30	6	85	0.78
Field corn, sweet corn	0.1	In furrow	30	6	99	0.05
Tuberous & corm vegetables	0.3	In furrow	30	6	99	0.16
Canola	0.04	Broadcast	N/A	N/A	0	0.42
Turf; ornamentals (various including Christmas trees, containerized), parks, recreational parks, around institutional, public, commercial and industrial buildings, golf courses, sod farms	0.4	Broadcast	N/A	N/A	0	4.17

3.3.2. Exposure to Terrestrial Invertebrates Derived Using T-REX

T-REX is also used to calculate EECs for terrestrial invertebrates exposed to bifenthrin. Available acute contact toxicity (LD_{50}) data for bees exposed to bifenthrin (in units of µg a.i./bee), are converted to µg a.i./g (of bee) by multiplying by 1 bee/0.128 g. Dietary-based EECs calculated by T-REX (version 1.5.1) for arthropods (units of a.i./g) are used to estimate exposure to terrestrial invertebrates (**Table 3-7**). The EECs are later compared to the adjusted acute contact toxicity data for bees in order to derive RQs.

These terrestrial invertebrate EECs are applicable to estimating direct effects to the VELB and BCB and in estimating indirect effects based on reduction in prey to the CCR, SFGS, and CTS. Complete 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 from Bifenthrin Exposure Derived Using T-REX ver. 1.5.1

Use(s), Type of Application	App Rate (lb a.i./A), # Apps, Interval (d)	Upper Bound Arthropod Residues (ppm)*
Agricultural Uses		
Agricultural crops/ soils	0.0832, 3, 21	16.38
Alfalfa, Clover	0.1, 5, 45	15.75
Artichokes	0.1, 5, 15	28.29
Beets, garden beets	0.1, 4, 7	30.91
Bushberries	0.1, 5, 7	36.31
Caneberries	0.1, 2, 14	16.52
Canola, rapeseed, crambe	0.04, 2, 14	6.61
Citrus crops	0.5, 1	47.00
Corn	0.1, 3, 3	26.60
Cotton	0.1, 5, 3	41.88
Cucurbits:	0.1, 3, 7	24.71
Deciduous Fruits, Apple, Stone Fruits	0.21, 1	19.74
Dried Peas and Beans	0.1, 1	9.40
Fruits (unspecified)	0.2, 2, 7	35.17
Grapes	0.1, 1	9.40
Head and Stem Brassica; Lettuce, Leafy Petiole Vegetables	0.1, 5, 7	36.31
Hops	0.1, 3, 21	19.69
Pears, Mayhaw, Fruits (unspecified), Strawberry	0.167, 3, 7	41.26
Peppers, Succulent Peans and Beans; Tomato & Tomatillo; Eggplant, Ground Cherry, Pepino	0.1, 2, 7	17.58
Root Crops	0.1, 5, 7	36.31
Spinach	0.1, 4, 7	30.91
Sweet corn	0.1, 2, 3	18.26
Tree Nut Crops (1)	0.18, 3, 15	38.83
Tuberous and Corn Vegetables	0.3 at plant, then 0.1x2, 3, 21	28.20
Non-Agricultural Uses		
Agricultural Right-of-Ways/ Fencerows/ Hedgerows	0.21, 1	19.74
Airports/ Landing Fields	0.0096, 1	0.90
Christmas Tree Plantations, Golf Course Turf	0.2, 1	18.80
Farm Premises/Buildings	0.0317, 2, 7	5.57
Forest Tree Plantations	0.205, 3, 30	35.78
Forest Trees - unspecified, softwoods	0.1058, 3, 30	18.47
Non-agricultural Uncultivated Areas	0.167, 3, 56	22.58
Nursery Stock	0.1, 1	9.40
Ornamental & Shade Trees (1)	0.95, 1	89.30
Ornamental & Shade Trees (2)	0.3, 3, 30	52.36
Ornamental Grasses	0.232, 2, 56	29.00
Pave Area Perimeters	0.38, 1	35.72
Refuse/Solid Waste Sites (outdoors)	0.23, 1	21.62
Residential Lawns (1)	0.0634, 1	5.96
Residential Lawns (3)	0.06, 2, 56	7.50

Use(s), Type of Application	App Rate (lb a.i./A), # Apps, Interval (d)	Upper Bound Arthropod Residues (ppm)*
Right of Way (1)	0.021, 1	1.97
Roses	0.1, 5, 7	36.31
Sod farms, ornamental sod farms	0.2, 2, 7	35.17

* EECs calculated using default foliar dissipation half life of 35 days using T-REX version 1.5.1.

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 and reptiles. This can be seen when comparing the allometric equations for caloric requirements for free living iguanid lizards (used in this case as a surrogate for terrestrial-phase amphibians) to passerine birds (USEPA, 1993):

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

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

With relatively comparable slopes to the allometric functions and 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 bifenthrin 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 (v. 1.1). 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 3-8**.

Table 3-8. Upper-bound Kenaga Nomogram EECs for Dietary- and Dose-based Exposures of Amphibians Derived Using T-HERPS for Bifenthrin

Use(s), Type of Application	App Rate (lb a.i./A, # App, Interval (days)	EEC for Medium CTS (medium birds consuming herbivorous mammals)*	
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)
Agricultural Use Patterns			
Agricultural crops/ soils	0.0832, 3, 21	41.99	27.99
Alfalfa, Clover	0.1, 5, 45	40.36	26.91
Artichokes	0.1, 5, 15	72.50	48.34
Beets, garden beets	0.1, 4, 7	79.21	52.80
Bushberries	0.1, 5, 7	93.04	62.03
Caneberries	0.1, 2, 14	42.34	28.23
Canola, rapeseed, crambe	0.04, 2, 14	16.94	11.29
Citrus crops	0.5, 1	120.4	80.29
Corn	0.1, 3, 3	68.18	45.45
Cotton	0.1, 5, 3	107.3	71.55
Cucurbits:	0.1, 3, 7	63.31	42.21
Deciduous Fruits, Apple, Stone Fruits	0.21, 1	50.58	33.72
Dried Peas and Beans	0.1, 1	24.09	16.06
Fruits (unspecified)	0.2, 2, 7	90.12	60.08
Grapes	0.1, 1	24.09	16.06
Head and Stem Brassica; Lettuce, Leafy Petiole Vegetables	0.1, 5, 7	93.04	62.03
Hops	0.1, 3, 21	50.46	33.64
Pears, Mayhaw, Fruits (unspecified), Strawberry	0.167, 3, 7	105.7	70.49
Peppers, Succulent Peans and Beans; Tomato & Tomatillo; Eggplant, Ground Cherry, Pepino	0.1, 2, 7	45.06	30.04
Root Crops	0.1, 5, 7	93.04	62.03
Spinach	0.1, 4, 7	79.21	52.80
Sweet corn	0.1, 2, 3	46.79	31.19
Tree Nut Crops (1)	0.18, 3, 15	99.51	66.34
Tuberous and Corn Vegetables	0.3 at plant, then 0.1x2, 3, 21	Not available [(a)]	Not available [(a)]
Non-Agricultural Use Patterns			
Agricultural Right-of-Ways/ Fencerows/ Hedgerows	0.21, 1	50.58	33.72
Airports/ Landing Fields	0.0096, 1	2.31	1.54
Christmas Tree Plantations, Golf Course Turf	0.2, 1	48.18	32.12
Farm Premises/Buildings	0.0317, 2, 7	14.28	9.52
Forest Tree Plantations	0.205, 3, 30	91.69	61.13
Forest Trees - unspecified, softwoods	0.1058, 3, 30	47.32	31.55
Non-agricultural Uncultivated Areas	0.167, 3, 56	57.87	38.58
Nursery Stock	0.1, 1	24.09	16.06
Ornamental & Shade Trees (1)	0.95, 1	228.8	152.56
Ornamental & Shade Trees (2)	0.3, 3, 30	134.2	89.45
Ornamental Grasses	0.232, 2, 56	74.32	49.55

Use(s), Type of Application	App Rate (lb a.i./A, # App, Interval (days)	EEC for Medium CTS (medium birds consuming herbivorous mammals)*	
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)
Pave Area Perimeters	0.38, 1	91.53	61.02
Refuse/Solid Waste Sites (outdoors)	0.23, 1	55.40	36.93
Residential Lawns (1)	0.0634, 1	15.27	10.18
Residential Lawns (3)	0.06, 2, 56	19.22	12.81
Right of Way (1)	0.021, 1	5.06	3.37
Roses	0.1, 5, 7	93.04	62.03
Sod farms, ornamental sod farms	0.2, 2, 7	90.12	60.08

n/a = not applicable; App=Application
* EECs calculated using default foliar dissipation half life of 35 days using T-HERPS version 1.1.
[(a)] T-HERPS does not have the capability to calculate variable rates. Further evaluation of the risk quotients for this scenario indicated that they were below the levels of concern; therefore, these EECs were not needed.

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.[36] That is why birds consuming short grass in T-REX are used as the screen to determine whether further refinement in T-HERPS is needed for snakes. T-HERPS was modified (version 1.1) to estimate exposure to snakes based on the maximum size prey item they could consume and is used to refine a risk estimate when LOCs are exceeded for small birds consuming short grass based on RQs estimated in T-REX. The following allometric equation developed by King 2002 was used to estimate the maximum size prey items for snakes (King, 2002).

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

The 95% confidence limits on the exponent 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 terrestrial-phase amphibians. The most sensitive EECs and RQs for SFGS are for the medium-sized animal consuming small herbivorous mammals. EECs calculated using T-HERPS for the SFGS are shown in **Table 3-9**.

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

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

Use(s), Type of Application	App Rate (lb a.i./A, # App, Interval (days)	EEC for Small SFGS (small bird consuming small insects)		EEC for Medium SFGS (medium birds consuming herbivorous mammals)	
		Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)	Dietary-based EEC (mg/kg-diet)	Dose-based EEC (mg/kg-bw)
Agricultural Use Patterns					
Agricultural crops/ soils	0.0832, 3, 21	23.53	1.31	41.99	39.67
Alfalfa, Clover	0.1, 5, 45	22.62	1.26	40.36	38.13
Artichokes	0.1, 5, 15	40.63	2.26	72.50	68.50
Beets, garden beets	0.1, 4, 7	44.39	2.47	79.21	74.83
Bushberries	0.1, 5, 7	52.14	2.90	93.04	87.90
Caneberries	0.1, 2, 14	23.73	1.32	42.34	40.00
Canola, rapeseed, crambe	0.04, 2, 14	9.49	0.53	16.94	16.00
Citrus crops	0.5, 1	67.50	3.75	120.4	113.8
Corn	0.1, 3, 3	38.21	2.12	68.18	64.41
Cotton	0.1, 5, 3	60.15	3.34	107.3	101.40
Cucurbits:	0.1, 3, 7	35.48	1.97	63.31	59.82
Deciduous Fruits, Apple, Stone Fruits	0.21, 1	28.35	1.57	50.58	47.79
Dried Peas and Beans	0.1, 1	13.50	0.75	24.09	22.76
Fruits (unspecified)	0.2, 2, 7	50.50	2.80	90.12	85.14
Grapes	0.1, 1	13.50	0.75	24.09	22.76
Head and Stem Brassica; Lettuce, Leafy Petiole Vegetables	0.1, 5, 7	52.14	2.90	93.04	87.90
Hops	0.1, 3, 21	28.28	1.57	50.46	47.68
Pears, Mayhaw, Fruits (unspecified), Strawberry	0.167, 3, 7	59.26	3.29	105.73	99.89
Peppers, Succulent Peans and Beans; Tomato & Tomatillo; Eggplant, Ground Cherry, Pepino	0.1, 2, 7	25.25	1.40	45.06	42.57
Root Crops	0.1, 5, 7	52.14	2.90	93.04	87.90
Spinach	0.1, 4, 7	44.39	2.47	79.21	74.83
Sweet corn	0.1, 2, 3	26.22	1.46	46.79	44.20
Tree Nut Crops (1)	0.18, 3, 15	55.77	3.10	99.51	94.01
Tuberous and Corn Vegetables	0.3 at plant, then 0.1x2, 3, 21	Not available [(a)]	Not available [(a)]	Not available [(a)]	Not available [(a)]
Non-Agricultural Use Patterns					
Agricultural Right-of-Ways/ Fencerows/ Hedgerows	0.21, 1	28.35	1.57	50.58	47.79
Airports/ Landing Fields	0.0096, 1	1.30	0.07	2.31	2.18
Christmas Tree Plantations, Golf Course Turf	0.2, 1	27.00	1.50	48.18	45.51
Farm Premises/Buildings	0.0317, 2, 7	8.01	0.44	14.28	13.49
Forest Tree Plantations	0.205, 3, 30	51.39	2.85	91.69	86.62
Forest Trees - unspecified, softwoods	0.1058, 3, 30	26.52	1.47	47.32	44.71

Use(s), Type of Application	App Rate (lb a.i./A, # App, Interval (days)	EEC for Small SFGS (small bird consuming small insects)		EEC for Medium SFGS (medium birds consuming 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)
Non-agricultural Uncultivated Areas	0.167, 3, 56	32.44	1.80	57.87	54.68
Nursery Stock	0.1, 1	13.50	0.75	24.09	22.76
Ornamental & Shade Trees (1)	0.95, 1	128.25	7.12	228.8	216.2
Ornamental & Shade Trees (2)	0.3, 3, 30	75.20	4.18	134.2	126.8
Ornamental Grasses	0.232, 2, 56	41.65	2.31	74.32	70.21
Pave Area Perimeters	0.38, 1	51.30	2.85	91.53	86.48
Refuse/Solid Waste Sites (outdoors)	0.23, 1	31.05	1.72	55.40	52.34
Residential Lawns (1)	0.0634, 1	8.56	0.48	15.27	14.43
Residential Lawns (3)	0.06, 2, 56	10.77	0.60	19.22	18.16
Right of Way (1)	0.021, 1	2.84	0.16	5.06	4.78
Roses	0.1, 5, 7	52.14	2.90	93.04	87.90
Sod farms, ornamental sod farms	0.2, 2, 7	50.50	2.80	90.12	85.14

n/a = not applicable; App = Application
[(a)] T-HERPS does not have the capability to calculate variable rates. Further evaluation of the risk quotients for this scenario using T-REX indicated that they were below the levels of concern; therefore, these EECs were not needed.

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 bifenthrin by aquatic biota. For bifenthrin, 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[37]. For fish, a measured BCF of 6,090 L/kg wet wt is available for whole fish (Acc. No. 264642 or MRID: 163094, 163095). From this study, a k_t value of 0.0182 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 1180 L/kg ww is available from Holzer (2011) based on the freshwater amphipod, *Hyalella azteca*. Because Holzer (2011) did not determine a depuration rate constant value for *H. azteca*, k_2 was estimated based on the following equation:

$BCF_{ss} = k_1/k_2$ and therefore,

$k_2 = k_1/BCF_{ss}$

where,

BCF_{ss} = experimentally measured BCF at steady state (L/kg ww);
k_1= calculated uptake rate constant via respiration by KABAM (L/kg-d);
k_2= elimination rate constant via respiration determined algebraically (1/d)

In estimating the value of k_2 using a measured BCF and a calculated k_1 from KABAM, chemical loss via fecal elimination (k_e) and metabolism k_m is set to zero, since the experimentally-measured BCF_{ss} reflects the impact of these loss processes. A similar approach was used for estimating the k_2 for zooplankton based on a BCF of 4,600 L/kg for *D. magna* reported by Yang (2006).

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 L**.

Four pesticide-specific inputs are required to estimate bifenthrin residue concentrations in aquatic organism tissues: 1) log K_{ow}, 2) K_{oc}, 3) aqueous concentration of bifenthrin, and 4) sediment pore water concentrations of bifenthrin. The K_{oc} and log K_{ow} are based on registrant-submitted studies (see Section 2.4). Bifenthrin concentrations in pore water and the water column were based on PRZM/EXAMS scenarios adapted specifically for California (**Table 3-10**). The 21-day EECs are used based on the time to steady state as indicated in submitted BCF studies (Acc. No. 264642 or MRID: 163094, 163095). Additional model input parameters related to aquatic organisms (including body weight, and food and water intake) and

[37] 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.

environmental characteristics (*e.g.*, temperature, organic carbon content) are identified and explained in **Attachment I**.

Two scenarios were modeled: the highest EECs that result from any of the assessed uses of bifenthrin (ornamentals, pressure liquid application), and a scenario that resulted in EECs typical of many of the agricultural bifenthrin uses that were assessed in this document (citrus crops).

Table 3-10. Bioaccumulation Model Input Values for Bifenthrin

Parameter	Input Value	Source
Pesticide Name	Bifenthrin	
Log K_{OW}	6.48	Laskowski, 2002
K_{OC}	236,750 L/kg_{OC}	Acc. No. 254411 or MRID 00141203
Fish k_2 (Based on fish BCF)	0.0182/day (for the inedible tissue)[38]	Acc. No. 264642 or MRID: 163094, 163095
Benthic invertebrates k_2 (based on *H. azteca* BCF)	3.22/day	Determined using BCF and KABAM calculated k_1 (Holzer, 2011)
Zooplankton k_2 (based on *D. magna* BCF)	9.27/day	Determined using BCF and KABAM calculated k_1 (Yang et al., 2006)
	Scenario 1 (typical)	**Scenario 2 (maximum)**
Use patterns	Citrus crops (Ground, app rate 0.5 lb a.i./A)	Ornamentals (Pressure liquid, app rate 0.95 lb a.i./A)
Concentration in sediment pore water (ppb)	Peak=0.00748 ppb	Peak=0.014 ppb
Total pesticide concentration in water (ppb)	Peak=0.014 ppb	Peak=0.014 ppb

Based on KABAM, estimated concentrations of bifenthrin residues in the tissue of organisms in the different trophic levels following application on ornamentals range from 25 to 1,444 µg/kg (**Table 3-11**). Bifenthrin residues in phytoplankton and filter feeders were comparatively high because bifenthrin-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 3-11. Predicted Concentrations of Bifenthrin in Aquatic Organism Tissues at Different Trophic Levels

Trophic Level	Estimated Total Concentration (µg/kg)	
	Citrus crops (Ground, app rate 0.5x1)	**Ornamentals (Pressure liquid, app rate 0.95 lb a.i./A)**
Phytoplankton	1,066	1,066
Zooplankton	88	88
Benthic Invertebrates	25	25
Filter Feeders	1,422	1,444
Small Forage Fish	641	655
Medium Forage Fish	706	721
Large Forage Fish	818	833

[38] Depuration half-lives are 32.3 and 38.0 days, for the edible and inedible tissues, respectively. The depuration rate constant corresponds to the inedible tissue.

3.4. Terrestrial Plant Exposure Assessment

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

4. Effects Assessment

This assessment evaluates the potential for bifenthrin 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 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 bifenthrin.

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 H**. 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 H**. The list of citations including toxicological and/or efficacy data on target insect species not considered in this assessment is provided in **Appendix G**.

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 G. Appendix G** 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 H**. **Appendix I** includes a summary of the human health effects data for bifenthrin.

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

4.2. Toxicity of Bifenthrin 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. Additional information on these and other toxicity studies submitted by the registrant is provided in **Appendix F**. 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 Bifenthrin

Assessment Endpoint	Acute/ Chronic	Species (% a.i.)***	Toxicity Value Used in Risk Assessment	Citation or MRID # (Author, Date)[1]	Study Classification/ Comment
Freshwater fish (surrogate for aquatic-phase amphibians)	Acute	Rainbow Trout *Oncorhynchus mykiss* (88.4%).	**96-hr LC_{50} = 0.15 µg a.i./L** (C.L. 0.102-0.191 µg/L; slope 3.53)	ACC251727 (Hoberg, 1983)	Supplemental (Very highly toxic)
	Chronic	NA	Estimated Chronic **NOAEC = 0.004 µg a.i./L***	NA	No valid chronic study is available
Freshwater invertebrates	Acute	Amphipod *Hyalella azteca* (98.0%)	**96-hr EC_{50} = 0.0019 µg a.i./L** (C.L. 0.0015-0.0021 µg/L)	(Weston & Jackson, 2009)	Supplemental/Quantitative (open literature study) (Very highly toxic)
	Chronic	Water Flea *Daphnia magna* (97%)	21-d NOAEC = 0.0013 µg/L 21-d LOAEC = 0.0029 µg/L	41156501	Acceptable Based on significant effects on reproduction and growth
Freshwater benthic invertebrates	Sub-chronic	Amphipod *Hyalella azteca* TGAI (% a.i. not available)	Based on Pore Water Concs: **10-d NOAEC = 0.17 ng a.i./L** 10-d LOAEC = 0.34 ng a.i./L Based on OC-normalized sediment concs: **10-d NOAEC= 40 µg a.i./kg-$_{OC}$** 10-d LOAEC= 80 µg a.i./kg-$_{OC}$	(Amweg *et al.* 2005)	Supplemental/Quantitative (open literature study) Based on significantly reduced amphipod growth.
Estuarine/ marine fish	Acute	Sheepshead Minnow *Cyprinodon variegatus* 88.35 % a.i.	**96-hr LC_{50} = 17.8 µg a.i./L** (C.L. 14.6-21.1 µg/L)	ACC264646 (Battelle, 1987)	Acceptable (Very highly toxic)
	Chronic	NA	Estimated Chronic **NOAEC = 0.004 µg a.i./L***	NA	No valid chronic toxicity study was submitted

Assessment Endpoint	Acute/ Chronic	Species (% a.i.)***	Toxicity Value Used in Risk Assessment	Citation or MRID # (Author, Date)[1]	Study Classification/ Comment
Estuarine/ marine invertebrates	Acute	Mysid Shrimp *Americamysis bahia* 88.35% a.i.	**96-hr LC_{50} =** **<u>0.00397 µg a.i./L</u>** (C.L. 0.00309-0.00497 µg/L)	ACC264647 (Battelle, 1987)	Acceptable (Very highly toxic)
	Chronic	NA	Estimated Chronic **NOAEC = <u>0.2 ng a.i./L</u>****	NA	No valid chronic toxicity study was submitted
Estuarine/ marine benthic invertebrates	Chronic	Amphipod *Leptocheirus plumulosus* 96.4% purity	Based on Pore Water Concs: **28-d NOAEC =** **<u>0.005 µg a.i./L</u>** Based on OC-normalized Sediment Concs: **28-d NOAEC =** **<u>1220 µg a.i/kg-$_{OC}$</u>**	465915-01	Supplemental Significantly reduced amphipod growth and survival
Aquatic plants	Vascular	NA	NA	NA	No study was submitted.
	Non-vascular	NA	NA	NA	No study was submitted.

1-ECOTOX references are designated with an E followed by the ECOTOX reference number.
<u>Bolded and underlined</u> endpoint values represent the most sensitive values for a given taxa that are used in risk estimation.
***** No acceptable data were submitted or found in the open literature on the chronic toxicity of bifenthrin to freshwater or saltwater fish. The value used is based on the most sensitive chronic NOAEC reported for pyrethroids (tefluthrin; MRID 41705101; See **Appendix J** for details).
******Mysid acute-to-chronic ratio was used to derive this value NOAEC = 0.00397 µg/L / highest ACR among all pyrethroids, using results for mysid species 0.00397 µg/L/18.6 = 0.0002 µg/L = 0.2 ng /L).
*** all test materials are TGAI unless otherwise noted.

Toxicity to fish and aquatic invertebrates is categorized using the system shown in **Table 4.2** (USEPA, 2004). Toxicity categories for aquatic plants have not been defined.

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

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

4.2.1. Toxicity to Freshwater Fish

A summary of the most sensitive acute and chronic freshwater fish toxicity endpoints available for bifenthrin technical grade active ingredient (TGAI), including data from the open literature, is provided below in Sections 4.2.1.a through 4.2.1.c.

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

The most sensitive freshwater fish species to bifenthrin is the rainbow trout *(Oncorhynchus mykiss)*; the LC_{50} is 0.15 µg a.i./L, making bifenthrin very highly toxic to freshwater fish (ACC251727) on an acute exposure basis. No sublethal effects were documented. Although the study authors used a solvent to facilitate dissolution of bifenthrin, it is noted that the LC_{50} exceeds the reported solubility of 0.014 µg a.i./L. Although no precipitates were reported by the study authors, there is uncertainty in the amount of bifenthrin that was bioavailable to fish in this study since samples were not centrifuged prior to analysis.

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

No acceptable or supplemental early life stage or fish full life cycle study for bifenthrin. A fish full life cycle test (OCSPP Guideline 850.1500) using TGAI for bifenthrin was conducted for the fathead minnow *(Pimphales promelas)*. Due to results below performance standards for analytical chemistry and other factors, the study was classified as unacceptable. No other studies were identified (either from the registrant or ECOTOX) for quantifying the chronic toxicity of bifenthrin to freshwater fish.

In absence of chronic toxicity data to freshwater fish, various approaches were considered to bridge this data gap. Typically, chemical-specific acute-chronic ratios (ACRs) are used for bridging chronic toxicity data gaps. For bifenthrin, no chronic NOAECs are available for freshwater or saltwater fish that are considered acceptable for quantitative use. Although ACR values can be calculated with data for other pyrethroids, application of any ACR to the current acute toxicity values for bifenthrin is considered uncertain due to concerns regarding the bioavailability of bifenthrin in these studies (*e.g.*, test concentrations greatly exceed its water solubility).

Therefore, a "read across" approach for bridging the chronic toxicity data gap to freshwater fish was investigated. This approach involved identifying all available chronic NOAECs for fish for other pyrethroid insecticides that were classified as acceptable or supplemental using the EFED Ecotoxicity database. A plot of these data is shown in **Figure 4-1** where red-colored diamonds represent the lowest freshwater and estuarine/marine fish NOAECs among all pyrethroids.

The NOAEC values vary by four orders of magnitude, likely due to differences in pyrethroid potency, fish species exposed, and test design. The most sensitive chronic NOAEC available among the pyrethroids is 0.004 µg a.i./L obtained with tefluthrin from a full life cycle study with fathead minnow (*P. promelas)*. The LOAEC from this study is 0.008 µg a.i./L based on adverse effects on survival. In absence of reliable data on the chronic toxicity of bifenthrin to fish, a conservative approach is taken by selecting the lowest available chronic NOAEC for fish (0.004 µg a.i./L) as a surrogate NOAEC for bifenthrin. Additional details of this bridging approach are provided in **Appendix J**.

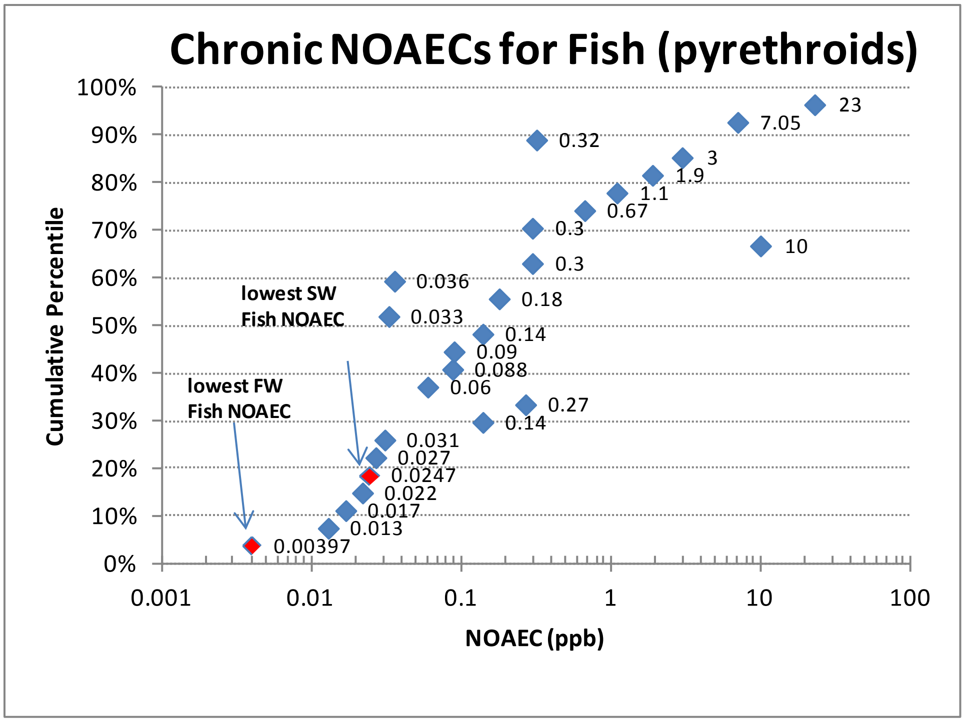


Figure 4-1. Summary of fish chronic NOAEC values for pyrethroids

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

There were no additional acceptable studies from the open literature identified for freshwater fish that did the following: 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 clearly and reasonable 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. Toxicity to Freshwater Invertebrates

A summary of the most sensitive acute and chronic freshwater invertebrate toxicity endpoints available for bifenthrin, including data published in the open literature, is provided below in Sections 4.2.2.a through 4.2.2.c.

4.2.2.a. Freshwater Invertebrates: Acute Exposure Studies

One acceptable study was submitted for *Daphnia magna* with an LC_{50} of 1.6 µg a.i./L making bifenthrin very highly toxic to freshwater invertebrate species (MRID 41156501). Although the study authors used a co-solvent to facilitate dissolution of bifenthrin, it is noted that the LC_{50} exceeds the reported solubility of 0.014 µg/L. Although no precipitates were reported by the study authors, there is uncertainty in the amount of bifenthrin that was bioavailable to *D. magna* in this study since samples were not centrifuged prior to analysis and concentrations greatly exceeded aqueous solubility. No sublethal effects of bifenthrin were documented in this study.

4.2.2.b. Freshwater Invertebrates: Chronic Exposure Studies

One chronic study with the waterflea *(D. magna*) was available for freshwater invertebrates. The full life cycle test yielded a LOAEC of 0.0029 µg a.i./L and a NOAEC of 0.0013 µg a.i./L (MRID 41156501). Toxicity endpoints were based on reductions in length, mean number of young/adult, and an increase in mean time to first brood.

4.2.2.c. Freshwater Invertebrates: Open Literature Data

A search of open literature yielded one study (classified as supplemental, quantitative) with an acute freshwater invertebrate endpoint that is substantially lower than the most sensitive endpoint available based on registrant-submitted studies. In this study, Weston and Jackson (2009) investigated the role of enzymes in potentially reducing the toxicity of organophosphate and pyrethroid insecticides, including bifenthrin to the freshwater amphipod, *Hyalella azteca*. *H. azteca* is known to be much more sensitive to pyrethroids compared to the *D. magna.* The study yielded an EC_{50} of 0.0019 µg a.i /L, categorizing bifenthrin as very highly toxic to freshwater invertebrates on an acute exposure basis. The EC_{50} reflects both mortality and immobilization of amphipods and is considered appropriate for quantitative use.

4.2.3. Toxicity to Estuarine/Marine Fish

A summary of the most sensitive endpoints from acute and chronic estuarine/marine fish studies, 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

One acceptable submitted study examined the acute toxicity of bifenthrin to marine/estuarine fish. In this study, bifenthrin is very highly toxic to the sheepshead minnow (*Cyprinodon variegatus)* with an LC_{50} of 17.5 µg a.i./L (ACC264646). Although the study authors used a co-solvent to facilitate dissolution of bifenthrin, it is noted that the LC_{50} exceeds the reported solubility of 0.014 µg a.i./L. Although no precipitates were reported by the study authors, there is uncertainty in the amount of bifenthrin that was bioavailable to the sheepshead minnow in this study since samples were not centrifuged prior to analysis. No sublethal effects were documented.

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

An estuarine/marine full life cycle test (72-5) using bifenthrin TGAI has not been submitted. As a result, a similar approach was taken to bridging this data gap as described previously for freshwater fish (**Figure 4-1**). With saltwater fish, however, only 5 chronic NOAEC values were available and the lowest value is 0.0247 µg a.i./L (sheepshead minnow; cyfluthrin). Due to the very limited chronic data set for pyrethroids and saltwater fish and the observation of no consistent sensitivity difference between freshwater and saltwater fish chronic toxicity, a conservative approach is taken by selecting the lowest available chronic NOAEC for fish (*i.e.*, tefluthrin full life cycle study with fathead minnow NOAEC of 0.004 µg a.i./L) as a surrogate NOAEC for bifenthrin. Additional details of this bridging approach are provided in **Appendix J**.

4.2.4. Toxicity to Estuarine/Marine Invertebrates

A summary of the most sensitive acute and chronic estuarine/marine invertebrate toxicity 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: Acute Exposure Studies

The most sensitive endpoint for acute toxicity was a study with the mysid shrimp *(Americamysis bahia)*. This acceptable study produced an LC_{50} of 0.00397 µg a.i./L, indicating that bifenthrin is very highly toxic to mysid shrimp (ACC264647) on an acute exposure basis. No sublethal effects were reported. A second study was performed with the embryos and larvae of the Eastern oyster *(Crassostrea virginica)*. This study reported a 48-hour LC_{50} of 0.285 ppm, classifying bifenthrin as highly toxic to the Eastern oyster on an acute exposure basis.

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

An estuarine/marine aquatic invertebrate life-cycle test (Guideline 850.1350) using bifenthrin TGAI has not been submitted. In order to bridge this data gap, ACR values were determined using the mysid shrimp with other pyrethroids. A total of 5 mysid ACR values could be determined for the following pyrethroids: cyfluthrin, *lambda* cyhalothrin, cypermethrin, *beta* cypermethrin, and fenpropathrin. These ACR values range from 1.8 to 18.6. For estimating the chronic toxicity of bifenthrin to estuarine/marine invertebrates, a conservative approach was taken by using the highest observed ACR with mysid shrimp (18.6). The resulting estimated NOAEC is 0.0002 µg ai/L (bifenthrin acute EC_{50} of 0.00397 µg a.i./L/18.6 = 0.0002 µg a.i./L = 0.2 ng a.i./L). Additional details of this bridging approach are provided in **Appendix J**.

Table 4-3. Mysid shrimp acute-chronic ratios for pyrethroids

Pyrethroid	NOAEC (µg ai/L)	Acute EC/LC_{50} (µg ai/L)	ACR	MRID or Acc. No. (acute, chronic)
Cyfluthrin	0.00017	0.00242	14.2	40069501, 00158785
Lambda-Cyhalothrin	0.00022	0.0041	**18.6**	00151729 073989
Tralomethrin	0.00051	--	--	00162969
Cypermethrin	0.00078	0.005	6.4	42444601, 42725301
Beta-Cypermethrin	0.0015	0.0059	3.9	44561209, 44546035
Fenpropathrin	0.012	0.021	1.8	40974404, 40974407

4.2.5. Toxicity to Aquatic Plants

Aquatic plant toxicity studies are used as one of the measures of effect to evaluate whether bifenthrin 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. Aquatic plant testing (EC_{50} Aquatic Plant Test: Guideline; Tier I) is required for bifenthrin but has not been submitted.

For aquatic plants, there are a variety of studies available for other pyrethroids with marine diatom, green algae and duckweed (**Table 4-4).** Of the 11 acceptable or supplemental study endpoints available in the EFED Ecotoxicity database, only 2 are definitive values (92 µg a.i./L for permethrin and 15,000 ppb for *gamma* cyhalothrin). The remaining nine toxicity endpoints were non-definitive (*i.e.,* > values) because sufficient effects were not observed at the highest test concentration from which to derive an EC_{50}. In general, these data suggest that aquatic plants are not nearly as sensitive to pyrethroids as the aquatic invertebrates described earlier, although the data are still quite limited in terms of numbers of species and chemicals tested.

Table 4-4. Aquatic plant toxicity data for pyrethroids

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

* formerly *Selenastrum capricornutum*

4.2.6. Aquatic Field/Mesocosm Studies

Given the high aquatic toxicity of bifenthrin, a field study on the effects of bifenthrin in an outdoor pond was conducted and submitted to the Agency (Sherman, 1989; EPA Accession No 409818- 01). This study consisted of a single treatment pond and single control pond monitored during baseline and treatment years. Bifenthrin was applied as Capture 2.0 EC (0.1 lb ai/A) on each of 10 consecutive Monday mornings starting June 16 and ending August 18, 1986. Pesticide was applied using standard aerial application practices limited to the crop areas of the field (50 acres of cotton) and not to be sprayed directly onto the pond. A 5 meter buffer strip of grasses was established between the pond edge and the cotton crop. lights were conducted only when wind speed was not greater than 2 mph. Deposition cards were placed on the pond and field each spray day to determine the amount of pesticide leaching the field or pond surface. Residues were measured in pond water, runoff water, sediment, soil and biota through August the following year (1987). At the time of the first application (June 16, 1986) drift inadvertently introduced bifenthrin directly into the pond.

A summary of results from this study indicates:

1. Bifenthrin concentration in runoff water ranged from 0.7 ppb to 3.15 ppb. Average residues in the sediment portion of runoff ranged from 80 ppb to 5250 ppb.
2. Average residues during the pond water from the treated pond ranged from 0.00195 ppb to 0.0179 ppb, peaking after treatment six.
3. Average residues ranged from 2.32 ppb to 52.4 ppb during the treatment period, peaking after treatment ten. However, during 14 post-treatment sampling, average residues ranged from 9.86 ppb to 60.1 ppb.
4. During the treatment period, bifenthrin residues in live samples ranged from a low of 0.22 ppb for a mussel sample taken immediately after the first treatment to a high of 133 ppb for a bluegill sunfish collected after the eighth treatment.
5. More than 1600 gizzard shad (almost the entire population) died the winter following application; all tested had high concentrations of bifenthrin residues in their tissue. Other fish kills were observed in the treated pond and are tabulated as follows: a) shad, 2; b) carp, 2; c) crappie, 13; d) Large-mouth bass, 3; e) catfish, 1; f) bluegill sunfish, 16; and g) spotted gar, 3.

4.3. Toxicity of Bifenthrin to Terrestrial Organisms

Table 4-5 summarizes the most sensitive terrestrial toxicity endpoints, based on an evaluation of both the submitted studies and the open literature. A brief summary of submitted and open literature data considered relevant to this ecological risk assessment is presented below. Additional information is provided in **Appendix F**.

Table 4-5. Terrestrial Toxicity Profile for Bifenthrin

Endpoint	Acute/ Chronic	Species (% a.i.)*	Toxicity Value Used in Risk Estimation	Citation MRID/ ECOTOX reference No.	Study Classification/ Comments
Birds (surrogate for terrestrial-phase amphibians and reptiles)	Acute	Bobwhite Quail *Colinus virginianus* 88.35% a.i.	21-d LD_{50} = **1800 mg/kg bw** (C.I. 1250-1592 mg/kg bw, slope = 3.52)	ACC251727 (Fletcher, 1984)	Acceptable Slightly toxic
	Sub-acute	Mallard Duck *Anas platyrhynchos* 88.35 % a.i.	8-d Dietary LC_{50} = **1280 mg/kg bw**	ACC251727 (Fletcher, 1984)	Supplemental Slightly toxic

Endpoint	Acute/ Chronic	Species (% a.i.)*	Toxicity Value Used in Risk Estimation	Citation MRID/ ECOTOX reference No.	Study Classification/ Comments
	Chronic	Bobwhite Quail *Colinus virginianus* 88.35 % a.i.	168-d NOAEC **= 75 ppm-diet**	ACC264644 (Huntington, 1987)	Acceptable No treatment-related effects at highest test concentration
Mammals	Acute	Rat *Rattus norvegicus* 91.4% a.i.	LD_{50} = **53.8 mg/kg bw**	00132519	Acceptable Moderately toxic
	Chronic	Rat *Rattus norvegicus* 88.35% a.i.	NOAEC **= 30 ppm-diet (NOAEL = 1.5 mg/kg-bw/d)** LOAEC = 60 ppm	00005336	Acceptable. Female rats showed a significant decrease in body weight during lactation and gestation
Terrestrial invertebrates	Acute Contact	Honey bee *Apis mellifera* 0.8 % EC	96-hr LD_{50} = 0.015 µg/L	(Atkins, 1981)	Acceptable Very highly toxic
Terrestrial plants	n/a	Seedling Emergence Monocots	NA	NA	No terrestrial plant toxicity studies have been submitted
	n/a	Seedling Emergence Dicots	NA	NA	No terrestrial plant toxicity studies have been submitted
	n/a	Vegetative Vigor Monocots	NA	NA	No terrestrial plant toxicity studies have been submitted
	n/a	Vegetative Vigor Dicots	**NA**	NA	No terrestrial plant toxicity studies have been submitted

n/a: not applicable; ND = not determined; bw = body weight
* all test materials are TGAI unless otherwise noted.

Acute toxicity to terrestrial animals is categorized using the classification system shown in **Table 4-6** (USEPA, 2004). Toxicity categories for terrestrial plants have not been defined.

Table 4-6. Categories of Acute Toxicity for Avian and Mammalian Studies

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

4.3.1. Toxicity to Birds

As specified in the Overview Document, the Agency uses birds as a surrogate for reptiles and terrestrial-phase amphibians when toxicity data for each specific taxon are not available (USEPA, 2004). A summary of the most sensitive endpoints from acute and chronic toxicity data to birds, including data published in the open literature is provided below in **Section 4.3.1.a** and **Section 4.3.1.b**.

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

Two acceptable, avian acute oral toxicity studies were submitted to the Agency. One study conducted with a mallard duck (*Anas platyrhynchos*) yielded an LD_{50} of 2150 mg a.i./kg (ACC251727). The other study, conducted with a bobwhite quail (*Colinus virginianus*), yielded an LD_{50} of 1800 mg/kg (ACC251727) showing bifenthrin to be slightly toxic to birds on an acute oral exposure basis. No data are currently available for passerine species, although such data have been recommended as part of Registration Review for bifenthrin. In a test with formulated beta cyfluthrin, Addy-Orduna et al. (2011) reported that the canary (*Serinus sp.)* was 13 times more sensitive on an acute exposure basis compared to two non-passerine species (shiny cowbirds, *Molothrus bonariensis* and eared doves (*Zenaida auriculata*). No sublethal effects were reported in either of these studies.

Two subacute dietary studies were also performed to establish an LC_{50} for bifenthrin. The most sensitive endpoint (8-d LC_{50} of 1,280 ppm; ACC251727) was derived from a mallard duck (*Anas platyrhynchos.* The other study was conducted with bobwhite quail (*Colinus virginianus)* and produced an 8-d LC_{50} of 4,450 ppm (ACC251727). Therefore, bifenthrin is classified as slightly toxic to birds on a subacute dietary exposure basis. No sublethal effects were reported in either of these studies.

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

There is one reproductive study available each for both the bobwhite quail and the mallard duck. Bifenthrin showed no adverse effects on reproduction up to and including the highest concentration tested (NOAEC = 75 mg/kg diet, ACC264644). In the study conducted with the bobwhite quail (MRID ACC264645), the same NOAEC of 75 ppm was found but there was a slight increase in the number of damaged eggs at bifenthrin concentrations of 50 ppm and 75 ppm at 12% and 10%, respectively, as compared to 9% in the control group (ACC264644). Although these increases were found to be statistically significant, they were not interpreted as having an adverse consequence on reproductive success.

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 I**, which is a copy of the Health Effects Division (HED) Bifenthrin Human Health Assessment Scoping Document in Support of Registration Review and Toxicology Data Needs Update.

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

The acute oral toxicity LD_{50} of bifenthrin was determined to be 53.8 mg/kg in female rats (*Rattus norvegicus)* and 70.1 mg/kg in male rats, categorizing bifenthrin as moderately toxic to mammals on an acute oral exposure basis (MRID 00132519). Clinical signs of toxicity observed in the study were clonic convulsions, tremors, ataxis, loss of muscle control, decreased activity, chromorhinorrhea (pigmented discharge from the nose), chromodacyorrhea (pigmented discharge from the eyes) and oral discharge. Sublethal effects included weight gain in the surviving organisms over the course of the study.

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

A two-generation reproduction study performed on rats (*R. norvegicus)* is available. The NOAEC was determined to be 30 ppm and the LOAEC was determined to be 60 ppm (MRID 00157225). It was found that dietary exposure to 100 ppm causes tremors in female rats during lactation and in the 2- week period following lactation. Females exposed to 60 ppm and 100 ppm bifenthrin respectively, showed noticeably lower mean body weights than controls, an effect that was determined to be treatment related. Females dosed at 30 ppm, had a lower mean ovarian weight than their controls; this was accompanied by a dose-related trend through all of the higher groups. For ecological risk assessment, a LOAEC of 60 ppm was determined based on the dose-related lower weights in females during the first and second lactation periods as well as for the second gestation period. Other effects included significantly decreased mean absolute ovarian weights at 60 ppm and 100 ppm. Reproductive parameters were not affected at the highest dose level nor was there evidence of fetal toxicity.

4.3.3. Toxicity to Terrestrial Invertebrates

Bifenthrin is highly toxic to young adult honey bees (*Apis mellifera*) on an acute contact exposure basis, with a 48-h LD_{50} of 0.015 µg a.i./bee. Available data from the open literature were available for numerous species (**Appendix G**); however, most were field studies on the efficacy of bifenthrin in relation to crop yields. Of the limited number of acute dose-response studies available for selected beetles (*Coleoptera spp.*) and moths (*Lepidoptera spp.*), none provide acute toxicity endpoints that were lower than the honey bee on an µg a.i./g organism basis. Specifically, an LD_{50} of 0.018 µg/organism was reported for the most sensitive beetle tested (Bluegrass weevil, *Listronotus maculicollis*) and the most sensitive Lepidoptera tested (Striped riceborer, *Chilo suppressalis*) (**Appendix H**). Due to the smaller body weights of these organisms compared to the honey bee, the acute contact LD_{50} value is higher on an µg a.i./g organism basis. Therefore, the toxicity endpoint for honey bee was selected for evaluating acute risk to terrestrial invertebrates.

4.3.4. Toxicity to Terrestrial Plants

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

4.4. Toxicity of Chemical Mixtures

As previously discussed, the results of available toxicity data for mixtures of bifenthrin with other pesticides are presented in **Appendix A**. Based on a qualitative evaluation of the best available data and the Agency's existing guidance, it is reasonable to conclude that some formulations or tank mixes may exhibit a synergistic effect in some instances (*e.g.*, tank mixing bifenthrin with PBO). 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 those instances. However, the limited size of the data set and the variation in co-formulated pesticides prohibits any definitive conclusions. Analysis of the available open literature and acute oral mammalian LD_{50} data for multiple active ingredient products relative to the single active ingredient is provided in **Appendix A**. This data set is limited and a qualitative analysis does not support any broad conclusions about the interactive nature of bifenthrin in combination with other pesticides. Consequently, an assessment of bifenthrin potential effect when it is co-formulated with other active ingredients will be based on the toxicity of bifenthrin.

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 contained in the Incident Data System (IDS), and the Avian Monitoring Information System (AIMS) for ecological incidents involving bifenthrin was completed on November 1, 2012. AIMS did not report any incidents in relation to avian species. IDS reported 34 minor fish and wildlife incidents and 5,635 plant incidents. The results of this review for terrestrial, plant, and aquatic incidents are discussed below in Sections 4.5.1 through 4.5.3. A complete list of the incidents involving bifenthrin including associated uncertainties is included as **Appendix K.**

4.5.1. Terrestrial Incidents

The EIIS database has records for four terrestrial incidents, three involving honey bees and one involving leafcutter bees. Dates of these incidents ranged from 1992 to 2012. Three of the incidents were classified as 'probable' and one was listed as 'possible.' The magnitude of damage was unknown for two incidents but classified as 'probable' for these incidents. In the most recent incident involving honey bees (2012), a reported reduction in 50% of worker bees after a reported use on cotton (legality = unknown; causality = probable). In 2007, a loss of 61 hives was reported after use on alfalfa (legality = unknown; causality = possible). Only one of the incidents, resulting in an unknown number of dead bees, was documented as a registered use.

4.5.2. Plant Incidents

The EIIS database has records for four terrestrial plant incidents which occurred from 1999 to 2011. The incidents were reported to involve peanuts, cherry, laurel and roses. Only one incident was classified as 'probable;' the incident involved a residential, registered use on roses. The other three incidents were classified as 'possible.' The IDS reported a total of 5,635 minor incidents involving plants, the vast majority of these involved application of "Turf Builder with Summerguard®" was involved in 3,605 plant incidents and "Lawn Pro Step 3®" was involved in 2,489 plant incidents.

4.5.3. Aquatic Incidents

The EIIS database has records for five aquatic incidents from 1993 to 2006, all of which involve fish mortality. The incidents involved catfish (*Ictalurus spp.*), fathead minnows, trout, bull heads (*Ameiurus spp*) and koi (*Cyprinus carpio*). Two incidents did not report which species of fish were affected. Two of the incidents were classified as 'highly probable' and were the result of a registered use in compliance with the label; the magnitude of these incidents was 400 and 500-1,000 individuals. The other three incidents were classified as 'probable.' One was a result of a misuse resulting in death of a small number of organisms. Another incident involved a registered use with an unknown magnitude affected. The final incident resulted in the death of 25 catfish; however, it is unknown if the product was applied according to the label.

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 bifenthrin 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 acute and chronic risk levels of concern (LOCs) for each category evaluated (**Appendix C**). For acute exposures to the listed aquatic animals, as well as terrestrial invertebrates, the LOC is 0.05. For acute exposures to the birds (and, thus, reptiles and terrestrial-phase amphibians) and mammals, the acute risk to listed species LOC is 0.1. The LOC for chronic risk to animals, as well as acute risk to plants is 1.0.

5.1.1. Exposures in the Aquatic Habitat

5.1.1.a. Freshwater Fish and Aquatic-phase Amphibians

Acute risk to fish and 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 (*O. mykiss* 96-hr LC_{50}=0.15 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=0.004 µg/L). Risk quotients for freshwater fish are shown in **Table 5-1**. Acute RQs ranged from **<0.01 to 0.09** and chronic RQs ranged from **0.01 to 3.50** (3.50 corresponds to the RQ for those EECs that were capped at the limit of solubility of bifenthrin). Ninety-five percent of the bifenthrin uses exceeded the acute risk to listed species LOC (0.05) and 89% exceeded the chronic risk to listed species LOC (1). Therefore, bifenthrin 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. The EECs from PRZM/EXAMS in most instances exceeded this limit.

As discussed in **Section 6.1.2**, some of the available solubility studies suggest a solubility limit of <0.1 ppb for bifenthrin (*e.g.*, MRID 46937802). In order to get an upper bound estimate of the potential RQs, it was also assumed that the limit of solubility was 0.1 ppb. It is noted for example, that when the nursery scenario was run, assuming pressure liquid applications, the resulting peak EEC was 3.00 ppb, and the 21-day EEC was 0.549 ppb, and the 60-day EEC was 0.474 ppb. If the limit of solubility is assumed to be 0.1 ppb, the acute RQ is 0.67 and the chronic RQ is 25. The concentration of bifenthrin in water may be above the limit of solubility if the chemical is sorbed to suspended matter/ particulate or dissolved organic carbon. The fraction that is bioavailable, however, is likely near the limit of solubility. The uncertainties related to the value of solubility of bifenthrin are discussed in **Section 6.1.2**.

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

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*
Alfalfa, Clover	0.1x5	Aerial	0.014	0.014	**0.09**	**3.50**
Tree nut crops	0.18x3	Aerial	0.014	0.014	**0.09**	**3.50**
Tree nut crops	0.18x3	Ground	0.014	0.014	**0.09**	**3.50**
Tree nuts	0.4x1	Granular	0.014	0.014	**0.09**	**3.50**
Citrus crops	0.5x1	Ground	0.014	0.014	**0.09**	**3.50**
Head and Stem Brassica Vegetables	0.1x5	Aerial	0.014	0.014	**0.09**	**3.50**
Head and Stem Brassica Vegetables	0.1x5	Granular	0.014	0.014	**0.09**	**3.50**
Corn, Sweet corn	0.1x1	Granular	0.014	0.014	**0.09**	**3.50**
Corn	0.1x3	Aerial	0.014	0.014	**0.09**	**3.50**
Sweet corn	0.1x2	Aerial	0.014	0.014	**0.09**	**3.50**
Cotton	0.1x5	Aerial	0.014	0.014	**0.09**	**3.50**
Pears, Mayhaw, Fruits (unspecified)	0.167x3	Aerial	0.014	0.014	**0.09**	**3.50**
Fruits (unspecified), Small Fruits (unspecified)	0.2x2	Ground	0.014	0.0123	**0.09**	**3.08**
Deciduous Fruits, Apple, Stone Fruits	0.21x1	Ground	0.014	0.00663	**0.09**	**1.66**
Deciduous Fruits, Apple, Stone Fruits	0.4x1	Granular	0.014	0.00364	**0.09**	0.91
Grapes	0.1x1	Aerial	0.014	0.0104	**0.09**	**2.60**
Lettuce, Leafy petiole vegetables	0.1x5	Aerial	0.014	0.014	**0.09**	**3.50**
Lettuce	0.1x2	Granular	0.014	0.014	**0.09**	**3.50**

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*
Spinach	0.1x4	Aerial	0.014	0.014	**0.09**	**3.50**
Cucurbit vegetables	0.1x3	Aerial	0.014	0.014	**0.09**	**3.50**
Cucurbit vegetables	0.1x3	Granular	0.014	0.00230	**0.09**	0.58
Tuberous and corm vegetables	0.3 at plant, then 0.1x2	Aerial	0.014	0.014	**0.09**	**3.50**
Tuberous and corm vegetables	0.3 at plant	Granular	0.014	0.0107	**0.09**	**2.68**
Root Crops	0.1x5	Ground	0.014	0.014	**0.09**	**3.50**
Artichokes	0.1x5	Aerial	0.014	0.014	**0.09**	**3.50**
Peppers (bell and non-bell); and Succulent Peas and Beans	0.1x2	Aerial	0.014	0.014	**0.09**	**3.50**
Dried peas and beans	0.1x1	Ground	0.014	0.0109	**0.09**	**2.73**
Succulent peas and beans; Dried beans	0.1x1	Granular	0.014	0.014	**0.09**	**3.50**
Peppers (bell and non-bell)	0.1x2	Granular	0.014	0.014	**0.09**	**3.50**
Agricultural crops/ soils	0.0832x3	Ground	0.014	0.014	**0.09**	**3.50**
Strawberry	0.167x3	Aerial	0.014	0.014	**0.09**	**3.50**
Strawberry	0.167x3	Ground	0.014	0.014	**0.09**	**3.50**
Beets, garden beets	0.1x4	Aerial	0.014	0.014	**0.09**	**3.50**
Tomato and tomatillo, Eggplant, Ground cherry, Pepino	0.1x2	Aerial	0.014	0.014	**0.09**	**3.50**
Eggplant	0.1x2	Granular	0.014	0.00432	**0.09**	**1.08**
Canola, rapeseed, crambe	0.04x2	Aerial	0.014	0.014	**0.09**	**3.50**
Canola, rapeseed, crambe	0.04x2	Granular	0.014	0.014	**0.09**	**3.50**
Caneberries	0.1x2	Aerial	0.014	0.014	**0.09**	**3.50**
Bushberries	0.1x5	Aerial	0.014	0.014	**0.09**	**3.50**
Hops	0.1x3	Aerial	0.014	0.014	**0.09**	**3.50**
Herbs & Spices (OR mint)	0.4x1	Granular	0.014	0.014	**0.09**	**3.50**
Herbs & Spices (CA nursery)	0.4x1	Granular	0.014	0.014	**0.09**	**3.50**
Forest Trees - conifers; Conifers (plantations/ nurseries); Conifers (seed orchard)	0.205x3	Ground	0.014	0.014	**0.09**	**3.50**
Forest Trees - unspecified, softwoods	0.1058x3	Ground	0.014	0.014	**0.09**	**3.50**
Christmas tree plantations	0.2x1	Ground	0.014	0.014	**0.09**	**3.50**
Christmas tree plantations	0.4x1	Granular	0.014	0.014	**0.09**	**3.50**
Nursery stock	0.1x1	Drench	0.014	0.014	**0.09**	**3.50**
Mulch, Potting Soil/Top Soil	0.211x1	Granular	0.014	0.014	**0.09**	**3.50**
Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.3x3	Ground	0.014	0.014	**0.09**	**3.50**

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*
Nursery stock plus Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.4x1	Granular	0.014	0.014	**0.09**	**3.50**
Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.95x1	Pressure liquid	0.014	0.014	**0.09**	**3.50**
Roses	0.1x1	Ground	0.014	0.014	**0.09**	**3.50**
Sod farms, ornamental sod farms	0.2x2	Aerial	0.014	0.014	**0.09**	**3.50**
Sod farms, ornamental sod farms	0.4x1	Granular	0.014	0.014	**0.09**	**3.50**
Agricultural Right-of-Ways/ Fencerows/ Hedgerows	0.21x1	Ground	0.014	0.014	**0.09**	**3.50**
Non-agricultural uncultivated areas (soils); Livestock/ Livestock Feed Lots, Poultry Feedlots/ Poultry Processing Plant Premises (non-food contact), Poultry Litter	0.167x3	Ground	0.014	0.014	**0.09**	**3.50**
Non-agricultural uncultivated areas (soils)	0.167x3	Granular	0.014	0.014	**0.09**	**3.50**
Golf course turf	0.2x1	Ground	0.014	0.00667	**0.09**	**1.67**
Golf Course Turf plus Ornamental Grasses; Ornamental Lawns and Turf; Ornamental Sod Farms; Recreational Areas; Recreational Area Lawns	0.4x1	Granular	0.014	0.00653	**0.09**	**1.63**
Ornamental Grasses; Ornamental Lawns and Turf; Ornamental Sod Farms; Recreational Areas; Recreational Area Lawns	0.232x2	Ground	0.014	0.014	**0.09**	**3.50**
Airports/ Landing Fields	0.0096x1	Perimeter treatment, directed spray	0.00687	7.93×10^{-4}	**0.05**	0.20
Paths/Patios	0.369x1	Perimeter treatment	0.014	0.014	**0.09**	**3.50**
Residential Lawns; Commercial/ Industrial Lawns, plus Paths/ Patios, plus Urban Areas, Wide Area/ General Outdoor Treatment (Public Health Use)	0.06x2	Ground	0.014	0.00679	**0.09**	**1.70**
	0.06x6	Ground	0.014	0.0123	**0.09**	**3.08**
Residential lawns	0.00735x1	Granular	1.29×10^{-4}	3.49×10^{-5}	<0.01	0.01
Residential lawns	0.0634x1	Perimeter treatment	0.014	0.00522	**0.09**	**1.31**
	0.0634x6	Perimeter treatment	0.014	0.0130	**0.09**	**3.25**

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*
Animal Feedlots, Animal Housing Premises, Animal Kennel (Sleeping Quarters), Pet Living/ Sleeping Quarters	0.0038x2	Various[39]	0.00345	4.33×10^{-4}	<0.01	0.11
Urban and rural structures and buildings (as shown in the footnote[40]), plus the following: Farm Premises (Agricultural), Barnyards/ Auction Barns, Seed Houses/ Stores/Storage Areas/ Warehouses	0.969x1	Barrier treatment	0.014	0.014	**0.09**	**3.50**
Urban and rural structures and buildings (as shown in the footnote)	0.0421x1	Granular/ Bait solid	7.01×10^{-4}	2.04×10^{-4}	<0.01	0.05
Urban and rural structures and buildings (as shown in the footnote)	9.44x1	Various[41]	0.014	0.014	**0.09**	**3.50**
Urban and rural structures and buildings (as shown in the footnote)	0.00125x1	Various[42]	0.014	0.00804	**0.09**	**2.01**
Urban and rural structures and buildings (as shown in the footnote)	0.00244x2	Soil treatment (trenching)	0.014	0.00471	**0.09**	**1.18**
Farm Premises (Agricultural), Barnyards/ Auction Barns, Seed Houses/ Stores/Storage Areas/ Warehouses	0.0317x2	Ground[43]	0.014	0.00491	**0.09**	**1.23**
Wood Protection Treatment to Buildings/ Products (Outdoors)	1.59×10^{-4}x2	Ground	0.014	0.014	**0.09**	**3.50**
Wood Protection Treatment to Buildings/ Products (Outdoors)	0.0287x1	Ground (void treatment)	0.014	0.014	**0.09**	**3.50**
Right-of-Way	0.021x1	Ground	0.014	0.00213	**0.09**	0.53
Right-of-Way	0.0167x3	Granular	0.00513	0.00157	0.03	0.39
Paved Areas (Private Roads/ Sidewalks)	0.38x1	Perimeter treatment	0.014	0.014	**0.09**	**3.50**
Refuse/Solid Waste Sites (outdoors)	0.23x1	Various[44]	0.014	0.014	**0.09**	**3.50**
Utilities, Utility Poles/Rights-of-Way	2.2x1	Perimeter treatment	0.014	0.014	**0.09**	**3.50**
Utility Poles/Rights-of-Way	0.1x1	Granular	0.014	0.00396	**0.09**	0.99

[39] Spot treatment, crack & crevice, directed spray, outdoor general surface spray, wall treatment, brush on
[40] May include various types of facilities: 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)/Diary Farm Milk Storage Rooms/Houses/Sheds/ Eating Establishments (food and non-food areas)/Egg Handling Rooms/Egg Packing Plants (Commercial)/Feed Mills/Feed Processing Plants/ Food/Grocery/Marketing/ Storage/Distribution Facility Premise/Food Processing Plant Equipment (food contact)/(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/ Public Buildings/Structures/ Storage Areas (empty or full).
[41] Outdoor general surface spray, perimeter treatment, space spray
[42] Crack & crevice, brush on, void treatment, foam application
[43] Spot treatment, crack & crevice, directed spray, perimeter treatment
[44] Perimeter treatment, general surface spray

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*

* = LOC exceedances (acute RQ ≥ 0.05; chronic RQ ≥ 1.0, for listed species) are bolded and shaded. Acute RQ = use-specific peak EEC / 0.15 ppb [for rainbow trout, *Oncorhynchus mykiss*]. Chronic RQ = use-specific 60-day EEC / 0.004 ppb [estimated chronic NOAEC reported for pyrethroids (tefluthrin; MRID 41705101)].

5.1.1.b. Freshwater 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 (*H. azteca* 96-hr EC_{50} = 0.0019 µg/L). Chronic risk is based on 1-in-10 year average 21-day EECs and the lowest chronic toxicity value for freshwater invertebrates (*H. azteca* 10-day NOAEC = 0.00017 µg/L). Risk quotients for freshwater invertebrates are shown in **Table 5-2**. Risk quotients for freshwater invertebrates range from **0.07 to 7.37** (acute) and from **0.22 to 82.35** (chronic). The highest RQs were observed for EECs that were capped at the limit of solubility of bifenthrin. Acute risk to listed (LOC = 0.05), and non-listed species (LOC = 0.5) LOCs are exceeded for all bifenthrin uses. The chronic risk to listed and non-listed LOC (LOC = 1) is exceeded for all but one (99%) of the scenarios. Therefore, there is the potential for bifenthrin 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**).

As discussed in **Section 6.1.2**, some of the available solubility studies suggest a solubility limit of <0.1 ppb for bifenthrin (*e.g*., MRID 46937802. In order to get an upper bound estimate of the possible RQs, it was also assumed that the limit of solubility was 0.1 ppb. If the limit of solubility is assumed to be 0.1 ppb, the acute RQ is 52.6 and the chronic RQ is 588. The concentration of bifenthrin in water may be above the limit of solubility if the chemical is sorbed to suspended matter/ particulate or dissolved organic carbon. The fraction that is bioavailable, however, is likely near the limit of solubility. The uncertainties related to the value of solubility of bifenthrin are discussed in **Section 6.1.2**.

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

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*
Alfalfa, Clover	0.1x5	Aerial	0.014	0.014	**7.37**	**82.35**
Tree nut crops	0.18x3	Aerial	0.014	0.014	**7.37**	**82.35**
Tree nut crops	0.18x3	Ground	0.014	0.014	**7.37**	**82.35**
Tree nuts	0.4x1	Granular	0.014	0.014	**7.37**	**82.35**
Citrus crops	0.5x1	Ground	0.014	0.014	**7.37**	**82.35**
Head and Stem Brassica Vegetables	0.1x5	Aerial	0.014	0.014	**7.37**	**82.35**
Head and Stem Brassica Vegetables	0.1x5	Granular	0.014	0.014	**7.37**	**82.35**
Corn, Sweet corn	0.1x1	Granular	0.014	0.014	**7.37**	**82.35**
Corn	0.1x3	Aerial	0.014	0.014	**7.37**	**82.35**

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*
Sweet corn	0.1x2	Aerial	0.014	0.014	**7.37**	**82.35**
Cotton	0.1x5	Aerial	0.014	0.014	**7.37**	**82.35**
Pears, Mayhaw, Fruits (unspecified)	0.167x3	Aerial	0.014	0.014	**7.37**	**82.35**
Fruits (unspecified), Small Fruits (unspecified)	0.2x2	Ground	0.014	0.014	**7.37**	**82.35**
Deciduous Fruits, Apple, Stone Fruits	0.21x1	Ground	0.014	0.014	**7.37**	**10.77**
Deciduous Fruits, Apple, Stone Fruits	0.4x1	Granular	0.014	0.00456	**7.37**	**26.82**
Grapes	0.1x1	Aerial	0.014	0.014	**7.37**	**82.35**
Lettuce, Leafy petiole vegetables	0.1x5	Aerial	0.014	0.014	**7.37**	**82.35**
Lettuce	0.1x2	Granular	0.014	0.014	**7.37**	**82.35**
Spinach	0.1x4	Aerial	0.014	0.014	**7.37**	**82.35**
Cucurbit vegetables	0.1x3	Aerial	0.014	0.014	**7.37**	**82.35**
Cucurbit vegetables	0.1x3	Granular	0.014	0.00270	**7.37**	**19.29**
Tuberous and corm vegetables	0.3 at plant, then 0.1x2	Aerial	0.014	0.014	**7.37**	**82.35**
Tuberous and corm vegetables	0.3 at plant	Granular	0.014	0.0133	**7.37**	**78.24**
Root Crops	0.1x5	Ground	0.014	0.014	**7.37**	**82.35**
Artichokes	0.1x5	Aerial	0.014	0.014	**7.37**	**82.35**
Peppers (bell and non-bell); and Succulent Peas and Beans	0.1x2	Aerial	0.014	0.014	**7.37**	**82.35**
Dried peas and beans	0.1x1	Ground	0.014	0.0125	**7.37**	**73.53**
Succulent peas and beans; Dried beans	0.1x1	Granular	0.014	0.014	**7.37**	**82.35**
Peppers (bell and non-bell)	0.1x2	Granular	0.014	0.014	**7.37**	**82.35**
Agricultural crops/ soils	0.0832x3	Ground	0.014	0.014	**7.37**	**82.35**
Strawberry	0.167x3	Aerial	0.014	0.014	**7.37**	**82.35**
Strawberry	0.167x3	Ground	0.014	0.014	**7.37**	**82.35**
Beets, garden beets	0.1x4	Aerial	0.014	0.014	**7.37**	**82.35**
Tomato and tomatillo, Eggplant, Ground cherry, Pepino	0.1x2	Aerial	0.014	0.014	**7.37**	**82.35**
Eggplant	0.1x2	Granular	0.014	0.00500	**7.37**	**29.41**
Canola, rapeseed, crambe	0.04x2	Aerial	0.014	0.014	**7.37**	**82.35**
Canola, rapeseed, crambe	0.04x2	Granular	0.014	0.014	**7.37**	**82.35**
Caneberries	0.1x2	Aerial	0.014	0.014	**7.37**	**82.35**
Bushberries	0.1x5	Aerial	0.014	0.014	**7.37**	**82.35**
Hops	0.1x3	Aerial	0.014	0.014	**7.37**	**82.35**
Herbs & Spices (OR mint)	0.4x1	Granular	0.014	0.014	**7.37**	**82.35**
Herbs & Spices (CA nursery)	0.4x1	Granular	0.014	0.014	**7.37**	**82.35**
Forest Trees - conifers; Conifers (plantations/ nurseries); Conifers (seed orchard)	0.205x3	Ground	0.014	0.014	**7.37**	**82.35**
Forest Trees - unspecified, softwoods	0.1058x3	Ground	0.014	0.014	**7.37**	**82.35**
Christmas tree plantations	0.2x1	Ground	0.014	0.014	**7.37**	**82.35**

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*
Christmas tree plantations	0.4x1	Granular	0.014	0.014	**7.37**	**82.35**
Nursery stock	0.1x1	Drench	0.014	0.014	**7.37**	**82.35**
Mulch, Potting Soil/Top Soil	0.211x1	Granular	0.014	0.014	**7.37**	**82.35**
Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.3x3	Ground	0.014	0.014	**7.37**	**82.35**
Nursery stock plus Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.4x1	Granular	0.014	0.014	**7.37**	**82.35**
Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.95x1	Pressure liquid	0.014	0.014	**7.37**	**82.35**
Roses	0.1x1	Ground	0.014	0.014	**7.37**	**82.35**
Sod farms, ornamental sod farms	0.2x2	Aerial	0.014	0.014	**7.37**	**82.35**
Sod farms, ornamental sod farms	0.4x1	Granular	0.014	0.014	**7.37**	**82.35**
Agricultural Right-of-Ways/ Fencerows/ Hedgerows	0.21x1	Ground	0.014	0.014	**7.37**	**82.35**
Non-agricultural uncultivated areas (soils); Livestock/ Livestock Feed Lots, Poultry Feedlots/ Poultry Processing Plant Premises (non-food contact), Poultry Litter	0.167x3	Ground	0.014	0.014	**7.37**	**82.35**
Non-agricultural uncultivated areas (soils)	0.167x3	Granular	0.014	0.014	**7.37**	**82.35**
Golf course turf	0.2x1	Ground	0.014	0.00902	**7.37**	**53.05**
Golf Course Turf plus Ornamental Grasses; Ornamental Lawns and Turf; Ornamental Sod Farms; Recreational Areas; Recreational Area Lawns	0.4x1	Granular	0.014	0.00836	**7.37**	**49.18**
Ornamental Grasses; Ornamental Lawns and Turf; Ornamental Sod Farms; Recreational Areas; Recreational Area Lawns	0.232x2	Ground	0.014	0.014	**7.37**	**82.35**
Airports/ Landing Fields	0.0096x1	Perimeter treatment, directed spray	0.00687	9.73×10^{-4}	**3.62**	**5.72**
Paths/Patios	0.369x1	Perimeter treatment	0.014	0.014	**7.37**	**82.35**
Residential Lawns; Commercial/	0.06x2	Ground	0.014	0.00770	**7.37**	**45.29**

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*
Industrial Lawns, plus Paths/ Patios, plus Urban Areas, Wide Area/ General Outdoor Treatment (Public Health Use)	0.06x6	Ground	0.014	0.0137	**7.37**	**80.59**
Residential lawns	0.00735x1	Granular	1.29×10^{-4}	3.72×10^{-5}	**0.07**	0.22
Residential lawns	0.0634x1	Perimeter treatment	0.014	0.00640	**7.37**	**37.65**
	0.0634x6	Perimeter treatment	0.014	0.014	**7.37**	**82.35**
Animal Feedlots, Animal Housing Premises, Animal Kennel (Sleeping Quarters), Pet Living/ Sleeping Quarters	0.0038x2	Various[45]	0.00345	4.92×10^{-4}	**1.82**	**2.89**
Urban and rural structures and buildings (as shown in the footnote[46]), plus the following: Farm Premises (Agricultural), Barnyards/ Auction Barns, Seed Houses/ Stores/Storage Areas/ Warehouses	0.969x1	Barrier treatment	0.014	0.014	**7.37**	**82.35**
Urban and rural structures and buildings (as shown in the footnote)	0.0421x1	Granular/ Bait solid	7.01×10^{-4}	2.17×10^{-4}	**0.37**	**1.28**
Urban and rural structures and buildings (as shown in the footnote)	9.44x1	Various[47]	0.014	0.014	**7.37**	**82.35**
Urban and rural structures and buildings (as shown in the footnote)	0.00125x1	Various[48]	0.014	0.0102	**7.37**	**60.00**
Urban and rural structures and buildings (as shown in the footnote)	0.00244x2	Soil treatment (trenching)	0.014	0.00582	**7.37**	**34.24**
Farm Premises (Agricultural), Barnyards/ Auction Barns, Seed Houses/ Stores/Storage Areas/ Warehouses	0.0317x2	Ground[49]	0.014	0.00612	**7.37**	**36.00**
Wood Protection Treatment to Buildings/ Products (Outdoors)	1.59×10^{-4}x2	Ground	0.014	0.014	**7.37**	**82.35**
Wood Protection Treatment to Buildings/ Products (Outdoors)	0.0287x1	Ground (void treatment)	0.014	0.014	**7.37**	**82.35**

[45] Spot treatment, crack & crevice, directed spray, outdoor general surface spray, wall treatment, brush on
[46] May include various types of facilities: 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)/Diary Farm Milk Storage Rooms/Houses/Sheds/ Eating Establishments (food and non-food areas)/Egg Handling Rooms/Egg Packing Plants (Commercial)/Feed Mills/Feed Processing Plants/ Food/Grocery/Marketing/ Storage/Distribution Facility Premise/Food Processing Plant Equipment (food contact)/(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/ Public Buildings/Structures/ Storage Areas (empty or full).
[47] Outdoor general surface spray, perimeter treatment, space spray
[48] Crack & crevice, brush on, void treatment, foam application
[49] Spot treatment, crack & crevice, directed spray, perimeter treatment

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*
Right-of-Way	0.021x1	Ground	0.014	0.00260	**7.37**	**16.29**
Right-of-Way	0.0167x3	Granular	0.00513	0.00180	**2.70**	**10.59**
Paved Areas (Private Roads/ Sidewalks)	0.38x1	Perimeter treatment	0.014	0.014	**7.37**	**82.35**
Refuse/Solid Waste Sites (outdoors)	0.23x1	Various[50]	0.014	0.014	**7.37**	**82.35**
Utilities, Utility Poles/Rights-of-Way	2.2x1	Perimeter treatment	0.014	0.014	**7.37**	**82.35**
Utility Poles/Rights-of-Way	0.1x1	Granular	0.014	0.00460	**7.37**	**27.06**

* = 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 / 0.0019 ppb [for *Hyalella azteca*]. Chronic RQ = use-specific 21-day EEC / 0.00017 ppb [for *Hyalella azteca*].

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 (*H. azteca* 96-hr EC_{50}=0.0019 µg/L). Chronic risk is based on 1-in-10 year average 21-day EECs and the lowest chronic toxicity value for benthic invertebrates (*H. azteca* NOAEC 0.00017 µg/L). Risk quotients for freshwater benthic invertebrates range from **0.01 to 7.37** (acute) and **0.06 to 82.35** (chronic). Ninety-eight percent of the bifenthrin uses exceed the acute risk to listed species LOC (0.05) and 96% of the uses exceeded the chronic risk LOC (1). Consequently, bifenthrin has the potential to directly affect the CFWS. Additionally, since 93% of the uses exceed the acute risk to non-listed species LOC (0.5), bifenthrin 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**).

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 (*H. azteca* NOAEC=40 $\mu g/kg_{oc}$). Chronic risk quotients for freshwater benthic invertebrates range from **0.07 to 974**. Since 96% of the uses exceed the chronic risk to listed and non-listed species LOC (1), bifenthrin 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**).

As discussed in **Section 6.1.2**, some of the available solubility studies suggest a solubility limit of <0.1 ppb for bifenthrin (*e.g.*, MRID 46937802. In order to get an upper bound estimate of the possible RQs, it was also assumed that the limit of solubility was 0.1 ppb. If the limit of solubility is assumed to be 0.1 ppb, the acute RQ is 52.63 and the chronic RQ is 588. The concentration of bifenthrin in water may be above the limit of solubility if the chemical is sorbed to suspended matter/ particulate or dissolved organic carbon. The fraction that is bioavailable is,

[50] Perimeter treatment, general surface spray

however, likely near the limit of solubility. The uncertainties related to the value of solubility of bifenthrin are discussed in **Section 6.1.2**.

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

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*
Alfalfa, Clover	0.1x5	Aerial	0.014	0.014	4,600	4,600	**7.37**	**82.35**	NA	**115.0**
Tree nut crops	0.18x3	Aerial	0.014	0.014	5,050	5,030	**7.37**	**82.35**	NA	**125.6**
Tree nut crops	0.18x3	Ground	0.0117	0.0116	2,780	2,750	**6.16**	**68.24**	NA	**68.8**
Tree nuts	0.4x1	Granular	0.0115	0.0114	2,730	2,700	**6.05**	**67.06**	NA	**67.5**
Citrus crops	0.5x1	Ground	0.00748	0.00744	1,770	1,770	**3.94**	**43.76**	NA	**44.3**
Head and Stem Brassica Vegetables	0.1x5	Aerial	0.014	0.014	9,280	9,230	**7.37**	**82.35**	NA	**230.6**
Head and Stem Brassica Vegetables	0.1x5	Granular	0.014	0.014	7,080	7,030	**7.37**	**82.35**	NA	**175.6**
Corn, Sweet corn	0.1x1	Granular	0.00587	0.00584	1,390	1,380	**3.09**	**34.35**	NA	**34.6**
Corn	0.1x3	Aerial	0.014	0.014	8,230	8,200	**7.37**	**82.35**	NA	**205.0**
Sweet corn	0.1x2	Aerial	0.014	0.014	5,480	5,450	**7.37**	**82.35**	NA	**136.3**
Cotton	0.1x5	Aerial	0.014	0.014	5,280	5,250	**7.37**	**82.35**	NA	**131.3**
Pears, Mayhaw, Fruits (unspecified)	0.167x3	Aerial	0.014	0.014	3,430	3,425	**7.37**	**82.35**	NA	**85.6**
Fruits (unspecified), Small Fruits (unspecified)	0.2x2	Ground	0.00408	0.00405	965	958	**2.15**	**23.82**	NA	**24.0**
Deciduous Fruits, Apple, Stone Fruits	0.21x1	Ground	0.00216	0.00214	510	508	**1.14**	**12.59**	NA	**12.7**
Deciduous Fruits, Apple, Stone Fruits	0.4x1	Granular	0.00125	0.00125	298	295	**0.66**	**7.35**	NA	**7.38**
Grapes	0.1x1	Aerial	0.00335	0.00333	793	790	**1.76**	**19.59**	NA	**19.8**
Lettuce, Leafy petiole vegetables	0.1x5	Aerial	0.014	0.014	12,400	12,350	**7.37**	**82.35**	NA	**308.8**
Lettuce	0.1x2	Granular	0.014	0.014	3,950	3925	**7.37**	**82.35**	NA	**98.1**
Spinach	0.1x4	Aerial	0.00989	0.00986	2,340	2,330	**5.21**	**58.18**	NA	**58.3**
Cucurbit vegetables	0.1x3	Aerial	0.00838	0.00833	1,990	1,970	**4.41**	**49.00**	NA	**49.3**
Cucurbit vegetables	0.1x3	Granular	0.000759	0.000756	180	179	**0.40**	**4.45**	NA	**4.48**
Tuberous and corm vegetables	0.3 at plant, then 0.1x2	Aerial	0.014	0.014	4,050	4,050	**7.37**	**82.35**	NA	**101.3**
Tuberous and corm vegetables	0.3 at plant	Granular	0.00409	0.00408	968	965	**2.15**	**24.00**	NA	**24.1**
Root Crops	0.1x5	Ground	0.00638	0.00636	1,510	1,510	**3.36**	**37.41**	NA	**37.7**

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 ($\mu g/kg_{oc}$)	Sediment 21-day EEC ($\mu g/kg_{oc}$)	Pore Water Acute RQ*	Pore Water Chronic RQ*	Sediment Acute RQ*	Sediment Chronic RQ*
Artichokes	0.1x5	Aerial	0.014	0.014	5,580	5,550	**7.37**	**82.35**	NA	**138.7**
Peppers (bell and non-bell); and Succulent Peas and Beans	0.1x2	Aerial	0.0101	0.0101	2,400	2,390	**5.32**	**5.94**	NA	**59.7**
Dried peas and beans	0.1x1	Ground	0.00389	0.00387	923	915	**2.05**	**22.76**	NA	**22.9**
Succulent peas and beans; Dried beans	0.1x1	Granular	0.00634	0.00631	1,500	1,490	**3.34**	**37.11**	NA	**37.3**
Peppers (bell and non-bell)	0.1x2	Granular	0.00638	0.00636	1,510	1,510	**3.36**	**37.41**	NA	**37.6**
Agricultural crops/ soils	0.0832x3	Ground	0.00789	0.00781	1,870	1,850	**4.15**	**45.94**	NA	**46.3**
Strawberry	0.167x3	Aerial	0.0131	0.0131	3,130	3,100	**6.89**	**7.71**	NA	**77.5**
Strawberry	0.167x3	Ground	0.00513	0.00510	1,220	1,210	**2.70**	**30.00**	NA	**30.2**
Beets, garden beets	0.1x4	Aerial	0.014	0.014	4,550	4,550	**7.37**	**82.35**	NA	**113.8**
Tomato and tomatillo, Eggplant, Ground cherry, Pepino	0.1x2	Aerial	0.00636	0.00632	1,510	1,500	**3.35**	**37.18**	NA	**37.4**
Eggplant	0.1x2	Granular	0.00152	0.00152	360	360	**0.80**	**8.94**	NA	**9.00**
Canola, rapeseed, crambe	0.04x2	Aerial	0.014	0.014	3,380	3,380	**7.37**	**82.35**	NA	**84.4**
Canola, rapeseed, crambe	0.04x2	Granular	0.0129	0.0129	3,080	3,050	**6.79**	**7.59**	NA	**76.3**
Caneberries	0.1x2	Aerial	0.014	0.014	4,380	4,350	**7.37**	**82.35**	NA	**108.8**
Bushberries	0.1x5	Aerial	0.014	0.014	10,630	10,600	**7.37**	**82.35**	NA	**263.8**
Hops	0.1x3	Aerial	0.014	0.014	7,550	7,530	**7.37**	**82.35**	NA	**188.1**
Herbs & Spices (OR mint)	0.4x1	Granular	0.0104	0.0104	2,470	2,460	**5.47**	**6.12**	NA	**61.5**
Herbs & Spices (CA nursery)	0.4x1	Granular	0.014	0.014	13,500	13,400	**7.37**	**82.35**	NA	**335.0**
Forest Trees - conifers; Conifers (plantations/ nurseries); Conifers (seed orchard)	0.205x3	Ground	0.014	0.014	26,000	25,800	**7.37**	**82.35**	NA	**694.0**
Forest Trees - unspecified, softwoods	0.1058x3	Ground	0.014	0.014	13,400	13,300	**7.37**	**82.35**	NA	**333.1**
Christmas tree plantations	0.2x1	Ground	0.014	0.014	7,500	7,480	**7.37**	**82.35**	NA	**186.9**
Christmas tree plantations	0.4x1	Granular	0.014	0.014	14,380	14,300	**7.37**	**82.35**	NA	**357.5**
Nursery stock	0.1x1	Drench	0.014	0.014	4,130	4,100	**7.37**	**82.35**	NA	**102.5**

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*
Mulch, Potting Soil/Top Soil	0.211x1	Granular	0.014	0.014	7,100	7,050	**7.37**	**82.35**	NA	**176.2**
Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.3x3	Ground	0.014	0.014	34,500	34,500	**7.37**	**82.35**	NA	**862.5**
Nursery stock plus Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.4x1	Granular	0.014	0.014	11,550	11,500	**7.37**	**82.35**	NA	**286.9**
Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.95x1	Pressure liquid	0.014	0.014	39,200	38,980	**7.37**	**82.35**	NA	**974.4**
Roses	0.1x1	Ground	0.014	0.014	19,980	19,850	**7.37**	**82.35**	NA	**496.3**
Sod farms, ornamental sod farms	0.2x2	Aerial	0.014	0.014	4,850	4,800	**7.37**	**82.35**	NA	**120.0**
Sod farms, ornamental sod farms	0.4x1	Granular	0.0107	0.0106	2530	2,500	**5.63**	**62.35**	NA	**62.5**
Agricultural Right-of-Ways/ Fencerows/ Hedgerows	0.21x1	Ground	0.00674	0.00671	1,595	1,590	**3.55**	**39.47**	NA	**39.8**

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*
Non-agricultural uncultivated areas (soils); Livestock/ Livestock Feed Lots, Poultry Feedlots/ Poultry Processing Plant Premises (non-food contact), Poultry Litter	0.167x3	Ground	0.014	0.014	3,650	3,550	**7.37**	**82.35**	NA	**88.8**
Non-agricultural uncultivated areas (soils)	0.167x3	Granular	0.0120	0.0117	2,850	2,780	**6.32**	**68.82**	NA	**69.4**
Golf course turf	0.2x1	Ground	0.00262	0.00260	620	615	**1.38**	**15.29**	NA	**15.4**
Golf Course Turf plus Ornamental Grasses; Ornamental Lawns and Turf; Ornamental Sod Farms; Recreational Areas; Recreational Area Lawns	0.4x1	Granular	0.00249	0.00248	590	588	**1.31**	**7.71**	NA	**14.7**
Ornamental Grasses; Ornamental Lawns and Turf; Ornamental Sod Farms; Recreational Areas; Recreational Area Lawns	0.232x2	Ground	0.00594	0.00591	1,940	1,940	**3.13**	**34.76**	NA	**48.4**
Airports/ Landing Fields	0.0096x1	Perimeter treatment, directed spray	0.0108	0.0108	2,570	2,560	**5.68**	**63.52**	NA	**64.0**
Paths/Patios	0.369x1	Perimeter treatment	0.00603	0.00600	1,430	1,420	**3.17**	**35.29**	NA	**35.5**
Residential Lawns; Commercial/ Industrial Lawns, plus Paths/ Patios, plus Urban Areas, Wide Area/ General Outdoor Treatment (Public Health Use)	0.06x2	Ground	0.00186	0.00183	440	433	**0.98**	**10.76**	NA	**10.8**
	0.06x6	Ground	0.00405	0.00403	959	954	**2.13**	**23.71**	NA	**23.9**

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*
Residential lawns	0.00735x1	Granular	1.11×10^{-5}	1.10×10^{-5}	2.63	2.61	0.01	0.06	NA	0.07
Residential lawns	0.0634x1	Perimeter treatment	0.00104	0.00103	245	244	**0.55**	**6.06**	NA	**6.10**
	0.0634x6	Perimeter treatment	0.00428	0.00426	1010	1010	**2.25**	**25.06**	NA	**25.2**
Animal Feedlots, Animal Housing Premises, Animal Kennel (Sleeping Quarters), Pet Living/ Sleeping Quarters	0.0038x2	Various[51]	1.19×10^{-4}	1.17×10^{-4}	28.1	27.7	**0.06**	0.69	NA	0.69
Urban and rural structures and buildings (as shown in the footnote[52]), plus the following: Farm Premises (Agricultural), Barnyards/ Auction Barns, Seed Houses/ Stores/Storage Areas/ Warehouses	0.969x1	Barrier treatment	0.014	0.014	3,750	3,740	**7.37**	**82.35**	NA	**93.5**
Urban and rural structures and buildings (as shown in the footnote)	0.0421x1	Granular/ Bait solid	6.44×10^{-5}	6.42×10^{-5}	15.3	15.2	0.03	0.38	NA	0.38
Urban and rural structures and buildings (as shown in the footnote)	9.44x1	Various[53]	0.014	0.014	36,500	36,400	**7.37**	**82.35**	NA	**909.1**

[51] Spot treatment, crack & crevice, directed spray, outdoor general surface spray, wall treatment, brush on

[52] May include various types of facilities: 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)/Diary Farm Milk Storage Rooms/Houses/Sheds/ Eating Establishments (food and non-food areas)/Egg Handling Rooms/Egg Packing Plants (Commercial)/Feed Mills/Feed Processing Plants/ Food/Grocery/Marketing/ Storage/Distribution Facility Premise/Food Processing Plant Equipment (food contact)/(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/ Public Buildings/Structures/ Storage Areas (empty or full).

[53] Outdoor general surface spray, perimeter treatment, space spray

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*
Urban and rural structures and buildings (as shown in the footnote)	0.00125x1	Various[54]	0.00141	0.00141	334	333	**0.74**	**8.29**	NA	**8.33**
Urban and rural structures and buildings (as shown in the footnote)	0.00244x2	Soil treatment (trenching)	0.00111	0.00111	263	262	**0.58**	**6.53**	NA	**6.55**
Farm Premises (Agricultural), Barnyards/ Auction Barns, Seed Houses/ Stores/Storage Areas/ Warehouses	0.0317x2	Ground[55]	0.00110	0.00109	260	258	**0.58**	**6.41**	NA	**6.45**
Wood Protection Treatment to Buildings/ Products (Outdoors)	1.59×10^{-4}x2	Ground	0.00982	0.00980	2,330	2,320	**5.17**	**57.65**	NA	**58.0**
Wood Protection Treatment to Buildings/ Products (Outdoors)	0.0287x1	Ground (void treatment)	0.014	0.014	7,660	7,630	**7.37**	**82.35**	NA	**190.9**
Right-of-Way	0.021x1	Ground	5.20×10^{-4}	5.17×10^{-4}	123	122	**0.27**	**3.04**	NA	**3.05**
Right-of-Way	0.0167x3	Granular	5.57×10^{-4}	5.54×10^{-4}	132	131	**0.29**	**3.26**	NA	**3.28**
Paved Areas (Private Roads/ Sidewalks)	0.38x1	Perimeter treatment	0.00938	0.00934	2,220	2,210	**4.94**	**54.94**	NA	**55.3**
Refuse/Solid Waste Sites (outdoors)	0.23x1	Various[56]	0.00568	0.00565	1,350	1,340	**2.99**	**33.24**	NA	**33.5**
Utilities, Utility Poles/Rights-of-Way	2.2x1	Perimeter treatment	0.014	0.014	12,900	12,800	**7.37**	**82.35**	NA	**320.4**
Utility Poles/Rights-of-Way	0.1x1	Granular	0.00134	0.00133	317	316	**0.71**	**7.82**	NA	**7.90**

* = LOC exceedances (acute RQ $\geq$ 0.05; chronic RQ $\geq$ 1.0, for listed species) are bolded and shaded. NA is not applicable or not available. Acute pore water RQ = use-specific pore water peak EEC / 0.0019 ppb [water column test for *Hyalella azteca*]. Chronic pore water RQ = use-specific pore water 21-day EEC / 0.00017 ppb [estimated for *Hyalella azteca*]. Chronic sediment RQ = use-specific sediment 21-day EEC normalized for organic carbon content / 40 µg/kg_{OC} [for *Hyalella azteca*].

[54] Crack & crevice, brush on, void treatment, foam application

[55] Spot treatment, crack & crevice, directed spray, perimeter treatment

[56] Perimeter treatment, general surface spray

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 (*C. variegatus* 96-hr LC_{50}=17.8 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 (NOAEC=0.004 µg/L). Risk quotients are **<0.01** for all the scenarios modeled (acute) and range from **0.01 to 3.50** (chronic). None of the bifenthrin uses exceed the acute risk to listed species LOC (0.05) and 89% exceed the chronic risk LOC (1). Thus, based on the potential for chronic effects, bifenthrin has the potential to directly affect TG and DS. None of the uses exceed the acute risk to non-listed species LOC (0.5). Given that numerous scenarios exceed the chronic risk LOC, 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**.

As discussed in **Section 6.1.2**, some of the available solubility studies suggest a solubility limit of <0.1 ppb for bifenthrin (*e.g.*, MRID 46937802. In order to get an upper bound estimate of the possible RQs, it was also assumed that the limit of solubility was 0.1 ppb. If the limit of solubility is assumed to be 0.1 ppb, the acute RQ is 0.01 and the chronic RQ is 25. The concentration of bifenthrin in water may be above the limit of solubility if the chemical is sorbed to suspended matter/ particulate or dissolved organic carbon. The fraction that is bioavailable is, however, likely near the limit of solubility. The uncertainties related to the value of solubility of bifenthrin are discussed in **Section 6.1.2**.

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

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*
Alfalfa, Clover	0.1x5	Aerial	0.014	0.014	<0.01	**3.50**
Tree nut crops	0.18x3	Aerial	0.014	0.014	<0.01	**3.50**
Tree nut crops	0.18x3	Ground	0.014	0.014	<0.01	**3.50**
Tree nuts	0.4x1	Granular	0.014	0.014	<0.01	**3.50**
Citrus crops	0.5x1	Ground	0.014	0.014	<0.01	**3.50**
Head and Stem Brassica Vegetables	0.1x5	Aerial	0.014	0.014	<0.01	**3.50**
Head and Stem Brassica Vegetables	0.1x5	Granular	0.014	0.014	<0.01	**3.50**
Corn, Sweet corn	0.1x1	Granular	0.014	0.014	<0.01	**3.50**
Corn	0.1x3	Aerial	0.014	0.014	<0.01	**3.50**
Sweet corn	0.1x2	Aerial	0.014	0.014	<0.01	**3.50**
Cotton	0.1x5	Aerial	0.014	0.014	<0.01	**3.50**
Pears, Mayhaw, Fruits (unspecified)	0.167x3	Aerial	0.014	0.014	<0.01	**3.50**
Fruits (unspecified), Small Fruits (unspecified)	0.2x2	Ground	0.014	0.0123	<0.01	**3.08**
Deciduous Fruits, Apple, Stone Fruits	0.21x1	Ground	0.014	0.00663	<0.01	**1.66**
Deciduous Fruits, Apple, Stone Fruits	0.4x1	Granular	0.014	0.00364	<0.01	0.91

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*
Grapes	0.1x1	Aerial	0.014	0.0104	<0.01	**2.60**
Lettuce, Leafy petiole vegetables	0.1x5	Aerial	0.014	0.014	<0.01	**3.50**
Lettuce	0.1x2	Granular	0.014	0.014	<0.01	**3.50**
Spinach	0.1x4	Aerial	0.014	0.014	<0.01	**3.50**
Cucurbit vegetables	0.1x3	Aerial	0.014	0.014	<0.01	**3.50**
Cucurbit vegetables	0.1x3	Granular	0.014	0.00230	<0.01	0.58
Tuberous and corm vegetables	0.3 at plant, then 0.1x2	Aerial	0.014	0.014	<0.01	**3.50**
Tuberous and corm vegetables	0.3 at plant	Granular	0.014	0.0107	<0.01	**2.68**
Root Crops	0.1x5	Ground	0.014	0.014	<0.01	**3.50**
Artichokes	0.1x5	Aerial	0.014	0.014	<0.01	**3.50**
Peppers (bell and non-bell); and Succulent Peas and Beans	0.1x2	Aerial	0.014	0.014	<0.01	**3.50**
Dried peas and beans	0.1x1	Ground	0.014	0.0109	<0.01	**2.73**
Succulent peas and beans; Dried beans	0.1x1	Granular	0.014	0.014	<0.01	**3.50**
Peppers (bell and non-bell)	0.1x2	Granular	0.014	0.014	<0.01	**3.50**
Agricultural crops/ soils	0.0832x3	Ground	0.014	0.014	<0.01	**3.50**
Strawberry	0.167x3	Aerial	0.014	0.014	<0.01	**3.50**
Strawberry	0.167x3	Ground	0.014	0.014	<0.01	**3.50**
Beets, garden beets	0.1x4	Aerial	0.014	0.014	<0.01	**3.50**
Tomato and tomatillo, Eggplant, Ground cherry, Pepino	0.1x2	Aerial	0.014	0.014	<0.01	**3.50**
Eggplant	0.1x2	Granular	0.014	0.00432	<0.01	**1.08**
Canola, rapeseed, crambe	0.04x2	Aerial	0.014	0.014	<0.01	**3.50**
Canola, rapeseed, crambe	0.04x2	Granular	0.014	0.014	<0.01	**3.50**
Caneberries	0.1x2	Aerial	0.014	0.014	<0.01	**3.50**
Bushberries	0.1x5	Aerial	0.014	0.014	<0.01	**3.50**
Hops	0.1x3	Aerial	0.014	0.014	<0.01	**3.50**
Herbs & Spices (OR mint)	0.4x1	Granular	0.014	0.014	<0.01	**3.50**
Herbs & Spices (CA nursery)	0.4x1	Granular	0.014	0.014	<0.01	**3.50**
Forest Trees - conifers; Conifers (plantations/ nurseries); Conifers (seed orchard)	0.205x3	Ground	0.014	0.014	<0.01	**3.50**
Forest Trees - unspecified, softwoods	0.1058x3	Ground	0.014	0.014	<0.01	**3.50**
Christmas tree plantations	0.2x1	Ground	0.014	0.014	<0.01	**3.50**
Christmas tree plantations	0.4x1	Granular	0.014	0.014	<0.01	**3.50**
Nursery stock	0.1x1	Drench	0.014	0.014	<0.01	**3.50**
Mulch, Potting Soil/Top Soil	0.211x1	Granular	0.014	0.014	<0.01	**3.50**

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***
Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.3x3	Ground	0.014	0.014	<0.01	**3.50**
Nursery stock plus Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.4x1	Granular	0.014	0.014	<0.01	**3.50**
Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.95x1	Pressure liquid	0.014	0.014	<0.01	**3.50**
Roses	0.1x1	Ground	0.014	0.014	<0.01	**3.50**
Sod farms, ornamental sod farms	0.2x2	Aerial	0.014	0.014	<0.01	**3.50**
Sod farms, ornamental sod farms	0.4x1	Granular	0.014	0.014	<0.01	**3.50**
Agricultural Right-of-Ways/ Fencerows/ Hedgerows	0.21x1	Ground	0.014	0.014	<0.01	**3.50**
Non-agricultural uncultivated areas (soils); Livestock/ Livestock Feed Lots, Poultry Feedlots/ Poultry Processing Plant Premises (non-food contact), Poultry Litter	0.167x3	Ground	0.014	0.014	<0.01	**3.50**
Non-agricultural uncultivated areas (soils)	0.167x3	Granular	0.014	0.014	<0.01	**3.50**
Golf course turf	0.2x1	Ground	0.014	0.00667	<0.01	**1.67**
Golf Course Turf plus Ornamental Grasses; Ornamental Lawns and Turf; Ornamental Sod Farms; Recreational Areas; Recreational Area Lawns	0.4x1	Granular	0.014	0.00653	<0.01	**1.63**
Ornamental Grasses; Ornamental Lawns and Turf; Ornamental Sod Farms; Recreational Areas; Recreational Area Lawns	0.232x2	Ground	0.014	0.014	<0.01	**3.50**
Airports/ Landing Fields	0.0096x1	Perimeter treatment, directed spray	0.00687	7.93×10^{-4}	<0.01	0.20
Paths/Patios	0.369x1	Perimeter treatment	0.014	0.014	<0.01	**3.50**
Residential Lawns; Commercial/ Industrial Lawns, plus Paths/ Patios, plus Urban Areas, Wide Area/ General Outdoor Treatment (Public Health Use)	0.06x2	Ground	0.014	0.00679	<0.01	**1.70**
	0.06x6	Ground	0.014	0.0123	<0.01	**3.08**

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*
Residential lawns	0.00735x1	Granular	1.29×10^{-4}	3.49×10^{-5}	<0.01	0.01
Residential lawns	0.0634x1	Perimeter treatment	0.014	0.00522	<0.01	**1.31**
	0.0634x6	Perimeter treatment	0.014	0.0130	<0.01	**3.25**
Animal Feedlots, Animal Housing Premises, Animal Kennel (Sleeping Quarters), Pet Living/ Sleeping Quarters	0.0038x2	Various[57]	0.00345	4.33×10^{-4}	<0.01	0.11
Urban and rural structures and buildings (as shown in the footnote[58]), plus the following: Farm Premises (Agricultural), Barnyards/ Auction Barns, Seed Houses/ Stores/Storage Areas/ Warehouses	0.969x1	Barrier treatment	0.014	0.014	<0.01	**3.50**
Urban and rural structures and buildings (as shown in the footnote)	0.0421x1	Granular/ Bait solid	7.01×10^{-4}	2.04×10^{-4}	<0.01	0.05
Urban and rural structures and buildings (as shown in the footnote)	9.44x1	Various[59]	0.014	0.014	<0.01	**3.50**
Urban and rural structures and buildings (as shown in the footnote)	0.00125x1	Various[60]	0.014	0.00804	<0.01	**2.01**
Urban and rural structures and buildings (as shown in the footnote)	0.00244x2	Soil treatment (trenching)	0.014	0.00471	<0.01	**1.18**
Farm Premises (Agricultural), Barnyards/ Auction Barns, Seed Houses/ Stores/Storage Areas/ Warehouses	0.0317x2	Ground[61]	0.014	0.00491	<0.01	**1.23**
Wood Protection Treatment to Buildings/ Products (Outdoors)	1.59×10^{-4}x2	Ground	0.014	0.014	<0.01	**3.50**
Wood Protection Treatment to Buildings/ Products (Outdoors)	0.0287x1	Ground (void treatment)	0.014	0.014	<0.01	**3.50**
Right-of-Way	0.021x1	Ground	0.014	0.00213	<0.01	0.53
Right-of-Way	0.0167x3	Granular	0.00513	0.00157	<0.01	0.39
Paved Areas (Private Roads/ Sidewalks)	0.38x1	Perimeter treatment	0.014	0.014	<0.01	**3.50**

[57] Spot treatment, crack & crevice, directed spray, outdoor general surface spray, wall treatment, brush on
[58] May include various types of facilities: 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)/Diary Farm Milk Storage Rooms/Houses/Sheds/ Eating Establishments (food and non-food areas)/Egg Handling Rooms/Egg Packing Plants (Commercial)/Feed Mills/Feed Processing Plants/ Food/Grocery/Marketing/ Storage/Distribution Facility Premise/Food Processing Plant Equipment (food contact)/(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/ Public Buildings/Structures/ Storage Areas (empty or full).
[59] Outdoor general surface spray, perimeter treatment, space spray
[60] Crack & crevice, brush on, void treatment, foam application
[61] Spot treatment, crack & crevice, directed spray, perimeter treatment

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*
Refuse/Solid Waste Sites (outdoors)	0.23x1	Various[62]	0.014	0.014	<0.01	**3.50**
Utilities, Utility Poles/Rights-of-Way	2.2x1	Perimeter treatment	0.014	0.014	<0.01	**3.50**
Utility Poles/Rights-of-Way	0.1x1	Granular	0.014	0.00396	<0.01	0.99

* = LOC exceedances (acute RQ ≥ 0.05; chronic RQ ≥ 1.0, for listed species) are bolded and shaded. Acute RQ = use-specific peak EEC / 17.8 ppb [for sheepshead minnow, *Cyprinodon variegatus*]. Chronic RQ = use-specific 60-day EEC / 0.004 ppb [estimated chronic NOAEC reported for pyrethroids (tefluthrin; MRID 41705101)].

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 (*A. bahia* LC_{50}=0.004 µg/L). Chronic risk is based on 21-day average EECs and the lowest chronic toxicity value for estuarine/marine invertebrates (NOAEC=0.0002 µg/L). Risk quotients range from **0.03 to 3.53** (acute) and **0.19 to 70** (chronic). Ninety-nine percent of the bifenthrin uses exceed the acute risk to listed LOC (0.05) and the chronic risk LOC (1). In addition, 98% of the uses exceed the acute risk to non-listed species LOC (0.5). Therefore, bifenthrin 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**.

As discussed in **Section 6.1.2**, some of the available solubility studies suggest a solubility limit of <0.1 ppb for bifenthrin (*e.g.*, MRID 46937802). In order to get an upper bound estimate of the possible RQs, it was also assumed that the limit of solubility was 0.1 ppb. If the limit of solubility is assumed to be 0.1 ppb, the acute RQ is 25 and the chronic RQ is 500. The concentration of bifenthrin in water may be above the limit of solubility if the chemical is sorbed to suspended matter/ particulate or dissolved organic carbon. The fraction that is bioavailable is, however, likely near the limit of solubility. The uncertainties related to the value of solubility of bifenthrin are discussed in **Section 6.1.2**.

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

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*
Alfalfa, Clover	0.1x5	Aerial	0.014	0.014	**3.53**	**70.00**
Tree nut crops	0.18x3	Aerial	0.014	0.014	**3.53**	**70.00**
Tree nut crops	0.18x3	Ground	0.014	0.014	**3.53**	**70.00**
Tree nuts	0.4x1	Granular	0.014	0.014	**3.53**	**70.00**
Citrus crops	0.5x1	Ground	0.014	0.014	**3.53**	**70.00**
Head and Stem Brassica Vegetables	0.1x5	Aerial	0.014	0.014	**3.53**	**70.00**

[62] Perimeter treatment, general surface spray

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*
Head and Stem Brassica Vegetables	0.1x5	Granular	0.014	0.014	**3.53**	**70.00**
Corn, Sweet corn	0.1x1	Granular	0.014	0.014	**3.53**	**70.00**
Corn	0.1x3	Aerial	0.014	0.014	**3.53**	**70.00**
Sweet corn	0.1x2	Aerial	0.014	0.014	**3.53**	**70.00**
Cotton	0.1x5	Aerial	0.014	0.014	**3.53**	**70.00**
Pears, Mayhaw, Fruits (unspecified)	0.167x3	Aerial	0.014	0.014	**3.53**	**70.00**
Fruits (unspecified), Small Fruits (unspecified)	0.2x2	Ground	0.014	0.014	**3.53**	**70.00**
Deciduous Fruits, Apple, Stone Fruits	0.21x1	Ground	0.014	0.014	**3.53**	**70.00**
Deciduous Fruits, Apple, Stone Fruits	0.4x1	Granular	0.014	0.00456	**3.53**	**22.80**
Grapes	0.1x1	Aerial	0.014	0.014	**3.53**	**70.00**
Lettuce, Leafy petiole vegetables	0.1x5	Aerial	0.014	0.014	**3.53**	**70.00**
Lettuce	0.1x2	Granular	0.014	0.014	**3.53**	**70.00**
Spinach	0.1x4	Aerial	0.014	0.014	**3.53**	**70.00**
Cucurbit vegetables	0.1x3	Aerial	0.014	0.014	**3.53**	**70.00**
Cucurbit vegetables	0.1x3	Granular	0.014	0.00270	**3.53**	**13.50**
Tuberous and corm vegetables	0.3 at plant, then 0.1x2	Aerial	0.014	0.014	**3.53**	**70.00**
Tuberous and corm vegetables	0.3 at plant	Granular	0.014	0.0133	**3.53**	**66.50**
Root Crops	0.1x5	Ground	0.014	0.014	**3.53**	**70.00**
Artichokes	0.1x5	Aerial	0.014	0.014	**3.53**	**70.00**
Peppers (bell and non-bell); and Succulent Peas and Beans	0.1x2	Aerial	0.014	0.014	**3.53**	**70.00**
Dried peas and beans	0.1x1	Ground	0.014	0.0125	**3.53**	**62.50**
Succulent peas and beans; Dried beans	0.1x1	Granular	0.014	0.014	**3.53**	**70.00**
Peppers (bell and non-bell)	0.1x2	Granular	0.014	0.014	**3.53**	**70.00**
Agricultural crops/ soils	0.0832x3	Ground	0.014	0.014	**3.53**	**70.00**
Strawberry	0.167x3	Aerial	0.014	0.014	**3.53**	**70.00**
Strawberry	0.167x3	Ground	0.014	0.014	**3.53**	**70.00**
Beets, garden beets	0.1x4	Aerial	0.014	0.014	**3.53**	**70.00**
Tomato and tomatillo, Eggplant, Ground cherry, Pepino	0.1x2	Aerial	0.014	0.014	**3.53**	**70.00**
Eggplant	0.1x2	Granular	0.014	0.00500	**3.53**	**2.50**
Canola, rapeseed, crambe	0.04x2	Aerial	0.014	0.014	**3.53**	**70.00**
Canola, rapeseed, crambe	0.04x2	Granular	0.014	0.014	**3.53**	**70.00**
Caneberries	0.1x2	Aerial	0.014	0.014	**3.53**	**70.00**
Bushberries	0.1x5	Aerial	0.014	0.014	**3.53**	**70.00**
Hops	0.1x3	Aerial	0.014	0.014	**3.53**	**70.00**
Herbs & Spices (OR mint)	0.4x1	Granular	0.014	0.014	**3.53**	**70.00**
Herbs & Spices (CA nursery)	0.4x1	Granular	0.014	0.014	**3.53**	**70.00**

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*
Forest Trees - conifers; Conifers (plantations/ nurseries); Conifers (seed orchard)	0.205x3	Ground	0.014	0.014	**3.53**	**70.00**
Forest Trees - unspecified, softwoods	0.1058x3	Ground	0.014	0.014	**3.53**	**70.00**
Christmas tree plantations	0.2x1	Ground	0.014	0.014	**3.53**	**70.00**
Christmas tree plantations	0.4x1	Granular	0.014	0.014	**3.53**	**70.00**
Nursery stock	0.1x1	Drench	0.014	0.014	**3.53**	**70.00**
Mulch, Potting Soil/Top Soil	0.211x1	Granular	0.014	0.014	**3.53**	**70.00**
Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.3x3	Ground	0.014	0.014	**3.53**	**70.00**
Nursery stock plus Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.4x1	Granular	0.014	0.014	**3.53**	**70.00**
Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.95x1	Pressure liquid	0.014	0.014	**3.53**	**70.00**
Roses	0.1x1	Ground	0.014	0.014	**3.53**	**70.00**
Sod farms, ornamental sod farms	0.2x2	Aerial	0.014	0.014	**3.53**	**70.00**
Sod farms, ornamental sod farms	0.4x1	Granular	0.014	0.014	**3.53**	**70.00**
Agricultural Right-of-Ways/ Fencerows/ Hedgerows	0.21x1	Ground	0.014	0.014	**3.53**	**70.00**
Non-agricultural uncultivated areas (soils); Livestock/ Livestock Feed Lots, Poultry Feedlots/ Poultry Processing Plant Premises (non-food contact), Poultry Litter	0.167x3	Ground	0.014	0.014	**3.53**	**70.00**
Non-agricultural uncultivated areas (soils)	0.167x3	Granular	0.014	0.014	**3.53**	**70.00**
Golf course turf	0.2x1	Ground	0.014	0.00902	**3.53**	**22.55**
Golf Course Turf plus Ornamental Grasses; Ornamental Lawns and Turf; Ornamental Sod Farms; Recreational Areas; Recreational Area Lawns	0.4x1	Granular	0.014	0.00836	**3.53**	**45.10**
Ornamental Grasses; Ornamental Lawns and Turf; Ornamental Sod Farms; Recreational Areas; Recreational Area Lawns	0.232x2	Ground	0.014	0.014	**3.53**	**70.00**

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*
Airports/ Landing Fields	0.0096x1	Perimeter treatment, directed spray	0.00687	9.73×10^{-4}	**1.73**	**4.87**
Paths/Patios	0.369x1	Perimeter treatment	0.014	0.014	**3.53**	**70.00**
Residential Lawns; Commercial/ Industrial Lawns, plus Paths/ Patios, plus Urban Areas, Wide Area/ General Outdoor Treatment (Public Health Use)	0.06x2	Ground	0.014	0.00770	**3.53**	**38.50**
	0.06x6	Ground	0.014	0.0137	**3.53**	**68.5**
Residential lawns	0.00735x1	Granular	1.29×10^{-4}	3.72×10^{-5}	0.03	0.19
Residential lawns	0.0634x1	Perimeter treatment	0.014	0.00640	**3.53**	**32.00**
	0.0634x6	Perimeter treatment	0.014	0.014	**3.53**	**70.00**
Animal Feedlots, Animal Housing Premises, Animal Kennel (Sleeping Quarters), Pet Living/ Sleeping Quarters	0.0038x2	Various[63]	0.00345	4.92×10^{-4}	**0.87**	**2.46**
Urban and rural structures and buildings (as shown in the footnote[64]), plus the following: Farm Premises (Agricultural), Barnyards/ Auction Barns, Seed Houses/ Stores/Storage Areas/ Warehouses	0.969x1	Barrier treatment	0.014	0.014	**3.53**	**70.00**
Urban and rural structures and buildings (as shown in the footnote)	0.0421x1	Granular/ Bait solid	7.01×10^{-4}	2.17×10^{-4}	**0.18**	**1.09**
Urban and rural structures and buildings (as shown in the footnote)	9.44x1	Various[65]	0.014	0.014	**3.53**	**70.00**
Urban and rural structures and buildings (as shown in the footnote)	0.00125x1	Various[66]	0.014	0.0102	**3.53**	**51.00**
Urban and rural structures and buildings (as shown in the footnote)	0.00244x2	Soil treatment (trenching)	0.014	0.00582	**3.53**	**29.10**

[63] Spot treatment, crack & crevice, directed spray, outdoor general surface spray, wall treatment, brush on

[64] May include various types of facilities: 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)/Diary Farm Milk Storage Rooms/Houses/Sheds/ Eating Establishments (food and non-food areas)/Egg Handling Rooms/Egg Packing Plants (Commercial)/Feed Mills/Feed Processing Plants/ Food/Grocery/Marketing/ Storage/Distribution Facility Premise/Food Processing Plant Equipment (food contact)/(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/ Public Buildings/Structures/ Storage Areas (empty or full).

[65] Outdoor general surface spray, perimeter treatment, space spray

[66] Crack & crevice, brush on, void treatment, foam application

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*
Farm Premises (Agricultural), Barnyards/ Auction Barns, Seed Houses/ Stores/Storage Areas/ Warehouses	0.0317x2	Ground[67]	0.014	0.00612	**3.53**	**30.60**
Wood Protection Treatment to Buildings/ Products (Outdoors)	$1.59x10^{-4}x2$	Ground	0.014	0.014	**3.53**	**70.00**
Wood Protection Treatment to Buildings/ Products (Outdoors)	0.0287x1	Ground (void treatment)	0.014	0.014	**3.53**	**70.00**
Right-of-Way	0.021x1	Ground	0.014	0.00260	**3.53**	**13.00**
Right-of-Way	0.0167x3	Granular	0.00513	0.00180	**1.29**	**9.00**
Paved Areas (Private Roads/ Sidewalks)	0.38x1	Perimeter treatment	0.014	0.014	**3.53**	**70.00**
Refuse/Solid Waste Sites (outdoors)	0.23x1	Various[68]	0.014	0.014	**3.53**	**70.00**
Utilities, Utility Poles/Rights-of-Way	2.2x1	Perimeter treatment	0.014	0.014	**3.53**	**70.00**
Utility Poles/Rights-of-Way	0.1x1	Granular	0.014	0.00460	**3.53**	**23.00**

* = LOC exceedances (acute RQ ≥ 0.05; chronic RQ ≥ 1.0, for listed species) are bolded and shaded. Acute RQ = use-specific peak EEC / 0.00397 ppb [for *Americamysis bahia*]. Chronic RQ = use-specific 21-day EEC / 0.0002 ppb [calculated using the highest ACR for mysids (*lambda*-cyhalothrin)].

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; *A. bahia* LC_{50}=0.004 µg/L). Chronic risk is based on 21-day EECs and the lowest chronic toxicity value for estuarine/marine benthic invertebrates (*L. plumulosus* 28-day NOAEC= 0.005 µg/L). Additionally, chronic RQs were calculated based on sediment concentrations, and the lowest chronic sediment toxicity value for an estuarine/marine benthic species (*L. plumulosus* 28-day NOAEC=1220 $\mu g/kg_{oc}$).

Based on pore water concentrations, risk quotients range from **<0.01 to 3.53** (acute) and **<0.01 to 2.80** (chronic). Ninety-six percent of the bifenthrin uses exceed the acute risk to listed species LOC (0.05) and chronic risk to listed and non-listed species LOC (1). In addition, 84% 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). Based on pore water concentrations, 72% of the bifenthrin uses exceed the chronic risk to listed and non-listed species LOC (1).

Based on sediment concentrations, chronic risk quotients range from <0.01 to 32.15. Seventy-one percent of the bifenthrin uses exceed the chronic risk to listed and non-listed species LOC (1) (see **Table 5-6**).

[67] Spot treatment, crack & crevice, directed spray, perimeter treatment
[68] Perimeter treatment, general surface spray

As discussed in **Section 6.1.2**, some of the available solubility studies suggest a solubility limit of <0.1 ppb for bifenthrin (*e.g.*, MRID 46937802). The uncertainties related to the value of solubility of bifenthrin are discussed in **Section 6**. In order to get an upper bound estimate of the possible RQs, it was also assumed that the limit of solubility was 0.1 ppb. If the limit of solubility is assumed to be 0.1 ppb, the acute RQ is 25 and the chronic RQ is 20. The concentration of bifenthrin in water may be above the limit of solubility if the chemical is sorbed to suspended matter/ particulate or dissolved organic carbon. The fraction that is bioavailable is, however, likely near the limit of solubility.

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

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*
Alfalfa, Clover	0.1x5	Aerial	0.014	0.014	4,600	4,600	**3.53**	**2.80**	NA	**3.77**
Tree nut crops	0.18x3	Aerial	0.014	0.014	5,050	5,030	**3.53**	**2.80**	NA	**4.12**
Tree nut crops	0.18x3	Ground	0.0117	0.0116	2,780	2,750	**2.95**	**2.32**	NA	**2.25**
Tree nuts	0.4x1	Granular	0.0115	0.0114	2,730	2,700	**2.90**	**2.28**	NA	**2.21**
Citrus crops	0.5x1	Ground	0.00748	0.00744	1,770	1,770	**1.88**	**1.49**	NA	**1.45**
Head and Stem Brassica Vegetables	0.1x5	Aerial	0.014	0.014	9,280	9,230	**3.53**	**2.80**	NA	**7.56**
Head and Stem Brassica Vegetables	0.1x5	Granular	0.014	0.014	7,080	7,030	**3.53**	**2.80**	NA	**5.76**
Corn, Sweet corn	0.1x1	Granular	0.00587	0.00584	1,390	1,380	**1.48**	**1.17**	NA	**1.13**
Corn	0.1x3	Aerial	0.014	0.014	8,230	8,200	**3.53**	**2.80**	NA	**6.72**
Sweet corn	0.1x2	Aerial	0.014	0.014	5,480	5,450	**3.53**	**2.80**	NA	**4.47**
Cotton	0.1x5	Aerial	0.014	0.014	5,280	5,250	**3.53**	**2.80**	NA	**4.30**
Pears, Mayhaw, Fruits (unspecified)	0.167x3	Aerial	0.014	0.014	3,430	3,425	**3.53**	**2.80**	NA	**2.81**
Fruits (unspecified), Small Fruits (unspecified)	0.2x2	Ground	0.00408	0.00405	965	958	**1.03**	0.81	NA	0.79
Deciduous Fruits, Apple, Stone Fruits	0.21x1	Ground	0.00216	0.00214	510	508	**0.54**	0.43	NA	0.42
Deciduous Fruits, Apple, Stone Fruits	0.4x1	Granular	0.00125	0.00125	298	295	**0.31**	0.25	NA	0.24
Grapes	0.1x1	Aerial	0.00335	0.00333	793	790	**0.84**	0.67	NA	0.65
Lettuce, Leafy petiole vegetables	0.1x5	Aerial	0.014	0.014	12,400	12,350	**3.53**	**2.80**	NA	**10.12**
Lettuce	0.1x2	Granular	0.014	0.014	3,950	3925	**3.53**	**2.80**	NA	**3.22**
Spinach	0.1x4	Aerial	0.00989	0.00986	2,340	2,330	**2.49**	**1.97**	NA	**1.91**
Cucurbit vegetables	0.1x3	Aerial	0.00838	0.00833	1,990	1,970	**2.11**	**1.67**	NA	**1.62**
Cucurbit vegetables	0.1x3	Granular	0.000759	0.000756	180	179	**0.19**	0.15	NA	0.15
Tuberous and corm vegetables	0.3 at plant, then 0.1x2	Aerial	0.014	0.014	4,050	4,050	**3.53**	**2.80**	NA	**3.32**

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*
Tuberous and corm vegetables	0.3 at plant	Granular	0.00409	0.00408	968	965	**1.03**	0.82	NA	0.79
Root Crops	0.1x5	Ground	0.00638	0.00636	1,510	1,510	**1.61**	**1.27**	NA	**1.24**
Artichokes	0.1x5	Aerial	0.014	0.014	5,580	5,550	**3.53**	**2.80**	NA	**4.55**
Peppers (bell and non-bell); and Succulent Peas and Beans	0.1x2	Aerial	0.0101	0.0101	2,400	2,390	**2.54**	**2.02**	NA	**1.91**
Dried peas and beans	0.1x1	Ground	0.00389	0.00387	923	915	**0.98**	0.77	NA	0.75
Succulent peas and beans; Dried beans	0.1x1	Granular	0.00634	0.00631	1,500	1,490	**1.60**	**1.26**	NA	**1.22**
Peppers (bell and non-bell)	0.1x2	Granular	0.00638	0.00636	1,510	1,510	**1.61**	**1.27**	NA	**1.23**
Agricultural crops/ soils	0.0832x3	Ground	0.00789	0.00781	1,870	1,850	**1.97**	**1.56**	NA	**1.52**
Strawberry	0.167x3	Aerial	0.0131	0.0131	3,130	3,100	**3.30**	**2.62**	NA	**2.54**
Strawberry	0.167x3	Ground	0.00513	0.00510	1,220	1,210	**1.29**	**1.02**	NA	0.99
Beets, garden beets	0.1x4	Aerial	0.014	0.014	4,550	4,550	**3.53**	**2.80**	NA	**3.73**
Tomato and tomatillo, Eggplant, Ground cherry, Pepino	0.1x2	Aerial	0.00636	0.00632	1,510	1,500	**1.60**	**1.26**	NA	**1.23**
Eggplant	0.1x2	Granular	0.00152	0.00152	360	360	**0.38**	0.30	NA	0.30
Canola, rapeseed, crambe	0.04x2	Aerial	0.014	0.014	3,380	3,380	**3.53**	**2.80**	NA	**2.77**
Canola, rapeseed, crambe	0.04x2	Granular	0.0129	0.0129	3,080	3,050	**3.25**	**2.58**	NA	**2.50**
Caneberries	0.1x2	Aerial	0.014	0.014	4,380	4,350	**3.53**	**2.80**	NA	**3.57**
Bushberries	0.1x5	Aerial	0.014	0.014	10,630	10,600	**3.53**	**2.80**	NA	**8.65**
Hops	0.1x3	Aerial	0.014	0.014	7,550	7,530	**3.53**	**2.80**	NA	**6.17**
Herbs & Spices (OR mint)	0.4x1	Granular	0.0104	0.0104	2,470	2,460	**2.62**	**2.08**	NA	**2.01**
Herbs & Spices (CA nursery)	0.4x1	Granular	0.014	0.014	13,500	13,400	**3.53**	**2.80**	NA	**10.98**
Forest Trees - conifers; Conifers (plantations/ nurseries); Conifers (seed orchard)	0.205x3	Ground	0.014	0.014	26,000	25,800	**3.53**	**2.80**	NA	**21.10**
Forest Trees - unspecified, softwoods	0.1058x3	Ground	0.014	0.014	13,400	13,300	**3.53**	**2.80**	NA	**10.92**
Christmas tree plantations	0.2x1	Ground	0.014	0.014	7,500	7,480	**3.53**	**2.80**	NA	**6.13**
Christmas tree plantations	0.4x1	Granular	0.014	0.014	14,380	14,300	**3.53**	**2.80**	NA	**11.72**
Nursery stock	0.1x1	Drench	0.014	0.014	4,130	4,100	**3.53**	**2.80**	NA	**3.36**

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*
Mulch, Potting Soil/Top Soil	0.211x1	Granular	0.014	0.014	7,100	7,050	**3.53**	**2.80**	NA	**5.78**
Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.3x3	Ground	0.014	0.014	34,500	34,500	**3.53**	**2.80**	NA	**28.28**
Nursery stock plus Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.4x1	Granular	0.014	0.014	11,550	11,500	**3.53**	**2.80**	NA	**9.41**
Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba	0.95x1	Pressure liquid	0.014	0.014	39,200	38,980	**3.53**	**2.80**	NA	**32.15**
Roses	0.1x1	Ground	0.014	0.014	19,980	19,850	**3.53**	**2.80**	NA	**16.27**
Sod farms, ornamental sod farms	0.2x2	Aerial	0.014	0.014	4,850	4,800	**3.53**	**2.80**	NA	**3.93**
Sod farms, ornamental sod farms	0.4x1	Granular	0.0107	0.0106	2530	2,500	**2.70**	**2.12**	NA	**2.05**
Agricultural Right-of-Ways/ Fencerows/ Hedgerows	0.21x1	Ground	0.00674	0.00671	1,595	1,590	**1.70**	**1.34**	NA	**1.30**

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*
Non-agricultural uncultivated areas (soils); Livestock/ Livestock Feed Lots, Poultry Feedlots/ Poultry Processing Plant Premises (non-food contact), Poultry Litter	0.167x3	Ground	0.014	0.014	3,650	3,550	**3.53**	**2.80**	NA	**2.91**
Non-agricultural uncultivated areas (soils)	0.167x3	Granular	0.0120	0.0117	2,850	2,780	**3.02**	**2.34**	NA	**2.27**
Golf course turf	0.2x1	Ground	0.00262	0.00260	620	615	**0.66**	0.52	NA	0.50
Golf Course Turf plus Ornamental Grasses; Ornamental Lawns and Turf; Ornamental Sod Farms; Recreational Areas; Recreational Area Lawns	0.4x1	Granular	0.00249	0.00248	590	588	**0.63**	0.50	NA	0.48
Ornamental Grasses; Ornamental Lawns and Turf; Ornamental Sod Farms; Recreational Areas; Recreational Area Lawns	0.232x2	Ground	0.00594	0.00591	1,940	1,940	**1.50**	**1.18**	NA	**1.59**
Airports/ Landing Fields	0.0096x1	Perimeter treatment, directed spray	0.0108	0.0108	2,570	2,560	**2.72**	**2.16**	NA	**2.10**
Paths/Patios	0.369x1	Perimeter treatment	0.00603	0.00600	1,430	1,420	**1.52**	**1.20**	NA	**1.16**
Residential Lawns; Commercial/ Industrial Lawns, plus Paths/ Patios, plus Urban Areas, Wide Area/ General Outdoor Treatment (Public Health Use)	0.06x2	Ground	0.00186	0.00183	440	433	**0.47**	0.37	NA	0.35
	0.06x6	Ground	0.00405	0.00403	959	954	**1.02**	0.81	NA	0.78
Residential lawns	0.00735x1	Granular	1.11x10^{-5}	1.10x10^{-5}	2.63	2.61	<0.01	<0.01	NA	<0.01
Residential lawns	0.0634x1	Perimeter treatment	0.00104	0.00103	245	244	**0.26**	0.21	NA	0.20
	0.0634x6	Perimeter treatment	0.00428	0.00426	1010	1010	**1.08**	0.85	NA	0.83

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*
Animal Feedlots, Animal Housing Premises, Animal Kennel (Sleeping Quarters), Pet Living/ Sleeping Quarters	0.0038x2	Various[69]	1.19×10^{-4}	1.17×10^{-4}	28.1	27.7	0.03	0.02	NA	0.02
Urban and rural structures and buildings (as shown in the footnote[70]), plus the following: Farm Premises (Agricultural), Barnyards/ Auction Barns, Seed Houses/ Stores/Storage Areas/ Warehouses	0.969x1	Barrier treatment	0.014	0.014	3,750	3,740	**3.53**	**2.80**	NA	**3.03**
Urban and rural structures and buildings (as shown in the footnote)	0.0421x1	Granular/ Bait solid	6.44×10^{-5}	6.42×10^{-5}	15.3	15.2	0.02	0.01	NA	0.01
Urban and rural structures and buildings (as shown in the footnote)	9.44x1	Various[71]	0.014	0.014	36,500	36,400	**3.53**	**2.80**	NA	**29.80**
Urban and rural structures and buildings (as shown in the footnote)	0.00125x1	Various[72]	0.00141	0.00141	334	333	**0.36**	0.28	NA	0.27
Urban and rural structures and buildings (as shown in the footnote)	0.00244x2	Soil treatment (trenching)	0.00111	0.00111	263	262	**0.28**	0.22	NA	0.21

[69] Spot treatment, crack & crevice, directed spray, outdoor general surface spray, wall treatment, brush on
[70] May include various types of facilities: 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)/Diary Farm Milk Storage Rooms/Houses/Sheds/ Eating Establishments (food and non-food areas)/Egg Handling Rooms/Egg Packing Plants (Commercial)/Feed Mills/Feed Processing Plants/ Food/Grocery/Marketing/ Storage/Distribution Facility Premise/Food Processing Plant Equipment (food contact)/(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/ Public Buildings/Structures/ Storage Areas (empty or full).
[71] Outdoor general surface spray, perimeter treatment, space spray
[72] Crack & crevice, brush on, void treatment, foam application

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*
Farm Premises (Agricultural), Barnyards/ Auction Barns, Seed Houses/ Stores/Storage Areas/ Warehouses	0.0317x2	Ground[73]	0.00110	0.00109	260	258	**0.28**	0.22	NA	0.21
Wood Protection Treatment to Buildings/ Products (Outdoors)	1.59×10^{-4}x2	Ground	0.00982	0.00980	2,330	2,320	**2.47**	**1.96**	NA	**1.90**
Wood Protection Treatment to Buildings/ Products (Outdoors)	0.0287x1	Ground (void treatment)	0.014	0.014	7,660	7,630	**3.53**	**2.80**	NA	**6.26**
Right-of-Way	0.021x1	Ground	5.20×10^{-4}	5.17×10^{-4}	123	122	**0.13**	0.10	NA	0.10
Right-of-Way	0.0167x3	Granular	5.57×10^{-4}	5.54×10^{-4}	132	131	**0.14**	0.11	NA	0.11
Paved Areas (Private Roads/ Sidewalks)	0.38x1	Perimeter treatment	0.00938	0.00934	2,220	2,210	**2.36**	**1.87**	NA	**1.81**
Refuse/Solid Waste Sites (outdoors)	0.23x1	Various[74]	0.00568	0.00565	1,350	1,340	**1.43**	**1.13**	NA	**1.10**
Utilities, Utility Poles/Rights-of-Way	2.2x1	Perimeter treatment	0.014	0.014	12,900	12,800	**3.53**	**2.80**	NA	**10.51**
Utility Poles/Rights-of-Way	0.1x1	Granular	0.00134	0.00133	317	316	**0.34**	0.27	NA	0.26

* = LOC exceedances (acute RQ ≥ 0.05; chronic RQ ≥ 1.0, for listed species) are bolded and shaded. Acute pore water RQ = use-specific pore water peak EEC / 0.00397 ppb [water column test for *Americamysis bahia*]. Chronic pore water RQ = use-specific pore water 21-day EEC / 0.005 ppb [estimated for *Leptocheirus plumulosus*]. Chronic sediment RQ = use-specific sediment 21-day EEC normalized for organic carbon content / 1,220 $\mu g/kg_{OC}$ [for *Leptocheirus plumulosus*].

5.1.1.g. Non-vascular Aquatic Plants

Risk to aquatic non-vascular plants could not be calculated because toxicity data are not available. See **Section 5.2** for a characterization of the risk.

5.1.1.h. Aquatic Vascular Plants

Risk to aquatic vascular plants could not be calculated because toxicity data are not available. See **Section 5.2** for a characterization of the risk.

5.1.2. Exposures in the Terrestrial Habitat

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

[73] Spot treatment, crack & crevice, directed spray, perimeter treatment

[74] Perimeter treatment, general surface spray

As previously discussed in **Section 3.3**, potential direct effects to terrestrial species are based on foliar, granular, and seed treatment applications of bifenthrin. Potential risks to birds and, thus, terrestrial-phase amphibians are evaluated using T-REX based on 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 terrestrial-phase amphibians if T-REX indicates potential risk to this taxa. Small snakes and amphibians only consume insects while medium- and large-sized snakes and amphibians consume small and large insects, small mammals, and amphibians. The most sensitive RQ for snakes and terrestrial-phase amphibians are for medium-sized snakes consuming small herbivorous 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 3-4**) and acute oral (*C. virginianus* 21-day LD_{50}=1800 mg/kg bw), subacute dietary (*A. platyrhynchos* 8-day LC_{50}-1280 mg/kg diet) and chronic toxicity endpoints for avian species (*C. virginianus* 168-day NOAEC=75 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 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, 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=75 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 5-7**. Three out of 42 application scenarios (7%) exceed the acute risk to listed species LOC (0.1) and 15 application scenarios (36%) exceed the chronic risk to both listed and non-listed species LOC (1).

Table 5-7. Acute and Chronic RQs Derived Using T-REX for Birds, Reptiles and Terrestrial-Phase Amphibians Exposed to Foliar Applications of Bifenthrin

Use, Type of Application	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
Agricultural Use Patterns			
Agricultural crops/ soils	0.04	0.03	0.56

Use, Type of Application	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
Alfalfa, Clover	0.04	0.03	0.54
Artichokes	0.06	0.06	0.96
Beets, garden beets	0.07	0.06	**1.05**
Bushberries	0.08	0.07	**1.24**
Caneberries	0.04	0.03	0.56
Canola, rapeseed, crambe	0.01	0.01	0.23
Citrus crops	**0.11**	0.09	**1.60**
Corn	0.06	0.05	0.91
Cotton	0.09	0.08	**1.43**
Cucurbits	0.06	0.05	0.84
Deciduous Fruits, Apple, Stone Fruits	0.04	0.04	0.67
Dried Peas and Beans	0.02	0.02	0.32
Fruits (unspecified)	0.08	0.07	**1.20**
Grapes	0.02	0.02	0.32
Head and Stem Brassica; Lettuce, Leafy Petiole Vegetables	0.08	0.07	**1.24**
Hops	0.04	0.04	0.67
Pears, Mayhaw, Fruits (unspecified), Strawberry	0.09	0.08	**1.40**
Peppers, Succulent Peans and Beans; Tomato & Tomatillo; Eggplant, Ground Cherry, Pepino	0.04	0.04	0.60
Root Crops	0.08	0.07	**1.24**
Spinach	0.07	0.06	**1.05**
Sweet corn	0.04	0.04	0.62
Tree Nut Crops (1)	0.09	0.08	**1.32**
Tuberous and Corn Vegetables	0.06	0.06	0.96
Non-Agricultural Use Patterns			
Agricultural Right-of-Ways/ Fencerows/ Hedgerows	0.04	0.04	0.67
Airports/ Landing Fields	0.00	0.00	0.03
Christmas Tree Plantations, Golf Course Turf	0.04	0.04	0.64
Farm Premises/Buildings	0.01	0.01	0.19
Forest Tree Plantations	0.08	0.07	**1.22**
Forest Trees - unspecified, softwoods	0.04	0.04	0.63
Non-agricultural Uncultivated Areas	0.05	0.05	0.77
Nursery Stock	0.02	0.02	0.32
Ornamental & Shade Trees (1)	**0.20**	**0.18**	**3.04**
Ornamental & Shade Trees (2)	**0.12**	**0.10**	**1.78**
Ornamental Grasses	0.07	0.06	0.99
Pave Area Perimeters	0.08	0.07	**1.22**
Refuse/Solid Waste Sites (outdoors)	0.05	0.04	0.74
Residential Lawns (1)	0.01	0.01	0.20
Residential Lawns (3)	0.00	0.00	0.02
Right of Way (1)	0.02	0.01	0.26

Use, Type of Application	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
Roses	0.00	0.00	0.07
Sod farms, ornamental sod farms	0.08	0.07	**1.20**

LOC exceedances (acute RQ ≥ 0.1 and chronic RQ ≥ 1.0) are bolded.
[1]Based on dose-based EEC and Northern bobwhite quail oral LD_{50} = 1800 mg/kg-bw
[2]Based on dose-based EEC and Mallard duck sub acute dietary LC_{50} =1280 mg/kg-diet
[3]Based on dietary-based EEC and Northern bobwhite quail NOAEC = 75 mg/kg-diet.

Based on several scenarios exceeding the acute and/or chronic risk to listed species LOCs, bifenthrin has the potential to directly affect the CCR. Additionally, since the acute and/or chronic risk to non-listed species LOCs are exceeded, 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 (*e.g.*, SFGS).

Additional refinements for the SFGS and terrestrial-phase CTS were conducted with T-HERPS. Acute and chronic RQs for the CTS derived using T-HERPS refinements are shown in **Table 5-8.** Six out of 42 application scenarios (14%) exceed the acute risk to listed species LOC (0.1) and 15 application scenarios (36%) exceed the chronic risk to listed and non-listed species LOC (1). It is noted that with refinements, the acute RQs for listed species were slightly higher, resulting in additional application scenarios exceeding the acute risk to listed species LOCs. This results from the slightly greater exposure of amphibians consuming very small (2g) herbivorous mammals in addition to the lack of acute toxicity scaling for amphibians. Therefore, based on results of the refined terrestrial exposure modeling with T-HERPS, there is potential for direct effects on terrestrial phase CTS for 15 of the use scenarios modeled (**Table 5-8**).

Table 5-8. Acute and Chronic RQs Derived Using T-HERPS for Bifenthrin and Terrestrial-Phase Amphibians Exposed to Bifenthrin [75]

Use, Type of Application	RQs for CTS (all DPS) (medium [20g] amphibians consuming herbivorous mammals)		
	Acute Dose-Based	Acute Dietary Based	Chronic Dietary Based
Agricultural Use Patterns			
Agricultural crops/ soils			
Alfalfa, Clover			
Artichokes			
Beets, garden beets	0.08	0.06	**1.06**
Bushberries	0.09	0.07	**1.24**
Caneberries			
Canola, rapeseed, crambe			
Citrus crops	**0.12**	0.09	**1.61**
Corn			
Cotton	**0.11**	0.08	**1.43**
Cucurbits			
Deciduous Fruits, Apple, Stone Fruits			

[75] Cells shaded pale blue mean that these are scenarios for which the acute and chronic RQs did not exceed the LOCs; therefore, refinements were not required.

Use, Type of Application	RQs for CTS (all DPS) (medium [20g] amphibians consuming herbivorous mammals)		
	Acute Dose-Based	Acute Dietary Based	Chronic Dietary Based
Dried Peas and Beans			
Fruits (unspecified)	0.09	0.07	**1.20**
Grapes			
Head and Stem Brassica; Lettuce, Leafy Petiole Vegetables	0.09	0.07	**1.24**
Hops			
Pears, Mayhaw, Fruits (unspecified), Strawberry	**0.11**	0.08	**1.41**
Peppers, Succulent Peans and Beans; Tomato & Tomatillo; Eggplant, Ground Cherry, Pepino			
Root Crops	0.09	0.07	**1.24**
Spinach	0.08	0.06	**1.06**
Sweet corn			
Tree Nut Crops (1)	**0.10**	0.08	**1.33**
Tuberous and Corn Vegetables			
Non-Agricultural Use Patterns			
Agricultural Right-of-Ways/ Fencerows/ Hedgerows			
Airports/ Landing Fields			
Christmas Tree Plantations, Golf Course Turf			
Farm Premises/Buildings			
Forest Tree Plantations	0.09	0.07	**1.22**
Forest Trees - unspecified, softwoods			
Non-agricultural Uncultivated Areas			
Nursery Stock			
Ornamental & Shade Trees (1)	**0.23**	**0.18**	**3.05**
Ornamental & Shade Trees (2)	**0.14**	**0.10**	**1.79**
Ornamental Grasses			
Pave Area Perimeters	0.09	0.07	**1.22**
Refuse/Solid Waste Sites (outdoors)			
Residential Lawns (1)			
Residential Lawns (3)			
Right of Way (1)			
Roses			
Sod farms, ornamental sod farms	0.09	0.07	**1.20**

LOC exceedances (acute RQ $\geq$ 0.1 and chronic RQ $\geq$ 1.0) are bolded. Cells shaded blue were uses not assessed because the risk quotients using T-REX were below the LOCs. Therefore, refinements were not required.
[1]Based on dose-based EEC and Northern bobwhite quail oral LD_{50} = 1800 mg/kg-bw
[2]Based on dose-based EEC and Mallard duck sub acute dietary LC_{50} =1280 mg/kg-diet
[3]Based on dietary-based EEC and Northern bobwhite quail NOAEC = 75 mg/kg-diet.

Additional refinements for reptiles were conducted with T-HERPS. Acute and chronic RQs for the SFGS derived using T-HERPS refinements are shown in **Table 5-9**. One out of 42 application scenarios (2%) exceed the acute risk to listed species LOC (0.1) and 6 application scenarios (14%) exceed the chronic risk to listed and non-listed species LOC (1). It is noted that with refinements, several of the acute and chronic RQs were smaller, resulting in fewer application scenarios exceeding the acute listed LOCs, as compared to the initial T-REX modeling. Therefore, based on results of the refined terrestrial exposure modeling with T-HERPS, there is potential for direct effects on the SFGS for 6 of the use scenarios modeled (**Table 5-9**).

Table 5-9. Acute and Chronic RQs Derived Using T-HERPS for Bifenthrin and Reptiles Exposed to Bifenthrin [76]

Use, Type of Application	RQs for Small SFGS (small bird consuming small insects)			RQs for Medium SFGS (medium birds consuming herbivorous mammals)		
	Acute Dose-Based	Acute Dietary Based	Chronic Dietary Based	Acute Dose-Based	Acute Dietary Based	Chronic Dietary Based
Agricultural Use Patterns						
Agricultural crops/ soils						
Alfalfa, Clover						
Artichokes						
Beets, garden beets	0.00	0.03	0.59	0.04	0.05	0.81
Bushberries	0.00	0.04	0.70	0.05	0.06	0.95
Caneberries						
Canola, rapeseed, crambe						
Citrus crops	0.00	0.05	0.90	0.06	0.07	**1.23**
Corn						
Cotton	0.00	0.05	0.80	0.06	0.06	**1.09**
Cucurbits						
Deciduous Fruits, Apple, Stone Fruits						
Dried Peas and Beans						
Fruits (unspecified)	0.00	0.04	0.67	0.05	0.05	0.92
Grapes						
Head and Stem Brassica; Lettuce, Leafy Petiole Vegetables	0.00	0.04	0.70	0.05	0.06	0.95
Hops						
Pears, Mayhaw, Fruits (unspecified), Strawberry	0.00	0.05	0.79	0.06	0.06	**1.08**
Peppers, Succulent Peans and Beans; Tomato & Tomatillo; Eggplant, Ground Cherry, Pepino						
Root Crops	0.00	0.04	0.70	0.05	0.06	0.95
Spinach	0.00	0.03	0.59	0.04	0.05	0.81
Sweet corn						
Tree Nut Crops (1)	0.00	0.04	0.74	0.05	0.06	**1.01**
Tuberous and Corn Vegetables						
Non-Agricultural Use Patterns						
Agricultural Right-of-Ways/ Fencerows/ Hedgerows						
Airports/ Landing Fields						

[76] Cells shaded pale blue mean that these are scenarios for which the acute and chronic RQs did not exceed the LOCs; therefore, refinements were not required.

Use, Type of Application	RQs for Small SFGS (small bird consuming small insects)			RQs for Medium SFGS (medium birds consuming herbivorous mammals)		
	Acute Dose-Based	Acute Dietary Based	Chronic Dietary Based	Acute Dose-Based	Acute Dietary Based	Chronic Dietary Based
Christmas Tree Plantations, Golf Course Turf						
Farm Premises/Buildings						
Forest Tree Plantations	0.00	0.04	0.69	0.05	0.05	0.93
Forest Trees - unspecified, softwoods						
Non-agricultural Uncultivated Areas						
Nursery Stock						
Ornamental & Shade Trees (1)	0.00	**0.10**	**1.71**	**0.12**	**0.14**	**2.33**
Ornamental & Shade Trees (2)	0.00	0.06	**1.00**	0.07	0.08	**1.37**
Ornamental Grasses						
Pave Area Perimeters	0.00	0.04	0.68	0.05	0.05	0.93
Refuse/Solid Waste Sites (outdoors)						
Residential Lawns (1)						
Residential Lawns (3)						
Right of Way (1)						
Roses						
Sod farms, ornamental sod farms	0.00	0.04	0.67	0.05	0.05	0.92

LOC exceedances (acute RQ $\geq$ 0.1 and chronic RQ $\geq$ 1.0) are bolded. Cells shaded blue were uses not assessed because the risk quotients using T-REX were below the LOCs. Therefore, refinements were not required.

[1]Based on dose-based EEC and Northern bobwhite quail oral LD_{50} = 1800 mg/kg-bw

[2]Based on dose-based EEC and Mallard duck sub acute dietary LC_{50} =1280 mg/kg-diet

[3]Based on dietary-based EEC and Northern bobwhite quail NOAEC = 75 mg/kg-diet.

Results from the seed treatment uses of bifenthrin indicate that estimated exposures exceed risk to listed species LOCs both on acute (dose-based) and chronic exposure bases (**Table 5-10).** Although only the highest acute RQ is shown here, it is noted that acute RQs calculated on the basis of LD_{50}/ft^2 also exceeded the acute risk to listed species LOCs in all but one scenario for mammals (discussed in **Section 5.1.2b**) but no scenario for birds. This largely reflects the greater sensitivity of mammals to bifenthrin compared to birds.

Table 5-10. Acute and Chronic RQ values for Birds and Mammals Exposed to Seed Treatment Uses of Bifenthrin

Seed Treatment Use Category	T-REX Seed Treatment Scenario	RQs for 20g Birds and CCR, CTS (all DPS), and SFGS		RQs for Small (15g) Mammals	
		Max. Acute RQ*[1]	Chronic Dietary RQ[2]	Max. Acute RQ*[3]	Chronic Dose RQ[4]
Beans	beans, lima	**0.11**	**7.8**	**1.1**	**37.5**
Brassica (head and stem vegetables)	cabbage				
Canola/rape/ crambe	corn, all or unspecified				
Corn (field, pop,	canola				

Seed Treatment Use Category	T-REX Seed Treatment Scenario	RQs for 20g Birds and CCR, CTS (all DPS), and SFGS		RQs for Small (15g) Mammals	
		Max. Acute RQ*[1]	Chronic Dietary RQ[2]	Max. Acute RQ*[3]	Chronic Dose RQ[4]
sweet)					
Cotton	cotton, all or unspecified				
Cucurbits	cucumber				
Lettuce and leafy vegetables	kale for market				
Succulent peas	pea, garden				
Pepper and Eggplant	peppers, all				

* Maximum acute RQ determined on an acute dose basis. Since according to the labels, the maximum application rate to seeds remains the same, dose- and dietary-based RQs do not change across application scenarios

[1]Based on dose-based EEC and Northern bobwhite quail oral LD_{50} = 1800 mg/kg-bw

[2] Based on dietary-based EEC and Northern bobwhite quail NOAEC = 75 mg/kg-diet.

[3] based on acute dose-based of LD_{50}=53.8 mg/kg bw for the rat.

[4] Based on chronic mammalian NOAEL of 30 mg/kg diet for the rat.

For granular applications, T-REX calculates the LD_{50} ft^{-2} risk index *in lieu* of the traditional RQ. These values are compared against the acute risk to listed species LOC for birds (0.1). For small birds, the acute risk to listed species LOC is exceeded for several uses for which the application rate is high (0.4 lb a.i./A) and where broadcast applications are used. This indicates that there is potential risk for listed birds (surrogates CCR, CTS (all DPS), and SFGS). It is noted that it is highly uncertain whether the SFGS's diet may include granules; however, it may additionally be indirectly affected by consuming small birds that have eaten granules. For other uses the acute risk to listed species LOC is not exceeded.

Table 5-11. Bifenthrin Avian (Surrogate for Reptiles and Terrestrial-Phase Amphibians) LD50 ft-2 Index for Granular Applications of Bifenthrin

Use	App rate (lb a.i./A)	Method of App	Avian LD_{50} ft^{-2} (a)
Corn (field), sweet corn, cucurbit vegetables, succulent peas and beans, head and stem brassica vegetables, lettuce, eggplant, cotton, bell and non-bell peppers, root crops	0.1	Broadcast	0.04
Field corn, sweet corn (at plant)	0.1	T-Band	0.03
Sweet corn	0.1	In furrow	<0.01
Tuberous & corm vegetables	0.3	In furrow	0.01
Canola	0.04	Broadcast	0.02
Turf; ornamentals (various including Christmas trees, containerized), parks, recreational parks, around institutional, public, commercial and industrial buildings, golf courses, sod farms	0.4	Broadcast	**0.16**

(a) LOC = 0.1 for listed species; bolded/shaded values exceed the acute listed LOC for birds (surrogate for terrestrial phase amphibians and reptiles).

[1]Based on dose-based EEC and Northern bobwhite quail oral LD_{50} = 1800 mg/kg-bw

5.1.2.b. Mammals

Potential risks to mammals are evaluated using T-REX, acute (*R. norvegicus* LD_{50}=53.8 mg/kg bw) and chronic mammalian toxicity data (*R. norvegicus* NOAEC=30 mg/kg diet, NOAEL=1.5 mg/kg-bw/d), and a variety of body-size and dietary categories.

Potential for indirect effects to the SFGS, CCR, and CTS may result from direct effects to mammals due to a reduction in prey. Potential indirect effects to the SFGS and CTS 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.

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 of 30 mg/kg diet (NOAEL=1.5 mg/kg-bw/d) from a chronic reproductive study for the rat (*R. norvegicus*). Dietary-based EECs are divided by toxicity values to estimate chronic dietary-based RQs.

Table 5-12. Acute and Chronic RQs Derived Using T-REX for Mammals Exposed to Various Uses of Bifenthrin

Use, Type of Application	RQs for Small Mammals (small [15g] mammals consuming short grass)		
	Acute Dose-Based[1]	Chronic Dose Based[1]	Chronic Dietary Based[1]
Agricultural Use Patterns			
Agricultural crops/ soils	**0.34**	**12.10**	**1.39**
Alfalfa, Clover	**0.32**	**11.63**	**1.34**
Artichokes	**0.58**	**20.89**	**2.41**
Beets, garden beets	**0.64**	**22.82**	**2.63**
Bushberries	**0.75**	**26.81**	**3.09**
Caneberries	**0.34**	**12.20**	**1.41**
Canola, rapeseed, crambe	**0.14**	**4.88**	0.56
Citrus crops	**0.97**	**34.70**	**4.00**
Corn	**0.55**	**19.64**	**2.26**
Cotton	**0.86**	**30.92**	**3.56**
Cucurbits	**0.51**	**18.24**	**2.10**
Deciduous Fruits, Apple, Stone Fruits	**0.41**	**14.58**	**1.68**
Dried Peas and Beans	**0.19**	**6.94**	0.80
Fruits (unspecified)	**0.72**	**25.97**	**2.99**
Grapes	**0.19**	**6.94**	0.80
Head and Stem Brassica; Lettuce, Leafy Petiole Vegetables	**0.75**	**26.81**	**3.09**
Hops	**0.41**	**14.54**	**1.68**
Pears, Mayhaw, Fruits (unspecified), Strawberry	**0.85**	**30.47**	**3.51**
Peppers, Succulent Peans and Beans; Tomato & Tomatillo; Eggplant, Ground Cherry,	**0.36**	**12.98**	**1.50**

Use, Type of Application	RQs for Small Mammals (small [15g] mammals consuming short grass)		
	Acute Dose-Based[1]	Chronic Dose Based[1]	Chronic Dietary Based[1]
Pepino			
Root Crops	**0.75**	**26.81**	**3.09**
Spinach	**0.64**	**22.82**	**2.63**
Sweet corn	**0.38**	**13.48**	**1.55**
Tree Nut Crops (1)	**0.80**	**28.67**	**3.30**
Tuberous and Corn Vegetables	**0.58**	**20.82**	**2.40**
Non-Agricultural Use Patterns			
Agricultural Right-of-Ways/ Fencerows/ Hedgerows	**0.41**	**14.58**	**1.68**
Airports/ Landing Fields	0.02	0.67	0.08
Christmas Tree Plantations, Golf Course Turf	**0.39**	**13.88**	**1.60**
Farm Premises/Buildings	**0.11**	**4.12**	0.47
Forest Tree Plantations	**0.74**	**26.42**	**3.05**
Forest Trees - unspecified, softwoods	**0.38**	**13.64**	**1.57**
Non-agricultural Uncultivated Areas	**0.46**	**16.68**	**1.92**
Nursery Stock	**0.19**	**6.94**	0.80
Ornamental & Shade Trees (1)	**1.84**	**65.94**	**7.60**
Ornamental & Shade Trees (2)	**1.08**	**38.66**	**4.46**
Ornamental Grasses	**0.60**	**21.41**	**2.47**
Pave Area Perimeters	**0.74**	**26.38**	**3.04**
Refuse/Solid Waste Sites (outdoors)	**0.45**	**15.96**	**1.84**
Residential Lawns (1)	**0.12**	**4.40**	0.51
Residential Lawns (2)	0.01	0.51	0.06
Residential Lawns (3)	**0.15**	**5.54**	0.64
Right of Way (1)	0.04	**1.46**	0.17
Right of Way (2)	0.08	**3.05**	0.35
Roses	**0.75**	**26.81**	**3.09**
Sod farms, ornamental sod farms	**0.72**	**25.97**	**2.99**

LOC exceedances (acute RQ $\geq$ 0.1 and chronic RQ $\geq$ 1.0) are bolded.
[1] RQ values based on the acute dose-, chronic dose- based and chronic dietary-based EECs and the following endpoints: acute (*R. norvegicus* LD_{50}=53.8 mg/kg bw) and chronic (*R. norvegicus)* NOAEC=30 mg/kg diet and NOAEL=1.5 mg/kg-bw/d)

Based on the acute and chronic RQs exceeding the risk to non-listed species LOCs, 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)).

As indicated above, for granular applications, T-REX calculates the LD_{50} ft^{-2} risk index *in lieu* of the traditional RQ. These values are compared against the acute risk to non-listed LOC for mammals. For small mammals, the acute risk to non-listed LOC for mammal species is exceeded for several uses for which the application rate is high (0.4 lb a.i./A) and broadcast applications are used. Additionally, it is exceeded for several agricultural uses at a rate of 0.1 lb a.i./A with broadcast applications. This indicates that there is potential risk for risk to non-listed mammals, and thus, indirect effects on listed species that use mammals as prey (*i.e.*, the CCR, CTS, and SFGS), or indirect effects due to potential effects to habitat or a reduction in rearing sites (*i.e.*, SFGS and CTS). For other uses the acute non-listed LOC was not exceeded.

Table 5-13. Bifenthrin Mammalian LD50 ft-2 Index for Granular Applications of Bifenthrin

Use	App rate (lb a.i./A)	Method of App	Mammalian LD_{50} ft^{-2} (a)
Corn (field), sweet corn, cucurbit vegetables, succulent peas and beans, head and stem brassica vegetables, lettuce, eggplant, cotton, bell and non-bell peppers, root crops	0.1	Broadcast	**0.59**
Field corn, sweet corn (at plant)	0.1	T-Band	0.44
Sweet corn	0.1	In furrow	0.03
Tuberous & corm vegetables	0.3	In furrow	0.09
Canola	0.04	Broadcast	0.23
Turf; ornamentals (various including Christmas trees, containerized), parks, recreational parks, around institutional, public, commercial and industrial buildings, golf courses, sod farms	0.4	Broadcast	**2.35**

(a) LOC = 0.5 for non-listed species; bolded/shaded values exceed the acute non-listed LOC for mammals
RQ values based on the acute dose-based LD_{50} of 53.8 mg/kg bw for rat (*R. norvegicus.*)

5.1.2.c. Terrestrial Invertebrates

In order to assess the potential risks of bifenthrin to terrestrial invertebrates, the honey bee is used as a surrogate for terrestrial invertebrates. The toxicity value for terrestrial invertebrates is calculated by multiplying the lowest available acute contact LD_{50} of 0.015 µg a.i./bee by 1 bee/0.128g, which is based on the weight of an adult honey bee. EECs (µg a.i./g of bee) calculated by T-REX for small insects are divided by the calculated toxicity value for terrestrial invertebrates, which is 0.114 µg a.i./g of bee. Risk quotients are shown for insects, in **Table 5-14**. Based on the fact that all RQs exceeded the acute risk to listed species LOC (0.05), bifenthrin has 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 5-14. Summary of RQs for Terrestrial Invertebrates Exposed to Various Uses of Bifenthrin

Use Category	App Rate (lb a.i./A), # Apps, Interval (d)	Invertebrate RQ
Agricultural crops/ soils	0.0832, 3, 21	**149.0**
Alfalfa, Clover	0.1, 5, 45	**143.2**
Artichokes	0.1, 5, 15	**257.2**
Beets, garden beets	0.1, 4, 7	**281.0**
Bushberries	0.1, 5, 7	**330.1**
Caneberries	0.1, 2, 14	**150.2**
Canola, rapeseed, crambe	0.04, 2, 14	**60.1**
Citrus crops	0.5, 1,	**427.3**

Use Category	App Rate (lb a.i./A), # Apps, Interval (d)	Invertebrate RQ
Corn	0.1, 3, 3	**241.9**
Cotton	0.1, 5, 3	**380.7**
Cucurbits:	0.1, 3, 7	**224.6**
Deciduous Fruits, Apple, Stone Fruits	0.21, 1,	**179.5**
Dried Peas and Beans	0.1, 1,	**85.5**
Fruits (unspecified)	0.2, 2, 7	**319.7**
Grapes	0.1, 1,	**85.5**
Head and Stem Brassica; Lettuce, Leafy Petiole Vegetables	0.1, 5, 7	**330.1**
Hops	0.1, 3, 21	**179.0**
Pears, Mayhaw, Fruits (unspecified), Strawberry	0.167, 3, 7	**375.1**
Peppers, Succulent Peans and Beans; Tomato & Tomatillo; Eggplant, Ground Cherry, Pepino	0.1, 2, 7	**159.8**
Root Crops	0.1, 5, 7	**330.1**
Spinach	0.1, 4, 7	**281.0**
Sweet corn	0.1, 2, 3	**166.0**
Tree Nut Crops (1)	0.18, 3, 15	**353.0**
Agricultural Right-of-Ways/ Fencerows/ Hedgerows	0.21, 1,	**179.5**
Airports/ Landing Fields	0.0096, 1,	**8.2**
Christmas Tree Plantations, Golf Course Turf	0.2, 1,	**170.9**
Farm Premises/Buildings	0.0317, 2, 7	**50.7**
Forest Tree Plantations	0.205, 3, 30	**325.3**
Forest Trees - unspecified, softwoods	0.1058, 3, 30	**167.9**
Non-agricultural Uncultivated Areas	0.167, 3, 56	**205.3**
Nursery Stock	0.1, 1,	**85.5**
Ornamental & Shade Trees (1)	0.95, 1,	**811.8**
Ornamental & Shade Trees (2)	0.3, 3, 30	**476.0**
Ornamental Grasses	0.232, 2, 56	**263.7**
Pave Area Perimeters	0.38, 1,	**324.7**
Refuse/Solid Waste Sites (outdoors)	0.23, 1,	**196.5**
Residential Lawns (1)	0.0634, 1,	**54.2**
Residential Lawns (2)	0.00735, 1,	**6.3**
Residential Lawns (3)	0.06, 2, 56	**68.2**
Right of Way (1)	0.021, 1,	**17.9**
Right of Way (2)	0.0167, 3, 7	**37.5**
Roses	0.1, 5, 7	**330.1**
Sod farms, ornamental sod farms	0.2, 2, 7	**319.7**
Tuberous and Corn Vegetables	0.3 at plant, then 0.1x2, 3, 21	**256.4**

* = LOC exceedances (RQ $\geq$ 0.05) are bolded.
RQ is based on the arthropod EECs from T-REX and the toxicity value for terrestrial invertebrates, which is 0.114 µg a.i./g of bee.

5.1.2.d. Terrestrial Plants

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

5.1.2.e. Bioaccumulation Analysis Results

KABAM was used to calculate risk quotients from a bioaccumulation pathway for food items that may be consumed by listed species. The rail was used to represent the CCR. The sandpiper group (family: Scolopacidae) was used to represent the SFGS and CTS because its body size was the same as these organisms (0.02 kg). The fog/water shrew category was used to represent a piscivorous mammalian food item that may be consumed by the SFGS. The 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, 0.95 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 Bifenthrin

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				
Citrus crops (Ground, app rate 0.5x1)	<0.001	<0.001	N/A	0.004
Ornamentals (Pressure liquic, app rate 0.95 lb a.i./A)	<0.001	<0.001	NA	0.005
SFGS and CTS (all DPS)				
Citrus crops (Ground, app rate 0.5x1)	0.001	0.001	N/A	0.009
Ornamentals (Pressure liquic, app rate 0.95 lb a.i./A)	0.001	0.001	N/A	0.009
Fog/Water Shrew				
Citrus crops (Ground, app rate 0.5x1)	<0.001	N/A	0.005	0.001
Ornamentals (Pressure liquic, app rate 0.95 lb a.i./A)	<0.001	N/A	0.005	0.001

*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…. Acute dose-, chronic dose- and chronic diet-based RQ values for Fog/Water Shrew based on following endpoints: acute (*R. norvegicus* LD_{50}=53.8 mg/kg bw) and chronic (*R. norvegicus)* NOAEC=30 mg/kg diet and NOAEL=1.5 mg/kg-bw/d

5.1.2.f. Toxicity of Chemical 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. Bifenthrin has 90 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 in a limited and a qualitative analysis does not support any broad conclusions about the interactive nature of bifenthrin in combination with other pesticides.

In the case of bifenthrin, 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 instances where there is sufficient data, the formulation is no more toxic than the single active ingredient.

Furthermore, there are several studies on mixture analysis in the open literature (**Appendix A**). 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 (*e.g.*, a tank mix with PBO). 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 those instances. However, the limited size of the data set and the variation in co-formulated pesticides prohibits any definitive conclusions. An assessment of bifenthrin potential effect when it is co-formulated with other active ingredients is based on the toxicity of bifenthrin.

5.1.3. Primary Constituent Elements of Designated Critical Habitat

For bifenthrin 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 bifenthrin 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 Bifenthrin 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} = 0.0146 µg a.i./g bee	6.3-811.8	4.5[1]	1.00 – 1.00
Small Bird LD_{50} = 1800 mg ai/kg-bw	<0.01-0.20	3.52[2]	1.00×10^{16} – 1.44×10^{2}
Medium Amphibian LD_{50} = 1800 mg ai/kg-bw	<0.01-0.08	4.5[1]	1.00×10^{16} - 1.42×10^{6}
Medium Reptile LD_{50} = 1800 mg ai/kg-bw	<0.01-0.08	4.5[1]	1.00×10^{16} – 9.27×10^{6}
Small Mammal LD_{50} = 53.8 mg/kg-bw	<0.01-1.84	4.5[1]	1.00×10^{16} – 1.13
FW Fish LC_{50} = 0.15 µg ai/L	<0.01-0.09	3.53[2]	1.20×10^{12} – 8.97×10^{3}
FW Invertebrate EC_{50} = 0.0019 ng ai/L	0.07-7.37	4.5[1]	9.88×10^{6} – 1.00
FW Benthic Invertebrate EC_{50} = 0.0019 ng ai/L	0.01-7.37	4.5[1]	8.86×10^{18} – 1.00
E/M Fish LC_{50} = 17.8 µg ai/L	<0.01	4.5[1]	8.86×10^{18}
E/M Invertebrate LC_{50} = 0.00397 µg ai/L	0.03-3.53	4.5[1]	2.76×10^{11} – 1.01
E/M Benthic Invertebrate LC_{50} = 0.00397 µg ai/L	<0.01-3.53	4.5[1]	8.86×10^{18} – 1.01

1 Default slope; 2 Species specific slope.

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 bifenthrin'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 bifenthrin. Based on this risk estimation process described above, all species in this assessment, the BCB, CCR, CFWS, CTS (all DPS), DS, SFGS, TG, and VELB have a preliminary "may affect" determination. A summary of the risk estimation results are provided in **Table 5-17** for direct and indirect effects to the listed species assessed here and the PCEs of their designated critical habitat.

Table 5-17. Risk Estimation Summary for Bifenthrin: 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)	Even though none of the RQ values exceed the risk to non-listed species LOC (0.5), about 89% of the uses exceed the chronic risk LOC (1).	Indirect Effects (prey items): CCR, CTS (all DPS), SFGS	CTS-CC, CTS-SB, DS, TG
	Listed Species (Yes)	Out of 82 uses assessed, all but four exceed the acute risk to listed species LOC (0.05) (uses that did not exceed the risk to listed LOC are residential lawn granular, animal feedlots and premises, urban and rural structures granular application, and rights-of-way granular). Approximately 89% of the uses exceed the chronic risk LOC [77]	Direct Effects: CTS (all DPS), DS, TG	

[77] Uses that exceed LOCs (acute risk and/or chronic risk) include: alfalfa/clover; tree nut crops (aerial, ground and granular); head and stem brassica (aerial and granular); corn/sweet corn (aerial and granular); cotton; pears, mayhaw, fruits (small and unspecified); deciduous fruits, apple, stone fruits (ground and granular); grapes; lettuce & leafy petiole vegetables (aerial); lettuce (granular); spinach; cucurbit vegetables (aerial and granular); tuberous and corm vegetables (aerial and granular); root crops; artichokes; peppers; succulent peas and beans; dried beans and peas (aerial, ground, granular); agricultural crop soils; strawberry (aerial and ground); beets, garden beets, tomato and tomatillo, eggplant,ground cherry, pepino; eggplant (granular); canola, rapeseed, crambe (aerial and granular); caneberry; bushberry; hops; herbs and spices; forest trees - conifers; conifers (plantations/ nurseries); conifers (seed orchard); forest trees (unspecified), softwoods; Christmas tree plantations (ground, granular); nursery stock; mulch, potting soil/top soil; ornamental and/or shade trees; ornamental ground cover; ornamental herbaceous plants; ornamental non-flowering plants; ornamental woody shrubs and vines; jojoba (ground, granular, pressure liquid); roses; sod farms, ornamental sod farms; agricultural right-of-ways/ fencerows/ hedgerows; non-agricultural uncultivated areas (soils); livestock/ livestock feed lots, poultry feedlots/ poultry processing plant premises (non-food contact), poultry litter (ground, granular); golf course turf, ornamental grasses; ornamental lawns and turf; ornamental sod farms; recreational areas; recreational area lawns (ground, granular); ornamental grasses; ornamental lawns and turf; ornamental sod farms; recreational areas; recreational area lawns; airport/ landing fields; paths/patios; residential lawns; commercial/ industrial lawns, paths/ patios, urban areas, wide area/ general outdoor treatment (public health use) (however the residential granular application is not included); urban and rural structures and building, farm premises, (agricultural), barnyards/ auction barns, seed houses/ stores/storage areas/ warehouses (various applications, except granular); wood protection treatment to buildings/ products (outdoors); rights-of-way (ground only, but not granular); paved areas; refuse/solid waste sites (outdoors); utilities, utility poles/rights-of-way (perimeter treatment and granular).

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 Invertebrates (Non-Benthic)	Non-listed Species (Yes)	All but two of the uses exceed the acute risk to non-listed species LOC (0.5) (the exceptions are residential lawn granular and urban and rural structures granular applications), and all but one of the uses exceed the chronic risk LOC (1) (residential lawn granular application).	Indirect Effects (prey items): CCR, CFWS, CTS (all DPS), DS, SFGS, TG	CTS-CC, CTS-SB, DS, TG
	Listed Species (Yes)	All uses exceed the acute risk to listed species LOC (0.05) and all but one of the uses exceed the chronic risk LOC (1) (the following use does not exceed the chronic risk LOC: residential lawn granular application).	Direct Effects: CFWS	
Freshwater Benthic Invertebrates	Non-listed Species (Yes)	All but six uses exceed the acute risk to non-listed species LOC (0.5). All but three uses exceed the chronic risk LOC (1). Uses that do not exceed the acute risk to non-listed species LOC are urban and rural structures (granular), animal feedlots, residential lawn (granular), rights-of-way granular and ground, and cucurbit vegetables (granular). Of these six uses, urban and rural structures (granular), animal feedlots, and residential lawn (granular) do not exceed the chronic risk LOC.	Indirect Effects (prey items): CCR, CFWS, CTS (all DPS), DS, SFGS, TG	CTS-CC, CTS-SB, DS, TG
	Listed Species (Yes)	All but two uses (residential lawns granular and urban and rural structures granular) exceed the acute risk to listed species LOC (0.05). All but three uses exceed the chronic risk LOC (see above).	Direct Effects: CFWS	
Estuarine/ Marine Fish	Non-listed Species (Yes)	None of the uses exceed the acute risk to non-listed species LOC (0.5) for bifenthrin. The chronic risk LOC (1) is exceeded for 89% of the uses. Uses that do not exceed the chronic risk LOC include deciduous fruits, apple, stone fruits (granular); cucurbit vegetables (granular); airports/landing fields; residential lawns (granular); animal feedlots; urban and rural structures (granular); rights-of-way (ground and granular); utility poles rights-of-way (granular)	Indirect Effects (prey items): CCR	DS, TG
	Listed Species (Yes)	None of the uses exceed the acute risk to listed species LOC (0.05). Chronic risk LOCs are exceeded for 89% of the uses (see previous row).	Direct Effects: 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 Invertebrates (Non-Benthic)	Non-listed Species (Yes)	Ninety-eight percent of the bifenthrin uses exceed the acute risk to non-listed species LOC (0.5) and 99% exceed the chronic risk LOC (1). The following uses do not exceed the acute and/or chronic risk LOCs: residential lawns (granular) (acute and chronic); and urban and rural structures (only acute).	Indirect Effects (prey items): CCR, DS, TG	DS, TG
Estuarine/ Marine Benthic Invertebrates	Non-listed Species (Yes)	Eighty-seven percent of the uses exceed the acute risk to non-listed species LOC (0.5) and 59% of the uses exceed the chronic risk LOC (1). Uses that do not exceed the acute risk to non-listed species LOC include residential lawns (2 ground applications; however, the LOC is exceeded when 6 applications are modeled); residential lawn (granular); residential lawn (perimeter treatment, 1 application; however, the LOC is exceeded when 6 applications are modeled); animal feedlots; urban and rural structures (granular); urban and rural structures (void treatment, soil treatment or trenching, and ground); rights-of-way (ground and granular); and utility poles rights-of-way (granular).	Indirect Effects (prey items): CCR, DS, TG	DS, TG
Birds, Reptiles, and Terrestrial-Phase Amphibians	Non-listed Species (Yes)	Based on T-REX modeling, no RQs exceed the acute risk to non-listed species LOC (0.5) for birds; however, the chronic risk LOC (1) is exceeded for 15 out of 42 application scenarios[78]. The T-HERPS refinements for these uses result in RQs that exceed the chronic risk LOC for the same 14 uses for terrestrial-phase amphibians; however, chronic risk LOCs are exceeded for only 6 of the application scenarios for reptiles[79]. For the granular applications, the acute risk to non-listed species LOC is not exceeded for any of the uses.	Indirect Effects: CCR, CTS (all DPS), SFGS	CTS-CC, CTS-SB

[78] Uses include beets and garden beets; bushberries; citrus crops; cotton; fruits (unspecified); head and stem brassica; lettuce, leafy petiole vegetables; pears, mayhaw, fruits (unspecified), strawberry; root crops; spinach; tree nut crops (1); forest tree plantations; ornamental & shade trees (1); ornamental & shade trees (2); pave area perimeters; and, sod farms, ornamental sod farms.
[79] Uses include citrus crops; cotton; pears, mayhaw, fruits (unspecified), strawberry; tree nut crops (1); ornamental & shade trees (1); ornamental & shade trees (2).

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 the listed species acute LOC (0.1) is exceeded for 3 out of 42 application scenarios (citrus crops; ornamental & shade trees (1); and, ornamental & shade trees (2)). T-HERPS refinements, result in RQs that exceed the acute risk to listed species LOC for 6 application scenarios for amphibians (citrus crops; cotton; pears, mayhaw, fruits (unspecified), strawberry; ornamental & shade trees (1); and, ornamental & shade trees (2)) and one application scenario of reptiles (ornamental & shade trees (1)). Chronic risk LOCs are exceeded as described in the previous row. For the granular applications, the acute risk to listed species LOC is exceeded for numerous uses such as turf, Christmas tree plantations, and golf courses, for which the application rate is high (*i.e.*, 0.4 lb a.i./A). These represent broadcast applications (as opposed to T-band or in furrow applications).	Direct Effects: CCR, CTS (all DPS), SFGS	
Mammals	Non-listed Species (Yes)	Based on T-REX modeling, RQs exceed the acute risk to non-listed LOC (0.5) for a 9 out of 44 uses (citrus crops, cotton, unspecified fruits, pears/ mayhaw/strawberry, ornamental & shade trees (two scenarios), paved area perimeter treatments, sod and ornamental sod farms, tuberous and corm vegetables). With the exception of airports/landing fields and residential lawns (2), all other uses exceed the chronic risk LOC (1). For the granular applications, the acute risk to non-listed species LOC is exceeded for numerous uses such as turf, Christmas tree plantations, and golf courses, for which the application rate is high (0.4 lb a.i./A). Additionally, the acute risk to non-listed species LOC is exceeded for various agricultural uses at a rate of 0.1 lb a.i./A. These represent broadcast applications (as opposed to T-band or in furrow applications).	Indirect Effects: (prey items) CCR (prey items and habitat) CTS (all DPS), SFGS	CTS-CC, CTS-SB
Terrestrial Invertebrates	Listed Species (Yes)	All the RQs exceed the acute risk to listed and non-listed species LOCs for all uses.	Direct Effects: BCB, VELB	BCB, VELB
	Non-listed Species (Yes)		Indirect Effects: CCR, CTS (all DPS), SFGS	CTS-CC, CTS-SB

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

- 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 **Section 5.2.1** through **Section 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 bifenthrin. 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 for all bifenthrin uses exceed the acute risk to listed species LOC (0.05) for direct effects to the BCB, resulting in a preliminary "may affect" determination. Bifenthrin is an insecticide and thus it is expected to have adverse effects on insects. Although there is uncertainty regarding the use of honeybee data as a surrogate for lepidopteran species (Hoang *et al.* 2011), use of available of toxicity data for the most sensitive lepidopteran species tested in place of the honey bee would not change the overall risk conclusions.

Three incidents involving terrestrial invertebrates (honeybees) were reported for bifenthrin in the EIIS database. One reported a large number of dead bees and the loss of 61 hives associated with pesticide application to alfalfa, which included bifenthrin (I020835-001). This incident was classified in the certainty category of ‘possible’ due to co-application of other pesticide and its legality classification is ‘unknown.’ Another incident involved loss of 50% of the worker bees (number unspecified) associated with application of bifenthrin to cotton. This incident was classified as probable (I024221-001) but the legality of use is unknown. The third incident (I023061-001) involved a residential application via a pest control company use and was reportedly associated with an unknown number of bees. This incident is considered a registered use for residential perimeter treatment and is classified as probable (I000080-009). These incidents occurred between 2007 and 2012. Additionally, there is an incident involving an unknown number of leafcutter bees (*M. rotundata*) that occurred in 1992 and that was classified as probable although it was attributed to a misuse of bifenthrin. Details of these incidents are provided in **Appendix K**.

The maximum probability of an individual effect for a BCB is 1 in 1.00 (100%) for all application rates and scenarios (**Appendix E**). This probability is based on the maximum acute RQs and the default probit slope of 4.5.

Given the exceedances of the LOCs using the default foliar dissipation half-life of 35 days, a pyrethroid-specific foliar dissipation half-life of 8.3 days was also employed for characterization purposes, based on the work of Willis & McDowell (1987) (refer to the **Appendix E**). This foliar DT_{50} was not used for risk estimation because it is not specific to bifenthrin and differences in DT_{50} values are likely to be substantial across pyrethroid insecticides. Even with the shorter foliar dissipation half-life of 8.3 days, RQs range from **6.3-812** across all of the uses evaluated and exceed the acute risk to listed species LOC of 0.05.

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

No plant toxicity data are available from registrant-submitted studies. *In lieu* of these data, the Pesticide Ecotoxicity Database (maintained by EFED) was consulted for information on terrestrial plant data for other pyrethroids. Submitted terrestrial plant studies were not available for any of the other pyrethroids that were considered suitable for use as a surrogate for bifenthrin. In addition, information published in the open literature (**Appendix E**) was not considered suitable to evaluate the effect of bifenthrin on terrestrial plants since most evaluated the effect of bifenthrin on pests simultaneously with those on the plant and others did not evaluate or express endpoints that were consistent with the assessment endpoints (survival, growth, reproduction).

As discussed in Section 4, four ecological incidents are available for bifenthrin that involve terrestrial plants. Of these, only one is classified as "probable" which involved application to roses according to the label (*i.e.,* classified as a 'registered use'). A search of the Incident Data System (IDS), however, indicates that there is a large number of minor plant incidents involving bifenthrin (5,635). The vast majority of these minor incidents involved residential application of "Turf Builder with Summerguard®" (3,605 plant incidents) and "Lawn Pro Step 3®" (2,489 plant incidents and reported effects on turf grass. It is noted that these formulations include bifenthrin and various fertilizer ingredients. Additional details regarding these minor incidents are not reported or available, such as the strength of causal relationship between pesticide application and effects and the legality of use. Although effects on terrestrial plants are not expected based on the mode of action of bifenthrin, the large number of minor incidents suggests there is a potential of bifenthrin to cause adverse effects on terrestrial plants at least when applied to turf grass using the aforementioned formulations. Therefore, a potential for indirect effects of bifenthrin on the BCB via adverse effects on terrestrial plants is identified.

5.2.1.c. Modification of Designated Critical Habitat

Based on the assessment of direct and indirect effects to the BCB above, the modification of designated critical habitat for the BCB is possible. 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 44 possible application rate/interval combination scenarios, three bifenthrin uses resulted in RQs that exceed the acute risk to listed species LOC for direct effects to the CCR. One of the scenarios was agricultural (citrus crops), and ornamental and shade trees (two types of application). On a chronic risk basis, 15 of the 44 scenarios yielded RQs that exceed the chronic risk LOC for direct effects to the CCR. Thus, a preliminary "may affect" determination is appropriate.

No incidents involving birds have been reported. No open literature studies on the effects of bifenthrin on birds or terrestrial-phase amphibians have been identified

The maximum probability of an individual effect for a CCR based on avian toxicity data is between 1 in 144 (0.7%) for the two bifenthrin application rates (citrus crops, and ornamental and shade trees) (**Appendix E**). This probability is based on the maximum acute RQs and the species-specific probit slope of 3.52.

Given the exceedances of the LOCs using the default foliar dissipation half-life of 35 days, a pyrethroid-specific foliar dissipation half-life of 8.3 days was also employed for characterization purposes. This foliar DT_{50} was not used for risk estimation because it is not specific to bifenthrin and differences in DT_{50} values are likely to be substantial among different pyrethroid insecticides. Results are summarized in **Table 5-18** and show that only two of the uses exceed the acute risk to listed species LOCs. Further, of 16 uses that previously exceeded the chronic risk LOC, eight still exceed the LOC using the pyrethroid-specific dissipation half-life.

Table 5-18. Acute and Chronic RQs Derived Using T-REX for Bifenthrin and CCR, Using a Pyrethroid-Specific Foliar Dissipation Half-life of 8.3 Days.

	RQs for CCR (small bird consuming short grass)		
Use, Type of Application	Acute Dose-Based	Acute Dietary Based	Chronic Dietary Based
Agricultural Use Patterns			
Beets, garden beets	0.04	0.04	0.65
Bushberries	0.05	0.04	0.68
Citrus crops	0.11	0.09	1.60
Cotton	0.07	0.06	1.03
Fruits (unspecified)	0.07	0.06	1.00
Head and Stem Brassica; Lettuce, Leafy Petiole Vegetables	0.05	0.04	0.68
Pears, Mayhaw, Fruits (unspecified), Strawberry	0.07	0.06	1.00
Root Crops	0.05	0.04	0.68
Spinach	0.04	0.04	0.65
Tree Nut Crops (1)	0.05	0.05	0.79
Non-Agricultural Use Patterns			
Forest Tree Plantations	0.05	0.04	0.71
Ornamental & Shade Trees (1)	0.20	0.18	3.04
Ornamental & Shade Trees (2)	0.07	0.06	1.04
Pave Area Perimeters	0.08	0.07	1.22
Sod farms, ornamental sod farms	0.07	0.06	1.00
LOC exceedances (acute RQ $\geq$ 0.1 and chronic RQ $\geq$ 1.0) are bolded.			

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 bifenthrin 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, exposure through terrestrial food items exceed the acute risk to listed species LOC for two uses and exceed the chronic risk LOC for eight uses, even with a reduced foliar dissipation half-life. Therefore, there is a potential for direct effects to the CCR as a result of registered bifenthrin 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 SF 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 89% of the uses exceeded the chronic risk LOC (1) for freshwater fish.

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

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

Freshwater Invertebrates

All but two (*i.e.*, residential lawn granular and urban and rural structures granular applications) out of 82 uses exceeded the acute risk to non-listed LOC (0.5) for freshwater invertebrates, and all but one of the uses (*i.e.*, residential lawn granular application) exceed the chronic risk LOC (1) .

All but six of 82 uses exceed the acute risk to non-listed LOC (0.5) for benthic freshwater invertebrates. All but three uses exceed the chronic risk LOC (1) for freshwater benthic invertebrates. Uses that did not exceed the acute risk non-listed species LOC are urban and rural structures (granular), animal feedlots, residential lawn (granular), cucurbit vegetables (granular), and rights-of-way (granular and ground 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 bifenthrin 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 bifenthrin for estuarine/marine fish; however, the chronic risk LOC (1) was exceeded for 89% of the uses. Uses that do not exceed the chronic risk LOC included deciduous fruits, apple, stone fruits (granular); cucurbit vegetables (granular); airports/landing fields; residential lawns (granular); animal feedlots; urban and rural structures (granular); rights-of-way (ground and granular); utility poles rights-of-way (granular).

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

Estuarine/Marine Invertebrates

Ninety-eight percent of the bifenthrin uses exceed the acute risk to non-listed LOC (0.5) for estuarine/ marine invertebrates, and 99% exceed the chronic risk LOC (1). The following uses do not exceed the LOCs: residential lawns (granular) (acute and chronic); and urban and rural structures (only acute).

Eighty-seven percent of the uses exceed the acute risk to non-listed species LOC (0.5) for estuarine/marine benthic invertebrates, and 59% of the uses exceed the chronic risk LOC (1). Uses that do not exceed the acute risk to non-listed species LOC include residential lawns (2 ground applications; however the LOC is exceeded when 6 applications were modeled); residential lawn (granular); residential lawn (perimeter treatment, 1 application; however, the LOC is exceeded when 6 applications are modeled); animal feedlots; urban and rural structures (granular); urban and rural structures (void treatment, soil treatment or trenching, and ground); rights-of-way (ground and granular); and utility poles rights-of-way (granular).

The maximum probability of an individual effect for a non-listed species of estuarine/marine (water column and benthic) invertebrates is 1 in 1.01 (99%) calculated 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 bifenthrin 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

No data on the toxicity of bifenthrin to aquatic plants was submitted to the Agency or available in the open literature (**Appendix E**). However, given the low toxicity of other pyrethroids to aquatic plants (see **Table 4-4**) and the mode of action of bifenthrin, risks to aquatic plants at its limit of solubility (0.014 ug ai/L) are considered very low. 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. None of the registered uses exceed the acute risk to non-listed species LOC (0.5) in T-REX; however, for 16 of the 44 scenarios, the chronic risk LOC is exceeded.

Small Mammals

Out of 44 uses evaluated, two exceed the acute risk to non-listed species LOC and all but two of the scenarios exceed the chronic risk LOC. The probability of an individual acute effect ranges from 1 in 1.00×10^{16} to 1 in 1.13 (88%) 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 seem to pose a risk for mammals eating aquatic prey.

Although bioaccumulation does not appear to represent a risk mammals, potential acute and chronic risk to mammals combined with a relatively high likelihood of individual acute effects from some uses combine such that 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**, a search of the Incident Data System (IDS) indicates that there is a large number of minor plant incidents involving bifenthrin (5,635). The vast majority of these minor incidents involved residential application of "Turf Builder with Summerguard®" (3,605 plant incidents) and "Lawn Pro Step 3®" (2,489 plant incidents and reported effects on turf grass. It is noted that these formulations include bifenthrin and various fertilizer ingredients. Additional details regarding these minor incidents are not reported or available, such as the strength of causal relationship between pesticide application and effects and the legality of use. Although effects on terrestrial plants are not expected based on the mode of action of bifenthrin, the large number of minor incidents suggests there is a potential of bifenthrin to cause adverse effects on terrestrial plants at least when applied to turf grass using the aforementioned formulations. Therefore, a potential for indirect effects of bifenthrin on the CCR via adverse effects on terrestrial plants is 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 acute risk to non-listed species LOC (0.5) for freshwater invertebrates (water column dwelling), and all but one (*i.e.*, residential lawn granular application) of the uses exceed the chronic risk LOC (1). The vast majority of assessed uses also exceed the non-listed LOC for benthic invertebrates and the maximum probability of an individual acute effect for a non-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 bifenthrin on freshwater invertebrates; however, incidents on invertebrates are unlikely to be noticed and reported to the Agency. Bifenthrin has been implicated in the toxicity of sediments to benthic invertebrates in selected urban streams in California.[80]

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 bifenthrin.

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.

---

[80] For example, see Amweg, E., Weston, D., You, J, and Lydy. 2006. Pyrethroid Insecticides and Sediment Toxicity in Urban Creeks from California and Tennessee. *Env. Sci. Technol.* 40:1700-1706.

Aquatic Plants

As summarized for indirect effects on the CCR in **Section 5.2.2.b** no data on the toxicity of bifenthrin to aquatic plants was submitted to the Agency or available in the open literature (**Appendix E**). However, given the low toxicity of other pyrethroids to aquatic plants (see **Table 4-4**) and the mode of action of bifenthrin, risks to aquatic plants at its limit of solubility (0.014 ug ai/L) are considered very low. Therefore, indirect effects to the CFWS based on this food and habitat component are not likely.

Terrestrial Plants

As discussed previously for the BCB in **Section 5.2.1.b**, a large number of minor plant incidents are reported for application of pesticides containing bifenthrin based on a search of the Pesticide Incident Data System (IDS). Although effects on terrestrial plants are not expected based on the mode of action of bifenthrin, the large number of minor incidents suggests there is a potential of bifenthrin to cause adverse effects on terrestrial plants at least when applied to turf grass using the aforementioned formulations. Therefore, a potential for indirect effects of bifenthrin on the CFWS via adverse effects on terrestrial plants is identified.

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 bifenthrin (Attachment III).

As described previously for effects on freshwater fish (Section 5.2.2.b), the vast majority of uses exceed the acute risk to listed species LOC (0.05) and the chronic risk LOC (1.0). The maximum probability of an individual effect for listed freshwater fish is 1 in 7,370 (1.4%) based on the maximum acute RQ and the freshwater fish-specific probit slope (3.53).

No incidents were reported for aquatic-phase amphibians; however, such incidents may not be readily observed. As discussed previously, incidents have been reported for 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. Three acute RQs and 15 chronic RQs for bifenthrin uses exceed the risk to listed species LOC for direct effects to the terrestrial-phase CTS, resulting in a preliminary "may affect" determination.

A refinement of the acute and chronic risks posed to the terrestrial-phase CTS was performed using the T-HERPS model. Avian RQ values used as screening surrogates for terrestrial-phase amphibians likely overestimate risks to amphibians because of the higher energy requirements of birds over amphibians of the same body weight, which results in a higher daily food intake rate value and a resultant higher dose-based exposure for birds than would 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 risk to listed species LOCs are exceeded for 6 uses (rather than 3) and the same 15 chronic RQs. Acute RQ values increased under the T-HERPS model while the chronic RQs were similar. Model results from T-HERPS are from the most sensitive RQs, *i.e.*, medium amphibians (20 g) consuming herbivorous mammals.

The probability of an individual effect for a CTS based on avian toxicity data range from 1 in 1.00×10^{16} to 1 in 144 for the full range of bifenthrin application rates (**Table 5-16**).

Given the exceedances of the LOCs using the default foliar dissipation half-life of 35 days, a pyrethroid-specific foliar dissipation half-life of 8.3 days was also employed for characterization purposes. This foliar DT_{50} was not used for risk estimation because it is not specific to bifenthrin and differences in DT_{50} values are likely to be substantial among different pyrethroid insecticides. Results are summarized in **Table 5-19**; of the six uses that initially exceeded the acute risk to listed species LOC using the default half-life value, only one exceeds using the half-life of 8.3 days. Further, of 15 uses that exceed the chronic risk LOC using a half-life of 35 days, 8 still exceed the chronic risk LOC using the pyrethroid-specific foliar dissipation half-life.

Table 5-19. Acute and Chronic RQs Derived Using T-HERPS for Bifenthrin and Terrestrial Phase Amphibians, Using a Pyrethroid-Specific Foliar Dissipation Half-Life of 8.3 Days

Use, Type of Application	RQs for CTS (all DPS) (medium amphibians consuming herbivorous mammals)		
	Acute Dose-Based	Acute Dietary Based	Chronic Dietary Based
Agricultural Use Patterns			
Beets, garden beets	0.02	0.04	0.66
Bushberries	0.02	0.04	0.69
Citrus crops	0.04	0.09	**1.61**
Cotton	0.03	0.06	**1.04**
Fruits (unspecified)	0.03	0.06	**1.00**
Head and Stem Brassica; Lettuce, Leafy Petiole Vegetables	0.02	0.04	0.69
Pears, Mayhaw, Fruits (unspecified), Strawberry	0.03	0.06	**1.00**
Root Crops	0.02	0.04	0.69
Spinach	0.02	0.04	0.66
Tree Nut Crops (1)	0.02	0.05	0.79

Use, Type of Application	RQs for CTS (all DPS) (medium amphibians consuming herbivorous mammals)		
	Acute Dose-Based	**Acute Dietary Based**	**Chronic Dietary Based**
Non-Agricultural Use Patterns			
Forest Tree Plantations	0.02	0.04	0.72
Ornamental & Shade Trees (1)	0.08	**0.18**	**3.05**
Ornamental & Shade Trees (2)	0.03	0.06	**1.05**
Pave Area Perimeters	0.03	0.07	**1.22**
Sod farms, ornamental sod farms	0.03	0.06	**1.00**

LOC exceedances (acute RQ $\geq$ 0.1 and chronic RQ $\geq$ 1.0) are bolded.

Based on the weight of evidence presented here, direct effects to the terrestrial-phase CTS as a result of bifenthrin uses 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, 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 bifenthrin on aquatic plants, terrestrial plants, and small mammals (Attachment III).

Freshwater Invertebrates

As summarized for indirect effects on the CCR in **Section 5.2.2.b**, 98% of the assessed uses exceed the acute risk to non-listed species LOC (0.5) for freshwater invertebrates (water column dwelling), and all but one (*i.e.*, residential lawn granular application) of the uses exceed the chronic risk LOC (1). The vast majority of assessed uses also exceed the non-listed LOC for benthic invertebrates and the maximum probability of an individual acute effect for a non-listed species of freshwater invertebrate (water column and benthic) is high.

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

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

Even though none of the RQ values exceed the acute risk to non-listed species LOC (0.5) for freshwater fish, about 89% of the uses exceed the chronic risk LOC (1). Based on output from KABAM, bioaccumulation does not seem to pose a risk for amphibians eating aquatic prey.

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

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

Terrestrial Invertebrates

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

Small Mammals

Mammals are part of the CTS diet. In addition, juvenile and adult CTS rely on the burrows of small mammals for habitat in the dry summer and fall months. Out of 44 uses, two exceed the acute risk to non-listed species LOC and all but two of the scenarios exceed the chronic risk LOC. The probability of an individual effect ranges from 1 in 1.00×10^{16} to 1 in 1.13 (88%) for all uses. These probabilities are based on acute RQs and the default probit slope (4.5). As noted in previous sections, bioaccumulation does not seem to pose a risk for mammals eating aquatic prey.

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

Aquatic Plants

No data on the toxicity of bifenthrin to aquatic plants was submitted to the Agency or available in the open literature (**Appendix E**). However, given the low toxicity of other pyrethroids to aquatic plants (see **Table 4-4**) and the mode of action of bifenthrin, risks to aquatic plants at its limit of solubility (0.014 ug ai/L) are considered very low. Therefore, indirect effects to the CTS based on this food and habitat component are not likely.

Terrestrial Plants

As discussed previously for the BCB in **Section 5.2.1**, effects on terrestrial plants are not expected based on the mode of action of bifenthrin. However, a large number of minor incidents suggests there is a potential of bifenthrin to cause adverse effects on terrestrial plants at least when applied to turf grass using the aforementioned formulations. Therefore, a potential for indirect effects of bifenthrin 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 on freshwater fish are used instead of estuarine/marine fish because the former appeared to be more sensitive than the latter and the DS inhabits both types of aquatic habitats. Out of 82 uses assessed, all but four exceed the acute risk to listed species LOC (0.05) for freshwater fish (uses that do not exceed acute risk to listed species LOC include residential lawn granular, animal feedlots and premises, urban and rural structures granular application, and rights-of-way granular). Approximately 89% of the uses exceed the chronic risk LOC. The maximum probability of an individual acute effect for listed freshwater fish is1 in 7,370 based on the maximum acute RQs and the freshwater fish-specific probit slope (3.53).

Of the 5 aquatic incidents involving fish, 2 are classified as 'highly probable' or 3 as 'probable' in the context of bifenthrin use. Catfish were cited in 3 incidents, fathead minnow, trout, bullheads and koi were listed in one incident, and two incidents did not report the species killed. Of these incidents, three were associated with rainfall and runoff events soon after application to a building roof, lawn turf, and corn field. One incident was associated with aerial application (presumably spray drift).

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

Terrestrial Plants

As discussed previously for the BCB in **Section 5.2.1.b**, a large number of minor plant incidents are reported for application of pesticides containing bifenthrin based on a search of the Pesticide Incident Data System (IDS). Although effects on terrestrial plants are not expected based on the mode of action of bifenthrin, the large number of minor incidents suggests there is a potential of bifenthrin to cause adverse effects on terrestrial plants at least when applied to turf grass using the aforementioned formulations. Therefore, a potential for indirect effects of bifenthrin 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. Three acute RQs and all chronic RQs for bifenthrin uses exceed the risk to listed species LOCs for direct effects to the SFGS, resulting in a preliminary "may affect" determination.

Given that there are exceedances 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. One RQ, (*i.e.*, ornamentals & shade trees) exceeds the acute risk to listed species LOC after refinements and six RQs exceed the chronic risk LOC.

The maximum probability of an individual acute effect for a SFGS is 1 in 9.27×10^6 based on the maximum RQ and a default slope of 4.5. (**Appendix E** and **Table 5-16**).

Given the exceedances of the acute and chronic risk LOCs using the default foliar dissipation half-life of 35 days, a pyrethroid-specific foliar dissipation half-life of 8.3 days was also employed for characterization purposes. This foliar DT_{50} was not used for risk estimation because it is not specific to bifenthrin and differences in DT_{50} values are likely to be substantial among different pyrethroid insecticides. Results are summarized in **Table 5-20** the one RQ that exceeded the acute risk listed LOC with the default half life still exceeds the LOC with a pyrethroid-specific half life. Further, of 6 uses that exceeded the chronic risk LOC with the default half-life of 35 days, 2 still exceed the LOC using the pyrethroid-specific dissipation half-life.

Table 5-20. Acute and Chronic RQs Derived Using T-HERPS for Bifenthrin and SFGS, Using a Pyrethroids-Specific Foliar Dissipation Half-life of 8.3 Days

	RQs for Small SFGS (small snake consuming small insects)			RQs for Medium SFGS (medium snake consuming herbivorous mammals)		
Use, Type of Application	**Acute Dose-Based**	**Acute Dietary Based**	**Chronic Dietary Based**	**Acute Dose-Based**	**Acute Dietary Based**	**Chronic Dietary Based**
Agricultural Use Patterns						
Citrus crops	0.00	0.05	0.90	0.06	0.07	**1.23**
Cotton	0.00	0.03	0.58	0.04	0.05	0.79
Pears, Mayhaw, Fruits (unspecified), Strawberry	0.00	0.03	0.56	0.04	0.04	0.77
Tree Nut Crops (1)	0.00	0.03	0.44	0.03	0.04	0.60
Non-Agricultural Use Patterns						
Ornamental & Shade Trees (1)	0.00	**0.10**	**1.71**	**0.12**	**0.14**	**2.33**
Ornamental & Shade Trees (2)	0.00	0.03	0.59	0.04	0.05	0.80

LOC exceedances (acute RQ $\geq$ 0.1 and chronic RQ $\geq$ 1.0) are bolded.

Based on output from KABAM, bioaccumulation of bifenthrin 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 bifenthrin uses are possible.

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

Even though none of the RQ values exceed the acute risk to non-listed species LOC (0.5) for freshwater fish, about 89% of the uses exceed the chronic risk LOC (1). As noted previously, bioaccumulation does not seem to pose a risk for amphibians eating aquatic prey.

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

Based on the potential for chronic risk to fish and aquatic-phase amphibians, 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. None of the registered uses exceed the acute risk to non-listed species LOC (0.5) in T-REX; however, for 16 of the 44 scenarios, the chronic risk LOC is exceeded.

Small Mammals

The SFGS consumes small mammals as part of its diet. In addition, it relies on the burrows of small mammals for shelter and aestivation when ponds become dry. They may also forage for amphibians in the rodent burrows during the summer. In addition, SFGS rely on the burrows of small mammals for habitat in the dry summer and fall months. Out of 44 uses, two exceed the acute risk to non-listed species LOC and all but two of the scenarios exceed the chronic risk LOC. The maximum probability of an individual acute effect is to 1 in 1.13 (88%) based on the maximum acute RQ and the default probit slope (4.5). Bioaccumulation does not pose a risk concern for mammals eating aquatic prey based on KABAM model results.

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

Terrestrial Invertebrates

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

Aquatic Plants

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 bifenthrin and low toxicity of pyrethroids to aquatic plants.

Terrestrial Plants

As discussed previously for the BCB in **Section 5.2.1.b**, a large number of minor plant incidents are reported for application of pesticides containing bifenthrin based on a search of the Pesticide Incident Data System (IDS). Although effects on terrestrial plants are not expected based on the mode of action of bifenthrin, the large number of minor incidents suggests there is a potential of bifenthrin to cause adverse effects on terrestrial plants at least when applied to turf grass using the aforementioned formulations. Therefore, a potential for indirect effects of bifenthrin 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 on freshwater fish was used instead of estuarine/marine fish because the former appeared to be more sensitive than the latter and the TG inhabits both types of aquatic habitats. Out of 82 uses assessed, all but four exceed the acute risk to listed species LOC (0.05) for freshwater fish (uses that do not exceed acute risk to listed species LOC are residential lawn granular, animal feedlots and premises, urban and rural structures granular application, and rights-of-way granular). Approximately 89% of the uses exceed the chronic risk LOC. The maximum probability of an individual effect for listed freshwater fish is 1 in 7,370 (1.4%) based on the maximum acute RQ and the freshwater fish-specific probit slope (3.53).

No incidents were reported for estuarine/marine fish. However, of the 5 aquatic incidents involving freshwater fish associated with bifenthrin use, 2 are classified as ‘highly probable’ or 3 as ‘probable’ in the context of bifenthrin use. Catfish were cited in 3 incidents, fathead minnow, trout, bullheads and koi were listed in one incident, and two incidents did not report the species of the kill. Of these incidents, three were associated with rainfall and runoff events soon after application to a building roof, lawn turf, and corn field. One incident was associated with aerial application (presumably spray drift).

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

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

Terrestrial Plants

As discussed previously for the BCB in **Section 5.2.1.b**, a large number of minor plant incidents are reported for application of pesticides containing bifenthrin based on a search of the Pesticide Incident Data System (IDS). Although effects on terrestrial plants are not expected based on the mode of action of bifenthrin, the large number of minor incidents suggests there is a potential of bifenthrin to cause adverse effects on terrestrial plants at least when applied to turf grass using the aforementioned formulations. Therefore, a potential for indirect effects of bifenthrin 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

RQs for all bifenthrin uses exceed the LOC (0.05) for direct effects to the VELB, resulting in a preliminary “may affect” determination. Bifenthrin is an insecticide and thus it is considered likely to have adverse effects on insects.

Three incidents involving terrestrial invertebrates (honeybees) were reported for bifenthrin in the EIIS database. One reported a large numbers of dead bees and the loss of 61 hives as a result of bifenthrin applications. This incident was classified in the certainty category of possible. Another of the incidents involved loss of 50% of the worker bees (number unspecified) and was classified as probable. The last one involved an unknown number of bees and was classified as probable. The legality of use was unknown for the first and second incident and a registered use for the thirds one. These incidents occurred between 2007 and 2012. Additionally, there is an incident involving leafcutter bees (number unknown) that occurred in 1992 and that was classified as probable and whose legality of use was a misuse.

The maximum probability of an individual effect for a VELB is 1 in 1 (100%) for all application rates (**Appendix E**). This probability is calculated based on the highest acute RQ and the default probit slope of 4.5.

Based on the weight of evidence presented here, there is a potential for direct effects to the VELB as a result of bifenthrin 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 indicated previously for the CCR, no plant toxicity data are available from registrant-submitted studies or open literature for bifenthrin (or other pyrethroids) that are considered suitable for effects determination to non-target terrestrial plants.

As discussed previously for the BCB in **Section 5.2.1.b**, a large number of minor plant incidents are reported for application of pesticides containing bifenthrin based on a search of the Pesticide Incident Data System (IDS). Although effects on terrestrial plants are not expected based on the mode of action of bifenthrin, the large number of minor incidents suggests there is a potential of bifenthrin to cause adverse effects on terrestrial plants at least when applied to turf grass using the aforementioned formulations. Therefore, a potential for indirect effects of bifenthrin on the VELB via adverse effects on terrestrial plants is 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 bifenthrin's use patterns are identified, using corresponding land cover data, see Section 2.7. However, given bifenthrin'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 bifenthrin, and was not performed.

5.2.9.a. Spray Drift

To determine terrestrial habitats of concern from bifenthrin 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 bifenthrin 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, 90^{th} 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 labels mainly used were the ones for Brigade® 2EC, Brigade® WSB, Fanfare® 2SC, and Capture® 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 bifenthrin is not included in the analysis. The results are summarized in **Table 5-21, Table 5-22, and Table 5-23**).

Insects are the most sensitive group and buffer distances are out of range for all the scenarios (>1,000 ft for ground applications and >2,608 ft for aerial applications) (**Table 5-21**). The single exceptions are tree nut crops, fruits and small fruits, and deciduous fruits/ apple and stone fruits, which are modeled using airblast applications. Buffer zones are slightly less than 500 ft in such cases. For these uses, however, it appears that conventional ground methods of application can also be used. Buffer distances for mammals range from 3.3 to 6.6 ft. For birds, there is only one exceedance and the buffer zone in that instance is 3.3 ft. Many of the calculated buffer distances for mammals are less than 25 ft.

Table 5-21. Terrestrial Organisms Buffers for Bifenthrin Calculated with AgDRIFT

Use	Single App Rate (lb a.i./A)	Fraction of Applied			Buffer Distance (ft)		
		Insect	Birds	Mammal	Insect	Birds	Mammal
		$6.1x10^{-5}$	0.474	0.258	N/A	N/A	N/A
Alfalfa, Clover	0.1 (aerial)	$6.1x10^{-4}$	N/C	N/C	>2,608	N/C	N/C
Tree nut crops	0.216 (aerial)	$2.8x10^{-4}$	N/C	N/C	>2,608	N/C	N/C
Tree nut crops	0.216 (air blast)	$2.8x10^{-4}$	N/C	N/C	499	N/C	N/C
Citrus crops	0.5 (ground)	$1.4x10^{-4}$	0.948	0.516	>1,000	3.3	6.6
Head and Stem Brassica Vegetables	0.1 (aerial)	$6.1x10^{-4}$	N/C	N/C	>2,608	N/C	N/C
Corn	0.1 (aerial)	$6.1x10^{-4}$	N/C	N/C	>2,608	N/C	N/C
Sweet corn	0.1 (aerial)	$6.1x10^{-4}$	N/C	N/C	>2,608	N/C	N/C
Cotton	0.1 (aerial)	$6.1x10^{-4}$	N/C	N/C	>2,608	N/C	N/C
Pears, Mayhaw, Fruits (unspecified)	0.167 (aerial)	$3.7x10^{-4}$	N/C	N/C	>2,608	N/C	N/C
Fruits (unspecified), Small Fruits (unspecified)	0.2 (air blast)	$3.1x10^{-4}$	N/C	N/C	479	N/C	N/C
Deciduous Fruits, Apple, Stone Fruits	0.21 (air blast)	$2.9x10^{-4}$	N/C	N/C	492	N/C	N/C
Grapes	0.1 (aerial)	$6.1x10^{-4}$	N/C	N/C	>2,608	N/C	N/C
Lettuce	0.1 (aerial)	$6.1x10^{-4}$	N/C	N/C	>2,608	N/C	N/C
Leafy petiole vegetables	0.1 (aerial)	$6.1x10^{-4}$	N/C	N/C	>2,608	N/C	N/C
Spinach	0.1 (aerial)	$6.1x10^{-4}$	N/C	N/C	>2,608	N/C	N/C
Cucurbit vegetables	0.1 (aerial)	$6.1x10^{-4}$	N/C	N/C	>2,608	N/C	N/C
Tuberous and corm vegetables	0.3 (at plant) (ground)	$2.0x10^{-4}$	N/C	0.860	>1,000	N/C	3.3
Root Crops	0.1 (ground)	$6.1x10^{-4}$	N/C	N/C	>1,000	N/C	N/C
Artichokes	0.1 (aerial)	$6.1x10^{-4}$	N/C	N/C	>2,608	N/C	N/C
Peppers (bell and non-bell)	0.1 (aerial)	$6.1x10^{-4}$	N/C	N/C	>2,608	N/C	N/C
Succulent Peas and Beans	0.1 (aerial)	$6.1x10^{-4}$	N/C	N/C	>2,608	N/C	N/C
Dried peas and beans	0.1 (ground)	$6.1x10^{-4}$	N/C	N/C	>1,000	N/C	N/C
Agricultural crops/ soils	0.112 (ground)	$5.4x10^{-4}$	N/C	N/C	>1,000	N/C	N/C
Strawberry	0.216 (aerial)	$2.8x10^{-4}$	N/C	N/C	>2,608	N/C	N/C
Strawberry	0.216 (ground)	$2.8x10^{-4}$	N/C	N/C	>1,000	N/C	N/C
Beets, garden beets	0.1 (ground)	$6.1x10^{-4}$	N/C	N/C	>1,000	N/C	N/C
Eggplant, Ground cherry, Pepino	0.1 (aerial)	$6.1x10^{-4}$	N/C	N/C	>2,608	N/C	N/C
Tomato and tomatillo	0.08 (aerial)	$7.6x10^{-4}$	N/C	N/C	>2,608	N/C	N/C
Canola, rapeseed, crambe	0.04 (aerial)	$1.5x10^{-3}$	N/C	N/C	>2,608	N/C	N/C
Caneberries	0.1 (aerial)	$6.1x10^{-4}$	N/C	N/C	>2,608	N/C	N/C
Bushberries	0.1 (aerial)	$6.1x10^{-4}$	N/C	N/C	>2,608	N/C	N/C
Hops	0.1 (aerial)	$6.1x10^{-4}$	N/C	N/C	>2,608	N/C	N/C

N/C = not calculated because acute RQ did not exceed LOC; **Even though the acute RQ exceeded the LOC for this application, two applications were modeled. However, AgDRIFT can only model a single application, in which case, the LOC would not be exceeded.

For freshwater fish, buffer zones at the acute risk to listed species LOC (0.05) range from 259 ft to >2,608 ft or >1000 ft (**Table 5-22**). Buffer distances for freshwater fish at the acute risk to non-listed species LOC (0.5) range from 722 to >2,608 ft or >1000 ft. Buffer distances for estuarine/marine fish at the acute risk to non-listed species LOC (0.5) range from 509 to >2,608 ft or >1000 ft. In 2008, EPA issued a memo 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.

Table 5-22. Freshwater and Estuarine/Marine Fish Buffers Distances for Bifenthrin, Calculated with AgDRIFT

Use	Single application 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)		
		(75) (Acute)	(15) (Acute restricted)	(7.5) (Acute listed)	(8,900) (Acute)	(1,780) (Acute restricted)	(890) (Acute listed)
Alfalfa, Clover	0.1 (aerial)	N/C	N/C	>2,608	N/C	N/C	N/C
Tree nut crops	0.216 (aerial)	N/C	N/C	>2,608	N/C	N/C	N/C
Tree nut crops	0.216 (air blast)	N/C	N/C	269	N/C	N/C	N/C
Citrus crops	0.5 (ground)	N/C	N/C	>1000	N/C	N/C	N/C
Head and Stem Brassica Vegetables	0.1 (aerial)	N/C	N/C	>2,608	N/C	N/C	N/C
Corn	0.1 (aerial)	N/C	N/C	>2,608	N/C	N/C	N/C
Sweet corn	0.1 (aerial)	N/C	N/C	>2,608	N/C	N/C	N/C
Cotton	0.1 (aerial)	N/C	N/C	>2,608	N/C	N/C	N/C
Pears, Mayhaw, Fruits (unspecified)	0.2 (aerial)	N/C	N/C	>2,608	N/C	N/C	N/C
Fruits (unspecified), Small Fruits (unspecified)	0.2 (air blast)	N/C	N/C	259	N/C	N/C	N/C
Deciduous Fruits, Apple, Stone Fruits	0.21 (air blast)	N/C	N/C	266	N/C	N/C	N/C
Grapes	0.1 (aerial)	N/C	N/C	>2,608	N/C	N/C	N/C
Lettuce	0.1 (aerial)	N/C	N/C	>2,608	N/C	N/C	N/C
Leafy petiole veg	0.1 (aerial)	N/C	N/C	>2,608	N/C	N/C	N/C
Spinach	0.1 (aerial)	N/C	N/C	>2,608	N/C	N/C	N/C
Cucurbit vegetables	0.1 (aerial)	N/C	N/C	>2,608	N/C	N/C	N/C
Tuberous and corm vegetables	0.3 at plant (ground)	N/C	N/C	>1000	N/C	N/C	N/C
Root Crops	0.1 (ground)	N/C	N/C	932	N/C	N/C	N/C
Artichokes	0.1 (aerial)	N/C	N/C	>2,608	N/C	N/C	N/C
Peppers (bell and non-bell)	0.1 (aerial)	N/C	N/C	>2,608	N/C	N/C	N/C
Succulent Peas and Beans	0.1 (aerial)	N/C	N/C	>2,608	N/C	N/C	N/C
Dried peas and beans	0.1 (ground)	N/C	N/C	932	N/C	N/C	N/C
Agricultural crops/ soils	0.112 (ground)	N/C	N/C	>1000	N/C	N/C	N/C
Strawberry	0.216 (aerial)	N/C	N/C	>2,608	N/C	N/C	N/C
Strawberry	0.216 (ground)	N/C	N/C	>1000	N/C	N/C	N/C
Beets, garden beets	0.1 (ground)	N/C	N/C	932	N/C	N/C	N/C
Eggplant, Ground cherry, Pepino	0.1 (aerial)	N/C	N/C	>2,608	N/C	N/C	N/C
Tomato and tomatillo	0.08 (aerial)	N/C	N/C	>2,608	N/C	N/C	N/C
Canola, rapeseed, crambe	0.04 (aerial)	N/C	N/C	1690	N/C	N/C	N/C
Caneberries	0.1 (aerial)	N/C	N/C	>2,608	N/C	N/C	N/C
Bushberries	0.1 (aerial)	N/C	N/C	>2,608	N/C	N/C	N/C

Use	Single application 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)		
		(75) (Acute)	(15) (Acute restricted)	(7.5) (Acute listed)	(8,900) (Acute)	(1,780) (Acute restricted)	(890) (Acute listed)
Hops	0.1 (aerial)	N/C	N/C	>2,608	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 5-23**).

Table 5-23. Freshwater and Estuarine/Marine Benthic and Non-Benthic Invertebrate Buffers Distances for Bifenthrin, 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)		
		(0.95) (Acute)	(0.19) (Acute restricted)	(0.095) (Acute listed)	(1.99) (Acute)	(0.40) (Acute restricted)	(0.20) (Acute listed)
Alfalfa, Clover	0.1 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608
Tree nut crops	0.216 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608
Tree nut crops	0.216 (air blast)	745	>1000	>1000	528	>1000	>1000
Citrus crops	0.5 (ground)	>1,000	>1,000	>1,000	>1,000	>1,000	>1,000
Head and Stem Brassica Vegetables	0.1 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608
Corn	0.1 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608
Sweet corn	0.1 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608
Cotton	0.1 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608
Pears, Mayhaw, Fruits (unspecified)	0.2 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608
Fruits (unspecified), Small Fruits (unspecified)	0.2 (air blast)	722	>1000	>1000	509	>1000	>1000
Deciduous Fruits, Apple, Stone Fruits	0.21 (air blast)	735	>1000	>1000	522	>1000	>1000
Grapes	0.1 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608
Lettuce	0.1 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608
Leafy petiole veg	0.1 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608
Spinach	0.1 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608
Cucurbit vegetables	0.1 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608
Tuberous and corm vegetables	0.3 at plant (ground)	>1000	>1000	>1000	>1000	>1000	>1000
Root Crops	0.1 (ground)	>1000	>1000	>1000	>1000	>1000	>1000
Artichokes	0.1 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608
Peppers (bell and non-bell)	0.1 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608
Succulent Peas and Beans	0.1 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608
Dried peas and beans	0.1 (ground)	>1000	>1000	>1000	>1000	>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)		
		(0.95) (Acute)	(0.19) (Acute restricted)	(0.095) (Acute listed)	(1.99) (Acute)	(0.40) (Acute restricted)	(0.20) (Acute listed)
Agricultural crops/ soils	0.112 (ground)	>1000	>1000	>1000	>1000	>1000	>1000
Strawberry	0.216 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608
Strawberry	0.216 (ground)	>1000	>1000	>1000	>1000	>1000	>1000
Beets, garden beets	0.1 (ground)	>1000	>1000	>1000	>1000	>1000	>1000
Eggplant, Ground cherry, Pepino	0.1 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608
Tomato and tomatillo	0.08 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608
Canola, rapeseed, crambe	0.04 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608
Caneberries	0.1 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608
Bushberries	0.1 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608
Hops	0.1 (aerial)	>2,608	>2,608	>2,608	>2,608	>2,608	>2,608

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

5.3. Effects Determinations

5.3.1. Bay Checkerspot Butterfly

It is possible for bifenthrin to directly affect the BCB based on RQs exceeding the acute risk to listed species LOC for terrestrial invertebrates. In addition, four major incidents were reported for terrestrial invertebrates. Indirect effects from adverse effects on terrestrial plants are considered possible given the large number of 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 bifenthrin to directly affect the CCR based on RQs exceeding the risk to listed and non-listed species LOCs 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, and freshwater and estuarine/marine invertebrates. Five incidents have been reported for freshwater fish and four incidents for terrestrial invertebrates. Indirect effects on habitat from adverse effects on terrestrial plants are not anticipated. Effects are not expected from modifications to the aquatic plant community. However, indirect effects from adverse effects on terrestrial plants are considered possible given the large number of minor incident reports involving terrestrial plants. Bifenthrin 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 bifenthrin 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 not anticipated. Indirect effects are not expected from changes to the aquatic plant community. However, indirect effects from adverse effects on terrestrial plants are considered possible given the large number of minor incident reports involving terrestrial plants. Bifenthrin 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 bifenthrin 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. Five incidents for freshwater fish and four incidents for terrestrial invertebrates have been reported. 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 large number of minor incident reports involving terrestrial plants. Bifenthrin 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 bifenthrin to directly affect the DS based on RQs exceeding the risk to listed species LOCs for freshwater and estuarine/marine fish. Five incidents for freshwater fish have been reported as being associated with bifenthrin use with probable or highly probable causality classifications. 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 large number of minor incident reports involving terrestrial plants. Bifenthrin 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 bifenthrin to directly affect the SFGS based on RQs exceeding the risk to listed species LOCs for reptiles (using avian surrogate species data). Indirect effects from affected prey are also possible based on RQs exceeding the risk to listed and non-listed LOCs for terrestrial-phase amphibians (using avian surrogate species data), reptiles, mammals, terrestrial invertebrates, freshwater fish/aquatic-phase amphibians, and freshwater invertebrates . Five incidents for freshwater fish have been reported as being associated with bifenthrin use with probable or highly probable causality classifications. 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 SFGS depend upon for shelter, and aestivation. Indirect effects on habitat from adverse effects to terrestrial plants are not expected. Effects from changes to the aquatic plant community are not expected. However, indirect effects from adverse effects on terrestrial plants are considered possible given the large number of minor incident reports involving terrestrial plants. Bifenthrin 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 bifenthrin to directly affect the TG based on RQs exceeding the risk to listed species LOCs for freshwater and estuarine/marine fish Five incidents for freshwater fish have been reported as being associated with bifenthrin use with probable or highly probable causality classifications. 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 on habitat from adverse effects on terrestrial plants are not expected. Effects on habitat from changes to the aquatic plants in the environment are not expected. However, indirect effects from adverse effects on terrestrial plants are considered possible given the large number of minor incident reports involving terrestrial plants. Bifenthrin 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 bifenthrin to directly affect the VELB based on RQs exceeding the risk to listed species LOCs for terrestrial invertebrates. In addition, indirect effects from adverse effects on terrestrial plants are considered possible given the large number of minor incident reports involving terrestrial plants. Bifenthrin uses extend across the state of California, thus use is expected to occur within the VELB range. Therefore, the Agency makes a **may affect, and likely to adversely affect** determination based on the potential for direct effects to the VELB and a **habitat modification** determination for 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 bifenthrin on the BCB, CCR, CFWS, CTS (all DPS), DS, SFGS, TG, and VELB and their designated critical habitat.

The labeled use of bifenthrin may:

- … directly affect the BCB, CCR, CFWS, CTS (all DPS), DS, SFGS, TG, and VELB by causing acute mortality or by adversely affecting chronic growth or fecundity;
- … indirectly affect the BCB, CCR, CFWS, CTS (all DPS), DS, SFGS, TG, and VELB and/or affect their designated critical habitat by reducing or changing the composition of the food supply;
- … indirectly affect none of the assessed species and their designated critical habitat by reducing or changing the composition of the aquatic plant community in the species' current range, thus, affecting primary productivity and/or cover;
- … not 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, fruits/pods/seeds, arthropods, 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 are available to conclude that birds or mammals may not exclusively feed on a dietary class for at least some time period. However, most birds and mammals consume a variety of dietary items and thus the RQ will overestimate risk to those organisms. For example, the CCR is estimated to consume only 15% plant material (USFWS, 2003). Additionally, some organisms will not feed on all of the dietary classes. For example, many amphibians would only consume insects and not any plant material.

6.1.1.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)

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

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			
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 Bifenthrin

Uncertainties Associated With the Solubility Limit

There is uncertainty associated with the bifenthrin limit of solubility value, derived from a study by Herbst (1983) (MRID 00132518, Acc. \No. 251725). In this study, eight values of the limit of solubility were determined, of which two were non-detects. The average of six solubility values was found to be 0.014 ± 0.006 µg/L (mean ± standard deviation). This is the study reported in the open literature by Laskowski (2002). Given the uncertainties in measuring such a low solubility, the author of the study (Herbst) stated that the solubility was <0.1 ppb, a value which is two orders of magnitude higher than the individual measured values. Another solubility study by Claussen (2006) was evaluated (MRID 46937802) in which bifenthrin was measured 14 times and in all instances, the values were non-detects. Therefore, the solubility was reported as <0.1 ppb as well. These two studies do not provide an indication of the limit of detection or quantitation of bifenthrin in the tested samples. In the second study, a laboratory fortified sample at 0.103 ppb yielded a concentration of 0.111 ppb (107%), which indicates that a 0.1 ppb limit of solubility would have been properly detected. Furthermore, it appears that the solubility of bifenthrin is much smaller than 0.1 ppb (*i.e.*, all values were reported as 0.000 ng/mL, with a concentration factor of 10). Since in PRZM/EXAMS the EECs exceeded 0.1 ppb for several of the samples, an upper bound estimate of the risk quotient, assuming that the solubility was 0.1 ppb, was assumed in the risk estimation section.

In this aquatic exposure assessment, the great majority of the peak EECs (>90%) were reported at the limit of solubility of bifenthrin, since the PRZM/EXAMS output values were above this value. Available monitoring data from Cal DPR show concentrations above the solubility of bifenthrin (the highest value was 5.209 µg/L). This is possible if there is presence of dissolved organic matter or suspended matter in the water that could sorb the chemical and cause it to be present at higher concentrations, although it would not be bioavailable. Comparison of sediment concentrations shows that the aquatic modeling may have been conservative. The highest sediment concentration was 0.437 µg/kg in monitoring and 1,580 µg/kg in modeling (value not adjusted for organic carbon content). There is an extensive body of open literature articles that show that bifenthrin is frequently detected in sediments of both agricultural and non-agricultural areas where the chemical is applied.

Even though they are expected to be lower than the water column EECs, many 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. For the evaluation of benthic organisms, the sediment EECs appeared to be more indicative of the relative potential of certain applications of bifenthrin to cause higher or lower impact on sediments.

Uncertainties Related to Data Gaps

During the opening of the docket for the Registration Review of bifenthrin, a number of deficiencies associated with the available environmental fate studies were identified for bifenthrin that could lead to uncertainties in the input values for the aquatic modeling of this chemical. Firstly, the hydrolysis study was conducted in the presence of 7% acetonitrile as a co-solvent (maximum allowed is 1%). Furthermore, it was conducted at a concentration that greatly exceeded the limit of solubility (by a factor of >35,000x), and there was evidence of precipitation during the test. For an input value, it was assumed that the chemical was stable under hydrolytic conditions.

Second, the aqueous photolysis study was conducted in the presence of 30% acetonitrile, the solution was not buffered and the test was conducted at 1 ppm (compared to a solubility of 0.014 ppb). The presence of the co-solvent may affect the photolytic behavior of bifenthrin. The study pointed towards stability of the chemical, which was conservatively assumed in modeling the chemical.

Thirdly, there is no aerobic aquatic metabolism study, and the input value was based on the aerobic soil metabolism input value (2x the input value as per guideline for input parameters). Gan *et al.* 2005 reported that the aerobic aquatic half-lives in three sediments, at 20ºC, were in the range of 428-483 days. Even though these data cannot be used in risk assessment, the input value of 358.1 days appears to be similar to that range.

Also, there is no anaerobic aquatic metabolism study. Bifenthrin appeared to be stable under anaerobic conditions in an anaerobic soil metabolism study when anaerobic conditions were established. It was conservatively assumed that the chemical is stable under anaerobic aquatic conditions. Gan *et al.* 2005 reported that the anaerobic aquatic half-lives in three sediments, at 20ºC, were in the range of 251-498 days, indicating that the chemical is persistent in anaerobic aquatic environments.

The mobility (soil adsorption/desorption) study was conducted at a single concentration and in the presence of a co-solvent at 2%. There are no Freundlich sorption coefficients and the actual mobility may be lower or higher, since the co-solvent could cause the chemical to be more soluble in the water phase. Thus, there is uncertainty in the selected input value. Nonetheless, the chemical was immobile in all soils tested (according to EFED's accepted mobility classification (FAO 2000)).

Bifenthrin's degradation is possibly a function of the reduction/oxidation (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. In addition, bifenthrin's EECs may be different than actually predicted if the temperature is different than 20-25°C, which is the temperature used frequently in laboratory studies.

Urban Use Uncertainites

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, a single application was modeled since the model did not appear to be sensitive to the number of applications (*i.e.*, the EECs were at the limit of solubility of the chemical). For some of the scenarios, for comparison, multiple (6) applications were modeled in addition to a single application. 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). Bifenthrin was the active ingredient that was named most often by the applicators. This study was performed in response to the reevaluation of a number of synthetic pyrethroids in California.

Chirality of Bifenthrin

Bifenthin (mainly *cis*-bifenthrin, as opposed to the *trans* isomers), consists of two stereoisomers (1 *R-cis* and 1 *S-cis*). In this assessment, it was assumed that both stereoisomers of bifenthrin (1 *R-cis*- and 1 *S-cis*-bifenthrin degrade equally, as per results of the available environmental fate studies in EFED files. However, Liu *et al.* (2005) demonstrated that in the 1 *S-cis* stereoisomer of bifenthrin degrades preferentially over the 1 *R-cis* stereoisomer. They also demonstrated that the 1 *R-cis* stereoisomer was the only one toxic to the species *Cerodaphnia dubia*. There is uncertainty in, both the degree of degradation and toxicity in time for bifenthrin, since the individual stereoisomers were not evaluated in the environmental fate or ecological effects studies.

Aquatic Modeling Uncertaities

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.

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 bifenthrin in water were actually at the limit of solubility (*i.e.*, if the EEC>0.014 ppb, it was assumed to be equal to 0.014 ppb). In saline environments, the solubility of bifenthrin 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 bifenthrin'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 standard EXAMS pond. However, as chemical constituents in water draining from freshwater streams encounter brackish or other near-marine-associated conditions, there is potential for important chemical transformations to occur. Many chemical compounds can undergo changes in mobility, toxicity, or persistence when changes in pH, Eh (redox potential), salinity, dissolved oxygen (DO) content, or temperature are encountered. For example, desorption and re-mobilization of some chemicals from sediments can occur with changes in salinity (Jordan *et al.*, 2008; Means, 1995; Swarzenski *et al.*, 2003), changes in pH (*e.g.*, Wood and Baptista 1993; Parikh *et al*. 2004; Fernandez *et al.* 2005), Eh changes (Velde and Church, 1999; Wood and Baptista, 1993), and other factors. Thus, although chemicals in discharging rivers may be diluted by large volumes of water within receiving estuaries and embayments, the hydrochemistry of the marine-influenced water may negate some of the attenuating impact of the greater water volume; for example, the effect of dilution may be confounded by changes in chemical mobility (and/or bioavailability) in brackish water. In addition, freshwater contributions from discharging streams and rivers do not instantaneously mix with more saline water bodies. In these settings, water will commonly remain highly stratified, with fresh water lying atop denser, heavier saline water – meaning that exposure to concentrations found in discharging stream water may propagate some distance beyond the outflow point of the stream (especially near the water surface). Therefore, it is not assumed that discharging water will be rapidly diluted by the entire water volume within an estuary, embayment, or other coastal aquatic environment.

PRZM/EXAMS model results should be considered consistent with concentrations that might be found near the head of an estuary unless there is specific information (*e.g.*, 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 (*e.g.*, 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 the California Department of Pesticide Regulation (Cal DPR) for bifenthrin concentrations measured in surface waters receiving runoff from agricultural and urban areas, as well as for sediments. 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 bifenthrin use areas.

Peak model-estimated environmental concentrations (EECs) resulting from different bifenthrin uses range from 1.29×10^{-4} to 0.014 µg/L in the water column (up to the limit of solubility of bifenthrin). Of 82 scenarios modeled (42 agricultural and 40 non-agricultural scenarios), 78 peak water column EECs were capped at the limit of solubility of bifenthrin. The peak model-estimated non-normalized sediment EECs resulting from different bifenthrin uses range from 0.105 to 1,580 µg/Kg; meanwhile the organic carbon normalized sediment EECs resulting from different bifenthrin uses range from 2.63 to 39,509 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 bifenthrin, reported by the California Department of Pesticide Regulation surface water database was 5.209 µg/L. This value is roughly 370 times higher than the highest peak model-estimated environmental concentration and greatly exceeds the limit of solubility of the chemical in water. It was measured in Alameda. The maximum sediment concentration was 0.437 µg/kg, which was measured in Placer.

6.2. Effects Assessment Uncertainties

6.2.1. Data Gaps and Uncertainties

The primary data gaps and uncertainties with the aquatic effects assessment include the lack of chronic toxicity data for freshwater and estuarine fish. In absence of these data, a bridging strategy was used based on acceptable and supplemental toxicity submitted for other pyrethroids (Section 4; **Appendix J**). A wide range in chronic toxicity to fish is observed for the pyrethroids (up to four orders of magnitude), which likely reflects their differential potency, study design differences, and species tested. As a conservative screening estimate, the most sensitive chronic NOAEC available for freshwater and estuarine fish for pyrethroids was used as a surrogate for bifenthrin. Therefore, should bifenthrin be substantially less toxic to fish on a chronic exposure basis compared to the most chronically toxic pyrethroid for which data are available (0.0002 µg a.i./L), then the risk conclusions for fish could change.

There are also no submitted data on the toxicity of bifenthrin to aquatic and terrestrial plants. Other lines of evidence (mode of action, toxicity data for other pyrethroids, long history of its use on crops and ornamental plants) suggest that plants are not nearly as sensitive and aquatic animals. On the other hand, a large number of minor incidents have been reported with bifenthrin use on turf . The lack of bifenthrin-specific plant toxicity data remains a source of uncertainty in the effects assessment and risk conclusions.

6.2.2. Use of Surrogate Species Effects Data

Guideline toxicity tests and open literature data on bifenthrin are not available for aquatic-phase amphibian; therefore, freshwater fish are used as surrogate species for aquatic-phase amphibians and the CTS. Similarly, avian toxicity data are used as surrogates for terrestrial-phase amphibians (CTS) and reptiles (SFGS). 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. Similar assumptions are made for the protectiveness of avian data for terrestrial-phase amphibians and reptiles. For direct effects on BCB and VELB, surrogate toxicity data using the honey bee were used since these represented the most sensitive terrestrial invertebrate taxa for which data were available. Acute toxicity data were available for target insects (beetles; Coleoptera and moths; Lepidoptera). Specifically, an LD_{50} of 0.018 µg/organism was reported for the most sensitive beetle tested (Bluegrass weevil, *Listronotus maculicollis*) and the most sensitive Lepidoptera tested (Striped riceborer, *Chilo suppressalis*) (**Appendix H**). Due to the smaller body weights of these organisms compared to the honey bee, the acute contact LD_{50} value is higher on an µg a.i./g organism basis. Use of these toxicity endpoints, however, do not affect the risk assessment conclusions regarding effects on terrestrial invertebrates and subsequent direct and indirect effects on listed species evaluated in this assessment. 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 bifenthrin on listed species may be underestimated.

6.2.4. Temperature Effects on Bifenthrin Toxicity to Aquatic Organisms

Synthetic pyrethroids like bifenthrin have shown a negative temperature coefficient regarding toxicological effects. The effect of temperature on bifenthrin toxicity is discussed by Weston *et al.* (2009). Sediment toxicity tests were performed at various temperatures (13, 18, 23 and 28ºC). The 10-day LC_{50}s to *H. azteca* were determined in laboratory tests conducted on four pyrethroids (*lambda*-cyhalothrin, permethrin, bifenthrin and esfenvalerate). The toxicity approximately doubled when the temperature was decreased from 23 to 18ºC, and approximately tripled when the temperature was further decreased to 13ºC. This effect has implications for aquatic organisms that inhabit water bodies in colder climates (Weston *et al.* 2011). The potential for temperature-mediated changes in bifenthrin's toxicity is a source of uncertainty.

6.2.5. Bioavailability of Bifenthrin in Aquatic Toxicity Tests

As noted in **Section 4**, acute toxicity values for fish greatly exceed the reported solubility limit for bifenthrin in water (0.014 ppb). Although a co-solvent was used in these studies, there is uncertainty regarding the amount of bifenthrin that was actually bioavailable to test organisms in these studies. This uncertainty results from the lack of centrifugation of samples which is recommended in OSCPP toxicity test guidelines when concentrations approach solubility limits. If the bioavailable fraction of bifenthrin in these studies is at or near its solubility limit, then RQ values would be greater than those calculated using the reported LC_{50} values. This, however, would not alter the overall LAA determination based on effects to freshwater or estuarine/marine fish.

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 bifenthrin to CTS (all DPS), BCB, VELB, DS, CCR, CFWS, SFGS, and TG and their designated critical habitat.

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

A summary of the risk conclusions and effects determinations for the CTS (all DPS), 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 Bifenthrin 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 **<0.01 to 0.09** (LOC = 0.05) and chronic RQs range from **0.01 to 3.5,** (LOC = 1) exceeding the listed species LOC for direct effects to CTS; Five ecological incidents reported for fish are consistent with the risk hypothesis and risk findings. The individual effects probability associated with the acute RQ ranges from 1 in $1.20\text{x}10^{12}$ to 1 in $8.97\text{x}10^{3}$. 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 bifenthrin 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): Avian acute RQs determined using T-REX range from **0.01 to 0.2** (LOC=0.05) and chronic RQs range from **0.03 to 3.0** (LOC=1)**,** exceeding the listed species LOC for direct effects to terrestrial-phase CTS. Refinement of these RQs using T-HERPS resulted in acute RQs ranging from **0.1 to 0.2** (LOC=0.1) and chronic RQs ranging from **1.0 to 3.1** (LOC=1). Further, use of a pyrethroid-specific foliar dissipation half-life also exceeded LOCs with acute RQs ranging from **0.02 to 0.2** (LOC=0.1) and chronic RQs ranging from **0.7 to 3.1** (LOC=1). The individual effects probability associated with the acute RQ ranges from 1 in 1.00×10^{16} to 1 in 1.42×10^{6}. 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 bifenthrin use is likely to spatially and temporally coincide with all of the critical life-stages of the terrestrial phase CTS (all DPS), and disrupt its life-cycle at various points.
		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 RQs for freshwater invertebrates (water column and benthic-dwelling) range from **0.07 to 7.4** (LOC=0.5) and the chronic RQ range from **0.2 to 82** (LOC=1). 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 1.84** (LOC=0.5) and the chronic RQs range from **0.06** (dietary based) **to 39** (dose based) (LOC=1). ***Terrestrial prey items, riparian habitat*** Acute RQ values exceed the LOC for terrestrial invertebrates, ranging from **6.3 to 812** (LOC=0.05). Potential risk to terrestrial plants identified from numerous incident reports involving terrestrial plants.
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 **6.3 to 812**, exceeding the acute risk LOC for the BCB (LOC=0.05). Refinements using a pyrethroid specific foliar dissipation half-life yielded RQs that also exceeded the acute risk LOC, with values ranging from **6.3-812** (LOC=0.05). The individual effects probability associated with the acute RQ is 1 in 1.00 for all scenarios assessed. 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 bifenthrin 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
		I Potential risk to terrestrial plants identified from numerous incident reports involving terrestrial plants.
Valley Elderberry	May Affect,	**Potential for Direct Effects**

Species	Effects Determination	Basis for Determination
Longhorn Beetle (VELB) (*Desmocerus californicus dimorphus*)	Likely to Adversely Affect (LAA)	Acute RQ values range from **6.3 to 812**, exceeding the acute risk LOC for the VELB (LOC=0.05). Refinements using a pyrethroid specific foliar dissipation half-life yielded RQs that also exceeded the acute risk LOC, with values ranging from **6.3-812** (LOC=0.05). The individual effects probability associated with the acute RQ is 1 in 1.00 (100%) for all scenarios assessed. 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 bifenthrin 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
		Potential risk to terrestrial plants identified from numerous incident reports involving terrestrial plants.
Delta Smelt (DS) (*Hypomesus transpacificus*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Freshwater fish acute RQs range from **<0.01 to 0.09** (LOC=0.05) and chronic RQs range from **0.01 to 3.5** (LOC=1)**,** exceeding listed species LOC for direct effects to the DS; Five ecological incidents reported for fish are consistent with the risk hypothesis and risk findings. The individual effects probability associated with the acute RQ ranges from 1 in 1.20×10^{12} to 1 in 8.97×10^{3}. 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 bifenthrin 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
		Freshwater invertebrate acute RQs range from **0.07 to 7.4** (LOC=0.5) and chronic RQs range from **0.22 to 82** (LOC=1)**,** exceeding non-listed species LOC for indirect effects to the DS. Estuarine invertebrate acute RQs range from **0.03 to 3.5** (LOC=0.5) and chronic RQs range from **0.19 to 70** (LOC=1)**,** exceeding the non-listed species LOC for DS prey. Acute and chronic RQ values also exceed the LOCs for freshwater (acute RQs range from **0.01 to 7.37**, LOC=0.5; while the chronic RQs range from **0.07 to 974**, LOC=1) and estuarine/ marine (acute RQs range from **<0.01 to 3.53**, LOC=0.5; while the chronic RQs range from **0.02 to 32**, LOC=1) benthic invertebrates. Potential risk to terrestrial plants identified from numerous incident reports involving terrestrial plants.
Clapper Rail	May Affect,	**Potential for Direct Effects**

Species	Effects Determination	Basis for Determination
(CCR) (*Rallus longirostris obsoletus*)	Likely to Adversely Affect (LAA)	Avian acute RQs determined using T-REX range from **0.01 to 0.2** (LOC=0.1) and chronic RQs range from **0.03 to 3.0** (LOC=1)**,** exceeding listed species LOC for direct effects to terrestrial-phase CTS. Refinement of these RQs using a pyrethroid-specific foliar dissipation half-life also resulted in the LOC being exceeded. The acute RQ values, using a pyrethroid-specific foliar dissipation half-life range from **0.04 to 0.11** (LOC=0.1) and the chronic RQs were **0.7-3.0** (LOC=1) when evaluating only the uses that exceeded the LOCs with the T-REX default half-life. The individual effects probability associated with the acute RQ ranges from 1 in $1.00x10^{16}$ to 1 in $1.44x10^{2}$. 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 bifenthrin use is likely to spatially and temporally coincide with the CCR life-cycle and breeding season.
		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), with acute and chronic RQ values that exceed the non-listed species LOCs. The acute RQs for small mammals range from **0.01 -1.84** (LOC=0.5) and the chronic RQs range from **0.06** (dietary based) **to 39** (dose based) (LOC=1). A potential for indirect effects is also indicated based on effects on terrestrial invertebrates (acute RQs values ranging from **6.3-812**, LOC=0.05); based on effects on freshwater fish with acute RQs range from **<0.01 to 0.09** (LOC=0.5, therefore the acute non-listed LOC is not exceeded), and chronic RQs range from **0.01 to 3.5** (LOC=1); based on effects on estuarine/ marine fish (acute RQ **<0.01** in all instances (LOC=0.5, therefore it is not exceeded for non-listed estuarine/marine fish), but chronic RQs range from **0.01-3.5** (LOC=1); based on effects on freshwater invertebrates (acute RQs range from **0.07 to 7.4** (LOC=0.5); chronic RQs range from **0.22 to 82** (LOC=1); and effects on estuarine/marine invertebrates with acute RQs range from **0.03 to 3.5** (LOC=0.5) and chronic RQs range from **0.19 to 70** (LOC=1). Therefore, acute and chronic RQ values exceed the non-listed species LOC for multiple taxa. Potential risk to terrestrial plants identified from numerous incident reports involving terrestrial plants.
California Freshwater Shrimp (CFWS) (*Syncaris pacifica*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Freshwater invertebrate acute RQs range from **<0.07 to 7.4** (LOC=0.05) and chronic RQs range from **0.22 to 82** (LOC=1)**,** exceeding the listed species LOC for direct effects to the CFWS. Acute and chronic RQ values also exceed the LOCs for freshwater benthic invertebrates with acute RQs ranging from **0.01 to 7.37** (LOC=0.05) while the chronic RQs range from **0.07 to 974** (LOC=1). The individual effects probability associated with the acute RQ ranges from 1 in $9.88x10^{6}$ to 1 in 1.00 (100%). 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 permethrin use is likely to spatially and temporally coincide with the CFWS, and disrupt its life-cycle at various points.
		Potential for Indirect Effects

Species	Effects Determination	Basis for Determination
		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 numerous incident reports involving terrestrial plants.
San Francisco Garter Snake (SFGS) (*Thamnophis sirtalis tetrataenia*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Avian acute RQs (birds are used as surrogate for reptiles) determined using T-REX range from **0.01 to 0.2** (LOC=0.1) and chronic RQs range from **0.03 to 3.0** (LOC=1)**,** exceeding the listed species LOC for direct effects to the SFGS. Refinement of these RQs using T-HERPS (acute RQs ranging from **<0.01 to 0.14** and chronic RQs ranging from **0.59-2.3**, same LOCs) and pyrethroid-specific foliar dissipation rate (acute RQs ranging from **<0.01-0.14** and chronic RQs ranging from **0.56-2.3**, same LOCs) also resulted the LOC being exceeded. The individual effects probability associated with the acute RQ ranges from 1 in 1.00×10^{16} to 1 in 9.27×10^{6}. 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 permethrin use is likely to spatially and temporally coincide with the SFGS breeding season in the spring and fall, and disrupt its life-cycle at various points.
		Potential for Indirect Effects
		Acute and chronic RQ values for prey species (other reptiles, fish and amphibians, freshwater invertebrates, terrestrial invertebrates and small mammals all exceed their respective LOC values as indicated above. Potential risk to terrestrial plants identified from numerous incident reports involving terrestrial plants.
Tidewater Goby (TG) (*Eucyclogobius newberryi*)	May Affect, Likely to Adversely Affect (LAA)	**Potential for Direct Effects**
		Freshwater fish acute RQs range from **<0.01 to 0.09** (LOC=0.05) and chronic RQs range from **0.01 to 3.5** (LOC=1)**,** exceeding listed species LOC for direct effects to the TG; five ecological incidents reported for fish are consistent with the risk hypothesis and risk findings. The individual effects probability associated with the acute RQ ranges from 1 in 1.20×10^{12} to1 in 8.97×10^{3}. 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 permethrin use is likely to spatially and temporally coincide with the TG, and disrupt its life-cycle at various points
		Potential for Indirect Effects

Species	Effects Determination	Basis for Determination
		Freshwater invertebrate acute RQs range from **0.07 to 7.4** (LOC=0.5) and chronic RQs range from **0.22 to 82** (LOC=1)**,** exceeding non-listed species LOC for indirect effects to the DS. Estuarine/marine invertebrate acute RQs range from **0.03 to 3.5** (LOC=0.5) and chronic RQs range from **0.19 to 70** (LOC=1), exceeding the non-listed species LOC for DS prey. Acute and chronic RQ values also exceed the LOCs for freshwater benthic invertebrates (acute RQs range from **0.01 to 7.37**, LOC=0.5; while the chronic RQs range from **0.07 to 974**, LOC=1) and estuarine/ marine benthic invertebrates (acute RQs range from **<0.01 to 3.53**, LOC=0.5; while the chronic RQs range from **0.02 to 32.15**, LOC=1). Potential risk to terrestrial plants identified from numerous incident reports involving terrestrial plants.

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 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 numerous minor incident reports involving terrestrial plants.
Bay Checkerspot Butterfly (BCB) (*Euphydryas editha bayensis*)	Habitat Modification	Direct effects BCB. Potential risk to terrestrial plants (including its obligate host plant, the drwarf plantain) based on numerous minor incident reports involving terrestrial plants.
Valley Elderberry Longhorn Beetle (VELB) (*Desmocerus californicus dimorphus*)	Habitat Modification	Direct effects VELB. Potential risk to terrestrial plants (including its obligate host plant, elderberry trees) based on numerous minor incident reports involving terrestrial plants..
Delta Smelt (DS) (*Hypomesus transpacificus*)	Habitat Modification	Direct effects on DS and indirect effects on aquatic prey. Potential risk to terrestrial plants identified from numerous minor incident reports involving terrestrial plants.
Tidewater Goby (TG) (*Eucyclogobius newberryi*)	Habitat Modification	Direct effects on TG and indirect effects on aquatic prey. Potential risk to terrestrial plants identified from numerous incident reports involving terrestrial plants.

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])[2]		Freshwater Invertebrates (includes CFWS)[3]		Freshwater Benthic Invertebrates[6]		DS, TG and Estuarine/ Marine Vertebrates[1]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
AGRICULTURAL USE PATTERNS													
Alfalfa, clover (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Tree nut crops (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Tree nut crops (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Tree nut (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Citrus crops (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Head and stem brassica vegetables (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Head and stem brassica vegetables (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Corn, sweet corn (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Corn (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Sweet corn (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Cotton (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Pears, mayhaw, fruits (unspecified) (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Fruits (unspecified), Small Fruits (unspecified) (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Apple, stone fruits, deciduous fruits (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Apple, stone fruits, deciduous fruits (GR)	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No
Grapes (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Lettuce, leafy petiole vegetables (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Lettuce (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Spinach (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Cucurbit vegetables (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Cucurbit vegetables (GR)	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No
Tuberous and corm vegetables (aerial)	Yes	Yes	Yes	Yes	Yes	Yes	No	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])[2]		Freshwater Invertebrates (includes CFWS)[3]		Freshwater Benthic Invertebrates[6]		DS, TG and Estuarine/ Marine Vertebrates[1]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Tuberous and corm vegetables (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Root crops (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Artichokes (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Peppers (bell and non-bell); Succulent peas and beans (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Dried peas and beans (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Succulent peas and beans; Dried beans (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Peppers (bell and non-bell) (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Agricultural crops/soils (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Strawberry (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Strawberry (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Beets, garden beets (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Tomato and tomatillo, Eggplant, Ground cherry, Pepino (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Eggplant (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Canola, rapeseed, crambe (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Canola, rapeseed, crambe (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Caneberries (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Bushberries (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Hops (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Herbs & Spices (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
NON-AGRICULTURAL USE PATTERNS													

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	Freshwater Vertebrates (includes DS, TG, CTS [all DPS])[2]		Freshwater Invertebrates (includes CFWS)[3]		Freshwater Benthic Invertebrates[6]		DS, TG and Estuarine/ Marine Vertebrates[1]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Forest Trees: Conifers (plantations/ nurseries); Conifers (seed orchard) (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Forest trees (unspecified), Softwoods (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Christmas tree plantations (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Christmas tree plantations (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Nursery stock (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Mulch, Potting Soil/ Top Soil (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Nursery Stock; Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	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])[2]		Freshwater Invertebrates (includes CFWS)[3]		Freshwater Benthic Invertebrates[6]		DS, TG and Estuarine/ Marine Vertebrates[1]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Ornamental and/or Shade Trees; Ornamental Ground Cover; Ornamental Herbaceous Plants; Ornamental Non-flowering Plants; Ornamental Woody Shrubs and Vines; Jojoba (G, pressure liquid)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Roses (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Sod farms, ornamental sod farms (A)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Sod farms, ornamental sod farms (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Agricultural Right-of-Ways/ Fencerows/ Hedgerows (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Non-agricultural uncultivated areas (soils); Livestock/Livestock Feed Lots, Poultry Feedlots/Poultry Processing Plant Premises (non-food contact), Poultry Litter (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Non-agricultural uncultivated areas (soils) (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Golf course turf (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	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])[2]		Freshwater Invertebrates (includes CFWS)[3]		Freshwater Benthic Invertebrates[6]		DS, TG and Estuarine/ Marine Vertebrates[1]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Golf Course Turf plus Ornamental Grasses; Ornamental Lawns and Turf; Ornamental Sod Farms; Recreational Areas; Recreational Area Lawns; plus Airports/Landing Fields (GR)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Ornamental Grasses; Ornamental Lawns and Turf; Ornamental Sod Farms; Recreational Areas; Recreational Area Lawns (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Airports/Landing fields (PT, directed spray)	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No
Paths/Patios (PT)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Residential Lawns; Commercial/ Industrial Lawns, plus Paths/ Patios, plus Urban Areas, Wide Area/ General Outdoor Treatment (Public Health Use) (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Residential lawns (GR)	No	No	Yes	No	No	No	No	No	No	No	Yes	No	No
Residential lawns (PT)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Animal Feedlots, Animal Housing Premises, Animal Kennel (Sleeping Quarters), Pet Living/ Sleeping Quarters (G, CC, spot treatment)	No	No	Yes	Yes	Yes	No	No	No	Yes	Yes	No	No	No

Uses	Potential for Effects to Identified Taxa Found in the Aquatic Environment												
	Freshwater Vertebrates (includes DS, TG, CTS [all DPS])[2]		Freshwater Invertebrates (includes CFWS)[3]		Freshwater Benthic Invertebrates[6]		DS, TG and Estuarine/ Marine Vertebrates[1]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Urban and rural structures and buildings, Farm Premises (Agricultural), Barnyards/ Auction Barns, Seed Houses/ Stores/ Storage Areas/ Ware-houses (Barrier Trt)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Urban and rural structures and buildings (GR)	No	No	Yes	Yes	No	No	No	No	Yes	Yes	No	No	No
Urban and rural structures and buildings (PT, surface/space spray)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Urban and rural structures and buildings (CC, brush on, void trt, foam application)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Urban and rural structures and buildings (soil treatment, trenching)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Farm Premises (Agricultural), Barnyards/ Auction Barns, Seed Houses/ Stores/Storage Areas/ Warehouses (CC, spot trt, PT, directed spray)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Wood Protection Treatment to Buildings/ Products (Outdoors) (G)	Yes	Yes	Yes	Yes	Yes	Yes	No	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])[2]		Freshwater Invertebrates (includes CFWS)[3]		Freshwater Benthic Invertebrates[6]		DS, TG and Estuarine/ Marine Vertebrates[1]		Estuarine/Marine Invertebrates[4]		Estuarine/ Marine Benthic Invertebrates[4]		Vascular and non-vascular plants[5]
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	
Wood Protection Treatment to Buildings/ Products (Outdoors) (G, void treatment)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Right-of-Way (G)	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No
Right-of-Way (GR)	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No
Paved Areas (Private Roads/ Sidewalks) (PT)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Refuse/Solid Waste Sites (outdoors) (PT, surface spray)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Utilities, Utility Poles/Rights-of-Way (PT)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Utility Poles/Rights-of-Way (GR)	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No

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]		
AGRICULTURAL USE PATTERNS, LIQUID FORMULATIONS											
Agricultural crops/ soils	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Alfalfa, Clover	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Artichokes	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Beets, garden beets	Yes	Yes	No	Yes	No	Yes	No	No	Yes	Yes	Yes
Bushberries	Yes	Yes	No	Yes	No	Yes	No	No	Yes	Yes	Yes
Caneberries	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Canola, rapeseed, crambe	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Citrus crops	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Corn	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]		
Cotton	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Cucurbits	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Deciduous Fruits, Apple, Stone Fruits	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Dried Peas and Beans	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Fruits (unspecified)	Yes	Yes	No	Yes	No	Yes	No	No	Yes	Yes	Yes
Grapes	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Head and Stem Brassica; Lettuce, Leafy Petiole Vegetables	Yes	Yes	No	Yes	No	Yes	No	No	Yes	Yes	Yes
Hops	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Pears, Mayhaw, Fruits (unspecified), Strawberry	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Peppers, Succulent Peans and Beans; Tomato & Tomatillo; Eggplant, Ground Cherry, Pepino	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Root Crops	Yes	Yes	No	Yes	No	Yes	No	No	Yes	Yes	Yes
Spinach	Yes	Yes	No	Yes	No	Yes	No	No	Yes	Yes	Yes
Sweet corn	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Tree Nut Crops (1)	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Tuberous and Corn Vegetables	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
SEED TREATMENTS											
Beans; brassica (head and stem vegetables); canola/ rape/crambe; corn (field, pop, sweet); cotton; cucurbits; lettuce and leafy vegetables; succulent peas; pepper and eggplant (ST)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
GRANULAR APPLICATIONS											

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]		
Corn (field), sweet corn, cucurbit vegetables, succulent peas and beans, head and stem brassica vegetables, lettuce, eggplant, cotton, bell and non-bell peppers, root crops (GR)	Yes	N/A	No	N/A	No	N/A	No	N/A	No	Yes	Yes
Field corn, sweet corn (at plant) (GR, T-band)	No	N/A	No	N/A	No	N/A	No	N/A	No	Yes	Yes
Sweet corn (GR, in-furrow)	No	N/A	No	N/A	No	N/A	No	N/A	No	Yes	Yes
Tuberous & corm vegetables (GR)	No	N/A	No	N/A	No	N/A	No	N/A	No	Yes	Yes
Canola (GR)	No	N/A	No	N/A	No	N/A	No	N/A	No	Yes	Yes
Turf; ornamentals (various including Christmas trees, containerized), parks, recreational parks, around institutional, public, commercial and industrial buildings, golf courses, sod farms (GR)	Yes	N/A	Yes	N/A	Yes	N/A	Yes	N/A	No	Yes	Yes
NON-AGRICULTURAL USE PATTERNS											
Agricultural Right-of-Ways/ Fencerows/ Hedgerows	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Airports/ Landing Fields	No	No	No	No	No	No	No	No	Yes	Yes	Yes
Christmas Tree Plantations, Golf Course Turf	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Farm Premises/Buildings	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Forest Tree Plantations	Yes	Yes	No	Yes	No	Yes	No	No	Yes	Yes	Yes
Forest Trees - unspecified, softwoods	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Non-agricultural Uncultivated Areas	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Nursery Stock	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 & Shade Trees (1)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ornamental & Shade Trees (2)	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Ornamental Grasses	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Pave Area Perimeters	Yes	Yes	No	Yes	No	Yes	No	No	Yes	Yes	Yes
Refuse/Solid Waste Sites (outdoors)	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Residential Lawns (1)	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Residential Lawns (2)	No	No	No	No	No	No	No	No	Yes	Yes	Yes
Residential Lawns (3)	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Right of Way (1)	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Right of Way (2)	No	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Roses	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Sod farms, ornamental sod farms	Yes	Yes	No	Yes	No	Yes	No	No	Yes	Yes	Yes

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 CTS (all DPS), 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 G**.

Addy-Orduna, L, Zaccagnini, M, Canavelli, S, Mineau, P. 2011. Formulated beta-cyfluthrin shows wide divergence in toxicity among bird species. *Journal of Toxicology.* Volume 2011, Article ID 803451.

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

Armitage, J.M., & Gobas, F.A.P.C. 2007. A terrestrial food-chain bioaccumulation model for POPs. *Environmental Science and Technology, 41*, 4019-4025.

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.

California Air Resources Board. 2001. Report for the Application and Ambient Air Monitoring for Propargite and Bifenthrin in Fresno and Kings Counties. Bifenthrin Project No. C99-033 (Ambient) and C99-033a (Application); Propargite Project No. C99-032 (Ambient) and C99-032a (Application). Report dated 8/8/01. California Environmental Protection Agency.

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.

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, DM, Zarba CS, Hansen DJ, Berry WJ, Swartz RC, Cowan CE, Pavlou SP, Allen HE, Thomas NA, Paquin PR. 1991. Technical basis for establishing sediment quality criteria for nonionic organic chemicals using equilibrium partitioning. Environ. Toxicol. Chem. 10:1541-1583.

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 (accessed 07/05/2012).

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.

Gan, J., S.J. Lee, W.P. Liu, D.L. Haver, and J.N. Kabashima. 2005. Distribution and Persistence of Pyrethroids in Runoff Sediments. J. Environ. Qual. 34:836–841 (2005).

Gobas, F.A.P.C., B.C. Kelly and J.A. Arnot. 2003. Quantitative structure activity relationships for predicting the bioaccumulation of POPs in terrestrial food webs. QSAR Comb. Sci. 22:329-336.

Hoang, C.T., R.L. Pryor, G.M. Rand, and R.A. Frakes. 2011. Use of Butterflies as Nontarget Insect Test Species and the Acute Toxicity and Hazard of Mosquito Control Insecticides. Environ. Toxicol. & Chem. 30 (4), pp. 997–1005, 2011.

Holzer, B.R. 2011. Determination of Critical Body Residue Values for Three Current Use Pesticides in Hyalella azteca Predictive Techniques Versus Direct Tissue Residue Measurement. ECOTOX Reference Number 156712. Thesis submitted in partial fulfillment for the degree of Masters in Science at Oklahoma State University.

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.

Liu, W., J. Gan, S. Lee, and I. Werner. 2005. Isomer Selectivity in Aquatic Toxicity and Biodegradation of Bifenthrin and Permethrin. *Environ. Toxicol. Chem.* 24, 2005, pp. 1861-1866.

Matsumura, F. 1985. Toxicology of insects. 2nd ed. Plenum New York.

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.

Rexrode, M. and J.L. Meléndez. 2003. EFED's rationale for choosing Cypermethrin, Esfenvalerate, Bifenthrin, and Cyfluthrin for sediment testing as discussed with the Pyrethroid Working Group (PWG). Memorandum to M. Johnson & G. LaRocca dated 12/22/03. Environmental Fate and Effects Division, OPP, OPPTS, USEPA.

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.

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.

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. 1999. FIFRA Scientific Advisory Panel Meeting, February 23, 1999 held at the Holiday Inn Hotel, Arlington, VA. SAP Report No. 99-03A. March 25, 1999. Office of Pesticide Programs. Available at url: http://www.epa.gov/scipoly/sap/meetings/1999/022399_mtg.htm#materials (Accessed September 19, 2012)

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 12/05/2012).

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 11/28/2012).

USEPA. 2010a. EFED Registration Review Problem Formulation for Bifenthrin. Memorandum from the Environmental Fate and Effects Division to Pesticide Re-evaluation Division dated June 9, 2010. DP Barcode D370920, Document ID EPA-HQ-OPP-2010-0384-0006 at www.regulations.gov.

USEPA. 2010b. Revised EFED Registration Review Problem Formulation for Bifenthrin. Memorandum from the Environmental Fate and Effects Division to Pesticide Re-evaluation Division dated December 22, 2010. DP Barcode D384352, Document ID EPA-HQ-OPP-2010-0384-0033 at www.regulations.gov.

USEPA. 2012a. County-Level Usage for Aldicarb, Bensulide, Bifenthrin, Brodifacoum, Chlorothalonil, Diazinon, Difenacoum, Lambda-Cyhalothrin, Methomyl, PCNB, and Pendimethalin in California in Support of a San Francisco Bay Endangered Species Assessment Memorandum from Monisha Kaul, through Arnet Jones, to Rochelle Richardson, dated February 23, 2012.

USEPA. 2012b. Bifenthrin and Pendimethalin Usage Maps by Crop Reporting District (PC codes: 128825, 108501). Memorandum from Monisha Kaul, through Arnet Jones, to Rochelle Richardson, dated May 3, 2012.

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. 2007. Species Account: Delta Smelt (*Hypomesus transpacifica*). Sacramento Fish and Wildlife Office. Available online at: http://www.fws.gov/sacramento/es/animal_spp_acct/delta_smelt.pdf (Accessed on January 28, 2008).

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.

Wang, L., W. Ye, S. Zhou, K. Lin, M. Zhao, and W. Liu. 2009. Acute and Chronic Toxicity of Organophosphate Monocrotophos to *Daphnia magna*. *Journal of Environmental Science and Health, Part B: Pesticides, Food Contaminants, and Agricultural Wastes*, (2009) **44**, 38-43.

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.

Weston, D.P., J. You, A.D. Harwood and M.J. Lydy. 2009. Whole Sediment Toxicity Identification Evaluation Tools for Pyrethroid Insecticides: III. Temperature Manipulation. Environ. Tox. & Chem., Vol. 28, No. 1, pp. 173–180, 2009.

Weston, D.P., and C.J. Jackson. 2009. Use of Engineered Enzymes to Identify Organophosphate and Pyrethroid-Related Toxicity in Toxicity Identification Evaluations. *Environ. Sci. Technol.* **2009,** *43,* 5514–5520.

Weston, D.P., Asbell A.M., Hecht S.A., Scholz N.L. and M.J. Lydy. 2011. Pyrethroid insecticides in urban salmon streams of the Pacific Northwest. Environmental Pollution Vol. 159, No. 10 (2011), pp. 3051-3056.

Willis, G.H. and L.L. McDowell. 1987. Pesticide persistence on foliage. Reviews of Environmental Contamination and Toxicology. Vol. 100 (1987), pp. 23-73.

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

Yang, W., J. Gan, W. Hunter, and F. Spurlock (2006). Effect of Suspended Solids on Bioavailability of Pyrethroid Insecticides. *Environ. Toxicol. Chem.*, 25 (6) 1585–1591, 2006.

Zhang, Z.Y., D.L. Wang, Z.J. Chi, X.J. Liu, and X.Y. Hong. 2008. Acute Toxicity of Organophosphorus and Pyrethroid Insecticides to *Bombyx mori*. *Journal of Economic Entomology*, 101(2):360-364. 2008

Zhang, Z.Y., X.Y. Yu, D.L. Wang, H.J. Yan, and X.J. Liu. 2010. Acute Toxicity to Zebrafish of Two Organophosphates and Four Pyrethroids and Their Binary Mixtures. *Pest Manag Sci* 2010; **66**: 84–89

9. MRID List

161-1 Hydrolysis

MRID	Citation Reference
132518	FMC Corp. (1983) FMC 54800 Insecticide. (Compilation; unpublished study received Nov 3, 1983 under 279-EX-101; CDL:251725-A)
132539	Herbst, R.; Kikta, E. (1983) Hydrolysis of FMC 54800: P-0701. (Un- published study received Nov 3, 1983 under 279-EX-

	101; submitted by FMC Corp., Philadelphia, PA; CDL:251728-A)
152860	FMC Corp. (1984) Chemistry: Environmental Fate [of FMC 54800]. Un- published study. 10 p.

161-2 Photodegradation-water

MRID	Citation Reference
163084	Wu, J. (1986) Photodegradation of FMC 54800 in Aqueous Solution: Rept. No. P-1349. Unpublished study prepared by FMC Corp., Agricultural Chemical Group. 33 p.

161-3 Photodegradation-soil

MRID	Citation Reference
163085	Wu, J. (1986) Photodegradation of FMC 54800 in/on Soil: Rept. No. P-1351. Unpublished study prepared by FMC Corp., Agricultural Chemical Group. 38 p.

162-1 Aerobic soil metabolism

MRID	Citation Reference
132540	Bixler, T.; Gross, E.; Willow, E.; et al. (1983) FMC 54800 Aerobic Soil Degradation: P-0712. (Unpublished study received Nov 3, 1983 under 279-EX-101; submitted by FMC Corp., Philadelphia, PA; CDL:251728-B)
141202	Reynolds, J. (1984) Aerobic Soil Metabolism of FMC 54800 - Fate of Acid Cyclopropyl ring)-[Carbon 14] FMC 54800 and Metabolite Characterization: P-0872. Unpublished study prepared by FMC Corp. 22 p.
152266	Reynolds, J. (1984) Aerobic Soil Metabolism of FMC 54800 - Fate of Alcohol (Phenyl)-[Carbon-14] FMC 54800 in a Sandy Loam Soil after 21 Days. Unpublished study prepared by FMC Corp. 17 p.
152860	FMC Corp. (1984) Chemistry: Environmental Fate [of FMC 54800]. Un- published study. 10 p.

162-2 Anaerobic soil metabolism

MRID	Citation Reference
163088	Reynolds, J. (1986) Metabolism of Acid (Cyclopropyl Ring)-[carbon 14] and Alcohol(Phenyl Ring-[carbon 14] FMC 54800 in Soil under Anaerobic Conditions: Rept. No. P-1338. Unpublished study pre- pared by FMC Corp., Agricultural Chemical Group. 26 p.

163-1 Leach/adsorption/desorption

MRID	Citation Reference
132541	Kinne, L.; Froelich, L. (1983) Soil Mobility of FMC 54800: P-0721. (Unpublished study received Nov 3, 1983 under 279-EX-101; sub- mitted by FMC Corp., Philadelphia, PA; CDL:251728-C)
141203	Froelich, L. (1984) Soil Adsorption/Desorption Characteristics of FMC 54800: P-0797. Unpublished study prepared by FMC Corp. 19 p.
163089	Kinne, L. (1984) Mobility of FMC 54800 Aged Soil Residues: Rept. No. P-1029; Study No. S-182-84-19. Unpublished study prepared by FMC Corp., Agricultural Chemical Group. 21 p.

163-2 Volatility - laboratory

MRID	Citation Reference
163090	Ferraro, C.; Zuccarello, W. (1986) FMC 54800 Laboratory Volatility Study: The Volatility of Active Ingredient in Capture 2.0 EC Insecticide/Miticide from Soil under Varying Conditions of Temp- erature, Soil Moisture and Air Flow Rate: Rept. No. P-1463. Unpublished study prepared by FMC Corp., Agricultural Chemical Group. 24 p.
163223	Hu, H. (1983) Vapor Pressure of FMC 54800: Rept. No. CGP-83-1; Pr. No. G182.305. Unpublished study prepared by FMC Corp., Center Technical Dept. 17 p.
41220601	Bowman, B. (1989) Laboratory Volatility from Soil of FMC 54800: Proj. ID PC 0119. Unpublished study prepared by Analytical Bio- Chemistry Laboratories. 40 p.

164-1 Terrestrial field dissipation

MRID	Citation Reference
163091	Stearns, J. (1984) Dissipation of Residues of FMC 54800 in Soils Treated with Capture 2.0 EC: Rept. No. RAN-0141. Unpublished study prepared by FMC Corp., Agricultural Chemical Group. 25 p.
41673101	Hicks, S. (1990) Bifenthrin Field Dissipation Study .: Lab Pro- ject Number: 182E4188E1: 882037-1: PC-0147. Unpublished study prepared by Siemer & Associates, Inc. 383 p.
41673102	Culligan, J. (1990) Terrestrial Field Dissipation: Magnitude of the Residue of Bifenthrin and 4'-Hydroxy-Bifenthrin in Soil: Lab Project Number: 182E4188E1-1. Unpublished study prepared by FMC Corp. 91 p.
41673103	Stenzel, J. (1990) Interim Report of the Terrestrial Field

Dissipation of Bifenthrin and 4'-Hydroxy-Bifenthrin in/on Bare Soil: Lab Project Number: 182E4189R1. Unpublished study prepared by FMC Corp. 118 p.

42339201 Stenzel, J.; Culligan, J. (1991) Final Report of the 1989 Study of the Terrestrial Field Dissipation of Bifenthrin in/on Bare Soil in Champaign, Il: Lab Project Number: P-2639: 182E4189R1. Unpublished study prepared by FMC Corp. 117 p.

42339203 Culligan, J. (1991) Terrestrial Field Dissipation--Bifenthrin and 4'-Hydroxy-Bifenthrin in Soil: Lab Project Number: 18234188E1-1. Unpublished study prepared by FMC Corp. 114 p.

165-4 Bioaccumulation in fish

MRID	Citation Reference
163094	Surprenant, D. (1985) Accumulation and Elimination of [Carbon 14]- Residues by Bluegill (Lepomis macrochirus) Exposed to [Carbon 14]-FMC 54800: Rept. #BW-85-4-1765; Bionomics Study #282.1184. 6108.140. Unpublished study prepared by Springborn Bionomics, Inc. 46 p.
163095	Tullman, R. (1986) Analysis of [Carbon 14]-FMC 54800 Residues in Bluegill Sunfish and Water: Rept. No. P-1342. Unpublished study prepared by FMC Corp., Agricultural Chemical Group. 37 p.

165-5 Bioaccumulation in aquatic non-target organisms

MRID	Citation Reference
42529902	Surprenant, D. (1988) Bioavailability, Accumulation and Aquatic Toxicity of carbon 14|-FMC 54800 Residues Incorporated into Soil: Lab Project Number: BW-85-12-1894: 282-0185-6109-000. Unpublished study prepared by Springborn Bionomics Inc. 87 p.

NON Guideline Section Selections

46535601 Cheplick, J. (2005) National Runoff, Erosion, and Leaching Assessment with the Pesticide Root Zone Model (PRZM): Pyrethroid. Project Number: WEI/794/05. Unpublished study prepared by Waterborne Environmental, Inc. (WEI). 14 p.

46535602 Cheplick, J. (2005) Direct Observation Based Method to Assign Topographic Factor (LS) to Areas of Concern with Quantified Statistical Confidence: (Pyrethroid). Project Number: WEI/794/05. Unpublished study prepared by Waterborne Environmental, Inc. (WEI). 12 p.

46535603 Holmes, C. (2005) Proposed Methodology to Redistribute Doane Pesticide Use Data Based on NASS 2002 Census of Agriculture

	Data: (Pyrethroid). Project Number: WEI/794/05. Unpublished study prepared by Waterborne Environmental, Inc. (WEI). 14 p.
46535604	Ritter, A. (2005) Approach for the Monte Carlo Assessment (Task I) of the Sensitivity Analysis of Synthetic Pyrethroid Sediment Exposure Assessments to Drift and Runoff Entry Routes. Project Number: WEI/794/05. Unpublished study prepared by Waterborne Environmental, Inc. (WEI). 49 p.
47454101	Chen, A. (2007) Determination of Bifenthrin Residues Leaching from Wood Treated with Bistar WT Insecticide. Project Number: 182WAT07PS01, P/3932. Unpublished study prepared by FMC Corp. 36 p.
47454102	Enriquez, M. (2006) Determination of Bifenthrin Leaching From Wood Treated with 3% Bifenthrin ME (Wood Preservative Formulation). Project Number: A/25/05/05. Unpublished study prepared by Battelle Europe. 52 p.
47506602	Hall, L.; Killen, W.; Anderson, R. (2008) A Comparison of Sediment Sampling Methods for Pyrethroids in Urban/Residential Sediments of California Streams and Additional Pyrethroid Sampling in Pleasant Grove Creek Backwater Surrogate Sites- Pyrethroid: Assessment. Project Number: T001584/08. Unpublished study prepared by Wye Research and Education Center. 62 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 an 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.
47647801	Hanzas, J.; Stone, C.; Toth, B.; et al. (2008) Bifenthrin and Beta-Cyfluthrin: Quantification of Pyrethroid Runoff Losses from Treated Turfgrass Under Over-Irrigation Conditions and Simulated Rainfall: Final Report. Project Number: 082018, SEI001. Unpublished study prepared by Stone Environmental, Inc., CRG Marine Laboraties, Inc. and Agvise Laboratories. 280 p.
163080	Martin, F. (1985) Storage Stability of Bifenthrin in/on Various Crops and Soils: Rept. No. P-1268. Unpublished study prepared by FMC Corp., Agricultural Chemical Group. 23 p.
163081	Martin. F. (1986) Storage Stability of Bifenthrin in/on Various Crops and Soils: Rept. No. P-1459. Unpublished study prepared by FMC Corp., Agricultural Chemical Group. 26 p.

71-1 Avian Single Dose Oral Toxicity

MRID	Citation Reference
132532	Fletcher, D. (1983) Report to ...: Acute Oral Toxicity Study with FMC 54800 Technical in Bobwhite Quail: BLAL No. 83 QD 30;

	FMC #A83-963. (Unpublished study received Nov 3, 1983 under 279- EX-101; prepared by Bio-Life Assoc., Ltd., submitted by FMC Corp., Philadelphia, PA; CDL:251727-A)
132534	Fletcher, D. (1983) Report to ...: Acute Oral Toxicity Study with FMC 54800 Technical in Mallard Ducks: BLAL No. 83 DD 23; FMC #A83-964. (Unpublished study received Nov 3, 1983 under 279-EX- 101; submitted by FMC Corp., Philadelphia, PA; CDL:251727-C)

71-2 Avian Dietary Toxicity

MRID	Citation Reference
132533	Fletcher, D. (1983) Report to ...: 8-Day Dietary LC50 Study with FMC 54800 Technical in Bobwhite Quail: BLAL No. 83 QC 34; FMC No. A83-965. (Unpublished study received Nov 3, 1983 under 279-EX-101; prepared by Bio-Life Assoc., Ltd., submitted by FMC Corp., Philadelphia, PA; CDL:251727-B)
132535	Fletcher, D. (1983) Report to ...: 8-Day Dietary LC50 Study with FMC 54800 Technical in Mallard Ducklings: BLAL No. 83 DC 34; FMC No. A83-966. (Unpublished study received Nov 3, 1983 under 279-EX-101; submitted by FMC Corp., Philadelphia, PA; CDL: 251727-D)

71-4 Avian Reproduction

MRID	Citation Reference
163097	Roberts, N.; Phillips, C.; Anderson, A.; et al. (1986) The Effects of Dietary Inclusion of FMC 54800 on Reproduction in the Bob- white Quail: Rept. No. FCC 57A/851423. Unpublished study pre- pared by Huntingdon Research Centre Ltd. 337 p.
163098	Roberts, N.; Phillips, C.; MacDonald, I. (1986) The Tissue Residues of FMC 54800 in the Bobwhite Quail following a Reproduction Study: Rept. No. FCC 57(b)/851567. Unpublished study prepared by Huntingdon Research Centre Ltd. 54 p.
163099	Roberts, N.; Phillips, C.; Anderson, A.; et al. (1986) The Effect of Dietary Inclusion of FMC 54800 on Reproduction in the Mallard Duck: Rept. No. FCC 58A/851430. Unpublished study prepared by Huntingdon Research Centre Ltd. 239 p.
163100	Roberts, N.; Phillips, C.; MacDonald, I. (1986) The Tissue Residues of FMC 54800 in the Mallard Duck following a Reproduction Study. Rept. No. FCC 58(b)/851316. Unpublished study prepared by Huntingdon Research Centre Ltd. 51 p.
40266301	Roberts, N.; Phillips, C.; Anderson, A.; et al (1987) The Effects of Dietary Inclusion of FMC 54800 on Reproduction in the Bob- white Quail (Revised): Lab Proj. ID FCC 57A/851423 and FCC 57(b) 851567. Unpublished study revised by Huntington Research Cent-

re, Ltd. 368 p.

72-1 Acute Toxicity to Freshwater Fish

MRID	Citation Reference
132536	LeBlanc, G.; Hoberg, J. (1983) Acute Toxicity of FMC-54800 Technical to Bluegill ...: Bionomics Report #BW-83-8-1445; FMC Study No. A83-987. (Unpublished study received Nov 3, 1983 under 279-EX-101; prepared by EG & G, Bionomics, submitted by FMC Corp., Philadelphia, PA; CDL:251727-F)
163156	Hoberg, J. (1983) Acute Toxicity of FMC-54800 Technical to Rainbow Trout (Salmo gairdneri): FMC Study No. A83-967. Unpublished study prepared by EG&G Bionomics. 21 p.

72-2 Acute Toxicity to Freshwater Invertebrates

MRID	Citation Reference
132537	LeBlanc, G.; Surprenant, D. (1983) Acute Toxicity of FMC 54800 Technical to Daphnia magna: Bionomics Report #BW-83-8-1444; FMC Study #A83-986. (Unpublished study received Nov 3, 1983 under 279-EX-101; prepared by EG & G, Bionomics, submitted by FMC Corp., Philadelphia, PA; CDL:251727-G)
163139	Hoberg, J.; Noll, M.; Henzel, S.; et al. (1985) [Carbon 14] - FMC-54800: D. magna: 21-Day Chronic (Flow-through): Study # 282-0484-6102-130. Unpublished raw data prepared by Springborn Bionomics, Inc. 97 p.

72-3 Acute Toxicity to Estuarine/Marine Organisms

MRID	Citation Reference
163101	Barrows, M. (1986) Acute Toxicity of FMC 54800 to Sheepshead Minnow (Cyprinodon variegatus): Final Report. Unpublished FMC study no. A85-1874 prepared by Battelle, New England Marine Research Lab. 304 p.
163102	Barrows, M. (1986) Acute Toxicity of FMC 54800 to Mysid Shrimp (Mysidopsis bahia): Final Report: Unpublished FMC Study No. A85- 1875 prepared by Battelle, New England Marine Res. Lab. 443 p.
163103	Ward, G. (1986) Acute Toxicity of FMC 54800 Tech. on Shell Growth of the Eastern Oyster (Crassostrea virginica): Revised Toxicity Rept.: ESE No. 85-322-0950-2130. Unpublished study prepared by Environmental Science and Engineering, Inc. 80 p.
40266501	Ward, G. (1987) Acute Effect of FMC 54800 Technical on New Shell Growth of the Eastern Oyster (Crassostrea virginica): Study No. A86-2203; Lab Project ID: 85-322-0960-2130. Unpublished study prepared by Environmental Science and Engineering, Inc.

37 p.

40383501	Ward, G. (1987) Acute Toxicity of FMC 54800 Technical to Embryos and Larvae of the Eastern Oyster (Crassostrea virginica): Laboratory Project ID ESE No. 87-318-0200-2130: FMC Corporation Study No. A87-2264. Unpublished study prepared by Environmental Science and Engineering, Inc. 71 p.

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

MRID	Citation Reference
40275401	Hoberg, J.; Nicholson, R.; Grandy, K.; et al. (1985) The Chronic Toxicity of [Carbon 14]-FMC-54800 Daphnia magna under Flow-through Conditions: Laboratory ID: 282-0484-6102-130. Unpublished study prepared by Springborn Bionomics, Inc. 35 p.
40569402	Drenner, R.; Hoagland, K.; Smith, J.; et al. (1988) Experimental Microcosm Study of the Effects of Sediment-Bound Bifenthrin on Gizzard Shad and Plankton: FMC Study No. A87-2414. Unpublished study prepared by Texas Christian University. 197 p.
41156501	Burgess, D. (1989) Chronic Toxicity of Carbon 14|-FMC 54800 to Daphnia magna under Flow-through Test Conditions: ABC Final Report No. 36980. Unpublished study prepared by Analytical Bio-Chemistry Laboratories, Inc. 244 p.
41640501	Ward, T.; Boeri, R. (1990) Life Cycle Toxicity of Bifenthrin FMC 54800 to the Mysid, Mysidopsis bahia: Lab Project Number: 9080/FMC. Unpublished study prepared by Resource Analysts, Inc., EnviroSystems Div. 49 p.
42338801	Boeri, R.; Ward, T. (1991) Life Cycle Toxicity of Bifenthrin (FMC 54800) to the Mysid, Mysidopsis bahia: Lab Project Number: A90-3318. Unpublished study prepared by Resource Analysts, Inc., EnviroSystem Div. 48 p.

72-5 Life cycle fish

MRID	Citation Reference
40791301	McAllister, W. (1988) Full Life Cycle Toxicity of Carbon 14|-FMC 54800 to Fathead Minnow (Pimephales promelas) in a Flow-through System: ABC Final Report No. 34843. Unpublished study prepared by Analytical Bio-Chemistry Laboratories, Inc. 1922 p.
41032101	Palmieri, M. (1989) FMC Response to Ecological Effects Branch Review Classification of the "Full Life Cycle Toxicity of Carbon14|-FMC 54800 to Fathead Minnow (Pimephales Promelas) in a Flow-through System". Unpublished study. 17 p.

72-7 Simulated or Actual Field Testing

MRID	Citation Reference

40981802 Akkari, K. (1985) Bifenthrin Pond Study - Analytical Methodology, Storage Stability, and Pre-Test 1 Data: Proj. ID SG 182-85-10; P-1217. Unpublished study prepared by FMC Corp. 101 p.

40981803 Alvarez, M. (1988) Bifenthrin (FMC 54800) Aquatic (Pond) Study - Drift Card Analysis: Proj. ID 182AF8760; P-1918. Unpublished study prepared by FMC Corp. 61 p.

40981805 Akkari, K. (1988) Bifenthrin Pond Study - Magnitude of the Residue of Bifenthrin in Pond Water: Proj. ID 182E55E01; P-1937. Unpublished study prepared by FMC Corp. 65 p.

40981807 Akkari, K. (1988) Bifenthrin Pond Study - Storage Stability of Bifenthrin in Field Fortified Samples: Proj. ID 182E55E01; P-1949. Unpublished study prepared by FMC Corp. 72 p.

40981808 Akkari, K. (1988) Bifenthrin Pond Study - Magnitude of the Residue of Bifenthrin in Pond Sediment: Proj. ID 182E55E01; P-1955. Unpublished study prepared by FMC Corp. 70 p.

40981812 Ridler, J. (1988) Bifenthrin Pond Study - Magnitude of The Residue of Bifenthrin in Biological Samples: Proj. ID 182E55E01; P-1976. Unpublished study prepared by FMC Corp. 85 p.

40981813 Ridler, J. (1988) Analytical Method for the Determination of Bifenthrin in Biological Samples: Project ID: 182E55E01. Unpublished study prepared by FMC Corp. 46 p.

40981814 Akkari, K. (1988) Bifenthrin Pond Study--Magnitude of the Residue of Bifenthrin in Sediment Bucket: Project ID: 182E55E01. Unpu- blished study prepared by FMC Corp. 60 p.

40981815 Liu, D. (1988) Bifenthrin (FMC 54800) Aquatic (Pond) Study--Aircraft Tank Mixture Analysis: Project ID: AF860038. Unpublished study prepared by FMC Corp. 19 p.

40981816 ui, D. (1988) Bifenthrin Pond Study: Analytical Method for the Determination of Bifenthrin in Aircraft Tank Mixture: Project ID: AF860038. Unpublished study prepared by FMC Corp. 9 p.

40981817 Akkari, K. (1988) Bifenthrin Pond Study--Magnitude of the Residue of Bifenthrin in Bioassay Water: Project ID: 182E55E01. Unpu- blished study prepared by FMC Corp. 97 p.

40981818 Akkari, K. (1988) Bifenthrin Pond Study--Magnitude of the Residue of Bifenthrin in Run-Off Water and Sediment: Project ID: 182E55E01. Unpublished study prepared by FMC Corp. 60 p.

40981819 Akkari, K. (1988) Bifenthrin Pond Study--Magnitude of the Residue of Bifenthrin in Field Soil: Project ID: 182E55E01; 182E55E763. Unpublished study prepared by FMC Corp. 72 p.

40981820 Akkari, K.; Javick, R. (1988) Bifenthrin Pond Study: Analytical Method for the Determination of Bifenthrin in Soil: Project IDs: 182AF8763; 182E55E01. Unpublished study prepared by FMC Corp. 46 p.

40981821 Giddings, J. (1988) FMC 54800 Aquatic Effects Field Study: Phase I Baseline Ecological Survey of Hagan's Pond Orrville, Alabama: Project ID:Report BW-86-7-2082; Study No. 282-6110-

	000. Unpublished study prepared by Springborn Life Sciences, Inc. 600 p.
40981822	Sherman, J. (1989) Bifenthrin Pond Study: Ecological Effects During Treatment and Post-Treatment Follow-up Studies of Hagan's Pond, Orville, Alabama: Project ID: A84-1285-02; FMC/54800. Unpu- blished study prepared by The Academy of Natural Sciences of Philadelphia. 1037 p.

81-1 Acute oral toxicity in rats

MRID	Citation Reference
132519	Norvell, M.; Freeman, C. (1983) Acute Oral Toxicity of FMC 54800 Technical in Rats: Study #A83-859. (Unpublished study received Nov 3, 1983 under 279-EX-101; submitted by FMC Corp., Philadel- phia, PA; CDL:251726-A)
132527	DeProspo, J.; Freeman, C. (1983) Acute Oral Toxicity of 54800, 2EC in Rats: Study #A83-1027. (Unpublished study received Nov 3, 1983 under 279-EX-101; submitted by FMC Corp., Philadelphia, PA; CDL:251726-I)
141187	Freeman, C. (1984) Acute Oral Toxicity of FMC 54800 10 WP in Rats: Study Number A84-1268. Unpublished study prepared by FMC Toxi- cology Laboratory. 54 p.
155285	Freeman, C. (1983) Acute Oral Toxicity of FMC 54800, 100 g/l EC in Rats: Study Number A83-1054. Unpublished study prepared by FMC Corp. 61 p.
40383605	Freeman, C. (1987) Acute Oral Toxicity Study in Rats: FMC 102032 Tech.: Study No. A87-2314. Unpublished study prepared by FMC Corp. 15 p.
40637602	Gabriel, D. (1987) 1.0% Talstar, Aerosol Concentrate,: Acute Oral Toxicity, Single Level - Rats: Proj. No. 87-5835A. Unpub- lished study prepared by Biosearch Inc. 9 p.
41150202	Gabriel, D. (1989) PT 1800DS, Aerosol Concentrate, Form #62-002: WRL Project #35-014: Acute Oral Toxicity, Single Level - Rats: Biosearch Project No. 89-6589A. Unpublished study prepared by Biosearch Inc. 8 p.
41413602	DeProspo, J. (1984) FMC 54800 80 G/L Flowable: Acute Oral Toxicity in Rats: Study No. A84-1247. Unpublished study prepared by FMC Toxicology Laboratory. 51 p.
41539002	Freeman, C. (1987) Acute Oral Toxicity Study in Rats: Capture 2 EC: Lab Project Number: A87-2410. Unpublished study prepared by FMC Toxicology Laboratory. 26 p.
41744301	Freeman, C. (1990) Acute Oral Toxicity Study in Rats: FMC 54800 1 EC: Lab Project Number: A90-3234. Unpublished study prepared by FMC Corp. 25 p.
41968506	Freeman, C. (1990) Acute Oral Toxicity Study in Rats: FMC 78161 Technical: Lab Project Number: A90-3173. Unpublished

study pre- pared by FMC Corp. 24 p.

41968513 Freeman, C. (1990) Acute Oral Toxicity Study in Rats: FMC 78162 Technical: Lab Project Number: A90-3172. Unpublished study pre- pared by FMC Corp. 24 p.

42023302 Freeman, C. (1991) Bifenthrin 5% Tablet Blend: Acute Oral Toxicity Study in Rats: Lab Project Number: A91-3412. Unpublished study prepared by FMC Corp. 27 p.

42094202 Freeman, C. (1990) Bifenthrin 0.2% Granules: Acute Oral Toxicity Study in Rats: Lab Project Number: A90-3157. Unpublished study prepared by FMC Corp. Toxicology Lab. 14 p.

42231802 Freeman, C. (1991) Acute Oral Toxicity Study in Rats: Lab Project Number: A91-3473. Unpublished study prepared by FMC Corp. 22 p.

42376102 Gabriel, D. (1992) Acute Oral Toxicity, LD50--Rats: PT 1810 Concentrate Less Propellant|: Lab Project Number: 91-7460A: 35-43. Unpublished study prepared by Biosearch Inc. 18 p.

43758101 Freeman, C. (1994) FMC 54800 0.3% ME: Acute Oral Toxicity Study in Rats: Revised Report: Lab Project Number: A90-3300. Unpublished study prepared by FMC Corp. 20 p.

43758402 Freeman, C. (1995) FMC 54800 13% MUP: Acute Oral Toxicity Study in Rats: Lab Project Numbers: A94-4124: ATM-0214: 307. Unpublished study prepared by FMC Corp. 44 p.

43780502 Freeman, C. (1995) FMC 54800 0.2G: Acute Oral Toxicity Study in Rats: Lab Project Number: A95/4138. Unpublished study prepared by FMC Corp. 38 p.

43782102 Freeman, C. (1995) FMC 54800 0.2% G (Fertilizer): Acute Oral Toxicity Study in Rats: Lab Project Numbers: A95-4148: ATM-0229. Unpublished study prepared by FMC Corp. 37 p.

44368201 Freeman, C. (1997) Acute Oral Toxicity Study in Rats: FMC 54800 2EC: Lab Project Number: A96-4546: 26. Unpublished study prepared by FMC Corp. 65 p.

44418201 Hoffman, G. (1996) Acute Oral Toxicity Study with PT-1820 Talstar T.R. in Rats: Lab Project Number: 95-1316. Unpublished study prepared by Huntingdon Life Sciences. 39 p.

44657101 Freeman, C. (1998) Acute Oral Toxicity Study in Rats: FMC 54800 IF: Lab Project Number: A97-4772. Unpublished study prepared by FMC Corporation. 43 p.

44869002 Freeman, C. (1998) FMC 54800 2.4% ME: Acute Oral Toxicity Study in Rats: Lab Project Number: A38-4879. Unpublished study prepared by FMC Corporation. 31 p.

45353602 Freeman, C.; Scubelek, S. (2001) Acute Oral Toxicity Study in Rats: Bifenthrin 1.15 G: Lab Project Number: A20000-5290. Unpublished study prepared by FMC Corporation. 21 p. {OPPTS 870.1100}

45364902 Allen, D. (1995) Semafor 20 FS: Acute Oral Toxicity Test in the Rat: Lab Project Number: 240/125: A2001-5348. Unpublished

MRID	Citation Reference
	study prepared by Safepharm Labs., Ltd. 34 p.
45654404	Tiwari, V. (2002) Acute Oral Toxicity Study of Bifenthrin Technical in Rats: Final Report: Lab Project Number: 3415. Unpublished study prepared by Jai Research Foundation. 33 p.
45730302	Kuhn, J. (2002) Acute Oral Toxicity Study in Rats: Bifenthrin/Spinosad 240 g/l SC: Final Report: Lab Project Number: A2002-5548: 7025-02. Unpublished study prepared by Stillmeadow, Inc. 22 p. {OPPTS 870.1100}
46425301	H.R. Mclane, Inc. (2004) Restricted Use Product: Control XX-X-X Turf Fertilizer with 0.069% Bifenthrin Insecticide. Project Number: EPA/CSI/BIFENR69/PC1. Unpublished study. 7 p.
46431902	Wright, J. (2004) Talstar 2% MB Insecticide Acute Toxicology Waiver Request. Project Number: 04/PRA/104. Unpublished study prepared by Product & Regulatory Associates, L.L.C. 14 p.
46778504	Wright, J. (2006) NUP Granule Insecticide: Acute Toxicity Waiver Request. Project Number: 06/PRA/119. Unpublished study prepared by Product & Regulatory Associates, LLC. 11 p.
46795910	Wright, J. (2006) NUP Fertilizer Insecticide: Acute Toxicology Waiver Request. Project Number: 06/PRA/121. Unpublished study prepared by Product & Regulatory Associates, LLC. 10 p.

123-2 Aquatic plant growth

MRID	Citation Reference
45020014	Hoagland, K.; Drenner, R.; Smith, J. et al. (1992) Freshwater Community Responses to Mixtures of Agricultural Pesticides: Effects of Atrazine and Bifenthrin. Environmental Toxicology and Chemistry 12:627-637.

850.1790 & 850.1735 Chironomid Sediment Toxicity Test

MRID	Citation Reference
46871501	Giddings, J. (2006) Overview of Sediment Toxicity Studies with Synthetic Pyrethroids. Project Number: 06723, 06273. Unpublished study prepared by Compliance Services International. 62 p.
46591502	Putt, A.E. (2005) Bifenthrin - Toxicity to Midge *(Chironomus tentans*) During a 10-Day Sediment Exposure. Laboratory Report ID 13656.6106. Unpublished study prepared by Springborn Smithers Laboratories and sponsored by the Pyrethroid Working Group.

850.1780 Amphipod Sediment Toxicity Test

MRID	Citation Reference
465915-01	Putt, A.E. (2005) Bifenthrin – Toxicity to Estuarine Amphipods

(*Leptocheirus plumulosus*) During a 28-Day Sediment Exposure. Laboratory Report ID 13656.6107. Unpublished study prepared by Springborn Smithers Laboratories and sponsored by the Pyrethroid Working Group.

141-1 Bee/Non-target Insect Toxicity

163096 FMC Corp. (1986) Hazard Evaluation: Wildlife & Aquatic Organisms: Bifenthrin Tech. Insecticide/Miticide. Unpublished compilation. 60 p.

163104 FMC Corp. (1986) Nontarget Insects [Toxicity of Residues on Foliage]: Bifenthrin Tech. Unpublished compilation. 45 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.